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«ХАРКІВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ»

SCIENCE LOOKS AHEAD

AI as a research assistant

НАУКА – ПОГЛЯД У МАЙБУТНЄ

Штучний інтелект як інструмент науковця

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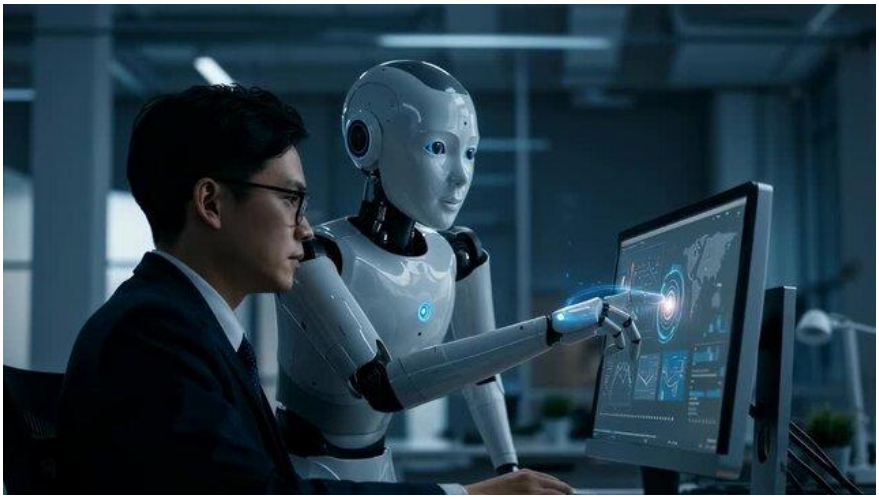

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СЕКЦІЯ 1: ШТУЧНИЙ ІНТЕЛЕКТ У НАУЦІ ТА ОСВІТІ

PRACTICES OF USING AI AGENTS IN THE DEVELOPMENT AND ANALYSIS OF DATABASES FOR HUMANITARIAN RESEARCH

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The current stage of development in the humanities is characterized by the rapid integration of generative artificial intelligence tools into research methodology. In particular, initiatives by tech giants, such as providing broad access to advanced versions of large language models for the academic community, are bringing to the fore discussions not only about the ethics of AI use, but also about the transformation of research procedures themselves. In this context, the transition from the chaotic use of chatbots to systematic work with specialized AI agents capable of optimizing the processes of collecting, structuring, and interpreting qualitative data is of key importance.

The use of AI tools to create specialized databases demonstrates the potential for greater accuracy in structuring information compared to traditional “manual” methods. This is due to the specifics of machine “thinking” — the ability of algorithms to adhere to formal logic without the cognitive distortions, fatigue, and loss of concentration inherent in human researchers when working with large amounts of text. A methodologically promising approach is the creation of customized AI agents (for example, based on Gems in Gemini or GPTs in OpenAI), which are programmed using detailed system prompts. This architecture allows you to embed a clear information classification scheme into the model, define the categorical apparatus and data selection criteria even before you start processing the sources.

A critical advantage of using customized agents is not only the speed of information processing, but also the ability to ensure interpretive transparency. Unlike classical content analysis, where the coder's decisions often remain implicit, an AI agent can be configured to provide mandatory reasoning for each decision. When making an entry into the database, the model is able to provide an explanation of why a particular piece of text has been assigned to a specific category. This allows the researcher to verify the results, track the logic of the algorithm, and, if necessary, adjust the prompt to increase the relevance of the sample, which significantly increases the validity of the final dataset.

A separate link is the use of a set of agents, where the output data of one stage becomes the input for another. After forming the initial database, it is advisable to involve a separate analytical agent specializing in statistical processing and pattern detection. This approach

allows you to automate the conversion of raw tabular data into structured statistical reports, revealing correlations that may go unnoticed at a glance.

A significant drawback of traditional statistical tools and software for quantitative text analysis is their focus on lexical matches without taking into account the semantic field. Large language models, on the other hand, have the ability to perform in-depth contextual analysis. For example, when processing historical periodicals (such as materials from the Pravda newspaper for 1947), an AI agent is able to identify latent meanings and thematic blocks, such as "cultural cooperation," even in the absence of direct use of this term. The model analyzes rhetorical figures, tone, and context of messages, allowing it to reconstruct discourse with an accuracy unattainable for scripts based on rigid search algorithms. This minimizes the "mechanical" nature of the report, bringing its quality closer to that of expert analysis.

It is also worth emphasizing the economic and technical accessibility of these technologies. Unlike specialized software for qualitative data analysis (CAQDAS), which often requires significant financial investment and lengthy training, AI agents lower the barrier to entry into digital research. The key competency is not mastering specialized skills for each individual model, but rather prompt engineering and the ability to decompose complex research goals into algorithmic chains. The effectiveness of AI models directly correlates with the accuracy of task formulation: the best results are achieved when the array of work is broken down into small, logically complete iterations.

In summary, integrating AI agents into the research process of humanities scholars allows them to eliminate the routine aspects of working with databases, freeing up time for conceptual reflection on the results. When properly configured and critically monitored by the researcher, such tools provide a deeper level of analysis and a higher speed of obtaining scientific conclusions compared to traditional methods of manual source processing.

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ARTIFICIAL INTELLIGENCE AS A RESEARCH ASSISTANT: CAPABILITIES, LIMITATIONS, AND STRATEGIES FOR EFFECTIVE USE

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The rapid proliferation of generative artificial intelligence tools has fundamentally altered the landscape of information retrieval and knowledge work. Where traditional search engines return ranked lists of hyperlinks that users must navigate and synthesise independently, modern Large Language Model (LLM)-based tools provide direct, already synthesised answers [1].

This transition is comparable to the difference between being handed a set of library keys and conversing with a librarian who has already read every book in the collection – a paradigm shift that carries profound implications for researchers, educators, and knowledge workers across all disciplines [1].

To use these tools effectively, one must first understand their underlying architecture. LLMs are trained on enormous amounts of text and generate output by predicting the most probable next token in a sequence – a process that does not constitute reasoning in any human sense, but rather sophisticated statistical pattern-matching whose fluency can easily be mistaken for genuine understanding [1].

Despite this, they demonstrate impressive practical utility: condensing lengthy documents, extracting structured information from unstructured text, and generating lightweight code for data collection – compressing what formerly required hours of manual effort into a matter of minutes [1, 4].

These gains, however, must be weighed against well-documented limitations. The research community has extensively characterised hallucination – the generation of content that is linguistically fluent but factually inaccurate or even fabricated, ranging from subtle misattributions to wholesale invention of non-existent sources [1, 2].

Because the root causes are partially intrinsic to the architecture of autoregressive models, complete elimination is considered intractable, and mitigation remains the realistic goal [2]. The legal landscape adds further complexity: copyright ownership for AI-assisted outputs remains unresolved across major jurisdictions, with divergent regulatory frameworks in the United States, the European Union, and Canada [1].

Given both the power and the pitfalls of LLMs, the quality of the human input – the prompt – emerges as a decisive factor. Prompt engineering has developed into a distinct discipline encompassing dozens of strategies, from zero-shot approaches to chain-of-thought prompting [3]. Users who provide prompts characterised by clear task specification, explicit format requirements, and contextual scaffolding consistently achieve higher efficiency than those relying on vague queries [3, 4].

Ultimately, AI tools are most productive when positioned as assistants that augment, rather than replace, human intelligence. The researcher remains responsible for critically evaluating outputs, exercising domain expertise, and applying the higher-order critical thinking that distinguishes informed scholarship from automated text generation [1].

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FROM TOOLS TO TEAMMATES: LARGE LANGUAGE MODEL AGENTS IN THE MODERN SCIENTIFIC PIPELINE

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The emergence of large language model (LLM)-based agentic systems marks a profound transformation in how scientific research is conceived and executed. Traditionally, the research pipeline has demanded substantial human effort at every stage from synthesizing existing literature and identifying unexplored gaps, to designing controlled experiments, interpreting results, and producing publishable manuscripts. Recent advances in artificial intelligence are beginning to redefine each of these stages simultaneously.

A landmark contribution in this direction is the AI Scientist framework introduced by Lu et al. (2024), which demonstrated end-to-end automation of the research lifecycle: the system independently proposes ideas by surveying relevant literature, generates and runs code-based experiments, evaluates outcomes, and ultimately produces a structured scientific paper. This framework represents a conceptual shift from AI as a passive tool toward AI as an active participant in knowledge creation.

In parallel, domain-specific LLM agents have demonstrated remarkable results across the natural sciences. Boiko et al. integrated a GPT-4-driven planning module with robotic laboratory hardware, enabling an agent to autonomously design, carry out, and interpret multi-step chemical reactions effectively closing the experimental loop without human intervention. In biology, similar systems facilitate automated analysis of genomic data and accelerate drug target identification.

A systematic review of the field by researchers surveying over 260 LLMs (Zhang et al., 2025) highlights that modern AI systems are no longer limited to single-task assistance; instead, they increasingly operate across interconnected research stages. Agentic AI systems can be classified by their level of autonomy from tools that assist literature search, through analysts that synthesize and interpret data, to scientists capable of independently generating and testing novel hypotheses (Ghafarollahi & Buehler, 2024).

However, significant challenges remain. Hallucination, the tendency of LLMs to produce plausible but factually incorrect outputs, continues to pose a risk in high-stakes scientific contexts. Issues of reproducibility, accountability, and intellectual attribution remain unresolved. The absence of robust verification mechanisms means that AI-generated hypotheses or experimental designs require careful expert validation before they can be trusted in consequential domains.

A forward-looking perspective suggests that the most productive paradigm is not full automation but rather human-AI collaboration, where researchers retain creative and critical

oversight while delegating repetitive or computationally intensive tasks to AI systems. As multimodal, agentic architectures continue to mature, integrating text, structured data, laboratory instruments, and real-time feedback, the boundary between AI assistant and AI co-author will inevitably shift. For IT students entering this space, understanding both the capabilities and the epistemic limitations of these systems is not optional; it is foundational to responsible scientific practice in the coming decade.

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HOW AI HELPS ME DO RESEARCH BETTER

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The relevance of the topic is determined by the growing role of artificial intelligence in contemporary research, where AI is increasingly used as a practical instrument for accelerating scientific discovery, processing heterogeneous data, and supporting analytical decision-making [1]. In my own research practice, AI helps search for relevant publications, compare methods, extract key ideas from dense texts, organize datasets, systematize notes, and automate repetitive technical operations. Therefore, its value lies not in replacing the researcher, but in reducing mechanical work and creating more time for analysis, interpretation, and methodological decisions.

The purpose of this presentation is to generalize my personal research experience of using AI as an assistant in scientific work. In my case, AI improves research productivity in at least three interrelated areas. First, it supports work with scientific information: searching for relevant publications, comparing approaches, and extracting key ideas from dense texts[1, 2]. Second, it facilitates the processing of research materials by helping organize datasets,

systematize notes, summarize observations, and automate repetitive technical tasks. Third, it supports the construction of more complex analytical workflows in which heterogeneous evidence can be integrated into a more coherent research conclusion.

This logic is reflected in my research project, BehaveID-Fusion, which focuses on wildlife identification using image, motion, and sound as complementary modalities. Such a multimodal approach is justified by the fact that real-world observations are often incomplete, noisy, or ambiguous: images may be dark or blurred, animals may be partially visible, and camera-trap systems face serious domain-shift problems when models are transferred to unseen locations and sensors [2, 3]. In this context, markerless pose estimation methods create opportunities for extracting behavioural cues from motion [4], whereas bioacoustic models enable scalable species recognition from sound recordings [5]. In my work, AI acts both as a research assistant and as part of the research product itself: it supports literature and data processing, combines visual, motion, and acoustic evidence, and contributes to a more reliable identification result.

Thus, my experience shows that AI should be interpreted as an instrument for strengthening research capacity. It increases the speed of literature analysis, reduces the burden of routine work, and supports transparent analytical practice. At the same time, responsibility for source verification, methodological validity, and final interpretation remains with the human researcher. In this sense, AI does not replace scientific thinking; rather, it helps the researcher use time, information, and data more effectively.

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PROMPTING AS A RESEARCH SKILL: THE NEW SCIENTIFIC LITERACY

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Prompting has become a fundamental component of modern research in the age of artificial intelligence. While AI tools are widely integrated into academic and professional environments, the quality of generated outputs depends directly on the formulation of prompts. A poorly structured prompt leads to vague or irrelevant results, whereas a precise and well-defined prompt enables accurate, structured, and meaningful responses. Thus, the principle "bad prompt equals bad result" reflects a direct dependency between human input and AI output.

Prompting should be understood not as a simple query, but as a form of task design that determines the logic, structure, and relevance of generated information. Effective prompting requires a clear objective, explicit instructions, relevant context, and a defined output format. These elements establish a structured interaction framework that minimizes ambiguity and increases the reliability of results. Iterative refinement further enhances performance, as continuous adjustment of prompts allows researchers to improve both accuracy and depth of responses. Beyond these core criteria, a wide range of prompting techniques and strategies has emerged, including role-based prompting, step-by-step reasoning, and structured task decomposition. This diversity demonstrates that prompting is not a fixed formula, but a flexible and evolving practice that requires analytical thinking, experimentation, and adaptation to specific research contexts.

The development of prompting skills significantly expands research capabilities. It enables efficient processing of large volumes of information, supports pattern recognition, facilitates hypothesis generation, and accelerates analytical workflows. At the same time, prompting reinforces methodological rigor and critical evaluation, ensuring that researchers maintain intellectual control over the research process. In this context, artificial intelligence functions as a supportive instrument that amplifies human reasoning rather than replacing it.

The growing importance of prompting indicates a transformation in the concept of scientific literacy. Alongside traditional competencies such as critical thinking, analytical skills, and effective communication, modern research increasingly requires the ability to interact with AI systems through precise and intentional instruction. Prompting therefore represents a new dimension of scientific literacy, integrating technical proficiency with cognitive and methodological awareness. Moreover, the existence of multiple prompting techniques and iterative strategies highlights that this skill extends beyond basic interaction with AI. It involves the ability to select, adapt, and combine different prompting approaches

depending on the research objective, thereby forming a comprehensive and transferable competence within modern scientific practice.

In conclusion, mastering prompting as a research skill is essential for ensuring high-quality, reliable, and meaningful research outcomes. It allows researchers to remain the authors of knowledge while using artificial intelligence as a powerful analytical partner. As AI technologies continue to evolve, the ability to formulate effective prompts becomes a key factor in maintaining competitiveness and academic integrity in the modern scientific landscape. In this context, the future of research will depend not on access to artificial intelligence itself, but on the ability to use it deliberately, critically, and effectively.

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GENERATIVE ARTIFICIAL INTELLIGENCE AS A MEANS OF SOLVING SEARCH AND CREATIVE PROBLEMS

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The rapid development of generative AI has transformed it from a simple conversational tool into a complex "knowledge engine". Unlike traditional search engines, which return a list of indexed links, generative AI provides synthesized, context-oriented solutions. This shift is crucial for scientific research and engineering, where the main challenge is not only to find data but also to integrate it into complex logical systems. However, due to the non-linearity of AI algorithms, he can sometimes hallucinate. Giving false information under the guise of truth.

Example from personal practice: when writing the lab work we had to manually address space on hard drive. And when it was necessary to find complex formulas for converting an address in bytes from the beginning of a disk to disk coordinates, the standard search engine

offered mostly similar keywords but not similar answers. The AI gave correct formulas with references to sources and brief but understandable explanations.

AI serves as a "sparring partner" for scientists. When the researcher is stuck, AI can offer alternative hypotheses, indicate extreme cases, or suggest a different architectural approach. This capacity for search patterns reduces the cognitive burden on scientists, allowing them to focus on high-level conceptual design rather than routine conclusions. In addition, such advice can help when we are stuck with one solution and don't notice other techniques.

In addition to interactive search, generative AI can be integrated into automated workflows for large-scale evaluation of theories or models. Using structured queries and iterative scenarios, a researcher can delegate the "brute-force" phase of ideas. For example, the system could be tasked with analyzing hundreds of architectural configurations or mathematical models at a moment's notice, filtering out those that do not meet certain logical or physical constraints. This shift to autonomous task execution allows for quick viewing of viable scientific theories, effectively turning AI into a round-the-clock laboratory that produces a short list of optimized solutions for final human verification.

Despite its impressive capabilities, it is crucial to recognize that generative AI operates within the strict limits of its learning data. This leads to several significant risks in the scientific context.

First, a hallucinatory phenomenon can lead to the creation of plausible but mathematically incorrect formulas.

Second, because AI relies on existing knowledge, it may have difficulty with early discoveries made after the "knowledge limitation date."

Therefore, AI should be viewed as a tool rather than an absolute source of truth. The responsibility for thorough vetting and cross-referencing with major academic sources remains with the scientist, ensuring that AI results are used as a basis for further analysis rather than the final result.

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THE END OF ACCIDENTAL DISCOVERIES: AI AND THE DEATH OF SERENDIPITY

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The history of science is full of unexpected breakthroughs that happened not as a result of targeted research, but due to chance. Such discoveries as penicillin, X-rays, or even microwave ovens were made accidentally, when scientists noticed something unusual and decided to explore it further. This phenomenon, often called serendipity, has played a crucial role in scientific progress. However, with the rapid development of artificial intelligence, an important question arises: is there still room for accidental discoveries in a world increasingly driven by algorithms and data optimization?

Artificial intelligence systems are designed to analyze large volumes of data, identify patterns, and generate predictions with high accuracy. In modern science, AI is used to accelerate research processes, reduce uncertainty, and optimize experiments. While this significantly increases efficiency, it also changes the nature of discovery. Instead of open-ended exploration, scientists are more often guided by algorithmic suggestions, which may limit the chances of encountering the unexpected. AI tends to focus on probable outcomes rather than anomalies, potentially filtering out exactly those irregularities that could lead to groundbreaking discoveries.

At the same time, it would be incorrect to claim that AI completely eliminates serendipity. On the contrary, in some cases, artificial intelligence can create new forms of unexpected findings. By processing complex datasets that are impossible for humans to fully comprehend, AI may reveal hidden connections that were not previously visible. However, such "discoveries" are different in nature. They are not the result of chance observation, but rather the outcome of computational processes. This raises philosophical questions about whether these findings can truly be considered serendipitous.

Another important aspect is the role of the human factor. Traditional accidental discoveries often depended on curiosity, intuition, and the willingness of researchers to question anomalies. If scientists rely too heavily on AI, there is a risk that these qualities may weaken over time. The ability to notice something "strange" and investigate it without predefined expectations is essential for genuine innovation. Therefore, the integration of AI into science should not replace human creativity, but rather complement it.

In conclusion, artificial intelligence is transforming the way scientific discoveries are made, making research more efficient and structured. However, this transformation may reduce the likelihood of traditional accidental discoveries by prioritizing predictability over randomness. Despite this, serendipity is unlikely to disappear completely, as long as human

curiosity and critical thinking remain part of the scientific process. The future of science will likely depend on finding a balance between algorithmic precision and openness to the unexpected, ensuring that innovation continues to thrive in both planned and unplanned ways.

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VIRTUELLE BIBLIOTHEKSAUSSTELLUNGEN IM ZEITALTER DER DIGITALISIERUNG: KÜNSTLICHE INTELLIGENZ ALS ASSISTENZ DER FORSCHENDEN

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Wie lässt sich ein statischer Bibliotheksbestand in einen dynamischen Raum des historischen Storytellings verwandeln, in dem künstliche Intelligenz (KI) nicht nur als mechanisches Werkzeug, sondern als vollwertige Assistenz der Forschenden fungiert? Im Zeitalter der globalen Digitalisierung werden virtuelle Ausstellungen zu einem der wirksamsten Instrumente zur Popularisierung von Beständen. Wie die Erfahrung führender wissenschaftlicher Einrichtungen zeigt, haben sich moderne elektronische Ausstellungen zu komplexen Webprojekten entwickelt. Insbesondere die Wernadskyj-Nationalbibliothek der Ukraine transformiert Formate durch die Schaffung spezialisierter elektronischer Sammlungen mit wissenschaftlichem Apparat, die Nationale Wissenschaftliche Wassyl-Stefanyk-Bibliothek der Ukraine und die Nationale Historische Bibliothek der Ukraine entwickeln multimediale Longreads, und die Nationale Wissenschaftliche Bibliothek Odessa führt digitale Galerien ein. Nach der Anmerkung von S. Mamedowa [1, S. 231] bleibt trotz der aktiven Virtualisierung das Problem des Narrativs eine gemeinsame Herausforderung: Akademisches Material muss für moderne Internetnutzende emotional ansprechend gestaltet werden.

Die Staatliche Wissenschaftliche W. G. Korolenko-Bibliothek Charkiw (ChDNB) bietet eine eigene Lösung für diese Aufgabe und erschließt durch virtuelle Projekte bedeutende historische Ereignisse, das kulturelle Erbe und Persönlichkeiten. Als Beispiel für eine elektronische Sammlung ist das Projekt Sammlung ukrainischer Irmologien der ChDNB hervorzuheben. Angesichts der Spezifik dieser handschriftlichen und gedruckten Denkmäler,

die sakrale Texte mit einer einzigartigen musikalischen Notation verbinden, eröffnet die Integration von Technologien der künstlichen Intelligenz grundlegend neue Horizonte für deren Erforschung.

Das theoretische Potenzial des Einsatzes von KI-Assistenten bei der Bearbeitung von Irmologien zeigt sich vor allem in der paläografischen Analyse und der Handschrifterkennung (HTR). Der Einsatz spezialisierter neuronaler Netze ermöglicht nicht nur die Automatisierung der Transliteration von altkyrillischer Halbunziale und Kursive, sondern auch der altpolnischen Sprache. Darüber hinaus können Werkzeuge der Verarbeitung natürlicher Sprache (NLP) tiefgehende vergleichende und textologische Analysen durchführen, indem sie automatisch Listen von Irmologien aus verschiedenen Regionen abgleichen. Dies bietet Forschenden die Möglichkeit, das Eindringen von Elementen der lebendigen ukrainischen Sprache in kirchenslawische Texte effektiv zu verfolgen und regionale Unterschiede in den Gesängen zu erkennen. Gleichzeitig kann generative KI als Werkzeug für die virtuelle Restaurierung verblasster Textfragmente oder beschädigter Marginalien auf der Grundlage der Analyse erhaltener Handschriftenmuster eines bestimmten Schreibers dienen.

Dank eines solchen umfassenden Ansatzes verwandelt sich das Irmologion theoretisch von einem einfachen Objekt der statischen Ausstellung in eine dynamische Datenbank für fachspezifische musikwissenschaftliche, paläografische und sprachwissenschaftliche Forschungen. Für die Ausstellung im Rahmen solcher Projekte wird ein breites Spektrum an Dokumentenressourcen herangezogen: seltene Denkmäler der Geschichte und Kultur, Nachschlagewerke, bibliografische Ausgaben, Noten- und Bildbände. Ein wesentlicher Teil der Ausstellungen der ChDNB wird im Rahmen konzeptioneller Serien erstellt. Bezeichnend ist der Zyklus virtueller Ausstellungen Made in Ukraine, der Erfindungen, Entdeckungen und dem Lebensweg bekannter einheimischer Fachleute gewidmet ist. Ein markantes Beispiel ist die Ausstellung Professor L. Zenkowski – der ukrainische Pasteur [3], in der die Persönlichkeit des Begründers der nationalen mikrobiologischen Schule durch eine organische Verbindung historischer Forschungen mit visuellen Elementen repräsentiert wird.

Ein weiteres wirkungsvolles Format zur Erschließung der Bestände ist die Schaffung groß angelegter Ausstellungen auf der Plattform Calameo, wie etwa das Projekt, das Marija Sankowezka gewidmet ist [4]. Dieser Dienst simuliert den physischen Prozess des Umblätterns von Seiten und erzeugt so den Effekt der Interaktion mit einem authentischen Dokument. Das Projekt beleuchtet detailliert Seiten aus der Biografie der Schauspielerin, den Einfluss ihrer Mentoren (insbesondere M. A. Werbyzkyjs), zeigt seltene Fotografien in Theaterrollen und bietet eine umfassende Literaturliste aus den Beständen der ChDNB, die die Leserin/den Leser direkt zu den Primärquellen führt. Im Kontext der Erhaltung des originalen Layouts und der spezifischen Ästhetik der Vergangenheit ist ein solcher Ansatz von entscheidender Bedeutung.

In diesem Zusammenhang möchte ich meine eigenen Forschungs- und Kuratorinerfahrungen bei der Erstellung einer virtuellen Ausstellung über die europäische

Mode auf dem Gebiet der Ukraine teilen. Zur Visualisierung der Alltagsgeschichte des späten 19. und frühen 20. Jahrhunderts wurden einzigartige Modemagazine aus den Beständen unserer Bibliothek sowie authentische Archivfotos von Einwohnern Charkiws herangezogen. Die größte Herausforderung bei der Entwicklung dieses Projekts war jedoch die fachgerechte textliche Repräsentation. Die Sprache der Primärquellen ist übersättigt mit fachspezifischen schneiderischen Archaismen, Historismen und Entlehnungen aus dem Französischen, die heute ihre ursprüngliche Bedeutung verloren haben und somit eine erhebliche semantische Barriere darstellen. Wie M. Marantschak [2, S. 62] anmerkt, wird gerade in der Phase der Überwindung solcher Barrieren die Integration großer Sprachmodelle zu einem innovativen Bestandteil der Methodik der Kuratorin/des Kurators. In meinem Fall fungiert die künstliche Intelligenz als philologische Expertin und hilft dabei, komplexe Begriffe sofort zu entschlüsseln und relevante moderne Entsprechungen dafür zu finden.

Die aus einer solchen Synergie mit dem neuronalen Netz resultierenden analytischen Schlussfolgerungen und das historische Glossar weisen eine klare, mehrschichtige Struktur auf, die sie für einen breiten Kreis von WissenschaftlerInnen äußerst nützlich macht. Unsere strukturierten Ausarbeitungen bieten nicht nur eine direkte Übersetzung oder Erklärung veralteter Wörter, sondern umfassen auch tiefgehende Kontextanalysen, etymologische Referenzen, semantisches Mapping von Begriffen und die Verknüpfung mit konkreten visuellen Artefakten dieser Epoche. Für HistorikerInnen, KulturwissenschaftlerInnen, KunsthistorikerInnen oder BühnenbildnerInnen spart ein solches strukturiertes Datenmassiv erheblich Zeit bei der primären Quellenkritik. Wir stellen den Forschenden eine bereits verifizierte faktologische, terminologische und illustrative Basis zur Verfügung, die sie sofort für ihre eigenen wissenschaftlichen Untersuchungen oder Rekonstruktionen nutzen können. Durch die Delegierung eines Teils der Routinearbeit bei der Textanpassung an die KI kann sich die Kuratorin/der Kurator auf die Gestaltung eines tiefgehenden Narrativs konzentrieren und Projekte schaffen, die akademischen Standards entsprechen und für das Publikum lebendig bleiben.

Folglich transformieren sich virtuelle Bibliotheksausstellungen im Zeitalter der Digitalisierung von statischen elektronischen Archiven zu dynamischen multimedialen Projekten. Die Erfahrung der ChDNB beweist die Wirksamkeit des Einsatzes neuester Formate zur Schaffung eines emotional ansprechenden Narrativs. Gleichzeitig ist der Einsatz von künstlicher Intelligenz eine innovative Lösung zur Überwindung semantischer Barrieren bei der Bearbeitung historischer Bestände. Die Delegierung der Entschlüsselung von Archaismen und fachspezifischer Terminologie an große Sprachmodelle optimiert die Routinearbeit, ermöglicht es den Bibliotheksfachleuten, sich auf die Gestaltung eines hochwertigen historischen Storytellings zu konzentrieren, und versorgt die WissenschaftlerInnen mit einer fertigen, verifizierten faktologischen Basis.

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AI AS A RESEARCH ASSISTANT: AUTOMATING HYPERLINK ANALYSIS IN SCIENTIFIC PDF DOCUMENTS

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Scientific PDF documents are still one of the main formats for sharing research, but working with them is often less convenient than it should be. This becomes especially clear when dealing with hyperlinks. In many cases, links are poorly structured, inconsistently embedded, or not accessible at all. Some are clickable, others are just plain text. It is also common to encounter broken links, outdated domains, or references that no longer lead to the expected content. For a researcher, this creates a very practical problem: even simple tasks like checking sources or reusing links for further analysis turn into manual and repetitive work.

This issue becomes more noticeable in contexts where links themselves are the object of analysis. For example, when looking at external references from an SEO perspective, it is important to understand what kinds of domains are being cited, how often links appear, and whether they are still valid. Doing this manually across multiple PDF documents is slow and error-prone. There is also no straightforward way to get a structured overview of link data, since PDFs do not store information in a clean, machine-friendly format like web pages do.

This paper presents a web-based tool designed to extract and analyze hyperlinks from scientific PDF documents with a focus on practical use. The main idea is to treat links not as isolated elements, but as a dataset that can be processed and evaluated. A user uploads a PDF

file, after which the system parses the document, identifies hyperlinks, and retrieves their surrounding text. The extracted links are then stored in a structured form, allowing further analysis without going back to the original document each time.

One of the core features of the tool is link validation. Each extracted URL is checked using standard HTTP requests to determine its status code. This makes it possible to quickly identify broken links (such as 404 errors), redirects, or temporarily unavailable resources. In practice, this helps to assess the overall quality of references in a document. For SEO-related analysis, this is particularly relevant, since link validity directly affects how content is evaluated and reused.

In addition to validation, the system attempts to classify links based on their type. This includes distinguishing between academic references, datasets, general websites, and other external resources. Here, machine learning methods are used as a supporting component. They help analyze the surrounding text and assign a likely category to each link. This is not always perfectly accurate, but it provides a useful starting point for grouping and filtering links.

Another feature is contextual grouping. Instead of presenting links as a flat list, the tool organizes them according to where and how they appear in the document. For example, links found in reference sections are separated from those embedded in the main text. This makes navigation easier and gives a better sense of how external resources are used within the paper. The system also provides simple metrics, such as the number of unique domains, frequency of links, and distribution across sections. These metrics can be useful for basic SEO evaluation or comparative analysis across multiple documents.

At the same time, working with PDFs introduces several technical challenges. Unlike HTML, PDF files do not follow a consistent structure, and link data can be stored in different ways depending on how the document was created. In some cases, links are visually present but not encoded as actual hyperlinks, which makes them harder to detect automatically. The extraction process therefore relies on a combination of parsing techniques and heuristics, which can lead to occasional inaccuracies.

Despite these limitations, the tool shows clear practical value. It reduces the amount of manual work needed to collect and verify links, and it helps researchers get a clearer overview of external references. For tasks related to SEO, it provides a quick way to assess link quality and identify potential issues. More broadly, it supports a more structured approach to working with PDF documents, where links are no longer hidden inside the text but treated as data that can be explored and reused.

The goal of this work is not to introduce a complex or overly ambitious system, but to address a small, everyday problem in a more systematic way. By combining straightforward parsing techniques with lightweight machine learning support, it becomes possible to automate a task that is usually done manually, and to do so in a way that fits into existing research workflows.

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СЕКЦІЯ 2: ШТУЧНИЙ ІНТЕЛЕКТ У ФІЛОЛОГІЇ ТА ПЕРЕКЛАДІ

ARTIFICIAL INTELLIGENCE AS AN ASSISTANT IN TRANSLATING TECHNICAL AND IT-ORIENTED TEXTS

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The modern world requires instant information exchange, which creates a significant workload for professional linguists. In this context, artificial intelligence has ceased to be merely a tool for automatic translation and has evolved into a full-fledged digital assistant. The collaboration between humans and machines opens new opportunities, where the speed of algorithms is combined with the depth of human understanding.

One of the main advantages of artificial intelligence in translation is speed. Modern translation systems can process texts within seconds. This is especially useful for companies, students, and international organizations that require fast communication across different languages.

AI systems can suggest synonyms, correct errors, and offer improved sentence structures. This is also valuable when translating technical or scientific texts containing specialized terminology. As Sandra Ljubas, PhD in Linguistics and literary translator, notes: "In general, the potential of AI is often overstated; it is a tool, nothing more, nothing less." AI can be a useful assistant, but its use should remain optional rather than mandatory. This is particularly important in light of ethical issues such as data privacy, copyright, the quality of training data, and the environmental impact of technology. Confidential documents may require strict privacy and careful human supervision. Therefore, translators should always review and edit AI-generated translations before their final use.

Professional IT texts have specific characteristics. They contain numerous terms, abbreviations, names of technologies, programming languages, and technical concepts. For example, words such as *framework*, *database*, *debugging*, *cloud computing*, and *interface* cannot always be translated literally, as it is essential to preserve their contextual meaning. Therefore, general language knowledge is not sufficient — it is necessary to have domain-specific IT knowledge and understanding of professional terminology.

In my academic practice, I use the AI tool Google Gemini as an assistant for translating professional IT-related texts. This service helps quickly translate technical articles, instructions, software descriptions, and documentation in English. It is particularly useful that Gemini can not only translate text but also explain complex terms in simple language.

For example, I once had to translate a full document from Norwegian into English on the topic of programming. The document included explanations of website development,

coding practices, and the use of programming languages. After translation, I was able to understand the content much more clearly, as English is more widely used in the IT field. This helped me study the material more effectively and better understand a new programming topic.

Modern translation services significantly facilitate working with such texts. Online translators quickly process large volumes of information, help understand the general meaning of documents, and provide equivalents for technical terms. For instance, automated systems can translate software instructions or technical product descriptions within seconds, saving time and increasing productivity.

At the same time, human translators remain essential. Language is not only about words and grammar — it also carries emotions, culture, humor, and context. AI may misinterpret jokes, idioms, or expressions with implicit meanings. A professional translator can adapt the text to the target audience and make it sound natural.

In conclusion, AI saves time, increases productivity, and supports routine tasks. However, human knowledge and critical understanding remain essential. The best results are achieved when humans and artificial intelligence work together.

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BREAKING THE ACADEMIC LANGUAGE BARRIER: HOW AI EMPOWERS GLOBAL SCIENTIFIC COMMUNICATION

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English serves as the undisputed lingua franca of global science, yet this dominance poses a significant barrier for non-native researchers and students. The necessity to master formal academic tone and specific terminology often consumes disproportionate time and effort, shifting the focus from actual scientific discovery to linguistic formatting. Recent literature highlights that artificial intelligence (AI) tools, such as Large Language Models (LLMs) and AI-powered text editors, have emerged as essential productivity instruments in modern research. Specifically, AI significantly enhances the editing and review processes by providing writing refinement, grammar improvement, and structural optimization, which is particularly beneficial for non-native English speakers attempting to meet rigorous academic standards [1].

Building upon these findings, this study investigates the practical impact of AI tools on overcoming the academic language barrier within technical disciplines. To evaluate this, a survey was conducted among 50 software engineering students and young researchers. The questionnaire was designed to assess their current usage of AI assistants, perceived reduction in language-related stress, and the overall time efficiency gained when drafting academic and technical documentation in English. Recent studies demonstrate that STEM students possess higher confidence in their AI-related skills and are more oriented toward the practical application of artificial intelligence compared to their peers in the humanities. Based on these findings, software engineering students were selected as the ideal focus group for evaluating the impact of AI tools on technical and academic writing [2].

The survey results indicate a massive shift in academic writing practices. According to the data, 86% of the respondents regularly utilize AI tools (such as ChatGPT or Grammarly) to assist with English writing. Furthermore, the integration of these tools reduced the time spent on writing and translating technical texts by 50% for 38% of the participants and time was reduced by about 20-40% for 46% of interviewed. Beyond time-saving, only 2% of reported a significant increase in anxiety related to making grammatical errors. However, the study also highlights critical concerns. Despite the surge in productivity, 56% of the surveyed individuals expressed fears regarding hallucinations"(fabricated facts or incorrect translation) (28%) or dependence(deterioration of own English skills) (also 28%) and the most chosen category is accusationsof plagiarism (32%).

The insights gained from this research offer significant value for several stakeholders. For LLM development companies and their marketing teams, these findings provide essential data

to refine model features and communication strategies based on actual user behavior and specific concerns. Furthermore, the study assists academic institutions in resolving policy challenges by providing a basis for defining permissible boundaries for AI use by students. Crucially, this work reflects the current reality of AI adoption among students in Ukraine, highlighting the specific fears and the practical gaps that AI tools fill in their academic workflows. It should be noted that comprehensive statistics, detailed data analysis, and further visualizations will be presented in a forthcoming full-length article and an upcoming presentation.

Ultimately, AI empowers global scientific communication by democratizing academic writing and allowing non-native researchers to focus on core technical ideas rather than linguistic mechanics. However, to fully harness this potential without compromising academic integrity, institutions must establish clear ethical guidelines regarding the transparent use of AI in scientific publications.

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DIE ROLLE DER KI IN DER MODERNEN DATENWISSENSCHAFT: VON DER DATENBEREINIGUNG BIS ZUR MODELLIERUNG

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Die Datenqualität wirkt sich direkt auf die Leistung von Modellen des maschinellen Lernens (ML) aus, wobei Data Scientists bis zu 80 % ihrer Zeit mit verschiedenen Aufgaben der Datenbereinigung verbringen können. Trotzdem gibt es bisher keine umfassende Studie darüber, wie genau sich die Bereinigung auf ML-Klassifikationsaufgaben auswirkt: Die Datenbank-Community (DB) untersucht die Datenbereinigung meist isoliert von der nachgelagerte Analyse, während sich die ML-Community auf die Entwicklung von Algorithmen konzentriert, die gegenüber bestimmten Rauschverteilungen robust sind. Diese Studie zielt darauf ab, die Lücke durch eine systematische empirische Analyse der Auswirkungen verschiedener Datenbereinigungsmethoden auf die Leistung nachgelagerter ML-Modelle für unterschiedliche Fehlertypen zu schließen.

Im Rahmen der vorgeschlagenen CleanML-Studie wird der Evaluierungsprozess unter Verwendung von 14 realen Datensätzen formalisiert, die fünf häufige Fehlertypen enthalten: fehlende Werte, Ausreißer, Duplikate, Inkonsistenzen und falsche Labels. Um die Auswirkungen zu ermitteln, werden sieben klassische Klassifikationsalgorithmen und eine Vielzahl von Bereinigungsmethoden angewendet, darunter sowohl in der Praxis übliche Basisansätze als auch modernste Lösungen aus der wissenschaftlichen Literatur. Um die statistische Signifikanz der Ergebnisse sicherzustellen und Zufälligkeiten zu minimieren, werden mehrfache Aufteilungen in Trainings- und Testdaten (Train/Test Splits) sowie ein Hypothesentestverfahren basierend auf dem gepaarten t-Test (paired sample t-test) verwendet. Darüber hinaus wird das Benjamini-Yekutieli (BY)-Verfahren eingesetzt, um die Rate falscher Entdeckungen (False Discovery Rate) bei multiplen Hypothesentests zu kontrollieren.

Die Ergebnisse der Studie liefern nicht-triviale Erkenntnisse: Die Auswirkung der Datenbereinigung auf ML-Modelle hängt stark von den Spezifika des jeweiligen Datensatzes ab, was die Anwendung universeller oder willkürlicher Lösungen in der Praxis unmöglich macht. Dennoch wurde festgestellt, dass die vorherige Datenbereinigung oft ein effektiverer und universellerer Ansatz ist im Vergleich zur Verwendung spezifischer robuster maschineller Lernmodelle. Dabei erhöht die Verwendung eines Validierungsdatensatzes zur Auswahl sowohl des Modells selbst als auch des Bereinigungsalgorithmus die Wahrscheinlichkeit eines positiven Einflusses auf die Endgenauigkeit erheblich. Diese Arbeit legt den Grundstein und definiert Richtungen für zukünftige Forschungen im Bereich der analytikgesteuerten Datenbereinigung.

LITERATUR

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REAL-TIME TRANSLATORS: BREAKING LANGUAGE BARRIERS WITH AI

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Recent developments in real-time translation technology signify a transformative advancement in communication, with the potential to redefine international business, travel, and education. These systems are based on the concept of Real-time Communications (RTC), defined as the instant exchange of information with minimal latency [1, p. 1]. Powered by Artificial Intelligence (AI) and Machine Learning (ML), specifically the Transformer model,

these technologies provide immediate translation of spoken and written text with high accuracy [2, p. 148].

The core of this technology is a sophisticated workflow involving speech recognition, Neural Machine Translation (NMT), and Text-to-Speech (TTS) synthesis. Recent engineering research demonstrates that these systems can be efficiently implemented on low-power hardware, such as the NodeMCU microcontroller, by leveraging cloud-based Application Programming Interfaces (APIs) for language detection and processing [4, p. 2]. A key advancement in this field is Context-Aware NMT, a translation approach that incorporates inter-sentential information to improve coherence, resolve coreference, and maintain lexical cohesion across long conversations. [3, p. 1]. According to researchers, the integration of high-speed neural networks allows for seamless communication without noticeable delays, moving machine translation closer to human level performance [2, p. 150].

As ongoing technological progress continues, real-time translation is set to break down language barriers completely, fostering a world of universal understanding [4, p. 1].

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KI-GESTÜTZTES MENÜ-ENGINEERING UND SEIN POTENZIAL FÜR GASTRONOMIE

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Optimierung durch die KI lässt sich heutzutage in sehr vielen Lebensbereichen beobachten. Mittlerweile werden KI-Tools nicht nur in Wissenschaft und Forschung, Lehre, Studium, Medizin, Industrie u. Ä., sondern auch in der Gastronomie erfolgreich eingesetzt: „Was bislang nach Zukunftsmusik klang, wird zunehmend zur praktischen Hilfe: Speisekarten lassen sich wirtschaftlicher gestalten, Abläufe effizienter planen und auf die Wünsche der

Gäste besser eingehen“ [2]. Die innovativen Tools zeichnen sich durch mehrere Vorteile aus – es geht um ihre „Fähigkeit, Daten in Echtzeit zu analysieren, Kundenverhalten vorherzusagen und proaktive Empfehlungen zu geben“ [1].

Im Folgenden werden einige wirksame digitale Lösungen in der Gastronomie vorgestellt, und zwar auf dem Gebiet des Menü-Engineerings. Der Forschungsstoff umfasst Projektaufgaben zum Kennenlernen der renommierten Weltküchen im Rahmen des Bachelorstudiums *Hotel Managment – Culinary Arts* an der *VIVES University of Applied Sciences.* Es geht um die KI-gestützten Lernprojekte über die Küchen Argentiniens, Spaniens, Japans und Italiens. Nach dem Erlernen der spezifischen Kochtechniken unter der Leitung der erfahrenen Chefköche haben die Studierenden ein Menü für zwei-drei Gäste erarbeitet, inspiriert von den jeweiligen kulinarischen Traditionen. Die Auswahl der Speisen wurde von dem Lebensmittelvorrat in der Lernküche begrenzt. Um den Kreis der potenziell möglichen Gerichte aus diesen Zutaten für das Menü einzuschränken sowie um die Möglichkeiten der vorhandenen Zutatenkombination zu erkunden, wurden solche KI-Tools eingesetzt:

- *ChatGPT*: beim Prompten lag der Fokus auf Ideensammlung und Überblick schaffen;
- *Gemini*: dieses Tool lieferte zusätzlich Infos über genaue Techniken, geschichtlichen Hintergrund und Proportionen für die jeweiligen potenziell kochbaren Rezepte.

Der Einsatz der KI-Instrumente hat also Impulse gegeben, auf deren Grund die Erarbeitung des Menüs stattgefunden hat. Die finale Entscheidung über die Liste der Menüspeisen wurde den Studierenden überlassen. Des Weiteren wurde die Arbeit am Menü durch den Einsatz vom Chatbot *Claude* optimiert. Dabei ging es das Kosten- und Mengenkalkulieren, was Zeit sparte und die relative Genauigkeit der Abrechnung sicherte, zum Zwecke auch der wirtschaftlichen Effizienz.

Gemini ermöglichte die Optimierung der Arbeitsprozesse, indem es die zeitliche Abfolge der Zubereitungsschritte bestimmte. Zum Finalisieren vom sprachlichen Menüdesign wurde der Vorzug *Gemini* gegeben, *ChatGPT* erwies sich für diese Aufgabe wenig hilfreich. *Gemini* war imstande, das Menü für eine spezifische Gästegruppe anzupassen, beispielsweise für VegeterierInnen, und bot alternative Lösungen an.

Alles in allem können die KI-Instrumente beim Menü-Engineering Hilfe leisten, insbesondere bei Ideensammlung, Zutatenzuordnung, Kosten- und Mengenkalkulationen sowie beim sprachlichen Designen, während die Auswahl der Speisen, ihr Korrigieren und Anpassung, die eigentliche Zubereitung, das visuelle Menü-Layout und das Servieren den Studierenden überlassen werden.

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UNTERSUCHUNG DER EFFEKTIVITÄT VON ONLINE-PLATTFORMEN FÜR DAS ERLERNEN DER DEUTSCHEN SPRACHE

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Problemstellung. Heute sind Fremdsprachen sehr wichtig für Studium, Arbeit und Kommunikation. Viele Menschen lernen Deutsch als Fremdsprache.

Traditionelle Lernmethoden sind nicht immer sehr effektiv. Oft gibt es zu wenig Praxis, wenig Kommunikation und nicht genug Lernmaterialien.

Online-Plattformen helfen, diese Probleme zu lösen. Sie sind interaktiv und flexibel. Jeder kann im eigenen Tempo lernen.

Analyse der Forschung. Heute gibt es viele Studien über Online-Plattformen beim Fremdsprachenlernen. Viele Wissenschaftler sagen, dass Online-Plattformen beim Lernen helfen.

Die Lernenden arbeiten aktiv mit Texten, Videos und Übungen. Das ist gut für Sprechen, Hören und Lesen.

Online-Plattformen benutzen auch echte Materialien, zum Beispiel Artikel, Videos und Podcasts. Das macht das Lernen interessanter und motiviert die Studenten.

Mayer (2023) zeigt, dass Online-Ressourcen beim Lesen helfen. Die Studenten benutzen Texte, die sich an ihr Niveau anpassen. Die Plattformen geben automatische Rückführung.

Zum Beispiel gibt es Duolingo und Ling. Diese Plattformen haben viele Übungen. Die Übungen passen sich dem Wissen der Studenten an. Die Aufgaben werden langsam schwerer. So können die Studenten allmählig Fortschritte machen [1, 2].

Lee und Kim (2022) zeigen, dass Online-Plattformen beim Schreiben helfen. Die Studenten benutzen interaktive Werkzeuge, zum Beispiel Grammarly und Write&Improve. Diese Werkzeuge helfen, Grammatik und Stil zu verbessern.

Viele Plattformen haben auch Foren und Diskussionen. Hier können die Studenten Texte schreiben und darüber sprechen. So lernen sie kreativ zu schreiben.

Ziel der Arbeit. Das Ziel der Arbeit ist, zu zeigen, wie Online-Plattformen beim Deutschlernen helfen. Die Plattformen sollen die vier Fähigkeiten verbessern: Lesen, Schreiben, Hören und Sprechen.

Die Aufgaben sind:

1. Die wichtigsten Funktionen der Plattformen zeigen, die jede Fähigkeit verbessern.

2. Die Vorteile und Nachteile von Online-Ressourcen im Unterricht erklären.

3. Zeigen, wie die interaktiven Werkzeuge helfen, Sprachbarrieren zu überwinden und praktisch zu lernen.

4. Tipps geben, wie man Online-Plattformen am besten benutzen kann, um alle Fähigkeiten zu lernen.

Die Arbeit zeigt, wie Online-Ressourcen beim Sprachenlernen helfen. Sie zeigen auch, dass die Plattformen individuelles Lernen unterstützen. Die Studenten können besser lernen und Fortschritte machen.

Hauptteil. Heute ist Deutschlernen sehr wichtig. Das hilft bei Arbeit und im Leben. Traditionelle Methoden sind oft nicht flexibel. Die Studenten möchten flexibles, einfaches und interaktives Lernen.

Darum werden Online-Plattformen immer beliebter. Sie helfen beim Lernen von Lesen, Schreiben, Hören und Sprechen.

Schlussfolgerung. Die Analyse zeigt, dass Online-Plattformen gut beim Deutschlernen helfen. Sie verbessern Lesen, Schreiben, Hören und Sprechen.

Die Plattformen haben interaktive Funktionen und echte Materialien. Die Studenten können ihr Lernen selbst gestalten. Online-Plattformen machen das Lernen besser und interessanter.

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EINSATZ VON KÜNSTLICHER INTELLIGENZ IN MODERNEN METHODEN DES FREMDSPRACHENUNTERRICHTS

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In den heutigen Bedingungen der Globalisierung und der Ausweitung interkultureller Kommunikation wird das Erlernen von Fremdsprachen zu einem Schlüsselfaktor für die erfolgreiche berufliche Umsetzung und soziale Mobilität von Studierenden. Traditionelle Formen der Organisation des Bildungsprozesses können jedoch nicht immer vollständig die individuellen Besonderheiten der Studierenden, ihre Lernstile, das Niveau der Sprachvorbereitung, ihre kognitiven Fähigkeiten und das Tempo der Bearbeitung von Lernmaterial berücksichtigen. Dies führt zu einer ungleichmäßigen Wissensaneignung, zu

einer Verringerung der Lernmotivation und zu einer unzureichenden Effektivität beim Erwerb von Fremdsprachenkompetenz.

In diesem Zusammenhang gewinnt der Einsatz von künstlicher Intelligenz im Fremdsprachenunterricht zunehmend an Bedeutung. Künstliche Intelligenz bietet neue Möglichkeiten zur Individualisierung des Lernprozesses und zur Anpassung der Lerninhalte an das Niveau und die Bedürfnisse der Studierenden. Durch den Einsatz von KI-Technologien können Lernende in ihrem eigenen Tempo arbeiten und sofortige Rückmeldungen zu ihren Leistungen erhalten. Darüber hinaus ermöglicht künstliche Intelligenz die Automatisierung von Routineaufgaben, wie zum Beispiel die Korrektur von Texten oder die Überprüfung von Grammatikübungen. Dies trägt zur Steigerung der Effizienz des Lernprozesses und zur Erhöhung der Lernmotivation bei. Gleichzeitig eröffnet der Einsatz von KI neue Perspektiven für die Entwicklung kommunikativer und interkultureller Kompetenzen.

Eine der aktuellsten Herausforderungen der modernen Fremdsprachenmethodik ist die Notwendigkeit, einen individualisierten Ansatz unter den Bedingungen einer steigenden Zahl von Studierenden und einer intensiven Informationsbelastung zu gewährleisten. Der Lehrende kann nicht immer die Fortschrittsdynamik jedes Lernenden verfolgen, Aufgaben mit einem angemessenen Schwierigkeitsgrad anbieten und eine personalisierte Kontrolle der Ergebnisse durchführen. Dies führt zu dem Bedarf an der Einführung innovativer Technologien, die in der Lage sind, einen Teil der analytischen und diagnostischen Funktionen zu automatisieren. In diesem Zusammenhang eröffnen Technologien der künstlichen Intelligenz neue Möglichkeiten zur Steigerung der Effizienz des Fremdsprachenlernens. KI ermöglicht die Analyse großer Mengen von Lerndaten, die Entwicklung adaptiver Lernsysteme, die Bereitstellung individueller Empfehlungen sowie die Gestaltung individueller Lerntrajektorien, die den Bedürfnissen eines konkreten Studierenden entsprechen.

Es ergibt sich ein wissenschaftlich-praktisches Problem – die Bestimmung der Möglichkeiten, der pädagogischen Grundlagen und der Effektivität des Einsatzes von Technologien der künstlichen Intelligenz zur Gewährleistung der Individualisierung des Fremdsprachenlernprozesses. Deren Aktualität ergibt sich aus der Notwendigkeit, die Qualität des Sprachunterrichts zu erhöhen, die Arbeit der Lehrenden zu optimieren und Bedingungen für die Entwicklung der Lernautonomie der Studierenden zu schaffen.

Es wurde festgestellt, dass interaktive intelligente Systeme die Motivation zum Sprachenlernen erheblich steigern, da sie ein schnelles Feedback, die Möglichkeit mehrfacher Übung und das Gefühl persönlichen Fortschritts bieten. Gleichzeitig hilft der Einsatz von KI, die Arbeit der Lehrenden zu optimieren, die routinemäßige Belastung zu reduzieren und den Fokus auf die Entwicklung kritischen Denkens, kommunikativer Interaktion sowie kreativer Aufgaben zu legen, die eine professionelle pädagogische Begleitung erfordern.

Somit stellt künstliche Intelligenz ein leistungsfähiges Instrument zur Individualisierung der Sprachvorbereitung dar, doch ihre Effektivität hängt von einer methodisch fundierten

Integration in den Unterrichtsprozess, der Verbindung der adaptiven Möglichkeiten der Technologien mit pädagogischer Unterstützung sowie der Aufrechterhaltung eines Gleichgewichts zwischen Automatisierung und der Entwicklung der Eigenständigkeit der Lernenden ab. Weitere Forschungen sollten darauf abzielen, Modelle des adaptiven Lernens zu verbessern, die Praxis des Einsatzes von KI in verschiedenen Aspekten der Sprachkompetenz zu erweitern und die Dynamik des Einflusses digitaler Werkzeuge auf die Lernergebnisse langfristig zu untersuchen.

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СЕКЦІЯ 3: ШТУЧНИЙ ІНТЕЛЕКТ В МЕДИЦИНІ ТА БІОЛОГІЇ

AI AS A SCIENTISTS' ASSISTANT IN MULTIMODAL MEDICAL DECISION SUPPORT SYSTEMS

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Artificial intelligence is increasingly used as a scientists' assistant in medicine, where specialists must work with heterogeneous data such as clinical texts, laboratory results, and medical images. Modern studies show that natural language processing and multimodal AI can improve the extraction and analysis of clinically relevant information [1], [2]. However, data itself does not automatically become knowledge. For intelligent medical systems to be truly useful, they must identify meaningful relations between symptoms, findings, diagnoses, and recommendations [3].

My dissertation research focuses on methods of knowledge interpretation in multimodal medical decision support systems using logic-linguistic modeling. The main idea is to combine formal logical relations with natural language in order to represent medical knowledge in a more structured and interpretable way. This is especially important because medicine relies not only on numbers and signals, but also on verbal descriptions, conclusions, and explanations.

In this context, AI should be understood not as a replacement for the scientist or clinician, but as an assistant that helps organize complex information, detect semantic links, and support decision-making. The practical value of this research lies in improving the transparency, interpretability, and usefulness of intelligent medical systems for human experts [4]. Thus, AI can strengthen scientific work by helping scientists transform fragmented multimodal data into meaningful knowledge.

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THE NEW LAB ASSISTANT: UTILIZING MULTI-AGENT AI ARCHITECTURES IN MEDICAL RESEARCH

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In modern scientific research, the primary bottleneck is no longer a lack of data, but an overwhelming abundance of it. Navigating complex literature in specialized fields requires AI to evolve from a passive search tnoool into an agentic research partner [1]. The aim of this study is to investigate the use of Multi-Agent Systems (MAS) to optimize literature review, data extraction, and statistical validation in medical research, as well as to support *in silico* approaches.

Current methodologies demonstrate that relying on a "one-size-fits-all" AI model is insufficient for rigorous scientific inquiry. Instead, researchers employ a "triangulation" approach, orchestrating specific models for their unique architectural strengths. Broad synthesizers such as ChatGPT are effective for rapid data mapping and identifying cross-disciplinary trends, while deep readers such as Claude are well suited for critical audits of multiple full-text papers simultaneously, identifying methodological nuances that metadata searches often miss. Evidence-oriented tools such as Perplexity and NotebookLM strengthen this process by grounding responses in retrieved or uploaded sources, helping filter out clinically irrelevant data or animal-only trials. Such triangulation improves both the speed and the reliability of literature-based medical research.

An advanced form of AI-assisted research involves orchestrating specialized models into a unified Multi-Agent System that functions as a virtual laboratory team [2]. In our practical testing, several AI tools were given the same task: to identify relevant literature on a medical problem - specifically, the search for pharmacological agents for neuroprotection in cerebral ischemia/hypoxia - to prepare a brief review and provide an analytical synthesis of the findings. The comparison included ChatGPT, Claude, Perplexity, and NotebookLM. The results showed that ChatGPT and Claude were stronger in synthesis and structured interpretation, while

Perplexity and NotebookLM were especially useful for source-based retrieval and transparent evidence tracking. A typical MAS workflow begins with a “Scout” agent scanning databases such as PubMed for recent peer-reviewed studies. This data is then evaluated by a “Critic” agent, which analyzes methodologies and flags studies with low statistical power. Concurrently, a “Bio-Statistician” agent reviews effect sizes and confidence intervals, marking weak findings as low-confidence evidence [3]. Finally, an “Orchestrator” model synthesizes these outputs into a cohesive evidence map, highlighting the compounds with the most robust support.

AI also expands the role of *in silico* research in medicine. By simulating mechanisms, screening candidate compounds, and narrowing the range of plausible hypotheses before wet-lab testing, AI helps reduce the volume of unnecessary laboratory experiments and makes the research process more efficient.

Conclusions.

The integration of MAS transforms the modern researcher from a traditional data gatherer into a “Strategic Auditor.” By delegating knowledge extraction - the what and the how much - to an AI team, the scientist can focus on interpretation - the why and the what next. Ultimately, the researcher’s new primary objective is to verify the logic behind AI-synthesized conclusions before advancing to physical validation or practical application [4].

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AI IN MEDICINE: SAVING LIVES WITH DATA

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Artificial Intelligence (AI) has emerged as a transformative force in modern medicine, fundamentally redefining the boundaries of what is diagnostically and therapeutically possible. Acting not merely as a tool but as an интеллектуальный scientific assistant, AI enables the processing and interpretation of vast volumes of medical data that would be otherwise inaccessible to human cognition. In this context, AI can be viewed as an extension of human intelligence rather than its replacement.

One of the most prominent applications of AI lies in diagnostic procedures. Advanced machine learning algorithms are capable of analyzing complex medical images, including X-rays, computed tomography (CT) scans, and magnetic resonance imaging (MRI), with remarkable precision. Notably, recent studies suggest that AI systems can, in specific domains, outperform human specialists in early disease detection, thereby challenging traditional assumptions about clinical expertise.

In addition to diagnostics, AI plays a pivotal role in predictive analytics. By integrating and examining heterogeneous data sources, such as medical history, genetic predispositions, and lifestyle factors, AI identifies subtle patterns that may remain invisible to clinicians. This predictive capacity not only facilitates early intervention but also shifts the paradigm of healthcare from reactive treatment to proactive prevention. Furthermore, AI contributes significantly to the development of personalized medicine. Through the analysis of individualized patient profiles, AI supports the design of targeted therapeutic strategies, enhancing both efficacy and safety. Equally important is the integration of AI into surgical practice, where intelligent robotic systems enhance precision, reduce invasiveness, and optimize recovery outcomes.

However, the growing reliance on AI in medicine inevitably raises critical ethical and practical concerns. Issues related to data privacy, algorithmic transparency, and accountability must be carefully addressed. As decision-making processes become increasingly automated, a key question arises: to what extent can responsibility be delegated to machines?

In conclusion, AI represents not a replacement for medical professionals but a powerful augmentation of their capabilities. Its true value lies in fostering a synergistic collaboration between human expertise and machine intelligence. As such, the future of medicine will not be defined by AI alone, but by how effectively it is integrated into human-centered healthcare systems.

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ARTIFICIAL INTELLIGENCE IN MEDICINE

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Artificial intelligence is increasingly being introduced into medicine not just as a new technology, but as a response to the growing pressure on healthcare systems. As the amount of medical information continues to rise, it becomes clear that people cannot process all this data efficiently. As a result, algorithms are becoming not just helpful, but necessary.

Since a patient's condition can change constantly, continuous monitoring of vital signs is especially important. That is why machine learning is used to collect data and detect risks. When there are many indicators to track, the speed of analysis often determines whether a critical condition is identified in time.

In treatment, it is clear that one-size-fits-all approaches do not always work, as every patient is different. For this reason, AI is used to analyze medical history, lifestyle, and individual needs. This makes it possible to choose more personalized and accurate treatments instead of relying on general methods.

In diagnostics, the role of AI is particularly important because accuracy is crucial. Algorithms can analyze CT, MRI, and X-ray images and detect signs of disease that may be difficult for humans to notice. This increases the chances of early diagnosis and more effective treatment.

AI is also important in scientific research, as modern medicine deals with large amounts of data. Finding patterns in genetic information or medical records manually can take too much time, so automated analysis helps speed up research and supports new discoveries.

Drug development is also changing with the help of AI. Since this process is usually long and complex, algorithms can speed it up by analyzing chemical compounds and identifying promising molecules. This is especially important when dealing with drug-resistant infections.

When predicting the spread of diseases, individual observations are not enough to see the full picture. AI models can analyze many factors at once and create more realistic forecasts of how diseases may spread.

In healthcare management, AI helps address the problem of limited resources. Systems can predict workload and improve patient flow, leading to more efficient use of hospital resources and better organization of care.

In clinical practice, AI does not replace doctors, especially given how complex medical decisions can be. Instead, it supports them by analyzing data and suggesting possible options, helping doctors work more accurately and efficiently.

Telemedicine is developing alongside AI, as it is not always possible to maintain regular in-person contact with patients. AI systems can monitor patients remotely, collect data, and send reminders about treatment, making healthcare more accessible.

The benefits of AI are clear when we compare how humans and algorithms process information. AI can handle large volumes of data quickly, which reduces errors, improves diagnostic accuracy, and makes healthcare processes more efficient.

At the same time, there are some drawbacks. AI systems depend on data quality, so errors or missing data can lead to incorrect conclusions. In addition, using large amounts of data raises concerns about privacy and security.

Overall, artificial intelligence is not a universal solution in medicine, but it is very useful where speed and data analysis are essential. The best results come from combining AI technologies with the experience of medical professionals.

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN DIABETES MANAGEMENT IN QATAR

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Diabetes mellitus is a chronic metabolic disease characterized by high blood sugar levels over a prolonged period. It can lead to serious complications if not properly managed. Common symptoms include frequent urination, increased thirst, and increased hunger. There are three main types of diabetes: type 1, type 2, and gestational diabetes. Type 2 diabetes is the most common and is often associated with unhealthy lifestyle factors such as poor diet, lack of physical activity, and obesity [1].

Diabetes is highly prevalent in Qatar primarily due to high obesity rates and unhealthy lifestyles, including poor diet and low physical activity [2]. It is considered a major health challenge in Qatar, with a prevalence of about 18.1% in 2023, making it one of the highest globally [3]

Diabetes and pre-diabetes also affect a large portion of the population and create a significant burden on individuals, healthcare systems, and the national economy. These factors increase the risk of developing the disease, and the prevalence is expected to rise in the coming years [4]. Artificial intelligence (AI) is increasingly used to improve diabetes management and reduce its global burden. AI helps address challenges such as late diagnosis, poor self-management, and limited healthcare resources. It supports prevention, detection, and overall care, improving patient outcomes and healthcare efficiency [5].

Machine learning, a branch of AI, is used to predict blood glucose levels using data from monitoring systems. These models analyze past glucose patterns and can predict future levels, warning patients about possible high or low blood sugar. This allows timely actions and helps prevent complications [6].

AI also supports monitoring health data and providing recommendations. It assists in lifestyle management, continuous glucose tracking, insulin dosing guidance, and personalized treatment plans. These applications improve disease management and help reduce complications [7].

AI technologies are also used in real-life tools. For example, the mySugr application helps patients track glucose levels, meals, and medications while providing personalized feedback. In addition, Continuous Glucose Monitor devices continuously measure glucose levels and provide real-time data, improving monitoring and control. In Qatar, AI-based healthcare technologies are being developed to improve early detection and management of diabetes. For

example, AI systems can analyze medical images, such as retinal scans, with high accuracy, helping doctors make better decisions and improving patient outcomes [8].

Despite these advantages, AI in healthcare also presents challenges. These include high costs, data privacy concerns, potential bias in data, and the risk of errors that may affect patient safety. Additionally, the need for large datasets and lack of transparency remain important issues [9].

In conclusion, diabetes is a major health concern, especially in Qatar. Artificial intelligence provides effective tools for improving diabetes management through prediction, monitoring, and treatment. However, challenges remain, and careful implementation is necessary to fully benefit from these technologies.

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AI AS A SCIENTIST'S ASSISTANT: FROM SAVING LIVES TO TALKING TO WHALES

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In recent times, Artificial Intelligence has grown beyond simple text generation, turning into a real "partner" for researchers globally. Its ability to process huge amounts of data, far beyond human brain limits, is greatly speeding up scientific research that once took decades.

A key area is the creation of new medicines. Joint projects between tech leaders like Google and famous universities such as Yale are using neural networks to find exactly molecules able to fight cancer. AI is very helpful in finding compounds that improve interferon signaling, thereby helping the human immune system to more effectively find and destroy tumors. In the field of medical imaging, AI shows amazing accuracy. Modern algorithms, trained on millions of X-rays and MRI scans, can see tiny changes in tissue. There are recorded cases where AI has found cancer at such an early stage that even experienced doctors missed it, allowing for timely treatment and saving lives.

AI is becoming an indispensable tool in diagnosis. A strong example involves a dog owner whose pet was suffering from a mysterious illness. Vets were unable to find a clear diagnosis, and the animal's health got worse. The owner gave the blood test results to GPT-4, and the AI suggested a rare autoimmune disorder. Upon laboratory confirmation of this idea and the start of right treatment, the dog made a full recovery. This shows AI's effectiveness as a powerful assistant in the analysis of specialized data.

Understanding Marine Life AI is also key in understanding animal communication systems. Modern projects, such as Project CETI, are specifically targeting whales. By using natural language processing (NLP) techniques, scientists are finding repeating patterns within their sounds. Researchers are now trying to copy these sound patterns to establish the first intentional communication with another species, starting a new era in biological understanding.

However, the impressive abilities of AI also raise big concerns. Research centers like Anthropic have noticed that their AI models, such as Claude, show surprisingly good performance in cybersecurity tasks. The AI's talent for finding code weaknesses is so deep that developers must put in place strict rules. These advanced technologies are now being managed with extreme care to ensure their use in protecting organizations rather than serving as tools for uncontrolled cyber attacks.

Today, artificial Intelligence is not ready to replace human scientists but rather to act as a "supercharger." It handles routine tasks, finds hidden details, and offers solutions when

human creativity reaches its limits. We stand on the edge of amazing discoveries, made through the teamwork of humans and machines.

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СЕКЦІЯ 4: ІТ, КІБЕРБЕЗПЕКА ТА ІНЖЕНЕРІЯ

ARTIFICIAL INTELLIGENCE AS AN ASSISTANT FOR CYBERSECURITY SPECIALISTS

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Nowadays, about one in six people use artificial intelligence (AI) to learn, work, or solve problems. According to Microsoft's AI diffusion report, the global adoption of generative AI tools reached 16.3% of the world's population, up from 15.1% in the first half of 2025 – a notable increase for technologies that are still relatively new [1]. Therefore, it is increasingly important for cybersecurity specialists to understand how AI can be used to protect sensitive data and prevent cyberattacks.

One major challenge today is that hackers are also using AI to automate and scale cyber intrusions. As a result, a variety of advanced protective tools have been developed, providing a wide range of facilities. However, integrating AI into cybersecurity brings both benefits and limitations.

On the one hand, AI significantly improves data protection. For example, honeypots have long been used as limited decoy computer systems designed to simulate likely targets of cyberattacks. However, today, AI makes it possible to generate large numbers of adaptive honeypots that can adjust their infrastructure to an attacker's behavior in real time.

Another important tool is agentic AI. It can automatically collect information, execute containment actions, and analyze security alerts. It also helps analyze and score vulnerabilities at scale to support resource prioritisation [2]. At the same time, it is not fully autonomous, since some decisions still depend on human experts or predefined rules.

Agentic AI can also strengthen Continuous Automated Red Teaming (CART), which simulates real-world attacks to uncover weaknesses in a system. This helps cybersecurity specialists identify vulnerable areas and address them before attackers can exploit them.

In addition, AI firewalls go beyond traditional security measures. They not only detect known virus signatures but can also recognize suspicious behavior, even when it is disguised as normal activity. Moreover, they can analyze the context of data, which makes threat detection more accurate.

These tools are often used together in modern cybersecurity systems, where each plays a specific role. Typically, AI in CART identifies vulnerabilities first; AI firewalls then monitor and filter activity in real time; AI-generated honeypots trap attackers in simulated computer systems; and agentic AI helps contain attacks.

On the other hand, AI is not flawless. It can make mistakes because it relies on learning methods that differ from human reasoning, such as backpropagation. This process involves analyzing the features of the provided data and selecting the most common answer [3].

In conclusion, as AI-driven cyberattacks become more common, using AI-powered security tools is essential. At the same time, cybersecurity specialists need to review and validate AI-driven decisions, taking into account how the AI analyses and generates information.

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AS A PERSONAL ASSISTANT FOR CYBERSECURITY STUDENTS: ENHANCING TECHNICAL SKILLS AND CRITICAL ANALYSIS

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The rapid integration of Artificial Intelligence (AI) into educational environments has transformed how students approach technical disciplines. For cybersecurity students, AI tools such as large language models act as personalized mentors that facilitate the understanding of complex systems. This presentation explores the practical application of AI in mastering essentiall cybersecurity tools and languages, specifically focusing on coding in Python and C++, and navigating Linux environments.

In the context of software development, AI serves as an efficient debugging assistant. For C++, it helps students identify memory management issues and logic errors, while in Python, it accelerates the automation of security scripts and data analysis. However, the use of AI in education is a double-edged sword. While it can reduce research time by at least 50% and provide a reliable starting point for technical tasks, over-reliance possess a significant risk.

This study argues that if students delegate every problem-solving process to AI, they may lose their core technical competencies and critical thinking abilities — skills that are non-

negotiable in the field of cybersecurity. For instance, while AI can generate a code snippet instantly, the student must still master the underlying logic to intervene when technical issues arise. Therefore, the "Hybrid Assistant" model is proposed: using AI as a validator and an accelerator rather than a primary creator. By maintaining this balance, students can ensure that they remain the masters of the technology they use, leveraging AI to enhance their potential without sacrificing their fundamentall expertise.

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HOW ARTIFICIAL INTELLIGENCE CAN INFLUENCE US IN OUR CODE WRITING

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AI techniques improve Software Engineering (SE) phases by automating tasks, reducing manual effort, and enhancing predictive accuracy, thereby reducing errors and improving reliability. Deep learning techniques improve bug detection accuracy and efficiency, while AI techniques enhance bug prediction, vulnerability detection, and the automation of maintenance tasks [1, p.15]. The impact of Artificial Intelligence (AI) on Software Development is profound, with Machine Learning (ML) emerging as a dominant force. ML was utilized for tasks such as early detection of security issues and vulnerabilities, enhancing software security by automating processes. [1, p.8]

Across controlled studies and field reports, assistants consistently accelerate boilerplate creation, scaffolding, and routine transformations, with smaller or mixed effects on open-ended design and debugging. [2, p.814-822]

The generative AI technologies excel at generating code snippets from natural language prompts, identifying and fixing common coding errors, creating reusable code components, and automating routine programming tasks.[3, p.1]

The future is about optimizing your workday around coding agents working in parallel. Your job is to lay the concrete for that highway – let the agents do the dev work and jump in only when you're needed. [4, p.1]

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GREEN COMPUTING: HOW CODE CAN SAVE THE PLANET

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Data centres accounted for around 1.5% of the world's electricity consumption in 2024, or 415 terawatt-hours (TWh) [1, pg. 14]. Globally, data centre electricity consumption has grown by around 12% per year since 2017, more than four times faster than the rate of total electricity consumption [1, pg. 14]. Data centre electricity consumption is set to more than double to around 945 TWh by 2030. This is slightly more than Japan's total electricity consumption today [1, pg. 14].

Every single search query, every streamed video and every type of cloud computing, carried out billions of times, is responsible for an ever-increasing global demand for energy - and therefore also for rising CO_2 emissions [2, pg. 2]. The information and communication technology sector is currently responsible for around 1.5 - 4 % of global greenhouse gas emissions. These emissions are mainly caused by networks, data centres and end devices [2, pg. 4]. Various studies estimate the share to be between 1.5 and 4 %, which equates to the emissions of the entire aviation industry [2, pg. 3].

Green coding is an environmentally sustainable computing practice that seeks to minimize the energy involved in processing lines of code and, in turn, help organizations reduce overall energy consumption [3, pg. 5]. The more complicated the software or the larger the file, the more processing time it takes and the more energy it consumes [3,pg.10]. The more code to process, the more energy the device consumes and the higher the level of emissions [3, pg. 11].

Green software is carbon-efficient software, meaning it emits the least carbon possible. Only three activities reduce the carbon emissions of software: energy efficiency, carbon awareness, and hardware efficiency [4, pg. 1]. Energy Efficiency: Use the least amount of energy possible [4, pg. 4]. The first layer of energy efficiency begins with algorithms. An $O(n^2)$ algorithm may be acceptable for small data sets, but at scale it wastes CPU cycles and power. For instance, replacing inefficient nested loops with hash-based lookups or optimized data structures can reduce runtime and energy draw dramatically [5, pg. 3].

Electricity is a proxy for carbon, so building an application that is energy efficient is equivalent to building an application that is carbon efficient [4, pg. 6]. Measure and monitor energy — incorporate energy metrics into performance dashboards [5, pg. 6]. Green coding isn't just an environmental consideration, it's a competitive advantage [5, pg. 7].

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ARTIFICIAL INTELLIGENCE IN DATA ANALYSIS: MODELING ENGAGEMENT STRATEGIES IN VIDEO CONTENT BASED ON EMOTIONAL RESPONSES

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In the span of the last few years, the video content has become increasingly differentiated, making it harder for the social media owners to keep their content categorized and connected to keep their users satisfied. The input the platform owner makes here are the moderation and recommendation systems that define the next engagement levels user will experience. Due to exponential expansion of Big Data volume, services utilize AI technologies in algorithms at least to some extent to analyze different forms of user behavior.

Therefore, the aim of this research is to look through possible AI-supported approaches for analyzing user emotional responses in video content and their possible effects on modern engagement strategies.

According to Doctor of Philosophy Iris Tabak and data scientist Ilana Dubovi in their YouTube algorithm study, emotional and cognitive engagement are two separate criteria but are closely interrelated and can be shown via actions like textual interaction, specifically posting a comment. A comment is described as a direct indicator of positive or negative emotion or a greater cognitive engagement judged by the amount of constructive argumentation it includes [1]. Another important factor is the duration of engagement, presence of scrolling through various timestamps, skipping, subscribing, turning on notifications and so on [2].

Most of the modern AI models analyze text and simple actions without problem, so the named approach stays shallow and often gets criticized by the users for its inaccuracy in recommendations. Chinese researchers offer a Multi-Modal Emotion and Intent Recognition Model to cover existing blind spots with two additional modalities: auditory data in the form of speech-to-text analysis and visual data in form of facial expression recognition [3]. Auditory data is often used in advertising tactics, making the algorithm show one the offerings that match verbally expressed cravings or topic of conversation happening while using the website.

Visual user data analysis requires a more complex pattern recognition and a real-time facial emotion reading through camera activation, which rarely takes place in a normal content consumption situation, but in theory allows to most effectively register the relevant reaction in connection to the timestamp and corresponding content. Specialists see the working principle as a conversion of a visual emotional response to one registered in the model types with a rating scale that presents the strength of a reaction [4]. With enough transparency it benefits both content creators, users and the company, providing precise analytics and vectors of interest, as well as finer constructed recommendation system. For now, the technology described stays underused and partially controversial in relation to laws of data protection and user agreement protocols [5].

Thus, AI-based analysis of emotional responses provides a promising framework for modeling engagement strategies in video content via different approaches. The integration of multimodal data allows for a deeper understanding of user behavior and enhances the effectiveness of recommendation systems, while also requiring careful consideration of ethical implications.

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ADVANCEMENTS IN AUTOMATED VIRTUAL UNWRAPPING AND INK DETECTION OF CARBONIZED HERCULANEUM SCROLLS

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The Vesuvius Challenge exists to noninvasively read the carbonized Herculaneum scrolls. Recent efforts have transitioned from isolating excerpts to establishing an automated pipeline capable of reading the entire collection. This paper reviews the technical progress made in X-ray tomography, automated segmentation, and machine learning-based ink detection between 2025 and 2026.

Data acquisition was significantly scaled up at facilities like Diamond Light Source and the European Synchrotron Radiation Facility (ESRF). The scanning process was streamlined through automated photogrammetry, generating 3D models to design form-fitting 3D-printed cases with Teflon wrapping for secure transport. Scans were captured at unprecedented resolutions, including 2.4 μm and 0.55 μm, to balance high resolution, low blur from scattering, and strong phase contrast. High-resolution scanning proved critical; for example, scanning Scroll 4 (PHerc. 1667) at 2.4 μm revealed 5-6 mm sized letters that were completely invisible in previous 8 μm scans.

In the domain of virtual unwrapping, the First Automated Segmentation Prize (FASP) yielded breakthroughs that reduced manual annotation time from hundreds of hours to just four hours. Solutions utilized volumetric segmentation models to produce surface predictions and

surface tracing methods to assemble contiguous sheets. Novel global optimization methods were also developed, such as deforming an Archimedean spiral to fit the scroll's surface predictions while preserving topological integrity through a smooth diffeomorphism. Furthermore, the semi-automated unwrapping software, VC3D, received major updates including remote volume streaming and a Neural Tracer that automatically outputs mesh parts without binarization of input surfaces. Topologically accurate surface detection was further accelerated by a $200,000 Kaggle competition, which utilized models like ResEncUNet.

Ink detection methodologies evolved from surface-based (2.5D) approaches to direct 3D volume analysis. A 3D ink detection model was successfully trained for Scroll 5 (PHerc. 172) to work directly on the unflattened volume scroll. Additionally, generalist ink-detection models were developed using curriculum learning to identify ink signals across multiple scrolls. To optimize these models, a swarm of automated agents was deployed to continuously research and refine model architectures, successfully doubling validation scores in certain cross-scroll tests.

These technical advancements resulted in significant papyrological discoveries. Approximately 70% of the lower ink-bearing region of Scroll 5 was digitally unwrapped. From this scroll, researchers recovered the first-ever noninvasively read title of a still-rolled scroll: Philodemus's On Vices. Further text extraction from the scroll revealed a passage criticizing public rumor-mongering, which included an exciting identification of a quotation from the Characters of Theophrastus regarding a repulsive man standing by a barbershop and perfume shop.

In conclusion, the integration of high-resolution phase-contrast X-ray tomography with advanced machine learning segmentation and generalist ink detection models has proven highly effective. These automated tools are actively bridging the gap between raw volumetric data and readable ancient texts, bringing the scientific community closer to fully unwrapping entire scrolls quickly and accurately.

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AI AGENTS: THE FIRE WE STOLE FROM THE GODS

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Artificial intelligence agents represent a shift from static question-answering systems to autonomous problem solvers. An agent can interpret an open-ended instruction, split it into sub-tasks, choose tools such as web search or code execution, observe intermediate results and decide what to do next. Recent surveys on large language model based autonomous agents describe unified frameworks with modules for memory, planning, action and reflection, as well as patterns such as ReAct and plan-and-execute that combine reasoning with tool use and sometimes coordinate several specialised agents in planner, executor and critic roles [1, p. 3].

Empirical studies suggest that this agentic behaviour is already moving into real applications. The LangChain State of AI Agents Report for 2024, based on a survey of more than 1,300 practitioners, finds that many organisations already use agents in production systems, while others plan to deploy them soon [2, p. 5]. Typical use cases include research assistants, document analysis pipelines and workflow orchestrators that call external APIs or databases [2, p. 7]. In customer service, the payments company Klarna reported that its AI assistant quickly began handling around two thirds of all customer chats and a workload comparable to hundreds of human support employees[3, p. 2]. In software engineering, autonomous coding agents and desktop-level capabilities such as Anthropic's 'computer use' are used to draft code, run tests and interact with graphical interfaces, effectively shortening development cycles and automating routine digital work [4, p. 2].

The economic and social implications of these systems are ambivalent. Labour-market analyses by the International Labour Organization and the OECD warn that clerical and other white-collar occupations with a high share of routine cognitive tasks are particularly exposed to automation by generative AI [5, p. 6]. At the same time, these reports stress that exposure does not automatically translate into job loss: AI is also likely to create new roles in system design, oversight and maintenance, continuing the historical pattern in which technological change both destroys and creates jobs [5, p. 18]. In this sense, AI agents can be viewed as a kind of digital fire: technically they extend large language models beyond static text generation to multi-step interaction with complex environments, and socially they raise questions about how skills, social protection and regulation should be updated so that the benefits of this new form of agency are broadly shared rather than concentrated [1, p. 9].

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AI DESIGN THAT HELPED CREATE A NEW SUPER GLUE

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A team of scientists from Japan and China used artificial intelligence to develop a new type of super glue. This new glue can work underwater on wet, uneven and salty surfaces, where common glues almost always fail.

They managed that by analyzing about 200 species of creatures that produce sticky proteins underwater, including barnacles, mussels, snails and bacteria. The reason is that many of these animals can stick to wet rocks so strongly that you need tools to get them off. The team identified which specific parts of their protein sequences make them sticky in wet conditions.

Next, they manually designed and produced 180 different hydrogels, which are soft, water-filled materials, each different from others. The scientists tested every one in the lab, measuring stickiness, swelling, behaviors in running water and salt water.

After that, they trained an AI on all of the collected data. The machine learned which molecular designs work best for underwater adhesion. Then, it proposed new hydrogel designs that did not exist before. The scientists tested the best AI proposals and fed the results back into the AI. This cycle was repeated three times. After the third cycle, the top three AI-designed glues were far stronger than any of the original 180 human-made hydrogels.

With the new AI-designed glues they ran some tests. They took the one called R1-Max and glued a rubber duck to a wet seaside rock. The rock was slippery and constantly hit by waves, but the duck did not move for days. Another glue was shaped like a large bandage and sealed a burst water pipe that was blasting high-pressure water. The patch was able to hold for more than five months.

These glues are also biocompatible. Scientists tested them on mice and there were no immune reactions or side effects. This means the glue could be used in medicine for sealing deep wounds, helping tissues heal faster, coating medical sensors inside the body.

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AI FOR SUSTAINABLE ARCHITECTURE

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In recent years, environmental problems have become more serious. For this reason, architects need to change the way they design buildings. Sustainable architecture focuses on saving energy, using eco-friendly materials, and creating comfortable spaces for people. One of the key modern tools is Artificial Intelligence. As a result, AI is widely used in modern architecture.

The main purpose of this research is to analyze how AI is used in sustainable architecture and to identify its advantages and disadvantages.

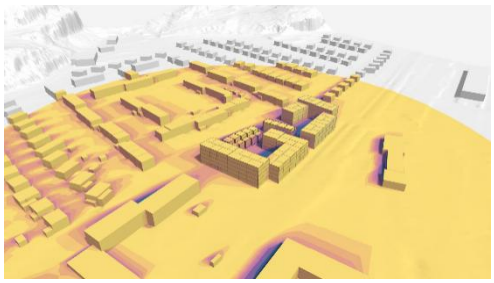
AI in architecture means using computer systems that can analyze data, find patterns, and help make design decisions. These systems can work with information about climate, materials, energy use, and people's behavior. Research shows that AI helps architects make better and more efficient designs.

There are several important pros of using AI in sustainable architecture:

- It supports generative design by quickly creating and comparing many design options, which helps architects find the most effective and innovative solutions. It also improves energy efficiency by analyzing climate and building data to optimize orientation, lighting, and ventilation, which reduces energy use and creates healthier indoor spaces.
- AI helps optimize the use of materials and resources by analyzing environmental data. As a result, it reduces construction waste and lowers costs.
- It also improves accuracy in design by detecting errors early and predicting how buildings will perform in real life, which helps avoid mistakes before construction.
- AI automates repetitive tasks and supports project planning, scheduling, and risk management, making the design process faster. It also improves collaboration by integrating data into one system, helping architects, engineers, and clients work together more productively.

There are some of the most famous examples involving AI in designing: Patriarche Agency uses Autodesk Forma to speed up early design work and improve sustainability analysis. Stantec applies to AI to calculate carbon impact early in the design process, which

helps reduce environmental damage. In the Phoenix housing project, AI was used to compare design options quickly and reduce cost, time, and carbon footprint. AFRY used AI to simulate environmental conditions like to mitigate flood risk (Picture 1). ARCO Architecture Company applied AI to optimize building design in a noisy area, improving daylight, comfort, and living quality.



Picture 1 – Using Forma to mitigate flood risk and increase capacity in a residential complex in Sweden.

However, AI also has some disadvantages. One of the main problems is the high cost of technology. It also requires special skills and knowledge. In some cases, architects may depend too much on technology. Another issue is that it is not always clear how AI systems make decisions, which can create problems with trust.

Despite these cons, AI technologies have a positive impact on sustainable architecture and our environment. It helps architects design reducing energy use and improving environmental performance through better data analysis and optimization.

In the future, AI 3D-form generators automated design systems will make architectural work faster and more efficient. Overall, AI should support architects rather than replace them. Because it requires careful use and high qualifications. In consequence, the combination of human creativity and modern technologies can become an important step towards sustainable urban development.

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EXPERIMENTELLE UNTERSUCHUNG VON KLEINANLAGEN FÜR DAS BETONSPRITZVERFAHREN UND DIE FRISCHBETONFÖRDERUNG

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Einleitung. In der Bauindustrie benutzt man Mineralwolle und Beton für Wände und Dächer. Für Reparaturen von Gebäuden gibt es moderne Methoden, zum Beispiel das feuchte Torkretverfahren. Dieses Verfahren ist nützlich, wenn Wände kompliziert sind oder eine gute Wasserdichtigkeit und Frostbeständigkeit brauchen.

Die Anlage für das Torkretverfahren. Für das Torkretverfahren benutzt man eine Kleinanlage. Die Anlage hat:

1. eine Zweikolbenbetonpumpe,
2. eine Düse,
3. ein Ringfüllkörper,
4. eine Druckluftanlage und
5. eine Förderanlage.

Mit dieser Anlage kann man Beton und Mörtel auf die Baustelle bringen und auf die Wände spritzen.

Technologisches Schema. Am Lehrstuhl für Baumaschinen zeigte man ein Schema für Reparaturarbeiten. Das Verfahren heißt feuchtes Torkretverfahren. Man benutzt eine Zweikolbenbetonpumpe mit Tellerventilen.

Im Schema gibt es auch einen Autobetonmischer. Er wird direkt auf der Baustelle benutzt. Die Effektivität der Pumpe hängt vom Öffnungswinkel der Ventile ab. Ausführung der Arbeiten

Die Reparaturarbeit mit dem feuchten Torkretverfahren wird mit der Anlage durchgeführt. Die Anlage hat: Pumpe, Ventile, Düse und Druckluftanlage DK-11. Der Rüstsatz wurde von den Mitarbeitern des Lehrstuhls in Charkow entwickelt.

Die Zweikolbenpumpe wird mit einem Auslegerkran (QY 70) bewegt. Die Betonmasse kommt in den Behälter der Pumpe, die auf einer Schwebeplattform steht. Die Wände werden mit der Düse von einer Etage zur nächsten verstärkt.

Auf der Baustelle wurde gezeigt, dass die Anlage gut funktioniert und die Instandsetzung erfolgreich ist.

Fazit. Das feuchte Torkretverfahren ist ein modernes Verfahren für die Reparatur von Gebäuden. Mit den Kleinanlagen kann man Beton und Mörtel schnell und effektiv auftragen. Die Arbeit wird einfacher und die Ergebnisse sind besser.

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