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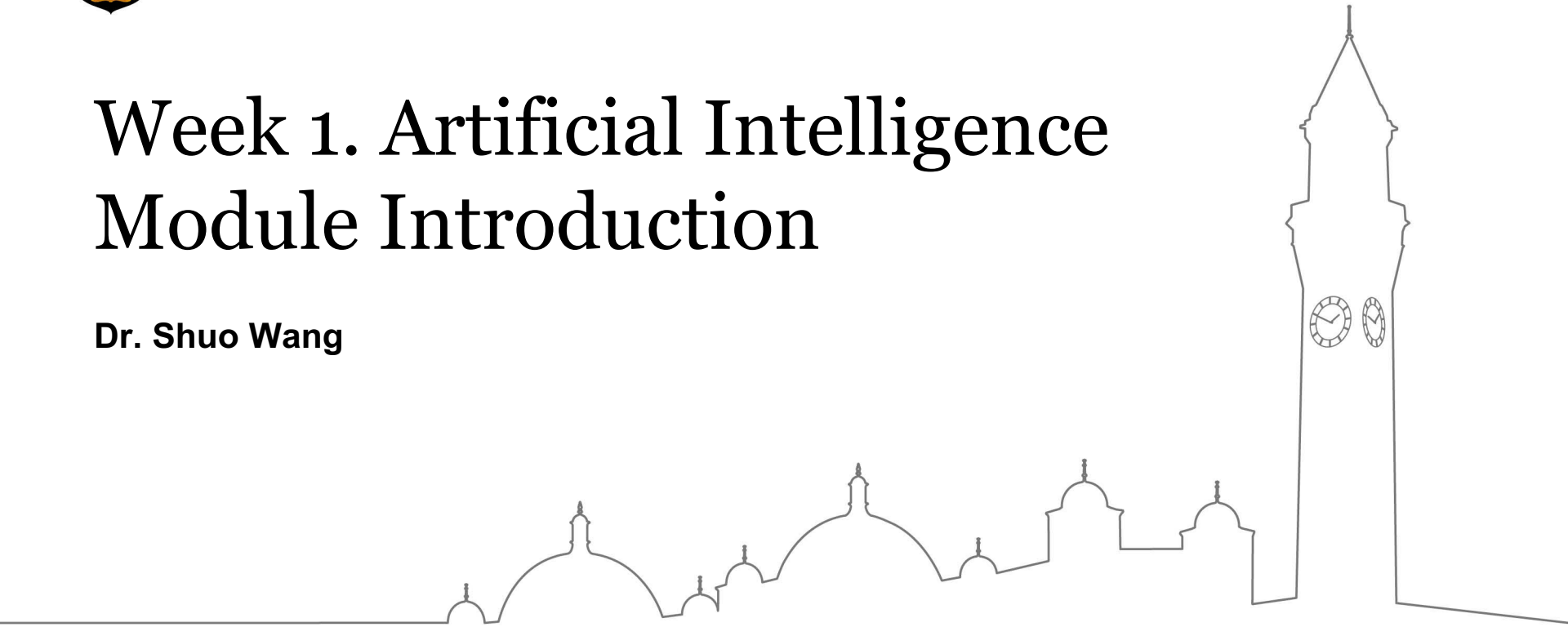
Week 1. Artificial Intelligence Module Introduction

Dr. Shuo Wang

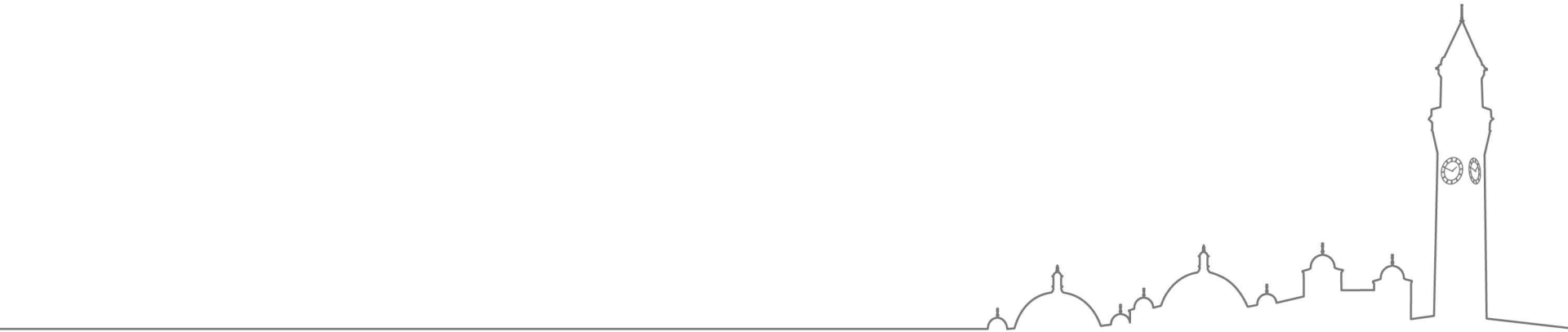


Module Objectives

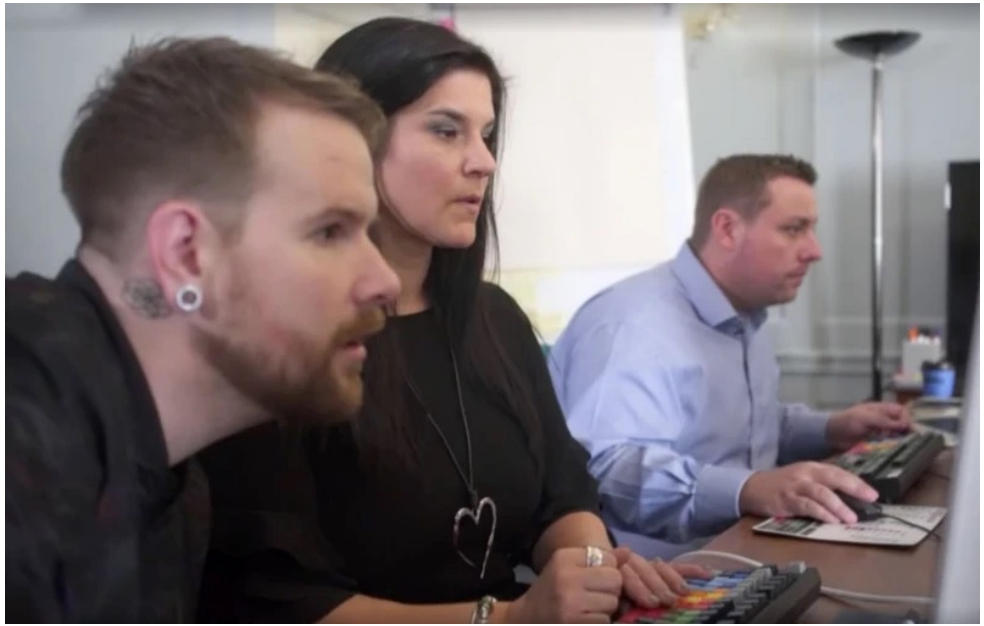
- Demonstrate an understanding of traditional AI approaches
- Demonstrate an understanding of the core principles of Optimisation and Machine Learning
- Demonstrate an understanding of the relationship between basic concepts of differentiation and techniques of AI
- Apply core principles of artificial intelligence to solve problems

Lecture Overview

- Why AI?
- What exactly is AI?
- Module overview



Super Recognizers



- Recognise faces and link to memories of who they are and how they met them.
- To track criminals

- Hard to recruit a team of these people.
- Very labour intensive, considering the size of the database.

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Underground pipe leak detection

- Need very specialised people
- Very costly if the wrong place is found.
- Hard for human to reach inside the pipes.

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So, why AI?

- Many real-world problems are:
  - time consuming and/or
  - challenging

  for humans to solve.
- Takes too much time and thus a lot of money.
- Solutions found manually may still not good enough.

Benefits of AI

- Reduce labor and human error
  e.g. automated production line in manufacturing that may cause injury.
- Always available, perform faster, don’t mind tedious/repetitive jobs
  e.g. chatbot to provide instant assistance.
- Make our life easier
  e.g. keyboard word prediction, product recommendation
- and more…

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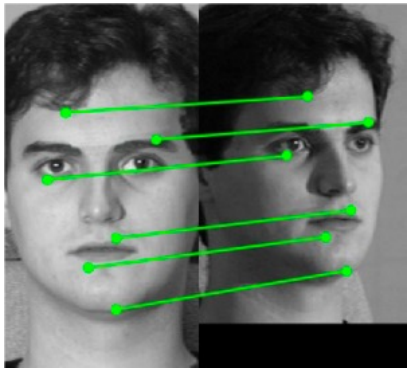
What Problems Can AI Solve?

- Face Recognition

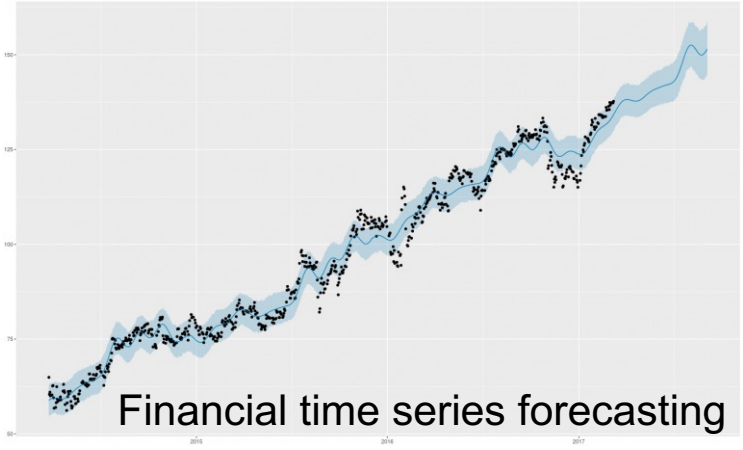


AI could automatically learn a model able to recognize whether faces match faces that are in a database.

To learn this model, AI uses examples of faces that are known to match/not match faces that are in the database.

Machine Learning Problems

Machine learning problems are those that require a model to be built automatically from data, e.g. to make classifications, estimations or predictions.



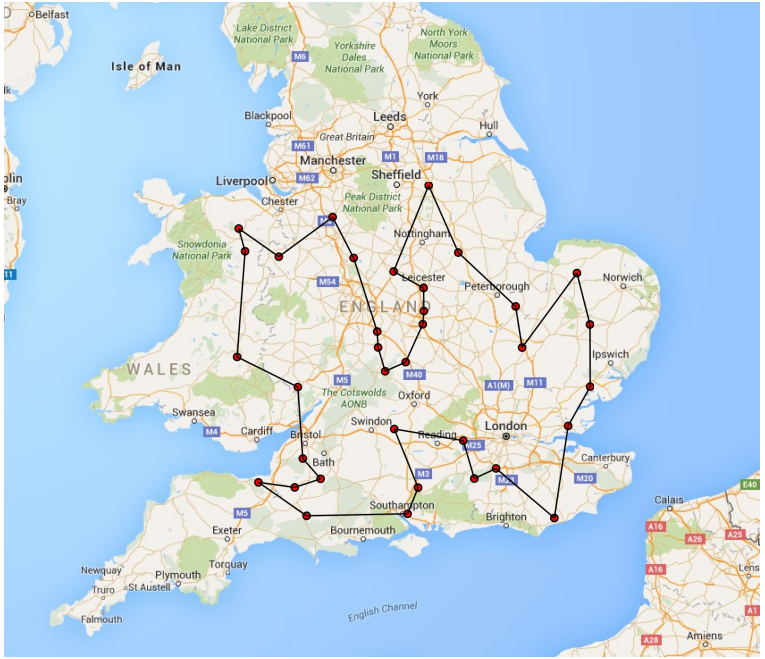
AI for Solving Machine Learning Problems

- AI can be used to automatically create models from data to perform certain tasks through machine learning.
- Typically not guaranteed to find perfect models, but may be able to find good models, depending on the difficulty of the problem and on the data available.
- Good for problems where models are necessary and it is difficult to create good models manually.
- Good for problems where there is no need for a perfect answer.

What Problems Can AI Solve?

Traveling Salesman Problem (TSP):

- Given N cities and the distances between each pair of cities, a salesman must travel passing through all the cities once and only once.
- Depending on the route the salesman takes, the travel distance can be longer or shorter.
- Problem: find a route that minimizes the travelling distance.



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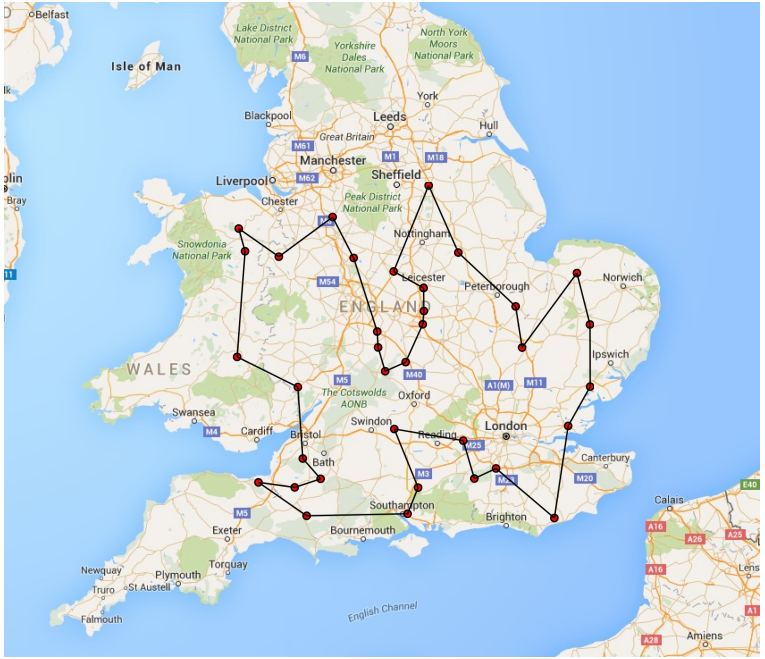
What Problems Can AI Solve?

Traveling Salesman Problem (TSP):

- Why is it difficult to solve manually?
- Is it time-consuming for computer to solve using brute-force strategy?

Brute-force: try all possible solutions and select the best one.



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Brute-Force for TSP

A solution is a sequence of cities, where each city appears only once.

- Number of cities N = 2

A	B
B	A

- Number of cities N = 3

A	B	C
A	C	B
B	A	C
B	C	A
C	A	B
C	B	A

Number of all possible sequences of N cities is factorial: N!
(time complexity)

Brute-Force for TSP

Computing N!

- 2! = 2 x 1 = 2
- 3! = 3 x 2 x 1 = 6
- …
- 10! = 10 x 9 x 8 x … x 1 = 3,628,800
- 20! = 20 x 19 x 18 x … x 1 = 2,432,902,008,176,640,000 ≈ 2.43 x 10^{18}
- …
- 50! ≈ 50 x 49 x 48 x … x 1 ≈ 3.04 x 10^{64}

Assume that 10^9 possible sequences (1 billion) take one second:

$2!/10^9$ = 0.000000002s

$3!/10^9$ = 0.000000006s

…

$10!/10^9$ = 0.0036288s

$20!/10^9$ ≈ 2,432,902,008s ≈ 77years

…

$50!/10^9$ ≈ 3.04 x 10^{55}s ≈ 9.64 x 10^{47}years

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Way Longer Than the Estimated Age of the Universe…

Brute-force works only for very small problems, or problems for which the number of possible solutions is small.

Real-world problems are often quite large.

AI can be used to find a route that minimizes travelling distance in a reasonable amount of time. (optimization problem)

Optimization Problems

Optimization: find a solution that minimizes/maximizes one or more objective functions, possibly subject to certain constraints.

Bin Packing Problems

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AI for Solving Optimisation Problems

- AI can help us to solve optimisation problems in a reasonable amount of time through optimisation techniques
- Typically not guaranteed to find optimal solutions in a reasonable amount of time, but able to find good (near-optimal) solutions in a reasonable amount of time.
- Good for optimisation problems where it is not a requirement to guarantee that the optimal solutions are found.
- Good for optimisation problems where we cannot afford enumerating all possible solutions to guarantee that a perfect solution is found.
- Good for optimisation problems where no specific technique exists that guarantees that an optimal solution can be found quickly.

Search Problems

Search: find a solution that satisfies certain constraints.

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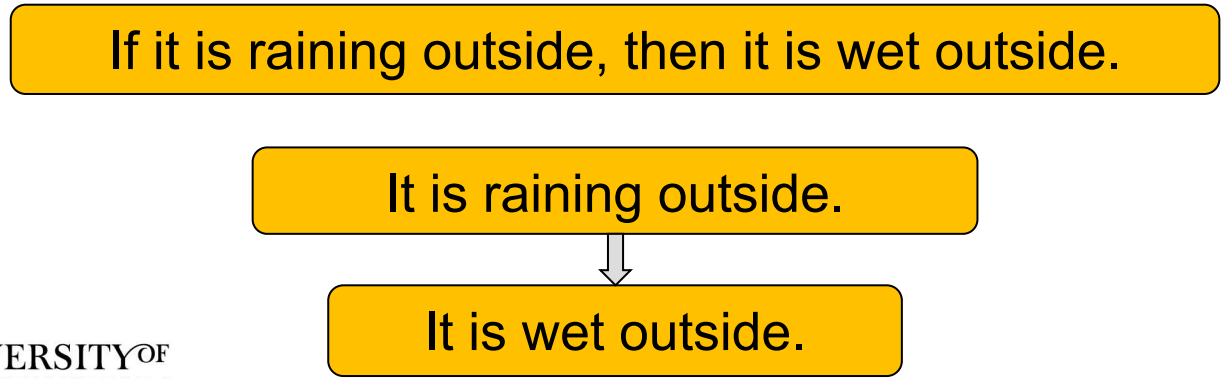
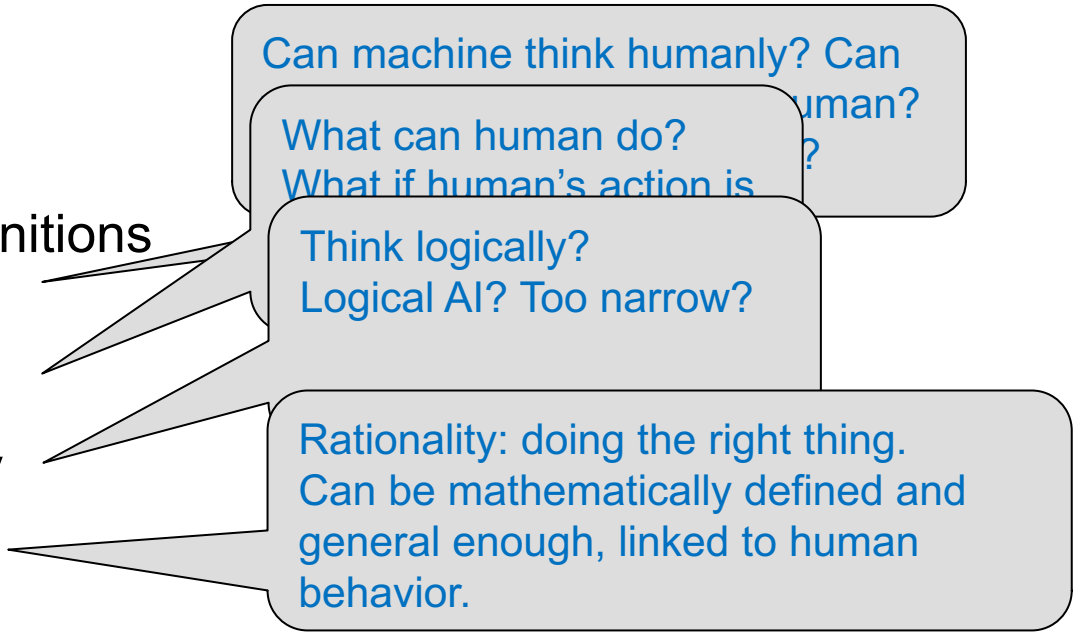
Logics

- Knowledge is represented in the form of logical statements.
- New knowledge can be inferred from existing statements.
- Problems can be solved based on such knowledge.



What is AI?

- Many different definitions
  - Think humanly
  - Act humanly
  - Think rationally
  - Act rationally



What is AI?

- Russell and Norvig's definition, based on "act rationally":
  - AI is the area of Computer Science which studies "rational agents".
  - Rational agents are computer programs that perceive their environment and take actions that maximise their chances of achieving the best [expected] outcome.

AI in Real Life

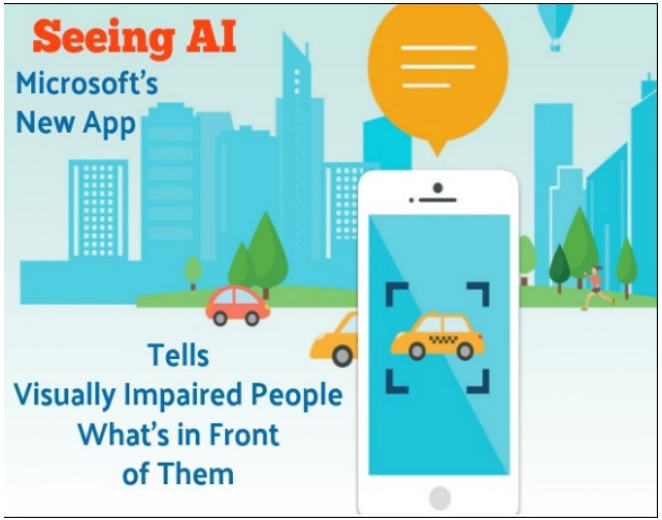
- **Facebook** uses neural nets for their automatic tagging algorithms, **Google** for their photo search, **Amazon** for their product recommendations, **Pinterest** for their home feed personalization, and **Instagram** for their search infrastructure.





BAD CREDIT

voiceitt


Seeing AI
Microsoft's
New App
Tells
Visually Impaired People
What's in Front
of Them


EMAIL FILTER
inbox
Spam

In this Module:

- You will get an introduction to different areas of Artificial Intelligence, including search / optimisation, and machine learning.
  - Artificial intelligence algorithms / approaches that can be used to create rational agents.
  - Examples of real world problems that can be solved using such algorithms.
  - Learn to solve real-world problems using Java-based AI tool – Weka.
- This will give you a general idea of the area.
- It will help you to decide whether you wish to investigate any topic further.

Module Organisation

Teaching plan (subject to changes) available in the “modules” tab on Canvas.

Teaching on campus:

- 2h lecture on Friday (attendance strictly taken) + 1 tutorial (attendance not taken)
- Recording of on campus lecture and slides available after the lectures on Friday.
- Reading materials and quizzes on the fundamentals covered during the lectures to try after the lecture on Canvas.
- Tutorials for smaller groups are exercise classes with the TAs.

  Content of Week ***x*** will be covered in Tutorial of Week ***x+1***. So, we recommend you to study Week ***x***’s materials before the Week ***x+1***’s tutorials.

Office Hours (Drop-ins)

- At least one office hour per day of the week by TA (from week2).
- You can attend any of the TAs drop-in hour.
- For lecturer office hours, please attend the office hours of the lecturer who led the content that you have questions about.
- Office and drop-in hours listed in Canvas, please use them.

Module Lecturers - Edgbaston

Shuo Wang
Weeks 1 – 3
Topics: Introduction, ML (classification)

Sharu Jose
Weeks 4, 5, 7
Topics: ML(clustering), Weka

Leonardo Stella
Weeks 8 – 10
Topics: search and optimisation

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Microsoft Teams

- For online Q&A throughout the week.
- MS Teams enables the module team to help with answering questions, so that questions can be answered more quickly.
- MS Teams enables peer support — students are also welcome to answer each other's questions!
- There is an individual channel for each week.
- Please do not send questions by email unless you wish them to be confidential.

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Assessment

- Continuous Assessment (20% of marks)
  - 1 summative Canvas quizz, worth 10%
    It will be timed, but can be taken at any time between the release and due dates.
    Release week 4, due week 5.
    Deadline is strict.
  - One open problem solving task (using Weka), worth 10%.
    Given 2 weeks and submit your solution.
    Week 7-9
- Exam (80% of marks).

Module Teaching Assistants

10 TAs for tutorials, drop-in sessions and Teams channels

They are:

- Efstratios Palias, Huanbo Lyu, Xi He, Qianrong Liu, Yi Miao, Xinxing Cheng, Naya Desai, Weijian Zhang, Shanshan Mao, Imane Basset