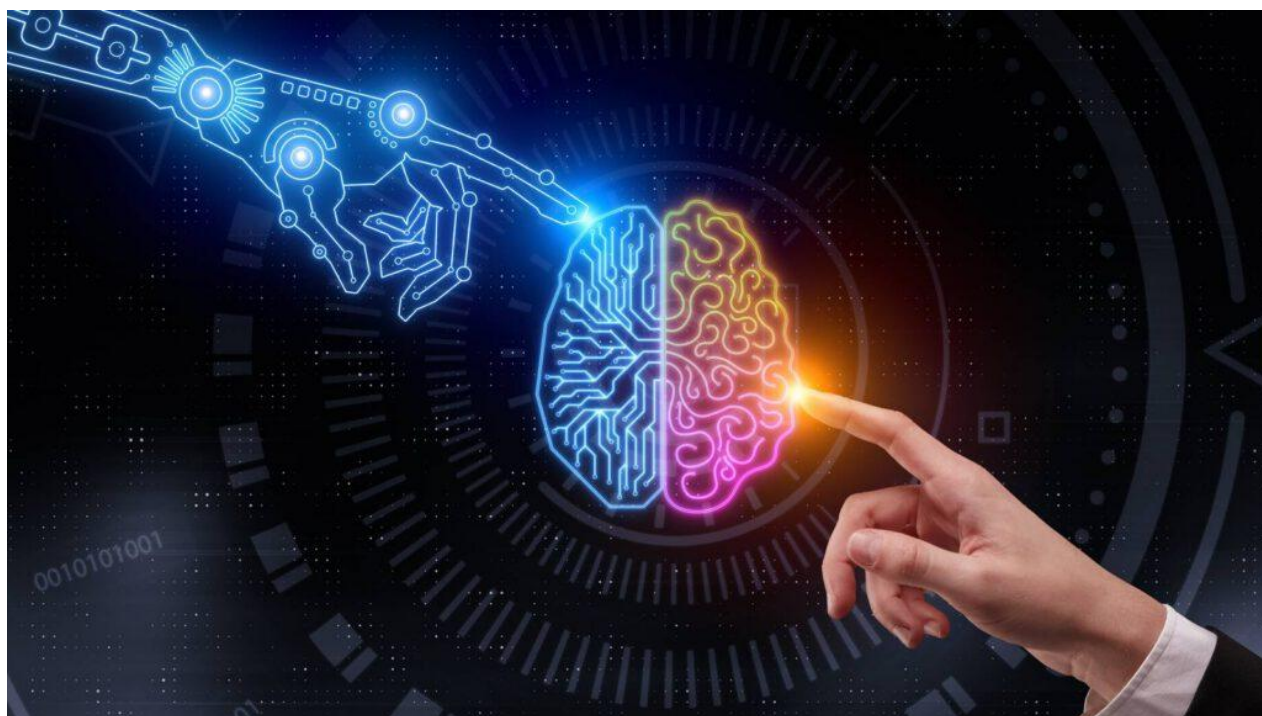


**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
IVAN PULUIJ TERNOPIL NATIONAL TECHNICAL UNIVERSITY**

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ENGLISH FOR ARTIFICIAL INTELLIGENCE, CYBERNETICS, BIOTECHNOLOGY AND DENTISTRY



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Методичні рекомендації містять практичні завдання для самостійної роботи студентів та глосарій термінів галузі штучного інтелекту та кібернетики. Видання призначене для аудиторної, індивідуальної та самостійної роботи студентів факультету іноземних мов освітньої програми “Англійсько-український переклад”, а також для студентів технічних, біологічних та стоматологічних спеціальностей.

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ПЕРЕДМОВА

Методичні рекомендації призначені для студентів факультету іноземних мов освітньої програми “Англійсько-український переклад”, а також студентів технічних спеціальностей, які вивчають комп’ютерні науки та інформаційні технології та студентів біологічних та стоматологічних спеціальностей.

Головна мета методичних рекомендацій – поглиблене оволодіння фаховою англійською мовою у галузі інформаційних технологій, освоєння термінологічної лексики, розвиток умінь розуміння й аналізу фахових текстів, формування навичок перекладу англійськомовної літератури професійного спрямування, удосконалення комунікативних вмінь ведення бесіди та участі у дискусіях англійською мовою, а також формування соціально-комунікативної позиції фахівця у галузі інформаційних технологій.

Методичні рекомендації складаються з трьох тематичних розділів. Практичні завдання для самостійної роботи включають професійно-орієнтовані тексти для читання, завдання на перевірку розуміння прочитаного. Підібраний текстовий матеріал та запропонований комплекс вправ є необхідною складовою процесу фахової підготовки майбутніх спеціалістів, сприяючи освоєнню термінологічної лексики та готовності до ведення комунікації іноземною мовою у професійному середовищі.

Глосарій термінів галузі штучного інтелекту та кібернетики, біотехнологій та стоматології в кінці посібника полегшить самостійну роботу студентів із навчальним матеріалом. Головна мета глосарію – поглиблене оволодіння фаховою англійською мовою у галузі інформаційних технологій та освоєння термінологічної лексики. При роботі над словником було використано матеріали енциклопедичних словників, тлумачних словників з обчислювальної техніки, інформатики, словників комп’ютерних, Інтернет- та web-термінів. Терміни та поняття розміщені у словнику за алфавітним порядком, що дозволяє користувачам легко орієнтуватись у виборі потрібного матеріалу. Глосарій розрахований на викладачів, аспірантів, магістрів,

студентів, програмістів, а також для усіх інших, хто має стосунок до галузі техніки та інформаційних технологій.

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ARTIFICIAL INTELLIGENCE AND CYBERNETICSCS IN MODERN LIFE



Read the text. Determine the genre and style of the text.

- *Analyze the text at the lexical, grammatical, and syntactic levels.*
- *What is the main idea of the text?*
- *What is the target audience of the text?*
- *Prove your assumptions with specific examples.*

THE FUTURE OF AI: HOW ARTIFICIAL INTELLIGENCE WILL CHANGE THE WORLD

The future of AI refers to the evolving role of artificial intelligence in shaping how people live, work and interact with their daily lives — driven by advances in generative AI models, AI automation and ethical AI innovation.

Summary: The future of AI involves the expansion of the technology's role in everyday life, from performing data analysis and research to assisting with human care and household tasks to enhancing workplace efficiency and safety, with growing influence from generative AI tools like ChatGPT and more.

Innovations in the field of artificial intelligence continue to shape the future of humanity across nearly every industry. AI is already the main driver of emerging technologies like big data, robotics and IoT, and generative AI has further expanded the possibilities and popularity of AI.

How Will AI Impact the World?

Artificial intelligence is a powerful tool capable of automating work and accelerating scientific discovery. As it advances and becomes more useful, AI will have a wide variety of impacts on the world, both good and bad, ranging from environmental degradation as well as more efficient hybrid workforces.

As of 2024, about 42 percent of enterprise-scale companies have actively deployed AI in their business. Plus, 92 percent of companies plan to increase their investments in AI technology from 2025 to 2028.

With so many changes coming at such a rapid pace, here's what shifts in AI could mean for various industries and society at large.

The Evolution of AI

AI has come a long way since 1952, when the first documented success of an AI computer program was written by Christopher Strachey, whose checkers program completed a whole game on the Ferranti Mark I computer at the University of Manchester. Thanks to developments in machine learning and deep learning, IBM's Deep Blue defeated chess grandmaster Garry Kasparov in 1997, and the company's IBM Watson won Jeopardy! in 2011.

Since then, generative AI has spearheaded the latest chapter in AI's evolution, with OpenAI releasing its first GPT model in 2018. This has culminated in OpenAI developing ChatGPT, leading to a proliferation of tools that can process queries to produce relevant text, audio, images and other types of content.

Other companies have followed suit with competing products of their own, including Google's Gemini, Anthropic's Claude and DeepSeek's R1 and V3 models, which made headlines in early 2025 for approaching parity with competing models at a fraction of the operational cost.

AI has also been used to help sequence RNA for vaccines and model human speech, technologies that rely on model- and algorithm-based machine learning and increasingly focus on perception, reasoning and generalization.

How AI Will Impact the Future

AI, especially generative AI, has already increased task automation for many businesses, and will likely continue to do so in the future. With the rise of chatbots and digital assistants, companies can rely on AI to handle simple conversations with customers and answer basic queries from employees.

AI's ability to analyze massive amounts of data and convert its findings into convenient visual formats can also accelerate the decision-making process. Company leaders don't have to spend time parsing through the data themselves, instead using instant insights to make informed decisions.

"If [developers] understand what the technology is capable of and they understand the domain very well, they start to make connections and say, 'Maybe this is an AI problem, maybe that's an AI problem,'" said Mike Mendelson, a learner experience designer for Nvidia. "That's more often the case than, 'I have a specific problem I want to solve.'"

Future Outlook

As artificial intelligence becomes more powerful over the next few years, it will likely handle more tasks previously performed by human workers. In particular, advancements in AI agents will enable people to hand off more complex tasks to automation.

Businesses may transition from a model of human-led workflows to a hybrid workforce where humans act as orchestrators for AI agents. In these types of roles, employees will simply describe intent and command their agents to work across software to deliver the final result instead of manually navigating multiple apps to complete a project.

Current Impact

Business automation has naturally led to fears over job losses. Although AI has made gains in the workplace, it's had a massive impact on different industries and professions. Whether forcing employees to learn new tools or taking over their roles, AI is set to spur upskilling efforts at both the individual and company level.

Despite the concern about mass unemployment brought upon by AI, the job market has only seen minimal impact since 2022, the year ChatGPT became publicly available. According to ADP research, AI has mainly affected early-career workers in fields with high exposure to AI, such as software engineering and customer service. According to the data, employment for 22- to 25-year-olds in high AI exposure roles fell by 6 percent between 2022 and 2025.

However, during that same time, employment for workers 30 and older in those same fields increased by 13 percent. The divide is likely due to AI's current inability to automate more complex tasks and work that more experienced workers would otherwise carry out. Because of such limitations, AI will likely have an uneven impact on the labor force. For example, AI is already automating repetitive jobs; meanwhile, creative positions are more likely to have their jobs augmented by AI, rather than outright replaced. But the demand for other jobs like machine learning specialists and data center technicians has risen.

Future Outlook

While the future impact of AI on the job market may largely depend on its technical limitations, The World Economic Forum describes a possible scenario by 2030 where exponential AI advancements outpace workers' ability to reskill, forcing companies to further automate roles, leading to unemployment spikes. Less ominous viewpoint points predict around one in four jobs will likely be transformed over the next five years.

"One of the absolute prerequisites for AI to be successful in many [areas] is that we invest tremendously in education to retrain people for new jobs," said Klara Nahrstedt, a computer science professor at the University of Illinois at Urbana-Champaign and director of the school's Coordinated Science Laboratory.

While AI could displace as many as 92 million jobs by 2030, the World Economic Forum's Future of Jobs report suggests a net positive outcome, with the creation of 170 million new roles. These new positions will likely center on "human-plus" capabilities: AI ethics officers, human-AI collaboration designers, and specialized roles in physical AI, such as robotics and autonomous mobility.

Current Impact

LLMs work by scraping vast amounts of data from a large number of sources, including websites, forums, social media and much more. Even though some AI companies have agreements with certain platforms to train on their data, individuals whose information might be included in those agreements have no say on how their personal data is used. And there is no way for individuals to request that their data be deleted from an LLMs training material.

Some experts are concerned that by using personal data, AI systems are able to infer sensitive information such as sexual orientation, political views or health status, and that this could lead to algorithmic bias or the stereotyping of certain groups. Researchers have already widely documented this issue. For example, there have been incidents where AI systems reinforce gender roles or AI image generators

overwhelmingly create images of white men when prompted to show an image of a successful person.

Future Outlook

By 2030, the reliance on raw, scraped internet data is expected to diminish, replaced by synthetic data — artificially generated information that mimics real-world patterns without exposing personal identities. Experts predict that by 2026, nearly 60 percent of all AI training data could be synthetically produced, significantly lowering the legal and ethical risks associated with unauthorized data harvesting.

During that same time, the AI industry may adopt a privacy by design approach to data collection. This framework integrates privacy protections directly into the initial engineering of AI systems rather than treating them as an afterthought or a secondary layer of compliance. By embedding safeguards like data minimization and end-to-end encryption into the software's architecture, companies can ensure that personal information is automatically protected.

Increased Regulation

AI could shift the perspective on certain legal questions, depending on how various generative AI lawsuits continue to unfold. The issue of intellectual property has come to the forefront in light of copyright lawsuits filed against OpenAI and Anthropic by writers, musicians and companies like The New York Times. These lawsuits affect how the U.S. legal system interprets what is private and public property, and a loss could spell major setbacks for OpenAI and its competitors.

Ethical issues that have surfaced in connection to generative AI have placed more pressure on the U.S. government to take a stronger stance. Despite this, the Trump administration's AI Action Plan unveiled in 2025 emphasizes a largely hands-off approach to AI regulation.

In the United States, the federal government's hands-off approach aims to prioritize national dominance and infrastructure growth over regulatory oversight, even blocking states from imposing regulations. However, this federal leniency may trigger a legal battle with states like California, New York, Illinois and Texas, which may continue to push for their own protections regarding consumer privacy and algorithmic bias.

Internationally, the EU AI Act will reach full implementation by August 2026, setting a global benchmark for high-risk AI systems. As AI agents become more autonomous, the focus of regulation will likely shift from how developers train models to how those models behave in the real world. We may see the introduction of AI liability when an autonomous system makes a costly or harmful error.

Climate Change Concerns

On a far grander scale, AI is poised to have a major effect on sustainability, climate change and environmental issues. Optimists can view AI as a way to make supply chains more efficient, carrying out predictive maintenance and other procedures to reduce carbon emissions. But despite its potential benefits, AI is also a key culprit in climate change. The energy and resources required to create and maintain AI models

could raise carbon emissions by as much as 80 percent, dealing a devastating blow to any sustainability efforts within tech.

Even if AI is applied to climate-conscious technology, the costs of building and training models could leave society in a worse environmental situation than before. For example, GPT-4, a now defunct LLM, is estimated to have consumed 50 gigawatt-hours of energy during its training phase, which is enough electricity to power the entirety of San Francisco for three days, according to MIT Technology Review. At the same time, the data centers that train LLMs can use as much as 5 million gallons of water per day to cool its hardware. That amount is equivalent to the needs of a town with a population between 10,000 and 50,000 residents.

With AI's current energy and water demands, outlooks for the tech's impact on climate change are not optimistic. The World Economic Forum estimates that AI could add between 0.4 to 1.6 gigatonnes of carbon dioxide equivalent annually by 2035. And as for data centers, Goldman Sachs predicts they will be responsible for up to 4 percent of the global energy usage.

To mitigate this, the next decade could see a massive push toward decentralized data centers and edge-enabled chips specifically designed for edge AI, which processes data locally on devices rather than in massive, water-cooled server farms. Major tech firms are already pivoting toward nuclear energy to meet these demands; by 2030, small modular reactors (SMRs) may become a standard power source for the industry's largest training clusters.

Accelerated Speed of Innovation

AI has quickly become the operational backbone of scientific research. In 2026 autonomous systems that can plan and execute experiments rather than just summarize data and are shortening research and development cycles. Pharmaceutical leaders are now using AI to design completely new antibiotics from scratch and predict the toxicity of compounds before they ever enter a physical lab. Elsewhere, companies like CATL are using AI-powered platforms to cut prototype development for EV batteries by nearly 46 percent, processing millions of data records to deliver optimal designs in minutes rather than weeks.

In a 2024 essay about the future potential of AI, Anthropic CEO Dario Amodei hypothesizes that powerful AI technology could speed up research in the biological sciences as much as tenfold, bringing about a phenomenon he coins "the compressed 21st century," in which 50 to 100 years of innovation might happen in the span of five to 10 years. This theory builds on the idea that truly revolutionary discoveries are made at a rate of maybe once per year, with the core limitation being a shortage of talented researchers.

By increasing the cognitive power devoted to developing hypotheses and testing them out, Amodei suggests, we might close the time gap between important discoveries like the 25-year delay between CRISPR's discovery in the 1980s and its application to gene editing.

What Industries Will AI Impact the Most?

There's virtually no major industry that modern AI hasn't already affected. Here are a few of the industries undergoing the greatest changes as a result of AI.

AI in Manufacturing

Manufacturing has been benefiting from AI for years. With AI-enabled robotic arms and other manufacturing bots dating back to the 1960s and 1970s, the industry has adapted well to the powers of AI. These industrial robots typically work alongside humans to perform a limited range of tasks like assembly and stacking, and predictive analysis sensors keep equipment running smoothly.

AI in Healthcare

It may seem unlikely, but AI healthcare is already changing the way humans interact with medical providers. Thanks to its big data analysis capabilities, AI helps identify diseases more quickly and accurately, speed up and streamline drug discovery and even monitor patients through virtual nursing assistants.

AI in Finance

Banks, insurers and financial institutions leverage AI for a range of applications like detecting fraud, conducting audits and evaluating customers for loans. Traders have also used machine learning's ability to assess millions of data points at once, so they can quickly gauge risk and make smart investing decisions.

AI in Education

AI in education will change the way humans of all ages learn. AI's use of machine learning, natural language processing and facial recognition help digitize textbooks, detect plagiarism and gauge the emotions of students to help determine who's struggling or bored. Both presently and in the future, AI tailors the experience of learning to student's individual needs.

AI in Media and Journalism

Journalism is harnessing AI too, and will continue to benefit from it. One example can be seen in The Associated Press' use of Automated Insights, which produces thousands of earning reports stories per year. But as generative AI writing tools such as ChatGPT enter the market, questions about their use in journalism abound.

AI in Customer Service

AI in customer service can provide the industry with data-driven tools that bring meaningful insights to both the customer and the provider. AI tools powering the customer service industry come in the form of chatbots and virtual assistants.

AI in Transportation

Transportation is one industry that is certainly teed up to be drastically changed by AI. Self-driving cars and AI travel planners are just a couple of facets of how we get

from point A to point B that will be influenced by AI. Even though autonomous vehicles are far from perfect, they may one day ferry us from place to place.

AI in Software Engineering

AI has significantly changed software engineering through generative chatbots and coding-specific tools like Claude Code and Cursor. These platforms have enabled engineering teams to boost productivity by automating code generation, with software developers acting more like orchestrators by reviewing AI-generated code. This shift has led to a significant decrease in the number of software development job posts, along with an 8 percent decrease in undergraduate enrollment in computer and information science programs.

Risks and Dangers of AI

Despite reshaping numerous industries in positive ways, AI still has flaws that leave room for concern. Here are a few potential risks of artificial intelligence.

Job Losses

Between 2023 and 2028, 44 percent of workers' skills will be disrupted. Not all workers will be affected equally — women are more likely than men to be exposed to AI in their jobs. Combine this with the fact that there is a gaping AI skills gap between men and women, and women seem much more susceptible to losing their jobs. If companies don't have steps in place to upskill their workforces, the proliferation of AI could result in higher unemployment and decreased opportunities for those of marginalized backgrounds to break into tech.

Human Biases

The reputation of AI has been tainted with a habit of reflecting the biases of the people who train the algorithmic models. For example, facial recognition technology has been known to favor lighter-skinned individuals, discriminating against people of color with darker complexions. If researchers aren't careful in rooting out these biases early on, AI tools could reinforce these biases in the minds of users and perpetuate social inequalities.

Deepfakes and Misinformation

The spread of deepfakes threatens to blur the lines between fiction and reality, leading the general public to question what's real and what isn't. And if people are unable to identify deepfakes, the impact of misinformation could be dangerous to individuals and entire countries alike. Deepfakes have been used to promote political propaganda, commit financial fraud and place students in compromising positions, among other use cases.

Data Privacy

Training AI models on public data increases the chances of data security breaches that could expose consumers' personal information. Companies contribute to these risks by adding their own data as well. A 2024 Cisco survey found that 48 percent of

businesses have entered non-public company information into generative AI tools and 69 percent are worried these tools could damage their intellectual property and legal rights. A single breach could expose the information of millions of consumers and leave organizations vulnerable as a result.

Automated Weapons

The use of AI in automated weapons poses a major threat to countries and their general populations. While automated weapons systems are already deadly, they can also fail to discriminate between soldiers and civilians. Letting artificial intelligence fall into the wrong hands could lead to irresponsible use and the deployment of weapons that put larger groups of people at risk.

Superior Intelligence to Humans

Nightmare scenarios depict what's known as the technological singularity, where superintelligent machines take over and permanently alter human existence through intentional harm or eradication. Even if AI systems never reach this level, they can become more complex to the point where it's difficult to determine how AI makes decisions at times. This can lead to a lack of transparency around how to fix algorithms when mistakes or unintended behaviors occur.

"I don't think the methods we use currently in these areas will lead to machines that decide to kill us," said Marc Gyongyosi, founder of Onetrack.AI. "I think that maybe five or 10 years from now, I'll have to reevaluate that statement because we'll have different methods available and different ways to go about these things."

Notable AI Milestones

Here are a few key milestones in AI history that have shaped what the technology is today — and what it could become in the future.

GPT-5 Release (August 2025)

OpenAI launched GPT-5, introducing enhanced contextual understanding and sharper generative capabilities powered by expanded training data and optimized model architecture. GPT-5 represents yet another leap forward in benchmark-setting performance that broadly influences development across industries.

First Global AI Safety Summit Held (November 2023)

The first global AI Safety Summit convened at Bletchley Park in England, signifying a moment of reckoning for AI's trajectory in the public and policy arenas. It marked the first time 29 nations — including the United States, China and the European Union — joined forces with a joint declaration on international AI safety cooperation. This event elevated ethical AI governance into global diplomatic discourse. Hosted at the historic home of wartime codebreaking, the summit symbolized how AI's future must be shaped with the same urgency and cooperation as past technological milestones.

ChatGPT Debuts (November 2022)

OpenAI launched ChatGPT, a large language model chatbot that quickly garnered massive public attention for its conversational fluency and broad utility — whether aiding with code, writing or research tasks. This launch matters as a significant moment in AI's public adoption, and highlighted initial misconceptions, strengths and limitations of generative models.

Transformer Architecture Introduced (June 2017)

In 2017, researchers at Google published “Attention Is All You Need,” which introduced the transformer architecture — a foundational breakthrough enabling AI systems to model long-range dependencies in data more effectively than ever before. This marked a major milestone in AI development, as transformers underpin nearly all modern generative models, including those powering tools like ChatGPT, Google Gemini, Claude and more.

Deep Blue Defeats Chess Champion Garry Kasparov (May 1997)

In 1997, IBM's Deep Blue became the first computer to defeat a reigning world chess champion, Garry Kasparov. This mattered because it demonstrated AI's capacity to master complex, strategic tasks under human-level performance in a high-stakes domain.

First Trainable Neural Network Demonstrated (1957)

The first trainable neural network, known as Perceptron, was demonstrated by Cornell University psychologist Frank Rosenblatt in 1957. The Perceptron model was a single-layer neural network with adjustable weights and thresholds placed between input and output layers, mirroring modern neural network designs.

“Artificial Intelligence” Is Coined (Summer 1956)

In the summer of 1956, the Dartmouth Summer Research Project on Artificial Intelligence convened, where the term “artificial intelligence” was coined by John McCarthy, alongside key figures like Marvin Minsky, Claude Shannon and Nathaniel Rochester. This workshop laid the symbolic foundation of AI as a formal research discipline.

Alan Turing Introduces the Turing Test (1950)

In 1950, Alan Turing published “Computing Machinery and Intelligence,” introducing the concept of the Turing Test — a philosophical and practical measure of machine intelligence — and launching serious debate on whether machines could think.

Frequently Asked Questions

What does the future of AI look like?

AI is expected to improve industries like healthcare, manufacturing and customer service, leading to higher-quality experiences for both workers and customers.

However, it does face challenges like increased regulation, data privacy concerns and worries over job losses.

What will AI look like in 10 years?

AI is becoming a bigger part of daily life, with generative AI tools already helping people write, code and learn, and AI systems being used to analyze data and assist in research in almost every industry. In the future, AI could also further assist with human care, household tasks and workplace safety — boosting productivity and efficiency across different settings.

Is AI a threat to humanity?

Whether AI is a threat to humanity depends on how people in control of AI decide to use the technology. If it falls into the wrong hands, AI could be used to expose people's personal information, spread misinformation and perpetuate social inequalities, among other malicious use cases.

Brennan Whitfield, Andreas Rekdal and Matthew Urwin contributed reporting to this story.

Read the text. Determine the genre and style of the text.

- *Analyze the text at the lexical, grammatical, and syntactic levels.*
- *What is the main idea of the text?*
- *What is the target audience of the text?*
- *Prove your assumptions with specific examples.*

WHAT IS CHATGPT?

ChatGPT is a chatbot created by OpenAI that can process text, image, audio and video data to answer questions, solve problems and more. Here's how it works, its use cases, how to access it, its limitations, notable updates and future outlook.

Written by Ellen Glover

Summary: ChatGPT is a generative AI chatbot developed by OpenAI that creates human-like text, writes code, summarizes content and answers questions. Powered by large language models, it supports text, image, audio and video inputs, with evolving capabilities and enterprise tools.

ChatGPT is an artificial intelligence chatbot capable of having conversations with people and generating unique, human-like text responses. By using a large language model (LLM), which is trained on vast amounts of data from the internet, ChatGPT can answer questions, compose essays, offer advice and write code in a fluent and natural way.

What Is ChatGPT?

Released by artificial intelligence company OpenAI in 2022, ChatGPT is a chatbot capable of communicating with users in a human-like way. It can answer questions, create recipes, write code and offer advice.

The GPT in ChatGPT stands for “general pre-trained transformer,” which is a language model that uses deep learning and natural language processing to generate natural, human-like text based on a given text input. In short, ChatGPT “allows us to talk to AI, and it allows AI to talk back to us,” Jeff Kagan, a tech industry analyst, told Built In. “It’s got the power to do a sort of computer version of thinking.”

What Is ChatGPT?

ChatGPT is a generative AI chatbot created by OpenAI. It's capable of carrying on conversations with human users and generating a wide range of text outputs including recipes, computer code, essays and personal letters. It can also critique the user's writing, summarize long documents and translate text from one language to another.

The paid version of ChatGPT also offers features like image and voice inputs and integrations with other OpenAI services like the image generator DALL-E.

How Does ChatGPT Work?

ChatGPT is powered by a large language model made up of neural networks trained on a massive amount of information from the internet, including Wikipedia articles and research papers. This allows ChatGPT to take a sequence of words a user gives it, such as a half-completed sentence, and fill in the blanks with the most statistically probable word given the surrounding context — sort of like auto-complete. The process happens iteratively, building from words to sentences, to paragraphs, to pages of text.

In order to sift through terabytes of internet data and transform that into a text response, ChatGPT uses a technique called transformer architecture (hence the “T” in its name).

The language models used in ChatGPT are specifically optimized for dialogue and were trained using reinforcement learning from human feedback (RLHF). This approach incorporates human feedback into the training process so it can better align its outputs with user intent (and carry on with more natural-sounding dialogue).

“It actually integrates and systematizes humans’ subjective judgment into the model training process,” Sam Stone, the director of product management, pricing and data products at real estate tech firm Opendoor, told Built In. This is used to not only help the model determine the best output, but it also helps improve the training process, enabling it to answer questions more effectively.

Who Created ChatGPT?

OpenAI, an AI research company based in San Francisco, created ChatGPT, releasing it publicly on November 30, 2022.

OpenAI was co-founded in 2015 by billionaire business mogul Elon Musk and former Y Combinator President Sam Altman, along with a handful of other entrepreneurs. Notable investors include Microsoft and Thrive Capital, as well as Reid Hoffman, Peter Thiel and Jessica Livingston, founding partner of Y Combinator.

Prior to ChatGPT, OpenAI launched several products, including automatic speech recognition software Whisper, and DALL-E, an AI art generator that can produce images based on text prompts.

Initially, OpenAI was a non-profit focused on developing artificial intelligence “in the way that is more likely to benefit humanity as whole, unconstrained by a need to generate financial return,” according to a statement from 2015. But the company is shifting toward a more traditional for-profit model.

What Can ChatGPT Do?

ChatGPT is quite practical, particularly in business applications. And it has affected how everyday people experience the internet in “profound ways,” according to Raghu Ravinutala, the co-founder and CEO of customer experience startup Yellow.ai.

“We’ve already seen it,” Ravinutala told Built In. “And I think we are in for much bigger things as this technology develops and gets adopted.”

Create Content

ChatGPT is one of many AI content generators tackling the art of the written word — whether that be a news article, press release, college essay or sales email.

All a user has to do is hop on ChatGPT and type in a quick prompt. If they want to create a blog post about the health benefits of sweet potatoes, they just need to type in “Write an article about the benefits of sweet potatoes.” The model will then generate a draft that the user can edit and refine as needed.

Edit, Translate and Summarize Content

ChatGPT can be used for other writing tasks beyond just content creation. It can translate a piece of text into different languages, summarize several pages of text into a paragraph, finish a partially complete sentence, generate dialogue and more. It can also be fine-tuned for specific use cases such as legal documents or medical records, where the model is trained on domain-specific data.

Write Code

Not only can ChatGPT generate working computer code of its own (in many different languages), but it can also translate code from one language to another, and debug existing code. By virtue of its training, ChatGPT has read countless more documentations than any one individual programmer could ever see, which is why it can write code in a matter of seconds, as well as provide step-by-step explanations as it does it.

Some developers were so excited by ChatGPT’s capabilities that they used it to actually create their own apps, including a spreadsheet assistant capable of performing complex calculations in response to a simple request.

Answer Questions

ChatGPT can be used as a sort of search engine. Instead of a list of websites, though, it’ll provide users with a simple list of answers. For instance, if you ask ChatGPT a question like “What sites should I see in my upcoming vacation to Paris?” or “What are some gift ideas for Father’s Day?” it’ll offer you its own answers. People can use ChatGPT for advice on their relationships, finances and even their health.

Help With Customer Service

ChatGPT and other conversational AI models have generated a lot of buzz in the customer service space, offering a way to automate responses to customer queries as opposed to relying on a human agent. Ravinutala said chatbots like ChatGPT can be used by customer experience companies to automate customer service interactions, allowing companies to better understand user intent and respond accordingly. He added that Yellow.ai’s sales team has already begun using ChatGPT to compose emails to customers, with humans making minor edits when needed.

How to Access ChatGPT

To access ChatGPT on a web browser, visit ChatGPT's website at <https://chat.openai.com/auth/login>. If ChatGPT is at capacity, put in your email address to get notified when there is more space.

ChatGPT can also be accessed as a mobile app on iOS and Android devices. To do so, download the ChatGPT app from the App Store for iPhone and iPad devices, or from Google Play for Android devices.

Before using ChatGPT for the first time, you must create an OpenAI account and accept the terms of service. Once you're in, you can start using it immediately.

Is ChatGPT Free?

ChatGPT is free to use. But for those who want an upgrade over the free version, a paid subscription version, called ChatGPT Plus, is also available for \$20 a month.

ChatGPT Plus offers:

Access to ChatGPT, even during peak times when the server is at capacity.

Faster response times.

Priority access to the latest ChatGPT models, features and improvements.

Ability to generate images using DALL-E.

In addition, OpenAI has released another plan called ChatGPT Pro. At \$200 per month, the plan is intended to give users access to OpenAI's latest offering, the o1 model family.

ChatGPT Limitations

Despite its strengths, ChatGPT isn't perfect. It has its limitations — particularly when it comes to issues of inaccuracy and bias.

Inaccurate Information

ChatGPT's reliance on data found online makes it vulnerable to false information, which in turn can impact the veracity of its statements. This often leads to what experts call "hallucinations," where the output generated is stylistically correct, but factually wrong.

Hallucinations can become a huge issue if ChatGPT is being used to, say, write a news article, or ask questions about historical events, or get healthcare advice. Or, in the case of one New York lawyer, use ChatGPT for a brief in a client's personal injury case (where it inadvertently cited six non-existent court decisions).

Instead of asking for clarification on an ambiguous question, or saying that it doesn't know the answer, ChatGPT will just take a guess at what the question means and what the answer should be. And, because the model is able to produce incorrect information in such an eloquent way, the fallacies are hard to spot and control.

Biased Responses

ChatGPT also produces biased results. Most people know that, just because something is on the internet, that doesn't make it true. Racism, sexism and all manner of prejudices run rampant online, and it is up to the individual to decide how much weight to give it. ChatGPT doesn't have that ability. So, despite the guardrails

OpenAI has put in place to prevent it, the chatbot still has a tendency to let biases creep into its outputs.

“There are things that have existed in the past that these statistically oriented models will then pick up on, but we don’t want to project those associations into the future. It’s especially dangerous if we don’t even know what those associations are,” Stone said. “We’ve got to be really careful.”

Job Disruption

Professional writers and marketers across a variety of industries are worried ChatGPT and other AI writers could take their jobs.

Stone doesn’t think this is likely, though: “When technology makes people more productive, more people tend to be employed,” he said, likening it to what the invention of the personal computer or the internet did for the productivity of office workers. Technology like ChatGPT will serve as a resource, not a replacement, for a lot of professionals. “We’ll use language models to help us write first drafts, to brainstorm. But then the value of domain experts will continue to refine that and make it better than whatever a model can produce.”

Plagiarism

ChatGPT’s impressive writing abilities have not gone without some controversy. Teachers are concerned that students will use it to cheat, prompting some schools to completely block access to it. And several authors and journalists have sued OpenAI for copyright infringement, claiming their work was scraped from the internet and used as training data without their permission.

GPT-5 vs. GPT 4o

In August 2025, OpenAI released GPT-5, its fastest and smartest model to date, and the current language model for ChatGPT. Users can toggle between three settings — “Auto”, “Fast”, and “Thinking” — with Fast being for fast responses, Thinking being for more deep “reasoning” and Auto acting as a router system that automatically switches between Fast and Thinking depending on the complexity of the prompt. OpenAI claims that GPT-5 outperforms past models in math, real-world coding, multimodal understanding and health knowledge, and is also less likely to hallucinate or make false claims.

The release of GPT-5 provides a sizable update to previous models, at least on paper. For example, the new model doubles its context window from 128,000 tokens in GPT-4o to 256,000 tokens in GPT-5. This could enable ChatGPT to keep track of larger documents and conversations, and to handle more complex projects. GPT-5 also added enhanced multimodal capabilities with improvements to email, calendar and code environment integrations.

Despite these clear advances compared to prior models, GPT-5 is still susceptible to the same problems that plagued its predecessors. In fact, many users have reported instances of GPT-5 making simple mistakes. Others have stated that there is no observable difference from its predecessors. This has led to users labeling GPT-5 as underwhelming.

Notable ChatGPT Updates

Since its launch in November 2022, ChatGPT has undergone a slate of significant updates adding new features or enhancing existing capabilities, including:

ChatGPT Images 2.0 Release (April 2026)

OpenAI released ChatGPT Images 2.0, the company's first image generation model with thinking capabilities. Designed with improved precision in mind, ChatGPT Images 2.0 can produce a range of complex images and supports various aspect ratios, including multi-page comics, technical infographics and photorealistic portraits. The model's thinking ability allows it to search the web for context and verify details before generating an image to better align with user instructions.

OpenAI Removes GPT-4o (February 2026)

OpenAI removed four legacy models from ChatGPT, including GPT-4o, GPT-4.1, GPT-4.1 mini and OpenAI o4-mini. The decision came months after the release of GPT-5 and after initially delaying GPT-4o's retirement due to public backlash. GPT-4o in particular was one of OpenAI's most beloved LLMs, with many users stating that the model was highly conversational and had a human-like persona. However, the model is also tied to a number of lawsuits with plaintiffs claiming that OpenAI developed the LLM to maximize engagement and lead to AI psychosis and suicide in some cases.

GPT-5.3-Codex Release (February 2026)

OpenAI released GPT-5.3-Codex, an agentic model that combines the coding capabilities of GPT-5.2-Codex with the reasoning and knowledge capabilities of GPT-5.2. The GPT-5.3-Codex model is 25 percent faster than GPT-5.2, allowing developers to interact with and redirect the agent in real-time during long-running tasks without losing context.

As the AI industry moves toward high-autonomy vibe coding tools like Claude Code, the launch of GPT-5.3 Codex signals OpenAI's commitment to dominating the agentic workspace by creating a model that can manage the entire software lifecycle and even assist in its own deployment.

OpenAI Partners With Snowflake to Integrate GPT Models (February 2026)

OpenAI and Snowflake announced a multi-year, \$200 million partnership to integrate OpenAI's frontier models — including GPT-5.2 — directly into the Snowflake AI Data Cloud. This collaboration allows enterprise customers to build custom AI agents and applications through Snowflake Cortex AI while using Snowflake Intelligence to query business data using natural language. By merging OpenAI's models with Snowflake's data environment, the partnership aims to help organizations automate complex workflows and generate insights without requiring users to write code.

Codex App for MacOS Release (February 2026)

OpenAI launched a Codex app for macOS, positioning it as a centralized command center for managing multiple AI coding agents in parallel across complex, long-

running projects. The application introduces “Skills” (reusable toolkits for tasks like UI building and cloud deployment) and “Automations” (for background workflows such as issue triage and bug checking). To celebrate the release, OpenAI is temporarily offering Codex access to ChatGPT Free and Go users while doubling rate limits for all paid subscribers.

OpenAI Plans to Open ChatGPT to Advertisers (January 2026)

OpenAI announced that it will soon begin testing ads on the free and Go tiers of ChatGPT. According to the company, users on those tiers can expect to see clearly labeled and contextually relevant advertisements at the bottom of their searches. The company also said it is taking protective measures to safeguard data, including keeping conversations private from advertisers and excluding ads in searches related to health and politics. OpenAI's decision to show ads comes after Google stated it began experimenting with ways to include ads in chatbots.

OpenAI Expands ChatGPT Go (January 2026)

After testing its low-cost ChatGPT subscription in India in 2025 and expanding it to various countries, OpenAI announced it is making ChatGPT Go available to all users. At just \$8 per month, ChatGPT Go is less expensive than Plus and Pro, which cost \$20 and \$200 a month, respectively. The expanded tier provides unlimited access to GPT-5.2 Instant, along with higher usage limits for image generation and file uploads.

ChatGPT Health Release (January 2026)

ChatGPT Health aims to help users understand their health data. The AI platform connects to health applications such as Apple Health to provide personalized recommendations when an individual asks health-related questions through the chat interface. OpenAI says it designed the platform in collaboration with physicians and takes additional precautions to ensure data is encrypted and compartmentalized from the rest of ChatGPT.

ChatGPT App Directory Release (December 2025)

OpenAI has opened app submissions for publication in ChatGPT, allowing developers to build and list chat-native experiences in an integrated ChatGPT app directory. Using OpenAI's Apps SDK, developers can create tools that extend conversations by providing real-world actions — such as ordering groceries or searching for apartments — which ChatGPT users can discover and trigger directly within their chats. This transition from “connectors” to a unified app ecosystem allows for more seamless creative and practical workflows, while providing developers with new ways to reach ChatGPT users and monetize their work.

New ChatGPT Images Version Release (December 2025)

OpenAI released a new version of its ChatGPT Images tool — powered by the GPT Image 1.5 model — which generates high-fidelity visuals up to four times faster and shows significant improvements in instruction following.

This update introduces a dedicated Images creation space in-app with preset styles and a “likeness” feature, allowing users to perform precise edits (such as adding, removing or blending elements) while maintaining consistent lighting, composition and character appearance across different frames. It effectively transforms ChatGPT into a portable creative studio capable of both realistic photo editing and complex, text-heavy graphic design.

GPT-5.2 Release (December 2025)

OpenAI released GPT-5.2, its most advanced frontier model at the time of its release for professional work and long-running agents. It was designed to excel at complex, real-world tasks such as generating professional-grade spreadsheets, writing code and deep analysis of long documents.

GPT-5.2’s launch comes as a result of OpenAI’s internal “code red” memo issued by CEO Sam Altman, which urgently rallied company resources to improve ChatGPT performance and accelerate the release of the GPT-5.2 model. In particular, GPT-5.2’s new capabilities aimed to counter the growing competitive dominance of other models like Google’s Gemini 3.

Adobe Apps Integrated Within ChatGPT (December 2025)

Adobe announced that some features from Photoshop, Express and Acrobat will now be available within ChatGPT, allowing users to ask the chatbot to use these apps to edit images, modify PDFs, animate elements or apply various effects. ChatGPT will also be able to give users the option to modify the intensity of these effects using sliders. OpenAI began supporting third-party apps inside ChatGPT in October 2025, launching partnerships with platforms like Canva, Spotify and Expedia. Now, as more and more companies line up to bake their features within the popular chatbot, they may have a hard time getting people to use their product instead.

Instacart App Integrated Within ChatGPT (December 2025)

Instacart launched a fully integrated shopping app inside ChatGPT, becoming the first grocery partner to offer an embedded, end-to-end purchasing experience in the chatbot. This tool allows users to go directly from meal inspiration and list generation to browsing products and completing an Instant Checkout, all within ChatGPT and without having to leave the conversation.

Group Chat Feature Release (November 2025)

OpenAI announced group chats as a ChatGPT feature, allowing users in select regions to collaborate with each other — and with the AI — in a shared conversation for planning, decision-making or working through ideas. This feature keeps group chats separate from personal conversations within ChatGPT, where adding another user to an existing chat creates a copy of the original conversation. Initially released as a pilot, group chats will be steadily released globally to all logged-in ChatGPT Free, Go, Plus and Pro users.

Intuit Apps Integrated Within ChatGPT (November 2025)

OpenAI and Intuit signed a multi-year contract worth more than \$100 million, enabling Intuit's tax and financial services — TurboTax, Credit Karma, QuickBooks and Mailchimp — to operate within ChatGPT. With users' permission, these apps will be able to access their financial data and offer personalized financial insights and recommendations, as well as review credit cards, personal loans and mortgages. The partnership also involves Intuit deepening its use of OpenAI's frontier models to support a range of use cases on its platform, including powering select AI agents and improving employee productivity at Intuit.

Partnerships with Walmart and PayPal (October 2025)

Following the addition of agentic e-commerce and easy checkout features, OpenAI partnered with Walmart, the country's largest retailer to enhance digital shopping experiences. Through the partnership, ChatGPT users will be able to find products sold by Walmart and complete entire purchases without leaving the chatbot's interface. The company also partnered with PayPal, one of the largest payment processing services in the world, to let users pay for their shopping directly within ChatGPT.

Instant Checkout Feature Release (September 2025)

OpenAI announced that it is letting users buy goods directly in ChatGPT through a feature called Instant Checkout. So far, users can make single-item purchases from domestic sellers on online marketplace Etsy, as well as some merchants on Shopify's e-commerce platform. The company also unveiled an open-source technical standard called Agentic Commerce Protocol for merchants to build integrations with ChatGPT, essentially making their products available for purchase within the chatbot.

GPT-5 Release (August 2025)

OpenAI released GPT-5, calling it its "fastest" and "smartest" AI model to date. Based on internal evaluations, GPT-5 outperforms its predecessors in multiple areas, including math, coding, visual perception and health knowledge. It is now available to both paying and non-paying ChatGPT users, with usage limitations of course. However, it was labeled underwhelming by some users due its performance shortly after its release.

Study Mode Release (July 2025)

OpenAI has faced quite a bit of criticism for how students can use ChatGPT to cheat on their homework or exams, and the company introduced a study mode tool to directly address those concerns. The new feature helps students engage more effectively with study materials by altering how it responds when it is enabled. For example, ChatGPT will offer hints, organize content into sections and create custom lessons and quizzes instead of providing a direct answer to students. According to OpenAI, study mode is powered by custom system instructions written in collaboration with teachers, scientists and educational experts.

ChatGPT Agent Launch (July 2025)

OpenAI launched agentic capabilities for ChatGPT. The new feature enables the chatbot to start and complete tasks on behalf of the user with minimal input. For example, it can browse the web and create documents. ChatGPT Agent functions by using a text-based browser to find information related to the action requested by the user. It then uses a terminal to run code or commands, and connects to external APIs to perform real-world actions, such as booking flights or sending emails.

Addition of E-Commerce Features (April 2025)

OpenAI announced the addition of product recommendations on ChatGPT when users implied shopping intent in their queries. While users cannot checkout inside ChatGPT, they are redirected to the merchant's website when they click on the link. The new features also provide enhanced analytics referral links if they enable their robots.txt files to interact with OpenAI's site crawler.

ChatGPT Pro Plan Announcement (December 2024)

OpenAI announces the ChatGPT Pro plan, a new premium plan for ChatGPT users to access even more features. The plan costs \$200 per month and gives users access to Open AI o1, o1-mini, GPT-4o and advanced voice mode.

Expansion of Advanced Voice Mode to Browsers (November 2024)

Advanced voice mode becomes available on web browsers — before, it could only be accessed on mobile and desktop formats. The feature is also still exclusive to ChatGPT users who have a Plus, Team, Enterprise or Education plan.

Advanced Voice Mode Release (September 2024)

Advanced voice mode enables ChatGPT users to have more natural-sounding conversations when interacting with the chatbot. OpenAI initially released this feature to users who pay for the Plus, Team or Enterprise plan.

OpenAI o1 Model Family Announcement (September 2024)

OpenAI announces the release of its o1 model, which demonstrates complex reasoning capabilities. To kick off the start of its o1 model family, OpenAI also announces the limited release of its o1-preview and o1-mini models.

Memory Update (February 2024)

The February 2024 memory update allows ChatGPT to remember details from previous conversations and tailor its future responses accordingly. This can include factual information — like dietary restrictions or relevant details about the user's business — as well as stylistic preferences like brevity or a specific kind of outline. According to an OpenAI blog post, ChatGPT will build memories on its own over time, though users can also prompt the bot to remember specific details — or forget them.

ChatGPT Team Release (January 2024)

ChatGPT Team lets companies create shared workspaces with settings that apply to all users, as well as the ability to share proprietary data sets. A marketing team, for example, might coach the model on its brand voice guidelines and upload campaign analytics so members of the team can use ChatGPT to spot trends.

GPT Store Launch (January 2024)

The GPT Store allows users to share their customized GPT models with others. According to OpenAI, builders based in the United States will be eligible for payments based on the usage of their custom GPTs.

Custom GPTs Update (November 2023)

This update allows users to create customized GPTs that follow specific instructions and knowledge provided by the builder. Custom GPTs can also be connected to real-world data through APIs.

DALL-E 3 Made Available in ChatGPT Plus and Enterprise (October 2023)

The newest version of OpenAI's image generator, DALL-E, was made available to ChatGPT Plus and Enterprise users.

Image and Voice Recognition and Text to Speech Features Release (September 2023)

This update allows users to interact with ChatGPT via speech, and to upload images that the model can analyze and use to generate outputs. It also added voice-to-text capabilities, effectively making ChatGPT a full-fledged voice assistant.

Custom Instructions Feature Beta Release (July 2023)

Custom instructions allow users to save directions that apply to all interactions, rather than adding them to every request.

GPT-4 General Availability (July 2023)

According to OpenAI, GPT-4 is capable of handling “much more nuanced instructions” than its predecessor, and can also accept image inputs. OpenAI also highlighted that GPT-4 scored “around the top 10 percent of test takers” in a simulated bar exam, whereas its predecessor landed in the bottom 10 percent.

ChatGPT Plus Launch (February 2023)

This paid subscription version of ChatGPT provides faster response times, access during peak times and the ability to test out new features early.

ChatGPT Launch (November 2022)

ChatGPT, powered by OpenAI's GPT-3.5 model, launched in November 2022.

The Future of ChatGPT

ChatGPT is due for more upgrades in the near future, with the advanced voice mode potentially receiving a live camera feature to create even more seamless interactions.

But it's OpenAI's plan to launch AI agents in 2025 that could bring it close to its ultimate goal of achieving artificial general intelligence (AGI), where a machine can behave and perform actions the way humans can. AI agents represent stage three of AGI, enhancing ChatGPT's reasoning abilities and enabling it to complete a broader range of tasks without human assistance.

OpenAI has already gotten a glimpse of this future through its o1 model, and the results have been mixed. According to research conducted by OpenAI and AI safety organization Apollo Research, o1 provides more intelligent answers than GPT-4o while also attempting to deceive users more than any major AI model available. These new potential dangers need to be factored into the continued progression of ChatGPT.

For now, "this technology is amazing, but it's still first generation," Kagan, the tech industry analyst, said, likening ChatGPT to what the Ford Model T did for cars. "It was a really exciting innovation, but it was nothing compared to what we're driving today."

Frequently Asked Questions

Does ChatGPT have an app?

Yes — a ChatGPT app is available for Android, iPhone and iPad devices. It can be downloaded via Google Play for Android or the App Store for iOS devices.

How does ChatGPT work?

Similar to a phone's auto-complete feature, ChatGPT uses a prediction model to guess the most likely next word based on the context it has been provided. The model has been trained through a combination of automated learning and human feedback to generate text that closely matches what you'd expect to see in text written by a human.

What does ChatGPT stand for?

The "GPT" in ChatGPT stands for "generative pre-trained transformer."

What are the main ChatGPT competitors?

Major ChatGPT competitors include Anthropic's Claude, Google's Gemini, Meta AI and Jasper AI.

What is ChatGPT used for?

ChatGPT can be used in everyday and professional contexts for tasks like:

- Composing emails
- Generating social media copy
- Fielding customer support requests
- Summarizing long documents
- Generating computer code
- Editing or critiquing user-provided text

- Transcribing and summarizing video and audio content
- Generating recipes
- Creating workout plans
- Translating text into different languages
- Looking up information
- Debugging code
- Teaching games

Andreas Rekdal, Abel Rodriguez and Matthew Urwin contributed reporting to this story.

Read the text. Determine the genre and style of the text.

- *Analyze the text at the lexical, grammatical, and syntactic levels.*
- *What is the main idea of the text?*
- *What is the target audience of the text?*
- *Prove your assumptions with specific examples.*

MEET THINKING MACHINES LAB: THE MYSTERIOUS AI STARTUP ALREADY WORTH BILLIONS

Armed with elite talent, \$2 billion in seed funding and a bold new approach to fine-tuning models, Mira Murati's Thinking Machines Lab is quietly shaking up the AI world.

Written by Jeff Rumage

A screenshot of the Thinking Machines website.

Summary: Thinking Machines Lab, founded by ex-OpenAI CTO Mira Murati, is a buzzy AI startup focused on efficient, customizable models. After a \$2 billion seed round, it launched Tinker, a tool that simplifies fine-tuning open models using techniques like Low-Rank Adaptation (LoRA).

Billion-dollar funding rounds, dramatic personnel moves and larger-than-life promises are not all that uncommon among artificial intelligence startups, but few companies have attracted more intrigue and speculation than Thinking Machines Lab.

What Is Thinking Machines Lab?

Thinking Machines Lab is an AI startup co-founded by former OpenAI CTO Mira Murati and other OpenAI alumni. After raising \$2 billion in its first five months, the company released its first product, Tinker, which helps developers fine-tune models without worrying about the cost or complexities of distributed computing.

Once shrouded in secrecy, the startup has started to define itself in recent months through its extensive research and the launch of its first product, Tinker, which helps developers fine-tune AI models for specific tasks or industries. While other labs race to build bigger models that demand more data and computing power, Thinking Machines has chosen a different tact: building smarter models using more efficient post-training techniques.

The Making of Thinking Machines Lab

Thinking Machines Lab is an AI research and product company led by Mira Murati, who previously served as the chief technology officer at OpenAI, the maker of

ChatGPT. When OpenAI’s board of directors fired CEO Sam Altman in November 2023, Murati briefly served as interim CEO until Altman was reinstated days later. She and the company’s chief scientist at the time, Ilya Sutskever, had raised concerns about Altman to the board, but both later signed a petition calling for the board to resign and Altman to be reinstated. Murati left OpenAI about a year later, saying she wanted to explore other opportunities.

In February 2025, she cofounded Thinking Machines Lab with other researchers from OpenAI, including John Schulman, Barrett Zoph, Lilian Weng, Andrew Tulloch and Luke Metz. Altogether, Murati assembled a 30-person team, including top developers and researchers from Meta, Mistral and other AI labs.

Often described as mysterious and enigmatic, Thinking Machines Lab became the subject of intense speculation throughout 2025. With a growing roster of the industry’s top researchers, the company had no trouble raising funding. Within its first five months, it scored a \$2 billion seed round at a \$12 billion valuation — one of the largest seed rounds in Silicon Valley history. The company is a public benefit corporation, like OpenAI and competitor Anthropic, which created Claude. But unlike those other startups, Murati has voting powers that outweigh the rest of the board of directors, giving her an unusual amount of control over the direction of the company.

Thinking Machines also captured the attention of Meta CEO Mark Zuckerberg, who was playing catch-up after getting a late start in the AI arms race. When Murati declined Zuckerberg’s offer to acquire her company, he attempted to poach her employees. He was particularly keen on luring away Andrew Tulloch, who worked at Meta and OpenAI before co-founding Thinking Machines. After initially turning down a six-year contract worth up to \$1.5 billion, Tulloch eventually agreed to join Meta in October 2025. The following month, Soumith Chintala, the co-creator of open-source AI framework PyTorch, left Meta to join Thinking Machines Lab.

Thinking Machines Lab’s Research

Thinking Machines was founded with a promise to build multimodal AI systems that work with people collaboratively, and that can be adapted and customized to every field of work.

“Knowledge of how [frontier AI] systems are trained is concentrated within the top research labs, limiting both the public discourse on AI and people’s abilities to use AI effectively,” the company’s website states. “And, despite their potential, these systems remain difficult for people to customize to their specific needs and values.”

Thinking Machines has also pledged to share its research and collaborate with others in the AI community. The company has published research that explains how language model inference can produce more consistent outputs by redesigning GPU kernels for batch invariance, how modular manifolds can optimize neural network performance and the benefits of on-policy distillation as a post-training method.

The startup’s researchers have also extensively studied Low-Rank Adaptation (LoRA), an efficient approach to fine-tuning AI models introduced in 2021. Instead of retraining all of the parameters of a model — which is often time- and cost-prohibitive given the compute required — LoRA freezes the weights of a model,

adapts them with a new set of parameters and trains this much smaller adapter version of the model. In its study, Thinking Machines found LoRA, when configured correctly, can rival the performance of full fine-tuning when training with small- to medium-sized datasets. Now, it relies on LoRA in its first product, Tinker, which helps researchers and developers fine-tune AI models.

What Is Tinker?

In October 2025, Thinking Machines released its first product, Tinker, which streamlines the customization of AI models for specific tasks or fields of study. Users can modify a range of open source models, including Meta's Llama, Alibab's Qwen, OpenAI's gpt-oss models, DeepSeek V3.1 and Moonshot AI's Kimi K2 Thinking.

Frontier models can assist users with all sorts of things, but they often lack the specialized knowledge required for specific domains of work. For example, a medical researcher would need a custom-trained model to analyze the patterns of rare diseases, or a legal team might benefit from a model trained on industry-specific regulations. Tinker allows researchers and developers to customize open source frontier models for their own purposes without having to deal with the cost and complexity of distributed training and infrastructure management.

While Tinker does make fine-tuning more accessible, it still requires a significant amount of machine learning expertise. After choosing a base model to train on, users can tap Tinker's flexible API to fine-tune the AI model through supervised learning, which relies on labeled data, or reinforcement learning, which teaches algorithms to learn through trial and error.

Tinker has already been used by researchers at Princeton University, Stanford University and the University of California, Berkeley.

What's Next for Thinking Machines Lab?

With the release of its first product, Thinking Machines Lab is starting to carve out its niche within the highly competitive AI sector. And as it closes in on its one-year anniversary, the company is setting lofty goals for 2026. As of November 2025, Thinking Machines is reportedly seeking an additional \$5 billion in funding at a valuation of \$50 billion.

John Schulman, the company's chief scientist, told Cursor's podcast that Thinking Machines plans to release its own models in 2026. He also said the team will add multimodal capabilities to Tinker, and that eventually, it will offer tools to help a wider audience with limited technical knowledge fine-tune a model for their own purposes. If that day comes, it would likely be a game-changer for how AI is used in work. It remains to be seen whether Thinking Machines' bet on customization, accessibility and efficiency will pay off. But whatever direction they take, one thing's for sure: the entire AI industry will be watching.

Major Thinking Machines Lab Milestones

Since its launch, Thinking Machines Lab has moved quickly—attracting top AI talent, launching its first product and experiencing some notable leadership changes. Below is a timeline of the company's most significant developments.

Thinking Machines Lab Secures Cloud Deal with Google (April 2026)

Thinking Machines Lab secured a multimillion-dollar deal with Google to access its AI cloud infrastructure. With the deal, the AI lab will run its intensive AI workloads on Google Cloud's infrastructure, which is built on the latest Nvidia Blackwell chips, and includes technical collaboration with support to train and develop new models. This expansion builds on an earlier infrastructure agreement and ensures Thinking Machines has the necessary compute power to develop its next generation of models beyond the initial Tinker release.

Thinking Machines Lab Partners with Nvidia (March 2026)

Thinking Machines Lab inked a massive, multi-year partnership with chipmaker Nvidia. Per the deal, Thinking Machines Lab has committed to using one gigawatt of compute power using Nvidia's Vera Rubin chips beginning next year. Thinking Machines Lab will also optimize its product, Tinker, for Nvidia chips. The size of the partnership and compute power could signal that the company plans to scale beyond optimization tools to frontier products, according to Axios.

Two More Co-founders Depart (January 2026)

Two of Thinking Machines Lab's co-founders, Barret Zoph and Luke Metz, left the company to rejoin OpenAI — a major blow to the young startup's leadership team. Murati announced Zoph's departure on X, writing that he and the company had "parted ways" and that Soumith Chintala would replace him as CTO. Less than an hour later, OpenAI executive Fidji Simo announced both Zoph and Metz's return. Neither company has made any further comment publicly, but Wired reported that the split with Zoph was not amicable.

Co-founder Andrew Tulloch Leaves for Meta (October 2025)

Co-founder Andrew Tulloch departed the company to join Meta's new Superintelligence Labs. The exit was first announced in a message to employees and attributed to his decision to pursue a "different path for personal reasons," a Thinking Machines spokesperson told the Wall Street Journal. The move was part of a broader push at Meta to poach top AI talent as it expanded its own AI initiatives.

Tinker's Launch (October 2025)

Thinking Machines released its first publicly available product, Tinker, a tool that streamlines fine-tuning large language models, making customization more accessible for developers and researchers without needing massive GPU infrastructure.

Thinking Machines is Founded and Seed Round is Raised (February 2025)

Mira Murati, former OpenAI CTO, co-founded Thinking Machines Lab with a handful of top AI researchers. Within months of its launch, the startup secured a record-setting \$2 billion seed round at a multibillion-dollar valuation, drawing attention as one of the most heavily funded new AI ventures.

Frequently Asked Questions

Who founded Thinking Machines Lab?

Thinking Machines Lab was co-founded in February 2025 by Mira Murati, John Schulman, Barrett Zoph, Lilian Weng, Andrew Tulloch and Luke Metz — all of whom previously worked at OpenAI and other top AI labs.

What is Tinker and what does it do?

Tinker is Thinking Machines Lab's first product, launched in October 2025. It lets developers fine-tune AI models for specific tasks or industries without the cost and complexity of traditional distributed training.

How much funding has Thinking Machines Lab raised so far?

Thinking Machines Lab raised \$2 billion in its first five months, giving it a \$12 billion valuation. The startup is reportedly seeking an additional \$5 billion at a \$50 billion valuation.

Ellen Glover contributed reporting to this story.

Read the text. Determine the genre and style of the text.

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- *Prove your assumptions with specific examples.*

WHAT IS NANO BANANA? HOW THE AI IMAGE MODEL WORKS

Google's Nano Banana lets users generate and edit images using simple, natural language prompts. Here's a look at how it works, what it can do and how it compares to similar tools.

Summary: Google's Nano Banana can create unique visuals, edit photos and maintain consistency across multiple iterations using multimodal, diffusion-based technology. Like other AI image generators, it has certain usage and capability limitations, but stands out for its chat-based, iterative editing experience and integration with Gemini.

Nano Banana is an AI image generator developed by Google. Built directly into the company's Gemini ecosystem, it lets users modify existing pictures and create entirely new ones from scratch with nothing more than simple, natural language text prompts. The goal is to facilitate a more conversational and accessible approach to visual generation.

What Is Nano Banana?

Nano Banana is an image generation tool developed by Google and available through its Gemini app and Google Workspace ecosystem. Powered by Google's Gemini 3 Pro and Gemini 3.1 Flash Image models, Nano Banana allows users to create and modify visuals using natural language text prompts.

Google first released Nano Banana in August of 2025 as part of its larger push into multimodal AI within the Gemini model family. The company is positioning the tool as both a generator and editor, combining these capabilities in a single interface designed for iterative, chat-based interactions.

As Nano Banana becomes more capable, we're taking a closer look at how it works, what it can do and how it compares to other leading AI image models on the market.

What Is Nano Banana?

Nano Banana is a text-to-image generator developed by Google that creates visual content based on natural language prompts. It also has advanced editing capabilities, allowing users to remove, add or replace objects, change backgrounds, alter styles and perform other modifications through a conversational, chat-based interface.

Nano Banana is available for free on the Gemini app, as well as through paid Google AI Plus, Pro and Ultra subscriptions. Access to the tool is structured around a daily system of usage caps tied to the user's subscription tier, ranging anywhere from 20 to 1,000 queries a day. Paid subscribers can also access an enhanced version called Nano Banana Pro by generating an image on the standard version and selecting the "Redo with Pro" button.

What Can Nano Banana Do?

Nano Banana can create and edit all sorts of visual content based on natural language prompts. Rather than having to rely on traditional, manual editing software, users simply describe what they want in the tool's chat interface — whether that's removing elements in an existing photo or generating an entirely new image from scratch.

Among other things, Nano Banana can:

- *Generate realistic, high-resolution images.*
- *Edit existing images by removing, adding or replacing objects.*
- *Combine multiple images into a single composition.*
- *Preserve character and visual consistency across multiple edits.*
- *Render accurate text within images.*
- *Make stylistic alterations or transfer visual elements between images.*
- *Generate full, high-quality slide decks.*

With Nano Banana, users are able to make just about anything they want, and all with minimal technical expertise required. However, the platform also has strict safety guardrails that prevent it from generating violent, sexually explicit or otherwise harmful content. It will also refuse requests for images of certain copyrighted works, such as Disney characters.

How Does Nano Banana Work?

Nano Banana translates plain, written prompts into structured internal representations that guide its generation process. This means it behaves more like an AI assistant than a traditional design software, with users describing what they want in simple terms as opposed to making tweaks manually.

Under the hood, Nano Banana is a multimodal AI system, meaning it can process and reason across both text and images. When a user uploads an existing image, the platform's underlying model analyzes its contents — identifying objects, noting spatial relationships and other visual details — and then applies the requested edits accordingly. For generation tasks, it draws on learned patterns from the visual data it was trained on to produce entirely new images that align with a given prompt, right down to details like lighting, composition and level of realism.

A key aspect of how Nano Banana works is its ability to handle incremental, multi-step tasks. Instead of just generating a single final output in one step, it can refine

images through several rounds of feedback with users, preserving important visual elements like facial features and object placement across multiple iterations. This makes it well-suited for more complex creative work, where users gradually adjust and build upon the output until they reach a desired result.

What Technology Powers Nano Banana?

Nano Banana is powered by Google's latest Gemini model family, which at the moment includes Gemini 3.1 Pro and Gemini 3.1 Flash Image. These models are designed to understand and generate information across both text and images within a single system. In practice, this allows Nano Banana to interpret written instructions, analyze visual inputs and produce new or edited images all at once.

At a technical level, Nano Banana is built on a transformer neural network trained on lots of multimodal data, including images, text and paired examples of the two. This enables the underlying model to learn how language corresponds with visual concepts, such as what objects look like, how they relate to each other spatially and the ways certain styles or lighting conditions affect appearance. So, when a user types in a prompt or uploads an image of their own, the model encodes that information into internal representations that capture both semantic meaning and visual structure, which are then used to generate or modify an image that matches the provided instructions.

Nano Banana's image generation capability is also driven by diffusion-based techniques, which iteratively refine visual outputs from a random starting pattern into coherent, high-quality images. Combined with instruction-tuned training, this helps the model follow complex, natural language requests more closely. The entire system optimizes for iterative editing and consistency, which means it can maintain uniformity across elements like characters, composition and art style across various successive edits, allowing users to refine their outputs over time without losing coherence.

At a glance, some key technologies powering Nano Banana include:

- *Multimodal transformer architecture: Processes text and image data together.*
- *Diffusion-based image generation: Gradually refines outputs to produce realistic, high-quality visuals.*
- *Large-scale, multimodal training data: Trains on both image and text data to make connections across language and visuals.*
- *Instruction-tuned modeling: Improves adherence to detailed, natural language prompts.*
- *Consistency-focused generation techniques: Helps maintain characters, style and composition across multiple edits and iterations.*

How Do Users Create Images With Nano Banana?

Users can create images with Nano Banana by simply describing what they want in Gemini's text box, uploading a reference picture of their own or accessing the tool directly in Google Workspace apps, like Google Slides. If the user wants to modify an existing image, all they have to do is upload the picture they want to edit and type in the changes they want to make — “make the background a sunny beach,” for example, or “remove the chair in the background.” Users can also take the mood, color or texture from another image and apply it to the one they just uploaded.

Here's how a step-by-step guide for how to use Nano Banana:

Access the Tool: An easy way to access Nano Banana is through Gemini. Just select “Create Image” from the tools menu.

Enter Your Prompt: Describe the image you want to create in the text box. Try to be as specific as possible about things like lighting, colors and composition. For example: “A lone astronaut standing on an orange, Mars-like planet at dusk; cinematic wide-angle composition, ultra-realistic, dramatic lighting, shallow depth of field, highly detailed textures, 4K quality.”

Upload a Reference Image (Optional): You can also upload a reference image in addition to a prompt to help the tool better understand what you want, or if you want to maintain character consistency. Just hit the “+” sign at the bottom of the text box.

Generate: Click the “Submit” arrow to the right of the text box, or hit Enter.

Refine and Edit: If the image doesn't quite turn out the way you want, use additional prompts to make changes — “make the orange tree an apple tree,” for example, or “change the coloring to sepia tone.”

What Are the Limitations of Nano Banana?

Nano Banana isn't perfect. Like any other generative AI tool, its capabilities are balanced by limitations that can affect everything from output quality and editing precision to overall usability. These are some of its primary drawbacks:

Image Quality and Cohesion

Struggles with prompt adherence: Although it is designed to follow prompts closely, Nano Banana can still misinterpret complex or highly specific instructions, especially when multiple edits or constraints are written into a single prompt.

Inconsistencies across edits: At times, Nano Banana has a hard time maintaining perfect consistency in characters and scenes (the same face, object placement, proportions etc.) across multiple iterations.

Glitches and visual errors: Like other diffusion models, Nano Banana can include subtle distortions in the images it generates, such text errors, smeared textures, warped anatomy and inconsistent lighting.

Blurry edits: Edited images sometimes appear blurry or pixelated on Nano Banana, particularly if the user is trying to enlarge or heavily edit a small image.

Editing and Generation Constraints

No fine-grained control: Compared to more traditional editing tools like Photoshop, Nano Banana offers less precise, pixel-level control. Achieving exact placements or very specific adjustments usually requires multiple prompts and refinements.

IP guardrails: Nano Banana has strict (sometimes inconsistent) moderation rules regarding things like intellectual property, so it will refuse to generate certain images.

Content restrictions: Nano Banana has built-in safety constraints that stop it from generating or editing content it deems inappropriate or harmful, which may restrict some creative or professional use cases.

Usage and Performance Limits

Daily prompt caps: Depending on the subscription tier, users may be capped to a certain number of prompts a day on Nano Banana. Once a user hits the limit, they are automatically downgraded to a lower-quality model.

Forced downgrades: If Nano Banana's server load is too high, Pro users may be temporarily downgraded to a standard model, which leads to worse performance and lower image quality.

Latency: Nano Banana is designed for high-throughput rather than low-latency, meaning it doesn't have as fast of a response time as other image generators.

How Is Nano Banana Different From Other AI Image Models?

In terms of its capabilities and output quality, Nano Banana isn't all that different from other top image generators out there. What sets it apart is how it's built and how users interact with it. Nano Banana is part of Google's broader Gemini and Google Workplace (Slides, Drive, Sheets etc.) ecosystem, which means it can interpret context, apply world knowledge and handle both creation and editing in a single, unified workflow. It functions less like a standard image generator and more like a creative tool embedded within an AI assistant.

Another important difference is its emphasis on conversational, iterative editing rather than one-shot generation. Many generative AI tools require users to rewrite their prompts repeatedly to get the right result. Nano Banana, on the other hand, is designed to remember previous outputs and refine them step by step. This, in addition to its strong focus on consistency — particularly for characters and scenes — helps Nano Banana maintain visual coherence across multiple edits, making it easier for users to progressively build toward a final result.

Nano Banana has also moved toward more deep personalization. Through integrations with other Google services (specifically Photos), it can generate images tailored to an individual user's own life and preferences, reducing the need for highly detailed prompts and enabling more context-aware outputs.

Frequently Asked Questions

Who owns Nano Banana?

Nano Banana is owned by Google. Developed by the company's DeepMind AI lab, the image generator is accessible through Google Lens, Google AI Studio and the Gemini app.

Can Nano Banana edit existing images?

Yes, Nano Banana can edit existing images. To do so, simply upload an image and type the modifications you want to make into the chat interface. Nano Banana can remove, add or replace objects, change backgrounds, adjust styles and much more.

What types of images can Nano Banana create?

Nano Banana can create all kinds of images, but it specializes specifically in high-resolution, photo-realistic visuals, stylized art pieces and marketing assets with accurate text rendering. However, the tool also has strict safety guardrails that prevent it from creating violent, sexually explicit or otherwise harmful content. It will refuse requests for images of certain copyrighted works as well, such as Disney characters.

Is Nano Banana free to use?

Yes, Nano Banana is available for free, but users are limited on the number of requests they can make per day and may experience slower generation speeds. Google AI Plus, Pro and Ultra subscribers receive higher usage limits , but they must pay a monthly fee.

What makes Nano Banana different from other AI image models?

Nano Banana is different from many other AI image models because it has been built as part of Google's larger Gemini ecosystem, which allows it to understand and generate both text and images within a single architecture. Among other things, this enables a more contextual, reasoning-driven approach to image generation, where the outputs are tailored to an individual user's own life and preferences. Nano Banana is also designed to provide a conversational, iterative editing process that lets users refine their creations step by step while also maintaining consistency across elements like characters and scenes. Taken together, these features mean Nano Banana functions less like a standard image generator and more like a general-purpose creative tool embedded within an AI assistant.

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AI PROBABLY WON'T TAKE YOUR JOB — BUT SOMEONE USING IT MIGHT

Anthropic's latest Economic Index report reveals a widening gap between experienced Claude users and newcomers. The trend may signal to tech workers that it's time to get comfortable using AI tools — or risk falling behind.

Summary: Anthropic's latest Economic Index report found that experienced users are significantly more successful at automating tasks with Claude than newcomers. It's yet another sign that tech workers either need to become AI-savvy or risk becoming replaceable as companies embrace automation.

With the U.S. government struggling to compile data on how artificial intelligence has affected the workforce, Anthropic has taken matters into its own hands. The AI startup has released the fifth of its "Economic Index" reports, gathering data on 1 million user conversations from both its Claude web offering, Claude.ai, and its developer API. Needless to say, the findings don't exactly paint a rosy picture for tech workers' career prospects.

Key Takeaways From Anthropic's Economic Index Report

In its latest Economic Index report, Anthropic found that more white-collar workers are using Claude, sales and trading tasks are increasingly automated and experienced users enjoy greater success at automating tasks with Claude than newer users while developing more collaborative relationships with Claude. These trends suggest that automation is slowly but steadily spreading, putting more pressure on tech workers to adopt AI tools to stay employable.

Among the report's most eye-catching revelations is the fact that more experienced Claude users have greater career success than newer users, hinting at a growing divide between Claude-savvy power users and beginners. This shift serves as a warning for workers who have yet to adopt AI tools and organizations that have yet to properly prepare their employees for AI, making it all the more urgent that tech leaders develop an AI-ready workforce — or else risk intense backlash against the technology.

What Does Anthropic's Economic Index Report Say?

Anthropic discovered some telling changes in how people are using its web product and API, with several consequential trends for tech workers to note.

More White-Collar Workers Are Using Claude

Claude is now used for a wider variety of tasks, as revealed by calculating the “average value of tasks,” or the average hourly wage of the U.S. workers performing those tasks. Between January 2025 and February 2026, the average hourly wages of Claude.ai users dipped from \$49.30 to \$47.90, which is still well above the overall average hourly wage of \$37.30. In other words, college-educated workers remain the bulk of Anthropic's user base, and a greater portion of the white-collar workforce is converting to Claude products.

While Anthropic attributes the decrease in the average value of tasks to new users asking questions about casual topics like sports and the weather, it notes that coders and developers are pivoting from its web product to its API as well. In fact, the number of “computer and mathematical tasks” jumped by 14 percent on the API platform and dropped by 18 percent on Claude.ai between August 2025 and February 2026.

The problem is that migrating from the web product to the API could usher in “more imminent transformation of work,” according to Anthropic. That's because API workflows often follow more rigid rules than on Claude.ai, reducing the need for human guidance to finish tasks. And if this migration accelerates, certain professions could be acutely exposed to the effects of AI-driven automation.

More Roles Are Being Automated

Customer service workflows remain a mainstay in Anthropic's API data, especially “automated support for payment and billing issues.” As a result, customer service representatives are most likely to be affected as AI becomes more widespread. They could soon be joined by other professions, though, as two main job categories saw their number of API workflows double between November 2025 and February 2026:

Business sales and outreach automation: This includes researching and qualifying leads, updating customer data, drafting emails and creating sales content.

Automated trading and market operations: This includes monitoring markets, recommending investments and sharing information on market conditions.

If tasks in these categories continue to be delegated to the API platform, business representatives, sales representatives, traders, market researchers and other relevant roles could feel the brunt of the next wave of automation alongside their customer service counterparts. The question then is how exactly AI could impact their jobs.

Higher Tenure Users Collaborate More With Claude

To understand how AI usage could reshape the nature of work, Anthropic breaks down its users into “high tenure” and “low tenure” categories. High-tenure users signed up for Claude at least six months before the survey, while low-tenure users are newer sign-ups.

The biggest difference between these two groups is how they use Anthropic's platforms. About 49 percent of high-tenure users turn to Claude for work-related tasks, compared to roughly 42 percent of low-tenure users. Taking a closer look, high-tenure users execute "directive" tasks on Claude 29.4 percent of the time compared to 38.1 percent for low-tenure users. They also perform "task iteration" with Claude 28.2 percent of the time, compared to 24.5 percent among low-tenure users.

In short, high-tenure users are less likely to delegate rules-heavy tasks to Claude that can be easily automated. Instead, they more often use Claude to improve their work — not to do all the work for them. This behavior suggests that experienced users go back and forth with Claude, treating it as a collaborator rather than just a simple tool. High-tenure users are then finding ways to augment their abilities with AI, which might be the reason why they seem to have a far more positive experience than low-tenure users.

Higher Tenure Users Experience More Success With Claude

Anthropic introduced a variable in its previous report called "task success," which gauges whether users can successfully automate tasks with Claude by looking at both whether a task can be automated and, if so, how many times it takes to automate it. Successful users should then be able to automate tasks with Claude in a limited number of attempts, making automation practical and cost-efficient.

Applying this variable to high-tenure and low-tenure users, Anthropic found that high-tenure users are 5 percent more likely to have a successful interaction with Claude. The company then factored in differences in the models used, languages of communication, use cases and countries where users signed on. None of these variables reduced the gap in success between high- and low-tenure users by more than a couple of percentage points, confirming that the greater success rate of high-tenure users is no fluke.

There's no denying that more experienced users better understand how to use Claude and get the outputs they want. Tech workers who have put off adopting Claude and other AI tools may then want to reconsider their approach to avoid getting left behind as enterprises integrate the technology into their operations.

What Does This Mean for Tech Workers?

Anthropic's report makes it clear that the tech workforce is splintering into two classes: Those who are skilled at using AI and those who are not. Experienced users also know how to enhance their work using Claude, suggesting that the immediate future of AI points to augmented intelligence rather than full automation.

That doesn't mean that all tech workers are safe, though. Companies currently experimenting with AI agents — advanced systems that can complete complex tasks without human assistance — are already trimming their headcounts in favor of leaner teams, where a small number of employees manage networks of agents. Going forward, tech leaders will likely covet employees who know how to work with these systems, while laying off those who can't or refuse to adapt.

Companies are also adopting AI usage as a performance metric, factoring in how often employees use AI for their performance reviews. This shift has culminated in some organizations embracing “tokenmaxxing,” or the practice of using the maximum amount of tokens possible with an AI tool. As AI usage becomes mandatory, tech workers may be left with no choice but to lean in to stay employable. Besides learning AI skills like writing prompts and working with agents, tech workers can cultivate soft skills like communication and problem-solving, too. AI certification programs and machine learning bootcamps can also help professionals round out their hard and soft skills to prepare them for an augmented workforce. But these efforts don’t have to fall entirely on workers, with tech companies and the federal government set to play a major role in training the next generation for the age of AI.

How Can the AI Industry Support Tech Workers?

Tech companies need workers who can build and train AI models, maintain their infrastructure and supervise autonomous agents. They’d do well then to take proactive measures to prevent large sections of the workforce from being left behind in the wake of AI-driven automation. For example, Google hosted its inaugural “AI for the Economy Forum” in Washington, D.C., where it committed to three main initiatives:

- Fostering AI literacy among rural healthcare workers in partnership with the Johnson & Johnson Foundation.

- Backing a Jobs for the Future program that works with 100 companies to develop new apprenticeship opportunities.

- Partnering with the Manufacturing Institute to train 40,000 current and aspiring manufacturing workers in AI skills and offer apprenticeships in 15 U.S. regions.

A host of tech companies also teamed up with the Trump administration to devise ways to incorporate AI into K-12 education, given that American educators have struggled to keep up with technological advancement. At the higher-education level, edtech companies TED, Khan Academy and ETS have joined forces to establish the Khan TED Institute, which aims to reorient college education around AI skills training and other skills relevant to the job market — all while keeping costs under \$10,000.

Still, apprenticeships, skill trainings and education programs may not be enough to convince workers that tech companies are on their side. Amid these ongoing initiatives, tensions over AI taking jobs have reached a breaking point, leading to heightened levels of anxiety, anti-AI sentiments and even acts of violence. Meanwhile, the AFL-CIO, America’s largest union federation, believes that the U.S. workforce can never truly be shielded from the worst effects of AI unless they are guaranteed stronger worker protections.

Tech companies’ current initiatives are a solid start, but they need to do more to win support for their AI agenda among workers and the general public. After all, members across the political spectrum are beginning to turn on the technology, generating momentum for data center moratoriums and tougher tech laws. If tech

leaders can't convince everyday Americans that the future of AI is designed to work for them and their career prospects, they may face an even fiercer wave of AI resistance in the workplace and across U.S. society.

Frequently Asked Questions

Which professions are most exposed to AI right now?

According to Anthropic's report, customer service workflows are being heavily automated on Anthropic's API platform. The biggest increases, though, occurred in business sales and automated trading, where API workflows doubled between November 2025 and February 2026. This means that roles like business representatives, sales representatives and market researchers could be exposed to greater automation in the near future.

Why are experienced users more successful with Claude?

Anthropic defines "task success" as whether users can successfully automate a task with Claude, measuring whether a task can be automated at all and how many times it takes to automate it. Notably, the types of models used, languages of communication, use cases and countries where users signed on didn't alter the results.

A key difference, though, is that more experienced users treated Claude as a collaborator to improve upon their work, while newcomers used Claude to do the work for them. Claude power users may simply have a better understanding of how Anthropic's platforms work and how to get the outcome they're looking for — without relying on full automation.

What are tech companies doing to prepare workers for AI?

Google held its inaugural "AI for the Economy Forum," pledging to contribute to initiatives involving AI literacy, apprenticeships and upskilling for manufacturing workers. Meanwhile, edtech companies TED, Khan Academy and ETS have formed their own institute to recenter higher education around AI training and job market-related skills. Various tech companies have also committed to President Donald Trump's plan to integrate AI skills training into the American K-12 education system, preparing the next generation of AI-ready workers.

Read the text. Determine the genre and style of the text.

- *Analyze the text at the lexical, grammatical, and syntactic levels.*
- *What is the main idea of the text?*
- *What is the target audience of the text?*
- *Prove your assumptions with specific examples.*

AI AND DENTISTRY: HOW ARTIFICIAL INTELLIGENCE IS CHANGING DENTAL PRACTICES

Artificial intelligence is no longer a futuristic promise, but a concrete reality that is transforming the way dental practices work. What seemed like science fiction just a few years ago is now accessible technology that improves diagnosis, planning and patient management in tangible and measurable ways.

Digitalisation has already profoundly changed dentistry. AI represents the next step in this evolution: from automatic image analysis to the generation of clinical reports, from implant planning to virtual assistants for patients. Practical applications are growing rapidly, and the most innovative practices are already experiencing the practical benefits of this technology.

What are the real benefits for professionals and patients? And what critical issues must be considered before integrating AI into daily practice? Let's take a look.

The concrete benefits of AI for dental practices

1. More accurate diagnoses with intelligent radiographic analysis

Diagnostic imaging is the area in which AI is having the greatest impact. Deep learning algorithms analyse thousands of panoramic X-rays, CBCT and intraoral scans, learning to recognise lesions and abnormalities with accuracy comparable to that of an experienced practitioner. The system identifies occlusal or interproximal caries, periapical lesions, bone resorption and early signs of periodontal disease. The result? Fewer missed diagnoses, more timely interventions and greater safety, especially in ambiguous cases or with paediatric and geriatric patients, where early diagnosis really makes a difference.

2. Fast and accurate planning

Preparing a complex clinical case takes time and precision. Platforms with built-in artificial intelligence, such as MyRay's Neowise , automate the most repetitive and time-consuming processes:

- Automatic tracking of the inferior alveolar nerve
- Precise matching between CBCT volumes and intraoral scans
- Automatic segmentation of anatomical structures

This translates into time saved, fewer manual errors and greater focus on decision-making for the practitioner. Technology does the "dirty work", allowing the professional to focus on the treatment strategy.

A practical example of digital planning >> Let's imagine we need to plan a complex procedure. We start with CBCT acquisition, which provides a complete 3D model of the jaw. We add an intraoral scan, which eliminates traditional impressions and creates a digital model of the dental arch. In Neowise, these data integrate perfectly: it is possible to plan treatment virtually, taking into account anatomy, bone quality and the final result. Everything is fluid and integrated. The process becomes faster, safer and more predictable. And the patient is well aware of this.

3. Less time for paperwork, more time for clinical work

Reports, medical records, documentation for insurance companies: bureaucracy takes up valuable time at the clinic.

AI automates these processes through advanced speech-to-text systems and intelligent templates. The practitioner dictates, and the system transcribes and organises everything in the file in real time. In orthodontics, MyRay technologies generate complete cephalometric analyses in less than 30 seconds from the image alone.

A process that traditionally took a long time is now completed automatically, leaving the professional more time for interpretation and communication with the patient.

4. Happier patients, more efficient practice

Chatbots and AI-based virtual assistants are changing patient management through:

- Immediate answers to frequently asked questions
- Autonomous management of appointments and reminders
- Pre- and post-operative support available 24/7
- Personalized and timely communications
- Staff are freed from repetitive tasks and can focus on high-value interactions. Patients appreciate immediate availability and clear communication. The efficiency of the practice improves in all areas.
- Critical issues that should not be underestimated

AI offers huge opportunities, but it must be implemented with awareness. Let's take a look at the key critical issues:

1. Reliability and clinical validation

Not all AI tools have undergone rigorous clinical validation. Many perform very well in controlled environments, but may have limitations in real-world practice, especially with atypical anatomies or suboptimal image quality.

The golden rule: every AI output must be verified by the clinician. The system suggests, the dentist decides. Diagnostic and therapeutic responsibility always remains with the professional. Artificial intelligence is an intelligent assistant, not a substitute for clinical judgement. Caution is required and, above all, a human supervisor is essential to confirm each indication.

2. Human experience remains irreplaceable

AI is excellent at analysing data and patterns, but dentists are capable of much more. Professionals integrate:

Active listening and relationship with the patient

Objective clinical examination

Assessment of personal and psychological context

Ability to tailor treatment to the individual case

These human qualities cannot be replicated by an algorithm. Empathy, clinical intuition, the ability to reassure anxious patients: these are skills that belong exclusively to professionals.

AI enhances, it does not replace.

3. Data privacy and security: a fundamental responsibility

Using AI systems means managing large volumes of sensitive health data. The aspects to be overseen are critical:

Full GDPR compliance

Specific informed consent for AI use

Protection against cyber attacks and unauthorized access

Total transparency to patients

Data security is never negotiable. It is the firm's responsibility to verify that technology providers guarantee adequate standards of protection and regulatory compliance.

4. Investment and team training

Implementing AI requires investment on multiple fronts:

Software, hardware and licensing

Reorganization of work processes

Structured team training

Ongoing technical support

The learning curve can be challenging, especially for those who are less digitally savvy. A gradual approach is needed, with adequate training and constant support.

Success depends on the ability to guide the team through change, transforming technology into an ally rather than an obstacle.

AI as an ally of clinical practice

Artificial intelligence is a powerful tool for enhancing the quality of dental practice through more accurate diagnoses, optimised workflows, improved operational efficiency and greater patient satisfaction. But it must be properly understood: it is not a solution to all problems, nor is it a threat to the profession.

It is a technology that amplifies the practitioner's capabilities when used competently and critically. The future of dentistry belongs to professionals who can integrate traditional clinical skills and technological innovation, creating an ecosystem where AI works in synergy with human experience.

With the right technologies and the right mindset, artificial intelligence becomes part of a fluid and integrated workflow that benefits both professionals and patients.

This is precisely what happens with MyRay solutions: advanced technology at the service of more efficient, accurate and humane clinical practice.

АНГЛІЙСЬКИЙ АЛФАВІТ

<i>Aa</i> Aa [eɪ]	<i>Nn</i> Nn [en]
<i>Bb</i> Bb [bi:]	<i>Oo</i> Oo [əv]
<i>Cc</i> Cc [si:]	<i>Pp</i> Pp [pi:]
<i>Dd</i> Dd [di:]	<i>Qq</i> Qq [kju:]
<i>Ee</i> Ee [i:]	<i>Rr</i> Rr [a:]
<i>Ff</i> Ff [ef]	<i>Ss</i> Ss [es]
<i>Gg</i> Gg [dʒi:]	<i>Tt</i> Tt [ti:]
<i>Hh</i> Hh [eɪtʃ]	<i>Uu</i> Uu [ju:]
<i>Ii</i> Ii [aɪ:]	<i>Vv</i> Vv [vi:]
<i>Jj</i> Jj [dʒeɪ]	<i>Ww</i> Ww [ˈdʌblju:]
<i>Kk</i> Kk [keɪ]	<i>Xx</i> Xx [eks]
<i>Ll</i> Ll [el]	<i>Yy</i> Yy [waɪ]
<i>Mm</i> Mm [em]	<i>Zz</i> Zz [zed]

ENGLISH FOR ARTIFICIAL INTELLIGENCE



A

- **Access Time**

the time interval between the instance at which data is called from a storage device and the instance when delivery begins.

- **Algorithm**

a set of well-defined instructions for the solution of a problem in a finite number of steps.

- **Analog Computer**

a computer that operates on data which is in the form of continuous variable physical quantities.

- **Application Program**

a sequence of instructions written to solve a specific user problem.

- **Application Software**

a subclass of computer software that employs the capabilities of a computer directly to a task that the user wishes to perform.

- **Arithmetic Logic Unit (ALU)**

a part of the execution unit, a core component of all CPUs. ALUs are capable of calculating the results of a wide variety of basic arithmetical and logical computations.

- **Artificial Intelligence (AI)**

the ability of a computer running special software to act intelligently — perceiving new data, learning, drawing inferences, and solving problems. It allows computers to perform work that previously required human intervention.

- **Assembler**

a program that translates mnemonic statement into executable instruction.

- **Augmented Reality**

technology that enhances the real world through the use of sensory information (visual, audio, or otherwise) added to the actual view of the real world.

- **Automatic Data Processing (ADP)**

the collection, manipulation, and dissemination of data by electromechanical machines to attain specified objectives.

- **Auxiliary Memory**

also known as secondary memory that is not directly addressable by the CPU.

Bb

- **Back-End Processor**

a small CPU serving as an interface between a large CPU and a large data base stored on a direct-access storage device.

- **Backup**

a copy of a file or other item of data made in case the original is lost and damaged.

- **Bandwidth**

the maximum amount of data that can travel in a communication path in a given time, measured in bits per second (bps).

- **Bar Code**

a machine-readable representation of information in a visual format on a surface.

- **Batch File**

a text file that contains a sequence of commands for a computer operating system.

- **Batch Processing**

a method of processing data in which data items are collected and forwarded to the computer in a group.

- **Binary Coded Decimal (BCD)**

a coding system in which a 4 digit binary number represents each decimal digit from 0 to 9.

- **Biochip**

in theory, a chip whose circuits will be built from the proteins and enzymes of living matter such as E. coli bacteria.

- **Bit**

the most basic information unit used in computing and information theory.

- **Bit Cells**

the name for storage locations in semiconductors.

- **Blockchain**

a data structure containing records, called blocks, which are linked together in a cryptographically secure way.

- **Blocks**

also called blocked records; records grouped on magnetic tape or magnetic disk to reduce the number of interrecord gaps and more fully utilize the storage medium.

- **Blog**

a discussion or informational site published on the world wide web.

- **Branch**

program logic used to bypass or alter the normal flow of execution.

- **Broad-Band Channels**

communication channels that can transmit data at rates of up to 120,000 bits per second; for example, laser beams and microwaves.

- **Browser**

a special software that enables users to read/view Web pages and jump from one Web page to another.

- **Bubble Memory**

a memory medium in which data is represented by magnetized spots (magnetic domains) resting on a thin film of semiconductor material.

- **Buffering**

the process of storing data in a memory device, allowing the devices to change the data rates, perform error checking and error retransmission.

- **Bug**

an error, flaw, failure, or fault in a computer program or system that produces an incorrect or unexpected result.

- **Bus**

a circuit that provides a communication path between two or more devices of a digital computer system.

- **Byte**

a unit of storage measurement in computers, regardless of the type of data being stored.

Cc

- **Cache Memory**

also known as a high-speed buffer; a working buffer or temporary area used in primary storage to help speed the execution of a program.

- **Cell**

a box in a spreadsheet, in which you can enter a single piece of data.

- **Central Processing Unit (CPU)**

generally called by its generic name 'Processor'. It is also known as the brain of computer. It performs the actual processing of data.

- **Chain**

the logical path linking records according to one common field.

- **Chain Printer**

an output device that has the character set engraved in type and assembled in a chain that revolves horizontally past all print positions; prints when a print hammer (one for each column of the paper) presses the paper against an inked ribbon that presses against the characters on the print chain.

- **Cloud Computing**

services provided over a network by a collection of remote servers.

- **Code**

to translate data into machine-readable form so they can be entered into the computer system.

- **Command Area**

the area at the bottom of some electronic spreadsheets that displays the available commands to the user.

- **Commercial Data Base**

a collection of information accessible over communication lines to paying subscribers; also called information service and information utility.

- **Communication Protocol**

a system of rules that allow two or more entities of a communications system to transmit information.

- **Compiler Program**

translator program for a high-level language such as FORTRAN or COBOL; translates source-program statements into machine-executable code; also called compiler.

- **Computer Ethics**

term referring to the standard of moral conduct in computer use; way in which the spirit of the law is applied to computer-related activities.

- **Computer Graphics**

visual presentations on a computer screen. Examples are photographs, drawings, line arts, graphs or other images.

- **Computer Literacy**

general knowledge about computers; includes some technical knowledge about hardware and software, the ability to use computers to solve problems, and awareness of how computers affect society.

- **Computer Network**

a system for communication among two or more computers.

- **Computer Worm**

a self-replicating computer program, similar to a computer virus.

- **Computer-Assisted Instruction (CAI)**

use of a computer to instruct or drill a student on an individual or small-group basis.

- **Control Unit**

the part of a CPU that directs its operation. The outputs of this unit control the activity of the rest of the device.

- **Cookie**

a packet of information that travels between a browser and the web server.

- **Crawler**

an Internet bot that systematically browse the world wide web, typically for the purpose of Web indexing. It is also called a Web spider.

- **Cryptography**

the conversion of data into a secret code for transmission over a public network.

- **Cybersecurity**

an umbrella term for all systems that protect data, networks and computer systems from intrusion and attacks, very often due to being connected to the Internet.

Dd

- **Data**

facts; the raw material of information.

- **Data Base**

collection of data that are commonly defined and consistently organized to fit the information needs of a wide variety of users in an organization.

- **Data Communication**

the electronic transmission of data from one site to another usually over communication channels such as telephone/telegraph lines or microwaves.

- **Data Processing**

converting data into information.

- **Data Redundancy**

a condition created within a database or data storage technology in which the same piece of data is held in two separate places.

- **Database Management System (DBMS)**

a collection of various programs that provides a systematic way to create, retrieve, update and manage data.

- **Debugging**

a methodical process of finding and reducing the number of bugs, or defects are known as debugging.

- **Degree**

the number of fields associated with the database table or relation.

- **Desk-Checking**

a method used in both system and application program debugging in which the sequence of operations is mentally traced to verify the correctness of the processing logic.

- **Desktop Publishing (DTP)**

combines a personal computer, page layout software and a printer to create publications on small economic scale.

- **Device Driver**

a computer program that enables another program, typically, an operating system to interact with a hardware device.

- **Dial-up Line**

a line through which communication established.

- **Digital Computer**

a computer that operates with numbers expressed directly as digits.

- **Direct Access**

method of processing in which data are submitted to the computer as they occur, and located, retrieved, and updated without reading all preceding data.

- **Direct Access**

the capability of the computer equipment to obtain data from a storage device.

- **Directory**

an entity in a file system which contains a group of files and other directories.

- **Display Unit**

a device with a screen that displays characters or graphics representing data in a computer memory.

- **Domain Name**

a unique name that identifies a particular Website and represents the name of the server where the Web pages reside.

- **Dots Per Inch (DPI)**

the measure of the resolution of a printer, scanner or monitor. It refers to the number of dots in one inch line.

- **Download**

the act of transmitting data from a remote computer on the Internet or other network to one's own computer.

- **Downtime** – the time a system is not working because of equipment problems.

- **Drag and Drop**

the action of clicking on a virtual object and dragging it to a different location or onto another virtual object.

- **DVD**

an optical disc storage media format that can be used for data storage including movies with high quality video and sound.

- **Dynamic RAM**

a type of random access memory which stores each bit of data in a separate capacitor.

Ee

- **EBCDIC**

(Extended Binary Coded Decimal Interchange Code) – an 8-bit character encoding used on IBM mainframe operating systems, like Z/OS, S/390, AS/400 and i5/OS.

- **E-Commerce**

a type of industry where buying and selling of products or services is conducted over electronic systems such as the Intranet and other computer network.

- **Edge Computing**

processing and storing data close to its creation. Typically used in industrial Internet of Things applications, both edge computing and “fog computing” are terms used synonymously.

- **Editing**

the process of changing information by inserting, deleting, replacing, rearranging and reformation.

- **Electronic Data Processing (EDP)**

a data processing through equipment that is predominantly electronic such as digital computer.

- **Electronic Funds Transfer (EFT)**

cashless method of managing money; accounts involved in a transaction are adjusted by electronic communication between computers.

- **Electronic Mail**

a method of composing, sending, storing and receiving messages over electronic communication systems.

- **Electronic Spreadsheet**

an electronic ledger sheet used to store and manipulate any type of numerical data.

- **Electrostatic Printer**

a nonimpact printer in which electromagnetic impulses and heat are used to affix characters to paper.

- **Electrothermal Printer**

a nonimpact printer that uses special heat-sensitive paper; characters are formed when heated rods in a matrix touch the paper.

- **Encryption**

the process of encoding messages (or information) in such a way that hackers cannot read it, but the authorised users can access it.

- **End User**

any individual who uses the information generated by a computer based system.

- **Entity**

something that has certain attributes or properties which may be assigned values.

- **Error Message**

information displayed when an unexpected condition occurs usually on a computer or other device.

- **Excel**

allows users to create spreadsheets much like paper ledgers that can perform automatic calculations.

- **Exe (.exe)**

a common filename extension denoting an executable file (a program) in the DOS, MS-Windows.

- **Execution Time**

the total time required to execute a program on a particular system.

- **Expansion Slot**

a socket on the motherboard that is used to insert an expansion card which provides additional features to a computer.

- **Expert System**

form of artificial intelligence software that imitates the same decision-making processes of experts on a specific field.

- **Extranet**

a technology that permits the users of one organisation's Intranet to enter portions of another organisation's Intranet in order to conduct business transactions or collaborate on joint projects.

Ff

- **Fax**

stands for 'Facsimile'. It is used to transmit a copy of a document electronically.

- **Fiber Optics**

a data transmission concept using laser pulses and cables made of tiny threads of glass that can transmit huge amounts of data at the speed of light.

- **Field**

the attribute of an entity in the table representation.

- **File**

a collection of information stored electronically and treated as a unit by a computer. Every file must have its own distinctive name.

- **File Allocation Table (FAT)**

the name of a computer file system architecture. The FAT file system is a legacy file system which is simple and robust.

- **File Handler**

a data-management application package capable of operating on only one file at a time.

- **File Manager**

an operating system utility that provides a user interface to work with file systems.

- **File Transfer Protocol (FTP)**

used to transfer files from one place to another on Internet.

- **Firewall**

a security system usually consisting of hardware and software that prevents unauthorised persons from accessing certain parts of a program database or network.

- **Fixed Scanner**

an input device used to scan and read source data in bar-code form or in human-readable form.

- **Fixed-Length Records**

a record format in which a maximum number of character positions are assigned.

- **Flowcharts**

the means of visually representing the flow of data through an information processing system, the operations performed within the system and the sequence in which they are performed.

- **Flowlines**

the lines that connect flowchart symbols.

- **Foreign Key**

a field in a database table, which links it to another related table. Format To set margins, tabs, font or line spacing in layout of a document.

- **FORTRAN**

stands for formula translating system. The language was designed at IBM for scientific computing.

- **Freeware**

a form of software distribution where the author retains copyright of the software but makes the program available to others at no cost.

- **Front-End Processor**

a small CPU serving as an interface between a large CPU and peripheral devices.

- **Full-Duplex**

a type of communication channel through which data can be transmitted in both directions simultaneously.

- **Function Key**

a special key on a computer keyboard or a terminal devices keyboard that is used to perform specific functions. Many keyboards have function keys labelled from F1 to F12.

Gg

- **Garbage In Garbage Out (GIGO)**

pertains to the fact that most computer errors are not machine errors, they are data errors caused by incorrect input data.

- **Gateway**

a device that is used to joint together two networks having different base protocols.

- **Gigabyte (GB)**

a unit of information or computer storage equal to approximately one billion bytes.

- **Gigahertz (GHz)**

a measurement used to identify the speed of the central processing unit. One gigahertz is equal to 1 billion cycles per second.

- **Graphic Display Device**

a visual display device that projects output in the form of graphs and line drawings and accepts input from a keyboard or light pen.

- **Graphic Tablet**

an input device which is used to create images, etc.

- **Graphical User Interface (GUI)**

a method of interacting with a computer through a metaphor of direct manipulating of graphical images and widgets in addition to text.

- **Graphics Interchange Format (GIF)**

a simple file format for pictures and photographs, that are compressed so they can be sent quickly.

- **Graphics Software Package**

application software package designed to allow the user to display images on the display screen or printer.

- **Grid Chart**

a chart used in system analysis to summarize the relationships between the components of a system.

Hh

- **Hacker**

a computer criminal who penetrates and tempers with computer programs or systems.

- **Half-Duplex**

a type of communication channel through which data can be transmitted in both directions, but in only one direction at a time.

- **Hang**

to crash in such a way that the computer does not respond to input from the keyboard or mouse.

- **Hard Copy**

a printed copy of information from a computer.

- **Hard Disk**

a non-volatile data storage device that stores data on a magnetic surface layered onto disk platters.

- **Hardware**

the mechanical, magnetic, electronic and electrical components that comprises a computer system such as CPU, monitor, keyboard, mouse, etc.

- **High-Level Programming Language**

a programming language that is more user-friendly, to some extent platform-independent and abstract from low-level computer processor operations such as memory accesses.

- **Holler Plating**

placing the same word, phrase, or block of text in several documents.

- **Home Page**

a starting point or a doorway to the Website. It refers to the Web page that identifies a Website and contains the hyperlink to other Web pages in the Website.

- **Host Computer**

a computer that provides information or a service to other computers on the Internet. Every host computer has its own unique host name.

- **Hub**

a network device that connects multiple computers on a LAN, so that they can communicate with one another.

- **Hybrid Computer**

a computer made by taking the best features of the analog computer and digital computer.

- **Hyperlink**

an image or portion of text on a Web page that is linked to another Web page.

- **HyperText Markup Language**

stands for HTML. It is mainly used for designing websites.

- **HyperText Transfer Protocol (HTTP)**

an important protocol used on the world wide web for moving hypertext files across the Internet.

Ii

- **Icon**

a symbol (such as picture or a folder) that represents a certain function on your computer. When the user clicks on the icon, the appropriate function is executed.

- **Information**

the summarisation of data according to a certain pre-defined purpose.

- **Input**

in order to give instructions to a computer, the information has to be supplied to it.

- **Input/Output Management System**

a subsystem of the operating system that controls and coordinates the CPU while receiving input from channels, executing instructions of programs in storage, and regulating output.

- **Instant Messaging (IM)**

a chat program that lets people communicate over the Internet in real time.

- **Instruction**

a command or order given to a computer to perform a task.

- **Integrated Circuits**

multiple electronic components combined on a silicon chip.

- **Interactive Processing**

a data-processing method where the user enters input via a keyboard during processing.

- **Interblock Gap (IBG)**

a space on magnetic tape that facilitates processing; records are grouped together and then separated by interblock gaps.

- **Interface**

a device or program that helps a user to communicate with a computer.

- **Internet**

a vast computer network linking smaller computer networks worldwide.

- **Internet of Things (IoT)**

an idea of all objects in the world being uniquely identifiable, tracked, and connected to the Internet.

- **Internet Service Provider (ISP)**

a business organisation that offers users to access the Internet and related services.

- **Internet Surfing**

to search something on Internet is called Internet surfing.

- **Interpreter**

a program that converts and executes the source code into machine code line by line.

- **Interrecord Gap (IRG)**

a space that separates records stored on magnetic tape; allows the tape drive to regain speed during processing. Inverted list A list that has an index for every field in a file.

Jj

- **Java**

a programming language, used to create mobile applications, softwares, etc.

- **Javascript**

an object oriented programming language used to create interactive effects in a Web browser.

- **Joystick**

a computer peripheral or general control device consisting of a handheld stick that pivots about one end and transmits its angle in two or three dimensions to a computer

- **JPEG (Joint Photographic Experts Group)**

a commonly used method of lossy compression for digital photography.

Kk

- **Kernel**

the fundamental part of a program, such as an operating system, that resides in memory at all times.

- **Key**

the unique identifier or field of a record; used to sort records for processing or to locate specific records within a file.

- **Key Stroke**

the process of pressing button in keyboard.

- **Keyboard**

the standard input device attached to all computers. The layout of keyboard is just like the traditional typewriter of the type QWERTY.

- **Keypunch**

a keyboard device that punches holes in a card to represent data.

- **Key-to-Disk**

hardware designed to transfer data entered via a keyboard to magnetic (hard) disk.

- **Kilobyte (KB)**

a unit of information or computer storage equal to 1024 bytes.

Ll

- **LAN (Local Area Network)**

a network where the connected computers are geographically close together. They are either in the same building or within a smaller area.

- **Laptop**

a small, lightweight and portable batterypowered computers that can fit onto your lap. They each have a thin, flat and liquid crystal display screen.

- **Laser Printer**

a type of nonimpact printer that combines laser beams and electrophotographic technology to form images on paper.

- **Laser Storage System**

a secondary storage device using laser technology to encode data onto a metallic surface; most often used for mass storage.

- **Light Pen**

a light sensitive style for forming graphics by touching coordinates on a display screen, thereby seeming to draw directly on the screen.

- **Link**

a communication path between two nodes or channels.

- **Linked List**

a file using pointers to maintain the sequence of the records.

- **Links**

transmission channels that connect nodes.

- **LINUX**

an open source operating system, meaning that the source code of the operating system is freely available to the public.

- **List Processing (LISP)**

a high level programming language suitable for handling logical operations and non-numeric applications.

- **Log In**

the process by which an individual gains access to a computer system by identifying and authenticating themselves.

- **Log Off**

a process of withdrawal from function after performing program.

- **Loop**

program logic that causes a series of instructions to be executed repeatedly as long as specified conditions remain constant.

- **Low Level Language**

a assembly language which is used in computer. It was mostly used in first generation computers.

- **Machine Language**

the language of computer also called binary language. Instructions in this language are written as a sequence of 0's and 1's.

- **Machine Learning (ML)**

a branch of artificial intelligence focused on creating computer systems that accomplish tasks without explicit instructions.

- **Magnetic Disk**

a direct-access storage medium consisting of a metal platter coated on both sides with a magnetic recording material upon which data is stored in the form of magnetized spots.

- **Magnetic Domain**

a magnetized spot representing data in bubble memory.

- **Main Memory**

a volatile and speedy memory. It is divided into two parts RAM and ROM.

- **Mainframe**

a type of large, full-scale computer capable of supporting many peripherals.

- **Malware**

a software that disrupts normal computers functions or sends a users personal data without the user authorisation.

- **Mass Storage**

storage where large volumes of backup/data is stored.

- **Master File**

a file that contains all existing records organized according to the key field; updated by records in a transaction file.

- **Megabyte (MB)**

1 Megabyte is equal to 1048576 bytes, usually rounded off to one million bytes. It is also called a 'meg'.

- **Memory**

temporary storage for information, including applications and documents.

- **Memory Management/Memory Protection**

in a multiprogramming environment, the process of keeping the programs in primary storage separate from each other.

- **Menu Bar**

the horizontal strip across the top of an application's window. Each word on the strip has a context sensitive drop-down menu containing features and actions that are available for the application in use.

- **Merge**

combining two or more files into a single file.

- **Message Switching**

the task of a communications processor of receiving messages and routing them to appropriate destinations.

- **Microcomputer**

a microprocessor-based computer, consisting of an CPU, internal semiconductor memory, input and output sections and a system bus, all on one, or several monolithic IC chips inserted into one or several PC boards.

- **Microprocessor** – a complete Central Processing Unit (CPU) contained on a single silicon chip.

- **MIDI (Music Instrument Digital Interface)** allows a computer to store and replay a musical instrument's output.

- **Minicomputer**

a computer considered to be more capable than a microcomputer but less powerful than a mainframe.

- **Mnemonic**

a symbolic label or code remainder that assists the user in remembering a specific operation or command in assembly language.

- **Modem (Modulator/Demodulator)**

specific equipment that provides a means of communication between two computer systems over conventional telephone lines.

- **Modulation**

a technology used in modems to make data processing signals compatible with communication facilities.

- **Monitor**

the visual readout device of a computer system. A monitor can be in several forms; a Cathode Ray Tube (CRT), a Liquid Crystal Display (LCD), or a flat-panel, full-color display.

- **Mouse**

a desk-top input device that controls cursor movement, allowing the user to bypass the keyboard.

- **Multimedia**

software programs that combine text and graphics with sound, video and animation. A multimedia PC contains the hardware to support these capabilities.

- **Multiplexer**

a device that permits more than one I/O device to transmit data over the same communication channel.

- **Multitasking**

working simultaneously with several programs or interrelated tasks that share memories, codes, buffers and files.

- **Multithreading**

a facility available in an operating system that allows multiple functions from the same application packages.

Nn

- **Natural Language Processing (NLP)**

is a method used in artificial intelligence to process and derive meaning from the human language.

- **Network**

an interconnection of two or more than two computers.

- **Network Data Structure**

the data structure in which a primary data element may have many secondary elements and the secondary elements may have numerous primary elements.

- **Network Interface Card (NIC)**

a part of the computer that allows it to talk to other computers via a network protocol like TCP/IP.

- **Neural Network**

an artificial intelligence computing system modeled after the way that a human brain works. Neural networks use layers of interconnected nodes as artificial neurons to process data and solve a given problem.

- **Nibble**

sequence of four adjacent bits, or a half-byte. A hexadecimal or BCD coded digit can be represented by a nibble.

- **Node**

the endpoint of a network branch or the junction of two or more branches.

- **Non-Volatile Memory**

a memory where stored data remain undisturbed by the removal of electrical power.

- **Notebook**

a portable computer, that can fit into a briefcase. It is used as personal computer. It is also called laptop.

Oo

- **Object**

something that contains both the data and the application that operate on that data.

- **Odd Parity**

a method of coding in which an odd number of 1 bits is used to represent each character; facilitates error checking.

- **Office Automation**

integration of computer and communication technology with traditional office procedures to increase productivity and efficiency.

- **Offline**

the state in which a computer is temporarily or permanently unable to communicate with another computer.

- **Online**

the state of being connected to the networked computer system or the Internet.

- **Online Storage Symbol**

a symbol that indicates that the file is kept on an online external storage medium such as disk or tape.

- **Operand**

the part of an instruction that tells the computer where to find the data or equipment on which to operate.

- **Operating System**

a set of instructions that tells a computer on how to operate when it is turned ON. It sets up a filing system to store files and tells the computer how to display information on a video display.

- **Operation Code**

also known as op code; the part of an instruction that indicates what operation is to be performed.

- **Optical Disk**

also known as a laser disk; stores data as the presence or absence of a pit burned into the surface of the disk by a laser beam.

- **Optical-Character Recognition (OCR)**

a method of electronic scanning that reads numbers, letters, and other characters and then converts the optical images into appropriate electrical signals.

- **Optical-Mark Recognition (OMR)**

mark sensing; a method of electronic scanning that reads marks on a page and converts the optical images into appropriate electrical signals.

- **Output**

data that come out of a computer device.

Pp

- **Page**

in a virtual storage environment, the portion of a program that is kept in secondary storage and loaded into real storage only when needed during processing.

- **Page Frame**

in a virtual storage environment, one of the equal-sized physical areas into which primary storage is divided.

- **Parity Bit**

a bit added to detect incorrect transmission of data; it conducts internal checks to determine whether the correct number of bits are present.

- **Patch**

a small program that improves an existing piece of software or corrects an error in it.

- **Personal Computer (PC)**

a single-user computer containing a Central Processing Unit (CPU) and one or more memory circuits.

- **Piracy**

the illegal copying of software or other creative works.

- **Pixels**

an acronym derived from picture element. The smallest element (a dot) on a display screen.

- **Plotter**

an output device that converts data emitted from the CPU into graphic form; produces hard-copy output.

- **Plug-In**

a program that your browser uses to manipulate a downloaded file.

- **Pointer**

an additional field in a record that contains the address of the next record to be accessed.

- **Portrait**

a term that designates the position of conventional printing across the width of a page.

- **Post Office Protocol (POP)**

a protocol that specifies how a personal computer can connect to a mail server on the Internet and download E-mail.

- **Primary Key**

a key that uniquely identifies each tuple or row in a table.

- **Primary Memory/Storage**

also known as internal storage or main storage; the section of the computer that holds instructions, data, and intermediate and final results during processing.

- **Print Formatting**

the manner in which the word processor communicates with the printer to tell it how the text should be printed.

- **Printer**

a mechanical device for printing a computer's output on paper.

- **Process**

a collection of code, data and other system resources including at least one thread of execution that performs a data processing task.

- **Program**

a set of instructions to perform a specific task.

- **Programming Language**

a vocabulary and set of grammatical rules for instructing a computer to perform specific tasks.

- **Propagation Delay**

a time delay in a satellite communication system.

- **Protocol**

a set of rules that defines exactly how information is to be exchanged between two systems over Internet.

- **Pseudocode**

a short hand way of describing a computer program.

Qq

- **Quantum Computing**

a computer architecture based on quantum mechanics, the science of atomic structure and function.

- **Query**

a request for information from a database.

Rr

- **Random Access Memory (RAM)**

a volatile, semiconductor storage structure that accesses temporary data with a random or direct accessing method. Data in this memory can be read by the CPU directly.

- **Read Only Memory (ROM)**

a semiconductor memory whose data cannot be erased, or overwritten; it can only be accessed (read) for use by the CPU.

- **Real-Time**

descriptive of a system's capability to receive and process data, providing output fast enough to control the outcome of an activity.

- **Record**

a collection of all the information pertaining to a particular entity instance.

- **Register**

a temporary storage unit for quick, direct accessibility of a small amount of data for processing.

- **Remote Network**

a system where terminals are connected to the central computer by a communication channel.

- **Remote Server**

a network computer that allows a user on the network from a distant location to access information.

- **Retrieve**

to access previously stored data.

- **Router**

a network device that enables the network to reroute messages it receives that are intended for other networks. The network with the router receives the message and sends it on its way exactly as received.

- **Routing**

the process of choosing the best path throughout the LAN.

Ss

- **Scanner**

an electronic device that uses light-sensing equipment to scan paper images such as text, photos, illustrations and translate the images into signals that the computer can then store, modify, or distribute.

- **Screen Editor**

a word processing feature that allows the text on the entire screen to be edited.

- **Screen Formatting**

word-processing features that control the way in which text appears on the display screen.

- **Scrolling**

the process of moving a portion of a text file on to or off of the display screen; used to view portions of a document.

- **Search**

a feature of a program that permits the user to locate a word or set of characters throughout a file.

- **Search Engine**

software that makes it possible to look for and retrieve information on the Internet, particularly the Web. Some popular search engines are AltaVista, Google, HotBot, Yahoo!, Web Crawler and Lycos.

- **Sector**

a section of a recording track on a magnetic disk.

- **Sequential Access**

a class of data storage device that reads stored data in a sequence.

- **Server**

a computer that shares its resources and information with other computers on a network.

- **Shareware**

a software that is not free but is available for a free trial period.

- **Simplex**

transmission of data in one direction only.

- **Simulation**

duplication of conditions likely to occur in a real-world situation when variables are changed.

- **Smart City**

an urban area that uses technology to provide high-tech services as well as more efficient services to the neighborhood.

- **Smart Device**

any computer-controlled electronic apparatus that is not a desktop, laptop or tablet computer, which are technically “intelligent” devices.

- **Smart Home**

a category of electronic devices that automate and interconnect tasks in a house.

- **Software Compatibility**

the ability to use programs written for one system on another system with little or no change.

- **Software**

the set of computer programs, procedures and associated documentation related to the effective operation

- **Source Code** (Source Program)

a set of computer instructions in hard-copy or stored form.

- **Source-Data Automation**

the use of special equipment to collect data at its point of origin.

- **Spam**

irrelevant or unsolicited messages sent over Internet, typically to large numbers of users, for the purpose of advertising, phishing, spreading malwares, etc.

- **Spatial Digitizer**

an input device that can graphically reconstruct a three-dimensional object on the computer display screen.

- **Spreadsheet**

software that allows one to calculate numbers in a format that is similar to pages in a conventional ledger.

- **Static RAM**

a type of RAM, that contains its contents only whenever current supply is ON.

- **Status Area**

A portion of an electronic spreadsheet that appears at the top of the display and shows the location of the cursor within the spreadsheet and what was entered into a particular cell of the spreadsheet.

- **Sub Program**

a particular part of a program that complete the special work.

- **Supercomputer**

the largest mainframe computer featuring exceptionally high speed operation while manipulating huge amounts of information.

- **Swapping**

in a virtual storage environment, the process of transferring a program section from virtual storage to real storage, and vice versa.

Tt

- **TCP/IP (Transmission Control Protocol/Internet Protocol)**

a large grouping of programs and standards that govern how information moves round the Internet.

- **Template**

a predefined set of formulas for use on an electronic spreadsheet.

- **Terabyte (TB)**

a trillion bytes. Actually, it is 2^{40} or 10095111627776 bytes.

- **Terminal**

a computer screen.

- **Text Editing**

the process of making changes to a document after the text has been entered into the computer.

- **Thrashing**

a situation in virtual storage in which little processing occurs in comparison to the amount of locating and swapping of pages or segments.

- **Time Sharing**

the allocation of computer resources in a time dependent fashion to run several programs simultaneously.

- **Top-Down Design**

a method of defining a solution from general to specific in terms of major functions to be performed, and further breaking down the major functions into subfunctions; the further the breakdown, the greater the detail.

- **Topology**

the structure of the network including physical connection such as wiring schemes and logical interactions between network devices.

- **Trackball**

input device that controls the position of the cursor on the screen.

- **Trailer Value**

a value used to control loop execution in which a unique item signals the computer to stop performing the loop.

- **Transaction File**

a file containing changes to be made to the master file.

- **Transistor**

an on/off switch connecting the data line to the capacitor; a type of circuitry characteristic of second-generation computers; smaller, faster, and more reliable than vacuum tubes but inferior to third-generation, large-scale integration.

- **Transponders**

small amplifiers located on satellites, which receive signals from the earth station and reflect them to the receiving stations.

Uu

- **Uniform Resource Locator (URL)**

the specific Internet address for a resource such as an individual or an organisation.

- **Unix**

an operating system developed by AT & T. It is a big push that it allows one server to serve many different end users at one time.

- **Upgrade**

the process of improving hardware and software functionality.

- **Upload**

the processes of transferring information from a computer to a Website (or other remote location on a network).

- **UPS (Universal Power Supply or Uninterruptible Power Supply)**

an electrical power supply that includes a battery to provide enough power to a computer during an outage to back-up data and properly shut down.

- **User**

a person who uses or operates something.

- **User-Friendly**

a software program that has been designed to easily direct the user through the operation or application of a program.

- **Utility Program**

a program within an operating system that performs a specialized function.

Vv

- **Validation**

the process of making sure that the forms and documents from a particular transaction are correct.

- **Variable**

a meaningful name assigned by the programmer to storage locations of which the values can change.

- **Variable-Length Records**

a record format in which the unused character spaces are eliminated from the record.

- **Verify**

to check the accuracy and completeness of data.

- **Vertical Software Integration**

the enhancement of a single software package. For example, adding a spelling checker to a word processing program.

- **Very-Large-Scale Integration (VLSI)**

further miniaturization of integrated circuits, offering even greater improvements in price, performance, and size of computers.

- **Video Conferencing**

a remote 'face-to-face chat', when two or more people using a webcam and an Internet telephone connection chat online. The webcam enables both live voice and video.

- **Virtual Reality (VR)**

a computer-generated artificial environment that allows a user to view, explore, and manipulate the environment.

- **Virtual Storage**

an extension of multiprogramming in which portions of programs not being used are kept in secondary storage until needed, giving the impression that primary storage is unlimited; contrast with real storage.

- **Virus**

a piece of computer code designed as a prank or malicious act to spread from one computer to another by attaching itself to other programs.

- **Visual Display Terminal**

a terminal capable of receiving output on a cathode-ray tube (CRT) and, with special provisions, is capable of transmitting data through a keyboard.

- **Voice Recognition System**

an input system that allows the user to “train” the computer to understand his or her voice and vocabulary. The user must follow only the patterns the computer is programmed to recognize; also called audio input.

- **Voice Response Unit**

a device through which the computer “speaks” by arranging half-second records of voice sounds or prerecorded words; also called audio output.

- **Voice-Grade Channel**

a communication channel that has a wider frequency range and can transmit data at a rate of forty-five to ninety bits per second; for example, a telegraph channel/

- **Volatile Memory**

a memory whose contents are irretrievably lost when power is removed. If data in RAM must be saved after power shutdown, back-up in non-volatile memory (magnetic disk, tape, or CD-R) is essential.

- **Volatility**

the frequency of changes made to a file during a certain period of time.

Ww

- **Wand Reader**

an input device used in reading source data represented in optical bar-code form or in human readable characters.

- **Website**

a collection of web pages or hyperlinked webpages which owned by an individual, company or organisation.

- **Wide Area Network (WAN)**

a telecommunication network or computer network that extends over a large geographical distance.

- **Window**

a portion of a computer display used in a graphical interface that enables users to select commands by pointing to illustrations or symbols with a mouse.

- **Word Processor**

a computer system or program for setting, editing, revising, correcting, storing and printing text.

- **Word Wrap**

a feature of a program that automatically positions text so that full words are positioned within declared margins.

- **Workgroup**

persons sharing files and data between themselves.

- **Workstation**

the work area and/or equipment used for computer operations, including Computer-Aided Design (CAD). The equipment generally consists of a monitor, keyboard, printer and/or plotter and other output devices.

- **World Wide Web ('WWW' or 'The Web')**

a network of servers on the Internet that use hypertext-linked databases and files. It was developed in 1989 by Tim Berners-Lee, a British computer scientist and is now the primary platform of the Internet.

Xx

- **X-Y Plotter**

a computer-driven printing mechanism that draws coordinate points in graph form.

Zz

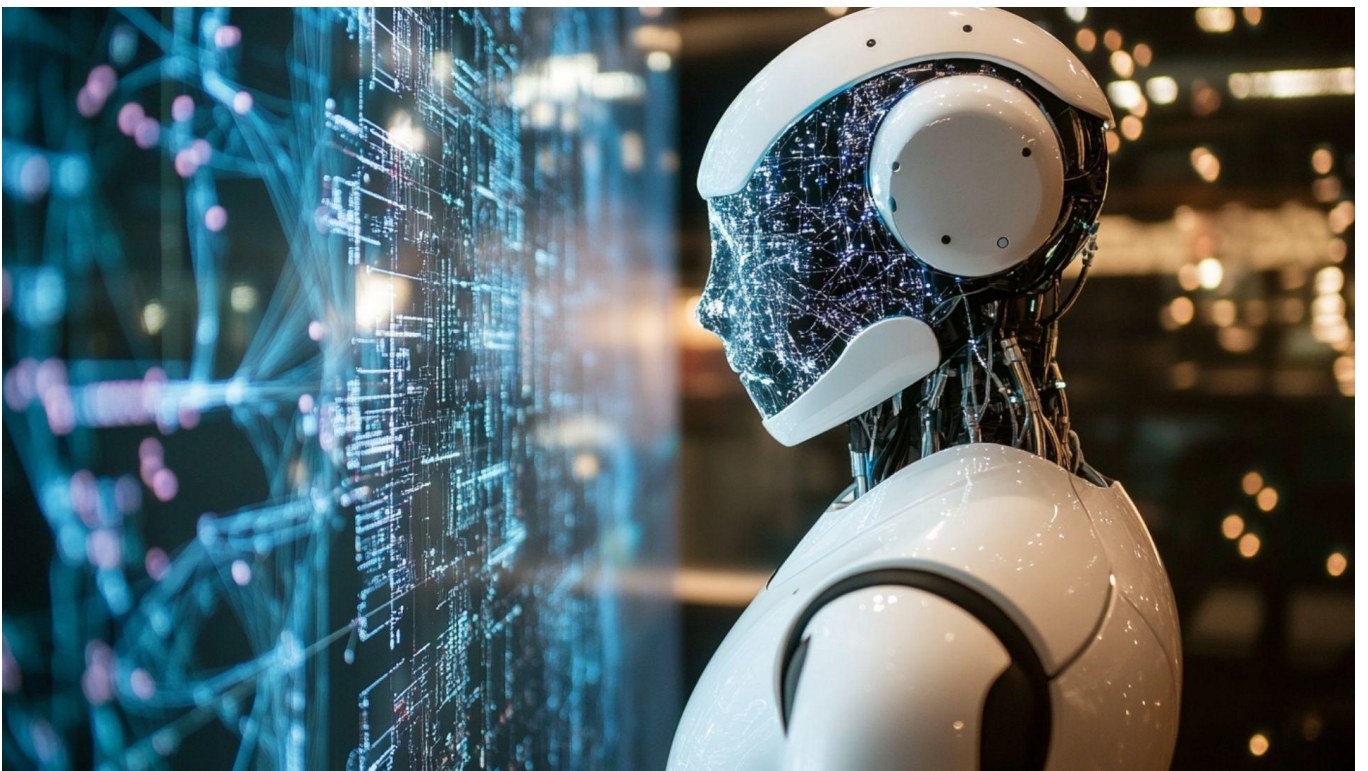
- **ZIP (Zone Information Protocol)**

an application that allows for the compression of application files.

- **ZOOM**

the enlarging or reducing an image displayed on a computer process of proportionately monitor.

ENGLISH FOR CYBERNETICS



Aa

- **A fortiori analysis**

a method of treating uncertainty that stacks the cards against one alternative (often the one intuitively preferred) by resolving questions of uncertainty in favor of another alternative. If the initially preferred alternative is still preferable, one has a stronger case in its favor.

- **Adaptation**

a form of behavior is adaptive if it maintains the essential variables within physiological limits. For example, the amount of carbon dioxide in the blood is important in its effect on the blood's alkalinity. If the amount rises, the rate and depth of respiration are increased, and carbon dioxide is exhaled at an increased rate. If the amount falls, the reaction is reversed. By this means the alkalinity of the blood is kept within limits.

- **Algedonic loop**

a term used by Stafford Beer to describe the feedback an organism, organization or machine receives from the environment. The algedonic loop is the large feedback loop that goes outside the organism and, through reward or punishment, indicates the environment's response to the organism's behavior.

- **Analog computer**

A computer that represents data in terms of physical measures or quantities and proceeds along a continuum constituted by its components. Analog computers are especially suited for the solution of complex non-linear equations and for the simulation of multi-dimensional, parallel and continuous processes. There is no restriction on the physical processes analog computers may utilize. Most common media are fluids and gases which can be made to vary in numerous DIMENSIONS. Compared with digital COMPUTERS, the programming of analog computers is time consuming and limited in scope.

- **Atomism**

A scientific doctrine which maintains that all complex systems are aggregates of smaller ones and that any whole can therefore be understood entirely from the knowledge of its parts. E.g., an atomistic social theory insists that all social institutions and events can be exhaustively explained in terms of the actions of individuals. A radical application of this doctrine suggests dividing a given phenomenon into smaller and smaller units until they are no longer divisible. The resulting atoms are the ultimate constituents of the phenomena in question and until one has identified these there is nothing to investigate.

- **Autocatalytic**

referring to something whose occurrence at one point increases the probability that it will occur again at another point. If a property of a system is autocatalytic, then such a system is, so far as that property is concerned, essentially unstable in its absence. (Ashby, 1956, p. 196) Examples: life on the planet Earth, guarantees of civil liberties in one nation among many, a product for which there is a demand.

- **Autopoietic machine**

a machine organized (defined as a unity) as a network of processes of production, transformation and destruction of components that produces the components which: i) through their interactions and transformations regenerate and realize the network of processes (relations) that produced them; and ii) constitute it as a concrete unity in the space in which they exist by specifying the topological domain of its realization as such a network.

Bb

- **Back channel communication**

communication which travels through informal rather than formal channels. Governments and players in bureaucracies use back channel or informal communication to test reactions while maintaining deniability.

- **Basin**

a subset and part of a partition of a system's states such that no state in one basin succeeds or is succeeded by states in another basin and any two state in one basin share at least one preceding state or successor. Inasmuch as behavior is defined as a sequence of states, the partition of a system's states into basins is also a partition of that system's possible behaviors, each defining a separately analysable behavior space or region thereof. Each basin may have one or more sets of equilibrium states. Ashby visualized a basin as a geographical area, fully surrounded by mountainous water sheds within which all rivers end up in one or more lakes.

- **Bifurcation**

a bifurcation is the appearance of an additional pattern of behavior or sequence of states for a system. Generally we have successive bifurcations where we increase the value of some characteristic parameter. One can think of a per-son traveling down a road. The farther the traveler goes, the more side streets or alternative routes appear. In a sense the bifurcation introduces history. To know the state of a system at any time implies a knowledge of the paths taken or not taken.

- **Black box method**

a strategy for investigating a complex object without knowledge or assumptions about its internal make-up, structure or parts. The method aims at either a formal description of the transformation rules linking inputs and outputs or the construction of a model exhibiting a behavior that approximates what is observable from the

outside of the "black box". Initially, the method codified the experiments an engineer would have to perform with a sealed piece of equipment in order to deduce what it does or how it could have been wired. The method is quite general, however. E.g., the linguist who can not utilize available knowledge of brain tissue for understanding linguistic production find himself in a similar situation. The resulting model of a black box is considered "grey" inasmuch as its structure is known, save for the knowledge of the internal make-up of that model's parts. The black box method applies to an extreme case. In practice an investigator may find and should utilize clues to the internal processes by non-experimental means. So, the engineer may conclude from the absence of a wire that a particular switch has nothing to do with a certain component just as the linguist may obtain insights about the use of language by being competent in that language himself. The isomorphism between the black box and its model, which the method aims to establish, does not imply structural correspondences between the two. One may be a mechanical device, a chemical process or human organ, the other may be a mathematical formula, an algorithm or electronic piece of equipment. However, the organization of such a model often leads to fruitful hypotheses concerning the structure of the black box.

Cc

- **Calculus**

a system of rules for the manipulation of characters as in the logical calculus or in the differential calculus. If the characters are SYMBOLs, a calculus provides the basis for the analysis of what the symbols represent collectively and individually. information theory is a calculus for analysing the amount of entropy in an observed system into various quantities of information exchanged within that system.

- **Causality**

a process linking two or more events or states of affairs so that one brings about or produces the other. One event is the cause of another if (a) the event occurs prior to the effect, (b) there is an invariant conjunction of the two events and (c) there is an underlying mechanism or physical structure attesting to the necessity of the conjunction. Since (c) is not always demonstrable in empirical data the requirement may be replaced by tests assuring that no third variable controls both or mediates between the two events. Without this weaker test, a cause may be termed spurious and genuine otherwise. Social events are rarely uni-causal phenomena and as deterministic as in the natural sciences. Causality in the social sciences therefore tends to be multi-causal and probabilistic. Philosophy of science has devoted much attention to the role of causality in scientific CONSTRUCTs. The theoretical importance of causal EXPLANATIONS is that one can apply them to explain what happened and predict what will happen. Their practical importance is that they lead one to produce or to prevent causally related events by direct or indirect intervention.

- **Channel capacity**

very similar to information processing capability; the number of messages per unit time handled by either a link or a node (system, element). The messages transmitted may be either similar or different. It is usually measured in bits per second.

- **Closed system**

an isolated system having no interaction with an environment. A system whose BEHAVIOR is entirely explainable from within, a system without input. Systems may be variously closed to matter/ENERGY, to information, and/or to organization. Systems closed to energy are autark, systems closed to information are independent, and systems closed to organization are autonomous. Biological organisms are largely closed to organization, the latter being specified by the dna at the point of inception. The output has nothing to do with whether a system is closed. Systems without output are non-knowable through observation from the outside.

- **Combinatorics**

That branch of mathematics concerned with the variety of combinations of elements that are possible within given constraints including the number of selections, permutations, arrangements, patterns, and organizations a system is capable of. Combinatorics is central to statistics and information theory.

- **Computer conferencing**

enables humans to conduct a conference even though widely scattered geographically, by communicating through a computer network. Each conferee has a MAILBOX--a reserved section of computer memory--to which messages may be sent by other conferees from their terminals. In addition to MESSAGES a computer conferencing system can include CONFERENCES and NOTEBOOKS. These are different ways of storing comments in computer memory and controlling who has access to the material.

- **Computing**

(from com-putare) literally, to reflect, to contemplate (putare) things in concert (com-). Any operation, not necessarily numerical, that transforms, modifies, rearranges or orders physical markers in a medium. The physical markers maybe objects or events in their own right as in the computations carried out by the human cell or they may be symbols and descriptions of events as in data processing by a man-made computer. The early (1936) concept of computing by a Turing Machine involved writing and erasing characters by specific rules on a theoretically infinite

tape. Examples are the simple permutation of the three letters A, B, C into C, A, B, the obliteration of the commas between them, yielding CAB, and the semantic transformation that changes CAB into TAXI, the recursive association of various adjectives before TAXI, etc. (von Foerster). Although computation by electronic computers is largely geared toward a desirable result computing does not imply a purpose.

- **Correspondence principle**

any new theory, whatever its character--or details--should reduce to the well-established theory to which it corresponds when the new theory is applied to the circumstances for which the less general theory is known to hold. This principle was first applied to the theory of atomic structure by Niels Bohr in 1923. (Weidner and Sells, 1960, p. 29) The principle can be applied to great advantage in relativity theory and in quantum mechanics. It can also be applied to the LAW OF REQUISITE variety, the principle of self-organization, and the more recent interpretations of the possibility of objectivity.

Dd

- **Data bank**

an organized and comprehensive collection of data, typically stored on Hollorith cards, magnetic tapes or disks and accessible for selective retrieval by a computer.

- **Digital computer**

a computer that stores data in terms of digits (numbers) and proceeds in discrete steps from one state to the next. The states of a digital computer typically involve binary digits which may take the form of the presence or absence of magnetic markers in a storage medium, on-off switches or relays. In digital computers, even letters, words and whole texts are represented digitally. Unlike analog computers, digital computers can only approximate a continuum by assigning large numbers of digits to a state description and by proceeding in arbitrarily small steps.

- **Domain**

generally a limited region or field marked by some specific property. In mathematics, it can have a somewhat more specialized meaning.

- **Dysfunction**

an attribute used by the structural-functional school of sociology to indicate a social action that does not enhance the adaptability of the social system in which it occurs. In contrast, a function enhances that adaptability.

Ee

- **Economy of scale**

relative saving realized when the size of a plant, enterprise, etc., is increased. For example, lower production cost of an automobile due to production of a large number of cars of the same type is due to economy of scale. There may also exist a DISECONOMY OF SCALE where the increased size contributes to an increase in unit cost.

- **Encoding**

the process of applying a suitable code to an original message in order to change its form into one which is more advantageous for transmission, storage, reading, etc. In cryptography, the task of enciphering is one of encoding a readable message into a form that unauthorized receivers cannot easily decipher. In human communication, the process of translating mental imagery into linguistic expressions is characterized as encoding just as is the process, embodied in a microphone, of converting acoustical signals into electrical impulses.

- **Error detecting code**

an encoding code which correctly identifies messages that contain transmission errors of up to a certain number per message without the ability to correct them. A code is error detecting only if the hamming distance between the messages sent exceeds the number of transmission errors per message.

Ff

- **Fail safe**

a property of a system in which failure is impossible.

- **First-order cybernetics**

the cybernetics of systems that are observed from the outside as opposed to the cybernetics of systems involving their observers (von Foerster). First-order cybernetics is concerned with circular causal processes, e.g., control, negative feedback, computing, adaptation.

- **Frequency**

the number of times a category of events, of objects or of individuals has been observed, the number of members in a class.

- **Function**

(1) Metaphor, that image which determines another image. (Rogers) (2) An association of a certain object(s) from one set with each object from another set (mathematics). (Rogers) (3) The normal or characteristic action of a system of entities, generally in time. (Iberall) (4) The variation of some magnitude that depends upon the variation of some other magnitude. (Iberall) (5) a notion that arises in the description made by the observer of the components of a machine or system in reference to an encompassing entity, which may be the whole machine or part of it and whose states constitute the goal that the changes in the components are to bring about. In mathematics, a relation between two or more variables so that the values of one are dependent on, determined by or correspond to values in the other variables, its arguments; a TRANSFORMATION whose range is uniquely specified by its domain. In algebra and set theory, functions are often called many-to-one mappings or images. In processes of communication, functions are found in equivocating codes. There is no presumption that a function must take numbers as arguments, nor that the correspondence be lawful. It can result from entirely arbitrary conventions. The structural-functional school of sociology sees the parts of a social system to

behave in such a way that they satisfy human and social needs and maintain one another and the totality. In this theory, regularly occurring acts that serve this purpose are called functions whereas those opposed to this are called dysfunctions.

Gg

- **Game**

a set of moves which are defined by a set of rules limiting what the players may do. A game may or may not be a simulation. A game does not necessarily involve a representation of events in a reference system.

- **Goal formulation**

the process of deciding what the next goal to be sought will be.

Hh

- **Hamming distance**

a measure of the difference between two messages, each consisting of a finite string of characters, expressed by the number of characters that need to be changed to obtain one from the other. E.g., 0101 and 0110 has a Hamming distance of two whereas "Butter" and "ladder" are four characters apart.

- **Heteropoiesis**

the space of human design.

- **Holism**

the process of focusing attention directly on the whole and its characteristics as a whole, without any recourse to consideration of its parts. A philosophical position claiming (a) that wholes cannot be taken apart and (b) that every apparent whole can be understood only in the context of the larger whole containing it. This belief is epitomized in the statement that "a whole is more than the sum of its parts". Although the position has merits, the infinite regression implied in the two-headed claim leads the wholist to believe in a hierarchical organization of the world. To understand anything requires him to explore larger and larger contexts, to seek refuge in increasingly universalistic kinds of understandings which renders him unable to simultaneously understand and cope with the particulars of a situation he started out with.

- **Homeostatic machines**

machines which display the condition of maintaining constant or within a limited range of values some of their variables.

Ii

- **Icon**

a sign that informs by its physical resemblance or similarity with features of its referent.

- **Impact**

impact is used in three different ways: (1) as synonymous with consequence; (2) to mean any consequence (beneficial or adverse) that reaches beyond the direct purpose of a given course of action, as in: "the impact of the new steel plant on employment opportunities in the region;" (3) as in (2), but the meaning restricted to adverse consequences, as in the impact of industrial growth on the ecological environment.

- **Incompleteness theorem**

Goedel's thesis initially about number theory but now found applicable to all formal systems that include the arithmetic of natural numbers: "any consistent axiomatic system does include propositions whose truth is undecidable within that system and its consistency is, hence, not provable within that system". The self-reference involved invokes the paradox: "a formal system of some complexity cannot be both consistent and decidable at the same time". The theorem rendered Frege, Russell and Whitehead's ideals of finding a few axioms of mathematics from which all and only true statements can be deduced non-achievable. It has profound implications for theories of human cognition, computational linguistics and limits artificial intelligence in particular.

- **Informatics**

a term designating the study of all information processing systems, artificial and natural, and the application of knowledge gained in such efforts to design and implement digital computers in society. In practice, informatik includes (the largely U.S.) computer science, the more application oriented efforts of management information systems, automation or production but also data processing including statistics for decision making. Because of its technological commitments, informatik

has de-emphasised the study of information flows and computation within organisms and largely ignored the organisational consequences of information flows, human communication and the use of computers in large social systems. Epistemological considerations which are characteristic in cybernetics are absent in informatik.

- **Information**

literally that which forms within, but more adequately: the equivalent of or the capacity of something to perform organizational work, the difference between two forms of organization or between two states of uncertainty before and after a message has been received, but also the degree to which one variable of a system depends on or is constrained by another. E.g., the dna carries genetic information inasmuch as it organizes or controls the orderly growth of a living organism. A message carries information inasmuch as it conveys something not already known. The answer to a question carries information to the extent it reduces the questioner's uncertainty. A telephone line carries information only when the signals sent correlate with those received. Since information is linked to certain changes, differences or dependencies, it is desirable to refer to theme and distinguish between information stored, information carried, information transmitted, information required, etc. Pure and unqualified information is an unwarranted abstraction. information theory measures the quantities of all of these kinds of information in terms of bits. The larger the uncertainty removed by a message, the stronger the correlation between the input and output of a communication channel, the more detailed particular instructions are the more information is transmitted.

- **Information environment**

the messages, symbols, meanings, that a person encounters in an average day through conversations with other persons and through the media. People inhabiting nearly the same physical environment can live in very different information environments. An example would be people working on a university campus or in an international organization.

- **Information system**

a system of functions concerning the acquisition and transfer of information, the carriers of which can be biological, personal, social or technical units. An information system is dedicated to a certain kind of information (topic), even if this may be a very broad one. It has always the purpose of providing information to a user or a group of users. In most cases a storage device is part of an information system.

- **Iteration**

a process for computing something by repeating a cycle of operations. Although circular and repetitive processes can be divergent, iteration should converge to the desired result, improving the approximation with increasing numbers of cycles.

Jj

- **Jump phenomena**

in many fields, there are surfaces of discontinuity on both sides of which the field phenomena change drastically. The change in conditions between the two sides is said to be described as a jump and represents jump phenomena.

Kk

- **Kluge**

something not designed as a whole but rather put together from available parts. The term is frequently used by engineers. Marvin Minsky has described the human brain as a kluge.

LI

- **LAG**

Metaphorically, trailing behind. In development, some variables may change faster than others and if they are dependent on each other these temporal differences, called Lag, can cause structural stress within a system. E.g., in modern society, institutional developments tend to lag behind changes in technology causing many social problems from alienations to social inequalities and conflicts. In cybernetics, lag refers to the time for information to pass through one complete feedback loop. Lag makes regulation difficult. E.g., if the time for a gunner to obtain information about his target plus the time for his projectile to reach its destination is large, a hit is considerably more difficult than if that lag is small. A regulator's lead may compensate for the lag in a feedback loop.

- **Law of diminishing returns**

an economic principle asserting that the application of additional units of any one input (labor, land, capital) to fixed amounts of the other inputs yields successively smaller increments in the output of a system of production.

- **Law/legal regulations**

rules and regulations of general validity which are formally adopted and proclaimed by formal legislative or jurisdictional bodies (including case law).

- **Limit cycle**

in a linear system (such as a vibrating string of a pendulum), if the system is displaced (the string plucked), it will start to vibrate or oscillate. However, by the second law of thermodynamics the system will decay to rest. In a non-linear system, e.g., a watch, a human being, a working engine, supplied with a constant source of fuel or energy, it is possible to obtain configurations such that if the system has started vibrating, oscillating or running, it will continue if the cycle thus formed operates independent of the precise initial starting conditions, in spite of the fact that

the system is lossy and in spite of moderate disturbances that try to slow the process down or speed it up, then it is said to be a limit cycle.

- **Logarithm**

a function expressing any number by the exponent of a chosen base. E.g., with $512=2^{**9}$, the dual logarithm (to the base 2) of 512, written $\log_2 512$ equals 9. Logarithms are used in the quantitative definition of information and are fundamental to the algebraic properties which information theory codifies. Its base of 2 assures the interpretation of that at function in terms of the number of binary decisionS. Decimal logarithms have a base of 10 and natural logarithms a base of 2.71828.

Mm

- **Machine**

a unity in the physical space, defined by its organization, which connotes a non-animistic outlook, and whose dynamisms are apparent.

- **Management**

the process of governing a country or administering an enterprise including the development of corporate strategy and longrange planning on the top and the regulation, coordination and control of such activities as production, accounting, marketing, personnel, research and development in the middle, the supervised operations being performed below. One key to effective management is the adequate flow of information between and within strategic, functional and operational levels so as to allow for timely and appropriate decisions to be made. Management information systems constitute a technological solution to information flow problems. Another key is the form of control exercised through spelling out objectives providing incentive schemes for production as well as cooperation, etc.

- **Mechanical phenomenology**

the phenomenology generated by relations between processes realized through the properties of components.

Nn

- **Negentropy**

A non-recommendable near synonym for information. The term has created considerable confusion suggesting that information processes negate the second law of thermodynamics by producing order from chaos. The history of the confusion stems from the mere formal analogy between Boltzmann's thermodynamic expression for entropy $S = k \log W$ and the Shannon-Wiener expression for information $H = -\log_2 p$. The only motivation for the negative sign in the latter is that it yields positive information quantities (the logarithm of a probability is always negative). The probability p of an event and the thermodynamic value W including Boltzmann's constant k measure entirely different phenomena. A meaningful interpretation of negentropy is that it measures the complexity of a physical structure in which quantities of energy are invested, e.g., buildings, technical devices, organisms but also atomic reactor fuel, the infrastructure of a society. In this sense organisms may be said to become more complex by feeding not on energy but on negentropy (Schroedinger).

- **NET**

Adjective indicating the essence of a quantity, e.g., net income, the income from which all costs to generate it are subtracted, net population growth, a population's birth rate adjusted by its mortality, net energy, the energy extracted minus the energy consumed in the extraction process.

- **Noosphere**

A term modelled after atmosphere and biosphere signifying (a) the space occupied by the totality of information and human knowledge collectively available to man and (b) the processes operating in this space, e.g., combinatorial mating, classification, reproduction, simplification, selective decay.

Oo

- **Objective**

an objective is something that a decision maker seeks to accomplish or to obtain by means of his decision. A decision maker may have more than one objective (the MULTIPLE-OBJECTIVES case). An objective may be specified in a more or less general fashion, may be quantified or not quantified, and is usually part of a hierarchy of objectives. The term goal is sometimes used to denote a very general objective(at the top of the hierarchy) and TARGET is used to mean a very definite objective. Example: "The goal of allocating money to the municipality was to increase the quality of urban life. The immediate objectives were to improve public transportation and fire services. A 10% reduction of average travel time from home to work and a 70% decrease of average alarm-to-action time taken by the fire brigades were set forth as targets.

- **Operation**

a basic process that applies to an operand and yields a transform, e.g., the multiplication of two numbers, driving a nail with a hammer, baking. A transformation describes an operation, sometimes in terms of an algorithm.

- **Operationalization**

the specification of measurable empirical referents for abstract definitions, concepts, and hypotheses.

- **Optimization theory**

a mathematical technique for determining the most profitable or least disadvantageous choice out of a set of alternatives. Typically the set of alternatives is restricted by several constraints on the values of a number of variables and an objective function locates the optimum in the remaining set. The method is largely used in operations research and systems analysis, e.g., for optimal scheduling of production processes, for determining the best way for transporting a certain commodity.

- **Output**

any change produced in the surrounding by a system. A variable at the boundary of an organism or machine through which information exits. The products, results or the observable parts (*see* subsystem) of a system's behavior. The medium through which a system may exogenously control others. The record left behind by a system of its own behavior. An output could conceivably include all of a system's behaviors, but it becomes an informative concept only if some of its variables remain inaccessible to an observer or have no effect. E.g., a computer prints or displays only the final results of a lengthy computation thus invoking the distinction between output and internal (intermediate and inaccessible) variables. Human cognitive processes remain similarly hidden from view and are therefore distinct from the primary verbal, manual and gestural output of man. Here, output is the overt manifestation of human (including cognitive and hormonal) behavior.

Pp

- **Paradigm**

an outstandingly clear or typical example or archetype. (Webster's) (2) The total pattern of perceiving, conceptualizing, acting, validating, and valuing associated with a particular image of reality that prevails in a science or a branch of science. (Kuhn) (3) A theoretical model to explain a type of social behavior. (Dict. of Anthropology) The pattern underlying the process of constructing theories and explanations and thereby affecting the form of the body of knowledge within a social domain, e.g., within 18th century science. Paradigms carry their own source of justification and are therefore less obviously related to or challenged by empirical evidence. Kuhn describes the history of science as a succession of paradigms, transitions resulting not only from the emergence of empirical phenomena an existing paradigm is unable to explain but also from socio-political interests within the scientific community.

- **Paradox**

a tenet contrary to received opinion; a statement that is seemingly contradictory or opposed to common sense and yet perhaps is true; a self- contradictory statement that at first seems true; an argument that apparently derives self-contradictory conclusions by valid deduction from acceptable premises. (Webster's) A paradox is not the same as a contradiction. "The shirt is blue; the shirt is not blue," and "It is raining; it is not raining," are examples of contradictions. A paradox occurs when one makes an assumption and, following a logical argument, arrives at the converse. A paradox will always result when one formulates a set that contains itself.

- **Perfect information**

a characteristic of a situation in which all data relevant to a problem is known. Numbers are available for all variables necessary for a solution, through some of the numbers may be the result of estimates rather than measurements. Perfect in this context refers to completeness with no implied judgment about quality.

- **Physical space**

the space within which the phenomenology of autopoiesis of living systems takes place.

- **Polystable system**

a state-determined system that has partial, fluctuating, and temporary independencies within the whole. Its parts have a high proportion of equilibrial states. A polystable system can be richly joined, so that almost every variable is joined to almost every other, or it can be poorly joined. A polystable system midway between the two will show a somewhat confused picture. Subsystems will be formed with kaleidoscopic variety and will persist only for short times; some will be stable for a brief interval, only to be changed and to disintegrate. The number of stable variables will tend to climb as a few subsystems become stable, only to fall back by a larger or smaller amount as they become unstable. The oscillations will be large until all subsystems become stable at the same time. Then the system as a whole will remain stable.

Rr

- **Random**

attribute of a process that is entirely or largely governed by chance, e.g., a roulette wheel, dice, the brownian movement, but also the pattern on the screen of a television set receiving atmospheric noise only. Perfect randomness rarely exists in nature and is difficult to simulate. In practice, randomness is confined by particular parameters, e.g., a roulette wheel is expected to be random only within a range of numbers, not regarding how long the wheel takes to pick one, and it may even deviate from the ideal of uniform probabilities , e.g., when the roulette wheel is biased. The simulation of randomness by computers utilizes so-called pseudo random generators whose behavior is nearly impossible to predict without knowledge of the starting number and its algorithm.

- **Recursive system theory**

in a recursive organizational structure any viable system contains, and is contained in a viable system.

- **Reification**

treatment of an analytic or abstract relationship as though it were a concrete entity.

- **Responsibility**

accountability of an individual for decisions and behavior under his control by virtue of his public role, office, charge or duty and to the public which endowed him with that role, office, charge or duty. Responsibility is constitutionally embedded within an autonomous system, e.g., in the public.

- **ROM**

(Read Only Memory) A memory, particularly in small computers, from which information is recalled in the same (or the reverse) order in which it was entered, e.g., from the left to right, line by line like removing beads from a necklace or in terms of whole chips. Random access is not possible.

Ss

- **Safe fail**

a property of a system which can recover from failure.

- **Scientific method**

a sequence of procedures intended to produce agreement among a set of observers, for example: 1. Define a problem, 2. Gather pertinent data, 3. Form a working hypothesis or explanation, 4. Do experiments to test the hypothesis, 5. Interpret the results, 6. Draw a conclusion and modify the hypothesis as needed.

- **Sensitivity analysis**

a procedure to determine the sensitivity of the outcomes of an alternative to changes in its parameters (as opposed to changes in the environment); If a small change in a parameter results in relatively large changes in the outcomes, the outcomes are said to be sensitive to that parameter. This may mean that the parameter has to be determined very accurately or that the alternative has to be redesigned for low sensitivity.

- **Statistical entropy**

a measure of variation or diversity defined on the probability distribution of observed events. Specifically, if P is the probability of an event a , the entropy $H(A)$ for all events a in A is: $H(A) = -\sum_a P_a \log_2 P_a$ The quantity is zero when all events are of the same kind, $p = 1$ for any one a of A and is positive otherwise. Its upper limit is $\log_2 N$ where N is the number of categories available and the distribution is uniform over these, $p = 1/N$ for all a of A The statistical entropy measure is the most basic measure of information theory.

- **Systems analysis**

this term has many different meanings. In the sense adopted for the Handbook, systems analysis is an explicit formal inquiry carried out to help someone (referred to as the decision maker) identify a better course of action and make a better decision than he might otherwise have made. The characteristic attributes of a problem situation where systems analysis is called upon are complexity of the issue and

uncertainty of the outcome of any course of action that might reasonably be taken. Systems analysis usually has some combination of the following: identification and re-identification) of objectives, constraints, and alternative courses of action; examination of the probable consequences of the alternatives in terms of costs, benefits, and risks; presentation of the results in a comparative framework so that the decision maker can make an informed choice from among the alternatives. The typical use of systems analysis is to guide decisions on issues such as national or corporate plans and programs, resource use and protection policies, research and development in technology, regional and urban development, educational systems, and health and other social services. Clearly, the nature of these problems requires an interdisciplinary approach. There are several specific kinds or focuses of systems analysis for which different terms are used: A systems analysis related to public decisions is often referred to as a POLICY ANALYSIS (in the United States the terms are used interchangeably). A systems analysis that concentrates on comparison and ranking of alternatives on basis of their known characteristics is referred to as decision analysis.

Tt

- **Technical assessment**

assessment (analysis and normative evaluation) of a particular technical device, system, or procedure with regard to a defined set of criteria, goals or objectives (e.g. technical security assessment according to the standards of the Orange Book).

- **Technological determinism**

the belief that technology develops by its own laws, that it realizes its own potential, limited only by the material resources available, and must therefore be regarded as an autonomous system controlling and ultimately permeating all other subsystems of society. Evidence for the first proposition is largely taken from the natural history of technology, its progressive character and the cooccurrence of independent inventions. Evidence for the second proposition stems from the unwarranted generalization that everything that is invented is ultimately installed and ignores human playfulness, individual and collective interests and man's cognitive limitations. The conclusion is nevertheless supported by the fact that technology has indeed penetrated all spheres of human existence from interpersonal communication, to definitions of the quality of life in technological terms.

- **Tenth theorem of information theory**

with the addition of a correction channel equal to or exceeding in capacity the amount of noise in the original channel, it is possible to so encode the correction data sent over this channel that all but an arbitrarily small fraction of the errors contributing to the noise are corrected. This is not possible if the capacity of the correction channel is less than the noise. This theorem is an isomorph of the law of requisite variety.

Uu

- **Ultrastability**

the ability to modify internal relationships and/or to influence environmental conditions in the interests of neutralizing actual or potential obstacles to the maintenance of stability. The ability of a system to change its internal organization or structure in response to environmental conditions that threaten to disturb a desired behavior or value of an essential variable. The changes such systems are capable of are qualitative in the sense of changing the mode of interaction with an environment in steps or jumps, not along a continuum, and they are purposeful because such systems seek a behavior that is disturbance defying. Ultrastability is stability of a logical level higher than the stability to which a system converges without change of its internal organization or structure. Ashby's homeostat was the first mechanical demonstration of this form of stability heretofore reserved to living organisms.

- **Unity**

that which is distinguishable from a background, the sole condition necessary for existence in a given domain. The nature of a unity and the domain in which the unity exists are specified by the process of its distinction and determination; this is so regardless of whether this process is conceptual or physical.

Vv

- **Validation**

the process of determining how well one system replicates properties of some other system or, more generally, any comparison between the representation of a system and specified criteria. The validation of an operating model cannot be separated from the purpose for which it is designed and used. Validation is the process of increasing the confidence that the outputs of the model conform to reality in the required range. In some cases, the model's output can be compared to data from historical sources or from an experiment conducted for validation. A model can never be completely validated. We can never prove that its results conform to reality in all respects. It can only be invalidated. Predictive models be validated only by judgment, since a model may fit past data well without having good predictive qualities.

- **Verification**

a (computer) model is said to be verified if it behaves in the way that the model builder wanted it to behave. This means that the instructions are correct and have been properly programmed. One check for verification is to hold some of the variables constant to determine whether the output changes in anticipated ways as other variables are changed. Another typical check is to test how the model behaves in limit situations.

Ww

- **Whole**

without recognition of its parts a whole is an essentially structureless and unanalyzable unity. If its parts are independent or randomly sampled by an observer, a whole has no outstanding quality other than that of being an observer's aggregate. If a whole is qualitatively different from a mere aggregate of its parts, the difference lies in its structure or organization. Thus any whole may be understood as, described in terms of, and considered equal to a structure or an organization of component parts. In some cases the properties of its parts may be ignored without appreciable loss of understanding a whole, particularly when parts are numerous, simple and the same as in the objects of computer sciences, macro-economics, and quantum physics all of which heavily rely on mathematics for their constructions. When the parts are few, complex, different, and tenuously related, as in a marriage, the properties or the parts figure more prominently in the understanding of a whole and can not be ignored in favor of such wholes' organization.

ENGLISH FOR BIOTECHNOLOGY



Bb

- **Biotechnology (or Biotech)**

Biotechnology (or Biotech) has evolved to include an array of complicated processes that utilize the natural systems found in living things. The resulting technologies are then applied to a wide range of purposes, including for the environment and health care as well as food production and food safety. For example, biotech tools called Marker Assisted Selection can provide the DNA sequence of specific traits in animals or crops without changing their DNA. Biotechnology has supported the creation of non-soil (hydroponic) methods to grow vegetables. However some have used the word “Biotech” interchangeably with “GMO”, “Genetically Engineered” and “Bioengineered” to mean seeds or animals that have been changed to include DNA from another species.

To further confuse things, various organizations have created their own standards for what qualifies as GMO or for non-GMO. The criteria are varied and sometimes self-serving for the locality or industry involved. That’s why, in 2016, Congress passed a law requiring a uniform nation-wide standard for disclosure (labeling) of “Bioengineered” foods. We’ve created the following guidance to help food retailers better respond as customers ask questions about product labels or see news reports on the topic.

- **Bioengineering/Bioengineered Food**

A mandatory labeling claim to be used on many foods and dietary supplements with at least one ingredient that has measurable DNA from another species. The law, to be implemented by 2022, does not include food made from animals that have either been fed or treated with bioengineered products. Nor does it require labeling of foods that are so highly refined that no measurable DNA is present. See also “Derived from Bioengineering.”

Cc

- **Chromosome**

A strand of DNA stored in cells that can replicate itself and divide when each cell divides for growth or repair. Humans have 23 chromosomes in our genome which contains the genetic blueprint for every cell in our bodies.

- **CRISPR**

A gene editing tool that mirrors the way that cells repair damaged DNA. Was first demonstrated in 2013. CRISPR allows scientists to make edits in precise places along a DNA strand. Also known as Clustered Regularly Interspaced Short Palindromic Repeats.

- **Cross-Breeding**

Deliberately inter-breeding (crossing) related individuals to produce new varieties. For example, Pluots are the result of cross-breeding apricots with plums. Multiple generations of back-crossing are needed to obtain the desired traits with any unintended traits removed. Also called conventional, traditional or selective breeding.

Dd

- **Deoxyribonucleic Acid (DNA)**

Is a double stranded molecule that holds genetic codes and is found in all living things. DNA forms the genes that provide inherited traits. It tells cells what proteins to make for growth and metabolism.

- **Derived from Bioengineering**

A food labeling claim used voluntarily on any food or dietary supplement that does not contain DNA from another species. However, at least one ingredient in the product was made through bioengineering. Examples include dairy products from cattle treated with a bioengineered hormone (rBST) to enhance milk production or meats from animals that were fed bioengineered crops like corn, soybeans or alfalfa. This claim could also be used on products that are so highly refined that no DNA is present. Examples could include refined corn, soybean and canola oils.

Ee

- **Enzyme**

Are vital proteins that speed up the chemical reactions taking place within cells. For example, they aid in digestion, metabolism and immune function.

Gg

- **Gene**

The most basic unit of heredity. Includes a segment of a DNA strand that is able to direct a specific function in the body.

- **Gene Editing**

Involved in food production as a breeding method to improve both plants and animals. Also promising as a bio-medical tool to address inherited diseases. It starts with a clear understanding of the genetic sequence and DNA location of selected traits. Uses an enzyme system to precisely edit (turn on, turn off or add to) the DNA. Gene Editing typically does not add DNA from another species but rather works with traits that are already found in a given species, therefore labeling is not usually required.

- **Genetic Engineering**

Involves direct manipulation of the genetic material of a living thing, for example, creating a bacteria to produce human insulin and other medications. Includes a number of different technologies including Recombinant DNA (GMO) and Gene Editing. Can be used to insert genes or knock them out, either randomly or to a specific part of the genome. This term had previously been used interchangeably with Biotech or GMO. However, it is not currently a regulated food labeling term, like “Bioengineered”.

- **Genetic Trait**

Characteristics of a plant or animal that are encoded within their genome and thereby inherited from generation to generation.

- **Genome**

The complete genetic blueprint of a living thing, containing all of its genes and DNA.

Genome Editing

- **GMO (Genetically Modified Organism)**

A plant, animal or microorganism with new or enhanced genetic traits. A DNA sequence from another living thing, often from a different species, is introduced into the genome. Also referred to as Recombinant DNA technology, Gene Spliced, Genetic Engineered or Transgenic. See “Bioengineered” for mandatory labeling info.

Mm

- **Mutagen**

Substances such as radiation or chemicals that can create random changes in the genetic material of living things.

- **Mutagenesis**

A biotech tool used by plant breeders for over 75 years. NOT considered genetic engineering or bioengineering. Seeds are treated with mutagens such as ionizing radiation or strong chemicals to induce random mutations to their genetic material, aiming for a desired trait. Examples include seedless watermelon and ruby red grapefruit. Currently allowed in both conventional and organic agriculture.

Nn

- **Non-GMO**

A voluntary labeling claim promoted by a group of food companies in 2009 when they formed the Non-GMO Project Verified. Requires a paper trail of affidavits to determine that ingredients in food products have not in any way been bioengineered or fed/treated with bioengineered substances. The absence of bioengineered disclosure does not mean that a product can be labeled as non-GMO. That's because bioengineered disclosure is only required when DNA from another species is present. Many non-GMO ingredients contain no measurable DNA even though they were made from or fed bioengineered crops.

Pp

- **Polyploidy**

Both wild and cultivated plants can have entire extra sets of chromosomes. Polyploidy (such as triploid and diploid) has been a major tool for plant breeders using traditional breeding techniques over the past century. NOT considered bioengineering. Plants with polyploidy can outperform relatives in several aspects. Hybrid corn can be an example.

- **Protoplast Fusion (Somatic Fusion)**

A type of genetic engineering where cells or cellular components from two different living things are combined. Able to transfer traits between species and potentially create an entirely different variety of plant. Currently allowed in both conventional and organic agriculture. One example: Triticale, a grain first made from fusing wheat with rye in the 1950s.

Rr

-

R

NA

Ribonucleic acid (RNA) is present in all living cells and acts as a messenger to translate instructions from DNA in order to make various proteins.

Ss

- **Species**

A group of living organisms that are capable of sharing genetic information through breeding (ie, they are sexually compatible)

- **Sustainability**

The ability to maintain conditions most often referring to the environment but also to economic, social or public health systems.

Tt

- **Transgenesis**

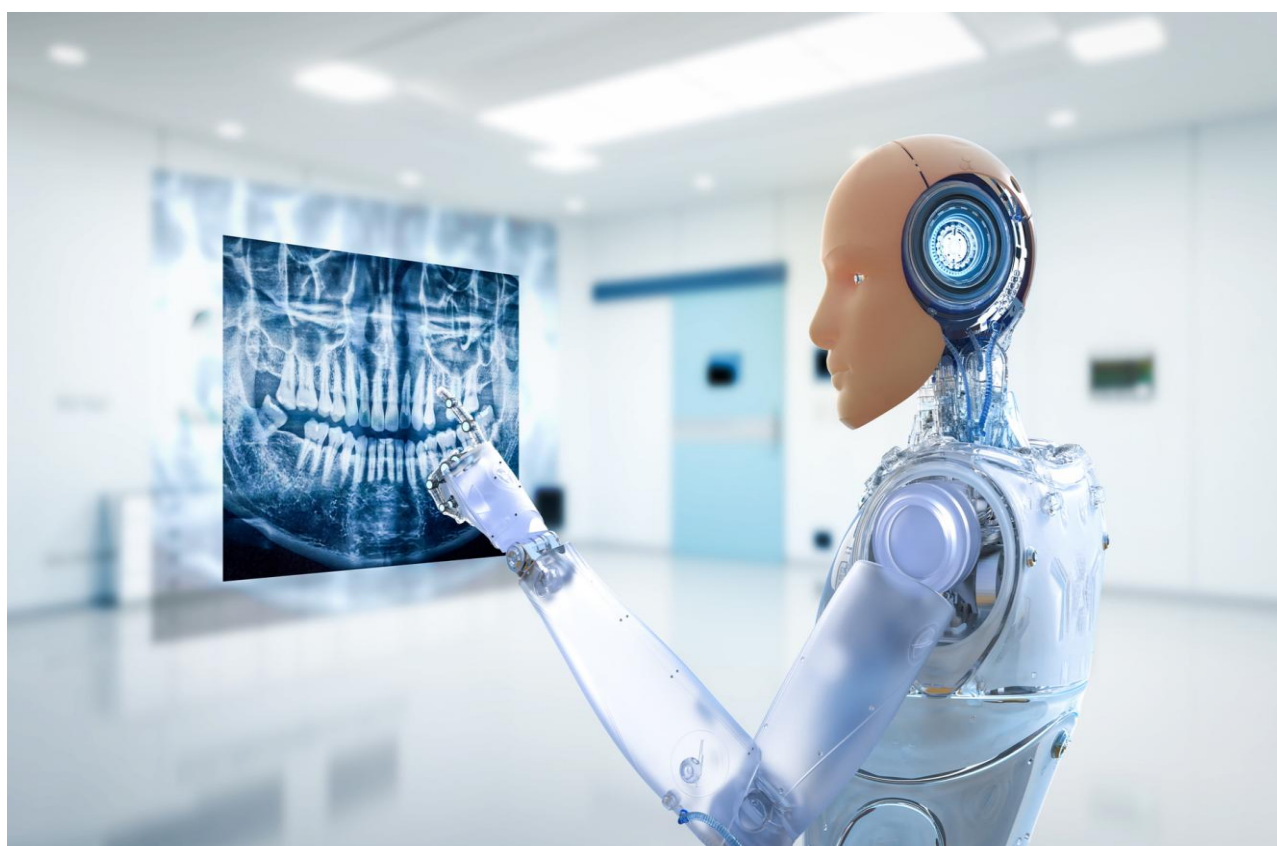
Involves addition of genetic material (DNA) from another species to create a new variety of plant or animal with desired traits. Also known as a GMO. Bioengineered labeling will be required in most food products that contain transgenic DNA.

Uu

- **USDA Certified Organic**

Does not allow several production methods common to modern agriculture. Organic products cannot be bioengineered, irradiated or be produced with antibiotics or certain pesticides. Nor can animals be fed bioengineered crops or be treated with medications produced through bioengineering. Other biotech methods, such as Mutagenesis, Marker Assisted Selection, Gene Editing, Hydroponics, Polyploidy and Protoplast Fusion have not yet been excluded from Certified Organic, however they are current topics of debate among organic stakeholders.

ENGLISH FOR DENTISTRY



Aa

- **Active Treatment**

The stage of orthodontic treatment is when teeth are being moved and/or jaws aligned.

- **Advanced periodontitis**

The most severe form of gum (periodontal) disease. It is a chronic infection of the gums caused by accumulation of plaque under the gum line. The plaque contains bacteria that produce toxins that destroy the soft tissue and bone that hold teeth in place. Pockets (spaces between the gum and the teeth) appear and deepen. Gums recede, and bone dissolves. Teeth can become loose and may have to be removed.

- **Aligners**

Clear, thin, removable trays that are formed to fit an individual's teeth and are used to straighten teeth. Patients are responsible for insertion and removal.

- **American Association of Orthodontists (AAO)**

The AAO is a professional association of educationally qualified orthodontic specialists who create healthy, beautiful smiles for their patients. The AAO only admits orthodontists as members. Orthodontists first graduate from dental school and then complete an additional two to three years of education in the orthodontic specialty at accredited orthodontic residency programs. Selecting an AAO member for orthodontic care is your assurance that the doctor is an orthodontist.

- **Anterior**

Front.

- **Appliances**

Any device used by an orthodontist, attached to the teeth or removable, designed to move the teeth, change the position of the jaw, or hold the teeth.

- **Arch**

Upper or lower jaw. The “dental arch.”

- **Archwire**

The metal wire that is attached to the braces and used to move the teeth.

- **Attachments**

The tooth-colored “bumps” are placed on teeth during clear aligner treatment. They help move the teeth while a patient wears aligners. They are removed once treatment is complete.

Bb

- **Band**

A metal ring, usually on a back tooth, that is cemented to a tooth for strength and anchorage.

- **Bite**

How top and bottom teeth come together. Ideally, each tooth meets its opposite tooth in a way that promotes functions such as biting, chewing and speaking. A bad bite is called a malocclusion. The goal of orthodontic treatment is to create an individualized healthy bite (ability to bite, chew, speak). Additionally, when teeth and jaws are in proper positions, it creates a pleasing appearance.

- **Blue Grass Appliance**

Used to help in the correction of a tongue thrust. Helps the patient retrain the tongue when swallowing, and can help correct an open bite.

- **Board-Certified Orthodontist**

An orthodontist who has completed the American Board of Orthodontics Specialty Certification exams. A board-certified orthodontist is known as a Diplomate of the American Board of Orthodontics. The American Board of Orthodontics is the only orthodontic specialty certifying board that is recognized by the American Dental Association. Board certification is voluntary for orthodontists.

- **Braces**

A word commonly used to describe a fixed orthodontic appliance, usually consisting of brackets, bands and wires.

- **Bracket**

The small metal, ceramic, or plastic attachment is bonded to each tooth with a tooth-colored adhesive. The bracket has a slot that the orthodontic wire fits into. Also known as a “brace.”

- **Bridge**

A replacement for a missing natural tooth/teeth that fills the opening between adjacent teeth. Most often, the existing adjacent teeth receive crowns and a prosthetic (false) tooth is attached to the crowns. This restores function, provides a good appearance, and maintains the shape of the face. Bridges do not last forever, eventually this will require replacement.

- **Brushing**

Brushing the teeth is part of an individual’s daily home dental care. Patients with braces should follow the orthodontist’s instruction on how often to brush.

- **Bruxism**

Grinding of the teeth, usually during sleep. Bruxism can cause abnormal tooth wear and may lead to pain in the jaw joints, facial and/or neck muscles and difficulty opening and closing the mouth.

- **Buccal**

A term orthodontists use to describe the cheek side of the back teeth in both jaws

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- **Buccal Tube**

A small metal part of the bracket is welded to the cheek side of the molar band. The tube may hold an archwire, lip bumper, headgear, facebow or other type of appliance an orthodontist may use to move the teeth.

Cc

- **Cephalometric Radiograph**

A side view x-ray of the head.

- **Chain**

A stretchable series of elastic o-rings connected together and placed around each bracket to hold the archwire in place and close the spaces between teeth. Also known as a “power chain.”

- **Class I Malocclusion**

A malocclusion in which the back molars meet properly, but the front teeth may appear to be crowded together or spaced apart. There may be an overbite, an openbite, a posterior (back) crossbite or an anterior (front) crossbite with a Class I Malocclusion.

- **Class II Malocclusion**

A malocclusion the lower teeth and/or jaw is positioned back relative to the upper teeth and/or jaw. This results the upper front teeth protruding forward.

- **Class III Malocclusion**

A malocclusion where the lower teeth and/or jaw is positioned ahead relative to the upper teeth and/or jaw.

- **Closed Bite/Deep Bite**

Also known as deep overbite, this occurs when the upper front teeth overlap the bottom front teeth an excessive amount.

- **Comprehensive Treatment**

Complete orthodontic treatment is performed to correct a malocclusion.

- **Cone Beam CT/CBCT**

A 3D x-ray.

- **Congenitally Missing Teeth**

A genetic occurrence in which permanent teeth do not develop.

- **Crossbite**

Upper back teeth are in crossbite if they erupt and contact inside or outside of the lower back teeth. Lower front teeth are in crossbite if they erupt in front of the upper front teeth. A crossbite can be a single tooth or groups of teeth.

- **Crown**

The part of the tooth that is visible above the gums; OR, A tooth restoration placed by a dentist. A crown restoration covers a tooth that may have had severe decay, was badly discolored, or was broken or otherwise misshapen. The crown covers the entire tooth and functions as a replacement for the natural tooth. Crowns placed by dentists can last for many years, but they are not permanent.

Dd

- **DDS or DMD**

DDS (Doctor of Dental Surgery) and DMD (Doctor of Dental Medicine) are degrees awarded to dental school graduates. Some dental schools award DDS, and some dental schools award DMD. The American Dental Association considers them equivalent degrees. All orthodontists educated in the U.S. or Canada will have either a DDS or DMD after their names. Orthodontists, who are also known as “orthodontic specialists,” are required to follow their dental school education with the completion of two to three years of orthodontic specialty education in an accredited orthodontic residency program. This additional education makes orthodontists specialists in the field of orthodontics.

- **Decalcification**

White marks on the teeth that can become cavities in the future. They are caused by poor brushing, and the consumption of sugary and acidic drinks.

- **Dentist**

Practicing general dentists are healthcare professionals concerned with overall oral health. Dentists diagnose oral diseases, treat decayed teeth (fillings) and remove failed teeth (extractions). They usually provide services such as crowns, veneers or bonding to improve the appearance and function of teeth that have extensive decay, or are misshapen or broken. Dentists look for abnormalities in the mouth and teach patients how to prevent dental disease.

- **Diagnostic Records**

The materials and information that the orthodontist needs to properly diagnose a malocclusion and plan a patient's treatment. Diagnostic records may include a thorough patient health history, a visual examination of the teeth and supporting structures, an electronic scan or plaster models of the teeth, extraoral and intraoral photographs, as well as a panoramic and cephalometric x-rays.

Ee

- **Ectopic Eruption**

Term used to describe a tooth or teeth that erupt in an abnormal position.

- **Elastics**

Rubber bands. During certain stages of treatment, small elastics or rubber bands are worn to provide individual tooth movement or jaw alignment.

- **Enamel**

The hard, white outer layer of a tooth, and the hardest substance in the human body. Enamel makes it possible to bite and chew. If enamel breaks away from a tooth, or is worn away due to abnormal forces generated by a bad bite (or malocclusion), it is gone forever. Enamel does not regenerate.

- **Eruption**

The process by which teeth enter into the mouth.

- **Essix Retainer**

A removable retainer made of a clear, plastic-like material.

- **Expander**

An orthodontic appliance that can widen the jaws.

- **Extraction**

The removal of a tooth.

- **Extraoral Photographs**

Photographs taken of the face from the front and side views.

Ff

- **Facebow**

An orthodontic appliance worn with orthodontic headgear, used primarily to move the upper first molars back, creating room for crowded or protrusive front teeth. The facebow has an internal wire bow and an external wire bow.

- **Fiberotomy**

A surgical procedure designed to cut part of the gum tissue around teeth, usually performed to reduce the chance of relapse or post-orthodontic tooth movement.

- **Fixed Appliances**

An orthodontic appliance that is bonded or cemented to the teeth and cannot be or should not be removed by the patient.

- **Flossing**

An important part of daily home dental care. Flossing removes plaque and food debris from between the teeth, brackets and wires. Flossing keeps teeth and gums clean and healthy during orthodontic treatment.

- **Forsus Spring**

An orthodontic appliance made of a fixed spring mechanism that moves the lower jaw forward, usually to correct an overjet (protruding upper teeth). It can also be used as an anchor for other types of movements.

- **Frenum**

The tissue attachment between the lip and the tongue or the lip and the upper jaw. A large frenum can cause spacing between the front teeth or cause the tongue to be “tied.” A large frenum can also cause the gum tissue on the lower front teeth to be pulled down.

- **Frenectomy**

The surgical removal or repositioning of the frenum.

- **Function**

Refers to biting, chewing and speaking. Teeth and jaws in their correct positions facilitate proper function.

- **Functional Appliances**

A type of orthodontic appliance that uses jaw movement and muscle action to place selective force on the teeth and jaws. They are usually removable. They are also known as orthopedic appliances with names such as orthopedic corrector, activator, bionator, Frankel, Herbst or twin block appliances.

Gg

- **Gingiva**

Soft tissue around the teeth, also known as the gums.

- **Gingivitis**

The mildest type of gum (periodontal) disease, usually caused by poor dental hygiene that allows a build-up of plaque and subsequent inflammation in the gums . Symptoms include red and/or swollen gums, and bleeding when you brush or floss. Gingivitis can be reversed with professional treatment and good dental care at home. If left untreated it may progress to periodontitis.

- **Growth Modification**

Placing braces or appliances to help modify and correct the growth of the jaws and teeth.

- **Gum disease**

Another name for periodontitis. A chronic infection of the gums that stems from a build-up of plaque ([link to glossary](#)). Also called periodontal disease. Untreated gum disease can lead to tooth loss. Patients having orthodontic treatment need to remove plaque frequently by brushing their teeth after meals/snacks and before bed, and by flossing at least once a day. There are three stages of gum disease: gingivitis, periodontitis and advanced periodontitis. Many people are unaware that they have gum disease because there is little or no pain.

- **Gummy Smile**

Showing an excessive amount of gingival (gum) tissue above the front teeth when smiling.

Hh

- **Hawley Retainer**

A removable retainer made of wire and a hard plastic-like material.

- **Headgear**

An appliance worn outside of the mouth to provide traction for growth modification and tooth movement.

- **Herbst Appliance**

This appliance is used to move the lower jaw forward. It can be fixed or removable. When it is fixed, it is cemented to teeth in one or both arches using stainless steel crowns. An expansion screw may be used to widen the upper jaw at the same time.

- **Holding/Lingual Arch**

Bands on the upper or lower molars are connected using a bar behind teeth; used to maintain space.

Ii

- **Impaction**

A tooth that does not erupt into the mouth or only erupts partially is considered impacted.

- **Implant**

An artificial replacement for a missing tooth/teeth. The process involves placing a metal post in the jawbone. A crown is placed on the implant so that the patient is able to bite, chew and speak. Implants can be used to anchor a single tooth or multiple teeth. An orthodontist can create space or hold space open in the mouths of patients who may need implants to achieve good dental function. Dental implants cannot be moved by conventional orthodontic forces.

- **Interceptive Treatment**

Orthodontic treatment is performed to intercept or correct a developing problem. Usually performed on younger patients that have a mixture of primary (baby) teeth and permanent teeth. Sometimes called Preventive or Phase I treatment.

- **Intraoral Photographs**

Photographs taken of the inside of the mouth, usually showing the biting surfaces of the teeth and sides of the mouth while biting down.

- **Interproximal Brush**

A tiny brush used to reach between teeth, and between teeth and braces, to remove plaque and food debris.

- **Interproximal Reduction**

Removal of a small amount of enamel from between the teeth to reduce their width. Also known as reproximation, slenderizing, stripping, polishing, enamel reduction or selective reduction.

Ll

- **Labial**

The surface of the teeth in both jaws that faces the lips.

- **Ligating Modules**

A small elastic o-ring, shaped like a donut, used to hold the archwire in the bracket. Also called “o-rings” or “o-ties.”

- **Ligature**

A tiny rubber band, or sometimes a very thin wire, that holds the orthodontic wire in the bracket slot/brace.

- **Lingual**

The tongue side of the teeth in both jaws.

- **Lip Bumper**

An orthodontic appliance used to move the lower molars back and the lower front teeth forward, creating room for crowded front teeth. The lower lip muscles apply pressure to the bumper creating a force that moves the molars back.

- **Lip Incompetence**

The inability to close the lips together at rest, usually due to protrusive front teeth or an excessively long face.

Mm

- **Malocclusion**

Latin for “bad bite.” The term used in orthodontics to describe teeth that do not fit together properly.

- **Mandible**

The lower jaw.

- **MARA Appliance**

A type of functional appliance used to bring the lower jaw forward to correct an overjet.

- **Maxilla**

The upper jaw.

- **Mixed Dentition**

The dental developmental stage in children (approximately ages 6-12) when they have a mix of primary (baby) and permanent teeth.

- **Mouthguard**

A removable device used to protect the teeth and mouth from injury caused by sporting activities. The use of a mouthguard is especially important for orthodontic patients.

Nn

- **Nightguard**

A removable appliance worn at night to help an individual minimize the damage or wear that occurs while clenching or grinding teeth during sleep.

Oo

- **Orthodontic treatments**

Orthodontic treatments are a branch of dentistry aimed at correcting irregularities in the teeth and jaw structure. These treatments help resolve both aesthetic and functional problems. Proper alignment of the teeth is crucial not only for maintaining oral health but also for boosting an individual's self-confidence.

- **Objectives of Orthodontic Treatment**

1. Aesthetic Improvement: Correcting crooked, misaligned, or irregular teeth.
2. Improved Chewing Function: Addressing jaw misalignments to ensure proper chewing of food.
3. Preservation of Dental Health: Misaligned teeth are harder to clean, increasing the risk of tooth decay and gum disease. Orthodontic treatment reduces these risks.
4. Correction of Speech Problems: Jaw structure or tooth alignment issues can lead to certain speech difficulties.

- **Orthodontic Treatment Process**

Orthodontic treatment typically occurs in several stages:

1. Evaluation and Planning: X-rays are taken, dental impressions are made, and a treatment plan is prepared.
2. Treatment Application: Braces or aligners are placed.
3. Follow-Up and Adjustments:** Regular check-ups are conducted throughout the treatment.
4. Post-Treatment: Retainers are used to ensure teeth remain in their correct positions permanently.

- **Advantages of Orthodontic Treatment**

1. A more aesthetic smile.
2. Reduction of pain and discomfort in the jaw and teeth structure.
3. Improved chewing and speech functions.
4. Long-term healthier teeth and gums.

- **Occlusion**

Latin for “bite.” In orthodontics, occlusion describes how the upper and lower teeth meet.

- **Open Bite**

A malocclusion in which teeth do not make contact with each other. With an anterior open bite, the front teeth do not touch when the back teeth are closed together. With a posterior open bite, the back teeth do not touch when the front teeth are closed together.

- **O-ring**

A tiny, o-shaped rubber band that is used as a ligature and holds the archwire to bracket slots. O-rings come in a variety of colors, and are generally changed at each adjustment appointment.

- **Orthodontics**

The specialty area of dentistry concerned with the diagnosis, supervision, guidance and correction of malocclusions. The formal name of the specialty is orthodontics and dentofacial orthopedics.

- **Orthodontist**

A specialist in the diagnosis, prevention and treatment of dental and facial irregularities. Orthodontists are required to complete college requirements, graduate from an accredited dental school and then successfully complete a minimum of two years of full-time study at an accredited orthodontic residency program. Only those who have completed this education may call themselves “orthodontists.” Orthodontists limit their scope of practice to orthodontic treatment. Only orthodontists may be members of the American Association of Orthodontists (AAO).

- **Orthognathic surgery**

Also called surgical orthodontics, orthognathic surgery is corrective jaw surgery performed to remedy skeletal problems that affect the ability to bite, chew and speak. Orthodontic treatment is done before and after surgery so that upper and lower teeth meet appropriately.

- **Orthopedic Appliance**

A removable functional appliance designed to guide the growth of the jaws and face.

- **Overbite**

The upper front teeth excessively overlap the bottom front teeth when back teeth are closed. Also called a closed bite or deep bite.

- **Overjet**

The upper front teeth protrude in front of the bottom front teeth when back teeth are closed. Sometimes called buck teeth.

Pp

- **Panoramic Radiograph**

An x-ray that shows all the teeth and both jaws at once.

- **Palatal Expander**

A fixed or removable orthodontic appliance used to make the upper jaw wider.

- **Periodontal Disease**

A chronic infection of the gums and jaw bones that stems from a build-up of plaque; many times there is little or no pain. Untreated periodontal disease can lead to tooth loss. There are three stages of periodontal disease: gingivitis, periodontitis and advanced periodontitis.

- **Periodontal Tissue**

Refers to the hard and soft tissue, or supporting structures, around the teeth.

- **Periodontitis**

A more serious form of gum (periodontal) disease as compared to gingivitis. It is a chronic infection caused by an accumulation of plaque under the gum line. The bacteria in plaque produce toxins that lead to destruction of the soft tissue and bone that hold teeth in place. Pockets (spaces between the gum and the teeth) form. Unless

treated professionally in conjunction with careful home care, the disease process will continue to break down tissues.

- **Phase One (Phase I) Treatment**

Orthodontic treatment performed to intercept or correct a developing problem. Usually performed on younger patients that have a mixture of primary (baby) teeth and permanent teeth. Sometimes called Preventive or Interceptive treatment.

- **Plaque**

Plaque is a colorless, sticky film which is a mixture of bacteria, food particles and saliva that constantly forms in the mouth. Plaque combines with sugars to form an acid that endangers teeth and gums. Plaque causes cavities, white marks (decalcification) and gum disease. Plaque is removed by brushing and flossing.

- **Posterior**

Back.

- **Power chain**

Interconnected elastic ligatures that are stretched across multiple teeth, holding the archwire to bracket slots. Orthodontists use power chains for some patients during specific times during their treatment to apply additional forces to move teeth.

- **Preventive Treatment**

Orthodontic treatment to prevent or reduce the severity of a developing malocclusion (bad bite). Also called Interceptive or Phase I treatment.

- **Primary Teeth**

Baby teeth. Also called deciduous or milk teeth.

Rr

- **Radiograph**

Also called an x-ray, a radiograph is a diagnostic tool that is used to see inside the body. Orthodontists take panoramic radiographs to see a complete horizontal image of a patient's upper and lower teeth. A cephalometric radiograph is a side view of a patient's head.

- **Removable Appliance**

An orthodontic appliance that can be removed from the mouth by the patient. Removable appliances are used to move teeth, align jaws and/or to keep teeth in their new positions when the braces are removed (retainers).

- **Retainer**

A fixed or removable appliance worn after braces are removed or aligner therapy is complete. A retainer is fitted to upper and/or lower teeth to hold them in their finished positions. When worn as prescribed, retainers are the best tool available to minimize unwanted tooth movement after active treatment ends.

- **Rubber Bands**

During certain stages of treatment, small elastics (rubber bands) are worn to provide individual tooth movement or jaw alignment.

Ss

- **Surgical Orthodontics**

Supported by surgical interventions in cases of severe problems in jaw and facial structure.

- **Separators**

An elastic o-ring or small wire loop is placed between the teeth to create space for placement of orthodontic bands. Separators are usually placed between the teeth a week before bands are scheduled to be placed on the teeth.

- **Self-Ligating Brackets**

Brackets that have a “door” on the front that holds the orthodontic wire to the bracket. With self-ligating brackets, an elastic ring is not needed to hold the orthodontic wire to the bracket.

- **Serial Extraction**

Selective or guided removal of certain primary (baby) teeth and/or permanent teeth over a period of time to create room, reduce crowding and create a better environment for the permanent teeth to erupt.

- **Skeletal maturity**

A time when an individual has stopped growing, and bones have reached their full development.

- **Spacers**

Tiny elastics (rubber bands) that are inserted between molars. Spacers are placed one or two weeks before getting braces to create space between molars if molar bands will be used as part of the orthodontic appliance. Occasionally, spacers fall out before braces are placed.

- **Space Maintainer**

A fixed appliance used to hold space for an unerupted permanent tooth after a primary (baby) tooth has been lost prematurely, due to accident or decay.

- **Specialist**

In dentistry, being a specialist usually requires:

General education – Completing college requirements (usually four years)

Dental School Education: Four-year program leading to a DDS or DMD in dentistry

Specialty education – Successful completion of two or more years (usually) of additional education in an accredited program in the chosen specialty area (such as orthodontics in dentistry).

Thus the doctor's experience is focused on the area of specialization

Orthodontists are the dental profession's specialists in the field of orthodontics and dentofacial orthopedics. Nine dental specialties are recognized by the National Commission on Recognition of Dental Specialties and Certifying Boards. After dental school, those who intend to be orthodontists must be accepted by, and successfully complete, an accredited orthodontic residency program lasting two years or longer (minimum of 3,700 hours). There are about 15 applications for each opening in an accredited orthodontic program. Those who attain this level of formal education may call himself/herself an orthodontist. Only orthodontists are admitted for membership in the American Association of Orthodontists.

- **Supernumerary Teeth**

An occurrence in which there are more teeth than the usual number. These teeth can be malformed or erupt abnormally. These teeth can also interfere with the normal pattern of tooth eruption and contribute to an orthodontic problem. Supernumerary teeth often need to be removed.

Tt

- **Types of Orthodontic Treatment**

1. Fixed Orthodontic Treatments (Braces):

- Metal Braces: The most commonly used method, known for its durability.
- Clear Braces: Provide a more aesthetic appearance.
- Lingual Braces: Attached to the back of the teeth, making them invisible from the front.

2. Removable Orthodontic Treatments:

- Clear Aligners (Invisalign): Removable and nearly invisible.
- Jaw Appliances: Used to correct jaw structure.

3. Functional Orthodontic Treatments:

- Special appliances used during jaw development to guide growth and development.

- **Temporary Anchorage Device (TAD)**

A miniature surgical screw that resembles an earring stud when it is in place. Positioned in gum and bone tissue, a TAD is used as an anchor – a fixed point from which to apply the force needed to move teeth in a direction that braces alone cannot move them. The TAD is removed when it is no longer needed.

- **Tongue Crib**

A fixed orthodontic appliance used to help a patient stop habits or undesirable tongue forces exerted on the teeth and bone that supports the teeth.

- **Tongue Thrust**

A habit where an individual's tongue pushes against the teeth when swallowing. This type of force generated by the tongue can move the teeth and bone and may lead to an anterior or posterior open bite.

Uu

- **Underbite**

The lower front teeth or jaw sit ahead of the upper front teeth or jaw. Also known as a Class III malocclusion.

Vv

- **Veneer**

A thin, tooth-colored shell that is glued to the fronts of teeth to improve their appearance. A veneer can cover up a discolored or broken tooth. Veneers cannot correct malocclusions (misaligned teeth and/or jaws). However, veneers can be easier to place and last longer after an individual has had orthodontic treatment and teeth are properly positioned.

Ww

- **Wax**

Orthodontic wax is placed on the brackets or archwires to prevent them from irritating the lips or cheeks.

- **Wires**

Also known as archwires, they are held to brackets using small elastic o-rings (rubber bands), stainless steel wire ligatures, or by a door on a self-ligating bracket. Wires are used to move the teeth.

Xx

- **X-ray**

Also called a radiograph, an x-ray is a diagnostic tool that is used to see inside the body. Orthodontists take panoramic x-rays to see a complete horizontal image of a patient's upper and lower teeth. A cephalometric x-ray is a side view of a patient's head.

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