1 – Introduction to Data Science and Artificial Intelligence

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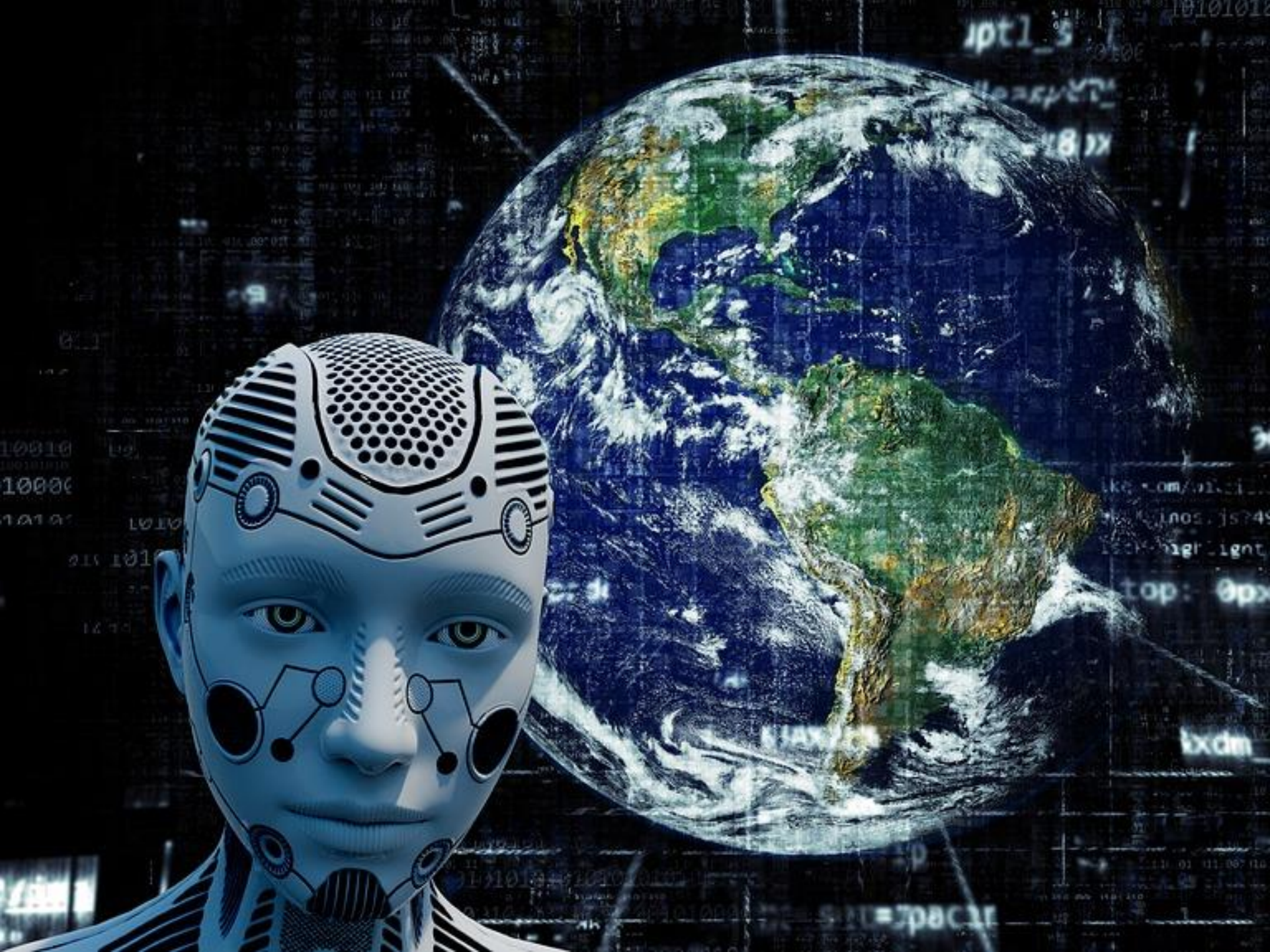


Learning Goals

- Understand what data science is
- Understand what artificial intelligence is
- Understand the relationship between data science and artificial intelligence

- Remember and understand different definitions of intelligence
- Be able to apply definitions to concrete examples
- Be able to critically reflect on definitions of intelligence in relationship to understanding intelligent (natural or artificial systems)
- Remember and explain key capabilities of intellient systems

Data Science is

The science of using data as key part in the process of creating knowledge.

What is Data, what is Knowledge?

Data

Factual, un-interpreted, punctual units of analysis;

Typically understood to exist outside an agent

Knowledge

Accumulated, interpreted, connected, actionable

Typically understood to exist inside an agent

What kinds of questions are asked in data science?

Correlation: What is the correlation between x and y?

Prediction: Given x, what is the likelihood of y?

Classification: Can the given data be partitioned into sub-groups based on pre-defined labels?

Clustering: Can the given data be partitioned into meaningful sub-groups based on the given data?

Other structure identification: Can the given data be described by a priori unkown structures (e.g., factor analysis, social network analysis)?

Other mathematical modelling: Does the given data confirm a given mathematical model? Which model of the phenomenon would explain the observed data?

Artificial Intelligence is…

1) Systems that are (partially) intelligent.

2) The science of engineering technologies that fulfill some criteria of intelligence.

BUT What is Intelligence?

In the context of AI?

Two ways of using definitions:

- Deciding whether an entity can be called intelligent
- Inspiration for engineering

An Intelligent Entity…

Turing test:

- A human asks written questions
- And gets written answers.
- The human does not know whether answers were written by a human or a computer.
- If the human cannot tell merely by analysing the answers, then the computer passes.

Acts Humanly

Problems: Not particularly helpful in engineering – it's a summative test; assumes that humanity is the goal

Fields interested how humans act and interact with their environment:

biology, psychology, linguistics, sociology

An Intelligent Entity…

Thinks Humanly

Focus on thinking = information processing rather than on action

Problems: Separates thought from action; assumes that humanity is the goal

Fields interested in understanding how humans think: Psychology, biology, esp. cognitive (neuro)psychology and neurobiology; philosophy

An Intelligent Entity…

Rational behavior: Behaviour that is (consciously?) aligned with goals, benefit, survival

Problems: Assuming that intelligence means being/acting rational

Fields modelling rational actions: Philosophy, economics, psychology, sociology, (evoloutionary) biology

Acts Rationally

An Intelligent Entity…

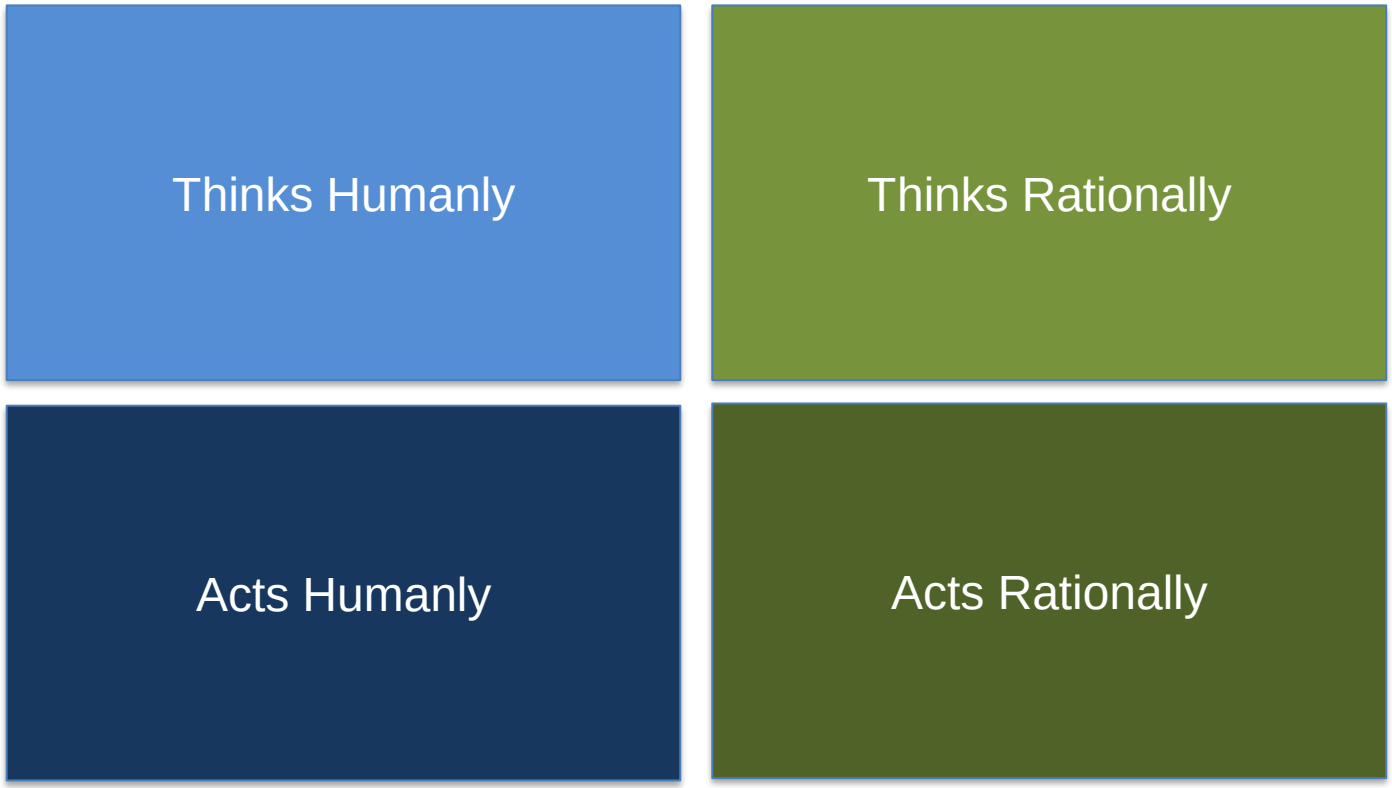
Focus on thinking = information processing rather than on action

Problems: Separating thought from action, assuming that assuming that intelligence = rationality

Fields interested in rational thought: Philosophy; mathematics – focus on normative, i.e. how thinking should be; artificial intelligence

Thinks Rationally

What is Intelligence?



New (and final) try: Intelligence means …

- That an entity is capable
- of adapting behavior
- in interaction with an environment of relevance
  - Responds to changes in environment
  - Responds to feedback/changes in environment due own interactions with environment
- in order to achieve goals

= that an entity' is able learn from experience in an environment.

What does a system need to be able to do in order to have a chance at passing as intelligent?

Perceive

Senses and sensors

Think

“Brain” - Memory, knowledge representation, reasoning

Act

Human body, and actuators

Key capabilities of intelligent systems

What does a system need to be able to do in order to have a chance at passing as intelligent?

Perceive

- Digital environment: Data, natural language, *Audio, Images, Videos*
  - **Connection to Data Science**: Data represents the environment -> perceive the environment through data.
- Physical environment: Audio, Vision, Physical or chemical sensors (temperature, substances, …)

What does a system need to be able to do in order to have a chance at passing as intelligent?

Think

- Memory, database
- Data analytics and machine learning models as data-oriented knowledge representations, incl. as used in special application scenarios: Computer vision, speech processing, natural language processing models.
  - **Connection to Data Science**: Application of data science methods and models derived through data science within a system
- Rules, logic, graphs as knowledge representation formalisms / structures
- Logic, graph mathematics, vector mathematics and neural networks as reasoning mechanisms
- Machine learning algorithms

What does a system need to be able to do in order to have a chance at passing as intelligent?

Act

- Digital environment: Interactive systems, e.g., recommender systems, decision support systems (e.g., in medical diagnosis), automated systems (e.g., automatically controlled heating)
  - **Connection to data science**: data analytics methods based on statistics or machine learning are part of these interactive/active systems
- Physical environment: Robots

Exercise 1

- How many definitions of intelligence have we just discussed?
- In what sense is Google (the search engine) intelligent?
- How does Google perceive the world? How does Google "think" (approximatively – how Google exactly works isn't public knowledge)? How does Google act?
- Find 2 entities in the world around you, of which one is NOT intelligent and one is, according to a majority of definitions. Discuss in what sense they are (not) intelligent. Reflect on the definitions of intelligence.