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, and apply them to concrete examples
- Remember and explain building blocks of intellient systems

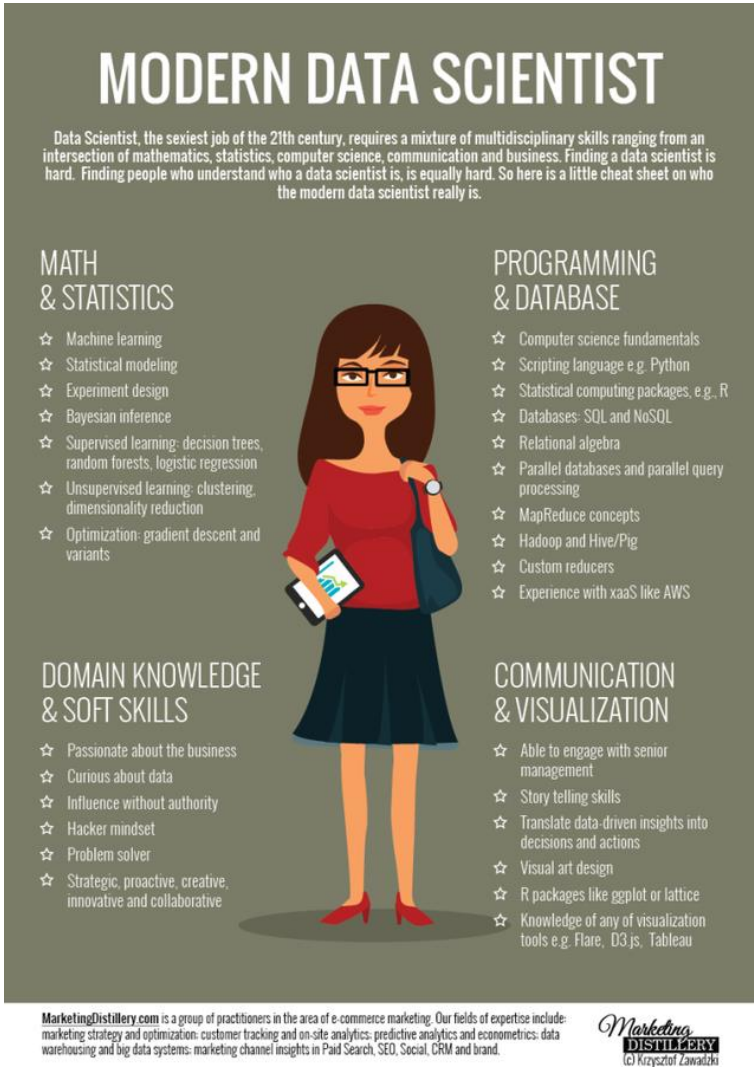
What is Data Science

Data Science is

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

Fields of knowledge

- Mathematics - statistics
- Computer science – data mining, machine learning, databases, programming
- Domain 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?

What is Artificial Intelligence?

Artificial Intelligence is…

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

Fields of knowledge

- Biology – understanding life
- Cognitive science and neuroscience
  – understanding the human brain and human thinking
- Philosophy – concepts of thought, rationality,
  ethics; valid argumentation lines
- (Computational) Linguistics – languages and grammar
- **Mathematics** – Logic, statistics
- **Computer science** – Machine Learning, Human-Computer
  Computer Vision, NLP, Robotics, Databases
- **Domain knowledge**

BUT What is Intelligence?

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

Problem: The test isn't particularly helpful in engineering, and iterative building of better systems – it's a summative test.

Fields interested in understanding human interactions with environment: iology, linguistics, sociology

An Intelligent Entity…

Rational behavior: Behaviour aligned with goals, aligned with benefits, which are ultimately aligned with survival

Fields modelling rational actions: Philosophy, economics, psychology, sociology, evolutionary biology; artificial intelligence

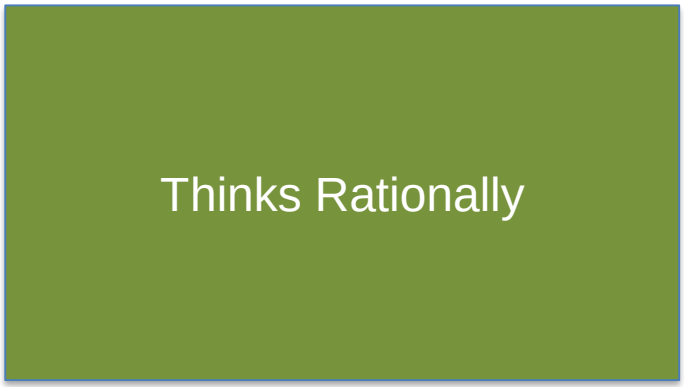
Acts Rationally

An Intelligent Entity…

Normative (pre-conception of how an entity should think) rather than descriptive).

Problem: Not all behaviours of entities that are typically understood as intelligent can be explained by rationality.

Fields interested in rational thought: Philosophy; mathematics; artificial intelligence



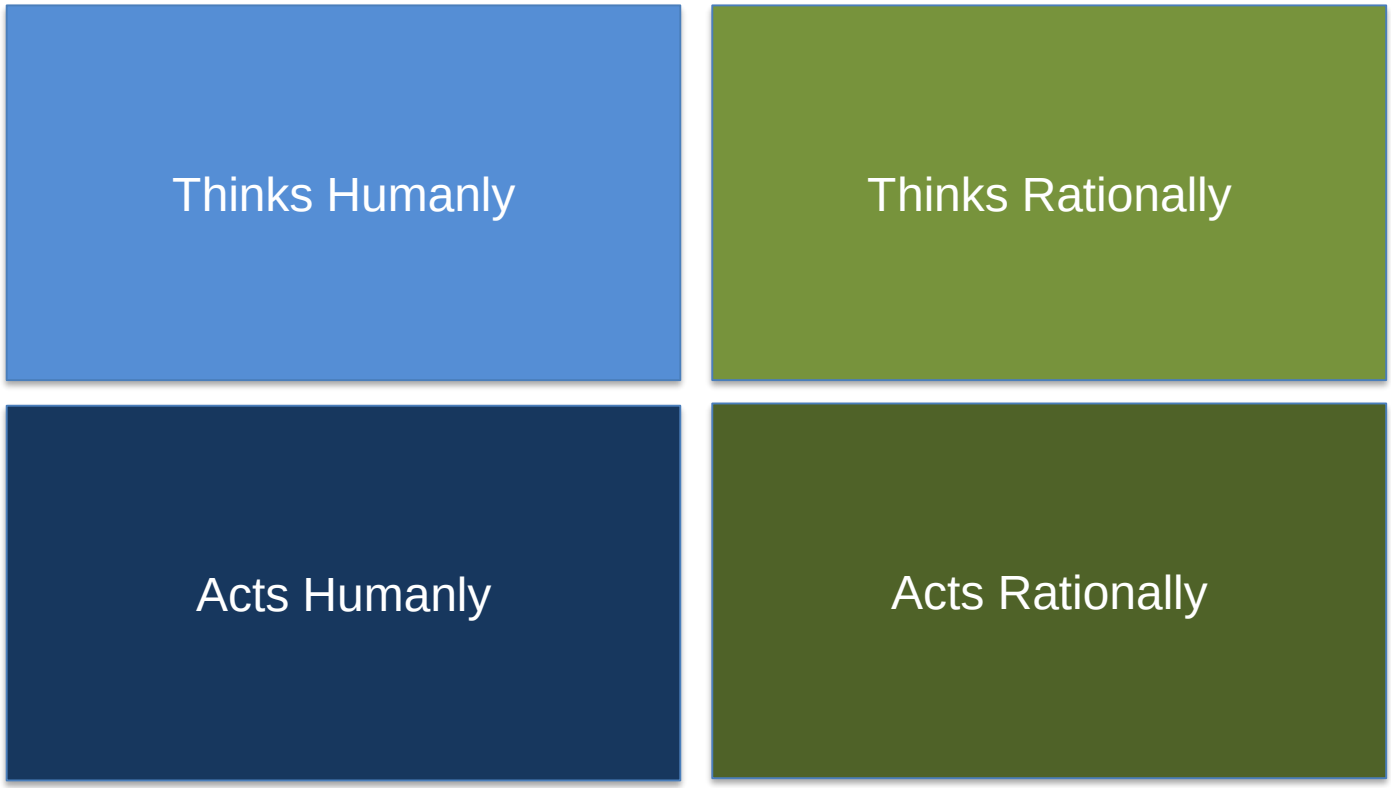
An Intelligent Entity…

Thinks Humanly

Problem: Informs the “how” (informs engineering), but maybe focusses too narrowly on humans as blueprint; and may not be sufficient to allow for intelligent entities who achieve and operationalize intelligence in a different manner.

Fields interested in understanding how humans think: Psychology, cognitive (neuro)psychology; artificial intelligence

What is Intelligence?



Intelligence as…

- an entity's capability
- to adapt behavior
  - in response to own interactions with environment
  - to a changing environment
- in order to achieve goals

= an entity’s capability to learn from experience.

It‘s time to breath out ….

Turn to the person next to you
Introduce yourself
…

How many definitions of intelligence have we just discussed?

In what sense is Google intelligent?

What does a system need to be able to do in order to pass as intelligent?

Perceive

Senses and sensors

Think

“Brain” - Memory, knowledge representation, reasoning

Act

Human body, and actuators

Building blocks of intelligent systems

What does a system need to be able to do in order to pass as intelligent?

Perceive

- **Digital environment: Data**
- Physical environment: Audio, Vision, Physical or chemical sensors (temperature, substances, …)

Think

- Memory, database
- Computer vision, speech processing, **natural language processing** – as processing capability for special types of sensed input
- Rules, logic, graphs, vectors as **knowledge representation formalisms**
- Logic, graph mathematics, vector mathematics and neural networks as **reasoning mechanisms**
- **Machine learning**

Act

- Digital environment: Human-computer interfaces
- Physical environment: Robots