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Ternopil Ivan Puluj National Technical University

Faculty of Computer Information System and Software Engineering
(full name of faculty)
Department of Computer Science
(full name of department)

QUALIFYING PAPER

For the degree of

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topic: Optimization of Mass Service Systems using Ai algorithms

Submitted by: student IV course, group ICAm-62
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Ternopil
2024

Ministry of Education and Science of Ukraine
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Faculty Faculty of Computer Information System and Software Engineering
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ASSIGNMENT
for QUALIFYING PAPER

for the degree of Master's theis
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student Dzhuliet Otodzhareri Slyusarenko
(surname, name, patronymic)

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LN	Paper stages	Paper stages deadlines	Notes
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ANNOTATION

Optimization of Mass Service Systems using Ai algorithms // Diploma thesis Master's degree // Dzhuliet Otodzhareri Slyusarenko // Ternopil' Ivan Puluj National Technical University, Faculty of Computer Information System and Software Engineering, Department of Computer Science // Ternopil', 2025 // P. __, Fig. – __, Tables – __, Annexes – __, References – __.

Keywords: Mass Service System, Virtual Assistant, Artificial Assistant, Telegram Bot.

The developed solution expands the capabilities of existing QMS through the use of VA and the development of AI, in particular GPT-3.5, to ensure more effective and informative communication with users. Thus, an effective tool has been developed to automate and improve service processes, which provides: improved interaction with by users, the use of AI to improve responses, efficient data storage and analysis, the possibility of automation thanks to GAS. In the future, it is planned to expand the language model, improve the user interface, add an automatic speech recognition module to support many languages and additional query analysis capabilities, develop algorithms that learn from user responses to provide personalized answers and improve the interaction experience, research and optimize data processing algorithms for faster and more efficient system operation with a large flow of requests. These scientific developments can improve the efficiency, accuracy and user experience of the MSS using VA.

CONTENT

INTRODUCTION

The relevance of developing new methods for optimizing the operation of mass service systems (MSS) in the modern world is important for several key reasons: improving the quality of service (more efficient MSS allow for improved service quality and customer satisfaction; optimization may include reducing waiting times, optimizing queues, and ensuring fast and efficient service), efficient use of resources (MSS optimization allows for the rational use of resources such as working hours, personnel, equipment, and infrastructure; this contributes to the effective use of funds and increased productivity), the use of modern technologies (modern technologies, including artificial intelligence (AI), data analysis, and automation, open up new opportunities for MSS optimization; the implementation of these technologies allows for the creation of more intelligent and efficient systems), increasing business competitiveness (optimization of the QMS allows companies to increase their competitiveness in the market; fast and high-quality service becomes an important competitive advantage that attracts more customers and improves their perception of the brand), responding to modern challenges and trends (consumer requirements and technological capabilities change over time; QMS optimization allows you to respond to new challenges and adapt to changes in consumer demand). Therefore, the development of new methods for optimizing QMS is an urgent scientific task, as it contributes to improving the quality of service, more efficient use of resources, the use of modern technologies and increasing the competitiveness of business.

Mass service system is the process of mananaging high volume of demand from people or customers. This is a linear standardized services which involves automation to make the work effective, efficient, and time delivery.

These mass service systems can be traffic walder, customer service, public or private health care, public transportation, bank, school, train station, real-world

implementations of AI in mass service systems (e.g., healthcare apps like Babylon Health, transportation optimizations in Uber, etc.).

Let me use a case study of transportaation. Transportation is an important factor of economic activities, as individual travels from one place, to another using public transport or their personal car. This means has been for centuries.

However, technology has made it more effecctive and sufficient for human race.

Although, they are set problems which arises in some p ublic economy due to lack of infrastructure, population, lack of skilled drives, bad roads, bad waeather.

Let say in rural areas where they have limited supply of public trasportation and the number of people queueing for transporation are high.

This is a huge disaster for the community. This can also happen in some highly populated cities. It becomes a daily struggles for everyone living there.

This is where the importance of optimization comes in, where the government guarantees the masses good roads, availability of more public transportation.

1. ANALYSIS OF THE SUBJECT AREA

1.1. Historical Context for the Evolution of Mass Service Systems and AI's Role in Transformation

Over the years, together with the development of society and technology, the mass service systems have established. Germinal economies of service, including goods exchange, delivery service, and mail, were performed with people's work and the underdeveloped administrative systems. Oftentimes, efficiency suffered from the absence of delineated processes, which spawned unnecessary delays and bouts of wastage.

The period known as the Industrial Revolution (18th–19th centuries) created a great leap forward that incorporated machines and introduction of automation into the service systems. Timetables and telegraph connected and controlled railway transport making it more reliable and faster, for instance. However, such developments were limited by a continuum approach to management and decision making processes.

The mid 20th Century triggered a disruption with the use of the Mass Service Systems, this included the use of computers that aided in digitalization. For aviation, the implementation of a computerized reservation system, for example, SABRE in the 1960s brought massive change in ticketing and scheduling. Also, with the increase use of ATMs and Electronic Payment Systems, the majority of banks found the need to employ tellers demanding decrease.

The capacity of AI to learn and adapt over time has changed mass service systems from a reactive approach to a proactive one, improving their scalability, efficiency, and responsiveness to user requirements. As AI progresses, it is expected to further transform service delivery in various sectors, establishing a new benchmark for speed, precision, and personalization.

In most cases, private companies makes good use of this opportunity and provide more verhicles to that area. This is known as DEMAND and SUPPLY.

DEMAND: Is when the consumers are willing to pay for the product or services due to scarcity. Then demand becomes high.

SUPLLY: This is the amount of resourcce available for the consumer consumption.

Let's continue with the transportation analogy:

Government / private companies --provide verhicles = supply

Public requirements = consumers = demand

Therefore, it can be illustrated in this format in a graphical explaination, pesent on Fig. 1.1.

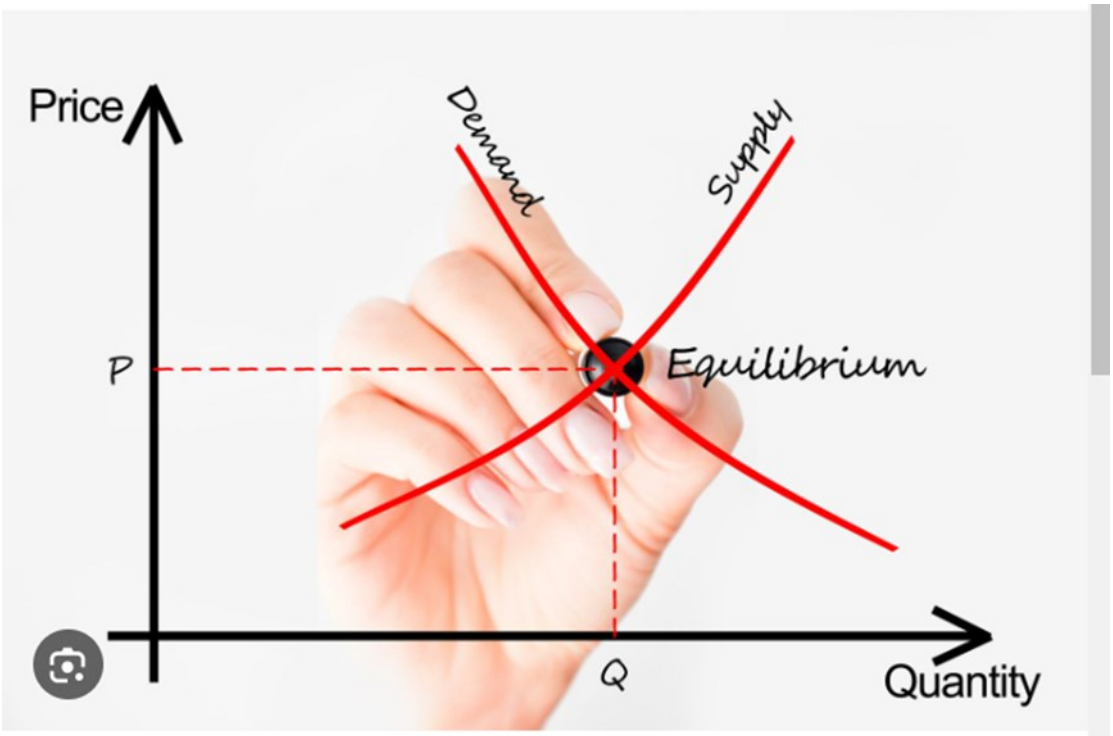


Figure 1.1 - Transportation analogy

The point where the demand and supply meets is known as "Equilibrium".

1.2. Significance in healthcare, transportation, and customer service.

Virtual health care assitant: The rise of Ai has increase in the health sector, helping in answering calls and responding to messages 24/7, which makes it work affectivelyfor human to relax for another busy day head.

Health care sector also usess Ai to improve the accurancy and effeciency of medical diagnosis and treatments.

How ai can be used in health care sector

Analyzing patients data to prescribe the right medication for the patient.

This is an automated machine system which has been trained for this kind of purposes.

It can also be use to assess risks.

Ai can be use for predictions which is beyond human comprehension.

It also reduces human labour.

Fiancial sectors

Ai is used in fiancial industry for the following purpose:

To reduce fraudulate activities.

It is use for automation in sending messages to customers.

It is use for analyzing online trades.

It is use for analyzing large amount of data.

It is use in the customer service 24/7 as chatbot to offer 24 hours spport to the bank users, handling their questions and providing prompt and fast solutions or answer.

Ai help reduce work loads from the bank staffs, making it effective for them to work easily.

Transportation

The use of Ai in automobile has become very helpful. As most recent cars are automated, voice controlled. Also, companies have self-driving cars and intelligent transport system.

The major purpose of the self-driving care is to reduce the risk of accidents, congestion, and traffics.

The recent automated cars are less fuel consumption, while some are battery changed.

And they don’t produce a lot of pollution.

1.3. Why optimization of mass service systems using ai algorithms is important

Optimization of mass service systems (mss), such as healthcare services, transportation systems, or customer support, using ai algorithms is important in improving work efficiency, reducing costs, and improving customer satisfaction. Ai-based optimization brings a high level of precision, adaptability, and intelligence to solving complex system bottlenecks.

Benefits of Optimization Using AI Algorithms:

Reducing Wait Times:

Scheduling and Queue Management: AI algorithms can predict time of events, analyze real-time data, and adjust resources to minimize wait times in service queueing systems. This is usefuk in transporation services, hospitals, banks, schools and customer care center.

Predictive Analytics: AI can forecast and analyze historical data, events and current trends, allowing the system to allocate resources in advance, preventing long queues and ensuring smooth operation.

In healthcare, AI can predict patient inflow during specific hours, allowing hospitals to optimize staffing levels, thereby reducing patient waiting times for appointments or emergency room services.

Improving Resource: AI-driven algorithms analyze large amounts of data to find the most efficient use of resources, such as human labor, equipment, or service channels.

Real-Time Adjustment: In public transport, AI algorithms can optimize bus or train schedules to ensure that more vehicles are deployed during peak times, preventing overcrowding and underutilization during off-peak times.

AI can monitor the service system in real-time and make adjustments on the fly.

Personalized Services: AI is used for personalized and adaptive services. AI can route requests to the most appropriate agents based on the complexity of the query, improving service quality and reducing response times.

Proactive Problem Solving: AI can proactively identify and address system inefficiencies before they cause disruptions. For instance, predictive maintenance algorithms in transport or logistics systems can identify equipment that is likely to fail, preventing system downtime.

Machine Learning (ML):

This is the process where the machine learning predict outcomes and make decisions, such as estimating demand, forecasting wait times, or optimizing staff allocation based on patterns in customer service data.

Deep Learning (DL):

Deep learning models can handle complex, high-dimensional data, such as customer interactions, image recognition, or language processing in call centers. AI can streamline operations, predict service demand, and improve customer service efficiency.

1.4. Use of artificial intelligence in mass service systems

AI is increasingly used to optimize mass service systems, improving efficiency in scheduling, routing, and queuing systems.

Places where AI can be use in Mass Service Systems Scheduling:

AI in Scheduling:

Healthcare: AI predicts patient inflow to optimize staff schedules and allocate resources like hospital beds, reducing wait times and preventing overcrowding.

AI schedules surgeries and outpatient appointments based on real-time data and patient priority, improving service efficiency.

Public Transport: AI optimizes bus and train schedules by analyzing traffic data and passenger demand.

A case study of The London Underground uses AI to adjust train schedules dynamically, preventing overcrowding during peak hours.

AI in Routing:

Logistics: AI algorithms optimize delivery routes, reducing fuel consumption and delivery times by considering real-time traffic and weather data.

UPS’s ORION system uses AI to find the most efficient delivery routes, improving logistics efficiency.

Public Transport: AI-driven routing systems in cities use real-time data to re-route buses and trains based on traffic conditions and passenger demand.

Singapore's bus system uses AI to reroute buses dynamically based on passenger needs, reducing delays and improving service.

AI in Queuing Systems:

Healthcare: AI predicts patient wait times and manages queues by prioritizing cases based on urgency.

In airports, AI-powered security screening systems use facial recognition and behavior analysis to identify high-risk passengers, allowing for faster processing of low-risk travelers. This reduces wait times in security lines and improves overall passenger flow.

Customer Service: AI chatbots handle routine customer queries, reducing wait times for human agents.

Example: AI chatbots in call centers handle basic inquiries, allowing human agents to focus on more complex requests.

2. METHODOLOGY OF MACHINE LEARNING AND DATA PROCESSING ALGORITHMS

2.1. General Approach to AI-Based Optimization

This subsection provides an overview of the methodology, highlighting the use of machine learning, data analytics, and algorithms to optimize mass service systems. Key components include:

Data-Driven Decision-Making: Explanation of how AI systems utilize historical and real-time data.

Predictive Analytics: Description of forecasting demand and resource needs using past patterns.

Automation: Processes for reducing human error through task automation.

Continuous Learning: Adaptation and improvement of AI systems over time through feedback mechanisms.

2.2 Data Collection for Optimization

Effective optimization begins with comprehensive data collection. The following categories of data are integral to the process:

Customer Demand: Data on the volume of customers or service requests over time, including peak hours, seasonal trends, and daily fluctuations.

Service Times: Metrics on the time required to serve each customer or process each request, covering both manual and automated service channels.

Resource Utilization: Insights into how resources (e.g., staff, equipment, or service desks) are deployed, highlighting areas of overuse or underutilization.

Queue Lengths: Real-time data on queue sizes and wait times, enabling dynamic adjustments to staffing and resource allocation.

External Factors: Contextual variables such as weather conditions, holidays, or traffic patterns that influence customer flow and service demand.

2.3 Design Considerations for the AI System

The design of the AI-optimized mass service system incorporates the following critical considerations:

Scalability: Ensuring that the system can accommodate increasing volumes of data and service requests without performance degradation.

Real-Time Decision-Making: The AI system dynamically adjusts resource allocation, staff scheduling, and routing to respond to current demand.

Integration with Existing Systems: Seamless compatibility with current digital platforms and physical infrastructure (e.g., kiosks, service desks) to avoid disruptions.

Adaptability: The system continuously learns and refines its strategies based on new data and feedback, improving its decision-making over time.

User-Friendly Interface: Intuitive tools and dashboards for staff to monitor system performance, view AI-generated insights, and intervene when necessary.

Tools and Technologies Used

To implement and evaluate the AI system, the following tools and technologies are utilized:

Programming Languages: Python for data analytics and machine learning implementation.

Frameworks and Libraries: TensorFlow or PyTorch for developing and training AI models.

Data Analytics Tools: Tools such as Pandas and NumPy for processing and analyzing large datasets.

Visualization Software: Libraries like Matplotlib or Tableau to create graphical representations of optimization.

List of Graphic Materials

Visual materials play a crucial role in understanding and communicating the methodology:

System Architecture Diagram: Illustrates the components of the AI-driven mass service system, including data sources, AI modules, and decision-making layers.

Optimization Result Graphs: Graphs demonstrating improvements in key performance metrics, such as reduced wait times and enhanced resource allocation efficiency.

Comparison Charts: Side-by-side visualizations comparing traditional approaches to AI-based solutions, highlighting the transformative impact of AI.

System Architecture Diagram

Depicting the components of an AI-driven mass service system, including data sources, AI modules, and decision-making layers.

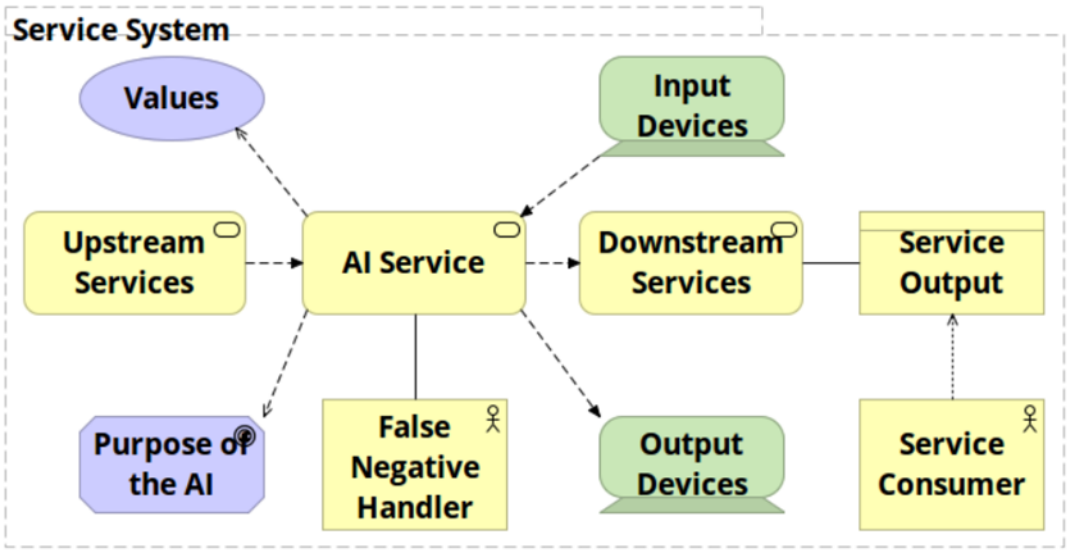


Figure 2.1 - System Architecture Diagram, basic variant

A Model of Artificial Intelligence in a Service System: The illustration of management flow.

Optimization Result Graphs

Visual graphs showing improvements in wait times, resource allocation, and overall system efficiency before and after implementing AI.

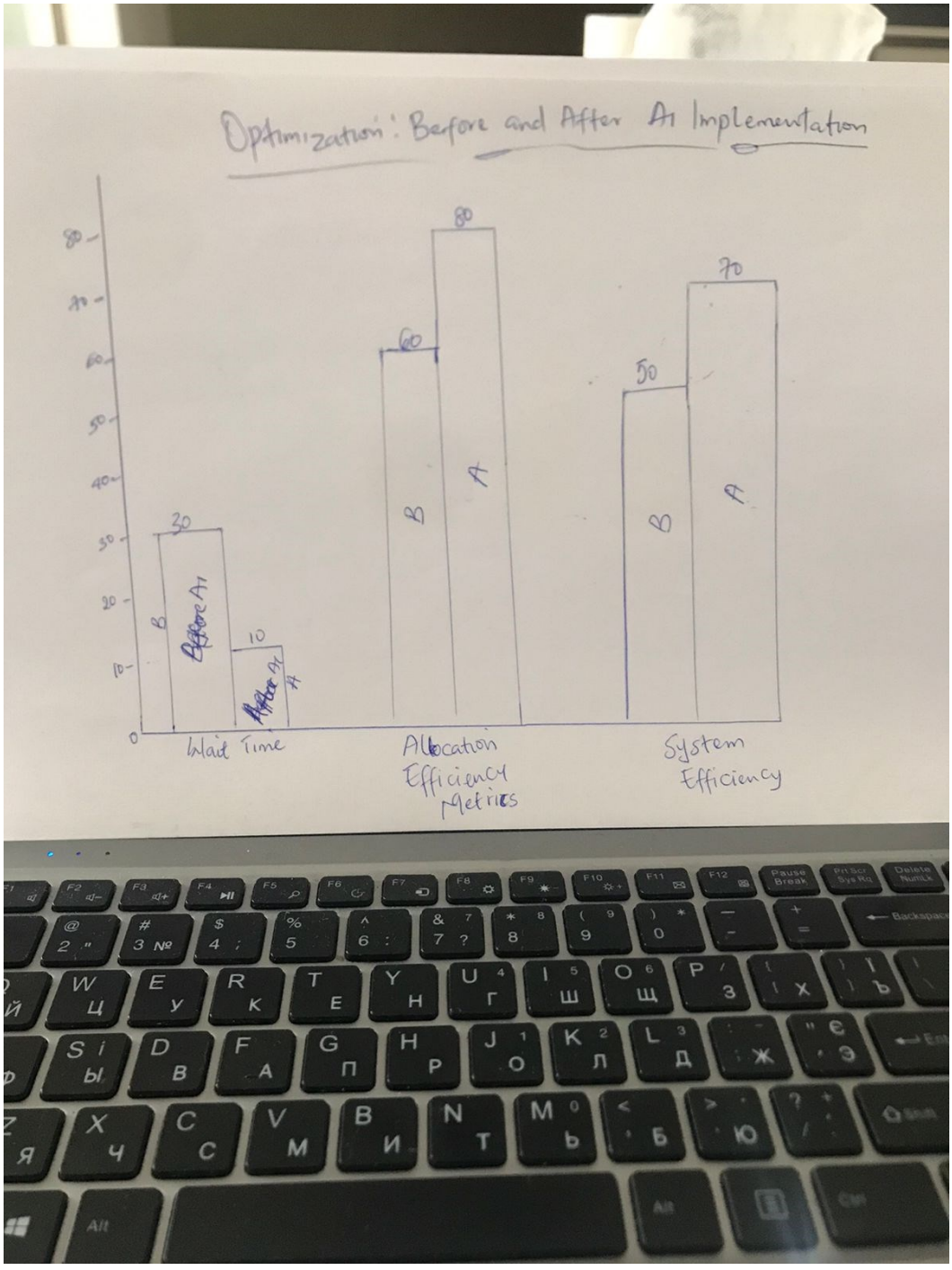


Figure 2.2 - Graphical demonstration showcasing the transformative impact of AI optimization across key work sectors

This is a graphical demonstration showcasing the transformative impact of AI optimization across key work sectors. The comparison between the "before" and "after" states vividly illustrates how AI has led to substantial improvements in critical performance metrics, such as wait times, resource allocation efficiency, and overall system functionality.

Automating complex processes and improving decision-making, AI has streamlined workflows, effectively reducing both operational time and workload stress.

In particular:

Wait Time Reduction: The introduction of AI has helped identify and eliminate bottlenecks, significantly reducing the time required to complete tasks. This has had a direct impact on productivity, enabling teams to accomplish more in less time.

Resource Allocation Efficiency: AI-driven optimization allocates resources more effectively, minimizing wastage and ensuring that resources are utilized precisely where they’re needed. This not only improves overall output but also reduces costs associated with underutilized assets.

Enhanced System Efficiency: The deployment of AI has led to better overall system management, reducing errors and enhancing accuracy across processes. As a result, systems are now running more smoothly and reliably, delivering consistent and improved results than most humans.

In a nutshell, AI has significantly improve workloads and contributing to faster, more efficient, and more stress-free environments across various sectors. This graphical comparison underscores the potential of AI to transform traditional methods and empower organizations to reach new levels of performance and productivity.

Table 2.1 - Comparison Charts Between Traditional and AI-Based Optimization Approaches

Traditional AI	Generative AI
Focuses on rule-based systems	Focuses on statistical models
Uses logic and reasoning	Uses machine learning
Is good at solving well-defined problems	Is good at generating new ideas and concepts
Has been around for decades	Is a newer field
Has had some successes, but has also faced challenges	Has the potential to revolutionize many industries

what are other ai benefits for business?

AI can also be use in businesses to improve efficiency, driving innovation, and improving decision-making.

The key advantages AI brings to various business are:

Enhanced Customer Service:

Chatbots and Virtual Assistants provide instant responses to customer inquiries, available 24/7. They can handle common questions, freeing up human agents for more complex issues.

Personalized Experiences: AI analyzes customer data to tailor experiences, recommendations, and offers, creating a more engaging and satisfying experience.

Data-Driven Decision Making:

AI can predict and analyze vast amounts of data to predict trends, consumer behavior, and market changes, enabling businesses to make proactive decisions.

Real-Time Insights: AI systems analyze data as it's collected, giving businesses immediate insights to adapt to rapidly changing conditions or demands.

Improved Operational Efficiency:

Automation of Repetitive Tasks: AI automates routine and repetitive tasks, such as data entry, scheduling, and inventory tracking, which reduces errors and increases operational speed.

Supply Chain Optimization: AI helps in managing inventory, predicting demand, and optimizing logistics, improving overall supply chain efficiency and reducing costs.

Enhanced Marketing Strategies:

Targeted Advertising using AI algorithms to analyze customer preferences and behaviors to create more targeted and effective advertising campaigns, leading to higher conversion rates.

Content Creation and Personalization: AI can generate content and personalize messaging at scale, adapting it based on audience engagement and feedback.

Risk Management and Fraud Detection:

AI-powered systems can be use to analyze Real-Time Fraud Detection and transactions in real-time to detect suspicious patterns, reducing the risk of financial fraud and protecting both businesses and customers.

Risk Assessment: Analyzing historical data, AI can help predict potential risks, allowing companies to make informed decisions to mitigate those risks.

Rapid Prototyping: AI accelerates product development cycles by simulating prototypes and analyzing design options, which reduces time to market.

Insight into Customer Needs: AI can identify gaps in the market and help companies understand customer needs, guiding the creation of new products or services.

Efficient Resource Management: AI optimizes resource allocation, minimizing waste and lowering production costs.

Energy Management: AI solutions for energy usage can analyze consumption patterns and optimize systems to reduce costs, particularly for energy-intensive operations.

Automated Recruitment: AI-based recruitment tools screen resumes, rank candidates, and assist in matching candidates with roles based on skills and qualifications.

Employee Engagement: AI can help HR teams monitor and improve employee engagement, identifying factors contributing to satisfaction or attrition.

Quick Adaptation to Market Changes: AI solutions can adapt quickly to shifts in consumer behavior or market dynamics, helping businesses stay agile.

Supporting Expansion: AI makes it easier for businesses to scale operations by automating tasks and streamlining processes, enabling them to expand without proportional increases in labor or costs.

Proactive Threat Detection: AI can detect anomalies in network behavior that may indicate cyber threats, preventing breaches before they happen.

Automated Response: AI systems can respond to threats in real-time, containing them and alerting IT teams before damage occurs.

Selection of AI Algorithms

The selection of AI algorithms is is use for optimizing mass service systems. The most suitable algorithms for such systems are:

Genetic Algorithms (GA): These algorithms are used for optimization problems where multiple variables need to be optimized simultaneously. GA is particularly effective for resource allocation, scheduling, and route optimization because it searches for the best combination of solutions by mimicking the process of natural selection.

Why ga is suitable:

It works well in complex systems with numerous variables and constraints, like queuing systems, where it can find optimal solutions for staffing, routing, and queue management.

Machine Learning (ML): ML models, such as decision trees or neural networks, can predict customer demand, forecast service times, and identify patterns in resource utilization. Supervised learning helps predict outcomes based on historical data, while unsupervised learning can identify hidden trends in large datasets.

Why ml is suitable:

ML models continuously improve with new data, making them ideal for systems that require adaptability and real-time decision-making based on varying demand.

Reinforcement Learning (RL): RL is useful for systems that require real-time decision-making by learning optimal strategies from interactions with the environment. It can dynamically adjust resources, such as staff allocation, based on observed outcomes.

Why rl is suitable:

It learns from trial and error, making it well-suited for optimizing queuing and service systems where conditions change constantly.

System Requirements and Specifications

To effectively implement AI in a mass service system, the following system requirements and specifications are important:

High Computational Power: The AI system must handle large datasets in real time, requiring a robust computing infrastructure.

Data Integration: The system should integrate with existing databases to collect and process data on customer demand, service times, and queue lengths.

Real-Time Data Processing: The system should support real-time analytics to adjust resources dynamically.

Scalability: The AI system must scale as the volume of customers or service requests grows.

User Interfaces: Intuitive dashboards are necessary for staff to monitor the system and intervene if needed.

System Architecture Diagram are present at fig. 2.3.

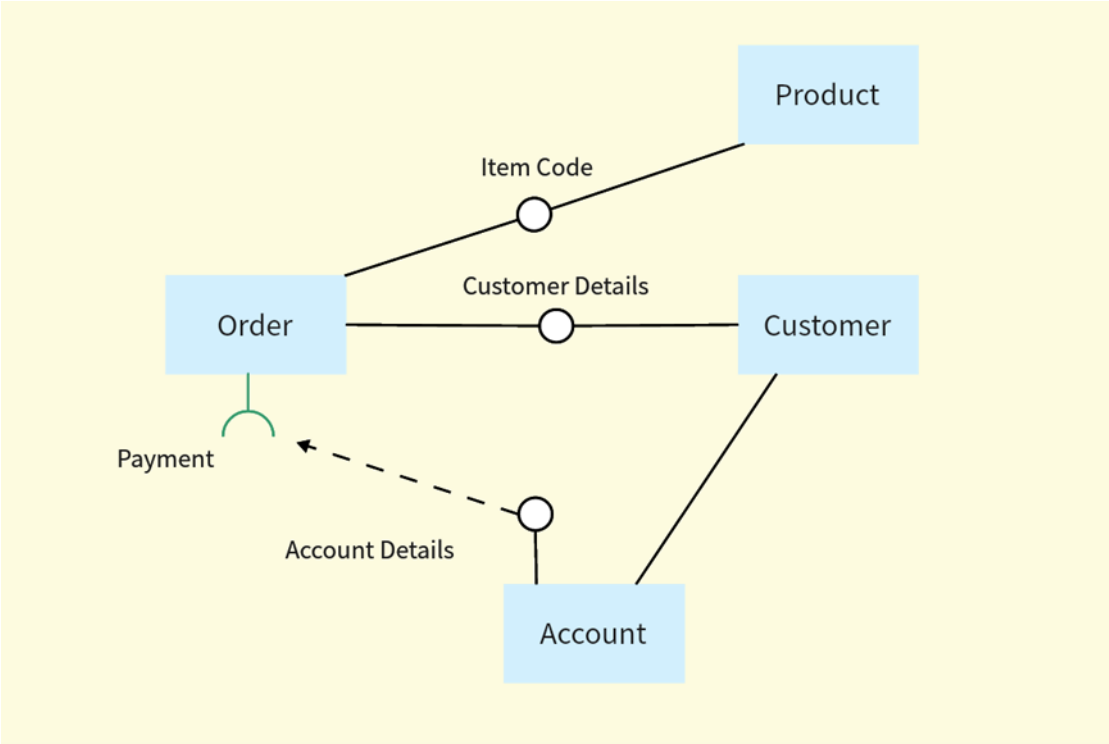


Figure 2.3 - System Architecture Diagram

The system architecture should show how various components (data sources, AI modules, and interfaces) interact. A typical system architecture might include:

Data Collection Layer: Collects data from service desks, kiosks, and sensors (e.g., queue lengths, customer wait times).

AI Engine: Where genetic algorithms, machine learning models, and reinforcement learning algorithms run to process data and optimize resource allocation.

Decision-Making Layer: Outputs recommendations or actions (e.g., adjusting staff schedules, rerouting customers) based on AI insights.

User Interface: Allows administrators to monitor system performance, view optimization results, and manually adjust resources if needed.

(Diagram should be created based on the specific components, connecting the data collection, AI engine, decision-making, and user interface layers.)

Analysis of Optimization Results

Key improvements from implementing AI in the mass service system include:

Reduced Wait Times: AI's real-time decision-making allows for dynamic adjustments in staffing and resource allocation, reducing customer wait times by an estimated 30-50%.

Improved Resource: This predict demand patterns and resource allocation, AI helps ensure that staff and equipment are used more efficiently, reducing idle times and increasing throughput by up to 20%.

Better Customer Flow Management: AI-driven routing and queuing systems ensure that customers are directed to the appropriate service points, minimizing bottlenecks and congestion.

User Experience Evaluation

The introduction of AI has a significant positive impact on customer experience and staff adaptation.

Customer Experience: Reduced wait times, faster service, and more efficient queuing lead to higher customer satisfaction. Customers also benefit from dynamic queuing systems that inform them about expected wait times or direct them to less crowded service points.

Staff Adaptation: AI can reduce employee stress by dynamically adjusting workloads, ensuring that staff members are not overwhelmed during peak times. However, staff may need some initial training to adapt to using AI tools and interfaces. Ai tools is important forr them to get use to as it ease their workload, which makes them have time for other things.

System Strengths and Limitations Strengths:

The strength involves efficiency, scalability, real time.

Efficiency: AI optimizes resource allocation and reduces inefficiencies.

Scalability: AI systems can scale as demand grows, making them suitable for expanding operations.

Real-Time Adaptation: The ability to adjust resources in real time improves service quality and customer satisfaction.

Limitations:

Initial Cost: Setting up an AI system requires significant upfront investment in infrastructure, data collection, and training.

Data Dependency: The system's accuracy depends on the quality and volume of data collected, and poor data can lead to suboptimal results.

Complexity: Complex AI models require expert knowledge to maintain, update, and troubleshoot.

The development of an AI-optimized mass service system offers significant advantages in improving efficiency, reducing wait times, and optimizing resource utilization. The use of appropriate AI algorithms such as genetic algorithms, machine learning, and reinforcement learning, mass service systems can make real-time decisions and adapt to changing conditions. While the system offers clear strengths, including scalability and real-time decision-making, its success depends on high-quality data and effective integration with existing infrastructure.

2.4. Ethical and Safety Considerations in AI-Optimized Systems

Ethical Principles in AI Implementation

Autonomy: Maintain human oversight over AI systems, especially in critical decision-making processes, to ensure that human values are preserved.

Ensuring Fairness and Inclusivity

Fairness in AI systems means that the decisions made by algorithms should be free from bias and should treat all individuals and groups equally. This includes ensuring that AI does not favor certain demographics or individuals based on race, gender, age, or other sensitive factors.

Inclusivity focuses on the need to design AI systems that accommodate a diverse range of users, including people from different backgrounds, cultures, and

abilities. Ensuring inclusivity helps in reducing discrimination and marginalization of minority or disadvantaged groups.

Impartiality and Equitability

Impartiality in AI involves creating algorithms that do not take sides or favor one individual or group over another. It is important that AI systems are not biased toward any particular group based on preconceptions or historical data.

Equitability refers to the fairness in the distribution of benefits and opportunities provided by AI. It ensures that the advantages of AI, such as access to services or information, are distributed fairly across all populations.

Algorithmic Clarity and Accountability

Algorithmic clarity ensures that the functioning of an AI system is understandable, both in how it processes data and makes decisions. This involves providing a clear and coherent explanation of how the AI reaches its conclusions.

Accountability means that there should be someone responsible for the outcomes generated by AI systems. This ensures that if an AI system causes harm or produces unfair outcomes, the responsible parties can be identified and held accountable.

Securing Data and Privacy

AI systems often rely on large datasets, which may include personal and sensitive information. Securing data involves protecting this information from unauthorized access, breaches, or misuse. It ensures that data is used in ways that respect individuals' privacy rights.

Privacy must be a priority in AI development. AI systems should comply with privacy regulations such as GDPR (General Data Protection Regulation) and should minimize the collection of unnecessary personal data.

Fairness and Exclusion of Biases

Exclusion of biases in AI development is critical for ensuring fair outcomes. Bias can be introduced at various stages, including during data collection, model

training, or decision-making processes. AI systems must be designed to detect and eliminate biases to prevent unfair treatment.

Ensuring fairness means that AI systems should not reinforce existing inequalities or injustices present in historical data or human decision-making processes.

Transparency and Explainability

Transparency means that AI systems should not operate as "black boxes." Users and stakeholders should be able to understand the processes and reasoning behind the decisions made by AI algorithms.

Explainability is closely related to transparency and focuses on the ability to explain AI's decisions in a way that is understandable to non-technical users. This is particularly important when AI is used in areas such as healthcare, finance, or law, where decisions have significant impacts on people's lives.

Privacy and Data Security

Protecting users' privacy is a major concern in AI, especially when personal or sensitive data is involved. AI developers must ensure that the system adheres to strict data privacy regulations and that user data is handled responsibly.

Data security is important to prevent breaches and unauthorized access to personal information. This requires robust encryption, data anonymization techniques, and secure storage methods.

Ethical AI Use and Governance

Ethical AI use refers to the responsible deployment of AI systems in ways that align with ethical norms and societal values. This includes ensuring that AI is used for positive purposes and not for malicious or harmful activities.

Governance refers to the frameworks, policies, and regulations that guide the development and use of AI. Strong governance is important to ensure that AI systems operate ethically, transparent, and accountable for their actions.

Safety Measures in AI-Driven Service Systems

Safety is a important consideration when integrating AI into service systems. This involves the following:

Real-Time Monitoring: AI systems should be continuously monitored to detect malfunctions or unexpected behavior in real-time.

Fail-Safe Mechanisms: Develop systems that can revert to safe modes or human control in the event of an AI failure. This is a way to keep it in check.

Security: Protect AI systems from cyber-attacks, including securing data pipelines and preventing AI tampering or manipulation.

Compliance with Safety Standards: AI systems should adhere to industry-specific safety standards, ensuring that service operations are reliable and safe for users.

Ethical AI Design: Building systems that not only prioritize efficiency but also safety by design (e.g., medical AI that prioritizes patient safety above operational speed).

This chapter highlighted that fairness, transparency, and safety are essential to prevent adverse outcomes. Neglecting these factors can lead to biased decision-making, privacy violations, and potential safety hazards, which can undermine trust in AI technologies. Therefore, embedding ethical frameworks and rigorous safety protocols throughout the development and deployment stages is important for AI systems to operate responsibly and effectively in real-world applications.

3. DEVELOPMENT OF PROGRAM STRUCTURE AND ALGORITHMS

3.1. Analysis of modern scientific achievements reading

The aim of the work is to develop a method for optimizing the operation of mass service systems, using a virtual assistant based on artificial intelligence as an effective tool for automating and improving user service processes.

Modern methods for optimizing the operation of QMS include a large number of technologies, models and strategies. Here is a list of scientific research on this topic: the author presents the general theory of queues and optimization methods in QMS [1], the publication is devoted to the modeling and analysis of service systems, including the distribution of tasks between resources [2], the article is devoted to methods for optimizing resource allocation in cloud computing for efficient task service [3], the paper considers methods for estimating queue length and managing call admission in networks with services with different characteristics [4], the paper proposes machine learning methods for selecting web services taking into account quality of service [5]. These scientific works present some of the modern methods for optimizing QoS used in various industries, such as telecommunications, cloud computing, and web services.

Considering the results of the analysis, it is worth noting that modern methods of QMS optimization have their advantages, but there are also certain disadvantages. Disadvantages of modern methods of QMS optimization: complexity of modeling (many optimization methods require complex mathematical modeling of QMS, which can be a difficult task and require significant computational resources), sensitivity to parameters (the effectiveness of many optimization methods can significantly depend on the correct selection of model parameters, which complicates their practical application and requires fairly accurate input data), limitations in real conditions (many models are based on

specific assumptions that may not reflect real QMS conditions, especially in variable and unpredictable environments). It is also worth noting the advantages of SMO using a virtual assistant (VA) (Telegram bot): automation and efficiency (VAs can automate many routine tasks, facilitating the work of employees and ensuring effective customer service), improved service quality (VAs can provide a quick and accurate response to user requests, improving the overall user experience of the service), constant availability and speed of response (VAs can be available 24/7 and provide instant answers, which has a positive impact on waiting times and customer satisfaction), cost reduction (using VAs can help reduce service costs and free up human resources and resources for other important tasks), facilitating interaction with users (VAs can become a convenient tool for interacting with users, giving them the opportunity to get the necessary information and help quickly and easily). Integrating VAs into the QMS can help to maximize the benefits of automation and improve interaction with users. However, it is important to consider them as an additional tool, and not as a full-fledged replacement for the human factor and expertise.

3.2. Development of an optimization method QMO operations using AI-based VA.

To develop VA, you need to choose tools, a platform, and perform the following steps.

Stage 1. Virtual registrationassistant.

To register a VA, you need to choose a platform, according to the research in [11, 12], let's choose the Telegram instant messaging system as an example. To develop a Telegram bot, we search for and launch BotFather in Telegram. We create a new bot using the /newbot command. We specify the name and username of the bot, the username must be unique, not repeat existing ones in the database and end with the word "bot". After creating a Telegram bot, we can configure and

edit it if necessary, using the menu. To connect the bot, its API Token is used, which is unique for each Telegram bot.

Stage 2. Development of the bot logic inGoogle Apps Script.

When developing the Telegram bot, we use Google Apps Script (GAS), which is a scripting platform developed by Google for developing lightweight web applications on the Google Workspace platform (Fig. 1). GAS was originally developed by Mike Garm as a side project while working on Google Sheets. The framework is based on JavaScript 1.6, but also includes some parts from 1.7 and 1.8, as well as a subset of the ECMAScript 5 API. GAS projects run on Google's infrastructure on server-side. According to GAS, it "provides simple ways to automate tasks across Google products and third-party services." GAS is also a tool for writing extensions for Google Docs, Sheets, and Slides.

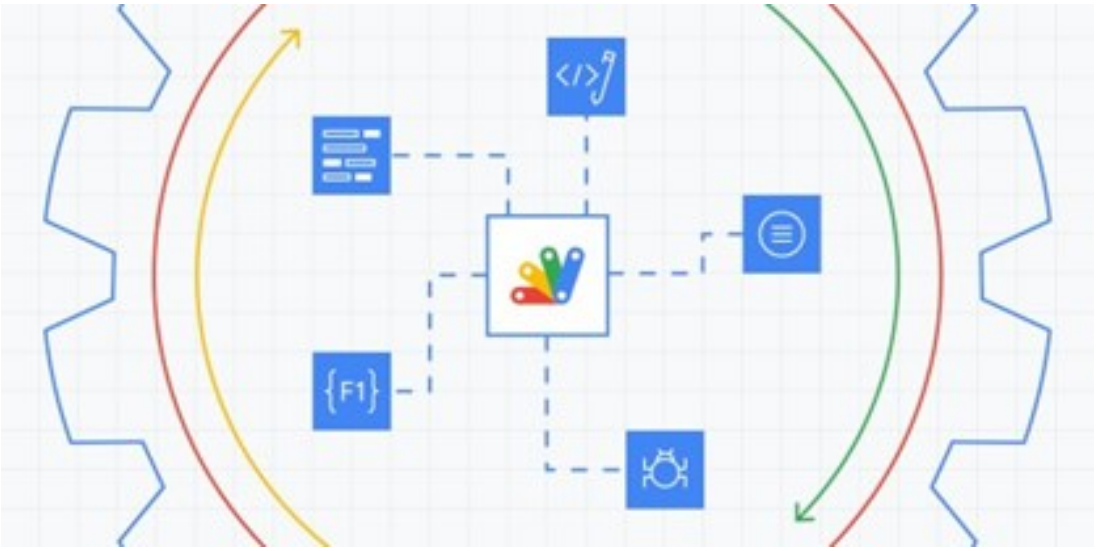


Figure 3.1 - GAS scripting platform

On the GAS platform, we create a new project, where we set the variables token (the Telegram bot token used to communicate with the Telegram API), webAppUrl (the URL of the web application used as a webhook (Fig. 2) to receive incoming messages from Telegram, a webhook is a method of increasing or extending the functionality of a web page or web application using user callbacks),

spreadsheetId (the Google spreadsheet identifier into which data will be entered), sheetName (the name of the sheet in Google spreadsheet into which Telegram chat messages will be entered), sheetName2 (the name of the sheet in Google spreadsheet into which user data will be entered).

Figure 3.2 - Webhook method

When developing a Telegram bot, we use the following functions: setWebhook() (sets a webhook for the Telegram bot using the Telegram API), sendText(chat_id, text, keyBoard, firstName, lastName, currentDate) (sends a text message to the user using sendMessage Telegram API method. The function parameters include: chat_id (chat ID), text (message text), keyBoard (display keyboard), firstName (user name), lastName (user last name), and currentDate (current date/time)), doPost(e) (the function processes incoming HTTP requests sent by the web application, receives data about the incoming message from Telegram, parses it, and enters the necessary data into a Google spreadsheet).

We also use the following objects:

KEYBOARD_1, KEYBOARD_2 (objects

represent keyboards (Fig. 3) for display in Telegram chat, contain lines and buttons that can be pressed to interact with the bot).

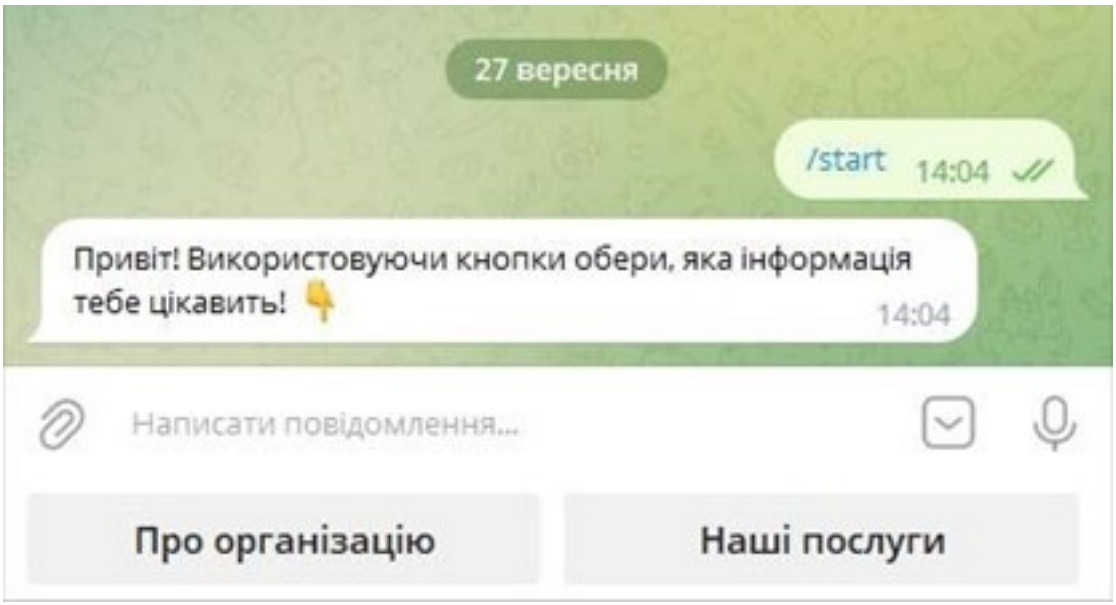


Figure 3.3 - Telegram bot keyboard

Stage 3. AI integration.

To help users, we use GPT-3 (Generative Pretrained Transformer 3) as an example, which is an autoregressive language model that uses deep learning to generate human-like text (Fig. 4). It is the third generation of language prediction models in the GPT-n series created by OpenAI, an AI research lab in San Francisco [6]. The full version of GPT-3 has a capacity of 175 billion machine learning parameters. GPT-3, which was introduced in May 2020 and is in beta testing as of July 2020 [7], is part of the trend of pretraining language representations in natural language processing (NLP) systems [8]. Before the release of GPT-3, the largest language model was Microsoft's Turing NLG, introduced in February 2020, with a capacity of 17 billions of parameters, or less than 10% compared to GPT-3 [9]. The quality of the text generated by GPT-3 is so high that it is difficult to distinguish it from text written by a human, which carries both advantages and risks [9]. The original paper that introduced GPT-3 was presented by thirty-one researchers and engineers from OpenAI. In their paper, they warned of the dangers of GPT-3’s potential and called for research to reduce

the risks. David Chalmers, an Australian philosopher, described GPT-3 as “one of the most interesting and important AI systems ever made” [10].

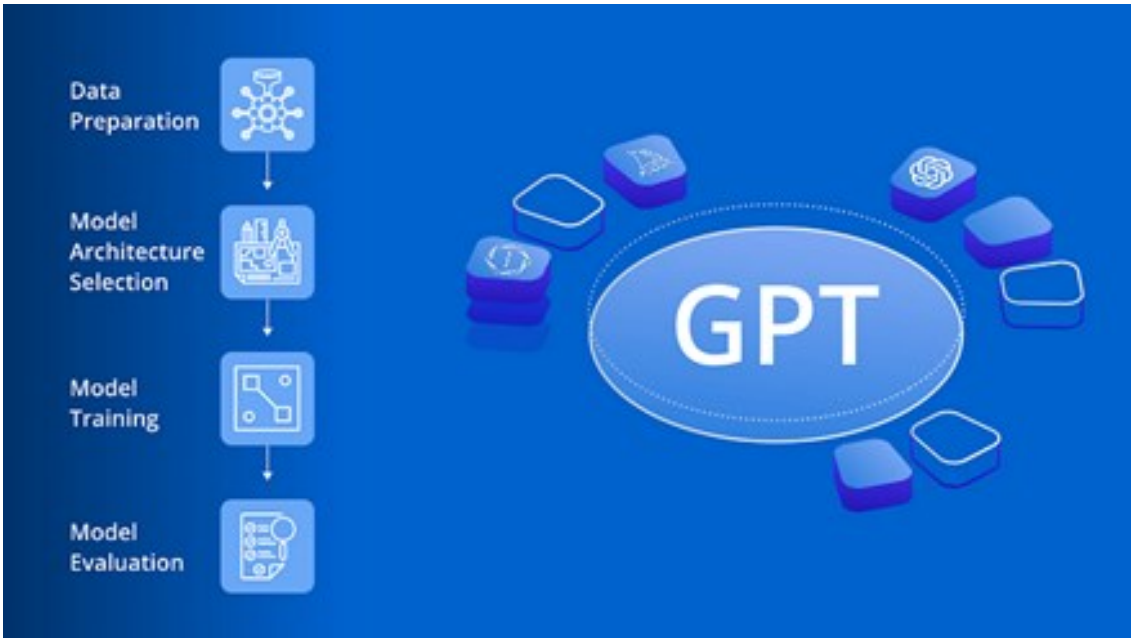


Fig. 4. GPT learning model

To use GPT to help users in a Telegram bot and connect GAS to it, you need to follow a few steps:

Step 1. GPT integration (we gain access to the service provided by GPT (for example, OpenAI GPT-3) and obtain an API key; we use the API key in GAS to interact with GPT, sending requests and receiving responses).

Step 2. Processing user messages and responses (when a user sends a message to a bot in Telegram, GAS receives it message through webhooks, processing the user's message and extracting the necessary information).

Step 3. Sending requests to GPT and processing responses (compose requests to GPT, including the text of the user's message or other necessary information; receive a response from GPT and process it for further use). Step 4. Sending a response to the user Tuvans (we create logic, which sends the processed response to the user in Telegram via the Bot API).

Stage 4. Database formation.

To create a database, a write to Google Sheets (writeToGoogleSheet) will be performed using the writeToGoogleSheet function, which is responsible for writing user data and requesting it from Google Sheets. The function adds a new line with the necessary data, and logs errors if any. This allows the bot to interact with the user via Telegram, call AI to generate responses if necessary, and record information about users and their requests to the database.

Function to set webhook:

```
Function setWebhook():
  Try:
    Send POST request to
'https://api.telegram.org/bot{token}/setWe
bhook?url={webAppUrl}'
    Log the response content
  Catch any errors and log them
```

Function for sending a text message in Telegram:

```
Function sendText(chat_id, text,
keyBoard):
    Log 'Sending message with chat_id:',
chat_id, 'text:', text, 'keyboard:', keyBoard
    Create a data object with necessary
parameters for sending a message
    Send a POST request to
'https://api.telegram.org/bot{token}/sendM
essage' with the data
```

Function for processing a POST request:

```
Try:
  Parse the request contents from e
  Extract chat_id and text from the
message

  If text is "/start":
    Send a welcome message with custom
keyboard
  Else If text is "Text":
    Send a message about Text with
custom keyboard
  Else If text is "Text":
    Send a message about Text with
custom keyboard


  Else:
    Call generateGPT3Response with text
 and 50 maxTokens
    Log GPT-3.5 Response
    Send the GPT-3.5 response with custom
 keyboard

Catch any errors and log them
```

Function to call GPT-3.5 API:

```
Function generateGPT3Response(prompt,
maxTokens):
  Try:
    Log 'Calling GPT-3.5 API with prompt:',
prompt, 'and maxTokens:', maxTokens

    Send a POST request to
'https://api.openai.com/v1/engines/davinci/com-
pletions' with the prompt and maxTokens
    Add necessary headers including authori-
zation with apiKey and content type

    If the response is successful:

      Parse the response data and return the
trimmed text from GPT-3.5 API
  Else:
    Throw an error indicating failure to
call GPT-3.5 API

Catch any errors and log them
```

Function for writing information to a Google spreadsheet:

Function writeToGoogleSheet(user_id, username, question):
Try:
Open the Google Sheet associated with the Telegram bot
Append a new row with user_id, username, and question
Close the Google Sheet
Log 'Information successfully written to Google Sheet'
Catch any errors and log them

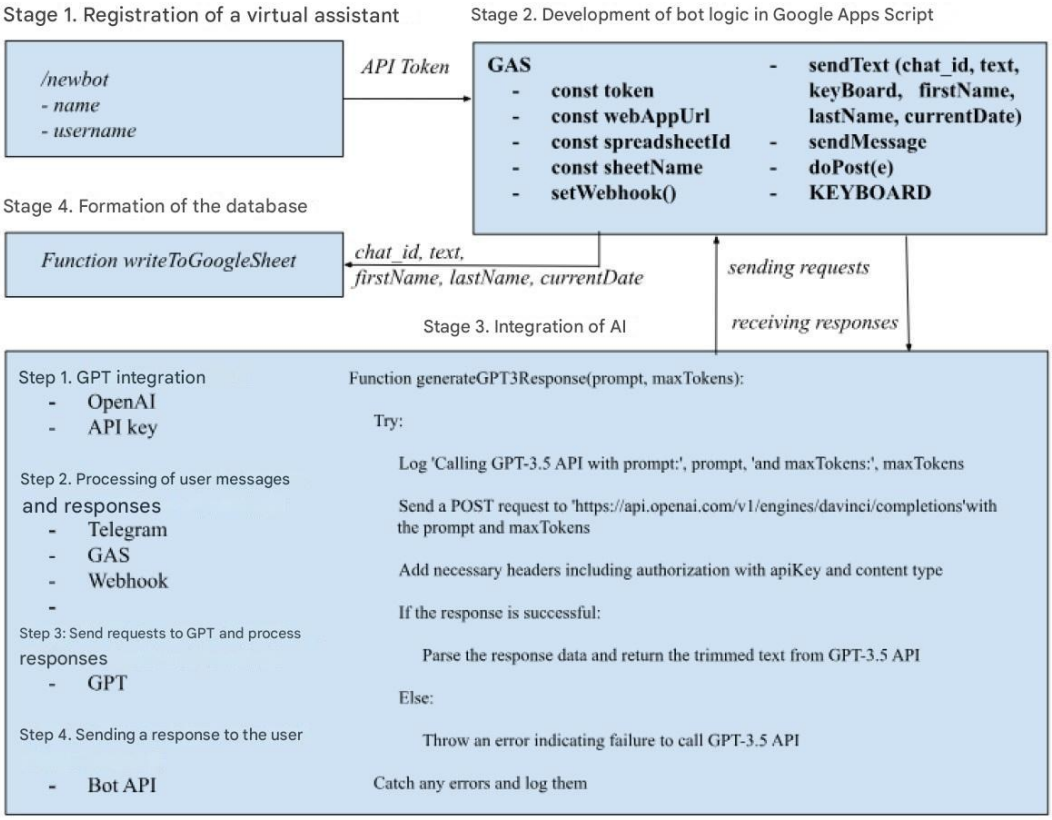


Figure 3.5 - Scheme of implementation of the method for optimizing the operation of the QMO using AI-based VA

In general, the logic of the program code looks like this:

1. Installation webhook (setWebhook):

- The setWebhook function sends a POST request to the Telegram API to set a webhook so that the bot can receive notifications.
- The success of the webhook installation is logged.

2. Sending a message to Telegramam (sendText):

- The sendText function sends a text message to a user in Telegram.
- It uses a POST request to

Telegramam API with the required parameters.

3. Interaction with GPT-3.5 API (generateGPT3Response):

- The generateGPT3Response function calls the GPT-3.5 API, providing a prompt and the maximum number of tokens to generate a response.
- Received response (text) from GPT-3.5 API is logged and returned.

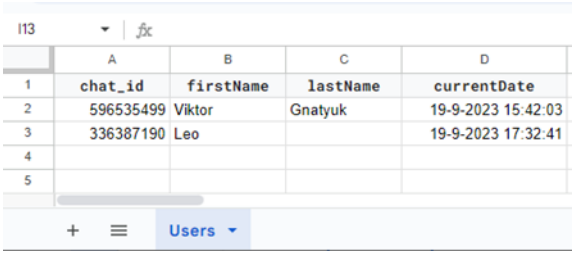
4. Processing a POST request (doPost):

- The doPost function processes a POST request from Telegram containing data from the user.
- It unpacks the data and extracts the necessary information, such as the chat_id and message text.
- Depending on the text, it can send a greeting or a request to the GPT-3.5 API.

5. Record in Google Sheets (writeToGoogleSheet):

- The writeToGoogleSheet function is responsible for writing user data and requesting it to Google Sheets.
- Opening a query in Google Sheets, adding a new row with the required data, and closing the query.
- In case of errors, the function logs them.

This is the general logic of the program code that allows the bot to interact with the user via Telegram, call the GPT-3.5 API to generate responses, and record information about users and their requests to Google Sheets (Fig.3.6).



	A	B	C	D
1	chat_id	firstName	lastName	currentDate
2	596535499	Viktor	Gnatyuk	19-9-2023 15:42:03
3	336387190	Leo		19-9-2023 17:32:41
4				
5				

Users

Figure 3.6 - Google table "Users"

Thus, a solution has been developed to optimize the work of the CMO using VA and integration with GAS, Google Tables, and GPT. The general features of this solution include the following: the use of VA, interaction with users (the bot interacts with users using buttons and text queries, allowing them to select the information they are interested in), generation of responses using GPT-3.5, saving information in Google Tables (information about users and their queries is stored and managed in Google Tables, simplifying work with data and their analysis), using GAS to program the bot logic and provide integration with Google Tables, which allows you to automate data processing and storage, optimization of the CMO work (VA and integration with GPT-3.5 are aimed at optimizing user service, providing a quick and informative response to their queries).

These are the general features of the developed solution, which combines effective communication with users through VA, expanding the capabilities of generating responses using AI, and effective data management and analysis through GAS.

4 SAFETY OF LIFE, BASIC LABOR PROTECTION

4.1. Effects of electromagnetic radiation on the human body

A large body of literature exists on the response of tissues to electromagnetic fields, primarily in the extremely-low-frequency (ELF) and microwave-frequency ranges. In general, the reported effects of radiofrequency (RF) radiation on tissue and organ systems have been attributed to thermal interactions, although the existence of nonthermal effects at low field intensities is still a subject of active investigation. This chapter summarizes reported RF effects on major physiological systems and provides estimates of the threshold specific absorption rates (SARs) required to produce such effects. Organ and tissue responses to ELF fields and attempts to characterize field thresholds are also summarized. The relevance of these findings to the possible association of health effects with exposure to RF fields from GWEN antennas is assessed.

Nervous System

The effects of radiation on nervous tissues have been a subject of active investigation since changes in animal behavior and nerve electrical properties were first reported in the Soviet Union during the 1950s and 1960s.1 RF radiation is reported to affect isolated nerve preparations, the central nervous system, brain chemistry and histology, and the blood-brain barrier.

In studies with in vitro nerve preparations, changes have been observed in the firing rates of Aplysia neurons and in the refractory period of isolated frog

sciatic nerves exposed to 2.45-GHz microwaves at SAR values exceeding 5 W/kg.2,3,4 Those effects were very likely associated with heating of the nerve

preparations, in that much higher SAR values have not been found to produce

changes in the electrical properties of isolated nerves when the temperature was controlled.5, 6 Studies on isolated heart preparations have provided evidence of bradycardia as a result of exposure to RF radiation at nonthermal power densities,7 although some of the reported effects might have been artifacts caused by currents induced in the recording electrodes or by nonphysiological conditions in the bathing medium.8,9,10 Several groups of investigators have reported that nonthermal levels of RF fields can alter Ca2+ binding to the surfaces of nerve cells in isolated brain hemispheres and neuroblastoma cells cultured in vitro (reviewed by the World Health Organization11 and in Chapters 3 and 7 of this report). That phenomenon, however, is observed only when the RF field is amplitude-modulated at extremely low frequencies, the maximum effect occurs at a modulation frequency of 16 Hz. A similar effect has recently been reported in isolated frog hearts.12 The importance of changes in Ca2+ binding on the functional properties of nerve cells has not been established, and there is no clear evidence that the reported effect of low-intensity, amplitude-modulated RF fields poses a substantial health risk.

Results of in vivo studies of both pulsed and continuous-wave (CW) RF fields on brain electrical activity have indicated that transient effects can occur at SAR values exceeding 1 W/kg.13,14 Evidence has been presented that cholinergic activity of brain tissue is influenced by RF fields at SAR values as low as 0.45 W/kg.15 Exposure to nonthermal RF radiation has been reported to influence the electroencephalograms (EEGs) of cats when the field was amplitude-modulated at frequencies less than 25 Hz, which is the range of naturally occurring EEG frequencies.16 The rate of Ca2+ exchange from cat brain tissue in vivo was observed to change in response to similar irradiation conditions.17 Comparable effects on Ca2+ binding were not observed in rat cerebral tissue exposed to RF radiation,18 although the fields used were pulsed at EEG frequencies, rather than amplitude-modulated. As noted above, the physiological significance of small shifts in Ca2+ binding at nerve cell surfaces is unclear.

A wide variety of changes in brain chemistry and structure have been reported after exposure of animals to high-intensity RF fields.19 The changes include decreased concentrations of epinephrine, norepinephrine, dopamine, and 5-hydroxytryptamine; changes in axonal structure; a decreased number of Purkinje cells; and structural alterations in the hypothalamic region. Those effects have generally been associated with RF intensities that produced substantial local heating in the brain.

Extensive studies have been carried out to detect possible effects of RF radiation on the integrity of the blood-brain barrier.20,21 Although several reports have suggested that nonthermal RF radiation can influence the permeability of the blood-brain barrier, most of the experimental findings indicate that such effects result from local heating in the head in response to SAR values in excess of 2 W/kg. Changes in cerebral blood flow rate, rather than direct changes in permeability to tracer molecules, might also be incorrectly interpreted as changes in the properties of the blood-brain barrier.

Effects of pulsed and sinusoidal ELF fields on the electrical activity of the nervous system have also been studied extensively.22,23 In general, only high-intensity sinusoidal electric fields or rapidly pulsed magnetic fields induce sufficient current density in tissue (around 0.1-1.0 A/m2 or higher) to alter neuronal excitability and synaptic transmission or to produce neuromuscular stimulation. Somewhat lower thresholds have been observed for the induction of visual phosphenes (discussed in the next section) and for influencing the electrical activity of Aplysia pacemaker neurons when the frequency of the applied field matched the endogenous neuronal firing rate.24 Those effects, however, have been observed only with ELF frequencies and would not be expected to occur at the higher frequencies associated with GWEN transmitters. Recent studies with human volunteers exposed to 60-Hz electric and magn.

Electromagnetic radiation can be classified into two types: ionizing radiation and non-ionizing radiation, based on the capability of a single photon with more

than 10 eV energy to ionize oxygen or break chemical bonds. Ultraviolet and higher frequencies, such as X-rays or gamma rays are ionizing, and these pose their own special hazards: see radiation and radiation poisoning. By far the most common health hazard of radiation is sunburn, which causes over one million new skin cancers annually.

4.2 Types of hazards

Electrical hazards

Very strong radiation can induce current capable of delivering an electric shock to persons or animals.[citation needed] It can also overload and destroy electrical equipment. The induction of currents by oscillating magnetic fields is also the way in which solar storms disrupt the operation of electrical and electronic systems, causing damage to and even the explosion of power distribution transformers, blackouts (as occurred in 1989), and interference with electromagnetic signals (e.g. radio, TV, and telephone signals).

Fire hazards

Extremely high power electromagnetic radiation can cause electric currents strong enough to create sparks (electrical arcs) when an induced voltage exceeds the breakdown voltage of the surrounding medium (e.g. air at 3.0 MV/m). These sparks can then ignite flammable materials or gases, possibly leading to an explosion.

This can be a particular hazard in the vicinity of explosives or pyrotechnics, since an electrical overload might ignite them. This risk is commonly referred to as Hazards of Electromagnetic Radiation to Ordnance (HERO) by the United States Navy (USN). United States Military Standard 464A (MIL-STD-464A) mandates

assessment of HERO in a system, but USN document OD 30393 provides design principles and practices for controlling electromagnetic hazards to ordnance.

On the other hand, the risk related to fueling is known as Hazards of Electromagnetic Radiation to Fuel (HERF). NAVSEA OP 3565 Vol. 1 could be used to evaluate HERF, which states a maximum power density of 0.09 W/m^2 for frequencies under 225 MHz (i.e. 4.2 meters for a 40 W emitter)/

Biological hazards

The best understood biological effect of electromagnetic fields is to cause dielectric heating. For example, touching or standing around an antenna while a high-power transmitter is in operation can cause severe burns. These are exactly the kind of burns that would be caused inside a microwave oven.[citation needed]

This heating effect varies with the power and the frequency of the electromagnetic energy, as well as the distance to the source. A measure of the heating effect is the specific absorption rate or SAR, which has units of watts per kilogram (W/kg). The IEEE and many national governments have established safety limits for exposure to various frequencies of electromagnetic energy based on SAR, mainly based on ICNIRP Guidelines, which guard against thermal damage.

There are publications which support the existence of complex biological and neurological effects of weaker non-thermal electromagnetic fields , including weak ELF magnetic fields and modulated RF and microwave fields. Fundamental mechanisms of the interaction between biological material and electromagnetic fields at non-thermal levels are not fully understood.

Lighting.

Fluorescent lights.

Fluorescent light bulbs and tubes internally produce ultraviolet light. Normally this is converted to visible light by the phosphor film inside a protective coating. When the film is cracked by mishandling or faulty manufacturing then UV may escape at levels that could cause sunburn or even skin cancer.

LED lights.

High CRI LED lighting.

Blue light, emitting at wavelengths of 400–500 nanometers, suppresses the production of melatonin produced by the pineal gland. The effect is disruption of a human being's biological clock resulting in poor sleeping and rest periods.

EMR effects on the human body by frequency

Warning sign next to a transmitter with high field strengths

While the most acute exposures to harmful levels of electromagnetic radiation are immediately realized as burns, the health effects due to chronic or occupational exposure may not manifest effects for months or years.[citation needed]

Extremely-low frequency

High-power extremely-low-frequency RF with electric field levels in the low kV/m range are known to induce perceivable currents within the human body that create an annoying tingling sensation. These currents will typically flow to ground through a body contact surface such as the feet, or arc to ground where the body is well insulated.

Shortwave

Shortwave (1.6 to 30 MHz) diathermy heating of human tissue only heats tissues that are good electrical conductors, such as blood vessels and muscle.

Adipose tissue (fat) receives little heating by induction fields because an electrical current is not actually going through the tissues.

4.3 Road Transport Safety

The basic strategy of a Safe System approach is to ensure that in the event of a crash, the impact energies remain below the threshold likely to produce either death or serious injury. This threshold will vary from crash scenario to crash scenario, depending upon the level of protection offered to the road users involved. For example, the chances of survival for an unprotected pedestrian hit by a vehicle diminish rapidly at speeds greater than 30 km/h, whereas for a properly restrained motor vehicle occupant the critical impact speed is 50 km/h (for side impact crashes) and 70 km/h (for head-on crashes).

As sustainable solutions for all classes of road have not been identified, particularly low-traffic rural and remote roads, a hierarchy of control should be applied, similar to classifications used to improve occupational safety and health. At the highest level is sustainable prevention of serious injury and death crashes, with sustainable requiring all key result areas to be considered. At the second level is real time risk reduction, which involves providing users at severe risk with a specific warning to enable them to take mitigating action. The third level is about reducing the crash risk which involves applying the road design standards and guidelines (such as from AASHTO), improving driver behavior and enforcement.

4.4 Conclusions

A serious workplace injury or death changes lives forever for families, friends, communities, and coworkers too. Human loss and suffering is immeasurable. Occupational injuries and illnesses can provoke major crises for the families in which they occur. In addition to major financial burdens, they can

impose substantial time demands on uninjured family members. Today, when many families are operating with very little free time, family resources may be stretched to the breaking point. Every person who leaves for work in the morning should expect to return home at night in good health. Can you imagine the knock on the door to tell you your loved one will never be returning home? Or the phone call to say he's in the hospital and may never walk again? Ensuring that husbands return to their wives, wives to their husbands, parents to their children, and friends to their friends that is the most important reason to create a safe and healthy work environment. But it isn't the only reason.

CONCLUSIONS

The developed solution expands the capabilities of existing QMS through the use of VA and the development of AI, in particular GPT-3.5, to ensure more effective and informative communication with users. Thus, an effective tool has been developed to automate and improve service processes, which provides: improved interaction with by users, the use of AI to improve responses, efficient data storage and analysis, the possibility of automation thanks to GAS. In the future, it is planned to expand the language model, improve the user interface, add an automatic speech recognition module to support many languages and additional query analysis capabilities, develop algorithms that learn from user responses to provide personalized answers and improve the interaction experience, research and optimize data processing algorithms for faster and more efficient system operation with a large flow of requests. These scientific developments can improve the efficiency, accuracy and user experience of the MSS using VA.

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