



UNIVERSITY OF  
BIRMINGHAM

# Week 1. Artificial Intelligence Module Introduction

**Dr. Shuo Wang\***

**\*Modified slightly by Dr. Hamid Mukhtar for  
Dubai Delivery**



# About the module

- Module lead for Dubai, shared with Sauleh Eetemadi
- About myself
- Lectures Mon 1pm – 3pm, Tue 1pm – 2pm
- Tutorials: Thu 1pm – 3pm (2 sections)
- Office hours: Tue and Thu 11am – 12pm
- Teams channels (Dubai and Global), daily TA's availability
- Assessments: 1 quiz 10%, 1 assignment 10%, exam 80%
- Resources, times, etc. on Canvas, separate link for Dubai material



UNIVERSITY OF  
BIRMINGHAM

# Let's get started

- About you?
- What are your expectations and apprehensions?
- So what is AI?
- Why is everyone excited about it?
- Are you excited as well?



# 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



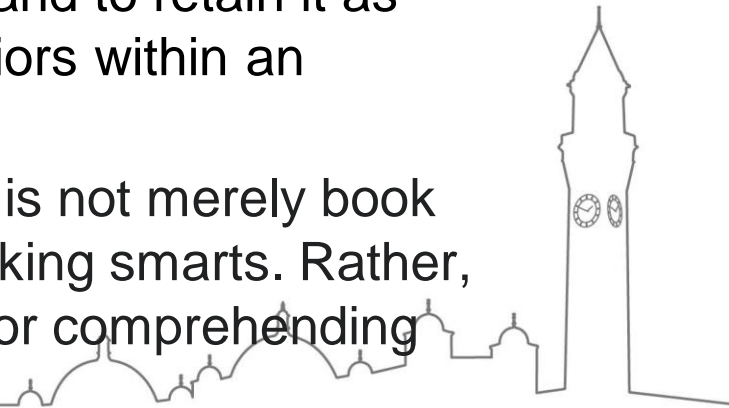
# Lecture Overview

- Why AI?
- What exactly is AI?
- What is intelligence? Can the computers be intelligent?
- Module overview



# Intelligence

- The ability to acquire and apply knowledge and skills
- The capacity for abstraction, logic, understanding, self-awareness, learning, emotional knowledge, reasoning, planning, creativity, critical thinking, and problem-solving
- The ability to perceive or infer information; and to retain it as knowledge to be applied to adaptive behaviors within an environment or context
- Learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings

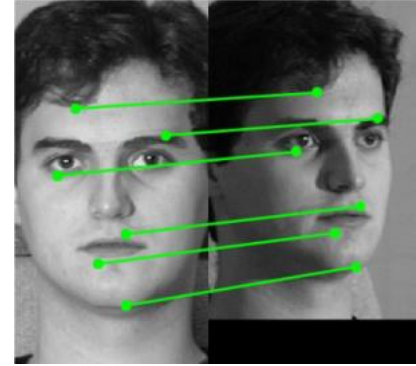


# What Problems Can AI Solve?

- 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.



# Quick Demo of Listen, Think, and Understand (LTU)

LTU is a new audio model that bridges audio perception and advanced reasoning, it can answer any open-ended question about the given audio. [\[Paper\]](#) [\[Github\]](#)

LTU is authored by Yuan Gong, Hongyin Luo, Alexander H. Liu, Leonid Karlinsky, and James Glass (MIT & MIT-IBM Watson AI Lab).

**Note LTU is not an ASR and has limited ability to recognize the speech content, it focuses on general audio perception and understanding.**

Input an audio and ask questions! Audio will be converted to 16kHz and padded or trim to 10 seconds. Don't have an audio sample on hand? Try some samples from AudioSet evaluation set: [\[sample audios from AudioSet evaluation set\]](#)

🔊 audio\_path

Drop Audio Here  
- or -  
Click to Upload

question

Why this audio is fun?

Audio Meta Information

Original input audio length 10.03 seconds, number of channels: 1, sampling rate: 16000.

LTU Output

### Instruction:  
Why this audio is fun?  
  
### Response:  
The audio is fun because it contains laughter and splashing sounds, which are associated with joy, happiness, and relaxation.

Flag

[GitHub - YuanGongND/ltu: Code, Dataset, and Pretrained Models for Audio and Speech Large Language Model "Listen, Think, and Understand".](#)



UNIVERSITY OF  
BIRMINGHAM



**Replacement**  
→ Floral Blouse

**Recoloring**  
→ Red

**Replacement**

**Removal**  
- Sleeve

**Addition**  
+ Leather Jacket

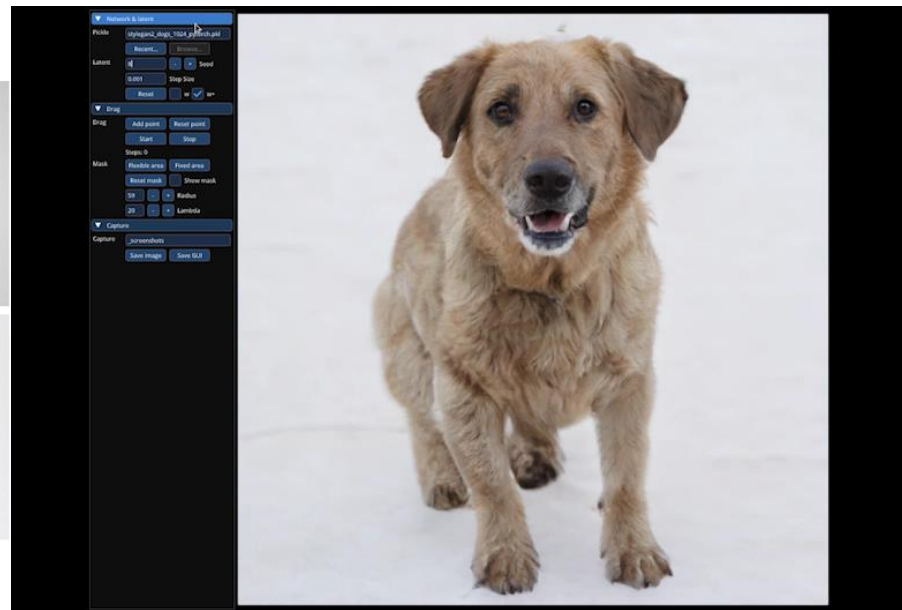
**AI Model**  
→ Asian Lady



**Fashion Matrix: Editing Photos by Just Talking**  
<https://github.com/Zheng-Chong/FashionMatrix>



UNIVERSITY OF  
BIRMINGHAM



Drag Your GAN: Interactive Point-based Manipulation on the Generative Image Manifold  
 (mpg.de)

# Diverse and Aligned Audio-to-Video Generation via Text-to-Video Model Adaptation



<https://github.com/guyyariv/TempoTokens>



UNIVERSITY OF  
BIRMINGHAM

# More examples...

- PanoHead: Geometry-Aware 3D Full-Head Synthesis in 360°



- Example speech generation audio/video in different languages
- <https://www.instagram.com/reel/CyIX1o8O1pZ/?igshid=NGEwZGU0MjU5Mw==>



# Underground pipe leak detection



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



# So, why AI?

- Many real-world problems are:
  - time consuming and/or
  - challengingfor humans to solve.
- Takes too much time and thus a lot of money.
- Solutions found manually may still not good enough.



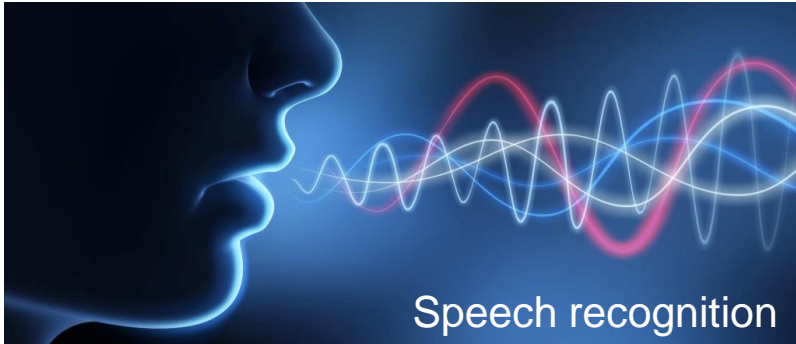
# Benefits of AI

- 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...

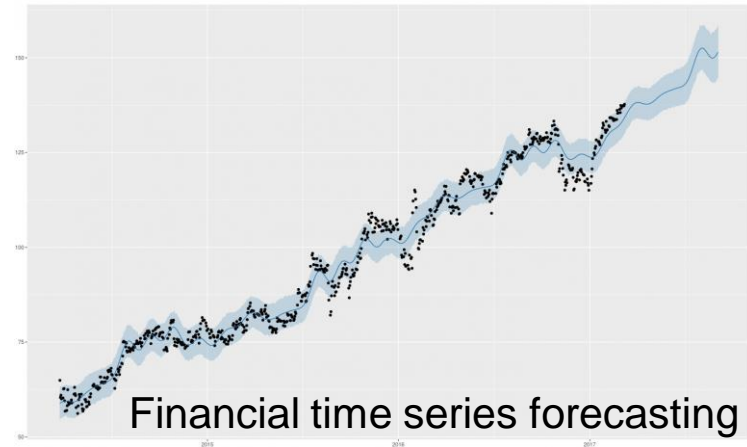


# Machine Learning Problems

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



UNIVERSITY OF  
BIRMINGHAM





# AI for Solving Machine Learning Problems

- AI can **automatically create models** from data to perform certain tasks through machine learning.
- **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
  - there is no need for a perfect answer

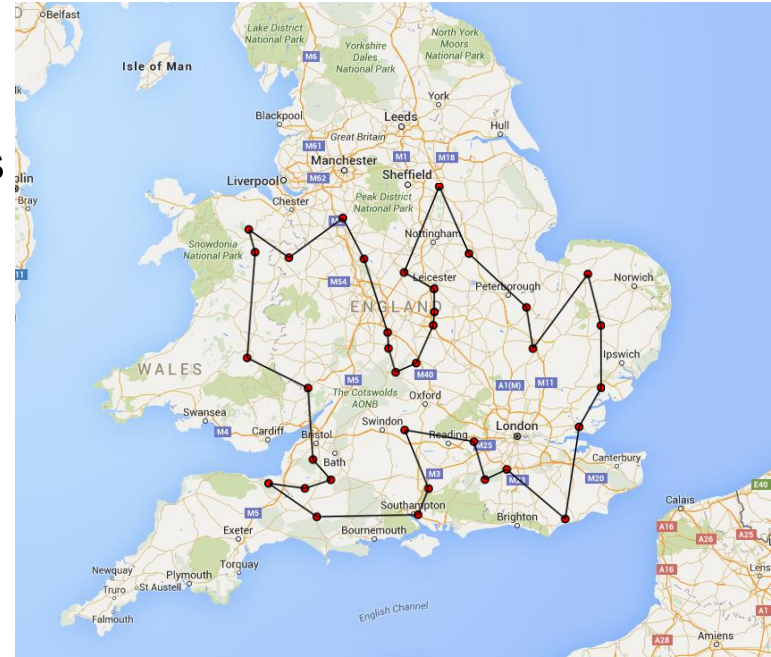




# What Problems Can AI Solve?

## Traveling Salesman Problem (TSP):

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

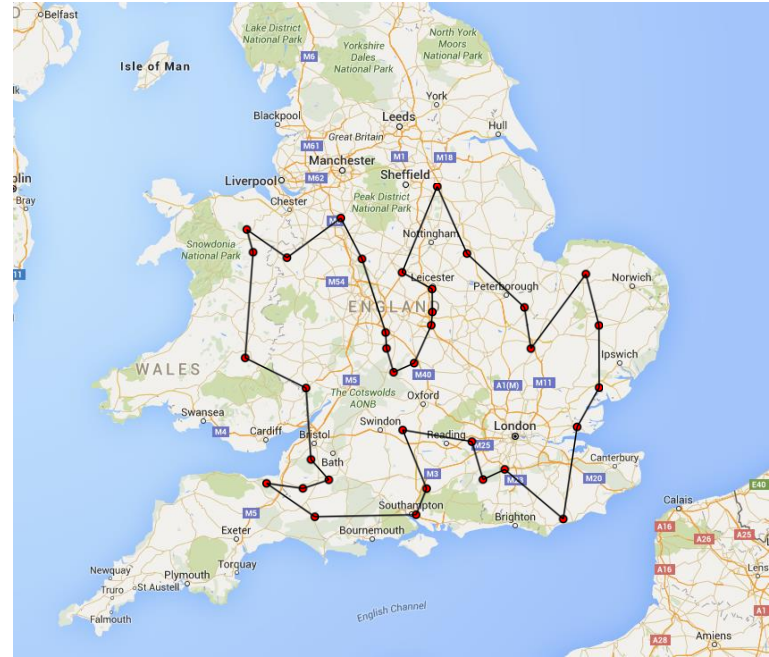


# What Problems Can AI Solve?

## 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.



# 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!

- $2! = 2 \times 1 = 2$
- $3! = 3 \times 2 \times 1 = 6$
- ...
- $10! = 10 \times 9 \times 8 \times \dots \times 1 = 3,628,800$
- $20! = 20 \times 19 \times 18 \times \dots \times 1 =$   
 $2,432,902,008,176,640,000 \approx 2.43 \times 10^{18}$
- ...
- $50! \approx 50 \times 49 \times 48 \times \dots \times 1 \approx 3.04 \times 10^{64}$

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

$$2!/10^9 = 0.000000002\text{s}$$

$$3!/10^9 = 0.000000006\text{s}$$

...

$$10!/10^9 = 0.0036288\text{s}$$

$$20!/10^9 \approx 2,432,902,008\text{s} \approx 77\text{years}$$

...

$$50!/10^9 \approx 3.04 \times 10^{55}\text{s} \approx 9.64 \times 10^{47}\text{years}$$





Way Longer Than the Estimated Age of the Universe...



UNIVERSITY OF  
BIRMINGHAM

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**.



UNIVERSITY OF  
BIRMINGHAM

## Bin Packing Problems

# AI can Solve Optimisation Problems

- In a **reasonable amount of time** through optimisation techniques
- **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
  - we cannot afford enumerating all possible solutions to guarantee that a perfect solution is found
  - no specific technique exists that guarantees that an optimal solution can be found quickly.





# Search Problems

Search: find a solution that **satisfies** certain constraints.



UNIVERSITY OF  
BIRMINGHAM

# Logic

- 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.

If it is raining outside, then it is wet outside.

It is raining outside.



It is wet outside.



# What is AI?

- Many different definitions

- Think humanly
- Act humanly
- Think rationally
- Act rationally

Can machine think humanly? Can

What can human do?

What if human's action is

human?  
?

Think logically?

Logical AI? Too narrow?

Rationality: doing the right thing.

Can be mathematically defined and  
general enough, linked to human  
behavior.



# 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.

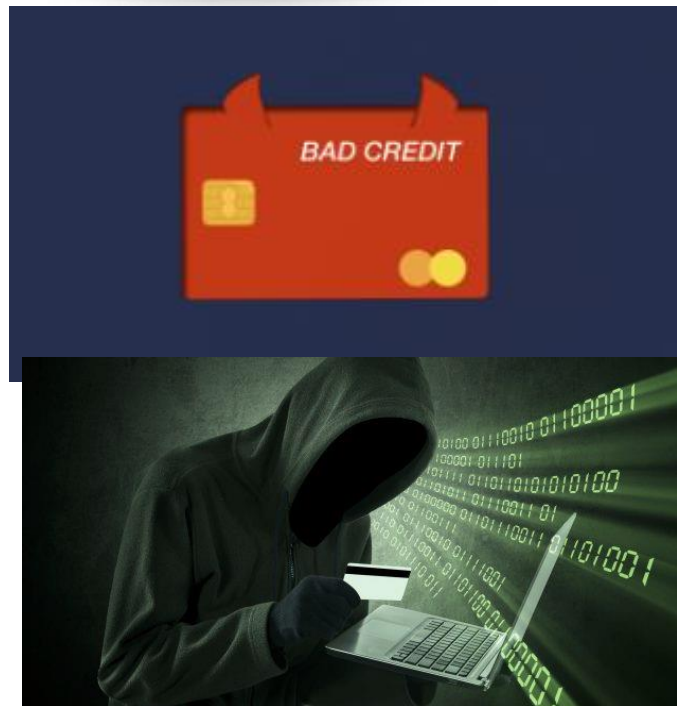


# AI in Real Life

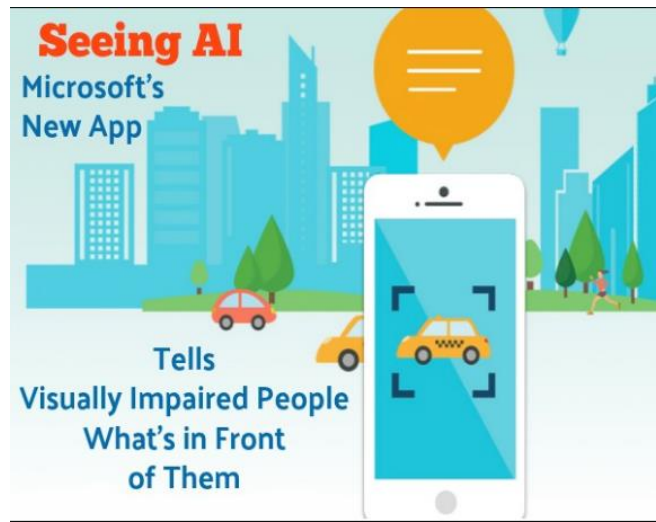
- **Facebook** uses neural nets for their automatic tagging algorithms, **Google** for their photo search, **Amazon** for their product recommendations, **Pinterest** for their home feed personalization, and **Instagram** for their search infrastructure.



UNIVERSITY OF  
BIRMINGHAM



voiceitt



# Summary: In this Module

- You will get an [introduction](#) to different areas of Artificial Intelligence, including search / optimisation, and machine learning.
  - AI [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.



# Summary

- What have you gained in this lecture w.r.t. AI?
- Intelligence, Artificial Intelligence
- Rational Agents
- Search problems, Optimisation problems
- Applications and Benefits of AI

