Introduction to intelligent systems

Introduction

Mikkel N. Schmidt

Technical University of Denmark,
DTU Compute, Department of Applied Mathematics and Computer Science.

Overview

1. Welcome to Introduction to Intelligent Systems
2. Expectations survey
3. The historical origin of AI
4. Intelligence and the brain
5. Methods of reasoning
6. Demo of image recognition
7. Python installation instructions
8. Tasks

Feedback group

- Jakob Lauge Reeh
- David Lindahl
- Philip Thinggaard
- Poul Skov

Learning objectives

I Reasoning: Induction, deduction, abduction

I Understand the concepts and definitions, and know their application. Reason about the concepts in the context of an example. Use correct technical terminology.

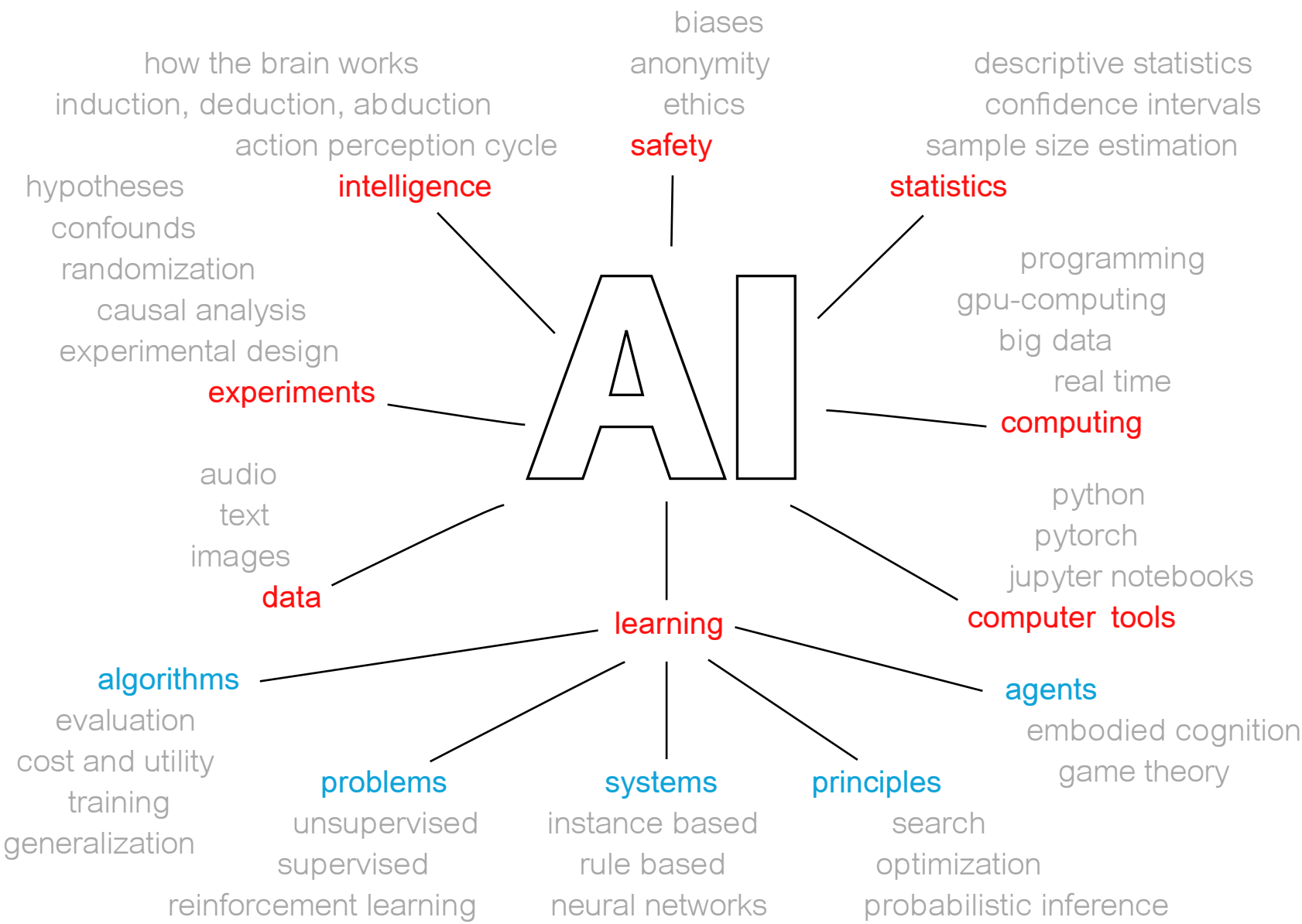
II As above plus: Read, manipulate, and work with technical definitions and expressions (mathematical and Python code). Carry out practical computations. Interpret and evaluate results.

Welcome to Introduction to Intelligent Systems

Welcome to Introduction to Intelligent Systems

Who am I?

Course overview



Course objectives

To provide the participants a basic knowledge of

- defining aspects of intelligent systems,
- application of intelligent systems in image, audio, text and game data,
- computational and collaborative tools for artificial intelligence.

Intelligent systems on DTU Learn

`learn.inside.dtu.dk`

Exercise: Examples of AI

Find the most significant and profound example of (one of) the following topics

A. Superhuman AI Artificial intelligence that outperforms humans

`https://finnaarupnielsen.wordpress.com/2015/03/15/status-on-human-vs-machines`

B. Emulating human creativity AI that emulates human creativity

`http://www.thepaintingfool.com`

C. Intelligent animal behavior Animal behavior

`https://www.thespruce.com/understanding-bird-intelligence-386440`,

`https://en.wikipedia.org/wiki/Dog_intelligence`

D. Augmented intelligence Enhancing human performance using AI

`https://www.technologyreview.com/s/603951/this-is-your-brain-on-gps-navigation`,

`https://deepmind.com/blog/2017-deepminds-year-review`

Prepare to present your example with *two sentences*:

1. Describe the example briefly.
2. Describe why you think this example is significant.

Expectations survey

Survey

Please fill out the *Expectations survey*, including

1. Goals and expectations
2. Self-assessment
3. Mini IQ-test

Find links to the surveys on DTU Learn

The historical origin of AI

Background

Cybernetics (Wiener, 1940s) Study of feedback, control and communication in the animal and the machine.

Cellular automata (Ulam and von Neumann, 1940s) Iteration of very simple rules can produce intricate and complex patterns.

You insist...

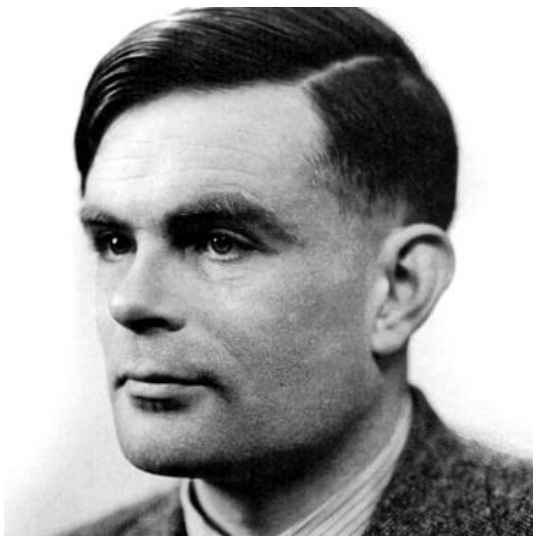
John von Neumann (1950)

> *"You insist that there is something a machine cannot do. If you will tell me precisely what it is that a machine cannot do, then I can always make a machine which will do just that!"*

Universal machines

Alan Turing

> *"This special property of digital computers, that they can mimic any discrete state machine, is described by saying that they are universal machines. The existence of machines with this property has the important consequence that, considerations of speed apart, it is unnecessary to design various new machines to do various computing processes. They can all be done with one digital computer, suitably programmed for each case. It will be seen that as a consequence of this all digital computers are in a same equivalent."*

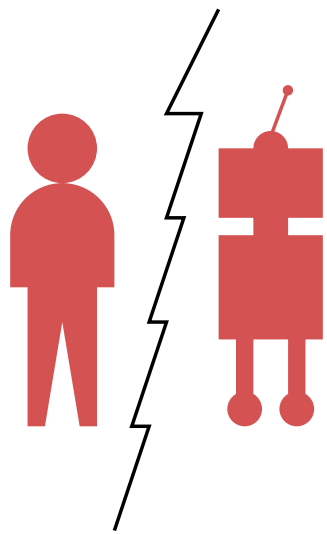


Turing's test (1950)

- Alan Turing speculated about the possibility of creating thinking machines.
- Since "thinking" is difficult to define, he devised his famous Turing Test.

  If a machine could carry on a conversation (over a teleprinter) that was indistinguishable from a conversation with a human being, then it was reasonable to say that the machine was "thinking".

- Turing argues that a thinking machine is at least plausible.



Exercise: Turings objections

Is it possible to create a *thinking machine*? Turing outlined 9 objections:

Theological	Only God can create thinking machines.
Heads in the sand	The consequences of thinking machines are too dreadful.
Mathematical	Fundamental limitations to the power of state machines.
Consciousness	The machine can merely imitate—it cannot feel.
Disabilities	Okay you can do all these things, but you can't do X...
Determinism	The machine can only do what we tell it.
Discrete	The human nervous system is continuous.
Informality	We cannot define rules for every conceivable circumstance.
Extra-sensory	As-of-yet undiscovered laws of physics govern thinking.

Discuss in groups

- Do you belive it is possible to create a thinking machine?
- Which of these objections you agree/disagree with
- Can you come up with any other objections?

Prepare to present your argument for or against thinking machines.

Dartmouth Summer Research Project on Artificial Intelligence

John McCarthy (1956) coined the term "artificial intelligence"

> *We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.*
>
> *The following are some aspects of the artificial intelligence problem:*
>
> 1. *Automatic computers*
> 2. *How can a computer be programmed to use a language*
> 3. *Neuron nets*
> 4. *Theory of the size of a calculation*
> 5. *Self-improvement*
> 6. *Abstractions*
> 7. *Randomness and creativity*

Intelligence and the brain

What is intelligence

Can you come up with the 3 most important factors that are required, in order to define a system (computer, human, animal, etc.) as intelligent?

A definition of intelligence

Interact Percieve the world and take actions which affect the world.

Learn Form mental representations of percepts and environment. Remember and generalize from past events.

Achieve Have goals and act in a way that helps achieve them.

A definition of intelligence

The ability to learn and apply individual knowledge and skills to achieve goals.

Artificial intelligence and data

Intelligence The ability to learn and apply individual knowledge and skills to achieve goals.

Artificial intel. The science of creating machines with intelligent behavior.

Data Information, facts, and statistics collected and stored in a computer.

Human intelligence

General intelligence factor

- Spearman (1904) argues that there exists a general mental capacity, the g factor, that influences performance on all cognitive tasks.
- According to this view, human intelligence can be measured as a single number, such as an IQ score.

Multiple intelligences

- Gardner's (1983) eight intelligences • musical-rhythmical • visual-spatial • verbal-linguistic • logical-mathematical • bodily-kinesthetic • interpersonal • intrapersonal • naturalistic
- Sternberg's (1985) thriarchic theory of intellgence • componential-analytic • experiential-creative • practical-contextual

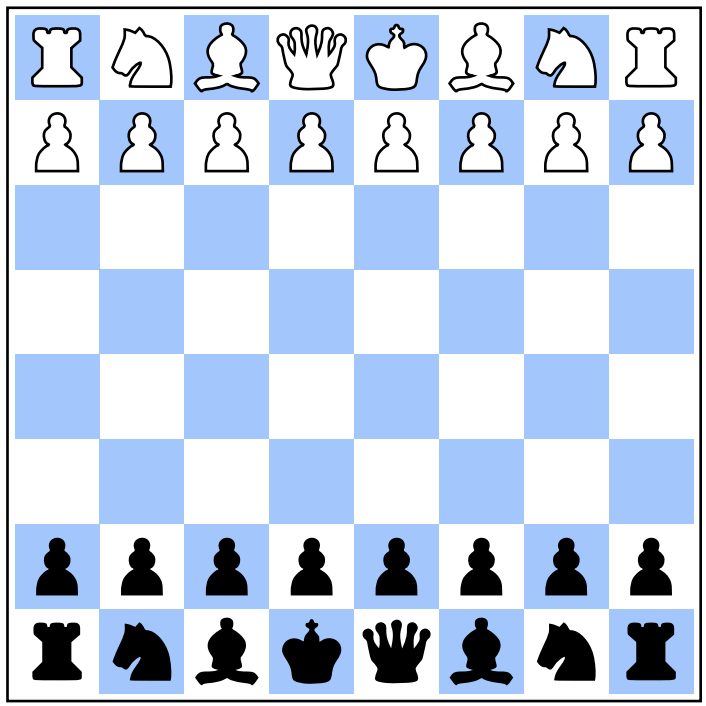
Why do we have a brain?

According to Daniel Wolpert

> *Not all species on the planet have brains, so if we want to know what the brain is for, let's think about why we evolved one. Now you may reason that we have one to percieve the world, or to think, and that is completely wrong.*
>
> *If you think about this questions for any length of time, it's blindingly obvious why we have a brain. We have a brain for one reason, and one reason only, and that is to produce adaptable and complex movements. There is no other reason to have a brain.*
>
> *Think about it: Movement is the only way you have of affecting the world around you.*

Daniel Wolpert. TED talk. The real reason for brains.

Which task is most difficult?

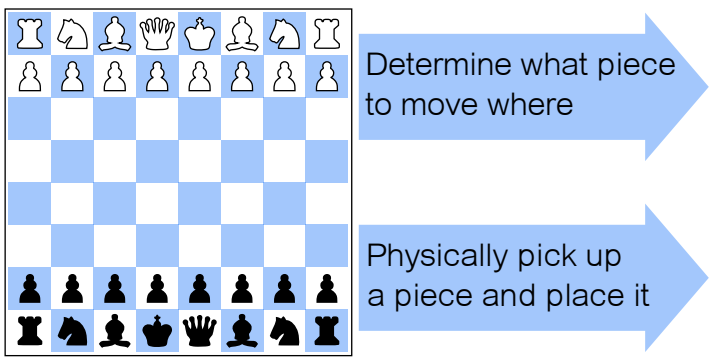


Determine what piece to move where

Physically pick up a piece and place it

Daniel Wolpert. TED talk. The real reason for brains.

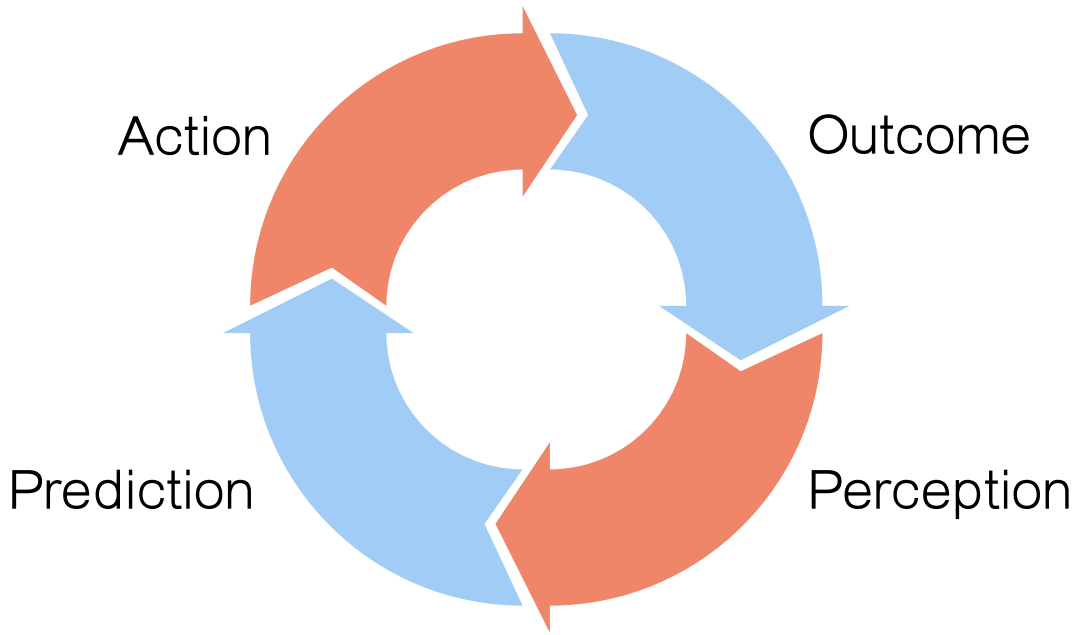
Which task is most difficult?



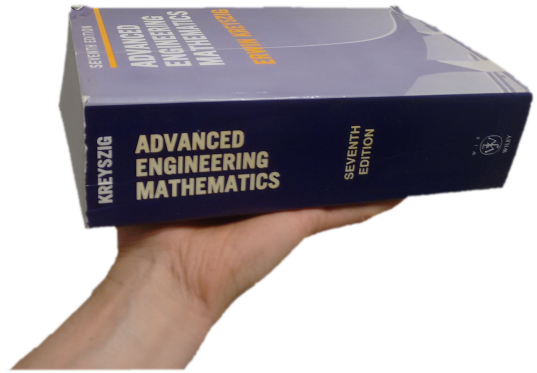
Decide which piece to move where:
Simple algorithm: Consider all possible moves to the end of the game. Choose the one that makes you win.

Physically pick up a piece and place it:
Algorithm: ???

The action-perception cycle



Heavy book experiment



Try this experiment with a friend. Pick up a heavy object, like a large book, and hold it underneath with your left hand. If you now use your right hand to lift the book off of your left hand, you'll notice that your left hand stays steady. However, if your friend lifts the book off of your hand, your brain will not be able to predict exactly when that will happen. Your left hand will rise up just a little after the book is gone, until your brain realizes it no longer needs to compensate for the book's weight. When your own movement removed the book, your brain was able to cancel out that action and predict with certainty when to adjust your left hand's support.

The 80 Percent Mental Blog. Daniel Wolpert On Why You Have A Brain. Dan Peterson

Methods of reasoning

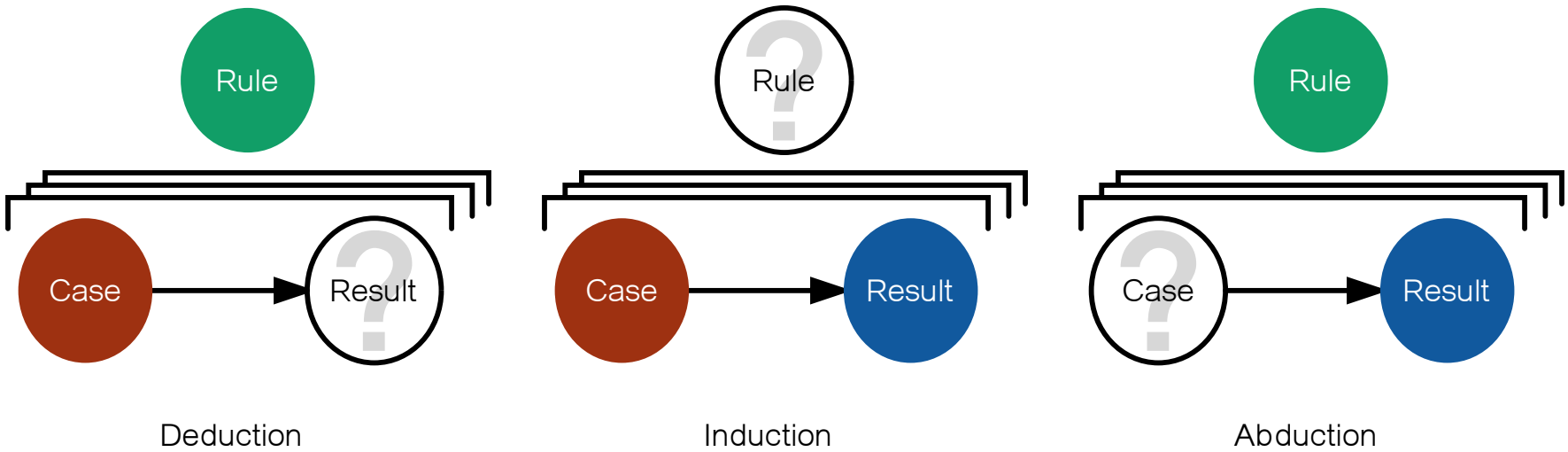
Deduction, induction, and abduction

Deduction Reasoning from general premises to specific conclusions. Infer what is necessarily true based on the premises.
Can be disproven by finding a flaw in the premise.

Induction Reasoning from specific facts to general rules. Infer what are likely conclusions based on statistics.
Can be disproven by a counterexample.

Abduction Reasoning about the simplest or most likely explanation.
Can be disproven by finding a flaw in the explanation.

Deduction, induction, and abduction

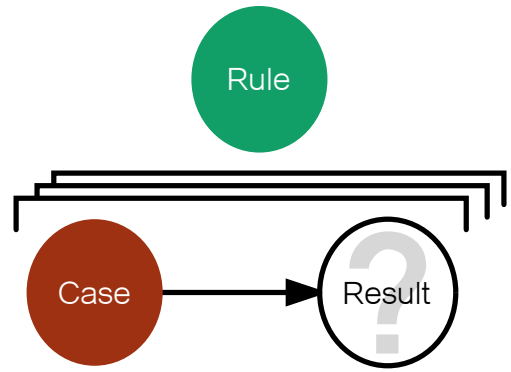


Examples of deduction

Rule All humans are mortal

Case Socrates is a human

Result Socrates is mortal

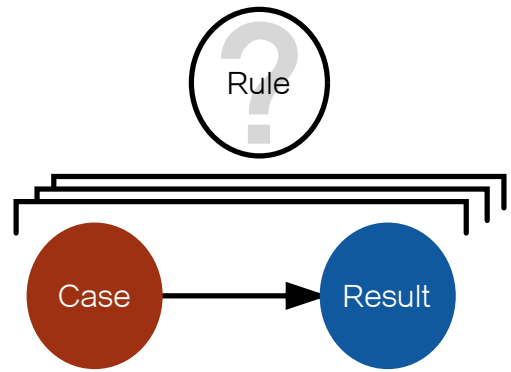


Deduction

Reasoning from general premises to specific conclusions. Infer what is necessarily true based on the premises.
Can be disproven by finding a flaw in the premise.

Example of induction

Case	My brother, my father, my mother
Result	Tall, tall, tall
Rule	All my relatives are tall



Induction

Reasoning from specific facts to general rules. Infer what are likely conclusions based on statistics.

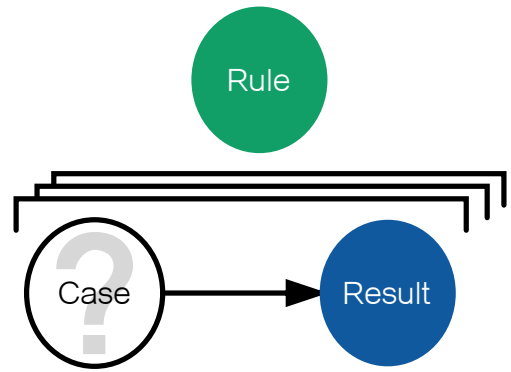
Can be disproven by a counterexample.

Example of abduction

Rule The library has many books

Result I have a book in my hand

Case The book was probably taken from the library



Abduction

Reasoning about the simplest or most likely explanation.

Can be disproven by finding a flaw in the explanation.

Deduction, induction, or abduction?

Q1 In the following number sequence, the next number is always equal to the sum of the two previous numbers. What are the missing numbers?

? - ? - 13 - 21 - 34 - 55

a) 4 - 9 b) 4 - 8 c) 5 - 9 d) 5 - 8

Q2 What are the missing numbers in this sequence?

1 - 3 - 6 - 10 - 15 - 21 - ? - ?

a) 27 - 34 b) 28 - 36 c) 27 - 36 d) 28 - 34

Q3 The following numbers are listed in random order. What are the missing numbers?

1 - 1 - 1 - 1 - 1 - 1 - 1
1 - 1 - 2 - 1 - 1 - 1 - 2
1 - 1 - 1 - 2 - 1 - 1 - 1
1 - 1 - 1 - 1 - 1 - 1 - 3
1 - 1 - 1 - 1 - 1 - 1 - 1
1 - 1 - 1 - 1 - 1 - 1 - 1
1 - 1 - 1 - 1 - 1 - ? - ?

a) 1 - 1 b) 2 - 3 c) 3 - 2 d) 4 - 2

Q4 What are the missing numbers in this sequence?

1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - ? - 1 - 1 - 1

Hint: the answer is not 1, so you really have to search from A to Z to find the solution.

a) 2 b) 3 c) 4 d) 5

Demo of image recognition

Python installation instructions

Python installation instructions

1. Install Python

   Get version 3.11 from `python.org`

2. Install VSCode

   Install the extensions Python and Jupyter

3. Create a virtual environment called IntelligentSystems

   ```
   python -m venv IntelligentSystems
   ```

4. Activate the virtual environment

   Windows powershell `IntelligentSystems\Scripts\Activate.ps1`
   MacOS/Linux `source IntelligentSystems/bin/activate`

5. Install required packages with pip

   ```
   pip install -r requirements.txt
   ```

6. Select the virtual environment as interpreter in VSCode

   Python script: Click on the interpreter version in the bottom right corner
   Jupyter notebook: Click on the kernel version in the top right corner and choose IntelligentSystems

Detailed instructions: Go to `pythonsupport.dtu.dk` and find course *02461*.

Tasks

Tasks

Today

1. Install Python (according to instructions)
2. Try out the following notebooks and programs in VSCode
   - The notebook *01-Introduction.ipynb*
   - The script *01-ImageRecognition.py*
   - The game Lunar Lander: *Play_LunarLander.py*
3. Today's feedback group
   - Jakob Lauge Reeh
   - David Lindahl
   - Philip Thinggaard
   - Poul Skov

For next time

1. Read the notes "Introduction" + Solve problems
2. Read the notes "Statistics" + Solve problems