

Artificial intelligence and machine learning in education

Why? What? How?

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Introduction

- Machine learning (ML) and artificial intelligence (AI) are pervading every part of our lives.
- Everyone needs to understand the opportunities, issues and threats provided by AI

This seminar will attempt to answer:

- How should we incorporate new challenges associated with rapid developments in artificial intelligence and machine learning into school learning and curricula?

By drawing on findings from:

- EDUsummIT 2019 -

Webb, M. E., Fluck, A., Magenheim, J., Malyn-Smith, J., Waters, J., Deschênes, M., & Zagami, J. (2020). Machine learning for human learners: opportunities, issues, tensions and threats. *Educational Technology Research and Development*. doi:10.1007/s11423-020-09858-2

- ZD Webinar 1 (IFIP TC3): “Social Impacts of Big Data Analysis and Machine Learning – Educational Implications”. <https://zanzibardeclaration.cicei.org/mod/page/view.php?id=17>
- “Informatics Curriculum Framework for School” informatics for all (I4ALL) www.informaticsforall.org/

Why?

How AI is impacting our lives?



“In many walks of life, artificial intelligence is now seen as a field of research and development that will significantly transform many aspects of the economy as well as daily lives. From this perspective, it is desirable that a study of Informatics should acquaint pupils with these developments but especially as they may affect their future. Exploring and discussing these developments will inspire pupils and motivate them to examine how to create a better society.” (I4ALL, 2023).



Why?

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Machine learning in education

Mary Webb¹, Andrew Fluck², Silvia Kheirallah³, Irene Lee⁴, Johannes Magenheim⁵, Joyce Malyn-Smith⁶, Guillaume Paré⁷, Raymond Trippe⁸, Juliet Waters⁹, Jason Zagami¹⁰, Michelle Deschênes¹¹

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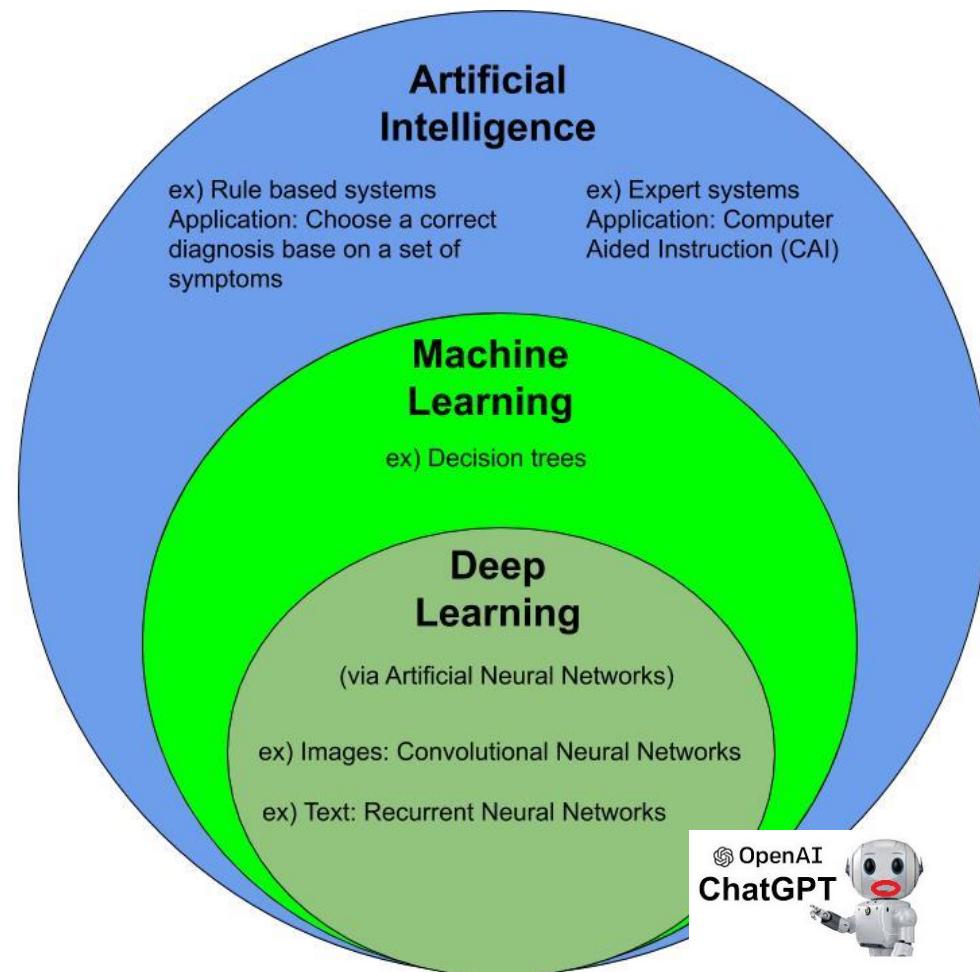
¹⁰Griffith University, Australia

¹¹Laval University, Québec, Canada

Why
machine
learning?

Webb, M. E., et al. (2021). "Machine learning for human learners: opportunities, issues, tensions and threats." *Educational Technology Research and Development* **69(4): 2109-2130.**

Key Concepts



EDUsummIT 2019
Understanding
machine learning
concepts

Expert systems young learners

For expert systems
being able to explain
their decisions was
crucial

Fully transparent

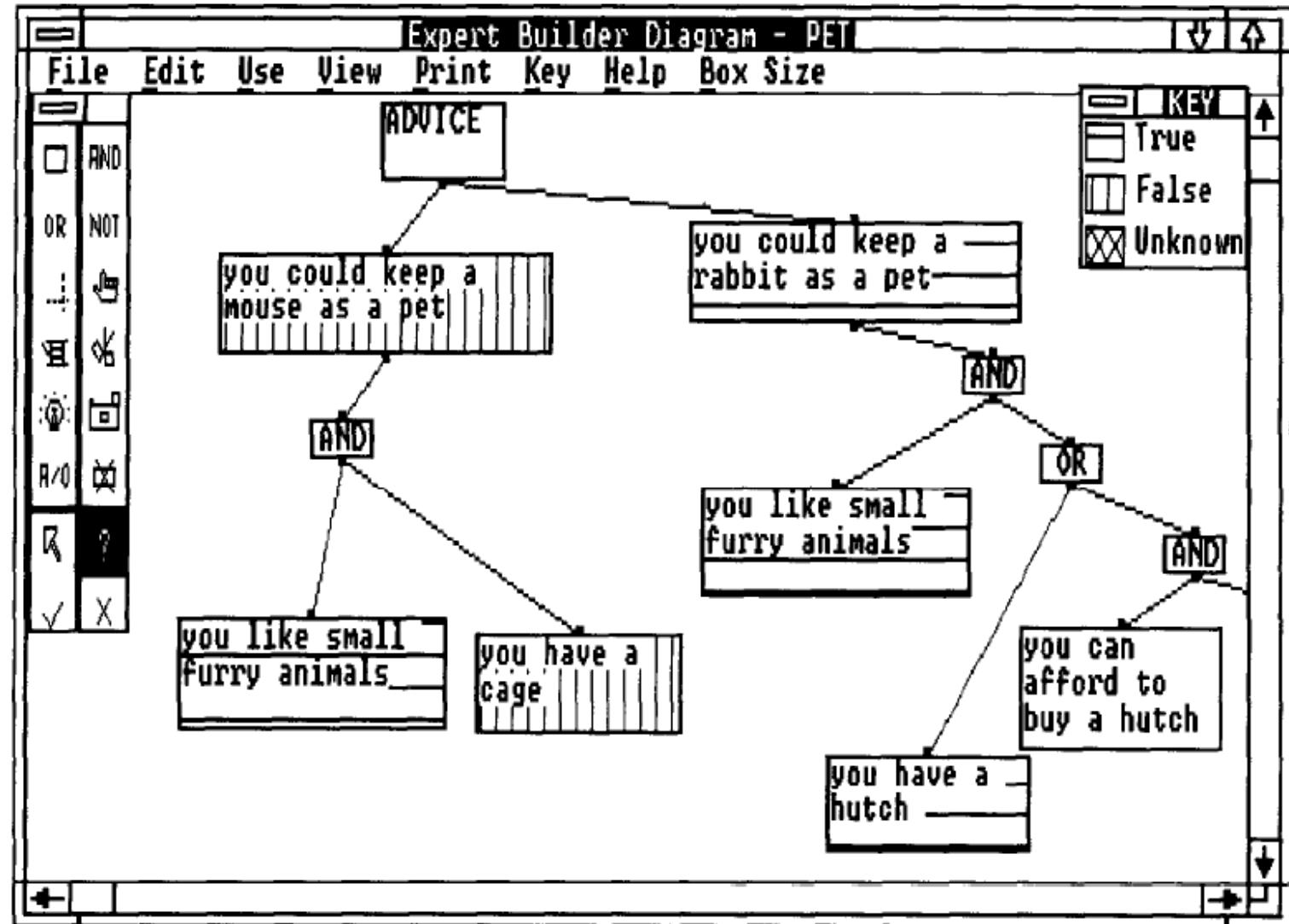
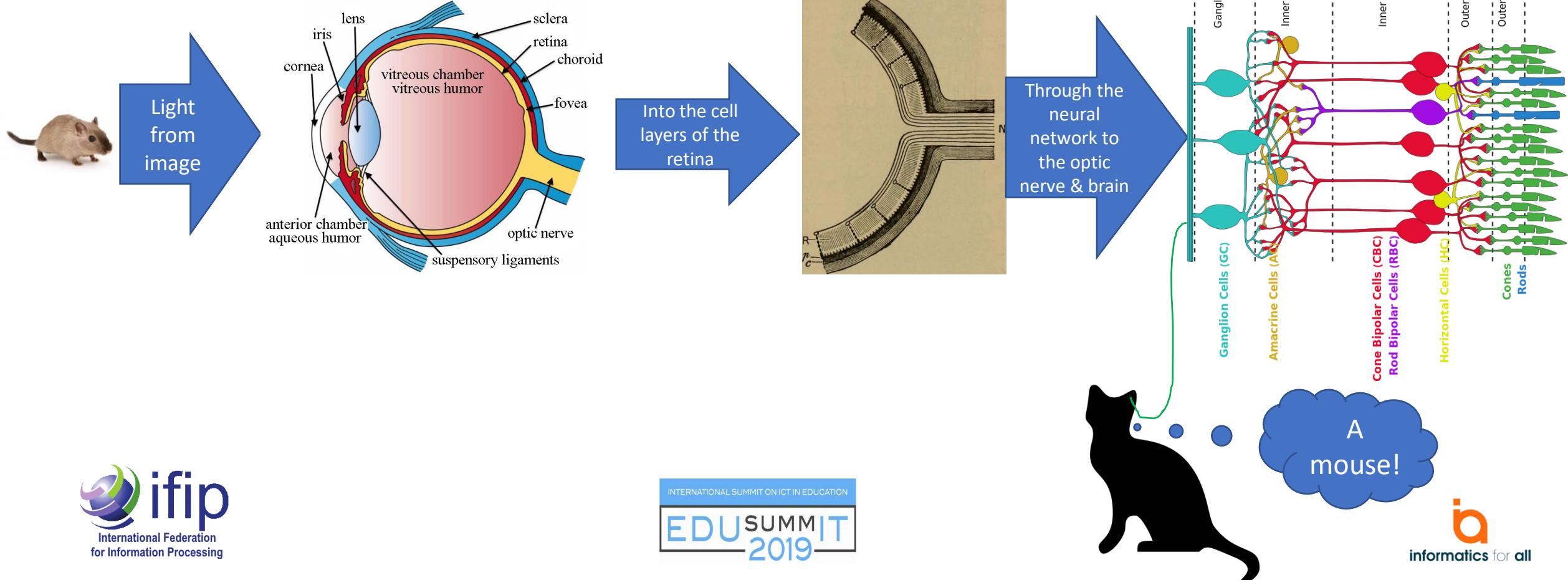
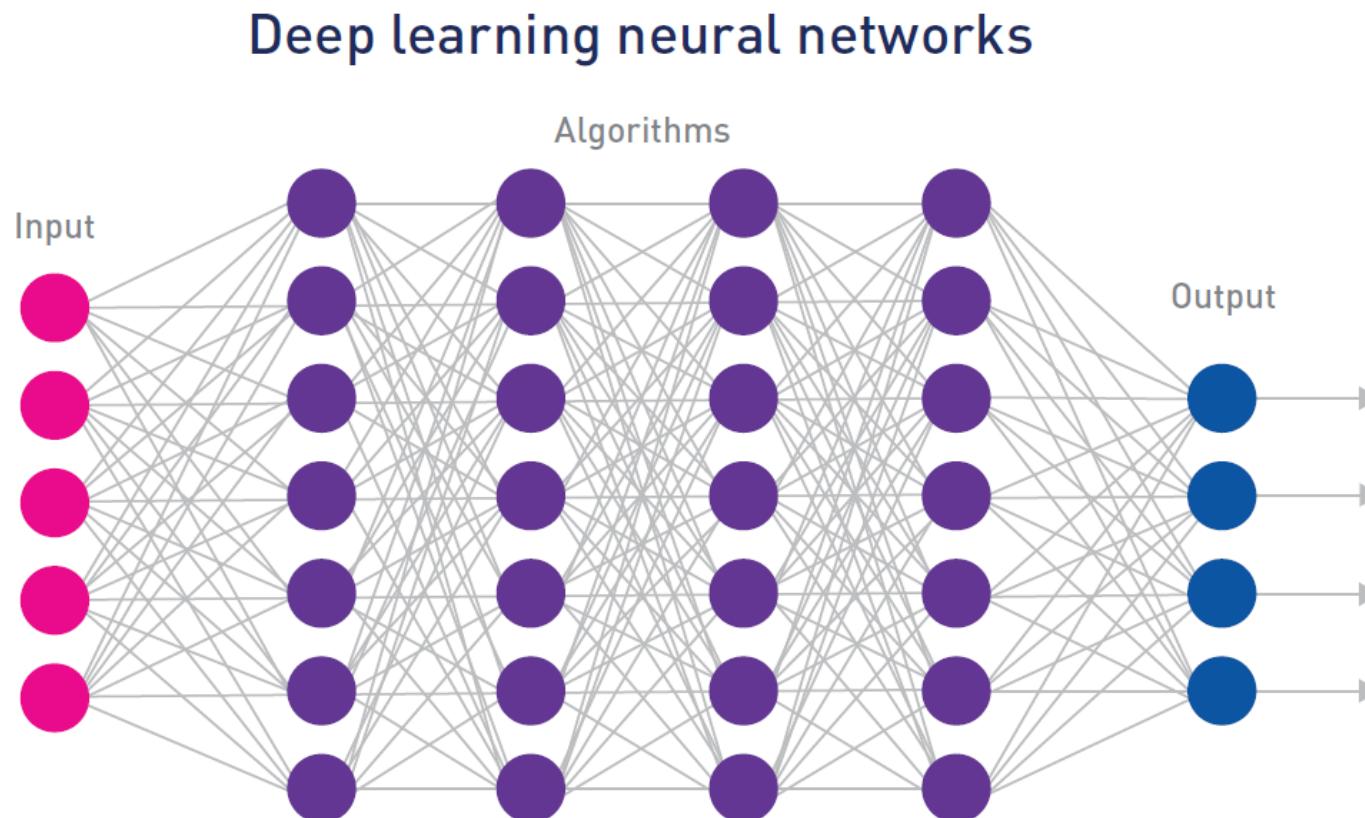


Fig. 2. The diagrammatic trace of the inference process.

How does a cat recognise a mouse?



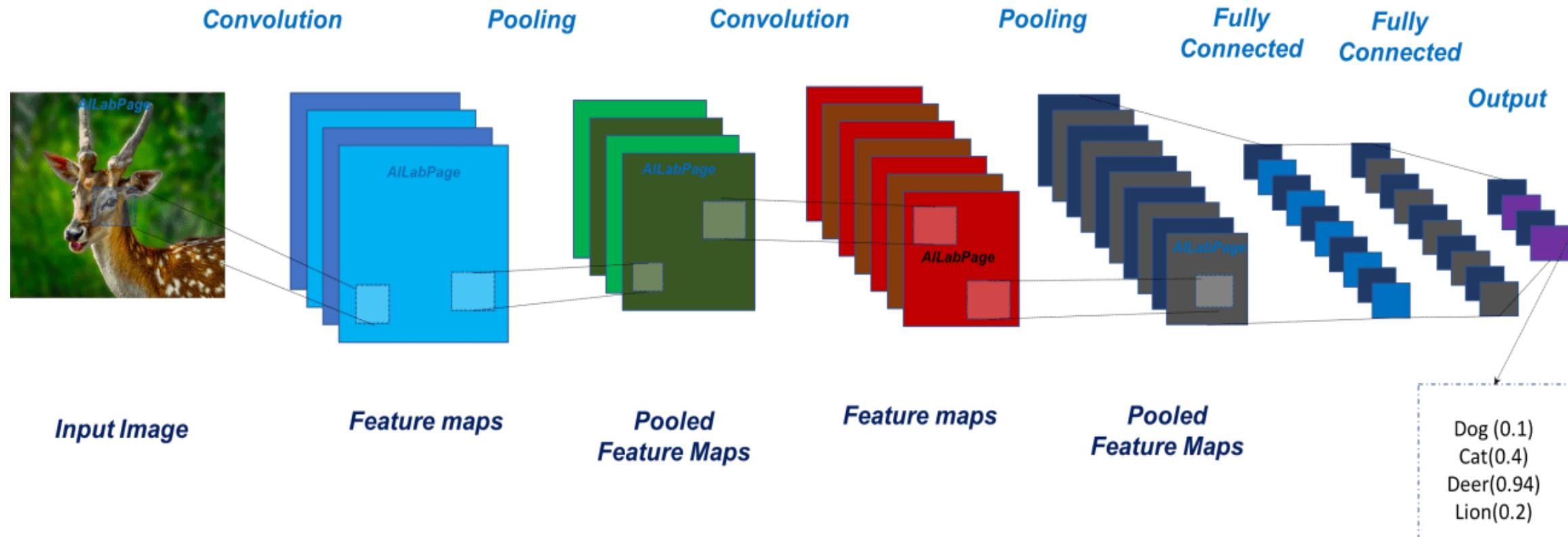
We can implement neural networks in software



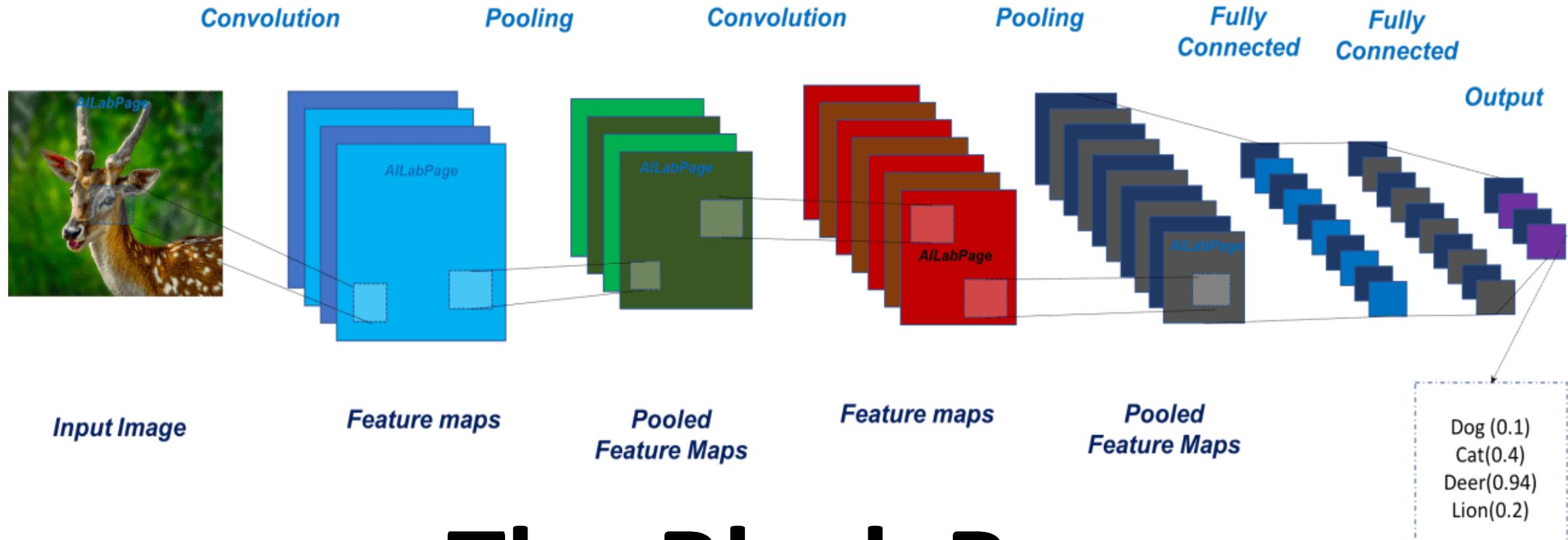
Key differences between Artificial Neural Networks (ANNs) and Human Neural Networks (HNNs)

1. Complexity
2. Structure and Function
3. Learning Process
4. Energy Efficiency
5. Speed
6. Robustness and Fault Tolerance
7. Transparency and Interpretability
8. Memory Storage
9. Generalization

E.G. Image processing – Convolutional Artificial Neural Network



E.G. Image processing – Convolutional Artificial Neural Network



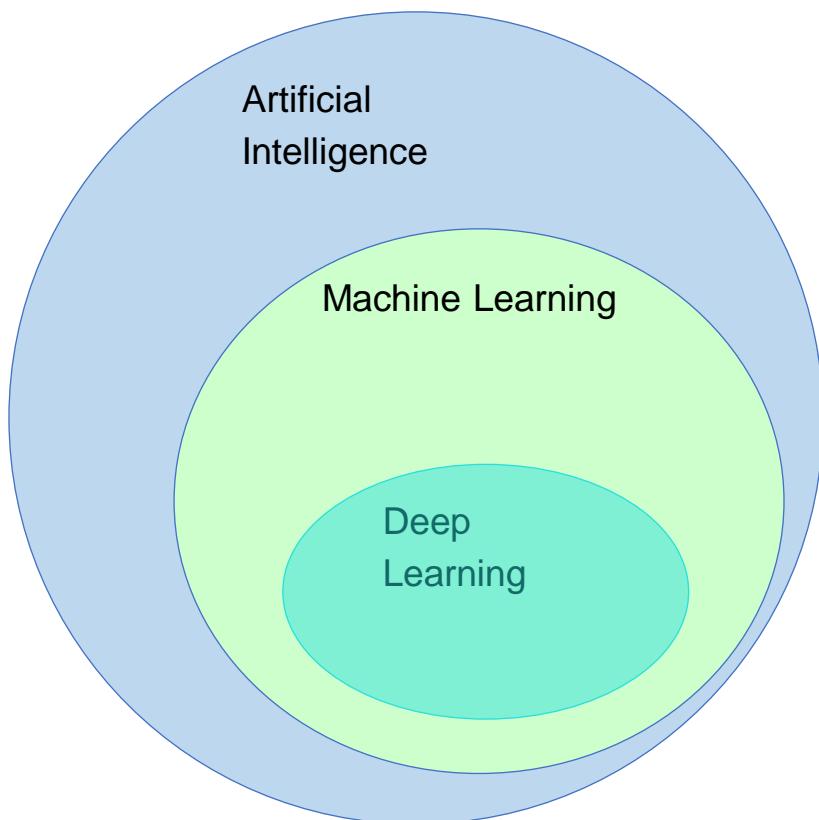
The Black Box

EDUsummIT 2019

Machine Learning – major challenges

- Explainability – black box problem
- Accountability – ethics, bias, who is accountable?

Understanding machine learning concepts



- What machine learning concepts should be understood by students and teachers?
- How do we make these accessible to teachers and students?
- By shifting the question from “how to program computers” to “how to allow them to program themselves,” (Mitchell 2006), machine learning is reshaping our view of computer science and thus computer science education

Recommended Strategies EDUsummit 2019

for policymakers (po), practitioners (pr), researchers (r), learners (l) and developers (d)

- **Reform curricula** to ensure all students develop a strong background in machine learning (po, pr, r, and/or d).
 - to develop their conceptual understanding of algorithms, models and how machine learning works, students must have opportunities to use and apply machine learning and to create their own examples.
 - need for students to understand how machine learning can be used to identify and solve real-world problems
- Identify and define **emerging literacies for machine learning, algorithm, data/big data, and modeling** (pr, and/or r).
- Report on the status of policy and practice of machine learning in education across countries around the world (r).
- **Update policies and practices to keep pace with developments in the field** (po, pr and r).
- **Develop a Code of Conduct for machine learning** in education for users and developers (po, pr, and r)
- Provide machine learning **professional development** and resources for teachers, educational leaders and other key stakeholders to support education reform (po, pr, r, and/or d)
- **Support educators and learners to conduct risk analysis for use of machine learning** (po, pr, l, and/or d).

Learning about machine learning

Literacies are needed to enable everyone to:

- understand the nature of the machine learning processes that may be supporting their own learning
- act as responsible citizens in contemplating the ethical issues that machine learning raises.

Learn about machine learning through practical examples:

- <https://machinelearningforkids.co.uk/#!/about> (IBM)
- <https://teachablemachine.withgoogle.com/> (Google)
- <http://cognimates.me/home/>

But overcoming the black box issue is more challenging:

- Jatzlau, S., et al. (2019). It's not Magic After All-Machine Learning in Snap! using Reinforcement Learning. 2019 IEEE Blocks and Beyond Workshop (B&B), IEEE.
- Broll, B. and S. Grover (2023). "Beyond Black-Boxes: Teaching Complex Machine Learning Ideas through Scaffolded Interactive Activities." Proceedings of the AAAI Conference on Artificial Intelligence 37(13): 15990-15998.

I4ALL Informatics Reference Framework

<http://informaticsforall.org>

- This is at a higher level than any curriculum document but it should offer guidance and challenge to those designing curricula
- Education is a devolved matter in Europe; all countries / educational regions have responsibility for their own curricula
- A group of 8 (chaired by Michael E. Caspersen) was set up to produce the Informatics Reference Framework
 - **ACM Europe:** Judith Gal-Ezer and Andrew McGetrick
 - **Informatics Europe:** Michael E. Caspersen and Enrico Nardelli
 - **CEPIS:** Ira Diethelm and Branislav Rovan
 - **IFIP (TC3):** Don Passey and Mary Webb

I4ALL Informatics Reference Framework

<http://informaticsforall.org>

At the end of upper secondary education, pupils will:

1. **Use** digital tools in a conscious, responsible, confident, competent and creative way.
2. **Understand** the phenomena, concepts, principles and practices of informatics and the multifaceted ways of **applying** them **to model, interpret, and operate** on reality.
3. **Analyse, design, frame and solve** problems by **devising** representations, designing algorithmic solutions and **implementing** these in a programming language.
4. **Develop** computational models to **creatively investigate, understand and communicate about** natural and artificial phenomena and systems.
5. **Identify, analyse and discuss** ethical and social issues associated with computational systems and their use as well as their potential benefits and risks.

I4ALL Informatics Reference Framework

Core topic areas	Description
Data and information	Understand how data are collected, organised, analysed and used to model, represent and visualise information about real-world artefacts and scenarios.
Algorithms	Evaluate, specify, develop, and understand algorithms.
Programming	Use programming languages to express oneself computationally by developing, testing and debugging digital artefacts; and understand what a programming language is.
Computing systems	Understand what a computing system is, how its constituent parts function together as a whole, and its limitations.
Networks and communication	Understand how networks enable computing systems to share information via interfaces and protocols, and how networks may introduce risks.
Human-computer interaction	Evaluate, specify, develop and understand interaction between people and computing artefacts.
Design and development	Plan and create computing artefacts taking into account stakeholders' viewpoints and critically evaluating alternatives and their outcomes.
Digital creativity	Explore and use digital tools to develop and maintain computing artefacts, also using a range of media.
Modelling and simulation	Evaluate, modify, design, develop, and understand models and simulations of natural and artificial phenomena and their evolution.
Privacy, safety and security	Understand risks when using digital technology, and how to protect individuals and systems.
Responsibility and empowerment	Critically and constructively analyse concrete computing artefacts as well as advanced and potentially controversial techniques and applications of informatics, particularly from an ethical and social perspective.

I4ALL Curriculum Framework Section about AI – Key Points

AI is a broad field whose study cuts across many of the core topics of informatics.

Important skills and activities

- Being aware of and recognising instances of “intelligent” behaviour
- Being able to rehearse achievements of recent advances in machine learning, such as decision making, applications in healthcare, robotics, voice recognition, and shaping public opinion.
- Being able to discuss about the future of education, work and life.
- Appreciating the consequences of using data with particular characteristics (e.g., unconscious biases), as well as any important related ethical issues.
- Experimenting with simple AI applications incorporating machine learning.

Understanding

- concepts and various approaches to the development of AI
- the comparison between AI and human intelligence
- applications of AI in the real world including advantages, limitations and implications for society.

AI in Education

Key points from IFIP Webinar on AI

- How do you understand AI: magic or everyday work? To what level will we be able to reveal the 'black box'?
- AI support should empower teachers AND empower learners
- The meanings of key terms have been drifting. Meanings of data science, data mining, machine learning and artificial intelligence are not clear and transparent. Terms must be clarified to avoid misinterpretation in communication between stakeholders from various professional areas.
- Education needs to be holistic and build on diverse interdisciplinary perspectives. Education is not only content knowledge but agency. We must enable students and teachers to work, dream, anticipate the impact of technology.

AI in Education

Key points from IFIP ZD

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Need
explainable
AI?

Explainable AI (XAI)

“the ability to explain or to present in understandable terms to a human”

(Doshi-Velez and Kim, 2017)

- A major field of research
- Many application areas demand XAI
- Should we demand XAI in education?



Current situation of XAI in relation to education (Rachha and Seyam, 2023).

Need for:

- a unified framework for xai in education
- established principles and guidelines for human-in-the-loop XAI systems
- a holistic consideration of incorporating multiple disciplines in XAI design
- identification of associated risk and mitigation

XAI Future Directions for Education – Key points

(Rachha and Seyam, 2023)

- algorithms that provide visual and textual explanations can be helpful
- lack of transparency in the decision-making processes of DNNs
- when an algorithm provides an incorrect explanation, - no established methods for identifying or correcting
- human supervision is necessary when using these algorithms in education.
- interpretability information should be treated as supplementary support
- risks associated with using machine decision making
- compare the performance of different interpretability methods
- shift the focus of interpretability research away from individual algorithms and towards establishing standards for model building.
- may take some time before these technologies are mature enough for widespread use
- collect more data and address issues of data ownership.

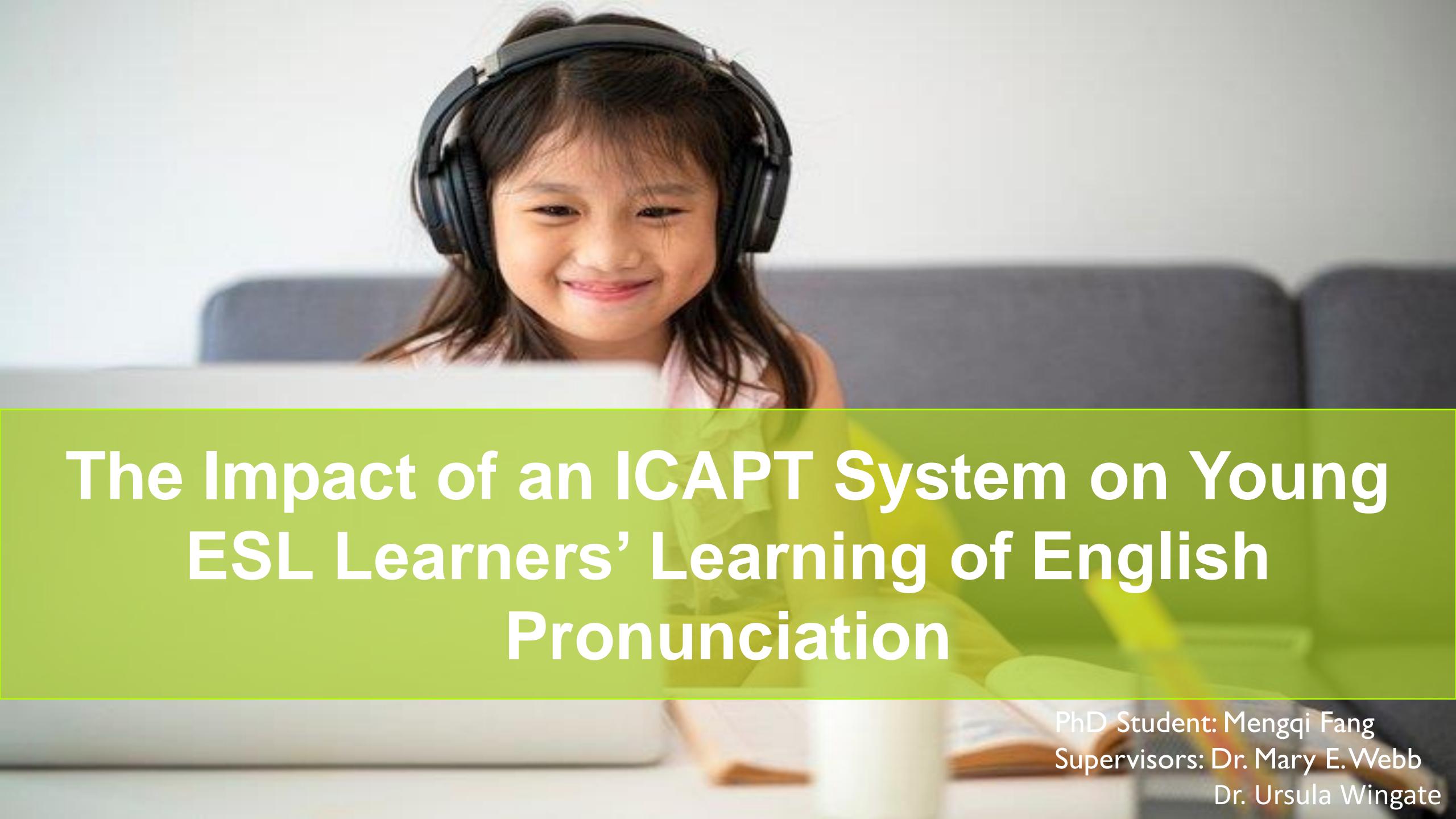
Explaining decisions made with AI - co-badged by the ICO and The Alan Turing Institute

Explanation types

- **Rationale**
- **Responsibility**
- **Data**
- **Fairness**
- **Safety**
- **Impact**



<https://ico.org.uk/for-organisations/uk-gdpr-guidance-and-resources/artificial-intelligence/explaining-decisions-made-with-artificial-intelligence/>

A young girl with long dark hair is wearing large black headphones and smiling. She is sitting at a desk with several books in front of her. The background shows a classroom setting with other desks and chairs.

The Impact of an ICAPT System on Young ESL Learners' Learning of English Pronunciation

PhD Student: Mengqi Fang
Supervisors: Dr. Mary E. Webb
Dr. Ursula Wingate

AI functionalities available in English learning apps for English pronunciation

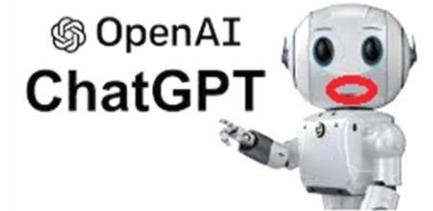
- Automatic evaluation of pronunciation
 - Detection of mispronunciation
- Personalised feedback
- Intelligent human–computer interaction
- Adaptive instruction
- Tracking learning activities

Fang and Webb (2023) Predictive Evaluation of AI Functionalities of Software: a Study of Apps for Children's Learning of English Pronunciation, in press.

Types of AI

1. Weak or specialized AI – e.g.

- recommends TV shows based on viewing history
- helps social services decide whether to deny parental custody
- chats with us about *whatever* on ChatGPT (**Generative AI**)



2. Strong or general artificial intelligence (AGI)

- more humanlike
- ability to replicate itself and learn at mind-blowing speeds
- has infinite potential
- not here yet.

But.....

Some experts are now saying that AGI may be closer than previously thought

- “Given the breadth and depth of GPT-4's capabilities, we believe that it could reasonably be viewed as an early (yet still incomplete) version of an artificial general intelligence (AGI) system”
(Bubeck, S., et al. (2023). "Sparks of artificial general intelligence: Early experiments with gpt-4." [arXiv preprint arXiv:2303.12712](https://arxiv.org/abs/2303.12712).)
- “Contemporary AI systems are now becoming human-competitive at general tasks, and we must ask ourselves: Should we let machines flood our information channels with propaganda and untruth? Should we automate away all the jobs, including the fulfilling ones? Should we develop nonhuman minds that might eventually outnumber, outsmart, obsolete and replace us? Should we risk loss of control of our civilization? Such decisions must not be delegated to unelected tech leaders. **we call on all AI labs to immediately pause for at least 6 months the training of AI systems more powerful than GPT-4”**

<https://futureoflife.org/open-letter/pause-giant-ai-experiments/>

British Computer Society (BCS)

AI open letter to UK Government and Industry (2023)

- AI is not an existential threat to humanity; it will be a transformative force for good if we get critical decisions about its development and use right.
- The UK can help lead the way in setting professional and technical standards in AI roles, supported by a robust code of conduct, international collaboration and fully resourced regulation.
- By doing so, "Coded in Britain" can become a global byword for high-quality, ethical, inclusive AI.

<https://www.bcs.org/sign-our-open-letter-on-the-future-of-ai/>

<https://www.bcs.org/articles-opinion-and-research/helping-ai-grow-up-without-pressing-pause/>

Artificial intelligence: threats and opportunities

European Parliament <https://www.europarl.europa.eu/news/en/headlines/society/20200918STO87404/artificial-intelligence-threats-and-opportunities>

Benefits of AI for People

- Improved healthcare through more accurate diagnostics and personalized treatment
- Safer transportation via advanced vehicle safety features
- Tailored, cost-effective, and durable products and services
- Enhanced access to information, education, and training
- Increased workplace safety through robotic automation in hazardous tasks
- Creation of new job opportunities in evolving AI-driven industries



Opportunities of AI for Businesses

- Development of next-generation products and services
- Boost in sales through data analytics and customer targeting
- Enhanced machine maintenance leading to reduced downtime
- Increased production output and quality
- Improved customer service through AI-driven chatbots and support systems
- Energy conservation through optimized operations

Artificial intelligence: threats and opportunities

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AI Opportunities in Public Services

- Cost reduction in public service operations
- Innovations in public transportation, education, energy, and waste management
- Improved sustainability of products and services



Strengthening Democracy

- Data-based scrutiny to prevent disinformation and cyber-attacks
- Ensured access to high-quality, unbiased information
- Support for diversity and openness, such as unbiased hiring processes

AI, Security, and Safety

- More accurate assessment of prisoner flight risks
- Prediction and prevention of crimes and terrorist attacks
- Advanced defence strategies against hacking and phishing
- Targeting key systems in cyber warfare

Artificial intelligence: threats and opportunities

European Parliament <https://www.europarl.europa.eu/news/en/headlines/society/20200918STO87404/artificial-intelligence-threats-and-opportunities>

Threats and Challenges of AI

Threats to Fundamental Rights and Democracy

- Risk of intentional or unintentional bias in design and data.
- Decisions influenced by sensitive attributes like ethnicity, sex, and age.
- Infringement on the right to privacy and data protection.
- Creation of unexpected data profiles from merging separate pieces of information.
- Online echo chambers stifling pluralistic and inclusive public debate.
- Deepfakes manipulating public opinion and elections.
- AI tracking potentially hampering freedom of assembly and protest.



Underuse and Overuse of AI

- Underuse: Missed opportunities and poor implementation can lead to economic stagnation and reduced competitive edge.
- Overuse: Investment in ineffective AI applications or inappropriate use cases.

Liability Issues

- Unclear responsibility for damages or errors caused by AI systems.

Artificial intelligence: threats and opportunities

European Parliament <https://www.europarl.europa.eu/news/en/headlines/society/20200918STO87404/artificial-intelligence-threats-and-opportunities>

Threats and Challenges of AI (cont.)

AI's Impact on Jobs and Competition

- Distorted competition, with data-rich companies potentially eliminating smaller competitors.



Safety and Security Risks

- Potential loss of human control over AI-enabled weapons due to poor regulation.

Transparency Challenges

- Imbalances in access to information can be exploited.
- Ambiguity in whether interactions are with AI or humans.

12 Challenges of AI

The governance of artificial intelligence: interim report, House of Commons Committee
<https://publications.parliament.uk/pa/cm5803/cmselect/cmsctech/1769/report.html>

- 1) The Bias challenge.
- 2) The Privacy challenge.
- 3) The Misrepresentation challenge.
- 4) The Access to Data challenge.
- 5) The Access to Compute challenge.
- 6) The Black Box challenge.
- 7) The Open-Source challenge.
- 8) The Intellectual Property and Copyright challenge.
- 9) The Liability challenge
- 10) The Employment challenge.
- 11) The International Coordination challenge.
- 12) The Existential challenge.

AI: threats and opportunities in Education

AI Benefits To Education

- Adaptation and personalisation (Rajagopal et al. 2017)
 - personalised learning perhaps with assistive tutors
 - recommending courses or resources based on students' characteristics
 - recommending groupings to teachers or students
- Predicting students' grades or behaviours (Han et al. 2011; Livieris et al. 2019)
- Interacting with students to provide feedback.
- Measuring learners' engagement (Dewan et al. 2019).
- Analysing student interactions in online systems especially in MOOCs (Alenezi and Faisal 2020).
- Multimodal interaction e.g. voice assistants enable a more natural way of interacting (Kloos et al. 2019)
- Identifying patterns in social interaction and students' behaviours.
- Language learning e.g. Duolingo
- Reading assistant (chat bot) e.g. Amira
- Scaffolding the development of self-regulated learning - hybrid human-AI regulation (Molenaar, 2022).

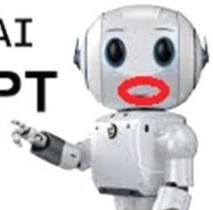
AI: threats and opportunities in Education

AI Benefits To Education

CHATGPT - Create a succinct bulleted list of AI Benefits To Education

- - Personalized Learning: Tailored curriculum and resources for individual student needs.
- - Automated Grading: Saves teachers' time and provides instant feedback to students.
- - Data-Driven Insights: Enables educators to identify learning gaps and adapt teaching methods.
- - Virtual Classrooms: Expands access to education, regardless of geographic location.
- - Enhanced Engagement: Gamification and interactive platforms keep students engaged.
- - Resource Optimization: Allocates educational resources more efficiently.
- - Collaboration Tools: Facilitates group work and communication between students and educators.
- - Accessibility: Supports students with disabilities through specialized tools and resources.
- - Lifelong Learning: Encourages continuous education through adaptive learning platforms.
- - Skill Gap Analysis: Identifies and addresses specific skill deficiencies in students.

OpenAI
ChatGPT



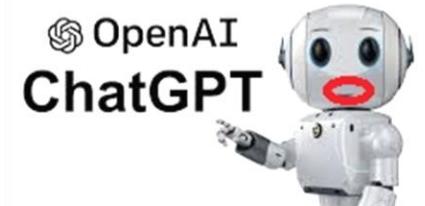
ChatGPT in Education - threats and opportunities

Strengths

- Productivity tool for teachers
- Productivity tool for older students?

Strengths of ChatGPT for students including young learners aged 7-11 (mostly written by ChatGPT)

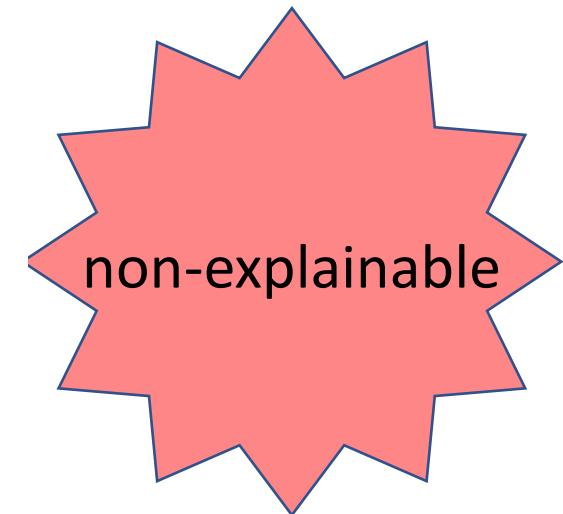
- Adaptability
- Accessible Learning
- 24/7 Availability
- Individualised Support
- Language Development
- Visual Aid Descriptions
- Instant Feedback
- Engaging Practice
- Interactive Learning
- Computer Programming Learning
- Wide Knowledge Base



Remember that while ChatGPT has these strengths, it's important for educators and parents to supervise and guide young learners' interactions to ensure the accuracy and appropriateness of the information being shared.

Swot analysis of using ChatGPT in education

(Farrokhnia, 2023)



Australian Framework for Generative Artificial Intelligence in Schools - Consultation Paper (Key Principles)

1. Teaching and learning

- *Generative AI tools are used to enhance teaching and learning.*

2. Human and social wellbeing

- *Generative AI tools are used to benefit all members of the school community.*

3. Transparency

- *Students, teachers, and schools understand how generative AI tools work, and when and how these tools are impacting them.*

4. Fairness

- *Generative AI tools are used in ways that are accessible, fair and respectful.*

5. Accountability

- *Generative AI tools are used in ways that are open to challenge and retain human agency and accountability for decisions.*

6. Privacy and security

- *Students and others using generative AI tools have their privacy and data protected.*

ChatGPT



Write a succinct account of how chatGPT works. Use bullet points if appropriate

- **Architecture:** Built on the Transformer model, GPT (Generative Pre-trained Transformer) consists of layers of attention mechanisms and feed-forward networks.
- **Training:** Trained on a large, diverse dataset of text from the internet to predict the next word in a sentence.
- **Parameters:** Contains millions to billions of adjustable weights, fine-tuned during training to minimize error.
- **Tokenization:** Converts text into numerical tokens that the model can interpret.
- **Inference:** User input is processed to generate contextually relevant text as output.
- **Attention:** Weighs the importance of different input words when generating each output word.
- **Decoding:** Utilizes techniques like greedy decoding or beam search to form output text from predictions.
- **Fine-Tuning:** Can be customized for specific tasks or domains.
- **Limitations:** May produce incorrect or nonsensical outputs, sensitive to input phrasing, and verbosity varies.

What data is used in GPT 4?



As of my last update in September 2021, OpenAI has not publicly disclosed specific details about the datasets used to train GPT-4. Generally, OpenAI trains models like GPT-3 and presumably GPT-4 on a diverse range of sources from the internet, which can include websites, books, Wikipedia, and other textual data to create a generalized language model.

Recent Developments in Digital Technologies in Education

Additional requirement for your assignment

Appendix on Use of Generative AI

Whether or not you use generative AI, such as CHAT GPT, to help you with your assignment is entirely your choice. But if you do choose to use generative AI you must incorporate (as Appendix 1) in your assignment an explanation of how you have used generative AI. Your explanation might include:

- specific questions that you have asked the AI
- a flowchart of the approach that you have used
- how you have checked the answers you have received.

You will not be penalised for the use of generative AI, indeed you might gain additional credit particularly in relation to the following marking criteria:

- flexible and creative analysis of complex or contradictory data/theories/evidence.
- evaluation and synthesis of digital and non-digital literature to inform responses

However, you must be critical in your use of generative AI and check all of the answers it gives you. Any assertions made by generative AI need to be checked by finding the relevant literature and reading it carefully – you will need to find references that support the assertions, otherwise you will be making unsupported assertions.

If we detect that you have used generative AI and have not explained that use, then you may be penalized.

Conclusion

Challenge: Everyone needs to understand the opportunities, issues and threats provided by AI

Question: How should we incorporate AI and ML into informatics curricula?

- Informatics education for all young people
- Informatics curricula integrating AI and ML approaches and methods. But also follow-up across the curriculum with broader considerations of AI literacy
- Opening up the black box – through hands-on activities with software environments that simulate machine learning

Question: How should we incorporate new challenges associated with rapid developments in AI and ML into school learning and assessment more generally?

- AI support should empower teachers AND empower learners
- Consider explainable AI (XA) – Develop a framework
- Examine generative AI as a specific challenge? Take note of the Australian consultation process

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Thanks and Questions

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