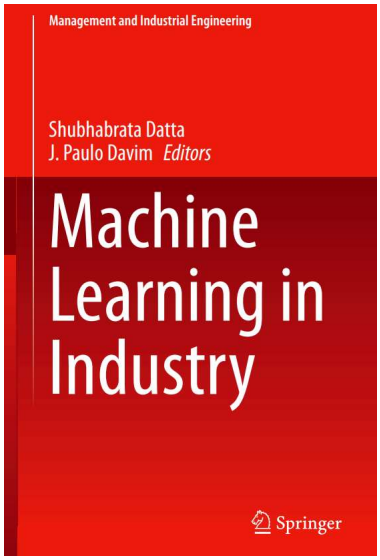
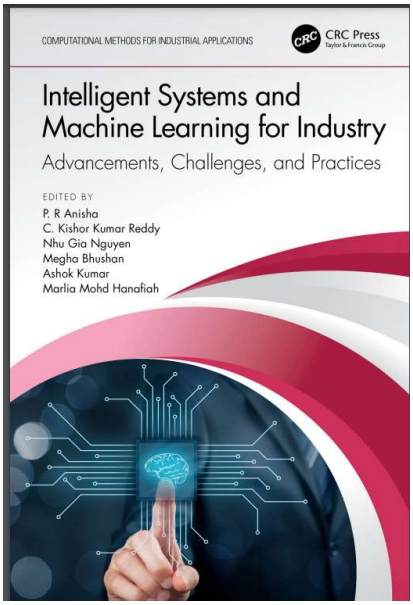
COURSE OUTLINE

- Word document uploaded
- Suggested Reading is course notes, slides and reference books

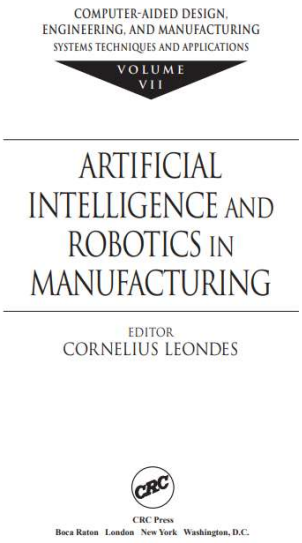
SUGGESTED READING

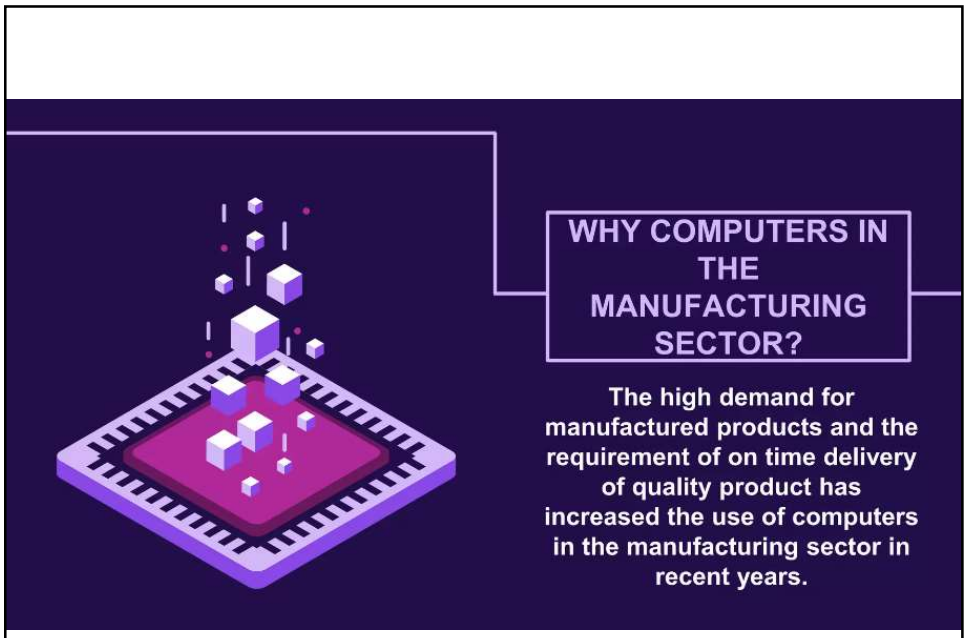


SUGGESTED READING

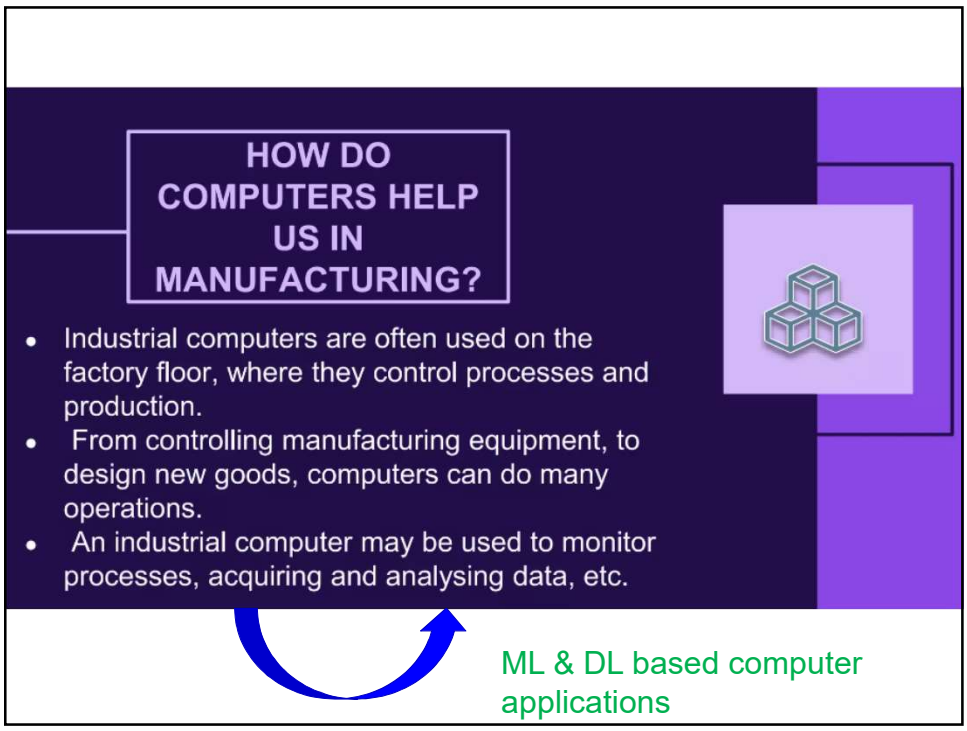


SUGGESTED READING





CAD, CAM, CIM & now Computer assisted mfr (CAsM)



ML & DL based computer applications

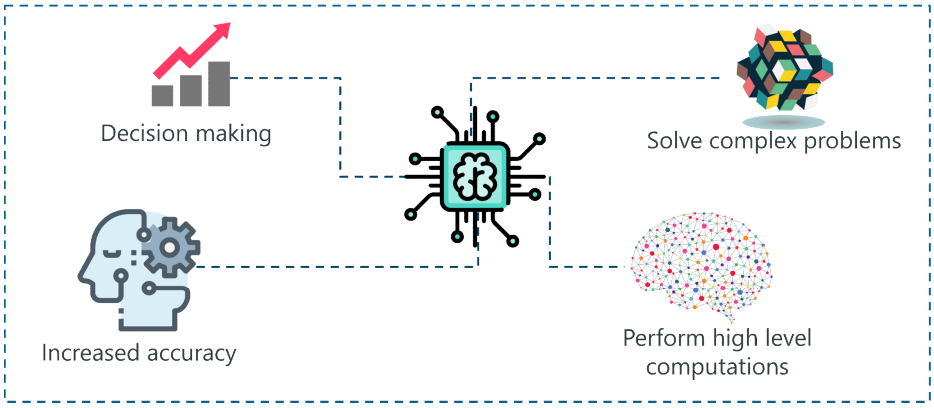
AI IN MANUFACTURING

What is AI

- "The science and engineering of making intelligent machines"
  - Term defined by John McCarthy in 1956
- Intelligence : "The capacity to learn and solve problems"

What is AI

- Development of computer systems capable of performing tasks that require human intelligence, such as decision making, object detection, solving complex problems and so on.



AI IN MANUFACTURING

- AI for manufacturing to grow from **$1.1 billion in 2020 to $16.7 billion by 2026** –.
- Annual growth rate of 57 percent due to
  - availability of big data,
  - increased industrial automation
  - improving computing power, and
  - larger capital investments.

HOW & WHY

AI IN MANUFACTURING

- The potential to transform the manufacturing industry completely.
  - increased productivity,
  - decreased expenses,
  - enhanced quality, and
  - decreased downtime.
- Big/Small factories are endeavoring to get their hands on high-value, low-cost AI solutions for manufacturing systems

AI IN MANUFACTURING

- There are many possible uses for AI in manufacturing. It improves defect detection by using complex image processing techniques to classify flaws across a wide range of industrial objects automatically.
- Latest research paper 

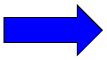
AI IN MANUFACTURING

- Huge Data being produced daily by industrial IoT and smart factories
- Manufacturers are increasingly turning to AI solutions like machine learning (ML) and deep learning neural networks to better analyse data and make decisions.

AI IN MANUFACTURING

- Predictive maint is an application of AI in manufacturing where production data is used to improve failure prediction and maintenance planning.
- This results in less costly maintenance for production lines.

AI IN MANUFACTURING

- Accurate demand forecasting and less material waste. Computer applications based on AI and manufacturing go hand in hand since humans and machines must collaborate closely in industrial manufacturing environments.
- Lumpy spare parts prediction 

TRY APPLYING LEARNING INTO MODELLING

- ANYTHING THAT SUPER HUMAN CO DO WITH POWERS OF
  - MEMORY AND
  - FAST PROCESSING

ROLE OF AI IN INDUSTRIAL SECTOR

- Preventing Future Problems
  - When functioning equipment will break so that repair planned before the failure
- Creative Generating

  - To mimic design process of engineers
  - Manufacturers quickly produce hundreds of design options for a single product.

ROLE OF AI IN INDUSTRIAL SECTOR

- Forecasting of Raw Material Prices
  - More correctly than humans
- Aspect/Data Analytics
  - Quick, decentralized insights
  - IIoT with AI improves precision
- Quality Controls
  - To spot deviations from the norm

ROLE OF AI IN INDUSTRIAL SECTOR

- Robotics process automation
  - Automate monotonous tasks,
  - eliminate human error, and
  - refocus human attention
- Process Improvement
  - To attain sustainable production levels

ROLE OF AI IN INDUSTRIAL SECTOR

- Enhancing Shop Floor Performance
  - Track and examine the production cycle
  - Spot potential quality problems or areas
  - Locate and eliminate inefficiencies by mining
  - Satisfying customers by prompt/precise delivery

AI IN MANUFACTURING

- AI in Logistics
  - Production losses due to overstocking or understocking.
  - To gain sales, money, and patronage when products are appropriately stocked.

AI IN MANUFACTURING

- Management of Supply Chains With AI
  - To alert failure in supply chain and evaluate the disruption's severity
  - Capacity forecasting to stocktaking
  - A real-time and predictive model for assessing and monitoring suppliers

AI IN MANUFACTURING

- Factory Automation, Autonomous Vehicles
  - Auto modify equipment settings while keeping eye on various indications on many screens
  - From assembly lines to conveyor belts
  - Deliveries 24/7 with self-driving trucks & ships
  - Connected cars with sensors to track real-time information to plan delivery routes
    - Decrease accidents & notify emergency

AI IN MANUFACTURING

- AI for IT operations
  - Uses big data and machine learning for
    - IT service management,
    - event correlation and analysis,
    - performance analysis,
    - anomaly identification, and
    - causation determination

AI IN MANUFACTURING

- Design and Production With AI
  - Generate multiple iterations of a product's design that improve upon the original. The generative design software, asks designers for inputs like:
    - Basic Ingredients
    - Measurements and mass
    - Processing Techniques
    - Limitations due to financial and other resources
    - The algorithm can generate an array of potential layouts based on these inputs.

AI IN MANUFACTURING

- IoT and Artificial Intelligence
  - IoT devices are high-tech gadgets with sensors that produce massive amounts of real-time operating data.
  - Known as the "Industrial Internet of Things" (IIoT) in the manufacturing sector.
  - The factory's combination of AI and IIoT can significantly improve precision and output.

AI IN MANUFACTURING

- AI in Warehouse Management
  - A constant eye on stock & improve logistics due to continual stream of data
  - Costs of managing a warehouse is lowered,
  - Productivity can be increased

AI IN MANUFACTURING

- AI-Based Product Development
  - Using AR and VR
  - Enhance and accelerate innovation with AI-based products
  - Items that hit the market ahead of competition

AI IN MANUFACTURING

- AI-Based Connected Factory
  - Sensor, cloud connected or "smart" factories
- AI for Purchasing Price Variance
  - Raw material cost estimation and vendor sel
- AI for Cyber security ☺
  - risk detection

NEWS IN MAIN STREAM MEDIA

ABB, IBM team up on industrial artificial intelligence

REUTERS — PUBLISHED ABOUT 9 HOURS AGO

Like 5 Share Tweet 1 COMMENT EMAIL PRINT

ABB has sealed a collaboration agreement with International Business Machines Corp (IBM), the Swiss engineering company said on Tuesday, the latest step in its efforts to ramp up its presence in digital technology and the internet of things.

In a joint statement ABB said it would combine its digital offering, which gathers information from machinery, with IBM's expertise in artificial intelligence featured in its Watson data analytics software.

The two companies will jointly develop and sell new products.

"This powerful combination marks truly the next level of industrial technology, moving beyond current connected systems that simply gather data, to industrial operations and machines that use data to sense, analyze, optimize and take actions that drive greater uptime, speed and yield for

TALKING MACHINES
SPEAKING OUT
PROBLEMS

Facebook turns to artificial intelligence to tackle suicides

REUTERS — PUBLISHED MAR 02, 2017 10:58AM

Like 12 Share Tweet 0 COMMENTS EMAIL PRINT

Facebook plans to use artificial intelligence and update its tools and services to help prevent suicides among its users.

The world's largest social media network said it plans to integrate its existing suicide prevention tools for Facebook posts into its live-streaming feature, Facebook Live, and its Messenger service.

Artificial intelligence will be used to help spot users with suicidal tendencies, the company said in a blogpost on Wednesday.

In January, a 14-year-old foster child in Florida broadcast her suicide reportedly on Facebook Live, according to the New York Post.

Facebook is already using artificial intelligence to monitor offensive material in live video streams.

Elon Musk on mission to link human brains with computers: report

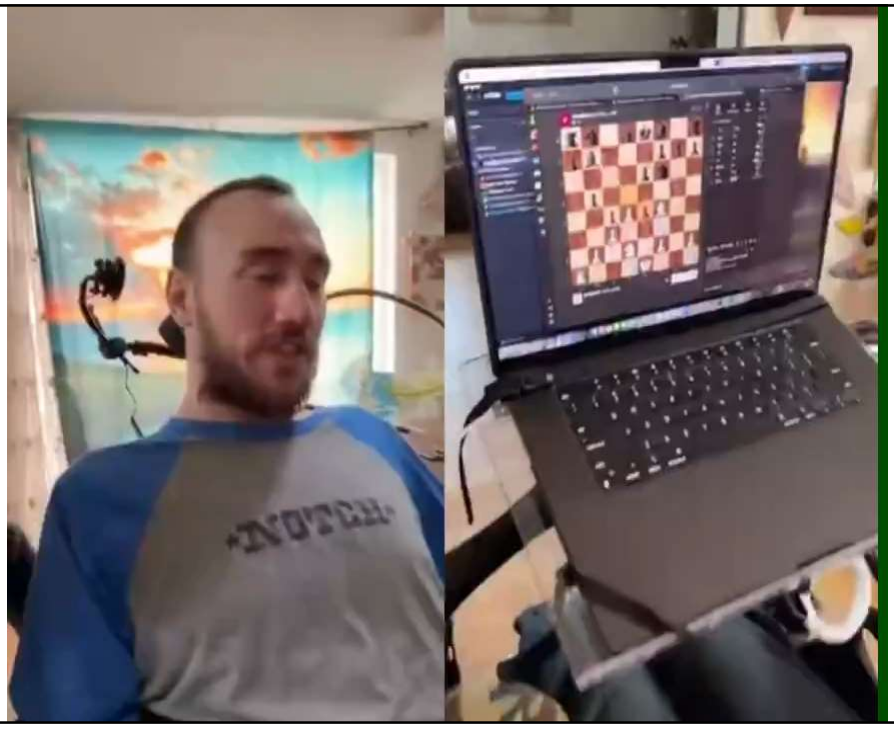
REUTERS — PUBLISHED APR 21, 2017 05:34PM

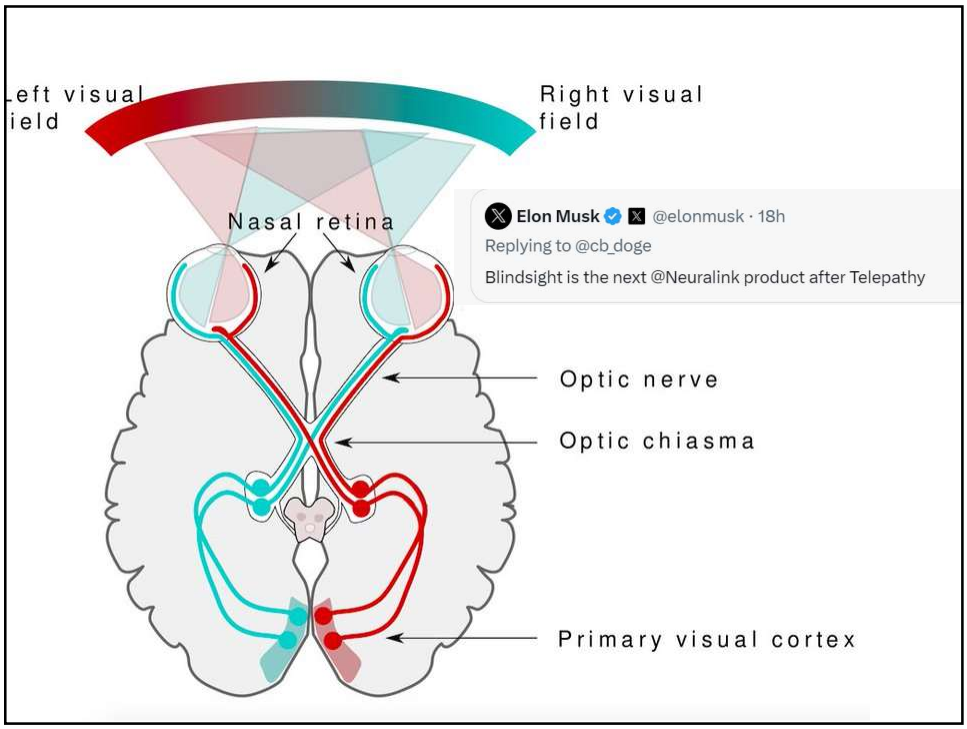
Tesla Inc founder and Chief Executive Elon Musk said his latest company Neuralink Corp is working to link the human brain with a machine interface by creating micron-sized devices.

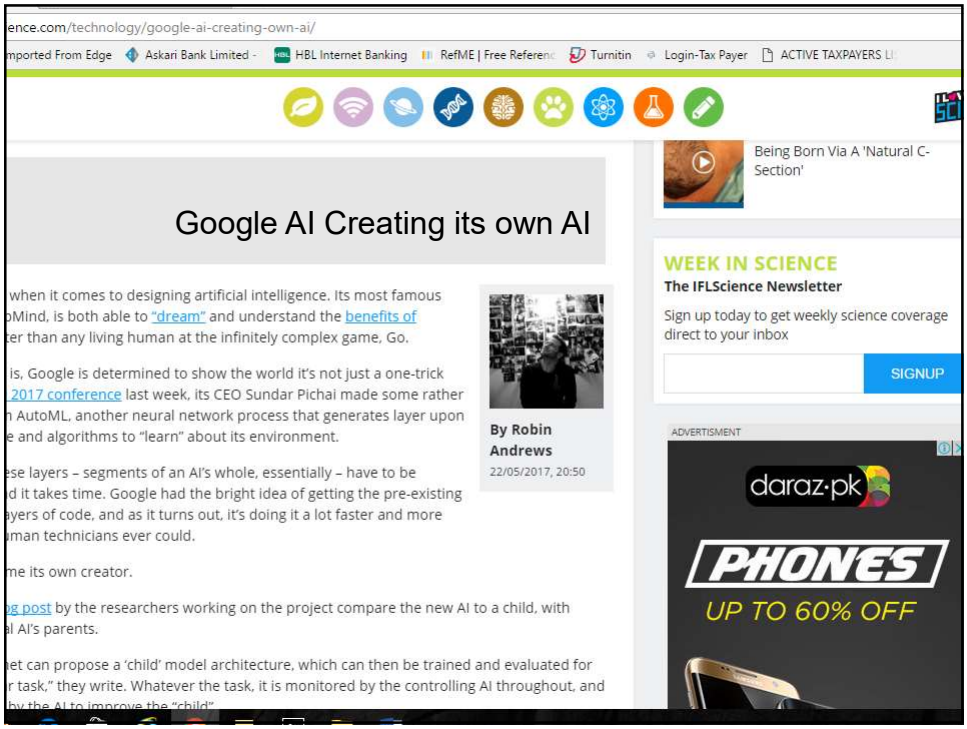
Neuralink is aiming to bring to the market a product that helps with certain severe brain injuries due to stroke, cancer lesion etc, in about four years, Musk said in an interview with website Wait But Why.

"If I were to communicate a concept to you, you would essentially engage in consensual telepathy," Musk said in the interview published on Thursday.

Artificial intelligence and machine learning will create computers so sophisticated and godlike that humans will need to implant "neural laces" in their brains to keep up, Musk said in a tech conference last year.




Left visual field
Right visual field
Nasal retina
Elon Musk @elonmusk · 18h
Replying to @cb_doge
Blindsight is the next @Neuralink product after Telepathy
Optic nerve
Optic chiasma
Primary visual cortex


ence.com/technology/google-ai-creating-own-ai/
Google AI Creating its own AI
when it comes to designing artificial intelligence. Its most famous
Mind, is both able to "dream" and understand the benefits of
er than any living human at the infinitely complex game, Go.
is, Google is determined to show the world it's not just a one-trick
2017 conference last week, its CEO Sundar Pichai made some rather
AutoML, another neural network process that generates layer upon
and algorithms to "learn" about its environment.
se layers – segments of an AI's whole, essentially – have to be
it takes time. Google had the bright idea of getting the pre-existing
yers of code, and as it turns out, it's doing it a lot faster and more
man technicians ever could.
me its own creator.
g post by the researchers working on the project compare the new AI to a child, with
AI's parents.
et can propose a 'child' model architecture, which can then be trained and evaluated for
r task," they write. Whatever the task, it is monitored by the controlling AI throughout, and
By Robin Andrews
22/05/2017, 20:50
Being Born Via A 'Natural C-Section'
WEEK IN SCIENCE
The IFLScience Newsletter
Sign up today to get weekly science coverage direct to your inbox
SIGNUP
ADVERTISMENT
daraz.pk
PHONES
UP TO 60% OFF

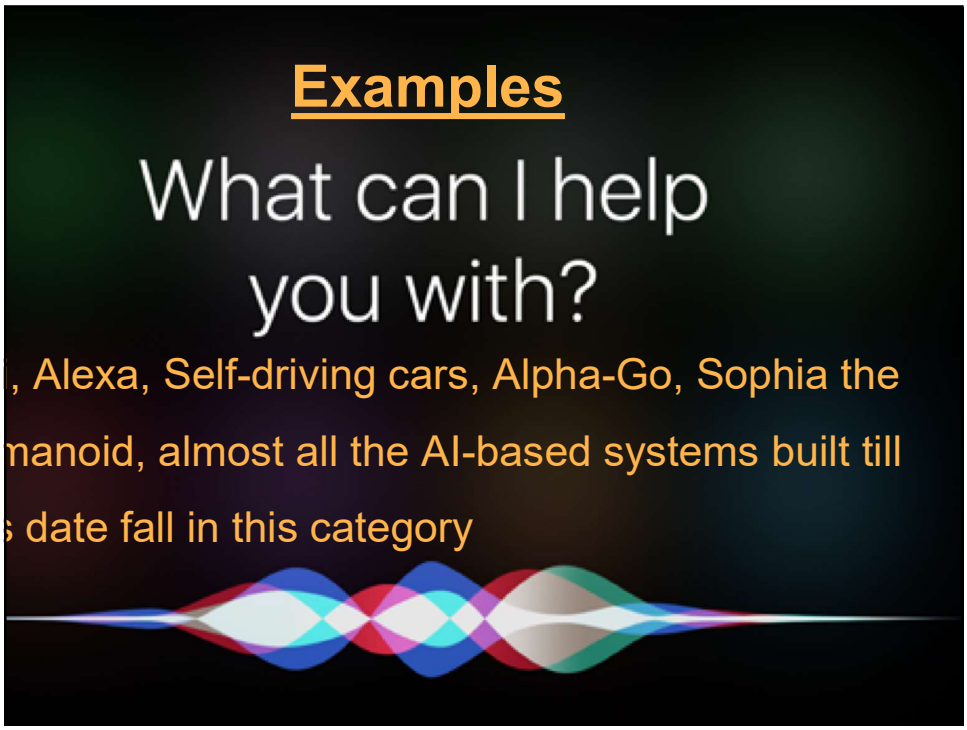
AI –LATEST TRENDS

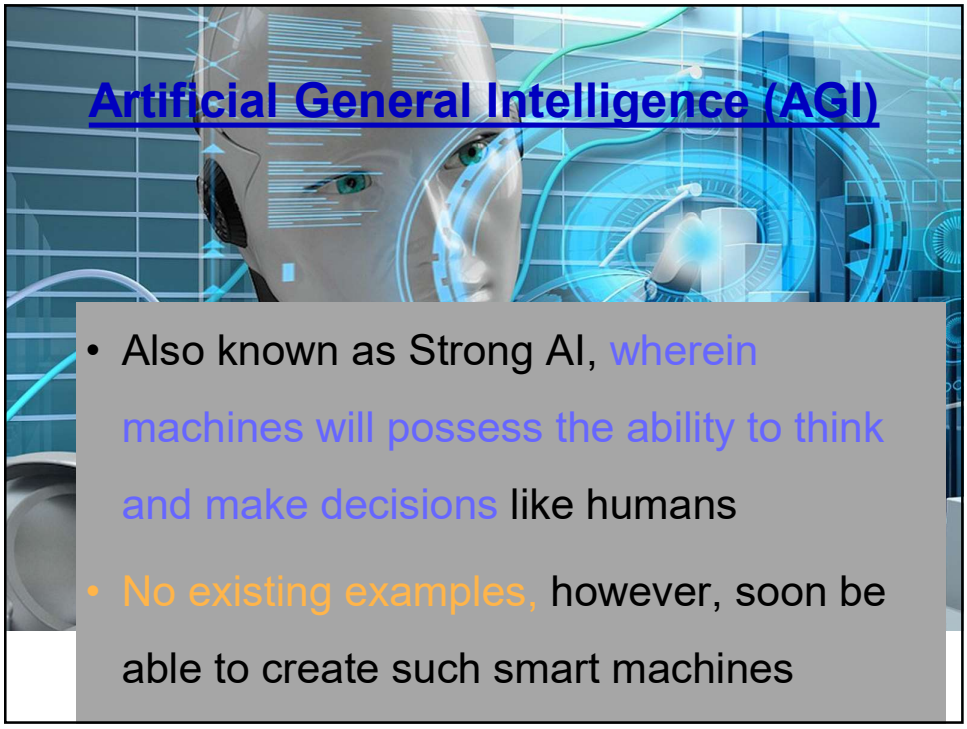
Stages of AI

- These are the three stages through which AI can evolve
  - Artificial Narrow Intelligence
  - Artificial General Intelligence
  - Artificial Super Intelligence

Artificial Narrow Intelligence (ANI)

- Its Weak AI, involving machines that can perform only a narrowly defined set of specific tasks
- At this stage, the machine does not possess any thinking ability, it just performs a set of pre-defined functions

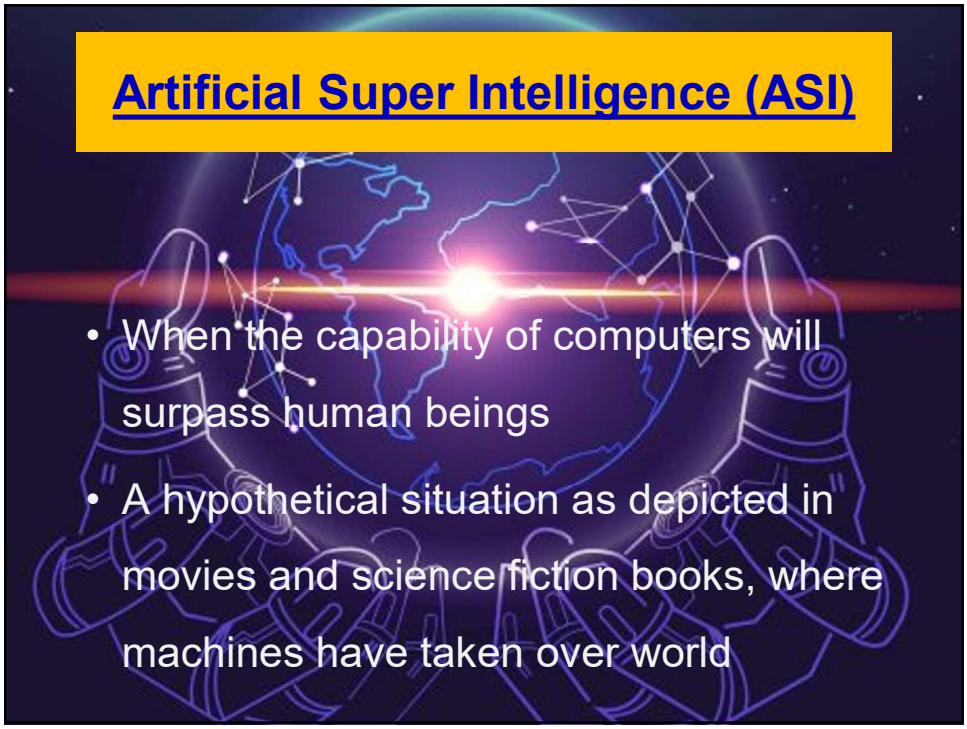

Examples
What can I help you with?
, Alexa, Self-driving cars, Alpha-Go, Sophia the
manoid, almost all the AI-based systems built till
s date fall in this category


Artificial General Intelligence (AGI)
• Also known as Strong AI, wherein machines will possess the ability to think and make decisions like humans
• No existing examples, however, soon be able to create such smart machines

Artificial General Intelligence (AGI)

- Considered a threat to human existence by many scientists, including Stephen Hawking who stated that:

"**The development of full artificial intelligence could spell the end of the human race…. It would take off on its own, and re-design itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, couldn't compete and would be superseded**."



Artificial Super Intelligence (ASI)

- When the capability of computers will surpass human beings
- A hypothetical situation as depicted in movies and science fiction books, where machines have taken over world

Artificial Super Intelligence (ASI)

- "The pace of progress in artificial intelligence (I'm not referring to narrow AI) is incredibly fast. Unless you have direct exposure to groups like Deepmind, you have no idea how fast—it is growing at a pace close to exponential. The risk of something seriously dangerous happening is in the five-year timeframe. 10 years at most." —Elon Musk

Types of AI Based Systems

- Based on the functionality of AI-based systems, AI can be categorized into the following types:
  - Reactive Machines AI
  - Limited Memory AI
  - Theory Of Mind AI
  - Self-aware AI

Reactive Machine AI

Reactive Machine AI

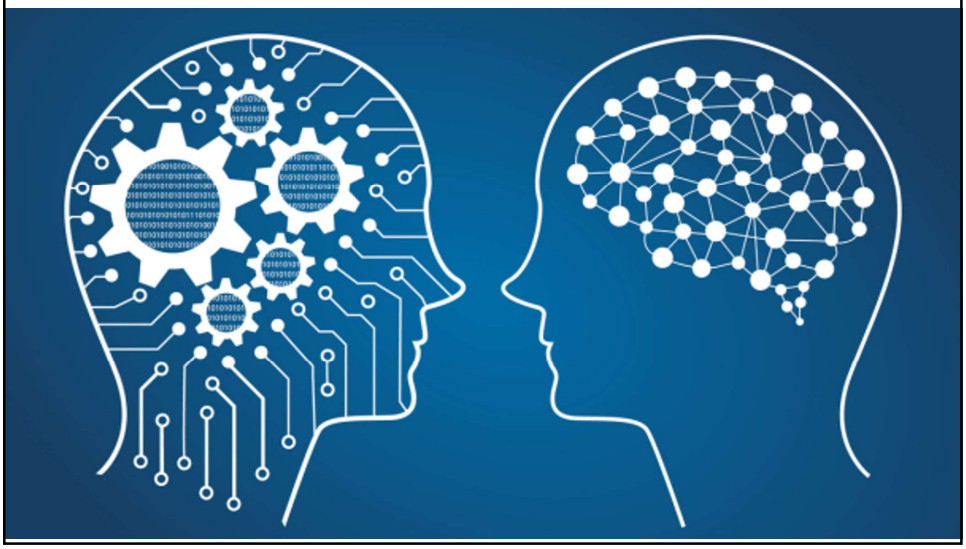
- Machines that operate solely based on the present data, taking into account only the current situation
- Reactive AI machines cannot form inferences from the data to evaluate their future actions. They can perform a narrowed range of pre-defined tasks
- Example - Famous IBM Chess program that beat the world champion, Garry Kasparov.

Limited Memory AI

Limited Memory AI

- Make improved decisions by studying the past data from its memory. It has a short-lived memory to store past experiences and evaluate future actions
- Example - Self-driving cars uses the data collected in the recent past to make immediate decisions
  - Use sensors to identify civilians crossing the road, steep roads, traffic signals for better decisions

Theory Of Mind AI



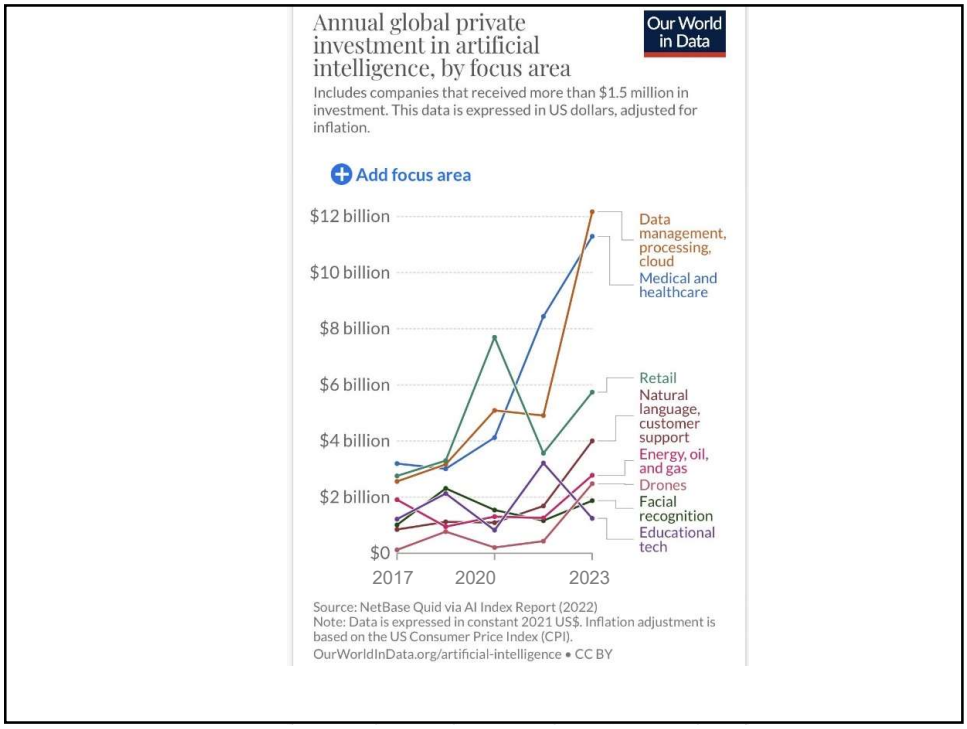
Theory Of Mind AI

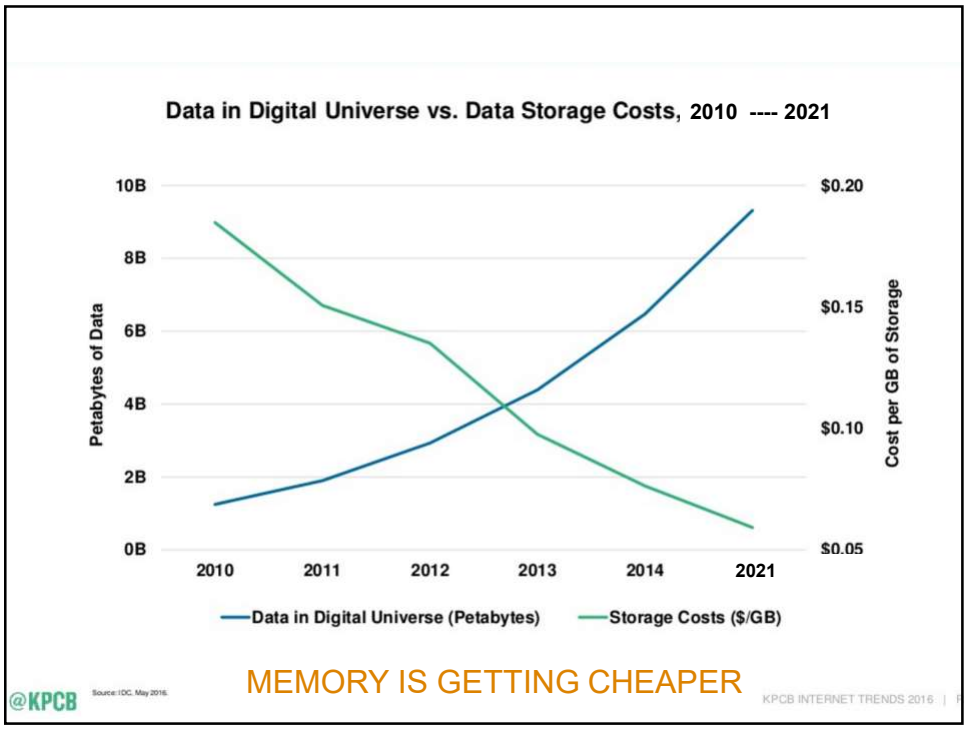
- This focus mainly on emotional intelligence so that human believes and thoughts can be better comprehended
- It has not yet been fully developed & rigorous research is happening in this area

Self-Aware AI

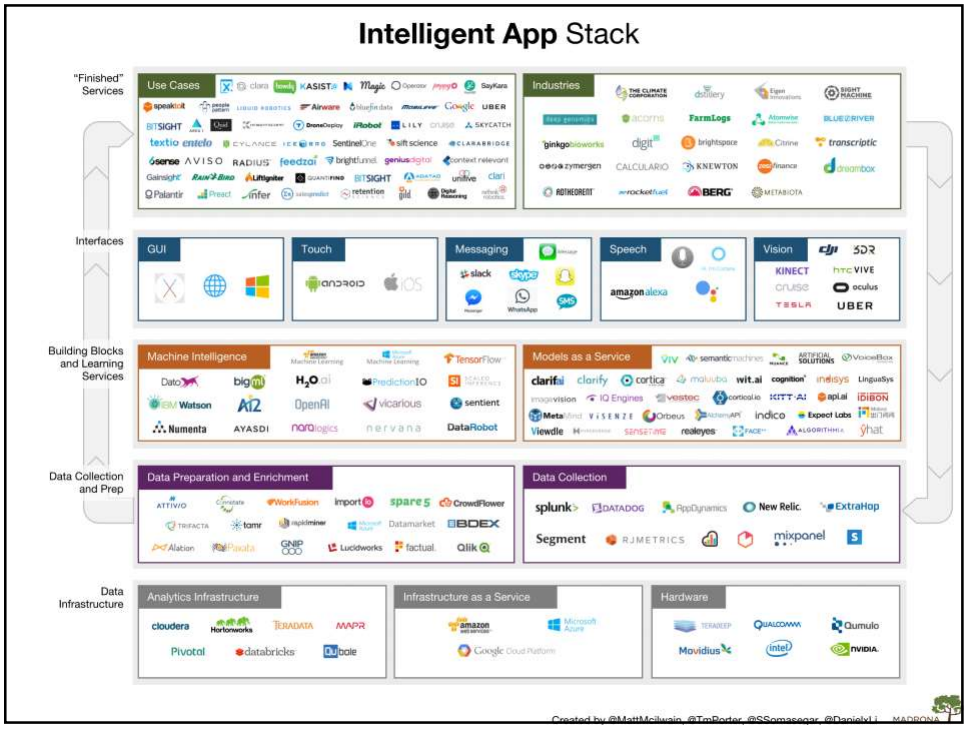
Self-Aware AI

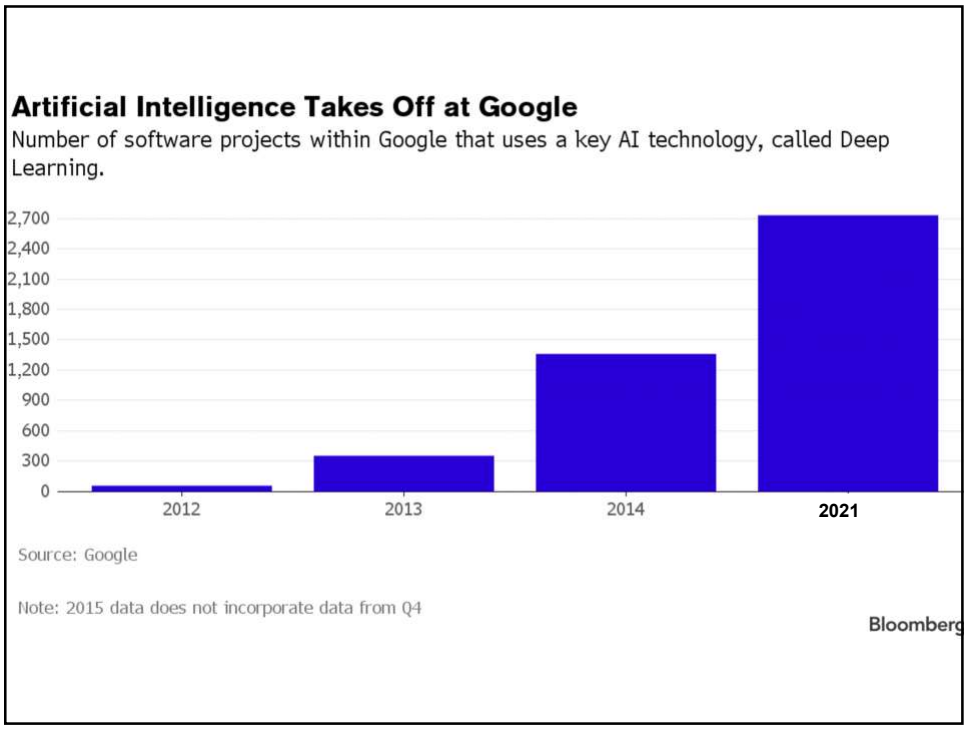
- Machines that have their own consciousness and become self-aware, a little far fetched at present
- Achieving a stage of super intelligence might be possible in future

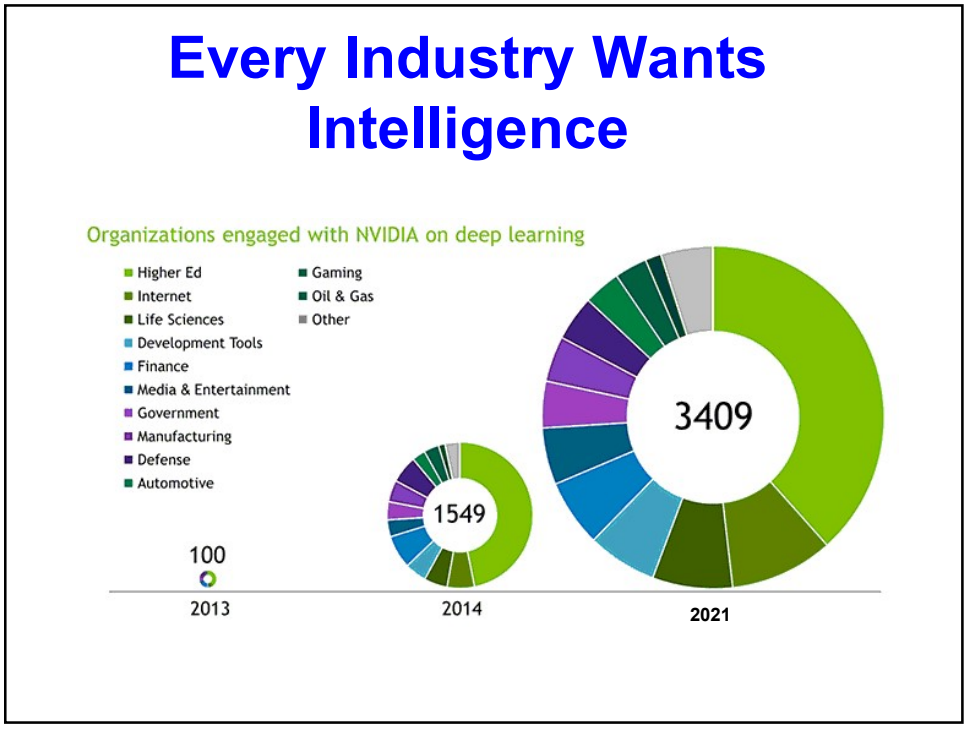

Annual global private investment in artificial intelligence, by focus area
Our World in Data
Includes companies that received more than $1.5 million in investment. This data is expressed in US dollars, adjusted for inflation.
Add focus area
$12 billion
$10 billion
$8 billion
$6 billion
$4 billion
$2 billion
$0
2017
2020
2023
Data management, processing, cloud
Medical and healthcare
Retail
Natural language, customer support
Energy, oil, and gas
Drones
Facial recognition
Educational tech
Source: NetBase Quid via AI Index Report (2022)
Note: Data is expressed in constant 2021 US$. Inflation adjustment is based on the US Consumer Price Index (CPI).
OurWorldInData.org/artificial-intelligence • CC BY

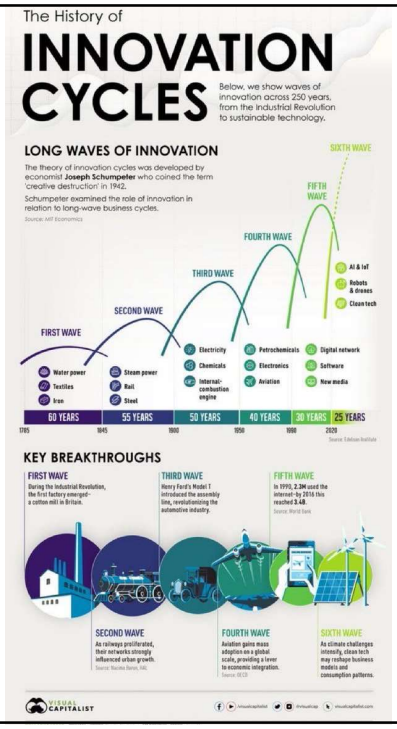


MEMORY IS GETTING CHEAPER




Artificial Intelligence Takes Off at Google
Number of software projects within Google that uses a key AI technology, called Deep Learning.
2,700
2,400
2,100
1,800
1,500
1,200
900
600
300
0
2012
2013
2014
2021
Source: Google
Note: 2015 data does not incorporate data from Q4
Bloomberg


Every Industry Wants Intelligence
Organizations engaged with NVIDIA on deep learning
Higher Ed
Internet
Life Sciences
Development Tools
Finance
Media & Entertainment
Government
Manufacturing
Defense
Automotive
Gaming
Oil & Gas
Other
100
1549
3409
2013
2014
2021

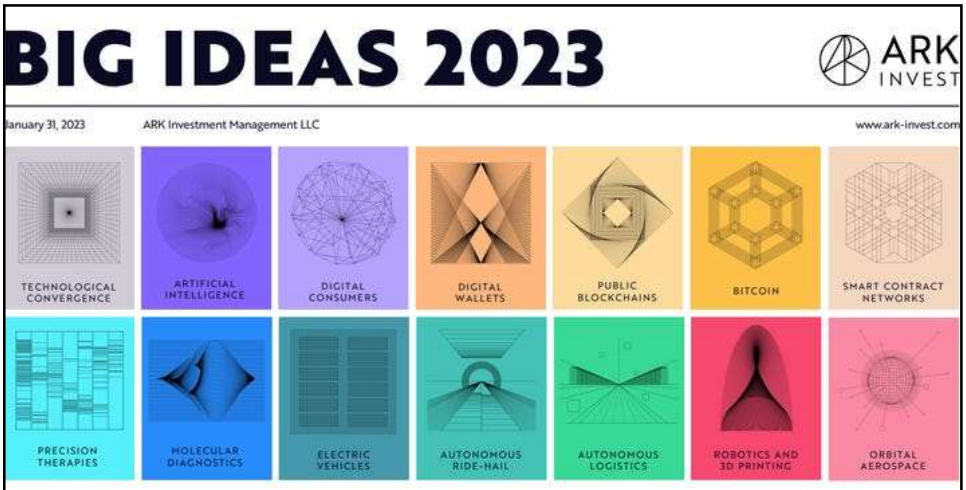


Disruptive innovation

…….

Video streaming

Data calls



- Artificial intelligence is the most important catalyst, its velocity cascading through all other technologies.

TODAY'S DISRUPTIVE INNOVATION PLATFORMS

- 5 innovation platforms with growth trajectories:
  - Artificial Intelligence,
  - Public Block chains,
  - Energy Storage,
  - Robotics, and
  - Multiomic Sequencing.

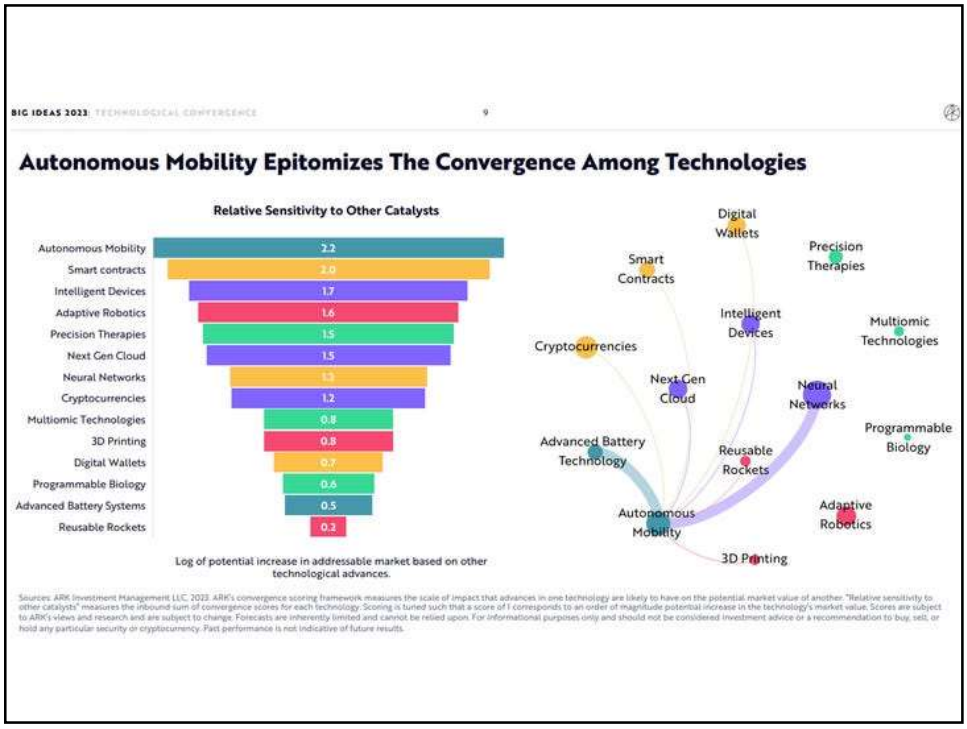
All platforms involve AI to leverage smart data analytics

ARTIFICIAL INTELLIGENCE

- AI/ANNs are the biggest where
  - Write a text and AI draw the picture
  - Show a picture and AI write the text
  - Image capturing and identification rate increase from 77% to 97% against human still at 94%
- Good if AI available to all, bleak in few hands

IMPORTANT

- Disruptive innovation platforms could scale 40% at an annual rate, from $13 trillion today to $200 trillion by 2030
- To account for majority of global equity market capitalization

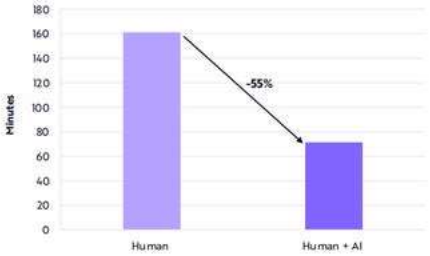


AI Is Increasing The Productivity Of Knowledge Workers

Coding Assistants

Software engineers completed a coding task in less than half the time with AI coding assistant GitHub Copilot.

Time to Complete Coding Tasks: 2022*



Generative Image Models

According to our research, AI can create a graphic design for just $0.08** in minutes — a *di minimis* cost compared to $150 for human labor.

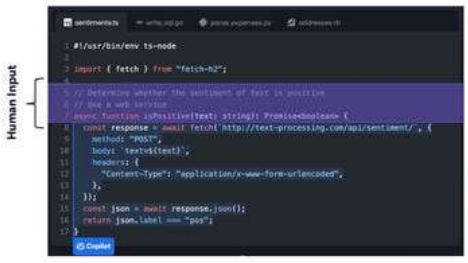
Human	
Cost	$150
Time	5 Hours
Generative AI	
Cost	$0.08
Time	< 1 Minute

*Based on data from GitHub. **Generative AI models translated " a picture of an astronaut on Mars" into multiple images in just a few seconds. Sources: ARK Investment Management LLC, 2023, Kalliamvakou, E. 2022. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

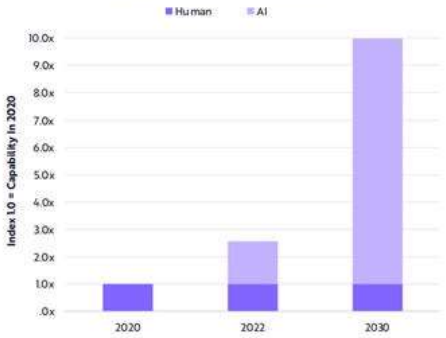
AI Could Lead To A 10-Fold Increase In Coding Productivity

Based on a 70% annualized drop in training costs and feedback loops, AI coding assistants like Copilot could increase the output of software engineers ~10-fold by 2030.

Github Copilot Example



Output of Human + AI: Coding Tasks



Sources: ARK Investment Management LLC, 2023, GitHub 2023. Forecasts are inherently limited and cannot be relied upon. For informational purposes only and should not be considered investment advice or a recommendation to buy, sell, or hold any particular security. Past performance is not indicative of future results.

LETS TALK TO BUILDING AI MODEL ON MATLAB OR PYTHON

HYPER-PARAMETERS

- learning rate
- epochs
- Batch size

- Lets run the exercise run last time once again to get more information on these

Iteration, epoch & batch size

- The system recalculates the model's loss value and adjusts the model's weights and bias after each **iteration**
- Each iteration is the span in which the system processes one batch. For example, if the **batch size** is 6, then the system recalculates the model's loss value and adjusts the model's weights and bias after processing every 6 examples.

Iteration, epoch & batch size

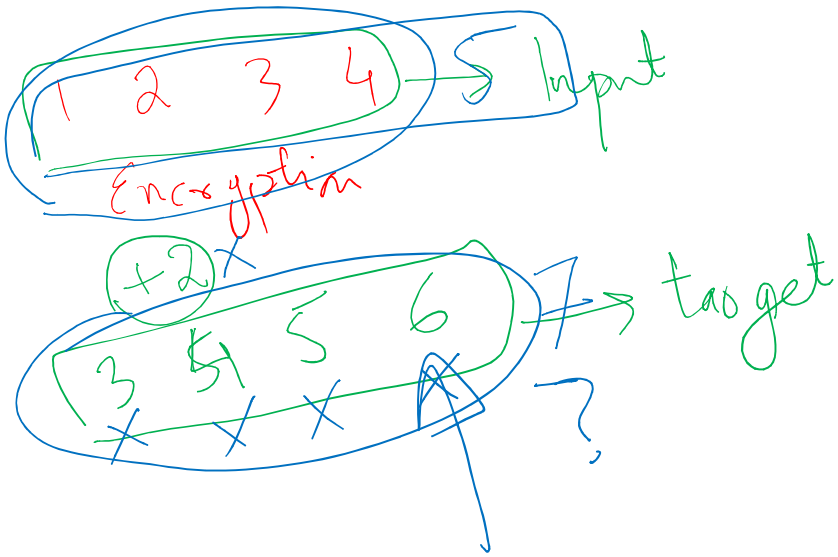
- One **epoch** spans sufficient iterations to process every example in the dataset. For example, if the batch size is 12, then each epoch lasts one iteration. However, if the batch size is 6, then each epoch consumes two iterations.

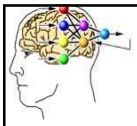
Iteration, epoch & batch size

- It is tempting to simply set the batch size to the number of examples in the dataset (12, in this case). However, the model might actually train faster on smaller batches. Conversely, very small batches might not contain enough information to help the model converge.

POINT TO KEEP IN MIND!

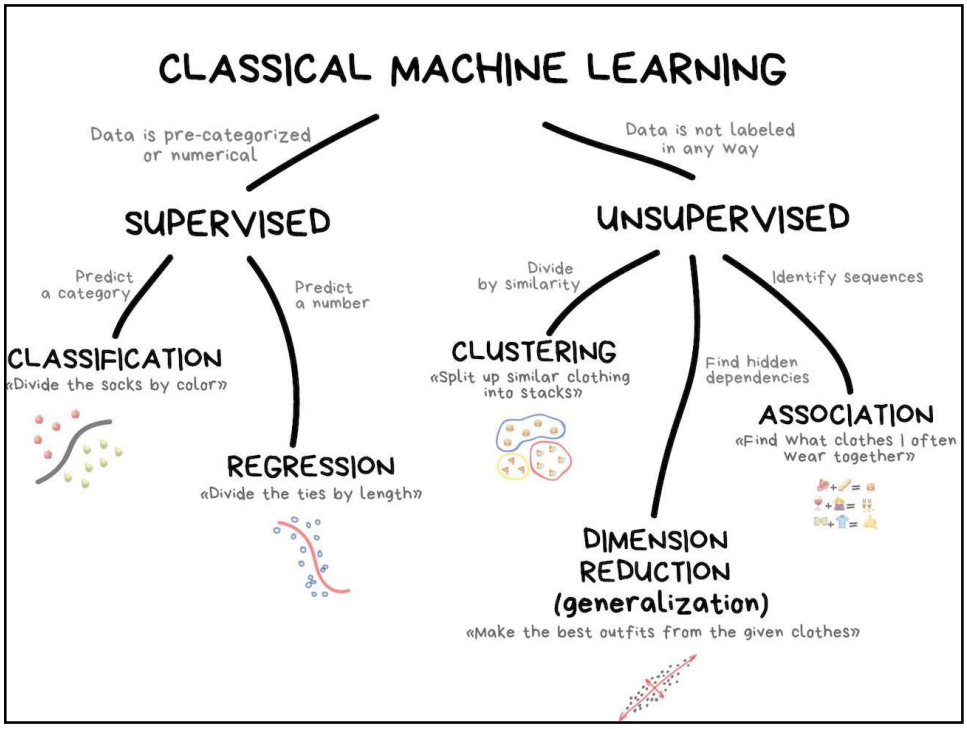
- EVERY PROBLEM CAN NOT BE SOLVED BY AI
- WHAT CAN BE PARTS OF SOLUTION BY AI APPROACH ?



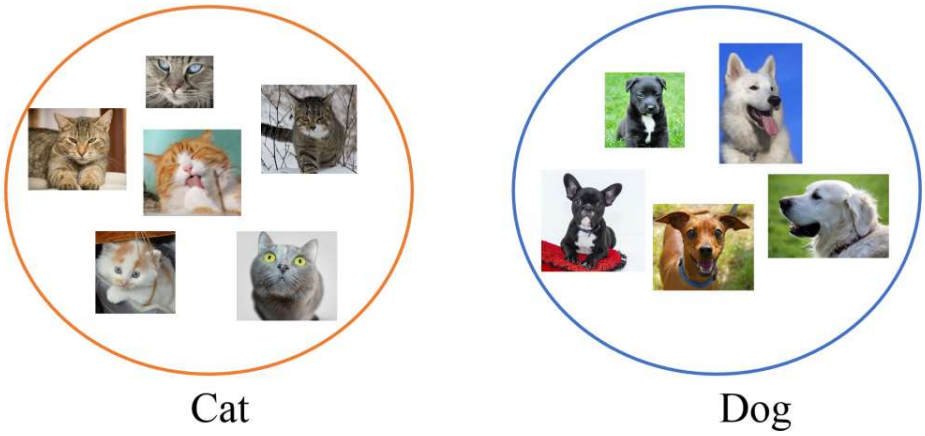


DON'T FORGET

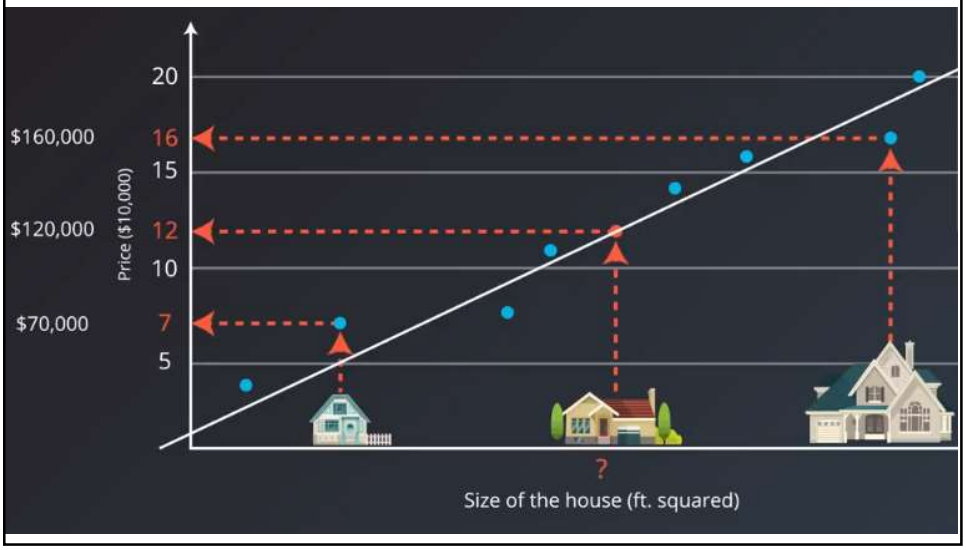
- Not every problem can be solved by an AI
  - You may wish to know next week's lottery result
  - know your shoe size
- You know (or at least strongly suspect) that there is a relationship between the proposed known inputs and unknown outputs
  - This relationship may be noisy but it must exist.
- For AI, you won't know the exact nature of the relationship between inputs and outputs
  - if you knew the relationship, you would model it directly.
- AI learn the input/output relationship through training
  - Supervised
  - Unsupervised
  - Reinforcement



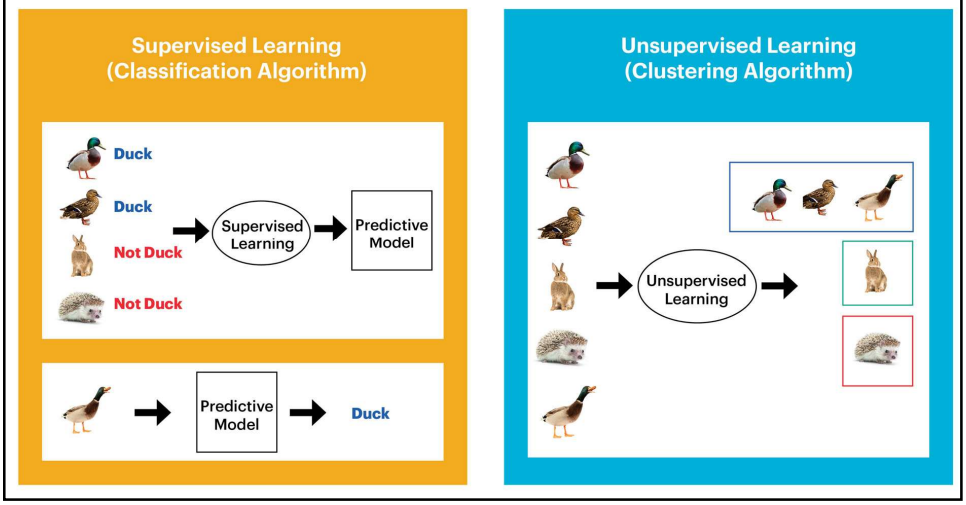
SUPERVISED/ CLASSIFICATION



SUPERVISED/ REGRESSION

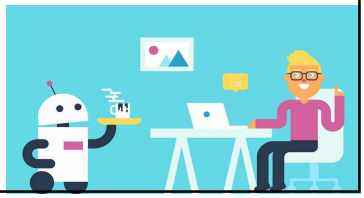


UNSUPERVISED/ CLUSTERING



Machine Learning

- In the past decade, ML given us
  - Self-driving cars
  - Speech recognition
  - Real-time computer vision
  - Effective web search
  - Understanding human genome



Deep Learning?

1. A class of machine learning techniques that exploit many layers of non-linear information processing for supervised or unsupervised feature extraction and transformation, and for pattern analysis and classification.
2. A sub-field within machine learning that is based on algorithms for learning multiple levels of representation in order to model complex relationships among data.