



MISKOLCI
EGYETEM
UNIVERSITY OF MISKOLC

**BOOK OF ABSTRACTS FROM THE
INNOVATION IN ENGINEERING EDUCATION
CONFERENCE**

(IEE2026)



IEE2026

5-6 February 2026 Miskolc, Hungary

organized by

**Faculty of Mechanical Engineering and Informatics,
University of Miskolc**



Copyright © 2026 Faculty of Mechanical Engineering, University of Miskolc



**BOOK OF ABSTRACTS FROM THE INNOVATION IN ENGINEERING
EDUCATION CONFERENCE**

2026

Editors:

Szilvia Árvai-Homolya
Sándor Lajos
László Rónai

Organizing committee:

Szilvia Árvai-Homolya
Boglárka Burján-Mosoni
Sándor Lajos
László Rónai
Erika Szilvásiné Rozgonyi
Attila Varga
Katalin Voith
Imre Kocsis

Miskolc, 2026

ISBN 978-963-358-425-5

Table of Contents

Abstracts of the Plenary Lectures

| | |
|--|---|
| Co-learning with Personal AI Agents: Implications for University Education under the Automation of Cognitive Work Peter Sinčák, Laura Pitukova | 2 |
| The First-Year Baseline: Evaluating Student Readiness Supplemental Learning Pathways Brigitta Szilágyi..... | 4 |
| Artificial Intelligence-based robotic applications for higher education Isabela Drămnesc | 6 |
| Best practice curriculum development: The bachelor's degree program »AI Engineering – Artificial Intelligence in Engineering« at the Otto von Guericke University Magdeburg Sebastian Lang | 7 |
| Beyond the Black Box: Integrating Legal Competencies and Algorithmic Liability into the Engineering Curriculum Zsolt Czékmann..... | 8 |

Sessions 1 – 2

| | |
|--|----|
| Factors Influencing Classification Performance and the Reliability of Performance Scores Attila Fazekas..... | 11 |
| Vibe Coding Principles Gábor Kusper | 12 |
| Initial Considerations for a Multimodal Educational Research Laboratory Éva Ádámkó, Gusztáv Áron Sziki, Attila Szántó | 13 |
| AI supported test writing in data visualization – A case study Marianna Zichar | 14 |
| Applicability of AI in code-based 3D modelling – Who will solve the modelling tasks: the students or the AI? Ildikó Papp, Marianna Zichar..... | 15 |
| On some thought-provoking observations gained during a soft skills development programme Boglárka Burján-Mosoni, Imre Kocsis | 16 |
| Why Hasn't AI Replaced University Teachers (Yet)? Johanna Pék..... | 17 |
| Measuring Engineering Students' Spatial Ability Using Digital Technologies Erika Perge, Tibor Guzsvinecz, Judit Szűcs, Péter Puskás | 18 |
| Opportunities for Using AI in a Deliberate Way to Support Engineering Students' Problem-Solving Skills László Árvai, Szilvia Homolya | 19 |
| AI-Enhanced Science Education: From Data to Physical Laws Ervin Szabolcs Murvai, Krisztián Hriczó, Attila Károly Varga | 20 |

Sessions 3 – 4

| | |
|---|----|
| Educational aspect from diagnostics of drones Ákos Cservenák..... | 22 |
|---|----|

| | |
|--|----|
| Student Experiences with AI Support in Environmental Management Courses Baibhaw Kumar..... | 23 |
| Attribute-Based Tabu Memory for Scheduling Problems Levente Fazekas, Károly Nehéz..... | 24 |
| The Answer is Contained in the Question: Shifting Engineering Education from Solution-Finding to Problem-Formulation Attila Aradi, Attila Károly Varga..... | 25 |
| Adaptive engineering education through the Graph4Learn Intelligent Tutoring System László Csépanyi-Fürjes | 26 |
| Challenges in OpenSet Learning of Neural Networks László Kovács, Péter Bán..... | 27 |
| The Role of Artificial Intelligence in Medical Imaging and Diagnostics – A Radiographer’s Perspective Anett Szalkó, Balázs Gadóczy, Andrea Lakatos, Attila Károly Varga..... | 28 |
| Visual Enterprise Management: Strengthening C-Level Understanding via Spatial and Narrative Data Experiences Péter Sághegyi..... | 29 |
| Fine-Tuning DistilBERT: A Pre-Trained Transformer Model for Software Defect Prediction Nasraldeen Alnor Adam Khleel, Károly Nehéz..... | 30 |
| Communication Attitudes of First-Year Engineering Students: Insights and Implications Krisztina Csiba, Imre Kocsis..... | 31 |
| Sessions 5 – 6 | |
| A case study on AI usage among participants in higher engineering education Adrienn Vámosiné Varga, Boglárka Burján-Mosoni, Imre Kocsis | 33 |
| MIssion: Possible reflection of higher education for NAT2020 Géza Csima, Brigitta Szilágyi | 34 |
| Tungfram Moon Radar: Advanced Educational Topics; Hungarian Academy of Science-200 that Builds Bridges Between Nations István Balajti | 35 |
| Integration and optimization of a 3D scanning–based wound coverage system with AI-driven boundary detection Szabina Molnár-Zékány | 36 |
| Integrating Artificial Intelligence into Engineering Design and Operation of Linear Fresnel CSP Systems Salman Brbhan | 37 |
| State-of-the-Art Multi-Modal Deep Learning Approaches for Breast Cancer Prediction: A Literature Review Rama Khazna | 38 |

ABSTRACTS OF THE PLENARY LECTURES

CO-LEARNING WITH PERSONAL AI AGENTS: IMPLICATIONS FOR UNIVERSITY EDUCATION UNDER THE AUTOMATION OF COGNITIVE WORK

Peter Sinčák, Laura Pitukova

Technical University of Košice
Letná 1/9, 040 01 Košice, Slovakia
peter.sincak@tuke.sk

Abstract

The increasing capability and availability of artificial intelligence is accelerating the automation of cognitive tasks and thereby altering the conditions under which universities educate, certify, and contribute to innovation. This contribution situates current developments within a broader framework of “digital intelligence,” understood as the convergence of AI methods with cloud infrastructures, pervasive connectivity, immersive interfaces, and platform-based business models. While these technologies can expand access to learning resources and improve personalization, they also raise concerns about the displacement of independent reasoning, weakened critical judgement, and a gradual erosion of deep reading and conceptual understanding.

To clarify the educational and workforce implications, the talk contrasts two archetypal profiles of AI-related expertise. The first profile emphasizes pragmatic tool use and rapid solution delivery—leveraging open ecosystems, collaborative repositories, and accessible model frameworks to prototype and integrate functional systems efficiently. The second profile emphasizes foundational competence: mathematical and algorithmic understanding of learning as optimization and approximation, systematic diagnosis of failure modes, robustness and validation practices, awareness of compute and infrastructure constraints, and informed engagement with ethical and socio-economic impacts. Although current labor markets may reward large numbers of tool-centric practitioners, the anticipated “botization” of routine development work is likely to increase the relative value of deeper expertise capable of governing systems, ensuring reliability, and assuming responsibility for consequential decisions.

Against this background, the talk proposes “co-learning with Personal AI Agents” (PAIA) as a plausible next stage of blended and lifelong education. PAIA can support learning by providing adaptive explanations, generating illustrative examples, guiding practice, and enabling continuity beyond classroom contact time. However, the primary requirement is not adoption per se but governance: PAIA must be designed to stimulate reasoning and metacognition rather than to replace them. Without explicit pedagogical constraints, the use of agents may encourage unreflective answer consumption, reduce learners’ responsibility for outputs, and undermine the development of mathematical proficiency and intellectual autonomy. Additional concerns include reduced peer interaction, diminished argumentative practice, and a narrowing of creative exploration when solutions are prematurely externalized.

A central pedagogical focus is the role of reading as an information input for thinking. The talk advances structured questioning as a mechanism to preserve and strengthen comprehension under AI mediation. Concretely, “text-to-question” transformations can convert learning materials into sequences of questions that elicit explanation, comparison, counterexample construction, and source verification, thereby supporting discussion with peers and instructors. Knowledge is expressed conceptually as

$$K = L + U,$$

where learning/memorization (L) and understanding (U) jointly constitute usable knowledge (K). In this formulation, question quality is not ancillary but instrumental: well-formed questions operationalize understanding by revealing hidden assumptions and enabling principled transfer.

Finally, the contribution outlines directions for evaluation in co-learning environments, including rubrics for question depth and falsifiability, robustness of reasoning under perturbations, and performance on transfer tasks where template answers are insufficient. It also considers the measurement of learning and understanding “speeds,” and the potential value of a Turing-like criterion for educational agents: not whether they imitate human dialogue, but whether they reliably support the formation of correct conceptual models through sustained, diagnostic interaction. The overarching conclusion is that universities should not seek advantage in information delivery speed; rather, their distinctive mandate

is to cultivate judgement, mathematical literacy, and epistemic responsibility. PAIA can be educationally beneficial when curricula and assessment explicitly reward explanation, critique, and transfer, and when agent design is aligned with these aims.

THE FIRST-YEAR BASELINE: EVALUATING STUDENT READINESS SUPPLEMENTAL LEARNING PATHWAYS

Brigitta Szilágyi

*Budapest University of Technology and Economics
Corvinus University of Budapest
MTA–ELTE Theory of Learning Mathematics Research Group
Budapest, Hungary
szilagyi@math.bme.hu*

Abstract

The aim of higher education diagnostic assessments goes beyond the ranking of students or the verification of secondary school results. With the massification of higher education, the heterogeneity of students' knowledge has increased significantly. This is especially pronounced in STEM fields, where more than a third of students drop out in the early stages of their studies. This can be largely attributed to their lack of basic mathematical and scientific skills. Since technical knowledge is strictly hierarchical, input deficiencies cannot be compensated for later; the lack of a stable foundation necessarily entails non-achievement in higher education.

The need for diagnostic measurements in Hungary is intensified by the changes in the public education regulatory system, especially regarding the introduction of the 2020 National Core Curriculum (NAT). During the transitional periods of curricular reforms, the differences between the knowledge levels of cohorts graduating in differing curricula led to heterogeneous first-year populations. The situation is further complicated by the performance assessment paradox phenomenon—the deterioration of the predictive power of admission scores. Experience shows that a high admission score is less and less a guarantee of stable basic knowledge and due to grade inflation, the admission results have become insufficient indicators for students' achievement at university.

Level assessments not only measure lexical knowledge but are suitable for the early identification of at-risk students, allowing us to intervene in a targeted manner before failure occurs. An often overlooked, but strategically critical function of diagnostic assessments is the identification of students who rank at the top 5-10%. In mass education, talents can remain latent if the pace of education is adjusted to the average or to a weaker level.

BME has long faced the challenge that first-year students' level of mathematical knowledge is extremely heterogeneous. This often results from the specificities of the Hungarian admissions system, which recognizes a variety of prior qualifications, i.e., higher level mathematics classes in high school are optional (facultative). Further, the lingering negative effects of the COVID-19 pandemic and online learning were even felt in the performance of the class admitted in 2024.

In response, the BME Mathematics Institute decided to divide the teaching of Calculus into two levels. Level A is recommended for students with a solid foundation, while level B is suited for students who show significant deficiencies in the material. The goal of the level B course is not segregation but reducing dropout: in addition to the regular curriculum, it aims at countering secondary school deficiencies. However, in order to objectively and effectively classify the more than 2000 incoming students, a reliable measurement tool was needed. Thus, we developed a three-stage, adaptive online placement test.

The first part of the test assessed basic procedural knowledge from grades 9-10. As the test progressed, students' performance deteriorated; the number of unanswered questions increased. For the second part the test divided the students into two groups based on their attendance of facultative higher level mathematics classes in school. The second block covered the curriculum of grades 11-12. Results differed the most here. Almost $\frac{3}{4}$ of the students who had not attended facultative higher level mathematics classes performed below 50%, while students with facultative mathematics background achieved a much higher average. In the third, final stage, the test further divided students into four subgroups. The results of the lowest performing group were worrying, which justified the introduction of differentiated instruction.

Based on past semesters' results, the adaptive placement test has proven to be a successful tool for mapping and grouping students. The introduction of differentiated learning was essential to ensure that

pupils with limited knowledge had a chance to catch up, while others with more knowledge in the required course material could progress at their own pace. In conclusion, our research showed that input measurements are essential for effective engineering education, especially in a transitional, post-pandemic period.

ARTIFICIAL INTELLIGENCE-BASED ROBOTIC APPLICATIONS FOR HIGHER EDUCATION

Isabela Drămnesc

West University of Timisoara

300223 Timișoara, Bulevardul Vasile Pârvan 4, Romania

isabela.dramnesc@e-uvt.ro

Abstract

This talk introduces AI-based robotic applications developed for higher education and shows how building these systems can make AI and robotics concepts tangible through problem-based learning (PBL). Building on key outcomes of the European AiRobo project, the talk outlines practice-based learning designs that bridge abstract concepts and working robotic systems, highlighting both educational and socially impactful applications, including assistive technologies for people with special needs.

The presentation is structured around modular robotic case studies that have been successfully developed as course projects, capstone topics, and staff-training exemplars. Each case study is mapped to core theoretical content—AI algorithms, programming paradigms, robotics foundations, and formal verification—so that students can see why the theory matters, how it is implemented, and how practical constraints shape the final design.

1. Indoor navigation with Pepper and Scout robots. By combining a social robot (Pepper) with a mobile robot (Scout), this case study supports learning activities around localization, path planning, and human–robot interaction. It links foundational methods in graph search, state estimation, sensor fusion, and safe behaviour design, while exposing practical constraints such as noisy perception, dynamic obstacles, and real-time decision requirements.
2. 2D/3D mapping with AgileX Scout Mini and LiDAR. This case study introduces SLAM principles and robotic perception through hands-on map generation and evaluation. Students work with coordinate frames, point-cloud processing, occupancy grids, and basic calibration, and they practice interpreting quantitative metrics (coverage, drift, loop-closure quality) and use these measures to iteratively improve the system design.
3. An AI-based Tic-Tac-Toe robotic arm. A compact manipulation scenario is used to connect computer vision, motion planning, and game AI. The pipeline integrates camera-based board detection, rule-based or search-based decision logic, and pick-and-place control. The case study also enables discussions on verification-oriented thinking: specifying critical properties (e.g., legal moves, collision avoidance) and validating them through systematic testing or formal specifications.
4. Building a telepresence robot. This project emphasizes systems integration: networking, streaming, remote control, autonomy assist, and interface design. It supports instruction in software architecture, concurrency, and evaluation with users, highlighting the engineering practices required for robustness and reproducibility beyond prototype-level demonstrations.
5. A 3D-printed rehabilitation exoskeleton. This case study shifts the emphasis to responsible robotics, including human-in-the-loop control, safety constraints, ergonomics, and ethical considerations. It illustrates how biomechanical requirements can be translated into design parameters, how prototypes can be validated, and how limitations and risk mitigations can be documented and communicated.

Across these examples, the talk highlights the PBL workflow: starting from a real life problem, identifying the concepts and methods required to address it, implementing and integrating solutions, and evaluating outcomes through measurable criteria and reflective reporting. All implementation code developed within the AiRobo project is freely available and can be reused or adapted for teaching and research.

BEST PRACTICE CURRICULUM DEVELOPMENT: THE BACHELOR'S DEGREE PROGRAM »AI ENGINEERING – ARTIFICIAL INTELLIGENCE IN ENGINEERING« AT THE OTTO VON GUERICKE UNIVERSITY MAGDEBURG

Sebastian Lang

Otto-von-Guericke-Universität Magdeburg
39106 Magdeburg Universitätsplatz 2, Germany
sebastian.lang@ovgu.de

Abstract

The rapid advancement of artificial intelligence technologies has created an unprecedented demand for professionals who can bridge the gap between AI research and industrial applications. While German companies increasingly recognize AI as a key technology for their future competitiveness, they struggle to implement AI solutions due to a significant shortage of qualified personnel. A comprehensive analysis conducted in 2021 revealed that no German university or university of applied sciences offered a degree program explicitly designed to train students as experts in industrial AI systems and services. This keynote presents the development and implementation of the bachelor's degree program "AI Engineering – Artificial Intelligence in Engineering" at Otto von Guericke University Magdeburg as a best practice example for addressing this educational gap.

The AI Engineering program was developed within a four-year project funded by the German Federal Ministry of Education and Research with 5 million euros, involving a consortium of Otto von Guericke University Magdeburg and four universities of applied sciences across the federal state of Saxony-Anhalt. The curriculum development followed a systematic approach that began with problem identification and needs analysis, proceeded through competency profiling and module matrix design, and culminated in the implementation of teaching and assessment concepts. A distinctive feature of this process was the active involvement of seven industrial partners from various sectors across Germany, who contributed both to defining the required competencies and to evaluating how well the final curriculum meets professional requirements.

The resulting competency profile encompasses the full lifecycle of industrial AI systems: graduates learn to analyse problems, define requirements, evaluate AI deployment potential, plan and manage AI projects, design and implement industrial AI systems, and assess these systems according to ethical, economic, and safety criteria. The curriculum synthesizes AI and computer science fundamentals with engineering disciplines, embedding practical project work in every semester. The program structure divides into a foundational phase at Otto von Guericke University during the first four semesters and a specialization phase at one of the partner institutions during semesters five through seven. Students can choose from five distinct specialization tracks offered by the different partner universities: Manufacturing, Production and Logistics; Biomechanics and Smart Health Technologies; Mobile Systems and Telematics; Agricultural Engineering; and Green Engineering.

A key innovation is the Cooperative Integrative Synergetic Study Model, which enables students to be enrolled simultaneously at all five participating institutions under a joint study and examination regulation. This model pools resources across institutions, strengthens interdisciplinary collaboration beyond traditional university boundaries, and creates synergies through shared development work and unbureaucratic exchange of teaching services. The technical infrastructure supporting this collaboration includes a centralized learning management system and the development of Open Educational Resources that can be shared across institutions and beyond. The program commenced in winter semester 2023/2024 and has demonstrated steady growth, with enrolment increasing by 41 percent within two years. The project has directly led to the establishment of new AI professorships, contributing to the sustainable expansion of AI teaching capacity in the region. This keynote shares lessons learned, discusses ongoing challenges including student retention and cross-institutional process harmonization, and outlines future developments such as international mobility options and a bilingual study track.

BEYOND THE BLACK BOX: INTEGRATING LEGAL COMPETENCIES AND ALGORITHMIC LIABILITY INTO THE ENGINEERING CURRICULUM

Zsolt Czékman

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

zsolt.czekmann@uni-miskolc.hu

Abstract

The rapid ascendancy of Artificial Intelligence (AI) has fundamentally altered the landscape of engineering design. AI is no longer merely a tool in the hands of engineers but an agent capable of autonomous decision-making, reshaping economic structures and individual rights. Consequently, the traditional technocratic approach to engineering education—focused solely on neural network architecture or optimisation—is no longer sufficient. This presentation argues that in the age of AI, legal regulation has evolved from a post-design compliance check into a fundamental design boundary condition, comparable to the laws of thermodynamics or material tensile strength. We posit that the engineer of the future must possess specific "legal literacy" to navigate a volatile regulatory environment, transforming from a technical specialist into a "T-shaped" professional with excellent technical skills and broad contextual understanding.

The first section of the presentation offers a comparative analysis of the global regulatory landscape, defining the new constraints for engineering design. We examine the divergent requirements of the world's three dominant economic blocs: the European Union's risk-based ex-ante regulation (EU AI Act), the United States' ex-post liability and litigation-focused model, and China's content-centric control. Crucially, we demonstrate how these legal frameworks translate into purely engineering tasks. For instance, the EU's prohibition of "unacceptable risk" systems defines a "negative design space" that students must learn to recognise immediately. Furthermore, legal mandates for data governance transform the technical task of data cleaning into a requirement for detecting statistical bias and ensuring representativeness. Similarly, the "duty of care" principle in US law and China's requirements for explainability (XAI) necessitate that engineers design software architectures that are transparent, auditable, and capable of human oversight, rejecting "black box" operations where they hinder legal accountability.

The second section addresses specific legal competencies required for daily decision-making. We explore the crisis of Intellectual Property (IP) in the era of generative AI, where students must learn "code hygiene" to segregate AI-generated snippets from proprietary work and manage the legal risks of open-source licensing in training data. We also analyse the shifting nature of liability and agency. Using the *Moffatt v. Air Canada* case—where a chatbot was deemed an agent of the company—we illustrate the necessity of designing Retrieval-Augmented Generation (RAG) systems with strict "guardrails" that prioritise static ground truth over generative hallucinations. Additionally, we discuss the implications of strict liability versus negligence in autonomous systems, emphasising that "state-of-the-art" defences may not suffice if a system causes harm.

The third section provides innovative methodological recommendations for curriculum development, moving away from frontal legal instruction, which is often ineffective for engineering students. We propose the "Legal Autopsy" method, in which students reverse-engineer real-world legal failures (such as the Uber self-driving fatality) to understand how technical design flaws, including automation bias, lead to criminal or civil liability. We advocate for Interdisciplinary Clinical Legal-Engineering Education, in which mixed teams of law and engineering students conduct compliance audits of real AI products, simulating the industrial environment. Furthermore, we suggest incorporating "Red Teaming" into lab exercises, where students actively try to "break" models to induce discriminatory or illegal outputs, thereby reinforcing legal boundaries through practical experience.

Finally, the presentation addresses the implementation challenges, specifically the "half-life" of knowledge in a hyper-fast regulatory environment. Given that university accreditation cycles cannot keep pace with legislation such as the EU AI Act or rapidly evolving generative AI measures, we argue that legal competencies cannot be fully imparted within traditional BSc/MSc frameworks. Instead, we

propose a shift toward a continuous, lifelong learning model utilising micro-credentials—short, competency-based courses (e.g., "AI Compliance Auditor") developed in cooperation with industry partners. This approach ensures that the integration of legal competencies serves not as a bureaucratic burden but as a risk-management tool that enables the development of socially responsible and sustainable AI systems.

SESSIONS 1 – 2

FACTORS INFLUENCING CLASSIFICATION PERFORMANCE AND THE RELIABILITY OF PERFORMANCE SCORES

Attila Fazekas

University of Debrecen

4032 Debrecen, Egyetem square 1, Hungary

attila.fazekas@inf.unideb.hu

Abstract

In the rapidly expanding world of artificial intelligence, where intelligent systems increasingly permeate our daily lives, classification stands as one of the most fundamental, yet most consequential tasks. It concerns the assignment of samples to predefined classes based on the available measurements. Consider, for example, autonomous vehicles: the objects captured and processed by on-board cameras raise critical, even life-or-death questions—does the system detect a pedestrian, a cyclist, or a car? Medical applications bear similarly high stakes, where diagnostic tools must determine whether a disease is caused by malignant processes.

Formally, the problem can be described as follows. Let $X = \{x_i \in \mathbb{R}^d \mid i = 1, \dots, n\}$ be a set of n elements, where each element (d -dimensional sample) constitutes part of a dataset. In addition, let $Y = \{0, \dots, k\}$ denote the set of class labels. We assume that the class label of every sample is known, that is, for each $x_i \in X$ there exists a corresponding $y_i \in Y$. The goal of classification is to find a classifier $c: X \rightarrow Y$ that assigns to each x_i , its corresponding label y_i . However, a perfect classifier virtually never exists, as errors are inevitable. Consequently, the task becomes the search for a classifier that produces as few misclassifications as possible. To this end, we must first define precisely how to measure the "quality" of a classifier, and then assess the reliability of these performance scores. Finally, we must understand the factors that influence classifier performance. Such clarity is essential, as our trust in AI-based systems depends heavily on how well we understand the behaviour of fundamental classifiers and the reliability of the performance scores used to evaluate them.

In our presentation, we aim to demonstrate that, although performance scores appear to give a favourable description of classifier behaviour, they often rely on flawed or misleading calculations. To address this issue, we introduce a consistency test developed by our research group, together with a concrete case study illustrating both the presence of these problems and the effectiveness of our method. It is important to emphasize that, beyond reproducibility, the results themselves strongly depend on the datasets used in evaluation (and, in the case of supervised classification, in training as well). Thus, it is essential to examine which properties of a dataset—and in what manner modify the classification performance. Two particularly influential factors are label noise (incorrectly assigned class labels) and class imbalance (differences in class sample sizes), both of which frequently pose challenges for classification. In the second part of our presentation, we investigate the effect of these two factors in binary classification, demonstrating the substantial difficulties they can introduce.

Our conclusions are twofold. First, rigorous scrutiny of experimental results is indispensable. Second, the selection of an appropriate classifier is shaped by numerous dataset-specific parameters, among which noise and class imbalance are especially decisive. Consequently, it becomes clear that selecting suitable machine-learning-based solutions is a highly complex task, one that requires careful theoretical consideration and thorough experimental validation.

VIBE CODING PRINCIPLES

Gábor Kusper

Eszterházy Károly Catholic University
3300 Eger, Eszterházy square 1, Hungary
kusper.gabor@uni-eszterhazy.hu

Abstract

The notion of vibe coding has been present in AI-assisted programming practice for years, even before it was explicitly named. Developers were already engaging in conversational, flow-oriented interactions with Large Language Models, rapidly accepting generated code and prioritizing momentum over detailed inspection. The term “vibe coding” was later popularized by Karpathy as an experience-driven, improvisational form of coding enabled by increasingly capable language models [1].

As vibe coding spread, discussions quickly moved beyond definition toward questions of quality, reliability, and responsibility. While first vibe coders emphasized speed, creativity, and flow, critics raised concerns about hidden defects, limited input coverage, loss of intent, and declining maintainability. Conceptual analyses frame vibe coding as a reconfiguration of intent mediation, where cognitive labor is redistributed and expertise shifts toward collaborative orchestration between humans and AI systems [2]. In this work, we intentionally enter this ongoing conversation. We propose a compact set of six Vibe Coding Principles, distilled from forum discussions, empirical studies, and our prior work on vibe coding in educational settings [3]. The proposed principles are:

1. Responsible Vibe Coding Principle
2. Tool-Aware Vibe Coding Principle
3. Specification-First Principle
4. Plan-Guide-Verify Principle
5. Rule of Principle-Guided Prompts
6. Definition of Done Principle

Each principle addresses a specific tension inherent in vibe coding. The Responsible Vibe Coding Principle emphasizes that responsibility for correctness, safety, and consequences remains with the human developer, including responsible use of energy-intensive AI tools. The Tool-Aware Vibe Coding Principle recognizes that vibe coding is inseparable from its tooling environment and that different tools actively shape reasoning, feedback loops, and trust. The Specification-First Principle responds directly to challenges of intent mediation by asserting that explicit specification must precede generation. The Plan-Guide-Verify Principle captures the iterative rhythm of vibe coding while embedding verification as a first-class activity rather than an afterthought, mitigating risks of false confidence identified in prior studies [4]. The Rule of Principle-Guided Prompts introduces disciplined prompting as a normative constraint, ensuring that prompts themselves reflect established software engineering principles such as SOLID. Finally, the Definition of Done Principle reframes completion criteria in AI-assisted development, emphasizing contracts, pre- and post-conditions, invariants, and independently meaningful tests.

We do not claim that this list is final or universally accepted. Instead, we view it as a contribution toward consolidation. Our goal is to help vibe coding mature from an ad hoc practice into a recognizable practice within the Principles–Patterns–Practices (PPP) framework of software engineering. We hope that our work provides a starting point for stabilization and invite further debate and refinement.

- [1] A. Karpathy (2025). Vibe Coding. Post on X (formerly Twitter), <https://x.com/karpathy/status/1886192184808149383>, 02.02.2025.
- [2] C. Meske et al. (2025). Vibe Coding as a Reconfiguration of Intent Mediation in Software Development: Definition, Implications, and Research Agenda. *IEEE Access*, vol. 13, pp. 213242-213259, doi: 10.1109/ACCESS.2025.3645466.
- [3] G. Kusper and Cs. Szabó (2025). Vibe Coding in Education. 2025 International Conference on Emerging eLearning Technologies and Applications (ICETA), Stary Smokovec, Slovakia, pp. 506-511, doi: 10.1109/ICETA67772.2025.11280285.
- [4] A. Sarkar, and I. Drosos (2025). Vibe coding: programming through conversation with artificial intelligence. arXiv:2506.23253.

INITIAL CONSIDERATIONS FOR A MULTIMODAL EDUCATIONAL RESEARCH LABORATORY

Éva Ádámkó, Gusztáv Áron Sziki, Attila Szántó

University of Debrecen

4028 Debrecen, Ótemető street 2-4, Hungary

adamko.eva@eng.unideb.hu

Abstract

The design of educational research laboratories increasingly requires careful consideration of how learning situations can be observed, documented, and analysed in a structured and methodologically sound manner. As teaching and learning processes become more complex, relying on a single source of data or a single observational perspective is often insufficient for capturing the multifaceted nature of instructional settings. This lecture presents the initial considerations guiding the planning and conceptual design of a multimodal educational research laboratory.

The focus of the proposed laboratory is not the implementation of specific technologies or analytical solutions, but the establishment of a flexible research infrastructure that enables systematic observation and comparison of teaching and learning situations. The laboratory is intended to support a wide range of educational research activities by providing a coherent framework for data collection, synchronization, and organization across different instructional contexts.

Within this design-oriented perspective, multimodality is understood as a guiding principle for laboratory construction. It refers to the inclusion of multiple, complementary observation channels that describe learning activities from different viewpoints, such as learner interactions, observable behavioural patterns, indicators related to cognitive effort, and contextual characteristics of the learning environment. These modalities are not treated as independent measurement systems, but as interconnected components within a unified laboratory structure. The design therefore emphasizes compatibility, temporal alignment, and interpretability of data rather than maximizing the number or complexity of measurement tools.

The planning of the laboratory addresses several key aspects, including the definition of core observation dimensions, the separation of data collection and analysis layers, and the establishment of procedures that support repeatable and comparable studies. Particular attention is given to ensuring that the laboratory can accommodate both traditional classroom-based instruction and technology-enhanced learning situations without privileging any specific instructional format. This generality is intended to preserve methodological openness and adaptability.

To manage complexity and ensure feasibility, the laboratory is conceived as a stepwise development. Initial stages focus on defining basic observational capabilities and establishing stable data handling practices. Further extensions are considered incremental and contingent on methodological experience gained during early use. Rather than presenting a finalized laboratory model, this lecture outlines a set of initial design considerations intended to guide the careful, transparent, and sustainable development of a multimodal educational research laboratory.

AI SUPPORTED TEST WRITING IN DATA VISUALIZATION – A CASE STUDY

Marianna Zichar

University of Debrecen

4028 Debrecen, Kassai street 26, Hungary

zichar.marianna@inf.unideb.hu

Abstract

Assessing students' knowledge has always been a significant challenge for both students and teachers. Beyond the traditional method, which relied solely on pen-and-paper tests and students' memories, there are other approaches to testing. An "open-book exam" is a test where students are allowed to use their textbooks or notes to find the answers, which can seem more appealing. It may create the impression that they need to know less or even nothing to pass. However, many students find that this is not the case during the actual test. I see some analogy when students are allowed to use AI tools during the tests. I recently experienced a similar situation when teaching a course on Data Visualization to 91 Chinese students. After conducting 16 online classes, I travelled to China to deliver the remaining classes in person, with tests also administered in the classroom. The course focuses on creating powerful visualizations and dashboards using specific software (Tableau from Salesforce); it is more hands-on than theoretical. To gain new insights or reveal hidden patterns in the different datasets, students must be familiar with the software's features and have some proficiency as well. Acquiring new knowledge in a foreign language is always a significant challenge; thus, to address language barriers and the challenges of intensive learning (four classes per day), I was forced to allow the students to use AI tools during the tests. Given the difficulty of preventing students from accessing AI, they were permitted to use it during the second test. However, I emphasized that without a solid understanding of the software, AI tools would not be effective in creating graphs, charts, and dashboards.

It was clear that students feel themselves much more self-confident with the possibility of using AI. During the assessment of their work, I collected and classified the typical traces of AI use. I identified three levels of unsuccessful AI assistance in the students' work.

The lowest level is when students received detailed instructions about how to create a visualization. This means that AI was familiar with the user interface and could provide a step-by-step description for the students. Unfortunately, some of them copied this information as an answer. These students were unable to follow the instructions, which demonstrated a lack of basic software skills.

The second level is when students received detailed instructions and tried to follow them. The time limit was a restriction for them, as it took them much longer to understand the steps and locate the menu items. The quality of their solution depended on their level of knowledge.

Students from the top level asked for help from AI to solve smaller problems while building the visualizations. Appropriate prompting played a crucial role in getting the right help. Prompting skills are related to students' knowledge. Some results of bad prompting: AI suggested creating calculations, although the aggregation function was available, or data filtering was achieved with embedded calculations.

In my experience, artificial intelligence cannot fully replace students' knowledge, although it may take time for students to realize this. Educators must adapt to this new situation by revising their testing methods to accurately measure students' true skills.

APPLICABILITY OF AI IN CODE-BASED 3D MODELLING – WHO WILL SOLVE THE MODELLING TASKS: THE STUDENTS OR THE AI?

Ildikó Papp, Marianna Zichar

University of Debrecen
4028 Debrecen, Kassai street 26, Hungary
papp.ildiko@inf.unideb.hu

Abstract

The development and democratization (making the technology accessible and affordable for everyone) of artificial intelligence (AI) is affecting many areas of our lives, including engineering and education. AI has been developed and used for years, but it has gained public attention primarily thanks to chatbot applications based on large language models (LLMs).

Higher education must also reflect on technological changes. It is not enough to regulate the method and extent of AI use in relation to student work, it is also necessary to explore the capabilities of AI across different fields of science and courses. Many fear that AI will make human knowledge, action, and experience unnecessary. For instance, there are widespread misconceptions that artificial intelligence can fully handle coding tasks.

When we think of 3D modelling, we most often think of the visual design environment, which not only allows the construction of 3D solids, but also provides the opportunity for analysis, testing, and simulation. Newer or more detailed custom functions can be added in the form of scripts, but there are also explicitly code-based modelling systems. At the Faculty of Informatics of the University of Debrecen, bachelor students in Computer Science learn the basics of 3D modelling in the form of an optional course. The course focuses on additive manufacturing and presents modelling methods that meet the requirements of 3D printing. Among various design applications, we also deal with code-based modelling related to the students' field of expertise.

OpenSCAD is a free modelling application with a unique scripting language to support generative design. OpenSCAD does not focus on the artistic aspects of 3D modelling (creating computer-animated movies or organic life-like models), but instead focuses on the CAD - engineering aspects in a non-interactive way. A compiler reads in a program file that describes the object and renders the model from this code, giving full control over the modelling process. Thus, it is easy to modify any step in the modelling process and create designs defined by configurable parameters.

In the context of code-based modelling, the question can easily arise: who will perform the modelling task: the student or the AI? We wanted to examine whether AI currently poses a real threat to our case. We decided to test the performance of two popular AI chatbot tools, ChatGPT and Gemini, which are the most popular among students and are available for free or with a discounted subscription. For testing, we used tasks that were easy for students to understand and could be easily solved based on short text and visual information. We treated the selected chatbots similarly, providing text and visual prompts at different levels.

In my presentation, I would like to present the results generated by the chatbots mentioned above, which show the current capacity of AI. We know that technology is constantly evolving and learning, but user knowledge, control, and critical thinking cannot be ignored.

ON SOME THOUGHT-PROVOKING OBSERVATIONS GAINED DURING A SOFT SKILLS DEVELOPMENT PROGRAMME

Boglárka Burján-Mosoni, Imre Kocsis

University of Debrecen

4028 Debrecenn Ótemető street 2-4, Hungary

burjan-mosoni.boglarka@eng.unideb.hu

Abstract

Although the latest digital technologies, including augmented reality, digital twins and generative AI, are used in industrial tasks and cutting-edge research, reliable and responsible engineering work requires an understanding of, and realistic perception of, the phenomena of the physical world. Engineering science and practice are grounded in an understanding of natural processes, phenomena and laws. To achieve this, it is necessary to experience and clearly understand a range of fundamental concepts and relationships.

As mathematical and engineering software, and increasingly AI-based tools, take over time-consuming and less creative aspects of engineering work, the focus may shift from executing routine steps to analysing, evaluating and controlling them. However, this assumes that the human in the loop has the necessary knowledge to make correct judgements about the solutions or decisions provided by the software.

Efficient engineering work requires an understanding of the problem to be solved, knowledge of adequate problem-solving tools and the capability to assess the completeness of the answer (i.e. understanding the criteria for a complete solution and what constitutes a solved engineering problem). The first of these requires adequate conceptual images and real-life experience (e.g. hands-on manipulation of real objects), while the third requires critical thinking above all else. Clearly, the success of engineering students largely depends on the competencies they acquire through public education and real-life experience.

Engineering education must remain conservative in its approach, encouraging a realistic view of things and common sense, while acknowledging the increasingly important role of virtual reality in shaping the experiences and consequently the attitudes of young people.

The problems with students' preparedness for engineering education, particularly with regard to mathematics and science, are well-known and widely studied. Our experience shows that another type of deficiency in students' preparedness for engineering education remains hidden and can significantly hinder the understanding of technical concepts, laws and explanations.

Modern information technology provides young people with an increasingly interesting and exciting virtual alternative to the real world. It is a well-known social issue that young people's personal and professional decisions are often based on virtual rather than real-life experiences. Meanwhile, there is a growing need for human control over software-generated solutions and processes in technical and economic processes.

For those who rarely experience physical reality and live in a virtual world, it can be difficult to judge situations that were once obvious to everyone. Playing with a seesaw or wheelbarrow, lifting objects, or wrestling can help children understand the physical laws related to one- and two-armed levers. However, a lack of this type of experience can lead to misconceptions. In one educational experiment, for example, some students thought that a mass on the platform of a wheelbarrow would be easier to hold if it was placed closer to the person holding the wheelbarrow than to the wheel's shaft.

A lack of real-world experience raises questions such as, 'What control can people who have grown up in a digital environment have over physical systems?' Based on their experience, educators teaching core engineering knowledge often assume a certain level of experience and understanding of real-world phenomena, and are reluctant to address these fundamental elements of knowledge. Meanwhile, they complain that many students do not understand their explanations, which include 'obvious' things.

To gain a realistic understanding, the real-world experience of freshers needs to be assessed. This requires knowledge of the fundamentals of engineering principles, as well as a suitable assessment method. However, identifying the fundamental set of required concepts and experiences is difficult given the diversity of the items and their various domains of origin.

WHY HASN'T AI REPLACED UNIVERSITY TEACHERS (YET)?

Johanna Pék

Budapest University of Technology and Economics
1111 Budapest, Műgyetem rkp. 3, Hungary
pek.johanna@epk.bme.hu

Abstract

In recent years, using artificial intelligence (AI) for virtually anything — from everyday tasks to complex scientific problems — has become a widespread trend. It is difficult to dispute that the emergence of AI represents a new kind of “industrial revolution”, one that affects not physical labour but intellectual work. Its presence and development are inevitable and unavoidable; however, its proper use is crucial.

Contemporary primary and secondary education increasingly prioritizes algorithmic, step-by-step thinking. As a result, higher education faces the complex task of teaching students — who have grown accustomed to convenience — to think, analyse, and filter information independently.

The university teacher of the future is effective only if they use AI in their teaching and teach students how to apply it responsibly and maximise its capabilities. At the same time, it must not be forgotten that current AI systems still exhibit a relatively high error rate and perform poorly on tasks requiring creativity. In higher-level mathematics, and more specifically in geometry education, AI is best described as a combination of a “super-Wikipedia” and a “conveniently accessible Wolfram Alpha”. This is precisely the point at which human contribution becomes indispensable: creativity, complex reasoning, and — above all — the evaluation of whether an obtained result is correct remain “human privileges”.

The current limitations of AI are well illustrated by a course offered to architecture students at the Budapest University of Technology and Economics: Advanced Computational Geometry. The course has a dual aim. First, students must determine, based solely on a few photographs (or occasionally video footage), which geometric surface types an existing building can be derived from – such as quadrics, surfaces of revolution, developable surfaces, or translation surfaces. This requires strong skills in form recognition and geometric analysis. Second, students must visualise their own design ideas without relying on classical modelling software (such as Rhino and Grasshopper). Instead, they use GeoGebra, a freely available software that is remarkably suitable for this purpose. Through this process, their knowledge of differential geometry develops significantly, which later enhances their efficiency when using professional modelling software.

Students are permitted to use AI when solving course assignments. The combination of geometric analysis and differential geometric modelling leads them to evaluate AI-generated outputs with a natural sense of scepticism: they immediately analyse, question, and correct the results. It is striking that in many cases students prefer traditional, manual methods of computation and routinely verify every result produced by software or AI tools. I believe the course has thus achieved its goal: we are training architects who possess excellent computational skills, who can master artificial intelligence rather than rely on it, and who retain all the — currently still — human privileges: critical thinking and creativity. Today’s university students are the future engineers and scientists — those who may one day contribute to the development of AI itself. For this reason, maintaining independence from AI, and being able to rise above it when necessary, is a crucial component of an engineer’s intellectual toolkit.

MEASURING ENGINEERING STUDENTS' SPATIAL ABILITY USING DIGITAL TECHNOLOGIES

Erika Perge, Tibor Guzsvinecz, Judit Szűcs, Péter Puskás

University of Debrecen
4028 Debrecen, Ótemető street 2-4, Hungary
perge@eng.unideb.hu

Abstract

Spatial skills are of crucial importance, as high-level performance in many professions - such as engineering, architecture, interior design, technical fields, IT, medicine, and creative industries - depends on them. Spatial skills include spatial orientation, mental rotation, shape recognition, and the ability to perceive relationships. Well-developed spatial thinking contributes to effective problem-solving, accurate planning, and rapid decision-making, thereby significantly enhancing professional performance and work quality.

Spatial ability can be measured using various methods, primarily standardized tests and practical tasks. Spatial ability tests commonly used in engineering and technical education examine different aspects of spatial thinking, spatial perception, visualization, and manipulation. Several tools have been developed to assess this ability, with their original versions being paper-based:

- Mental Rotation Test (MRT): Measures the ability to mentally rotate objects. In the tasks, the participant must decide whether a rotated spatial shape matches the reference model.
- Mental Cutting Test (MCT): Assesses spatial cutting and mental visualization. In these tasks, an object is “cut” with an imaginary plane, and the participant must identify the resulting shape.
- Purdue Spatial Visualization Test (PSVT): Evaluates multiple elements of spatial visualization, such as rotation, transformation between views, and recognition of object nets.
- Heinrich Spatial Visualization Test (HSVT): Examines more complex spatial operations and finer distinctions. It includes assessing the relative position, orientation, and distance of basic shapes, as well as recognizing their rotations in different directions.

The combined use of these tests provides a comprehensive and reliable assessment of students' spatial abilities and serves as an effective foundation for targeted skill development. Spatial ability can be improved; therefore, its development should be integrated into engineering education through various subjects, such as descriptive geometry and 3D modeling.

The perception of distance is a fundamental component of spatial perception. It refers to the ability to accurately judge the distances between objects and between oneself and objects in space. Distance perception is critically important in everyday life, as it fundamentally determines how we move, navigate, work, and orient ourselves in space. From the perspective of precise work - especially in engineering, technical, surgical, or industrial fields - accurate distance perception enables the precise fitting of components and error-free execution of cuts and assemblies. Distance perception also forms the basis of effective spatial design.

In modern digital environments, distance perception plays a key role in creating realistic spatial experiences and ensuring the authenticity of the user experience during 3D modelling, VR/AR systems, and simulations. Well-developed distance perception contributes to higher professional performance, faster decision-making, and fewer errors, making its development and measurement particularly important in technical and engineering education.

To measure spatial abilities and distance perception, we have designed and created several proprietary assessment tools that are well-suited for use in education and professional training, including engineering programs. These tools typically include traditional task types, but, leveraging the opportunities offered by digital technologies, the assessments are now conducted online. During the presentation, the assessment tools containing various task types and the results obtained so far will be demonstrated.

In our educational activities, the deliberate measurement and development of spatial abilities contribute to a higher level of mastery of engineering competencies, foster students' independent, creative, and precise engineering thinking, improve academic performance, and reduce dropout rates.

OPPORTUNITIES FOR USING AI IN A DELIBERATE WAY TO SUPPORT ENGINEERING STUDENTS' PROBLEM-SOLVING SKILLS

László Árvai, Szilvia Homolya

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

laszlo.arvai@uni-miskolc.hu

Abstract

The rapid expansion of artificial intelligence is evident in both everyday life and scientific and technological domains. In higher education, students increasingly rely on AI-based tools in a wide range of learning activities, including the study of mathematics, which plays a fundamental role in engineering education. This trend raises important questions regarding how artificial intelligence is used during the learning process and how its application may influence students' approaches to problem-solving.

The presentation builds on the results of a survey involving approximately 250 first-year engineering students at the University of Miskolc. The survey aims to provide an overview of students' general patterns of artificial intelligence use, as well as their AI-related practices in the context of mathematics courses. Rather than seeking to identify causal relationships, the survey serves as a starting point for an overview-oriented analysis.

Based on the identified usage patterns, the presentation examines methodologically grounded and deliberate ways in which artificial intelligence can be integrated into problem-solving processes. Problem-solving competence plays a central role in engineering education, as it forms the foundation of creative engineering work in later professional practice. As artificial intelligence becomes an increasingly prominent element of engineering environments, it is essential that students remain active participants in the thinking process rather than passive users who follow automatically generated solution patterns.

Without reflective engagement, there is a risk that reliance on AI-based tools may lead to superficial understanding and reduced cognitive involvement. These considerations are already highly relevant in foundational courses, including mathematics, where problem-solving is not merely about obtaining correct results but about developing structured reasoning, abstraction skills, and strategic thinking.

For this reason, special emphasis must be placed on the deliberate use of artificial intelligence. Instead of relying on uncontrolled solution-generating algorithms, AI should be employed in ways that support long-term learning goals, foster students' cognitive development, and strengthen their ability to analyse, evaluate, and construct problem-solving strategies independently. Numerous studies suggest that artificial intelligence is more likely to support the development of problem-solving competencies when students remain active and reflective participants in the learning process, and when the technology serves to support rather than replace cognitive engagement.

In line with these findings, the presentation argues that engineering education—particularly in foundational courses—should emphasize teaching the deliberate and methodologically grounded use of artificial intelligence. Such an approach may not only positively influence short-term academic performance but also foster the development of long-term problem-solving and thinking competencies that are essential in rapidly evolving, AI-enriched engineering practice.

AI-ENHANCED SCIENCE EDUCATION: FROM DATA TO PHYSICAL LAWS

Ervin Szabolcs Murvai, Krisztián Hriczó, Attila Károly Varga

University of Miskolc
3515 Miskolc-Egyetemváros, Hungary
murvai.ervin@gmail.com

Abstract

My research investigates how artificial intelligence can deepen scientific understanding by reinterpreting classroom demonstration experiments through data-driven modelling. Trained originally as a physics educator, I gradually shifted toward computer science, and this hybrid perspective highlighted a growing educational gap: many secondary-school and university students experience physics primarily as abstract formulas, while opportunities for hands-on experimentation are often limited. To test these assumptions, I conducted a survey with 144 participants. The results confirmed a strong demand for practice-oriented learning and for activities where theory is connected to real measurements and analysis.

To bridge physics and IT, I develop demonstrations that can be integrated into computer science lessons. Students collect data from physical processes, build models, validate predictions, and—crucially—use modern AI methods to infer the underlying physical relationships. This approach supports an “indirect proof” of natural laws: instead of starting from equations, learners begin with data and reconstruct the governing rules, experiencing scientific reasoning as discovery.

The first experiment focuses on thermodynamics using IoT sensors to measure indoor/outdoor temperature, air pressure, and background radiation. Because these signals are time-series, we apply an LSTM (Long Short-Term Memory) neural network to predict environmental changes. The model performs strongly and reveals how indoor temperature responds to external thermal effects. Beyond prediction, the results allow students to estimate quantities such as building heat capacity and to formulate simplified thermodynamic descriptions of the system.

The second demonstration examines kinematics through disc collisions recorded on video. Using shape and colour recognition, we extract trajectories and analyse them to investigate conservation of momentum and energy. We apply the SINDy algorithm (Sparse Identification of Nonlinear Dynamics, Steven Brunton), which identifies interpretable differential equations directly from measurement data. The reconstructed motion is highly realistic and provides compelling evidence for students that an AI-discovered equation of motion can match observed reality. A deliberately data-driven configuration is used to let the model independently “rediscover” the physics with minimal prior assumptions.

The third demonstration introduces the physics of music, an area often underrepresented in standard curricula despite its relevance in engineering (e.g., noise detection and predictive maintenance). Students record sounds digitally and use Python-based analysis to visualize Fourier spectra and Mel spectrograms, linking harmonics, decay, and signal profiles to physical interpretation and human perception.

Future work aims to make “invisible” phenomena tangible, including muon detection from cosmic rays (supporting relativistic concepts such as time dilation) and magnetic levitation, where AI-based control methods may provide robustness beyond classical PID control. To maximize accessibility, all tools and workflows are planned for distribution via containerization (e.g., Docker), enabling schools and individual learners to reproduce experiments and analyses with minimal setup.

Overall, this project demonstrates how AI-enhanced, measurement-based activities can reconnect students with natural laws. By moving from data to models—and from models to physical meaning—learners gain both deeper conceptual understanding and modern computational skills.

SESSIONS 3 – 4

EDUCATIONAL ASPECT FROM DIAGNOSTICS OF DRONES

Ákos Cservenák

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

akos.cservenak@uni-miskolc.hu

Abstract

Nowadays, everybody can hear about the different drone technologies, as they continuously appear in everyday life. It is enough to look at the internet to see how many possibilities are available with a drone. Social media platforms are full of spectacular aerial videos, breathtaking landscapes, and creative perspectives that were almost impossible to capture a few decades ago. The hobby use of aerial photography can be regarded as basic today, but this photographic feature can also be used for professional purposes, such as covering different festivals, weddings, sport events, construction sites, agricultural areas, and even supporting police and disaster management tasks.

Beyond photography and videography, drones are increasingly used in industry and research. They can assist in infrastructure inspection, for example, in examining bridges, power lines, wind turbines, or solar panels. In agriculture, drones help monitor crop health, irrigation efficiency, and pest infestation with the help of thermal and multispectral cameras. In logistics, several companies experiment with parcel delivery systems based on autonomous drones. These examples clearly show that drone technology is no longer just a hobbyist's playground, but an important and rapidly developing technological field with significant economic and social impact.

However, operating a drone is still not a toy-like activity. Even though many modern drones are equipped with intelligent stabilization systems, GPS positioning, obstacle avoidance sensors, and automated flight modes, the responsibility remains with the operator. Especially in the case of bigger drones, but also for smaller ones, several steps are necessary to operate them safely. Pre-flight checks must include battery status verification, propeller inspection, sensor calibration, and checking the surrounding airspace regulations. Weather conditions, such as wind speed, rain, and temperature, must also be taken into account. A small technical failure or a moment of inattention can lead to serious accidents, property damage, or personal injury.

Sometimes it occurs, especially with older drones, that testing and diagnostics are necessary to obtain information about malfunctions. These malfunctions can originate from various sources, including battery degradation, motor wear, electronic speed controller faults, sensor miscalibration, communication errors, or software-related problems. Without proper diagnostic tools and systematic analysis, identifying the root cause of a problem can be time-consuming and unreliable. Therefore, the development and application of structured diagnostic techniques are essential for increasing reliability and extending the lifetime of drone systems.

Educational purposes are also important in engineering education, and basic drone education should be extended with diagnostic viewpoints. Students often focus primarily on assembly, programming, and flight control, but they also need to understand failure mechanisms, maintenance procedures, and troubleshooting strategies. Integrating diagnostic measurements, data logging analysis, vibration monitoring, and fault simulation into the curriculum can significantly enhance practical knowledge. By analyzing real-life case studies and their own experiences, students can better understand the complex interaction between mechanical, electrical, and software components within a drone system.

The presentation introduces different diagnostic techniques for drones, presents personal experiences related to testing and fault detection, and evaluates their usability in education. The goal is not only to demonstrate technical solutions, but also to highlight the importance of a safety-conscious and analytical approach in drone operation and engineering training. Through combining theoretical background with practical examples, the presentation aims to contribute to the development of more reliable drone systems and more competent future engineers.

STUDENT EXPERIENCES WITH AI SUPPORT IN ENVIRONMENTAL MANAGEMENT COURSES

Baibhaw Kumar

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

baibhaw.kumar@uni-miskolc.hu

Abstract

Artificial intelligence is entering higher engineering education, including courses that prepare sustainability engineers to work with environmental management tools such as Life Cycle Assessment, Material Flow Analysis, Environmental Impact Assessment, and carbon accounting methods. These tools require students to handle complex datasets, design system boundaries, interpret multi-criteria indicators, and justify environmental trade-offs. Many students struggle with these steps because they involve large amounts of data handling and analytical judgment. In recent semesters, several courses in environmental management have started to integrate AI-supported guidance. In this study, a short survey captured student perceptions of this integration. The focus lies on how students experienced AI support during analytical tasks and how this shaped their learning process.

The study involved a group of master's-level engineering students enrolled in a course on environmental management for sustainability professionals. The course included practical assignments that required students to model product systems, interpret environmental indicators, and compare improvement scenarios. The survey was conducted immediately after students used AI in these assignments. The questionnaire included rating-scale items and open-ended reflection prompts. Responses covered ease of use, perceived effect on understanding, trust in the explanations, and personal preference for learning support.

The results present a pattern of cautious acceptance. Many students reported that AI support reduced the time spent searching for background data and standards. Students stated that the AI guidance helped them identify system boundaries and functional units more clearly. Several respondents described a stronger focus on interpreting environmental impact results instead of spending most of the time collecting and formatting input data. Students also noted that AI offered step-wise clarification during complex interpretation tasks, including allocation decisions and sensitivity checks. This indicates a shift in cognitive effort from mechanical tasks toward conceptual reasoning.

At the same time, some concerns surfaced. A portion of students questioned the reliability of AI explanations for advanced methodological issues such as allocation rules in multi-output processes or uncertainty treatment. They highlighted the importance of instructor oversight and verification against trusted references. A smaller group expressed concern about the risk of over-reliance on AI when facing open-ended analytical decisions. These responses indicate that while AI strengthens accessibility and clarity, it requires careful integration under clear academic expectations.

The survey results suggest several implications for pedagogy. First, AI works best as a structured guidance tool where the instructor sets boundaries for use and clarifies where human judgment holds priority. Second, instructors need to design assignments that require students to explain the reasoning behind each environmental decision step, including verification of AI-supported suggestions. Third, introducing AI does not reduce the instructor's role. Instead, the instructor shifts from demonstrating procedural steps to reinforcing conceptual interpretation, critical evaluation, and justification of analytical outcomes.

The findings support the integration of AI in environmental management pedagogy when the goal is to strengthen system thinking and interpretive skills. Students respond positively when AI decreases repetitive effort and increases focus on reasoning. At the same time, meaningful learning requires that students reflect on and verify AI-supported guidance. AI becomes a support structure for student engagement rather than a replacement for analytical judgment.

ATTRIBUTE-BASED TABU MEMORY FOR SCHEDULING PROBLEMS

Levente Fazekas, Károly Nehéz

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

levente.fazekas@uni-miskolc.hu

Abstract

Tabu search employs memory structures to prevent premature convergence and to better explore the search space. The design of the tabu list is often viewed as a technical detail rather than a crucial component. Classical tabu search stores entire solutions or moves explicitly. In the case of large, combinatorial problems, this approach proves slow and inefficient. Exact storage requires costly comparison operations, large storage requirements, and disregards similarities between solutions. The result is an algorithm that can still be limited, despite keeping track of solutions, since it may cycle between similar solutions despite being different at the representation level. This is usually due to solution encodings being simplified to aid search, instead of representations of full solutions — which are usually derived by a decoding scheme, often with semi-active scheduling.

Our paper proposes an alternative tabu list by utilizing attributes as well as full solutions while keeping memory usage to a minimum. These attributes are a generalization of each encoding without running a full simulation. This is enabled by the use of Bloom filters. Attribute-based Bloom filters are built from a list of attributes extracted from each solution. These attributes can be domain-driven. Problem-aware attributes include permutation fragments, assignment patterns, temporal relations, or aggregated features from processing times, setup times, due dates, start times, transfer times, etc. These attributes relate to decodings by identifying patterns not apparent in permutations themselves. Each attribute is mapped onto its own Bloom filter, forming a series of compact multi-filters with constant-time membership queries and strictly bounded memory usage.

This attribute-based approach shifts the role of tabu memory from exact, syntax-based repetition avoidance to a more general, semantic similarity. By marking attributes alongside complete solutions, the search is discouraged from exploring similar structural regions, even when their representations differ syntactically.

However, this level of generalization remains adjustable through hashing policies and attribute selection. A practical advantage is a broader range of filtered solutions that likely provide similar results, reducing the number of costly simulation and evaluation calls — and the ability to merge multiple, concurrently produced tabu lists efficiently. These abilities enable us to utilize tabu search in multi-threaded and population-based search algorithms as local search without expensive synchronization operations.

The method is evaluated on permutation-based scheduling problems with complex constraints and simulation-driven objective functions. The results indicate that Attribute-based Bloom filters provide more stable search and improved diversification — compared to classical tabu lists or simple genetic algorithms — while incurring negligible computational overhead. These findings suggest that treating tabu memory as an attribute-level component — rather than just a solution-level cache — can offer practical benefits in modern, large-scale optimization settings.

THE ANSWER IS CONTAINED IN THE QUESTION: SHIFTING ENGINEERING EDUCATION FROM SOLUTION-FINDING TO PROBLEM-FORMULATION

Attila Aradi, Attila Károly Varga

University of Miskolc
3515 Miskolc-Egyetemváros, Hungary
aradi.attila@gmail.com

Abstract

The traditional "calculator analogy"—suggesting AI is merely a faster way to compute—is now dangerously insufficient. Generative AI and advanced machine learning models demonstrate the capacity to write code, optimize complex topologies, and synthesize design constraints with a speed and accuracy that rivals human capability. Consequently, engineering education faces an existential pivot: we must transition from teaching students how to solve problems to teaching them how to orchestrate the solution of problems through intelligent agents.

This presentation addresses the core question: What shall we do with AI in Engineering Education? It argues that the response must go beyond simply adding "AI Ethics" or "Prompt Engineering" as elective modules. Instead, it proposes a fundamental restructuring of the engineering pedagogy based on three pillars: Cognitive Offloading, Verification Literacy, and Human-Centric Systems Thinking.

First, we examine Cognitive Offloading. If AI can handle syntax, calculation, and routine derivation, engineering education must abandon the "boot camp" mentality of rote memorization. The curriculum must shift focus toward "Problem Formulation." In an era where answers are cheap, the value of an engineer lies in asking the right questions. This presentation outlines a pedagogical framework where students are assessed not on their ability to manually derive a solution, but on their ability to decompose complex, ambiguous real-world problems into architectures that AI can process.

Second, we introduce the concept of Verification Literacy. As reliance on black-box algorithms increases, the primary technical skill of the 2026 engineer must be scepticism. We discuss methodologies for teaching "adversarial engineering"—training students to audit, stress-test, and debug AI-generated outputs. The engineer of the future is not just a creator, but a sophisticated editor and validator. We will present case studies of "flipped assessment" models, where students are graded on their ability to identify flaws in AI-generated engineering blueprints.

Third, we explore Human-Centric Systems Thinking. As technical barriers lower, the engineer's role expands into social, ethical, and environmental domains. We argue that AI allows us to re-humanize engineering education. With the technical drudgery automated, the curriculum can finally prioritize empathy, interdisciplinary communication, and ethical foresight. We propose a "Human-in-the-Loop" educational model where AI serves as a personalized Socratic tutor, freeing faculty to mentor students in high-level critical thinking and professional judgement.

Finally, the presentation confronts the digital divide. We will discuss the infrastructure required to ensure that AI-augmented education is accessible globally, preventing a tiered system where only resource-rich institutions produce "super-engineers."

We stand at a crossroads. We can continue to train students for a world that no longer exists, competing futilely against algorithms, or we can embrace a symbiotic future. This presentation offers a roadmap for the latter, defining the "AI-Augmented Engineer" not as a user of tools, but as an architect of intelligence.

ADAPTIVE ENGINEERING EDUCATION THROUGH THE GRAPH4LEARN INTELLIGENT TUTORING SYSTEM

László Csépanyi-Fürjes

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

laszlo.csepanyi-furjes@uni-miskolc.hu

Abstract

Engineering education is currently undergoing a transformation driven by two converging forces: the rapid evolution of domain knowledge and the disruptive impact of Generative AI on learning practices. These changes place unprecedented demands on Learning Management Systems (LMS), which must increasingly support adaptive, data-driven, and personalized learning experiences. However, widely used commercial LMS platforms, such as Moodle, eLearning suites, or CourseGarden still offer only limited personalization capabilities and provide restricted access to fine-grained learner activity tracking data. This lack of transparency hinders both instructional innovation and research efforts aimed at advancing educational technologies.

To address these limitations, the Graph4Learn (G4L) Intelligent Tutoring System was developed. The system is built upon the Evolving Knowledge Space Graph (EKSG) model, a structured graph-based knowledge representation designed to support rapid curriculum evolution, personalized learning path generation, and knowledge state prediction. The G4L framework also incorporates mechanisms for handling the forgetting phenomenon, thereby enabling more accurate and realistic modelling of knowledge retention over time. In addition, G4L provides detailed learner activity logs, making it possible to implement and evaluate a wide range of knowledge tracing algorithms for research and instructional development purposes.

In this presentation, I introduce the core components of the Graph4Learn framework and demonstrate its functionality through a case study conducted with 45 university students enrolled in a Databases course. The G4L system is implemented as a Python-based web application, employing a RESTful peer-to-peer architecture to facilitate communication among its distributed components. This architectural choice significantly improves scalability and modularity, which are critical for effective adaptation to rapidly evolving technological landscapes. The EKSG model is realized within a Neo4j graph database, primarily selected for its inherent capability to efficiently represent and query the intricate relationships between knowledge concepts using Cypher queries. This graph-native approach offers a distinct advantage in managing the complex characteristic of a dynamic knowledge domain. The learner profiles and activity logs are systematically stored in a MySQL relational database, providing robust and efficient management of structured individual progress data. The specific learning content, tightly linked to the EKSG model, is presented in concise two-page PDF documents, optimizing accessibility and focus. Furthermore, quizzes are stored in YAML files, which ensures ease of authoring and readability for domain experts and instructors, thereby facilitating agile content updates essential in such dynamic fields.

During the study, students used the G4L system to learn a selected topic, navigating through graph-structured learning materials and receiving personalized recommendations based on their dynamically inferred knowledge state. The results indicate that students responded positively to the system, reporting improved clarity in understanding the structural relationships within the domain. Moreover, the collected data reveal that graph-based knowledge representations can significantly support learners in visualizing prerequisite relations, identifying appropriate next learning steps, and self-regulating their study process.

Overall, the Graph4Learn framework demonstrates how intelligent tutoring principles, combined with flexible graph-based models, can provide an effective response to the emerging challenges of engineering education. The system not only enhances the learning experience but also offers a robust platform for future educational research in adaptive learning, learner modelling, and AI-supported instruction.

CHALLENGES IN OPENSET LEARNING OF NEURAL NETWORKS

László Kovács, Péter Bán

University of Miskolc
3515 Miskolc-Egyetemváros, Hungary
laszlo.kovacs@uni-miskolc.hu

Abstract

In the case of classification problems, the neurons of the output layer correspond to the different categories in the dataset and the neuron with the largest output value determines the winner category. For example, in the case of image classification, the set of image categories are fixed and the training set should cover all categories in a uniform way. The problem of unbalanced class distribution is a widely investigated issue as it can cause efficiency degeneration due to difficulty in the learning of decision boundaries or to misleading performance metrics.

In some situations, the test set may contain cases which do not belong to any of the categories presented in the training set. The test dataset may contain instances of previously unseen classes. This problem situation is called an openset learning problem, where the key challenge here is to detect these unseen cases, the neural network should recognize that the input significantly differs from any trained categories.

In the literature, we can find several approaches to cope with this kind of problem domain. The most widely used method is based on Threshold-based category acceptance. Using the softmax activation function, the output values represent the probability distribution over the different classes. If the maximum output value is below a certain threshold (no clear winner category), the test image is assigned as an outlier. The most widely used approach for the openset problem is the OpenMax method introduced in 2016. The method is a special variant of the threshold approach applying a Weibull distribution to involve the probability of an “unknown” class. Another baseline method is the distance-based approach where the method is based on the concept of locality. If the new item is far from any training items, the tested item can be considered an outlier, unknown class. A different way is the development of a MLP neural network for similarity regression, where the similarity shows the distance of the test image to the trained categories. We tested also the Isolation forest, a special variant of the random forest architecture, where the main goal is to locate outlier nodes in an efficient way. The method will partition the item into disjoint leaf nodes. If the size of the container nodes is below a threshold, the element is considered as an outlier.

The presentation summarizes our experiences in the efficiency comparison of the main outlier class detection methods. For the tests, we applied different datasets including synthetic tabular data and benchmark image datasets. CIFAR-10 benchmark dataset. The test system was implemented in Python Keras-Tensorflow framework using the Colab development environment.

Based on the test results, we can summarize our experiences in the following points:

- The threshold-based category acceptance methods including OpenMaX provided weak results.
- MLP neural network for similarity regression approach had only a slightly better efficiency.
- The target space transformation methodology is the most promising way in handling the openset learning cases.

We can conclude from the test results that the main shortcoming of the distance-based approaches working in the output layer is distortion of the object space. The neural network shrinks and distorts the initial input space. The parts of the input space where there are no training points will shrink, so that the existing larger distances disappear in the output space.

Based on these experiences, we have developed a novel approach which introduces a special category for the unknown cases and it applies a general background white-noise dataset to fill in the object space with elements considered as unknown cases. The performed tests. The tests performed have proven that the proposed method can provide significantly better results than traditional tools.

THE ROLE OF ARTIFICIAL INTELLIGENCE IN MEDICAL IMAGING AND DIAGNOSTICS – A RADIOGRAPHER’S PERSPECTIVE

Anett Szalkó, Balázs Gadóczy, Andrea Lakatos, Attila Károly Varga

University of Miskolc
3515 Miskolc-Egyetemváros, Hungary
szalkoanett06@gmail.com

Abstract

Artificial intelligence (AI) has become an integral part of everyday life in recent years, with particularly significant impact on healthcare and medical imaging diagnostics. Among imaging modalities, Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) play a fundamental role in clinical practice. Due to their different physical principles and technical characteristics, these modalities offer distinct advantages and limitations too. The integration of AI-based algorithms into diagnostic imaging supports radiographers by enabling standardized, reproducible, and more efficient workflows, while simultaneously improving image quality and patient safety.

MRI is a multiplanar and multiparametric imaging modality with expanding diagnostic capabilities due to technological advancements. Consequently, not only examination protocols but also ongoing technological developments of MRI systems are of great importance. One of the main challenges of MRI is the relatively long examination time, which typically ranges from 20 to 60 minutes depending on the examined region and the applied protocol. A key innovation in this field is deep learning-based image reconstruction, which enables faster data acquisition while improving signal-to-noise ratio and spatial resolution. It's offer new opportunities to reduce scan times without compromising diagnostic image quality, resulting in improved patient comfort. AI-driven tools such as automated anatomical region selection, automatic slice positioning, and protocol optimization significantly accelerate examination preparation and simplify daily clinical routine. These technologies reduce the occurrence of operator-related errors. Moreover, AI-Rad Companion is fully integrated into the image interpretation workflow, supporting radiologists through automated measurements and structured DICOM reporting. It enhances productivity by streamlining reading and reporting processes while maintaining full workflow control for evidence-based decision-making.

CT is one of the most widely used medical imaging modalities. It is a radiation-based technique that produces cross-sectional images of the body. One of the primary goals in CT imaging is radiation dose reduction while maintaining high diagnostic quality. Advanced AI-supported iterative reconstruction algorithms effectively reduce image noise and improve soft tissue contrast, which is particularly valuable in low-dose examinations. In addition, automatic dose optimization systems adjust scanning parameters based on patient size and the examined anatomical region, thereby enhancing patient safety and ensuring consistent image quality

In summary, the combination of advanced hardware developments and AI-based software solutions in both MRI and CT has led to faster, more efficient, and safer imaging examinations. Deep learning algorithms contribute to improved image quality, optimized workflows, and reduced examination times, ultimately supporting the work of radiographers and radiologists while improving overall patient care.

VISUAL ENTERPRISE MANAGEMENT: STRENGTHENING C-LEVEL UNDERSTANDING VIA SPATIAL AND NARRATIVE DATA EXPERIENCES

Péter Sághegyi

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

peter.saghegyi@gmail.com

Abstract

Modern enterprises generate unprecedented volumes of operational data, yet senior-level decision-makers are faced with lengthy documents and boring reports when it comes to utilising that very data. Static media are ineffective at communicating live, interconnected data, especially to people with limited time and attention. Current enterprise platforms and dashboards are designed for analytical precision rather than cognitive clarity, resulting in information overload and fragmented understanding at the management level. C-level leaders and their teams often lack the cognitive tools to perceive, interpret, and communicate complex dependencies across their organisations. If they don't see and are not able to communicate their system holistically, they can't be in the position to make optimal decisions.

Although hyperbolic statements seem to dominate the internet about the importance of visual communication, which are mostly marketing tricks serving company interests, we also know from research that the human brain is first and foremost a visual machine [1]. Certain industries not only know this very well but utilise this fact to our detriment. It is puzzling to see how effectively the marketing industry applies these instruments to influence our consumer decision-making, yet we don't use the same possibilities when it comes to handling complex systems or solving wicked problems in our world. This lack of implementing state-of-the-art solutions hinders the possibility to produce less waste, save time and cost, and move towards a more sustainable, circular economy.

My approach introduces the concept of Visual Enterprise Management (VEM), a real-time, interactive visualisation environment that transforms complex corporate data into intuitive, spatial, and narrative forms. The main characteristics of this approach are; the focus on visuals to attract attention, interactivity to control information load, and the accessibility of the system for non-technical personnel. The majority of data exploration tools are designed with technically oriented people in mind. However, the personal traits that help individuals obtain a C-level leadership position are not naturally linked to the enjoyment of handling numerical data.

Grounded in human visual thinking theory and cognitive design principles, VEM explores how interactive 3D visualisation and natural language control can enhance executive attention, information retention, and situational awareness in mid-to-large enterprises. Apart from attractive visuals that grab attention, interactivity plays another crucial role in learning and memory. Merkt et al. (2011) and Rop et al. (2018) confirmed that the effectiveness of interactive videos, where the user can self-regulate the pace of information delivery, was significantly higher compared to passive video watching [2], [3]. We also know from studies that visual communication has a significant impact on information retention and recall [4]. In my case, the possibility to naturally explore diverse aspects of the visually represented data and their connections would result in a holistic cognitive understanding of a large firm as a whole.

Since I'm at the very beginning of my research, in my talk I would present the generic idea of VEM, demonstrate how it is connected to video game development and AI, and show an example of how I think it could work in a real-life scenario.

- [1] Felleman D. J., Van Essen D. C. (1991). Distributed hierarchical processing in the primate cerebral cortex, *Cerebral Cortex*, 1(1), pp. 1–47.
- [2] Merkt M., Weigand S. Heier A., Schwan S. (2011). Learning with videos vs. learning with print: The role of interactive features, *Learning and Instruction* Vol. 21, pp. 687–704.
- [3] Rop G., Schöler A., Verkoeijen P., et al. (2018). The effect of layout and pacing on learning from diagrams with unnecessary text, *Appl. Cogn. Psychol.*, Vol. 32., DOI:10.1002/acp.3445
- [4] Vanichvasin P. (2020). Effects of Visual Communication on Memory Enhancement of Thai Undergraduate Students, *Higher Education Studies*, Vol. 11., DOI:10.5539/hes.v11n1p34.

FINE-TUNING DISTILBERT: A PRE-TRAINED TRANSFORMER MODEL FOR SOFTWARE DEFECT PREDICTION

Nasraldeen Alnor Adam Khleel, Károly Nehéz

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

nasr.alnor@uni-miskolc.hu

Abstract

Software Defect Prediction (SDP) is a critical and highly valuable task in the field of software engineering, aimed at identifying potential defects in software systems at an early stage of development. Early detection of defects not only significantly improves the overall quality and reliability of software but also reduces the cost and time associated with post-release maintenance and bug fixing. Traditionally, SDP approaches have relied on machine learning and deep learning models that use manually engineered software metrics, such as code complexity, churn, and historical defect data. While these features provide useful information, they often fail to capture the rich semantic, syntactic, and contextual characteristics present in source code. As a result, these models can struggle to generalize effectively across diverse codebases or detect subtle defect patterns embedded within complex software structures.

In recent years, significant progress in Natural Language Processing (NLP) has opened new avenues for software analysis. Pre-trained transformer models, such as BERT and its variants, have demonstrated remarkable ability in learning contextual and semantic representations from sequential data. These models can capture long-range dependencies, subtle patterns, and the structural relationships between elements in a sequence, making them particularly suitable for tasks that involve understanding source code. Source code, although distinct from natural language, shares several properties, including sequential structure, hierarchical organization, and the presence of meaningful tokens and identifiers. Leveraging these similarities, transformer-based models can be adapted to software-related tasks such as code summarization, code completion, and defect prediction.

In this work, we propose a novel approach for software defect prediction that leverages the supervised fine-tuning of DistilBERT, a lightweight and efficient variant of BERT. DistilBERT is designed to retain much of the language understanding capabilities of BERT while significantly reducing computational overhead, making it a practical choice for large-scale or resource-constrained applications. Our method involves representing source code as sequences of tokens that are input to the DistilBERT model, which is then fine-tuned on labeled defect datasets to predict whether a given code segment is defective or not. By using DistilBERT, our approach combines the benefits of deep contextualized embeddings with the efficiency required for real-world software engineering tasks.

We evaluate our proposed model on the Devign dataset, a widely used benchmark for SDP provided by the CodeXGLUE framework. Performance metrics including accuracy, precision, recall, and F1-score are used to assess the effectiveness of our approach. The experimental results indicate that DistilBERT-based defect prediction achieves competitive performance relative to existing baseline models and state-of-the-art methods while requiring significantly fewer computational resources. Furthermore, the results suggest that transformer-based models can effectively capture the semantic and contextual cues that are often missed by traditional code metrics, leading to improved detection of subtle and complex defects. Overall, our study highlights the potential of compact transformer models such as DistilBERT as practical, efficient, and effective tools for software defect prediction. The findings provide strong evidence that pre-trained language models, when properly fine-tuned on code data, can serve as powerful alternatives to conventional machine learning methods, bridging the gap between NLP advancements and software engineering applications. This work lays the foundation for further research into applying lightweight transformer architectures to other software analytics tasks, offering a promising direction for enhancing software quality and reliability in modern software development pipelines.

COMMUNICATION ATTITUDES OF FIRST-YEAR ENGINEERING STUDENTS: INSIGHTS AND IMPLICATIONS

Krisztina Csiba, Imre Kocsis

University of Debrecen
4028 Debrecen, Ótemető street 2-4, Hungary
csiba.krisztina@eng.unideb.hu

Abstract

The complexity of engineering work and responsibility requires multifaceted preparation. Within this, communication skills play a prominent role, which, on the one hand, determines the efficiency of information transfer in dealing with complex systems, and, on the other hand, the success of dialogue with society and the representation of professional values and interests.

Recently, new problems have appeared and require answers, also in engineering education. Algorithms (software) are increasingly present in engineering work as "colleagues" rather than as tools. This results in the expansion of the space of communication processes, with H2M and M2M channels assuming an increasingly significant role in information transfer, in addition to the previously dominant H2H space. Several questions can be raised in this regard, e.g. how H2H communication changes when the parties involved work (individually or in a team) with an AI employee. Previously, in a typical professional communication situation, the information had to be transferred about what each actor did within a project, they could detail their own work as needed now, what they did together with the AI employee has to be transferred since the details of the AI employee's activities are hidden.

In the literature on the content and methodological issues of engineering education, texts on the necessity of interdisciplinarity and multidisciplinary occupy a decisive place, in which soft skills, including communication skills, play a prominent role.

The transdisciplinary education concept, which goes beyond interdisciplinarity and multidisciplinary, is based on the active exchange of ideas among stakeholders, presenting real problem areas and decision-making situations in learning contexts.

A prerequisite for organizing transdisciplinary education, which also involves the latest digital technology, including generative AI, is that students have basic communication skills that they use consciously. To be prepared to support first-year students in being successful in it, it is necessary to examine their existing abilities, the extent to which they are aware of the expectations and challenges, and the extent to which they meet them.

The method of the investigation can be a questionnaire survey, an interview, or the creation of situations in which students must use their communication skills actively. In this talk, we present the results of a survey, during which we wanted to clarify the following: (i) whether students are aware of the requirements related to their future engineering work, (ii) whether they are aware of the extent to which they meet these, (iii) how they can mentally process their deficiencies, whether they have an idea of how these can be filled with help or self-training, (iv) how they judge the impact of the virtual environment surrounding them and the dominance of communication based on significantly simplified short text messages, (v) what impact generative AI has on their interpersonal and professional communication.

SESSIONS 5 – 6

A CASE STUDY ON AI USAGE AMONG PARTICIPANTS IN HIGHER ENGINEERING EDUCATION

Adrienn Vámosiné Varga, Boglárka Burján-Mosoni, Imre Kocsis

University of Debrecen
4028 Debrecen, Ótemető street 2-4, Hungary
vargaa@eng.unideb.hu

Abstract

In recent years, numerous studies have shown that the spread of generative Artificial Intelligence (GenAI) is forcing a reform of pedagogical practice in higher education. GenAI can provide administrative support and create new opportunities for developing creativity, critical thinking, and autonomous learning [1]. One of the greatest challenges is the lack of AI literacy among students and instructors [2]. Research conducted in Hungary indicates that local educators mainly use artificial intelligence for routine tasks—such as text translation, information retrieval, and grammar checking—while deeper pedagogical opportunities, such as creating personalized learning materials, remain in the background [3]. In addition to technical and educational challenges, the use of GenAI also raises significant ethical issues. Many instructors are likely already actively using or allowing the use of ChatGPT, while formal guidelines are incomplete or outdated [4]. For instructors, students, and AI to be able to work together effectively, familiarity with AI tools and their conscious use are required, along with up-to-date institutional-level regulation of their use and, last but not least, a willingness to experiment. We sought to explore the attitudes and habits related to AI use among Hungarian and international students and instructors at the Faculty of Engineering of the University of Debrecen, with the aim of integrating AI into education as effectively as possible in the future. For this purpose, separate online anonymous questionnaires were administered to students and instructors. Respondents evaluated the statements using a five-point Likert scale. We received an overview of which AI tools our institution's students and instructors mainly use, and for what purposes, in the course of their work. Among other things, we also get answers to the following questions. Is there any difference between the AI usage habits of our Hungarian and international students? Is there a difference between younger and older instructors in terms of how they use AI in teaching? Do students or instructors have greater distrust regarding the use of AI?

- [1] Qian, Y. Pedagogical Applications of Generative AI in Higher Education: A Systematic Review of the Field. *TechTrends* 69, 1105–1120 (2025). <https://doi.org/10.1007/s11528-025-01100-1>
- [2] Mah, DK., Groß, N. Artificial intelligence in higher education: exploring faculty use, self-efficacy, distinct profiles, and professional development needs. *Int J Educ Technol High Educ* 21, 58 (2024). <https://doi.org/10.1186/s41239-024-00490-1>
- [3] T. Nagy, J., Rajki, Z., & Dringó-Horváth, I. (2025). Mesterséges intelligencia a felsőoktatásban: – oktatói hozzájárás, attitűd és felhasználási gyakorlat. *Iskolakultúra*, 35(7), 3–20. <https://doi.org/10.14232/iskkult.2025.7.3>
- [4] Krause, S., Panchal, B.H. & Ubhe, N. Evolution of Learning: Assessing the Transformative Impact of Generative AI on Higher Education. *Front. Digit. Educ.* 2, 21 (2025). <https://doi.org/10.1007/s44366-025-0058-7>

MISSION: POSSIBLE REFLECTION OF HIGHER EDUCATION FOR NAT2020

Géza Csima, Brigitta Szilágyi

Budapest University of Technology and Economics

1111 Budapest, Műegyetem rkp. 3, Hungary

csimageza@gmail.com

Abstract

As a result of the new National Core Curriculum (NAT) that came into effect in 2020, a significant difference emerged in the secondary and advanced mathematics curriculum. In 2024, students who had already studied according to the new NAT during their high school years entered higher education. This resulted in a significant change in the knowledge level of incoming students. To effectively manage the new situation, we introduced differentiated education in 2024 at the BME Institute of Mathematics: Students who had a stable knowledge of the previous secondary curriculum began their studies at level A, while for those who did not, we recommended completing the first-semester calculus at level B. Level B supplemented the missing knowledge and strengthened calculation skills, while the student also mastered the material of university calculus.

To decide at what level we recommend that students start their calculus studies, we developed an adaptive input test, which was administered during the registration week preceding the fall semester and the first week of classes. From 2025, the mathematics test was supplemented with a reading comprehension task and, in some faculties, an adaptive physics input test.

The input tests not only helped us decide what level of course to recommend to our students, but their results provided a detailed picture of the input parameters and enabled the creation of a predictive model. In the first phase of the tests, we mapped knowledge of basic concepts and numeracy skills. This allowed us to obtain information from a sample of a few thousand in 2024 and 2025 on how stable the knowledge of the 9th-10th grade curriculum is furthermore, it was possible to compare the results of the two measurements. We found that the shortcomings in the early years curriculum significantly hinder students' progress in their studies, and parallel catch-up is time-consuming, thus burdensome and further complicates the progress of students who are already struggling.

In order to solve the early replenishment of missing knowledge and to help the transition from high school to university, in 2025, we launched mathematics and physics courses for students in grades 11-13 under the name MIssion Possible. Our idea is that this type of education will help students arrive at university with the knowledge necessary to complete their university studies. The course will be implemented in part-time study, over 18 weeks, in 4*45-minute weekly, with both face-to-face and online classes. By November 2025, nearly 150 high school students joined our program.

When designing the courses, we took into account the results of modern learning theory research: both recall learning and gamification are essential elements of our program. To address significantly different knowledge levels, we developed different levels of learning materials with the support of artificial intelligence. Customizing our adaptive input test, already proven at the university and used for differentiation, seems promising for establishing levels.

In our presentation, we will present the input test, its structure, and, based on the results obtained, why we consider it particularly important to acquire the knowledge, necessary to begin university studies, during high school.

We examine how strong the result of the input test was as a predictor of the success of university studies, we compare the results of the past two years, we present modern data analysis methods that can facilitate data-based decision-making. We talk about the MIssion Possible program, the development of the related curriculum system, and future plans.

TUNGSRAM MOON RADAR: ADVANCED EDUCATIONAL TOPICS; HUNGARIAN ACADEMY OF SCIENCE-200 THAT BUILDS BRIDGES BETWEEN NATIONS

István Balajti

Ludovika University of Public Service Doctoral School of Military Engineering
1083 Budapest, Ludovika square 2, Hungary
balajti.istvan@uni-nke.hu

Abstract

The task of engineering education today is the same as it was 80 years ago: to prepare students to meet the high competency requirements of competitive industrial companies in the labour market worldwide. During and after World War II (WWII), scientific and industrial activities focused on atomic and radar technologies presented a serious engineering challenge. In recent days, the development of Cyber-Physical Systems (CPS) applications has given the most exciting engineering systems design opportunities that tightly integrate physical processes with artificial intelligence (AI) supported computational algorithms, networked sensors, and synchronously operating actuators. They leverage sophisticated algorithms and real-time data analysis to monitor and control physical processes, creating a seamless interaction between the digital and physical worlds. Given the success of state-of-the-art engineering R&D in the XXI century requires understanding paradigm-driven disciplines, such as AI-supported solutions, the exploitation of synthetic systems knowledge, and the synergy among different engineering activities carried out with motivated domestic and international students of technical courses.

The Axiom Space 21-day space flight of Shubhanshu Shukla, Peggy Whitson, Sławosz Uznański-Wiśniewski, and Tibor Kupa, Hungary's second astronaut, has attracted considerable public interest, drawing attention to the importance of engineering innovation and education related to space, the Moon and beyond. The synergy indicated in the title focuses on engineering and scientific endeavours CPS related to space exploration, particularly the Moon, where the related R&D&I industrial and university activities have decisive importance in today's world. Furthermore, the presentation draws attention to fundamental engineering educational tasks that reduce losses, reflections, and distortions in the applications of various radars, 3D sensors, and microwave equipment of CPSs. Draws attention to the most accurate measurement methods known are based on the principles of interferometry, microwave holography, and polarimetry, which are connected to Moon radar measurements conducted 80 years ago. Therefore, they deserve special attention in electrical engineering and mechatronics hard skills education.

Using today's terminology, Hungarian education combines centrally required and pragmatically feasible challenge-based training methods. Within this context, the influence of the unique Hungarian language environment on engineering thinking, which differs from all other European languages, is also important at the international level. The Hungarian linguistic environment builds "top-down," in contrast to, for example, Italian and French, and, due to its comprehensive nature, it has characteristics that stimulate technical thinking.

Kunó Klebelsberg had a fundamental impact on the standard of engineering education in Hungary when he issued a highly advanced education requirement such as in the 1920s. His vision extended beyond the elite, aiming to educate the entire population and develop the education system to ensure the survival and growth of the Hungarian nation. During this period, teaching differential and integral calculus became a standard mathematical requirement even in secondary schools.

Thanks to these factors, the Hungarian electronics industry was among the world's leaders between the two world wars and engineers, scientists trained in Hungarian education became worldwide known, such as nuclear energy physicist Leo Szilárd and Edward Teller and see Figure 2 for radar technology relations. Although the use of nuclear energy also requires a great deal of engineering knowledge related to electromagnetism, sensor technologies, the study focuses on activities related to lunar radar measurements and CPS application-related connections.

INTEGRATION AND OPTIMIZATION OF A 3D SCANNING–BASED WOUND COVERAGE SYSTEM WITH AI-DRIVEN BOUNDARY DETECTION

Szabina Molnár-Zékány

University of Miskolc
3515 Miskolc-Egyetemváros, Hungary
sz.zekany@gmail.com

Abstract

Accurate characterization of the geometric and surface properties of pressure ulcers is important for supporting therapeutic decisions and wound coverage planning. Three-dimensional scanning technologies provide new possibilities for capturing wound geometry in a digital form and enable more detailed spatial analysis than traditional two-dimensional approaches. Despite these advances, practical application remains challenging, particularly with respect to system integration, usability, and long-term extensibility of the complete processing pipeline in real-world environments. An essential aspect of the present work is the incorporation of artificial intelligence methods into the wound analysis workflow, with a particular focus on the automatic detection of wound boundaries. This AI-based contour identification component is currently under active development and represents a key functional element of the processing pipeline, as accurate and consistent wound segmentation is fundamental for downstream geometric evaluation and coverage planning. Beyond its role in boundary detection, the integration strategy is designed to ensure that AI techniques can be extended to additional stages of the system in the future, enabling more advanced automation and improved clinical decision support. This study presents the integration and optimization of the system, building on processing components developed in earlier stages of the research. The processing pipeline integrates steps from 3D data capture to wound coverage planning. In its current state, the system combines steps requiring manual user interaction with automated algorithmic procedures. This hybrid approach reflects current practical constraints while allowing targeted automation where reliable solutions are available—including the incremental incorporation of AI-supported modules such as wound boundary detection. A key objective of the present work is to integrate these components into a unified system and to optimize individual processing steps in order to improve transparency, efficiency, and robustness across the pipeline. A modular system architecture forms a central design principle of the proposed approach. Individual functional units are implemented as separate modules that can be developed, tested, and refined independently. This structure allows modules to be replaced or extended without affecting the entire system and supports flexibility in adapting to different hardware configurations or algorithmic strategies, including the future addition of AI-enhanced processing stages. Scanning, processing, analysis, and visualization components can therefore evolve separately while maintaining consistent data flow and stable system behaviour over time. Compared to the initial wound coverage baseline version, further developments are introduced across multiple stages of the processing pipeline. These include the consolidation of selected functional units, incremental increases in automation—including the introduction of machine-learning-based wound boundary detection—and targeted improvements to the user interface. The graphical user interface is designed to support both clinical and engineering users by providing an interpretable and structured interaction environment, while manual control is preserved at stages where full automation is not yet feasible or clinically justified. The operating principles and application-specific characteristics of the algorithms used in the processing steps are presented with an emphasis on clarity and accessibility. Algorithmic concepts are described at a level that supports understanding of their role within the system, without relying on extensive implementation detail or complex mathematical formulations. Relevant recent literature is reviewed, and potential directions for future development are discussed, with particular attention to expanding AI integration, increasing automation, and enhancing clinical applicability.

INTEGRATING ARTIFICIAL INTELLIGENCE INTO ENGINEERING DESIGN AND OPERATION OF LINEAR FRESNEL CSP SYSTEMS

Salman Brbhan

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

salman.brubhan@uni-miskolc.hu

Abstract

The increasing complexity of modern energy systems has intensified the need for advanced engineering tools capable of handling multi-physics interactions, large design spaces, and high computational costs. Artificial Intelligence (AI) has emerged as a powerful enabler for engineering problem solving by augmenting traditional physics-based models with data-driven intelligence. This study explores the integration of AI tools into the analysis and optimization of concentrating solar power (CSP) systems, with particular focus on linear Fresnel reflector (LFR) technology and advanced receiver designs.

Linear Fresnel systems offer a cost-effective and structurally simple alternative to parabolic trough collectors; however, their performance is strongly influenced by non-uniform solar flux distribution, optical losses, and complex heat transfer mechanisms within the receiver cavity. Conventional optical ray-tracing, computational fluid dynamics (CFD), and experimental approaches provide high-fidelity results but remain computationally intensive, especially when evaluating multiple geometries, operating conditions, and geographical locations.

In this context, AI-based methodologies are introduced as complementary tools to accelerate design exploration and enhance system understanding. Machine learning surrogate models can be trained using data generated from optical simulations to rapidly predict optical efficiency and circumferential heat-flux distribution for different absorber configurations, such as asymmetric tubes and concave-wall designs. These models enable fast evaluation of receiver performance under varying solar positions and climatic conditions, significantly reducing reliance on repeated ray-tracing simulations.

Furthermore, AI techniques can be integrated with CFD-based thermal analysis to predict temperature fields, airflow patterns inside the receiver cavity, and global heat losses. By learning the nonlinear relationships between geometry, heat flux, and thermal behaviour, data-driven models can approximate complex heat transfer phenomena with reduced computational cost while maintaining acceptable accuracy. When combined with experimental measurements, AI also supports model calibration, uncertainty reduction, and real-time performance monitoring.

The proposed AI-assisted framework demonstrates how data-driven tools can support multi-objective optimization of LFR receivers by simultaneously improving flux uniformity, thermal stability, and overall efficiency. The results highlight the potential of AI to function as a digital engineering assistant, enabling faster design iterations, improved decision-making, and enhanced performance of concentrating solar systems. This work illustrates how the integration of AI tools with established engineering methods can address critical challenges in renewable energy system design and contribute to the development of next-generation CSP technologies. The integration of AI with established engineering principles represents a critical step toward smarter, more resilient, and economically competitive solar thermal power plants.

STATE-OF-THE-ART MULTI-MODAL DEEP LEARNING APPROACHES FOR BREAST CANCER PREDICTION: A LITERATURE REVIEW

Rama Khazna

University of Miskolc

3515 Miskolc-Egyetemváros, Hungary

ramakhazna3@gmail.com

Abstract

Keywords: Deep learning, multi-modal artificial intelligence, breast cancer prediction, medical imaging, artificial intelligence, literature review.

Breast cancer remains one of the most prevalent and life-threatening diseases worldwide, representing a major challenge for healthcare systems and a leading cause of cancer-related mortality among women. Early and accurate prediction is essential for improving patient outcomes, enabling timely treatment, and reducing mortality rates. However, conventional diagnostic approaches rely heavily on manual interpretation of medical data, particularly imaging examinations, which may be subjective and limited in capturing the complex, heterogeneous, and multi-factorial nature of breast cancer. These limitations have motivated the increasing adoption of artificial intelligence-based solutions in medical diagnostics. In recent years, deep learning has emerged as a powerful and effective approach for breast cancer prediction, offering automated, data-driven analysis of large and complex datasets. This paper presents a state-of-the-art literature review of multi-modal deep learning approaches for breast cancer prediction, focusing on methods that jointly exploit information from multiple data sources to enhance predictive performance and robustness. The reviewed studies integrate diverse data modalities, including medical imaging techniques such as mammography, ultrasound, histopathology, and magnetic resonance imaging, as well as complementary clinical and genetic information. By combining these heterogeneous data sources, multi-modal deep learning frameworks aim to provide a more comprehensive representation of the disease compared to single-modality approaches.

The review analyses recent methodological trends in multi-modal learning, including data fusion strategies, feature-level and decision-level integration, and commonly adopted training and evaluation practices. Reported performance improvements are discussed using standard evaluation metrics such as accuracy, precision, recall, and F1-score, highlighting the potential advantages of multi-modal approaches in improving diagnostic reliability. In addition, the review identifies key challenges reported in the literature, including data heterogeneity across modalities, limited availability of well-annotated multi-modal datasets, issues related to model interpretability, and barriers to clinical deployment.

Overall, this literature review provides an up-to-date overview of advances in multi-modal deep learning for breast cancer prediction and synthesizes current knowledge in this rapidly evolving field. The findings highlight promising research directions toward the development of more accurate, robust, and clinically meaningful AI-based diagnostic systems. Future research may focus on improving model transparency, validating approaches on large-scale real-world datasets, and extending multi-modal deep learning techniques to other cancer types and related medical applications.