Human Learning + Machine Learning

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Music exercise – Audio
Algorithmic Composition of Music
Computers can sketch too!

- Seven artists generated about 8,000 pen strokes
- Disney's software analyzed distance between facial features
Innovation follows patterns → automatable

Source: Invention Machine “IM Labs”
On the road to ExoBrain

Exponential Growth of Computing
Twenty-first through twenty-first century

Logarithmic Plot

Source: Moravec/Kurzweil/SU

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One-Two-Three-Four punches
SyNAPSE (chip) + BlueBrain (system) + Watson (software) + Cloud Computing (infrastructure)
Cloud Computing → “Synthetic Neocortex”
Artificial Intelligence applied everywhere
WikiBots

42% of Wikipedia is edited by 12 bots!
Cartoon to reality in five years

Magically schedule meetings
That’s us. That’s all we think about.

https://x.ai/about/
“What is...?”
Watson goes to medical school

- Collect and assess patient data
- Construct “inference paths” toward a probable diagnosis
Human workers, managed by an algorithm

“The latest trend in crowdsourcing is organizing foreign workers on a mass scale to do routine tasks that computers aren’t yet good at, assigned by an algorithm”
Computer scores 150 IQ

Math IQ tests are based on:

• progressive matrices, which test the ability to see patterns in pictures
• number sequences, which test the ability to see patterns in numbers.

“Our programs are beating the conventional math programs because we are combining mathematics and psychology”

Claes Strannegard
University of Gothenburg
Robots learning from each other

- Knowledge and experience shared worldwide
- Computing tasks carried out in the Cloud

→ Hyperbolic improvement
Robot Serves Up 360 Hamburgers Per Hour

• Pays for itself in a year
• No cashiers or servers
• Will never forget to ask “do you want fries with your order?”
Our Limited Imagination

Source: Jean-Marc Côté, 1899
Death by a thousand cuts?

Magically schedule meetings
That’s us. That’s all we think about.

https://x.ai/about/
The Impact of Big Data & Machine Learning

Three key areas in which machine bests humans:
• consume huge amounts of data
• receive thousands of inputs at once
• create a unified model of knowledge across that scale of information and make judgments from it

And do so with fewer human cognitive biases...

Timothy Estes, founder and CEO of Digital Reasoning
But Humans...

- Have access to a LOT more [diverse] data than a machine:
  - building intuitions and holistic pictures in our mind
  - seeing connections that the machine might not even have the possibility of seeing because it doesn’t have the right data.

- Have a powerful role in figuring out the sources of data to give the machine and projecting their intuition.
Acceleration, but...

*These are bounded/structured problems*

![Graph showing the relative complexity of games over time]

- 1979: Backgammon
- 1994: Chess
- 2011: Jeopardy
- 2016: Go

Computer Performance vs. Human Performance

—we are here
“…The machine matches the human error rate of 5.9 percent for the conversations on an assigned topic but outperforms humans in the task of transcribing friend and family conversations with an error rate of 11.1 percent.

arxiv.org/abs/1610.05256: Achieving Human Parity in Conversational Speech Recognition
Geoff Zweig, Microsoft Research
Hype Cycle

Source: Gartner Group

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Reality Check

"We tend to overestimate the effect of technology in the short run... and underestimate the effect in the long run."

Source: Roy Amara, Former President, Institute for the Future
A combinatorial explosion of possibilities

→ Accelerating change!
Will we need to learn a foreign language?

Demos

iPhone app: Speech-to-speech translator for 95% of world population (23 languages)
http://www.ustar-consortium.com/
Is this time different?
Worker Tasks in the U.S. Economy, 1960 – 2009:

All Education Groups

Mean Task Input in Percentiles of 1960 Distribution


- Red circle: Non-routine Analytical
- Blue diamond: Non-routine Interpersonal
- Black triangle: Non-routine Manual
- Green square: Routine Cognitive
- Orange line: Routine Manual

Autor, Levy and Murnane
Economy-Wide Changes in Job Task Content 1960 - 2009
The Race between Technology and Education

Inspired by “The race between technology and education”
Pr. Goldin & Katz (Harvard)
# 10 Jobs that did not exist 10 years ago

<table>
<thead>
<tr>
<th>Job</th>
<th>Pay level</th>
</tr>
</thead>
<tbody>
<tr>
<td>App developer</td>
<td>High</td>
</tr>
<tr>
<td>Social media manager</td>
<td>Medium</td>
</tr>
<tr>
<td>Uber driver</td>
<td>Low</td>
</tr>
<tr>
<td>Driverless car engineer</td>
<td>High</td>
</tr>
<tr>
<td>Cloud computing specialist</td>
<td>High</td>
</tr>
<tr>
<td>Big data analyst/data scientist</td>
<td>High</td>
</tr>
<tr>
<td>Sustainability manager</td>
<td>Medium</td>
</tr>
<tr>
<td>YouTube content creators</td>
<td>Medium</td>
</tr>
<tr>
<td>Drone operators</td>
<td>Medium</td>
</tr>
<tr>
<td>Millennial generational expert</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Science or Pseudoscience?

TWO conditionals missed by the hype: “potentially automatable”
Should we bother?

Predictions for Human-level AI

Source: MIRI, “Predicting AI”
Alarmism?

Yet... policymakers and the public need to take notice and stave off the problems (like Y2K bug...)

Example: Legal Profession

“Our assessment addresses three core weaknesses:

I. a failure to engage with technical details

II. an absence of data on how lawyers divide their time among various tasks, only some of which can be automated;

III. conformance to the values, ideals and challenges of the profession.”

Algorithmic Trading – Flash Crash

>60% of volume is now “high-speed trading”
Present/Future world → Adaptability → Versatility as key strategy
21st Century Education Framework

Knowledge
“What we know and understand”
- Interdisciplinarity
- Traditional (i.e., Mathematics)
- Modern (i.e., Entrepreneurship)
- Themes (i.e., Global Literacy)

Skills
“How we use what we know”
- Creativity
- Critical Thinking
- Communication
- Collaboration

Character
“How we behave and engage in the world”
- Mindfulness
- Curiosity
- Courage
- Resilience
- Ethics
- Leadership

Meta-Learning
“How we reflect and adapt”
- Metacognition
- Growth Mindset
# Learning and ICT: Definitions & Examples

<table>
<thead>
<tr>
<th>Learning through ICT (Teaching via ICT)</th>
<th>Simulations/Gaming Augmented reality Virtual reality E-Tutors Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning with ICT (Teaching with ICT)</td>
<td>Use for Problem-solving (e.g. GIS + GPS + search; MatLab/SPSS; etc.)</td>
</tr>
<tr>
<td>Learning about ICT (Acquire ICT knowledge)</td>
<td>Use standard apps (e.g. spreadsheets, search, etc.) and Robotics, Coding etc.</td>
</tr>
</tbody>
</table>
GLOSSARY OF ARTIFICIAL-INTELLIGENCE TERMS

ARTIFICIAL INTELLIGENCE
Broatest term, applying to any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning.

– MACHINE LEARNING
Subset of AI that includes statistical techniques that enable machines to improve at tasks with experience.

• DEEP LEARNING
Subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing multilayered neural networks to vast amounts of data.

HOW NEURAL NETWORKS RECOGNIZE A DOG IN A PHOTO

TRAINING
During the training phase, a neural network is fed thousands of labeled images of various animals, learning to classify them.

INPUT
An unlabeled image is shown to the pretrained network.

FIRST LAYER
The neurons respond to different simple shapes, like edges.

HIGHER LAYER
Neurons respond to more complex structures.

TOP LAYER
Neurons respond to highly complex, abstract concepts that we would identify as different animals.

OUTPUT
The network predicts what the object most likely is, based on its training.
Human + Machine

IBM Watson: collects and assess patient data to construct “inference paths” toward a probable diagnosis to aid physicians.

Gary Kasparov re chess: “Weak human + machine + better process is superior to a strong computer alone, and superior to a strong human + machine + inferior process”.

Google DeepMind: “Climate, disease... AI-assisted science will help the discovery process.”
“Event Horizon”:

• What if formal education cannot catch up?
• Will we need AI to catch up?
Thank you!

“What should students learn for the 21st century?”

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Making Education More Relevant