Using the *You and AI* lecture series in teaching

The complete lecture series is listed below and you may want to suggest to your students that they spend time watching the lectures in their own time. Additionally the lecture series could be used as the basis of CPD within your own departments.

You and AI – The History, Capabilities and Frontiers of AI
You and AI – The Practical Applications of AI
You and AI – The Challenges to Making Machines Play Fair
You and AI – The Politics of AI
You and AI – the future of work
You and AI – at the Manchester Science Festival
You and AI – Presented by Professor Brian Cox at the Barbican

Teachers from the Royal Society Schools Network have identified specific clips that you could use in your lessons and these have been edited as below:

Curriculum area: Computational Thinking: Abstraction, Decomposition, Algorithmic Thinking (Key Stage 3 and 4)			
Original Lecture	**Video title**	**Description of video clip and its potential use**	**Classroom ideas and stimulus questions.**
The History, Capabilities and Frontiers of AI	What do we mean by machine intelligence - is it possible?	Demis Hassabis, co-founder of Deep Mind, introduces the topic of what a learning machine is. The keyword "Algorithm" is used. Typically, an algorithm is conceived of as being single purpose, eg calculate Pi to 1000 places. The Deep Mind approach is to create a general learning algorithm that, when applied to new and unusual scenarios, is able to learn the rules of the scenario eg the rules for tic-tac-toe, chess, draughts without being given the rules for that scenario. Demis does concede that however such systems may be conceived, they have not really been successful yet and are no match for the human brain.	Is it possible to create a general learning algorithm that could be applied to any situation? What are current AI systems good at in relation to Computational Thinking? Topics would benefit from being introduced at Key Stage 3 or earlier. For example, observing board games and building rule sets around the observation. **GCSE** AQA – Representing Algorithms 3.1.1, Ethics and Impact 3.7 OCR – Ethical, Legal, Cultural Concerns 1.7, Computational Thinking 2.1

			A Level AQA – Consequences of uses of Computing 3.8.1, Abstraction 4.4.1.3, Automation 4.4.1.11, Turing Machine 4.4.5.1 OCR – Moral and Ethical Issues 1.5.2, Elements of Computational Thinking 2.1 Is it the case that computer systems are excellent at algorithmic thinking ie following rules but not so good at extracting what those rules are – **abstraction** – or defining precise problem areas – **decomposition**? The clip can be used to characterize what Machine Learning might be doing. Students, especially at Key Stage 4, sometimes struggle with the topic of "Computational Thinking" and the distinctions between the three major areas. They could be characterised as "isolating essential detail – **abstraction**", "building problem topics – **decomposition**" and "stating processes required to solve the problem – **algorithmic thinking**". Demis Hassabiss discusses the goal of a 'general purpose learning machine'. What he means by this is that from the observation of a set of actions a set of rules should be derived that can be applied to a wider set of problems. Take, for example, a pattern derived rule such as "where a driverless car is faced with colliding with 3 or 5 pedestrians it should choose the lower number". This rule could be turned into a more general rule such as "where life is in danger, save the most people". This rule could be applied to a robot designed to enter a nuclear powerplant that has gone into meltdown with staff trapped inside. Ask your class to discuss this and propose counter arguments to the rule. The above example is controversial – it does not take into ideas of social worth, blame (eg are any of the staff to be saved responsible for the meltdown?). You could follow this up with exploration of the Moral Machine to match the individual against the data set collected by the site. Ask, would a site such as this be useful for developing a general purpose rule on deciding who should be sacrificed? This is not a new dilemma developed out of computer science – the debate between Utilitarianism Vs Kantianism. Whilst some of the arguments rapidly become obscure, the basis of this is focused on outcomes Vs intent. Machine Learning tends towards a colder, outcomes based purpose

			that some believe removes the element of consciousness from the rules. This is an area that can be explored as part of a more general classroom exploration. An amusing but nonetheless foundation to this topic can be found here. The question could be reframed into “do we want computers to make general purpose rules?” That they can is becoming less doubtful. That they should is fraught with ethical pitfalls
The Practical Applications of AI	What can machines learn today?	This clip presents the history of speech recognition development from 1998-2018. It is a useful reference point to reflecting on how software and hardware has developed to the stage where error rates of 30% have reduced down to 6%. The current level of error rate is shown to coincide with the rise of Deep Neural Networks. Neural networks are a mathematical model used to train systems. Applications range from ANPR (automatic number plate recognition, through to predicting potential criminal behavior. As the driving feature of a neural network is a mathematical model, this lends itself to algorithmic processes.	In the classroom, collect responses on who uses voice to communicate with devices eg Alexa and Siri. Encourage students to explore other uses of voice. If your network and hardware allows for this, use Google Docs to create a document and ask students to dictate the same text (have a prepared document for them to use). Gather responses on how many mistakes the dictation algorithm made. Ask students to consider how the algorithm has been able to correctly interpret such a wide variety of voices. If there are a large amount if errors, ask students to explore why this might be so and how the Google dictation algorithm might overcome this. Students may need to be guided to arrive at the conclusion that it is primarily about pattern recognition. Using handwriting as the focus, ask students to handwrite a short piece of text. Encourage students to swap their original with other students and pose the question “What features does the other student’s text have in common with yours and what is different?” Students may need to be encouraged to dig deeper on this and consider aspects of slope of letter, how far above the ‘i’ the dot is, etc. Ask students to conclude what the defining characteristics are of certain letters eg ‘a’, ‘q’, ‘y’, ‘i’, ‘j’. Can a value be put on whether a letter conforms to the ideal or not eg if the letter ‘a’ when written conforms completely it has a value of 100%. As characteristics are not seen the percentage reduces eg if the tail on the letter ‘a’ is not present does this make it 90% like an ‘a’? Neural nets and speech recognition work on the basis that speech produces a pattern (that we understand speech is a function of repeated hearing of the

			same words from different sources. Sounds produce waves that interact with our ear mechanisms leading to us being able to recognise certain sounds). Use a program such as Audacity to record the same word/phrase several times using the same level of amplitude and modulation. Can students see common elements in their voice produced by the Audacity sound wave? Time permitting, screen print, print and cut the waves out. Layer on top of other student's versions. Can a pattern be spotted? Ask, 'which would be most likely to be recognised and which most likely to be rejected?' Can this exercise be used to form a general purpose rule on what the letters 'a', 'e', 'I', 'o' and 'u' might look like to a computer program looking for patterns in speech?
The History, Capabilities and Frontiers of AI	How do machines learn? "Deep" versus "shallow" learning in AI	The clip provides an overview of what a neural net/deep neural net is (a basic distinction is that a deep neural net has more layers than an ordinary neural net). The overriding point of this clip is that machine learning systems become better at their job eg distinguishing between cats and dogs as the amount of data it is presented with increases. As Demis indicates, the systems sometimes have millions of images presented to them.	**Discuss** is machine learning simply a case of pattern recognition? **Ask** How would you describe a table?", "How many tables might an alien need to see in order to be able to select a table as opposed to a bed/chair/plank of wood/LCD panel laying horizontally? This topic is not covered explicitly by the examination boards at Key Stage 4 in computer science. It has relevance at A Level in respect of algorithmic thinking and the handling of big data. At primary and Key Stage 3 this topic can be investigated by teachers at their discretion to explore the World around them and how testing information and matching it against existing data can produce a higher degree of certainty. **A Level** AQA – Big Data 4.11.1 OCR – Algorithms 2.3.1

The Politics of AI	When is a “criminal” not a criminal? Influencing lives of others with an algorithm	Kate Crawford raises a fundamental issue of machine learning systems. Using a crime classification database, Kate illustrates how pattern classification is only as good as the algorithm that drives it. This relates directly to the ethical consideration aspects of Key Stage 4 examined curricula. The ethical problem highlighted, eg classifying babies as gang members, is linked to the computational thinking aspect of curricula and raises the, not exclusively computer science related, issue of how much culpability do scientists have what they create? **Relevance** students need to be familiar with the Data Protection Act (GDPR is not yet examined but nonetheless important).	Ask students to create a list of ten factors that might indicate the likelihood of becoming a criminal (do your student background check first!). Instruct students to allocate a value of 1 to a ‘yes’ answer and 0 to a ‘no’ answer. Discuss what value might be used by the authorities to classify a person as a criminal. Would such a 10 point record be compliant with the DPA? Why/why not? “Should computer scientists be required to submit algorithms that have the potential to influence lives for prior approval before being applied to machine learning systems? **Curriculum Links:** National Curriculum **Key Stage 1 ~** recognise common uses of information technology beyond school **Key Stage 2 ~** collecting, analysing, evaluating and presenting data and information **Key Stage 3 ~** collecting and analysing data and meeting the needs of known users **Key Stage 4** **AQA** 3.7 Ethical, legal and environmental impacts of digital technology on wider society, including issues of privacy **OCR** 1.8 Ethical, legal, cultural and environmental concerns **Key Stage 5** **AQA** 4.8 Consequences of uses of computing **OCR** 1.5 Legal, moral, cultural and ethical issues

Curriculum area the topic runs across computer science, into ICT and digital citizenship. In respect of computer science there is opportunity to focus on program design. For example, if a program were designed to collect data and store it under labels, how would that labeling and storage be stewarded? In respect of ICT and digital citizenship, questions of how a student would judge the validity and veracity of search returns are raised			
The Politics of AI	What does a CEO look like?	Professor Kate Crawford examines bias within the field of Artificial Intelligence/Machine Learning. The clip exposes how training data might be inherently biased, portraying women as caring and men as violent. This is explained as being a result of classification. The clip goes further, indicating that search engines, such as Google, apply classification of words such as 'Jew' and 'gay' as being inherently negative.	**Task** Direct students to search, using different search engines, for images of child care. Students should view the first 10 images returned and count the number of adult women and adult men are spotted in total. Appoint students to collect the data and calculate the total men and women seen eg if a class of 25 students, how many men across 250 images. Open up the investigation to other areas that could be safely investigated. AQA make a specific reference to the issues in their A Level syllabus. Across the curriculum, both computing a wider context, this is a topic that warrants exploration as it challenges the ideas of stereotypes and the impact that this has. Students should be encouraged to answer the question 'Are search algorithms biased?'' 'How would you prove your answer either way?' **Consider** maybe the bias is not as bad as it seems. Try searching on 'teachers'. Ask students to count the number of male Vs female teachers. Did students come anywhere near the UK split of 26% of teachers being male and 74% being female?
Curriculum area this topic has relevance for business studies, economics, finance and PSHE alongside the computer science consideration of technological impact.			
The Future of Work	The Parable of the Alarm Clock	Professor Diane Coyle recounts how the now defunct job of the 'knocker upper' was usurped by the technology of the alarm clock and considers how this might have a parallel with respect to AI.	**Ask** "Are the effects of machine learning/AI likely to improve society – focus on financial impact?" **Task** generate a consensus list of effects and divide them broadly into two halves. Ask students to explore whether groups eg male/female, skilled/unskilled, minority are likely to be affected negatively or positively.

		The general thrust of her consideration is that history has a lot to teach us as society often leaves it too late to ameliorate the effects of technological disruption.	This has relevance when considering the wider societal effects of change. For example, epochs in history are noted by their impact, both negative and positive. The Industrial Revolution saw a massive swing away from Agrarian, rural life to mechanized, urban life. A history teacher may investigate this topic further. Economics, most likely at A Level would benefit from investigating cause and effect and the impact on society. The Geography syllabus at Key Stage 4 would benefit from an investigation of this topic area. The digital divide, a topic buried in the GCSE syllabus for OCR and AQA is related to the development of Machine learning – individuals and groups with the power and resources to harness ML are at a financial advantage with the possibility of greater positive impact whilst less developed groups are likely to be impacted by the further automation of jobs leading to a more restricted pool and amount of jobs available for some. Wider PSHE topics across the Key Stages include areas such as impact on economic immigration, potential for instability in governments as economies are affected.
The Politics of AI	What kind of World do we want?	Professor Kate Crawford examines the issue of technology driving the environment that we live in, in particular the abuse of power that may arise. She puts forward the idea that we should ask “What kind of World do we want and how can we harness technology to deliver this?” **Relevance** students will either be the benefactors or victims of technological change. As workforces transform, career paths will disappear to be replaced by new areas eg who would have thought in 1975 that we would need an army of cyber security experts in 2019?	**Task** ask students to consider which careers are most likely to be disrupted by AI. Use, for example https://blog.hubspot.com/marketing/jobs-artificial-intelligence-will-replace. Other searches will reveal what forecasters believe will change in the workforce. This could be used by the careers service in schools. Are students being guided into careers that may not exist in the next decades? Controversially, ask “will there be a need for computer programmers if algorithms on learning are effective?”

		At a whole school level, this series of clips can be used to engage students in the consideration of how they relate to technology as contributing citizens.	
The History, Capabilities and Frontiers of AI	Don't blame the tech.	Demis Hassabis considers the issue of how technology might be used. Early in the clip he states that the 'technology is neutral'. Using this statement, encourage your students to debate that statement. Raise the point that whilst the technology might be 'neutral' the creators cannot hide behind this	**Task** referring back to the clip featuring Kate Crawford, ask the students to discuss how they as adults might influence governments and technology companies to ensure that we have the World that we want and not the World that politicians and tech CEOs may want. This links into the ethical and legal concerns of the examination boards at GCSE and A Level. It also has a much wider curriculum focus and parallel eg soldiers and others claiming that they were following orders, scientists struggling with the dilemma between being able to create and solve problems eg Alfred Nobel and the Manhattan Project scientists. A more contemporary aspect of this is the use of data and algorithms to sway opinion eg Fake News, Facebook and related topics.
Curriculum area in both Key Stages 3 and 4 students are required to gain an understanding of architecture with particular reference to Von Neumann architecture (basis of modern computers). The theoretical idea of a Von Neumann architecture arises in 1945 and may have influenced Turing in his 1950 paper. The Turing Test can be conceived as using a stored program concept – the core of Von Neumann's idea.			
You and AI Presented by Professor Brian Cox	Is it all down to Turing?	The early history of AI is raised with reference to Alan Turing and the "Turing Test". The basic problem, posed by Alan Turing in the 1950s, was "Can machines think?" The short clip has relevance across the curriculum, pointing to the long history, in computationally comparative time, of machine learning.	Basic computational actions are carried out via sets of instructions. The Turing Test requires that a very basic set of instructions be followed. **Ask** "Is it possible to create a system that, when unseen, convinces another human that it is not a computer?" **Task** allow students to use a chat bot such as https://www.cleverbot.com/ **Ask** "How convincing was the chatbot? How well did it answer questions? How might the chatbot be doing this?" **Consider** Safeguarding is fraught with difficulties – ensure that any chatbots used compliant with safeguarding policies.

			Ideal topic at **Key Stage 2 and Key Stage 3** to encourage students to explore AI/ML. At **A Level** this is specifically used by AQA as an examined topic 4.4.51. Turing Machine. At **Key Stage 3** students should be encouraged to investigate Alan Turing from a historical computer science perspective alongside the algorithmic perspective. In respect of the **PSHE** curriculum, this topic has relevance to prejudice and tolerance – dealing with the question of homosexuality and how homophobia can impact.
You and AI Presented by Professor Brian Cox	Is it intelligence, learning or just mimicry?	The clip explores the idea of what AI is. The panel gives an overview of what they think AI might be with reference to machines learning. This follows on from the previous clip and student exercise. It has links to the concept of programming and logic.	**Ask** "What would an AI/ML system look like? How could one be developed?". As users of systems, students interact with programs on a daily basis. As ***computer scientists*** students need to acquire a more mature appreciation of the mechanics of systems. **Task** Introduce students to the **roboMaster.py** program. Encourage them to load and run the code and answer the questions. The system has a very narrow focus, to establish how a user is feeling. It has an inbuilt capability to acquire new knowledge (is user experiencing sadness, happiness or tiredness) based on submission of terms. For example, the system does not know what category the adjective 'annoyed' fits into. If a user submits that word the system will ask the user to classify it. Although simplified, the system allows new knowledge to be acquired. The next time that word is input the system will recognize it. **Ask** "How could you develop the roboMaster machine learning system?"

			Curriculum: **National Curriculum** **Key Stage 2** Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts **Key Stage 3** Use two or more programming languages, at least one of which is textual, to solve a variety of computational problems Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems **Key Stage 4** **AQA ~** 3.1.1 Representing Algorithms, 3.2.2 Programming concepts, 3.2.7 Input/output **OCR ~** 2.1 Algorithms, 2.2 Programming techniques, 2.3 Producing robust programs **Key Stage 5** **AQA ~** 4.1.1.2 Programming concepts, **OCR ~** 2.2 Problem solving and programming
You and AI Presented by Professor Brian Cox	Going to the Movies	The video clip exemplifies how real-time AI can be applied. A human actor is filmed, using multiple cameras, and from that an animated model is created. This allows the system to place the real-time video in a different context and apply a new skin to the model.	**Ask** “What applications might this system have outside of the film and media industry?”

			The growing use of augmented and artificial reality links into this topic area. This is not examined in the current computing curricula but does link into the topic of creativity at Key Stage 3 While relevant across the computer science curriculum it also has links into media based curricula at Key Stage 4. **Curriculum:** **OCR** GCSE Film Studies Component 2 **Educas** GCSE Film Studies component 1 At Key Stage 3: Understand the hardware and software components that make up computer systems, and how they communicate with one another and with other systems Undertake creative projects that involve selecting, using, and combining multiple applications, preferably across a range of devices, to achieve challenging goals
You and AI Presented by Professor Brian Cox	Applications for good	The short video clip provides some answers to the above question	Show the clip after the students have had the opportunity to reflect on how the system in question could be used. This relates back into the topic of ethics and computer science. Any subject where analysis of movement is key such as dance, PE and sport science would benefit from understanding of how this strand of MI could be of benefit as way of pointing how performance might be improved.
Curriculum area Bullet 1 of the National Curriculum, Aims: "All pupils … can understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation"			
You and AI – The Practical	I don't know what AI is but I do know	Hypothesis	Starter So, what is a machine learning and why is it important?

Applications of AI	something else	Artificial Intelligence (AI) does not = Machine Learning (ML)
		
		o AI is an abstract concept (An idea)
		o ML is a process (An action):
		  That is carried out using algorithms
		  That are designed to fulfil a purpose eg identify the size and site of a tumour
		  So that medical practitioners are better placed to diagnose and take action to cure/prevent/alleviate cancer and its consequences
			Look at 10 different images of butterflies
			From the 10 images, what can you tell me that each image has in common? Create a list, writing each point on a separate line.
			
			Compare the lists with a partner. Where you agree on a point, eg butterflies have 4 legs, write the number 1 next to it. Where you have written a point but your partner has not, write the number 0.5 next to it.
			
			Find the average of your points eg:
			
			1, 1, 1, .5, 1, .5, .5, 1, 1, 1 = 8.5/10 = .85
			
			Well done, you have produced an algorithm that carries out machine learning!
			
			You can now apply your 10 points to images of butterflies you have not seen before. The higher the average is above .5 the greater the likelihood that what you are looking at is a butterfly.
			
			Curriculum: National Curriculum
			
			Key Stage 1
			
			Recognise common uses of information technology beyond school
			
			Understand what algorithms are; how they are implemented as programs on digital devices; and that programs execute by following precise and unambiguous instructions
			
			Key Stage 2
			
			Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs
			
			Key Stage 3

			Design, use and evaluate computational abstractions that model the state and behaviour of real-world problems and physical systems Undertake creative projects
You and AI – The Practical Applications of AI	Can you tell what it is?	In this section of the Video, Professor Steve Young explores how cancerous cells and growths can be identified by the application of Machine Learning. The classroom activity extends the idea into classification of butterflies. There is a direct link in respect of abstraction. Computer systems do not know whether it is pictures of butterflies or growths that are being looked at. The images are simply a set of binary digits. Those with a pattern close to each other are deemed to be part of the same taxonomy.	Development from above activity: With a partner, agree 10 features of a butterfly. Using 5 images of butterflies and 5 images of birds, calculate the likelihood of the image being a bird or butterfly. Use the “Butterfly ID” recording template. The closer to an average of 1, the more likely it is you are looking at a butterfly. The learning machine is now being used to apply a taxonomy. Not only are you identifying what may be butterflies but you may, as a consequence be identifying birds as well – the lower the score the more likely it is that the image is of a bird. Discuss the need to take into account the features that may distinguish a bird from a giraffe and a butterfly. The decision that an image is not a butterfly does not automatically make it a bird. This provides the link into the massive data sets that are required by machine learning algorithms to make predictions. This exercise can be developed in the primary and Key Stage 3 curriculum.
You and AI – The Practical Applications of AI	You’ll need your hat and coat – how AI keeps us dry	The video segment focuses on the use of computer systems, and in particular ML, to improve weather forecasting. Dame Julia Slingo explores how accurate weather forecasting requires the handling of two aspects of data: massive quantities and rapidly changing data sets. She shows how this is an ideal topic for the development of ML.	Ask “How can using machine learning enable humans to make intelligent decisions?” At Key Stage 5 this topic is specifically examined under the topic of Big Data by AQA.

			Across the curriculum, the use and analysis of massive data is an aspect of advanced mathematics and physics. At Key Stage 4, this topic whilst not specifically examined is a useful way to consider how computer programs are essentially used ot work with massive data sets very quickly but that it needs the correct set of algorithms applied.
You and AI – The Challenges to Making Machines Play Fair	A sense of identity – machine learning and medical diagnosis	The video segment explores how brain tissue is examined to identify healthy, infected and at risk brain cells.	Using the butterfly identification experience, explain the algorithm used to predict whether an image is a butterfly. How can the algorithm be modified so that the processes can be applied to classifying other objects or events, eg identifying a tumour, whether a planet can support life. This topic is ideal for use at Key Stage 2 and 3. It provides an opportunity to explore how algorithms are developed to identify objects. This leads to consideration of programs and programming thereby linking the two aspects together.