immerse
EDUCATION

Introduction to the Artificial Intelligence Programme

Elizabeth Savochkina | 5th June

Elizaveta Savochkina (Elizabeth)

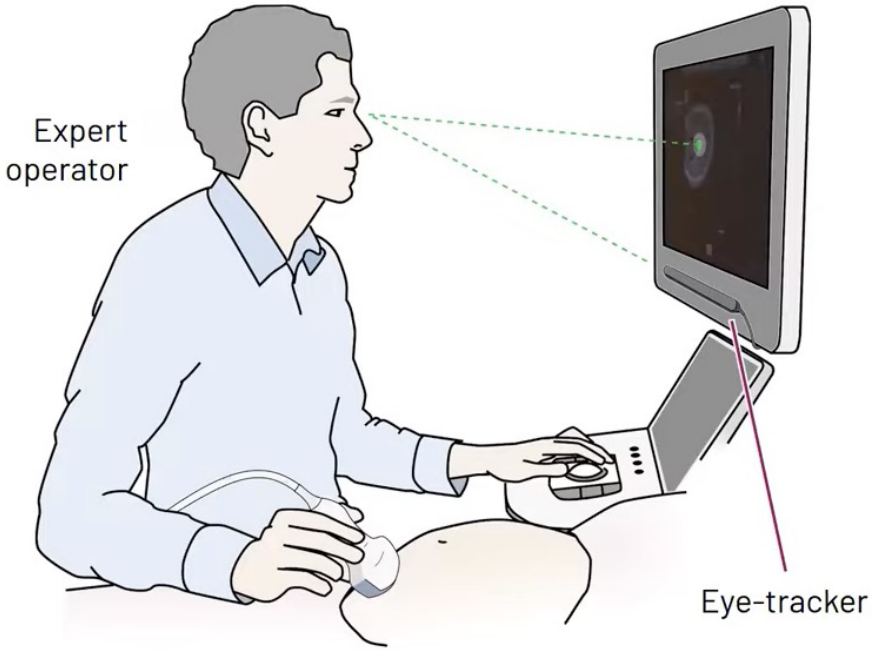
- DPhil Candidate in Biomedical Engineering at the University of Oxford
- Work with Deep Learning and Ultrasound (US)
- Creating and automating guidance mechanisms for real-time first trimester US scanning

Focus:
- Gaze estimation
- 3D fetal reconstruction
- Probe motion

Goal:
- Help identify high risk pregnancies
- Abnormality finding
- Improve and ease general screening practices

Background:
- Robotics and Autonomous Systems (MSc)
- Economics and Mathematics (BSc)

Eye-tracker attached to screen of a clinical ultrasound machine.



Programme Outline Week 1

Monday 4 July 2022	Tuesday 5 July 2022	Wednesday 6 July 2022	Thursday 7 July 2022	Friday 8 July 2022
Registration 9.00am to 9.30am	**Registration** 9.00am to 9.30am	**Registration** 9.00am to 9.30am	**Registration** 9.00am to 9.30am	**Registration** 9.00am to 9.30am
Welcome & Introduction to Artificial Intelligence in 2022 9.30am to 11.30am	**History of AI** 9.30am to 11.00am **Team Formation** 11.00am to 11.30am	**Supervised Learning** 9.30am to 11.30am	**Unsupervised Learning** 9.30am to 11.30am	**Reinforcement Learning** 9.30am to 11.30am
Break 11.30am to 13.30 pm	**Break 11.30am to 13.30 pm**	**Break 11.30am to 13.30 pm**	**Break 11.30am to 13.30 pm**	**Break 11.30am to 13.30 pm**
AI - What is possible? 13.30am to 14.00pm	**Workshop: Identifying Opportunitis for AI** 13.30am to 14.30pm	**Hands on: RapidMiner, Python and Jupyter** 13.30am to 15.30pm	**Project Discussion: Opportunity Identification & Ideation** 13.30am to 15.30pm	**Keeping up with AI & Machine Learning updates** 13.30am to 14.30pm
Ice breaker and discussion excersises about AI 14.00am to 15.30pm	**Workshop: Team Poster +** ***Optional Installation*** 14.30am to 15.30pm			**Key Industry Players + Discussion** 14.30am to 15.30pm


rapidminer


python™

Shape of a Day

Registration 9.00am to 9.30am
Welcome & Introduction to Artificial Intelligence in 2022 9.30am to 11.30am
Break 11.30am to 13.30 pm
AI - What is possible? 13.30am to 14.00pm
Ice breaker and discussion excersises about AI 14.00am to 15.30pm

Lectures

Assignments

Class Discussions

Exercises

Workshops

Group Work

Capstone Project

Networking

Capstone Project

Capstone Project - Summary

The ***Capstone Project*** is an Artificial Intelligence development exercise which requires the students to

> *Identify, examine and report on a way to apply AI to solve a problem or to improve or remove an existing process in an organisational entity.*

This represents the key deliverable from the programme, prepared by the students, working in teams.

Capstone Project - Summary

The ***Capstone Project*** is an Artificial Intelligence development exercise which requires the students to

> *Identify, examine and report on a way to apply AI to solve a problem or to improve or remove an existing process in an organisational entity.*

This represents the key deliverable from the programme, prepared by the students, working in teams.

*No coding is required and **no marks** are given for writing computer code or developing working software.*

Capstone Project – Elements

Business Goals | Technical Requirements | What Data are needed? | Ethical Considerations

- Set out the objective of the AI system
- Identify the opportunity to use AI in the proposed project
- Justify the use of an AI powered solution
- Explain how it links with the strategic goals of the sponsoring organisation

Capstone Project – Elements

Business Goals | **Technical Requirements** | What Data are needed? | Ethical Considerations

- Clearly identify the process to which you would apply the AI solution
- Describe the relevant business processes using Business Process Modelling and Notation (BPMN)
- Use BPMN to show which existing parts or processes it improves (or creates, or eliminates)
- Describe any machine learning models you would be applying to your data set, and explain why they would be appropriate

Capstone Project – Elements

Business Goals | Technical Requirements | **What Data are needed?** | Ethical Considerations

- Describe the potential data set and the required pre-processing considerations
- Identify any sources of error or bias arising from the expected data sources
- What are the potential data sources?
- How much data are likely to be available and what quality are they?

Capstone Project – Elements

Business Goals | Technical Requirements | What Data are needed? | Ethical Considerations

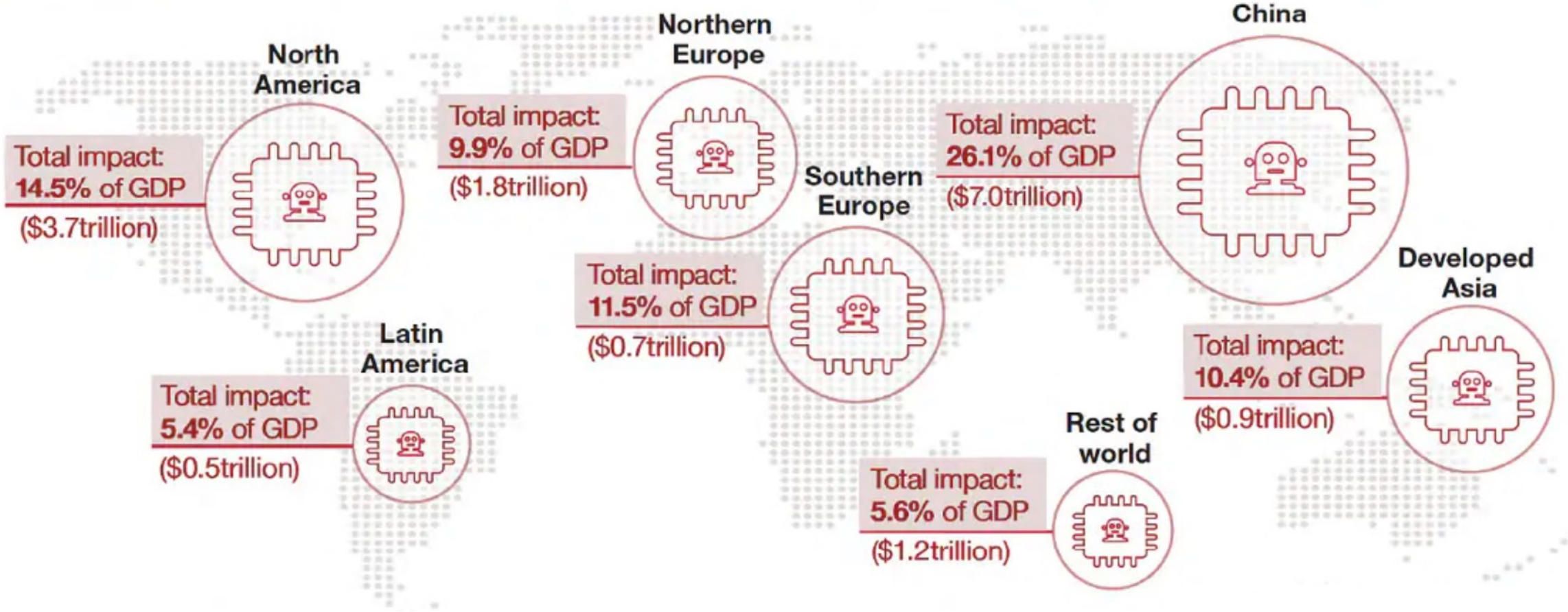
- Consider any privacy and other ethical issues related to the data.
- Discuss the ethical, social and security implications of your use of AI.

AI in 2022

Introduction to Artificial Intelligence

Advances in Artificial Intelligence (AI) are changing the way the government, business and society work and the impact on public policy is wide-ranging.

Economic Potential



Four key factors underpin the current developments in AI

- Growth in Big Data technologies
- Unlimited access to computer power
- Unlimited access to storage
- Developments in algorithms

What are the chief characteristics of AI?

- There is no one technology that represents AI
- The term refers to multiple technologies and there are different definitions.

"There are a range of different ways in which the technological nature of the AI is discussed and understood, ***and many of them have ambiguous interpretations***."

Artificial Intelligence – a definition:

Oxford English dictionary

The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

Many definitions of AI are available

"The science of making machines do things that would require intelligence if done by human."

Marvin Minsky

Many definitions of AI are available

"The science of making machines do things that would require intelligence if done by human."

Marvin Minsky

"The study of mental facilities through use of computational models. The ultimate goal of AI is to build an artificial person."

Charniak and McDermott

What is intelligence?

How can we know whether a machine can think?

What is Artificial Intelligence?
What is artificial about it?

- Some claim that artificial should stand for ‘false’ because it’s not human
- ‘Artificial’ only because it is created by humans and didn’t originate from natural causes
- So far, we can say AI is the best umbrella term for explaining advanced computer intelligence

What is Artificial Intelligence?

- It summarises the efforts to make computers think the way we think, to be able to simulate human cognitive thinking and decision-making, leading to human-like actions, and ultimately to be better and faster at problem-solving than we are

What is Artificial Intelligence?

- Artificial intelligence (AI) makes it possible for machines to use experience for learning, adjust to new inputs and perform human-like tasks

Types of Artificial Intelligence

- Artificial intelligence is generally divided into two types – narrow (or weak) AI and general AI, also known as AGI or strong AI

Narrow AI

- Perform one task at a time and to continue improving its execution.
- Improve something that already works, but can work better
- Most of Artificial Intelligence is Narrow AI
- Software that is automating an activity typically performed by humans

Examples of narrow AI:

- Self-driving cars that learn how to drive (Google, Uber cars)
- Ask our smartphones about the weather etc

General AI

- The goal is the machine's ability to think generally, to be able to make decisions based on learning rather than previous training
- Independent learning from experience, which is the way humans learn and reason, is the goal
- Creating an intelligence that is equivalent to that of a human being

General AI

- Four tests of AGI have emerged as the primary definitions of the concept and the marker for judging whether something is generally intelligent

1. Turing Test (1950)
2. The Coffee Test
3. The Robot University Student Test
4. The Employment Test

1. Turing Test (1950)

- AI program needs to be able to win the the $100,000 Loebner Prize (This prize has been available for over 28 years, and no one has won it yet)
- $25,000 for the first program that judges cannot distinguish from a real human, and which can convince judges that the human is the computer program.
- $100,000 first program that judges cannot distinguish from a real human in a Turing test that includes deciphering and understanding text, visual, and auditory input.

AI Application areas

- Driverless cars
- Virtual agents
- Identity Analytics
- Speech Analytics
- Cognitive automation
- Cognitive Robotics
- Recommendation Systems
- Modelling & Data Visualisation
- L.A.W.S.

AI Risks and Ethics

L.A.W.S.

Lethal Autonomous Weapon System

Driverless Cars

Algorithmic Bias

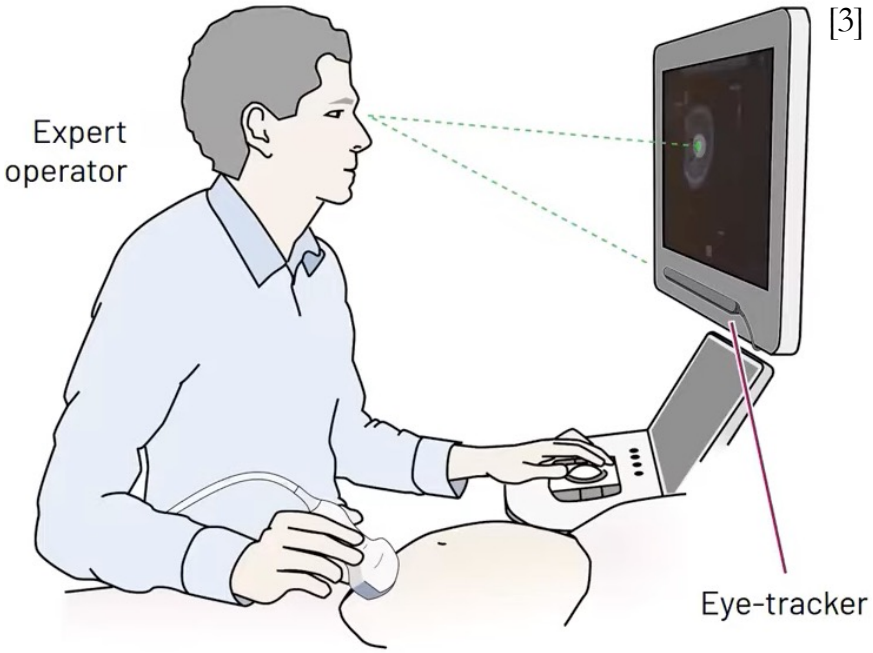
Continuation of Introduction to AI…

Biomedical Image Analysis

BIOMEDICAL IMAGE ANALYSIS

FIRST TRIMESTER VIDEO SALIENCY PREDICTION

Eye-tracker attached to screen of a clinical ultrasound machine.



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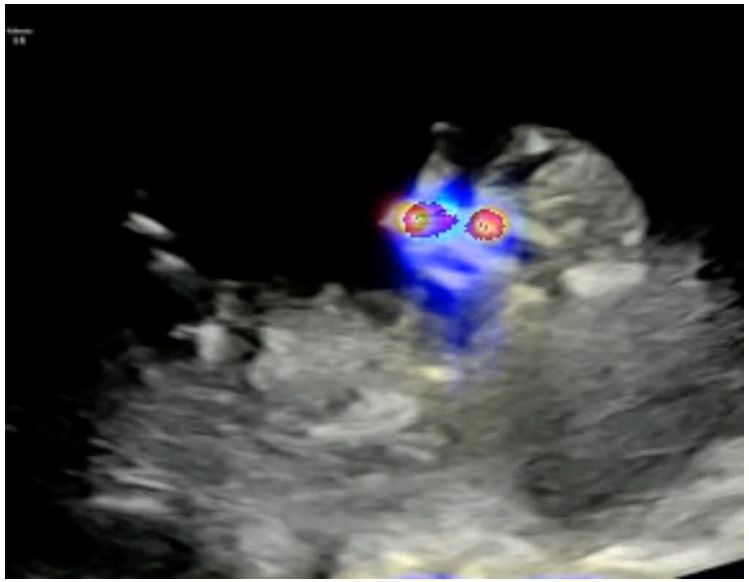


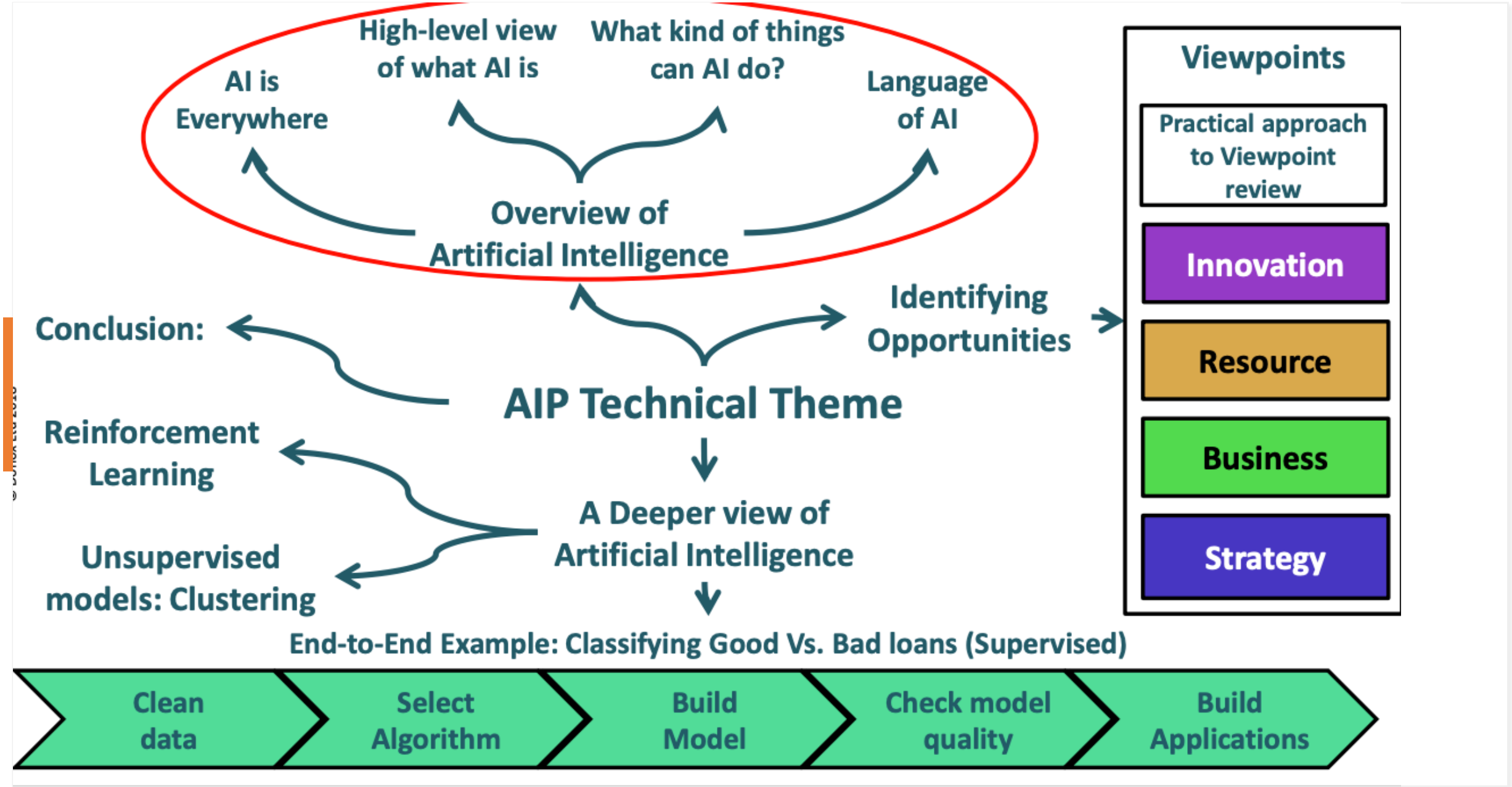
Actual gaze overlaid as a **yellow map**

Predicted gaze overlaid as a **blue map**

Overlap of both creates a **red map**

1. Acquire **image and gaze data** during a routine ultrasound examination

2. Train a model to predict the sonographer gaze distribution: **visual saliency map**


High-level view of what AI is
What kind of things can AI do?
AI is Everywhere
Language of AI
Overview of Artificial Intelligence
Viewpoints
Practical approach to Viewpoint review
Innovation
Resource
Business
Strategy
Identifying Opportunities
Conclusion:
AIP Technical Theme
Reinforcement Learning
A Deeper view of Artificial Intelligence
Unsupervised models: Clustering
End-to-End Example: Classifying Good Vs. Bad loans (Supervised)
Clean data
Select Algorithm
Build Model
Check model quality
Build Applications

More Human than Human

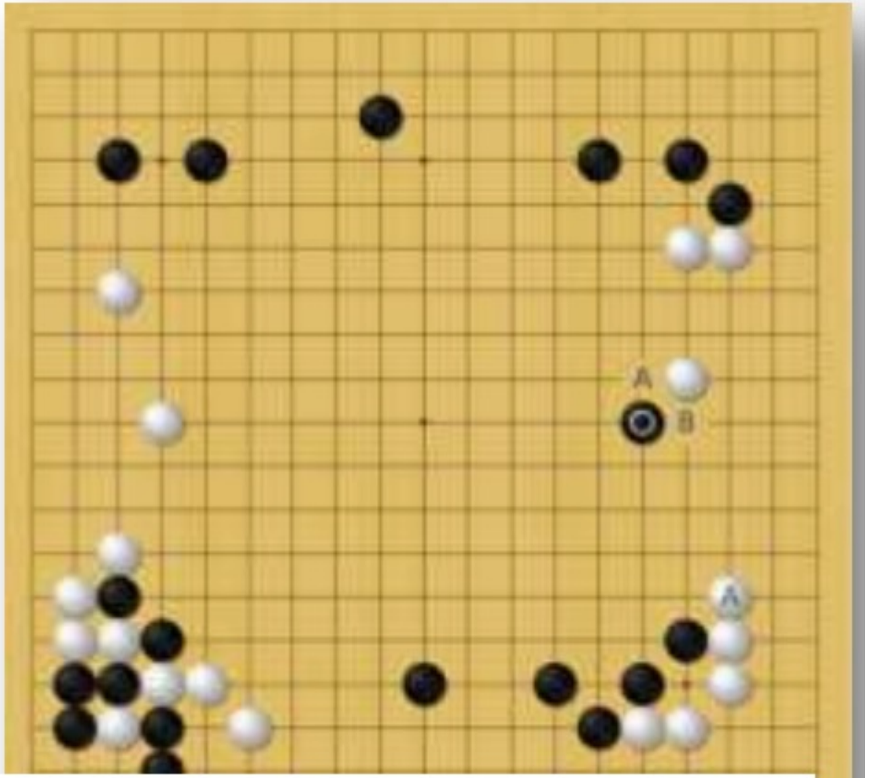
“An entity that cannot be defeated”

- Lee Sedol - South Korean Go player of 9 dan rank
- Became a professional Go player at the age of 12
- By 2016 he ranked as the world’s number 2 player
- On 19 November 2019, Lee announced his retirement from professional play
- He realised that he could never be the top overall player of Go due to the increasing dominance of AI

https://youtu.be/WXuK6gekU1Y

Go : The most difficult strategy board game

- Go is a 2500 year-old strategy board game
  - Played with black and white ‘stones’
  - On a 19x19 grid
- The number of legal board positions in Go has been calculated to be approximately 2×10^{170}
  - The number of atoms in the known, observable universe, estimated to be about 10^{80}



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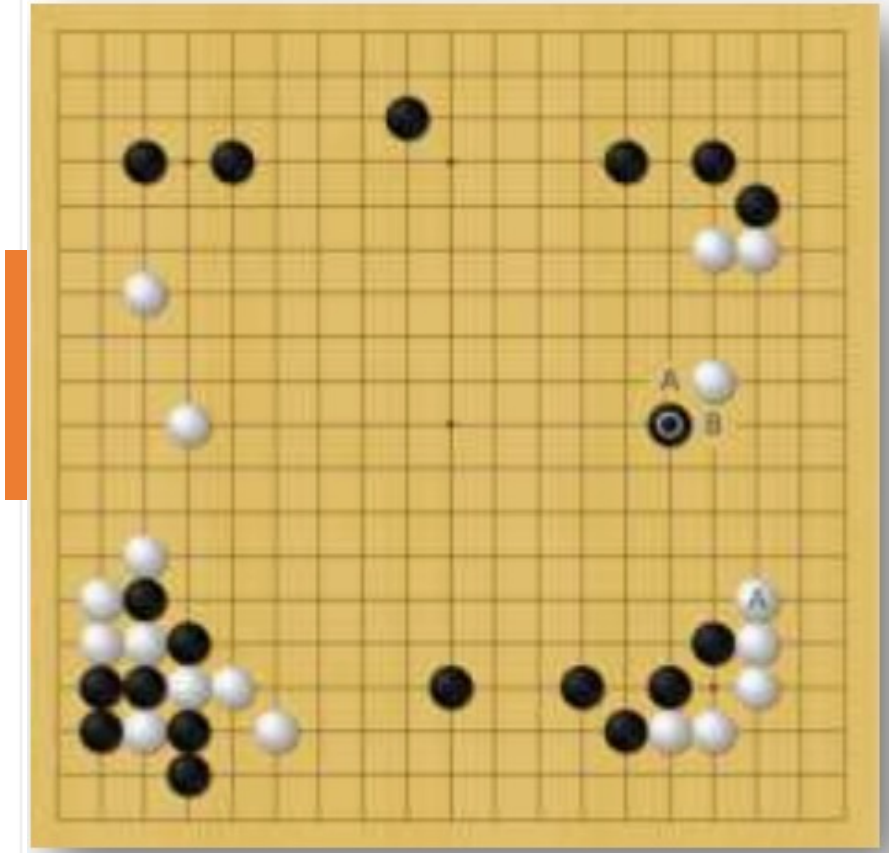
Move 37



- During March 2016 Lee Sedol played a match against the computer programme AlphaGo
- Ahead of the match, Sedol was confident of victory
- He lost the first 3 games of a five-match competition
- During game 2, AlphaGo made an astounding move that looked like extremely poor game play ..
  - Professional commentators were sure that the program had made a huge mistake
  - But by the end of the game, it was clear that the extremely unusual move was key to AlphaGo winning the game
- "Move 37" is now regarded as a turning point both for AI/ML and for Go

https://youtu.be/WXuK6gekU1Y

What is Artificial Intelligence? An Overview

AI is the new electricity.

Electricity transformed industries: agriculture, transportation, communication, manufacturing. Just as electricity transformed industry after industry 100 years ago, I think AI will do the same

Andrew Ng, Chief scientist at Baidu, Coursera co-founder, and Stanford adjunct professor

What is Artificial Intelligence (AI)?

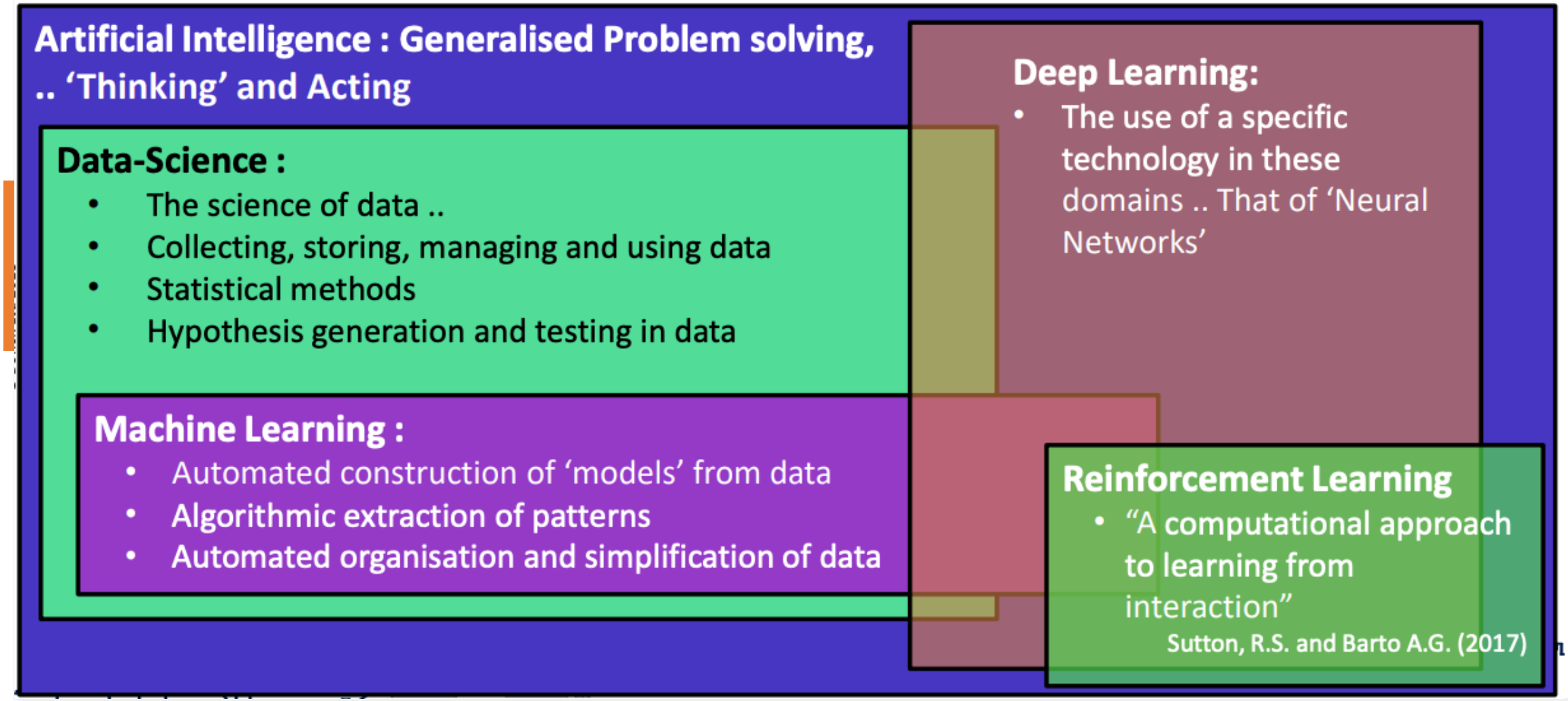
"... the science of making machines do things that would require intelligence if done by a human being"

Marvin Minsky

- Examples include
  - Translating text from one language to another
  - Naming the type of flower shown in a photograph
  - Predicting if a person will repay a bank loan or not
  - Playing complex strategy games such as chess or go
  - A computer-controlled, self-driving car

Image via www.vpnsrus.com

Over-loading / Over-lapping Buzz-Words



Artificial General Intelligence (AGI)

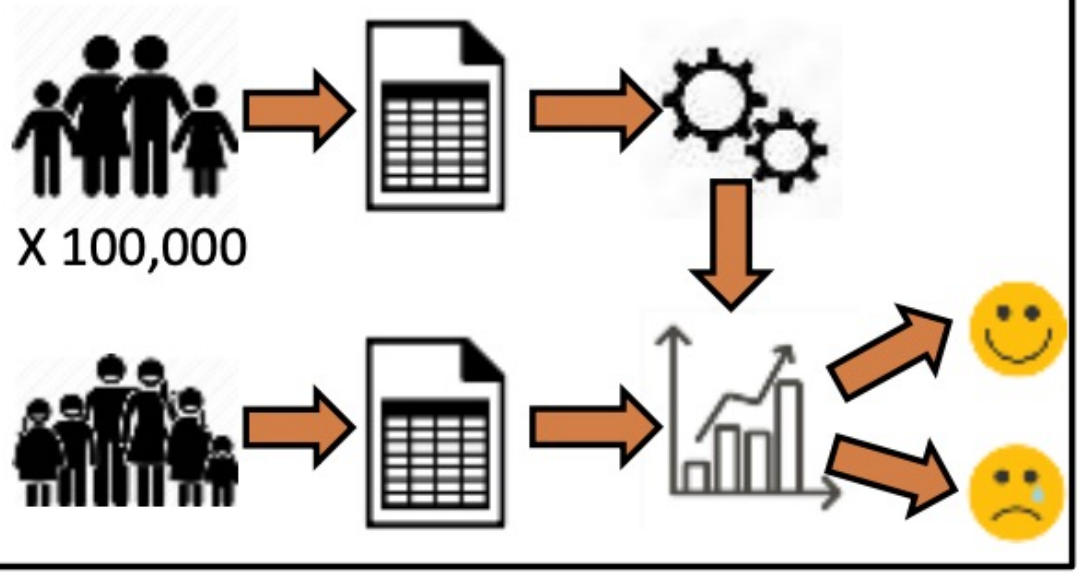
- Artificial General Intelligence (AGI) would be machines that think and learn at least as well as human beings ..
  - Maybe they would be 'conscious' (strong AI)
- AGI exists in the popular imagination, in Hollywood and it literature …
- But in reality it is not coming any-time soon!

Machine Learning : Decisions Built from Data

‘Traditional’ Decision Making in Software

```
if income < 35000 then
  cs = get_credit_score
  if cs < 650 then
     print “reject application”
  else
     print “Offer loan”
```

Machine Learning

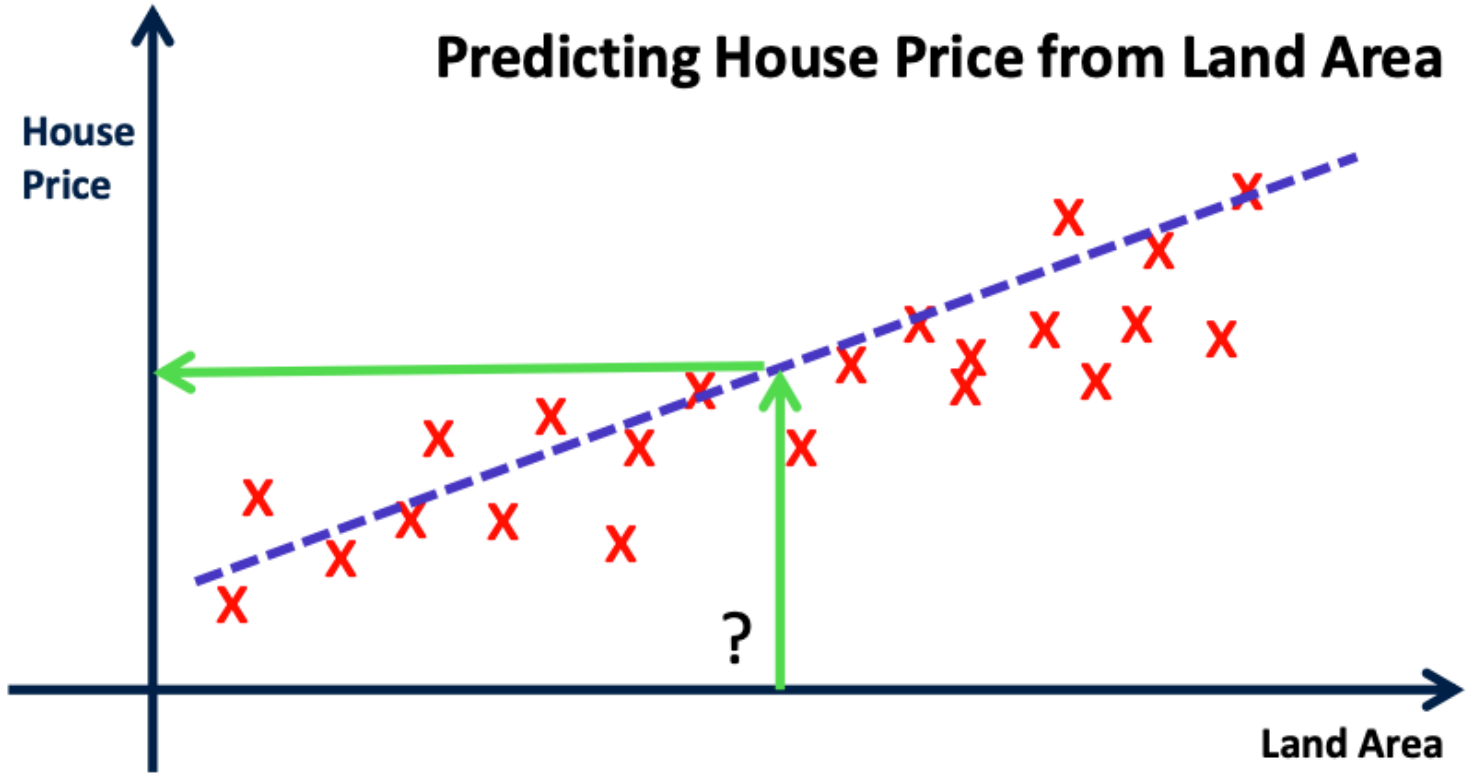


But how?!?!

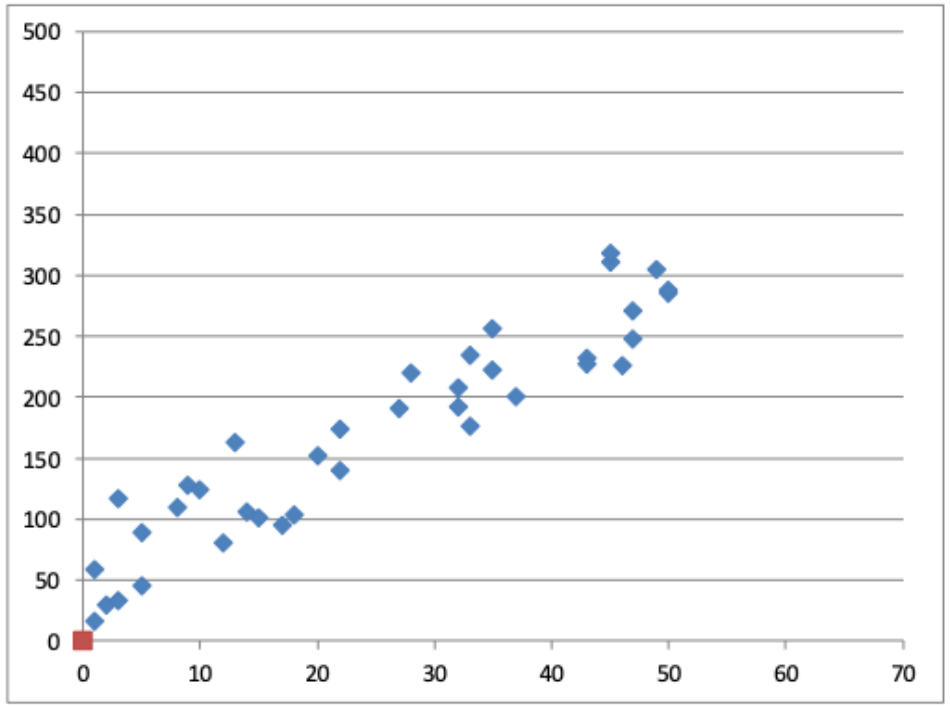
There are many ways ..

But some are as simple as drawing a ‘straight-line’ through existing data points and reading off new predictions

(Linear Regression)



But How do you “Wiggle the Line Until it fits?”



Error 1,372,453

0

0

It can't be that easy!

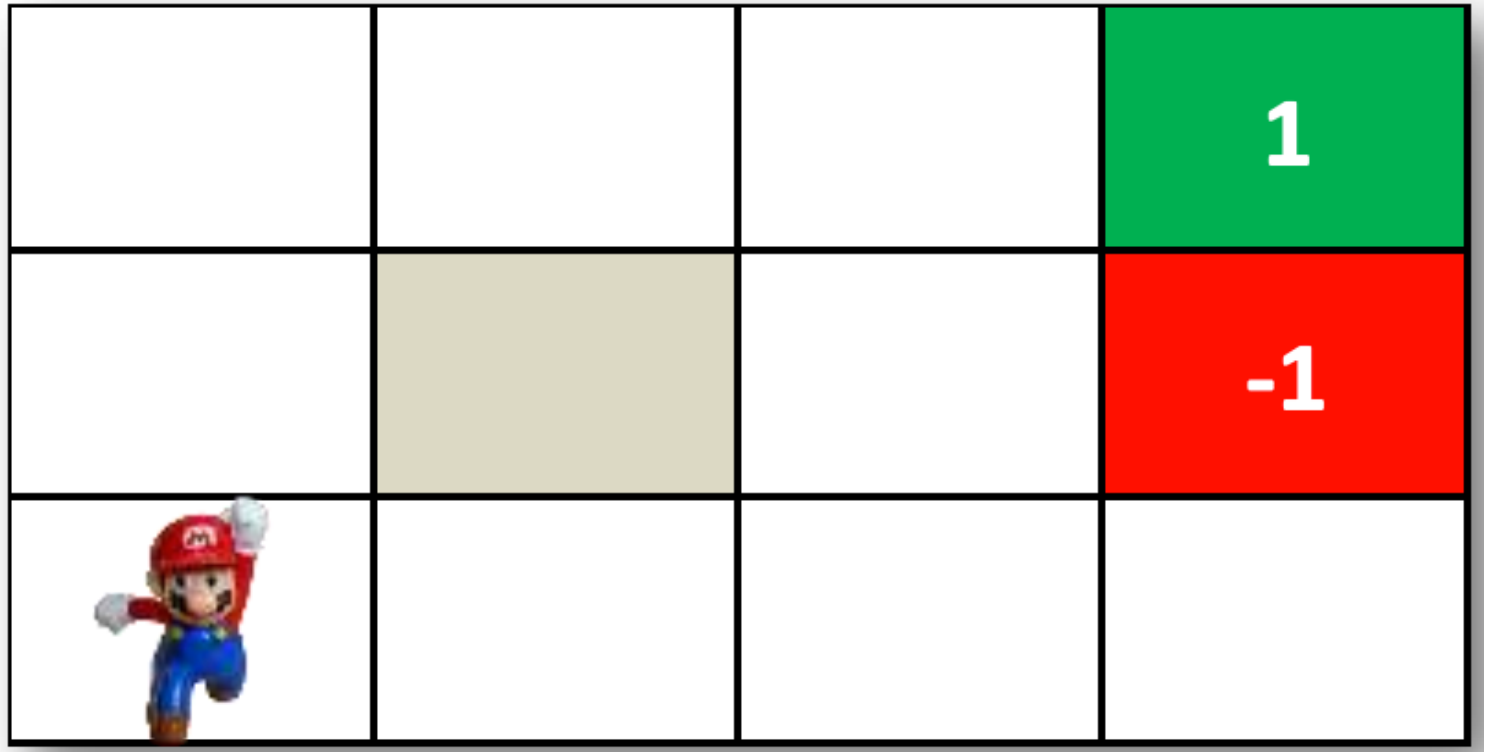
- It isn't ..
- ML models don't just work with straight-lines
  - .. They can fit more complex curves ..
- And they can work with <u>many</u> more variables
  - Often 1000's!

Fundamentally .. Its Statistics

- Fundamentally .. Machine Learning is Statistics ..
- Often using large data-sets ..
- Involving potentially hundreds of millions of calculations
- But still, fundamentally .. statistics

Reinforcement Learning : Behaviour from Exploration

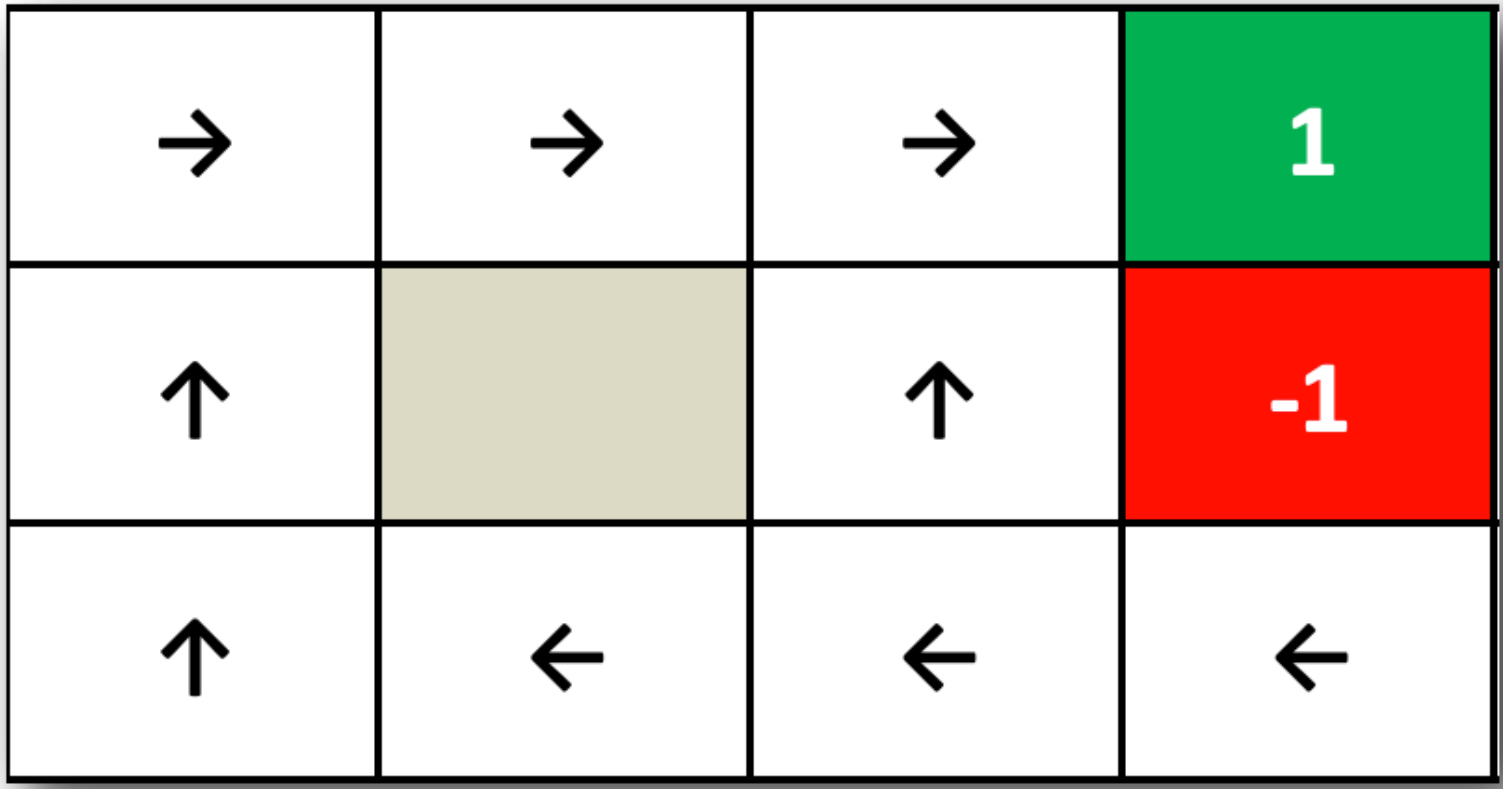
In Reinforcement Learning an Agent explores a World and attempts to achieve a Goal by developing optimum Policies



Sutton, S.S. and Barto, A.G. (2017) "Reinforcement Learning: An Introduction"

The ‘Best Route’ is not Always Simple

- Why does the agent take the long way around?
- Because in this world the agent can ‘slip’ in an unintended direction – and going past the ‘Pit of doom’ is dangerous!

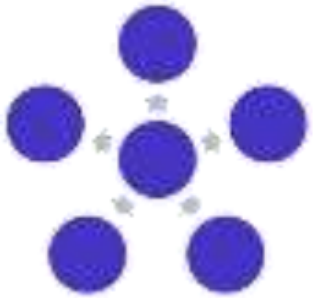


What kind of things can Artificial Intelligence do?

What kind of things can AI do?

Classification

- Filter Spam
- Detect fraudulent applications
- Sort resumes for jobs
- Direct enquiries to the correct expert
- Classify images from x-rays as malignant / benign



Clustering

- Segmenting customers into groups
- Grouping products into families that customers will relate to
- Grouping complaint types
- Personalised product offerings

What kind of things can Machine Learning do?

Detecting patterns in data

Recognition

- Identify money laundering
- Recognise when a machine is wearing out or needs maintenance
- Detect computer hacking attempts
- Identify misshaped / defective parts in production processes
- Identify fraudulent transactions
- Facial recognition for security

Prediction

Regression

- Predicting product /service prices (from suppliers / to customers)
- Predicting product /service demand
- Predicting process yield
- Predicting productivity
- Predicting performance

What kind of things can Machine Learning do?

Dimensionality reduction

- Identify the most important features of large data-sets
- Compress data : More ‘computable’, simpler, more explainable
- Modelling of complex dynamical systems
- Singular Value Decomposition (SVD) : Generalises Eigen Decomposition to non-square matrices

Complex Adaptive Control

- Learn to control and stabilise complex processes by trial-and-error

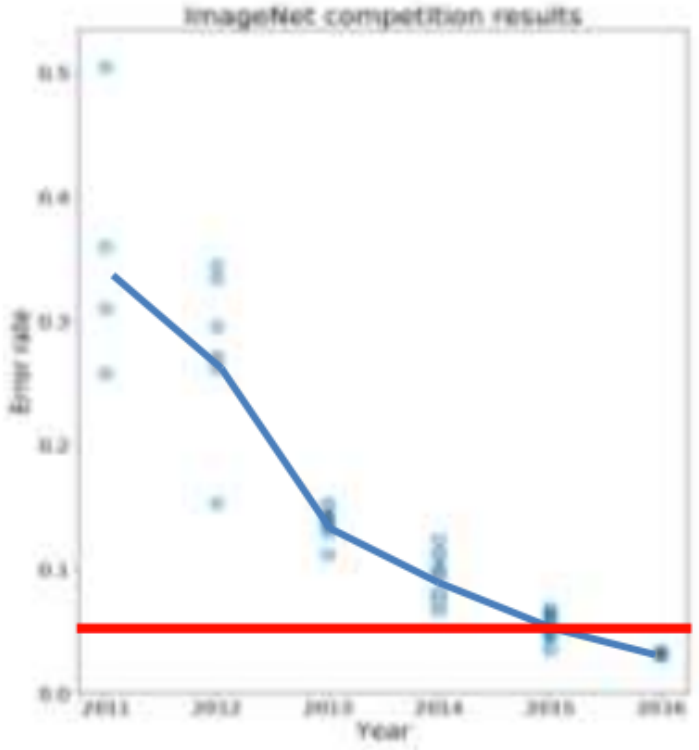
What kind of things can Machine Learning do?

Natural Language Processing (NLP)

- Statistical processing of text : frequency counts, distributions
- Grammatical analysis – Part-of-Speech (PoS) tagging
- Text cluster analysis : Group commonly occurring words
- Theme extraction : Discover common themes in large text corpus
- Sentiment analysis : Is the emotional tone positive or negative?
- Semantic associations : E.g. Word2Vec ..
  - Queen⇔King, Queen⇔Woman, King⇔Man, Man⇔Woman
  - King – Man + Woman = Queen
- Human like conversation
- Translation

It May be Better (Worse) Than you Think

- The ImageNet Challenge is a competition focussed on Visual Recognition
- In particular, the task is correctly label a series of images based on a very large set from the ImageNet database
- Human performance on the same task is around the 5% error level



http://image-net.org/index

And Sometimes Not So Good ..

Even state-of-the art visual recognition can make some 'obvious' mistakes

Introducing Some of the Language of AI ..

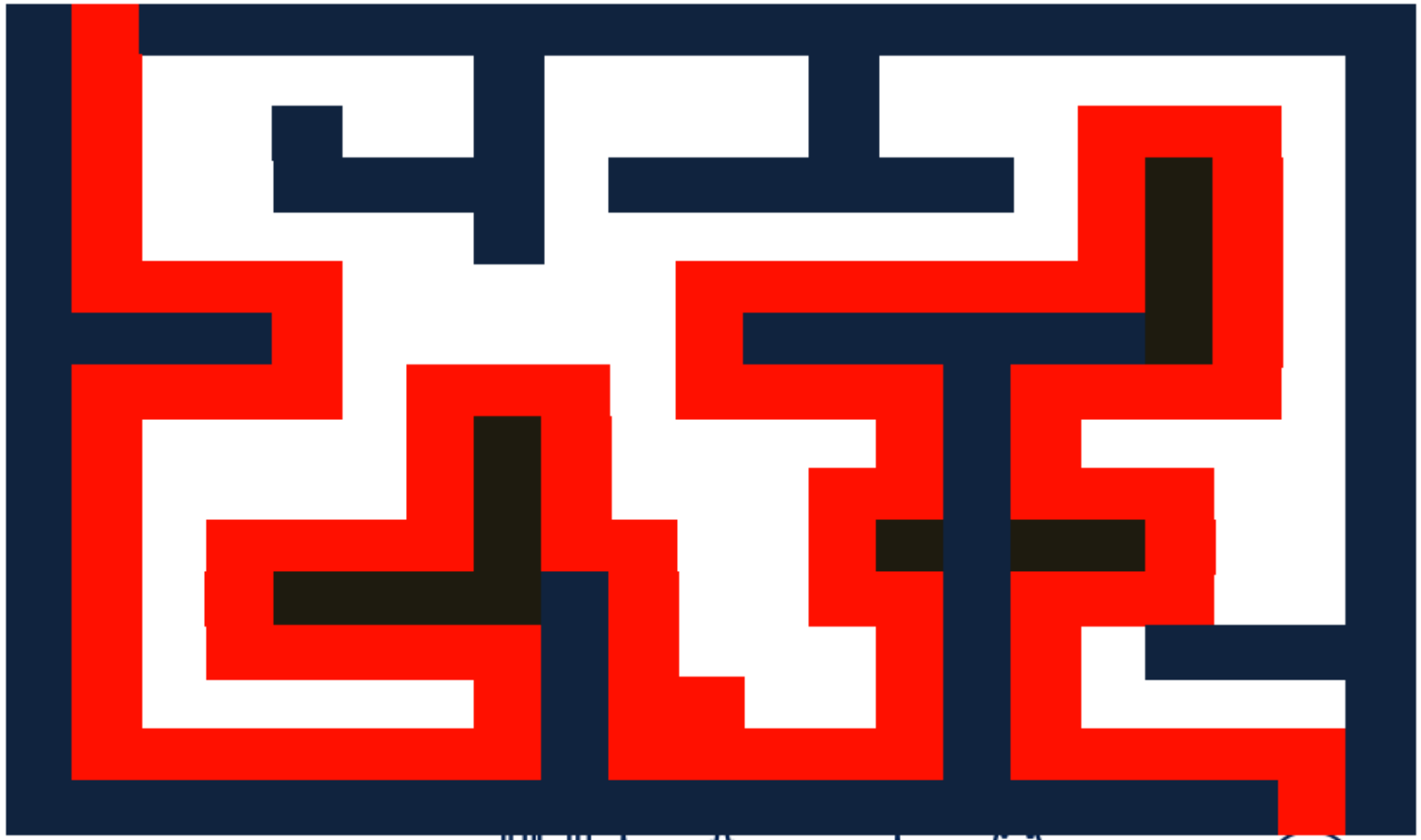
Machine Learning 'Algorithm'

- An 'algorithm' is an unambiguous set of instructions for solving a problem
  - First described by the 8th Century Persian mathematician Muhammad ibn Musa al-Khwarizmi
- Algorithms are the 'mechanisms' of AI
- They solve problems such as:
  - Clustering data into sets with similar characteristics, and
  - Building predictive models from data sets

Muhammad ibn Musa al-Khwarizmi

Example: Simple Maze Solving Algorithm (Not AI!)

Rule:
Stick to the right-hand wall



Describing sets of Data

Features / Dimensions

Label

Observations

ID	Homeowner	Marital Status	Income	Loan Default
1	Yes	Single	High	No
2	Yes	Married	High	No
3	Yes	Divorced	High	Yes
4	No	Married	Average	No
5	No	Married	Average	No
6	No	Divorced	High	No
7	Yes	Single	Low	Yes
8	No	Single	High	No
9	Yes	Married	Low	No

Labelled data creates the opportunity for supervised learning

Owning a large, labelled data-set could be a significant business asset

Do you have one or could you build one?

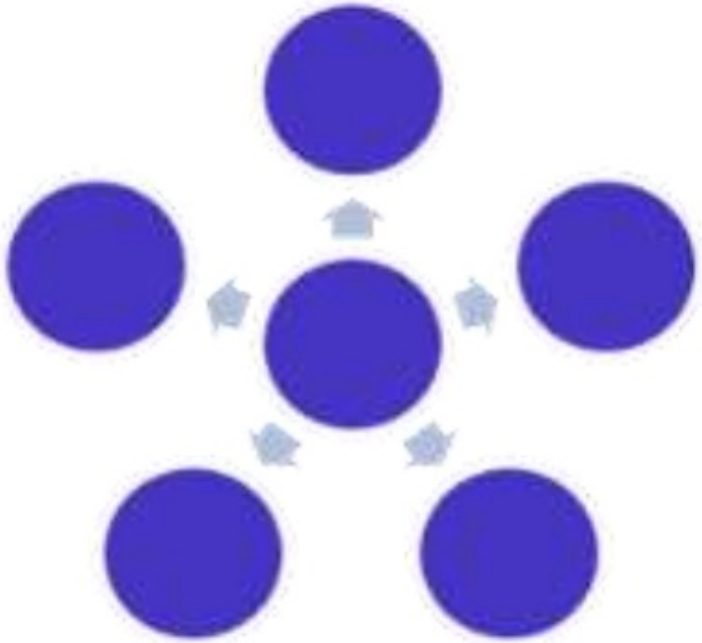
You Want to Squeeze Information from Data?

Un-Supervised Learning

Hunting for patterns in data

Extracting essential features

Making sense of data



Example: Clustering

You Have Examples of the 'Right' Answer?

Supervised Learning

Learning the 'right' answer

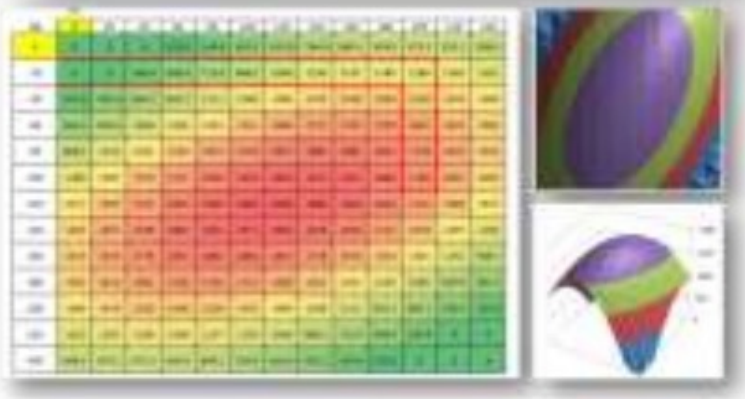
Learning from examples

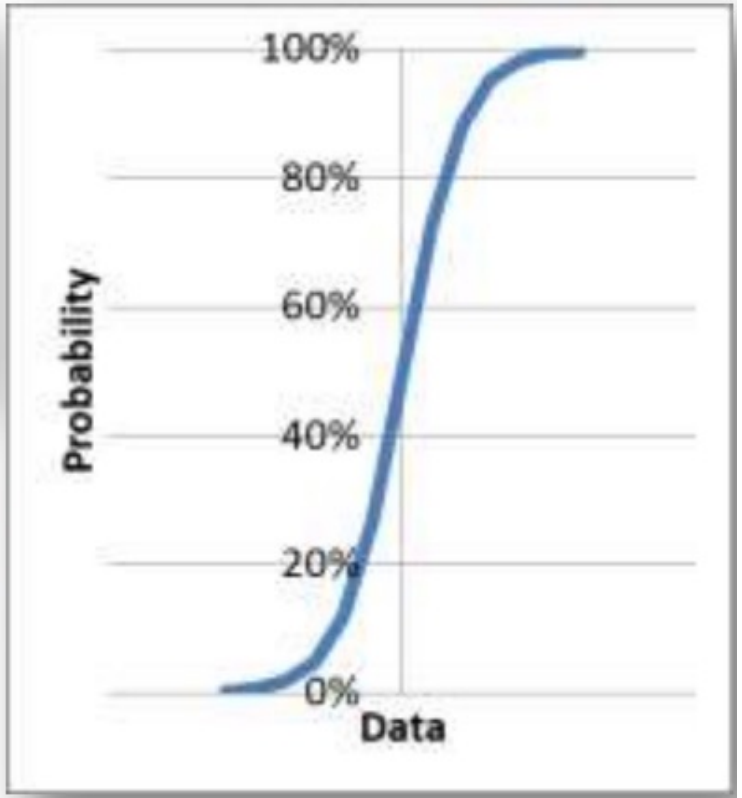
Inferring rules

Example : Classification

Making Predictions based on Known Data : Regression

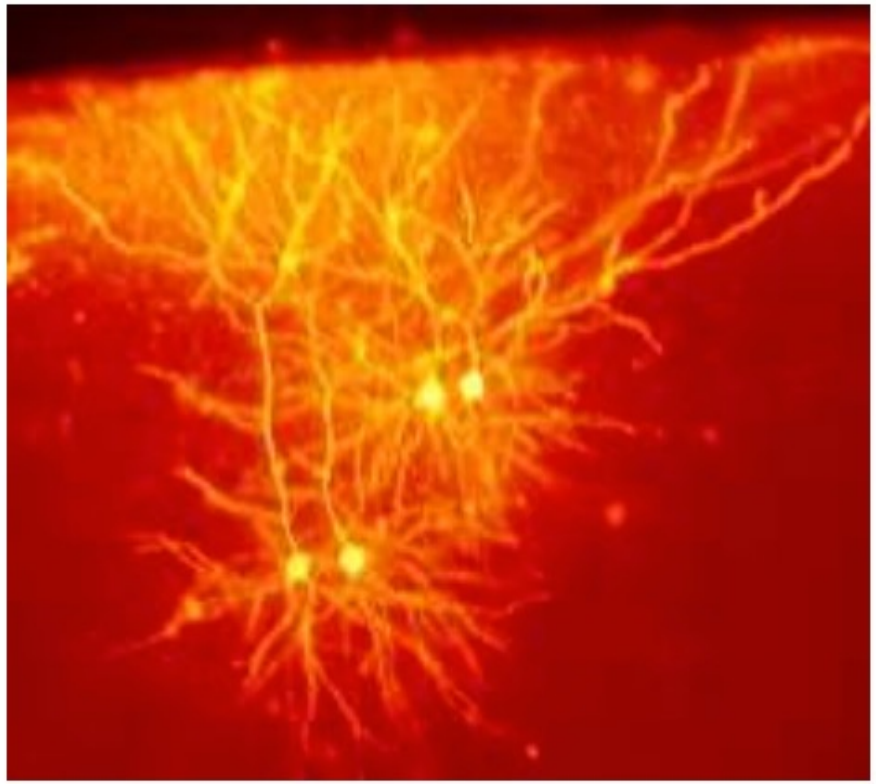
- Fitting lines, curves and surfaces to data-points
- Using these to make predictions for new data





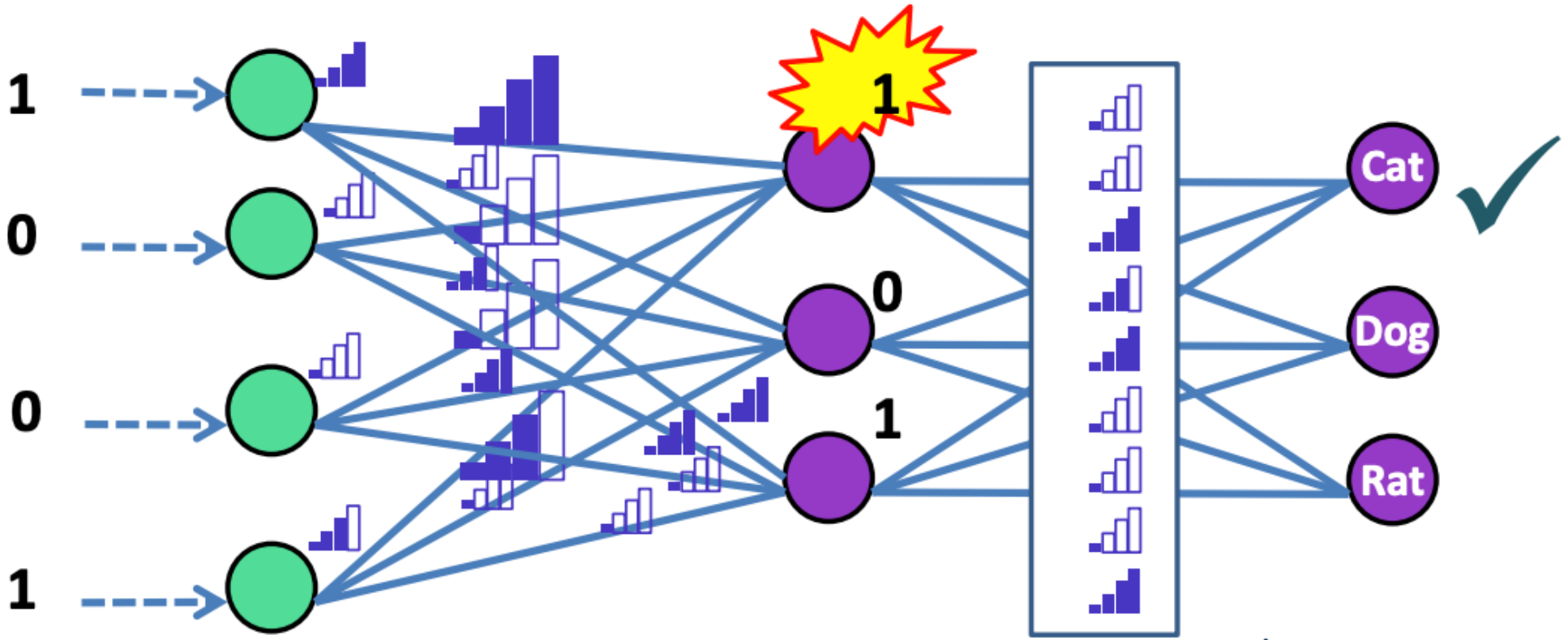
Complex Recognition : 'Neural Networks'

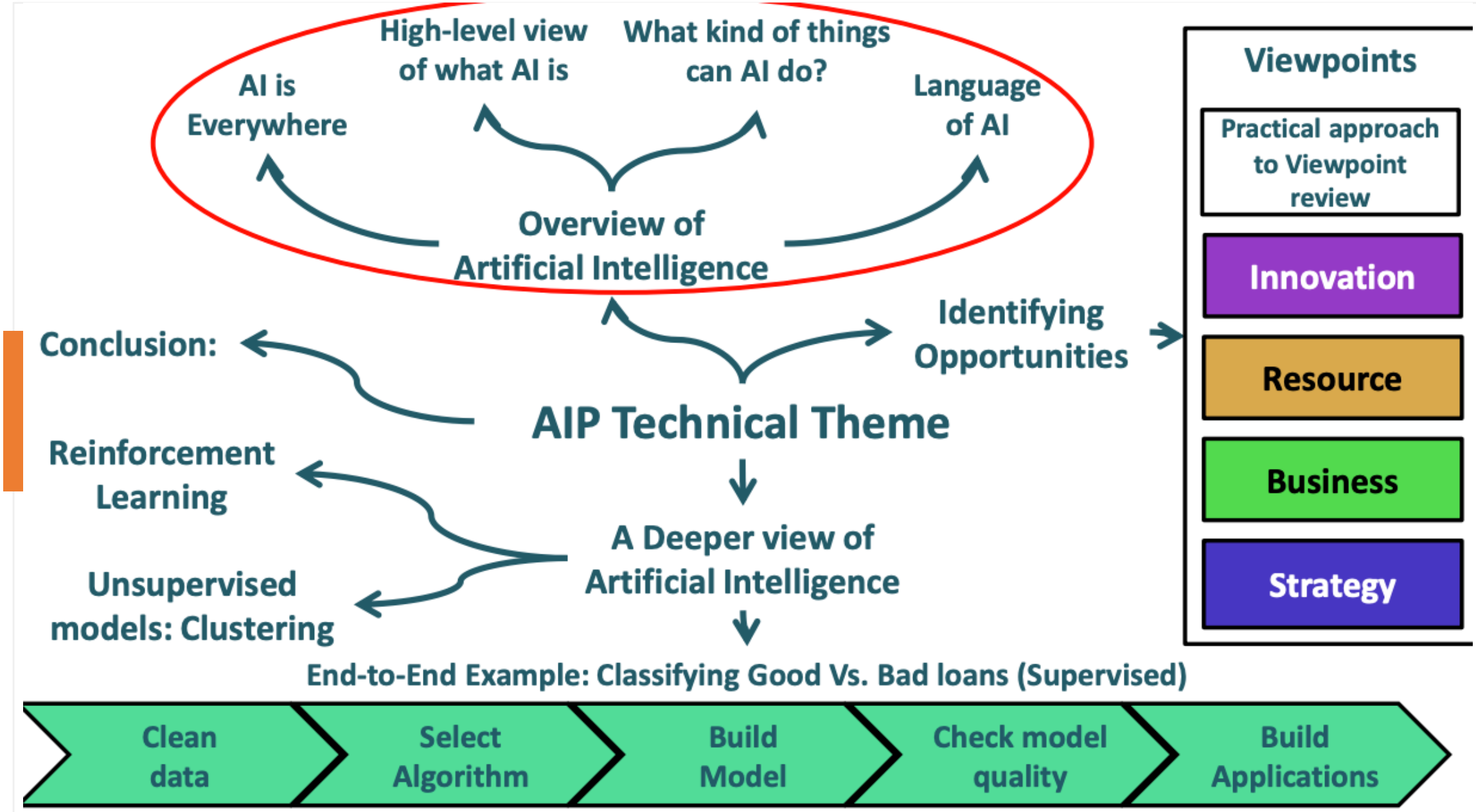
- Neural Networks were inspired by our understanding animal brains
- They are built from many, relatively simple but highly connected elements



By Mark Miller from San Francisco, CA, USA - tyramideFills, CC BY-SA 2.0,

Complex Recognition : 'Neural Networks'

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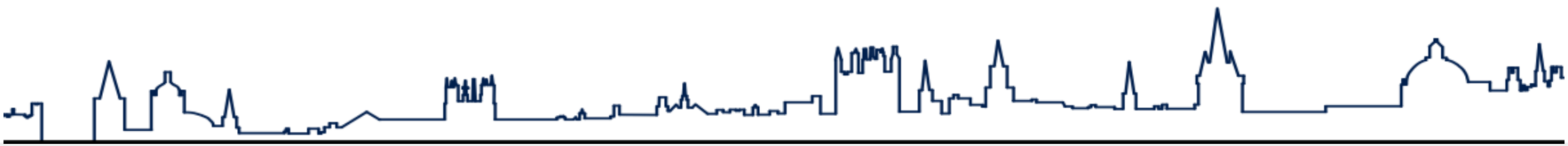
Clean data
Select Algorithm
Build Model
Check model quality
Build Applications

References and Further Study

References

- Russell, S and Norvig, P. (2010) “Artificial Intelligence, A Modern Approach”, Prentice Hall : Boston
- Sutton, S.S. and Barto, A.G. (2017) “Reinforcement Learning: An Introduction”, The MIT Press, Cambridge, Massachusetts



Further Study

- General Interest / Awareness:
  - Marcus du Sautoy (2019) “The Creativity Code: How AI is learning to write, paint and think”, Fourth Estate: London
  - Ford, M. (2015) “The Rise of the Robots: Technology and the Threat to Mass Unemployment”, Oneworld : London
  - Ayres, I. (2007) “Super Crunchers : How Anything can be Predicted”. John Murray: London

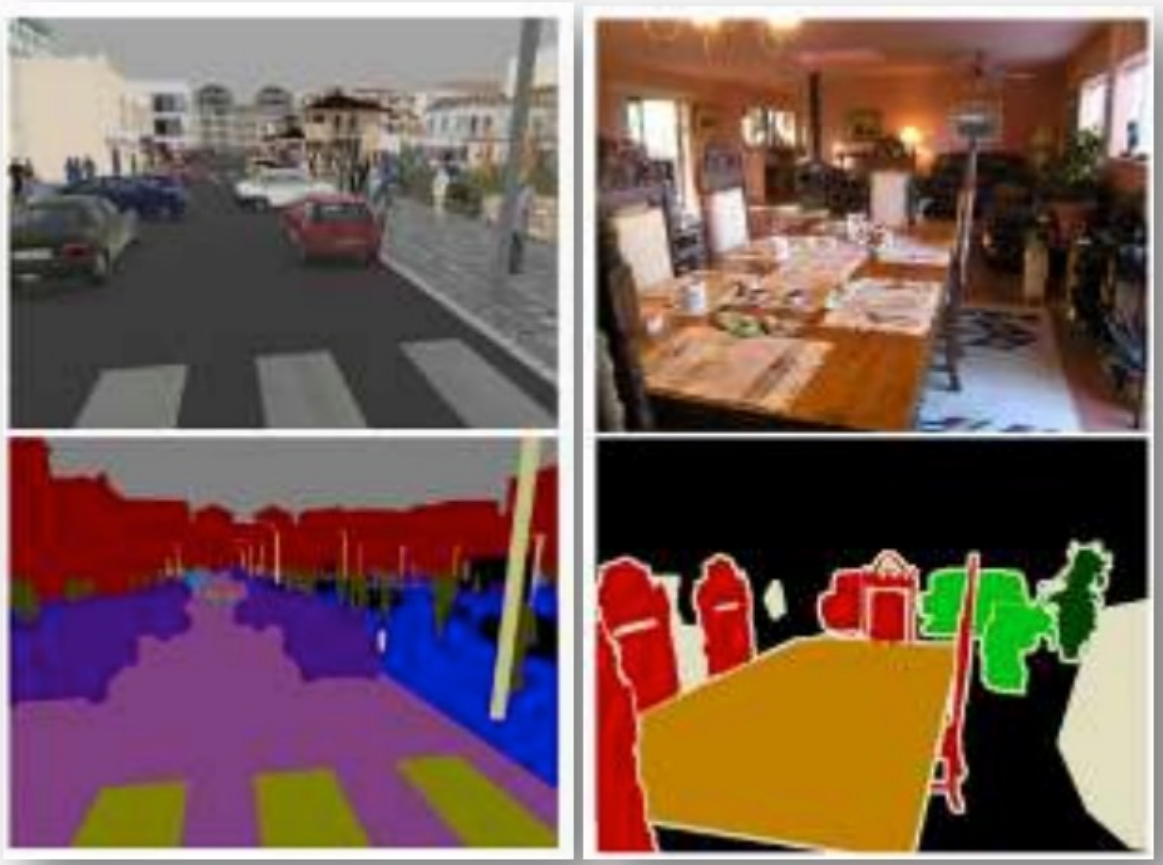
- Learning Machine Learning
  - Géron, Aurélien (2017) “Hands-on Machine Learning with Scikit-Learn and Tensorflow: Concepts, Tools and Techniques to Build Intelligent Systems”, O’Reilly : Sebastopol, CA.
  - Segaran, T. (2007) “Programming Collective Intelligence”, O’Reilly :Sebastopol, CA
  - Murphy, K.P. (2012) “Machine Learning : A Probabilistic Perspective”, MIT Press : Massachusetts

AI – What is possible?

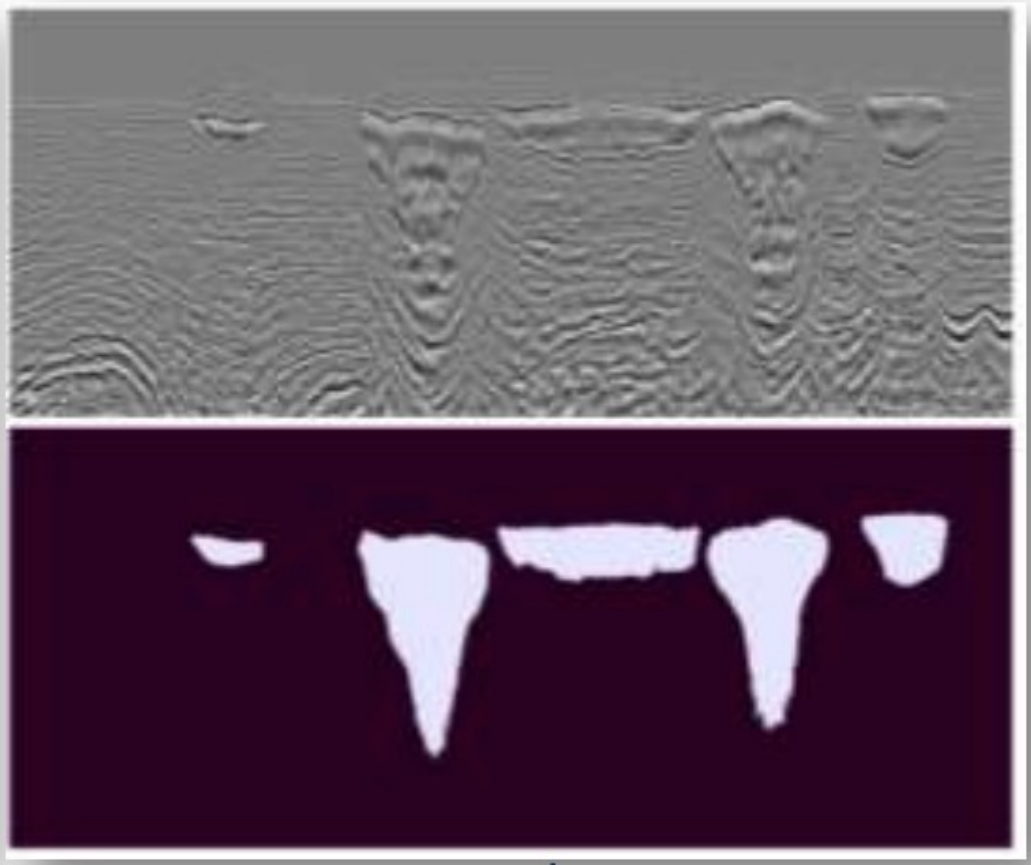
Information from images

Image Classification

Classification of Parts of Images



Deep learning based image segmentation

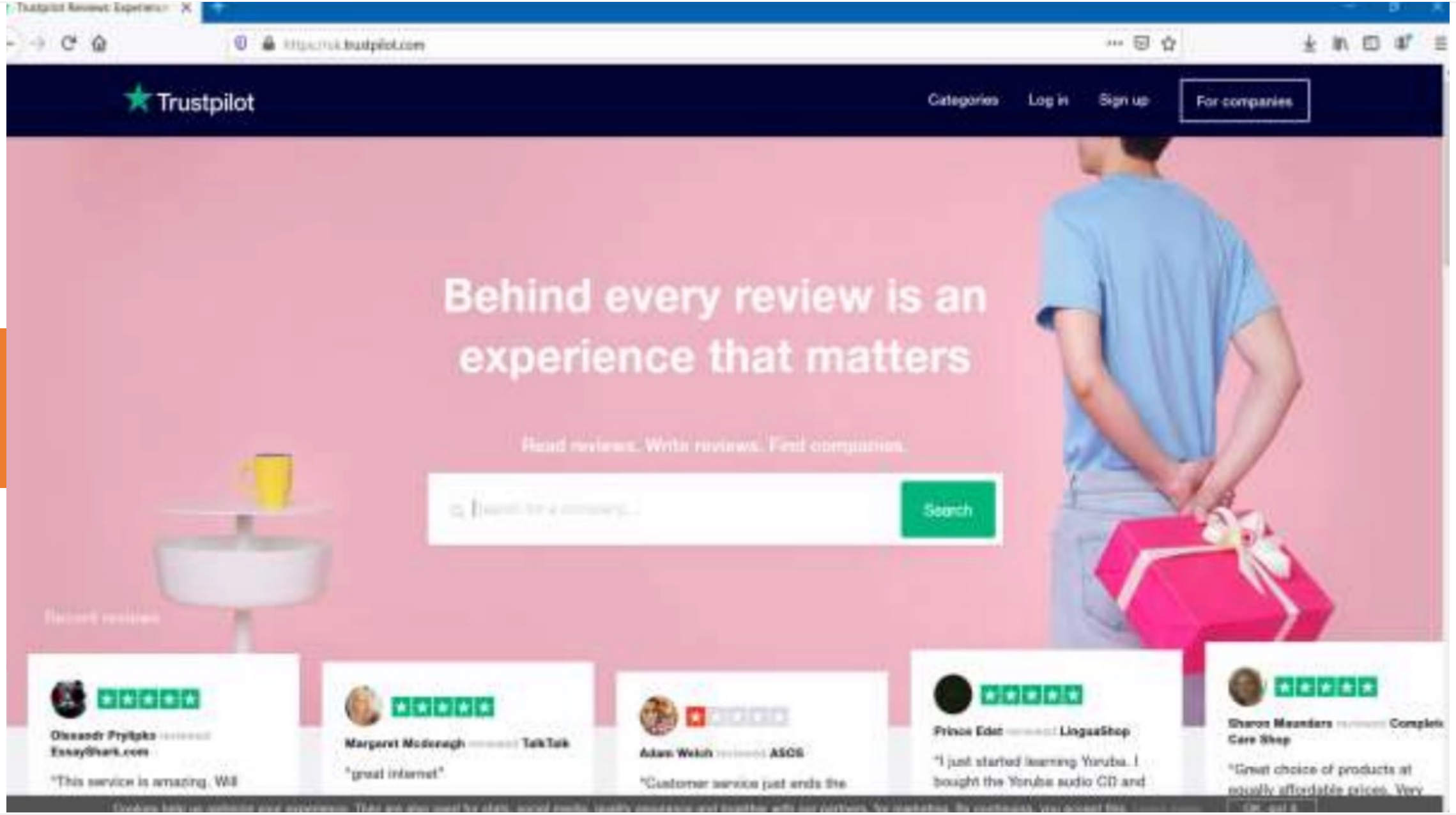


Applied to seismic images for salt detection

Real-time image segmentation

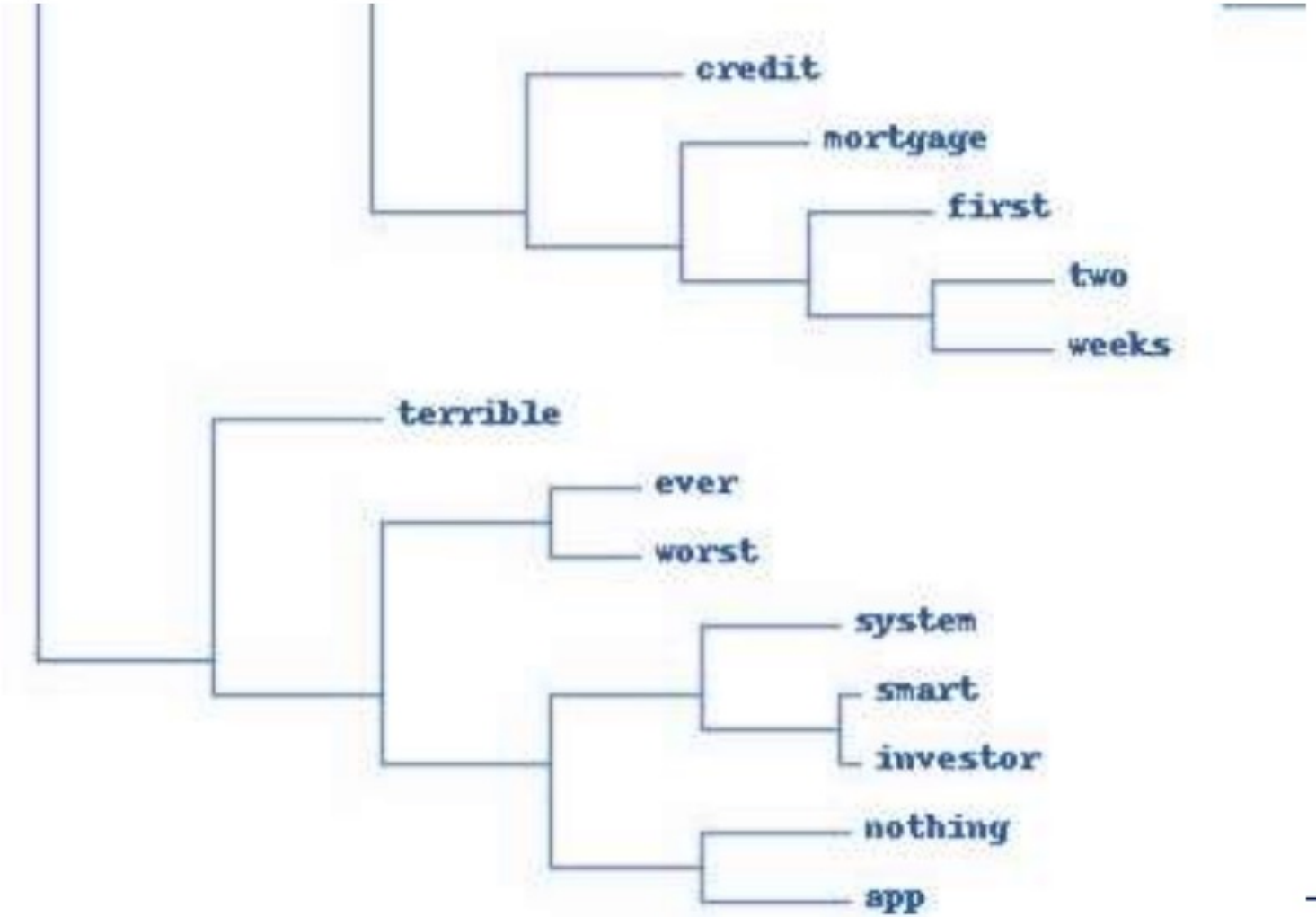
Further information: https://towardsdatascience.com/understanding-semantic-segmentation-with-unet-6be4f42d4b47
Original Video: https://www.youtube.com/watch?v=ATIcEDSPWXY
DeepLab source code: https://github.com/tensorflow/models/blob/master/research/deeplab/README.md

Insights from Natural Language


Trustpilot
Categories
Log in
Sign up
For companies
Behind every review is an experience that matters
Search
Margaret Mcdonagh
TalkTalk
"great internet"
Adam Welsh
ASOS
Prince Edet
LinguaShop
"I just started learning Yoruba. I bought the Yoruba audio CD and

Cluster dendrograms provide one mechanism for visualising hierarchical clusters

Word clusters suggest problem areas



‘Squeezing the juice’ from data with Dimensionality Reduction

Removing noise using Principle Component Analysis (PCA)

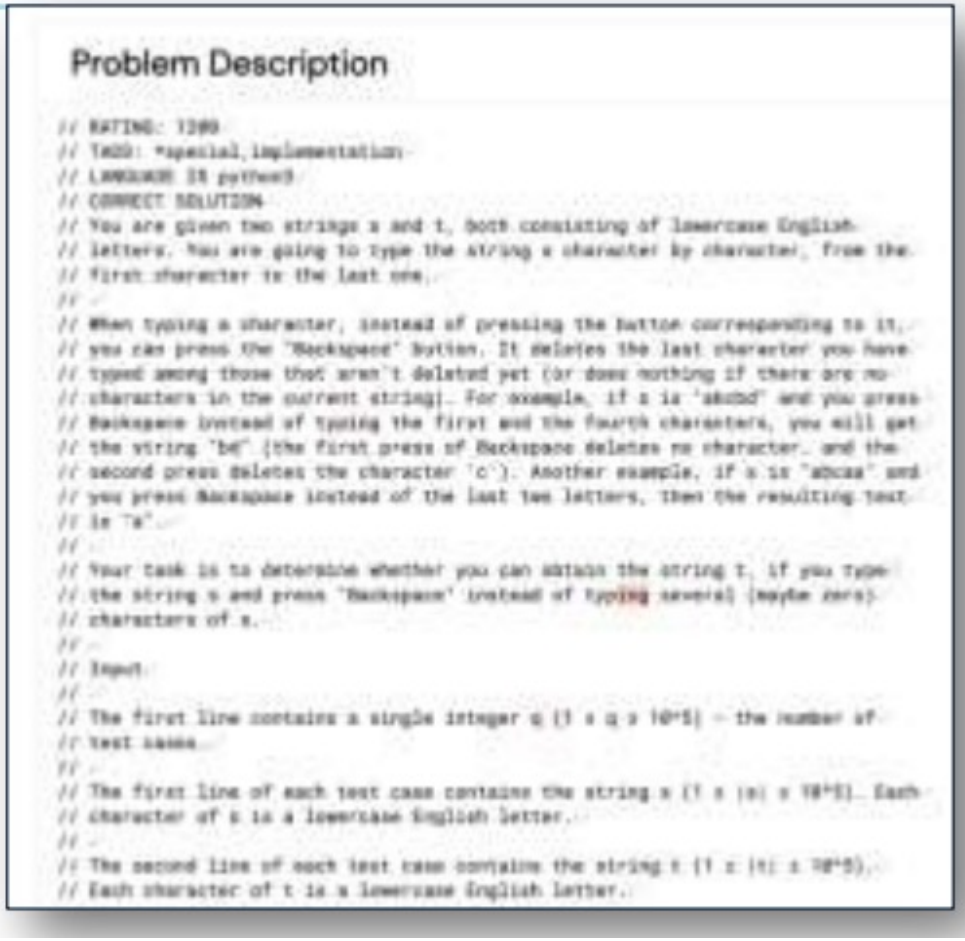
Errors (noise) reduced by reconstructing the images based only on 12 principle components

Writing software code by AI

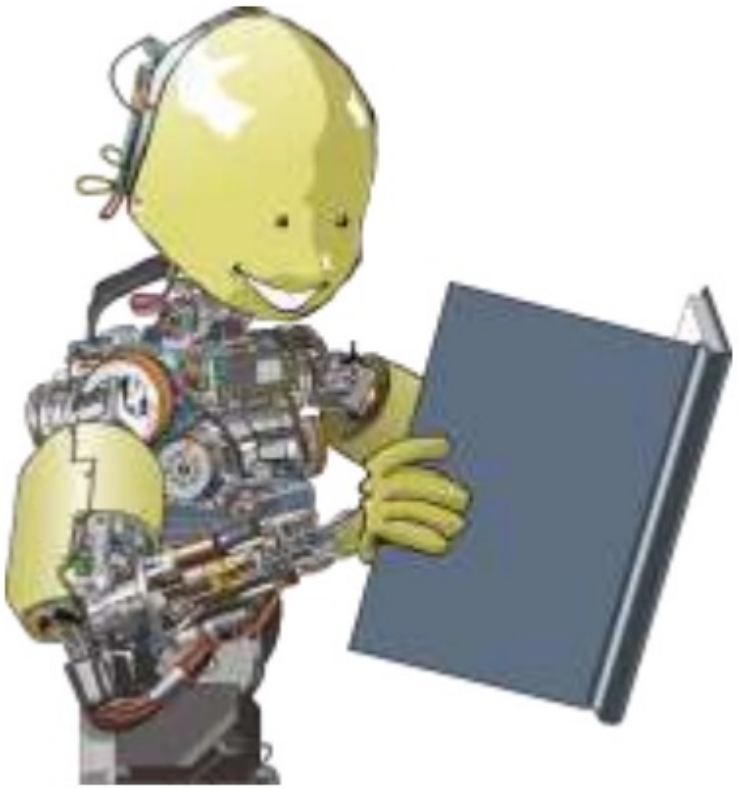
AI Application areas : Alpha Code

- Code can be thought of as just another language
- Sequence to sequence translation – just like natural language translation!
- To do this very very large models are required (in terms of numbers of parameters)
- The agent performs in the top 54% of code submissions….and keeps on rising

AI Application areas : : Alpha Code

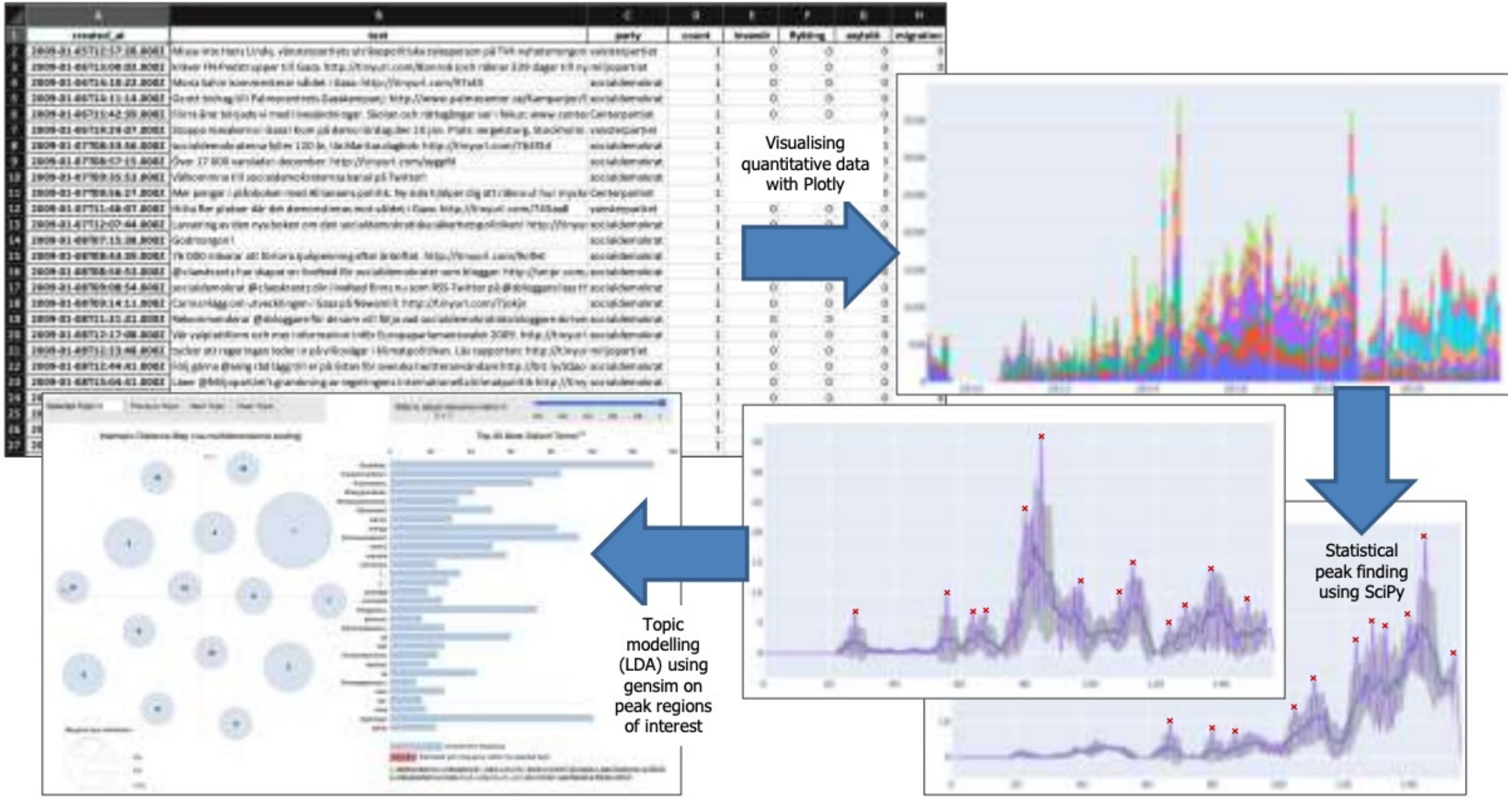


AI Application areas : Alpha Code



- What will the future look like with AI writing our code for us?
- Do you think this is a good thing? Will it be safe?
- Should there always be a human in the loop?
- How would you feel if your aeroplane/autonomous car was programmed by an artificial intelligence?

Insights from Social Media


Visualising quantitative data with Plotly
Statistical peak finding using SciPy
Topic modelling (LDA) using gensim on peak regions of interest

How you can build your high-performing team

Focus on Team Dynamics - Think about your team's behaviours and act to improve its performance

Focus on a great goal and a vision of the future Inspire your team to be something special

Build trust by sharing positive experiences, supporting other team members

Team Poster

- Name
- Background
- Location
- Skills I have
- Something I do for fun
- Something I am proud of

Team Poster

1. Each team to create a ‘Team Poster’
2. Agree a name for your team
3. Agree a ‘Slogan’ or ‘Catch phrase’’ that helps describe your team and its goals
4. Add some graphics, icons and pictures to illustrate your poster:

What motivates and excites you as a team?

What is your interest in AI?

What is your ‘Big Goal’ as a team?

How will you work together as a high-perfomance team?