# Module 1: Crash course in AI

## INFO901

**Marija Slavkovik 2022**

# Before we begin

Artificial Intelligence

≠

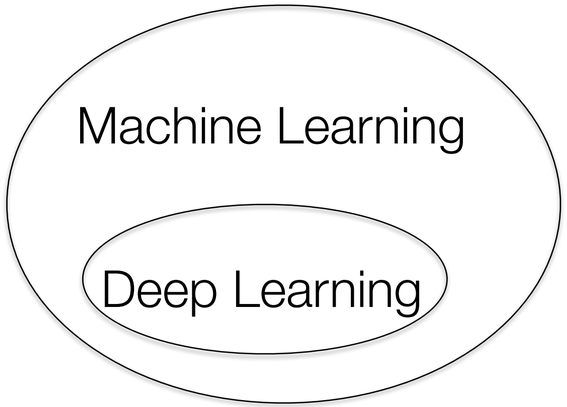
Machine Learning

≠

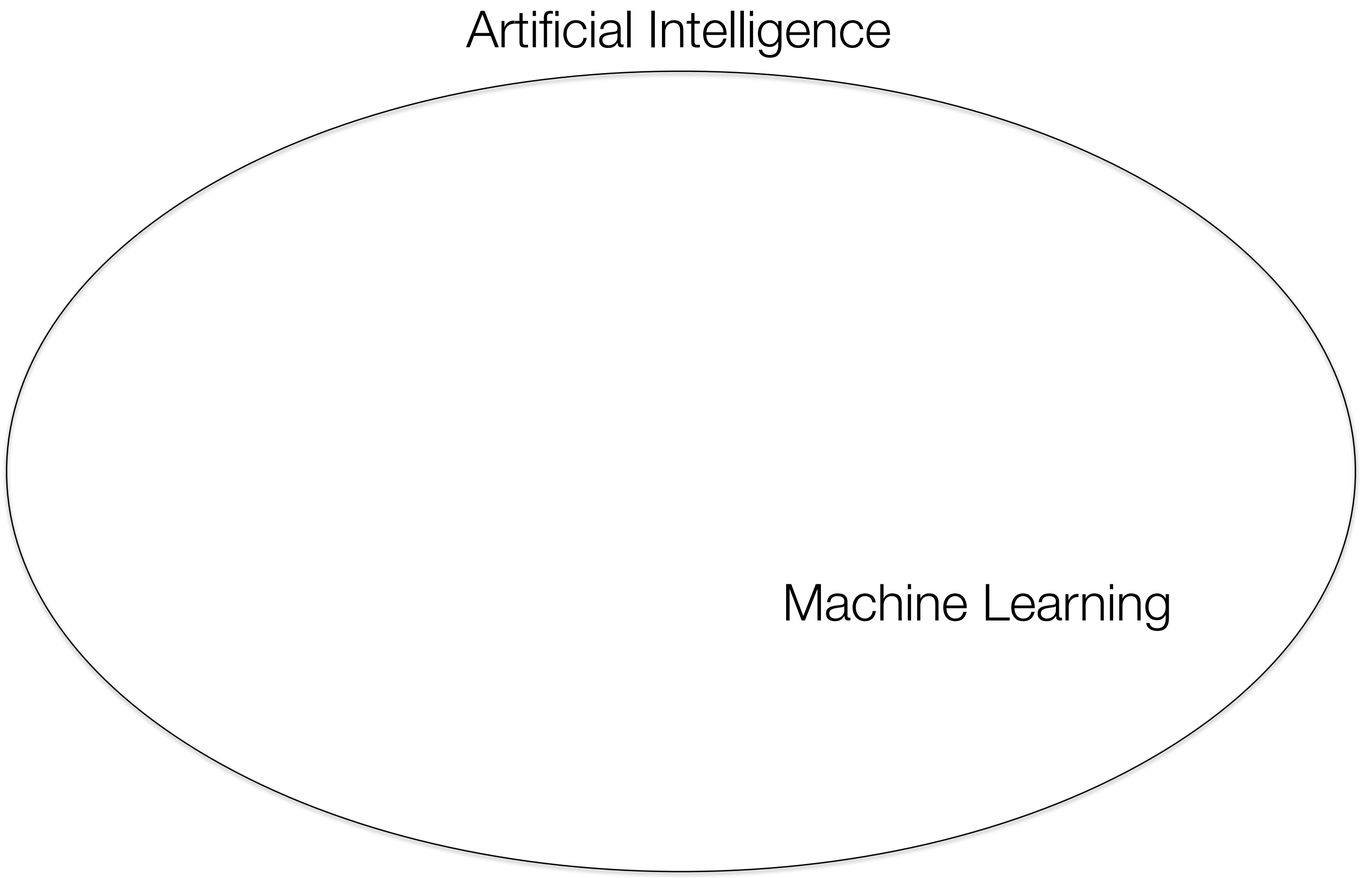
Deep Learning

# Before we begin

Artificial Intelligence

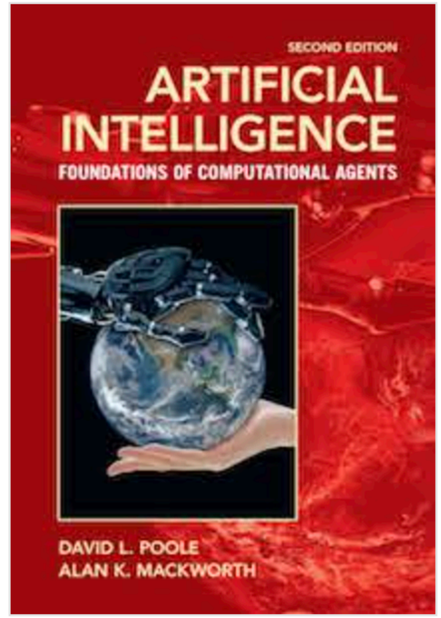


# Before we begin



# What is AI

- As per Poole and Mackworth (2017) “Artificial intelligence, or AI, is the field that studies the **synthesis** and **analysis** of computational agents that act intelligently.”



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Cognitive Science

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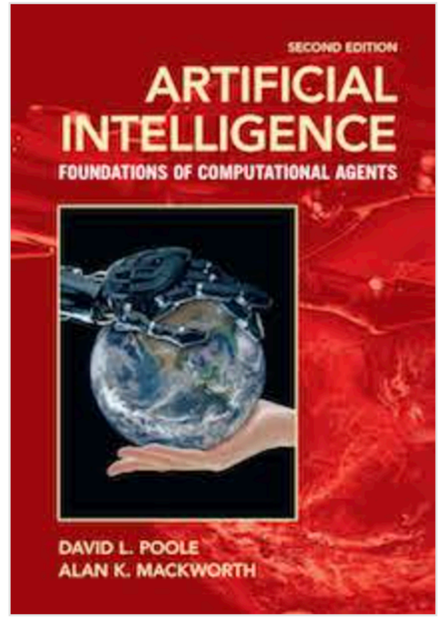

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**AI-discovered molecules**

by **David Rotman** April 2, 2020

https://www.sciencenews.org › article › ai-identify-anon...

How AI can identify people even in anonymized datasets

Jan 25, 2022 — How **AI** can **identify** people even in anonymized datasets. Weekly social interactions form unique signatures that make people stand out.

https://www.linkedin.com › pulse › how-ai-deciding-who-...

How AI Is Deciding Who Gets Hired - LinkedIn

Feb 5, 2022 — Think about it, the job hunt has changed as **artificial intelligence** increasingly scores resumes, runs interviews and **decides who** gets access ...

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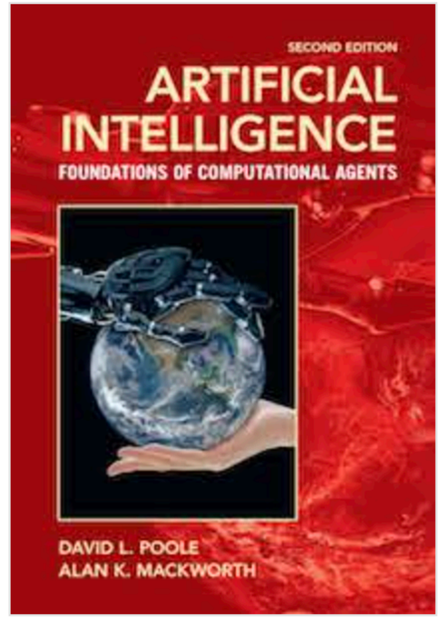
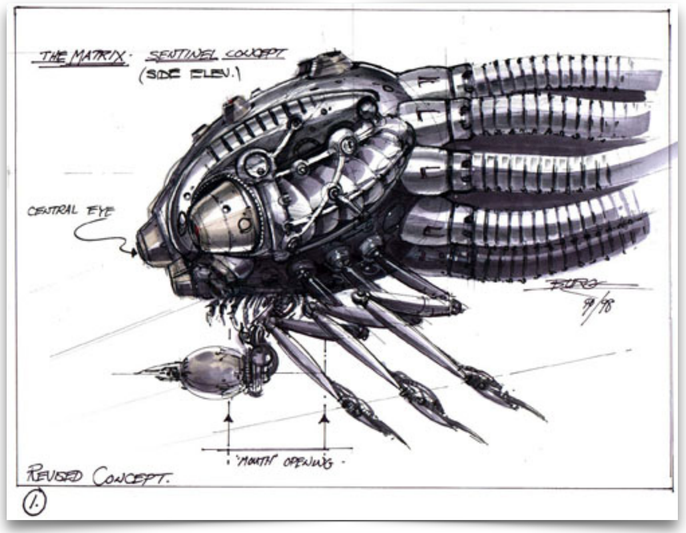


# What is AI

- As per Poole and Mackworth (2017) “Artificial intelligence, or AI, is the field that studies the synthesis and analysis of computational agents that act intelligently.”
- Bellman(1978) defined artificial intelligence as the automation of activities that we associate with human thinking, i.e., cognitive activities.
- What we are doing vs what we are aiming

# AI vs artificial life

- Life - the current definition, in wikipedia,  is that organisms maintain homeostasis, are composed of cells, undergo metabolism, can grow, adapt to their environment, respond to stimuli, and reproduce.



# Flavours of AI (in popular discourse)

- **General AI:** create an artificial (computational?) agent that has at least the same level of intelligence as a human (whatever that means)
- **Narrow AI:** solve individual tasks that require intelligence using computation ( ~ figure out how to solve the task without intelligence?)
- **Good old fashioned AI:** just don’t, it’s rude
- Symbolic vs sub-symbolic.

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- What we are doing vs what we are aiming

# Test

## Which task requires intelligence?

43758247529845789579825 72

+

8247527452884528

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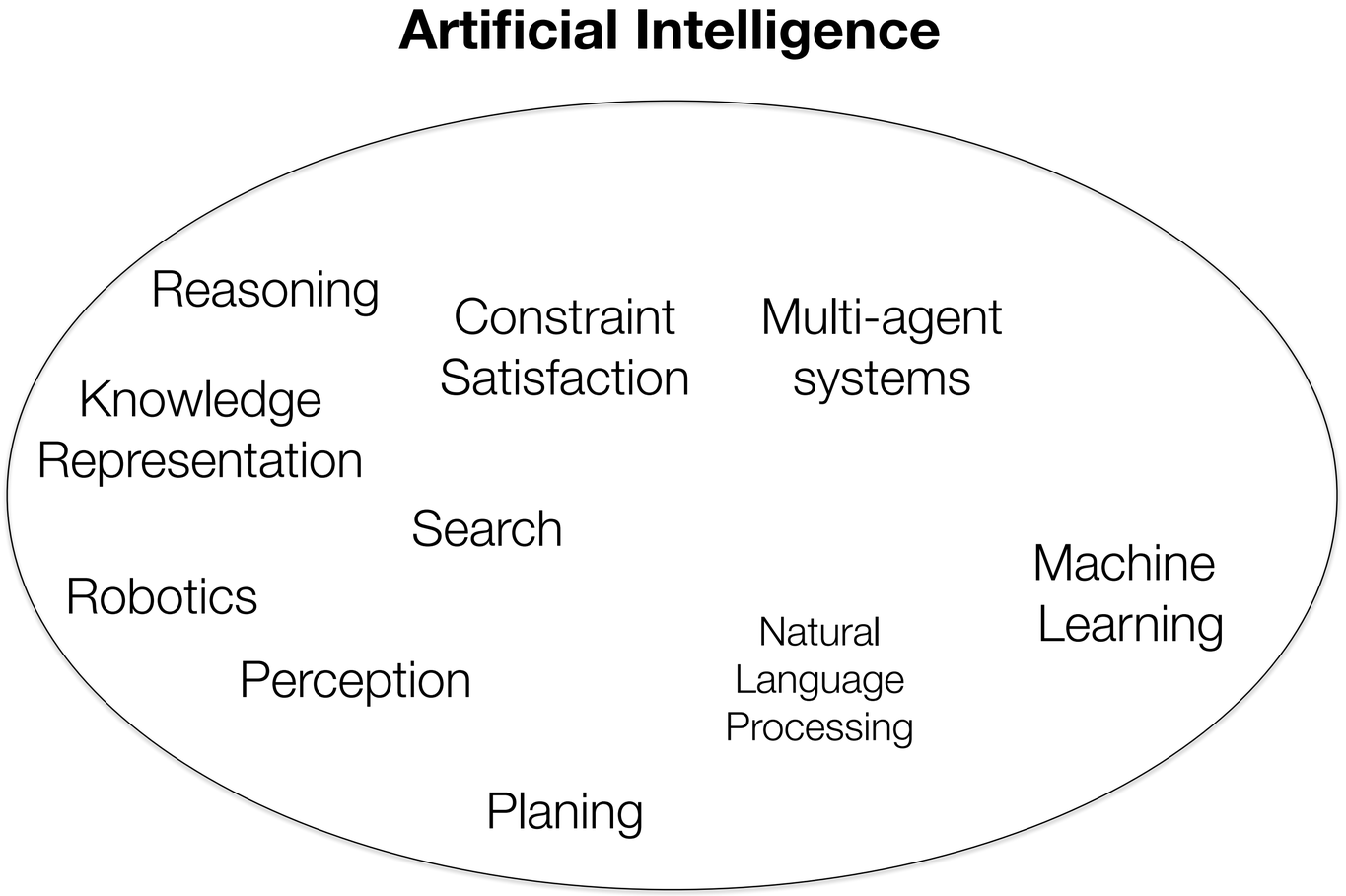
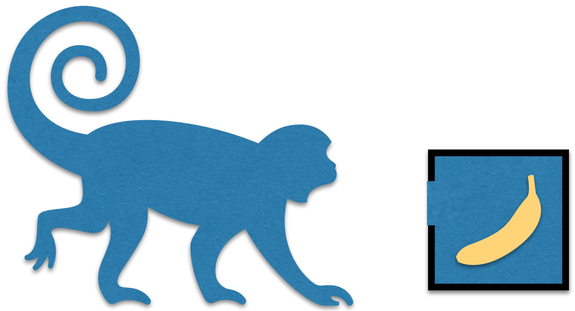
?

# Automating separate tasks

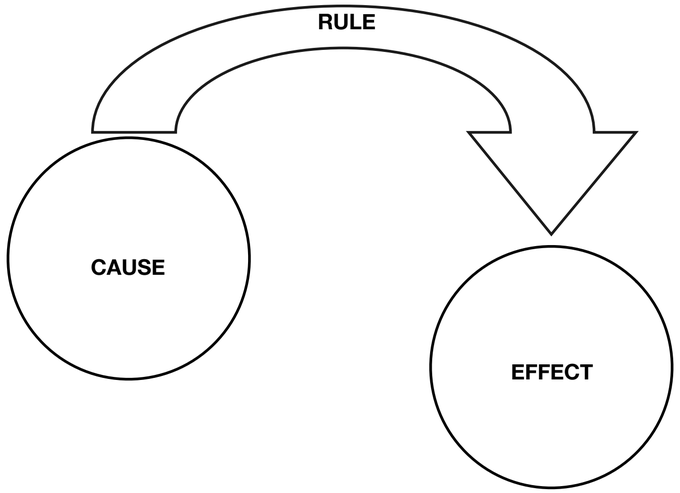


# Automated Reasoning

## a model we use, not a model of human reasoning

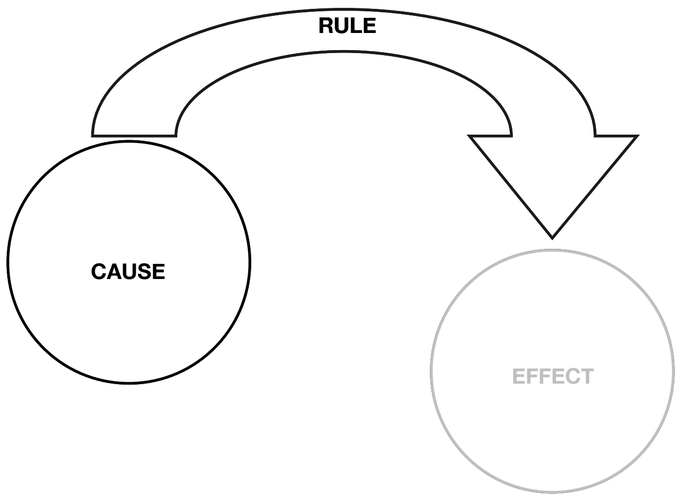






# Types of reasoning

Deduction



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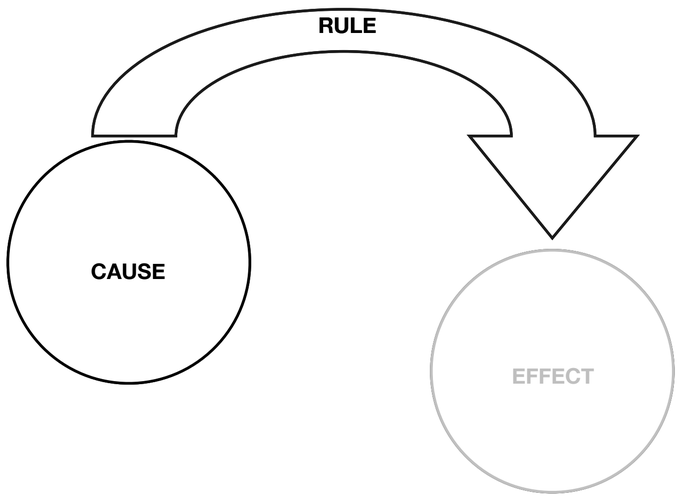
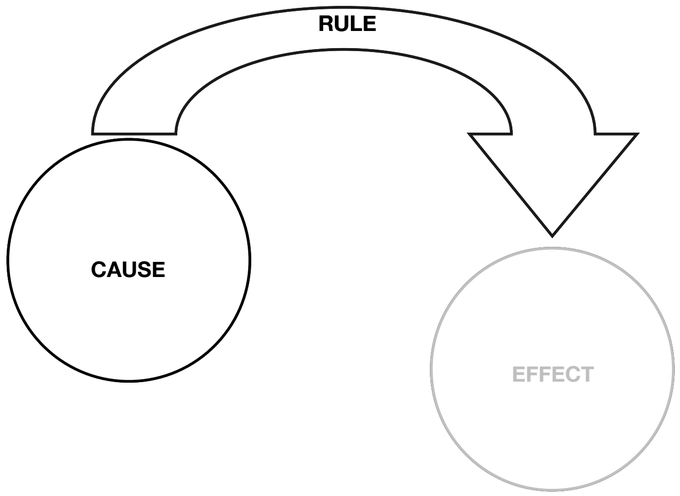



George is looking at Jane.
Jane is looking at Jack.
George is married.
Jack is not marred.

Is someone who is married looking at someone who not married?

# Types of reasoning

Deduction




- Fact: Socrates is a man.

  `man(socrates).`

- Rule: All men are mortal.

  `mortal(X):-men(X).`

- Query: Is Socrates mortal?

  `mortal(socrates).`

- Fact: I saw a swan.

  `saw(I,swan).`

- Rule: All swans are white.

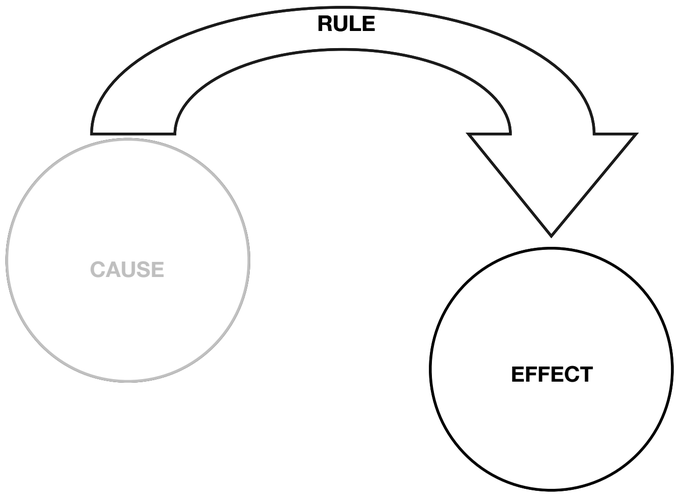
  `black(X):-is(X,swan).`

- Query: What colour swan did you see?

  `colour(swan).`

# Types of reasoning

Abduction

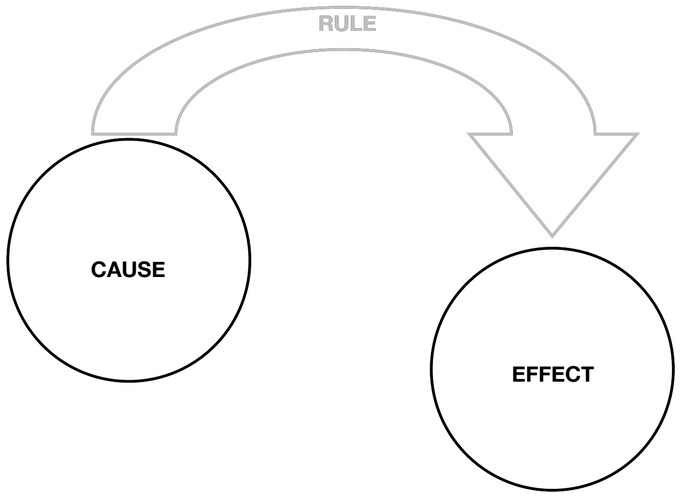



Someone in Dreadsbury Mansion killed Aunt Agatha. Agatha, the butler, and Charles live in Dreadsbury Mansion, and are the only ones to live there. A killer always hates the victim, and is no richer than his victim. Charles hates no one that is hated by Agatha. Agatha hates everybody except the butler. The butler hates everyone not richer than Aunt Agatha. The butler hates everyone whom Agatha hates. No one hates everyone.

This problem is originally from F. J. Pelletier: Seventy-five problems for testing automatic theorem provers. Journal of Automated Reasoning, 2: 191-216, 1986.

# Types of reasoning

Induction

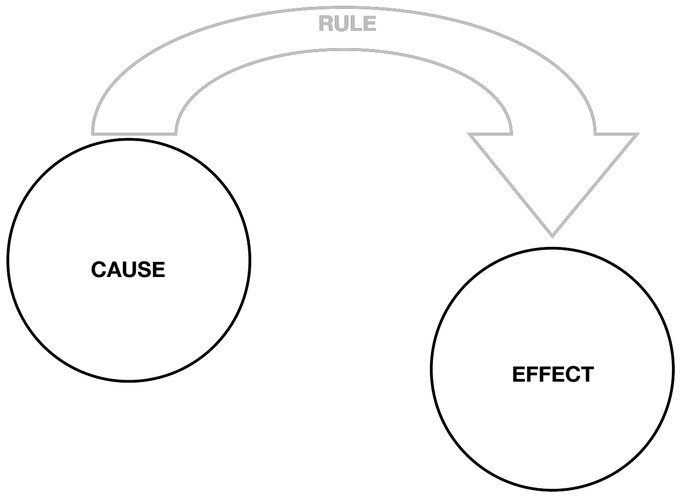



| | |
|---|---|
| My grandpa is a man. | My grandpa died. |
| John was is a man. | John died. |
| Bethoven was is a man. | Bethoven died. |

If X is a man, then X died.

# Types of reasoning

Induction

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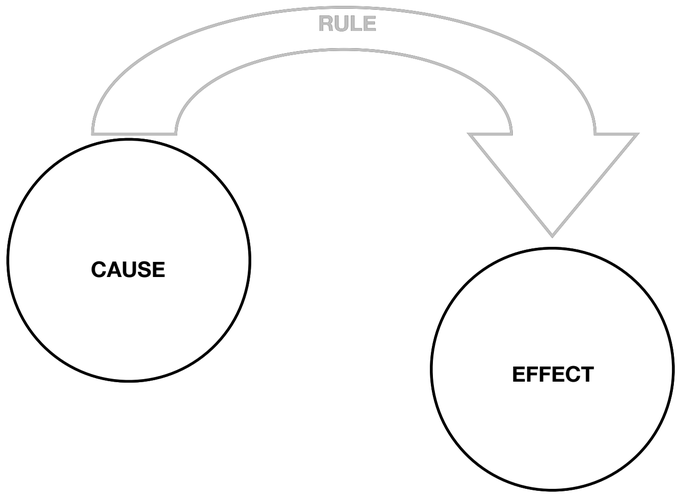


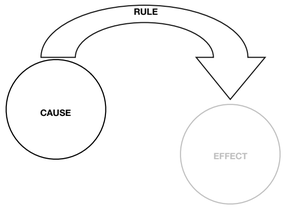

| Age | Number of cars owned | Owns house | Number of children | Marital status | Owns a dog | Bought a boat |
|---|---|---|---|---|---|---|
| 66 | 1 | yes | 2 | widowed | no | yes |
| 52 | 2 | yes | 3 | married | no | yes |
| 22 | 0 | no | 0 | married | yes | no |
| 25 | 1 | no | 1 | single | no | no |
| 44 | 0 | no | 2 | divorced | yes | no |
| 39 | 1 | yes | 2 | married | yes | no |
| 26 | 1 | no | 2 | single | no | no |
| 40 | 3 | yes | 1 | married | yes | no |
| 53 | 2 | yes | 2 | divorced | no | yes |

# AI Reasoning

- Deduction:  resolution (backbone of Prolog), SAT solvers
- Abduction: answer set programming (minimal model semantics)
- Induction: inductive logic programming (symbolic learning)

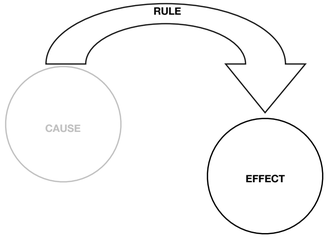
# Inherent limitations of reasoning

## Deduction




George is looking at Jane.
Jane is looking at Jack.
George is married.
Jack is not marred.
A person is either married or unmarried!.

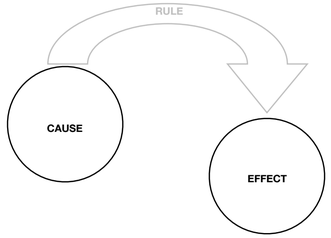
## Abduction




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 3 | | | 7 | | | | |
| 6 | | | 1 | 9 | 5 | | | |
| | 9 | 8 | | | | | 6 | |
| 8 | | | | 6 | | | | 3 |
| 4 | | | 8 | | 3 | | | 1 |
| 7 | | | | 2 | | | | 6 |
| | 6 | | | | | 2 | 8 | |
| | | | 4 | 1 | 9 | | | 5 |
| | | | | 8 | | | 7 | 9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 3 | | | 7 | | | | |
| 6 | | | 1 | | 5 | | | |
| | | 8 | | | | | 6 | |
| 8 | | | | 6 | | | | 3 |
| 4 | | | 8 | | 3 | | | 1 |
| 7 | | | | 2 | | | | 6 |
| | 6 | | | | | | 8 | |
| | | | 4 | 1 | 9 | | | 5 |
| | | | | 8 | | | 7 | |

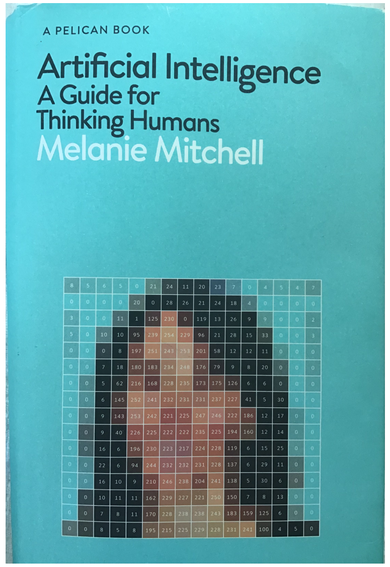
## Induction




- Have you thought of everything to include?
- How to add more information for testing?
- How to automatically design counter examples?

# Symbolic vs sub-symbolic AI

## going sub-symbolic




- Symbolic: rules  and domain knowledge are encoded by knowledge engineers and domain experts

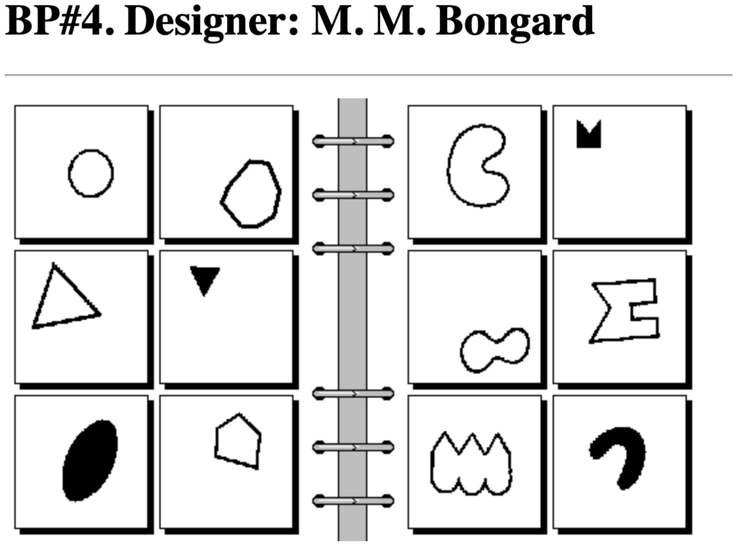
  “To the computer, the `meaning’ of the symbols derives from the ways in which they can be combined, related to one another and operated on” M.Mitchel

  Example: dead(X):-man(X). man(socrates).

- Sub-symboling: try to capture unconscious thought processes by looking for patterns

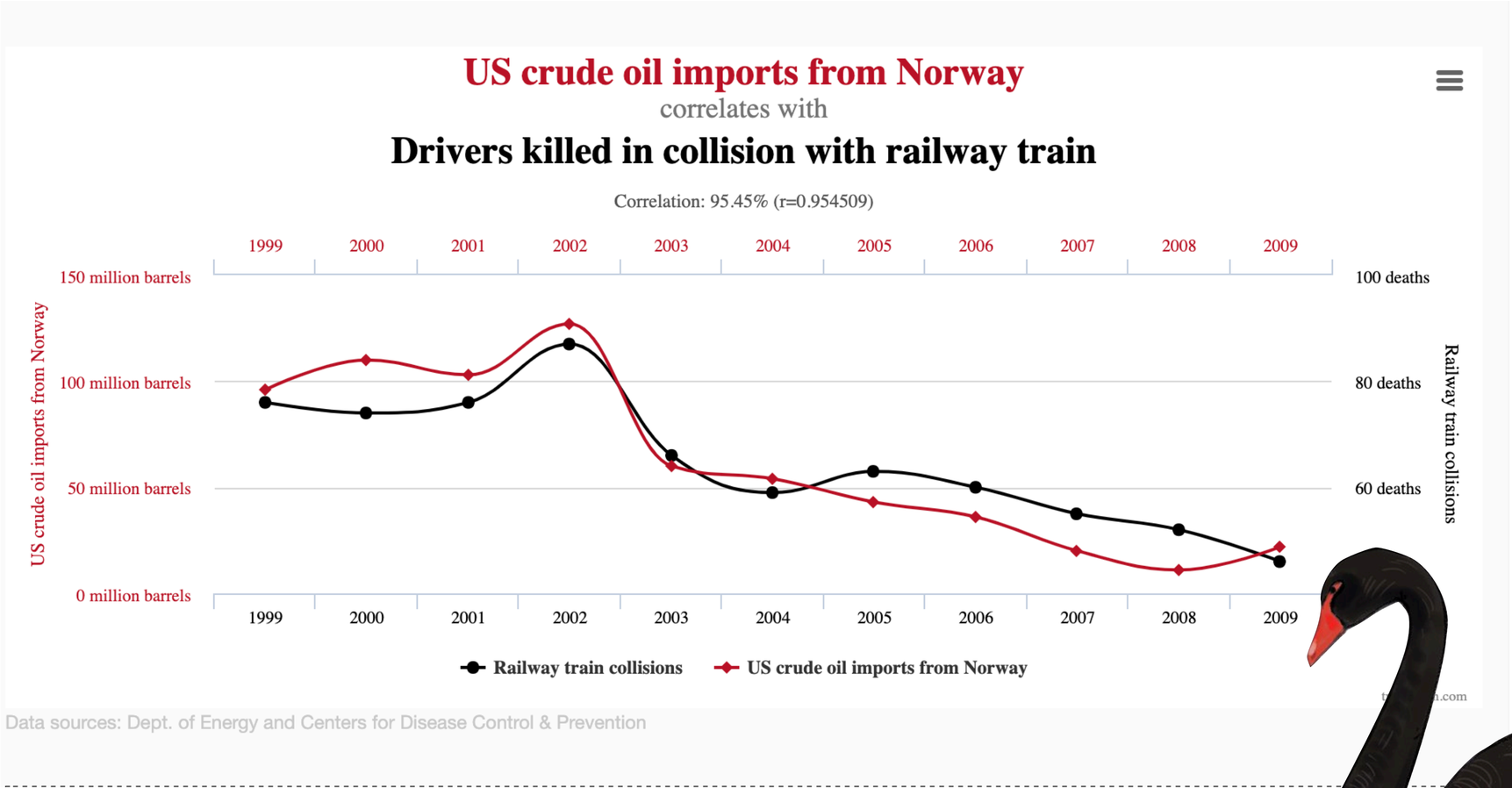
# Correlation vs causation

- Find the trait that all (cause, effect) pairs have instead of the inference rule.

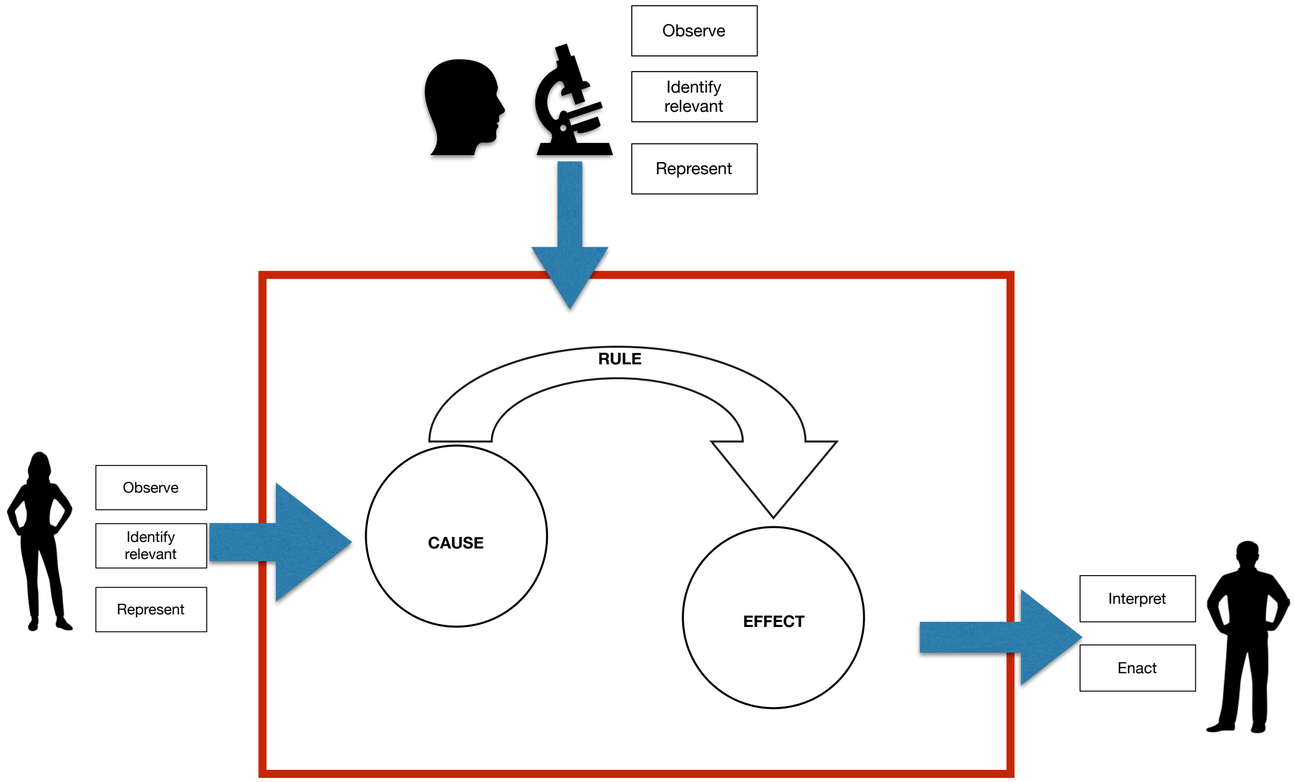



- The left six images represent one concept, and the right six images represent the opposite concept. Which is the left and which is the right?

# Limitation of correlation




# Why is reasoning expensive




- Expensive human skill needed
- Changes require oversight
- Computational cost is high:
- The more details you include in your representation the slower the reasoning
- (Quantum computers will not help)