

Artificial Intelligence in Education

What is it, where is it now, where is it going?

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Full source of above, (and these slides): www.brettbecker.com/publications (see [25])

What is Artificial Intelligence?

- ▶ AI is programming a computer (or any device) to perform a task that traditionally is only possible with human intelligence due to its *complexity*.
- ▶ Summing numbers from 1 to 1,000,000,000,000:
 - ▶ Not complex. Easy for a computer. Probably difficult for a human (time, errors).
 - ▶ *No AI required*
- ▶ Grading thousands of MCQs:
 - ▶ Not complex. Easy for a computer. Probably difficult for a human (time, errors).
 - ▶ *No AI required*
- ▶ Grading a 10,000 word essay on one of Shakespeare's works?
 - ▶ Complex. Difficult for a computer. Not too difficult for (an expert) human (but time consuming)
 - ▶ *AI required!*
 - ▶ *What if you want to grade 500 essays?*

What is Artificial Intelligence?

- ▶ There are two main 'types' of AI:
 - ▶ **Strong, (or general)**
 - ▶ Can perform 'general intelligent action'
 - ▶ This is the AI of 'robots taking over'
 - ▶ We are a (fairly long?) way away from this
 - ▶ **Narrow (weak or domain-specific)**
 - ▶ This is where we are
 - ▶ Computers beating chess and Go champions (and hundreds of other examples)
 - ▶ More on next slides

What is Artificial Intelligence?

- ▶ AI affects (most of) us every day
 - ▶ Voice commands on phone require AI
 - ▶ Servers that run AI algorithms are on the cloud (that's why it doesn't work without internet)
 - ▶ Google Translate
 - ▶ Not just a simple dictionary operation. Uses AI.¹
 - ▶ Facebook image tagging uses AI
 - ▶ Facial recognition uses AI. If you've flown recently, it has been used on you!

¹ <https://blog.statsbot.co/machine-learning-translation-96f0ed8f19e4>

Computers doing 'human' tasks

- ▶ In 2013 a system called KnIT¹ read 100,000 research papers (in 2 hours)
 - ▶ Looking for information on a protein called p53 which suppresses tumours in humans
 - ▶ Specifically, looking for links that implied undiscovered p53 kinases (that interact with p53)
 - ▶ The investigators purposely only let the computer read papers up to 2003
- ▶ In doing so, KnIT identified 7 of the 9 kinases discovered by humans *after 2003*
- ▶ It also found two that were unknown to science in 2013 (hadn't been discovered *at all*)

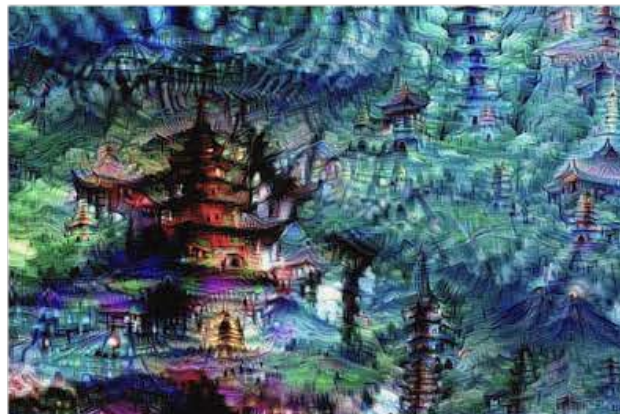
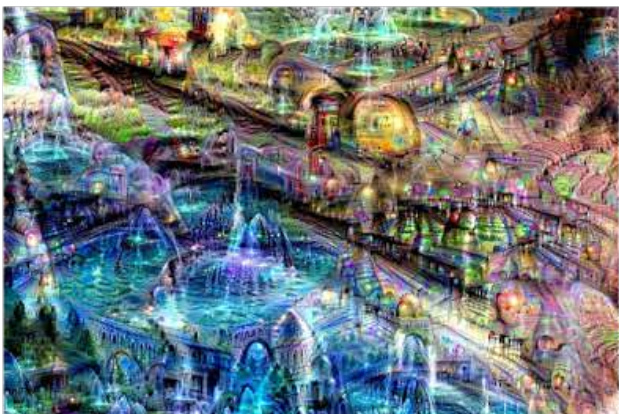
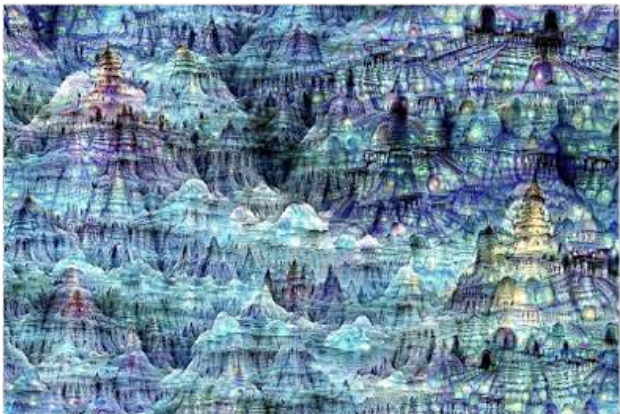
¹ [Spangler, S., Wilkins, A. D., Bachman, B. J., Nagarajan, M., Dayaram, T., Haas, P., ... & Stanoi, I. \(2014, August\). Automated hypothesis generation based on mining scientific literature. In *Proceedings of the 20th ACM SIGKDD international conference on Knowledge discovery and data mining* \(pp. 1877-1886\). ACM](#)

[H. Hodson, "Supercomputers Make Discoveries that Scientists Can't", *New Scientist*, 27 August 2014](#)

How 'good' is Artificial Intelligence?

- ▶ Google trained an artificial neural network on millions of images on the internet.
 - ▶ All it did was 'learn'. It saw thousands of buildings, birds, etc.
- ▶ The next slide shows examples of what happens when the network is given an input of random 'static', and 'instructed' to create a picture - by looking for patterns that look like real-world objects, and 'amplifying' them.
- ▶ These pictures are "purely the result of the neural network"¹

¹ <https://research.googleblog.com/2015/06/inceptionism-going-deeper-into-neural.html?m=1>

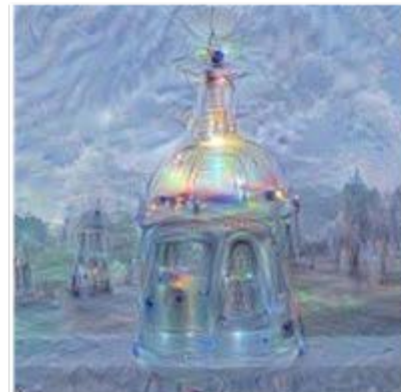


How 'good' is Artificial Intelligence?

- ▶ What happens when the input is not random static, but a real photo?
- ▶ The network was asked: "Whatever you see there, I want more of it!"
 - ▶ This creates a feedback loop: if a cloud looks a little bit like a bird, the network will make it look more like a bird. This in turn will make the network recognize the bird even more strongly on the next pass and so forth, until a highly detailed bird appears, seemingly out of nowhere.
- ▶ More here: <https://goo.gl/wB2Yqj>



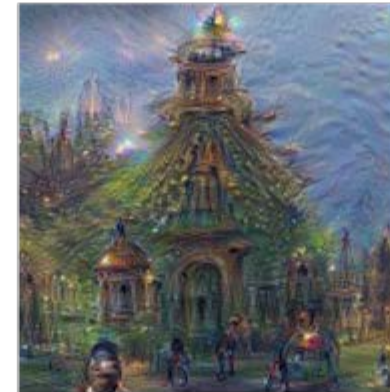
Horizon



Towers & Pagodas



Trees



Buildings



Leaves



Birds & Insects

How 'good' is Artificial Intelligence?

- ▶ Skin cancer is primarily diagnosed visually, beginning with an initial clinical screening
- ▶ A Deep Convolutional Neural Network (CNN) was trained on 129,000+ images with disease labels
- ▶ The CNN performed on par with board-certified dermatologist findings for two use-cases:
 - ▶ The most common skin cancer
 - ▶ The most deadly skin cancer
- ▶ This CNN (like all) is cheap, fast, upgradable, doesn't get tired, etc
 - ▶ There is little doubt that the best diagnoses come from an expert PLUS AI, working together

¹ [Esteva, A., Kuprel, B., Novoa, R. A., Ko, J., Swetter, S. M., Blau, H. M., & Thrun, S. \(2017\). Dermatologist-level classification of skin cancer with deep neural networks. *Nature*, 542\(7639\), 115-118.](#)

The two-sigma problem

- ▶ In 1984, educational psychologist Benjamin Bloom found that a *mastery learning* approach* helped students by more than one standard deviation.¹
 - ▶ When combined with personal tutoring this increased to two standard deviations, a so-called 'two-sigma' effect on performance.
- ▶ Categorizing students as "high" or "low" achievers was almost entirely incorrect.
- ▶ Students performing in the 50th percentile in a traditional classroom can perform in the 98th percentile with mastery learning plus one-on-one support.²

*A category of instructional methods which establishes a level of performance that all students must master before moving on to the next unit

¹ B. S. Bloom, "The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-To-One Tutoring," *Educational Researcher*, vol. 13, no. 6, pp. 4-16, 1984.

² [D. Levin, "How Artificial Intelligence Can Help Us Solve the 33-Year-Old "Two-Sigma Problem", " 20 September 2017](#)

The two-sigma problem

- ▶ Personalised tutoring and mastery learning are both problematic.
 - ▶ The former is extremely financially expensive and the latter is extremely temporally expensive.
- ▶ Thus, the 'two-sigma' problem was born:
 - ▶ What could be done efficiently, at scale, and be as effective as mastery-based personalised tutoring?
- ▶ For much of the last 25 years, the AIED community has been focusing, to a large degree, on solving the two-sigma problem, moving towards creating systems that are as effective as human one-on-one tutoring.¹
 - ▶ Unfortunately, much of this has not extended beyond scholarly work (yet).

¹K. VanLehn, "The Relative Effectiveness of Human Tutoring, Intelligent Tutoring Systems, and Other Tutoring Systems," *Educational Psychologist*, vol. 46, no. 4, pp. 197-221, 2011.

Artificial Intelligence in Education (AIEd)

- ▶ AI holds great promise for education.
- ▶ AIEd investigates learning wherever it occurs, in traditional classrooms or in workplaces, in order to support formal education as well as lifelong learning.
- ▶ It brings together AI, which is itself interdisciplinary, and the learning sciences (education, psychology, neuroscience, linguistics, sociology, and anthropology) to promote the development of adaptive learning environments and other AIEd tools that are flexible, inclusive, personalised, engaging, and effective.¹
- ▶ At the heart of AIEd is the scientific goal to “make computationally precise and explicit forms of educational, psychological and social knowledge which are often left implicit”.²

¹ [R. Luckin, W. Holmes, M. Griffiths and L. B. Forcier, “Intelligence Unleashed: An Argument For AI In Education,” 2016](#)

² J. Self, “The Defining Characteristics of Intelligent Tutoring Systems Research: ITSs Care, Precisely,” *International Journal of Artificial Intelligence in Education* (IJAIED), vol. 10, pp. 350-364, 1998.

Artificial Intelligence in Education (AIEd)

- ▶ Picture a classroom from 50 years ago.
 - ▶ Compare it to today's classroom.
- ▶ Why is there so little change?
 - ▶ Henry Ford once said: "If I had asked people what they wanted, they would have said faster horses" .¹
- ▶ We need to break free from our factory-model educational systems.
- ▶ To effect a big change, we need a revolution - that revolution could be the application of artificial intelligence to education.

¹I. Roll and R. Wylie, "Evolution and Revolution in Artificial Intelligence in Education," *International Journal of Artificial Intelligence in Education*, vol. 26, no. 2, pp. 582-599, 2016.

Where is AIEd Today?

- ▶ In the last decade, artificial intelligence and adaptive technologies have begun to mature, making both mastery learning and one-on-one instructional methods more scalable than Bloom ever could have imagined.¹
 - ▶ However, these technologies have yet to coalesce into widely adopted systems to facilitate teaching.
 - ▶ To a large extent, this is because our existing educational models and systems are still stuck in their traditional forms, hindering the true adoption of AI systems.
- ▶ There have however been major strides in technologies to help teachers currently teaching in traditional models, particularly in freeing up their time so that they can tend to tasks for which human intelligence is still required.

¹ [D. Levin, "How Artificial Intelligence Can Help Us Solve the 33-Year-Old "Two-Sigma Problem", " 20 September 2017.](#)

Where is AIEd Today?

- ▶ Last year, Ashok Goel at Georgia Tech used an AI program called Jill as a teaching assistant (fittingly, in his AI class).¹
- ▶ The program replied to student email queries regarding assignments.
 - ▶ Based on IBM's Watson AI platform²
 - ▶ Trained on 40,000 postings on a discussion forum to reply to similar questions based on prior responses
- ▶ Jill has a confidence level of 97%.
- ▶ Most students were surprised when told that Jill was a computer program.
- ▶ Next year Jill should be able to answer 40% of all students questions.

¹ <https://www.ibm.com/watson/>

² [M. Korn, "Imagine Discovering That Your Teaching Assistant Really Is a Robot," 6 May 2016.](#)

Where is AIEd Today?

- ▶ Smart content
- ▶ Intelligent tutoring systems
- ▶ Virtual facilitators and learning environments
- ▶ Virtual / Artificial reality tools
- ▶ Intelligent mining (and use) of student data for things like
 - ▶ Predicting performance
 - ▶ Improving performance
 - ▶ Customising admissions / learning pathways / learning modes
- ▶ BUT these are in their infancy (probably)

<https://www.techemergence.com/examples-of-artificial-intelligence-in-education/>

<https://www.forbes.com/sites/sebastienturbot/2017/08/22/artificial-intelligence-virtual-reality-education/#4b7d48506c76>

Ethics and Bias

- ▶ The ethics of using AI in education is a very important consideration.
- ▶ Imagine an AI-based automated grading assistant that, upon inspection, does a really good job of grading your students' work.
 - ▶ What data is this assistant trained on?
 - ▶ If that data is from female undergraduate students in Canada, that is what the assistant assumes (all of) your students are.
 - ▶ Also, who labelled the training data?¹ If it wasn't you, the assistant is learning from *their* subjective opinion, not yours. What if this person isn't even an expert?
- ▶ What are the ethical implications of using such a tool?

¹ assuming a certain type of AI, which needs to be trained. This is not a given. But those that do not need to be trained don't get their 'knowledge' from nowhere. Similar dangers apply.

What will AIEd do for us soon?

- ▶ Free up teacher time so that they can tend to tasks for which human intelligence is still required.
- ▶ Complement existing learning analytics by providing just-in-time information about learners' successes, challenges, and needs which can be used to shape their learning experiences.
- ▶ Help learners gain 21st century skills by helping us develop reliable and valid indicators to track learner progress, including characteristics such as creativity and curiosity that are notoriously difficult to measure.
- ▶ Provide new insights that are difficult or impossible to ascertain from traditional assessments.
 - ▶ For example, datasets could help teachers understand how learners arrive at answers, not just if they selected the correct one.
- ▶ AIEd will help us do away with the stop-and-test approach that pervades assessment today.
 - ▶ Instead of traditional assessments which rely on small samples of what students have been taught, AIEd-driven assessments will be built into meaningful learning activities, such as games and collaborative projects, and will assess all of the learning taking place, as it happens.

R. Luckin, W. Holmes, M. Griffiths and L. B. Forcier, "Intelligence Unleashed: An Argument For AI In Education," 2016

What will AIEd do for us a little later than soon?

- ▶ Embody new insights from the learning sciences to allow us to better understand the learning process and build more accurate models that can predict and influence learner progress, motivation, and persistence.
- ▶ Provide learners with lifelong learning partners.
 - ▶ Cloud-based learning companions will benefit from learner information gleaned not only from educational contexts but from all contexts: social, recreational, etc.
- ▶ Address achievement gaps
- ▶ Enhance teacher expertise
- ▶ Address teacher retention and teacher shortages
- ▶ Deliver a solution to the two-sigma problem?
- ▶ Break us free from our 19th century factory-model education¹?

¹ [J. Rose, "How to Break Free of Our 19th-Century Factory-Model Education System," 9 May 2012.](#)

[R. Luckin, W. Holmes, M. Griffiths and L. B. Forcier, "Intelligence Unleashed: An Argument For AI In Education," 2016](#)

What does all of this mean for you?

- ▶ You have (very most likely) already used AI, or been affected by AI in your daily life.
 - ▶ Put simply, the areas that are easiest, most in demand, and most profitable will be exploited first: medicine, mobile phones, etc.
- ▶ But, AI tools and implications are coming to education, and coming fast.
- ▶ Unless you are retiring soon, you will see these tools in your career.
- ▶ Be ready.
- ▶ Be informed!
- ▶ Beware bias and ethics. These are not a reason to dismiss AIEd, but they need to be understood, mitigated, applied properly.

¹ [J. Rose, "How to Break Free of Our 19th-Century Factory-Model Education System," 9 May 2012.](#)

So...

- ▶ Will AI replace teachers completely (as some claim)?

“Crucially we do not see a future in which AIEd replaces teachers. What we do see is a future in which the role of the teacher continues to evolve and is eventually transformed; one where their time is used more effectively and efficiently, and where their expertise is better deployed, leveraged, and augmented”¹

¹[R. Luckin, W. Holmes, M. Griffiths and L. B. Forcier, “Intelligence Unleashed: An Argument For AI In Education,” 2016](#)

So...

“Within a decade, AI will have transformed school and university life and given the biggest boost to social mobility our society has ever seen”

- *Sir Anthony Seldon*¹

- ▶ Ultimately, combining the best of human and machine for the benefit of the learner is the true goal of artificial intelligence in education.

¹ <https://www.britishtsciencefestival.org/event/the-4th-education-revolution/>

These slides are available

- ▶ At www.brettbecker.com/publications, under [25]

Questions?