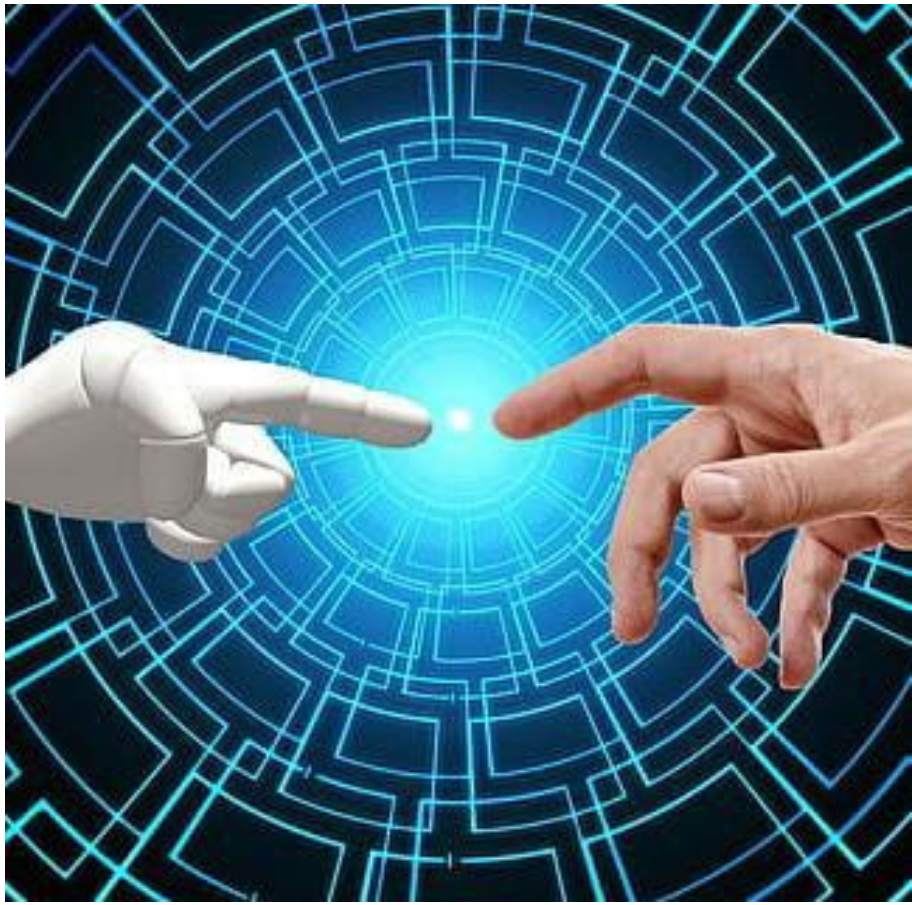
Artificial Intelligence (AI) for Engineering

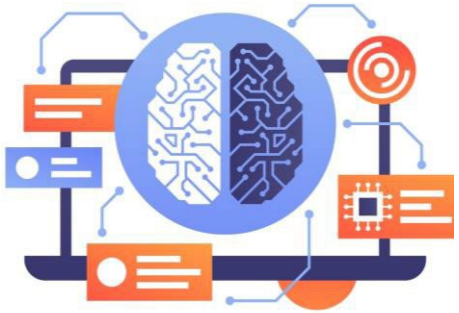


COS40007

Dr. Afzal Azeem Chowdhary

Lecturer, SoCET, Swinburne University of Technology

Seminar 1: 4th March 2025



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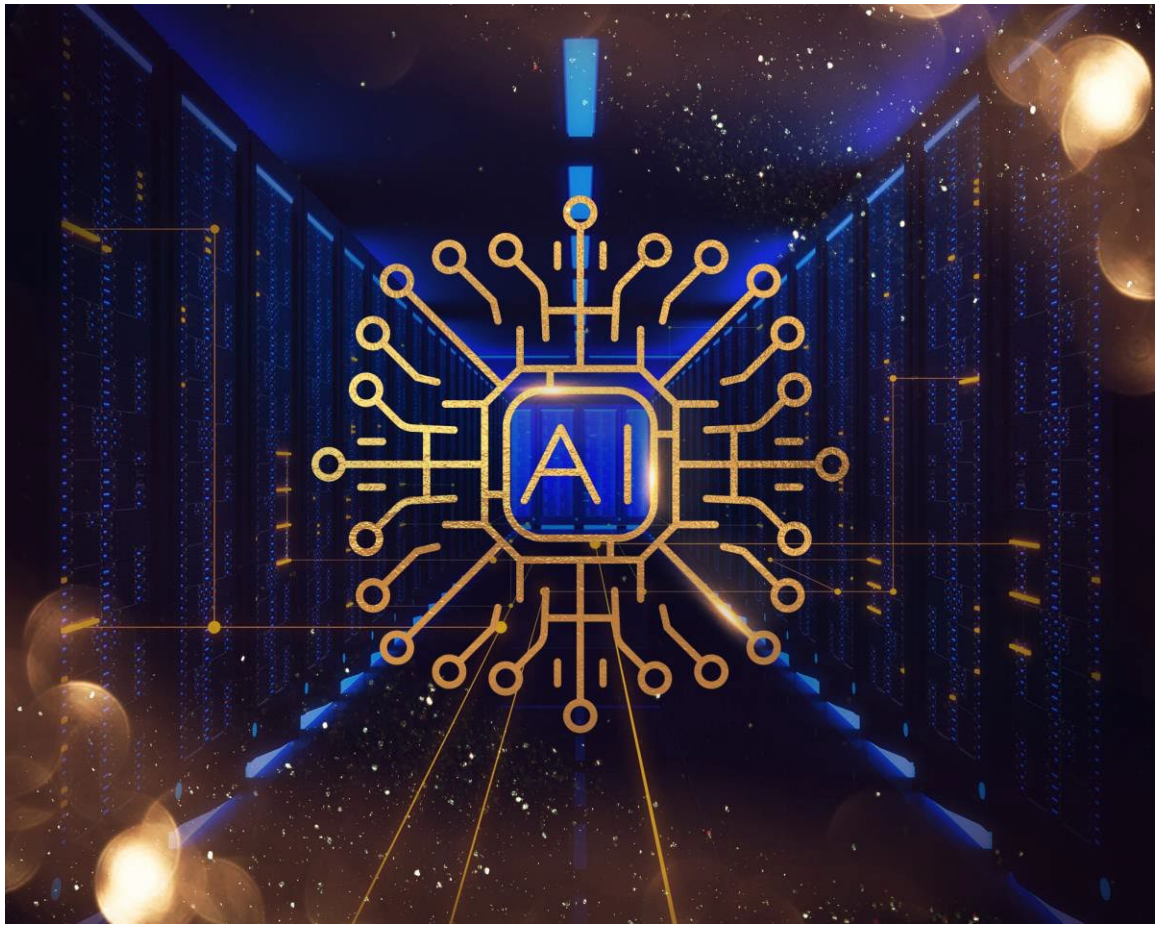
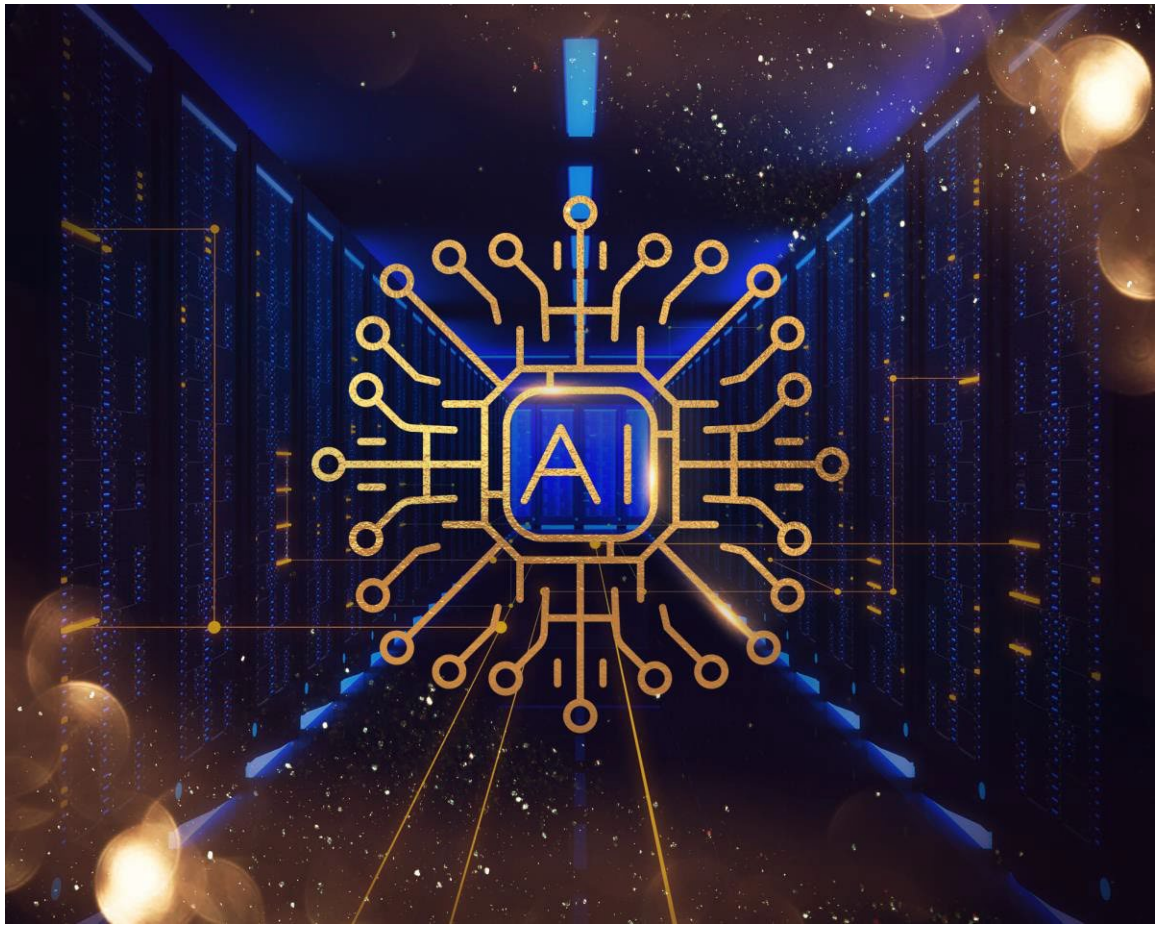
Introduction to Unit and Overview

- ❑ Staff contact
- ❑ Teaching Methods
- ❑ Assessments
- ❑ AI Overview
- ❑ AI in Engineering
- ❑ Applications of AI in Engineering



Required Reading

COS40007 Artificial Intelligence for Engineering Unit outline in Canvas



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At the end of this you should be able to

- Name of your lecturer and know where to find staff contact details
- Summarise the intended learning outcomes for the unit
- List the assessment items for the unit.

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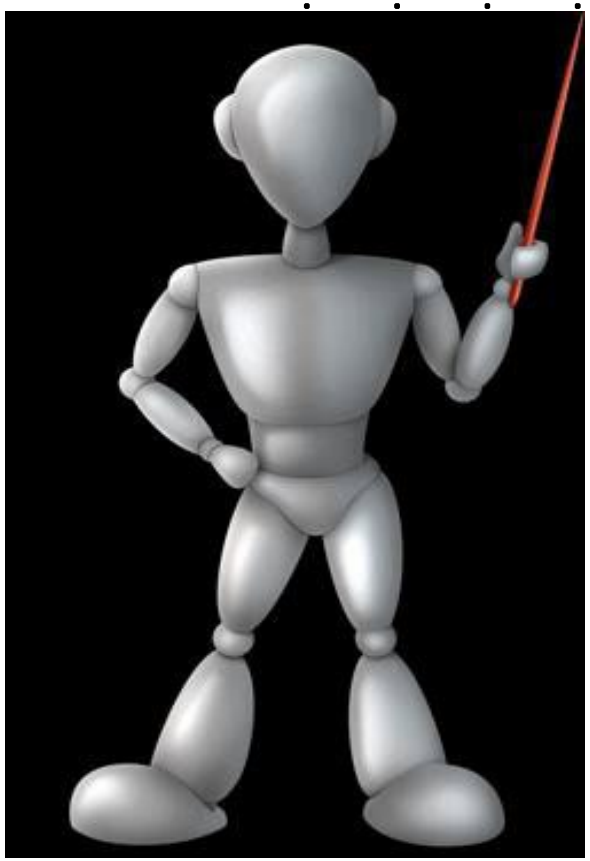
Staff contacts

- Convenor & Lecturer: Dr. Afzal Azeem Chowdhary (achowdhary@swin.edu.au)
- Tutors:
  - Mirza Irfan
  - Shakthi Weerasinghe
  - Abyan Salam
- See canvas for contact details



If you have an administrative question

- Read material supplied in unit outline and on Canvas (readings, seminar notes, studio notes)
- If you cannot find an answer, post your question on Canvas Discussion area
- Email questions/requests if they relate uniquely to your personal circumstance (e.g., sickness)

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Learning management system

- Unit outlines
- Learning materials
- Assessment details and submission
- Contacts
- Discussion board

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Intended Learning Outcomes

1. Design, build and train datasets using machine learning algorithms to solve multidisciplinary engineering problems
2. Demonstrate knowledge of a range of AI, machine learning and deep learning algorithms and their applications
3. Assess, appraise and justify appropriate AI techniques to solve computational engineering problems
4. Communicate effectively and succinctly through oral presentations and reports

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Graduate Attributes

1. GA1 Communication - Verbal communication
2. GA2 Communication - Communicating using different media
3. GA3 Teamwork - Collaboration and negotiation
4. GA4 Teamwork – Teamwork roles and processes
5. GA5 Digital Literacies– Information literacy
6. GA6 Digital Literacies– Technical literacy

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Teaching methods

- Seminar: 1 hour
  - Will be delivered In-person and recording will be available through Echo
  - Time: Tuesdays 5:30-6:30 PM - EN715
- Studio: 2 hours
  - Face to Face
  - Exercises
  - Portfolio Assignments and Design Project Work
- Consultation: 1 hour
  - Via MS teams/Collaborative Ultra
- Independent Learning
  - 8-10 hours weekly -> take ownership of your learning

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Resources

- Book
  - Applied AI/ML foundations:
    - Prosise, Jeff. Applied machine learning and AI for engineers. " O'Reilly Media, Inc.", 2022.
  - Python for ML and DL
    - Raschka, Sebastian, Yuxi Hayden Liu, and Vahid Mirjalili. Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python. Packt Publishing Ltd, 2022
    - Kapoor, Amita, Antonio Gulli, Sujit Pal, and Francois Chollet. Deep Learning with TensorFlow and Keras: Build and deploy supervised, unsupervised, deep, and reinforcement learning models. Packt Publishing Ltd, 2022.
- Library: online Reserve, databases, catalogue, referencing workshop
- Web (look for electronic resources on Canvas and studio materials)

Prerequisites

- Technical Experience
  - Introduction to Programming
- Willingness to learn more programming and software tools
  - Python and related ML libraries

Assessments

➢ Portfolio: 40%

- 8% each from Weeks 2 to 6.
- Submission Due in the following week

➢ Design Project: 60%

- Project Brief: 3%
- Progress Report: 12%
- Presentation: 5%
- Solution Design and Development: 30%
- Final report: 10%

The tutor will assess your work after the due date. It must be marked in person during Studio times the following week (not for Week 2 submissions). Portfolio work that is more than one week late will not be assessed.
For Project Work, students must contact their Tutors to show their Progress during Weeks 8 to 10. Failure to do so will result in marks being deducted, and the Tutor will decide.

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AI concepts

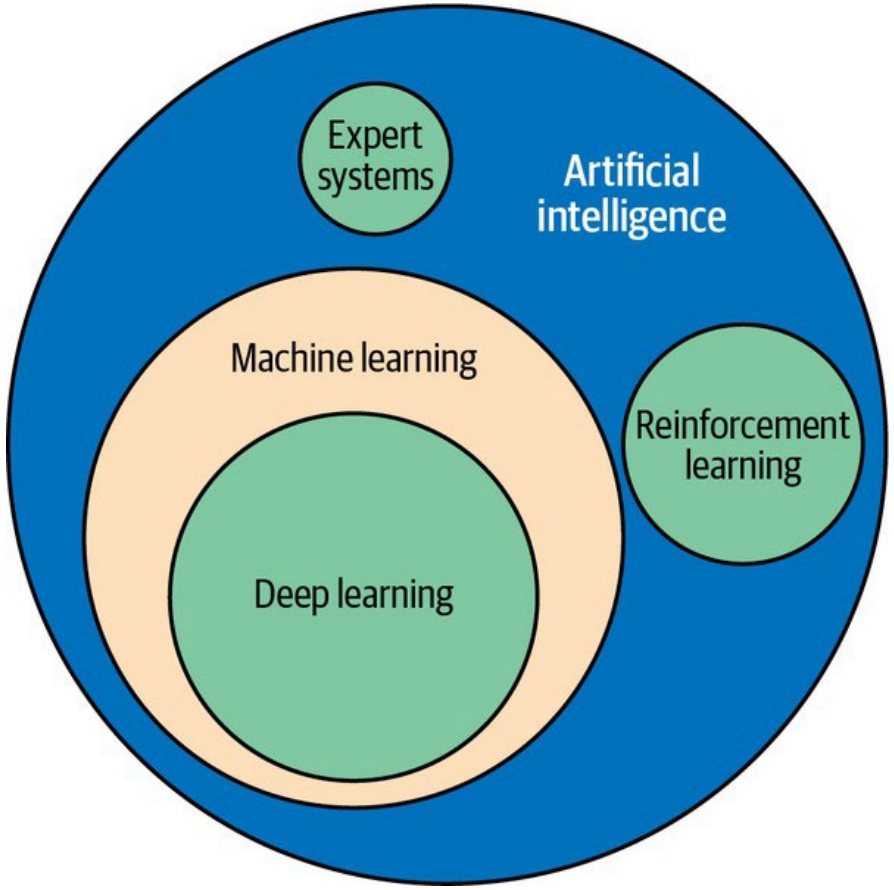
Concepts

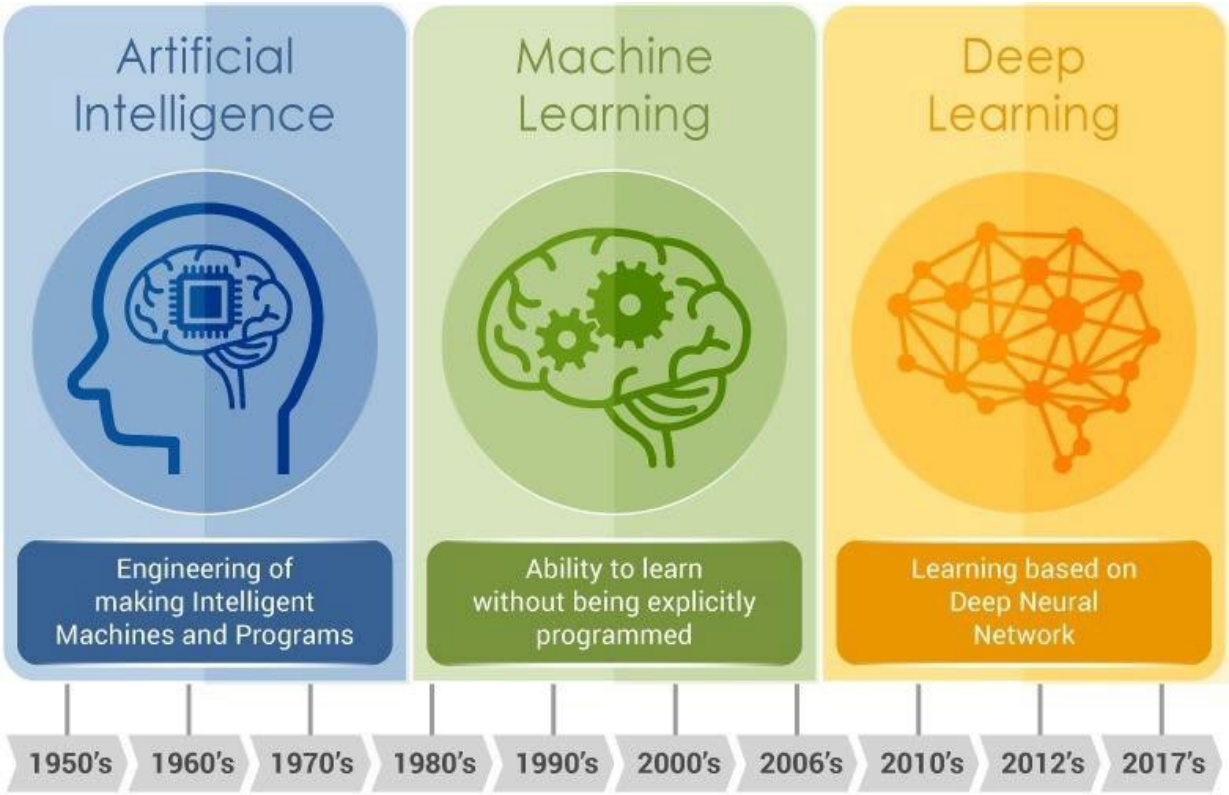
Artificial Intelligence (AI) plays many roles in Engineering. One of the most common subsets of AI is Machine Learning (ML)

Engineering process relies on AI to integrate data, analyse it, and produce the deep insights and predictions that help drive better decision-making. ML is the type of AI that requires big datasets to identify patterns and trends, then uses them to build models that predict future.

AI, ML and DL

- Machine Learning (ML) is a subset of Artificial Intelligence (AI)
- Deep Learning (DL) is a type of ML that use deep neural network
- Expert systems: Systems that makes decision based on defined rules
- Reinforcement learning: Learn behaviours by rewarding/penalising





AI, ML and DL

- Machine Learning (ML) is a subset of Artificial Intelligence (AI) technique
- Deep Learning (DL) is a type of ML that use deep neural network

Machine MIMIC Human Behaviour (Robot)	Train Machine to improve experience (mimic training)	Multilayer Neural Network (mimic neuron)

AI in Engineering

- Machines with AI work alongside with Human make things better, quicker, and smarter.
- Human and Machines with AI capability work together, interact and collaborate
- Both Human and AI use their capability to have an impact on the Engineering system/process
- AI empowers humans to perform additional or enhanced activities and provide feedback (data, information, etc) to them
- Human also augment the AI by enhancing, informing, controlling or training it.

AI offers insights from Data

Human provide feedback
(labelling cases, controlling machine settings)

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AI for Engineers

- Engineers' capabilities are influenced by AI. e.g., Engineer learn and make decision based on AI recommendations
- Engineers use AI to make better choices, improve processes, and even think of new ideas
- AI-enabled engineering systems/process can learn more efficiently or expand their knowledge range through their interaction with engineers

Impact of AI in Engineering

- Drive efficiency in production process
- Improve plant's productivity
- Enhance product consistency and quality
- Safer workplace
- Reduce unscheduled machine maintenance
- Optimise Inventory management
- Improve sustainability and energy consumption
- Reduce maintenance cost

AI applications: Civil Engineering

- AI helps engineers to design roads, bridges, and buildings more efficiently. E.g., Predict when a bridge needs fixing
- Road and Roadside infrastructure maintenance. E.g., automatically detect Road infrastructure issues
- Automate construction process (e.g., 3D printing)
- Monitor structural health of buildings

Example dataset for exercise: cement manufacturing

AI applications: Mechanical Engineering, Robotics

- Make machine intelligent to perform autonomous tasks. E.g., Robots, Autonomous cars
- Predictive maintenance: AI can look data from machines and predict next failure of a component or machine and alert engineers to perform maintenance to prevent such failure
- Product Quality: AI can check if products coming off an assembly line are perfect or if they have any defects, ensuring better quality.
- Process optimization: AI can find the best ways to manufacture things, making the process faster and cheaper.

Example dataset for exercise: Fault diagnosis problem of electromechanical device

AI applications: Electrical and Electronics Engineering

- AI-enhanced smart energy monitor makes electricity distribution more reliable and efficient.
- Smart Grid: Detect and react local changes in usage
- Predictive maintenance: Monitor data from electrical devices and predict failure
- Electronics manufacturing: AI algorithms assist in identifying and correcting manufacturing inefficiencies, reducing waste, and ensuring that each component meets the highest standards of quality and performance.
- Renewable Energy: AI algorithms analyse weather patterns, predict energy supply from renewable sources, and optimize their integration

Example dataset for exercise: Combined cycle power plant

AI applications: Biomedical Engineering

- Diagnose diseases more accurately
- Personalise treatment plan
- Predict disease outbreaks

Example dataset for exercise: Breast cancer diagnosis

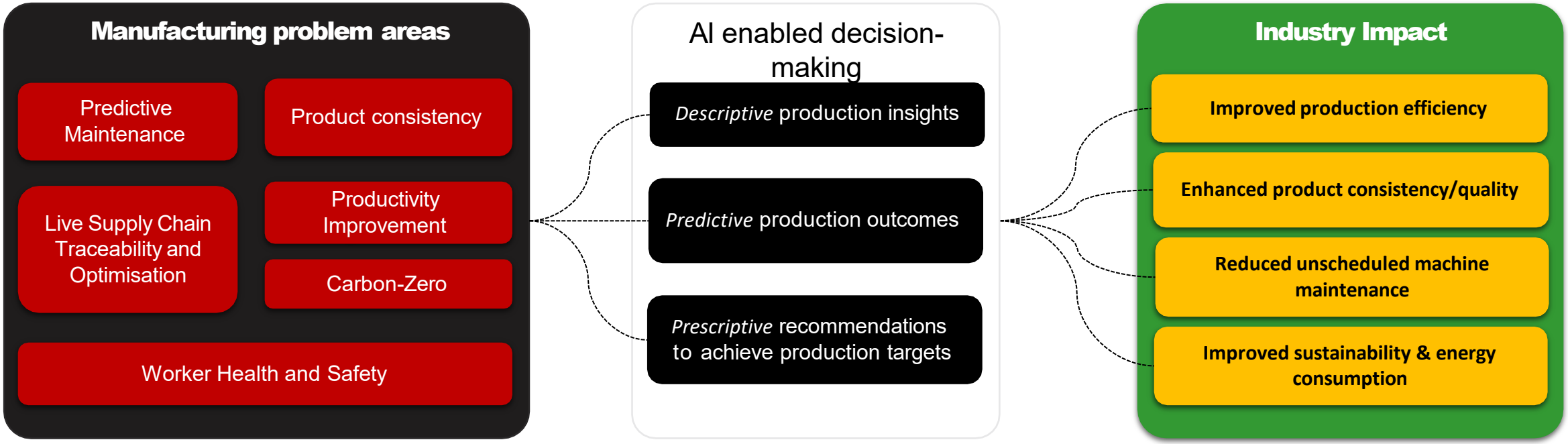
AI applications: Water Engineering

- Predicting and Managing Water Resources
- Water Demand Forecasting
- Smart Irrigation Systems
- Leak Detection and Prevention
- Wastewater Treatment

Example dataset for exercise: Water Quality

Digital Manufacturing in Product design

Digital Manufacturing – Bringing together machines, people, process and products underpinned by AI and IoT technologies to make our industry globally competitive



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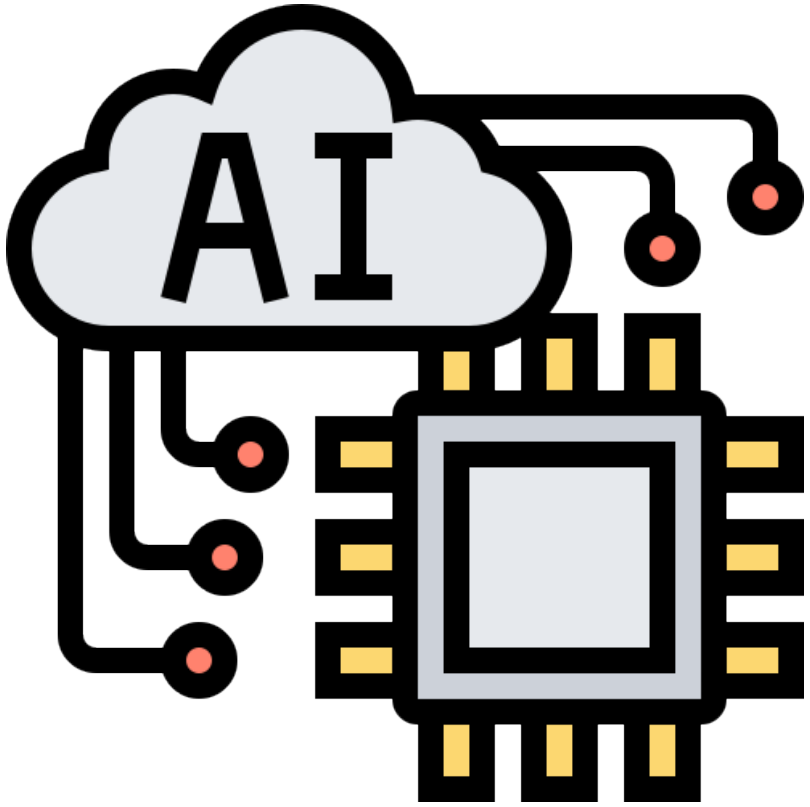
Learn, Practice and Enjoy the AI journey



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