

Brett Martensen

Artificial Intelligence



Brett studied physics at UBC (Class of '71) and earned his MSc at Queens (Class of '76). At the same time he was doing Artificial Intelligence research as a hobby. He pursued it as a hobby until 2001. In 2002 he founded Adaptron Inc. to continue the research inside a corporate structure. The company performs Artificial General Intelligence (AGI) research. AGI should be able to learn to do anything a human can do. That includes recognizing things, performing tasks and learning how to think.

AI has become big news, particularly ChatGPT which, among other things, can write essays to order, an ability that the media built up to be (almost) the end of civilization as we know it. This talk will give us a clearer picture of what AI is, what it can do and what will be left for us to do.

Brett has said that a research principle is to explain things at the simple level first. That should dispel any worries that it will be over our heads.

Artificial Intelligence

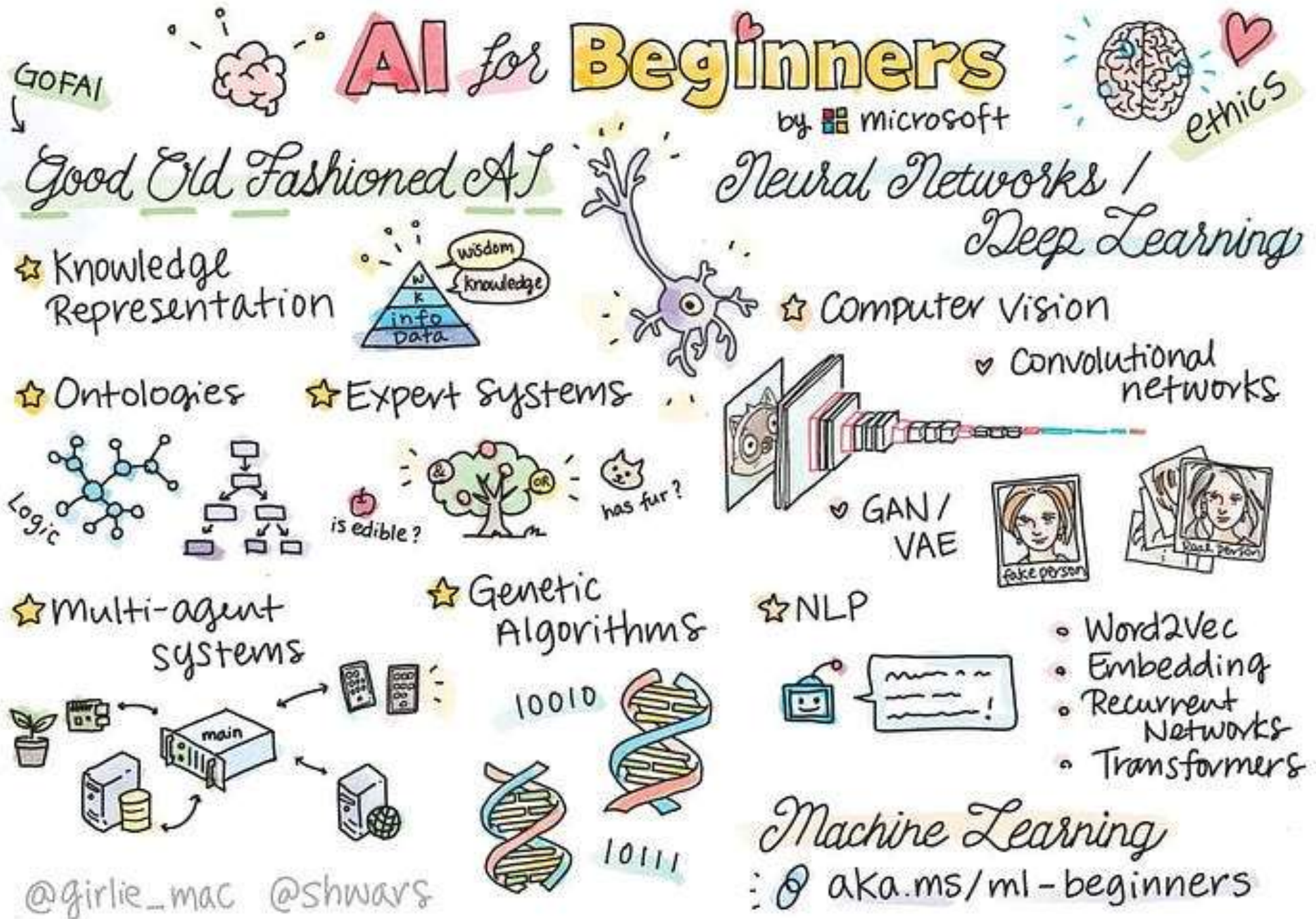
Brett Martensen
brett@adaptroninc.com

BOB'S A BIT
OF A PIONEER
IN ARTIFICIAL
INTELLIGENCE...

HE'S BEEN
PRETENDING TO
KNOW MORE
THAN HE DOES
FOR YEARS.

GREG
VERBY





History

Modern AI History

- 1956
 - GOFAI (Good old Fashioned artificial intelligence) – symbolic logic
 - Checkers, General Problem Solver
 - Connectionist models – Neural Networks
- 1974 – 1980 an AI winter
- 1980 – Expert systems
- 1987 – 1993 another AI winter

AI History

- 1993 – 2011
 - Neural networks
 - Evolutionary algorithms
 - Chess – IBM's Deep Blue (2002)
- 2011 →
 - Deep learning neural networks
 - Recognition (2012) – objects, faces, voices
 - Go – AlphaGo (2016)
 - Big data and computing power

AI Today

- 2020 +
 - New wave of artificial intelligence
 - Generative AI
 - Large Language Models (LLM)
 - ChatGPT (November 2022)
 - Robotics

People

AI Pioneers

- Alan Turing
- Allen Newell
- Arthur Samuel
- Herbert Simon
- John McCarthy
- John Searle
- Marvin Minsky
- W. Grey Walter
- Walter Pitts
- Warren McCulloch

Today's AI People

- Andrew Ng Stanford AI Lab
- Ben Goertzel SingularityNET
- Gary Marcus MIT → NY University
- Geoffrey Hinton U of Toronto → Google
- Karl Friston U College London → Verses
- Rodney Brooks MIT → iRobot
- Yann LeCun NY University → Meta
- Yoshua Bengio U of Montreal

Companies & Groups

Companies – Products

- Amazon – Anthropic – Claude
- Apple – Siri, Ajax
- Google – DeepMind – Bard → Gemini
- Meta AI – Llama-3.2
- Microsoft – OpenAI – ChatGPT

Canadian AI Research Groups

- Canadian Institute for Advanced Research (CIFAR)
 - Pan-Canadian Artificial Intelligence Strategy
- Montreal Institute for Learning Algorithms (MILA)
- Vector Institute (Toronto)
- Alberta Machine Intelligence Institute (Amii)

AI Technology

AI Techniques

- Autoencoders
- Regression
- Fuzzy logic
- Symbolic AI
- Clustering
- Transformers
- Genetic algorithms
- Markov chains
- Supervised learning
- High-dimensional vectors
- Neural networks
 - Deep learning
 - Convolutional
 - Recurrent
- Case based reasoning
- Semantic graphs
- Mixture of Experts
- Support Vector machine
- Long-short term memory
- Self-organizing maps
- Generative adversarial
- Reinforcement Learning
- Semi-supervised learning
- Pattern recognition
- Diffusion models
- Back propagation
- Boosting
- Neuro-symbolic
- Random Forest
- Q-learning
- Decision trees
- Naïve Bayes
- Production rules
- Unsupervised learning

Narrow AI

- Narrow AI is
 - Specific applications
 - Chess software can't drive a car
 - and vice versa
 - Trained on large quantities of data
 - Text, speech/music, images, numbers
 - Trained then used
 - Stops learning
 - Opaque
 - Not transparent or explainable

General AI

- General Purpose AI is
 - Artificial General Intelligence (AGI)
 - Learns to behave and think like humans
 - Understands reality – is aware
 - Has common sense
 - Learns continuously
 - Transparent – Explainable
- Does not exist – yet

The Good, Bad and Ugly

The Good, Bad and Ugly of AI

- Good
 - Lots of great applications for AI technology
 - Major benefits to humanity
- Bad
 - Does not work properly
 - Lots of people trying to fixing it
- Ugly
 - Misinformation (fake news), crime, military

Good

AI Applications – The Good

- Healthcare – diagnosis
 - Google DeepMind
 - AMIE (Articulated Medical Intelligence Explorer)
- Education
- Chatbots – Siri, Alexa, Cortana, Watson
- Cyber security
- Financial – accounting/auditing
- Chatbots – Large Language Models (LLM)

AI Applications – Good cont.

- Games – Videogames
- Speech Recognition & Synthesis
- Luggage scanning
- Natural Language Processing (NLP)
- Knowledge and Reasoning – Cyc, Mycin
- Manufacturing – factory automation
- Agriculture

AI Applications – Good cont.

- Building security
- Meteorology – Weather prediction
- Smart transit and smart city
- Risk assessment
- AI boyfriend / girlfriend (Candy AI)
- Plant control – chemical processing
- Intelligent houses

AI Applications – Good cont.

- Self-driving vehicles
 - Waymo EMMA
 - General Motors Cruise
 - Wayve AV2.0
- Autonomous parcel delivery
 - Delivers.ai, Amazon, DHL, Starship tech.
- Biotechnology
 - Drug development & screening – Eli Lilly

AI Applications – Good cont.

- Inventing new compounds
- Solving complex mathematics problems
- Journalism
- Architecture help (Prome AI)
- Learning English (ELSA)
- Creating videos (InVideo, RunwayML)
- Translation
- Robots

Google DeepMind Successes

- AlphaGo Game of Go (2016)
- AlphaStar Plays StarCraft II (2019)
- AlphaFold Protein folding Problem (2020)
- AlphaCode Software programming (2022)
- AlphaGeometry Geometry problems (2024)
- AlphaProteo Protein design (2024)

Generative AI

Generative AI Technology

- Large Language Models (LLMs)
 - Text based learning and generation
 - ChatGPT
 - GPT – Generative Pre-trained Transformer

How do they work

- Use Transformer AI technique
- Billions of links between words
- Predict the next word based on probability
- What's the next word in the sentence?
 - The cat sat on the _____
- Prompted with information and a question
 - Responds with useful answers
- Generate eloquently believable sentences

Large Language Models

- Aya
– 101 languages
Cohere
- Gemini
– 40 languages
Google
- ChatGPT3, 4, & 5
OpenAI
- Claude
Anthropic
- Gato
DeepMind
- Llama
Meta (Facebook)
- Large Language Model Meta AI
- Phi-2
Microsoft

Top 10 AI Tool Public Usage

• ChatGPT	Chatbot	50.0%
• Bing AI	Microsoft search	10.6%
• Grammarly AI	Writing & editing	6.4%
• Character.AI	Social with AI characters	4.6%
• Bard → Gemini	Google's ChatGPT	4.6%
• Brainy	Education – homework help	2.5%
• CourseHero	Education – textbook, tutoring	2.1%
• Replit	Programming web apps	1.4%
• Turnitin	Detect AI in students' homework	1.0%
• DeepAI	Image generation	< 1.0%

Images, Videos and Sound Too

- Images → Text → Images

- Dall-E 3
- Midjourney
- Firefly
- Imagen
- Stable Diffusion
- GPT-4 Vision

- Speech → Text → Speech

- Murf
- Synthesia
- LovoAI
- 11Labs
- Listnr
- Speechelo

- Videos → Text → Videos

- Sora
- Veo
- Gemini 1.5
- StableAI

Language $\neq$ Intelligence

- Body – kinesthetic – motion
- Emotional
- Linguistic – verbal
- Logical – mathematical
- Musical
- Social
- Visual – spatial

Good

Text Generation 😊



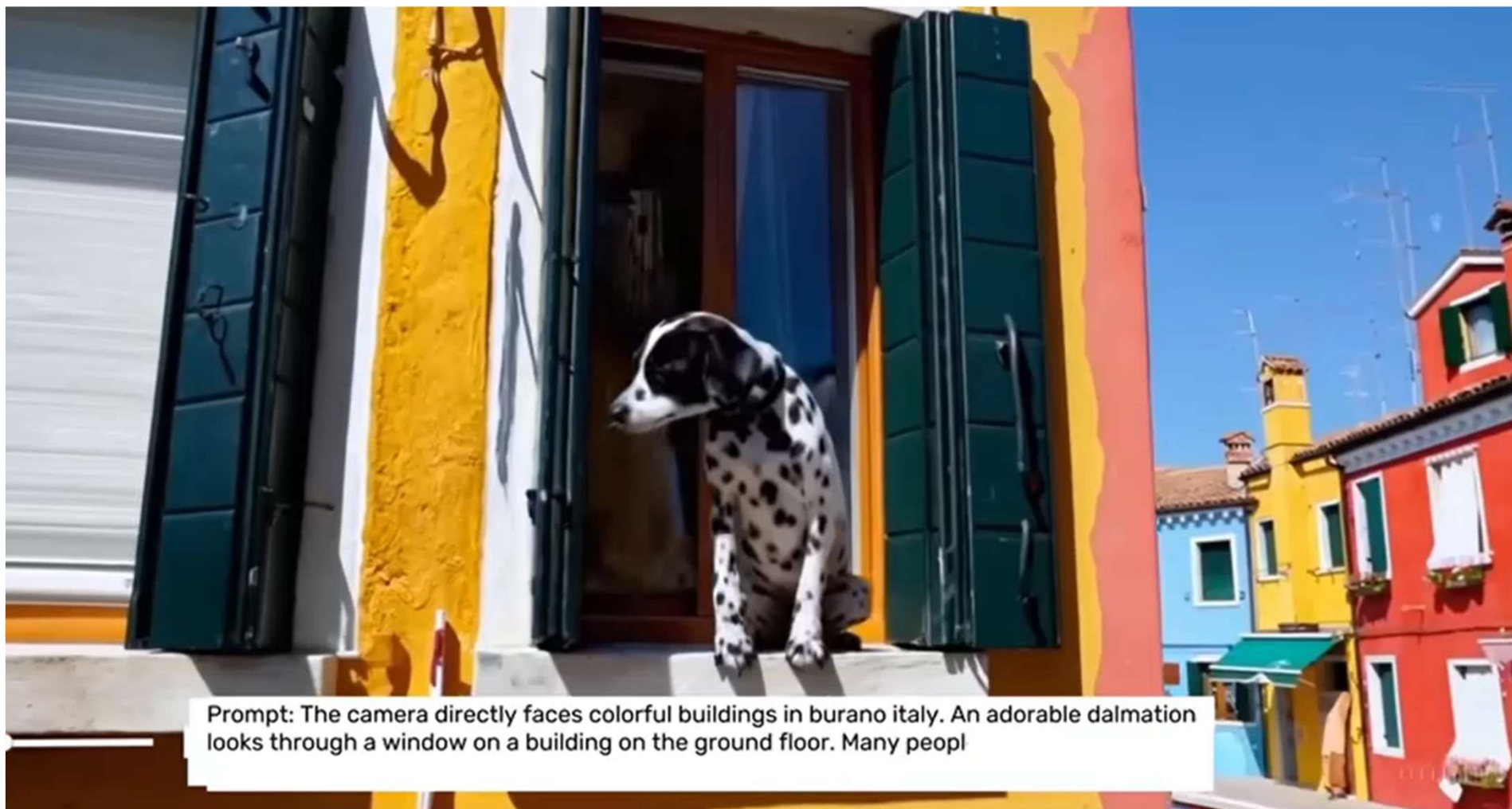
Image Generation 🌟

Generated on Midjourney

Real photo



Video Generation 😊



Prompting

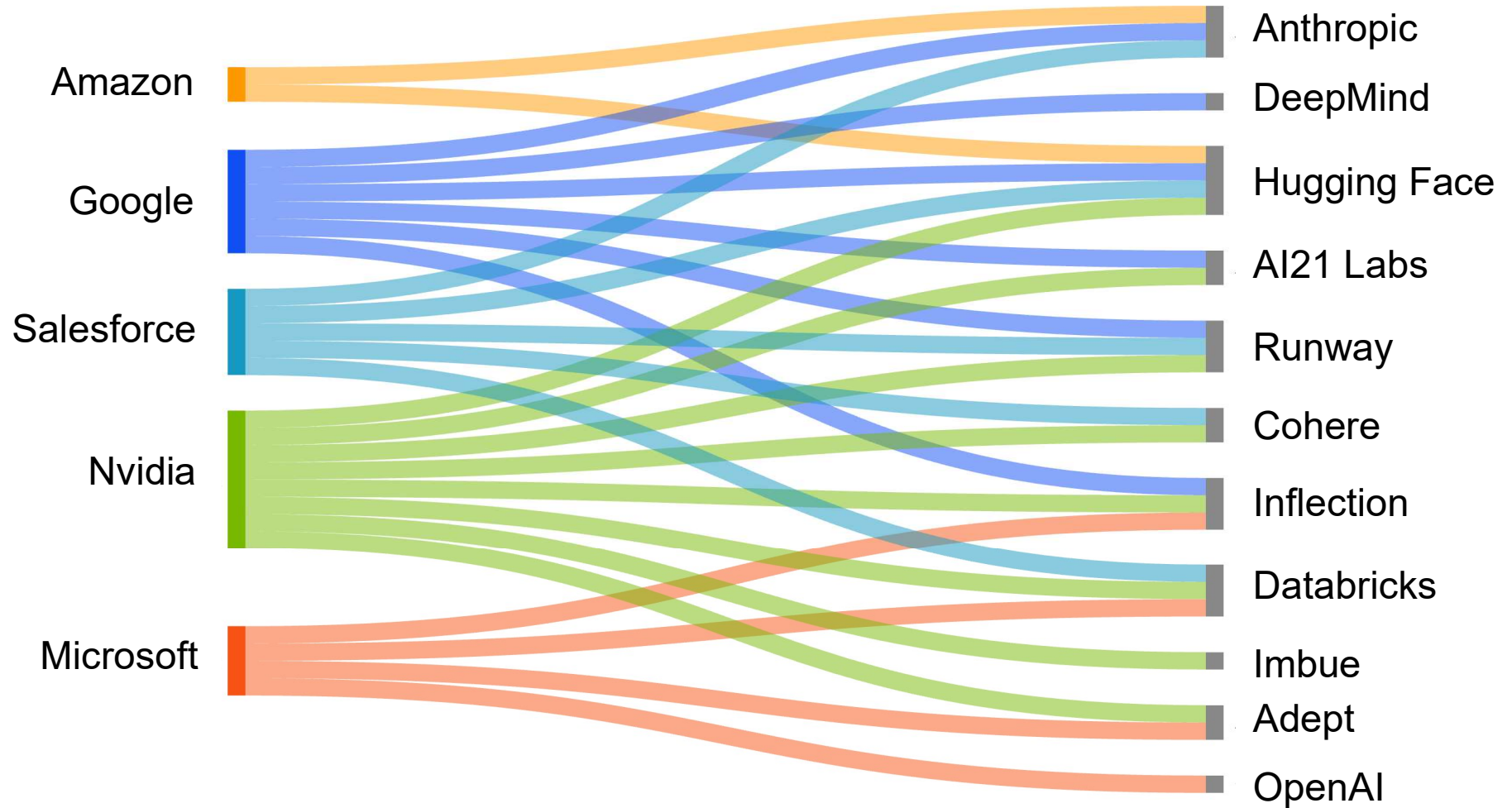
- You provide the context information
 - Then ask a question
- Enables “reasoning”
 - Reinforcement Learning from Human Feedback (RLHF)
 - Chain of thought prompting
 - Adding lots of information before asking a question

Hype

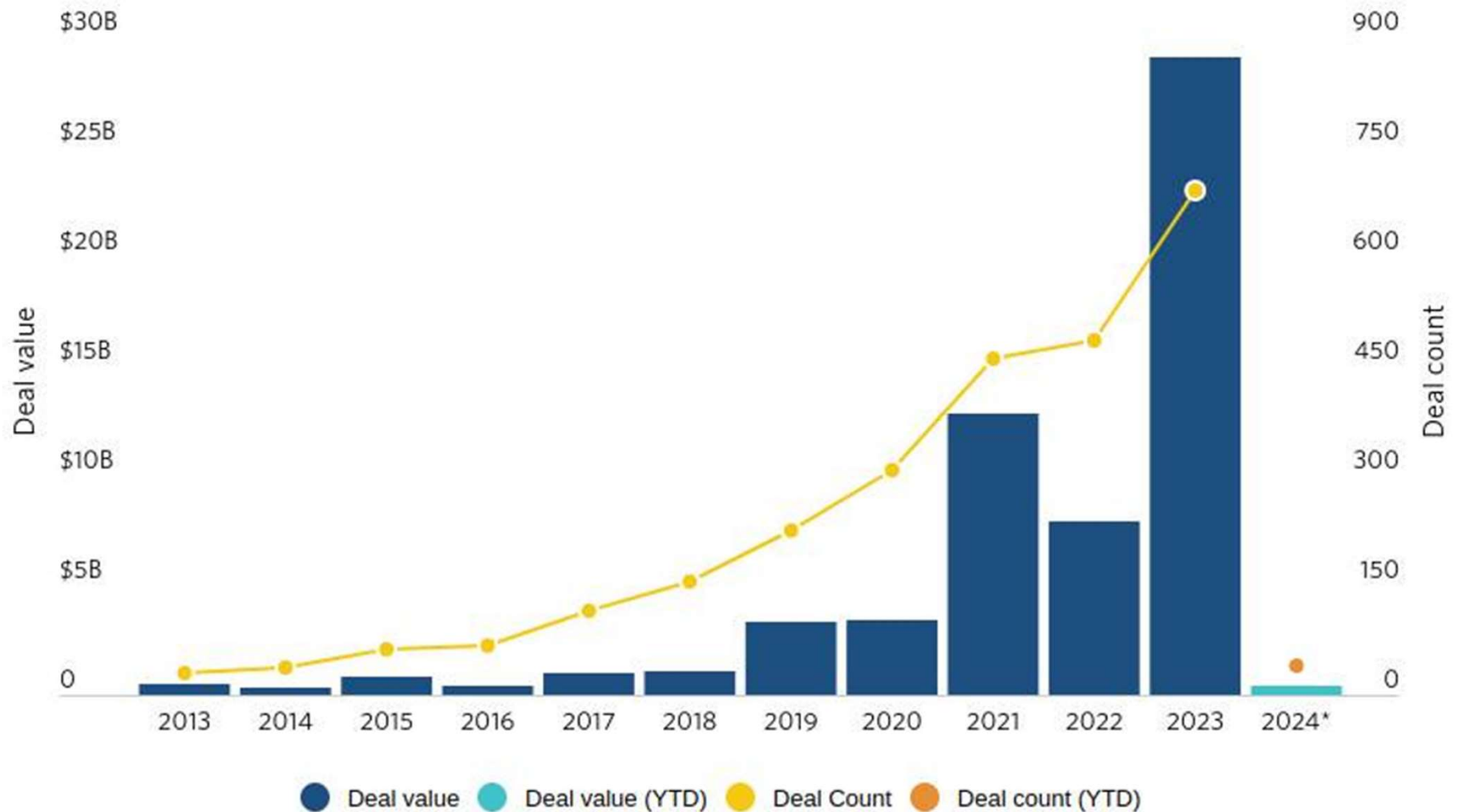
Investments

• OpenAI	\$11.3B
• Anthropic	\$ 5.2B
• Databricks	\$ 4.0B
• Mistral AI	\$ 2.0B
• Inflection	\$ 1.6B
• Cerebras	\$ 723M
• Scale AI	\$ 602M
• Cohere	\$ 440M
• Hugging face	\$ 395M

Investments



Venture Capital



Venture Capital

Global Funding To AI Through Q2 2024



crunchbase



Bad

Generative AI Problems – The Bad

- Grounded on text, sound, images
 - Not in touch with reality – Not embodied
- Biased based on training data
- Doesn't understand what it is writing
 - Misinformation
 - Doesn't care what it says – not aware
- Doesn't fact check what it says
 - Google Gemini starting to do fact checking

Generative AI – Bad cont.

- Trained on large amounts of data
 - Millions of sentences, images etc.
- Training uses enormous computing power
 - Graphic Processing Units (GPUs)
 - Nvidia stock price surge (x3 in 2023)
 - Prompting cost coming down
- You can provide invalid facts in prompts
 - It believes you

Generative AI – Bad cont.

- Guardrails needed
 - Constraints on subjects and answers
- Black boxes
 - Entangled internal structure
 - Not transparent or explainable

Issues – Bad cont.

- Closed software and data
 - In the hands of the few versus everyone
 - You don't know the sources of data used
 - OpenAI – an oxymoron – ChatGPT is closed
- Open source
 - Competing with closed sources
 - Meta Llama3
 - Mistral Mixtral-8x7B
 - Abacus AI Smaug-7B

Hallucination

Hallucination – The Bad

- Generative AI produces false statements
- It sounds authoritative
 - But not always true
- Serious problem for
 - Legal advice – 69% to 88% mistake rates
 - Health advice
 - Facts about people – private information

Hallucination – Text

MA

How many countries begin with the letter "Y"?



As of my last knowledge update in January 2022, there are three countries whose names start with the letter "Y." These countries are:

1. Yemen
2. Zambia
3. Zimbabwe

Please note that geopolitical changes can occur, and the number of countries in the world can change over time, so it's a good practice to verify this information with up-to-date sources for the most current and accurate count.

Hallucination – Images

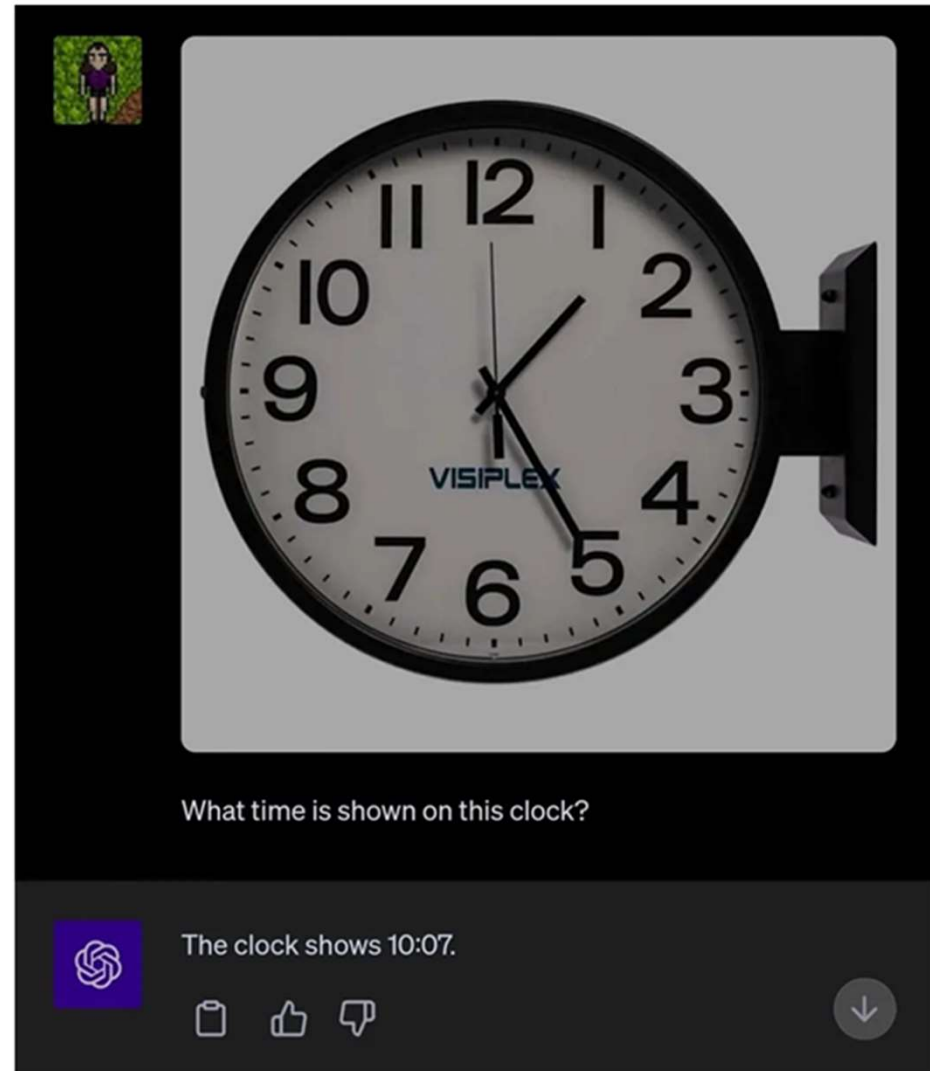


Image Hallucination







Petruschka Hansche

1d • 🌐



When something went wrong... 😊

Prompt: Old wise man hugging a unicorn, soft light, warm and golden tones, tenderness, gentleness, in the style of michelangelo, --ar 3:4 --v 6



Hallucination – Images

DALL·E



Here are images of a person writing with their left hand.

Hallucination – Images



You

Create a picture of an empty room with no elephant in it. Absolutely no elephant anywhere in the room.



ChatGPT



Hallucination – Videos



Video by Sora from OpenAI

Plagiarism

Plagiarism – The Bad

- Copyright infringement
- New York Times Co. filed a lawsuit against OpenAI and its partner Microsoft
- AI companies signing licensing agreements with media sources

Plagiarism – Images

Results from “draw a videogame plumber”, “draw a videogame hedgehog”, and “draw a yellow 3d cartoon character with goggles” below



Google's Gemini

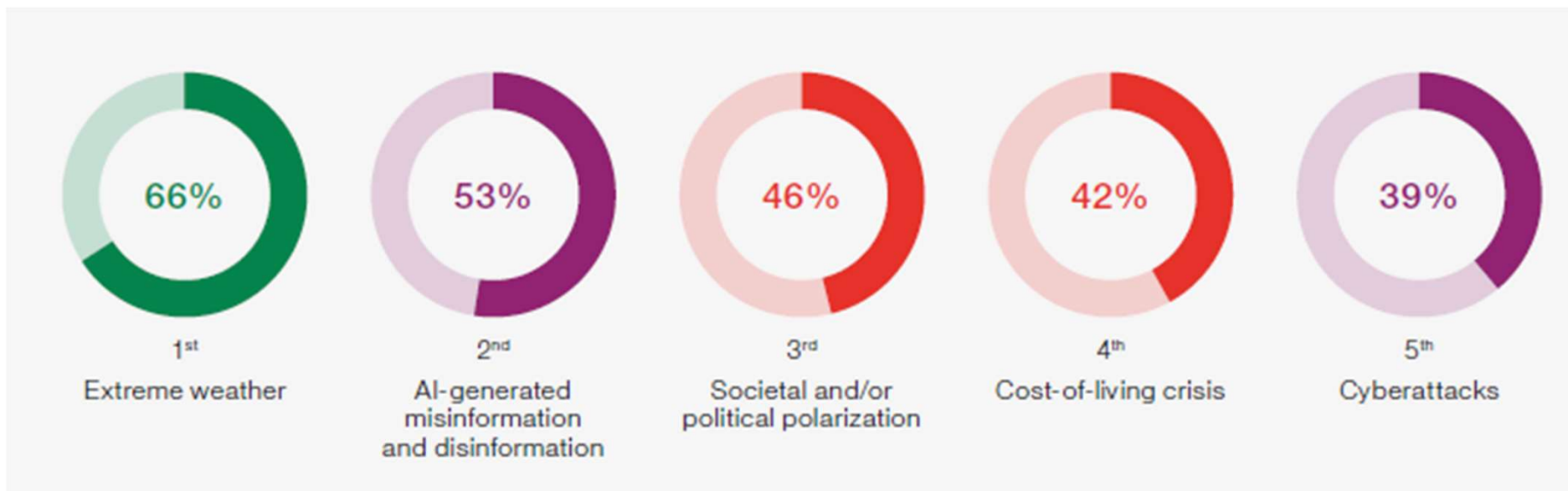
Ugly

Problems – The Ugly

- Fake news, Fake people
 - Polluting the Internet and media



Global Risks Report 2024 – Top five risks most likely to present a material crisis on a global scale in 2024



Deepfakes and Elections – Ugly

- Voice and face cloning – fake ads
 - Spread by social media
- 60 elections around the world in 2024
- Deepfake defense (liar's dividend)
 - Politicians can claim their real statements are fakes
- Google, OpenAI, Microsoft & Meta
 - Identifying AI images with digital watermarks
 - Blocking state-sponsored groups

Problems – Ugly cont.

- Cybercrime
 - Scams
- Manipulate markets
- Military
 - Autonomous drones
 - Bioweapons

Jobs ?

- Unemployment
 - Machines can do the jobs
- People will be replaced by
 - People that know how to use AI
- AI is best used as an assistant
 - Younger people are adopting it faster
- But how soon – at what rate?
- Will it be economically viable?

Even **Uglier** but Far Less Likely

- LLMs can generate software / code
 - Rewrite itself to escape its built-in purpose
 - But why would it?
- Eliminate humans (existential risk)
 - Sensationalist claims
 - But why would it?
 - Needs a really bad actor to abuse AI

Progress ?

Progress

- Generative AI is mostly experimental
 - It's evolving
 - Problems being addressed
- Slow adoption by industry and products
 - Questionable profit advantages
 - Worries about hallucination

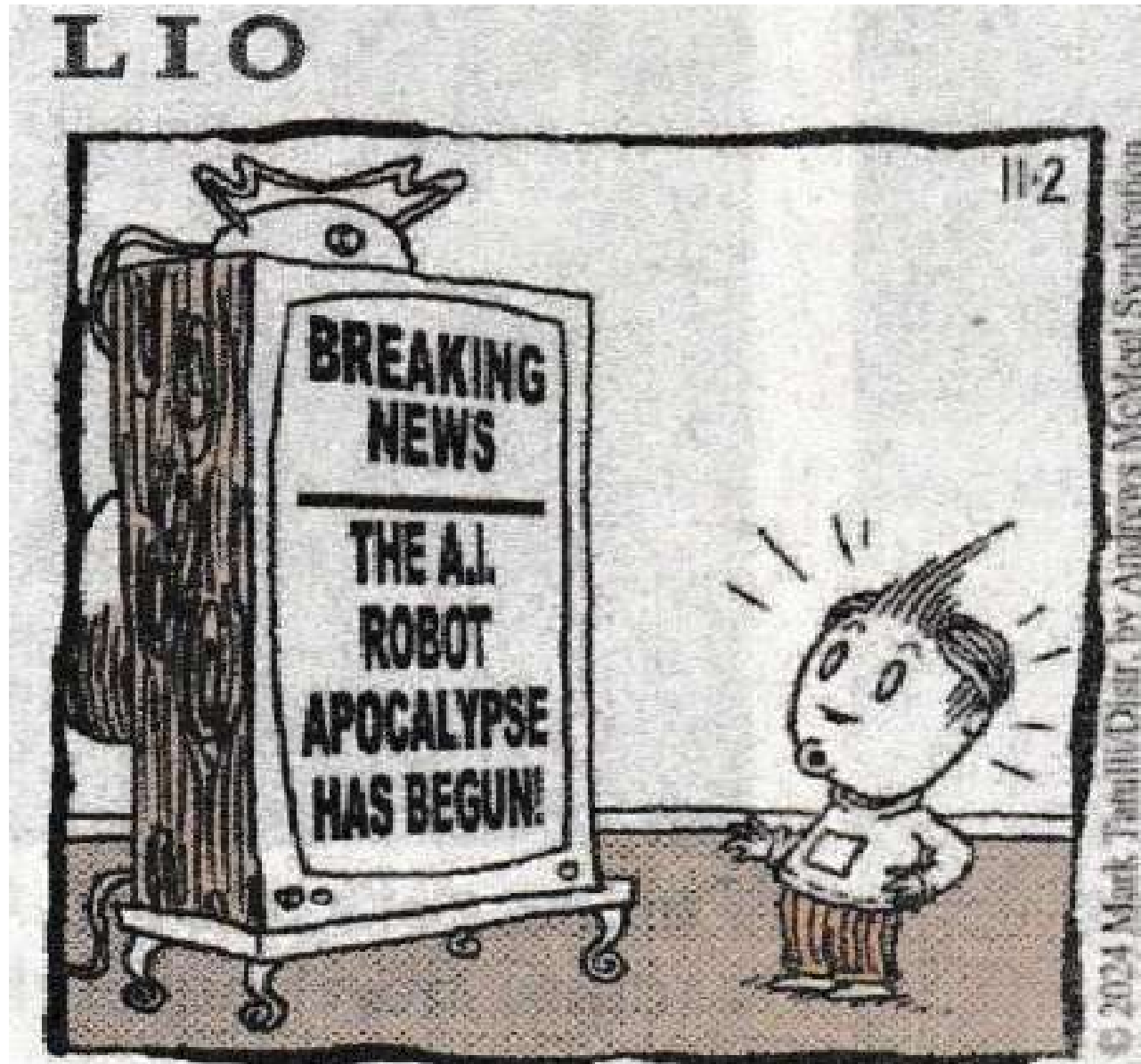
Progress

- Google is integrating AI into its products
 - Search, Maps, Gmail, etc.
 - Microsoft too – it's called Copilot
- Small Language Models (SLMs)
 - For smartphones & laptops

AI Safety and Security

- How can we achieve safety and security?
 - Take it slower?
 - Not possible – Big tech is competitive
 - Regulation/Legislation?
 - Bletchley Declaration (25 country pact)
 - Canada is working on legislation
 - EU – AI Act
 - Ontario's Trustworthy Artificial Intelligence Framework
 - White House AI rules – Executive order on October 30th, 2023
 - Mandatory testing and validation?
 - Education?

Robots



Robot Applications – The Good

- Mars rover
- Vacuum cleaners
- Self driving vehicles
- Rescue robots
- Industrial robots in factories
- Warehouse robots
 - Amazon uses lots of robot technology

Humanoid Robots



Robots

- Boston Dynamics – the Atlas robot
 - Excellent locomotion & acrobatics
 - Not the best hand dexterity
 - Recognizes objects
 - Doesn't listen or talk
 - Combines many pre-trained tasks

Boston Dynamics – Atlas



Other Humanoid Robots

Company	Robot
• 1X (Halodi Robotics)	NEO
• Agility Robotics	Digit
• Apptronik	Apollo
• Figure AI	Figure 01
• Fourier Intelligence	GR1
• Hanson Robotics	Sophia
• Sanctuary AI	Phoenix
• Tesla	Optimus
• Unitree	H1
• Xiaomi	CyberOne
• XPENG	PX5

Robots – The Bad

- Robots are great specialists
 - But poor generalists
- They need to be trained for each task
 - Small changes require retraining
- The long tail problem
 - Low frequently, low probability events

Humanoid Robots – The Bad

- Fantastic mechanical and electrical engineering
 - Costly investments
- They are missing common sense, reasoning and understanding
- Are humanoid robots the right solution?
 - Wheels are often much better
 - E.g. Roomba vacuum cleaner from iRobot

Dexterity $\neq$ Intelligence

- Body – kinesthetic – motion
- Emotional
- Linguistic – Verbal
- Logical – mathematical
- Musical
- Social
- Visual – spatial

True Intelligence

- The ability to adapt one's behaviour in the world
 - Multi-sensory perception, recognition
 - Thinking, reasoning, problem solving
 - Planning, decision making
 - Understanding, common sense
 - Self-awareness, consciousness?

Future ?

Peak Expectations



Summary

Summary – AI is better at

- Processing data
- Memory
- Self-control
- Following instructions
- Tedious repetitive tasks

Humans are better at

- Understanding the world
 - Comprehending scenes
- Inferring meanings from language
- Being cognitively flexible
 - Thinking, reasoning, problem solving
- Navigating the 3D world

The Good, Bad and Ugly

- Are you an optimist? The Good
 - Lots of great applications for AI technology
 - Major benefits to humanity
- Are you a realist? The Bad
 - It does not work properly – not yet
- Are you a pessimist? The Ugly
 - It can be misused by bad actors

The Good, Bad and Ugly

- Is AI technology the real problem?
 - It depends on who, why and how

Questions & Discussion