BCS ESSENTIALS CERTIFICATE IN ARTIFICIAL INTELLIGENCE

COURSEWARE

TUTOR MANUAL

The Chartered Institute for IT

BCS Essentials Certificate in Artificial Intelligence Courseware

Slide 1 – Title slide

Welcome

Greet course delegates as they enter and ensure that they are comfortable and ready to commence their learning experience.

Try to start on time as there is a lot to get through and in larger groups there may well be extended interaction making the course potentially longer.

Session 1
Introduction and course outline

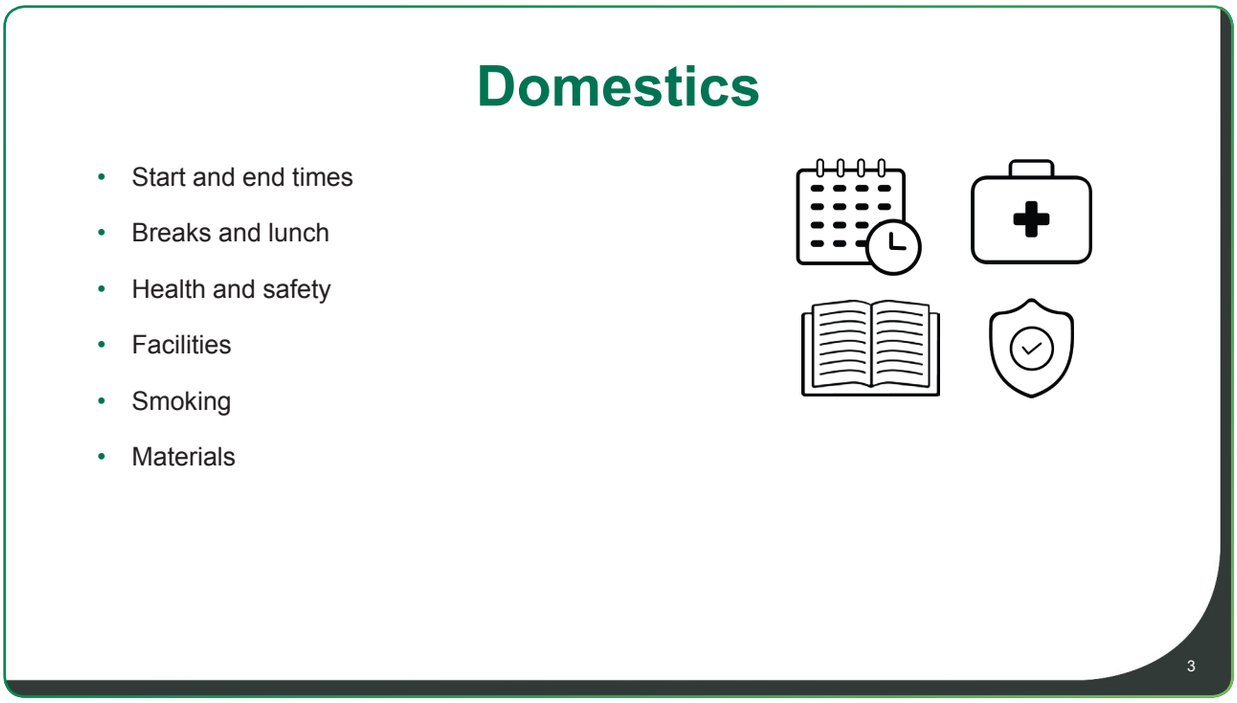
Slide 2 – Title slide

Provides delegates with an outline of the course content.

This gives the tutor an opportunity to find out about the delegates' roles, organisations and experience of AI.

To inform the delegates of the examination structure and what to expect in the end-of-course examination.

Slide 3 – Domestics

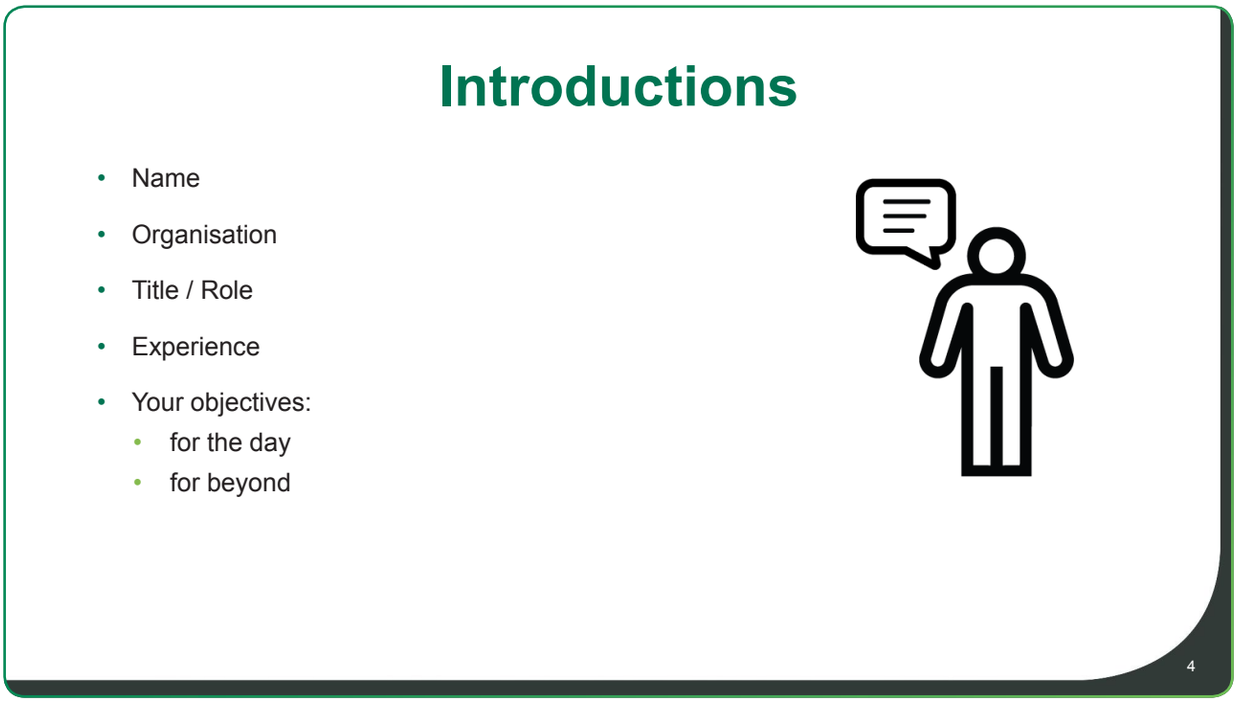


Explain the ground rules for the course.

Remember to have checked if there is likely to be a fire alarm test and where the exit points are from the building.

Also explain the course materials. The delegate folder contains printouts of the slide set with ample room beneath each slide for note taking.

Slide 4 – Introductions



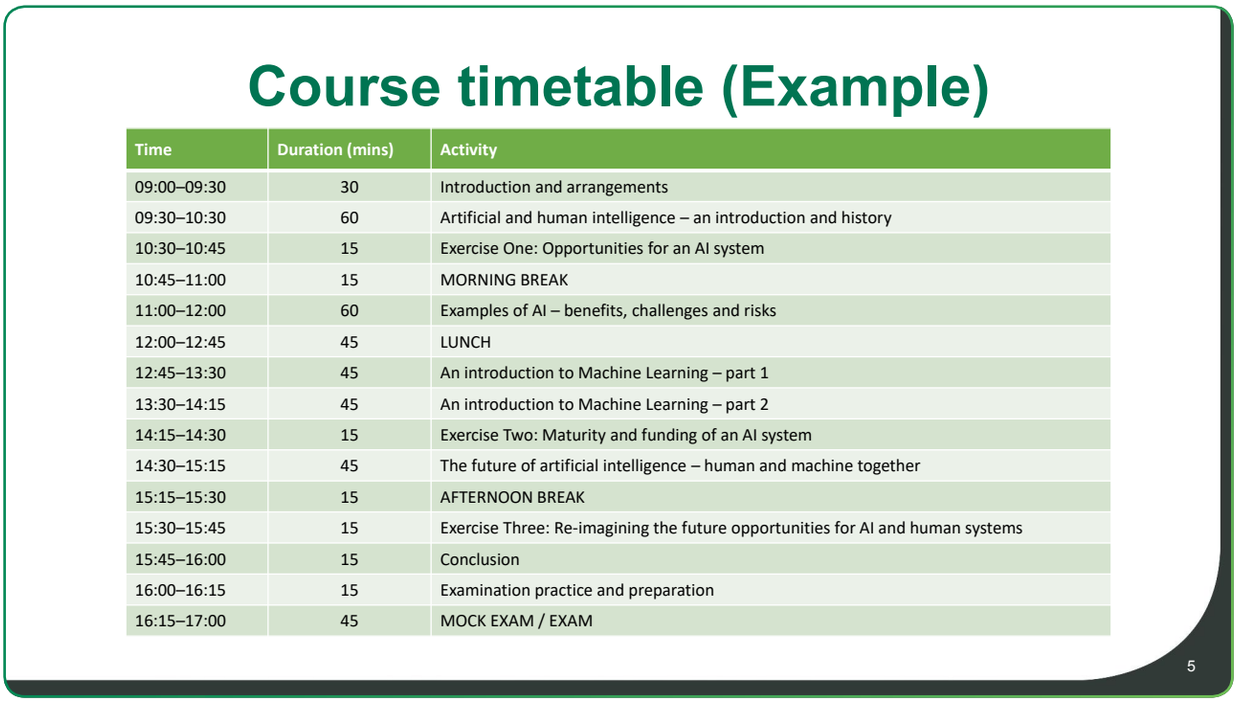
Get the delegates to introduce themselves individually.

Ask questions about their background and experience. Understanding these things makes it easier to bring out these experiences during the course.

Also, try to understand the reasons for the delegate attending the course as this can vary and affect the responsiveness of the delegates.

Get them to ask what their DNA is and what could they teach an AI system.

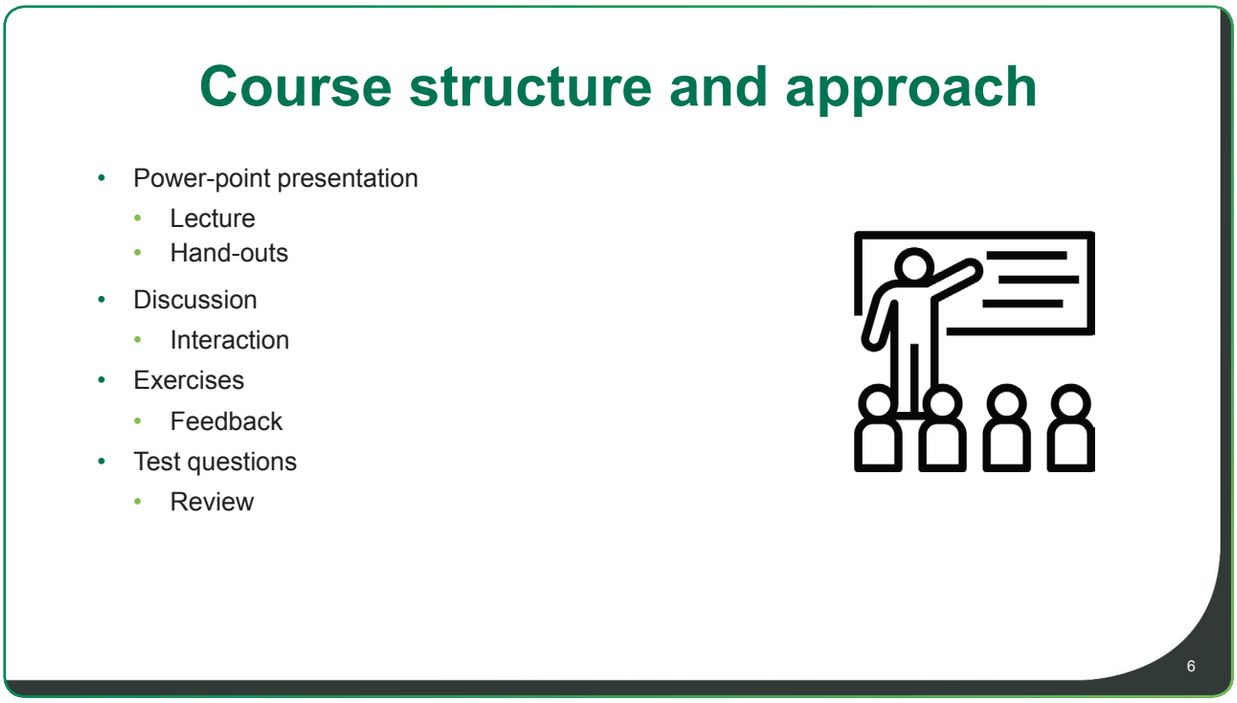
Slide 5 – Course timetable (Example)



Explain the high-level view of the timetable and the structure and approach that will be taken. It should be considered a guide.

If possible, try to stick to the timings as there is a lot to get through.

Slide 6 – Course structure and approach

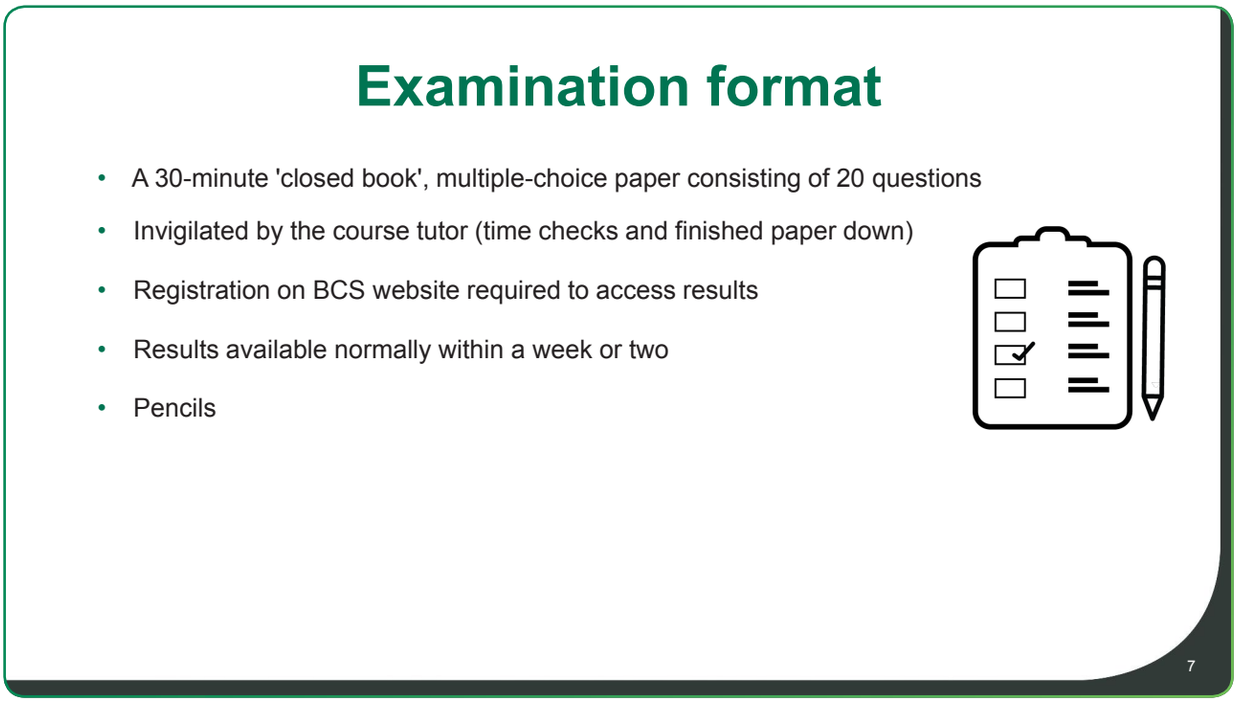


Explain that there should be interaction. This is not a lecture.

Encourage the delegates to share their experiences of AI but be aware that some may wish to share too much and may be disruptive. Use your judgement and experience as a trainer to control the day.

The course contains lots of links to be explored after the course and also an extensive reading list for those that seek more knowledge of AI.

Slide 7 – Examination format



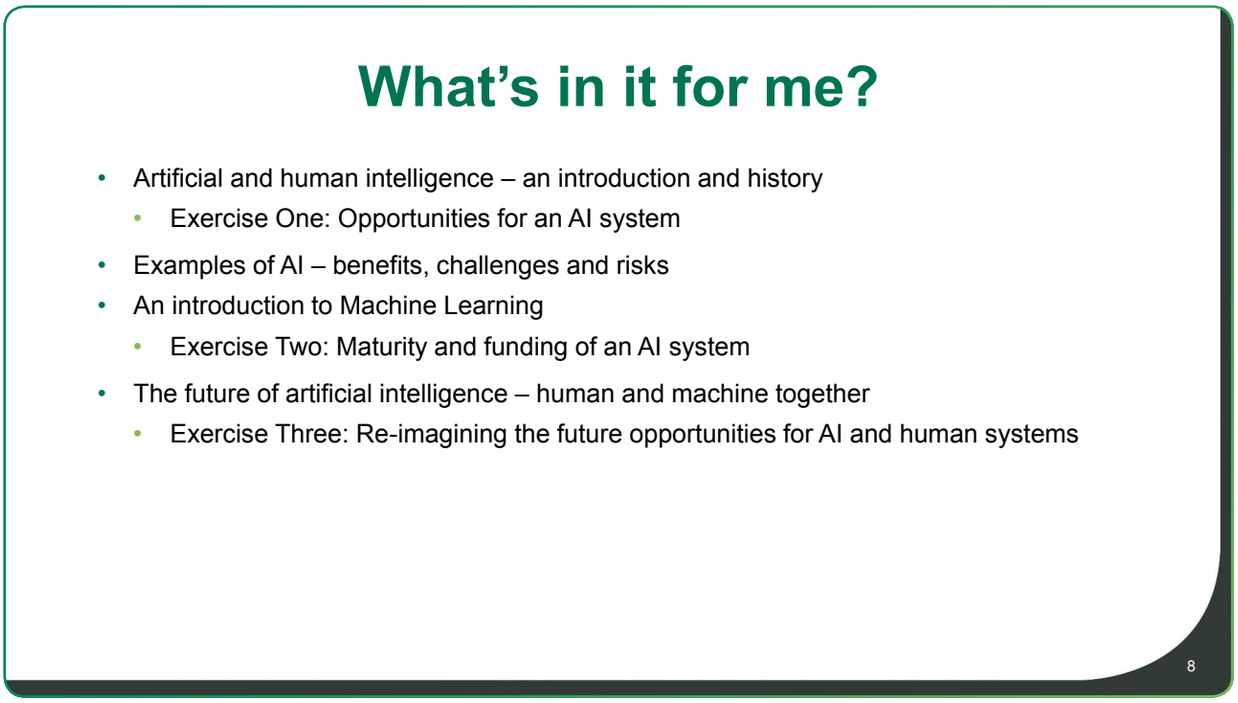
Explain the format of the BCS AI Essentials Exam. Explain that as the Invigilator you will represent BCS and will control all aspects of the examination.

Don't forget to acquire some pencils before the exam.

Post course: return the exam material and answer papers to BCS as normal.

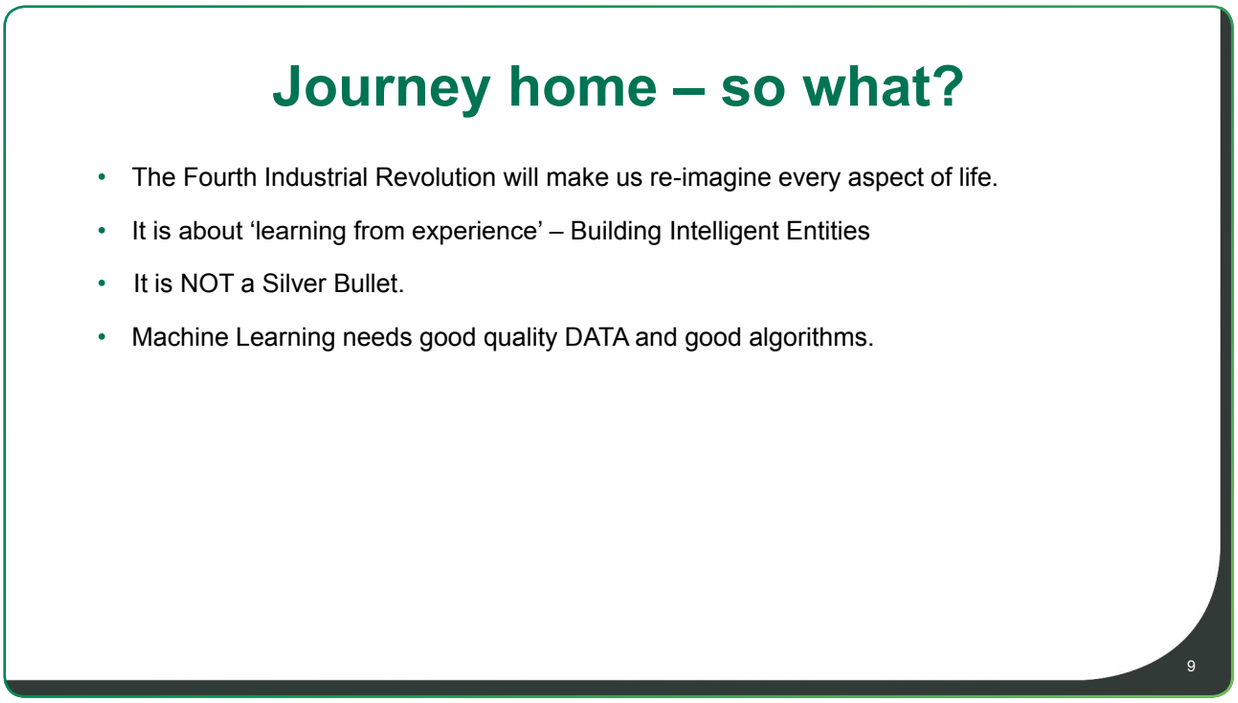
Do not allow delegates to copy or remove exam materials from the room.

Slide 8 – What's in it for me?



These are the main topic areas and there will be three exercises during the course to reinforce learning objectives, get the delegates to think and to aid discussion.

Slide 9 – Journey home – so what?



On the journey home after the course these bullet points should be the four key areas that the delegate reflect on.

In fact, they can start reflecting on them now and during the course.

This slide is repeated at the end of the course. The course is not intended as a one-off event.

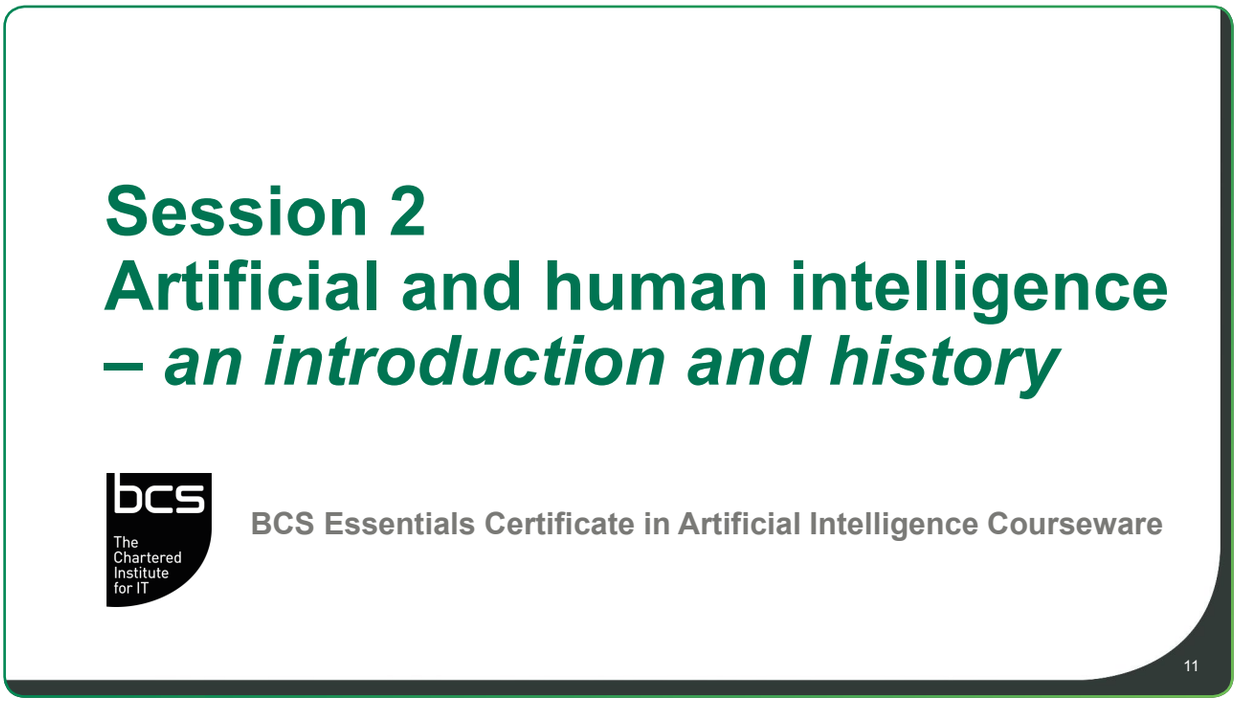
We hope to have sparked an interest in delegates to explore AI further in their work and personal lives.

Slide 10 – Any questions?

This is an opportunity to check that both you and the delegates understand the format of the rest of the day and identify if there are any specific aspects of AI that the delegates want to explore further during and after the course.

Session 2
Artificial and human intelligence – *an introduction and history*

Slide 11 – Title slide



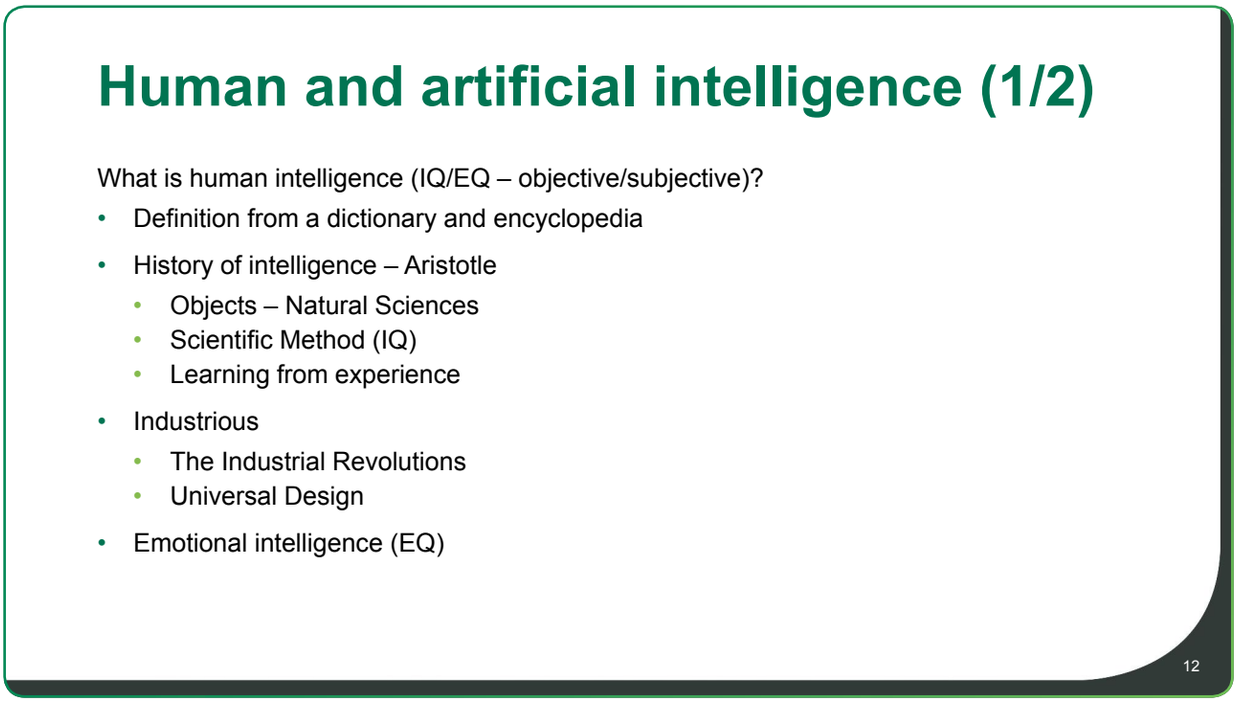
This section sets the scene in terms of an introduction to AI: what AI is; where AI has come from historically and how it compares to human intelligence.

This is the first main section of the course and we will cover a broad range of topics during the day.

Explain what is going to be covered in this section:

- an Introduction to AI;
- the history of AI;
- what 'Learning from Experience' actually means.

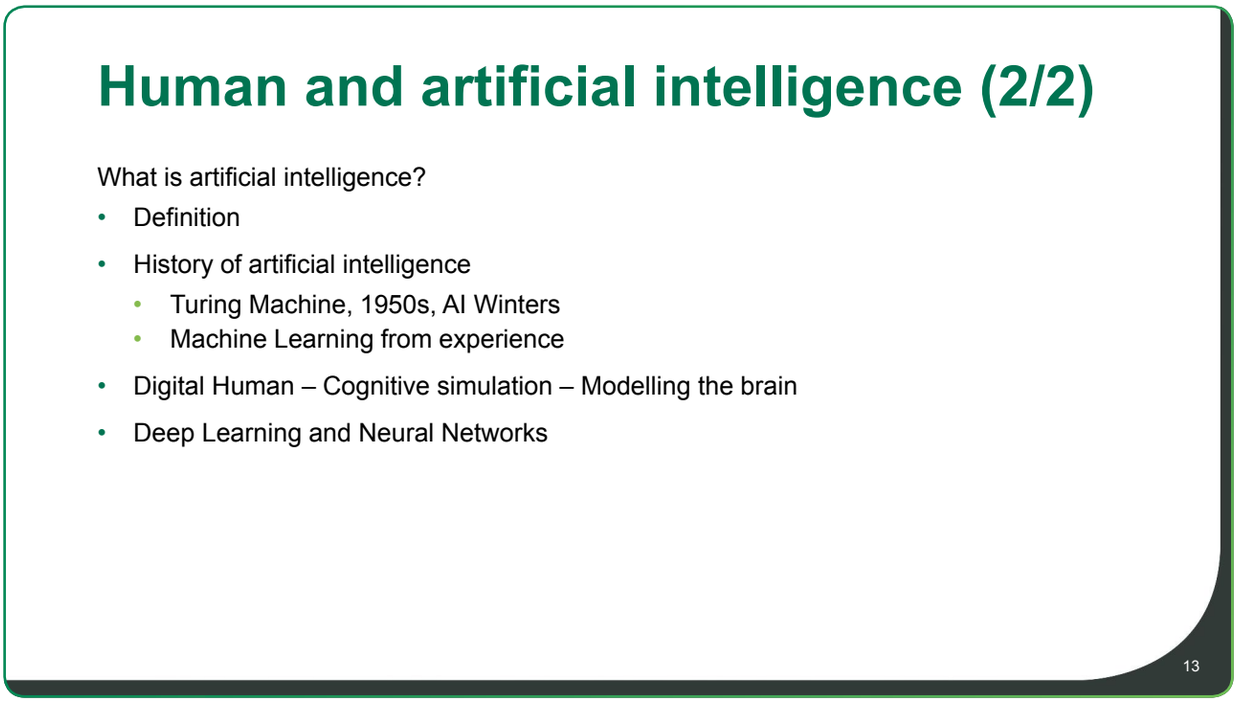
Slide 12 – Human and artificial intelligence (1/2)



Human and artificial intelligence (1/2)

Some of these bullets are expanded further in subsequent slides, but equally we could expand on these points on this slide.

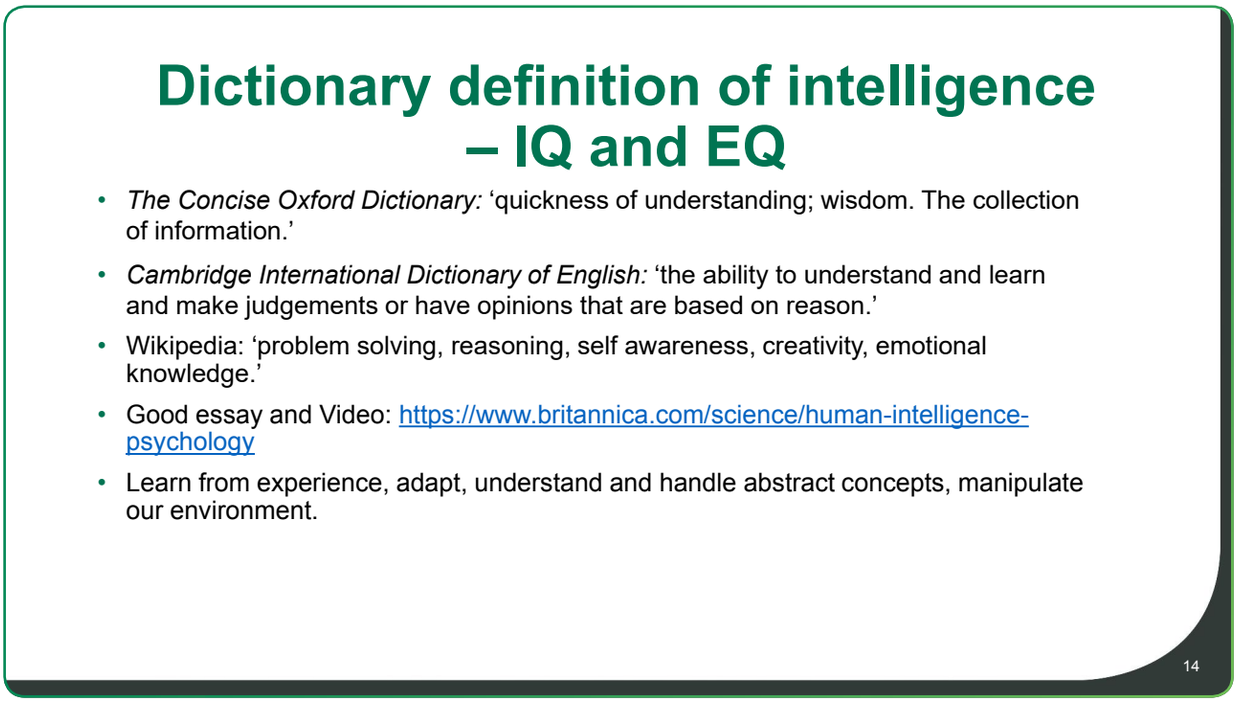
Slide 13 – Human and artificial intelligence (2/2)



Human and artificial intelligence (2/2)

Some of these bullets are expanded further in subsequent slides, but equally we could expand on these points on this slide.

Slide 14 – Dictionary definition of intelligence – IQ & EQ



This is an opportunity to explore what exactly human intelligence is. Here are three definitions from different sources.

Note they are similar but not the same – so do we really understand human intelligence? Get the delegates to give you some of their definitions.

Try not to get side-tracked into a philosophical debate.

If a white board or flip chart is available why not jot them down? You could use them as a reference later.

Slide 15 – Aristotle

Aristotle

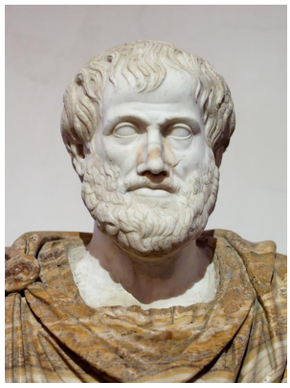


Image from:

https://en.wikipedia.org/wiki/Aristotle

364BC to 322BC – the father of western philosophy

He was the first to write about OBJECTS and laid the foundations of:

- Ontology – the natural of being, knowledge, engineering
- The Scientific Method

Today, we teach:

- Natural Science
- Data Science
- Computer Science
- Social Science
- Artificial Intelligence – a universal subject ???

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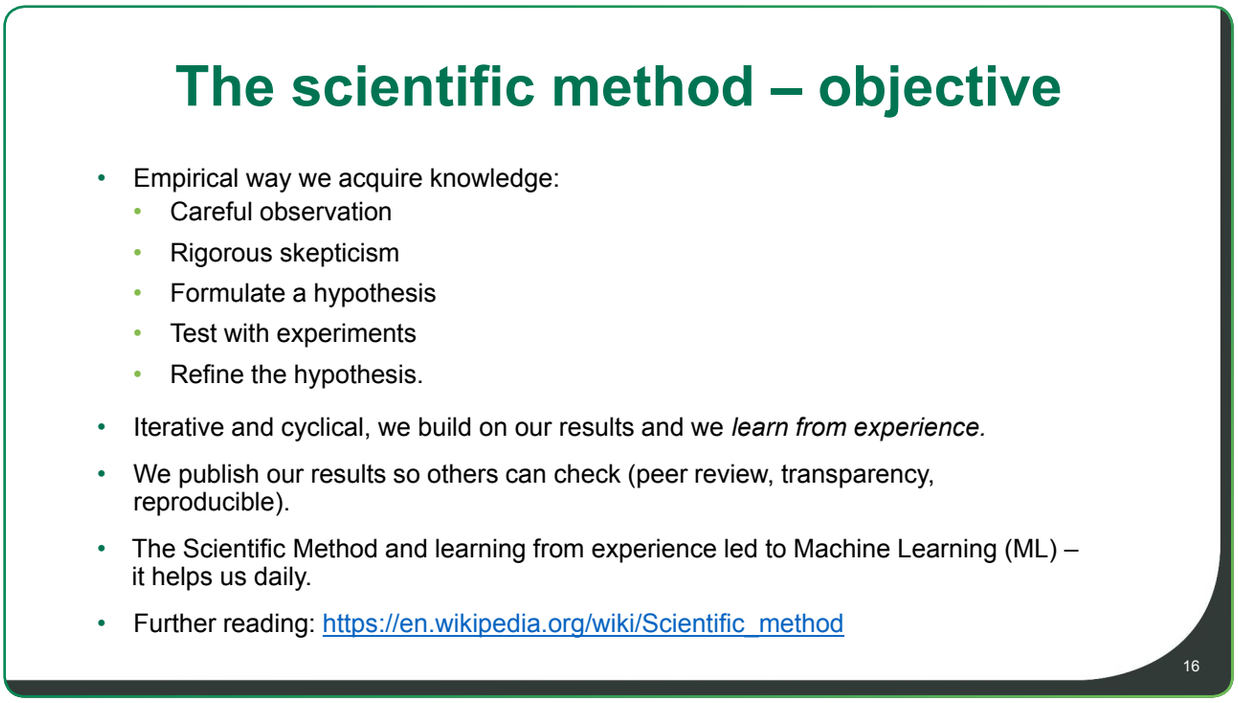
Aristotle started the idea of systematic learning via the nature of objects.

This approach led to the scientific method that gives human and artificial intelligence rigour.

Do some reading on Wikipedia about Aristotle's contribution to natural sciences.

He laid the foundation for knowledge engineering, computer science and physics.

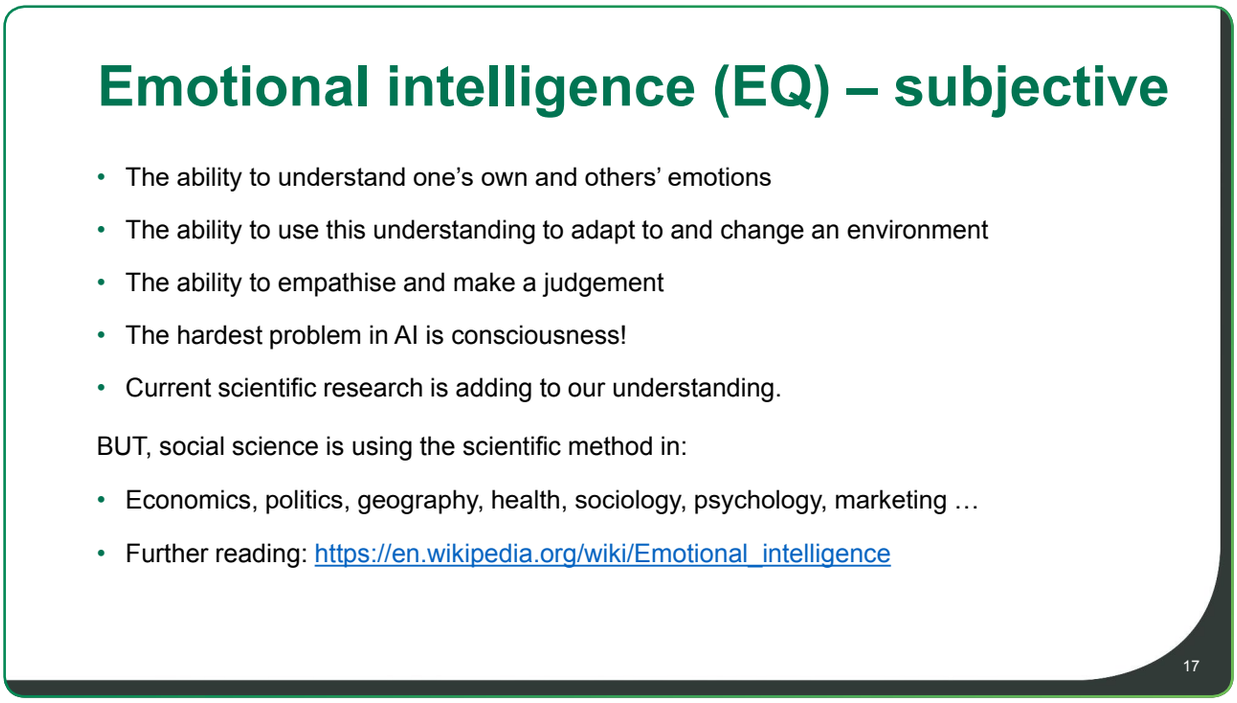
Slide 16 – The scientific method – objective



In the Foundation course we introduce the idea of a technological robust AI.

In the 1980s' AI adopted the scientific method. Professionals need the scientific method to produce robust and trustworthy AI. Indeed, the industrial revolutions are a consequence of the scientific method being used to enhance society.

Slide 17 – Emotional intelligence (EQ) – subjective



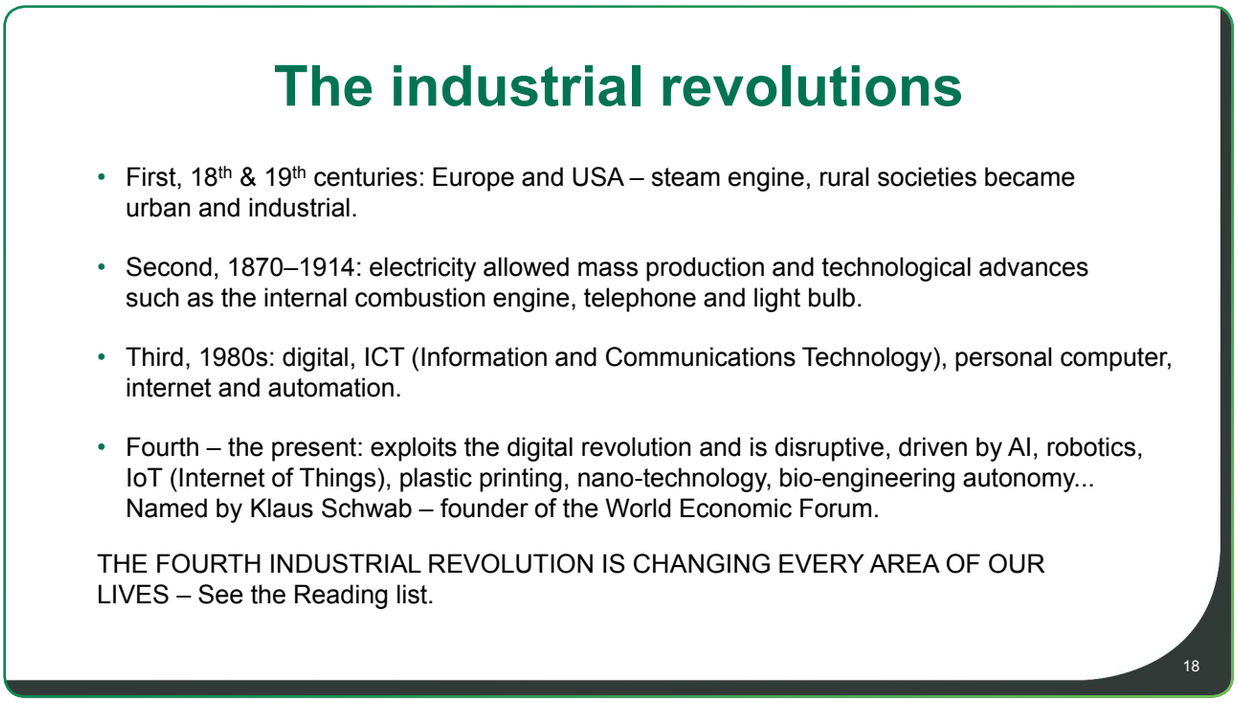
It's not just IQ that we need to understand; part of our intelligence is the ability to understand ourselves and others.

If we are to manipulate our environment, we must have emotional intelligence also.

We are conscious yet we don't have a clear theory of consciousness or indeed why we have consciousness.

How could an autonomous robot have empathy without emotional intelligence?

Slide 18 – The industrial revolutions

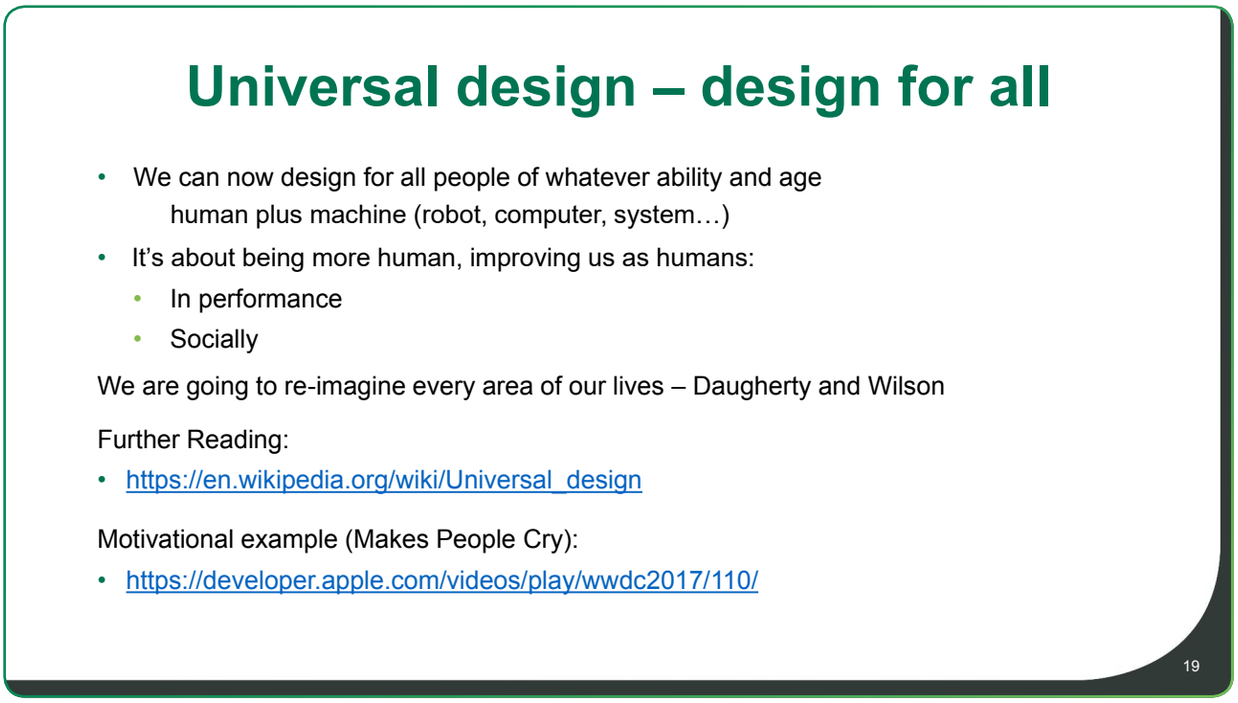


Human intelligence has led us to the industrial revolutions.

We are in the fourth industrial revolution but what does this mean if we think about AI? It means we will have more robots doing routine monotonous task – doing the heavy lifting.

Introduce the idea of humans and machines working together at what each are good at.

Slide 19 – Universal design – design for all

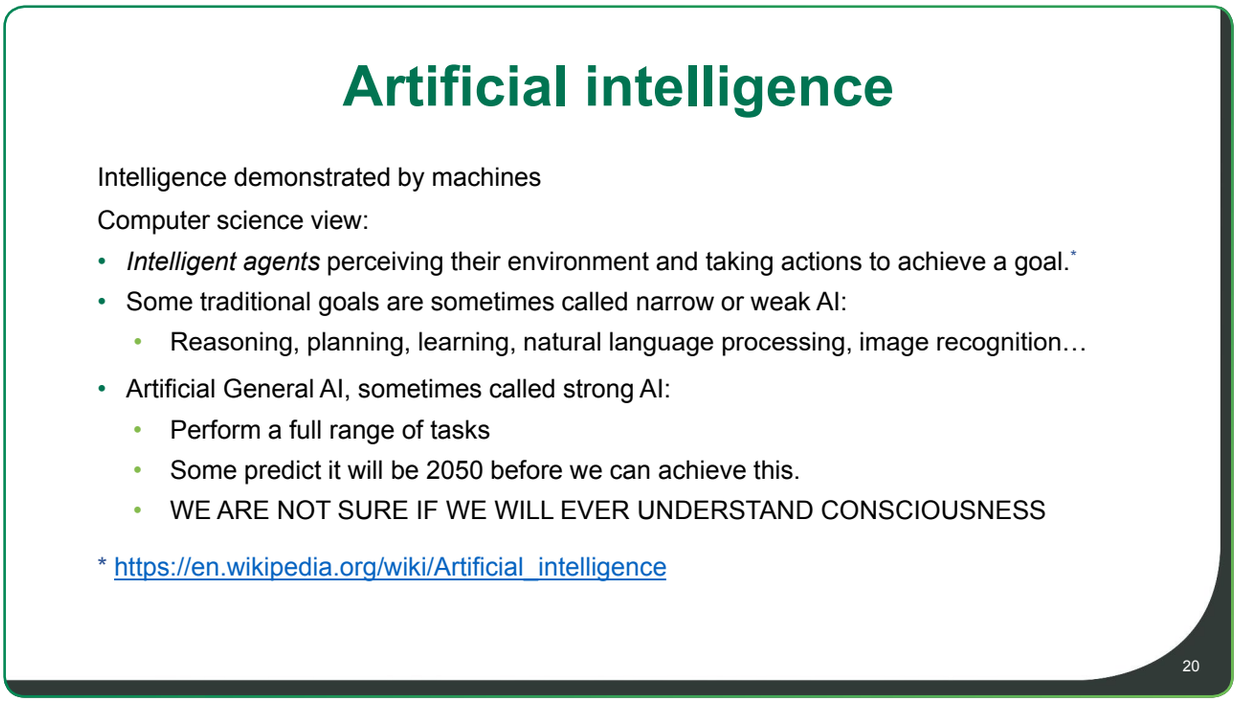


If humans can augment human intelligence, we must design for all.

In the Foundation course we go deeper into the concept of human-centric AI.

As a consequence of Universal Design we should become more Human – true to our own DNA.

Slide 20 – Artificial intelligence



Explain the computer science view of AI. It somehow misses the point of what emotions are. It explains that we are already good at narrow AI. Engineers and scientists use this every day.

Strong, or Artificial General, AI is some way off. It will be able to perform a full range of tasks, but it is a long way off.

Academics believe we will achieve this but we just don't know when and it will certainly not be any time soon.

Slide 21 – The history of AI and Machine Learning

The history of AI and Machine Learning

- 18th Century — Mathematical development of statistics (Bayes Theorem) and the first computer description and algorithm – Ada Lovelace
- 1950s — Turing Test – 'Computing Machinery and Intelligence'. Machines play draughts. Dartmouth College – first use of the term Artificial Intelligence – John McCarthy
  - Electronic Neural Net
- 1973 — Resources withdrawn from AI research – Sir James Lighthill's Report
  - https://www.youtube.com/watch?v=03p2CADwGF8
- 1980s — David Rumelhart and James McClelland Parallel Distributed Processing and Neural Network Models
- 1997 — Deep Blue (11.4 GFLOPS) beats world chess champion – won by searching 200,000,000 moves per second – iPhone 7 (400 GFLOPS)
- 2016 — Google Deep Mind Alpha Go beats Lee Sedol at Go

https://en.wikipedia.org/wiki/Ada_Lovelace#First_computer_program

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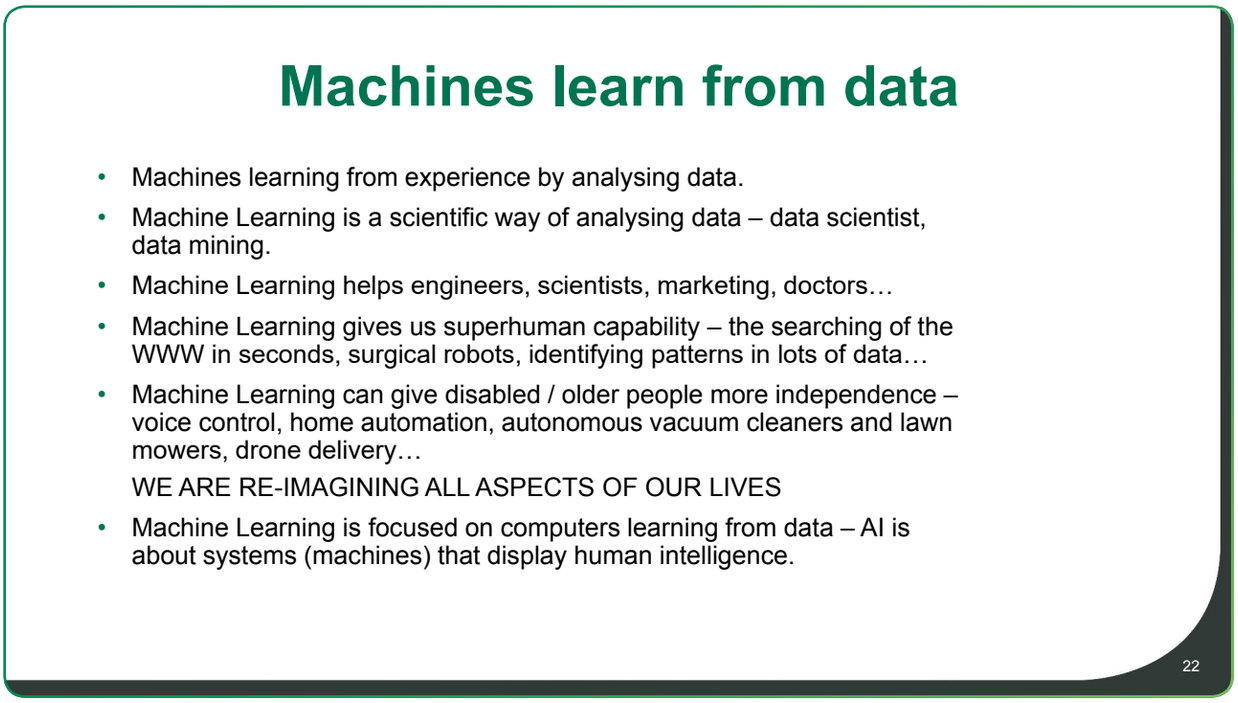
Research the history on Google or Wikipedia. Add your own examples. Point out that the first computer program was written by Ada Lovelace.

The Turing Test is famous. Explain what it is and why it's so important.

Alpha Go is a big step toward algorithms that learn by themselves. Explain why Alpha Go was such a success. Highlight that it identified a move that won the game and taught the masters!

Do not attempt to watch the video as it's 1hr 23 mins long.

Slide 22 – Machines learn from data

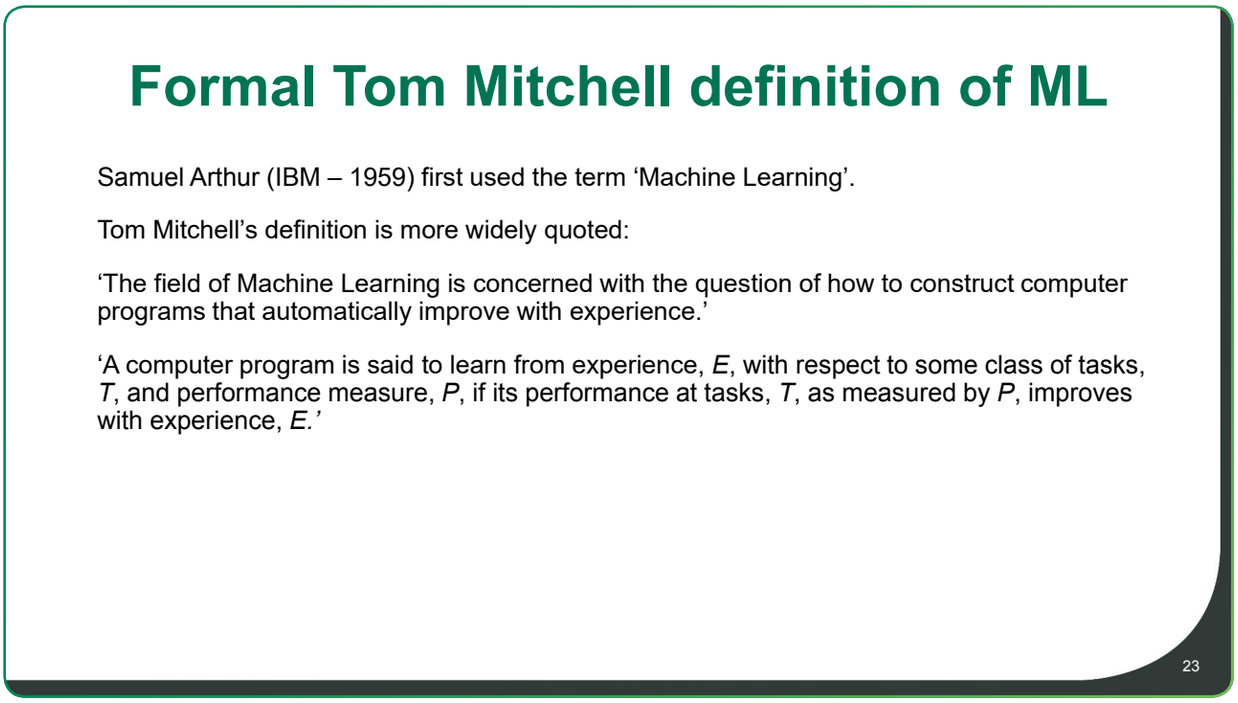


Machine learning is popular at the moment and the market for it is growing steadily.

ML is a subset of AI. Later in the course we will show the difference so attendees can explain the difference between human, artificial and machine learning.

ML augments our intelligence by learning from data; this is different to what humans do which is learn from experience.

Slide 23 – Formal Tom Mitchell definition of ML

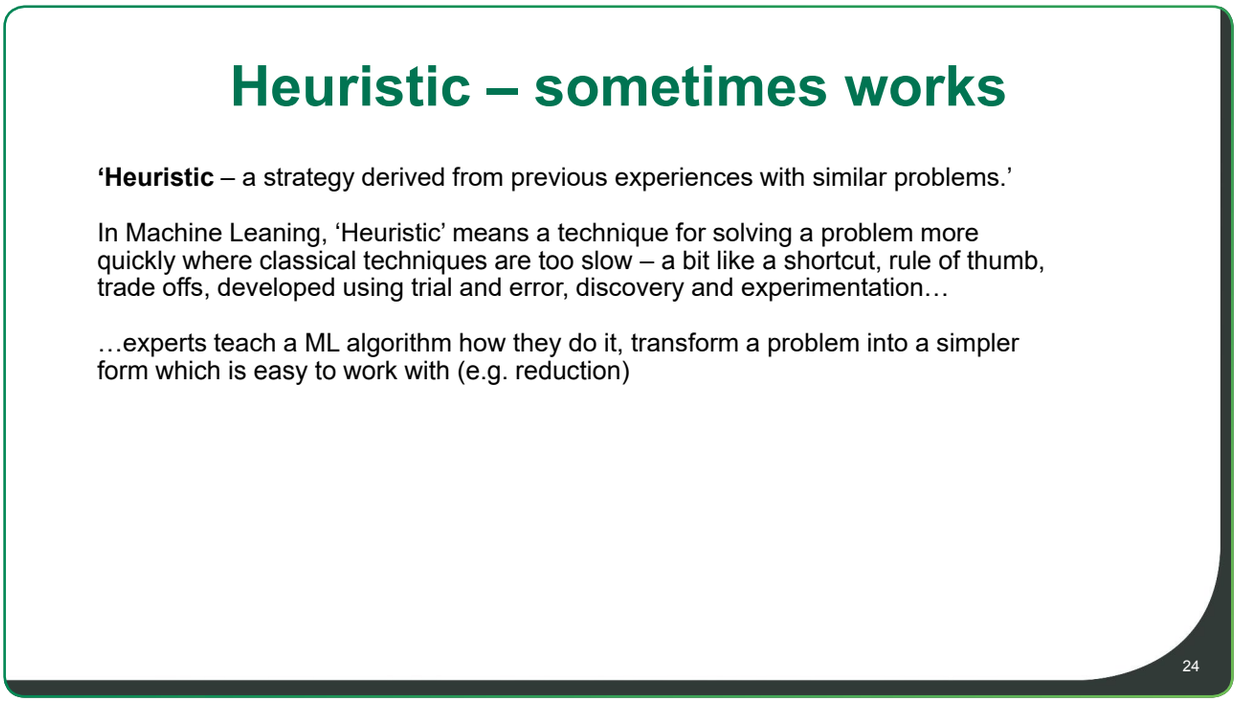


Formal Tom Mitchell Definition of ML.

Research the Tom Mitchell definition of ML.

Highlight that this is very much a computational description and that AI is a broader subject.

Slide 24 – Heuristic – sometimes works

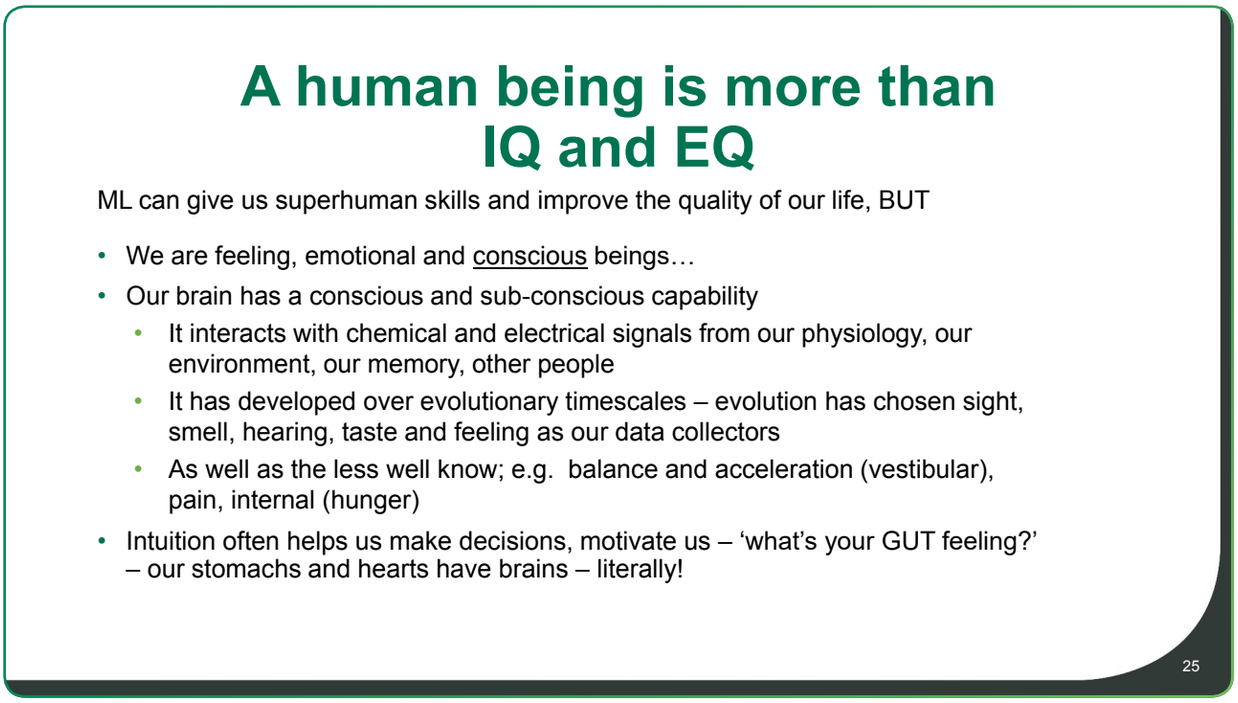


One of the big problems with machine learning is the combinatorial explosion. A heuristic approach can help us overcome this; an expert gives us a good best guess.

The shortcut or 'rule of thumb' allows machines to obtain an answer much quicker!

Find your own examples!

Slide 25 – A human being is more than IQ and EQ

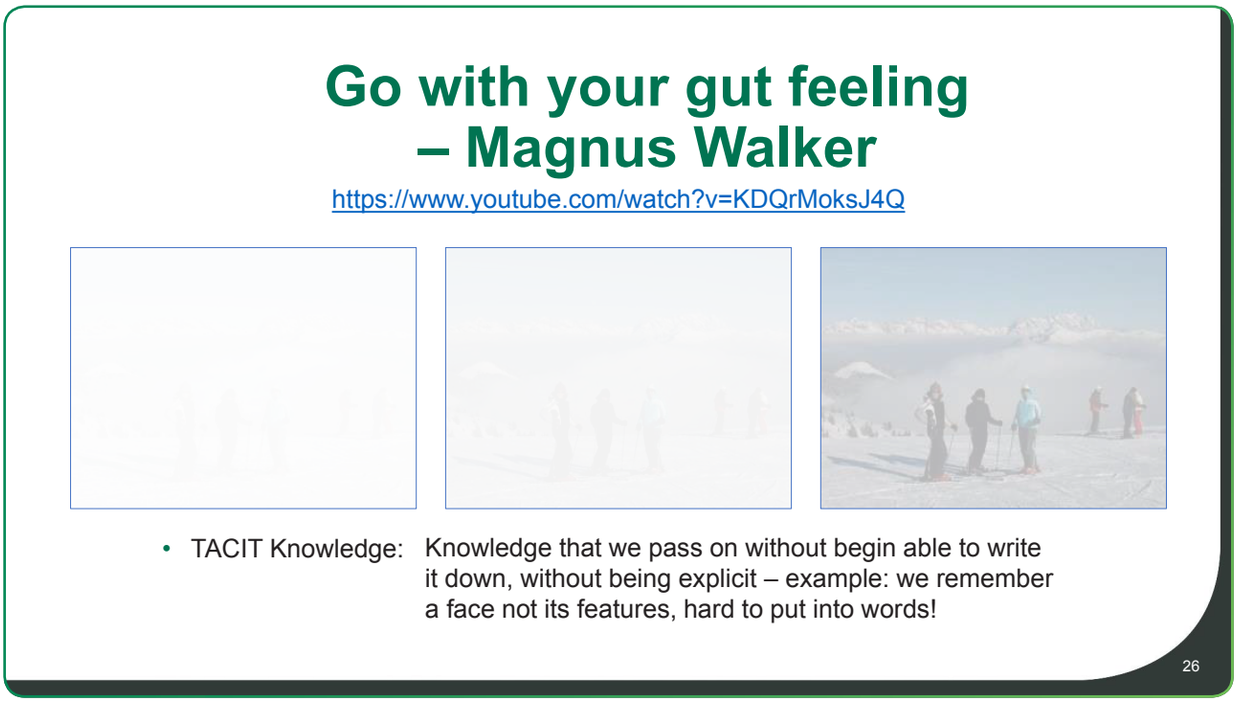


Machines can enhance or magnify our skills and capabilities but a human is more than a computer program.

Introduce the idea of consciousness and the conscious and sub-conscious aspects or being human.

When we dream, are we conscious? Explore this with the attendees.

Slide 26 – Go with your gut feeling – Magnus Walker

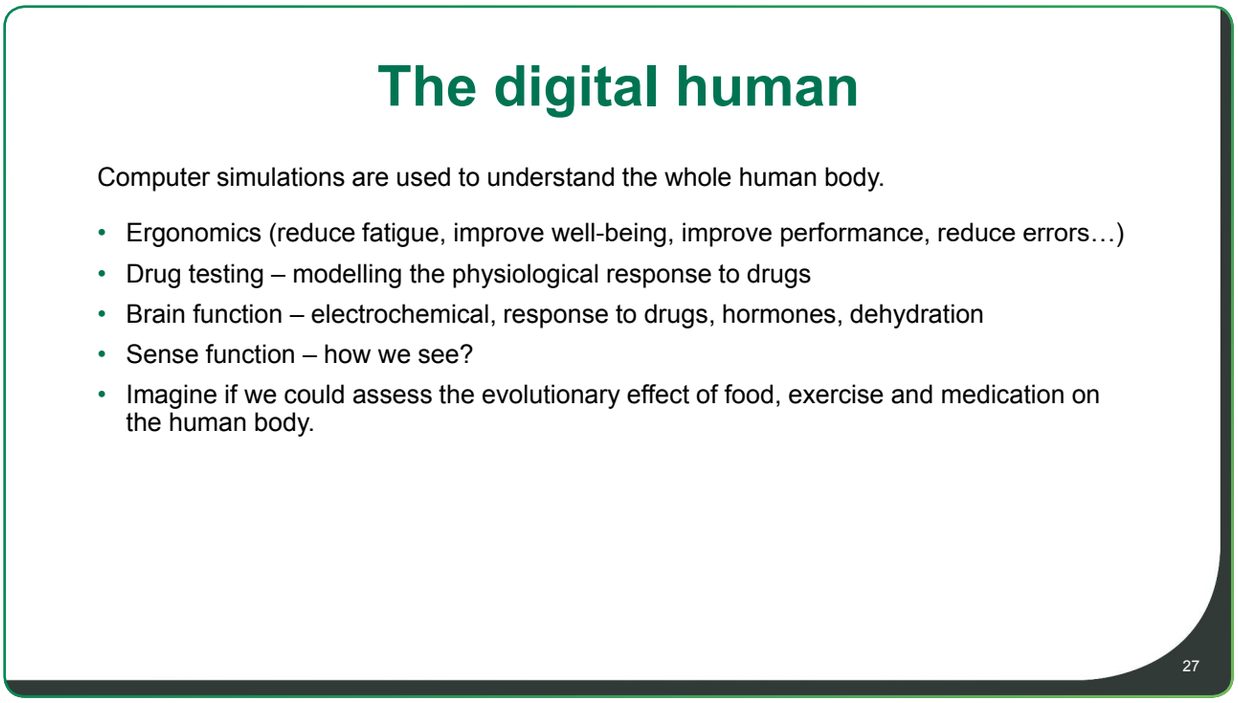


An interesting video to watch (not in the course) about someone who used his gut feeling to build an amazing life.

Also, in this slide is an example of just how quickly humans can identify objects from few examples. Given the right hand side image, a human (child) would find it easy to identify the skiers going from right to left.

The hard bit for AI is that even though a human finds this easy, we can't teach people how we do it. This is tacit knowledge.

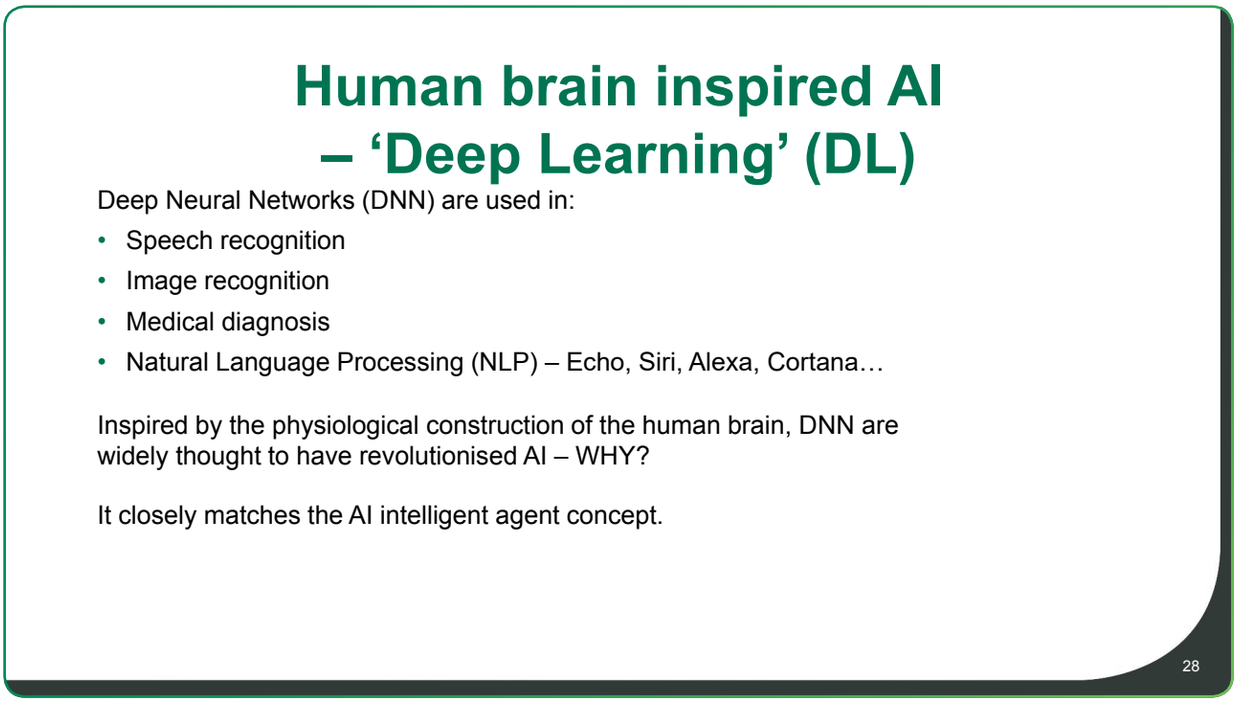
Slide 27 – The digital human



Imagine if we could simulate the whole of the human body, including the brain? It would lead to huge improvements in our well-being.

Drugs tested, medicine improved, loss of senses cured? The long-term effects of drugs, food and stress tested!

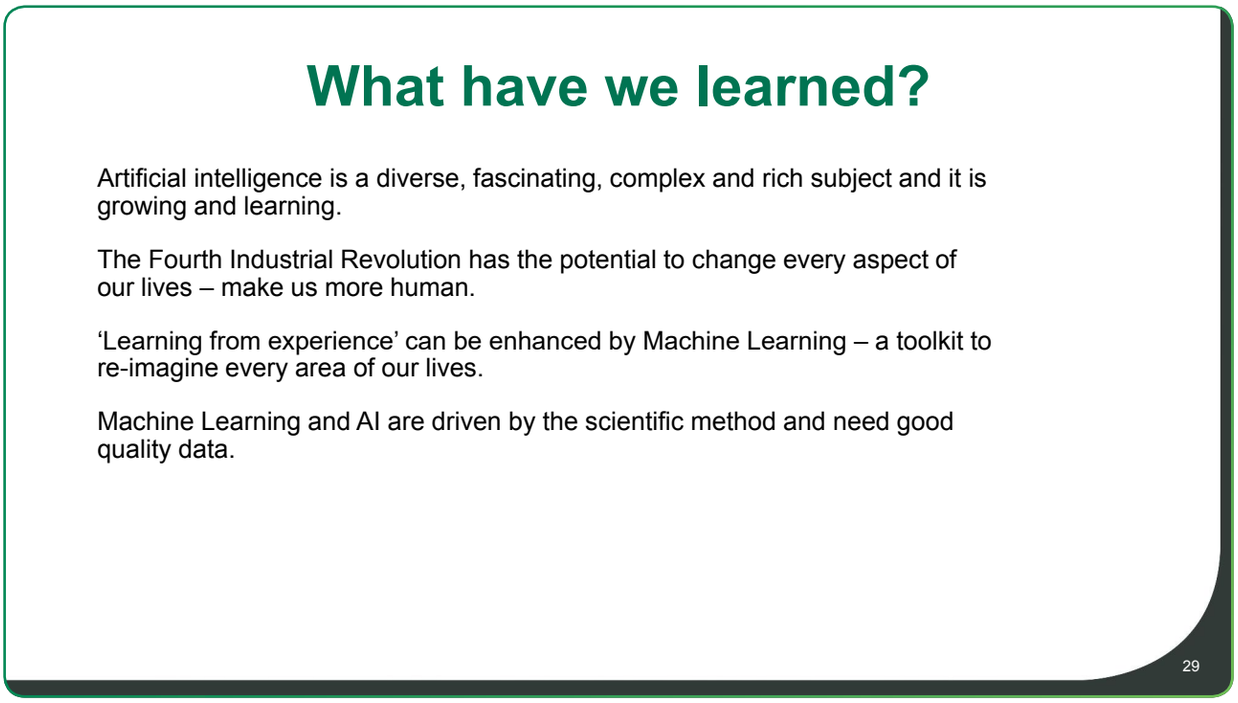
Slide 28 – Human brain inspired AI – 'Deep Learning' (DL)



Very recent advances in Deep Learning have accelerated the acceptance and use of AI, in particular Machine Learning.

Here we see machine learning approaching the simple idea of the agency of a human. This is the Deep Neural Network and it is inspired by the human brain. It learns by itself to achieve a goal.

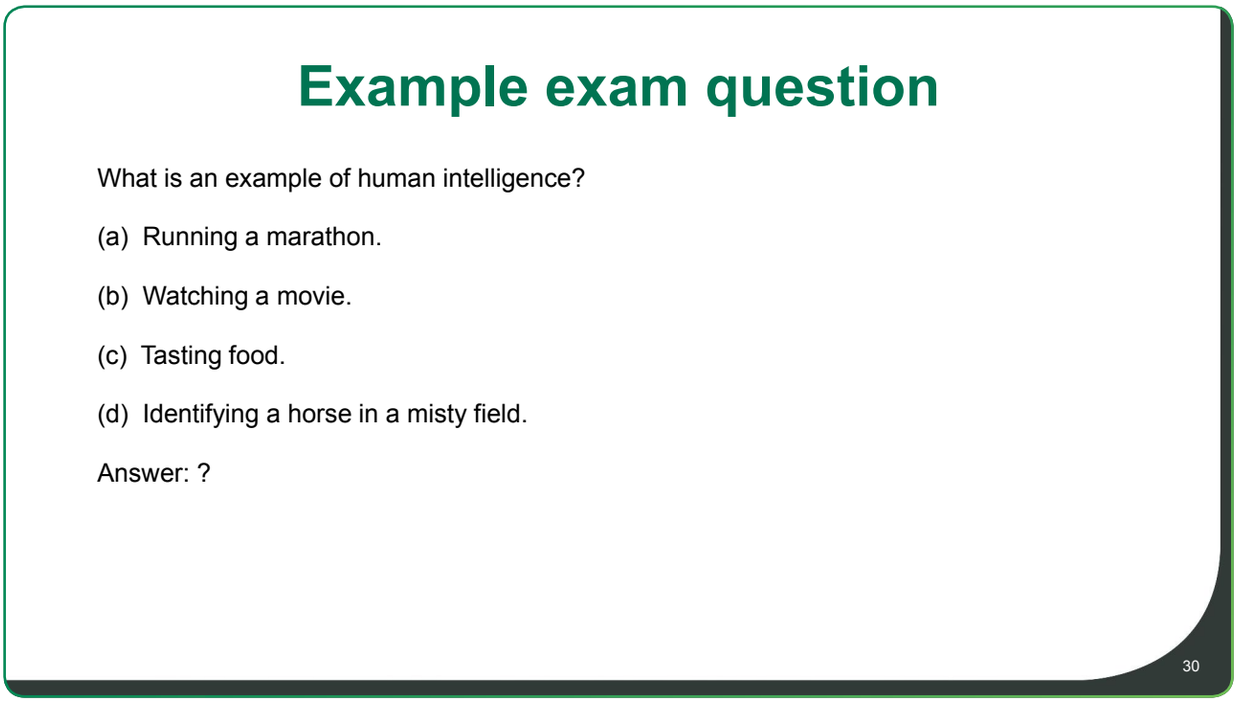
Slide 29 – What have we learned?



In summary we have learned that . . .

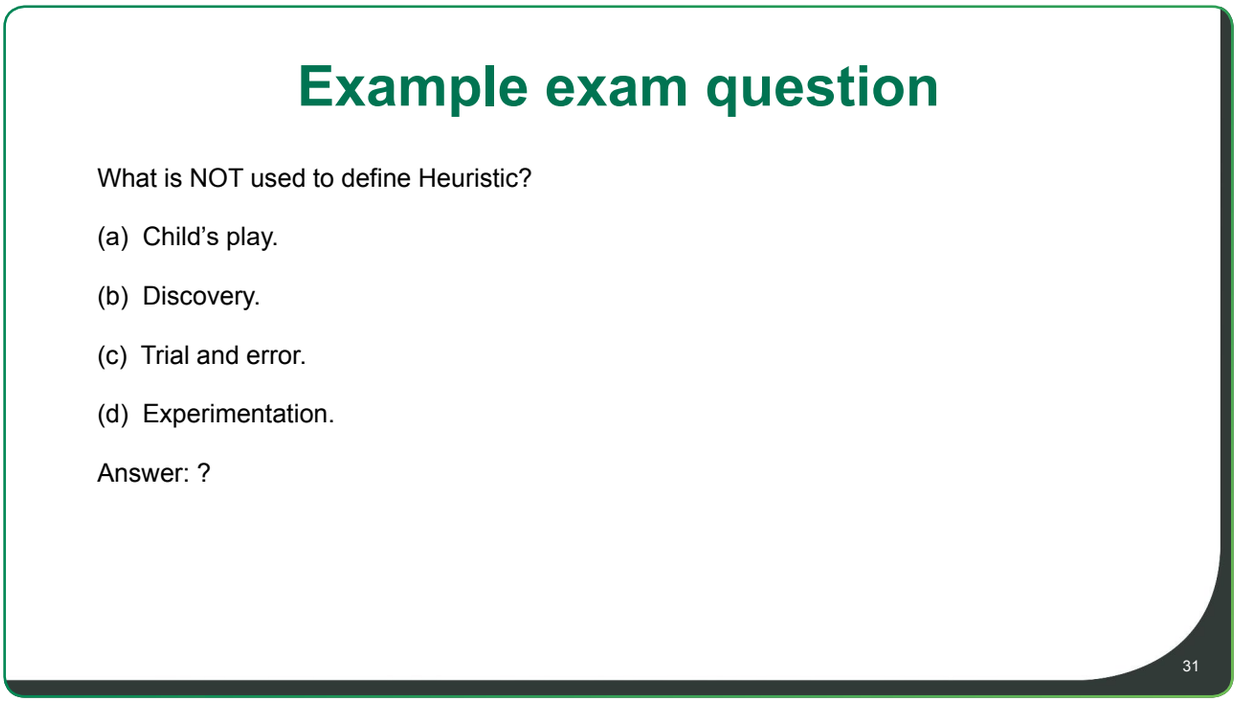
- Artificial intelligence is a diverse, fascinating, complex and rich subject and it is growing and learning.
- The Fourth Industrial Revolution has the potential to change every aspect of our lives – make us more human.
- 'Learning from experience' can be enhanced by Machine Learning – which is a potential toolkit to re-imagine every area and aspect of our lives.
- Machine Learning and AI are driven by the scientific method and need good quality data.

Slide 30 – Example exam question



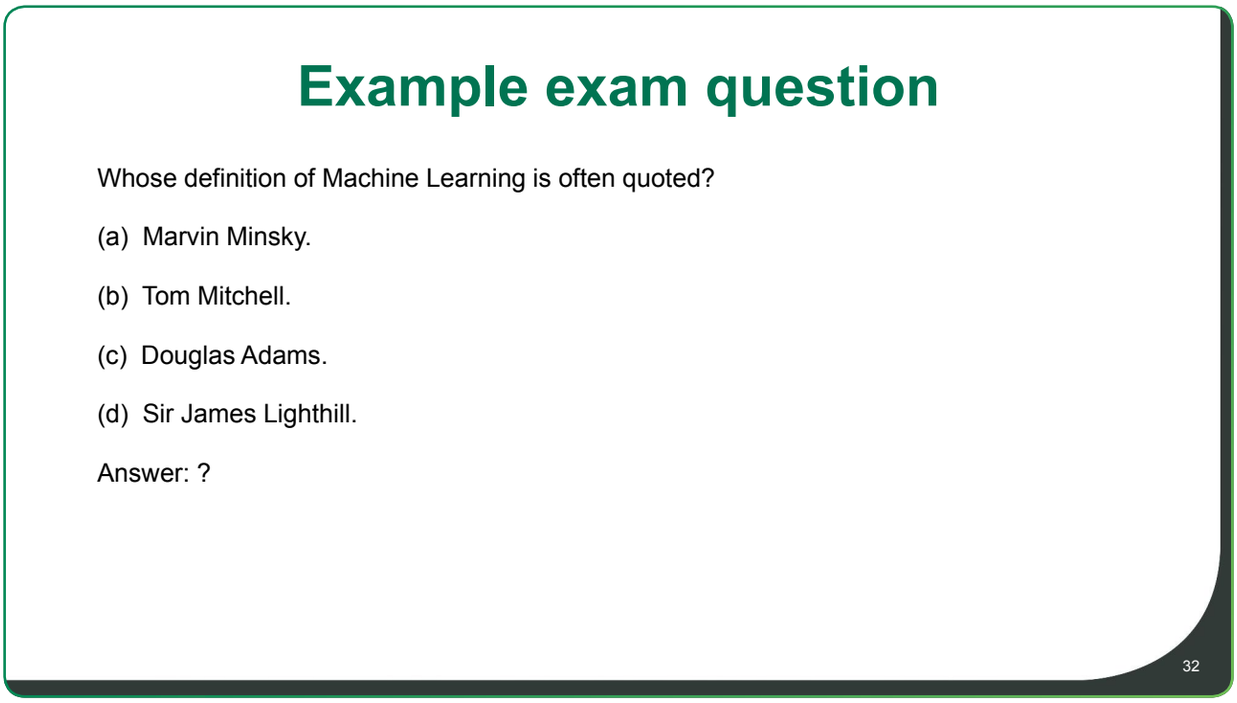
The answer is (d). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 31 – Example exam question



The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

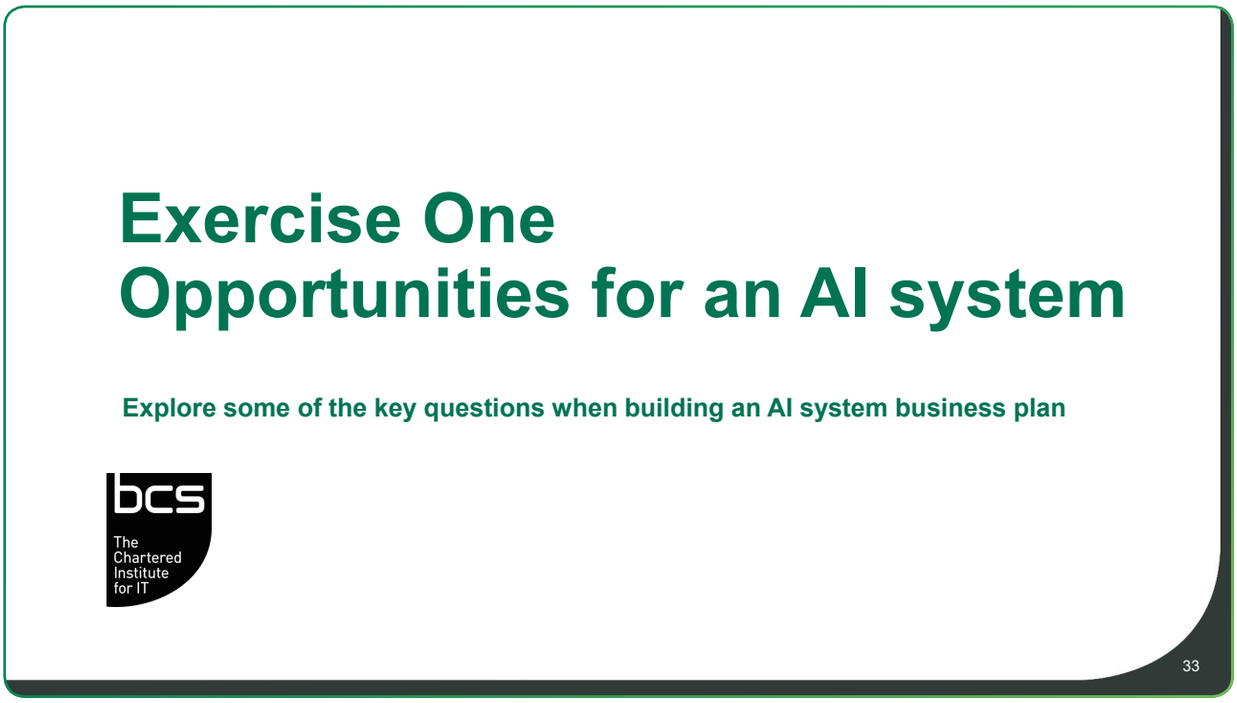
Slide 32 – Example exam question



The answer is (b). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Exercise One
Opportunities for an AI system

Slide 33 – Explore some of the key questions when building an AI system business plan



See Exercise book. Exercise One – Opportunities for an AI system

This exercise is self-explanatory – given the definitions, the exercise reinforces the content of the first section and gets the attendees to explore key questions when starting to define an AI project. Be disciplined with timing – guide the session so that only 5 minutes is spent on each question. If time permits and there aren't too many attendees go around the room so each person can explain briefly what they found! Do this for each question!

Objective: Allow participants to write down their first AI project(s) and in doing so explore key elements of an AI project. What would the AI system do? Where's the 'learning from experience'? What are the benefits, challenges and risks? Who will do the project? How important is the work and how much will it cost?

Tutor facilitated:

1. Spend a minute on each question allowing the participants to develop an idea or ideas.
2. When everyone has attempted each question, go through them allowing each participant to give a quick overview of their answers.
   - Allow brief discussion but avoid over indulging in excessive debate.
   - Key is to build confidence in starting to define an AI project.
   - Remind people that AI is about building intelligent entities – where's the 'learning from experience' – AI could well be a small part of a larger project.
   - Question 5 is the most interesting – emphasise STARTING with easy projects first and avoid the Bermuda Triangle!

Session 3
Examples of AI – *benefits, challenges and risks*

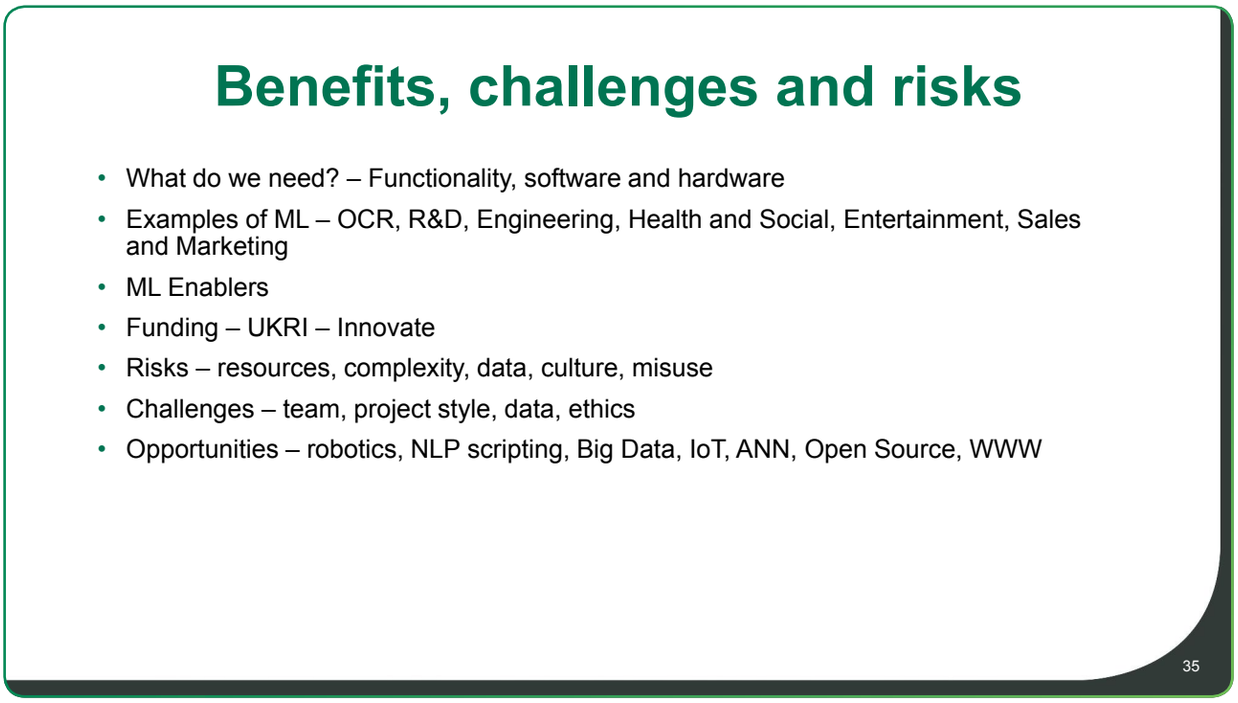
Slide 34 – Title slide

This section broadens the scope of AI via looking at examples of where it is applied.

In doing so, it highlights the Challenges and Risks an AI project poses.

In particular it looks at a typical Machine Learning project and what's involved from a computing point of view.

Slide 35 – Benefits, challenges and risks



This slide gives an overview of the session.

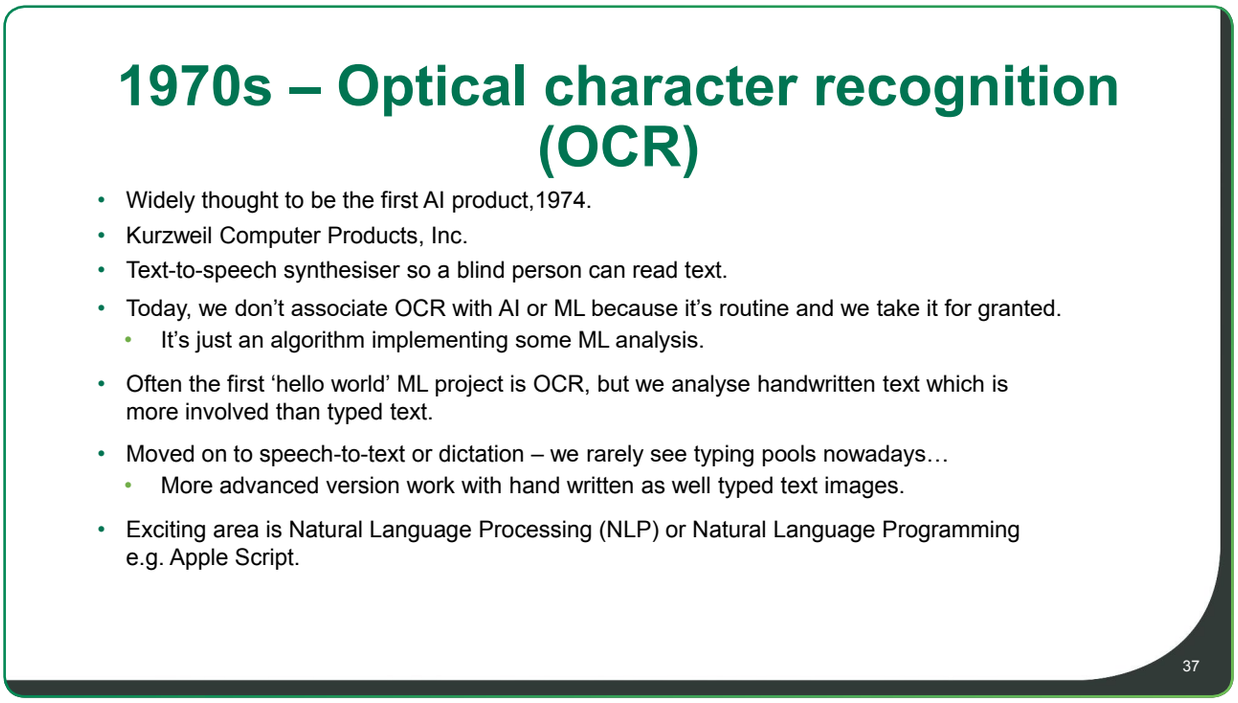
Highlight the funding the UK is putting into AI. Remember to reinforce that ML is part of the AI mix. Robotics is a good example of building an AI entity rather than learning from data.

Slide 36 – ML – What do we need?

This slide identifies some key steps in a Machine Learning project.

Ask the delegates to suggest what they would do or how it applies to their profession.

Slide 37 – 1970s – Optical character recognition (OCR)

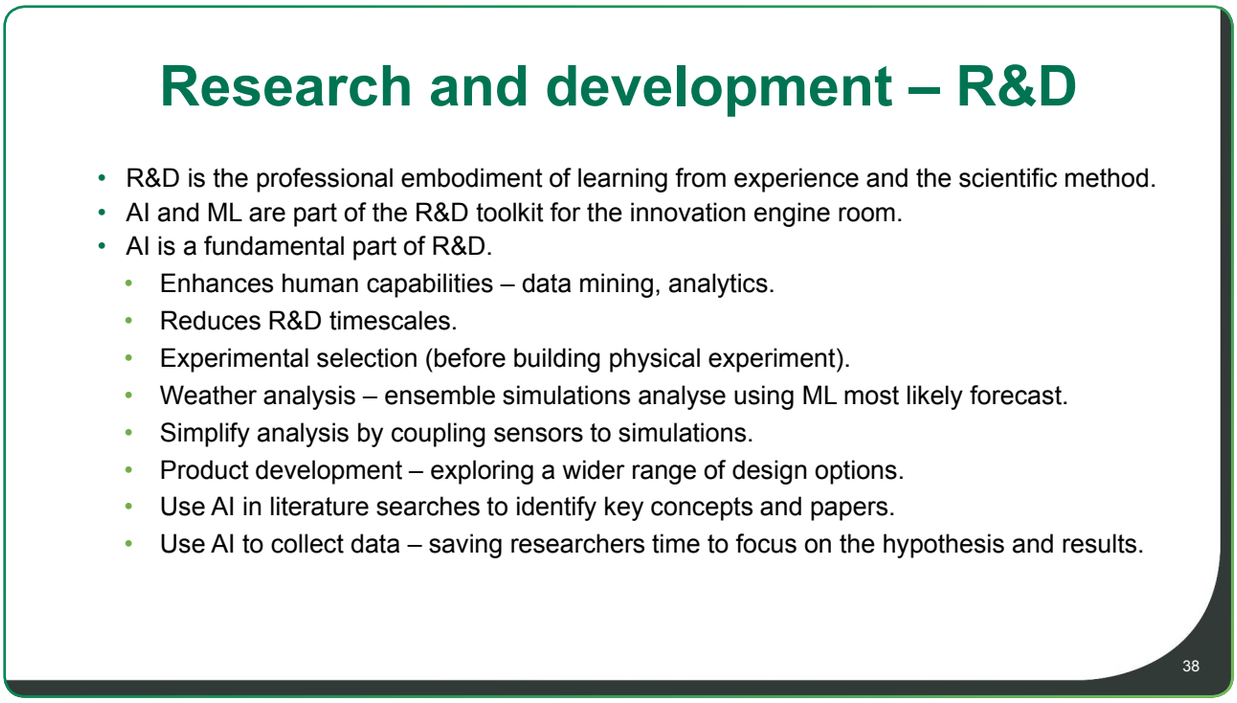


Optical Character Recognition was developed by Ray Kurzweil. This is often the first 'hello world' ML programme.

Highlight that this is now taken for granted and not recognised as Machine Learning. Today the challenge is handwritten as well as typed text.

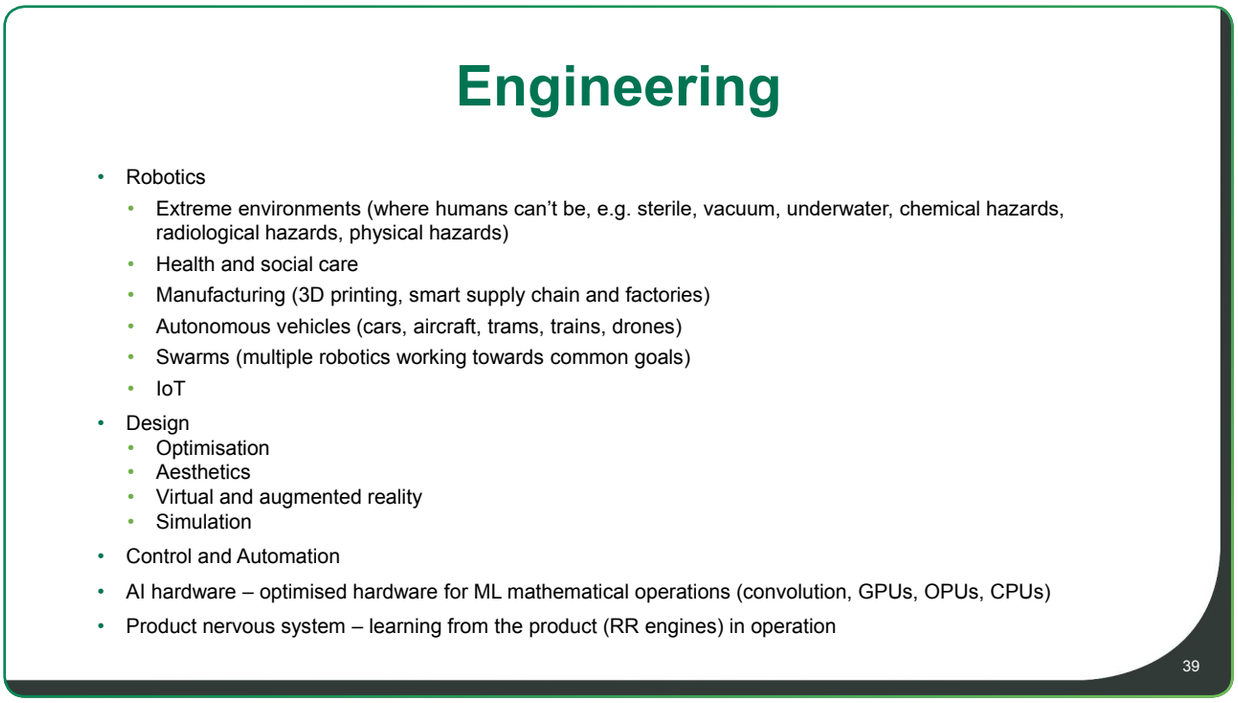
OCR: the fashion of today is the need of tomorrow!

Slide 38 – Research and development – R&D



This slide is full of examples of ML – ask the delegates if they have any experience with any of them and if so, could they describe it? R&D is first because it will fundamentally use the scientific method.

Slide 39 – Engineering



Engineering will be changed fundamentally by AI – products now will be expected to be intelligent entities (maybe connected to the IoT).

Every stage of an engineering project, product or service will be enhanced by AI.

Mention to the delegates that most engineering graduates will be familiar with ML and AI mathematics and computing, as will scientific and mathematical graduates.

Slide 40 – Health and social care

Health care stands to benefit enormously from AI and ML, medicine in particular is based on statistical methods and the scientific method.

Explore how our health and social care will be changed (possibly distrusted by) AI, examples are robotics, diagnosis, medical chatbots.

Don't watch the video it's too long. The video shows an example of someone who has been a fundamental user of technology.

Slide 41 – Entertainment

Entertainment already makes use of ML in particular.

Ask the delegates how it's used today (suggestion of content – Netflix Apple Music).

Content generation is also being enhanced with automated subtitling and captioning.

Animated movies and B&W movies made into colour are other good examples.

Game technology may become a major way of teaching ML systems where there is a lack of data – i.e. we simulate it.

Slide 42 – Sales and marketing

Sales and marketing

- Chatbots (FAQ, advice line sales assistants, helplines)*
- Analytics (identifying customers, opportunities, demand, supply)
- Preventing fraud
- Streamlining marketing, marketing suggestion…
- Product pricing
- Market-size prediction
- Website design
- Social media analytics
- Search engine optimization

*Alan Turing proposed a test where an observer is asked to determine if they are talking with a computer or a human based only on text-based questions: https://en.wikipedia.org/wiki/Turing_test

CHATBOTS allow humans to deal with ambiguous problems that require judgement!

42

It's important to mention that Alan Turing's test started the concept of a chatbot! In sales and marketing, we must emphasise the potential for unethical use of ML and AI.

Ask the delegates where this might happen.

Slide 43 – Logistics – planning and organisation

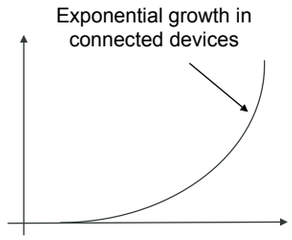
Some of the earliest and most successful applications of ML are logistics and organisation. This work started just after the Second World War and was called Operational Research. This is taught to business, engineering and mathematics graduates.

Ask the delegates if they think Agile Projects are a good idea for ML and AI projects.

Slide 44 – ML enabler – internet of things – BIG DATA

ML enabler – internet of things – BIG DATA

The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data.



The estimated number of devices connected including mobile phones and tablets is 15-20 billion. Estimates vary – we will generate lots of data.

BIG DATA is often described as having high velocity, high volume and a wide variety.

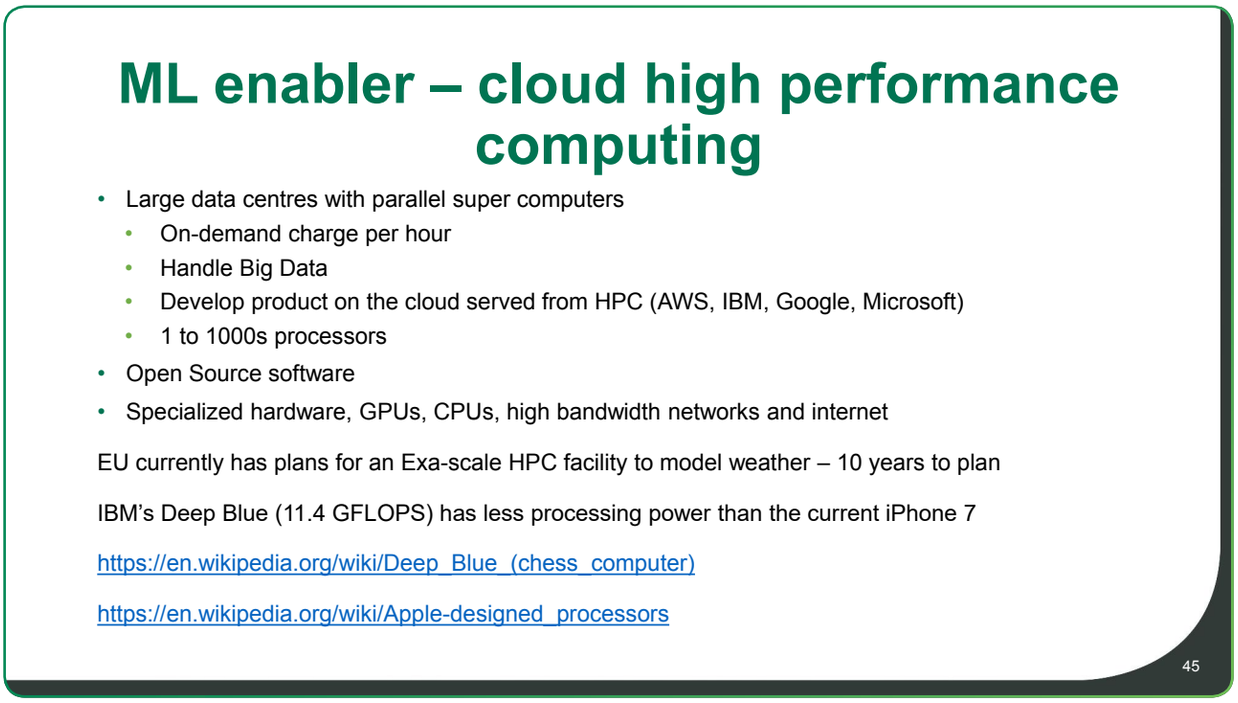
https://en.wikipedia.org/wiki/Internet_of_things

44

The Internet of Things has a huge potential to help everyone. It is an example of a key enabler of ML.

Make sure to highlight the definition of Big Data.

Slide 45 – ML enabler – cloud high performance computing



Cloud High Performance Computing is cheap and easily available. AI and ML often need significant computing power. Often Cloud HPC has the best hardware and open source software for a very competitive price.

Slide 46 – ML classification examples – boosting & clustering

ML classification examples – boosting and clustering

Boosting is a Machine Learning approach that turns weak learners (slightly better than random guessing) into a strong learner (well correlated with the true classification).

'Take lots of educated guesses and make a good learner!' – Or a group of experts make better decisions than a single expert!

Clustering is a Machine Learning technique that groups objects into clusters based on similarities. Exploratory data mining is a good example, a quick look at the data.

Random Decision Forests – Uses an ensemble (multitude, orchestra) of decision trees to improve their performance.

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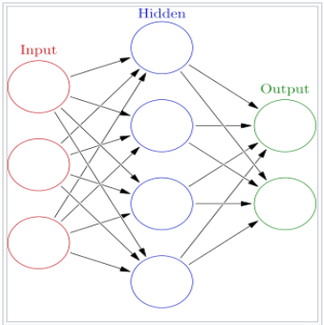
This slide moves away from enablers to some examples of ML that delegates will come across in the reading list and as tutorials online.

Take one of the types and explore in a little more detail.

Slide 47 – ML enabler – Deep Learning artificial neural networks

ML enabler – Deep Learning artificial neural networks

- Based on a mathematical representation of the human brain
- Deep Learning is a step change in ML capability
- Neural Networks have made significant progress in recent years
- **Require training and are black boxes – it is difficult to explain the results**
- Very promising results in Bioinformatics, Speech Recognition, Image Processing, Natural Language Processing
- Typically needs lots of computer resources
- IT LEARNS FROM STRUCTURED AND UN-STRUCTURED DATA



An artificial neural network is an interconnected group of nodes, similar to the vast network of neurons in a brain. Here, each circular node represents an artificial neuron and an arrow represents a connection from the output of one artificial neuron to the input of another.

https://en.wikipedia.org/wiki/Artificial_neural_network

47

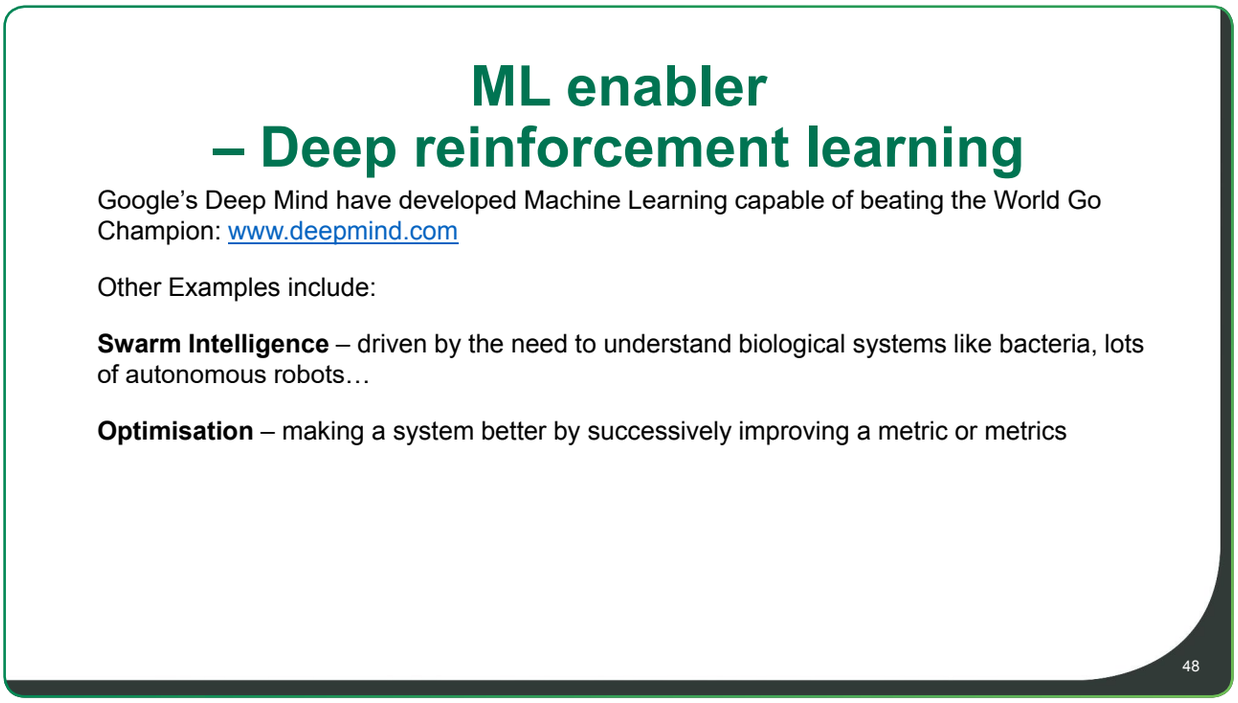
Deep Learning has driven a large number of new application areas of ML. Give a few examples.

Highlight that they are black boxes and difficult to explain or understand if they do not perform as expected.

Emphasise that neural networks learn from structured and unstructured data.

Give a brief overview of how an NN works. It's not essential to know the intricate nature of them.

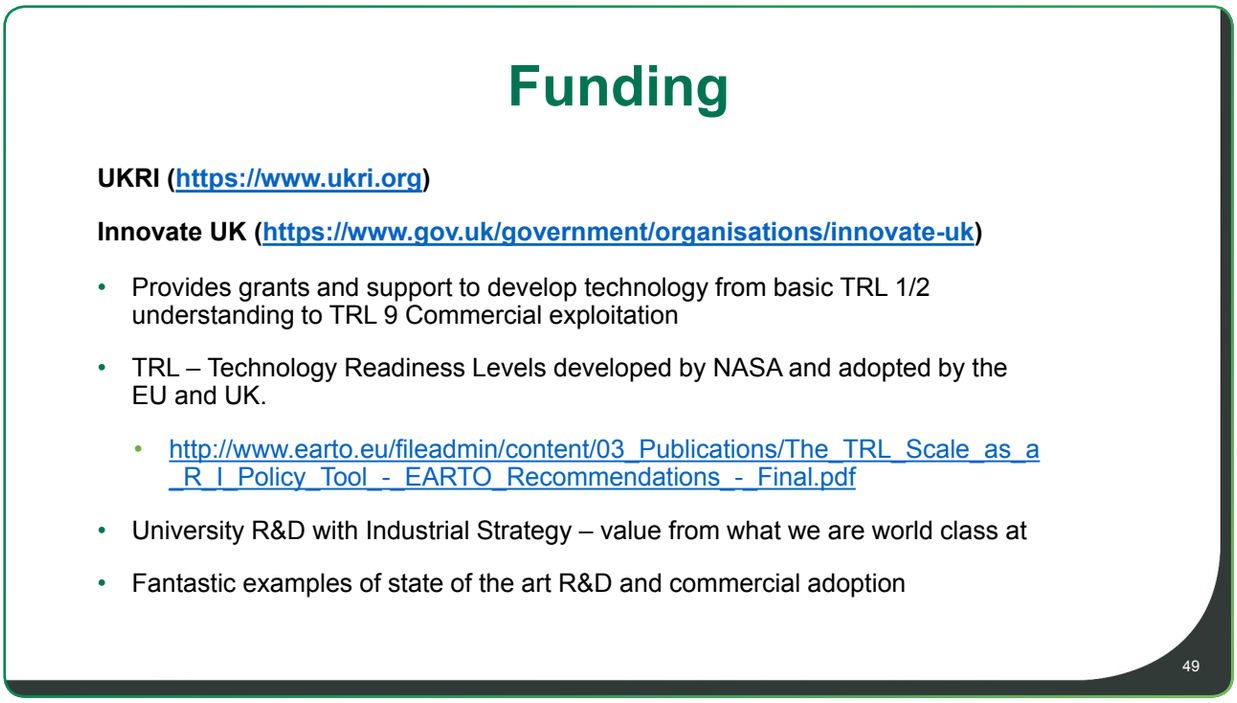
Slide 48 – ML enabler – Deep reinforcement learning



Explain what deep reinforcement learning is and how it is enabling ML to achieve better than human performance in many areas. Alpha Go is the usual example.

Mention that the algorithm learned from many simulated games in a real game proposed a move that the masters thought naive until it turned out to be the deciding move that won the game.

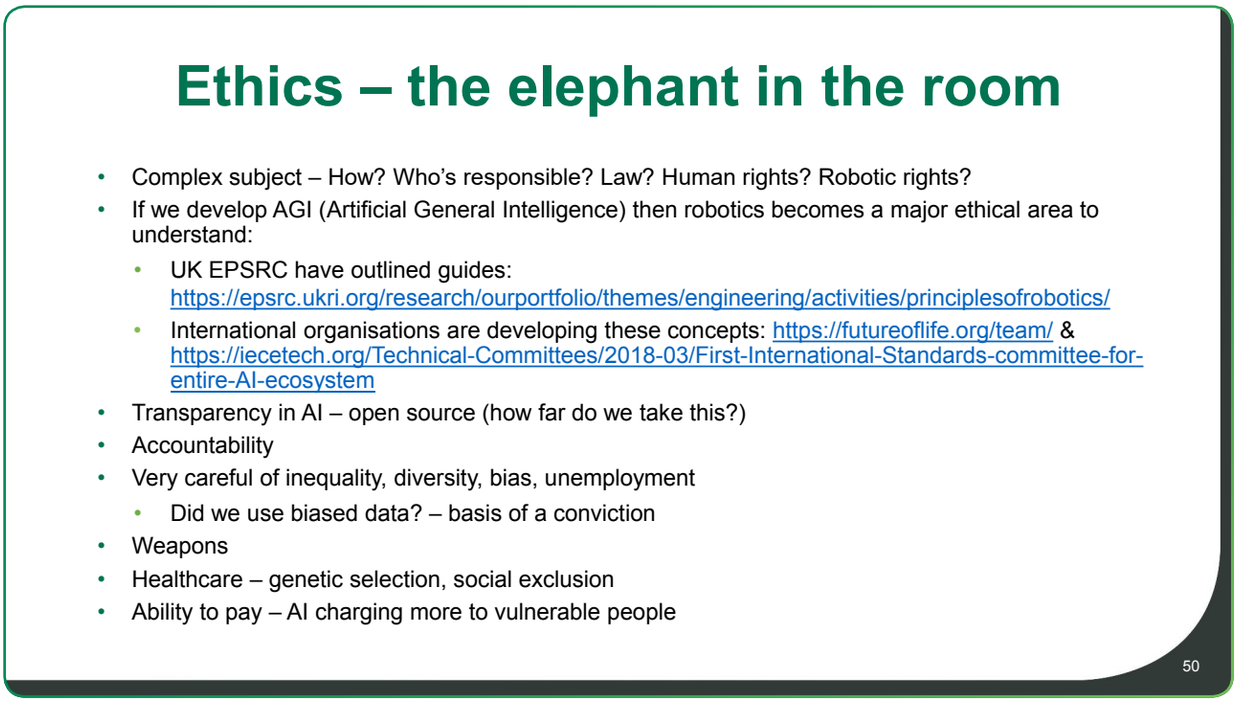
Slide 49 – Funding



There are many sources of funding. The UK has set up UKRI and Innovate UK. Highlight the TRL levels and how investment in the levels 2-8 is very rewarding for the government.

Find other sources of funding and explain those also. This is especially important if delegates are UK-based.

Slide 50 – Ethics – the elephant in the room

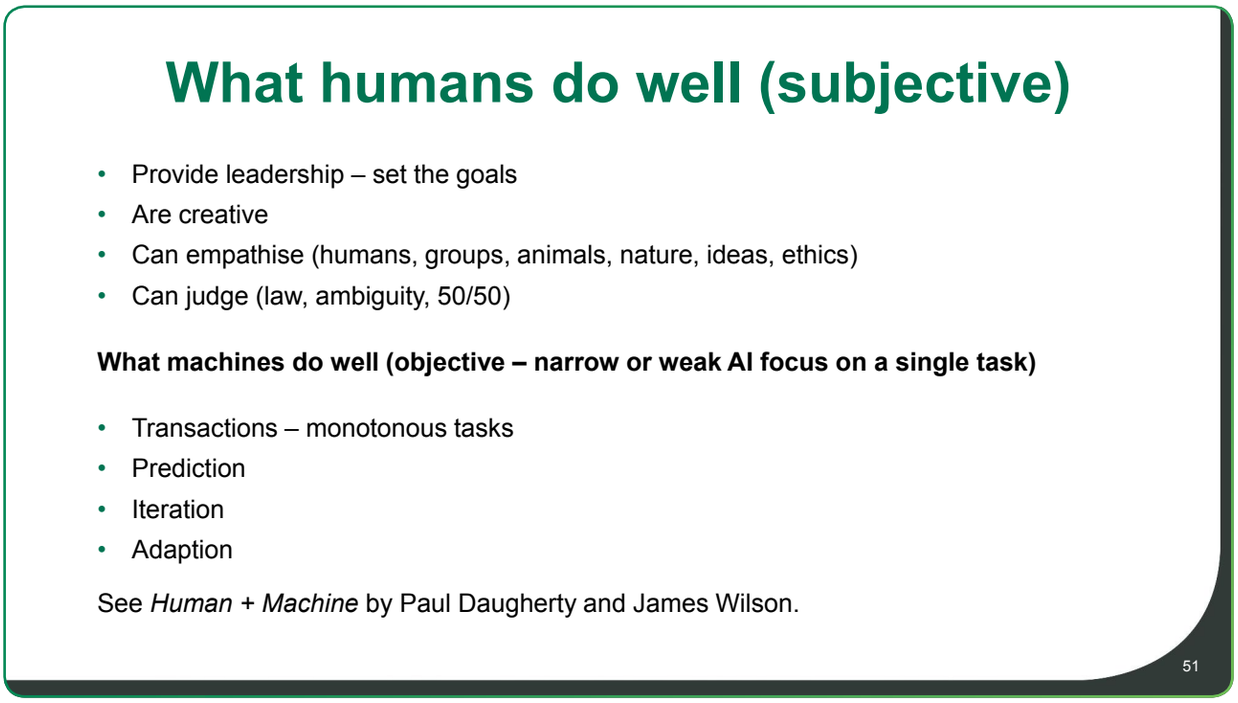


Up to now we have ignored ethics, but the EU has now made Ethical Purpose and Robust AI a core part of its guidelines for Trustworthy AI.

Ask the delegates to give examples of where ethics is important. Later in the day we will explore universal design and in the Fundamentals course we will look at Ethical purpose and Sustainability.

Find an example of where biased data has caused silly or harmful results.

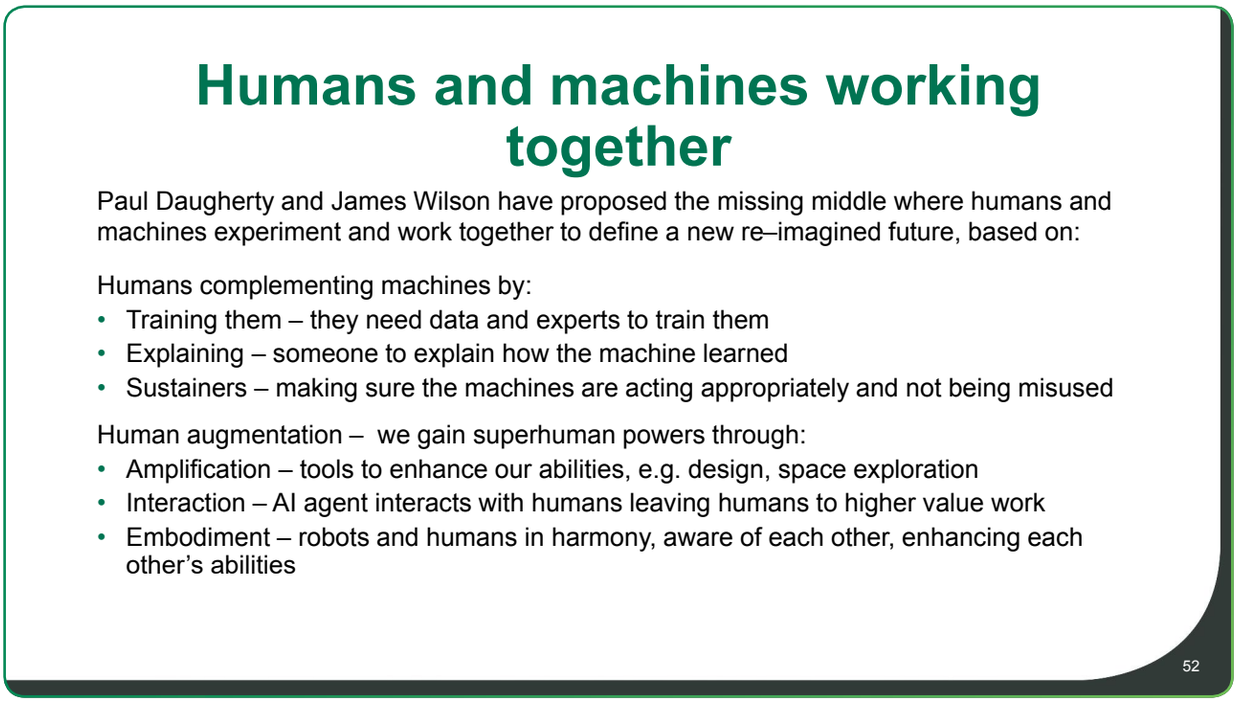
Slide 51 – What humans do well (subjective)



This slide is a taster for the last session, Human Plus Machine.

Emphasise the areas where humans are better than machines and where machines are better than humans.

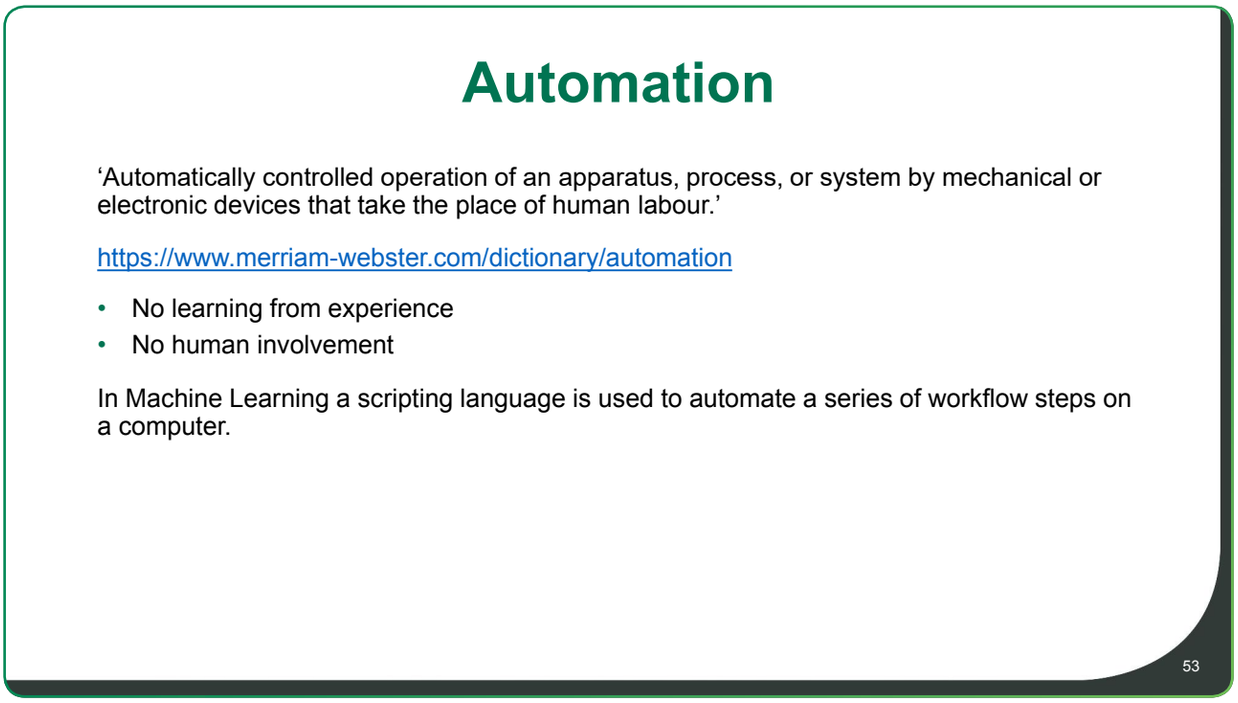
Slide 52 – Humans and machines working together



This slide shows where machines and humans will complement each other.

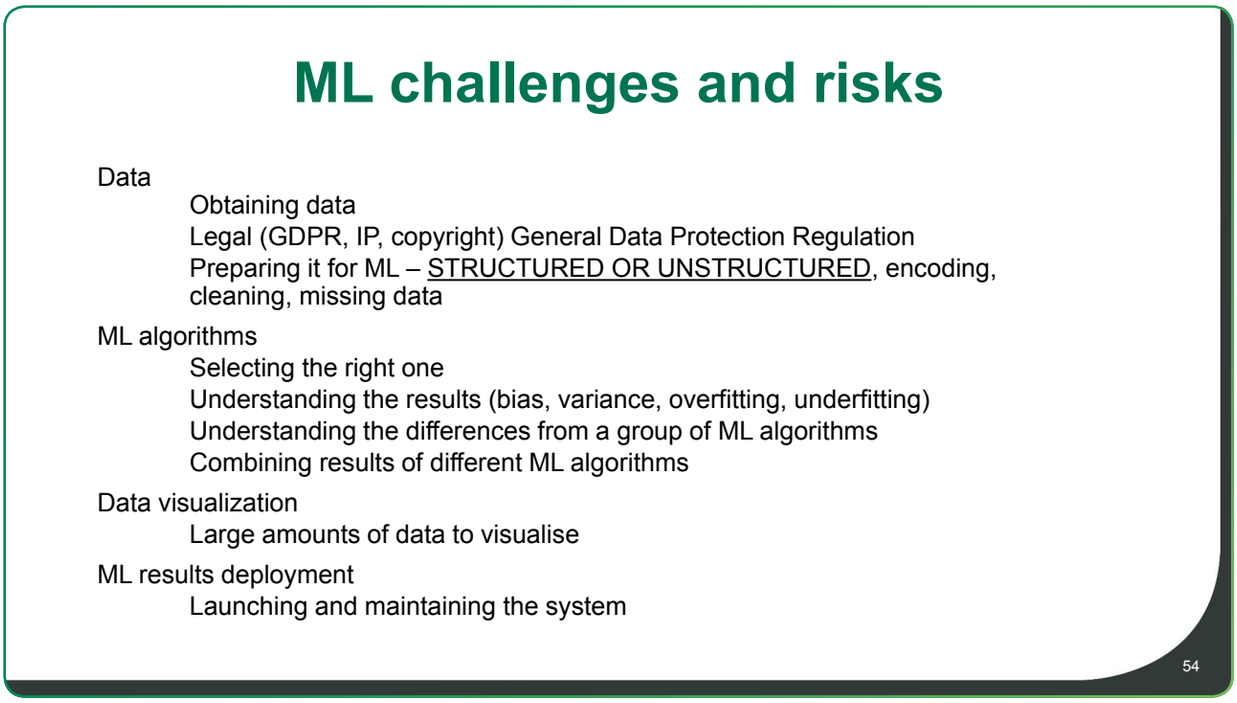
Ask the delegates if they can give other examples. If there's time, try to explore one of the examples.

Slide 53 – Automation



This slide defines automation. It's important to emphasise that this definition has no learning from experience and has no human involvement. It's an unintelligent implementation of machines.

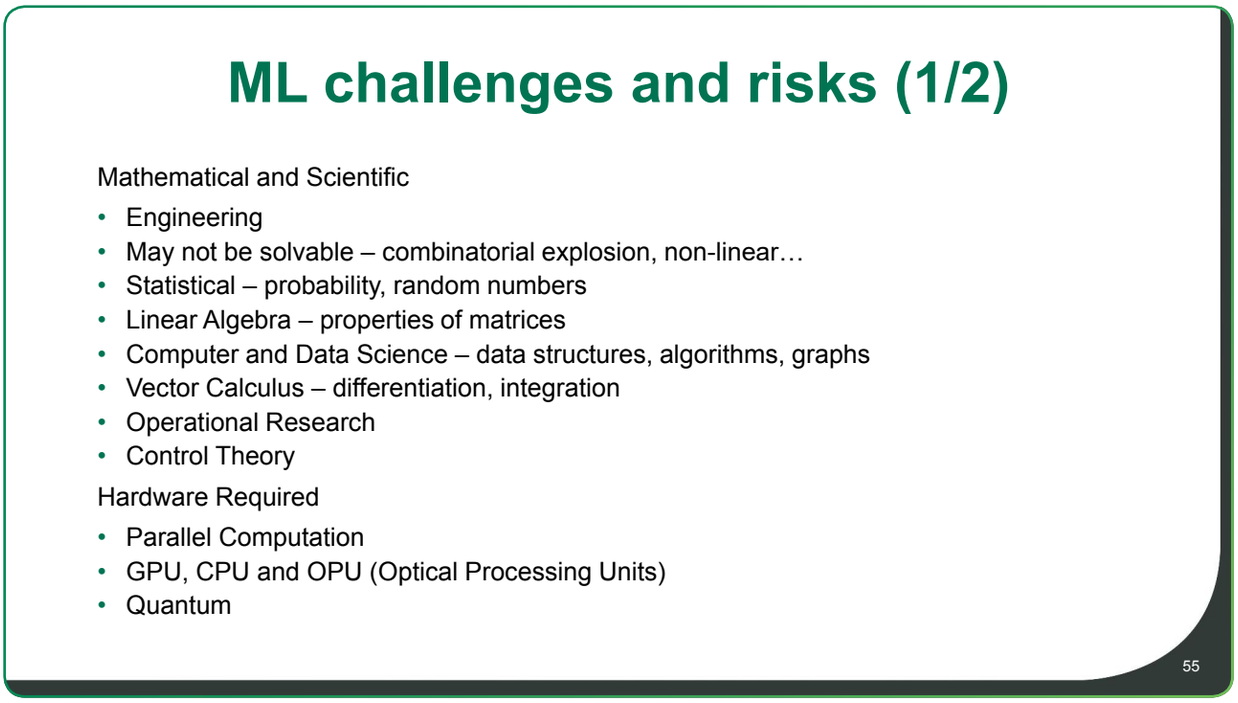
Slide 54 – ML challenges and risks



This slide is not an exhaustive list of challenges and risks from ML – our objective here is to get the delegates thinking critically about what is challenging and a possible risk to an ML project.

Explain over or underfitting and that we will go over it in more detail in one of the later sessions.

Slide 55 – ML challenges and risks (1/2)

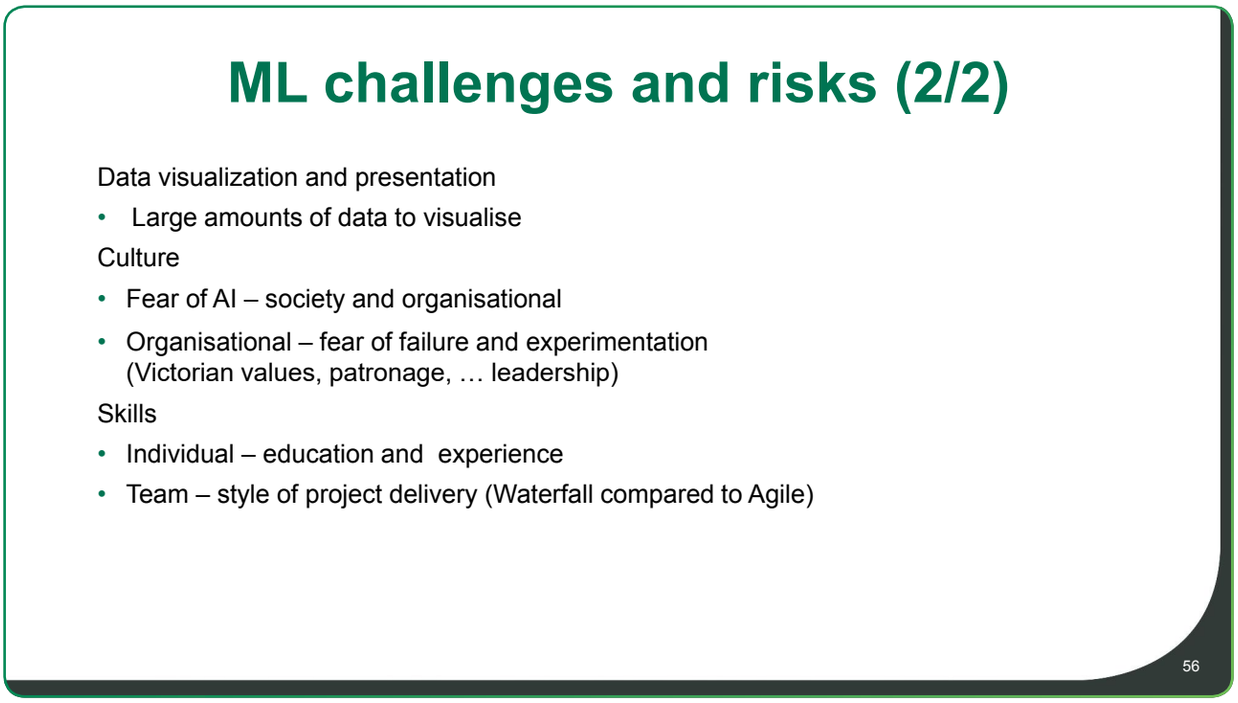


Here we identify some of the challenges and risks that we encounter. The top ones are the subject matter skills and possible challenges. Pick one and go through it in more detail.

A good example is one where a mathematical problem may not be solvable or that we simply do not have the computing power to solve it. Or we may not have the skills to solve it.

Data visualisation is another, e.g. how do we visualise and debug data spread across 1000s of processors?

Slide 56 – ML challenges and risks (2/2)

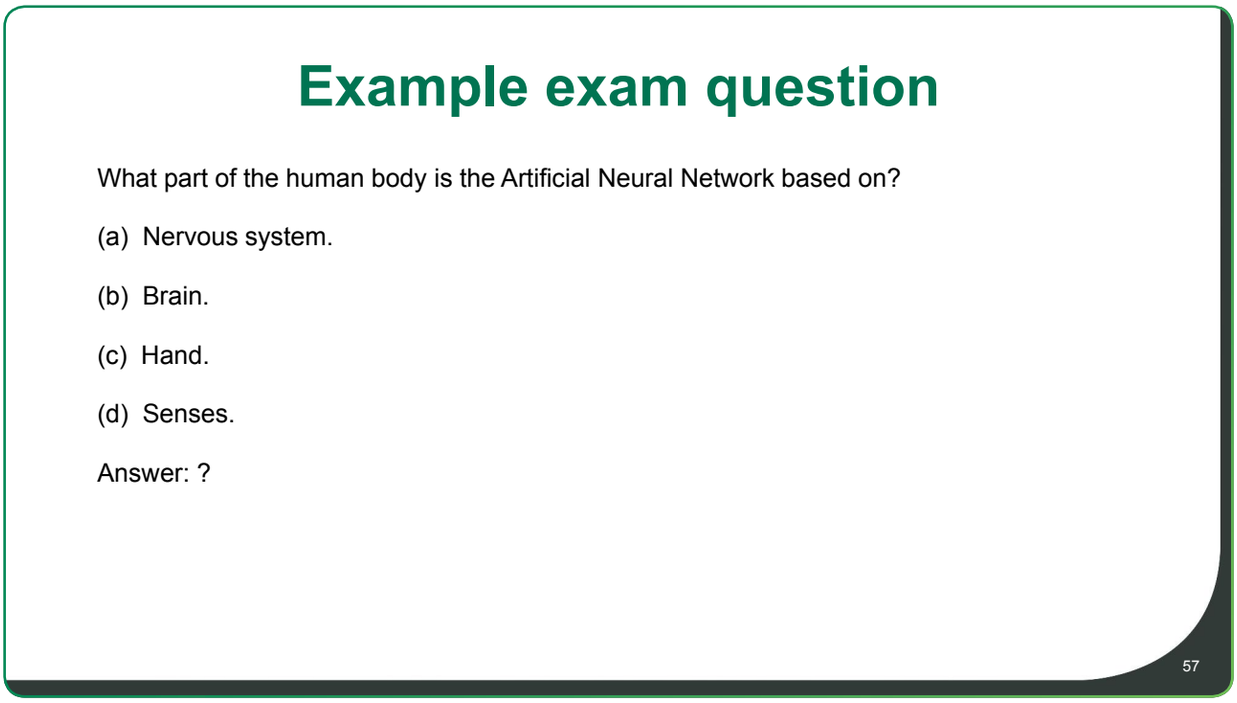


Probably the hardest problem of all is a person's or group's reaction to the use of AI. Examples could be the culture is 'old fashioned' and based on blame . . .

Admitting that someone doesn't know and needs learning from experience machines to help them. An individual may feel challenged by a machine learning approach.

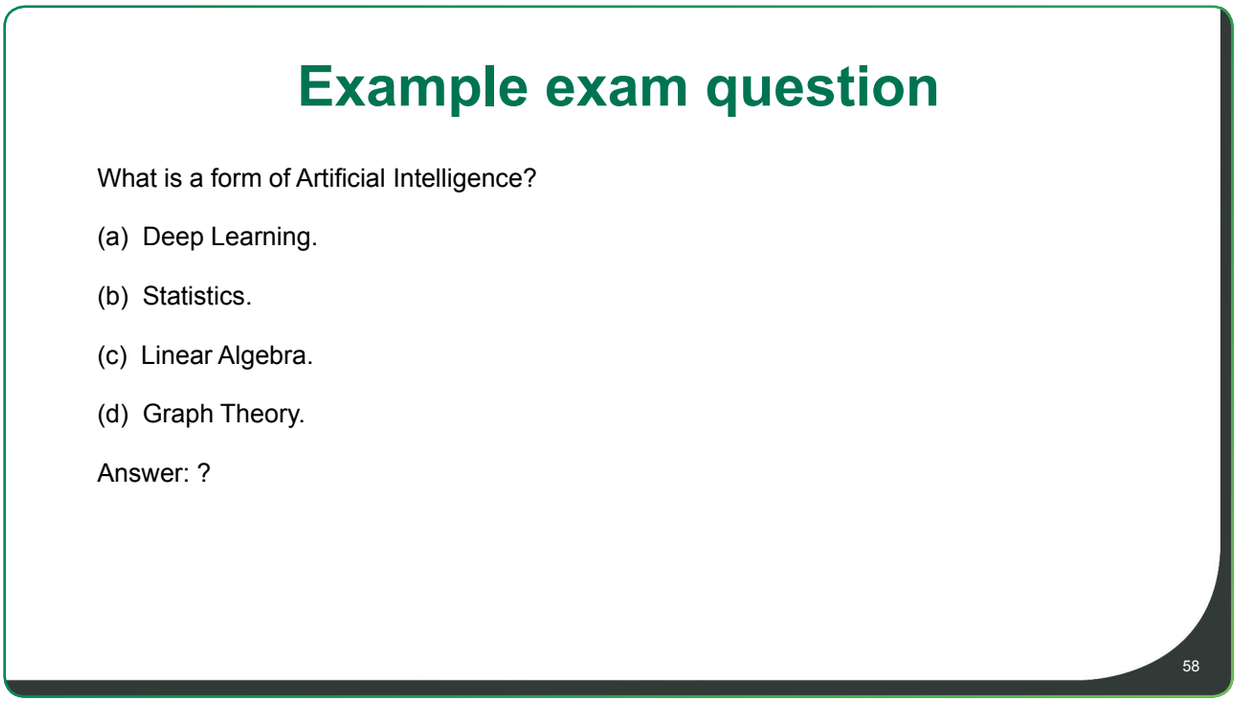
A no blame agile approach may make others feel uncomfortable if they have come from a right first time culture.

Slide 57 – Example exam question



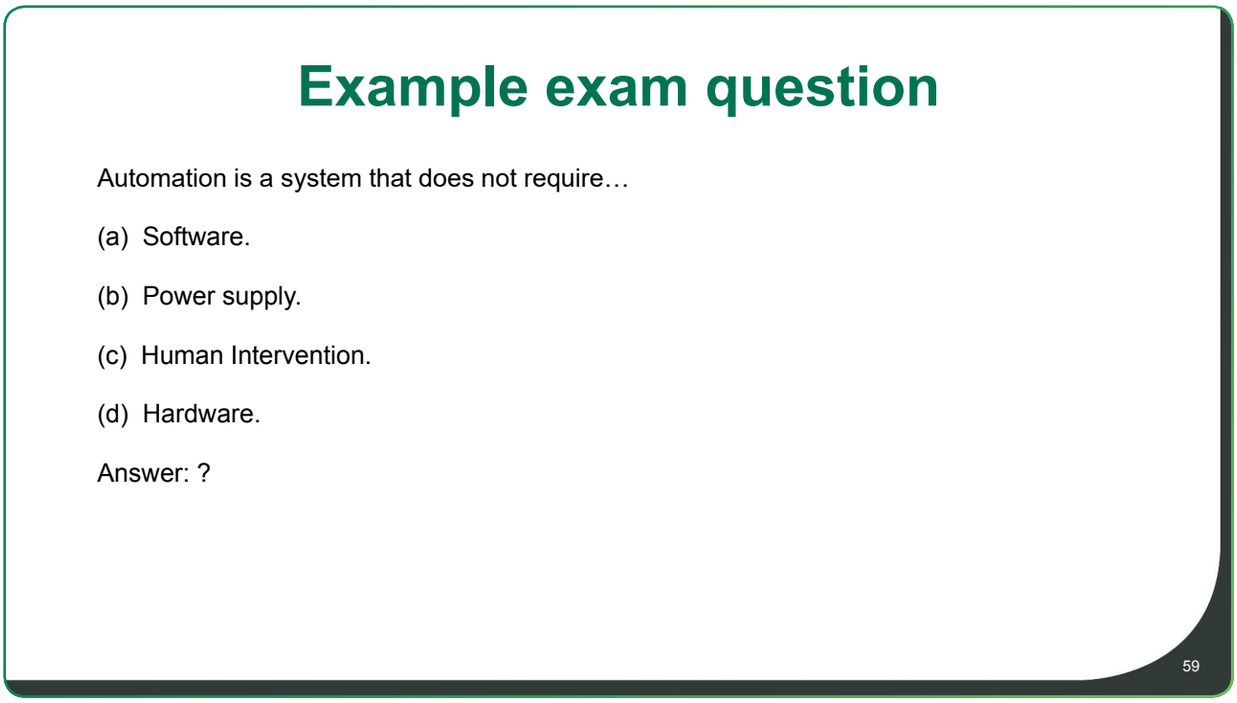
The answer is (b). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 58 – Example exam question



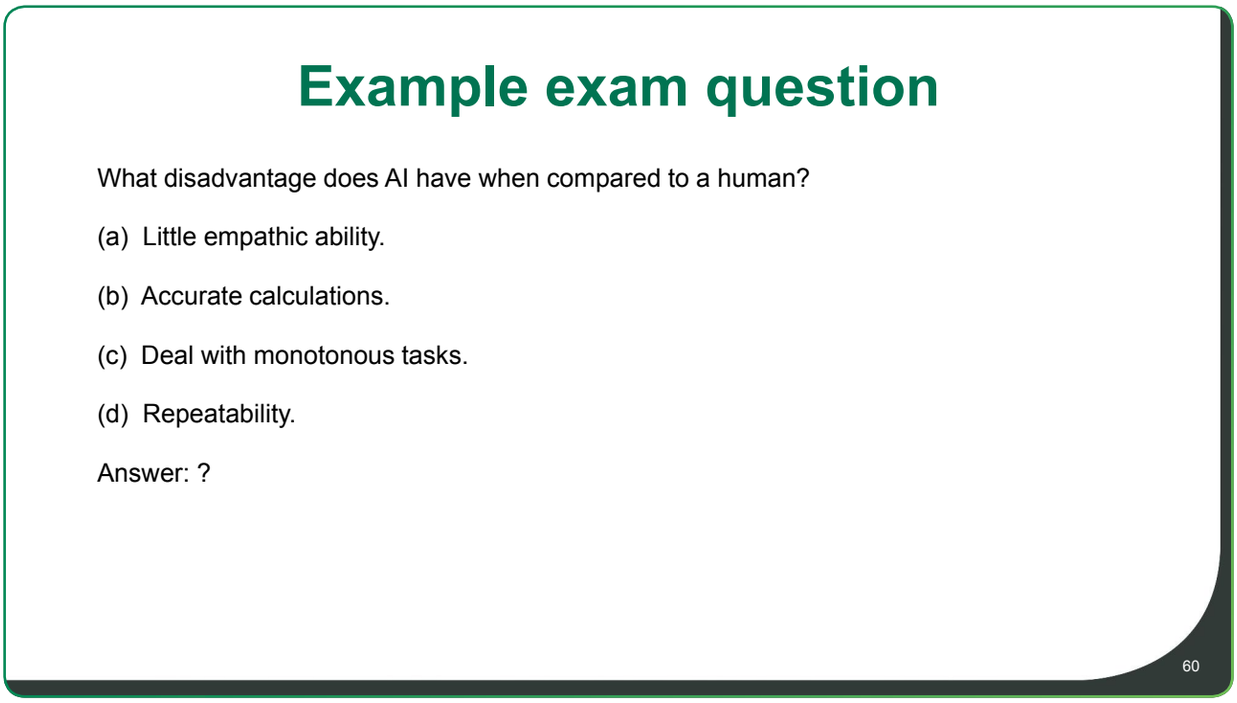
The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 59 – Example exam question



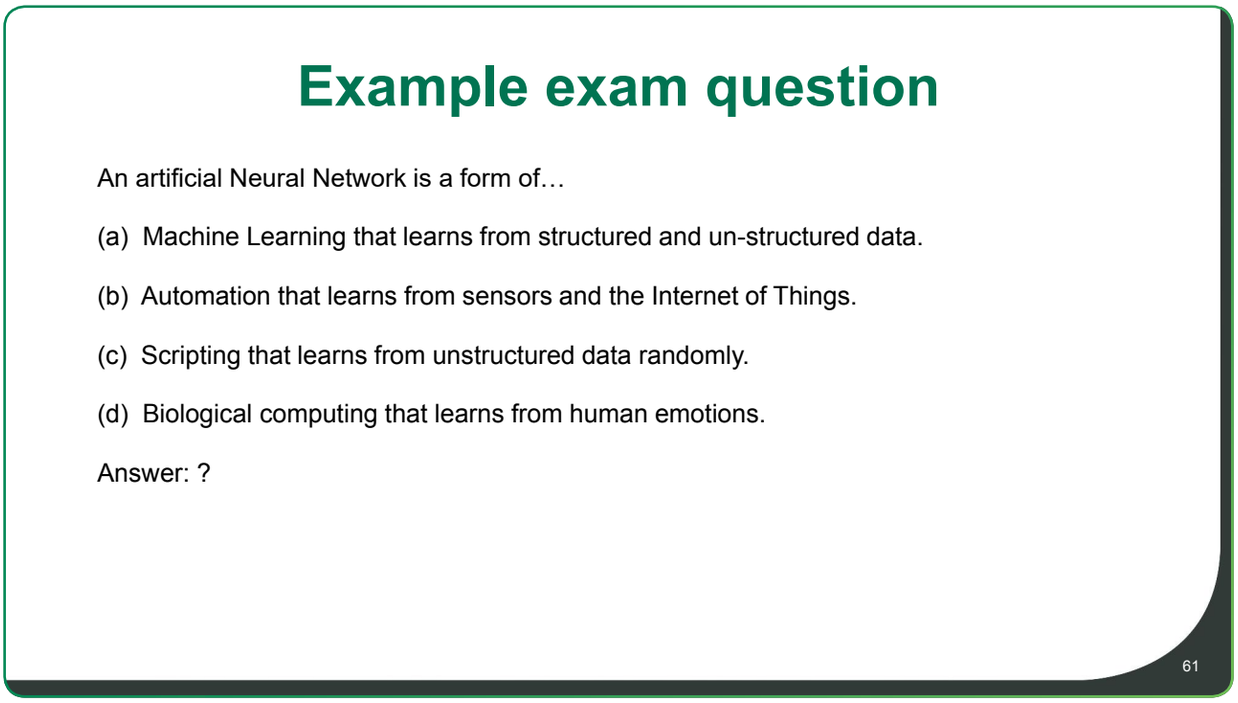
The answer is (c). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 60 – Example exam question



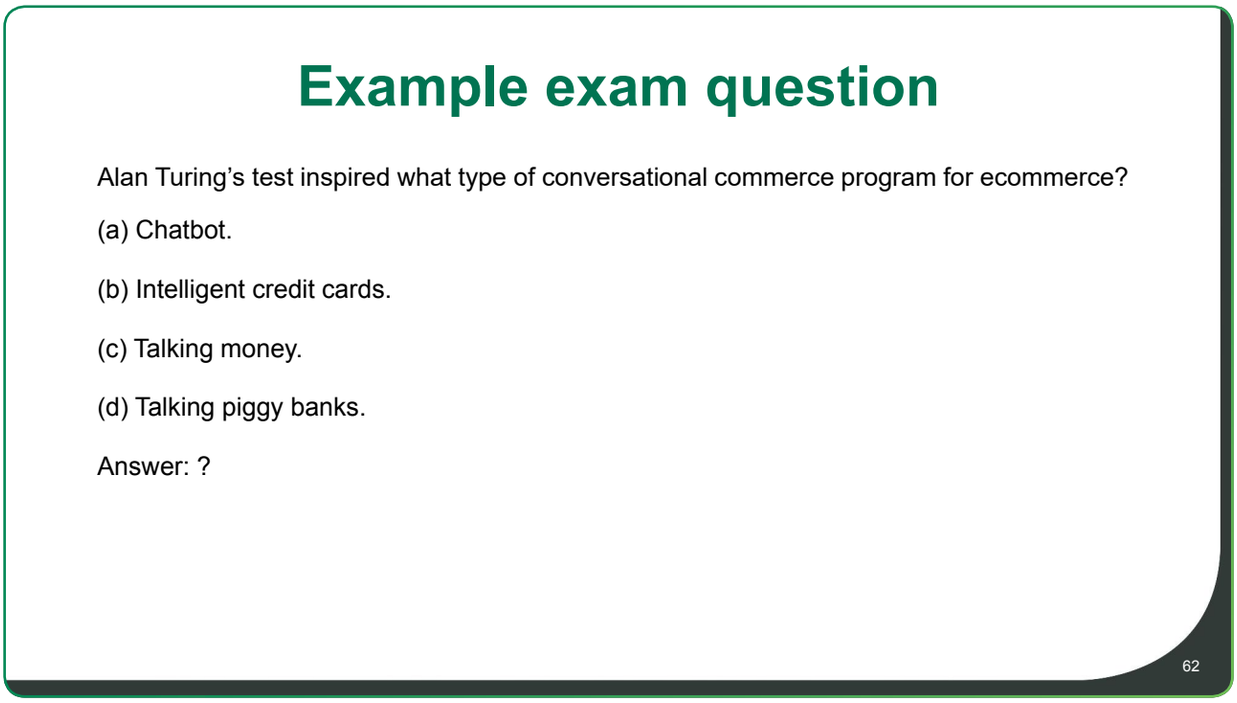
The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 61 – Example exam question



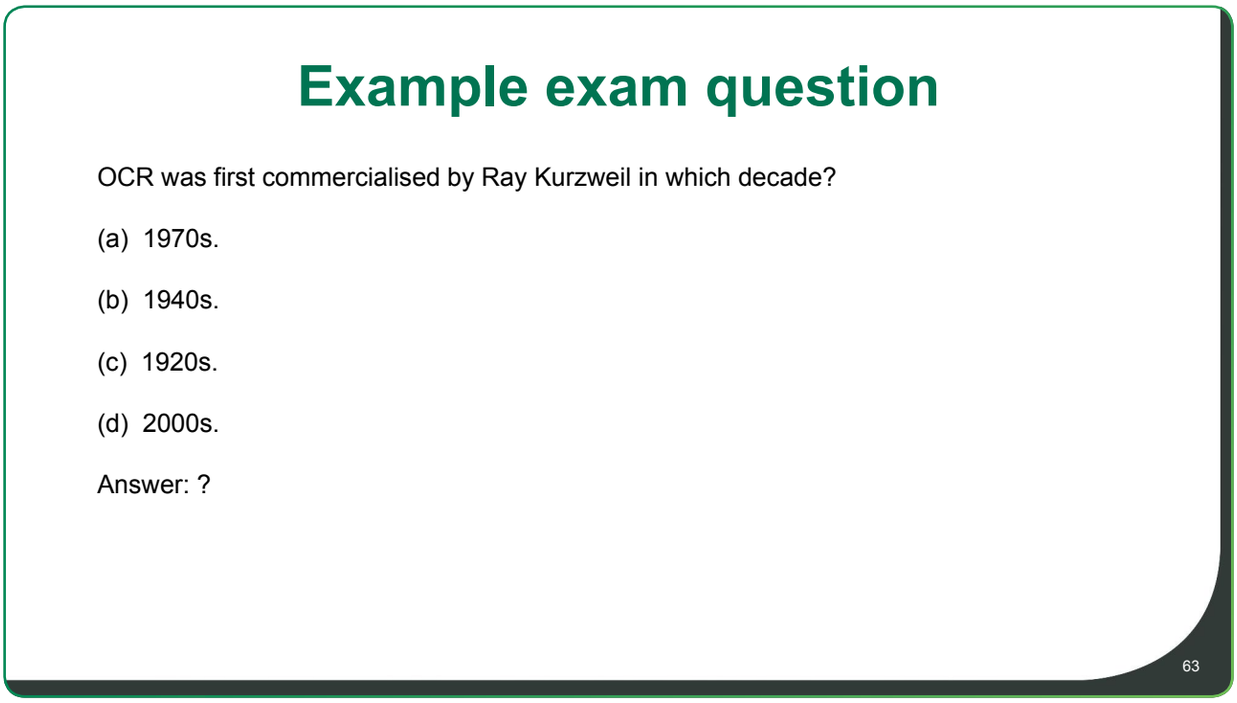
The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 62 – Example exam question



The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

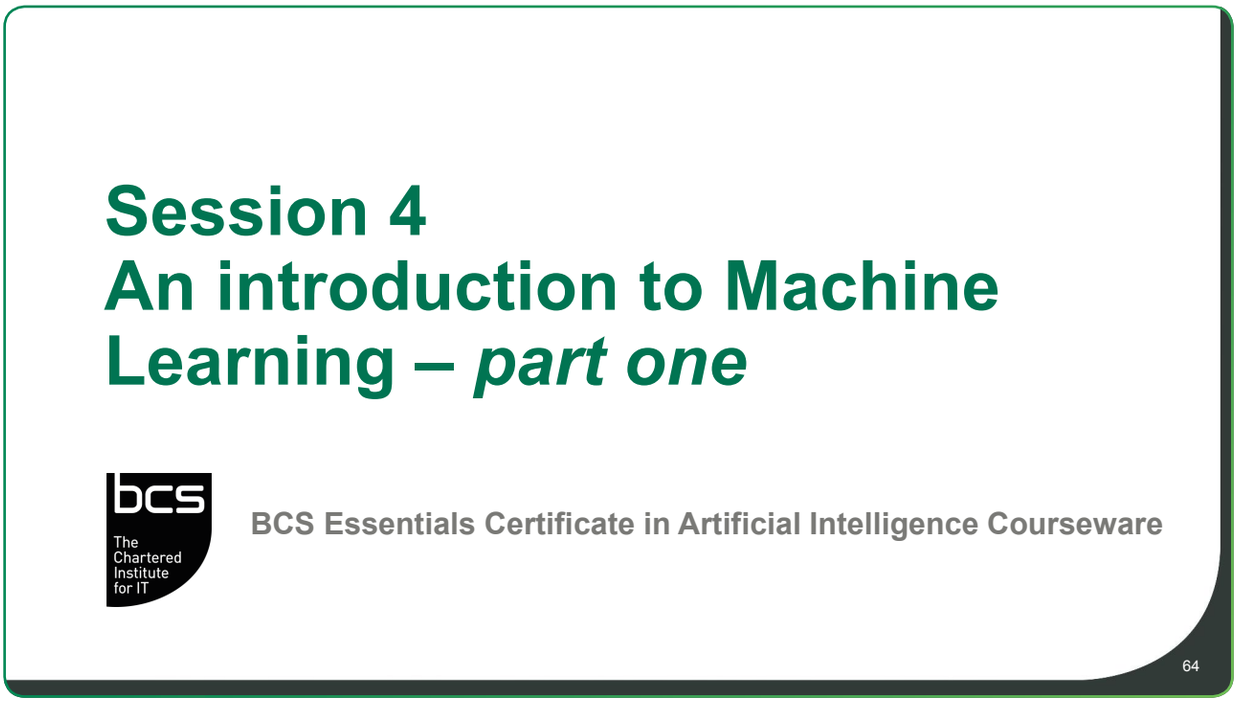
Slide 63 – Example exam question



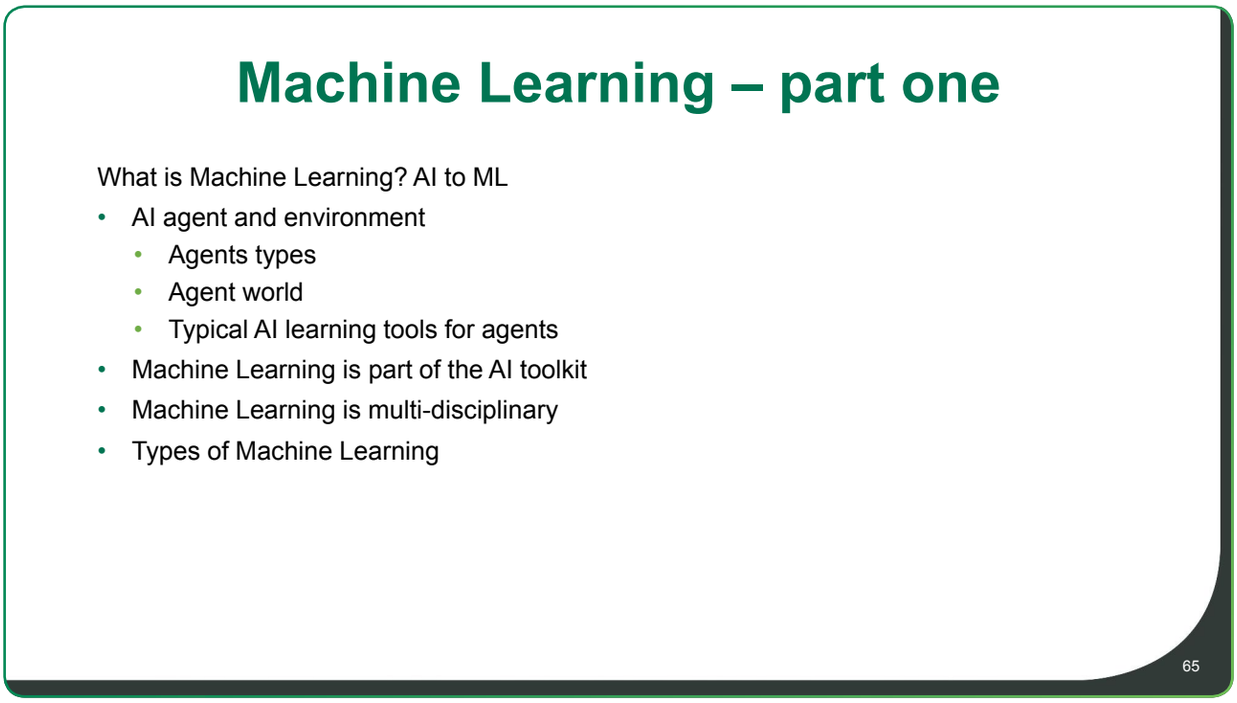
The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Session 4
An introduction to Machine Learning – *part one*

Slide 64 – Title slide



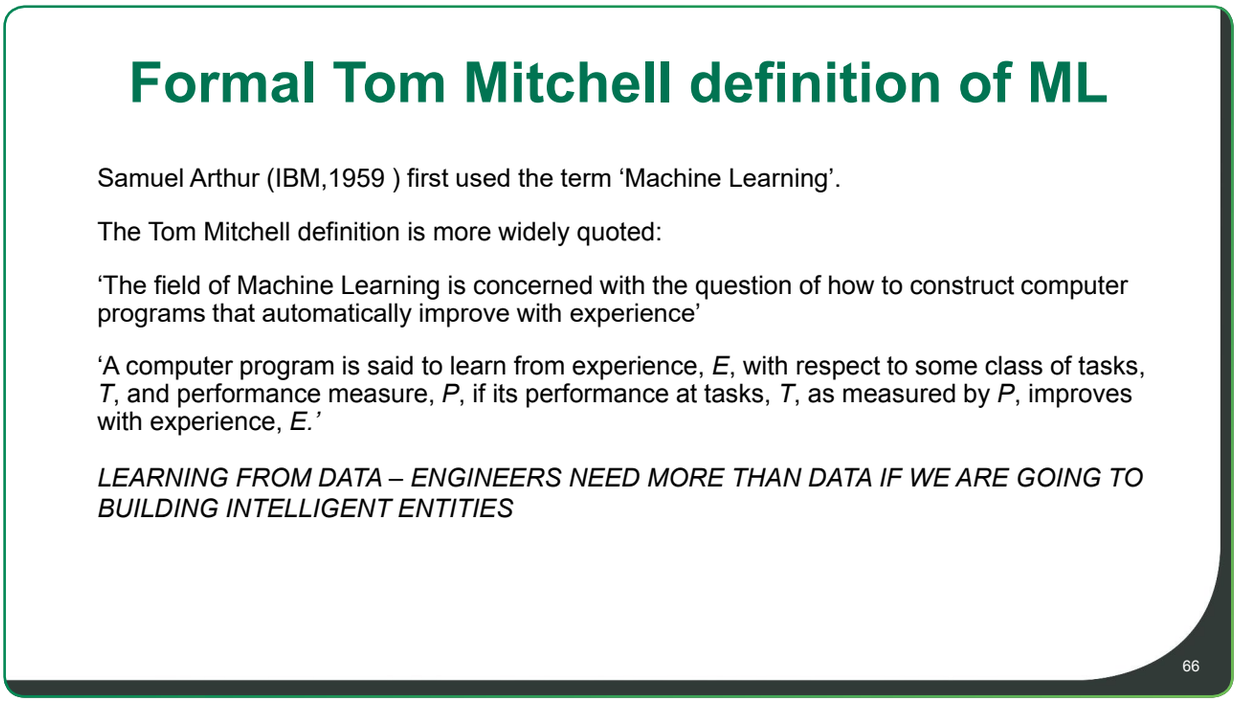
Slide 65 – Machine Learning - part one



This slide outlines what is covered in this session.

As you are going through, make sure to emphasise that we will show how the general learning from experience learning agent links to Machine Learning. Here we want to show that creating intelligent entities needs more than Machine Learning.

Slide 66 – Formal Tom Mitchell definition of ML

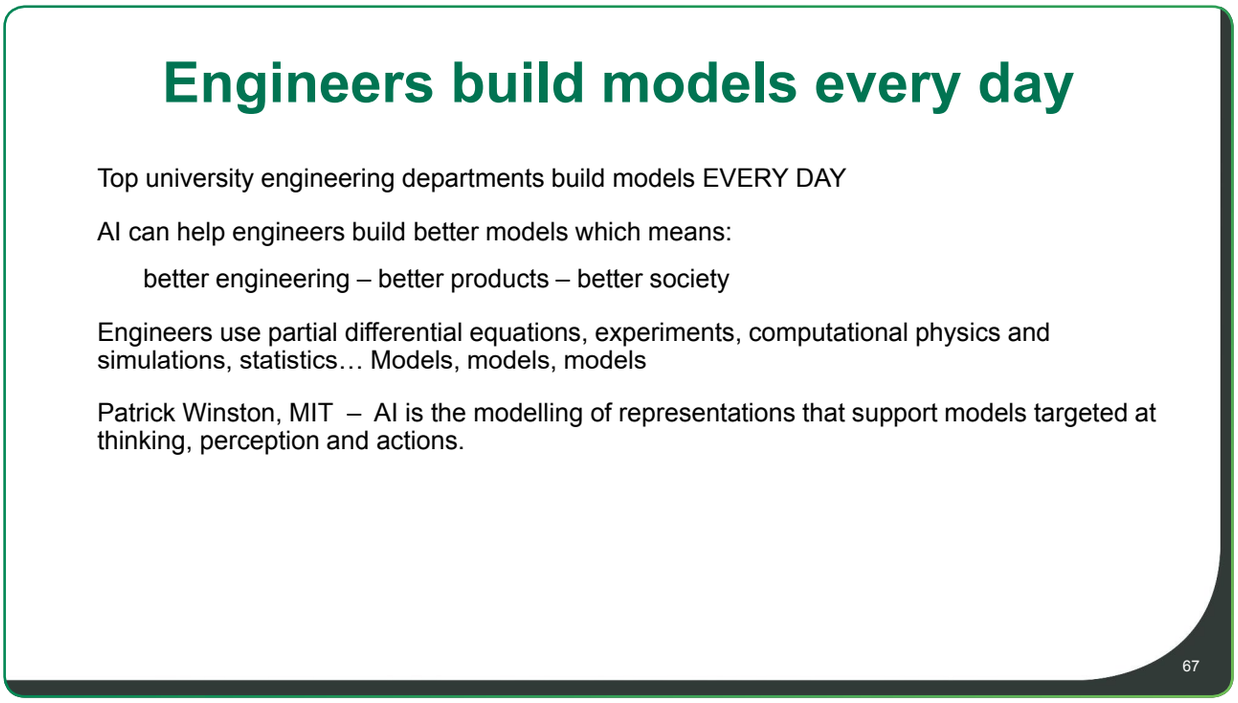


This is the widely accepted definition of machine learning by Tom Mitchell.

Explain both the general one that is quoted and the formal definition with each of the variables.

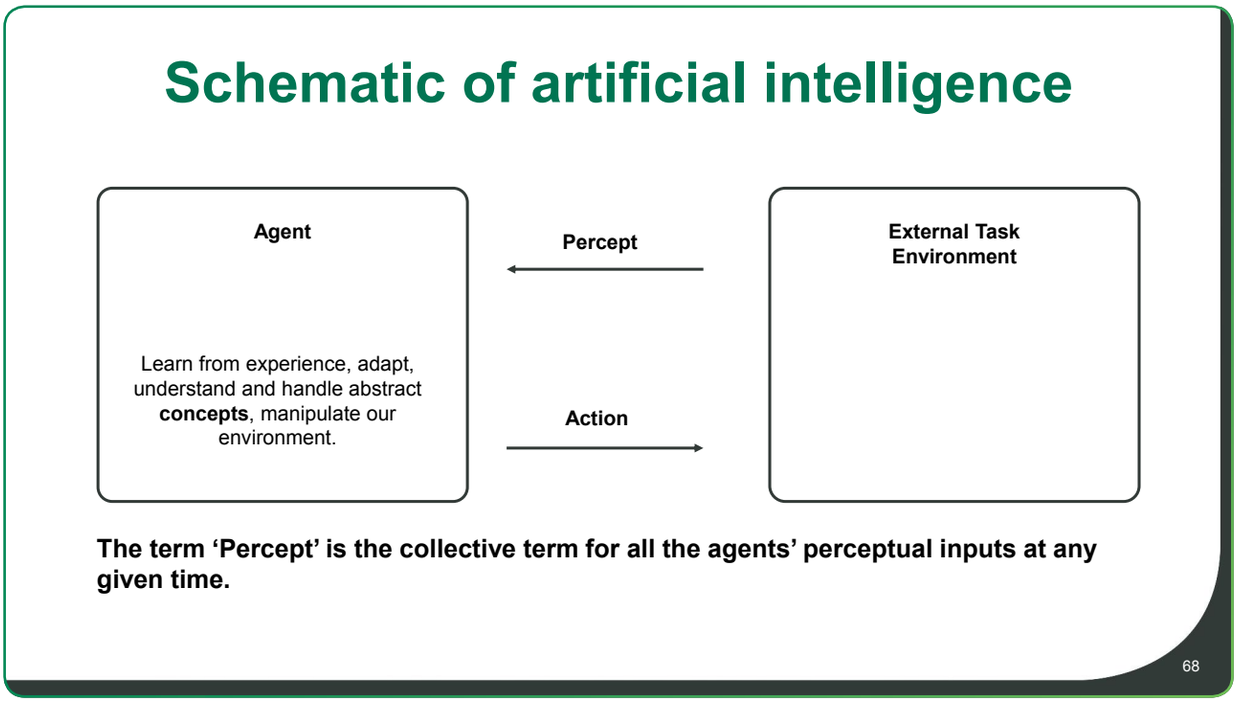
Remind them that engineers need more than data if we are going to build products!

Slide 67 – Engineers build models every day



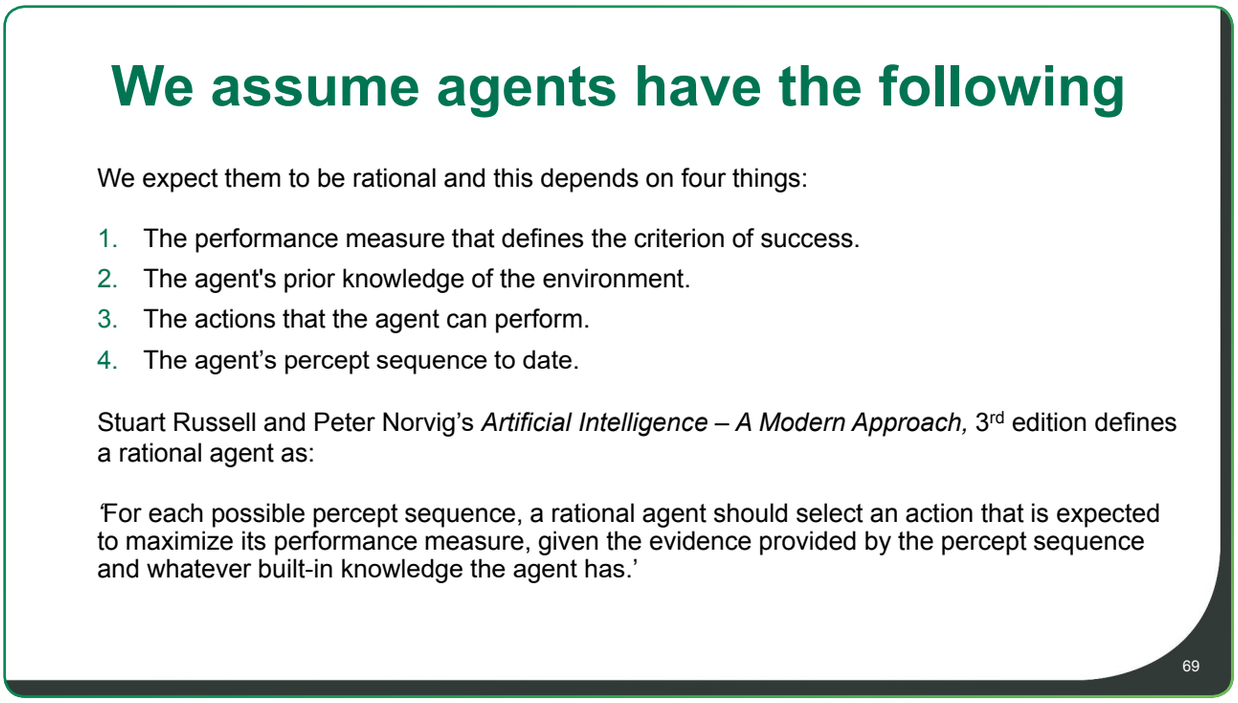
This slides shows how engineers are adopting AI to build intelligent entities. We want to emphasise that engineers (and scientists) use models to build products, experiments and services.

Slide 68 – Schematic of artificial intelligence



Describe the key components of the Schematic of Artificial Intelligence. Also make the link between the Britannica definition of human intelligence and this schematic.

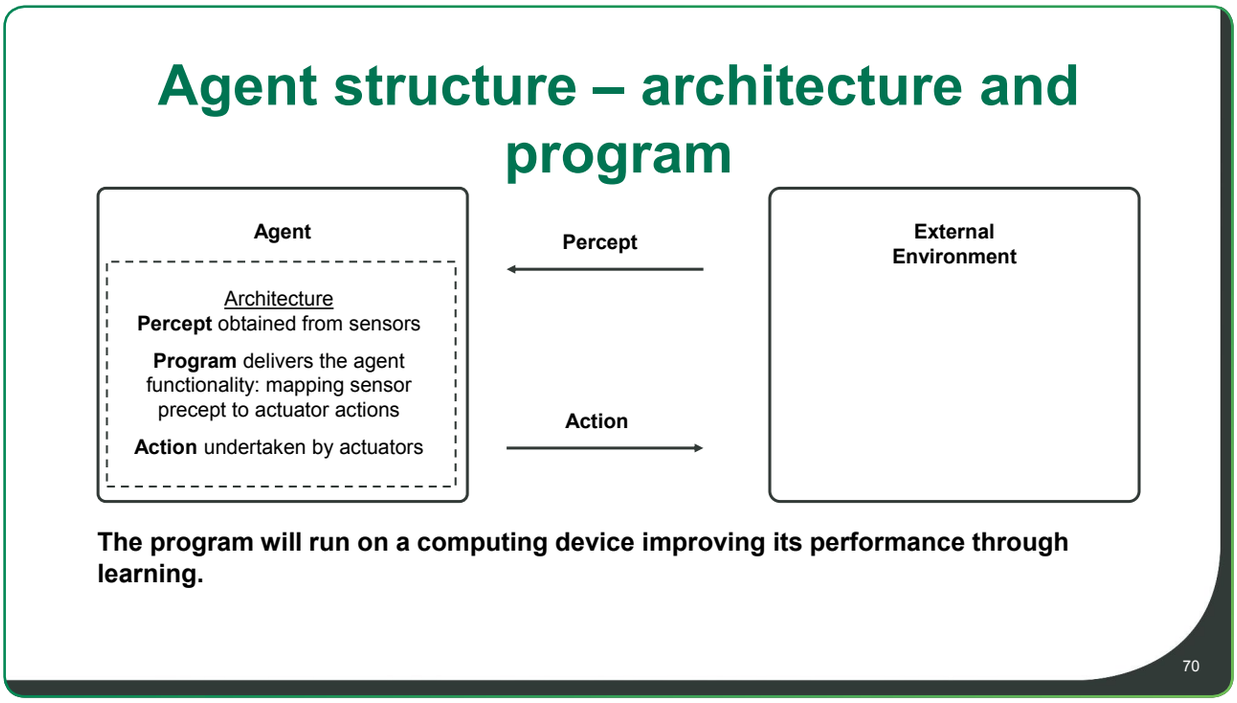
Slide 69 – We assume agents have the following



This slide describes our learning agent as rational; this is made up of four things.

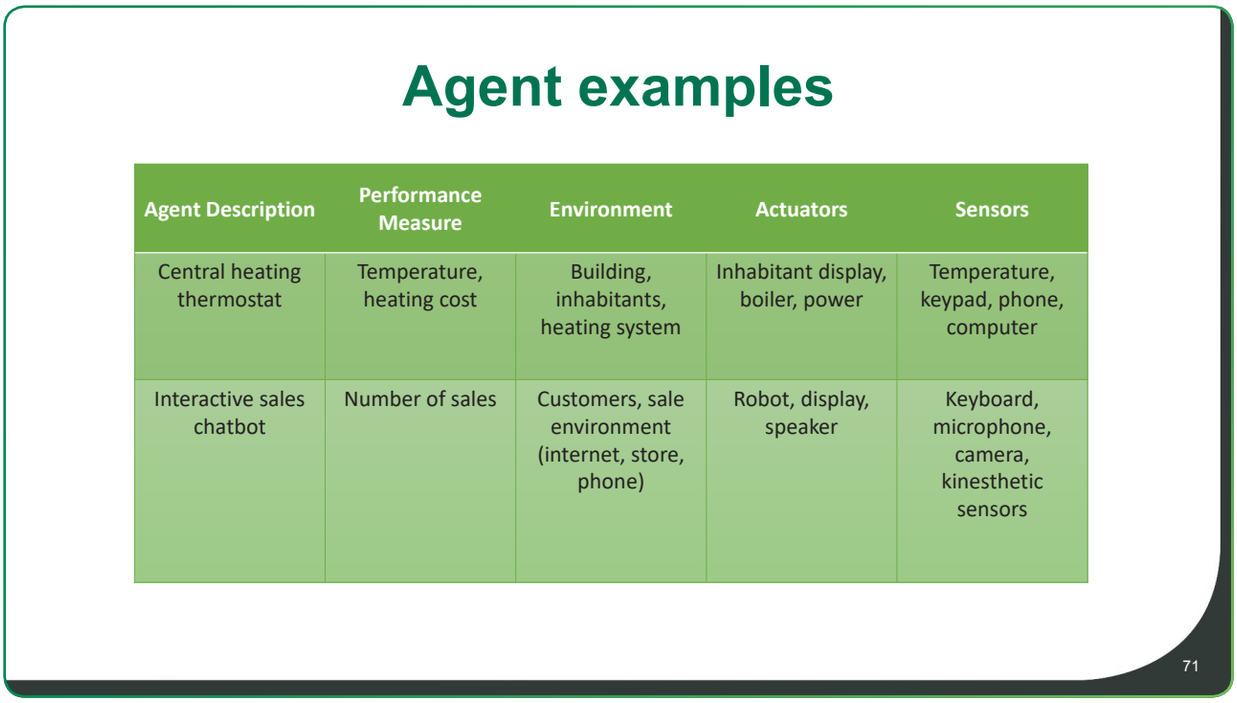
Go through the Russel and Norvig explanation of a rational agent and ask delegates if they have examples of where they could apply this (simulations of traffic or aircraft perhaps).

Slide 70 – Agent structure – architecture and program



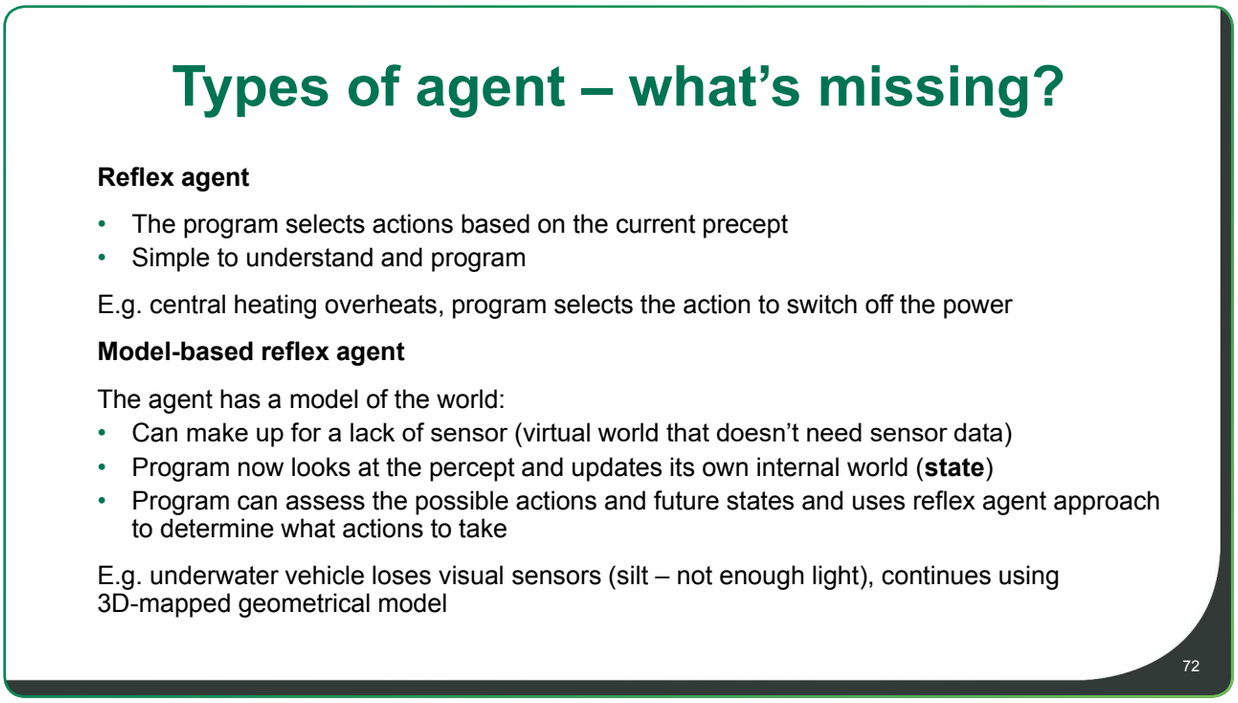
These slides explain the main terms that let the learning agent manipulate its environment and understand its environment and map its percept of the environment to actions on the environment.

Slide 71 – Agent examples



Go through each of these examples and ask for examples from the delegates.

Slide 72 – Types of agent – what's missing?



The next two slides go through four types of agent.

Describe each and ask what is missing in each of the agent descriptions.

Slide 73 – Types of agent – what's missing?

Types of agent – what's missing?

Goal-based agent

- The program needs more than just sensors and an internal world to implement the agent's functionality – it needs a goal
- These programs are more versatile and flexible – can adapt to changes

E.g. autonomous vehicle can chose one of five exits from a motorway – the goal: safest, quickest, most scenic, cheapest, shortest

Utility-based reflex agent

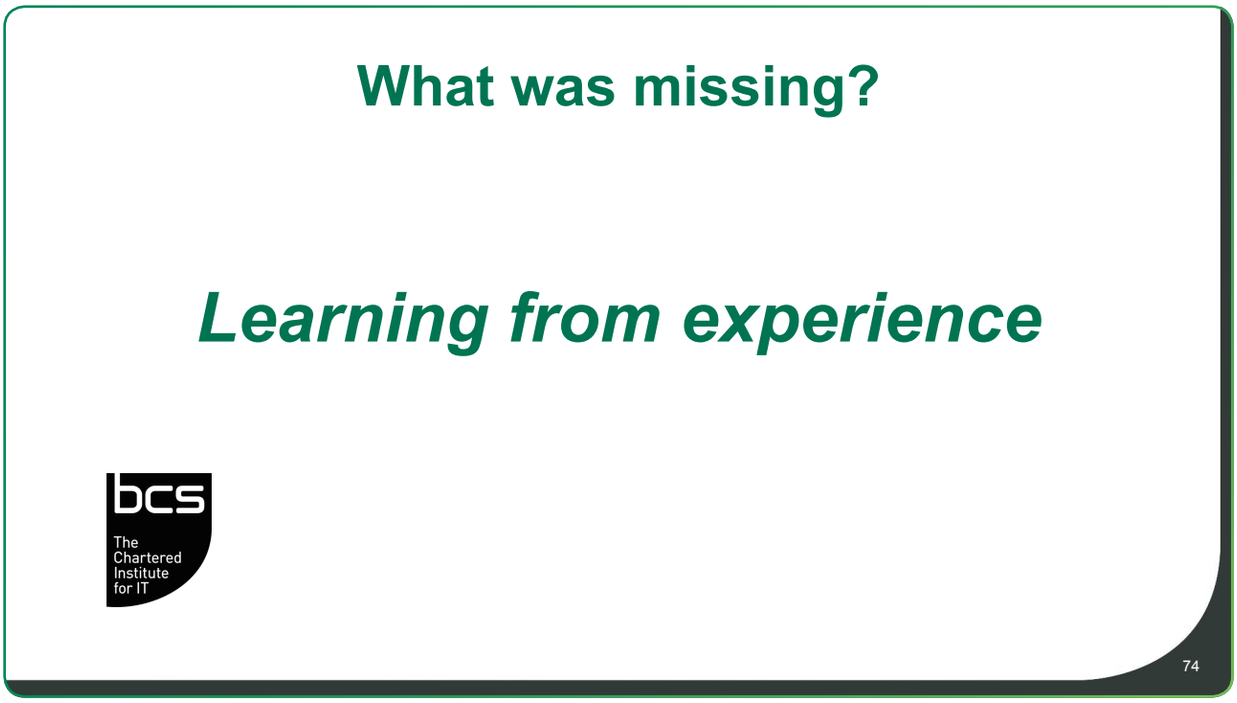
Utility is the scientific way economists measure an agent's happiness. It's more versatile than a yes/no, happy or unhappy – it measures how useful it is.

e.g. Chabot doctor assesses the efficacy of a treatment based on patients' needs

73

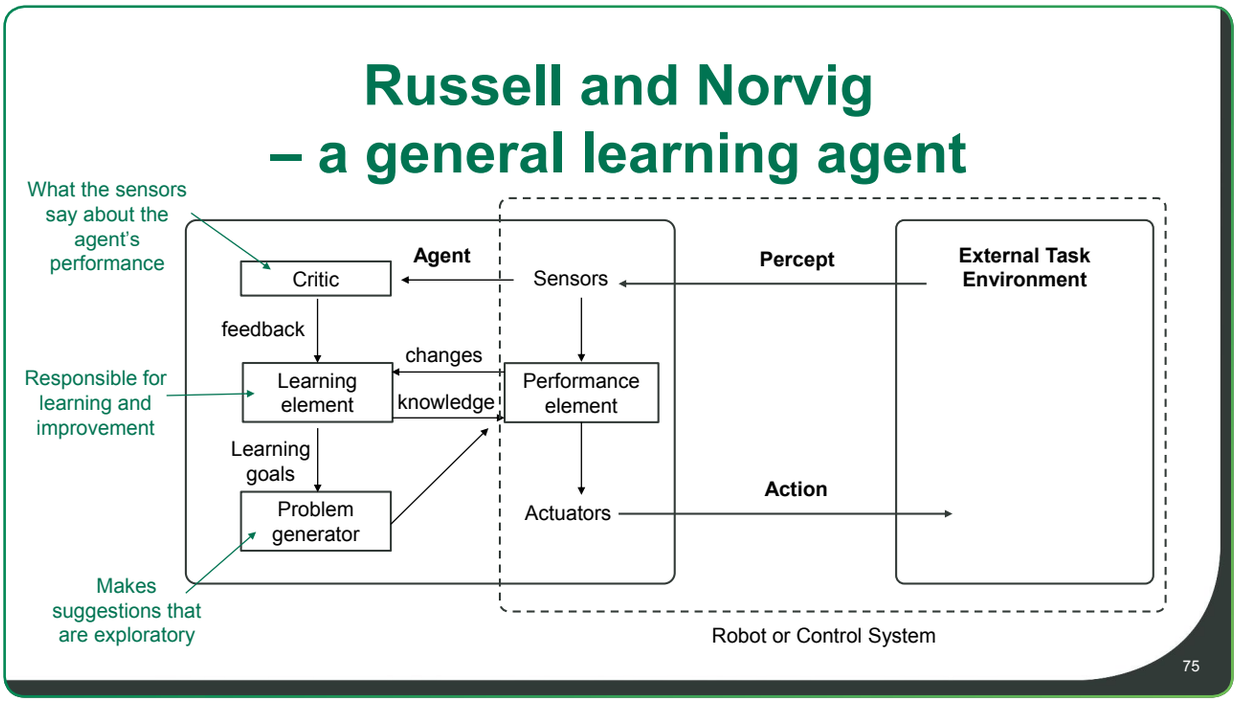
As previous slide.

Slide 74 – What was missing?



The answer to what was missing – Learning from experience

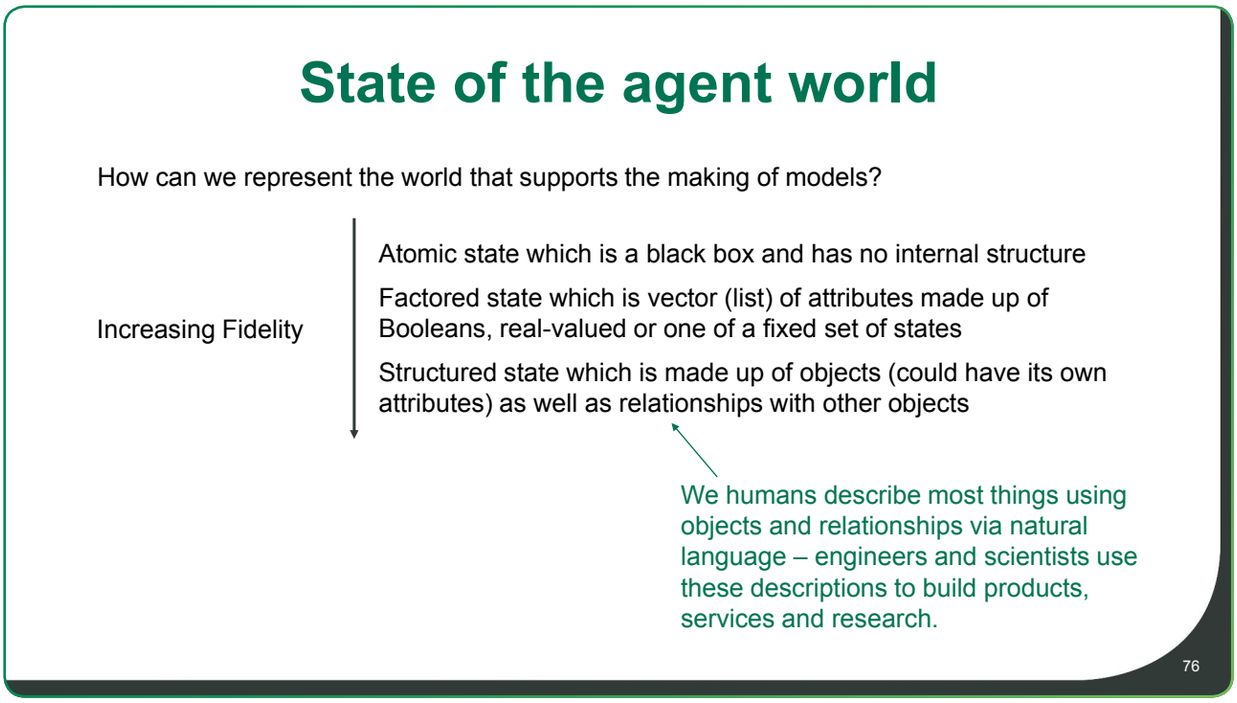
Slide 75 – Russell and Norvig a general learning agent



Delegates should now be able to see where the learning comes in, describe the learning element and how it relates to the agent models.

The dotted line is sometimes thought of as the control or robot system. We might think of the left hand side of this schematic as where machine learning fits in.

Slide 76 – State of the agent world

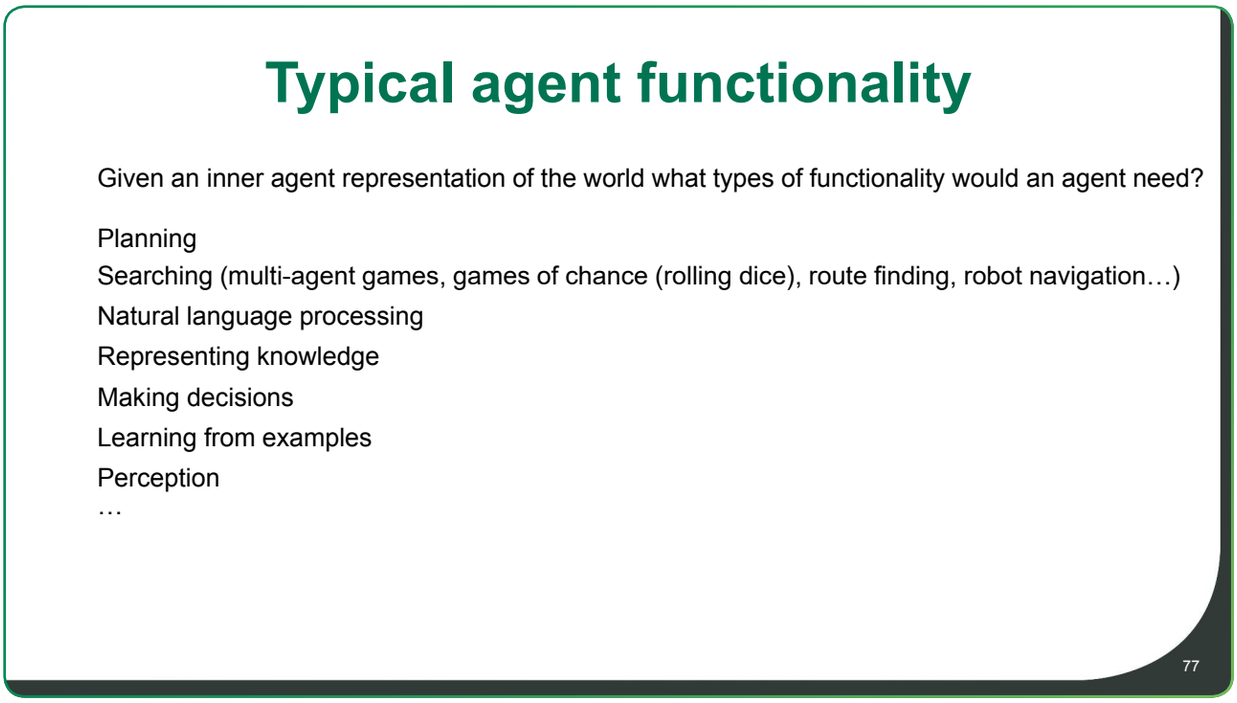


When an engineer builds a model of a product or service, they use models that have a state – the state of the agent world is important.

Explain each of the types of state descriptions.

Remind the delegates of the Britannica explanation of human intelligence – the ability to manipulate the environment.

Slide 77 – Typical agent functionality

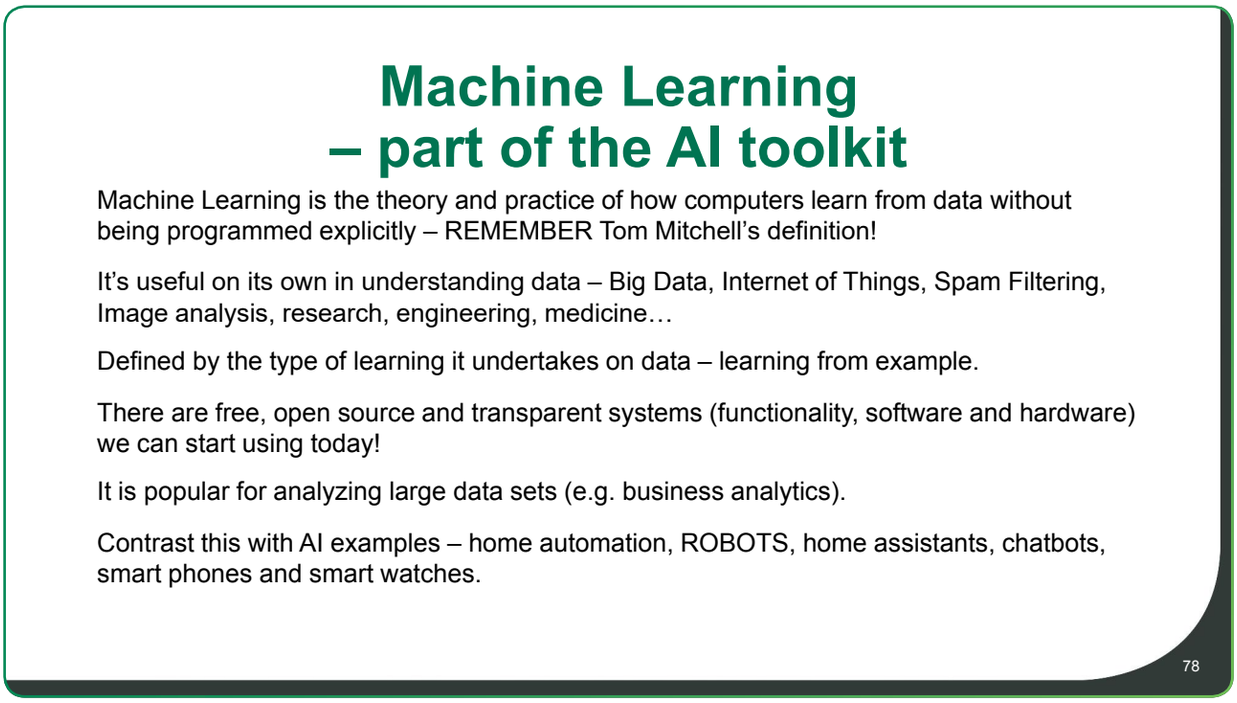


Now we have an agent schematic that understands the state of the environment, can manipulate it via actuators and learn (perhaps through machine learning).

This slide gives some of the functionality an agent might need.

Mention that this functionality is used successfully already by engineers, mathematicians and scientists every day. Ask delegates if they have any good examples.

Slide 78 – Machine learning – part of the AI toolkit

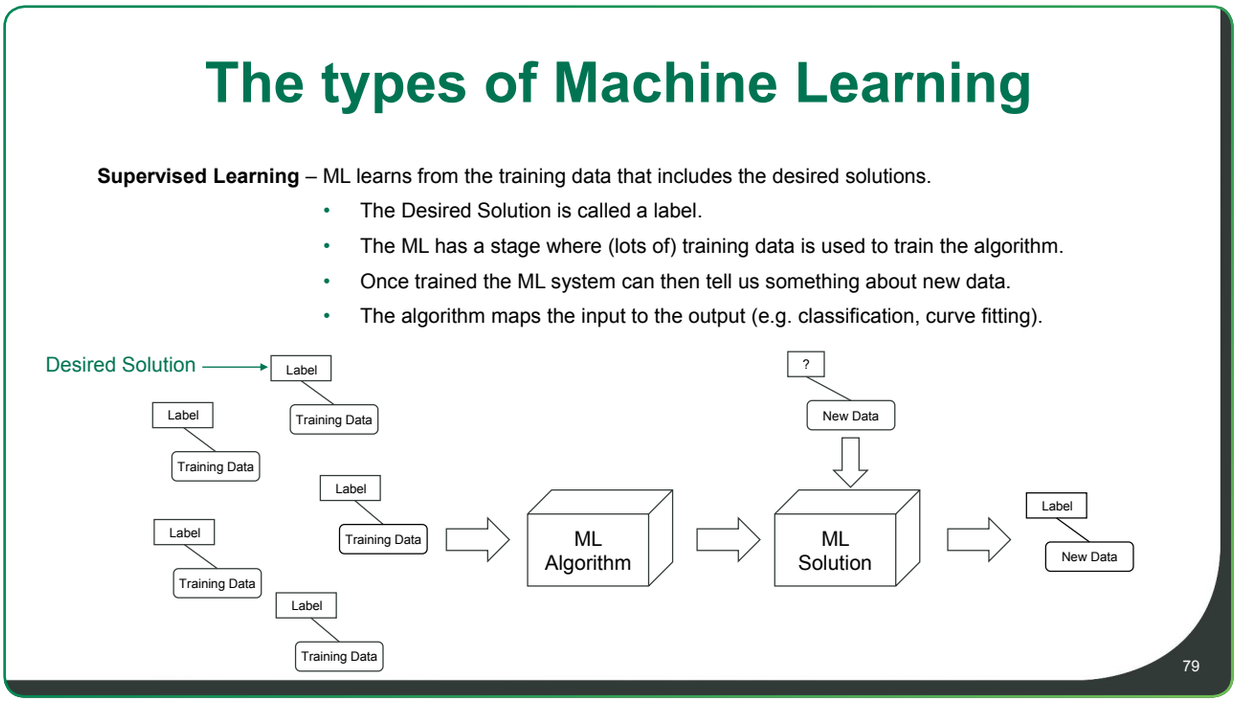


This is a recap of what machine learning is – highlight the difference between AI and machine learning.

Remind delegates that here we are talking about rational agents.

What about emotions and consciousness? This is a simplistic view of AI and a good starting point.

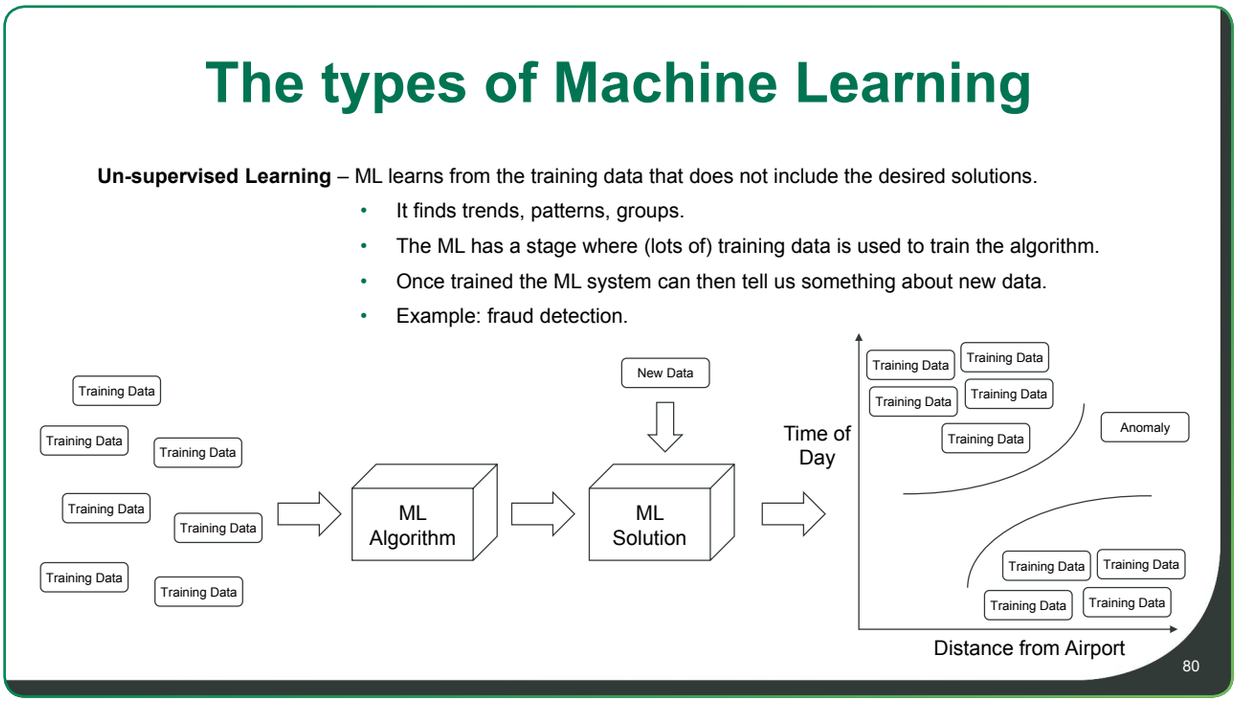
Slide 79 – The types of machine learning



Describe what supervised learning is and give examples.

Ask the delegates to think about what steps are involved in building a supervised learning machine learning project. How much data would they need?

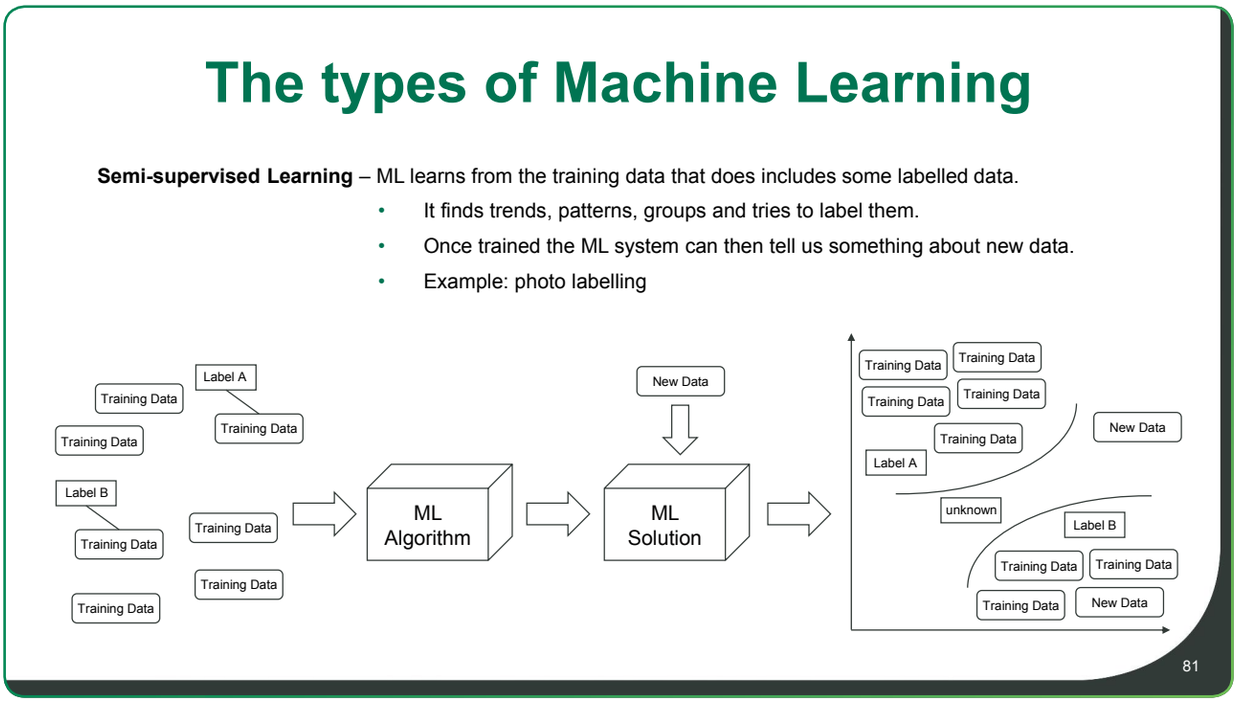
Slide 80 – The types of Machine Learning



Describe what un-supervised learning is and give examples.

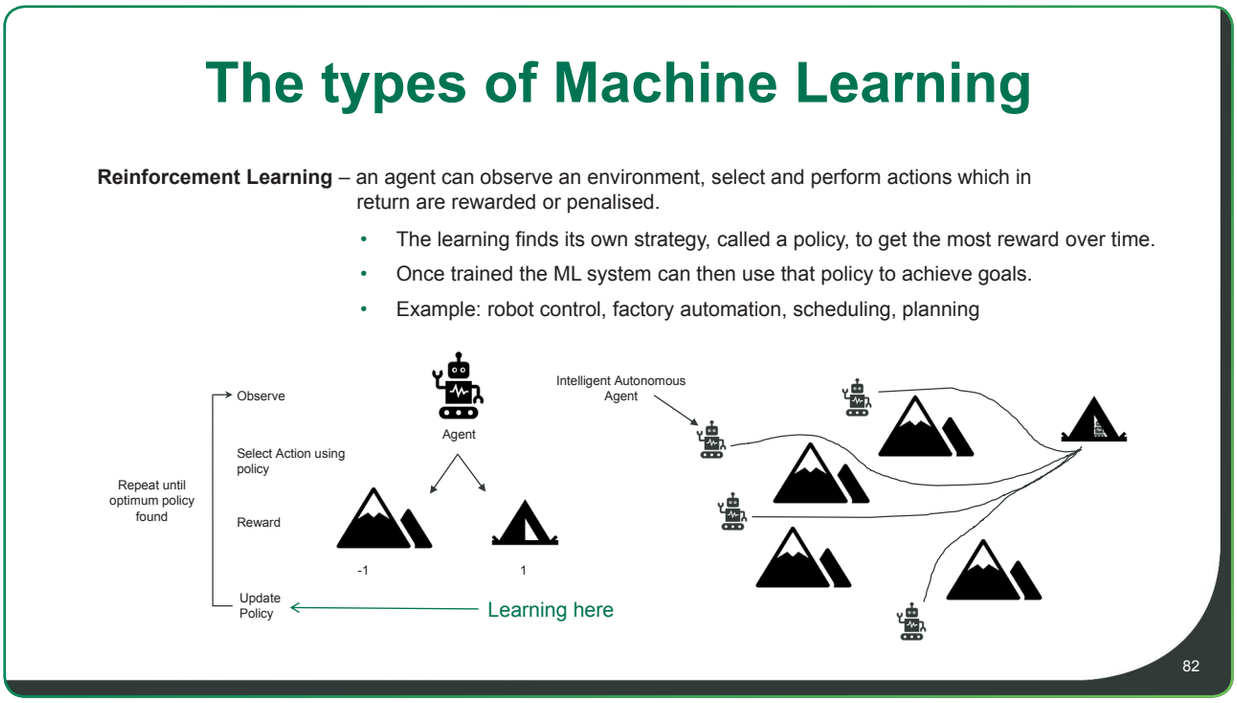
Ask the delegates to think about what steps are involved in building a supervised learning machine learning project. How much data would they need?

Slide 81 – The types of Machine Learning



Describe semi-supervised learning. A good example is photo labelling on smart phones.

Slide 82 – The types of Machine Learning

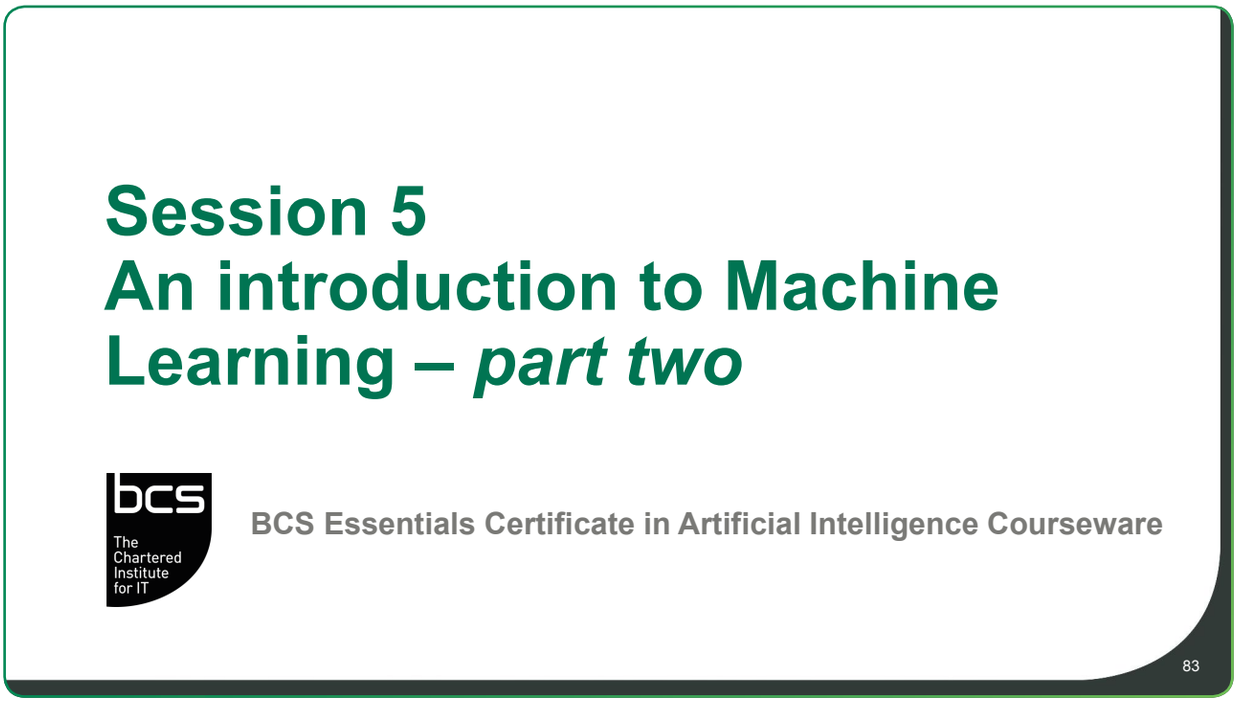


Describe what reinforcement learning is and how it relates to the AI agent schematic. The machine learning is now learning to achieve a goal using a reward or penalties for the actions it takes. It gives robots autonomy to learn.

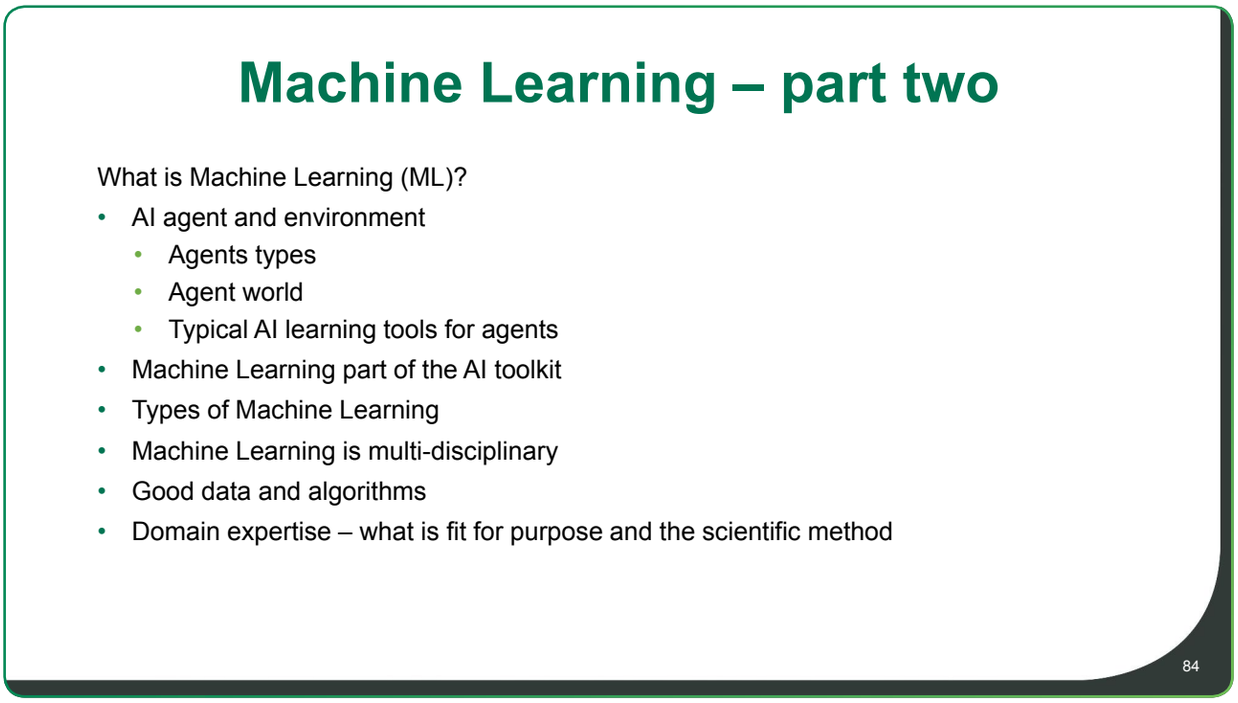
This is the last slide of ML part one. Maybe have a 2- to 3-minute refresh.

Session 5
An introduction to Machine Learning – *part two*

Slide 83 – Title slide



Slide 84 – Machine Learning - part two

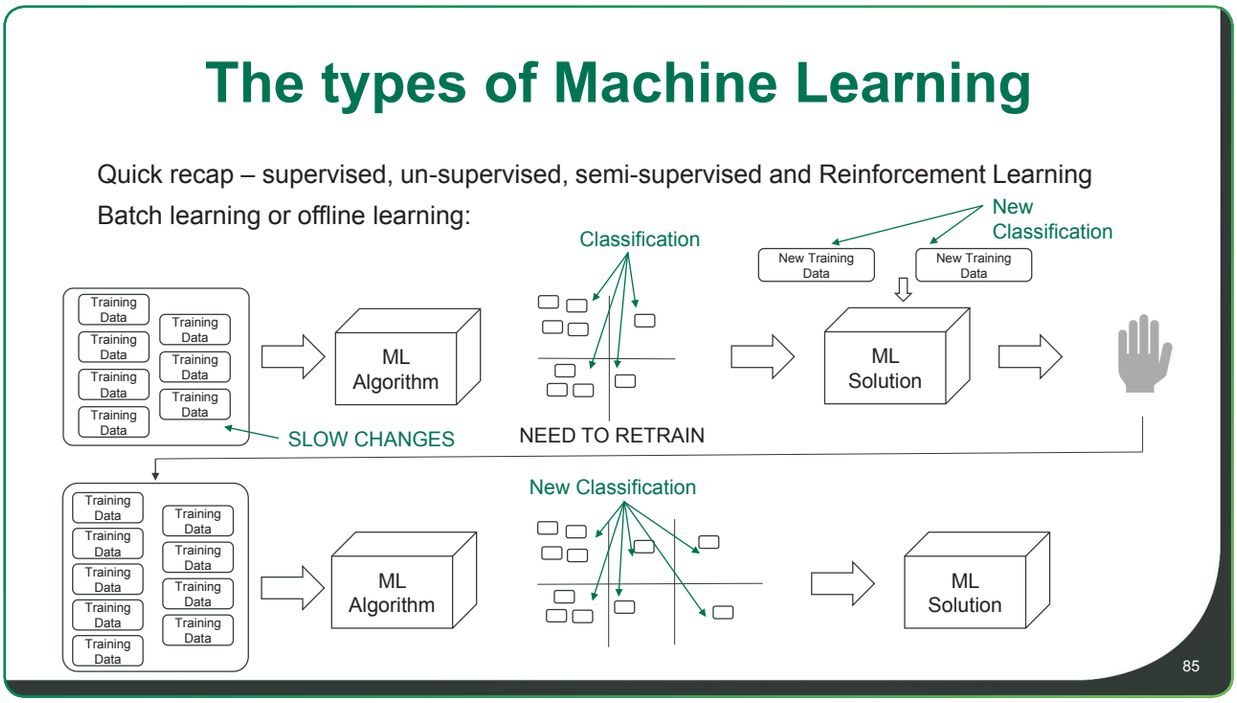


Recap what we learned in part one.

Explain that we are going to go into more detail about what we encounter with ML.

Remind the delegates that a domain expert will need to ascertain what is fit for purpose and remind them that AI is based on the scientific method.

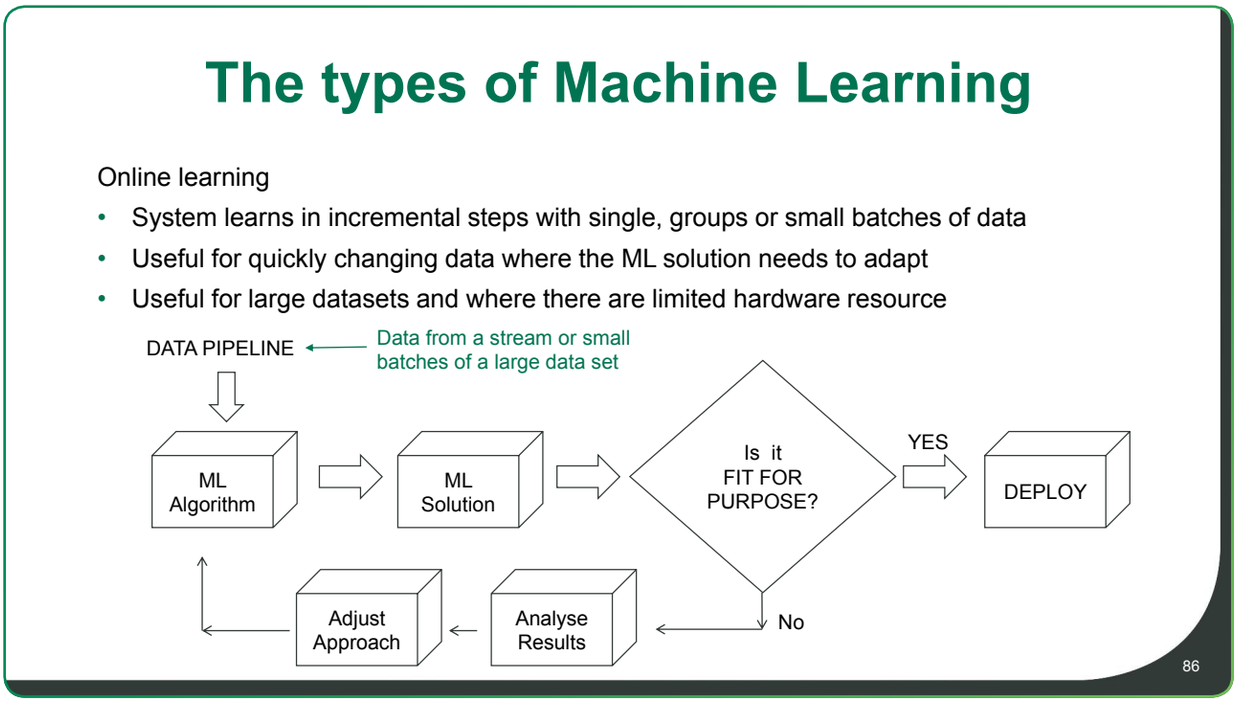
Slide 85 – The types of Machine Learning



Recap the types of Machine Learning we encounter.

Explain what batch and offline learning is and when it is used.

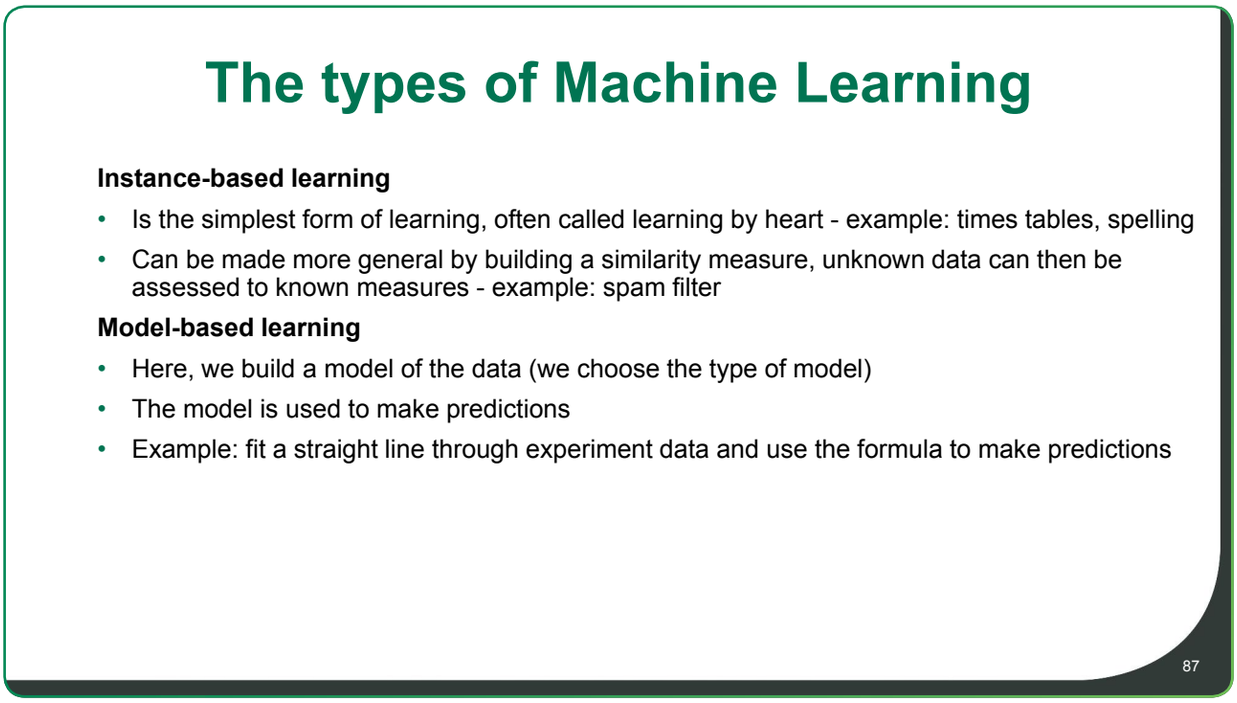
Slide 86 – The types of Machine Learning



Online learning (this could mean on the www) – here it means the machine learning algorithm is always learning form data.

If there's a lot of data to analyse, we may break it up into small batches and feed it continually into the Machine Learning algorithm.

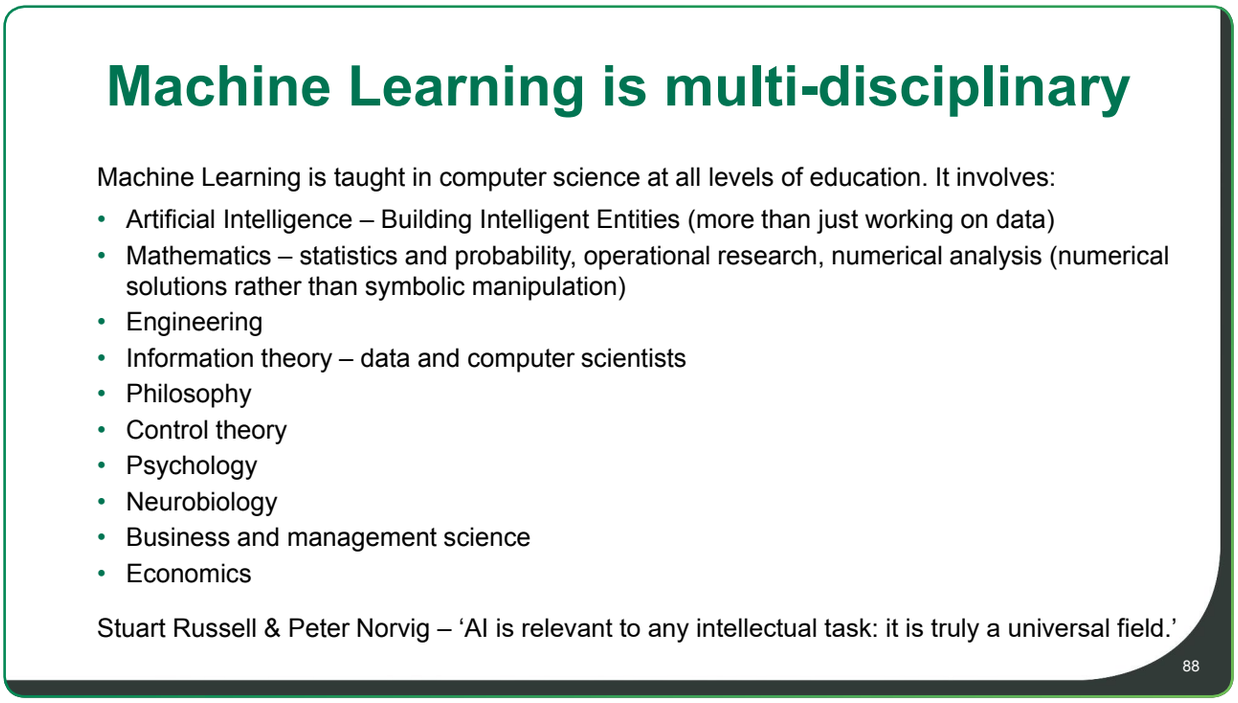
Slide 87 – The types of Machine Learning



Here are two more ways to describe Machine Learning.

Explain what they are and ask the delegates for examples.

Slide 88 – Machine Learning is multi-disciplinary

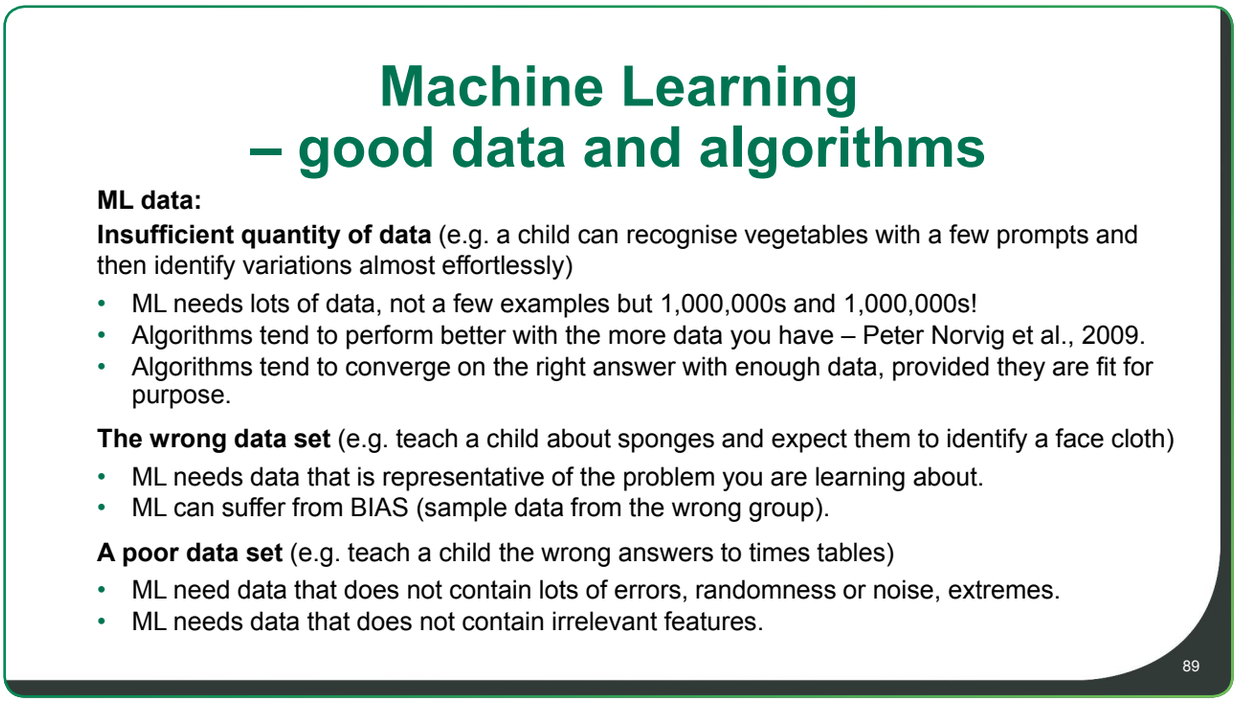


Machine Learning is a very important part of AI. It's fundamental.

This slide is used to emphasise that it is multi-disciplinary, and an AI project will need to draw on a team.

Mention that Russell and Norvig say that AI is a truly universal field.

Slide 89 – Machine Learning – good data and algorithms

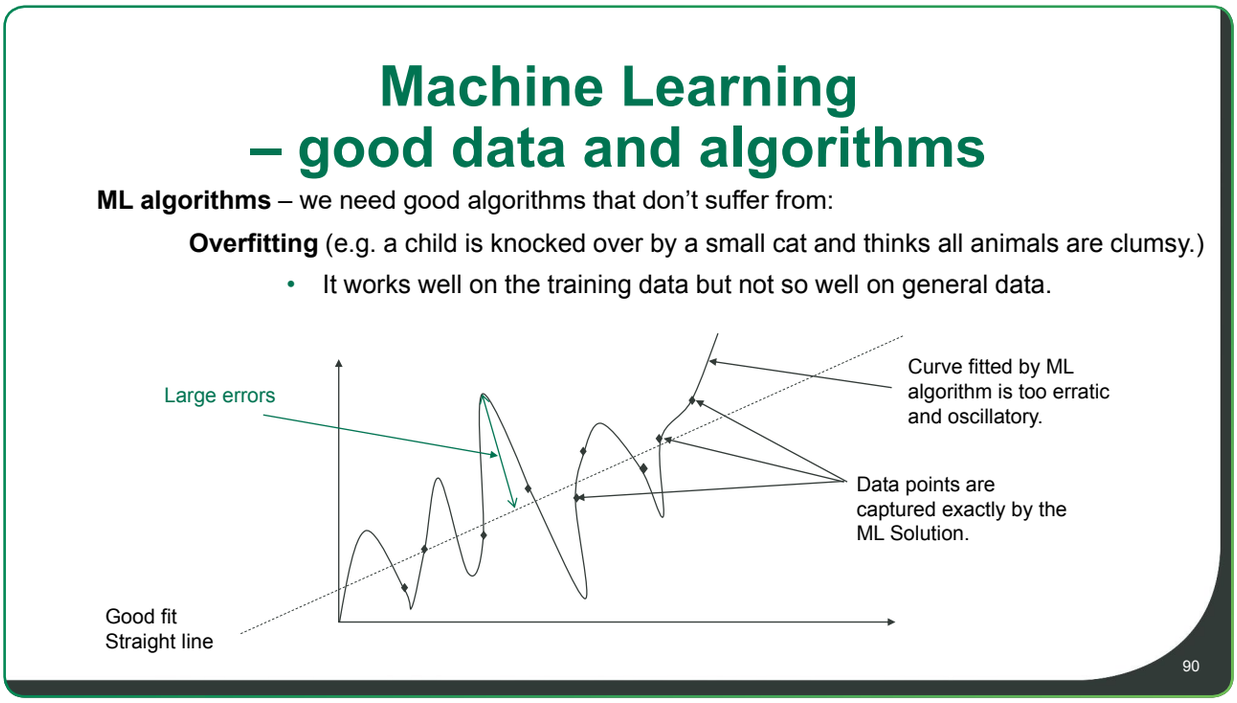


Machine Learning is a good place to start developing a learning system.

This slide is about getting good Data and list some of the problems with bad data.

Ask the delegates of their experience of working with bad data.

Slide 90 – Machine Learning – good data and algorithms



Algorithms are also a fundamental part of ML. One of the common issues with an algorithm is overfitting.

Explain what this is and how we might mitigate this effect.

The curvy or oscillatory line tells a numerical analyst that the curve is overfitted. The real data would be better represented by a straight line.

Slide 91 – Machine Learning – good data and algorithms

Machine Learning – good data and algorithms

ML algorithms – we need good algorithms that don't suffer from:

Overfitting – (e.g. a child is knocked over by a small cat and thinks all animals are clumsy)

- It happens when the algorithm is too complex and overly sophisticated.
- Reduce the complexity of the algorithm.
- Reduce the number of attributes in the training data.
- Use more training data.
- Reduce the noise in the data (remove outliers that can distort the result).
- Constrain the model, make it simpler and limit the amount of overfitting.

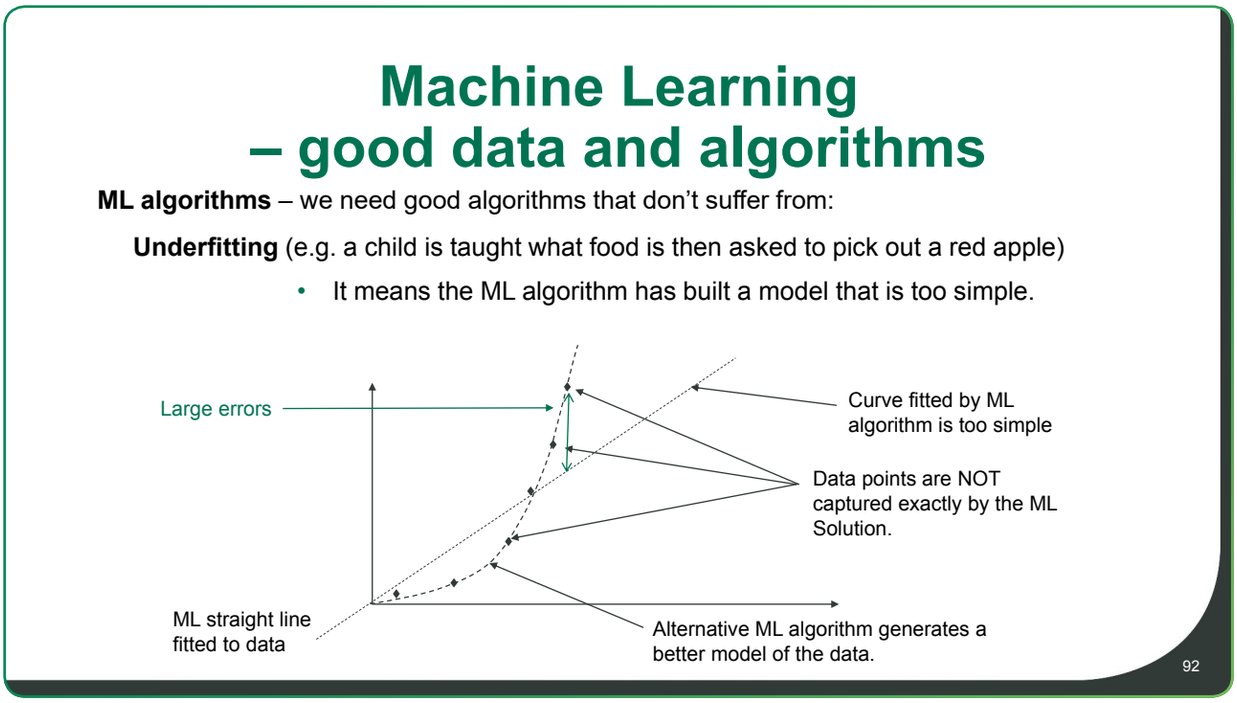
91

This slide adds more of a description of what overfitting is.

Highlight some of the possible ways we can fix this.

Ask the delegates if they can suggest ways of fixing this.

Slide 92 – Machine Learning – good data and algorithms



This slide is about underfitting.

Explain what this is. Put simply, our ML system is overly simplified. You can see this from the parabolic form of the data. Simply fitting a straight line is clearly not correct!

Ask the delegates if they can suggest an alternative fix.

Slide 93 – Machine Learning – good data and algorithms

Machine Learning – good data and algorithms

ML algorithms – we need good algorithms with the best hyper-parameters:

Hyper-parameters are high-level descriptions of the ML and model we are training with the data:

- Fixed at the start of the training of the ML algorithm
- Cannot be determined from the dataset
- Need to be systematically tuned to obtain the best learning results

Examples are:

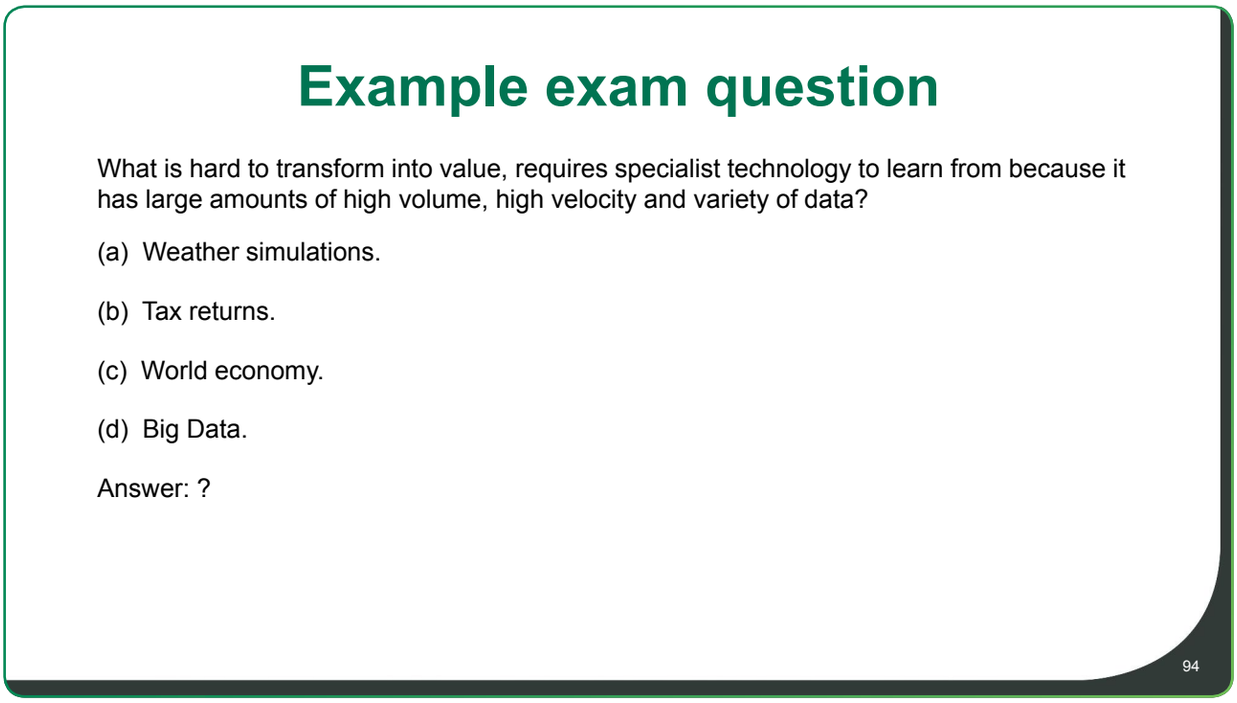
- Number of layers in a neural net
- Size of the dataset to train on
- Depth of a decision tree

93

Explain that ML algorithms have their own hyper-parameters that can be used to improve how they learn.

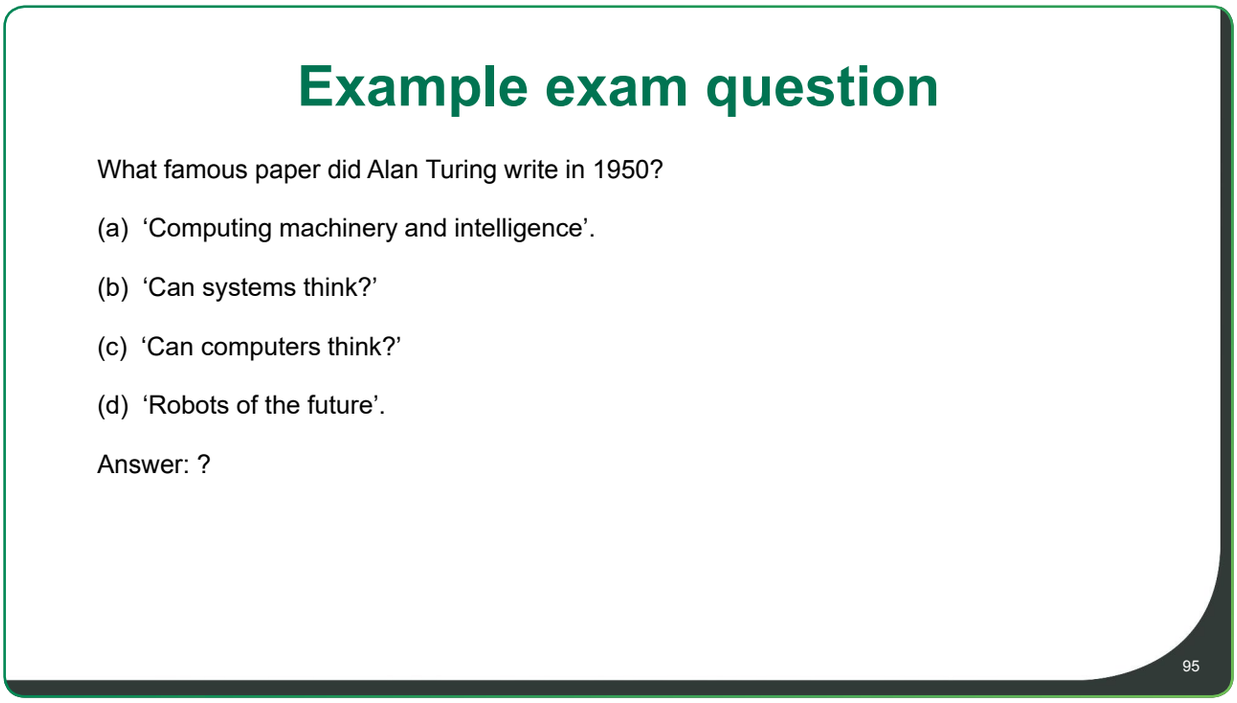
Explain that when training an ML algorithm, we must be systematic in how we train it so we obtain the best learning results.

Slide 94 – Example exam question



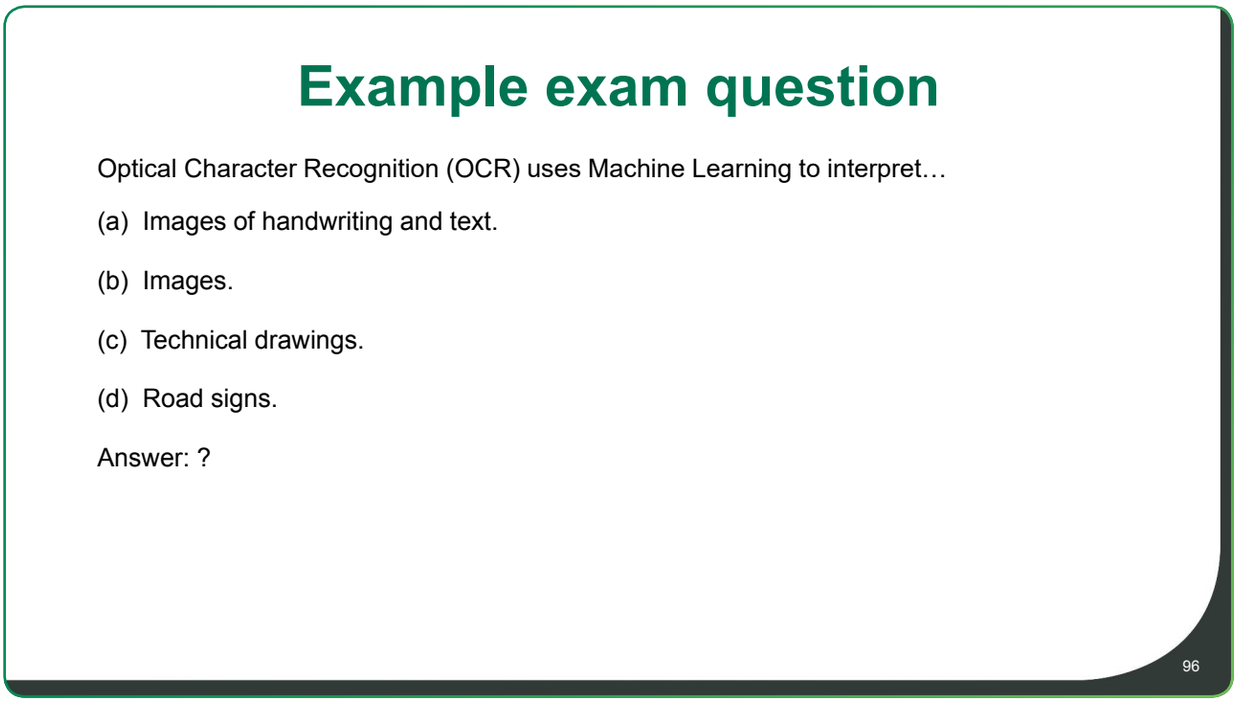
The answer is (d). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 95 – Example exam question



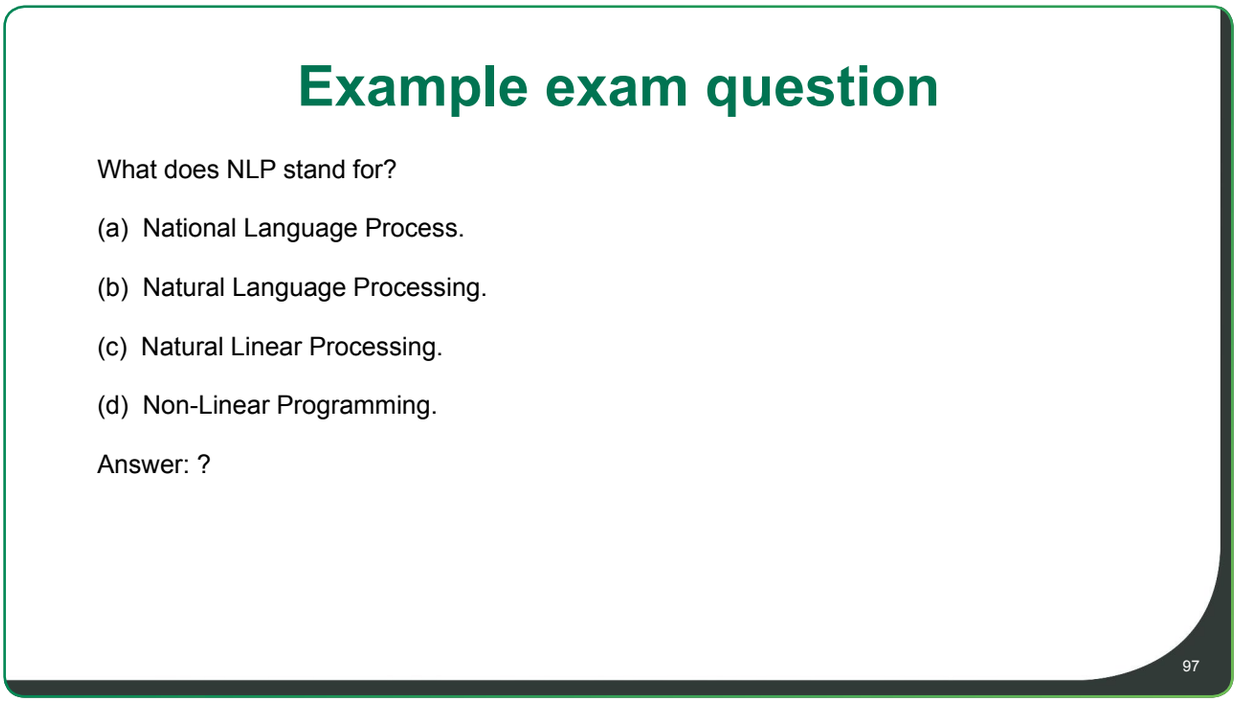
The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 96 – Example exam question



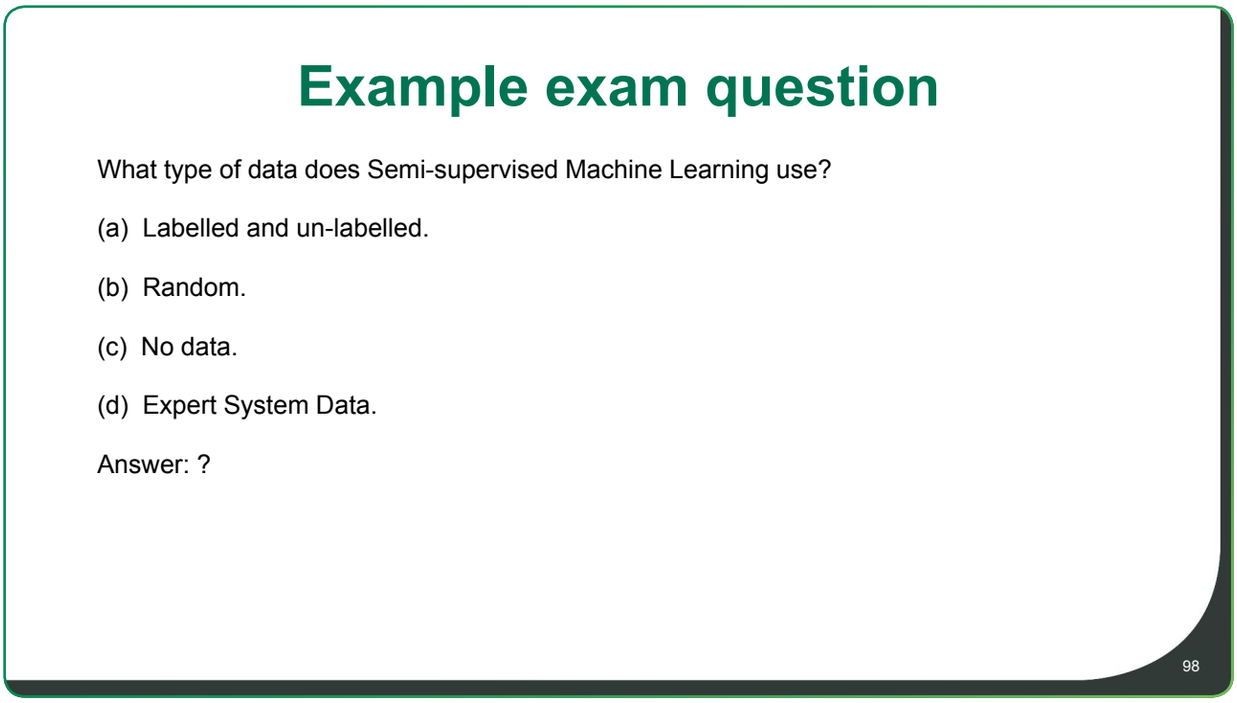
The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 97 – Example exam question



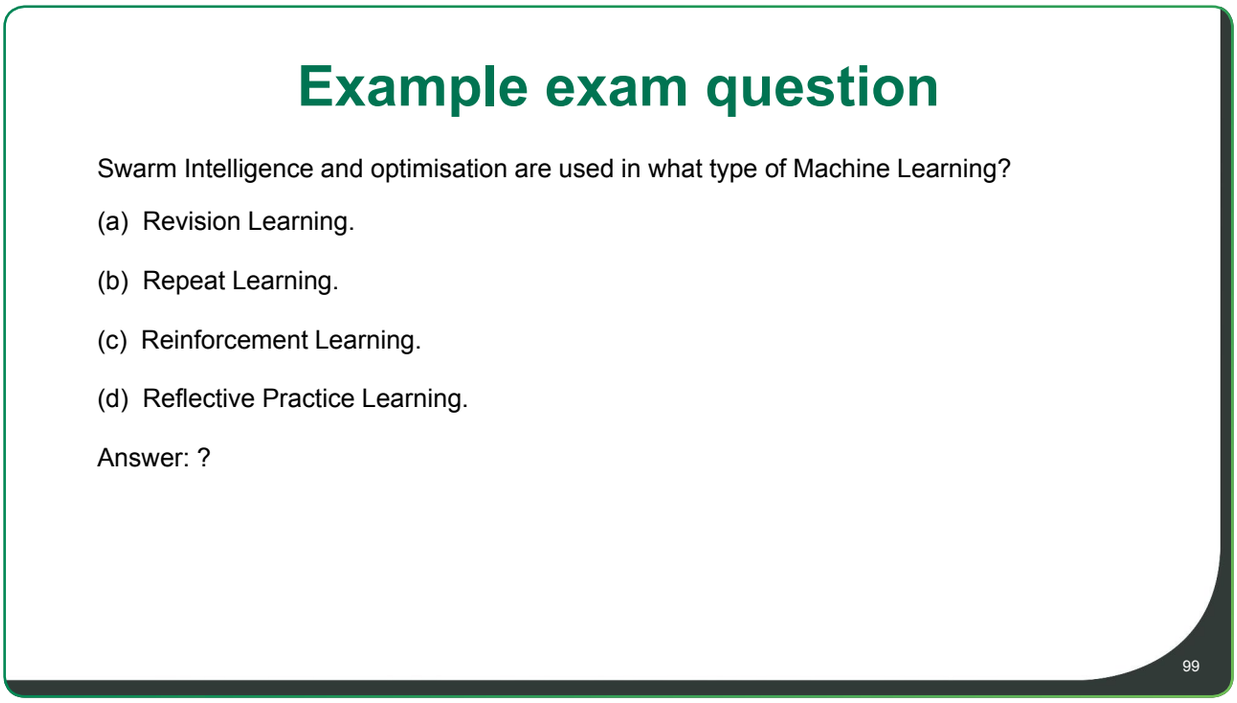
The answer is (b). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 98 – Example exam question



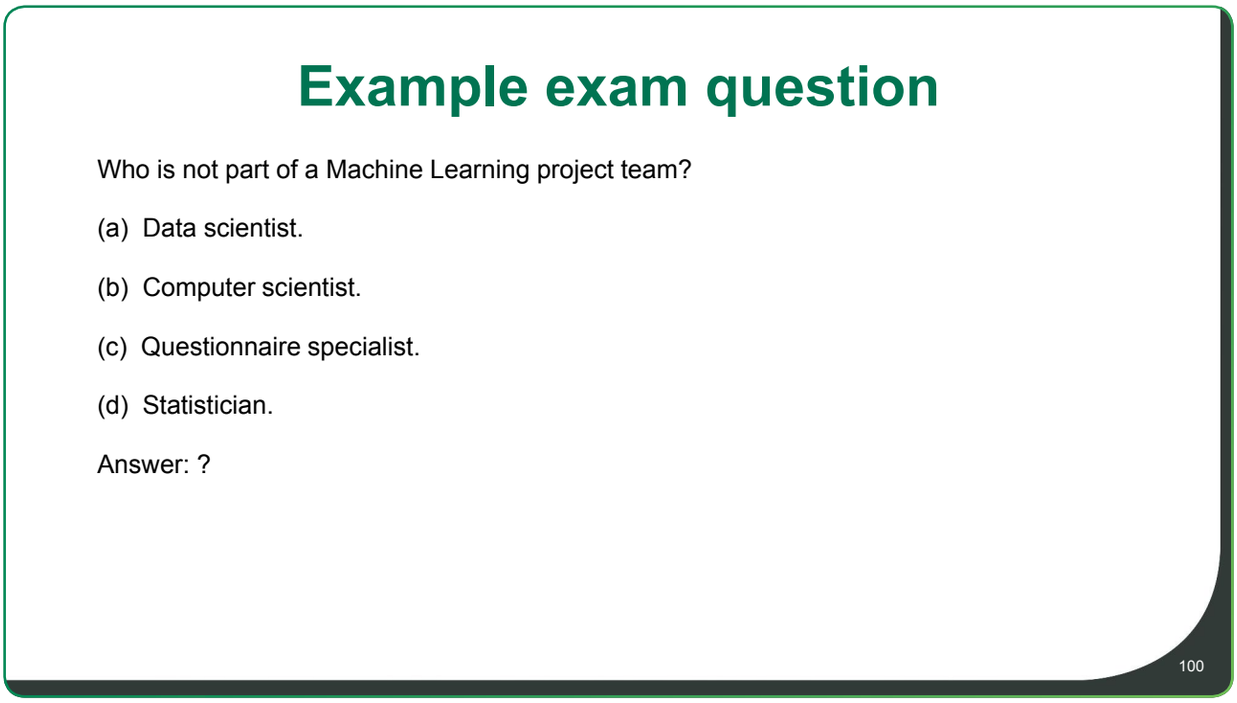
The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 99 – Example exam question



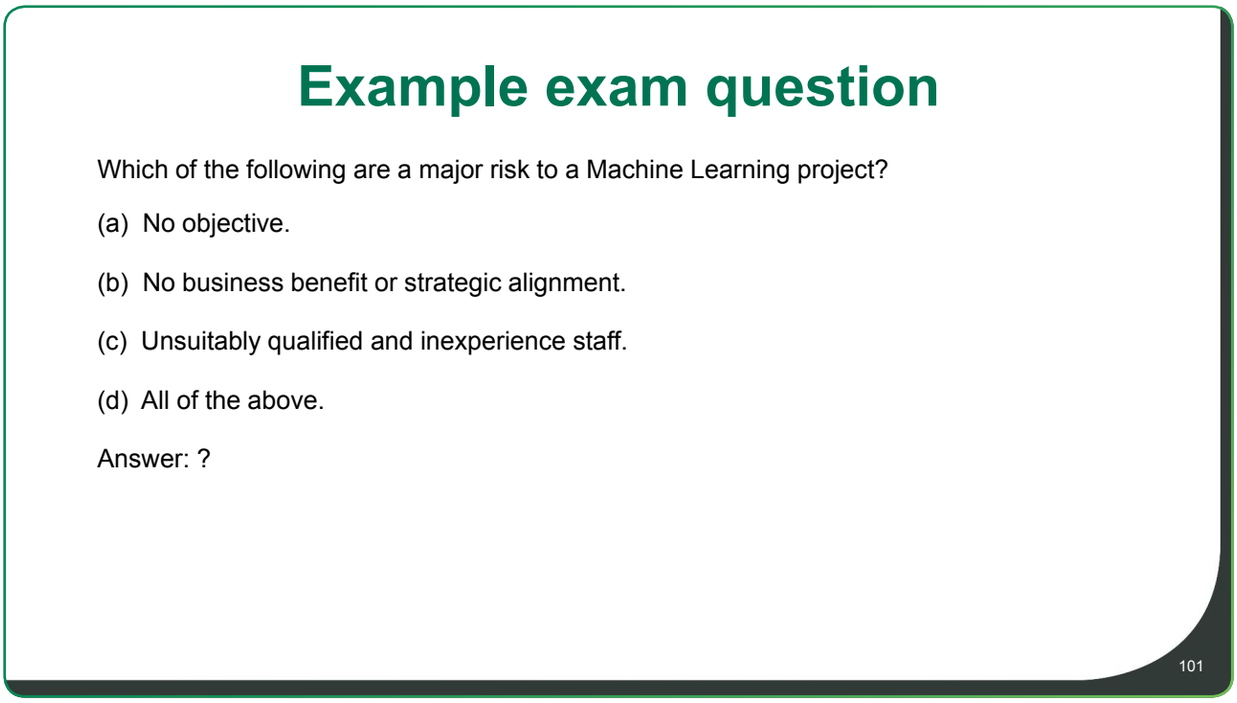
The answer is (c). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Slide 100 – Example exam question



The answer is (c). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

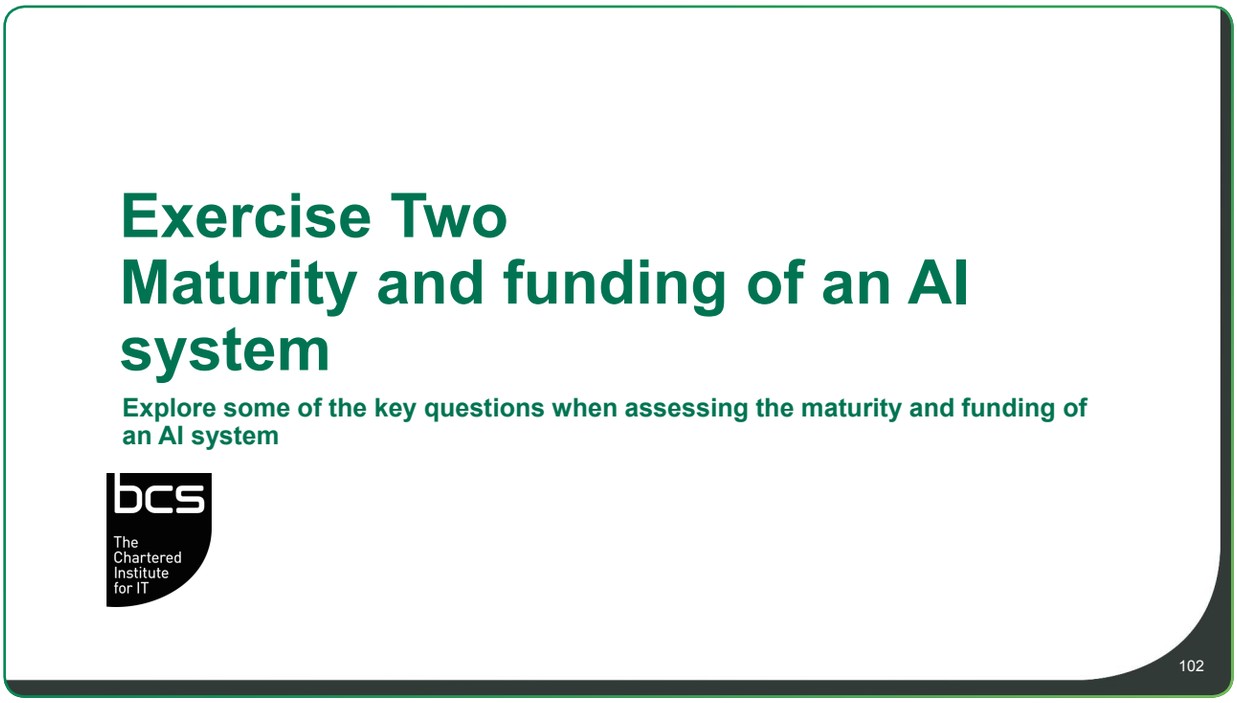
Slide 101 – Example exam question



The answer is (d). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Exercise Two
Maturity and funding of an AI system

Slide 102 – Explore some of the key questions when assessing the maturity and funding of an AI system



See Exercise book. Exercise Two – Maturity and Funding of an AI System

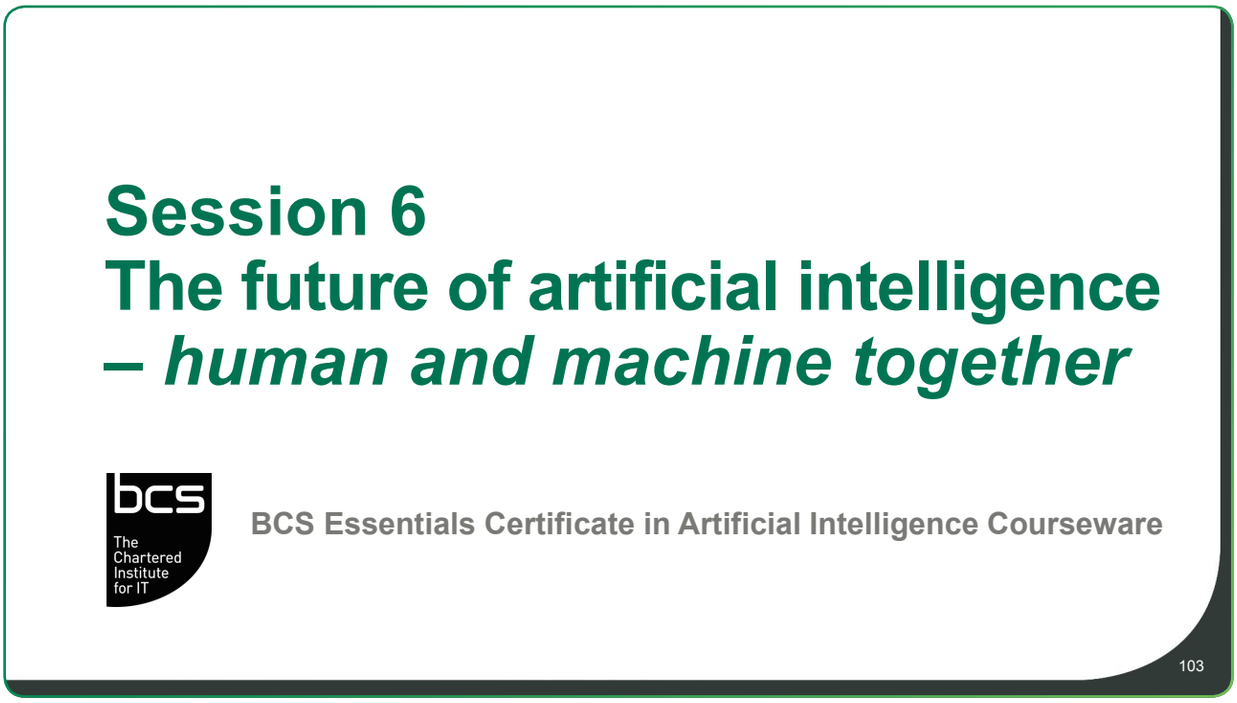
Objective: Allow participants to explore their first AI project(s) in terms of what is involved and how to measure the maturity of the technology.

Tutor facilitated:

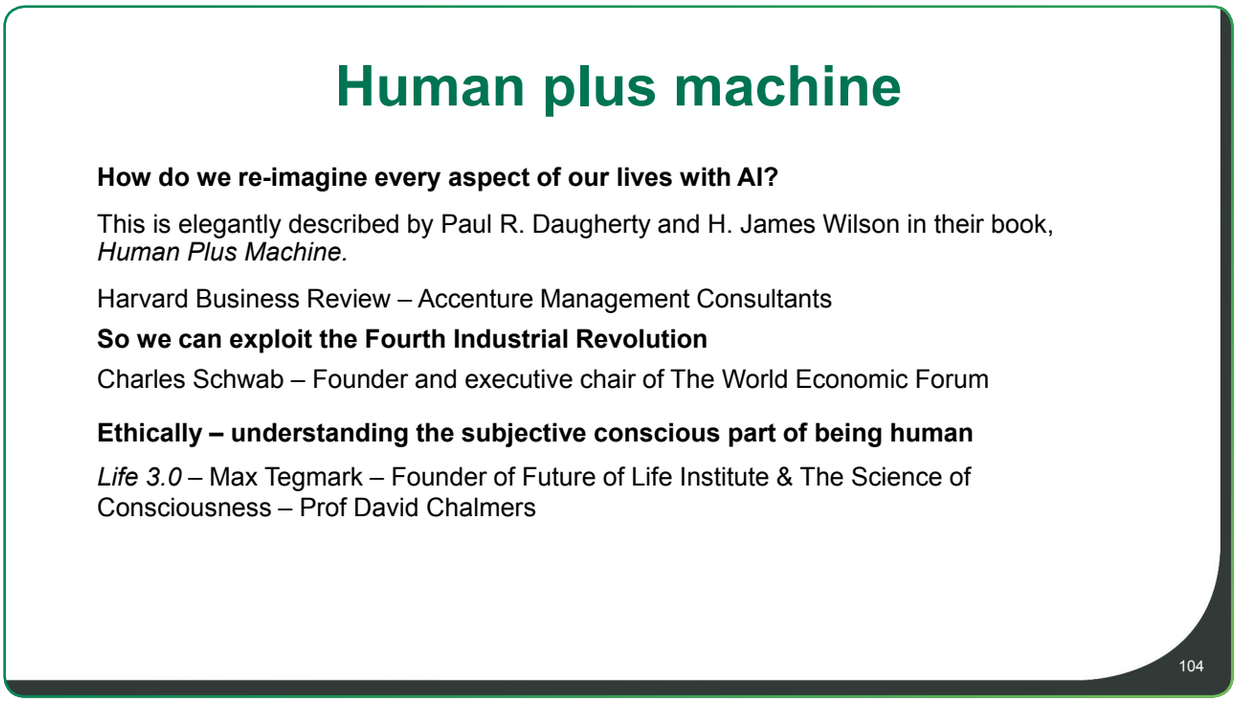
1. Allow the participants to explore the table and fill it in for about five minutes.
   - Explain what functionality is. Get the participants to assess if there is software out there to do their learning and assess if the hardware is available to undertake the project. Mention that they also need to understand who's going to pay for it!
   - Explain what the TRLs – Technology Readiness Levels are: http://www.earto.eu/fileadmin/content/03_Publications/The_TRL_Scale_as_a_R_I_Policy_Tool_-_EARTO_Recommendations_-_Final.pdf
2. When everyone has attempted the table, go around each participant and ask them to highlight their main learning point.
   - Allow brief discussion but avoid indulging in excessive debate.
   - Key is to build confidence in starting to define an AI project and develop a fuller understanding of what it takes to define an AI project. This exercise builds on Question 5 from Exercise One and is about defining that first AI project.

Session 6
The future of artificial intelligence – *human and machine together*

Slide 103 – Title slide



Slide 104 – Human plus machine



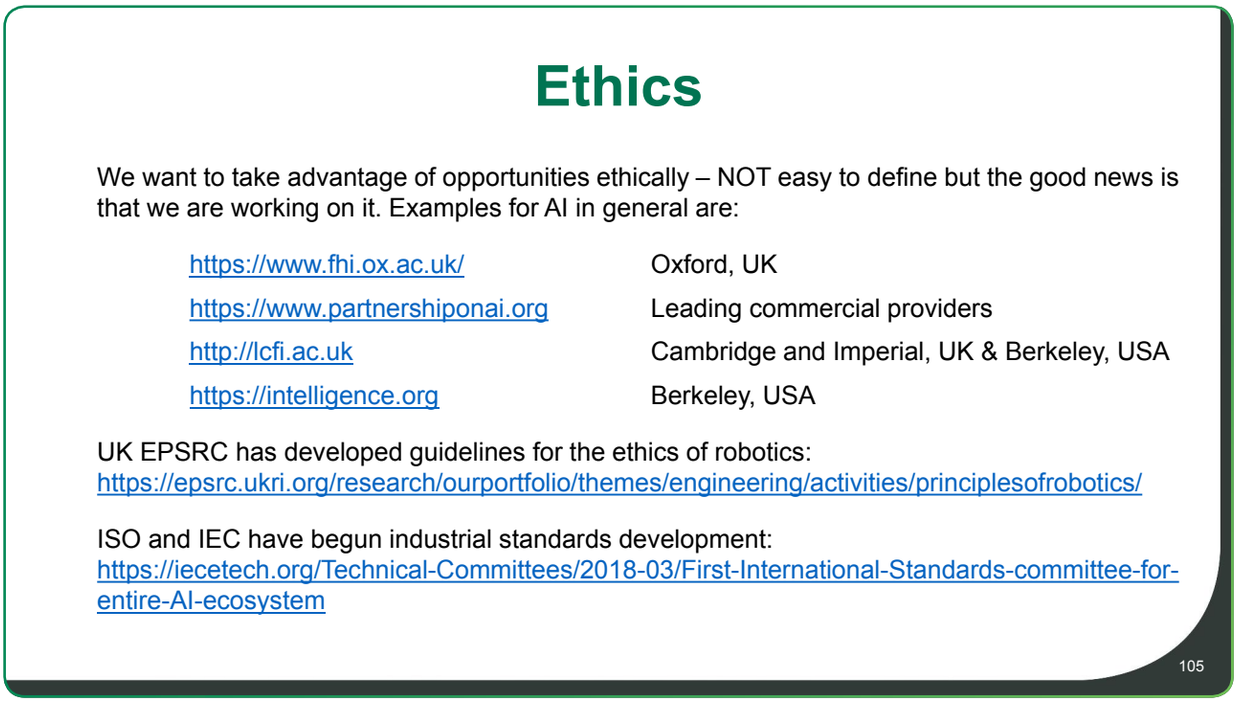
This slide introduces the idea of humans, machines, and humans and machines together.

Describe that we will explore what humans are good at and what machines are good at, and that there is an area where humans and machines can augment each other.

ETHICS is missing and we address this here.

Remind the delegates that AI can help us take advantage of the Fourth Industrial Revolution.

Slide 105 – Ethics



Start with ethics and how we take advantage of opportunities ethically. There has been a large push on ethical understanding from 2015 onwards.

Give examples and make the link between ethics and human consciousness.

Slide 106 – Robotics guidelines EPSRC

Describe the EPSRC’s general audience principles for robots.

Slide 107 – Ethics in AI

Ethics in AI

General background:

https://en.wikipedia.org/wiki/Ethics_of_artificial_intelligence#Machine_ethics

Common theme:

Open and transparent → Open Source Code.

Do no harm.

The culture in AI research and AI community is now developing AI for good:

- Just like chemists make medicine not poison.
- Engineers continually make cars safer, less polluting…

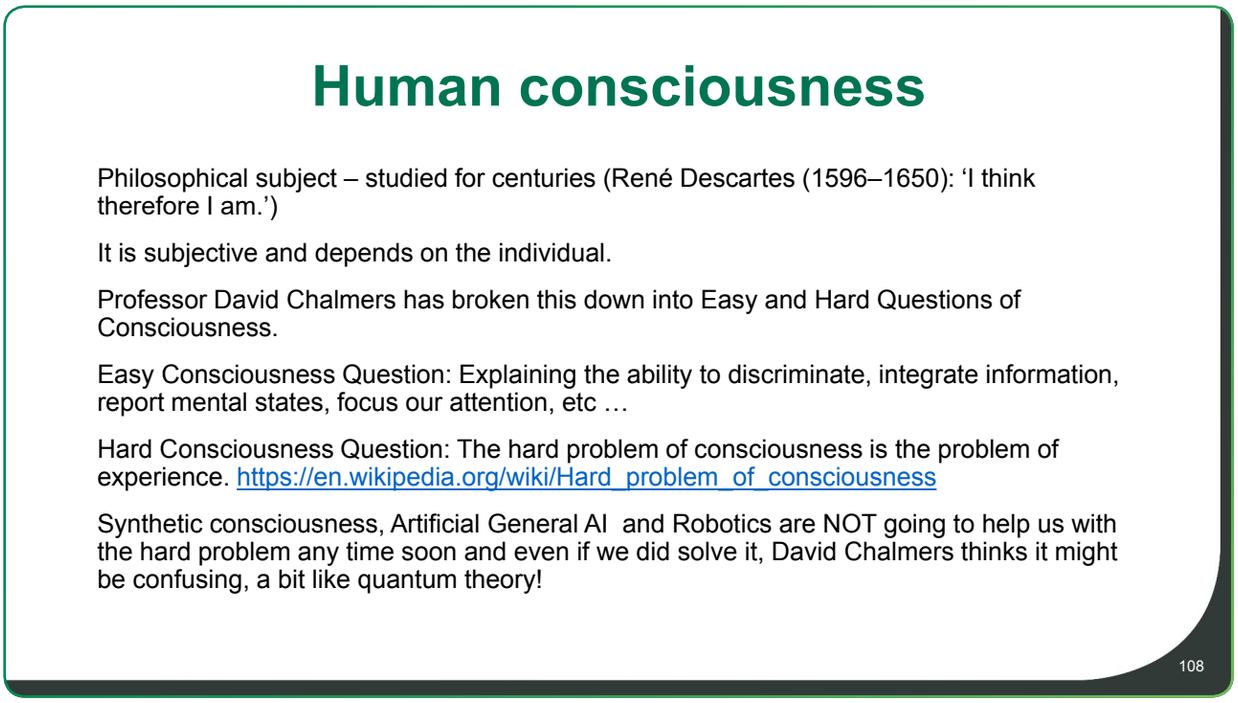
BUT: What happens if Super AI develops consciousness – WE DO NOT KNOW

107

Explore with the candidates the common themes in AI Ethics and that guidelines are being written but it takes a long time because they have to be written into law.

So far, we've only considered rational or unemotional AI – suggest the delegates think about what happens if AI is developed into super AI!

Slide 108 – Human consciousness

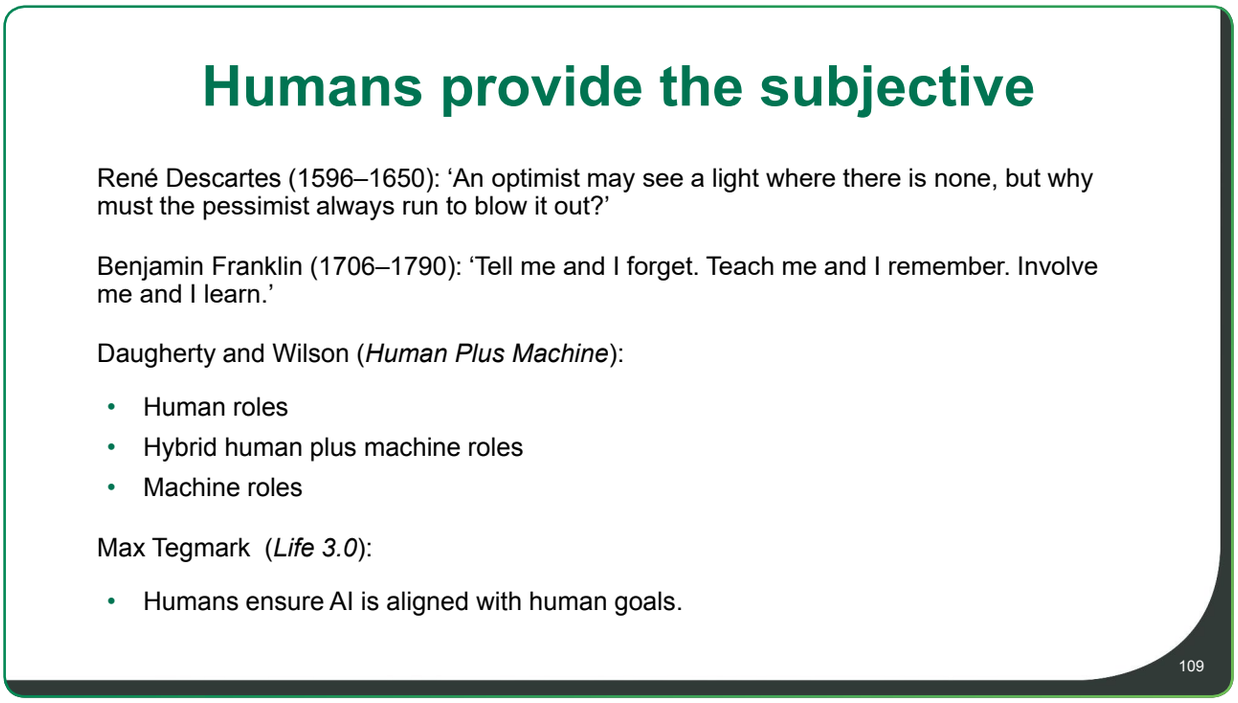


Super AI will have consciousness (we don't know if it is possible).

Explain that consciousness in AI is speculative and we should prepare for it, even though it's not likely soon.

Describe Prof David Chambers Easy and Hard Questions of Consciousness.

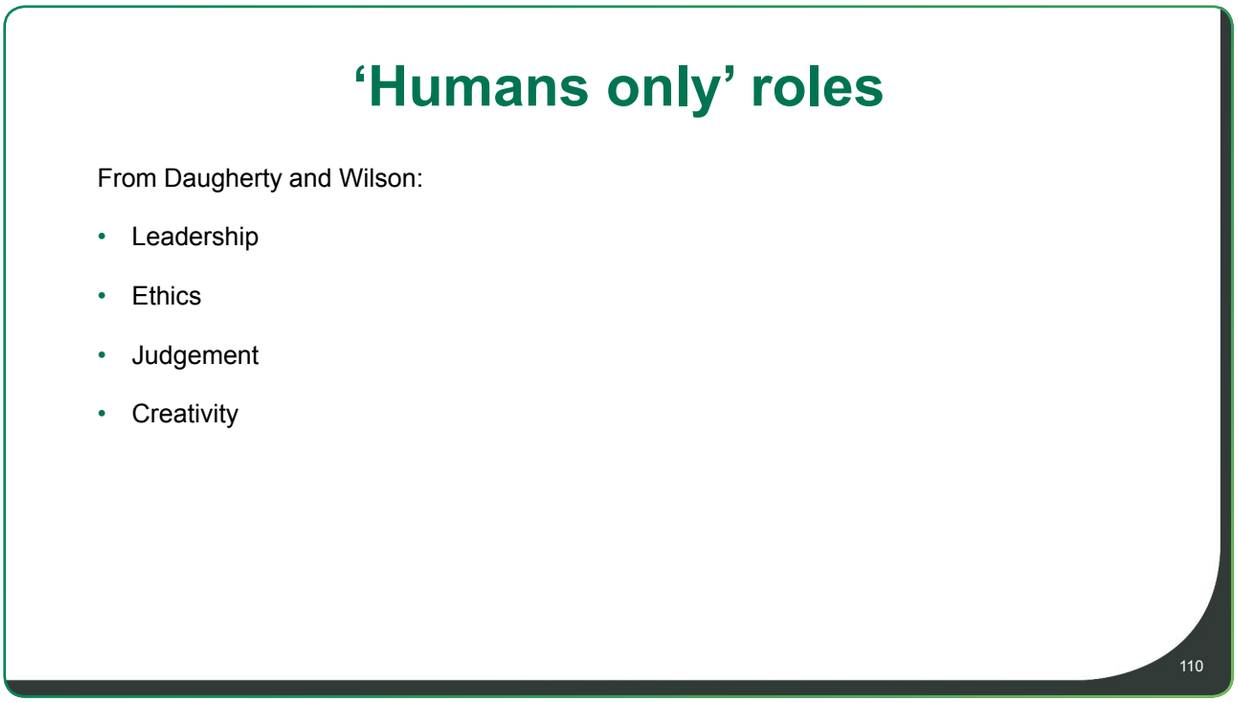
Slide 109 – Humans provide the subjective



Describe what Humans can bring to the human and machine partnership – the subjective, emotional empathic understanding and learning.

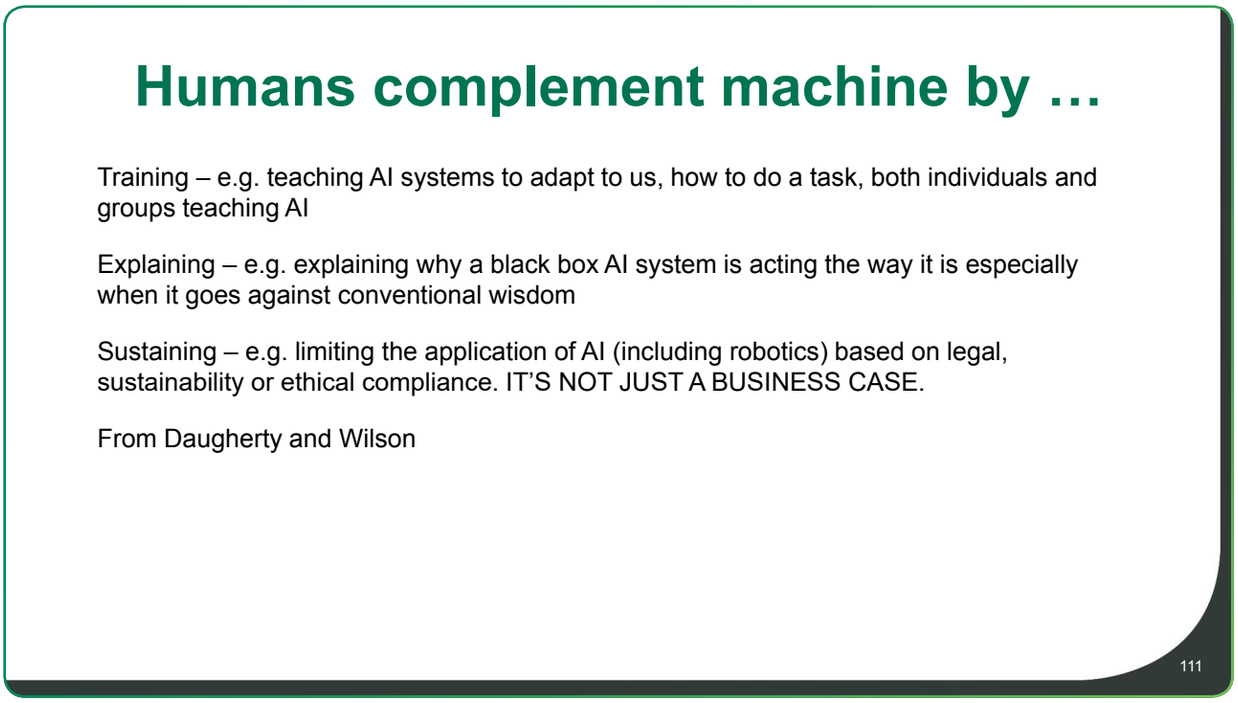
The key point is that humans make the ethics human centric, the goals of our AI are aligned with Human goals.

Slide 110 – ‘Humans only’ roles



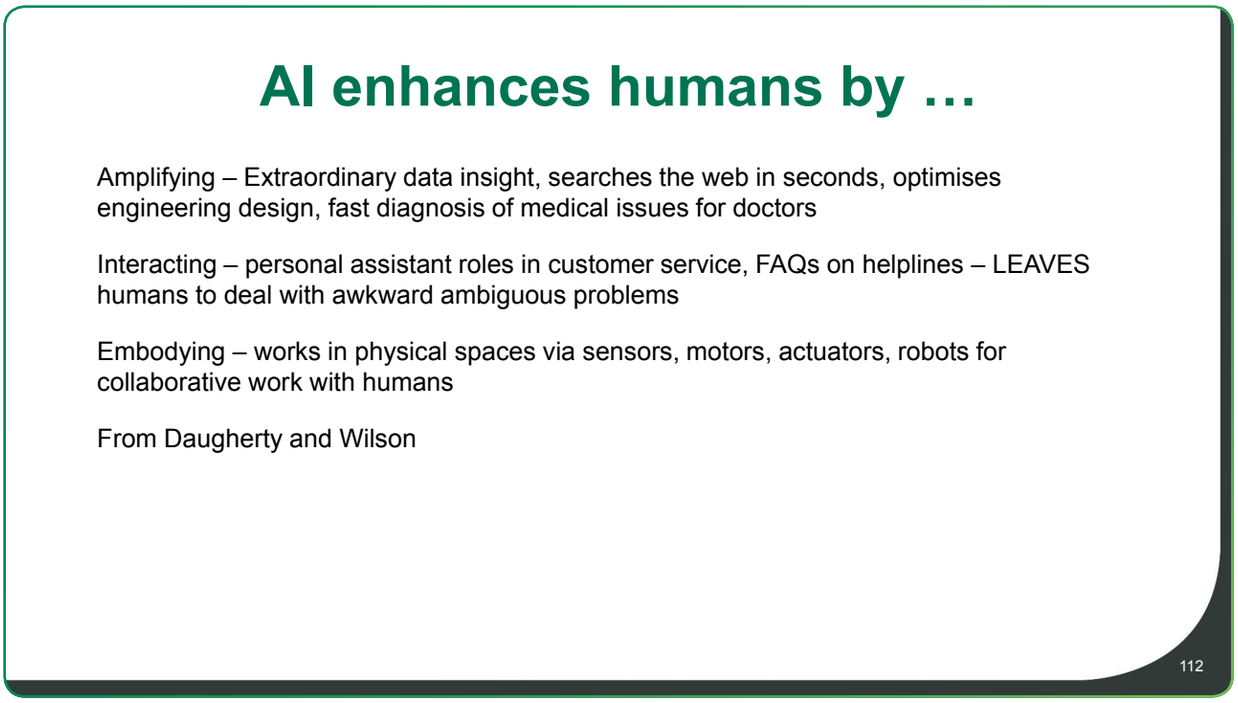
Describe the typical human roles from Daugherty and Wilson

Slide 111 – Humans complement machine by . . .



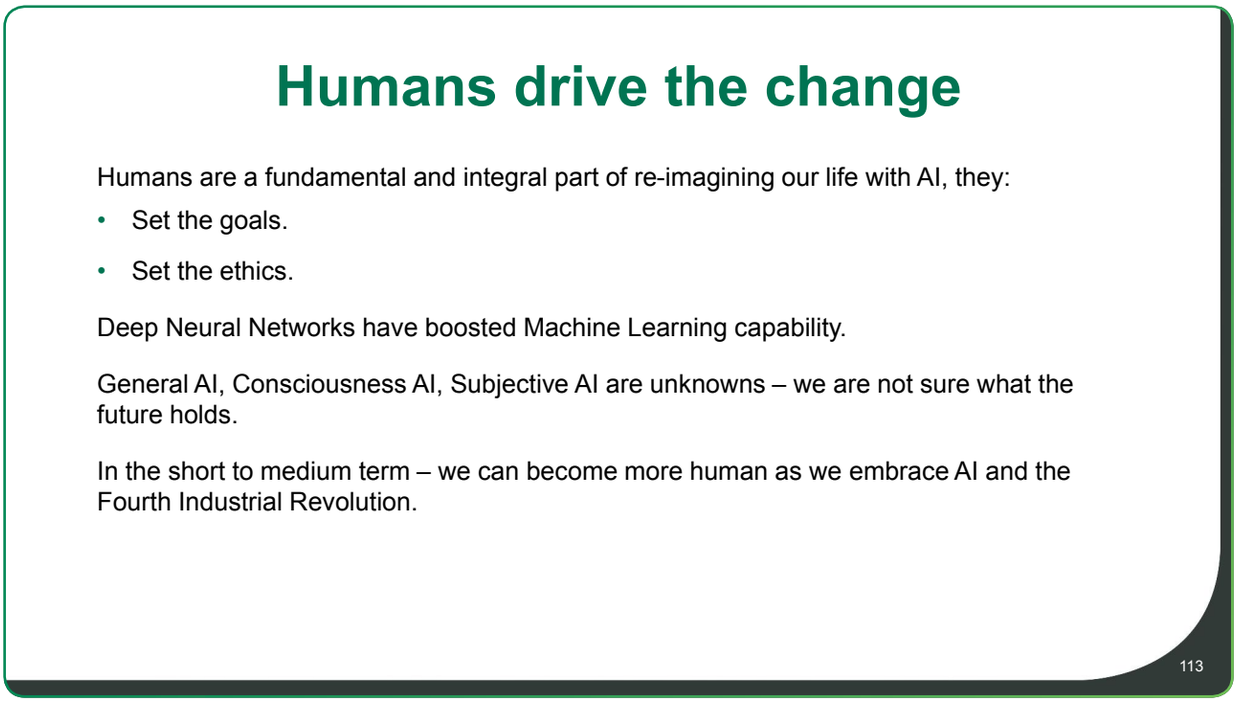
Describe the typical ways humans complement machines from Daugherty and Wilson.

Slide 112 – AI enhances humans by . . .



Describe how AI enhances humans from Daugherty and Wilson

Slide 113 – Humans drive the change

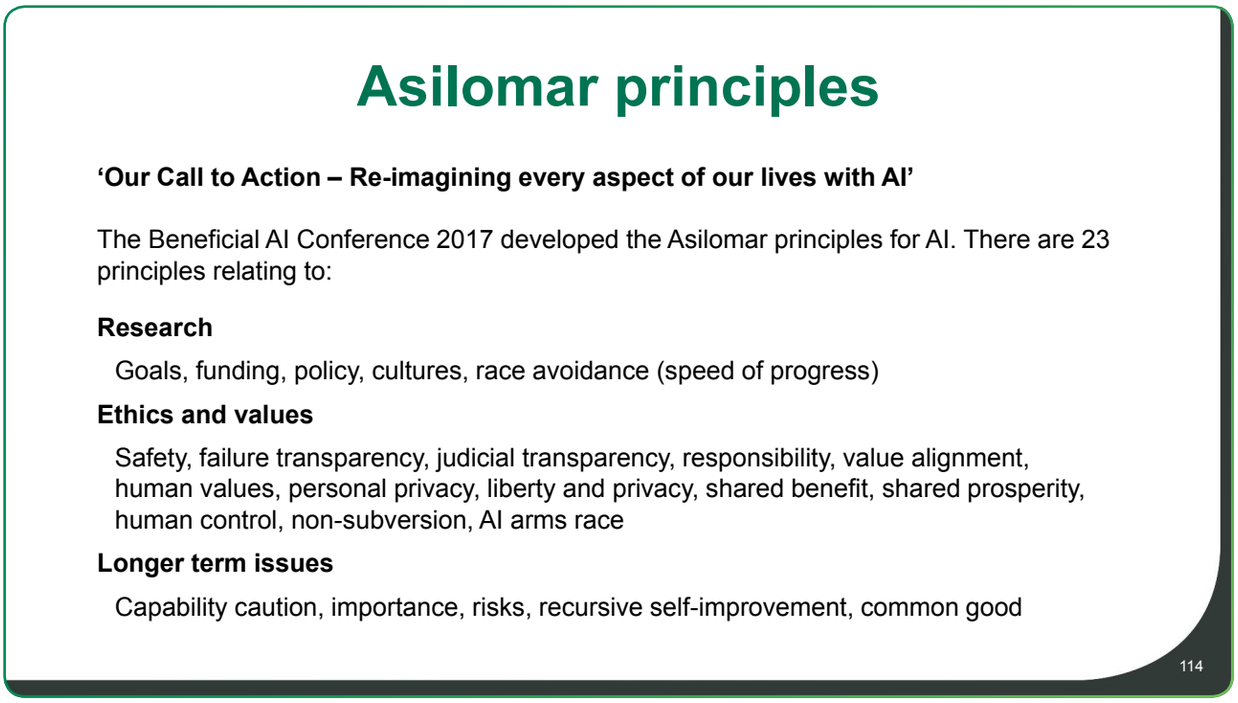


Explore what humans will do in the new era of AI in the Fourth Industrial Revolution.

Daugherty and Wilson claim we will become more human.

Stuart Russel says our future will be humans looking after other humans.

Slide 114 – Asilomar principles



Ethics is being driven by one international organisation in particular.

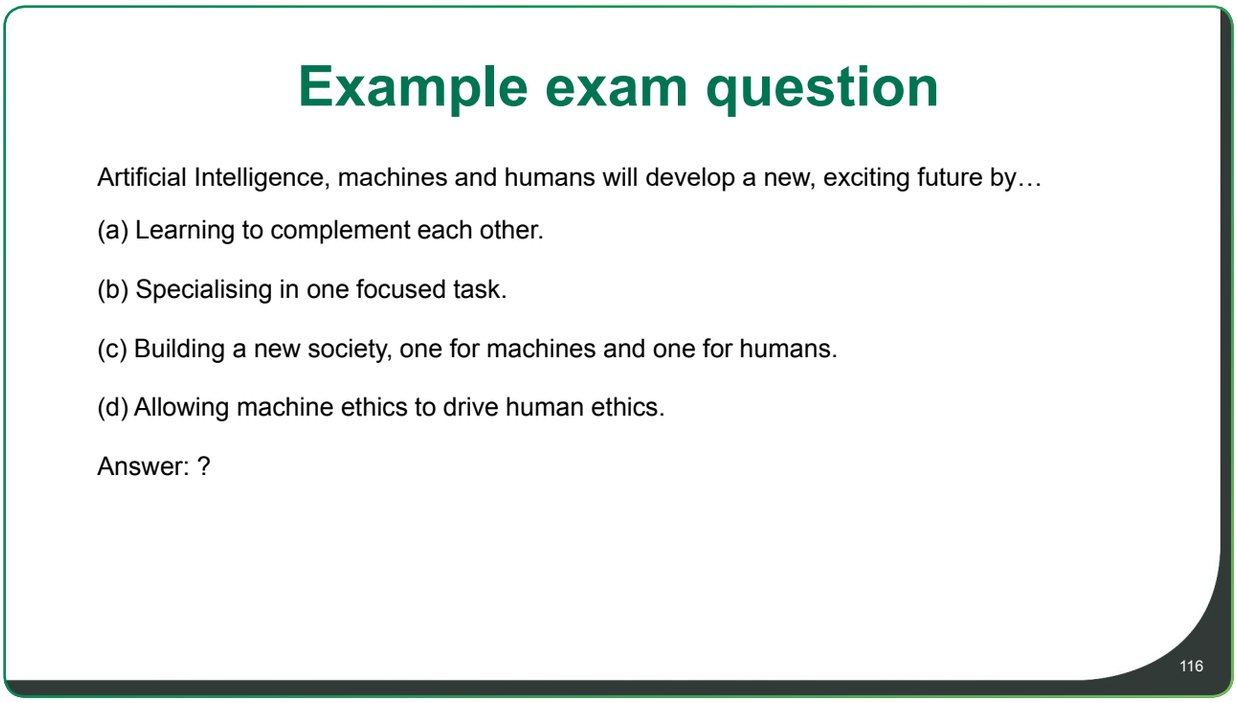
Explain the history of the Asilomar principles.

Mention that researchers and organisations are signing up to these principles.

Slide 115 – Get the KASH

Recap the session based on our Call to Action.

Slide 116 – Example exam question



The answer is (a). Explore the distractor answers with the group. Don't spend too long and let the group wonder.

Exercise Three
Re-imagining the future opportunities for AI and human systems

Slide 117 – Explore some of the key questions of what the future holds for human and machine augmented systems

See Exercise book. Exercise Three – Re-imagining the Future Opportunities for AI and Human Systems

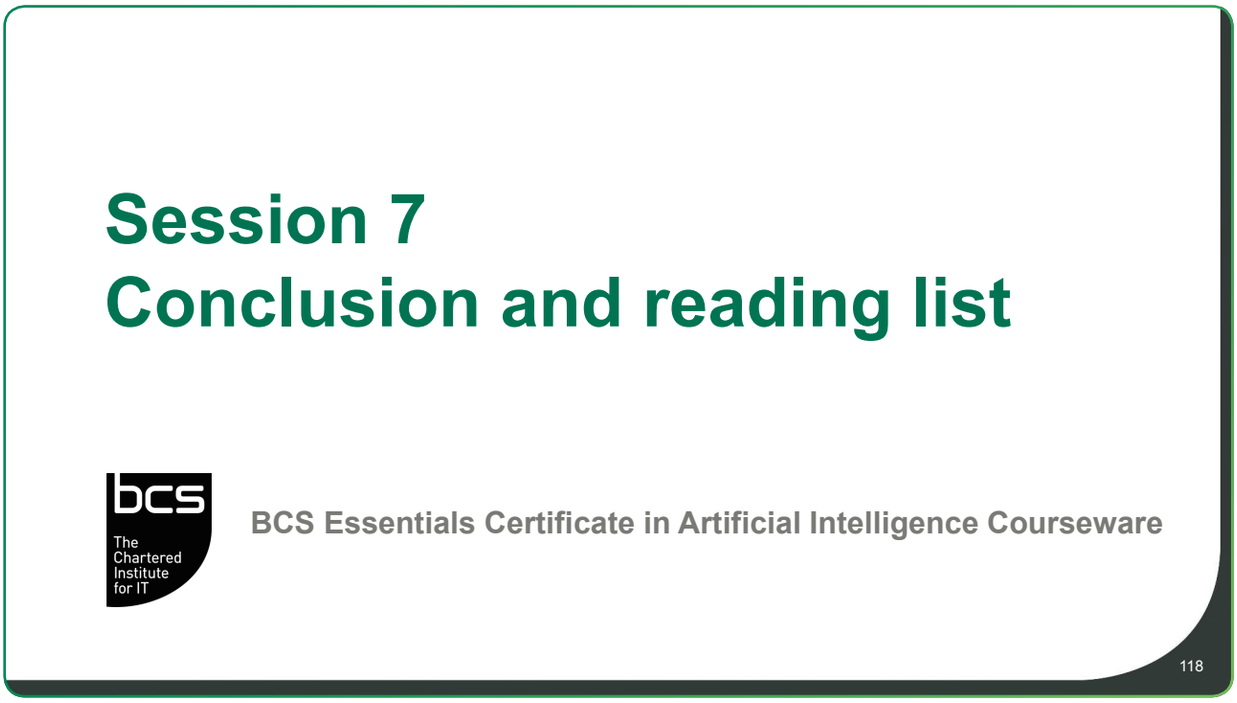
Objective: Allow participants to explore the future of AI and define a futuristic AI project. In doing so, start to build an understanding of where humans, machines and humans in combination with machines will be best suited to achieve a goal.

Tutor facilitated:

1. Spend a minute allowing the participants to develop an idea or ideas.
2. When everyone has attempted each question, go through them allowing each participant to give a quick overview of their answers.
   - Allow brief discussion but avoid over indulging in excessive debate.
   - Key is to build confidence in starting to define a futuristic AI project.
   - Remind people that AI is about building intelligent entities – where's the 'learning from experience'?
   - Remind people that humans and machines will work together (machines take up the heavy lifting) and that there will no doubt be ethical issues we will need to address!

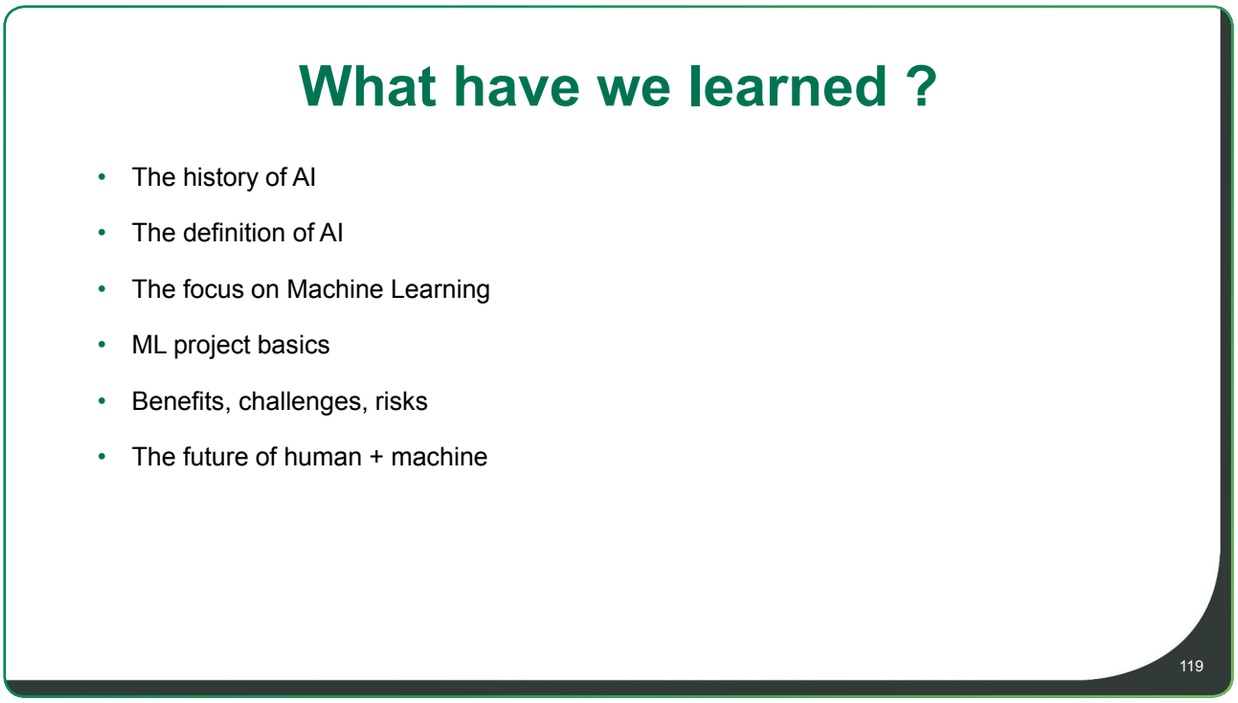
Session 7
Conclusion and reading list

Slide 118 – Title slide



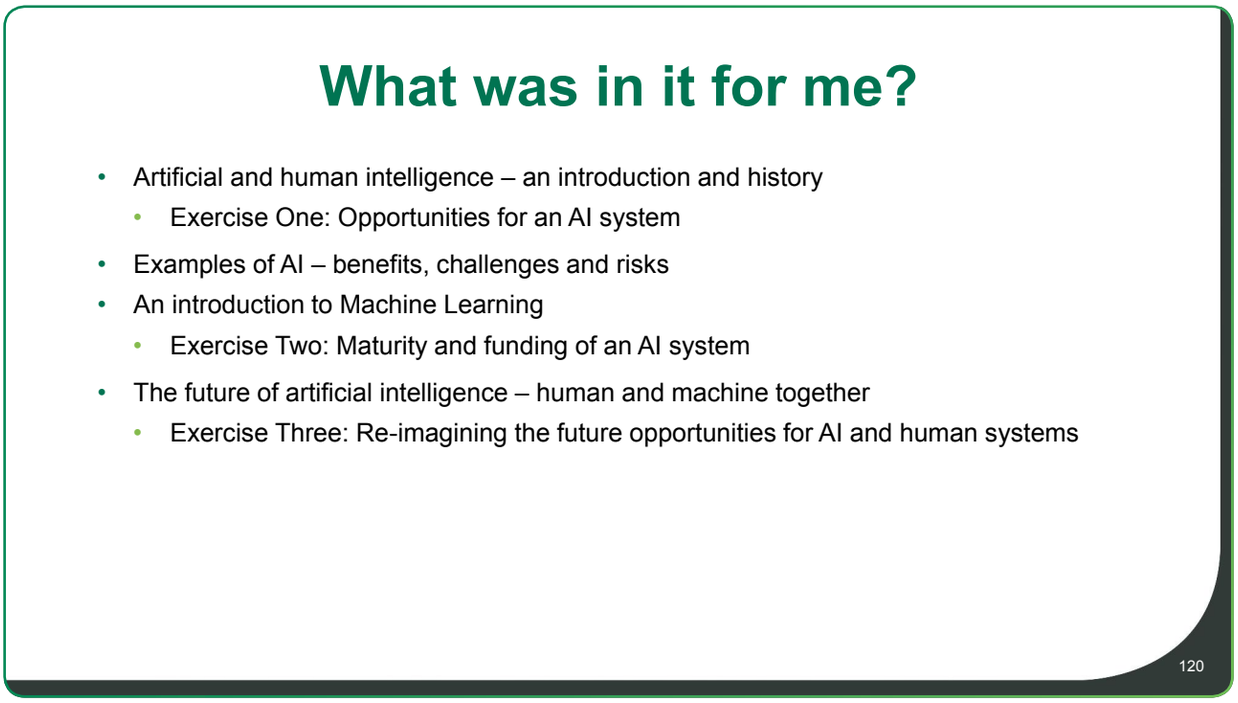
This is the final session.

Slide 119 – What have we learned?



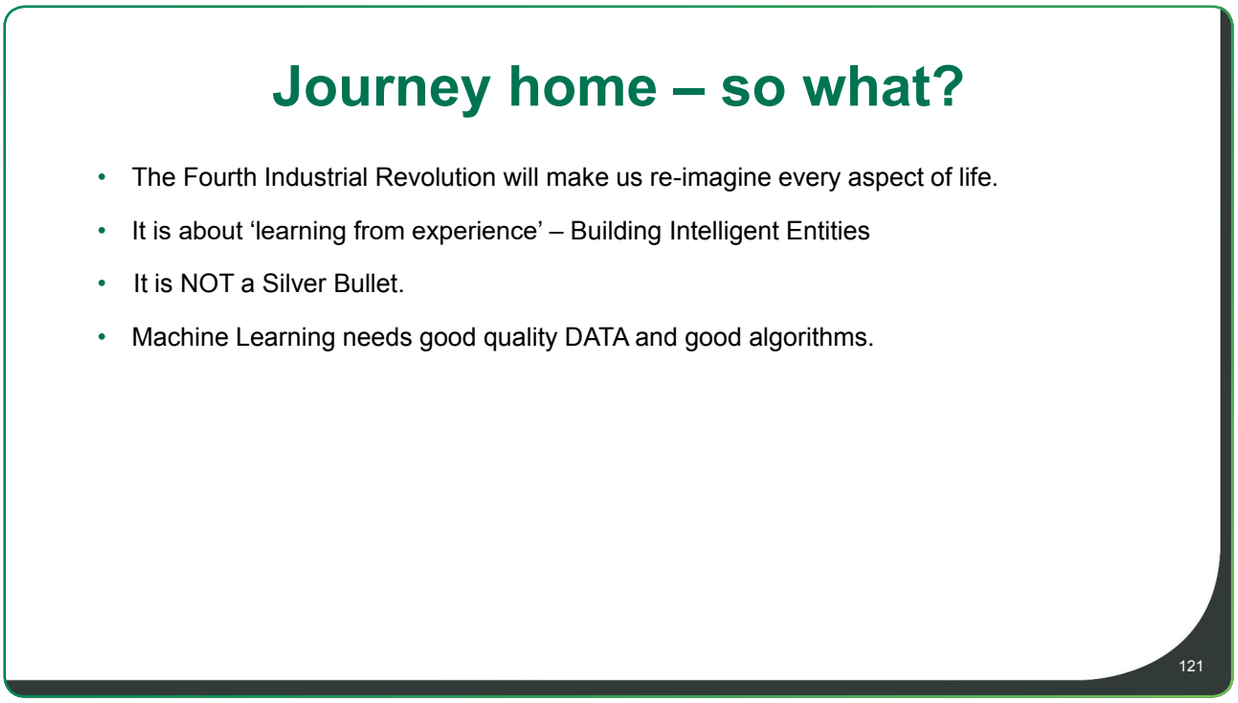
What we have learned. General recap, no specifics

Slide 120 – What was in it for me?



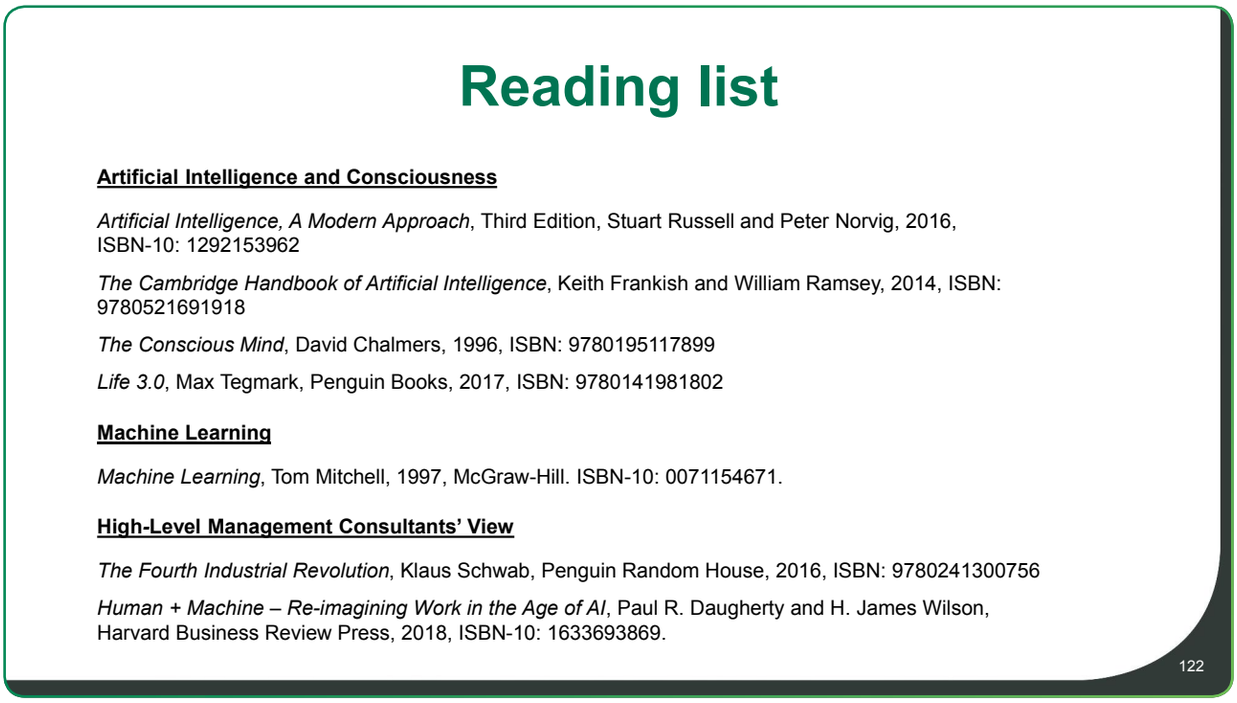
Explain what was in the course that will help their future AI projects and development.

Slide 121 – Journey home – so what?



Another recap of the main themes in the course – what the delegates can tell colleagues or family they learned on the course.

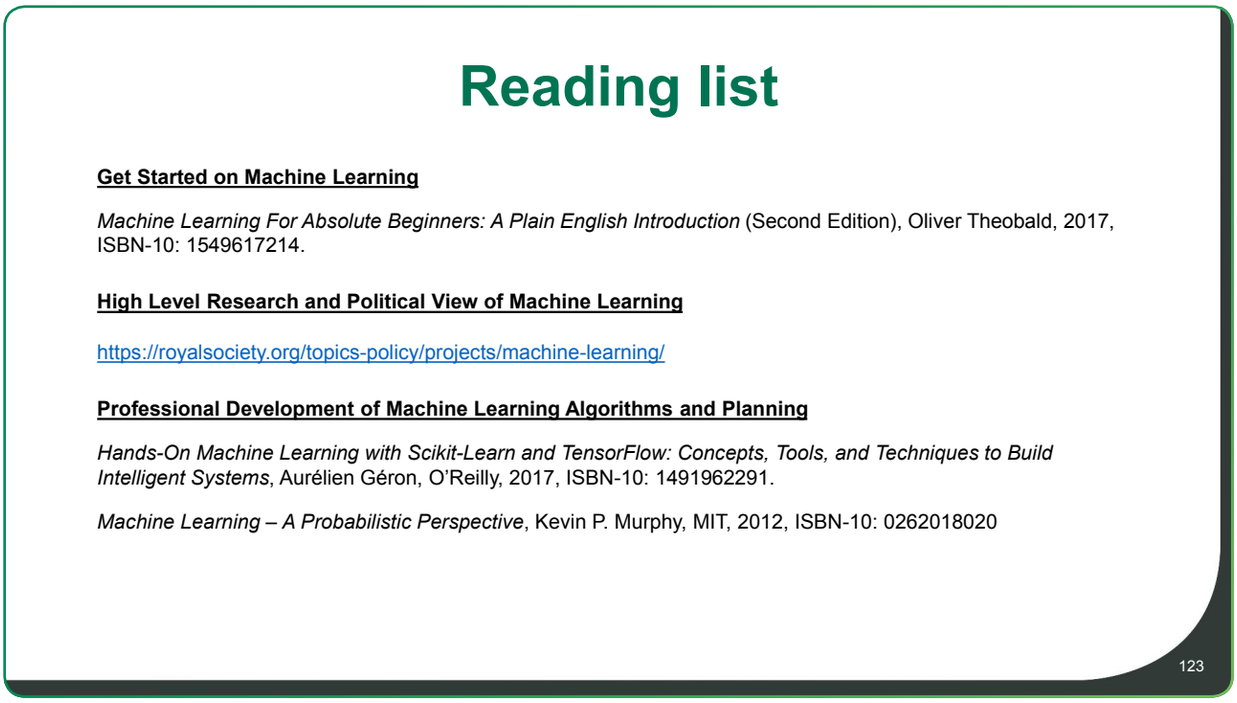
Slide 122 – Reading list



Go through the reading list book by book.

Give the delegates an idea of what to expect from these books.

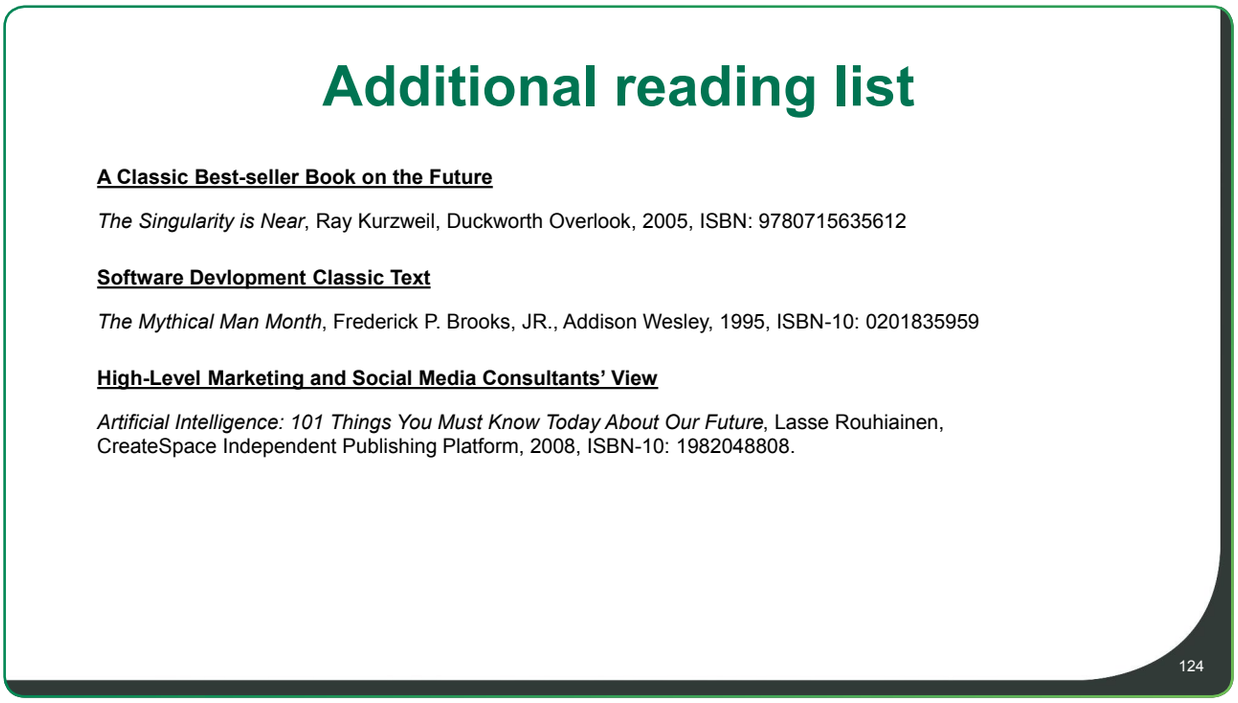
Slide 123 – Reading list



Go through the reading list book by book.

Give the delegates an idea of what to expect from these books.

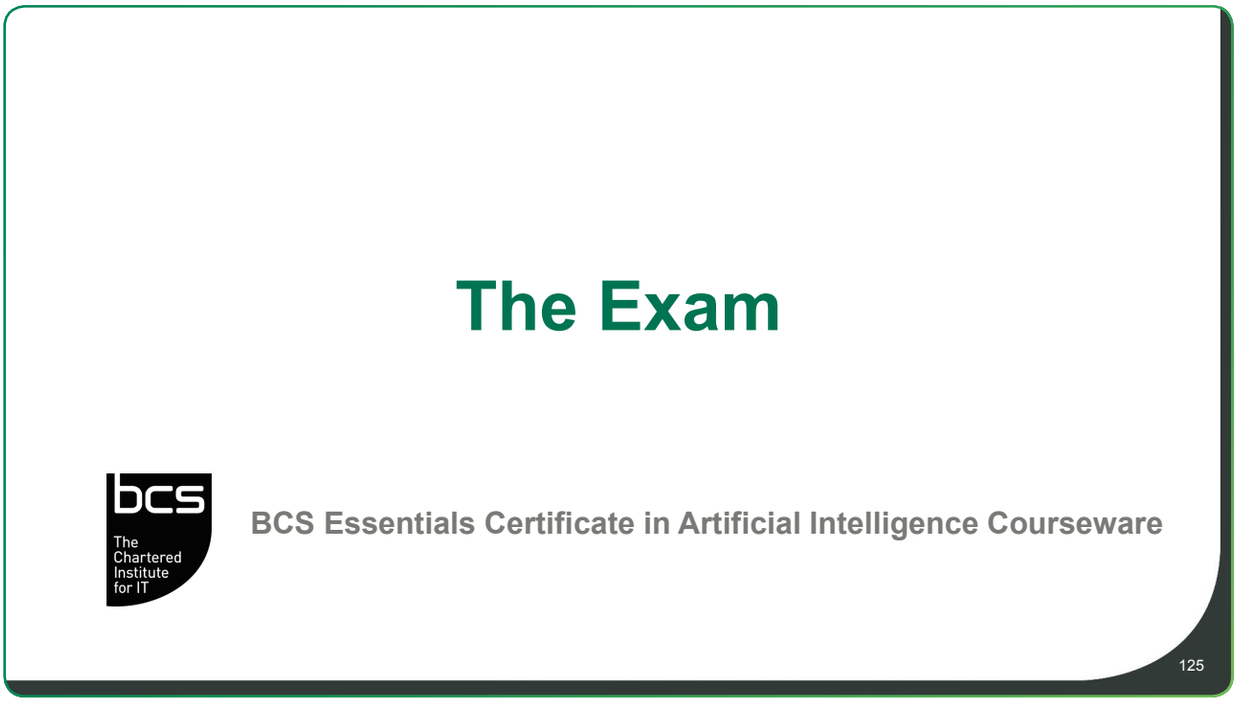
Slide 124 – Additional reading list



Go through the reading list book by book.

Give the delegates an idea of what to expect from these books.

Slide 125 – The Exam



The Exam