

Building Your Essential AI Toolkit

A Brief History of AI: The Secrets of Successful AI/GenAI in Practice

EAI The Institute for Experiential AI
Northeastern University

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ai.northeastern.edu

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Education

Large Orgs

Startups

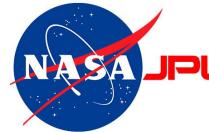
Goal: Make AI and Data usable, useful, manageable - democratize the responsible use of AI across fields

Education

- Ph.D. Computer Science & Engineering (CSE) in AI/Machine Learning
- MSE (CSE), M.Sc. (Mathematics)
- BSE (EE), BSE (Computer Engin)

Academic achievements

- Fellow: Association for the Advancement of Artificial Intelligence (AAAI) and Association for Computing Machinery (ACM)
- Over 100 technical articles on data mining, data science, AI/ML, and databases.
- Over 20 patents, 2 technical books.



- First in industry: Chief Data Officer at Yahoo!
- First Global Chief Data Officer & Group Managing Director at Barclays Bank, London
- Chaired/started major conferences in Data Science, Data Mining, AI
- Founding Editor-in-Chief on two key journals in Data Science



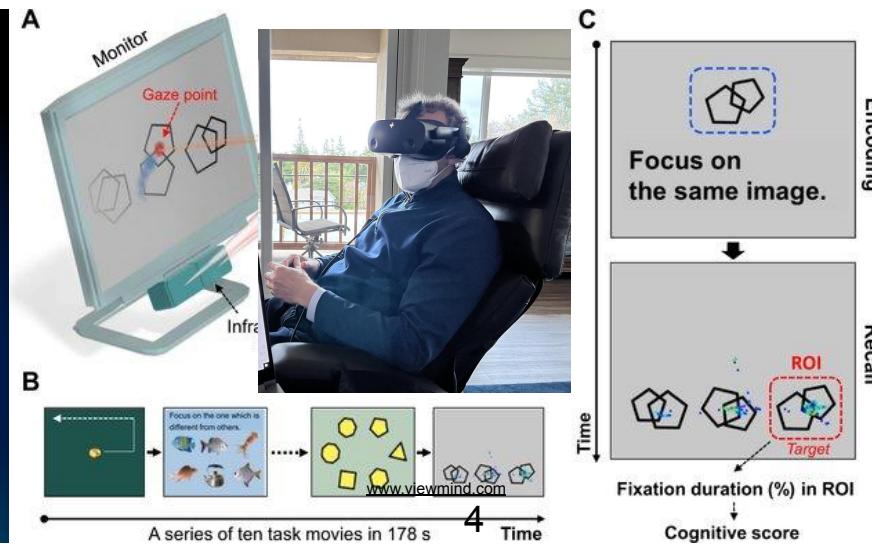
Unlock your iPhone with your face

- With Face ID, Apple has launched a grand experiment in a form of biometric security previously untested at this scale.



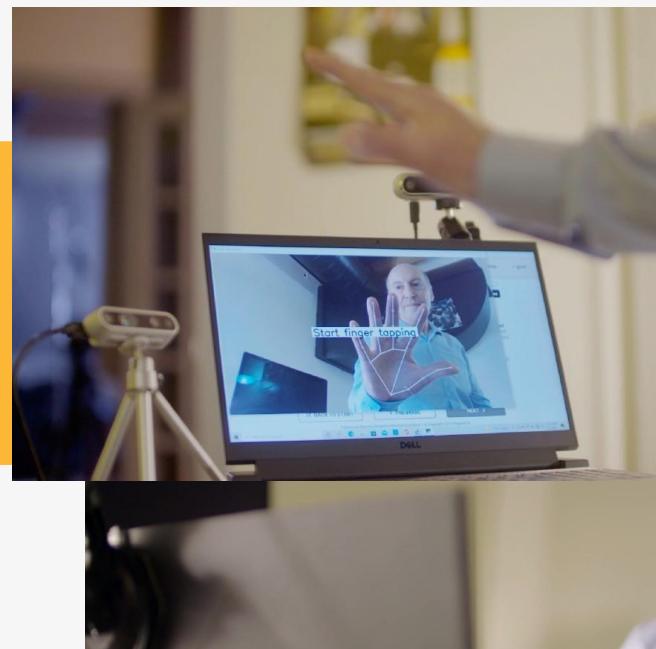


Health: Brain Disorder Detection



Viewmind uses Virtual Reality and Artificial Intelligence in the early detection of various debilitating diseases such as Alzheimer's, multiple sclerosis, and Parkinson's.

Parkinson's disease: Real-time motion capture & assessments in clinic



Welcome Back, John

Parkinson's scale for latest results: Normal | Slight | Mild | Moderate

Surveys
Complete and review your surveys
Start New Survey | View Survey History

Assessments
See your latest assessment details
View Assessment Details | View Assessment History

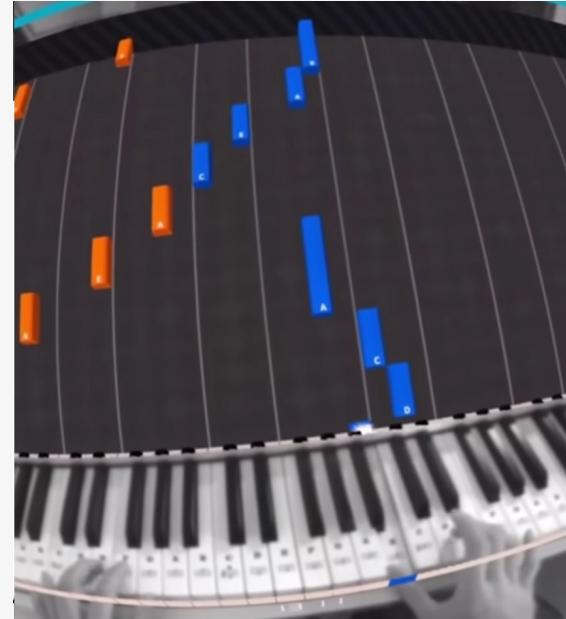
Appointments
Book appointments with your doctor
Schedule an appointment | Next Appointment



Pragmclin, Future of Health 2023: EAI, The Roux



Educational: Learning to Play Music



Augmented Reality based Piano tutor APPS align a virtual piano to your real keyboard, and then uses MIDI passthrough to teach songs by displaying notes falling in sequence toward the keys.



XR Example: oculavis *SHARE*



Modular augmented reality for self-guided machine troubleshooting and repair with remote support.



Transport: Drone Delivery



As seen in North Carolina, Flytrex delivers Starbucks Coffee by drone to your door



Lab samples delivery use case by Swiss company Jedsy

Assisting the blind with AI/vision technology



Glasses that empower the blind



Overview of Today's Master Class

1. Brief History of AI
2. How we got to deep learning and Generative AI
3. What is Generative AI and how does it work
4. What it takes to make AI work in practice
5. What has happened in Generative AI in the last 9 months?
6. Responsible AI
7. Summary and conclusions

The 7 “Secrets” of Making AI Work in organizations...

What is Artificial Intelligence?

People have struggled for a long time to figure out how we can get machines to “think” like humans and to define what we mean by “intelligence”

- **In mathematics:** the attempts are over 100 years old
- **As computing evolved:** people tried to codify tasks like game playing (checkers/chess), scheduling tasks, pattern recognition, statistical analysis, and optimization (OR) programs as examples of tasks requiring human intelligence

The Name AI: In 1956, at a workshop held at Dartmouth College a group of researchers agreed on a name for the field: **“Artificial Intelligence”**

The AI name got accepted in funding circles but not in many academic fields

- Statistical pattern recognition
- Machine Intelligence and Machines that learn
- Brain sciences, biological models of intelligence
- Systems theory and control, Optimization, Many fields in engineering

What is Artificial Intelligence?

The use of computers to “simulate” human intelligence

- Defining “intelligence” is an open problem
- “Common Sense Reasoning” still an open problem

The excessive hype lead to two AI Winters - Cut in funding, industry disillusionment, and practitioners avoid the field

- AI Winter 1 - Mid 1970's
- AI Winter 2 - Early 1990's

What about Machine Learning?

A subset of AI concerned with machines modifying/learning behaviors based on experience (inputs) - Training Data





The Hype and the AI Winters

From the early days of AI - the notion of “computers becoming intelligent” captured everyone’s imagination.

The AI researchers **encouraged the hype as well** claiming in the 1960’s that we will indeed achieve human-level intelligence in 10 years or less... **Never happened.**

The excessive hype lead to two AI Winters - Cut in funding, industry and sponsor disillusionment, and practitioners avoiding the field - researchers even denying their work is related to AI...

- AI Winter 1 - Mid 1970's
- AI Winter 2 - Early 1990's

We now went from an AI Summer, to a Heat Wave with generative AI...



First generation Artificial Intelligence

1950's to 1970's -- AI Winter I: mid-1970's

Where did the first wave fail?

Severe underestimations of the complexity of

- Common sense reasoning
- Natural language understanding
- Mathematical logic was only useful in theory but not computationally practical

What did we learn?

- **Extremely narrow problems**, with limited or no need for common sense reasoning
- **Many practical applications did work in very narrow verticals**
- Expert systems, scheduling in manufacturing, travel bookings, etc.
- **Game players** – chess, checkers, etc

Second generation Artificial Intelligence

1980's to early 1990's -- AI Winter II: early-1990's

Where did the second wave fail?

- Common sense reasoning still proved to be too challenging
- “Natural Language Understanding” continued to disappoint
- Severe under-estimation of the complexity of “Machine Vision”
- Probabilistic reasoning did not scale

What did we learn?

- **The problem was worse:** it seems like we needed a “complete understanding” of the world to do any of these tasks
- **Reasoning** turns out to be more complicated, multi-faceted, a very hard, but critical problem to solve

Hype Sounds Familiar?



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ENTREPRENEURS

Elon Musk: 'Robots will be able to do everything better than us'

Catherine Clifford | 12:23 PM ET Mon, 17 July 2017



TECH · A.I.

Elon Musk predicts AI will be smarter than humans by next year

BY CHRIS MORRIS
April 9, 2024 at 10:39 AM EDT



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FORTUNE

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VC Giant Andreessen Horowitz Joins AI Hype with Gargantuan Fundraise



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FEATURES ECONOMY EAST ASIA CHINA

China's AI Agenda Advances

As China throws state support behind AI development, major Chinese technology companies will remain integral players.

By Elsa Kania
February 14, 2018



Are China's ambitions to "lead the world" in artificial intelligence (AI) by 2030 credible? China's rapid emergence as an AI powerhouse is often hyped and sensationalized, variously provoking alarm and enthusiasm that can sometimes overshadow the reality of real progress. At the same time, critical challenges remain in China's quest to become "the world's premier AI innovation center" and build up an AI industry of 1 trillion RMB (about \$150 billion) in the process.



In this Oct. 21, 2016, file photo, Chinese students work on a humanoid bipedal robot displayed during the World Robot Conference in Beijing.

Image Credit: AP Photo/Ng Han Guan, File

HOT TAKE THOUGHT EXPERIMENT SELF EXPLANATORY WHY IS THIS HAPPENING?

Will robots take your job? Humans ignore the coming AI revolution at their peril.

Artificial intelligence aims to replace the human mind, not simply make industry more efficient.

Feb. 07, 2018 / 6:44 AM PST



- Major hype in the 1980's – AI was going to solve all problems and change the world
 - U.S. was afraid of Japan AI program – 5th Gen. Systems
 - We are all going to be useless
 - Jobless
 - Brainless
 - China 2030 AI is the new Japanese 5th Gen

Machine Learning survived both AI winters



*Not because we developed
new/better ML
algorithms...*

*But because we had a lot
more data*



The Hype and the AI Winters

Yet we don't seem to learn from the past lessons: The hype continued into 2000-2010 and then intensified now with the emergence of Generative AI and ChatGPT

Is it different this time? *Probably* - but not because of breakthrough algorithms - rather because:

1. We have **a lot more data** - courtesy of the Internet and Digital Transformation
2. The **knowledge economy** has many repetitive/robotic tasks that machines can accelerate dramatically
3. A **lot of compute and energy consumption** can make brute-force approaches work - at a very high cost in hardware and infrastructure - but the **benefits are worth it even for modest acceleration.**



Example in Machine Learning?

A subset of AI concerned with machines learning/modifying behaviors based on experience (inputs)

Early success: Arthur Samuel's Checkers player at IBM (1955-1959)

- Major insights on learning as an optimization problem



Significance of Samuel's ML Proof?

- Samuels's Checker player learned to play by playing games
- It “learned” by adjusting a scoring function that allowed it to prefer some moves over others – started beating Samuel himself!
- Became a “better” checkers player with each game it played



Example in Machine Learning?



The Significance of Samuel's Checkers Player results

Why is this a great test?

- Started beating Samuel consistently – became “better” than its author
- Fed it all championship games in simulation – the machine started playing at championship levels



So What?

- This is fundamentally an incremental, experience based, optimization technique
- This type of success was repeated in many “data analysis” tasks:
- Learning to diagnose illness, to predict marketing preferences, x-sell and up-sell recommendations



From Art Samuel's paper...

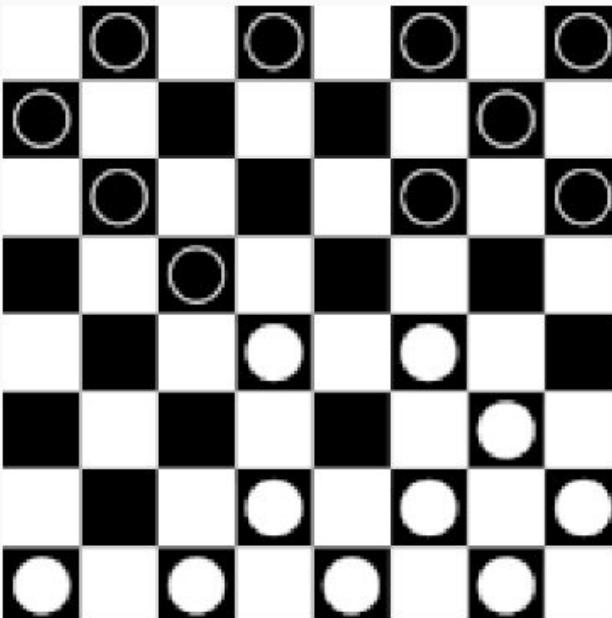
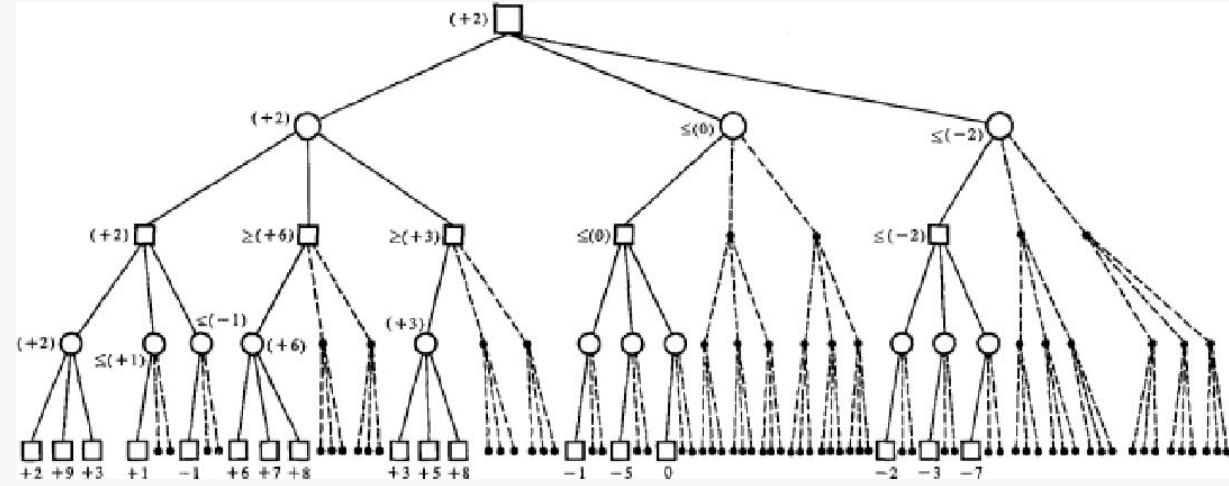


Figure 1: A typical mid-game checkers position.



Published in IBM Journal of Research and Development 1967
Some Studies in Machine Learning Using the Game of Checkers
A. Samuel



The 3 waves of AI

**Classical AI
(waves 1 &2)**

**Expert systems, rule-based systems,
scheduling, reasoning about
uncertainty, Machine Learning**

general problem solvers, heuristic search, knowledge representation, planning, causal reasoning, machine vision, natural language understanding, Pattern Recognition

**Predictive AI
(waves 2+ & 3)**

**Empirical/Data-Driven methods - data
mining/data science, Deep Learning
Optimization-driven approaches,**

predictive analytics, decision trees, Bayesian Models, and many classification and regression methods, Linear & Integer programming, intensive search, advanced satisfiability search and optimization

**Generative AI
(wave 3)**

**The generation of “content” (text,
images, voice, video, etc.) from a
textual or multimodal prompt**

Analyzes and learns from data to create (“generate”) something new - data, images, sounds, or other types of information.
Recent buzz driven by the simplicity of new user interfaces for creating high-quality text, graphics, and videos within seconds (e.g. ChatGPT)

How does GenAI fit within AI, Machine Learning

Artificial Intelligence

Programs with the ability to simulate human intelligence

Machine Learning

Programs with the ability to learn without being explicitly programmed

Generative Models

Programs with the ability to learn how to generate new data that is similar to a given set of training data

Applied ML

Supervised Learning (Predictive AI)

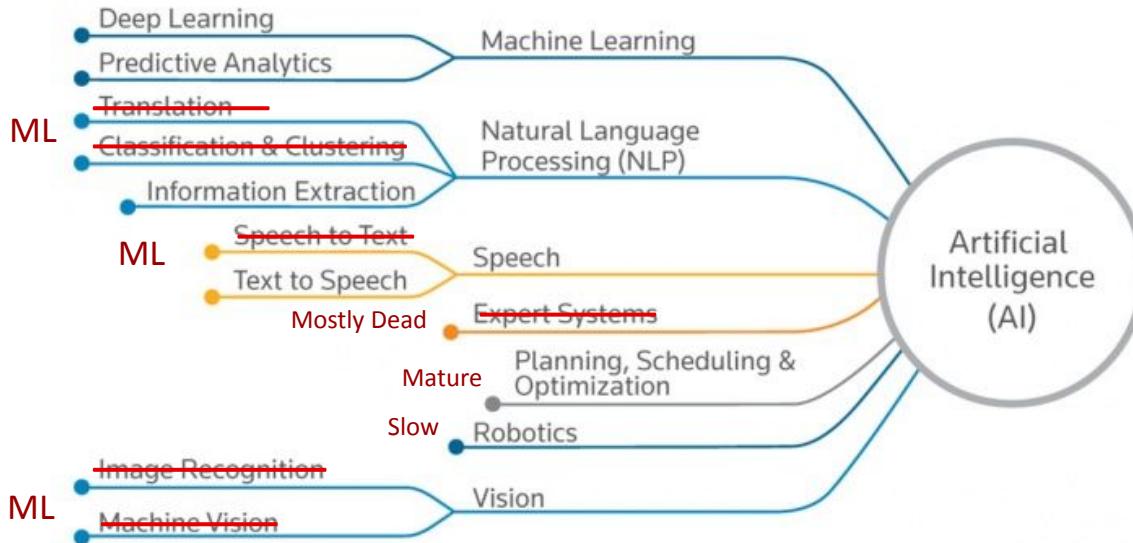
Unsupervised Learning

Gen AI

Reinforcement Learning

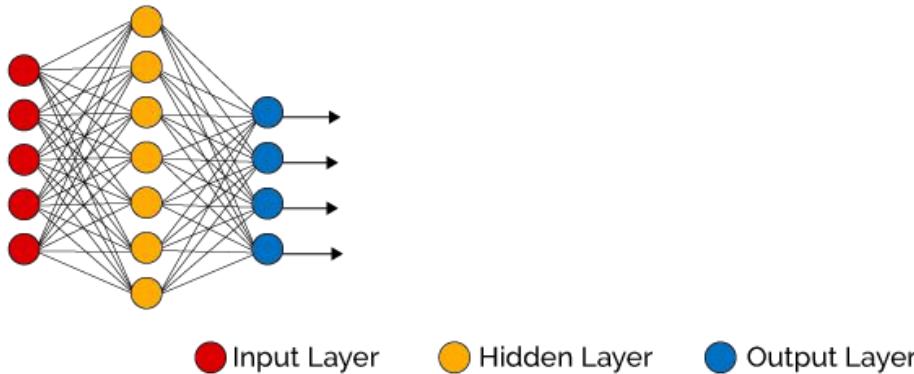
Genetic Algorithms, etc.

AI Redux....



The second incarnation of ML/neural nets: Deep Learning

Simple Neural Network



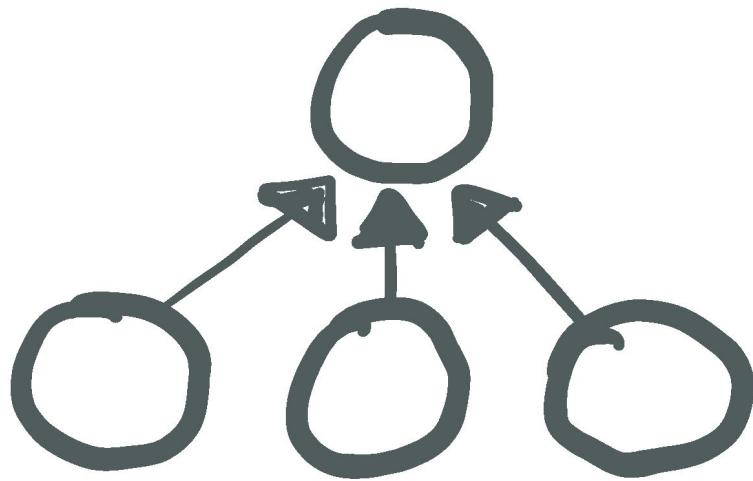
- Resurgence on Neural Networks in 2010 – Deep Learning

- Not much new, just lots of computation and lots of data
- Works very effectively in “non-declarative” knowledge
- Breakthroughs on learning “procedural knowledge” where we don’t know how humans do it – Jeff Hinton in 2012 – image recognition in 22K categories over 15 million images (85% accuracy)
- Object Recognition
- Speech Recognition
- High-dimensional regression/decision making



The Perceptron

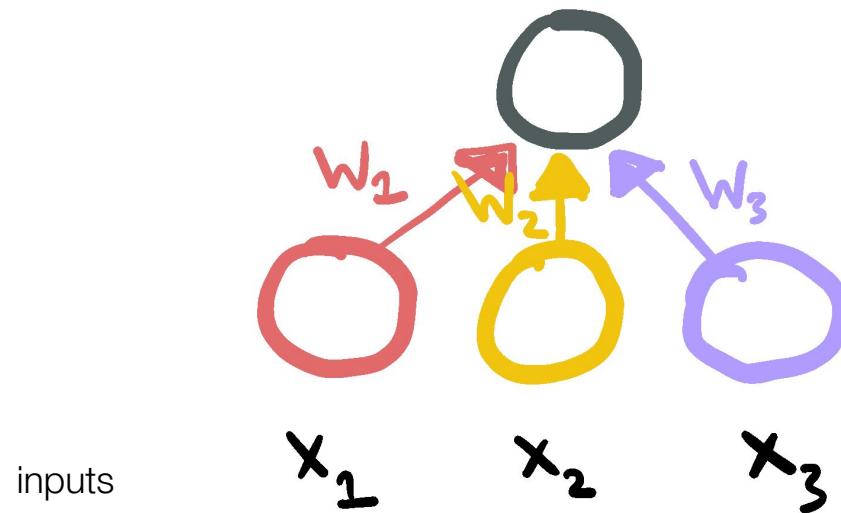
(from 1940's to F. Rosenblatt - 1958)



Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023



The Perceptron

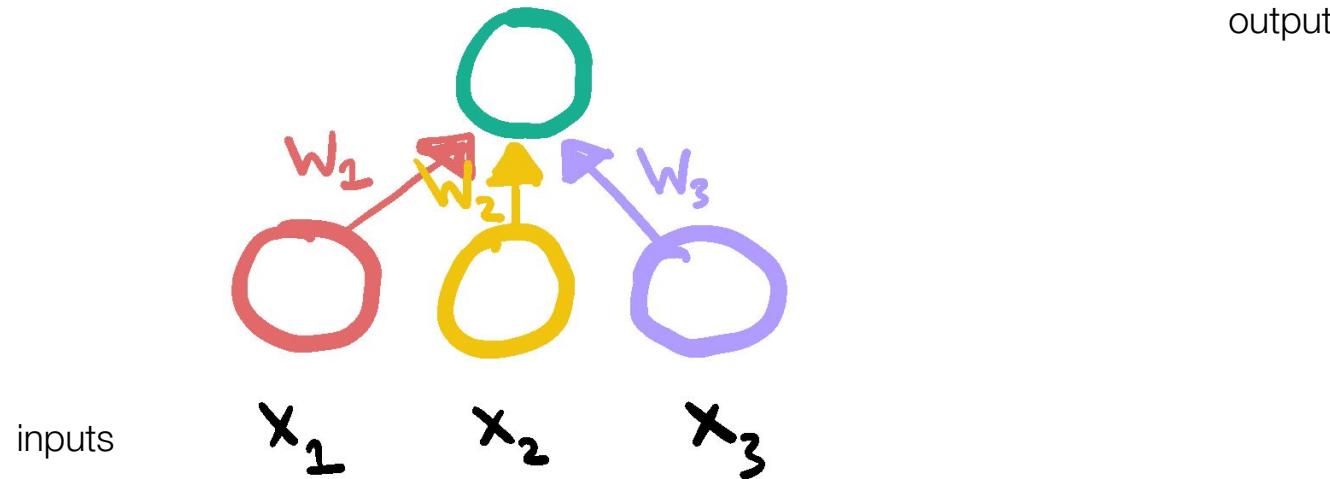


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The Perceptron

$$y = \sigma(w_1x_1 + w_2x_2 + w_3x_3)$$



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SUNDAY, JULY 13, 1958

The Perceptron

Electronic 'Brain' Teaches Itself

The Navy last week demonstrated the embryo of an electronic computer named the Perceptron which, when completed in about a year, is expected to be the first non-living mechanism able to "perceive, recognize and identify its surroundings without human training or control." Navy officers demonstrating a preliminary form of the device in Washington said they hesitated to call it a machine because it is so much like a "human being without life."

Dr. Frank Rosenblatt, research psychologist at the Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., designer of the Perceptron, conducted the demonstration. The machine, he said, would be the first electronic device to think as the human brain. Like humans, Perceptron will make mistakes at first, "but it will grow wiser as it gains experience," he said.

The first Perceptron, to cost about \$100,000, will have about 1,000 electronic "association cells" receiving electrical impulses from an eyelike scanning device with 400 photocells. The human brain has ten billion responsive cells, including 100,000,000 connections with the eye.

recognize the difference between right and left, almost the way a child learns.

When fully developed, the Perceptron will be designed to remember images and information it has perceived itself, whereas ordinary computers remember only what is fed into them on punch cards or magnetic tape.

Later Perceptrons, Dr. Rosenblatt said, will be able to recognize people and call out their names. Printed pages, longhand letters and even speech commands are within its reach. Only one more step of development, a difficult step, he said, is needed for the device to hear speech in one language and instantly translate it to speech or writing in another language.

Self-Reproduction

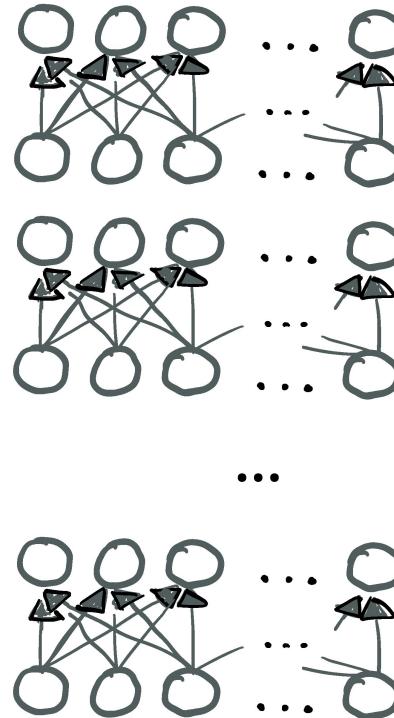
In principle, Dr. Rosenblatt said, it would be possible to build Perceptrons that could reproduce themselves on an assembly line and which would be "conscious" of their existence.

Perceptron, it was pointed out, needs no "priming." It is not necessary to introduce it to surroundings and circumstances, record the data involved and then store them

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023



Deep neural nets



100's of Billions of parameters

Billions of parameters

Millions of nodes

Stack many layers (depth) to get deep networks

Increase the number of inputs

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023

Marvels like
ChatGPT are
primarily a result
of scale in model
size and data



Rich Sutton
***"The Bitter Lesson"* - 2019**



So how does Generative AI work?



Scale: Self-supervision

Fat-free high frequency traders hop randomly

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023



Scale: Self-supervision

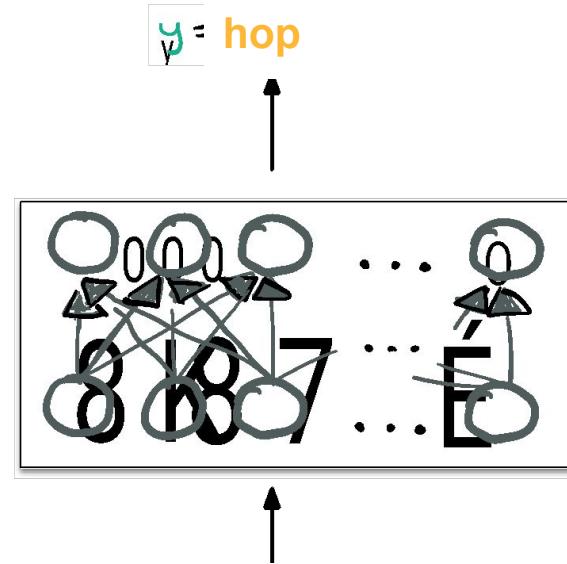
Fat-free high frequency traders **hop** randomly





Scale: Self-supervision

giant neural network,
billions of weights



Training
Adjust weights to make this output likely

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023

Scale: Self-supervision



A WEBCOMIC OF ROMANCE,
SARCASM, MATH, AND LANGUAGE.

THIS IS YOUR MACHINE LEARNING SYSTEM?

YUP! YOU POUR THE DATA INTO THIS BIG
PILE OF LINEAR ALGEBRA, THEN COLLECT
THE ANSWERS ON THE OTHER SIDE.

WHAT IF THE ANSWERS ARE WRONG?

JUST STIR THE PILE UNTIL
THEY START LOOKING RIGHT.

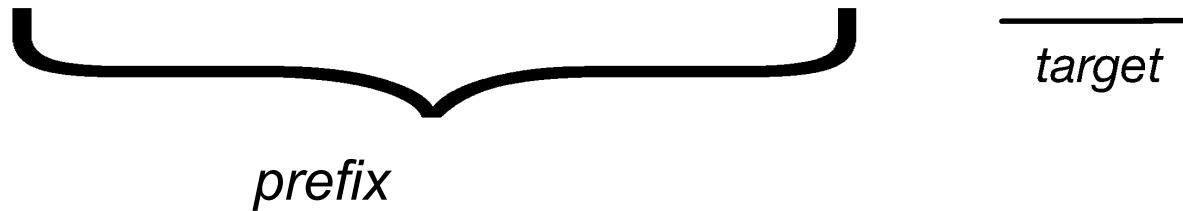


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Scale: Self-supervision

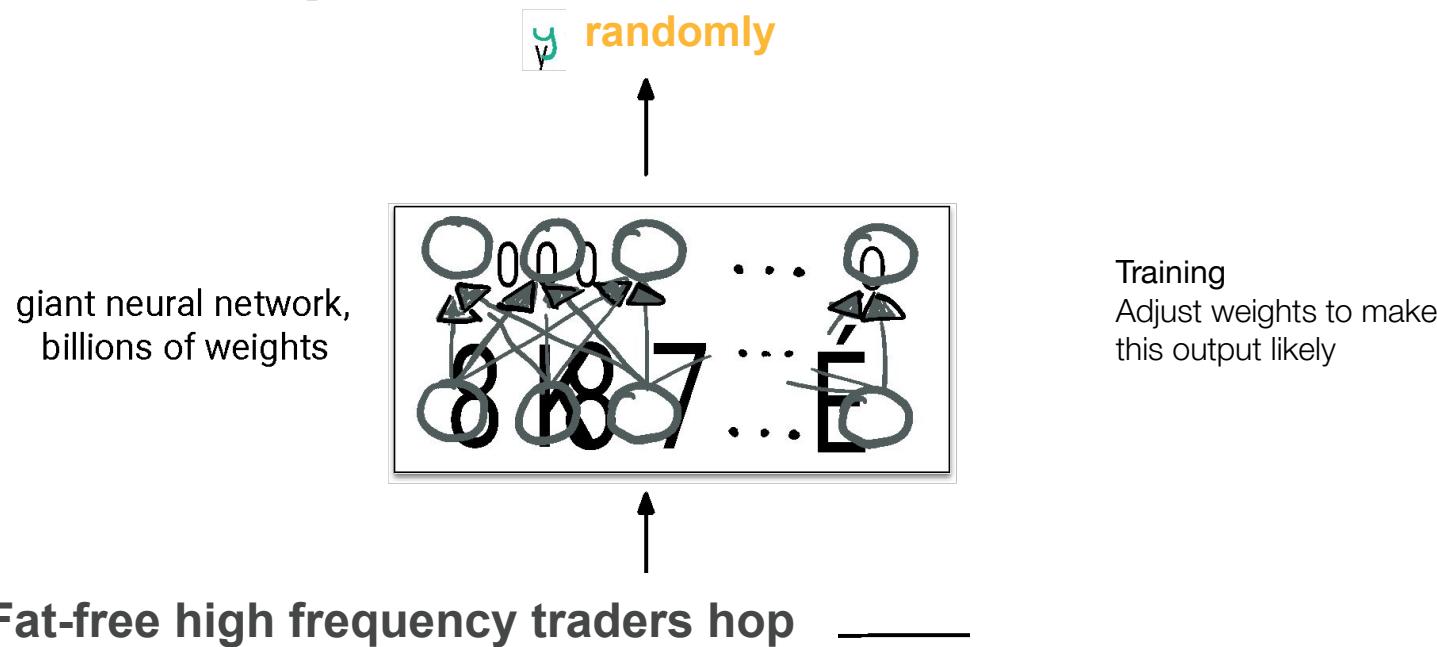
Fat-free high frequency traders hop **randomly**



Note: the use of the *prior output* ("hop") as part of the *new input* makes this an **Auto-Regressive Model**



Scale: Self-supervision



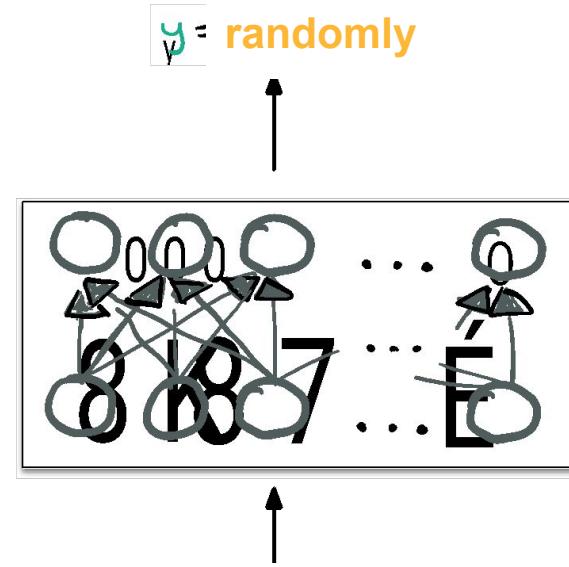
Do this over basically the entire internet (10s of terabytes – a petabyte of raw text)

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023



Scale: Self-supervision

giant neural network,
billions of weights



Training
Adjust weights to make this
output likely

Fat-free high frequency traders hop

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023



Human feedback

After “pre-training”, tune models to better align with *human feedback*



(Dall-E interpretation)

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023

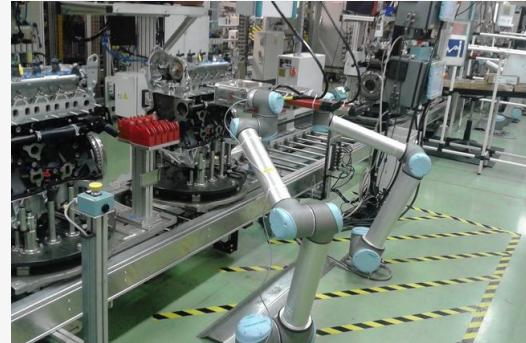
SECRET 1: Making AI Work

1

Narrow the Scope as Much as Possible

Reduce the problem domain to one where “**complete knowledge**” is possible by narrowing scope

Complete knowledge is impossible unless your focus is extremely narrow





Reduce the problem domain to one where “complete knowledge” is possible

How about “Grand Challenge problems” like Machine Vision in Commerce?

- Look for simplifications - recognizing objects is too hard?
- Avoid image analysis completely



*too hard to figure out items
in a basket?*



*Any relation to how
humans see?*

Amazon Go Stores



SHOPPING **Amazon.com, Inc.** [Add Topic +](#)

Why Amazon is ditching Just Walk Out checkouts at grocery stores

 **Betty Lin-Fisher**
USA TODAY

Published 5:48 p.m. ET April 2, 2024 | Updated 11:11 a.m. ET April 9, 2024

Amazon is ditching its "Just Walk Out" technology – which allows customers to shop and leave the store without going to a register – for what it says is better technology at its Amazon Fresh stores.

The change, announced Tuesday, only affects Amazon Fresh locations, the Seattle-based company's grocery stores, and not Amazon Go, which are smaller convenience stores. It also does not impact the more than 130 third-party retailers that Amazon partners with for use of its "Just Walk Out" technology at such locations as airports, college stores and cafes, an Amazon spokesperson confirmed to USA TODAY.

The artificial intelligence technology, which sends customers their receipts after they've taken items off the shelves and left the store, will be replaced by smart carts, which allow customers to scan their items as they shop and see what they're paying and saving on a screen, Amazon said.

In an email, Amazon said it made the decision to cut the technology, which can be found in Amazon Fresh and Amazon Go stores, due to customer feedback.

I spent 53 minutes in Amazon Go : the future of retail

By Matt McFarland, CNN Business

8 minute read · Updated 5:39 PM EDT, Wed October 3, 2018



Seattle (CNN Business) — If you want to glimpse the future of retail, check out an Amazon Go store.

They're sleek and modern, with a minimalist vibe. Black merchandise racks. Wood veneer. Polished concrete. Pop music plays softly in the background; cameras monitor your every move as you wander the aisles.



SECRET 2: Making AI Work

2 Benefits Buy-In from Across Organization

Reasonable ROI and timelines agreed with team, management, legal, risk, and **FINANCE** buy in

Latest in AI can be very expensive...

Depending on benefit expensive may be OK... Optimize later...

The Lost Themes: Data and the Human-in-the-Loop

Data is Essential

Must capture

Events Outcomes Context

most organizations struggle with the basics of making data work as an asset

The “AI-haves” understand this and they have systems to:

- Capture every bit of data + context
- The ability to leverage this data through Machine Learning (ML) to automate the determination of the right action in the proper context

Human Intervention is Essential

Must capture

Guidance Corrections Context

Capitalize on and capture every human intervention to guide AI

What about the human-in-the-loop?

Human intervention is the most valuable asset for Google, Open AI, Amazon, Tesla, and all companies that make AI work

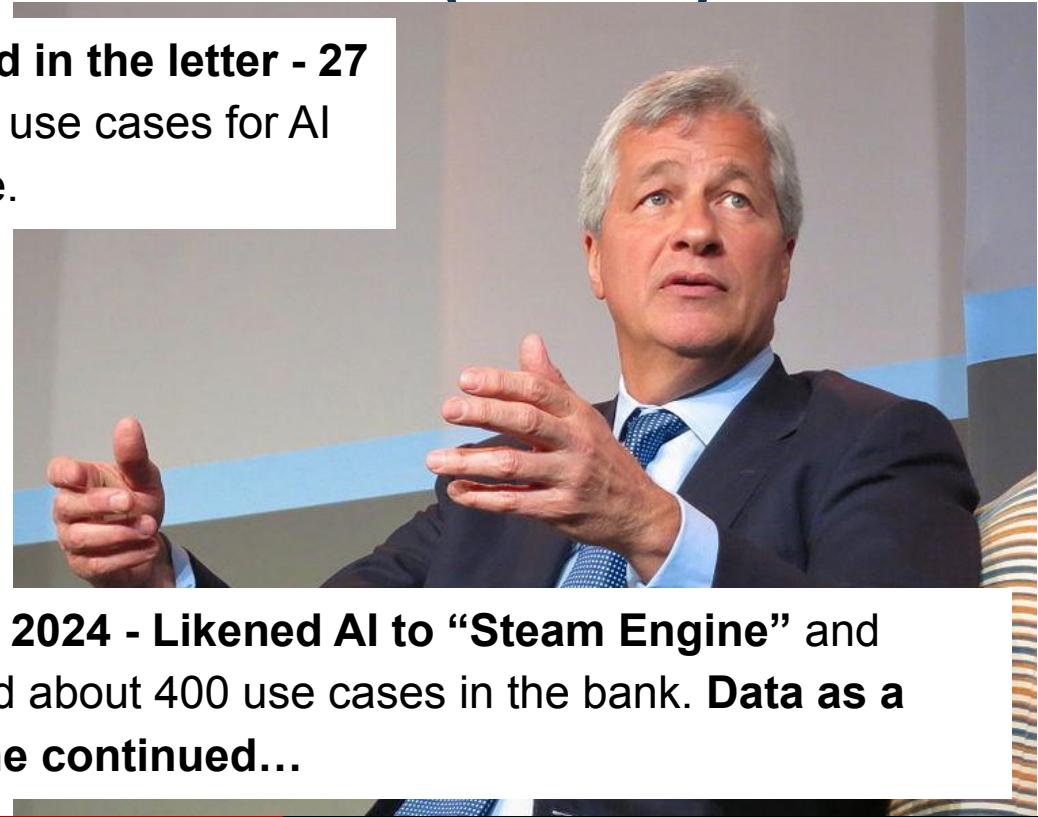
JPMorgan Chase in the Headlines (4/2023)

"Data" was the #1 most used word in the letter - 27 times. JPMorgan has identified 300 use cases for AI that are already in practice at Chase.

Jamie Dimon's annual Shareholder Letter for 2023

"Artificial intelligence (AI) and the raw material that feeds it, **data**, will be critical to our company's future success ... We already have more than 300 AI use cases in production today for risk, prospecting, marketing, customer experience and fraud prevention, and AI runs throughout our payments processing and money movement systems across the globe."

—Jamie Dimon, CEO of JPMorgan Chase



April 2024 - Likened AI to "Steam Engine" and talked about 400 use cases in the bank. Data as a theme continued...



Some of the Big Challenges for Applied AI

Fairness and bias in algorithms can have big consequences

Some decisions are much more **consequential** (than e.g. *targeting ads*)

Algorithms have little or no reasoning capability (or even common sense) – all they know is data (w/ *almost no context*)

Advanced tech and data enable **potentially deep intrusion on privacy & civil rights**

GenAI can be **Unstable** and in **unpredictable ways**

Modeling complex decisions & consequences is a hard problem

In new situations, random actions come out



Data: Some of the Big Challenges for AI

Successful AI is totally dependent on ML/Data Science, hence need good training data: Data remains a huge challenge for most organizations

Good training data is **extremely expensive** to get

... reliable labelling even more expensive

Just **collecting and managing** raw data is a **challenge** for most organizations

... data is growing exponentially with digitization, cloud, and IOT

Data manipulation is very difficult, few understand unstructured data



SECRET 3: Making AI Work

3

Capture All Data at High Granularity

Capture all **Events, Outcomes, and “Context”** at as fine a granularity as possible

Focus on Structured as well as Unstructured data

Majority of Data in any organization is Unstructured (90% per Gartner)



Must Capture Data at High Granularity

But most businesses are not equipped to effectively manage data as an asset

**How do we make
this Data work for
the business?**

New economy of
Interactions is rich with
unstructured data

in fact, 90% of Data in any
organization is
UNSTRUCTURED





We said successful AI is about ML + DATA

“We don’t have better algorithms. We just have more data.” - Peter Norvig, Google

So what do we do about getting the Data we need?

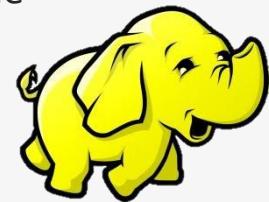
How do we deal with the volume, velocity & Variety of all this Data

New data collection and manipulation technology: BigData - with Map/Reduce for scale

- *Mostly open source*
- *Makes it easier to deal with many data types, especially unstructured Data*

BigData: is a mix of structured, semi-structured, and unstructured data

- Typically breaks barriers for traditional RDB storage
- Typically breaks limits of indexing by “rows”
- Typically requires intensive pre-processing before each query to extract “some structure” – usually using Map-Reduce type operations

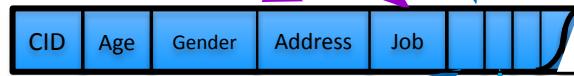


How “Classic” Data Explodes: really big

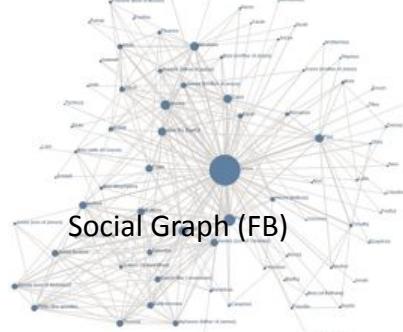


LinkedIn

Lives in London



Age 32, Male



Likes & friends likes



<meta>
</tags>

MetaData on everything

Used new iPhone,
iPad, downloaded
Banking apps

“Searched for low
Mortgage rate”

Opened Savings
Account

Applied for
a Barclaycard

Baidu 百度

Bing



Searched for social medias and
forums re mortgages products

Applied for a Barclays
Personal Loan



Blogs, publications,
news, local papers,
banking, mortgages
providers, credit cards

You Tube
flickr



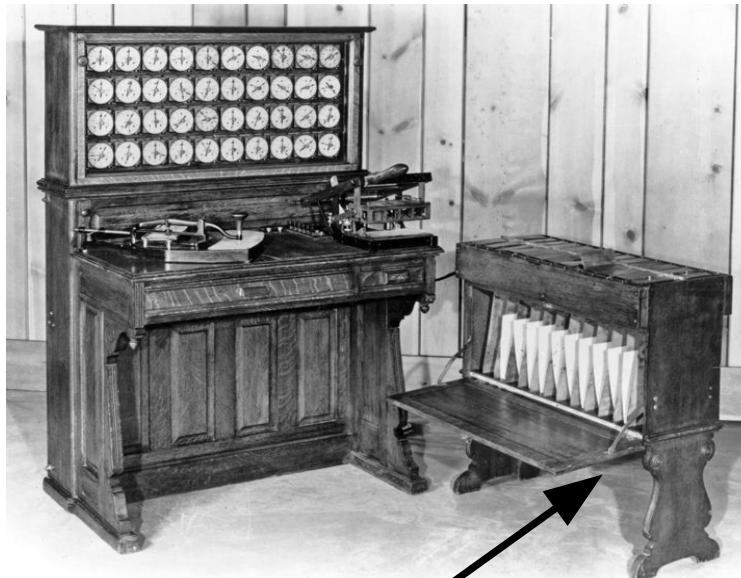
BigData How did it all start?

Why was this technology developed?

- We needed to count keywords in documents... billions of docs?
- Why?
 - Because that's what Search Engines needed to rank relevance of a doc to a “search phrase”?
 - Everything is bag of words with counts of occurrences...

What was the earliest “BigData” machine?

What Was the First BigData Machine?



T-bills sorting machine: *First punch cards were size of T-Bills? Why?*

Herman Hollerith



Won the 1888 Census Bureau competition for fast counting

Formed a company, called:

The Tabulating Machine Company

Merged with 3 other companies into:

Computing-Tabulating-Recording Company

After re-branding? The name changed to:





What is Experiential AI?

Human-centric approaches to solve real problems in real contexts with a human in the loop: Effective Human \leftrightarrow AI cooperation.



**Human intervention
is a must**



**Human intervention is a great
opportunity for knowledge
capture & ML**

Thesis: Taking an applied approach is the best way to solve problems in science and in practice:

- Leverage data in a way that amplifies the values and benefits of machine learning
- create mechanisms for machines and humans to learn together

Result: creating actions, decisions, & results that neither machine nor humans can achieve alone.

Is There a Human in the Loop (HITL) in ChatGPT?

Much speculation about pure AI (AGI) or much human intervention?

- Strong evidence that human editorial review is applied
- Some questions are answered by humans
- Generally, this is a good sign in our opinion
- Does raise issues about “intelligence” and “reasoning”
- This is a best practice – we call it Experiential AI – many do it:
 - Google MLR
 - Amazon recommendations
 - Many intervention-based relevance feedback



<https://mindmatters.ai/2023/01/found-chatgpts-humans-in-the-loop/>



SECRET 4: Making AI Work

4

Capture ALL data from EVERY human intervention

when, why, desired outcome, and context for interventions with clear permission and disclosure

In most organization this
data is never Captured

Leakage of IP into Data Exhaust – a
true waste of the most valuable
resource...

Generative AI

Now What?



What is Generative AI?

Generation of text, images, etc. from a textual or multimodal prompt

- Generating text is based on Large Language Models (LLMs)
- Other models generate images or videos

These models are referred to as
“Stochastic Parrots”
because they do not understand what they say



Examples of Generative AI

Generative AI for Text:

- ChatGPT (Open AI)
- Bard (Google)
- LlaMa (Meta)

Generative AI for Images:

- DALL-E (Open AI)
- Stable Diffusion (Stability AI)
- Midjourney (idem)

Generative AI for Short Videos:

- Midjourney (with a parameter)
- Runway

Generative AI for Code:

- Open AI's Codex
- Microsoft CoPilot (Codex on Github)
- Cognition's Devin (s/w engineer)

Generative AI for Voice & Music

- Aiva.ai
- Endel
- Lyricstudio.net

Plus other objects:

- DNA, Protein folding
- Chemistry, Physics, Molecular Design

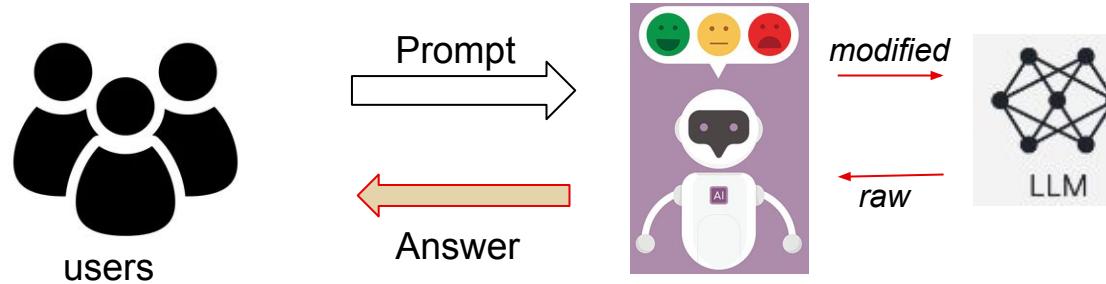
Examples of Training Data

<u>Sentiment</u>	
<u>Text (x)</u>	<u>Label (y)</u>
<i>I love you</i>	positive
<i>I hate you</i>	negative
<u>Outbound Telemarketing</u>	
<u>Audio (x)</u>	<u>Label (y)</u>
	sale
	no sale

<u>Flowers</u>	
<u>Picture (x)</u>	<u>Label (y)</u>
	Tulip
	Daisy
<u>Insight (Elusive)</u>	
<u>URL (x)</u>	<u>Label (y)</u>
http://.../...	Insightful
http://.../...	Lacks Insight



What is ChatGPT?



Chat interface running atop GPT-3 (Then GPT-3.5, later GPT4)

- **Generative Pre-trained Transformer** model – utilizes transformer
 - GPT3 trained on a corpus of about 1 TB of Web text data (with adjustments to reduces biases)
 - GPT-3 is a neural net with 175 billion parameters – expensive to train
- Uses generative unsupervised training
- Works by predicting next token in a sequence – sequences can be very long...



What is ChatGPT?



Most capabilities of ChatGPT not new – around since 2020 in GPT-3



Auto-complete on steroids – with prediction and “concept graph” & human feedback/editing

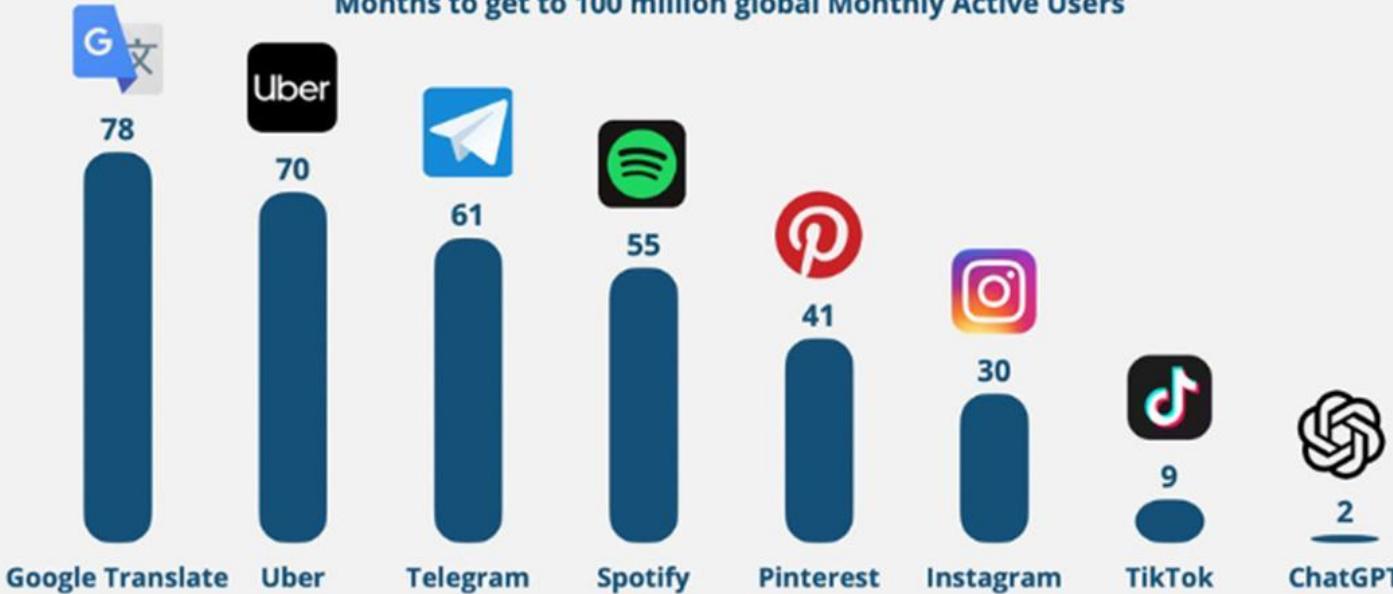
How much does it cost to train GPT-3 on the 1 TB of Curated Data?

How much did it cost to curate the right 1 TB of data?

Speed of Adoption

Time to Reach 100M Users

Months to get to 100 million global Monthly Active Users

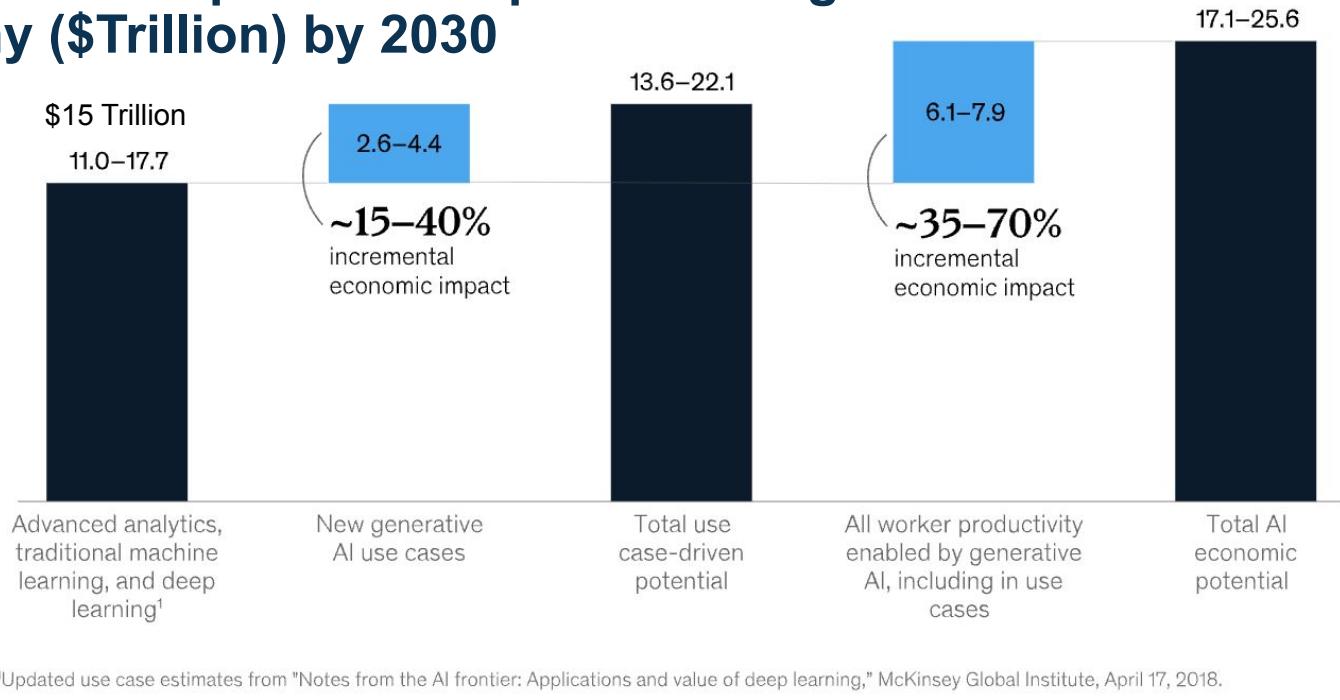


Source: UBS / Yahoo Finance

@EconomyApp

APP ECONOMY INSIGHTS

AI's and Gen-AI potential impact on the global economy (\$Trillion) by 2030



- AI will add \$20 trillion to the global economy by 2030
- Of this, 1/3 is likely to come from increased productivity and 2/3 trillion is likely to come from consumption-side effects

McKinsey & Co.

Sources: <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#business-value>

2023



Economic Impact

- Knowledge worker tasks
 - Several estimates, ranging from 15% to 80% of the work likely to experience significant acceleration
 - But total automation not in reach

What is the size of the “knowledge economy”?

Between 19.6% and 30.4% of **global employment** (ILO, 2023)

Percent of Knowledge Economy	
High Income Countries	35-54%
Upper-middle Income Countries	22-54%

Source: U.N. Report: “Automation hits the knowledge worker: ChatGPT and the future of work”

<https://sdgs.un.org/sites/default/files/2023-05/B59%20-%20Berg%20-%20Automation%20hits%20the%20knowledge%20worker%20ChatGPT%20and%20the%20future%20of%20work.pdf>



Jobs Impact

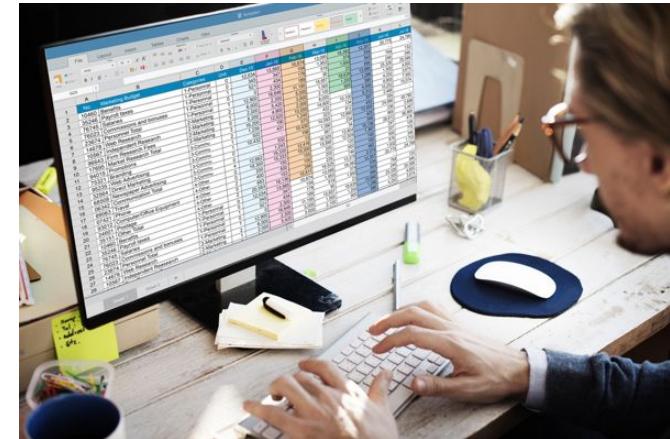
- Human in the Loop is ***Essential***
 - Need to check the output
 - Need to modify and edit
 - Need to approve

Will AI replace my job?

NO - but a Human using AI will
... if you are not using AI



Digital Transformation - Financial Services Example



Many Cross-sector Uses of Generative AI

Financial Services

Monitor transactions in the context of individual history to build better fraud detection systems.

Legal Firms

Design and interpret contracts, analyze case law and evidence, and suggest arguments.

Manufacturers

Combine data from cameras, X-ray and other metrics to identify defects and root causes more accurately and economically.

Film & Media

Produce content more economically and translate it into other languages with the actors' own voices.

Medical Industry

Identify promising drug candidates more efficiently, suggest rare disease diagnoses, answer general questions.

Architectural Firms

Design and adapt prototypes faster.

Gaming Companies

Use generative AI to design game content and levels.



The bottom line?

A Large Language Model - has no knowledge or understanding of what it “learned”

- Billions to trillions of weights
- They serve as a glorified “auto-complete” capability

It is amazing & astounding what these stochastic parrots can do!

In our new digital *knowledge economy*!

How does it work with trillions of parameters?

We discussed an example of self-supervised and interactive learning

Human feedback

After “pre-training”, tune models to better align with *human feedback*



(Dall-E interpretation)

Slides adapted from Primer Talk by Prof. Byron Wallace, Northeastern University - Generative AI Workshop: From the Classroom to the Economy - April 2023

The Evolution of GenAI Usage

A year in GenAI - what
happened from 2023-2024



Major Developments over the Last Year (1)

From fascination to pragmatics and evaluation

Demos of amusing and fascinating capabilities

How does it help the business?

Loose claims of impact, acceleration and ROI

Can you quantify the benefits?



Microsoft Co-Pilot for Code

Is learning code an easier LLM task than Natural Language?

- Microsoft acquires GitHub in 2018 for \$7.5B - Gets access to code by millions of developers using the open source platform
- Train LLM's to produce code (e.g. Python) instead of language (e.g. English)
 - Use documentation and notes
 - Label programs by purpose, and other metadata

?

Is this easier task than English?

?

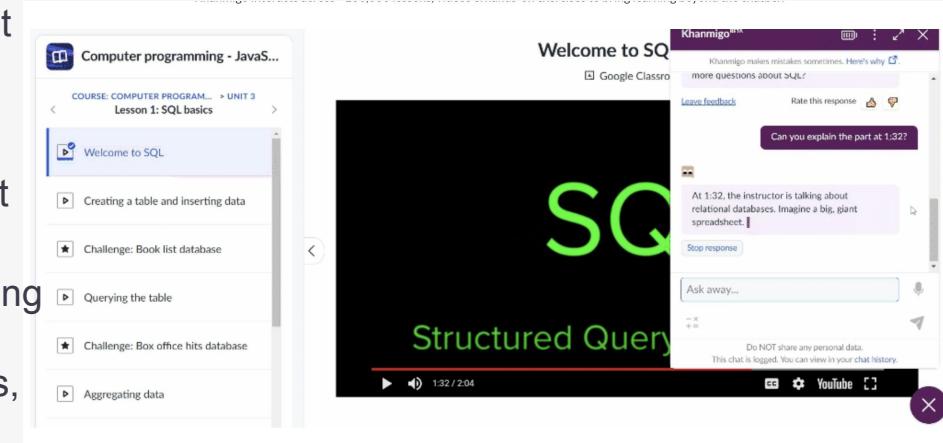
Does this replace programmers?

How much would it increase the productivity of a programmer?

Helpful to non-programmers (no-code applications)?

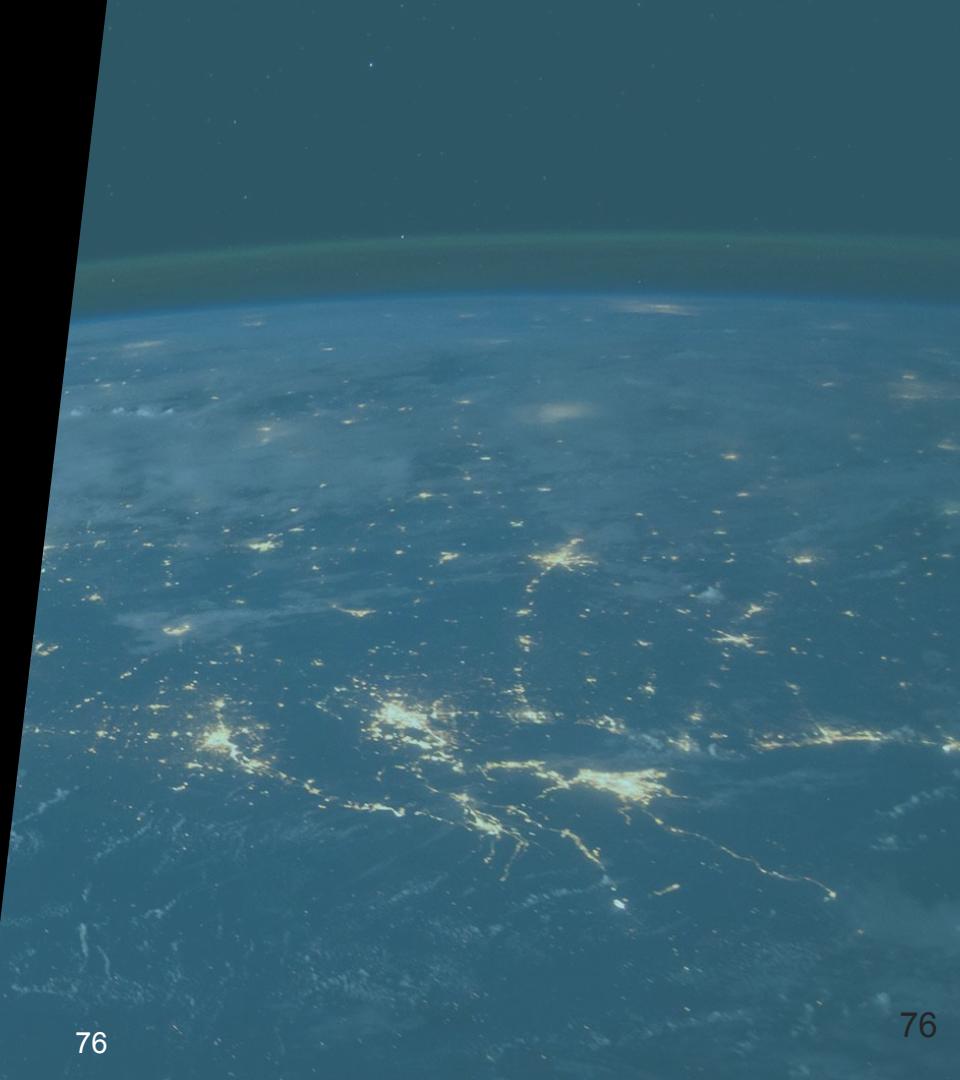
Khan Academy: Khanmigo: 24/7 access to personalized tutoring.

- Khan Academy: set of online tools to help educate students worldwide.
 - Offers thousands of math, science, and social studies lessons for students of all ages.
 - In addition, the organization produces short lessons through videos and blogs, and recently it began offering Khanmigo.
- Khanmigo is a new AI assistant powered by GPT-4.
 - Khanmigo can do a lot of things for students, such as guiding and encouraging them, asking questions, and preparing them for tests.
 - Khanmigo is designed to be a friendly chatbot that helps students with their classwork.
- Support for students and teachers
 - It does not give students answers directly, but instead guides them in the learning process.
 - Khanmigo can also support teachers by helping them make lesson plans, complete administrative tasks, and create lesson books, among other things.



Sample Case Study in Marketing

GenAI with Customers





From GenAI to JenAI?

Same Tech for Deep Fakes

An Interesting tool for marketing?

**Consider *Virgin Cruises*
Marketing Campaign...**



From GenAI to JenAI?

Same Tech for
Deep Fakes

Consider *Virgin Cruises*
Marketing Campaign...

An Interesting tool for marketing?



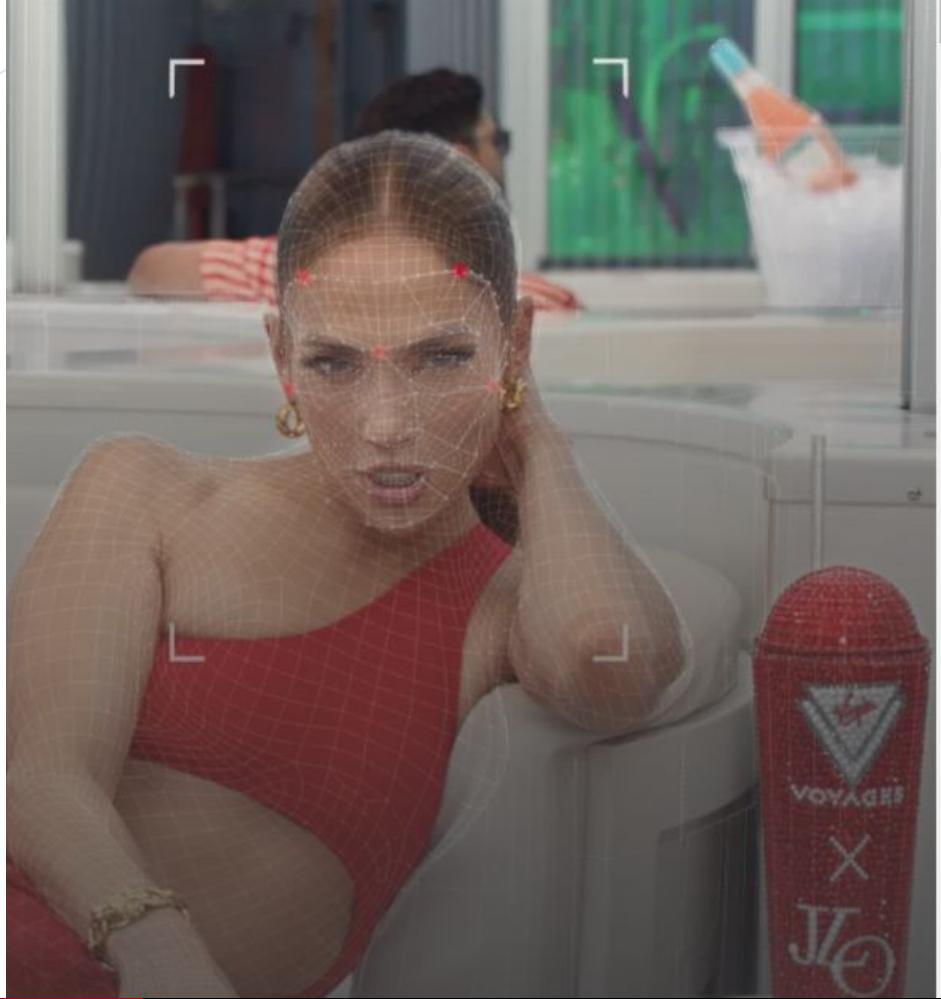
is JenAI really using Generative AI?

Personalization at scale:

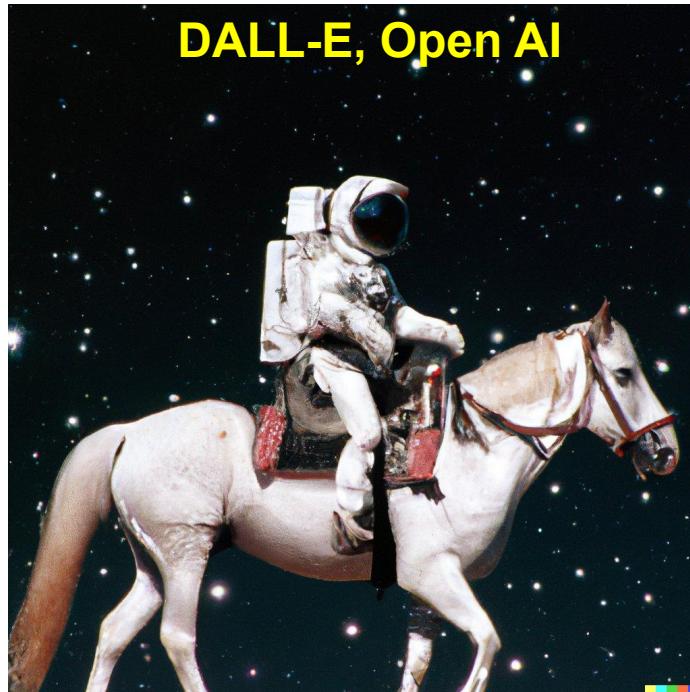
- **Using generative voice:** match user speech to JLo's speech pattern and style based on training.
- **Using generative video:** match movement, pose, gestures to JLo's avatar

users can craft custom video invites from JLo herself...

- Implemented by a startup: DeepLocal - *before the chatGPT hype*



Amusing Applications?



DALL-E, Open AI

Fiction is Easy to Recognize

But reality gets much more complicated (e.g., fake news)

Sophisticated mashup or plagiarism?

But Reality Gets Much More Complicated



+ Videos!



Gen AI enables Rapid Bad Uses

- Fraud
- Impersonation
- Social Engineering
- Cybercrime

- Human-likeness
(without transparency)

The image shows the cover of a report titled "EUROPOL TECH WATCH FLASH ChatGPT: The impact of Large Language Models on Law Enforcement". The cover is dark blue with the Euro-pol logo and the title in white text. Below the title, it says "The impact of Large Language Models on Law Enforcement".

The image shows a screenshot of a European Parliament website. At the top left is the European Union flag. To its right, the word "Topics" is written in large serif font, followed by "European Parliament" in a smaller sans-serif font. On the far right, the text "EU AI Act" is displayed in large bold letters, with "- June 2024" underneath it.

EU AI Act
- June 2024



Responsible AI

- An opportunity
- A strategic advantage
- We will come back to Responsible AI a little later



SECRET 5: Making AI Work

5

Responsible AI by Design and Risk Assessment Process

Risk assessment processes for unintended biases, and built-in **RESPONSIBLE AI** with embedded ethics team

In most organization **RAI** is an after-thought

Risks can create debilitating Reputational Damage – and serious economic costs and liability...

Major Developments over the Last Year (2)

Robustness and mitigating errors

RAG (Retrieval Augmented Generation)

Advanced RAG - pre- and post-retrieval processing

Modular RAG - Hybrid Search, Recursive Retrieval and Querying, Step-back approach, Sub-queries, Hypothetical Document Embeddings

Graph RAG - graph/hierarchy leverage in prompting



From search to GenAI

google.com/search?q=The+Roux+Institute&sca_esv=361d108b9e725553&sxsrf=ACQVn08BadUsc59ahY4cYonNIWTG2qC8

BluewAlive PO Processing Pip... NLM NEU Customer Login Slide Geeks - Sear... EAI Faculty - Sub... Calendar - Jam

Google The Roux Institute

All Images News Maps Videos More Tools

About 22,100,000 results (0.37 seconds)

AI overviews are experimental. Learn more :

The Roux Institute at Northeastern University is a graduate campus and research center in Portland, Maine that offers a new model of education, research, and entrepreneurship for the AI-driven economy. The institute was founded in 2020 and is located at 100 Fore Street in the WEX Inc. headquarters. It is named after David Roux and his wife, Barbara, who made a generous founding investment. The Rouxs understand the challenges posed to society by rapid technological change and believe that a new model of education is the best way to meet emerging industry needs. [^](#)

 roux.northeastern.edu : About - Roux Institute at Northeastern University
The Roux Institute is named in recognition of the generous foundin...

 [rouxinstitute](#) · Instagram
Northeastern's Roux Institute (@rouxinstitute) • Instagram...

From Google Google's Knowledge G information for this ove

The institute offers graduate students and partners experiential learning opportunities in high-tech fields. It works with leading companies and nonprofit organizations to create programs that prepare the workforce to stay agile. [^](#)

U. Fayyad © 2024



Major Developments over the Last Year (3)

Larger LLM's are not necessarily better

Smaller LLMs (SLM)

Better Together (SLM + Knowledge Graphs)

Private LLMs on the rise - Narrow specialization of SLMs

April 2024: Large Hyperscalers discover SLMs

- In The News: After pushing the thesis: “the larger the LLM, the better” - tech giants started admitting SLMs (Small Language Models) since LLMs created unsustainable costs



≡ Menu | Weekly edition | The world in brief | Search ▾

The World Ahead | Science and technology in 2024

AI models will become smaller and faster

They will improve in plenty of other ways, too

Microsoft Debuts Smallest AI Model as AI Eludes Small Businesses

BY PYMNTS | APRIL 23, 2024

|



The Institute for Experiential AI
Northeastern University

Artificial Intelligence | The New ChatGPT | Replacing the C.E.O. | Will A.I. Upend the Election? | Chatbots and Disinf

MIND

The Race to Make A.I. Smaller (and Smarter)

Teaching fewer words to large language models might help them sound more human.

March 21, 2024

Upstage Launches Small Language Model on AWS to Help Businesses Around the World Build and Scale Generative AI Applications for the Korean Market

Are bigger LLMs better?

Sample Case Study in Finance



BloombergGPT: a finance-aware LLM

- BloombergGPT, a 50-billion parameter large language model, purpose-built from scratch for finance [March 30, 2023]
- BloombergGPT represents the first step in the development and application of this new technology for the financial industry.
- Assists Bloomberg in improving existing financial NLP tasks, such as sentiment analysis, named entity recognition, news classification, and question answering, summarization, among others.
- BloombergGPT: What? So What? Now what?

[BloombergGPT ARXIV: <https://arxiv.org/abs/2303.17564>]

BloombergGPT: News headlines generator

INPUT

Input: The US housing market shrank in value by \$2.3 trillion, or 4.9%, in the second half of 2022, according to Redfin. That's the largest drop in percentage terms since the 2008 housing crisis, when values slumped 5.8% during the same period.

OUTPUT

Output: Home Prices See Biggest Drop in 15 Years

Example: Bloomberg



Generate Bloomberg queries (BQL) from natural language

INPUT
OUTPUT

Input: Get me the last price and market cap for Apple

Output: get(px_last,cur_mkt_cap) for(['AAPL US Equity'])





BloombergGPT: So what

This domain-specific language model allows Bloomberg to develop **many new types of applications** and achieve much **higher performance** than with custom models for each application - ***all with a faster time to market.***

sentiment analysis

auto entity recognition

answering financial questions

summarization

headline generation

[BloombergGPT ARXIV: <https://arxiv.org/abs/2303.17564>]



BloombergGPT: Some Questions

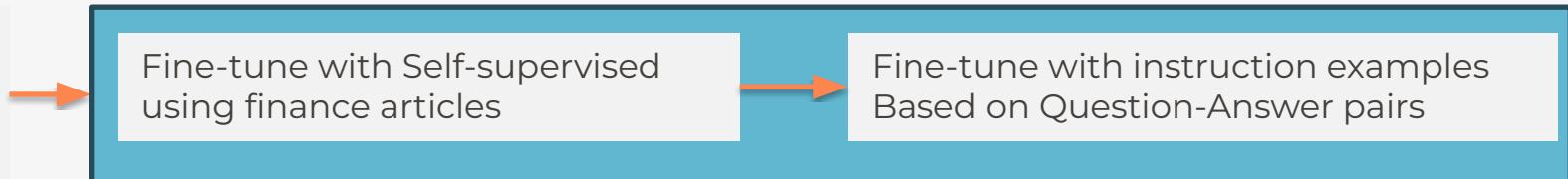
- Why a 50-billion parameter large language model?
 - Because team had a “compute” budget of \$3.5M
- What is the significance BloombergGPT for Bloomberg?
 - Addressed some really important high-business value problems.
 - The approach generalized to many problems: sentiment analysis, named entity recognition, news classification, and question answering, summarization, among others.
- BloombergGPT: What? So What? Now what?

[BloombergGPT ARXIV: <https://arxiv.org/abs/2303.17564>]

Xfinance LLM 13B Outperforms BloombergGPT

- Perform both unsupervised fine-tuning and instruction fine-tuning on the LLaMA 13B model (Stockastic.AI)

LLaMA
13B
model



- Fine-tuning on a GCP cluster of 8 A100 80GB GPUs over 24 hours **at a cost of \$1,000**
- Outperforms BloombergGPT on a range of financial applications

25% of the size of BloombergGPT

1000x cheaper?
Much more?

More Robust,
easier to maintain

Src 5/2023: <https://www.stochastic.ai/blog/xfinance-vs-bloomberg-gpt>



SECRET 2: in Making AI Work (reminder...)

2

Benefits Buy-In from Across Organization

Reasonable ROI and timelines agreed with team, management, legal, risk, and **FINANCE** buy in

Remember: in most cases **Larger LLM** is not necessarily better

Larger LLM is not only more expensive – but much more likely to be unstable and difficult to maintain...



Major Developments over the Last Year (4)

Ease of Use and Integration with Apps

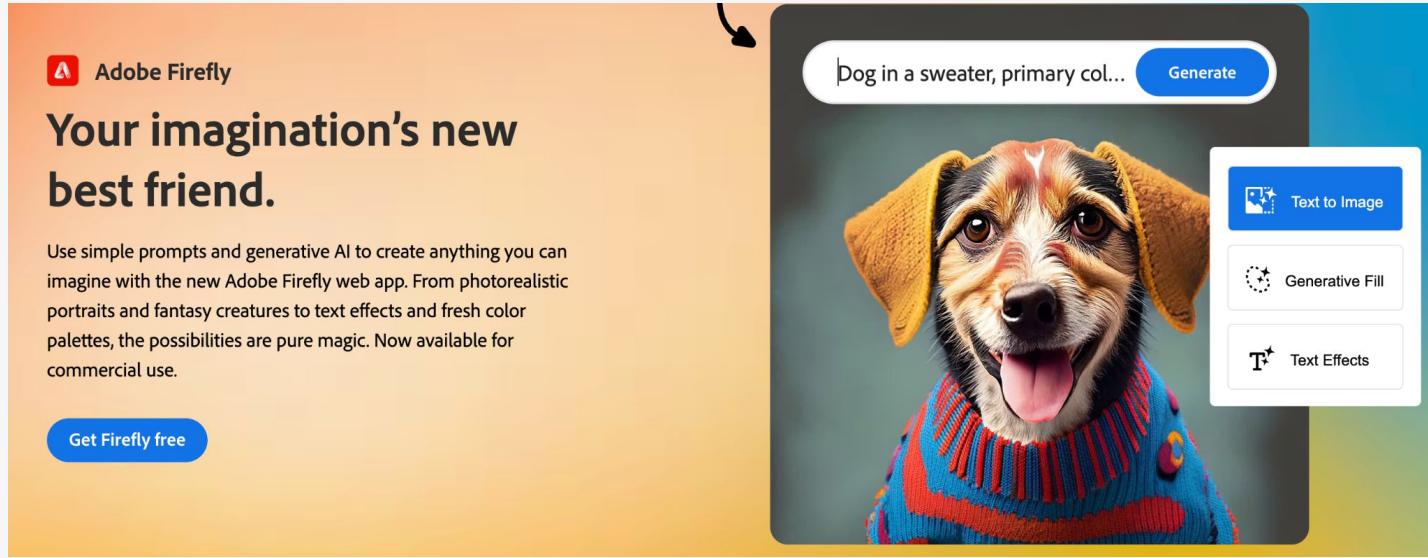
Deployment Simplification - e.g. Amazon Bedrock

Multi-modal interfaces: GPT4o

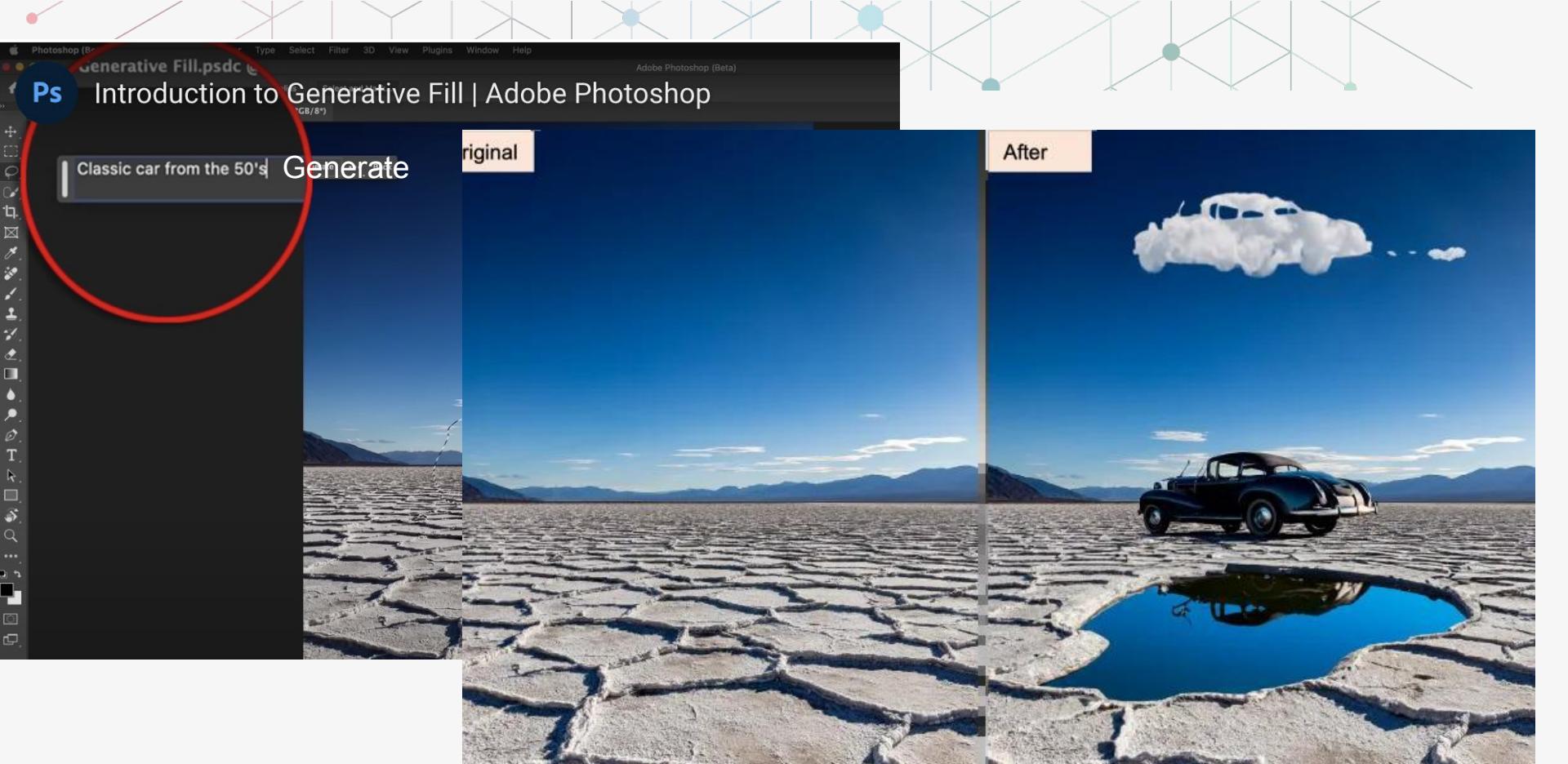
**Co-pilot like integration: Office, browser,
Windows, Search**

A great example of integrated GenAI tools?

A Great Example of Using GenAI



- Private LLM trained on fully-owned images (safe, owned, controlled DATA)
- Users indemnified against IP rights issues
- Integrated into a platform that reaches many millions of users
- Natural and intuitive integrations



Adobe's PhotoShop: Generative Fill feature



SECRET 6: in Making AI Work

6

Incremental and Continuous progress

Gradual, but **CONTINUOUS** improvement over *time*

Remember: Resist being
at head of the pack, but
use the technology in
regular work

Trying to catch up when others figure
out how AI is useful is too difficult –
and the gap will become rapidly a
prohibitive chasm...



Major Developments over the Last Year (5)

Many developments on technical fronts...

LM Agents

Student-teacher LLM models

Synthetic data

Research to understand what happens inside the “black box”

Recent Case-Study - Cybersecurity Hacking

TECHNOLOGY

https://newatlas.com/technology/gpt4-autonomously-hack-zero-day-security-flaws/?utm_source=flipboard&utm_content=other

GPT-4 autonomously hacks zero-day security flaws with 53% success rate

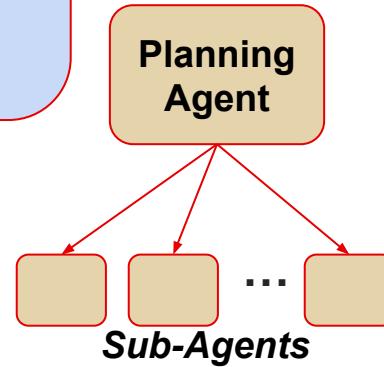
By Joe Salas

June 08, 2024

GPT-4 was able to exploit 87% of critical-severity CVEs (*Common Vulnerabilities & Exposures*) on its own.

HPTSA has shown to be 550% more efficient than a single LLM in exploiting vulnerabilities: 8 of 15 zero-day vulnerabilities.

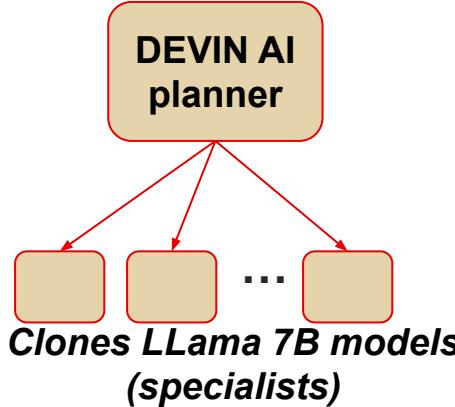
Solo LLM was able to hack only 3/15 vulnerabilities.



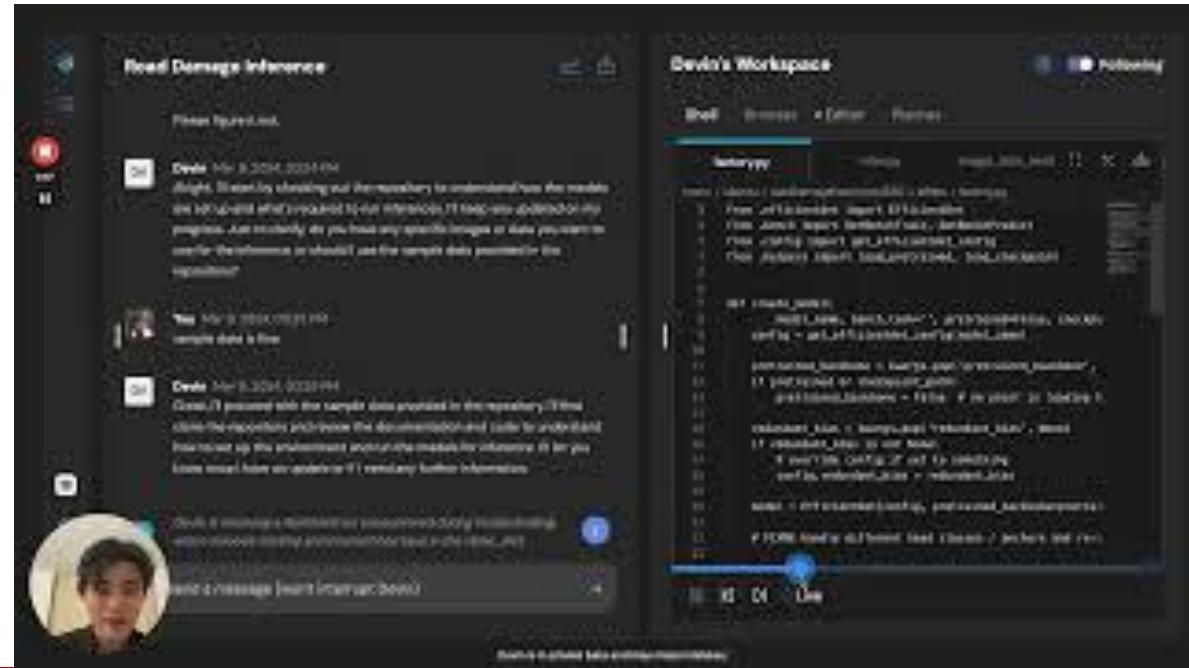
DEVIN - by Cognition Software

Claimed to “simulate” a software engineer - via planning and using specialized LLMs

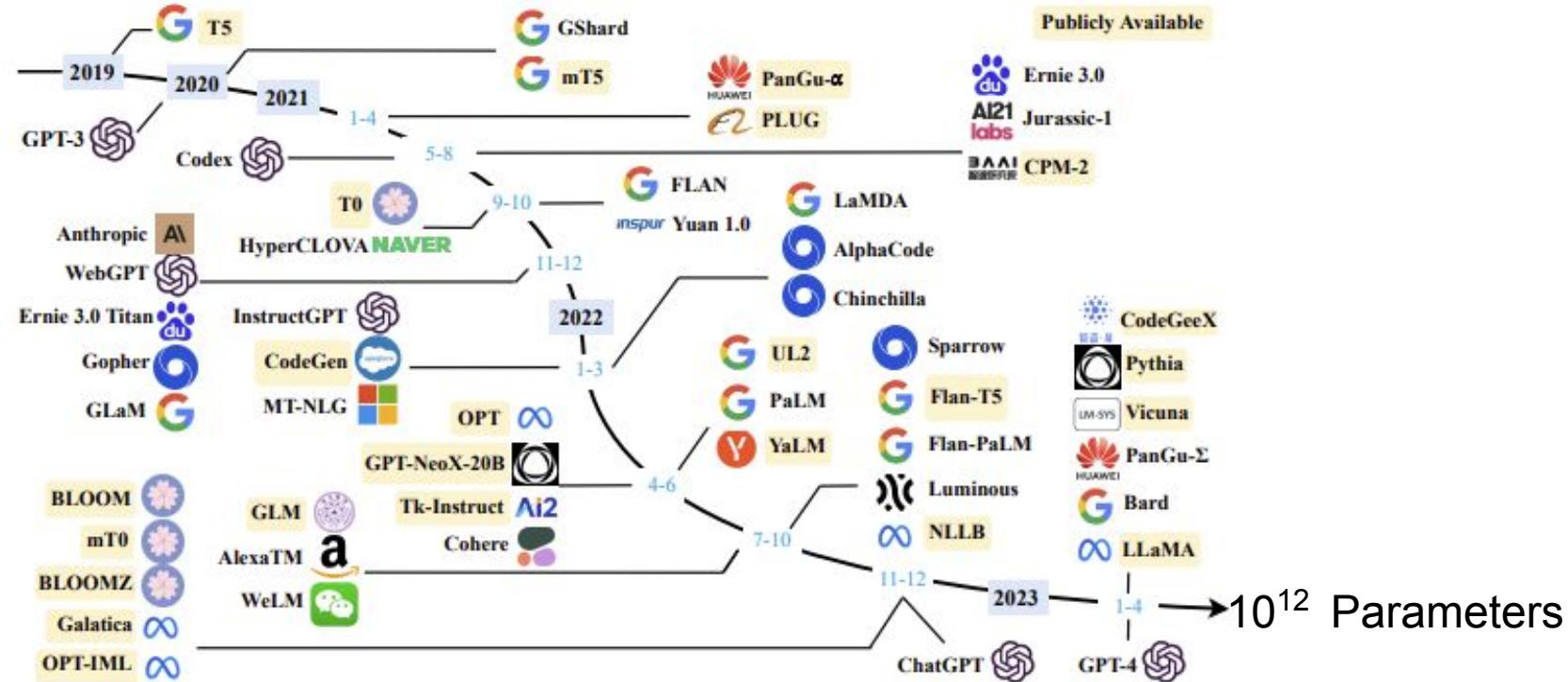
Can Devin get paid to do programming on Upwork?



Claims are being disputed
via further studies!



A Survey of Large Language Models (LLMs) 10B+

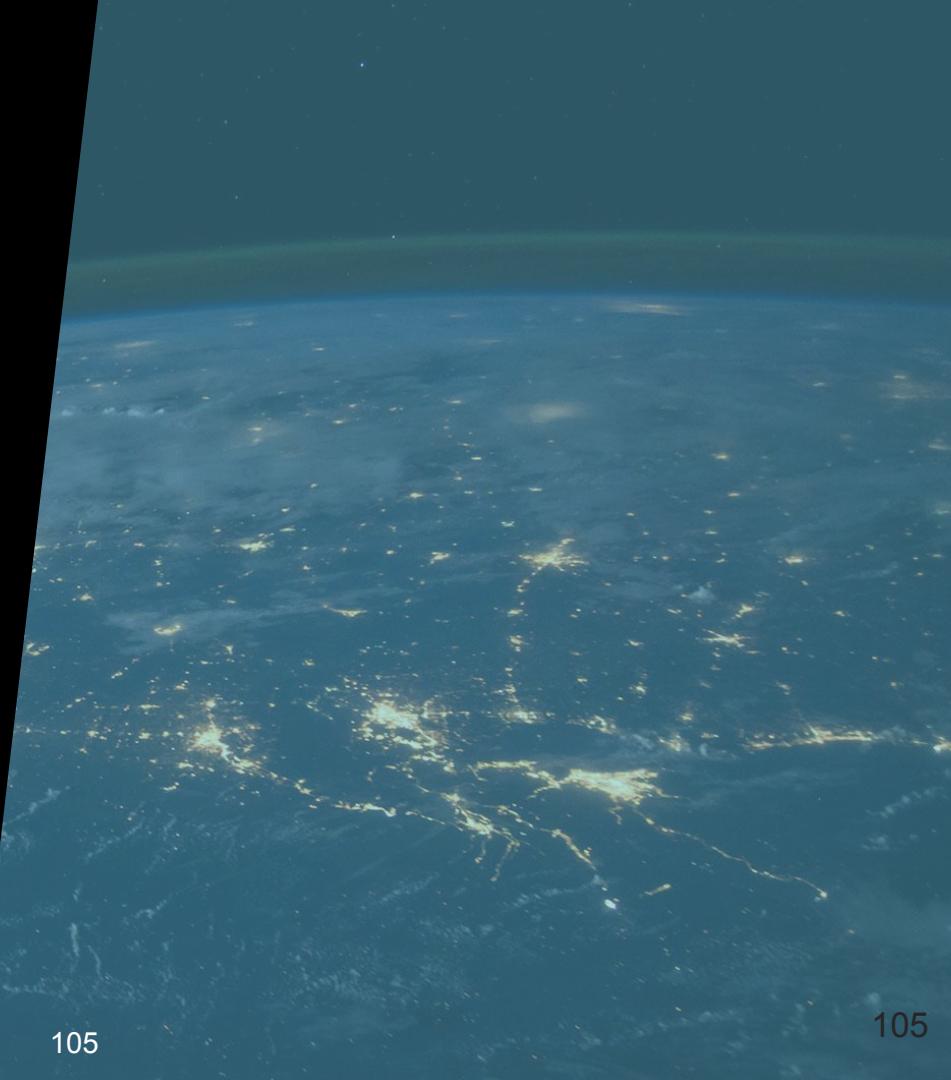


<https://arxiv.org/pdf/2303.18223.pdf>

Wayne Xin Zhao, Kun Zhou*, Junyi Li*, Tianyi Tang, Xiaolei Wang, Yupeng Hou, Yingqian Min, Beichen Zhang, Junjie Zhang, Zican Dong, Yifan Du, Chen Yang, Yushuo Chen, Zhipeng Chen, Jinhao Jiang, Ruiyang Ren, Yifan Li, Xinyu Tang, Zikang Liu, Peiyu Liu, Jian-Yun Nie and Ji-Rong Wen

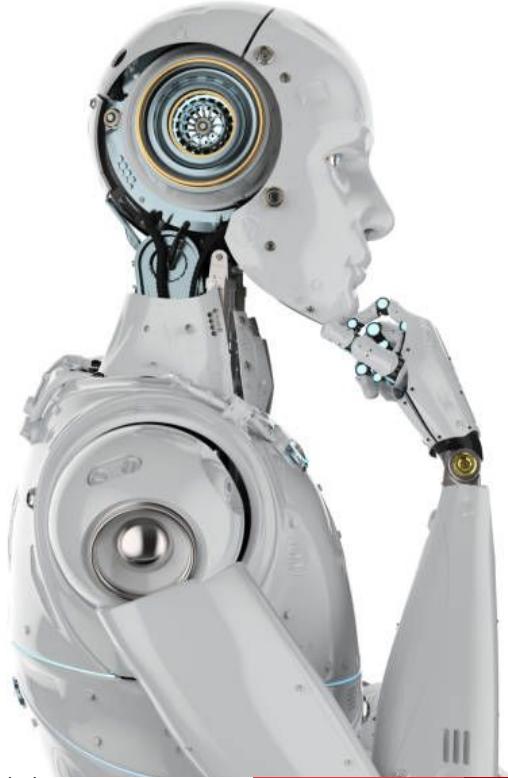
Generative AI

The Issues





Responsible AI for LLMs



Stay lucid about what LLMs can and cannot do.

- LLMs do not “hallucinate” – they make errors
- LLMs are not “thinking” – they mimic conversation
- LLMs do not “have” opinions or character – they exhibit / reflect those
- LLMs do not “intend” outcomes – they do produce outcomes
- LLMs do not intend manipulation and harm but they do “cause” manipulation, misinformation, and harm



WHY Responsible AI?

✗ reputational cost

MARKET

- ✓ customer trust
- ✓ competitive edge

✗ regulatory issues

LAW

- ✓ shaping policy

✗ systems designed against us

SOCIETY

- ✓ systems designed for us



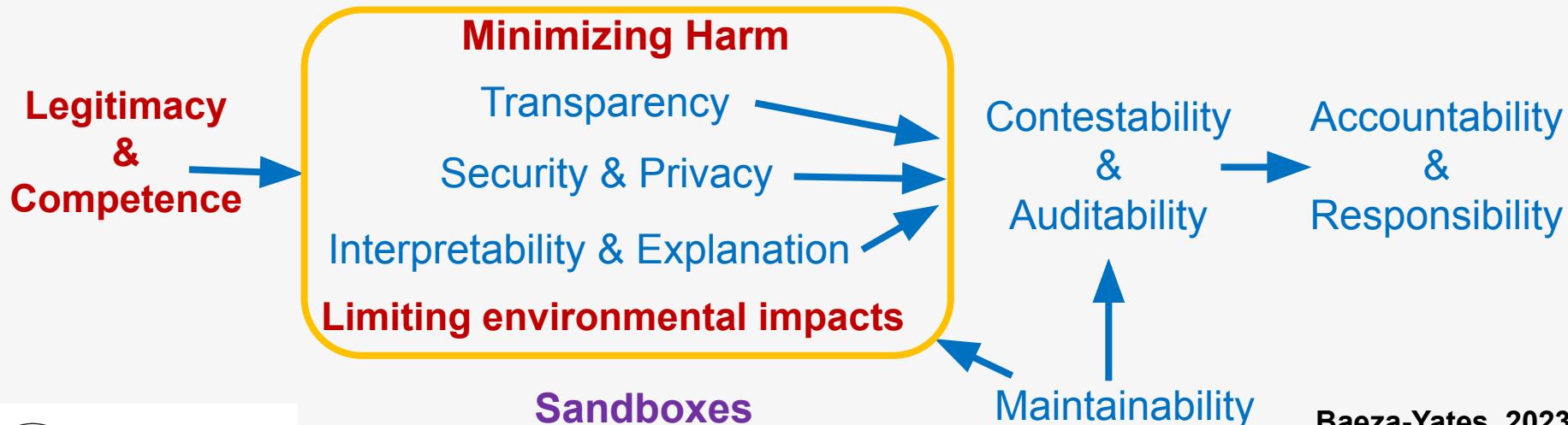
ACM's Statement on Responsible Algorithmic Systems

- 1. Legitimacy and competence**
- 2. Minimizing harm**
- 3. Security and privacy**
- 4. Transparency**
- 5. Interpretability and explanation**
- 6. Maintainability**
- 7. Contestability and auditability**
- 8. Accountability and responsibility**
- 9. Limiting environmental impacts**

Baeza-Yates, Matthews et al., October 2022

RAI Governance

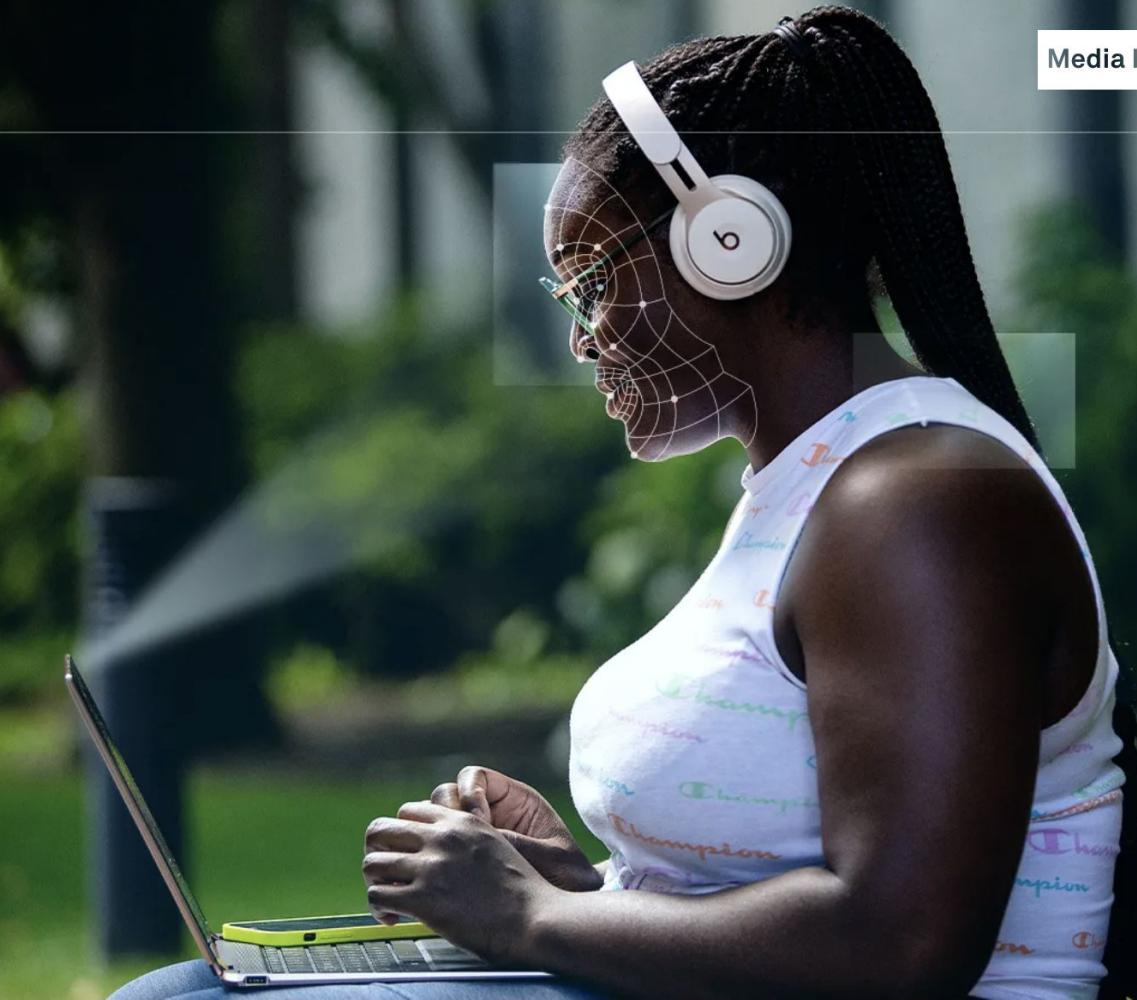
Idea	Design & Development	Operation	When It Fails	When It Harms
Ethical Risk Assessment	Validation & Testing	Monitoring Tools	Algorithmic Audit	



NORTHEASTERN LAUNCHES AI ETHICS ADVISORY BOARD TO HELP CHART A RESPONSIBLE FUTURE IN ARTIFICIAL INTELLIGENCE

Illustration by Zach Christensen/Northeastern University

by Cody Mello-Klein July 28, 2022





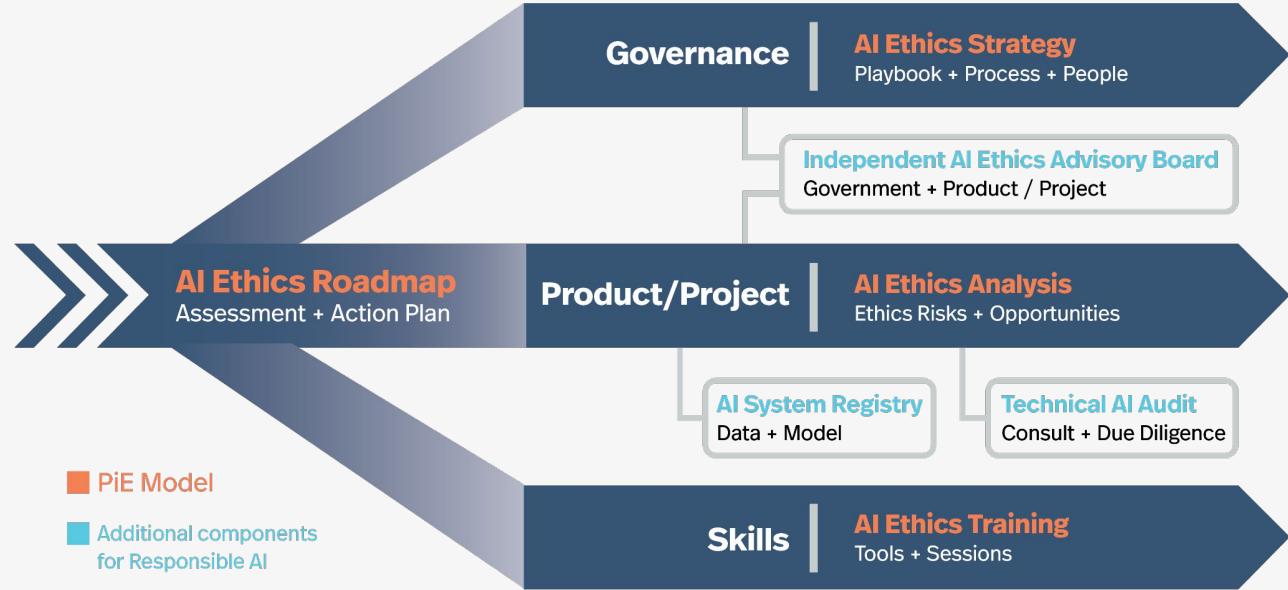
Experiential AI for the Largest Wireless Carrier in the United States

How Verizon Wireless partnered with experts at
the Institute for Experiential AI to integrate
Responsible AI into its innovation roadmap

OVERVIEW OF PROJECT

CLIENT:
Verizon Wireless

PROJECT:
Responsible
AI Governance



Example Project Structure | Comprehensive RAI Governance



RAI START

RAI Maturity Assessment

- Data collection
- Existing governance review
- Review of RAI workflow

Action-Plan Creation

- Stakeholder consultations
- Need and priority identification
- Action guiding roadmap



DEVELOP POLICY

Value Identification

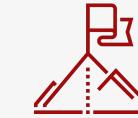
- Define & operationalize organizational values

Tool+Guideline Dev.

- To mitigate risks and identify opportunities

RAI Training

- Leadership/workforce training to upskill for defined RAI roles



DEPLOY GOVERNANCE

Workflow Integration

- Integrating tools and guidelines from Phase 2 within all relevant teams (e.g. product design or data management)

Organizational Change

- Equipping teams to work together across the organization to solve RAI challenges as they appear

Concluding Remarks

Now What?



What is Your AI Strategy?

Are you capturing the right data?

Are you closing the loop with ML/Data Science?

Do you know where to use Predictive AI vs GenAI?

What applications of AI give you highest competitive advantage?

How do you acquire, train, and retain the right talent?



What is Your AI Talent Strategy?

- **Levels of Training:**
 - a. AI Literacy & Awareness
 - b. AI business usage
 - c. AI technical usage
 - d. AI Technical in-house Expertise
 - e. AI for Executives and Leaders
 - f. AI Policies, Regulations, and Law

At Northeastern University's Institute for EAI we offer programs in all these

- For b, c, d: we believe best approach is **Experiential Education: Learn while applying the new technology to your work problems**

- **What do we need to attract the right talent?**
- **What do we need to retain the right talent?**
 - Working with startups ecosystem
 - Centers of excellence that offer up AI services and know how
 - The best upskilling programs for employees



SECRET 7: in Making AI Work

7

Nurture Talent and build AI Culture

Talent and **CULTURE** are critical, employee & executive education are a must

Culture eats Strategy for
Breakfast

Establish a Data and AI organization
with ongoing upskilling and strong
talent management



Some Questions Organizations Struggle With...

Should we do anything on AI/GenAI now or wait and see?

What happens if we just observe and learn?

Do we use public LLMs or should the team build private LLMs?

Can we leverage Open Source/Freeware to start?

Why is everyone saying larger models are better?



Some Final Reminders

Do Not Confuse:

- *Eloquence*
- *Facility in a topic*

with **Intelligence**

ChatGPT does NOT

- “*Hallucinate*”

It makes **Errors**

The Secrets of Making AI (and GenAI) work?

- 1 Narrowing the problem scope as *much as possible*
- 2 **Business Case:** with team, management, and **FINANCE** buy in and agreement to reasonable **ROI** expectations over time
- 3 Collect **ALL** data surrounding events, *outcomes and context*
- 4 Capture **ALL** data from **EVERY** human intervention: *when, why, desired outcome, and context* with clear permission and disclosure
- 5 Risk assessment processes for unintended biases, and built-in **RESPONSIBLE AI** with embedded ethics team
- 6 Incremental and gradual, but **CONTINUOUS** improvement over *time*
- 7 Talent and **CULTURE** are critical, employee & executive education are a must



Summary/Concluding Thoughts

1. Generative AI offers a means for accelerating work, but not fully automating it
2. Generative AI can help reduce robotic, repetitive, and manually intensive work
3. It can be a game changer for efficiency, accuracy and CX (customer experience)
4. National regulation is coming first in the EU and China, then the US
5. Barriers, complexity and costs (if done rationally) of GenAI are coming down – this tech is available to competitors and fintechs



Summary/Concluding Thoughts

1. AI is an enterprise imperative – challenging to make work – But is a big factor in competitiveness in the knowledge economy
2. HOWEVER:

No Data \Rightarrow No working AI

Capture your IP: events, outcomes, context

Human intervention a must

continuous correction of algorithmic errors

- Getting the data/context story right is the key enabler for business insights & AI
- There is a rational approach to getting to data assets - and capturing valuable human interactions \Rightarrow Experiential AI

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In the AI Loop

Welcome to In the AI Loop, the newsletter of the Institute for Experiential AI (EAI) at Northeastern University. As a research hub and business solutions provider, EAI exists at the intersection of human and machine intelligence, striving to balance what algorithms do well with what humans do best. With this newsletter, we hope to add a human element to the conversation. Each month, we'll feature a different cast of experts offering their take on a topical issue in artificial intelligence — plus news, events, business collaborations, and other updates from the Institute.



Featured Story The Truth About ChatGPT

Tech giants on red alert. Universities reimagining core curricula. Governments fretting over a new era of automated misinformation. Writers, coders, paralegals left out in the cold. ChatGPT's generative capabilities are able to produce streams of information that appears to be generated by an intelligent person. But is the panic justified?

Here are **six things to know** from EAI experts

1 ChatGPT is a stochastic parrot, meaning it doesn't know what it's saying.

GPT is good at regurgitating well-established knowledge if it is included (with repetition in multiple docs) in its training data. For well-chosen training corpus, ChatGPT is able to effectively

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Thank you! Any Questions?

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Let's Solve AI Challenges Together!

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