University of Roehampton London

Computing in English schools: Lessons to learn for AI education

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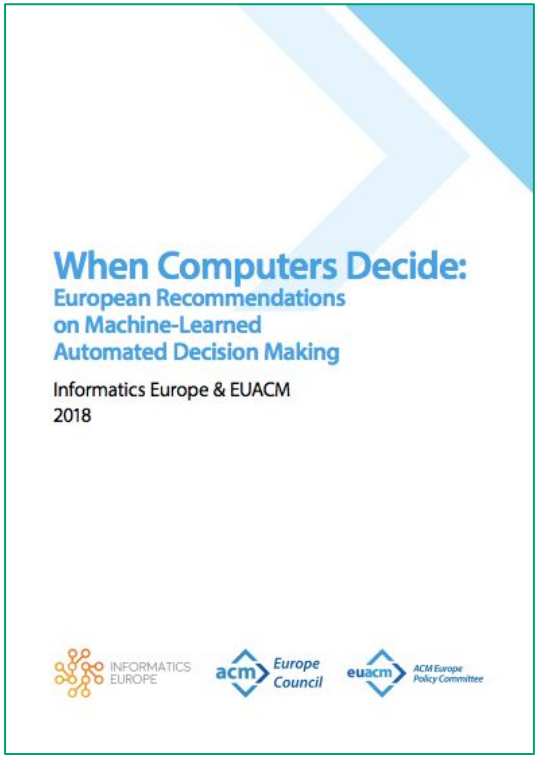
9 November 2019
These slides: bit.ly/aaai19slides

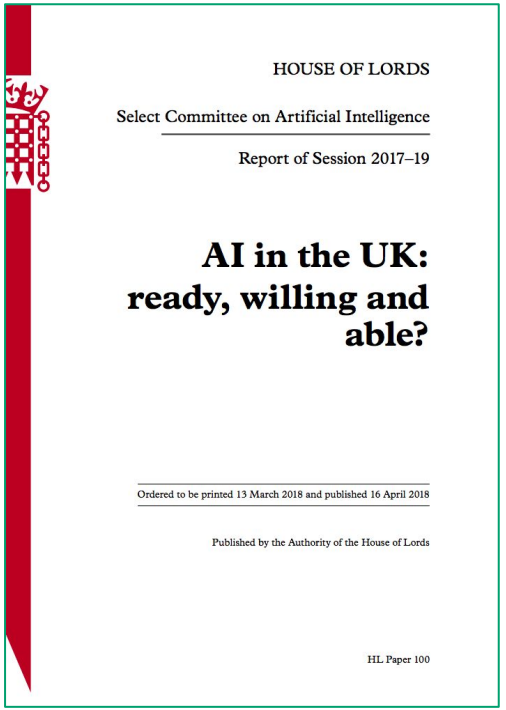
A basic understanding

In the near future, perhaps sooner than we think, virtually everyone will need a basic understanding of the technologies that underpin machine learning and artificial intelligence.



For some, or for all?

Children need to be adequately prepared for working with, and using, AI. **For a proportion**, this will mean a thorough education in AI-related subjects, requiring adequate resourcing of the computing curriculum and support for teachers. **For all children**, the basic knowledge and understanding necessary to navigate an AI driven world will be essential. In particular, we recommend that the ethical design and use of technology becomes an integral part of the curriculum.



HOUSE OF LORDS

Select Committee on Artificial Intelligence

Report of Session 2017–19

AI in the UK: ready, willing and able?

Ordered to be printed 13 March 2018 and published 16 April 2018

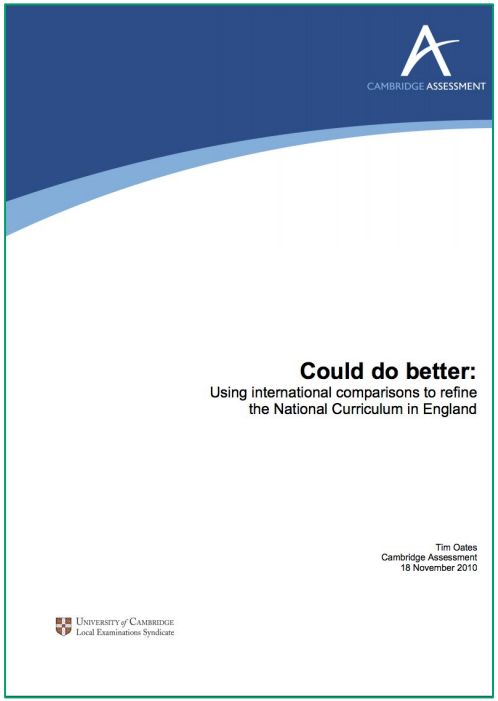
Published by the Authority of the House of Lords

HL Paper 100

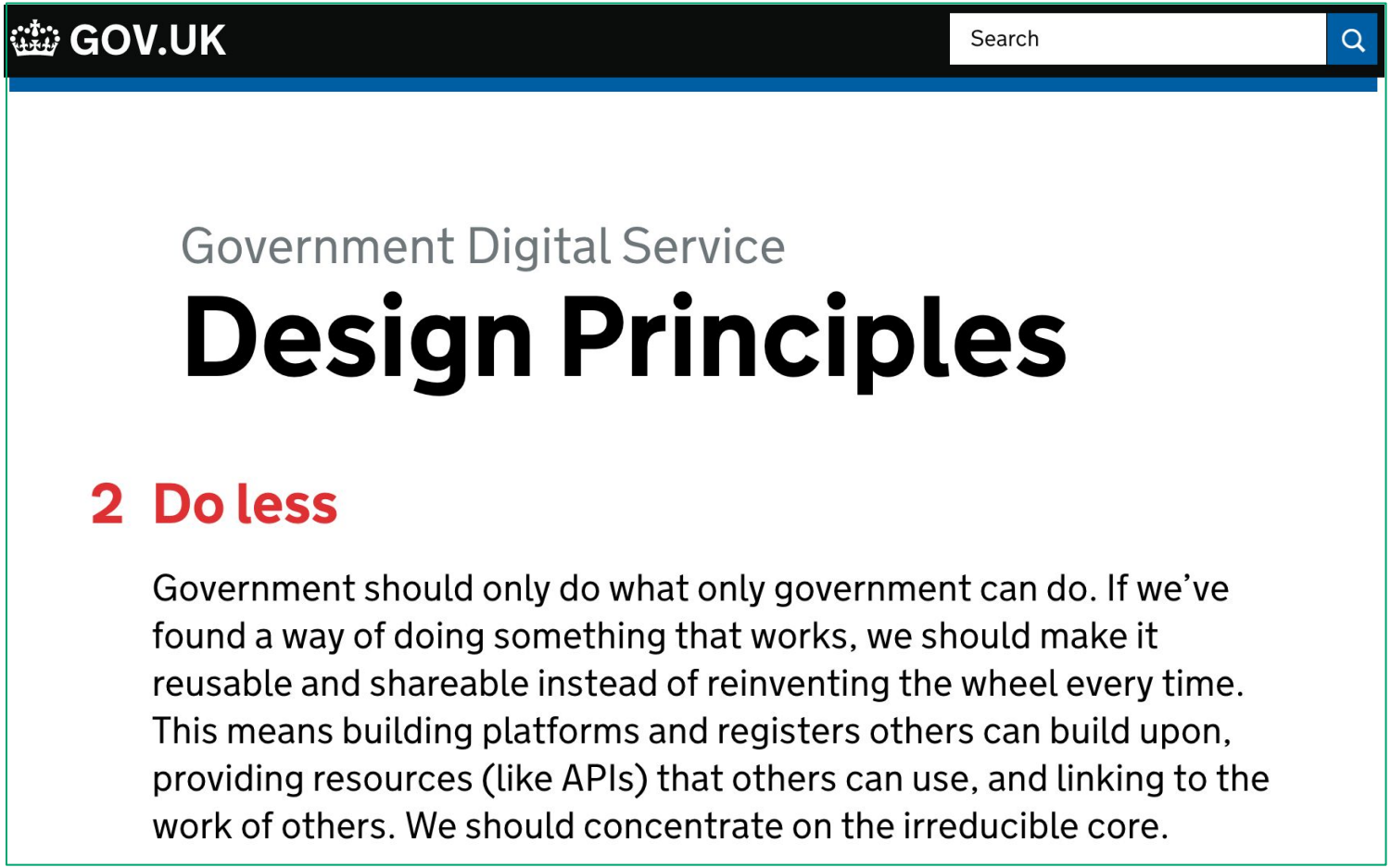
Curriculum coherence

Curriculum Coherence

The term ‘coherence’ is a highly precise technical term: a national curriculum should have content arranged in an order which is securely based in evidence associated with age-related progression, and all elements of the system (content, assessment, pedagogy, teacher training, teaching materials, incentives and drivers etc) should all line up and act in a concerted way to deliver public goods



Oates, 2010


GOV.UK
Search
Government Digital Service
Design Principles
2 Do less
Government should only do what only government can do. If we've found a way of doing something that works, we should make it reusable and shareable instead of reinventing the wheel every time. This means building platforms and registers others can build upon, providing resources (like APIs) that others can use, and linking to the work of others. We should concentrate on the irreducible core.

Content

What is the curriculum for?

General duties in respect of the curriculum

78 General requirements in relation to curriculum

(1) The curriculum for a maintained school or maintained nursery school satisfies the requirements of this section if it is a balanced and broadly based curriculum which—

(a) promotes the spiritual, moral, cultural, mental and physical development of pupils at the school and of society, and

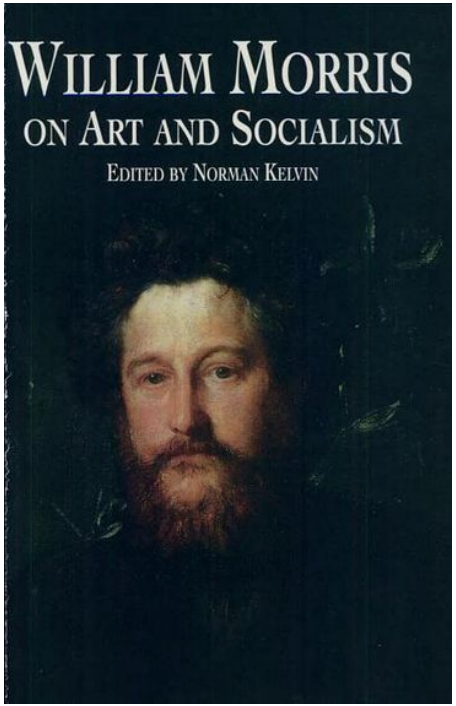
(b) prepares pupils at the school for the opportunities, responsibilities and experiences of later life.

Education Act, 2002

Beauty or utility?

If you want a golden rule that will fit everybody, this is it:

Have nothing in your houses that you do not know to be useful, or believe to be beautiful.



Morris, 1880

AI in the English computing curriculum?

Aims: **can evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems**

5-7: recognise common uses of information technology beyond school

7-11: use and combine a variety of software (including internet services) to create, systems and content that accomplish given goals, including analysing and evaluating data and information

11-14: undertake creative projects that involve using, and combining multiple applications, to achieve challenging goals, including analysing data

14-16: develop and apply their analytic, problem-solving, design, and computational thinking skills

16-18 (AQA): project suggestions include an application of artificial intelligence; investigating an area of data science using, for example, Twitter feed data or online public data sets; and investigating machine learning algorithms.

Foundations

Computer Science

Applications

Information Technology

Implications

Digital Literacy

Foundations

Artificial Intelligence

Applications

Machine Learning

Implications

Ethics

Foundations

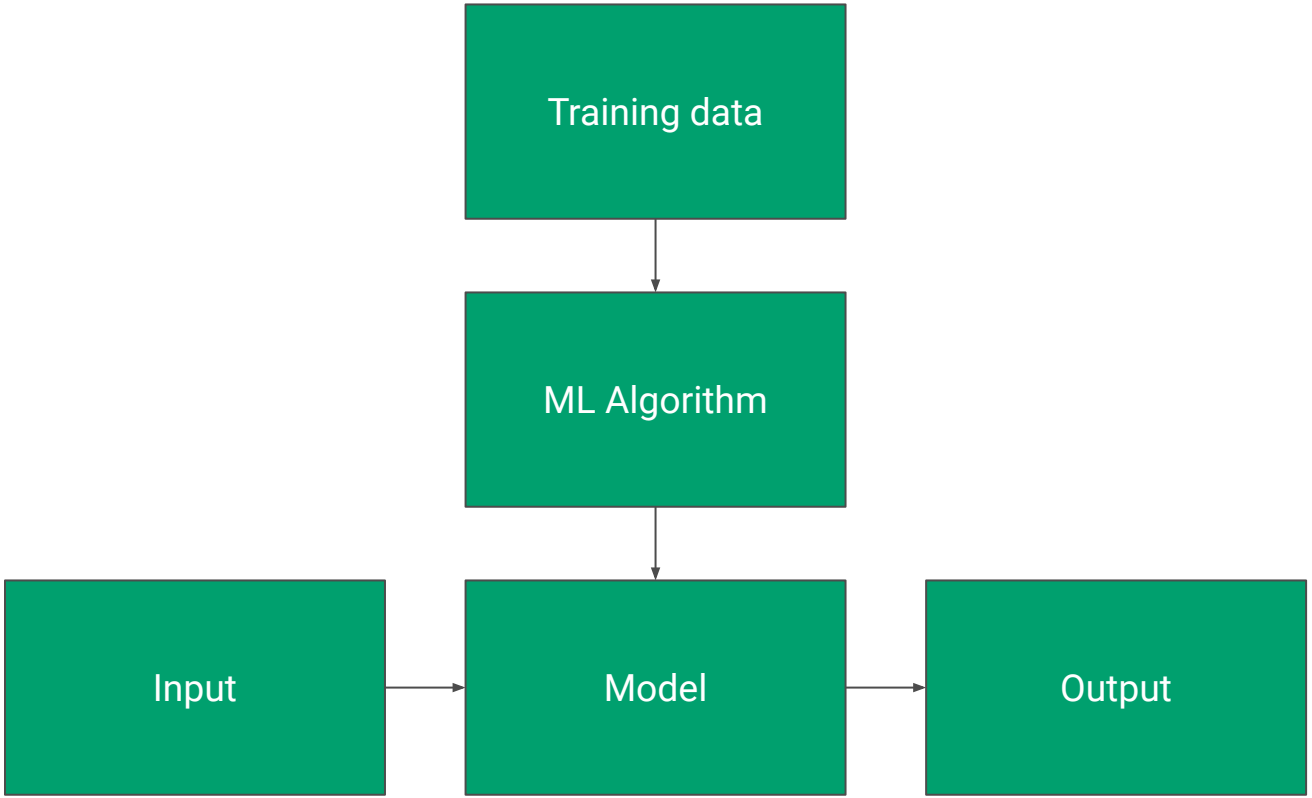
Thinking Humanly	Thinking Rationally
"The exciting new effort to make computers think . . . *machines with minds,* in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning .. ." (Hellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al,* 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure **1.1** Some definitions of artificial intelligence, organized into four categories.

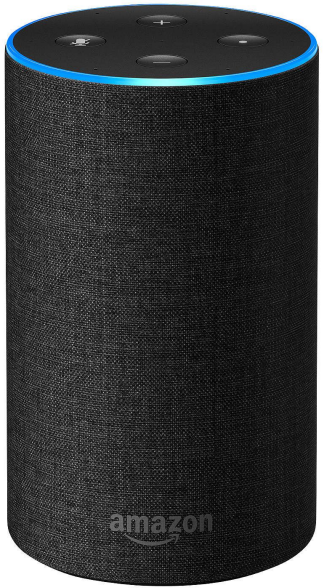
Russell and Norvig, 2010

Foundations

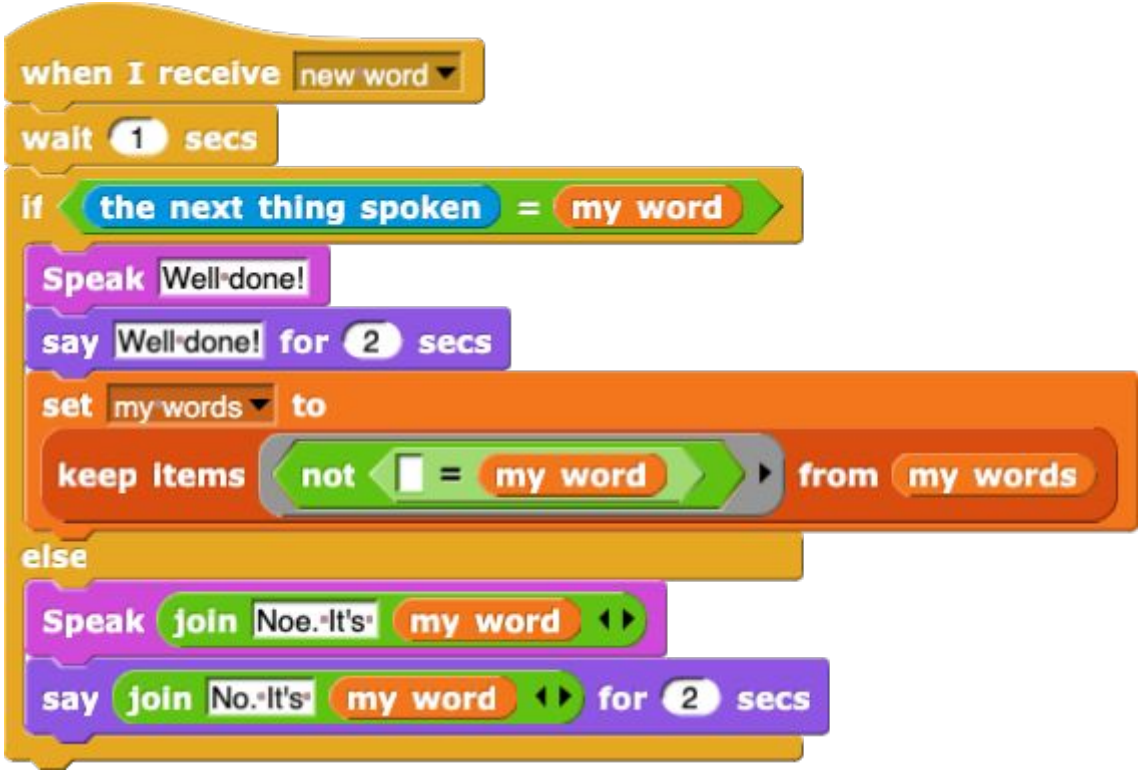
Foundations



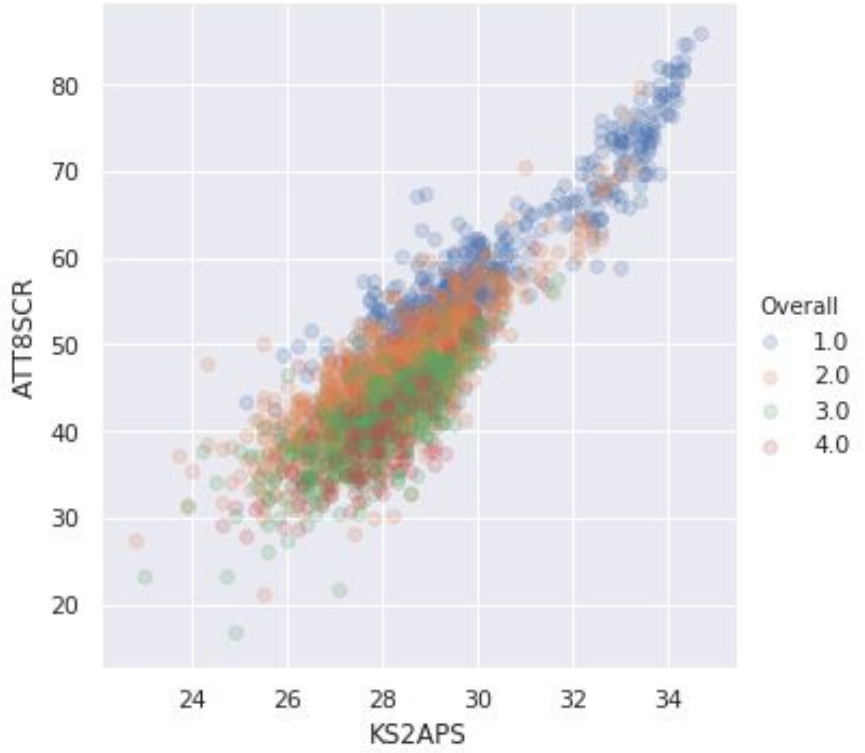
Applications

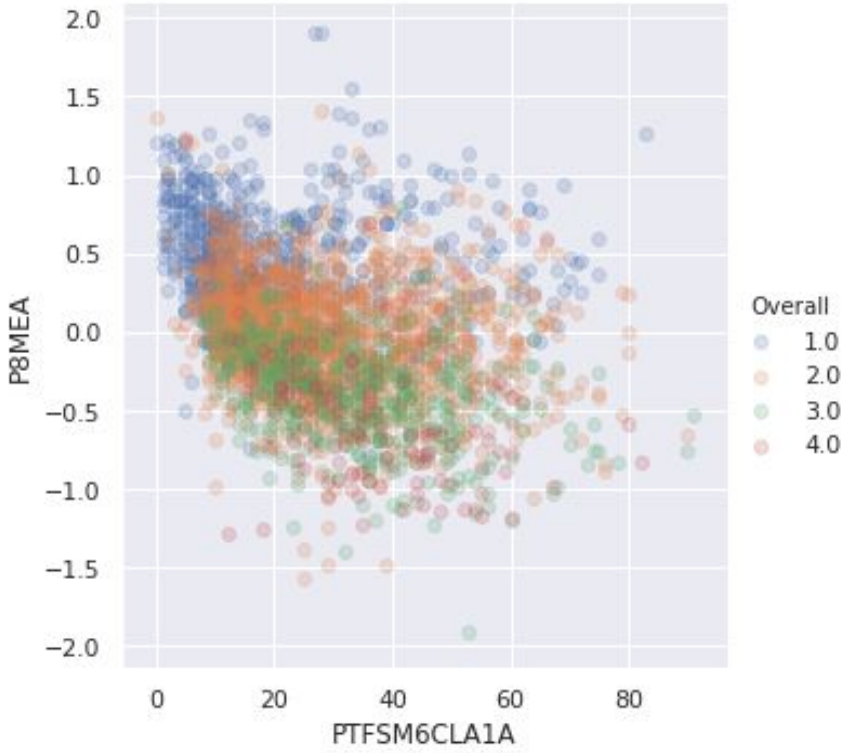


Applications



Applications





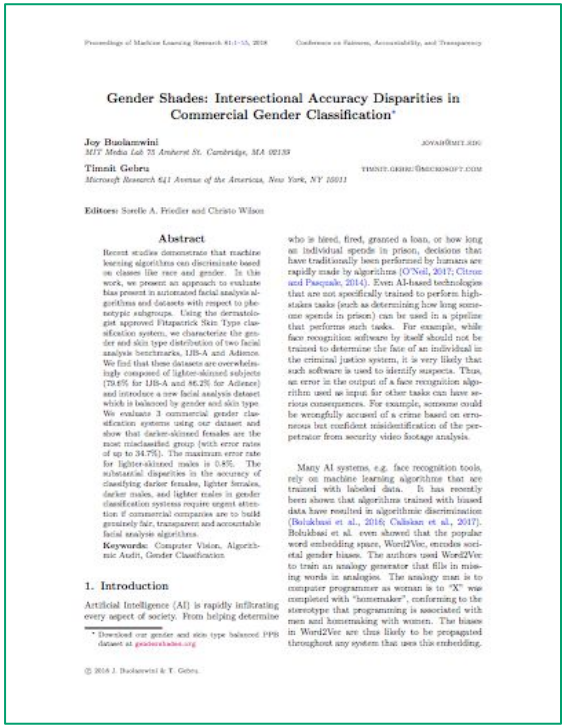
qv Harford, 2018

Implications

Using the dermatologist approved Fitzpatrick Skin Type classification system, we characterize the gender and skin type distribution of two facial analysis benchmarks, IJB-A and Adience.

We find that these datasets are overwhelmingly composed of lighter-skinned subjects (79.6% for IJB-A and 86.2% for Adience) and introduce a new facial analysis dataset which is balanced by gender and skin type.

We evaluate 3 commercial gender classification systems using our dataset and show that darker-skinned females are the most misclassified group (with error rates of up to 34.7%). The maximum error rate for lighter-skinned males is 0.8%.



Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification*

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Editors: Sorelle A. Friedler and Christo Wilson

Abstract

Recent studies demonstrate that machine learning algorithms can discriminate based on classes like race and gender. In this work, we present an approach to evaluate bias present in automated facial analysis algorithms and datasets with respect to phenotypic subgroups. Using the dermatologist approved Fitzpatrick Skin Type classification system, we characterize the gender and skin type distribution of two facial analysis benchmarks, IJB-A and Adience. We find that these datasets are overwhelmingly composed of lighter-skinned subjects (79.6% for IJB-A and 86.2% for Adience) and introduce a new facial analysis dataset which is balanced by gender and skin type. We evaluate 3 commercial gender classification systems using our dataset and show that darker-skinned females are the most misclassified group (with error rates of up to 34.7%). The maximum error rate for lighter-skinned males is 0.8%. The substantial disparities in the accuracy of classifying darker females, lighter females, darker males, and lighter males in gender classification systems require urgent attention if commercial companies are to build genuinely fair, transparent and accountable facial analysis algorithms.

Keywords: Computer Vision, Algorithmic Audit, Gender Classification

1. Introduction

Artificial Intelligence (AI) is rapidly infiltrating every aspect of society. From helping determine who is hired, fired, granted a loan, or how long an individual spends in prison, decisions that have traditionally been performed by humans are rapidly made by algorithms [O'Neil, 2017; Citron and Pasquale, 2014). Even AI-based technologies that are not specifically trained to perform high-stakes tasks (such as determining how long someone spends in prison) can be used in a pipeline that performs such tasks. For example, while face recognition software by itself should not be trained to determine the fate of an individual in the criminal justice system, it is very likely that such software is used to identify suspects. Thus, an error in the output of a face recognition algorithm used as input for other tasks can have serious consequences. For example, someone could be wrongfully accused of a crime based on erroneous but confident misidentification of the perpetrator from security video footage analysis.

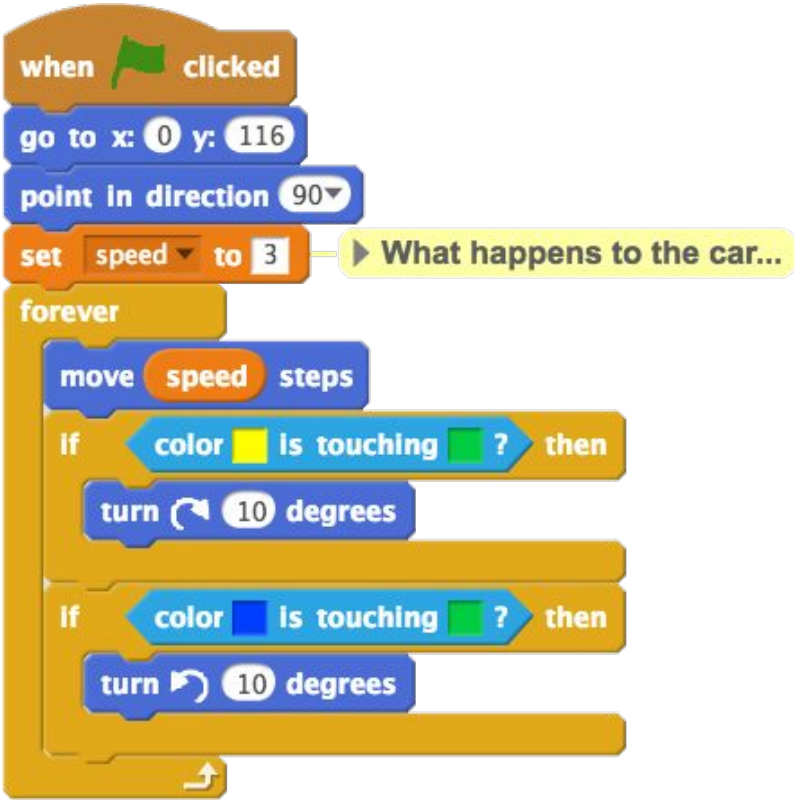
Many AI systems, e.g. face recognition tools, rely on machine learning algorithms that are trained with labeled data. It has recently been shown that algorithms trained with biased data have resulted in algorithmic discrimination (Bolukbasi et al., 2016; Caliskan et al., 2017). Bolukbasi et al. even showed that the popular word embedding space, Word2Vec, encodes societal gender biases. The authors used Word2Vec to train an analogy generator that fills in missing words in analogies. The analogy man is to computer programmer as woman is to 'X' was completed with "homemaker", conforming to the stereotype that programming is associated with men and homemaking with women. The biases in Word2Vec are thus likely to be propagated throughout any system that uses this embedding.

* Download our gender and skin type balanced PPB dataset at gendershades.org

© 2018 J. Buolamwini & T. Gebru.

Bulamwini and Gebru, 2018


speed
3


when clicked
go to x: 0 y: 116
point in direction 90
set speed to 3
What happens to the car...
forever
move speed steps
if color is touching ? then
turn 10 degrees
if color is touching ? then
turn 10 degrees

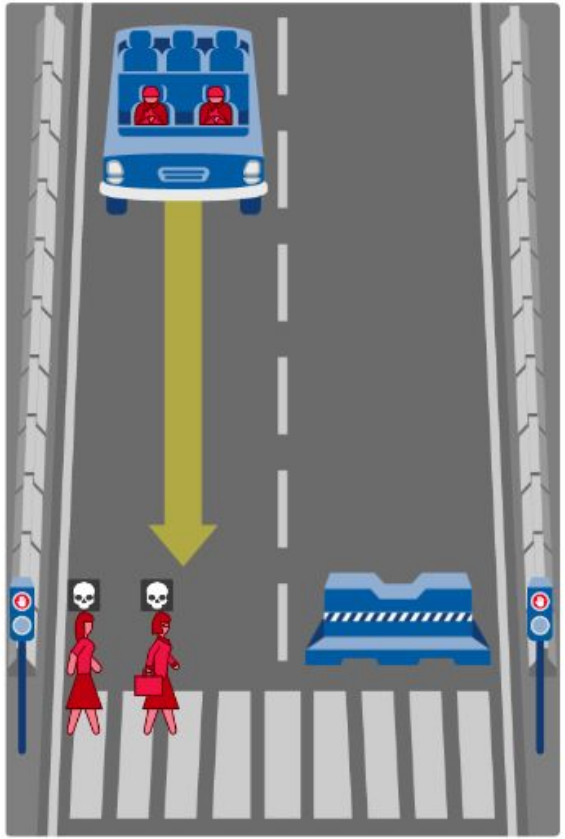
What should the self-driving car do?

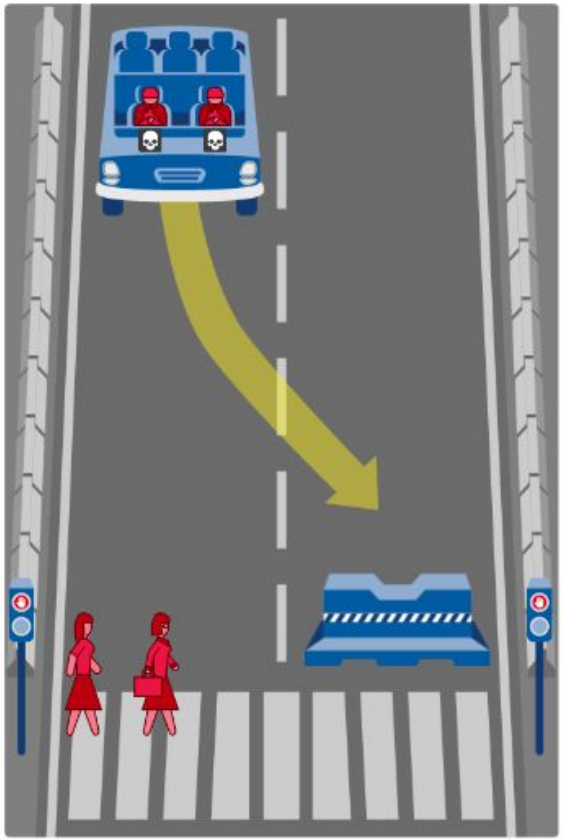
In this case, the self-driving car with sudden brake failure will continue ahead and drive through a pedestrian crossing ahead. This will result in ...

Dead:

- 1 woman
- 1 female executive

Note that the affected pedestrians are flouting the law by crossing on the red signal.



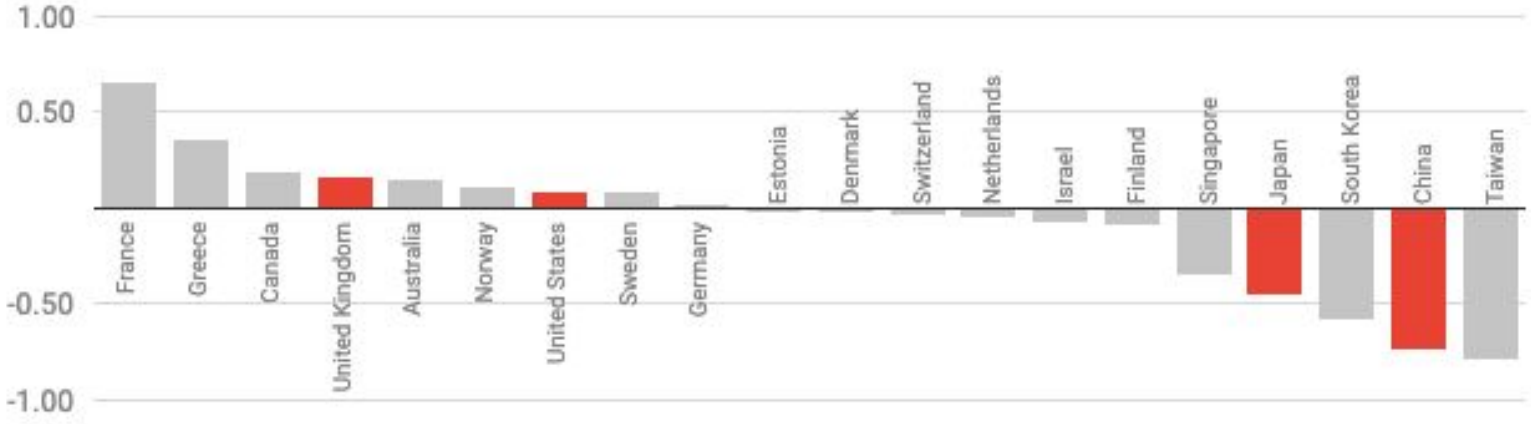


In this case, the self-driving car with sudden brake failure will swerve and crash into a concrete barrier. This will result in ...

Dead:

- 2 homeless people

Countries with more individualistic cultures are more likely to spare the young



A comparison of countries piloting self-driving cars: If the bar is closer to 1, respondents placed a greater emphasis on sparing the young; if the bar is closer to -1, respondents placed a greater emphasis on sparing the old; 0 is the global average.

Created with Datawrapper

Hao, 2018

Assessment

capability = knowledge + application

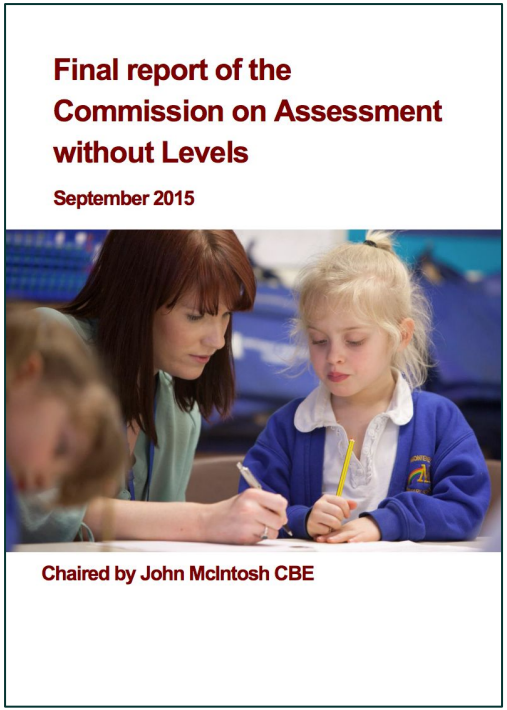
Projects *and* questions

Neither multiplechoice questions nor open-ended projects alone tell the whole story of student understanding. It would be unwise to ignore learner agency, motivation, creative expression and design thinking that students bring to projects of their own choosing. This is especially critical when one of the stated goals of introducing CS is to inspire children to pursue this discipline and broaden the CS pipeline. However, it would be equally imprudent to not include objective measures that can be scaled and assess students' understanding of core computational concepts as well as associated skills such as debugging and code-tracing.

Grover, Cooper and Pea, 2014

Test questions

The Commission recommends the establishment of a national item bank of assessment questions to be used both for formative assessment in the classroom, to help teachers evaluate understanding of a topic or concept, and for summative assessment, by enabling teachers to create bespoke tests for assessment at the end of a topic or teaching period.



McIntosh et al 2015

Students can choose between:

Solution to a problem

The student selects a problem and develops a system to solve it. Typically, the solution would be developed for a third party. There is no requirement for there to be an end user, but having one is likely to be useful. Examples of this type of project include:

- a simulation eg of a business or scientific nature, or a well know problem such as the game of life
- a solution to data processing problem for a business. eg stock control, membership systems
- the solution of an optimisation problem. eg production of a rota, shortest-path problems, route finding
- a computer game
- an application of artificial intelligence
- a control system, operated using a device such as Arduino board
- a website with dynamic content, driven by a database back-end
- an app for a mobile phone or tablet.

Investigation

The student selects an area of the subject that they are interested in and conducts an investigation of this area, with the focus being on programming. For an investigation, the student would need a supervisor with some knowledge of the area being investigated. Examples of this type of project include:

- machine learning algorithms
- 3d graphics rendering
- analysis of live data feeds eg Twitter feeds
- AI
- exploring large datasets for correlations, eg World Bank's, and creating useful visualisations of these correlations to answer interesting questions
- scientific investigations, eg where an analytic solution is not possible.

Pedagogy

The pragmatic teacher?

Computer Science instructors rely mostly on intuition and anecdotal evidence to make decisions about changes in their daily teaching practice… instructors used little empirical data for deciding to make a change, and for deciding whether a change was successful or a failure.

The Use of Evidence in the Change Making Process of Computer Science Educators

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ABSTRACT

This paper explores the issue of what kind of evidence triggers changes in the teaching practice of Computer Science educators, and how educators evaluate the effectiveness of those changes. We interviewed 14 Computer Science instructors from three different institutions. Our study indicates that changes are mostly initiated from instructors' intuition, informal discussion with students, and anecdotal evidence.

Categories and Subject Descriptors

K.3.2 [**Computer and Information Science Education**]: Computer science education

General Terms

Human Factors

1. INTRODUCTION

This paper investigates the question of what kind of evidence triggers and informs changes in the everyday teaching practice of Computer Science educators. As educators, we want to be constantly improving our practice. Success depends on identifying the opportunities or need for improvement, implementing appropriate changes, and then (iteratively) evaluating whether the change met the need.

Our community is productive in providing tools for implementing change. A number of innovative approaches for teaching introductory Computer Science have been designed, such as Beyond LEGOs [3], Media Computation [14], and TeachScheme [9]. Many software systems to support new teaching approaches have been developed, such as Scratch [23] and Alice [6], as well as tools such as algorithm visualization systems [25] and intelligent tutoring systems for Computer Science topics [20, 12].

Researchers are studying the factors that influence adoption of these teaching innovations [21, 22, 16, 8]. What leads a teacher to choose one kind of implementation versus another? These studies explore both catalysts and barriers to change. For example, Ni [22] reports external pressure, limited time, poor background of students, and conflicting views on desired learning outcomes as barriers to change. She also highlights that perceived benefits for students, well-defined pedagogical recommendations, and successful first-hand experience with new approaches are catalysts to innovation adoption. Thus, we know a good bit about innovative approaches, and what leads to their adoption.

In this study, we would like to understand the factors that influence teachers' decisions at a more microscopic level. The teacher has to make decisions about where there is a need for change, and whether the change is effective at meeting the need. For example, why would a teacher change a specific example, a homework assignment, or the format of a group project? Once a change is made, how does a teacher decide whether the change addressed the concern that initiated the change? If those decisions are not made well (e.g., a change is made to something that wasn't really broken, or a change is actually ineffective when judged successful), we are not actually improving practice when we make change.

Specifically, we are interested in understanding the role of evidence in the decision making process of instructors. Researchers have spent some effort in understanding and affirming the important role of evidence in higher-level educational policy and practice [5]. The use of formal evidence is also an essential component of accreditation programs such as ABET [1]. Less attention has been devoted to the use of evidence in the the design decisions in classroom.

Our study aims to provide an initial understanding of this issue in the context of Computer Science education. We interviewed 14 Computer Science instructors from three higher education institutions in the United States, and we extracted the recurring themes in the interviewees' answers. These answers suggest the predominance of instructors' intuition, informal discussion with students, and anecdotal reports as the primary evidence used to inform practical decisions.

2. METHODOLOGY

We interviewed 14 Computer Science instructors, most of them teaching in large research institutions in the Midwest. The background and range of expertise of the interviewees spanned across the majority of sub-disciplines in Computer Science. Some of the instructors were full-time lecturers, whereas others were mostly dedicated to research. The range of classes taught by these instructors also ranged from introductory CS courses for undergraduate students to advanced elective classes taken mostly by graduate students. All the interviews were audio recorded.

SIGCSE'11, March 9–12, 2011, Dallas, Texas, USA.

Fossati and Guzdial, 2011

What we're learning about teaching computing

- It's not about the code - think before you click
- You don't *have* to use a computer
- It's easier to read code than to write code
- It's easier to edit code that to start from a blank screen
- Making things matters
- Pair programming is powerful
- Debugging helps grow mindsets
- Go for depth not breadth
- Look for interesting contexts
- This is for everyone

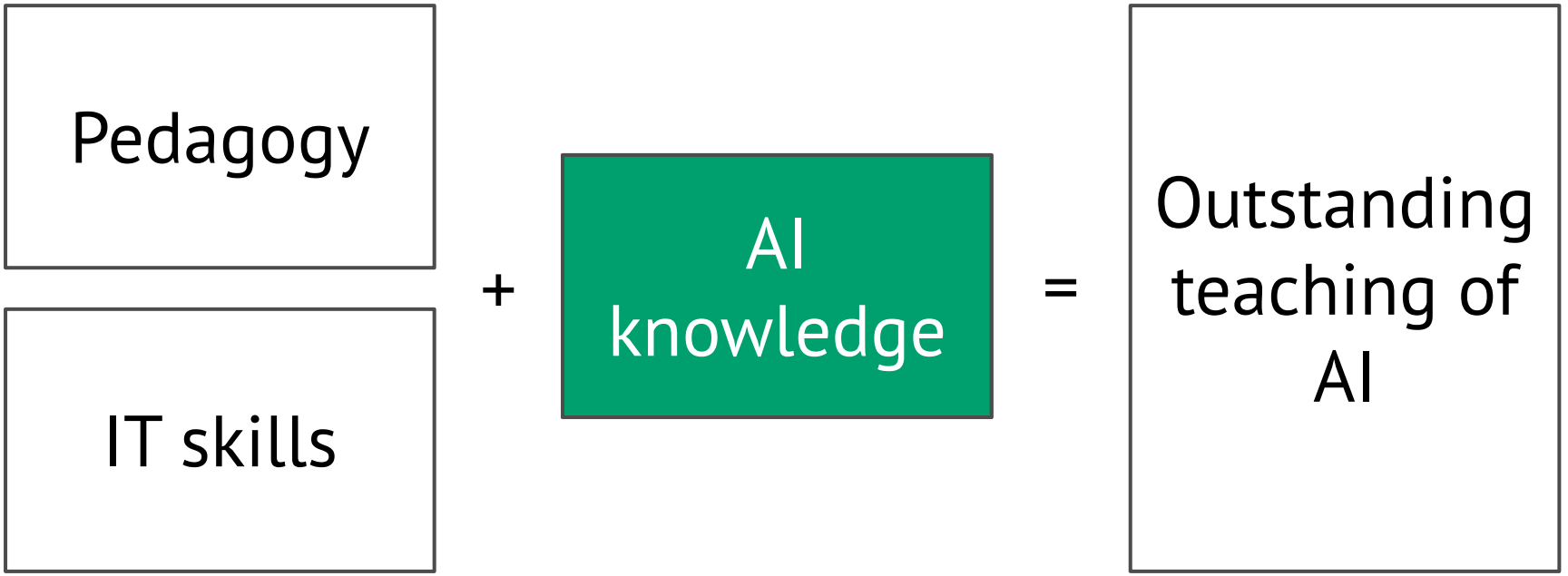
Teacher training

Teaching matters

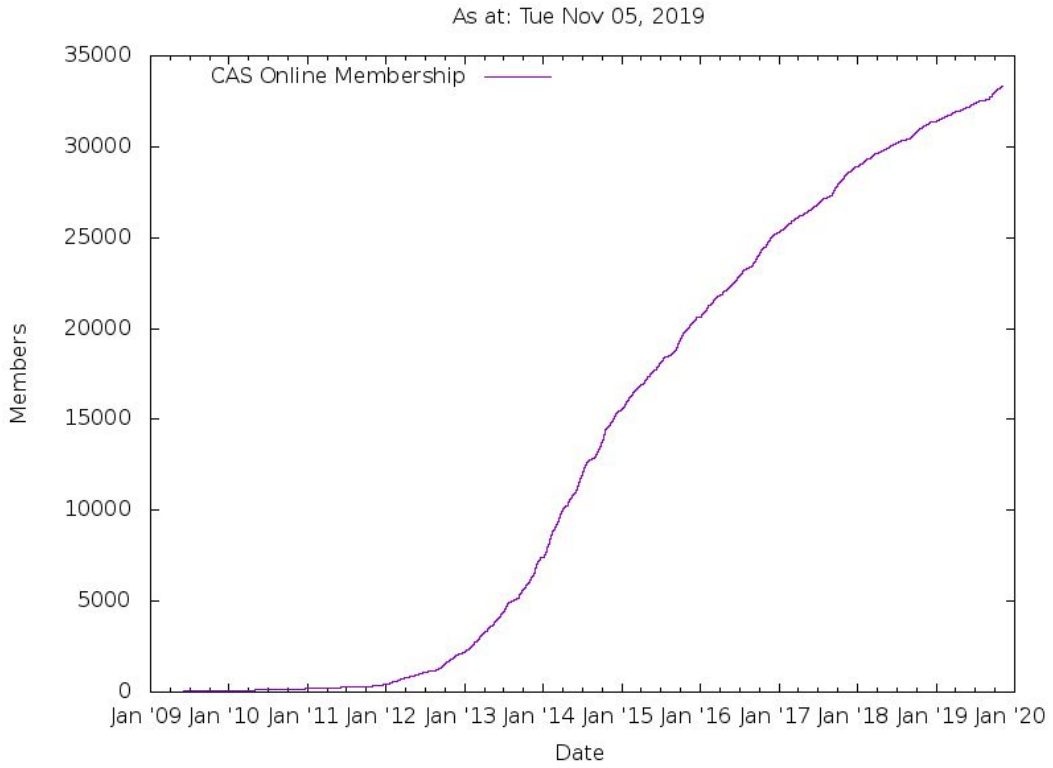
The quality of an education system cannot exceed the quality of its teachers

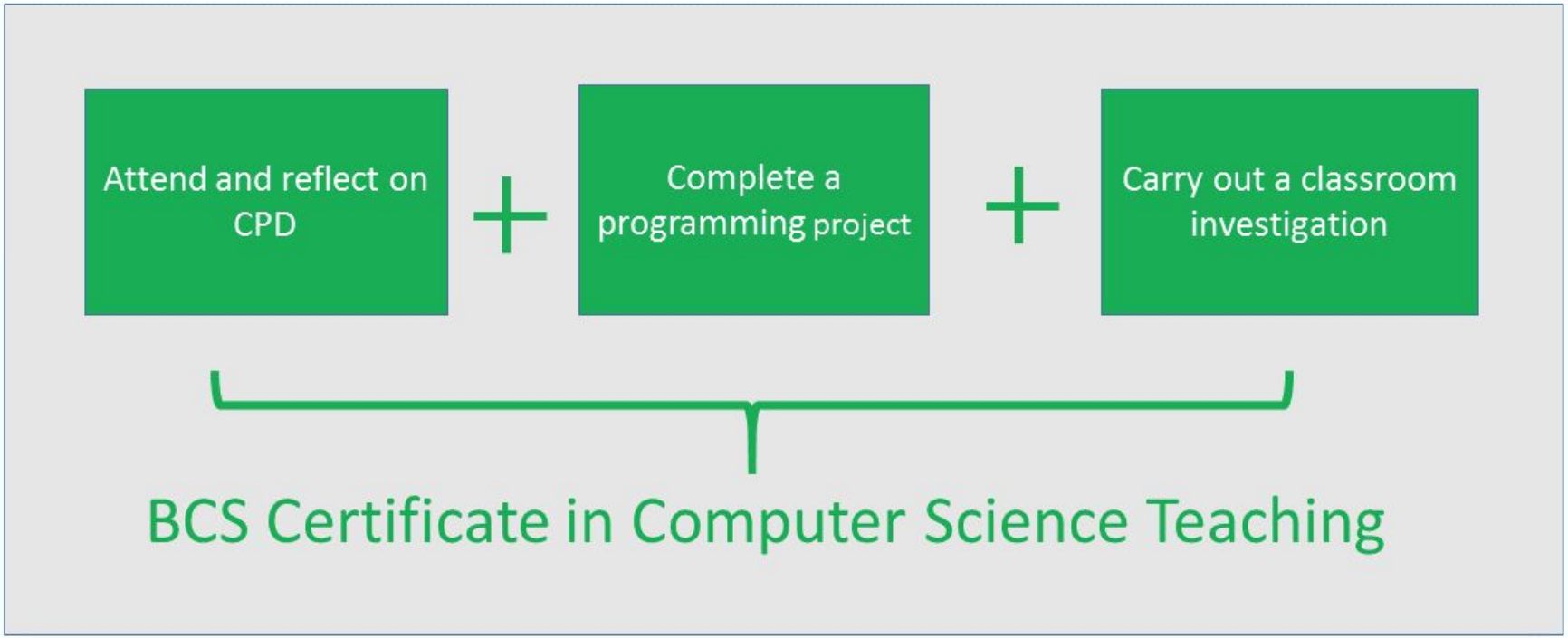
Interview South Korea 2007, cited in Barber and Mourshed 2007

Outstanding AI teaching?



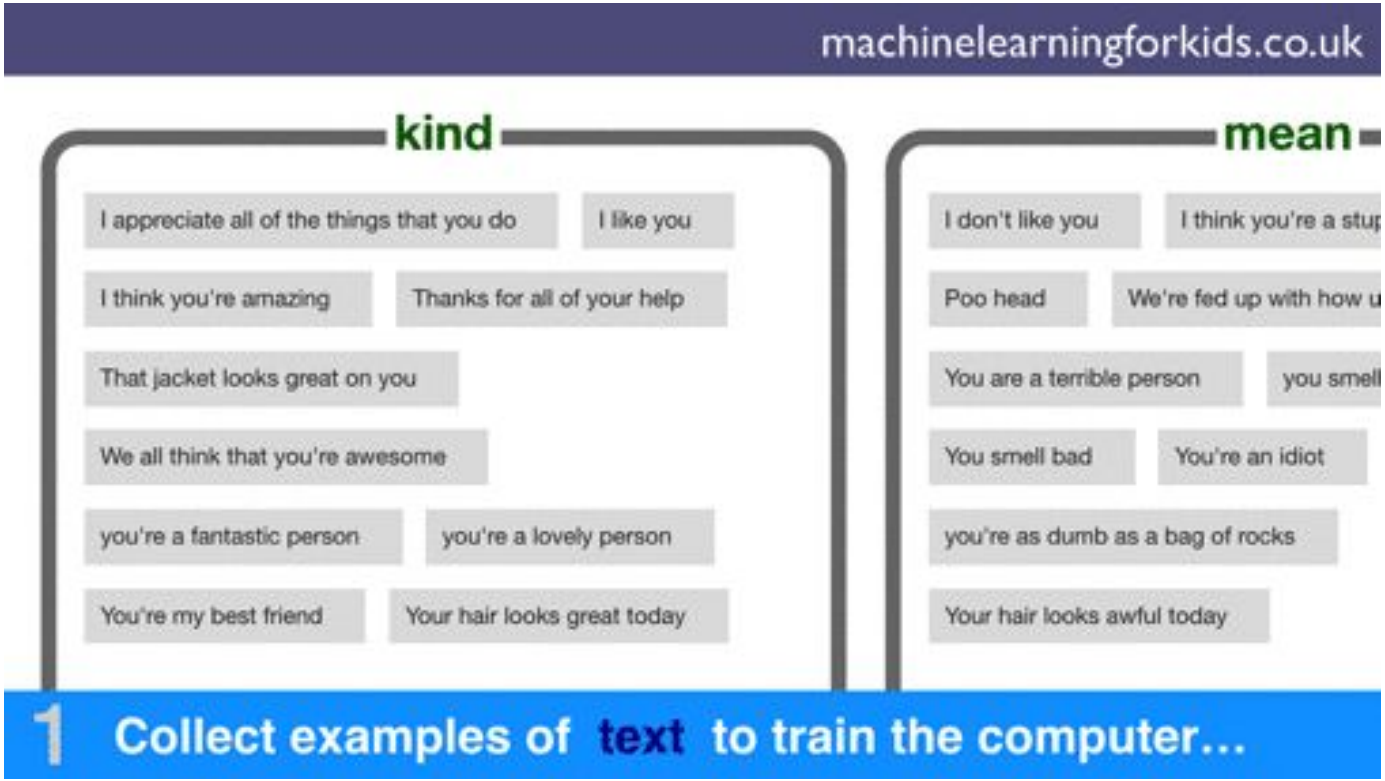
Computing At School




Attend and reflect on CPD
+
Complete a programming project
+
Carry out a classroom investigation
BCS Certificate in Computer Science Teaching

Teaching materials

Machine learning 4 kids



eCraft2Learn

1. Enabling your sprites to speak in over a hundred languages. Project or library.
2. Enabling your sprites to listen to speech in over a hundred languages. And to recognize sounds. Project or library.
3. Enabling your sprites to see using the camera. Project or library.
4. Enabling your projects to do arithmetic on words. Project or library.
5. Enabling your projects to create, train, and use deep learning neural networks. Project or library.
6. Miscellaneous AI blocks (style transfer, image embedding, and using Wikipedia and Yahoo Weather). Project or library.

AI programming guides

A guide currently consisting of six chapters describes the new blocks, possible projects, sample programs, background information, and the larger context about AI and machine learning:

Adding speaking to your programs	Speech synthesis requires only speakers or earphones
Adding listening to your programs	Speech recognition requires a microphone (builtin or connected to a USB port)
Adding image recognition to your programs	Requires a camera (builtin or connected to a USB port) and registering to get API keys
Adding pre-trained machine learning models to your programs	Many examples rely upon a camera. It is very slow unless your device has a GPU.
Working with words and language	No special hardware requirements
Making machine learning neural nets New!	It is very slow unless your device has a GPU.

Machine Learning

Create a problem solving prototype in 10-12 hours

Primary, Secondary and FE

10 - 12 hours

In-class or extracurricular

Programming required

Course Summary

Explore machine learning with your students, including the ethics and benefits, and use machine learning algorithms to solve a real-world problem they care about.

Incentives and drivers

Will a robot take your job?

11 September 2015

Share

Type your job title into the search box below to find out the likelihood that it could be automated within the next two decades.

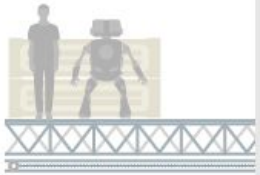
About 35% of current jobs in the UK are at high risk of computerisation over the following 20 years, according to a study by researchers at Oxford University and Deloitte.

I am a...

Rather search by typing? **Back to job search**

Actor, entertainer or presenter

Find out my automation risk >



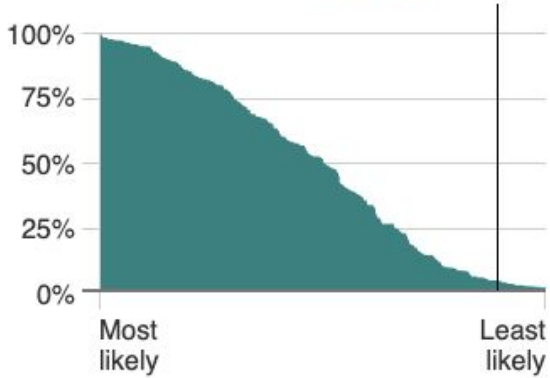
http://www.bbc.co.uk/news/technology-34066941

Higher education teaching professionals

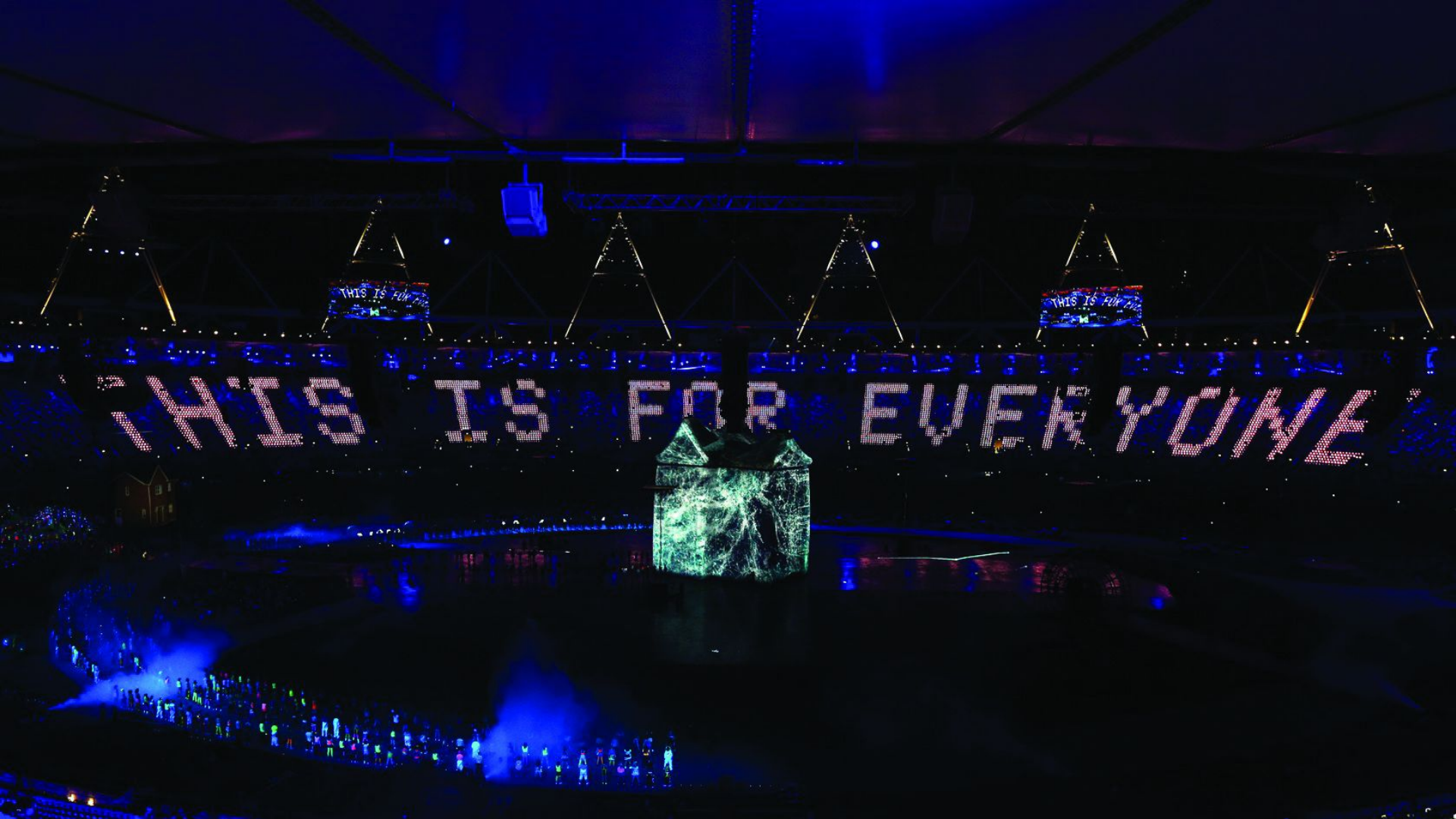
Likelihood of automation?
It's quite unlikely (3%)

How this compares with other jobs:

327th of 366



Share my result


THIS IS FOR EVERYONE

Discussion...

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milesberry.net

These slides: bit.ly/aaai19slides