

# Course Overview

## Decision Support Systems, MSc

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# Outline

## Lecturers

## Literature

## Practicalities

## Course introduction

## Next step

# Lecturer: Christian Fischer Pedersen

1/2



Christian Fischer Pedersen

Associate Professor, PhD

Dept. of Electrical and Computer Engineering, AU

Åbogade 34, Office 119, 8200 Aarhus N.

Research interests

- ▶ Biomedical signal/image/data processing
- ▶ Clinical decision support systems
- ▶ Machine/statistical learning in healthcare

# Lecturer: Christian Fischer Pedersen

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## Education

- ▶ PhD, Speech Signal Processing, AAU
- ▶ MSc, Math and Computer Science, AAU
- ▶ MSc, Computer Engineering, AAU

## Positions

- ▶ 10 years at Dept. of ECE, AU
- ▶ 10 years at Dept. of Electronic Sys., AAU

## Visiting scholar

- ▶ U of Erlangen-Nuremberg, DE
- ▶ Shanghai Jiao Tong U, CN
- ▶ Imperial College London, UK
- ▶ Aalto U, Helsinki, FI

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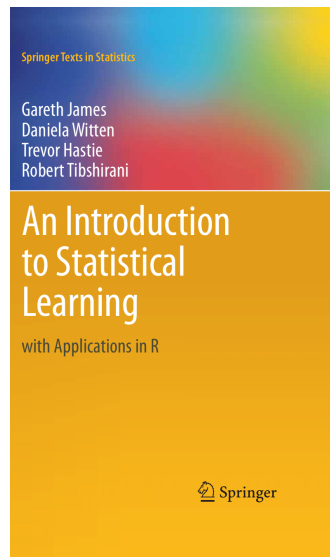
# Course book

## Book

- ▶ Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 2nd Edition, 1st printing
- ▶ Note the edition and printing no.
- ▶ Download for free

## Articles and tutorials

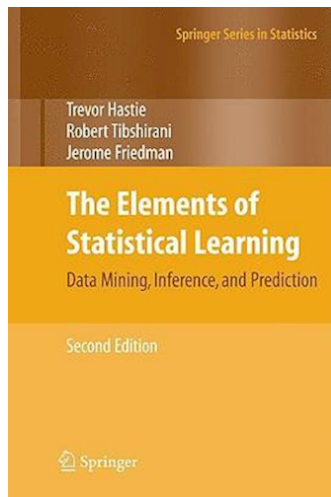
- ▶ To support the book
- ▶ Due to copyright, download yourself. Access via AU net / library



# If you want to dig deeper and broader

## Book

- ▶ Trevor Hastie, Robert Tibshirani, and Jerome Friedman, "The Elements of Statistical Learning", Springer, 2nd ed., 12th printing, 2017.
- ▶ Download for free



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# Course practicalities

- ▶ Brightspace used for all updates and communication
- ▶ Occasional changes on Brightspace site – stay updated
- ▶ Emails are welcome; however, I receive very many emails on a daily basis, so please allow some time for responding, and I encourage you to communicate with me during the course sessions instead

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# What is a decision support system?

## Decision support system

A decision support system is a computer-based system that supports humans or machines in optimal decision making under uncertainty.

# DSS is part of artificial intelligence

## Artificial intelligence (AI)

- ▶ A field of science and technology based on disciplines such as computer science, biology, psychology, linguistics, mathematics, and engineering

## Objective of artificial intelligence

- ▶ To develop computers that can simulate the ability to **think**, as well as see, hear, walk, talk, and feel
- ▶ Reasoning and deciding is part of the **ability to think**



# Turing test

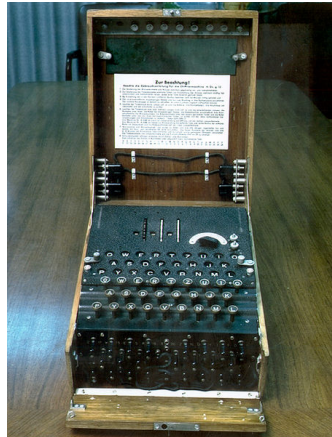
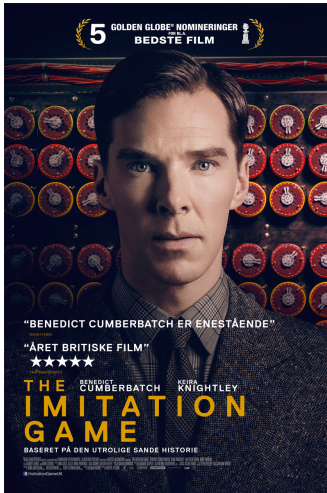
## Turing test

- ▶ A computer is artificially intelligent if it can "pass" as human
- Loebner Prize
- ▶ 1990: Cambridge Center for Behavioral Studies began offering prizes for "best AI systems" - chatter bots
  - ▶ Grand prize of \$100.000 to the first computer program whose responses are indistinguishable from a human's
  - ▶ No one has ever won the grand prize



**Figure:** Alan M. Turing, 1912-1954

# Turing's work on breaking the Enigma code

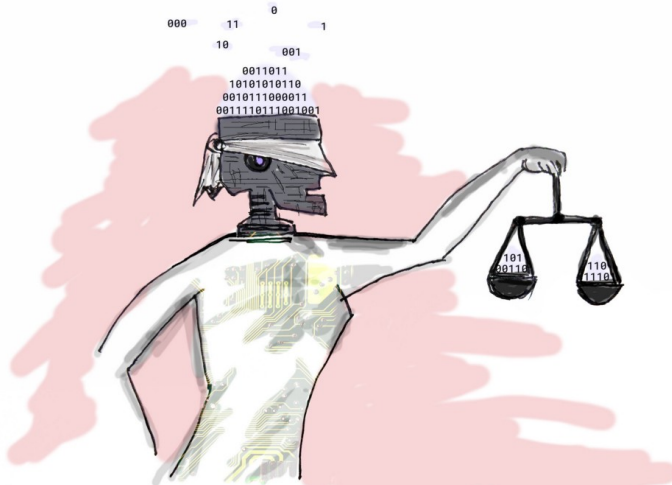


# Why is decision support needed?

## Cognitive biases

Tendencies in humans to think in certain ways that can lead to systematic deviations from a standard of rationality or good judgment.

# Cognitive bias mitigation



Source: [towardsdatascience.com/bias-and-algorithmic-fairness-10f0805edc2b](https://towardsdatascience.com/bias-and-algorithmic-fairness-10f0805edc2b)



Christian Fischer Pedersen, Electrical and Computer Engineering, Aarhus University



# Some common cognitive biases

## Bandwagon Effect

Ideas, fads, and beliefs grow as more people adopt them.



*Sally believes fidget spinners help her children. Francis does, too.*

## Blind Spot Bias

We don't think we have bias, and we see it in others more than ourselves.



*"I am not biased!"*

## Confirmation Bias

We tend to find and remember information that confirms our perceptions.



*You can confirm a conspiracy theory based on scant evidence while ignoring contrary evidence.*

## Dunning-Kruger Effect

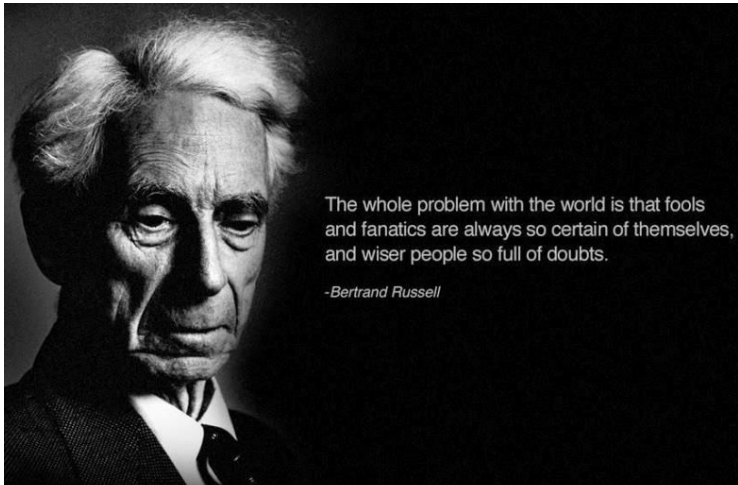
The less you know, the more confident you are. The more you know, the less confident you are.



*Francis confidently assures the group that there's no kelp in ice cream. They do not work in the dairy industry.*

Source: Visual Capitalist

# Bertrand Russell on the Dunning-Kruger effect



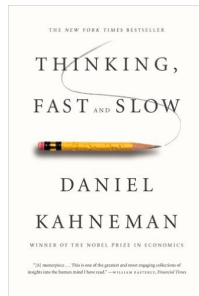
The whole problem with the world is that fools and fanatics are always so certain of themselves, and wiser people so full of doubts.

*-Bertrand Russell*

GeniusQuotes.net

# Cognitive biases is a mature research area and has been addressed from multiple viewpoints

- ▶ Nobel Prize in Economics 2002
- ▶ Constellation of psychological studies
- ▶ Human decision making under uncertainty
- ▶ Humans use a few simple heuristics when reasoning under uncertainty; they may be useful, but at other times lead to severe and systematic errors



# Tversky/Kahneman studies in psychology

## Judgment under Uncertainty: Heuristics and Biases

Amos Tversky; Daniel Kahneman

*Science*, New Series, Vol. 185, No. 4157. (Sep. 27, 1974), pp. 1124-1131.



- ▶ A constellation of psychological studies
- ▶ Elucidate human decision making under uncertainty
- ▶ Awarded the Nobel Prize in Economics 2002

## Main points

- ▶ Humans use a few simple heuristics when reasoning under uncertainty
- ▶ These heuristics may sometimes be useful, but at other times lead to severe and systematic errors

# Tversky/Kahneman example: Question

## Background

- ▶ Linda is thirty-one years old, single, outspoken, and very bright; she majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations

Which alternative is more probable?

1. Linda is a bank teller
2. Linda is a bank teller and is active in the feminist movement

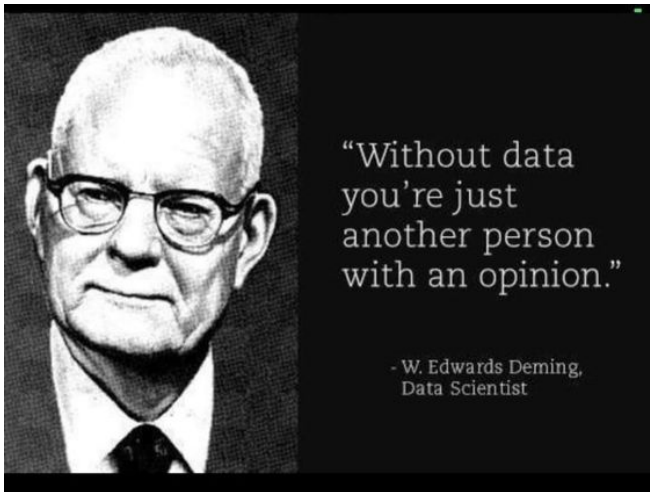
# Tversky/Kahneman example: Answer

- ▶ Approx. 85% opt for alternative no. 2
- ▶ However, alternative no. 2 is logically impossible
- ▶ If 2 is true, so is 1; thus option 1 must be most probable

## **Conjunction fallacy** a cognitive bias

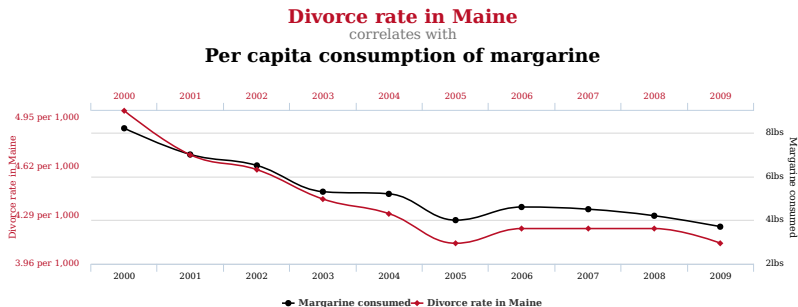
- ▶ The human mind is so wedded to stereotypes and so distracted by vivid descriptions that it will seize upon them, even when they defy logic, rather than upon truly relevant facts

# Engineering viewpoint: add data, statistics, probability theory, algorithms, ...





## ... and handle challenges, e.g. correlation vs. causation



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## DSS application areas include, e.g.

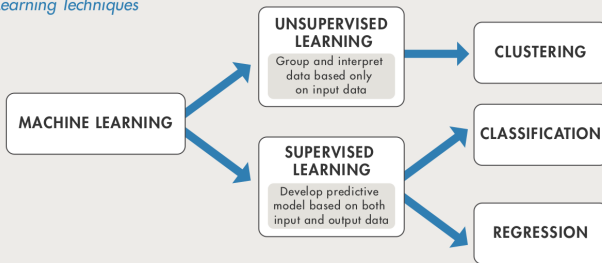
- ▶ Medicine, e.g. diagnosis, alerting, planning
  - ▶ **Watson in Jeopardy**
  - ▶ **Watson in healthcare**
- ▶ Process control, e.g. production optimization
- ▶ Retail and web-shops, e.g. recommender systems
- ▶ Finance, e.g. risk assessment of mortgages and stocks
- ▶ Energy, e.g. optimization of energy usage in buildings
- ▶ Business intelligence
- ▶ Computer games, e.g. chess or autonomous agents
- ▶ Transportation, e.g. self driving cars

# Business perspectives

- ▶ **Enversion, Aarhus**
- ▶ **SimHerd, Viborg**
- ▶ **TREAT Systems, Aalborg**
- ▶ **Hugin Expert, Aalborg**
- ▶ **Cambio Healthcare Systems, Aarhus**
- ▶ **Danske Bank (any bank) (e.g. fraud detection)**
- ▶ ...

# The course from a graphical viewpoint

## *Machine Learning Techniques*



A simple algorithm with well-tuned parameters often produces a better model than an inadequately tuned complex algorithm.

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# Action points

- ▶ Let us have a look at Brightspace and the course plan