[POSTECH AI Seminar]
The AI Renaissance 2.0 - Redefining Knowledge Systems and Human-Machine Collaboration

Sunghee Yun

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Advisor & Evangelist - Biz Dev @ CryptoLab, Inc.
Adjunct Professor & Advisory Professor @ Sogang Univ. & DGIST

About Speaker

- *Co-Founder & CTO @ Erudio Bio, San Jose & Novato, CA, USA*

- *Advisor & Evangelist @ CryptoLab, Inc., San Jose, CA, USA*

- Chief Business Development Officer @ WeStory.ai, Cupertino, CA, USA

- Advisory Professor, Electrical Engineering and Computer Science @ DGIST, Korea

- Adjunct Professor, Electronic Engineering Department @ Sogang University, Korea

- Global Advisory Board Member @ Innovative Future Brain-Inspired Intelligence System Semiconductor of Sogang University, Korea

- *KFAS-Salzburg Global Leadership Initiative Fellow @ Salzburg Global Seminar*, Salzburg, Austria

- Technology Consultant @ Gerson Lehrman Gruop (GLG), NY, USA

- *Co-Founder & CTO / Head of Global R&D & Chief Applied Scientist / Senior Fellow @ Gauss Labs, Inc., Palo Alto, CA, USA*   *2020 − 2023*

- Senior Applied Scientist @ Amazon.com, Inc., Vancouver, BC, Canada   – 2020

- Principal Engineer @ Software R&D Center, DS Division, Samsung, Korea   – 2017

- Principal Engineer @ Strategic Marketing & Sales Team, Samsung, Korea   – 2016

- Principal Engineer @ DT Team, DRAM Development Lab, Samsung, Korea   – 2015

- Senior Engineer @ CAE Team, Samsung, Korea   – 2012

- PhD - Electrical Engineering @ Stanford University, CA, USA   – 2004

- Development Engineer @ Voyan, Santa Clara, CA, USA   – 2001

- MS - Electrical Engineering @ Stanford University, CA, USA   – 1999

- BS - Electrical & Computer Engineering @ Seoul National University   1994 – 1998

Highlight of Career Journey

- BS in EE @ SNU, MS & PhD in EE @ Stanford University

  – *Convex Optimization - Theory, Algorithms & Software*

  – advised by *Prof. Stephen P. Boyd*

- Principal Engineer @ Samsung Semiconductor, Inc.

  – AI & Convex Optimization

  – collaboration with *DRAM/NAND Design/Manufacturing/Test Teams*

- Senior Applied Scientist @ Amazon.com, Inc.

  – e-Commerce AIs - anomaly detection, deep RL, and recommender system

  – Jeff Bezos's project - boosted up sales by *$200M* via Amazon Mobile Shopping App

- *Co-Founder & CTO* / Global R&D Head & Chief Applied Scientist @ Gauss Labs, Inc.

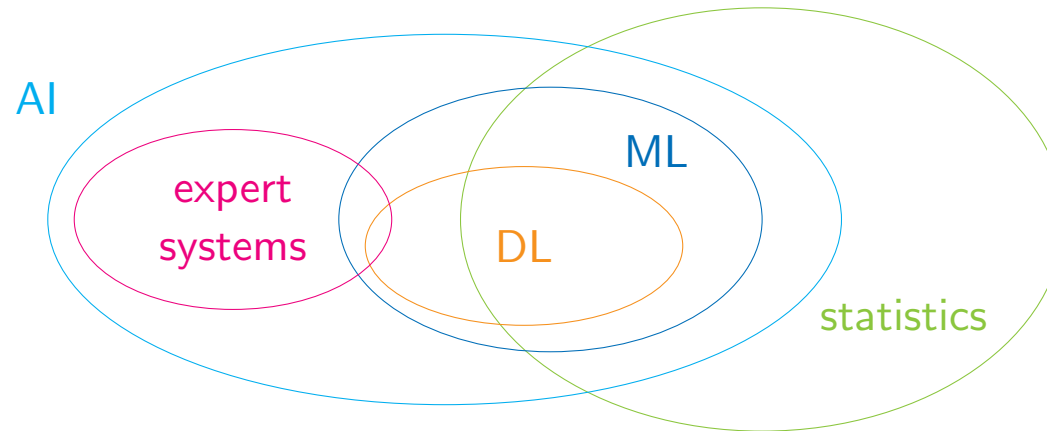- *Co-Founder & CTO* - AI Technology & Business Development @ Erudio Bio, Inc.

Today

Artificial Intelligence

Definition and History
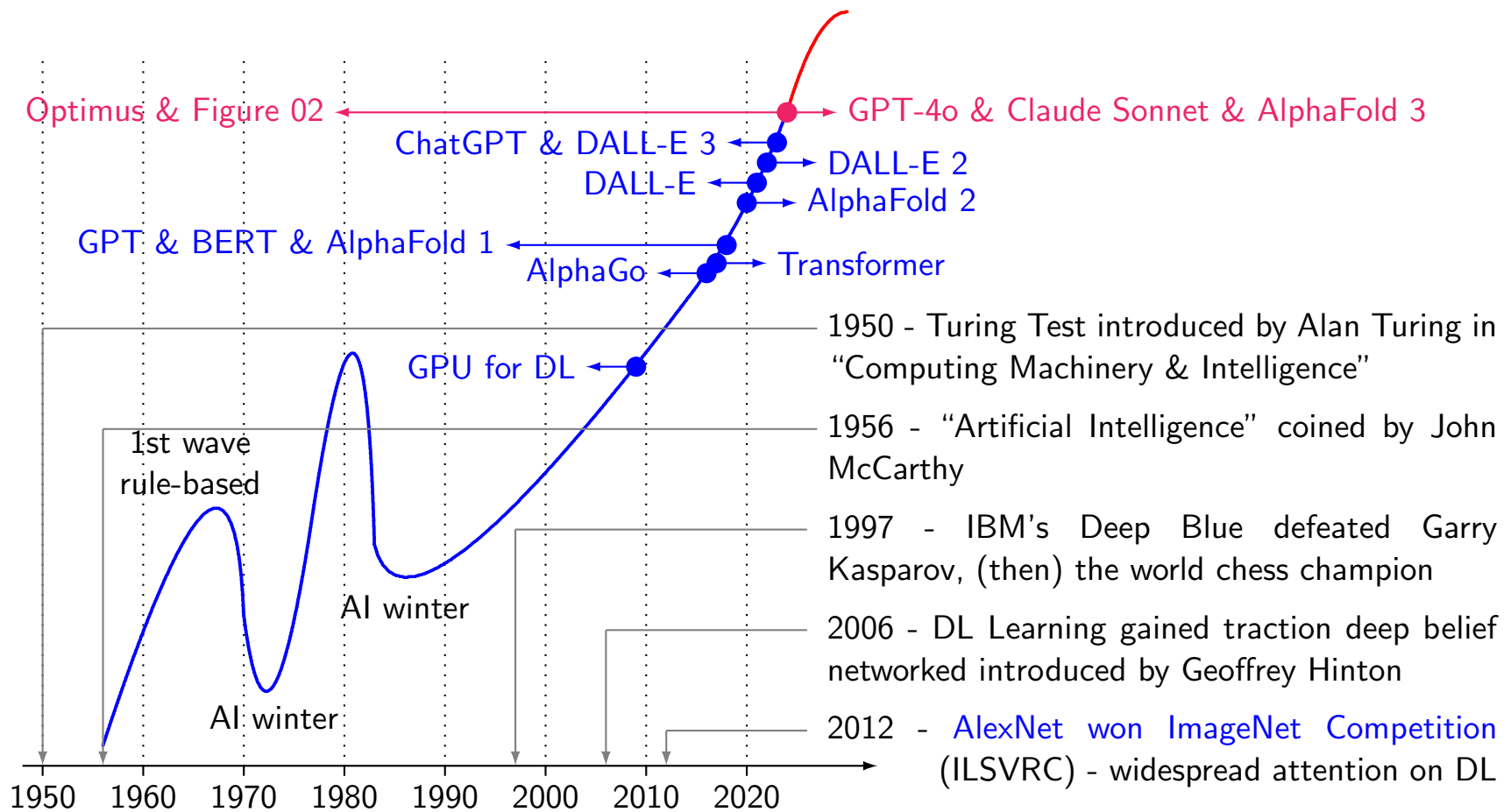
Definition & relation to other technologies

- AI

  – is technology doing tasks requiring human intelligence, such as learning, problem-solving, decision-making & language understanding

  – encompasses *range of technologies, methodologies, applications & products*

- AI, ML, DL, statistics & expert system[1] [HGH[+]22]

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[1]ML: machine learning & DL: deep learning

History

Optimus & Figure 02 ←————————————————→ GPT-4o & Claude Sonnet & AlphaFold 3

ChatGPT & DALL-E 3 ←
→ DALL-E 2

DALL-E ←
→ AlphaFold 2

GPT & BERT & AlphaFold 1 ←————————————

AlphaGo ← → Transformer

1950 - Turing Test introduced by Alan Turing in "Computing Machinery & Intelligence"

GPU for DL ←

1956 - "Artificial Intelligence" coined by John McCarthy

1st wave rule-based

1997 - IBM's Deep Blue defeated Garry Kasparov, (then) the world chess champion

AI winter

2006 - DL Learning gained traction deep belief networked introduced by Geoffrey Hinton

AI winter

2012 - AlexNet won ImageNet Competition (ILSVRC) - widespread attention on DL

1950 1960 1970 1980 1990 2000 2010 2020

Significant AI Achievements - 2014 – 2025

Deep learning revolution

- 2012 – 2015 - DL revolution[2]
  - CNNs demonstrated exceptional performance in image recognition, *e.g.*, *AlexNet's victory in ImageNet competition*
  - widespread adoption of DL learning in CV transforming industries
- 2016 - AlphaGo defeats human Go champion
  - DeepMind's AlphaGo defeated world champion in Go, extremely complex game *believed to be beyond AI's reach*
  - significant milestone in RL - AI's potential in solving complex & strategic problems

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[2]CV: computer vision, NN: neural network, CNN: convolutional NN, RL: reinforcement learning

Transformer changes everything

- 2017 – 2018 - Transformers & NLP breakthroughs[3]
  - *Transformer ($e.g.$, BERT & GPT) revolutionized NLP*
  - major advancements in, $e.g.$, machine translation & chatbots
- 2020 - AI in healthcare – AlphaFold & beyond
  - DeepMind's *AlphaFold solves 50-year-old protein folding problem* predicting 3D protein structures with remarkable accuracy
  - accelerates drug discovery and personalized medicine - offering new insights into diseases and potential treatments

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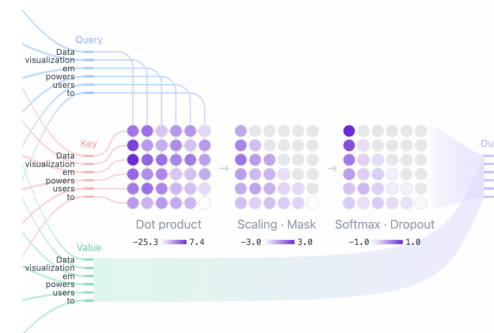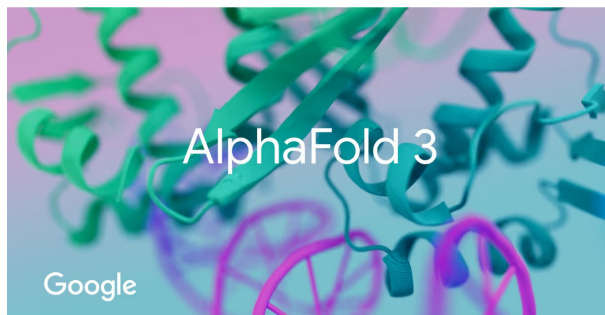
[3]NLP: natural language processing, GPT: generative pre-trained transformer

Lots of breakthroughs in AI technology and applications in 2024

- proliferation of advanced AI models
  - GPT-4o, Claude Sonnet, Claude 3 series, Llama 3, Sora, Gemini
  - *transforming industries* such as content creation, customer service, education, *etc.*
- breakthroughs in specialized AI applications
  - Figure 02, Optimus, AlphaFold 3
  - driving unprecedented advancements in automation, drug discovery, scientific understanding - *profoundly affecting healthcare, manufacturing, scientific research*
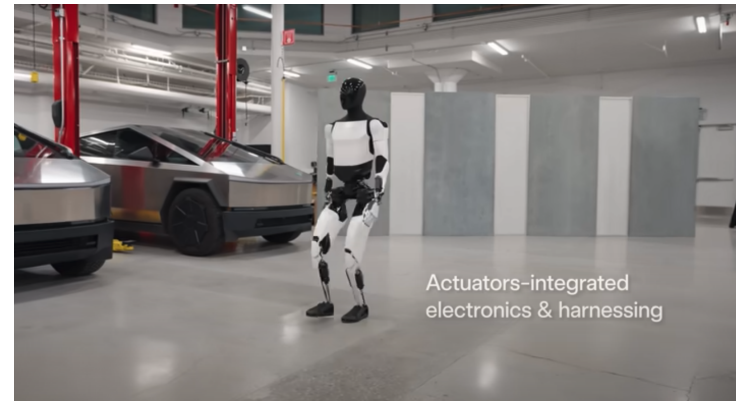
Major AI Breakthroughs in 2025

- next-generation foundation models
  - GPT-5 and Claude 4 demonstrate emergent reasoning abilities
  - open-source models achieving parity with leading commercial systems from 2024
- hardware innovations
  - NVIDIA's Blackwell successor architecture delivering 3-4x performance improvement
  - AMD's MI350 accelerators challenging NVIDIA's market dominance
- AI-human collaboration systems
  - seamless multimodal interfaces enabling natural human-AI collaboration
  - AI systems effectively explaining reasoning and recommendations
  - augmented reality interfaces providing real-time AI assistance in professional contexts
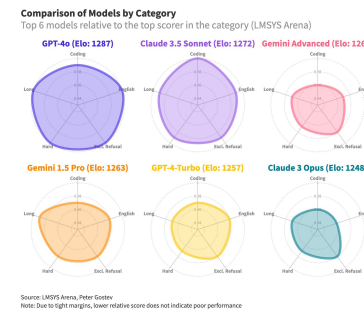
## Transformative impact of AI - reshaping industries, work & society

- accelerating human-AI collaboration
  - not only reshaping industries but *altering how humans interact with technology*
  - AI's role as collaborator and augmentor redefines productivity, creativity, the way we address global challenges, $e.g.$, *sustainability & healthcare*
- AI-driven automation *transforms workforce dynamics* - creating new opportunities while challenging traditional job roles
- *ethical AI considerations* becoming central not only to business strategy, but to society as a whole - *influencing regulations, corporate responsibility & public trust*
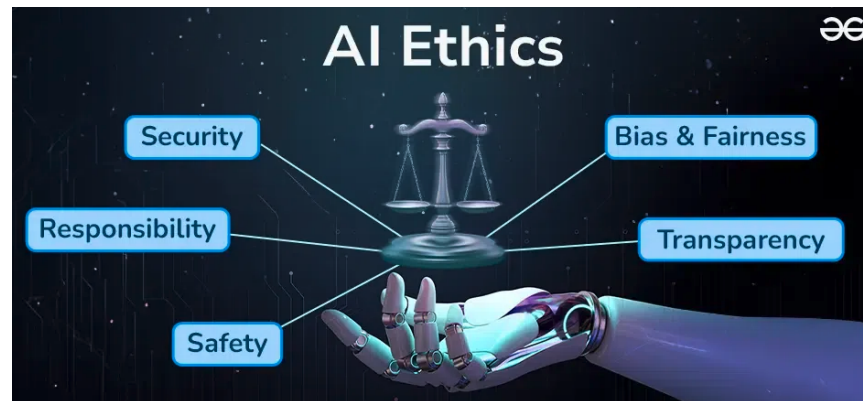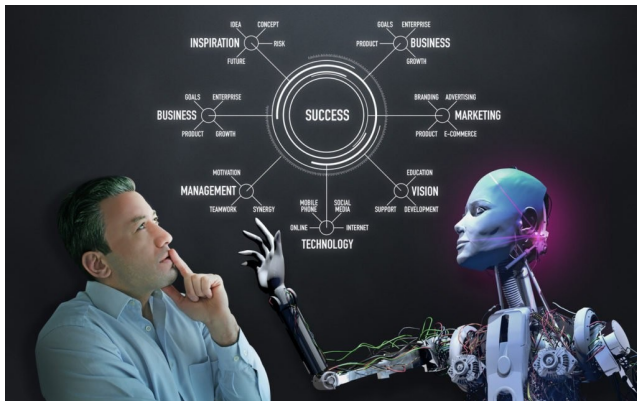
Recent Advances in AI

Where are we in AI today?

- sunrise phase - currently experiencing dawn of AI era with significant advancements and increasing adoption across various industries

- early adoption - in early stages of AI lifecycle with widespread adoption and innovation across sectors marking significant shift in technology's role in society

% US technology adoption
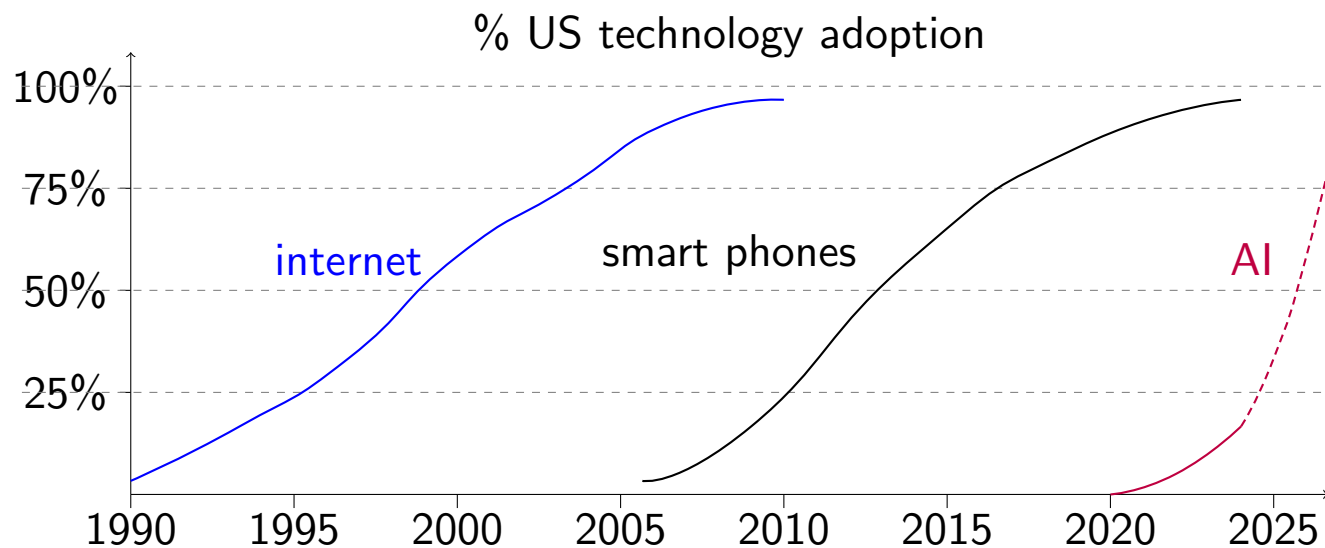
Explosion of AI ecosystems - ChatGPT & NVIDIA

- took only *5 months for ChatGPT users to reach 35M*

- NVIDIA 2023 Q2 earning exceeds market expectation by big margin - $7B vs $13.5B

  – surprisingly, *101% year-to-year growth*

  – even more surprisingly *gross margin was 71.2%* - up from 43.5% in previous year[4]

ChatGPT weekly unique visits
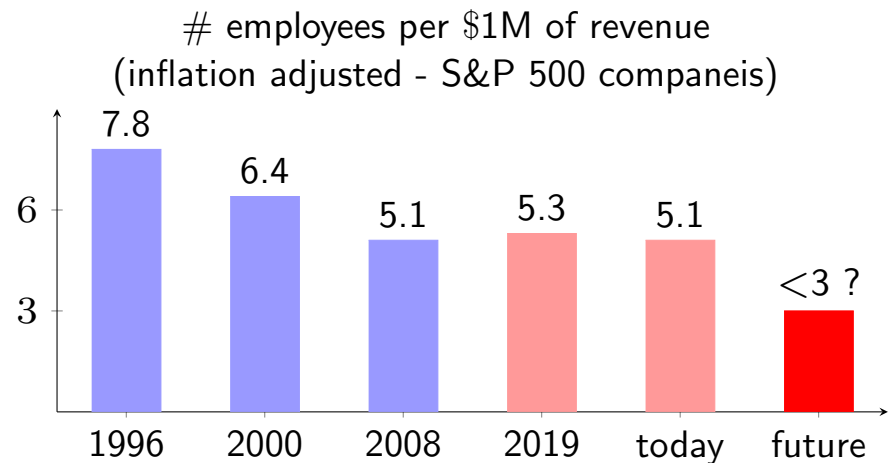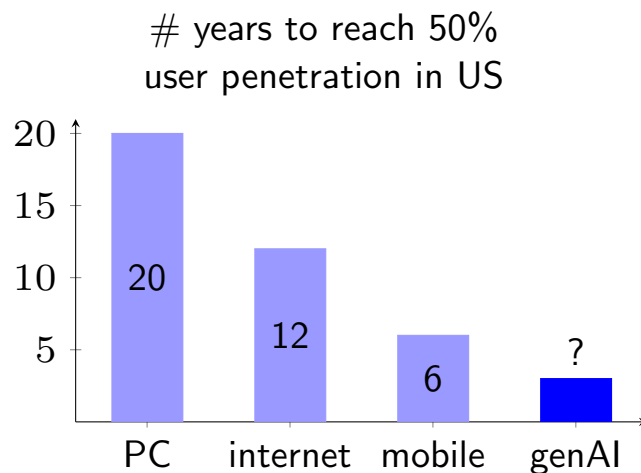
NVDA 2023-2Q earning

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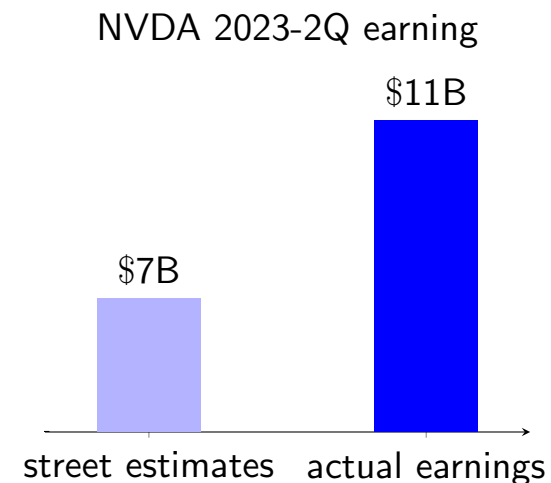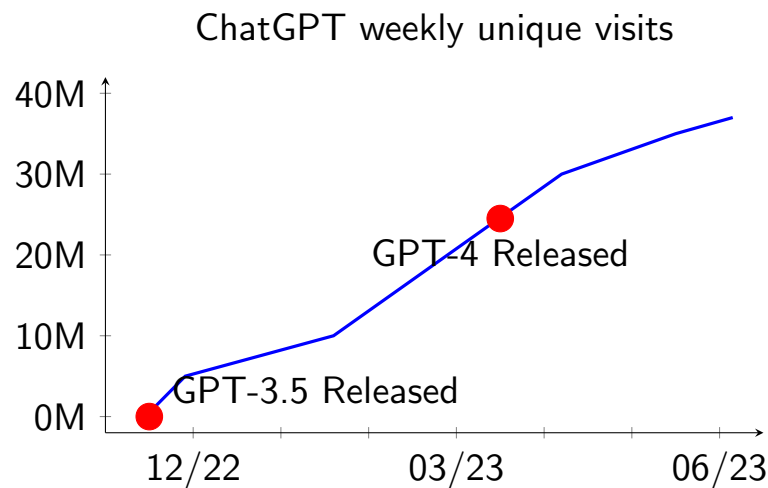
[4]source - Bloomberg

Explosion of AI ecosystems - AI stock market

- *AI investment surge in 2023 - portfolio performance soars by 60%*

    – AI-focused stocks significantly outpaced traditional market indices

- *over 8,000 new AI applications* developed in last 3 years

   – applications span from healthcare and finance to manufacturing and entertainment
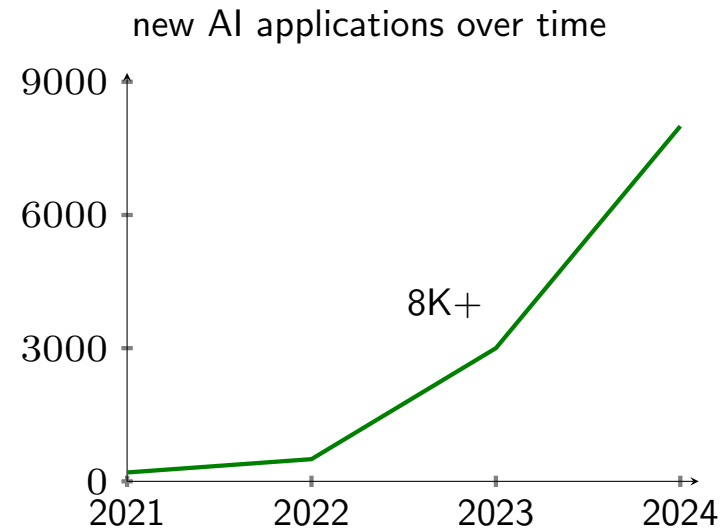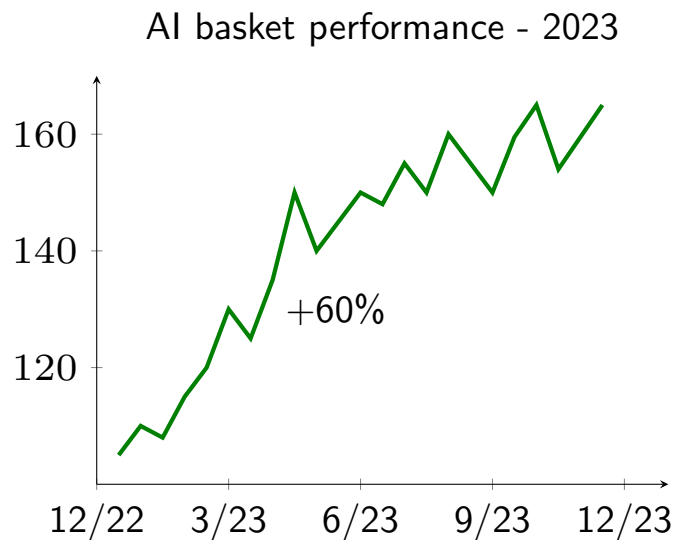
AI's transformative impact - adoption speed & economic potential

- adoption - has been twice as fast with platform shifts suggesting
  - increasing demand and readiness for new technology improved user experience & accessibility
- AI's potential to drive economy for years to come
  - 35% improvement in productivity driven by introduction of PCs and internet
 - greater gains expected with AI proliferation

years to reach 50% user penetration in US

employees per $1M of revenue (inflation adjusted - S&P 500 companeis)

AI getting more & more faster

- steep upward slopes of AI capabilities highlight accelerating pace of AI development
  - period of exponential growth with AI potentially mastering new skills and surpassing human capabilities at ever-increasing rate

- closing gap to human parity - some capabilities approaching or arguably reached human parity, while others having still way to go
  - achieving truly human-like capabilities in broad range remains a challenge
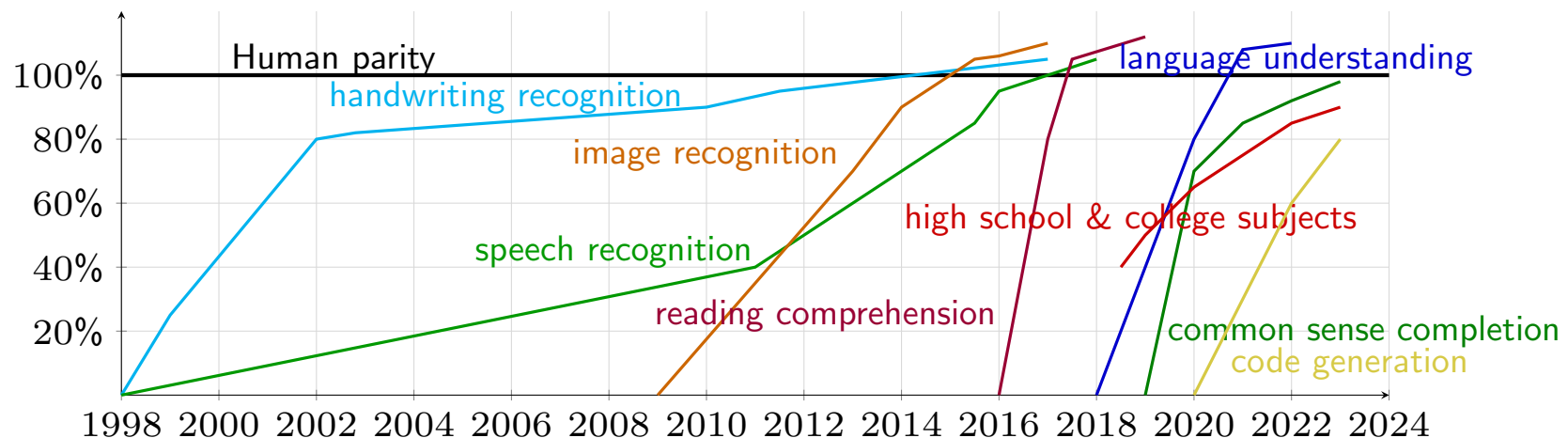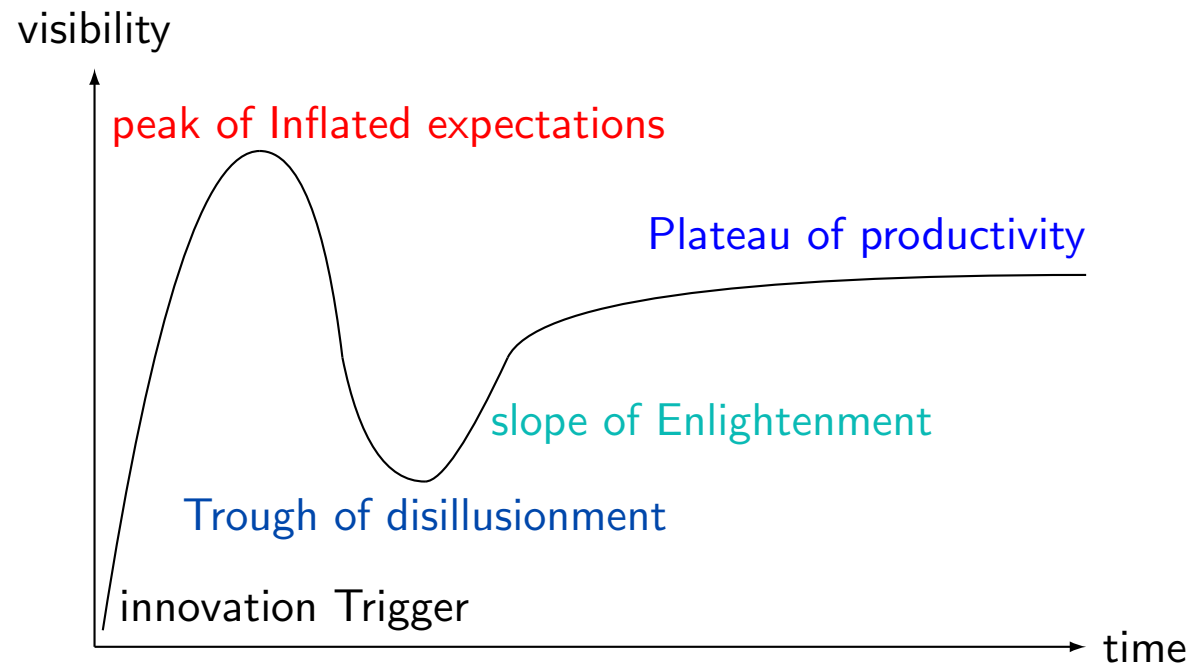
Massive investment in AI

- *explosive growth* - cumulative funding skyrocketed reaching staggering $28.2B
- OpenAI - significant fundraising (=$10B) fueled rapid growth
- *valuation surge* - substantial valuations even before public products for stella companies
- *fierce competition for capital* among AI startups driving innovation & accelerating development
- massive investment indicates *strong belief in & optimistic outlook for potential of AI* to revolutionize industries & drive economic growth

cumulative funding in private
AI companies since 2020

valuation before public product launch
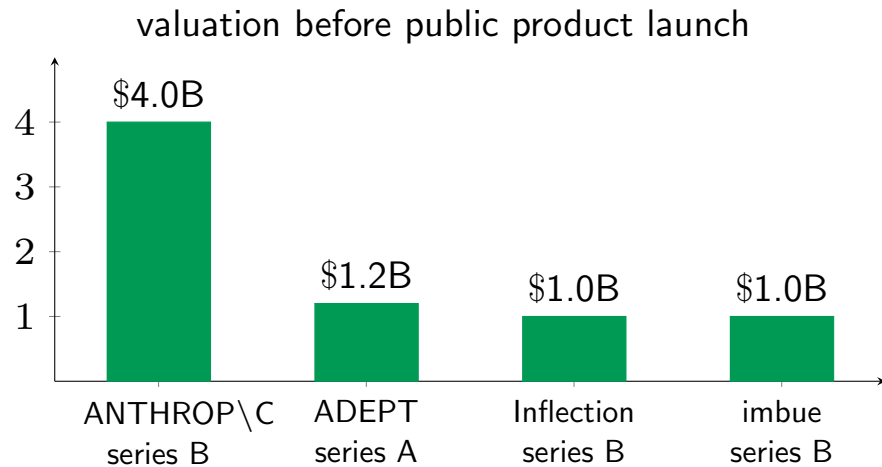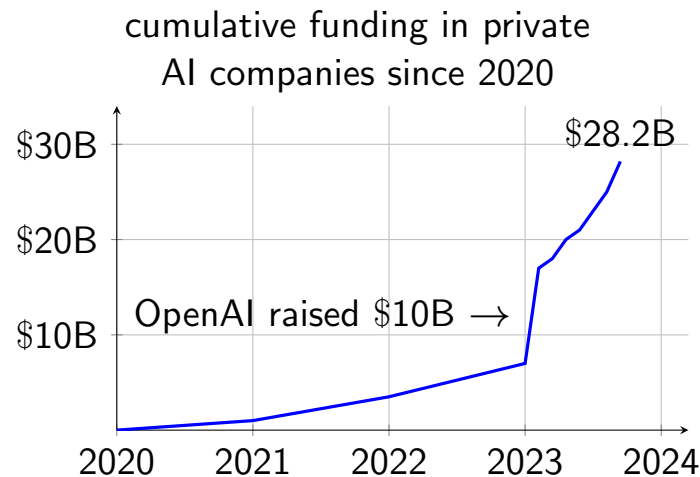
Is AI hype?

Technology hype cycle

visibility

peak of Inflated expectations

Plateau of productivity

slope of Enlightenment

Trough of disillusionment

innovation Trigger

time

- innovation trigger - technology breakthrough kicks things off
- peak of inflated expectations - early publicity induces many successes followed by even more
- trough of disillusionment - expectations wane as technology producers shake out or fail
- slope of enlightenment - benefit enterprise, technology better understood, more enterprises fund pilots

[POSTECH AI Seminar] The AI Renaissance 2.0 - Artificial Intelligence - Is AI hype?

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Fiber vs cloud infrastructure

- fiber infrastructure - 1990s

  – Telco Co's raised $1.6T of equity & $600B of debt

  – bandwidth costs decreased 90% within 4 years

  – companies - Covage, NothStart, Telligent, Electric Lightwave, 360 networks, Nextlink, Broadwind, UUNET, NFS Communications, Global Crossing, Level 3 Communications

  – became *public good*

- cloud infrastructure - 2010s

  – entirely new computing paradigm

  – mostly public companeis with data centers

 – *big 4 hyperscalers generate* $150B + annual revenue

Yes & No

| characteristics of hype cycles	speaker's views
value accrual misaligned with investment	• OpenAI still operating at a loss; business model *still* not clear • gradual value creation across broad range of industries and technologies ($e.g.$, CV, LLMs, RL) unlike fiber optic bubble in 1990s
overestimating timeline & capabilities of technology	• self-driving cars delayed for over 15 years, with limited hope for achieving level 5 autonomy • AI, however, has proven useful within a shorter 5-year span, with enterprises eagerly adopting
lack of widespread utility due to technology maturity	• AI already providing significant utility across various domains • vs quantum computing remains promising in theory but lacks widespread practical utility

AI Agents

Multimodal learning

- understand information from multiple modalities, $e.g.$, text, images, audio, video
- representation learning methods
  - combine multiple representations or learn multimodal representations simultaneously
- applications
  - images from text prompt, videos with narration, musics with lyrics
- collaboration among different modalities
 - understand image world (open system) using language (closed system)
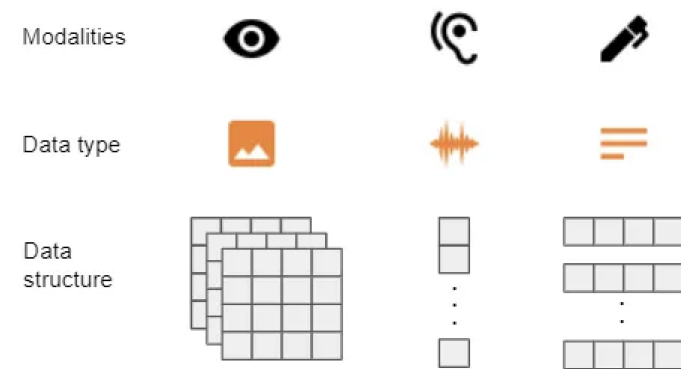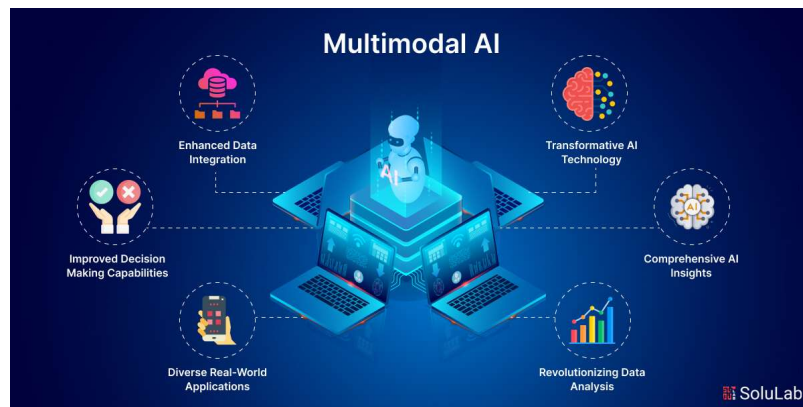
Implications of success of LLMs

- many researchers change gears towards LLM
  - from computer vision (CV), speech, music, video, even reinforcement learning
- *LLM is not only about NLP . . .* humans have . . .
  - evolved to optimize natural language structures for eons
  - handed down knowledge using *this natural languages* for thousands of years
  - internal structure (or equivalently, representation) of natural languages optimized via *thousands of generation by evolution*
- LLM *connects non-linguistic world (open system) via natural languages (closed system)*
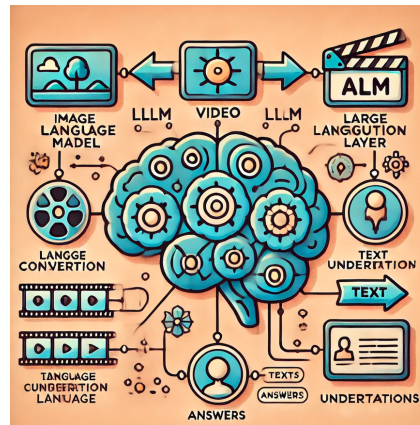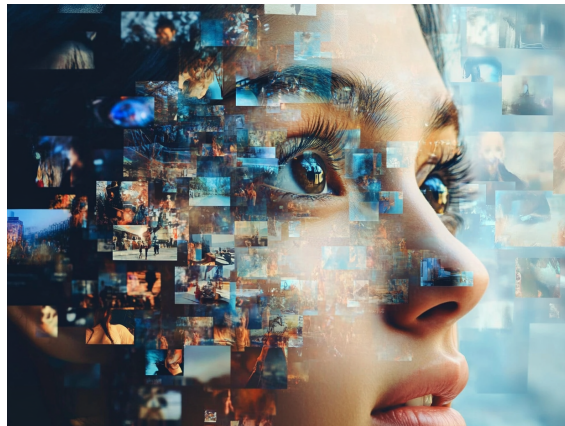
Multimodal AI (mmAI) - definition & history

- mmAI - systems processing & integrating data from multiple sources & modalities, to generate unified response / decision
- 1990s – 2000s - early systems - initial research combining basic text & image data
- 2010s - CNNs & RNNs enabling more sophisticated handling of multimodality
- 2020s - modern multimodal models - Transformer-based architectures handling complex multi-source data at highly advanced level
- mmAI *mimics human cognitive ability* to interpret and integrate information from various sources, leading to holistic decision-making
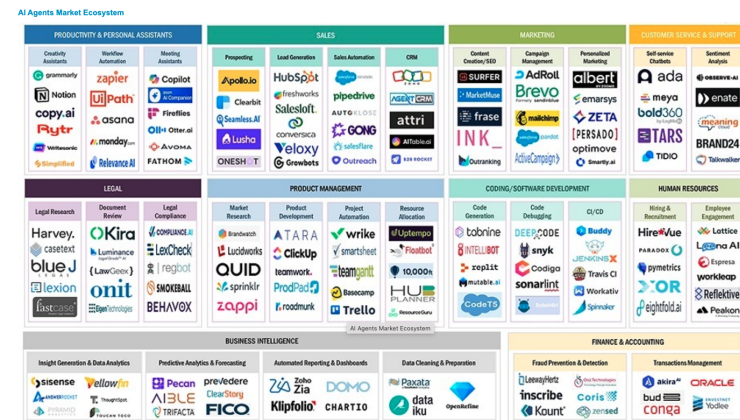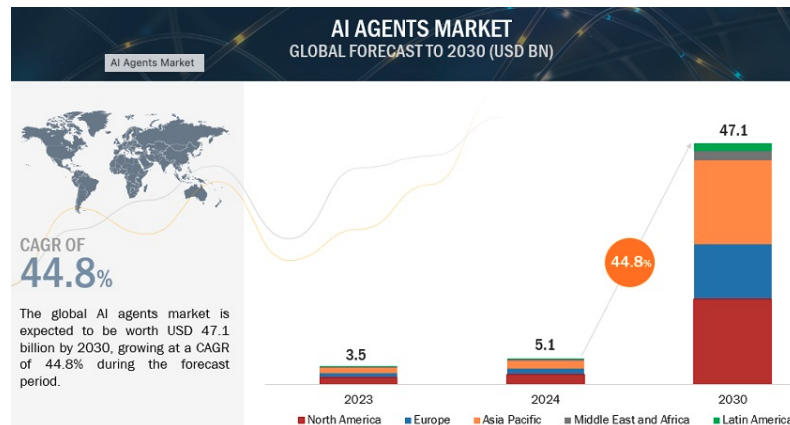
mmAI Technology

- core components

  - data preprocessing - images, text, audio & video

  - architectures - unified Transformer-based ($e.g.$, ViT) & cross-attention mechanisms / hybrid architectures ($e.g.$, CNNs + LLMs)

  - integration layers - fusion methods for combining data representations from different modalities

- technical challenges

  - data alignment - accurate alignment of multimodal data

  - computational demand - high-resource requirements for training and inferencing

  - diverse data quality - manage variations in data quality across modalities

- advancements

  - multimodal embeddings - shared feature spaces interaction between modalities

  - self-supervised learning - leverage unlabeled data to learn representations across modalities

AI agents powered by multimodal LLMs

- foundation
  - integrate multimodal AI capabilities for enhanced interaction & decision-making
- components
  - perceive environment through multiple modalities (visual, audio, text), process using LLM technology, generate contextual responses & take actions
- capabilities
  - understand complex environments, reason across modalities, engage in natural interactions, adapt behavior based on context & feedback
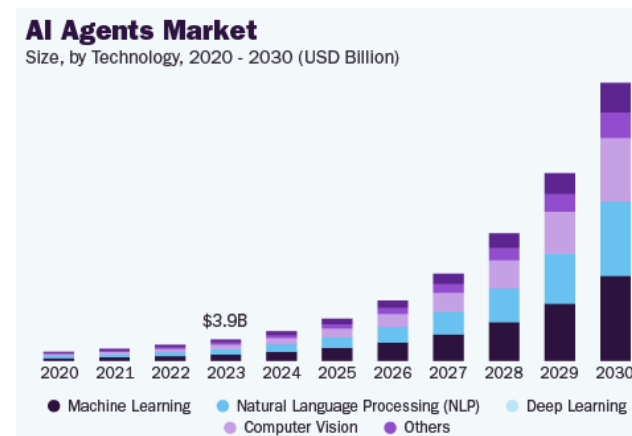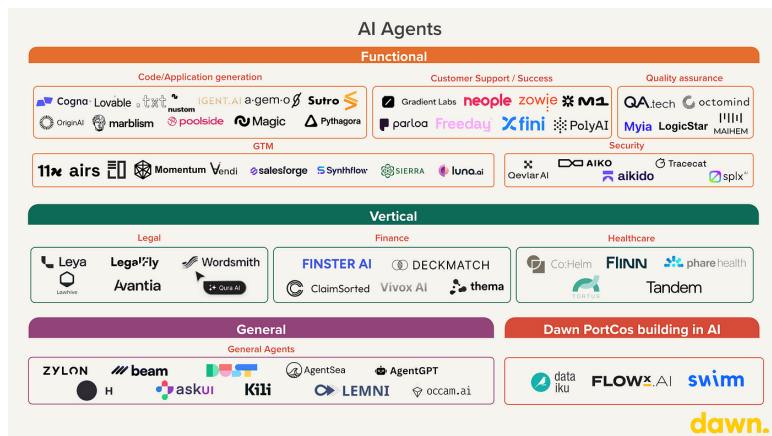
AI agents - Present & Future

- emerging applications
  - scientific research - agents analyzing & running experiments & generating hypotheses
  - creative collaboration - AI partners in design & art combining multiple mediums
  - environmental monitoring - processing satellite sensor data for climate analysis
  - healthcare - enhanced diagnostic combining imaging, $e.g.$, MRI, with patient history
  - customer experience - virtual assistants understanding spoken language & visual cues
  - autonomous vehicles - integration of visual, radar & audio data
- future
  - ubiquitous AI agents - seamless integration into everyday devices
 - highly tailored personalized experience - in education, entertainment & healthcare

Empowering Humanity for Future Enriched by AI

Blessings & Curses of AI

Blessings

- advancements in healthcare & improved quality of life
  - much faster & more accurate diagnosis, far superior personalized medicine, accelerated drug discovery, assistive technologies
- economic growth & efficiency
  - automation to increase productivity and reduce cost, far superior decision-making
- environmental solutions
  - climate change prediction, global warming effect mitigation, solutions for sustainability
- safety & security
  - natural disaster prediction & relief, cybersecurity
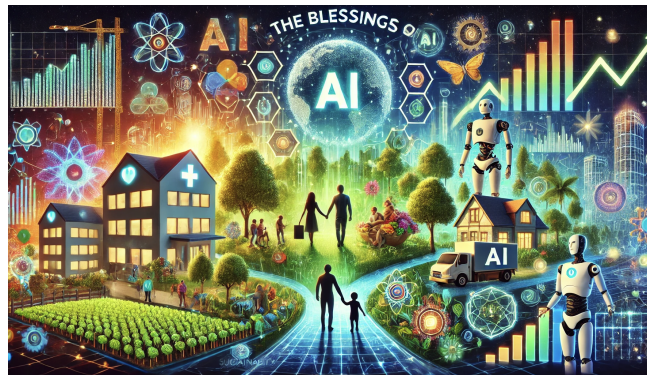
Curses

- job displacement & overall impacts on labor market
  - millions of jobs threatened, wealth gap widened
- bias & inequality, misinformation & manipulation
  - existing human biases, both conscious and unconscious, perpetuated through AIs, asymmetric accessibility to advanced AI technologies by nations & corporations
- ethical dilemmas
  - infringing privacy & human rights, accountability for weapon uses and damages by AI
- environmental costs
  - significant energy for training AI models, waste generated by obsolescent AI hardware

Salzburg Global Seminar

KFAS-Salzburg Global Leadership Initiative

- "Uncertain Futures and Connections Reimagined: Connecting Technologies" - 41 global leaders convened from 4-Dec to 8-Dec, 2024 @ Schloss Leopoldskron in Salzburg, Austria

- My working group was "Technology, Growth, and Inequality: The Case of AI"
  - International Cooperation Officer (Portugal)
  - Gender Equality, Disability Inclusion Consultant, UN Women (Lithuania)
  - Assistant Professor @ Lincoln Alexander School of Law (Canada)
  - Research Associate @ Luxembourg Institute of Socio-Economic Research
  - Policy Officer & Delegation of the EU Union (India)

- blog: Bridging Technology & Humanity - Reflections from Lyon, Salzburg, and München

KFAS-Salzburg Global Leadership Initiative

Salzburg Global photo collections

Empowering Humanity

# AI capacity building - scientists, engineers & practitioners

- ethics and responsible AI education or campaign via interdisciplinary collaboration
  - foster continuous learning programs on AI risks, bias & societal impacts
- bias detection & mitigation
  - bias-detection tools to identify & reduce discrimination in data & models
  - regular fairness audits
- transparency & explainability
  - explainable AI (xAI) techniques, frameworks like Model Cards for transparency
- environmental impact awareness
  - reduce AI's carbon footprint, advocate for sustainable AI development practices
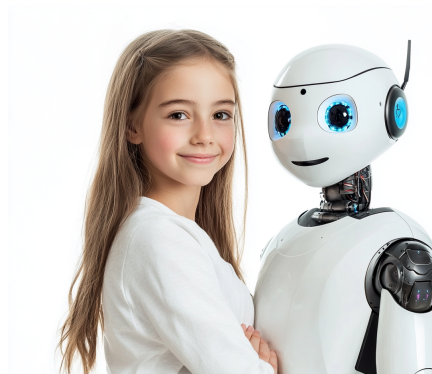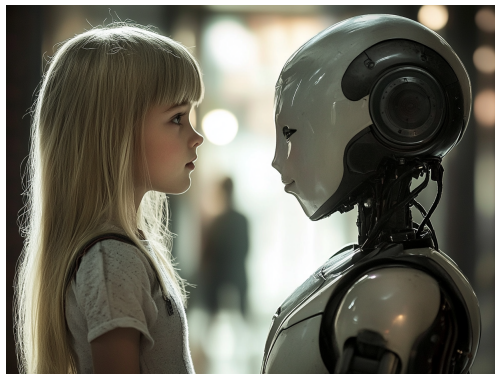
AI capacity building - lawmakers & policy makers

- problems
  - difficulties in understanding of rapidly evolving AI technologies
  - lead to reactive or insufficient regulation
- proposed solutions
  - develop comprehensive regulatory frameworks addressing transparency, bias & privacy concerns
    - gender bias, racial bias, hallucinations
  - foster public debates on ethical AI use & societal implications
  - introduce policies to limit spread of AI-generated misinformation,
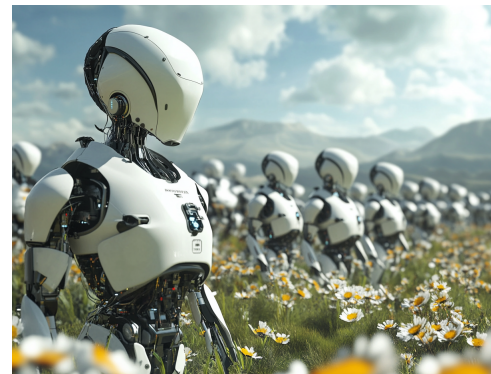
Participatory social agreements

- open data frameworks including data sovereignty, regulation of data transfer, storage & localization

- corporate social responsibility, extra-territorial obligations & environmental protection
  - including outside the jurisdiction of the country

- labour and employment displacements, tax cuts & algorithmic impact assessments
  - including remedies for AI harms and enforcements
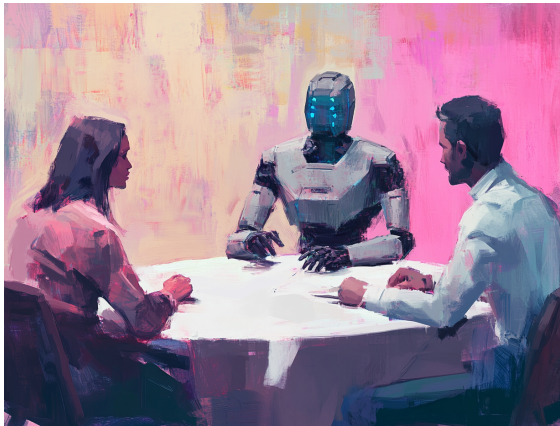
Reclaiming technology for Humanity

- strategic approach to AI development
    - *leverage very technologies alienating humans to strengthen human connection*
    - transform automation from replacement to *enhancement of human capabilities*
    - leverage technological scale to address fundamental human needs
- *paradigm shift* in technological implementation
    - recognize the duality of advanced technologies
    - *systematically channel AI capabilities toward human-centric solutions*
    - convert technological challenges into opportunities for human advancement
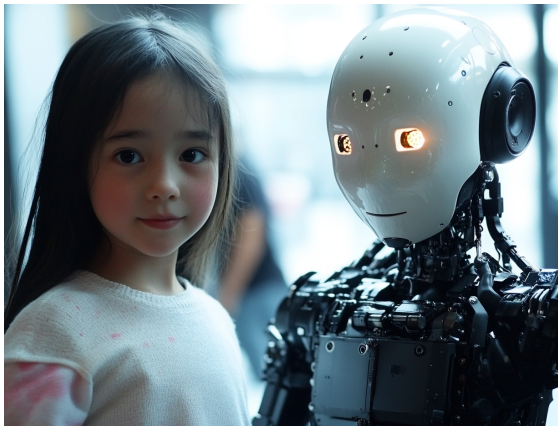
Serendipities around AIs

Serendipity or inevitability?

- What if Geoffrey Hinton had not been a persistent researcher?

- What if symbolists won AI race over connectionists?

- What if attention mechanism did not perform well?

- What if Transformer architecture did not perform super well?

- What if OpenAI had not been successful with ChatGPT in 2022?

- What if Jensen Huang had not been crazy about making hardware for professional gamers?

- Is it like Alexander Fleming's Penicillin?

- Or more like Inevitability?

Selected References & Sources

Selected references & sources

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- A. Vaswani, et al. "Attention is all you need" @ NeurIPS (2017)

- S. Yin, et. al. "A Survey on Multimodal LLMs" (2023)

- I.J. Goodfellow, ..., Y. Bengio "Generative adversarial networks (GAN)" (2014)

- T. Kuiken "Artificial Intelligence in the Biological Sciences: Uses, Safety, Security, and Oversight" (2023)

- Stanford Venture Investment Groups

- CEOs & CTOs @ startup companies in Silicon Valley

- VCs on Sand Hill Road - Palo Alto, Menlo Park, Woodside in California, USA

References

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[YFZ$^+$24] Shukang Yin, Chaoyou Fu, Sirui Zhao, Ke Li, Xing Sun, Tong Xu, and Enhong Chen. A survey on multimodal large language models, 2024.

Thank You