Dirbtinio intelekto sistemų inžinerija

Projektų inžinerijos vaidmuo kuriant DI sprendimus. Projekto tikslų ir sėkmės kriterijų apibrėžimas

Artificial Intelligence System Engineering

The role of project engineering in AI development. Defining project objectives and success criteria

- **Project engineering** includes all parts of the design of manufacturing or processing facilities, either new or modifications to and expansions of existing facilities

- **Project engineering** - managing complex resources and processes, particularly when physical and technical elements are crucial to project outcomes (*PMBOK® Guide* (2021))

- **Project engineering in AI** involves the integration of engineering principles with project management to ensure successful development and deployment of AI solutions
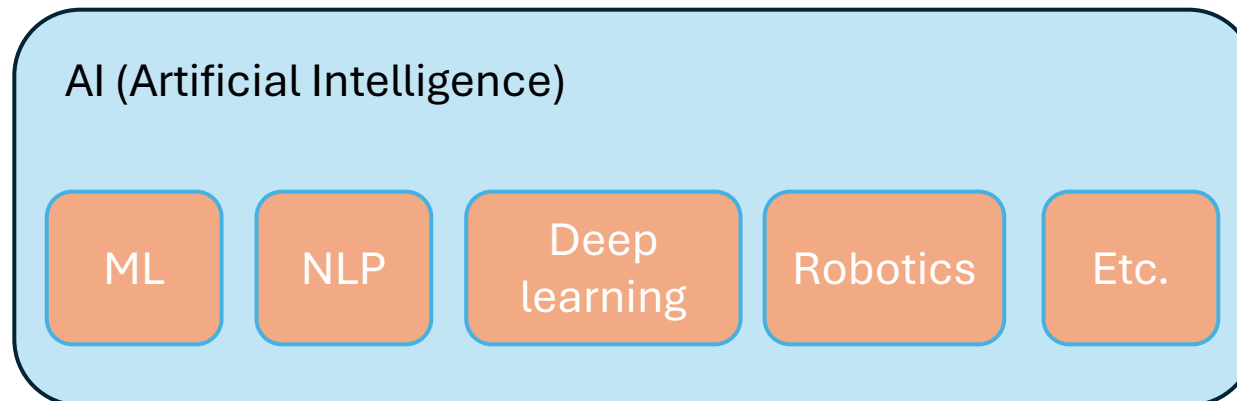
AI and ML Project complexity

- Unrealistic expectations of what AI can do - the fastest way for a project to fail is when executive or business leaders think that AI can solve all their problems;

- Technological knowledge does not mean that Your project will succeed;

- It's claimed that 85% of ML projects fail (Gartner 2018), and there are increasing concerns that ML is being applied unethically and harmfully (Bender et-al 2021).

- Everyone sees only the end result, so called "eye candy". However, ML Projects are far more complex than usual System engineering project and their management (and they are complex on their own)

Understanding AI and ML

ML is **an application of AI** that allows machines to extract knowledge from data and learn from it autonomously
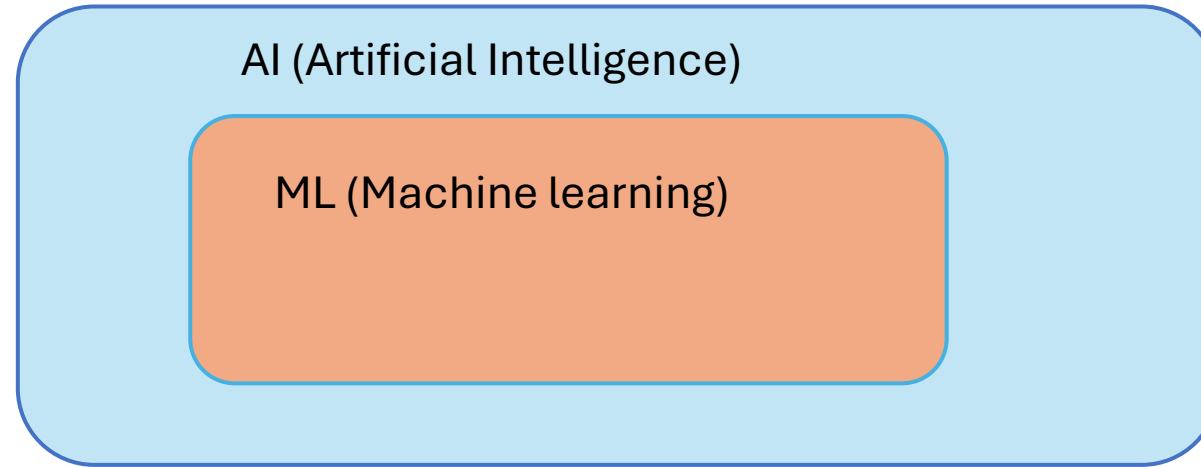
AI is **the broader concept** of enabling a machine or system to sense, reason, act, or adapt like a human

AI (Artificial Intelligence)

ML (Machine learning)

AI (Artificial Intelligence)

ML | NLP | Deep learning | Robotics | Etc.

Understanding AI and ML

- Artificial intelligence is a broad field, which refers to the use of technologies to build machines and computers that have the ability to mimic cognitive functions associated with human intelligence, such as being able to see, understand, and respond to spoken or written language, analyze data, make recommendations, and more.

- Although artificial intelligence is often thought of as a system in itself, it is a set of technologies implemented in a system to enable it to reason, learn, and act to solve a complex problem.

Understanding AI and ML

- <u>Machine learning</u> is a subset of artificial intelligence that automatically enables a machine or system to learn and improve from experience. Instead of explicit programming, machine learning uses algorithms to analyze large amounts of data, learn from the insights, and then make informed decisions.

- Machine learning algorithms improve performance over time as they are trained—exposed to more data. Machine learning models are the output, or what the program learns from running an algorithm on training data. The more data used, the better the model will get.

Artificial intelligence

- AI allows a machine to simulate human intelligence to solve problems
- The goal is to develop an intelligent system that can perform complex tasks
- We build systems that can solve complex tasks like a human
- AI has a wide scope of applications
- AI uses technologies in a system so that it mimics human decision-making
- AI works with all types of data: structured, semi-structured, and unstructured
- AI systems use logic and decision trees to learn, reason, and self-correct

Machine Learning

- ML allows a machine to learn autonomously from past data
- The goal is to build machines that can learn from data to increase the accuracy of the output
- We train machines with data to perform specific tasks and deliver accurate results
- Machine learning has a limited scope of applications
- ML uses self-learning algorithms to produce predictive models
- ML can only use structured and semi-structured data
- ML systems rely on statistical models to learn and can self-correct when provided with new data

Project objectives

Project objectives

- Translate business problems into research questions that align with measurable business metrics;
- AI project objectives should be tied closely to business goals rather than just technical metrics, such as RMSE, which may not directly indicate business success;

Key Roles in AI Projects

- Designing system architectures
- Overseeing data integration, processing, and scalability
- Managing cross-functional teams (e.g., data scientists, engineers, stakeholders)
- Ensuring compliance with regulatory and ethical standards

It is critical to define project objectives in AI

Objectives clarify the project's purpose and align technical development with business needs.

Well-defined objectives guide the AI model's design, feature selection, and evaluation processes.

Define objectives that are **Specific, Measurable, Achievable, Relevant,** and **Time-bound (SMART)**.

Collaborate with stakeholders to ensure objectives reflect organizational goals

It is critical to define project objectives in AI

- Business objectives are foundational in ML projects and should be identified before beginning development. ML systems designed for business use must connect with business objectives, translating these objectives into ML-specific goals, like influencing key business metrics (e.g., revenue or user engagement

- Identifying business objectives is a crucial first step in AI projects, as projects are often funded to achieve specific, strategic outcomes. A clear understanding of the business's exact goals ensures alignment, preventing wasted resources on irrelevant tasks

Establishing Success Criteria

- Success criteria are the standards used to measure project success in relation to the defined objectives.

- **Key Types of Success Criteria in AI Projects:**
  - **Strategic Alignment**: Success depends on project alignment with organizational goals and the creation of measurable value
    - **Business Impact Metrics:** Revenue growth, customer engagement, operational efficiency, reduced customer churn, increased sales, customer satisfaction, productivity improvements, cost reduction
    - **Defined KPIs:** Leading and lagging indicators, such as on-time deliverables, budget adherence, and project milestone completion rates

- **Key Types of Success Criteria in AI Projects:**
  - **Stakeholder Alignment**: how well the AI solution meets stakeholder-defined goals
  - **Compliance and Risk Reduction:** Metrics related to regulatory compliance or risk mitigation
  - **Model Performance Metrics:** Accuracy, recall, precision, F1 score (as relevant to technical success).
  - **Model Utility and Scalability**: Success involves the model's practical impact, its scalability, and adaptability to real-world data
  - **Quality Assurance and Monitoring**: maintain AI performance over time through quality metrics like accuracy, precision, and recall. Meet defined quality standards and ensure the system's reliability and scalability for long-term us

Aligning Objectives and Success Criteria with Business Goals

- **Challenges in AI Projects:**
  - Ensuring objectives are actionable and linked to tangible business outcomes.
  - Avoiding technical-only metrics (like model accuracy) that may not reflect business value.
- **Strategies:**
  - Engage business stakeholders early to determine relevant success metrics.
  - Use a **Value Delivery Framework** to connect AI deliverables to business value.
  - Regularly update objectives and success criteria to reflect evolving goals and project learning.

Project Engineering Approach to AI Success

- **Project Engineering Phases in AI Development:**
  - **Planning Phase:** Define clear objectives, requirements, and resources.
  - **Execution Phase:** Implement rigorous monitoring of AI model training, testing, and performance.
  - **Evaluation Phase:** Use established criteria to assess if AI models meet success thresholds.
  - **Key Engineering Contributions:**
    - Architectural design for scalability.
    - Process management to handle iterations in model development.
    - Risk assessment and mitigation, particularly for AI-specific risks (e.g., model drift, bias).

Continuous Alignment and Adaptability

- **Ongoing Evaluation:** In AI projects, both objectives and success criteria need regular reassessment due to data and market dynamics.

- **Project Engineering's Role in Adaptation:**
  - Ensure alignment with business strategy through adaptive success criteria.
  - Manage resources and timelines effectively to incorporate iterative changes.
  - Engage stakeholders regularly to refine the project's focus based on insights gained.

Literature

- Veljko Krunic - "Succeeding with AI"
- PMBOK® Guide (2021)
- Klaus Haller - "Managing AI in the Enterprise"
- Chip Huyen - "Designing Machine Learning Systems"