Co-funded by the European Union

FAAI:
The Future is in Applied Artificial Intelligence
Erasmus+ project 2022-1-PL01-KA220-HED-000088359

01.09.2022 – 31.08.2024

A 5.6. - Business Guide for FAAI Erasmus+ Project

Co-funded by the European Union

The production of this document has been possible thanks to the support of the ERASMUS+ project: The Future is in Applied Artificial Intelligence (2022-1-PL01-KA220-HED-000088359)

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Date
10.05.2024

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Abstract. This guideline provides strategic insights for business managers in IT companies specializing in artificial intelligence (AI). The FAAI training course offers a structured framework for integrating AI applications into business solutions, combining theoretical foundations with practical implementations. Key modules include an introduction to AI principles, research methodologies, and hands-on experience with embeddable AI technologies from leaders like IBM, Microsoft, Google, and AWS. Each module highlights sector-specific applications in ecology, agriculture, healthcare, smart cities, and industry, enabling managers to identify opportunities and address challenges effectively. The course also features insights from pilot programs and real-world case studies, illustrating successful AI deployments. By equipping managers with the necessary knowledge and tools, this guideline aims to drive innovation and enhance competitive advantage in the rapidly evolving technology landscape.

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1. Introduction

Project "The Future is in Applied Artificial Intelligence" (FAAI) aims to join together HEIs and businesses in order to address the competencies and compatible job profile. This collaboration will provide innovative solutions to the training of experts in the field of Machine Learning and Artificial Intelligence. The learning framework is based on "IEEE FEDERATED MACHINE LEARNINGWHITE PAPER ".

It will be observed and" THE IEEE GLOBAL INITIATIVE ON ETHICS OF AUTONOMOUS AND INTELLIGENT SYSTEMS".

In this context, this project aims:

a) bridge the current digital skills gap in part of European Countries following the European Commission's 'e-Skills for jobs' campaign.

b) build an ecosystem of key partners for creating an access port in underrepresented talent pools.

c) identification the underrepresented skills, the rationale behind the phenomenon of talented people who lack the traditional credentials to land a good job in the AI area;

d) promote business opportunities, through an AI Job Hub, between Universities and businesses, including based on the use of effective, artificial intelligence-based solutions in the real world.

e) Through AI Job Hub to support the creation of internship programs, PhD student supervision between HEIs and business.

f) launching new initiatives to ensure that these skills are adequately promoted in the curriculum, in teacher development, in assessment practices and in learning content compound new ICT, BigData and AI trends, new educational tools and learning resources to be collected, processed, and disseminated through the Smart AI Job Hub towards the modernization of curricula and to further.

The FAAI project brings together four partners from five European countries: Poland, Bulgaria, Slovakia, Serbia and Montenegro.

To fulfil the aforementioned objectives, the FAAI project includes three teaching/training activities focused on:

1. HEI trainers
2. Undergraduate and postgraduate students
3. Business managers

2. Programme overview

2.1 Module 1 - Introduction and basic principles of the AI application in science and in business solutions

The lecture explores how Artificial Intelligence (AI) is transforming both scientific research and business operations. By leveraging AI technologies, organizations and researchers can gain deeper insights, make more informed decisions, and optimize various processes. This overview covers the fundamental principles of AI applications in these two domains.

2.2 Module 2 - Conducting research related to the practical application of artificial intelligence

These lecture notes provide an overview of the research related to the practical application of Artificial Intelligence, focusing on its integration with IoT systems and edge computing technologies. Topics covered include Edge AI, TinyML, Federated Learning, and Online Continual Learning, along with their significance, challenges, and emerging trends in the field.

Edge AI refers to the implementation of artificial intelligence algorithms and models directly on edge devices, enabling real-time processing and analysis of data at the source. Edge AI allows for faster decision-making, reduced latency, and improved privacy by processing data locally without relying on cloud resources.

TinyML involves deploying machine learning models on resource-constrained edge devices, such as microcontrollers and sensors. TinyML enables the implementation of AI-driven applications in embedded systems, IoT devices, and wearable technologies, expanding the capabilities of edge computing.

Federated Learning is a distributed machine learning approach where model training occurs locally on edge devices, and only model updates are sent to a central server. Federated Learning preserves data privacy, reduces communication overhead, and allows for decentralized model training in heterogeneous environments.

2.3 Module 3 - Embeddable modules from IBM, Microsoft, Google, AWS

This module reviews the platforms and services from IBM Watson, Google, Amazon, and Microsoft that offer businesses a wide range of AI capabilities to solve various business problems, automate processes, and enhance customer experiences. IBM Watson is a comprehensive AI platform that offers various cognitive computing services and tools to help businesses extract insights from data, automate processes, and build AI-powered applications. Some key offerings include:

- Watson Assistant: A conversational AI platform for building chatbots and virtual assistants.
- Watson Discovery: A platform for extracting insights from unstructured data such as documents, articles, and websites.
- Watson Studio: An integrated environment for data scientists, developers, and business analysts to collaboratively build and deploy AI models.
- Watson Natural Language Understanding: A service for analyzing and extracting insights from text data.
- Watson Visual Recognition: A service for building computer vision applications that can analyze and categorize images and video content.

Google offers a wide range of AI services and tools through its Google Cloud platform. Some key offerings include:

- Google Cloud AI: Pre-trained machine learning models and APIs for vision, speech, language, and translation tasks.
- TensorFlow: An open-source machine learning framework for building and training custom models.
- AutoML: Tools for automating the process of building machine learning models without extensive coding or machine learning expertise.
- Dialogflow: A platform for building conversational interfaces such as chatbots and virtual agents.
- Google Cloud Vision API, Speech-to-Text API, Natural Language API, etc.: Pre-built AI services for specific tasks.

Amazon Web Services (AWS) provides a range of AI and machine learning services through its AWS AI/ML platform. Some key offerings include:

- Amazon SageMaker: A fully managed service for building, training, and deploying machine learning models.
- Amazon Rekognition: A service for image and video analysis, including facial recognition and object detection.
- Amazon Comprehend: A natural language processing service for extracting insights and relationships from text data.
- Amazon Polly: A text-to-speech service that converts text into lifelike speech.
- Amazon Lex: A platform for building conversational interfaces using voice and text.

Microsoft Azure offers a comprehensive set of AI services and tools through its Azure AI platform. Some key offerings include:

- Azure Cognitive Services: Pre-built AI services for vision, speech, language, and decision-making tasks.
- Azure Machine Learning: A platform for building, training, and deploying custom machine learning models.
- Azure Bot Service: A platform for building, testing, and deploying chatbots and virtual agents.
- Azure Text Analytics: A service for extracting insights from text data, including sentiment analysis and named entity recognition.
- Azure Computer Vision: A service for analyzing and categorizing images and video content.

2.4 Module 4 - Building software applications using AI

This module provides a comprehensive overview of building software applications using AI, examining its impact on software development, real-world examples, future trends, and ethical considerations.

Impact of AI on Software Development:

- Discusses the benefits of integrating AI into software applications, such as improved efficiency, enhanced user experiences, and increased automation.
- Explores various problem domains where AI can be applied, including natural language processing, computer vision, predictive analytics, and more.
- Emphasizes the importance of data quality and preparation in AI development, highlighting techniques for data collection, cleaning, and preprocessing.
- Covers model development methodologies, including supervised learning, unsupervised learning, and reinforcement learning.
- Examines DevOps practices in the context of AI development, focusing on continuous integration, continuous deployment, and model monitoring.

Real-World Examples of AI-powered Solutions:

- Illustrates AI applications through real-world examples such as AI Voice Assistants (e.g., Siri, Alexa), AI in Healthcare (e.g., diagnostic systems, patient monitoring), AI in Finance (e.g., fraud detection, algorithmic trading), and AI in Manufacturing (e.g., predictive maintenance, quality control).

Future Trends:

- Explores emerging trends in AI, including AI-Powered DevOps for streamlining AI model deployment and management.
- Discusses the importance of Explainable AI for enhancing trust and understanding of AI models.
- Highlights AI applications in Cybersecurity for threat detection and prevention.
- Explores AI for Code Generation and Testing & Debugging to automate software development processes.
- Discusses the role of AI in Natural Language Processing (NLP) for language translation, sentiment analysis, and chatbots.
- Examines AI for Personalization, leveraging machine learning to tailor user experiences and recommendations.

Ethical Considerations:

- Addresses ethical challenges in AI development, including bias and fairness in algorithms, privacy violations, and data misuse.
- Discusses the importance of transparency and explainability in AI systems, ensuring that decisions made by AI models are understandable and justifiable.
- Considers the potential impact of AI on job displacement and advocates for measures to address workforce transitions.
- Examines accountability and safety concerns related to AI-powered systems and the need for regulatory frameworks to govern AI development and deployment.

Overall, this module provides a holistic understanding of building software applications using AI, encompassing its impact, practical examples, future trends, and ethical considerations..

2.5 Module 5 - Implementation of external AI modules in software applications

This module provides an in-depth exploration of building software applications using AI, covering various aspects such as the impact of AI on software development, real-world examples, future trends, and ethical considerations.

Statement of the Problem/Case:
Discusses the incorporation of AI models into applications either directly into the main thread, as an additional thread, or as part of an external module/service.
Presents implementation examples for each case.

Competence Building:
Outlines the skills learners will develop, including understanding major AI areas, applying logic and probabilistic reasoning, and navigating ethical considerations in AI systems.

Background vs Requirements:

Highlights the prerequisite knowledge from previous modules necessary to understand the lecture's subject matter.
Emphasizes the importance of this background knowledge in relation to the examples presented and the tools used.

Course Outcomes:
Defines the expected outcomes for students after completing the lecture, including the ability to create and use machine learning models and convert models into services with APIs.

Case Studies:
Presents various scenarios where AI modules enhance application functionality, including AI Voice Assistants and external AI modules via APIs.
Details the process of using generative AI modules, external modules provided by APIs, and integrating modules into applications.

Conclusion:
Summarizes the lecture's key points, including the utilization of external AI modules, deploying models as services, and the importance of understanding and implementing AI in software development. Overall, the module provides a comprehensive overview of leveraging AI in software applications, offering practical examples and guidance for learners.

2.6 Module 6 - AI-based solutions for Ecology

The text provides an overview of various types of ecology and their significance, as well as examples and environmental issues.

Types of Ecology:
Global Ecology: Focuses on interactions among Earth's ecosystems, examining large-scale influences on the planet.
Landscape Ecology: Studies energy, material, and organism exchange in ecosystems, considering human impacts on landscape structures.

Community Ecology: Explores how community structure is influenced by interactions among organisms.
Population Ecology: Investigates factors impacting the genetic composition and size of organism populations.
Ecosystem Ecology: Examines entire ecosystems, including living and non-living components and their relationships.
Organismal Ecology: Studies individual organism behavior, morphology, and physiology in response to environmental challenges.
Molecular Ecology: Analyzes protein production and molecular interactions affecting organisms and their environment.

Importance of Ecology:
Conservation of Environment: Understanding ecology helps protect the environment and prevent species extinction.
Resource Allocation: Ecology guides resource management by identifying necessary resources for organisms.
Energy Conservation: Proper ecological knowledge prevents over-exploitation of energy resources, conserving energy for the future.
Eco-Friendliness: Ecology promotes harmonious living and sustainable lifestyles to protect the environment.

Examples of Ecology:
Human Ecology: Studies the relationship between humans and the environment to improve sustainability.
Niche Construction: Examines how organisms modify the environment for their benefit and the benefit of other organisms.

Environmental Issues:
The UN's 2030 Agenda for Sustainable Development outlines environmental challenges, indicating a need for urgent action to safeguard the planet.
The text highlights the interdisciplinary nature of ecology and its critical role in addressing environmental issues and promoting sustainability.

The module includes AI Use Cases for Ecology:

Use Case 1 - Integrating Data Science with Trees and Remote Sensing:
Research involves combining remote sensing imagery, large-scale surveys, and data science methods to understand forests at various scales. Aims to contribute to advancements in tree predictions, spatially explicit data on species and traits, and modeling of tree structural traits and allometry. Interdisciplinary team based at the University of Florida focuses on forest ecology, remote sensing, data science, machine learning, and modeling.

Use Case 2 - Species Identification:
Utilizes AI-ML-powered tools for detecting, identifying, and monitoring various flora and fauna species. AI system analyzes images to detect species, aiding in biodiversity conservation efforts. Applications include monitoring population trends, implementing population management programs, assessing ecosystem health, and conducting extinction analysis.

Use Case 3 - Habitat Mapping:
Automated workflow generates habitat maps using AI/ML classification, complementing habitat suitability layers. Achieves high accuracy in mapping marine habitats using multispectral data and machine learning algorithms. Utilizes boosting techniques to model relationships between habitat types and environmental variables.

Use Case 4 - Environmental Monitoring:
AI technology enhances environmental inspections, resource utilization, and real-time monitoring through wireless sensor networks and IoT. Machine learning algorithms analyze diverse environmental datasets, facilitating trend identification, forecasting, and decision support.

Use Case 5 - Wildlife Tracking:

AIoT-powered system captures dynamic behaviors of wild animals in zoos using AI and IoT devices. Hardware and software tools, including C++, Python, and NVIDIA Nano, facilitate system design and evaluation. Aims to protect wild animals and improve zoo management through non-invasive monitoring.

Use Case 6 - Conservation and AI:
AI aids in data classification, decision support, and enforcement of wildlife protection regulations. Example: AI models accurately classify land cover patterns using high-resolution aerial imagery. Integration of AI-based solutions enhances sustainable mining practices and environmental management.

Use Case 7 - AI in Environmental Impact Assessments in the Mining and Metals Sector:
AI techniques, such as AutoML and Bayesian networks, improve environmental impact assessments by reducing human bias. Statistical methods identify significant patterns in data to inform decision-making processes. Integration of AI-based platforms enhances sustainable mining practices and decision-making.

Use Case 8 - Species Classifiers Using Deep Learning:
Deep learning techniques, such as CNNs and RNNs, show promise for species classification in ecology. A comprehensive guide is provided for constructing image classifiers, increasing accessibility to AI approaches for species identification and image analysis.

These use cases demonstrate the diverse applications of AI in ecology, ranging from species identification and habitat mapping to environmental monitoring and conservation planning. The integration of AI technologies offers innovative solutions for addressing environmental challenges and promoting biodiversity conservation.

2.7 Module 7 - AI-based solutions for Agriculture

The module highlights the significant growth and potential of AI in revolutionizing agriculture by addressing traditional farming challenges, optimizing processes, and promoting sustainability. However, it also emphasizes the need for affordable and accessible AI solutions and education to ensure widespread adoption in the agriculture sector.

Market Overview:

- The global AgTech market is valued at $24.08 billion as of 2024.
- The AI market in agriculture is projected to grow from $2.08 billion in 2024 to $5.76 billion by 2029, with a CAGR of 22.55%.
- The IoT in agriculture market is expected to reach $78.85 billion by 2030, growing at a CAGR of 12.6%.

Agricultural Processes:

- Involves various stages like soil preparation, seed sowing, fertilization, irrigation, weed protection, harvesting, and storage.
- Traditional Farming Challenges:
- Challenges include climatic factors (rainfall, temperature, humidity), crop-specific soil nutrition requirements, and weed protection.

Benefits of AI in Agriculture:

- Data-driven decision-making.
- Cost savings through efficiency and optimization.
- Automation of repetitive tasks.
- Promotion of sustainable agriculture practices.
- Establishment of smart supply chains.
- Bridging the technology gap between traditional and modern farming practices.
- Integration of smart sensors for real-time monitoring.

Challenges for AI Tools Development:

- Developing affordable and practical AI products.
- Educating potential AI adopters about the capabilities and benefits of AI in

The AI-driven solutions address various challenges in agriculture, ranging from crop health monitoring to livestock management and weather prediction. By leveraging technologies like computer vision, IoT sensors, and machine learning algorithms, farmers can optimize their operations, increase productivity, and make informed decisions for sustainable agricultural practices.

Crop Analysis with Computer Vision: Uses image analysis for disease detection, pest identification, and weed detection.

Crop Monitoring with IoT Sensors: Involves monitoring soil moisture, nutrient levels, and analyzing temperature and humidity impacts on crops.

Livestock Recognition from Video: Utilizes video analysis for population control, health monitoring, and managing feeding and nutrition.

Livestock Monitoring with IoT Sensors: Includes analyzing vital signs, behavior patterns, and controlling climate conditions for livestock welfare.

AI in Aquaculture: Applies AI for behavior analysis of aquatic species, disease identification, and automated feeding processes.

Equipment Automation: Involves automating farming equipment for tasks like planting, seeding, crop monitoring, and weed control.

AI-Powered Weather Forecasting: Utilizes AI for weather forecasting to aid in climate-adaptive crop management, water resource management, and crop rotation planning.

2.8 Module 8 - AI-based solutions for HealthCare

The module on AI problems for healthcare provides an extensive overview of the current landscape, historical context, breakthroughs, challenges, and future directions in leveraging artificial intelligence (AI) and machine learning (ML) in the healthcare industry. Here's a breakdown of the key points covered:

- Introduction to Healthcare Expenditure and Challenges: Highlights the substantial healthcare expenditure in the U.S. despite challenges such as late diagnoses of chronic diseases and medical errors.

- Historical Developments in AI and ML in Healthcare: Discusses landmark systems like MYCIN and INTERNIST-1/QMR, showcasing early AI applications for diagnosis and treatment recommendations.
- Mentions pioneering work in automating medical discoveries and the introduction of neural networks in medicine in the 1990s.
- Current State of AI in Healthcare: Examines the widespread adoption of Electronic Health Records (EHRs), the significance of big data, and efforts towards data standardization. Discusses how AI and ML are transforming healthcare with advanced algorithms, open-source software, and significant projects in medical imaging and oncology.
- Transforming Healthcare with Machine Learning: Explores the potential of ML in emergency departments, chronic disease management, personalized medicine, and drug development.
- Healthcare Requirements for Machine Learning: Outlines the need for robust algorithms, solutions for data-related challenges, and interoperability issues in healthcare settings.
- Clinical Decision Support Systems (CDSS): Defines CDSS and discusses their functions, requirements, characteristics, and implementation methods.
- Future Directions and Conclusion: Emphasizes the transformative potential of AI and ML in revolutionizing healthcare, with examples such as diagnostic tools and personalized treatment plans. Highlights the importance of continuous advancement in big data analytics, algorithms, and collaboration among stakeholders.

Overall, the module provides a comprehensive understanding of the opportunities, challenges, and future prospects of integrating AI and ML into healthcare systems to improve patient outcomes and optimize resource allocation.

The module on AI-based solutions for healthcare dives into various use cases, methodologies, applications, and impacts of artificial intelligence (AI) and machine learning (ML) in revolutionizing the healthcare sector. AI and ML are transforming healthcare by enabling precise diagnostics, personalized treatment plans, and efficient healthcare delivery.

Use Case 1: SVM Classification for Diabetes and Kidney Diseases in Females:

Outlines the main idea behind Support Vector Machines (SVM) and its functionality. Details the project and dataset, including data extraction, processing, and handling. Discusses model training and evaluation, highlighting the choice of the Radial Basis Function (RBF) kernel and performance metrics.

Use Case 2: Risk Stratification of Patients with Type II Diabetes:

Objective: Categorize patients into high- and low-risk groups for better treatment outcomes and cost management. Compares traditional vs. modern approaches, emphasizing the role of ML in analyzing large datasets. Discusses early detection of Type 2 Diabetes and the methodology for ML-based risk stratification.

Use Case 3: Handling Censored Data in Healthcare:

Problem: Patients changing insurers lead to incomplete data records, challenging longitudinal studies and predictive modeling. Discusses types of censorship (left and right) and proposes solutions such as data alignment, dataset management, and advanced techniques.

2.9 Module 9 - AI-based solutions for Smart City

The module on AI-Based Solutions for Smart Cities delve into the integration of artificial intelligence (AI) technology to address the challenges and opportunities in urban development.

Introduces the concept of smart cities and their significance in urban development. Highlights the role of AI in improving various aspects of urban life. Outlines the objectives of the lecture notes, including understanding smart cities, exploring AI applications, discussing benefits and challenges, and analyzing future prospects.

1. Introduction:

Discusses the background of rapid urbanization and the emergence of smart cities. Highlights the importance of AI in transforming cities into intelligent environments. Sets the objectives for understanding the role of AI in smart cities.

2. Understanding Smart Cities:

Defines smart cities as urban environments leveraging technology and data to enhance quality of life and sustainability. Explores components of smart cities, including infrastructure, transportation, energy grids, buildings, healthcare, governance, and citizen engagement.

3. Artificial Intelligence in Smart Cities:

Explores the role of AI as the backbone of smart cities, enabling real-time data processing, decision-making, and automation. Discusses AI applications in transportation, energy management, waste management, pollution reduction, healthcare services, and public safety.

4. Benefits of AI-Based Solutions:

Highlights efficiency optimization, quality of life improvement, and sustainability in resource management as key benefits. Discusses how AI enhances resource utilization, transportation systems, healthcare, and environmental conservation.

5. Challenges and Limitations:

Addresses concerns regarding data privacy, security, ethical considerations, technological limitations, and financial implications associated with AI adoption in smart cities.

6. Future Prospects of AI in Smart Cities:

Explores innovations, advancements, collaborative opportunities, and citizen empowerment as future prospects. Discusses case studies and lessons learned from real-world smart city projects employing AI-based solutions.

7. Case Studies:

Presents case studies showcasing successful implementations of AI-based solutions in smart cities. Analyzes experiences, challenges, and lessons learned from AI implementation.

Summarizes the potential of AI in transforming smart cities into sustainable, livable environments. Acknowledges challenges and limitations while emphasizing the promising future prospects of AI in urban development.

The module provides a comprehensive overview of how AI technology can revolutionize smart cities, improve urban living standards, and address sustainability

challenges, while also discussing the associated benefits, challenges, and future opportunities.

2.10 Module 10 - AI-based solutions for Industry

The module offers a comprehensive analysis of the multifaceted obstacles faced by modern industries in the era of advanced technologies and interconnected systems. The key points covered in the lecture include:

Interconnected Industry Systems: The lecture emphasizes the complexity and interdependence of industry systems in the Industry 4.0 landscape. These systems integrate various technological advancements, leading to a highly interconnected environment where the failure of one component can affect the entire network.

Advanced AI Technologies: Artificial Intelligence (AI) technologies are central to Industry 4.0, driving automation, predictive maintenance, and data analytics. However, the integration of AI brings challenges such as algorithmic bias, data privacy concerns, and the need for continuous learning and adaptation of AI models.

Evolving Work Dynamics: The workforce is undergoing significant changes due to automation and AI. This shift requires new skill sets, continuous learning, and adaptation from employees. There is also a need to address potential job displacement and ensure that workers are prepared for new roles created by technological advancements.

Interconnected Challenges: The challenges of Industry 4.0 are not isolated. They intersect and influence each other, creating a complex web of issues that need to be addressed holistically. For example, ethical concerns in AI can impact regulatory requirements, which in turn affect technological deployment and operational processes.

Collaborative Solutions: Addressing the challenges of Industry 4.0 necessitates collaboration across various disciplines, industries, and geographical boundaries.

Organizations must work together to share insights, develop best practices, and create innovative solutions that are technologically sound, ethically responsible, and compliant with regulatory standards.

Technological, Ethical, and Regulatory Domains: Effective navigation of Industry 4.0 challenges requires a balanced approach that considers technological advancements, ethical implications, and regulatory frameworks. Organizations need to ensure that their innovations are not only cutting-edge but also ethically responsible and legally compliant.

Unlocking Potential: By responsibly addressing the challenges presented, organizations can unlock the full potential of interconnected systems, AI-driven insights, and automated processes. This involves leveraging collaboration, fostering innovation, and adhering to ethical and regulatory standards to achieve sustainable success in the Industry 4.0 era.

The lecture concludes that a comprehensive understanding of the interconnected challenges and collaborative efforts across multiple domains is essential for organizations to thrive in the Industry 4.0 landscape.

The module on "AI Use Cases for Industry 4.0" presents eight compelling examples of how artificial intelligence can optimize various aspects of modern industry through intelligent and data-driven solutions. Here is an overview of the discussed use cases:

Use Case 1: Predictive Maintenance for Manufacturing Equipment
Company: Siemens AG
Siemens has developed a predictive maintenance solution to address the financial challenges posed by unplanned downtimes in manufacturing. Leveraging AI, Siemens' Predictive Maintenance services collect, analyze, and assess machine data to predict failures before they occur, enhancing productivity and competitiveness.

Use Case 2: Quality Control and Defect Detection

Company: ABB Robotics

ABB Robotics uses AI-powered computer vision systems for automated defect detection in manufacturing, ensuring high quality and reducing manual inspection time. Their 3D Quality Inspection system, which uses structured light and photogrammetry, measures faults smaller than half the width of a human hair at a speed much faster than traditional methods. The system captures and compares images to master CAD models, facilitating quick, accurate quality checks and reducing rework and scrappage.

Use Case 3: Supply Chain Optimization

Company: IBM Watson

IBM's Supply Chain Insights with Watson utilizes AI to improve supply chain management by mitigating disruptions and enhancing forecasting. By leveraging cognitive technologies, IBM's solution processes both structured and unstructured data to provide proactive monitoring, predictive capabilities, and actionable insights. This includes the Operations Center with Smart-Alerts and Resolution Rooms with Ask Watson for swift disruption resolution.

Use Case 4: Energy Management and Sustainability

Company: Schneider Electric

Schneider Electric's Energy Management System (EMS) enhances grid management by providing visibility and control over transmission networks. It integrates with Siemens' ADMS for flexibility and reduced costs. EMS features include state estimation, load flow analysis, and voltage stability assessment, which help utilities manage the integration of renewables and ensure grid stability, reliability, and security.

Use Case 5: Smart Manufacturing with Digital Twins

Company: Siemens Digital Industries Software

Siemens' digital twin solutions create virtual replicas of production processes and products, enabling data-driven decision-making and operational optimization. A

notable success is the collaboration with Bye Aerospace, where Siemens' software reduced product development timelines significantly. Key tools include NX CAD, Teamcenter, Simcenter STAR-CCM+, Simcenter 3D, and Capital software, all part of the Siemens Xcelerator platform.

Use Case 6: Additive Manufacturing in Aerospace
Company: General Electric
GE has revolutionized aerospace manufacturing with 3D printing, enabling complex designs and reducing part counts. Benefits include cost savings, enhanced fuel efficiency, and streamlined production processes. Examples include the use of 3D-printed fuel nozzles in the GE90 and GE9X engines, and NASA's 3D-printed rocket injector for space applications.

Use Case 7: Demand Forecasting and Personalized Products
Company: SAP
SAP's demand forecasting solutions help manage the complexity of personalized products in supply chains by predicting customer preferences and ensuring efficient resource use. Benefits include minimizing waste, enhancing customer satisfaction, adapting to trends, and maintaining cost efficiency. SAP leverages predictive analytics and AI to provide precise demand forecasts, helping businesses stay competitive.

These use cases illustrate how AI can drive significant improvements in various aspects of Industry 4.0, from predictive maintenance and quality control to supply chain optimization and energy management.

2.11 Module 11 - AI-based solutions in Robotics

Robotics is an interdisciplinary field of engineering combining mechanical engineering, electrical engineering, and computer science. The primary goal is to create machines and robots that can assist humans across various domains, such as manufacturing, daily tasks, and healthcare. Advances in Artificial Intelligence (AI)

and Machine Learning (ML) have significantly enhanced the capabilities of robots, enabling them to handle complex tasks with greater efficiency and better human collaboration.

Impact on Employment:

Robots have the potential to render about 30% of jobs obsolete. Despite the transformative power of AI in robotics, a significant number of businesses have yet to adopt these technologies fully. It's crucial to distinguish between robots and AI—robots are physical entities, while AI encompasses the software that can imbue them with decision-making capabilities.

Key Robotics Tasks:

Path Planning and Navigation: Involves algorithms to calculate the optimal path for a robot from one point to another while avoiding obstacles.

Localization: Critical for estimating a robot's pose concerning its environment, involving 3D rigid transformations between coordinate frames.

Object Detection and Recognition: Identifying and locating objects within images or videos, extending to classification and precise boundary delineation using supervised learning models.

Motion Planning: Techniques enabling robots to navigate through a geometric path, often using sampling-based methods for high-dimensional spaces.

Dynamic Interaction with the Environment: Focuses on how robots adapt to changes in their surroundings, including interaction with other robots and varying surfaces, often using variable impedance controllers.

AI Challenges in Robotics:

Intelligence: AI is crucial for mimicking human cognitive abilities, enabling robots to perform tasks autonomously in diverse real-world environments.

Navigation: Enhances robot autonomy through techniques such as Convolutional Neural Networks (CNNs), Reinforcement Learning (RL), Deep Learning, Path Planning algorithms like A*, and Fuzzy Logic.

Autonomy: Full autonomy remains challenging, with energy efficiency being a critical aspect. Enhancing energy autonomy is crucial to reducing power demands and increasing robot independence.

- Potential AI Trends in Robotics:
- Advances in hardware, such as artificial muscles and soft robotics, are essential for improving robot efficiency.
- The sector is becoming more competitive, with an increasing number of companies driving innovation.
- Robotics could liberate human creativity by taking over routine tasks, highlighting the importance of continued investment and development in this field.

The rapid evolution of robotics and AI presents numerous challenges and opportunities. Achieving full robot autonomy is a central goal, necessitating advancements in energy efficiency and AI integration. Modern robotics leverages AI to enhance intelligence, precision, and functionality, which could profoundly impact human life and societal operations. As robotics continues to advance, ethical considerations—such as responsibility, privacy, and security—must also be addressed to ensure beneficial and responsible use of these technologies.

The integration of Artificial Intelligence (AI) in robotics has revolutionized various industries by enhancing the capabilities and efficiency of robotic systems. This lecture explores ten significant use cases where AI-driven robotics is making a profound impact.

Use Case 1 - Industry 4.0:
Quality Control: Autonomous robots perform quality control in industrial production by navigating and localizing with respect to environmental landmarks, such as Aruco markers.
Collision Avoidance: AI models are crucial for preventing collisions with machinery, other robots, and human workers.

Object Detection: AI models like YOLO and R-CNN variants detect products for inspection. Deep learning models are used for defect detection, characterization, and conformity checks.

Use Case 2 - Autonomous Cars:
SLAM (Simultaneous Localization and Mapping): Utilizes LiDARs and 3D sensors, with deep learning models processing sensor outputs.
2D Cameras: Deep learning models extract keypoints for 3D space reconstruction via "structure from motion" (SFM) methods.
Collision Avoidance: Object detection and sensor fusion ensure the car avoids collisions with other vehicles and pedestrians.

Use Case 3 - Space Exploration:
SLAM in Space: Robots on other planets use natural landmarks for localization and create relative maps of these landmarks using 3D sensors like LiDARs.
Swarm Exploration: Robots may communicate with each other (swarm intelligence) or with satellites (telepresence) to enhance exploration capabilities.

Use Case 4 - Medical Applications:
Surgical Robots: AI-assisted robots enhance precision and reduce errors in surgeries, providing real-time feedback and guidance to surgeons.
Prosthetics: AI interprets neural stimuli to control artificial limbs, improving the functionality and adaptability of prosthetics.

Use Case 5 - Controlling Drones and UAVs:
Autonomous Navigation: AI-powered drones perform tasks such as surveillance, delivery, search and rescue, and aerial photography.
Inspection: AI models detect and segment defects in buildings and infrastructure through 2D image analysis.

Use Case 6 - Military and Defense:

Unmanned Drones: AI-driven drones perform navigation, computer vision, path, and motion planning autonomously in combat situations, making critical decisions without human intervention.

Use Case 7 - Logistics and Warehouse Monitoring:
Automation: AI-powered robots handle tasks like picking, packing, and sorting with minimal human input, optimizing routes and managing inventory efficiently.
Cost Reduction: These robots reduce operational costs and improve productivity, allowing businesses to focus on core activities.

Use Case 8 - Environmental Monitoring:
Climate Monitoring: AI robots monitor environmental parameters such as air and water quality, aiding farmers and zookeepers in maintaining healthy conditions.
Disaster Prediction: Robots collect data and predict environmental changes, operating even in inaccessible areas.

Use Case 9 - Disaster Response:
Search and Rescue: Robots assist in search and rescue operations, damage assessment, and delivery in hazardous environments, enhancing response efficiency.
Types of Robots: Depending on the disaster location, aerial, marine, or ground robots are used to aid human efforts.

Use Case 10 - Retail and Customer Service:
Customer Interaction: AI robots enhance customer service by providing quick information retrieval and improving customer experiences.
Automated Services: Examples include automatic call centers, which reduce service costs while maintaining customer satisfaction.

AI-powered robotics is transforming multiple sectors by improving efficiency, safety, and precision. These advancements highlight the importance of continued investment and innovation in AI and robotics to address complex challenges and enhance human capabilities across various domains.

2.12 Module 12 - Application of other AI modules

The lecture delves into three pivotal areas in the field of Artificial Intelligence (AI) and Machine Learning (ML): Automated Machine Learning (AutoML), Machine Learning Operations (MLOps), and Generative AI. These domains are critical for advancing the capabilities, efficiency, and applications of AI systems.

AutoML (Automated Machine Learning) aims to automate the end-to-end process of applying machine learning to real-world problems. This includes automating tasks like data preprocessing, feature selection, model selection, and hyperparameter tuning.
Components of AutoML:

- Data Preprocessing: Automated techniques to clean and prepare data for model training.
- Feature Engineering: Identifying and creating the most relevant features from raw data automatically.
- Model Selection: Automating the selection of the best ML algorithms for a given task.
- Hyperparameter Optimization: Efficiently searching for the best hyperparameters for the selected model.

Benefits:

- Accessibility: Makes ML accessible to non-experts by reducing the need for in-depth knowledge of the ML pipeline.
- Efficiency: Saves time and resources by streamlining the ML process.
- Performance: Often results in highly optimized models through automated tuning processes.

Tools and Frameworks: Popular AutoML tools include Google AutoML, H2O.ai, TPOT, and Auto-sklearn.

MLOps (Machine Learning Operations) is a set of practices aimed at unifying ML system development (Dev) and ML system operations (Ops). It focuses on streamlining the deployment, monitoring, and maintenance of ML models in production.
Core Components:

- Version Control: Tracking changes in datasets, code, and models to ensure reproducibility and collaboration.
- CI/CD Pipelines: Continuous integration and continuous deployment pipelines for automating the testing and deployment of ML models.
- Monitoring and Management: Tools for monitoring model performance, detecting drift, and managing model lifecycle.
- Scalability: Ensuring that ML models can scale efficiently with increasing data and user demand.

Benefits:

- Reliability: Increases the reliability and robustness of ML models in production.
- Efficiency: Streamlines the deployment process, reducing the time from development to production.
- Collaboration: Enhances collaboration between data scientists, ML engineers, and IT operations.

Tools and Platforms: Notable MLOps platforms include MLflow, Kubeflow, TFX (TensorFlow Extended), and Amazon SageMaker.

Generative AI refers to AI models that can generate new content, such as images, text, music, and more, by learning from existing data.
Types of Generative Models:

- Generative Adversarial Networks (GANs): Consist of a generator and a discriminator network, where the generator creates data and the discriminator evaluates its authenticity.
- Variational Autoencoders (VAEs): Use probabilistic graphical models to generate new data points.

- Transformers: Deep learning models like GPT (Generative Pre-trained Transformer) that excel in generating coherent and contextually relevant text.

Applications:

- Art and Creativity: Generating artwork, music, and literature.
- Data Augmentation: Creating synthetic data to augment training datasets for improved model performance.
- Personalization: Generating personalized content for marketing, recommendations, and user engagement.
- Healthcare: Synthesizing medical data for research and training purposes without compromising patient privacy.

Challenges and Ethical Considerations:

- Bias and Fairness: Ensuring generated content does not reinforce existing biases.
- Authenticity and Trust: Differentiating between human-created and AI-generated content.
- Intellectual Property: Addressing concerns related to the ownership and originality of AI-generated works.

AutoML, MLOps, and Generative AI represents significant advancements in the field of AI. AutoML democratizes access to powerful machine learning techniques, MLOps ensures the seamless deployment and maintenance of these models, and Generative AI pushes the boundaries of what AI systems can create and achieve. Together, these domains are driving innovation and expanding the possibilities of AI applications across various industries.

3. Pilot Programme Overview

The fundamental goal of the FAAI initiative is to improve collaboration between businesses and universities by developing a novel approach and methodology for teaching Applied Artificial Intelligence material. The project is designed to become

part of the university curriculum as a course with relevant credits. FAAI is an experiential learning curriculum that, in addition to teaching Artificial Intelligence ideas, engages students in real-world difficulties and problems.

The total programme consists of 120 hours learning during which there will be 12 weekly sessions (topics) of 10 hours each (4 hours lectures + 6 hours learning activities). Additional work on practical problems related to the Artificial Intelligence presented by Business Managers (BM) is foreseen during the learning sessions. An overview of the programme is shown below with times when BM would be required to brief the students, deal with on-going queries and receive presentations:

No.	**Topic**	**Business managers presence**
1.	Introduction and Basic Principles of the AI application in Science and in Business Solutions	
2.	Conducting research related to the practical application of artificial intelligence	Presenting the practical problems
3.	Embeddable modules from IBM, Microsoft, Google, AWS	
4.	Building software applications using AI	Presenting technical requirements
5.	Implementation of external AI modules in software applications	
6.	AI-based solutions for Ecology	Discussion of the ideas
7.	AI-based solutions for Agriculture	
8.	AI-based solutions for HealthCare	Discussion of the ideas
9.	AI-based solutions for SmartCity	
10.	AI-based solutions for Industry	Presentations of draft solutions
11.	AI-based solutions in Robotics	
12.	Application of other AI modules	Presentations of final solutions

BM would optimally attend the programme on 6 occasions for a maximum of 2 hours to meet with the students. The BM would also be expected to additionally devote one hour per week to communicate with the Mentors through MS Teams or some other online platform in order to address any student queries or questions that may emerge outside of the scheduled meetings. BM live presence (see table above) is recommended but not required. The minimal number of live meetings, however,

can be optimized to three: introduction (presentations of the Artificial Intelligence practical business problems), mid-term (discussions of the ideas), and final (presentations of solutions). Meanwhile, all other sessions might be conducted remotely via MS Teams platform or email.

The purpose of these meetings is outlined as follows (please note that there may be variations from programme to programme):

Meeting 1:

- Provide background material about the company.
- Outline the challenge/business Artificial Intelligence problem.
- Detail consequences of not finding a solution.

Meeting 2:

- Identify any known constraints/limiting factors to resolving the challenge/business Artificial Intelligence problem.
- Discuss technology platforms for students' solutions.

Meetings 3, 4:

- Discuss the progress of the students' work.
- Make corrections if needed.
- Provide clarifications/additional information if needed.

Meeting 5:

- Students present draft solutions.
- BM to provide feedback to students.

Meeting 6:

- BM to select most suitable solution for their business.
- Official presentation by the student teams of their results/proposed concepts.

Students should be reminded that the information contained within the challenge is confidential and should not be discussed with persons outside the programme trial.

4. Business challenges

Business challenges are primarily intended for companies (regardless of size and type of activity) that are willing to present some of the problems and challenges they face and to offer to members of the scientific research community (including Mentors as representatives of higher education institutions, and students) to find solutions for these problems. Students will be organized into different teams consisting of 3-5 students. At the end of the programme the preferred solution will be selected by BM.

Business challenges aims to ensure that companies, which would set their own Artificial Intelligence problems and seek innovative solutions, get the integration of internal and external knowledge and resources into the new system and architecture of development and innovative Applied Artificial Intelligence processes, as well as the final result in increasing revenue and profit from the sale of research results to the other companies/customers.

The very concept of cooperation with the private sector in order to solve technical, technological, organizational and other Artificial Intelligence problems, shifts traditional research towards practical applications, while encouraging innovation and creativity of students.

The person presenting the business challenges from Artificial Intelligence domain is termed Business Manager. His role is to provide to the students with a synopsis that represents a problem that his organisation is facing and that requires a solution. Presented problems should satisfy the following requirements:

- Should not be too complex for students' abilities.
- Must be a real and genuine issue that is affecting the organization's viability and/or growth.
- It must be relevant to the Artificial Intelligence area.
- Although they may be working on a solution independently of the students training, the BM must not have previously solved the business problem.

5. Business case studies form

The information for the challenge needs to cover two separate parts (see the form given below), one is for the company information and the other one is dedicated to challenge itself. Part with the company information consists of Company name, Short company description and Contact person information, while part with Challenge needs information about Challenge name, Short challenge description, Consequences of not resolving this problem, and Specific requirements to be met. This form will be given to business representatives, and they should fill in with real information based on the instructions provided below.

Proposal for a Challenge problem

Thank you for offering a Applied Artificial Intelligence Challenge for our students to look for a solution. Can you please complete the form below? Please try not to exceed the word limit for each section. There are notes at the end of the form that you can use to assist you in completing the form. Please be aware that the students will be given access to the information below except for your contact details if you request so.

Basic information about the company:

Company name:	
Short company description (max 300 words)	
Contact person information:	

Defining business challenges:

Challenge name:	
Short challenge description (max 500 words):	
Consequences of not resolving this problem (200 words):	

Specific requirements to be met:	

Short company description: what kind of business are you in, what products or services do you sell/provide, target market, approximate market size, specific factors impacting on the organisation.

Short challenge description: what is the problem, what factors have caused this problem to emerge, what barriers are there to you solving the problem, are you currently working to solve the problem?

Consequences of not resolving this problem: if you do not resolve the problem what you do anticipate happening to the organisation?

Specific requirements to be met: what factors are you aware which may restrict solutions such as finance of software solution platform?

Conditions:

If your challenge is chosen, there are a few conditions that we would expect you to agree to. You can be working on a solution yourself, but you should not have already resolved the problem. You agree to attend minimum 3 and maximum 6 live sessions in total of 2 hours each to engage with the students. Meetings are organized first to provide an overview of the problem and then to supervise the progress and provide further information required by the students.

6. Appendix

Herein we briefly describe a real Applied Artificial Intelligence problem given by business representatives in accordance with challenge form presented in the last section.

Basic information about the company:

Company name:	Neurology Clinic, Clinical Center Niš
Short company description (max 300 words)	The Neurology Clinic treats patients with various diseases of the central and peripheral nervous system such as epilepsy, multiple sclerosis, neuromuscular diseases, diseases of the extrapyramidal system and heredodegenerative diseases, primary headaches and other chronic painful conditions of neurological origin, cognitive disorders, and also patients with various forms of stroke such as intracranial hemorrhages, cerebrovascular thrombosis and embolism, as well as comatose states of known and unknown origin. The Neurology Clinic covers the area of South-Eastern Serbia - the region with about 2.500.000 inhabitants. The most complex diagnostic and therapeutic procedures are performed at the clinic, along with the implementation of health information measures and education of the population regarding risk factors. Personnel, spatial, professional-medical potential and equipment, along with close cooperation with all institutes, clinics and institutes of the Clinical Center in Niš, make this clinic one of the most important neurological centers in the country. From its establishment until today, the Neurology Clinic has experienced progress in all three areas of its activity: health care, teaching and scientific research. From an ordinary neurological department, it has become a highly specialized health care institution that provides neurological care in the region, as well as a reference institution for certain areas of neurology.
Contact person information:	Firstname Lastname example@gmail.com +38118 xxx xxx

Defining business challenges:

Challenge name:	AI-based decision support system for predicting epileptic seizures
Short challenge description (500 words):	The focus of the challenge proposal is developing predictive models for neurological disorders with special application to the prediction of epileptic seizures supported by AI-based decision system. Epilepsy is one of the most common neurological disorders, affecting all age groups and almost 1% of the population worldwide. Accurate monitoring and prediction of the seizures are important to evaluate seizure burden, recurrence risk, response to treatment, and to understand sudden unexpected epileptic deaths. To accomplish this goal, the health monitoring system should be proposed, which uses IoT-based wearable electronics to acquire EEG data as the gold standard for accurately diagnosing and evaluating epilepsy and some other neurological disorders. The overall intelligence will be implemented by designing of advanced decision support system that will be used for capturing complex feature patterns in previously sensed user's EEG data, diagnostics, predicting epileptic seizures, and for taking consequent actions towards healthcare providers. In this part of the challenge, the role of students would be to consider the advanced machine learning techniques, particularly specially tailored deep learning tools trained on large number of recorded EEG characteristics.
Consequences of not resolving this problem (200 words):	Epilepsy is one of the most common neurological disorders. About 70% of epilepsy patients receive effective therapy with antiepileptic medications. The quality of life for the remaining 30% of patients is significantly diminished by their ongoing seizure activity. In order to obtain efficacy measures of therapeutic interventions for these patients, objective measures of seizure documentation and counting are needed. Seizure monitoring, however, relies on patient and family self-reporting in an outpatient context, away from the hospital, and is

	sometimes erroneous owing to underreporting, episodes missed by caregivers, and patients' difficulty recalling seizures. Although long-term electroencephalography (EEG) for epilepsy monitoring is the gold standard for precisely diagnosing and evaluating epilepsy, it is also expensive, time-consuming, and stigmatizing, and it puts more of a burden on patients and caregivers than seizure monitoring with wearable technology.
Specific requirements to be met:	The dedicated budget for the solution is around 50000 euros. The proposed software part of the solution should be based on Python programing language. Accuracy of predicting epileptic seizures has to be over 92%.