

Artificial intelligence in doctoral research

Opportunities, challenges and limitations

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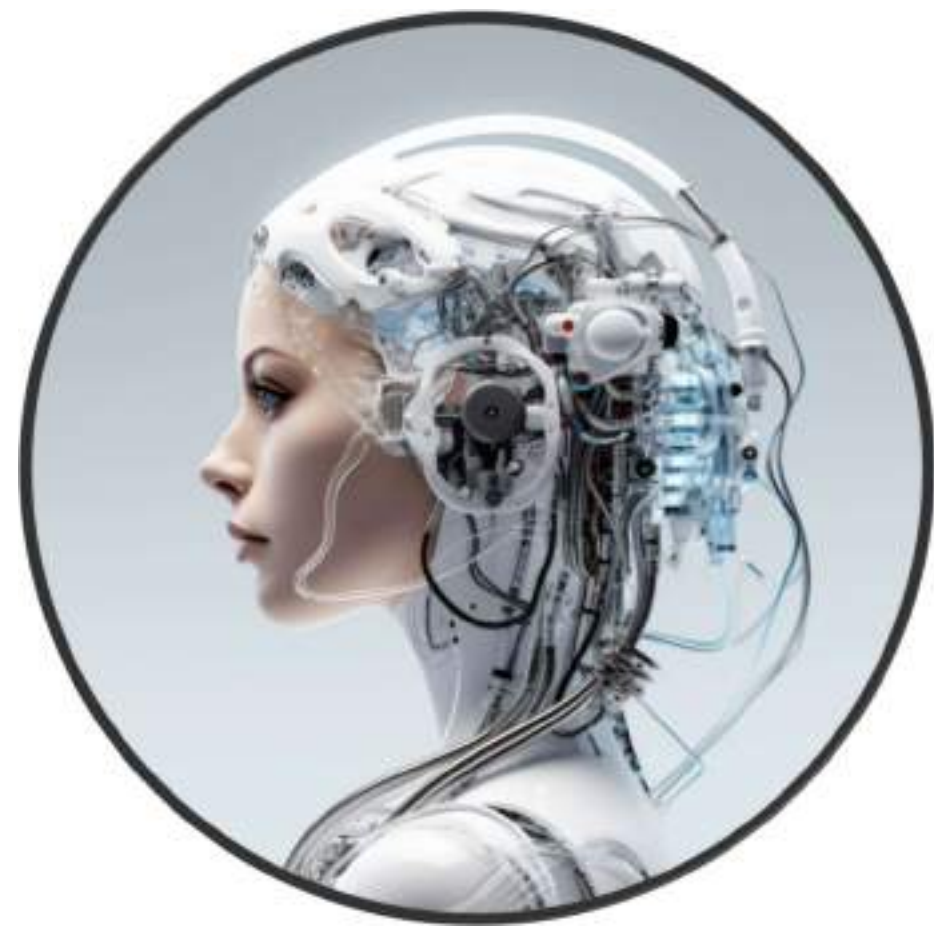
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- *What is Artificial Intelligence?*
- *Opportunities and Advantages of AI for Doctoral Research*
- *Impact, Risks and limitations*





What is Artificial Intelligence?

What is Artificial Intelligence?

«... the science and engineering of making *intelligent machines*, especially intelligent computer programs» [John McCarthy]¹



« the science of making machine do things that would require *intelligence* if done by men» [Marvin Lee Minsky]²

« the automation of activities associated with *human thinking*, which include decision- making, problem solving, and learning» [Richard Bellman]³



¹McCarthy, J. (2007). *What is Artificial Intelligence?*. Stanford University, 2007

²Minsky, M. (1961). *Steps Toward Artificial Intelligence*. Proceedings of the IRE

³Bellman, R. (1978). *An Introduction to Artificial Intelligence: Can Computers Think?*. San Francisco: Boyd & Fraser Publishing Company.

A misleading translation from English!

In English, '**Intelligence**' also means '**Information gathering, analysis, and surveillance**' (e.g., Central Intelligence Agency — CIA)

In French, '**Intelligence**' refers more to '**cognitive ability, reasoning, understanding, adaptation**'



Plaidoyer pour l'adoption de l'expression « renseignement artificiel »

Les termes que nous choisissons pour parler de technologie ne sont jamais neutres. Ils façonnent notre compréhension immédiate, créent des attentes, suscitent autant de craintes que d'espoirs.

10 mai 2024 Temps de lecture : 4 minutes

AA

<https://in-data-veritas.com/plaidoyer-pour-ladoption-de-lexpression-renseignement-artificiel/>

AI is a **TOOL** composed of **algorithms**, **techniques**, and **methods** that manipulate **data** and **human knowledge** to build **digital models** that process information and approximate **human reasoning**





Human reasoning is a complex ability that involves multiple cognitive processes to solve problems

Different Approaches in AI

Analytical or scientific reasoning

Rational or logical reasoning

Starting from specific observations to formulate general laws or conclusions

Starting from general laws or premises to arrive at specific conclusions

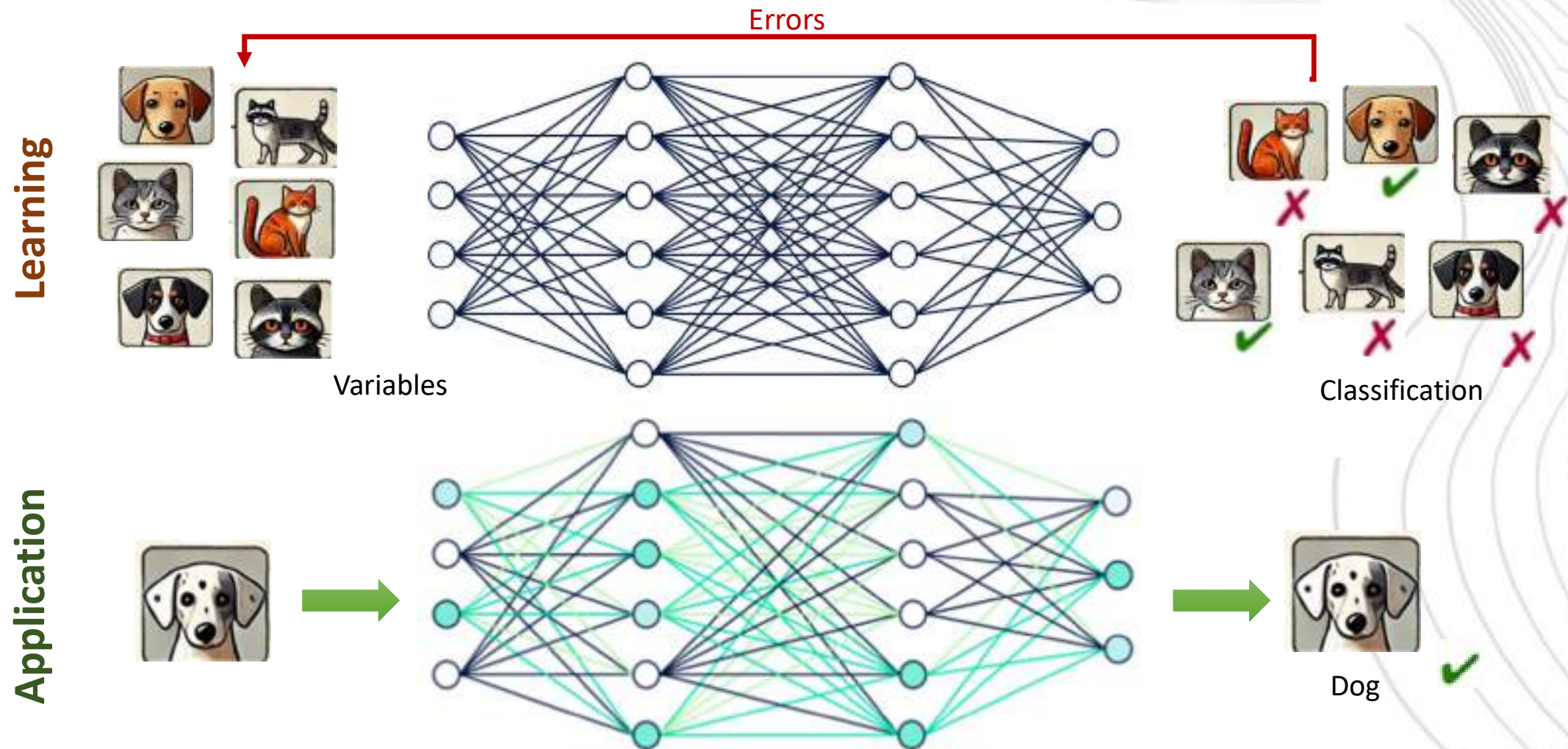


Hybrid AI

Reasoning



How does learning work?



How does learning work?

What is a dog?

- Animal
- Two ears
- Four legs
- A tail
- Fur



Dog



Dog



Dog



Dog



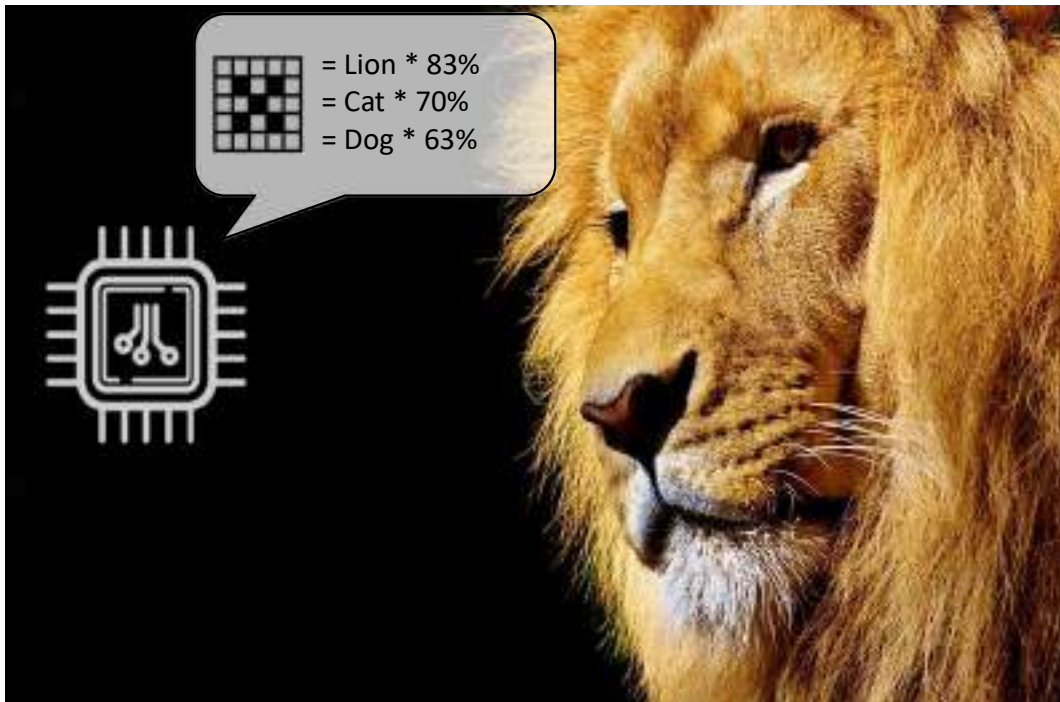
Sea Lion 99%



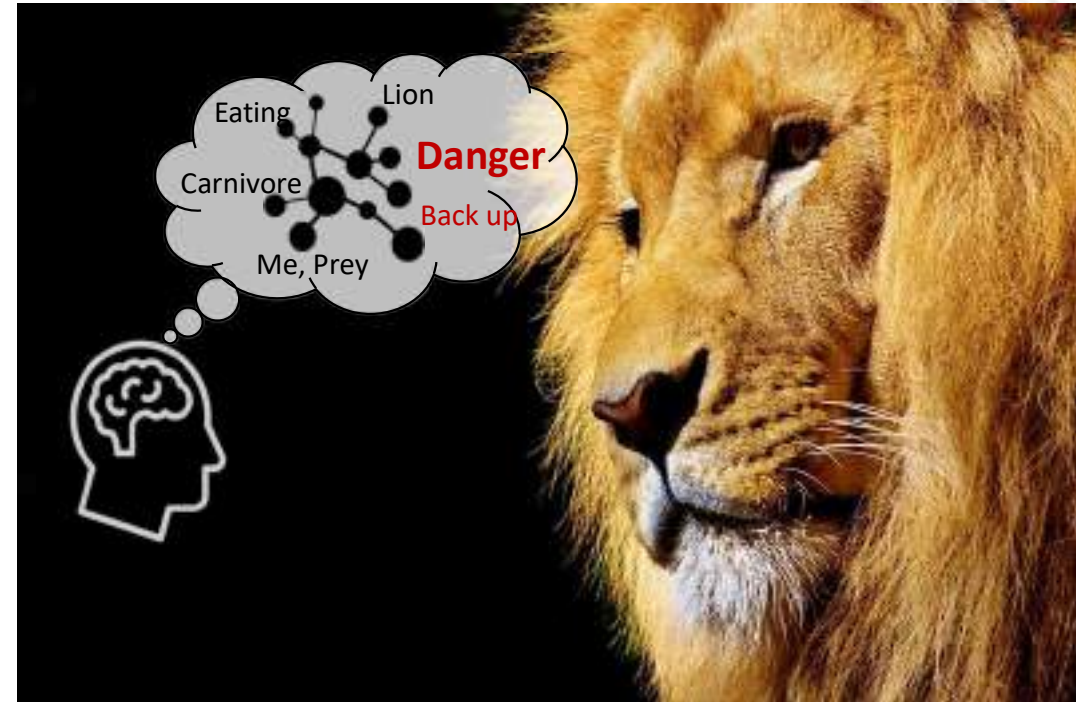
Pretzel 99%

<https://www.immuniweb.com/blog/top-10-failures-of-ai.html>

Logical Reasoning: Need to apply reasoning rules



The machine only displays bright dots called **pixels**



Humans **reason** and apply **logical rules**

Logical Reasoning: How Does It Work?

"Paul is a man"

"Paul's contact book contains Alexandre's phone number"

"Alexandre's phone number is 07 65 98 32 14"

"Jack's father is Alexandre"

"Paul's contact book contains Céline's phone number"

"Céline's number is 06 87 45 12 30"

"Paul's father is Jack"

...

"If X is Y's father and Y is Z's father, then X is Z's grandfather"

"If X is Y's father, then Y is X's child"

...



Call Paul's grandfather

Fact Base

Rule Base

Knowledge Base

```
man(Paul)
father(Paul, Jack)
father(Jack, Alexandre)
contact(Paul, Alexandre, 07 65 98 32 14)
contact(Paul, Céline, 06 87 45 12 30)
...
father(?x, ?y) ^ father(?y, ?z) -> grandfather(?x, ?z)
...
```

Reasoning

I dial 07 65 98 32 14



What About Generative AI?

Creation of new content from learned rules or generative models
(text, image, audio, video, code...)



Generative AI is not a type
of AI but a usage

What Does 'Generative' Mean?

Generating information automatically based on large datasets

- It imitates, improves, and generates outputs by **statistically recombining** the patterns and structures it learned during training
- Outputs are **statistical recompositions** of learned patterns





Opportunities and Advantages of AI for Doctoral Research

Intelligence Begins with Asking the Right Question

The intelligence in research lies in asking the right question, not in generating the answer

AI can:

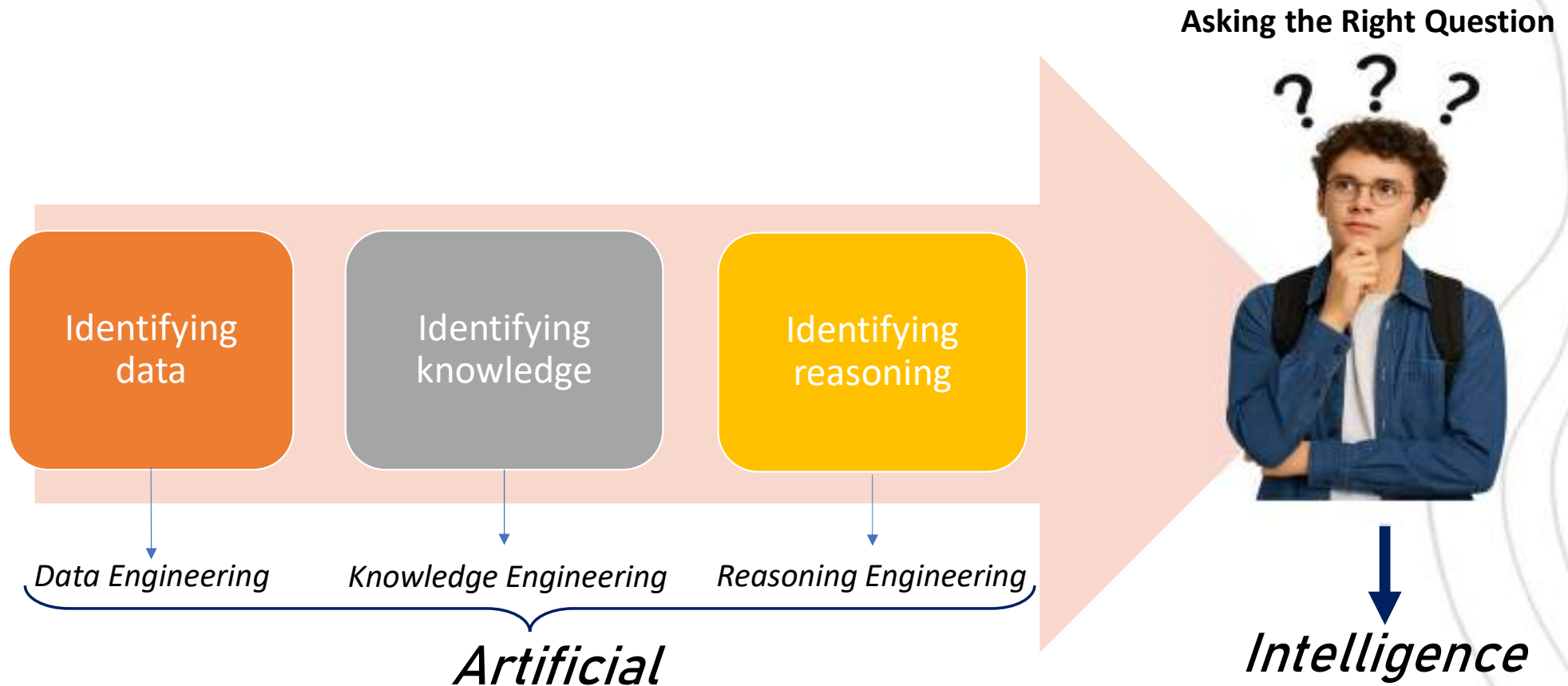
- ✓ Assist
- ✓ Accelerate
- ✓ Extend capabilities

AI cannot:

- ✗ Replace critical thinking
- ✗ Formulate research questions
- ✗ Judge scientific relevance



Intelligence Begins with Asking the Right Question



Positive Impact of AI on Doctoral Research



Significant Time Savings

- Automation of repetitive tasks allowing researchers to focus on scientific thinking

In-Depth Exploration

- Ability to analyze volumes of data impossible to process manually
- Acceleration of the iterative cycle: *hypothesis* → *test* → *analysis*

Easier access to massive knowledge

- Exploration of new solutions and enhanced creativity
- Improved reproducibility

Increased Accessibility

- Democratization of sophisticated tools previously reserved for large institutions

Examples of AI Applications for Doctoral Research



Literature Review

Rapid identification of relevant articles, summarization, classification, exploration, ...



Data Analysis and Automation of Repetitive Tasks

Processing large volumes of data, recognition of complex patterns, predictive modeling, ...



Writing Assistance

Translation, improvement of text structure, advanced linguistic correction, ...



Visualization and Presentation

Creation of sophisticated graphs, generation of conceptual diagrams, intelligent visualization of results, ...



Examples of AI Tools for Research

Conversational Assistants

*Idea brainstorming,
chapter structuring,
clarification of concepts*

ChatGPT, Claude,
Gemini

Reference Management

*Intelligent article search,
automatic extraction of
key information
recommendations of
relevant publications*

Elicit, Semantic
Scholar, Research
Rabbit

Data Analysis

*Coding assistance,
automated statistical
analysis
anomaly detection in
datasets*

GitHub Copilot,
DataRobot,
RapidMiner

Language Enhancement

*Advanced grammar
correction
academic-quality
translation*

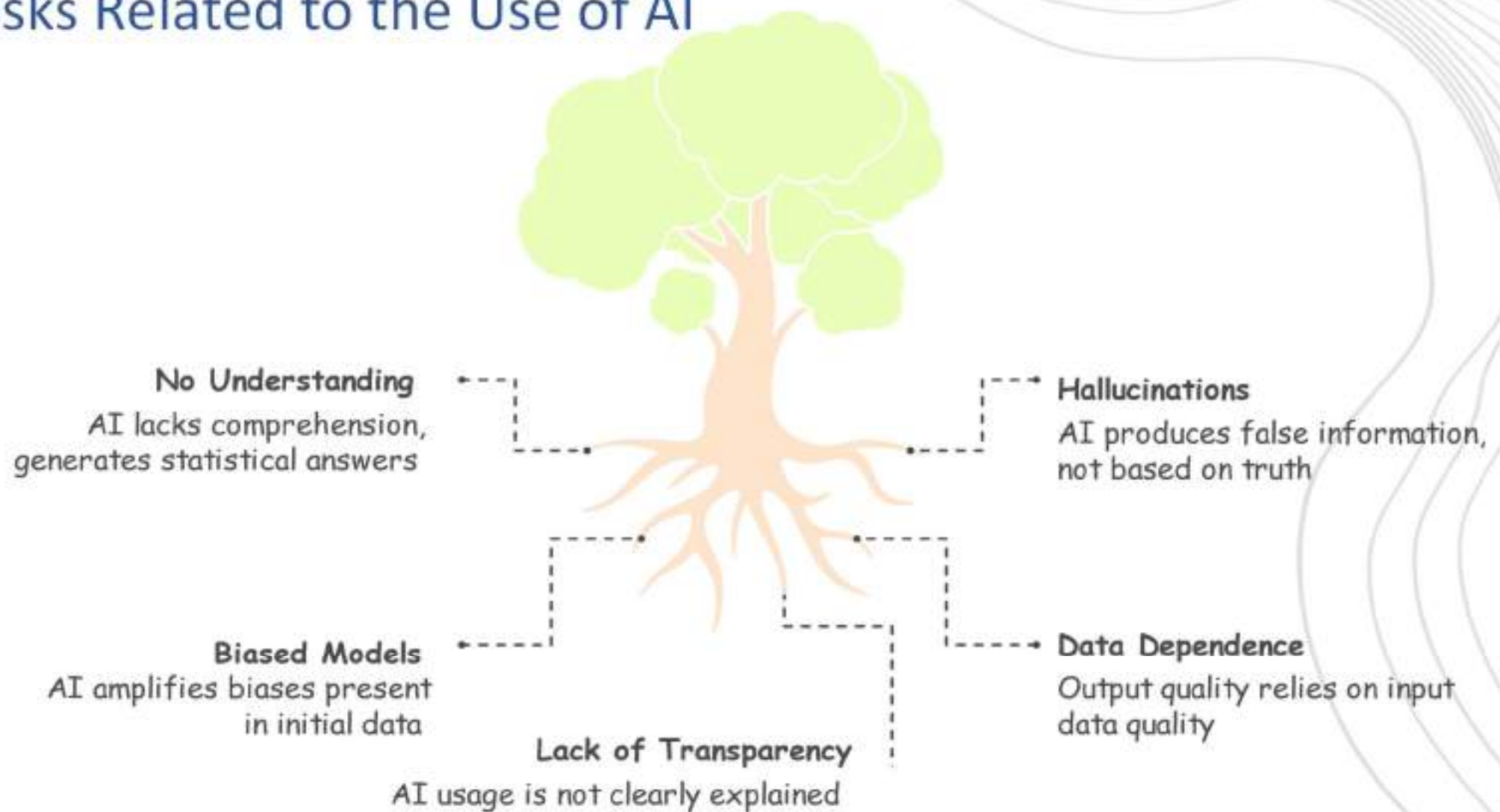
Grammarly, DeepL,
QuillBot





Impact, Risks and limitations

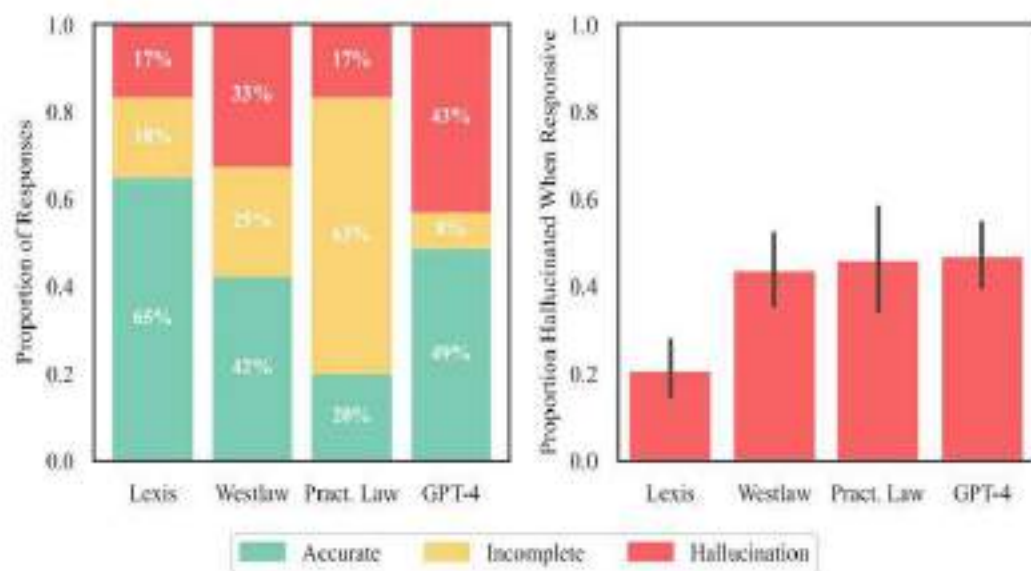
Risks Related to the Use of AI



Risk of Errors and Complex Control of Results

Risk of incorrect, inconsistent, or poorly contextualized results

Example: Researchers at Stanford tested 3 legal AI systems deployed in the United States



- Their promise? **0% hallucinations**
- The reality? **At least 20% errors!**

MAGESH, Varun, SURANI, Faiz, DAHL, Matthew, *et al.* **Hallucination-Free? Assessing the Reliability of Leading AI Legal Research Tools.** *arXiv preprint arXiv:2405.20362*, 2024.
<https://arxiv.org/abs/2405.20362>

Examples of AI-Generated False Information

What is Marvin Lee Minsky's opinion on AI?

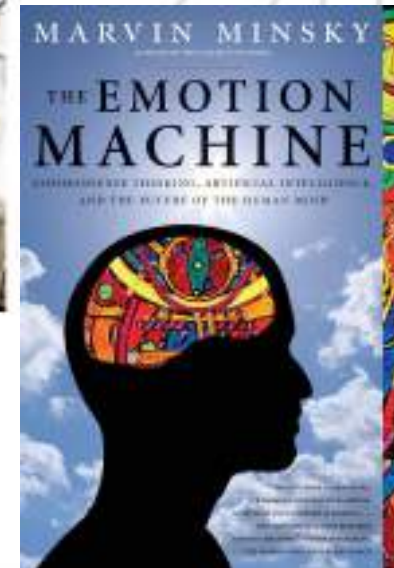
Great — here is a **clear, structured list** of Marvin Minsky's writings, talks, and interviews where he explicitly expresses his views on AI, along with **short annotated quotes** you can reuse in presentations or research documents.

■ **The Emotion Machine (2006)** — *on consciousness, introspection, reasoning*

Chapters 1, 3, 6 contain direct commentary on AI.

Quote:

"Emotions are not separate from reasoning — they ARE kinds of thinking."



Examples of AI-Generated False Information

In which reference did Marvin Lee Minsky write "Emotions are not separate from reasoning — they ARE kinds of thinking" ?

The phrase "*Emotions are not separate from reasoning — they ARE kinds of thinking*" is not a verbatim quotation from Marvin Lee Minsky, but it *accurately paraphrases* his central argument in his book **The Emotion Machine** (2006).

I wasn't able to locate a definitive page number in **The Emotion Machine: Commonsense Thinking, Artificial Intelligence, and the Future of the Human Mind** by Marvin Lee Minsky for the exact phrase:

"Emotions are not separate from reasoning — they ARE kinds of thinking."



Examples of AI-Generated False Information

Who invented professional didactics?

Professional didactics (**la didactique professionnelle**) was founded by the French researcher **Gérard Vergnaud** in the 1990s.

He developed the theoretical foundations by combining cognitive psychology, ergonomics, and educational sciences, with the aim of understanding how professionals acquire and mobilize competencies in real work situations.



Examples of AI-Generated False Information

I thought it was Pierre Pastré — is that correct?

Great question — and you're right to ask, because the history of *didactique professionnelle* involves **both** Gérard Vergnaud and Pierre Pastré, but with **different roles**.

✓ Short answer:

Pierre Pastré is indeed considered the main founder of *didactique professionnelle*.

✓ Longer explanation

- Gérard Vergnaud is the scholar who formulated the **theory of conceptual fields**, a major cognitive theory about how knowledge is structured and mobilized. His work strongly inspired the emergence of *didactique professionnelle*.
- Pierre Pastré applied Vergnaud's cognitive theories to workplace training and professional development.
- It is Pierre Pastré who formalized, developed, and structured *didactique professionnelle* as an autonomous field during the 1990s and 2000s.



Examples of AI-Generated False Information

Who invented professional didactics?

Here is the clearest and academically accurate answer:

Who invented professional didactics?

Professional didactics (*didactique professionnelle*) was founded by Pierre Pastré.

✓ Why him?

- Pierre Pastré formalized the field in the 1990s.
- He developed its core concepts (situated activity, conceptualization in action, analysis of professional situations).
- Although Gérard Vergnaud's cognitive theory of conceptual fields was a major foundation, **Pastré is the one who created and structured professional didactics as its own scientific discipline.**



Examples of AI-Generated False Results



Me (1st)

I am taking part in a cycling race. If I am well ahead of the third rider and I get overtaken by the second one, what position am I in the race?

If you are overtaken by the **second** rider, that means the rider who was in **2nd place** moves ahead of you.

You were ahead of the 3rd rider, so you were in **2nd place** before being overtaken.

➡ After the second rider passes you, you move to 3rd place.

✅ Final position: 3rd place.



Examples of AI-Generated False Results



Me (2nd)

But if I were in second place, it would be impossible for me to overtake myself

Ah — I see the confusion 🤔

Let's unpack it clearly.

Let's consider all possibilities:

For the second rider to overtake you, you must originally be in front of that rider.

So before being overtaken, your position must be **better** than 2nd — meaning:

➡ You were in 1st place.

✅ Final answer: You are in 2nd place.

Best Practices for Responsible Use



Intelligent Complementarity

Use AI as an assistant, not a substitute for critical thinking and disciplinary expertise



Compliance with Institutional Rules

Consult your institution's guidelines and comply with the ethical standards of your academic discipline



Document Process

Keep a record detailing when and how you use AI



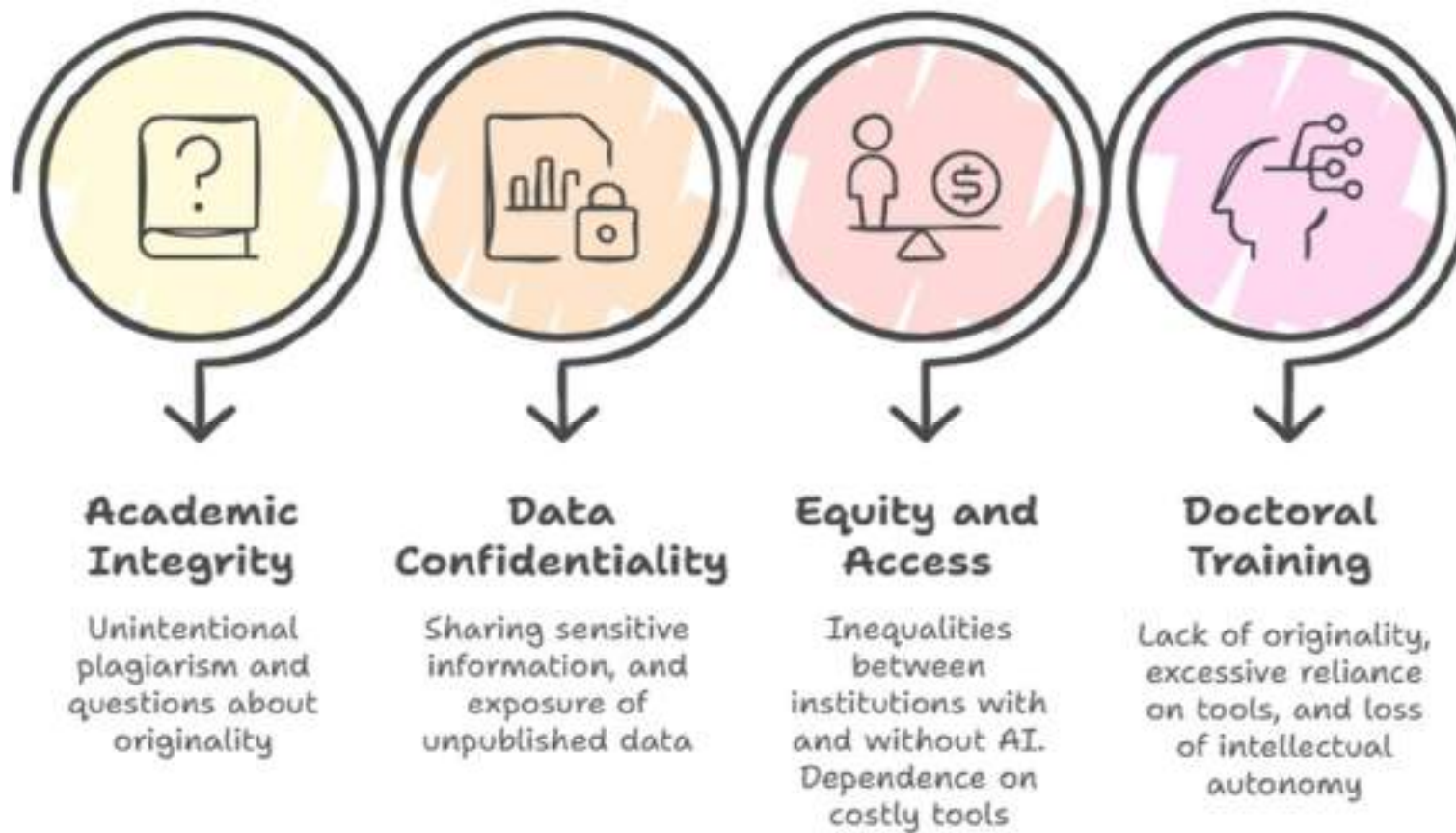
Communicate with Supervisor

Discuss AI practices openly with your supervisors



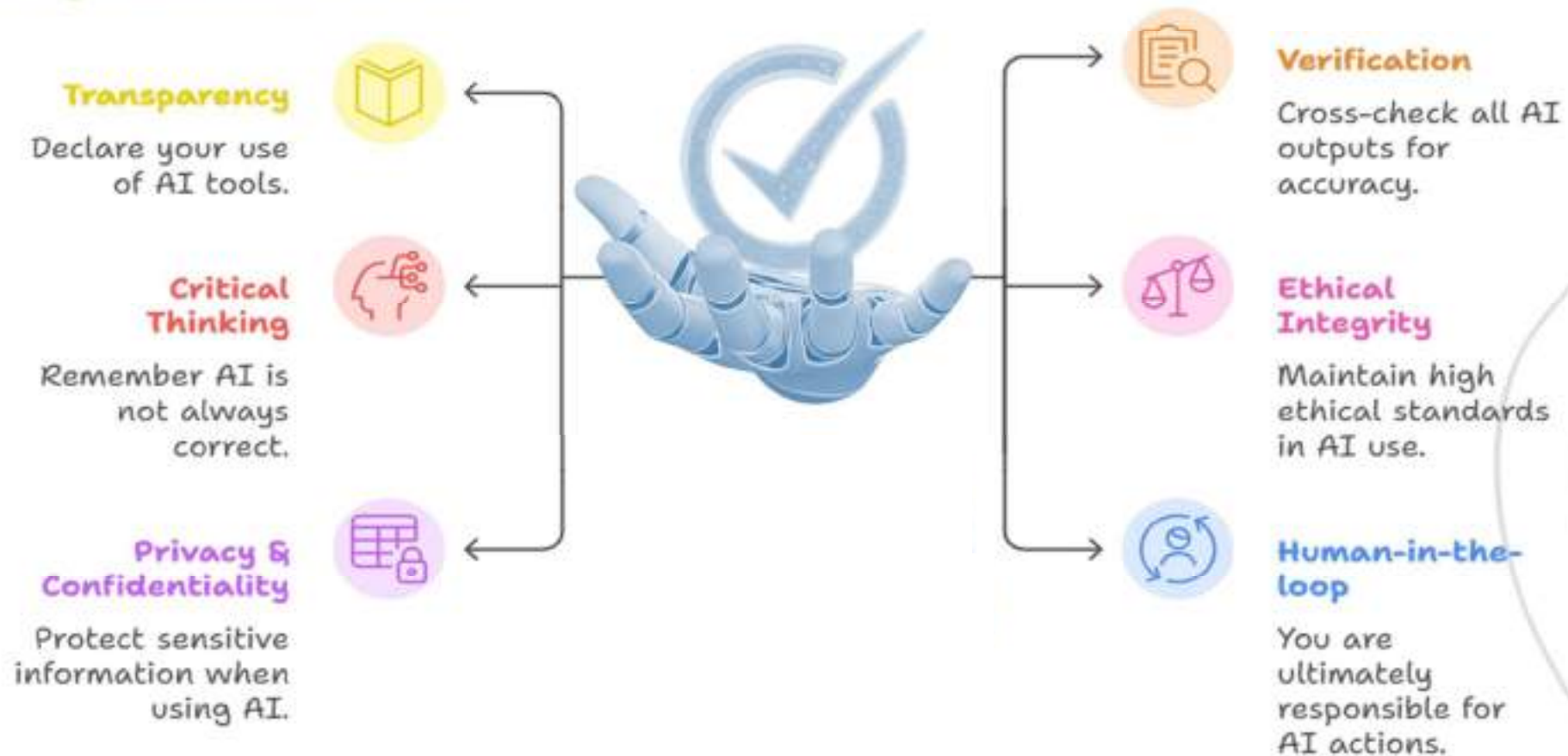
Risks in Academic Research

The impact of AI is profound and must be guided by scientific integrity



Responsible Use Principles

The goal is *not to forbid*, but to *control*





What You Should Never Do

- Never ask AI to write full sections of your thesis
- Never trust AI-generated references without verification
- Never let AI choose your methodology
- Never upload your scientific results
- Never rely on AI to interpret scientific findings

Build a hybrid approach that combines the best of traditional methods and modern technologies

Key Points to Remember

Position AI as a support system, not an author

- AI is a **powerful tool**, not a miracle solution
- **Transparency** and ethics are non-negotiable
- Your **intellectual skills** remain irreplaceable
- Adopt a **critical** and **thoughtful** approach
- Ensure **integrity** and **reliability**
- Do not confuse speed with **scientific rigor**

