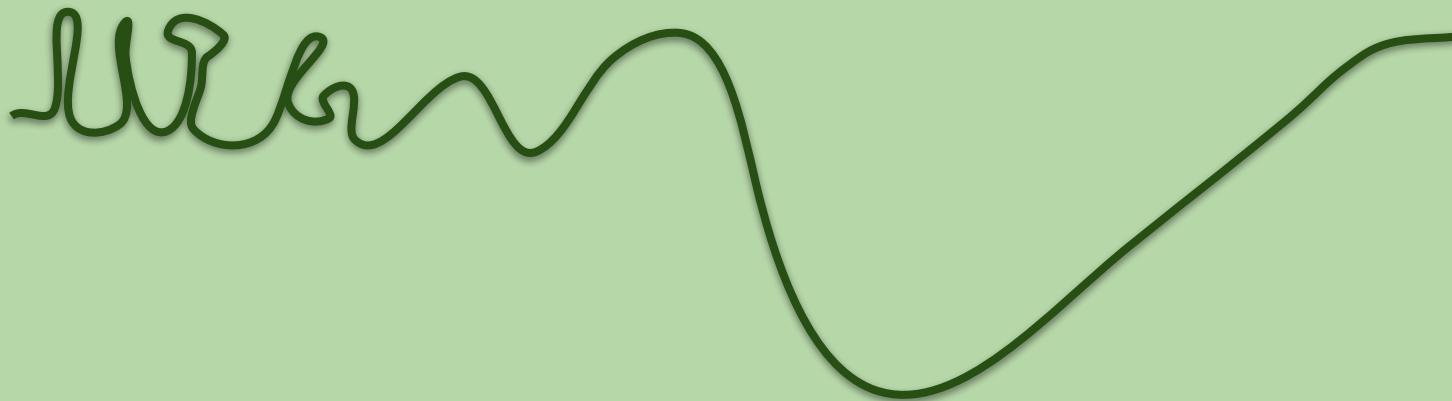


# Foundations of Artificial Intelligence



Jul - Nov 2025

IIT Guwahati

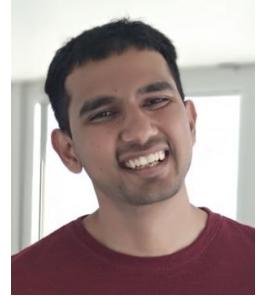
Instructors: Neeraj Sharma

Lect-01



# About Me

- Engineer, Researcher, Professor
- Trained at:
  - College of Engineering and Technology, Bhubaneswar, India
  - Indian Institute of Science Bangalore, India
  - Carnegie Mellon University, Pittsburgh, USA
  - International Audio Labs (at Fraunhofer), Erlangen, Germany
- Currently, Faculty, Mehta Family School of Data Science and AI, IIT Guwahati
- Researching on building intelligence via multimodal signal processing, ML and AI
- Badminton, Movies, Travelling, Talking to/Learning from curious minds!



<https://neerajww.github.io/>





# About my lab

SPIN @ IIT Guwahati

Home Research

## Sensing Perception & INtelligence (SPIN) Lab



# About Mehta Family School of DSAI, IITG

**BTech in Data  
Science & AI**

**Online BSc.  
(Hons.) in Data  
Science & AI**

**MTech in Data  
Science**

**PhD**

While making an impact with R&D through Data Science & AI, we cherish the opportunity to teach undergraduate and postgraduate students, and PhD Scholars.

Our degree programs in Data Science & AI are visionary, and amongst the early ones not only in India but globally as well.

**Apr,  
2021**  
Founded

**Oct,  
2021**  
First Batch of  
BTech in  
DS&AI joins

**Jan,  
2022**  
First Batch of  
PhD Scholars joins

**Jul,  
2023**  
Joins hands with  
Depts. EEE and  
Mathematics to  
offer MTech in  
Data Science

**Oct,  
2023**  
First Batch of  
BSc (Hons.)  
DS&AI joins



# Taking a course is like taking a lorry (?)



# This course code





# Foundations of Artificial Intelligence





# Foundations of Artificial Intelligence (FAI)





# Foundations of Artificial Intelligence (FAI)

FAI

FAI

FAI



# Foundations of Artificial Intelligence (FAI)

FAI

FAI

FAI

Φ

Jul - Nov 2025

IIT Guwahati

Instructors: Neeraj Sharma

**DA103  
DSA1**





# Foundations of Artificial Intelligence (FAI)

DA103DSAI

FAI or  $\Phi$

Jul - Nov 2025

Mehta Family School of DSAI, IIT Guwahati

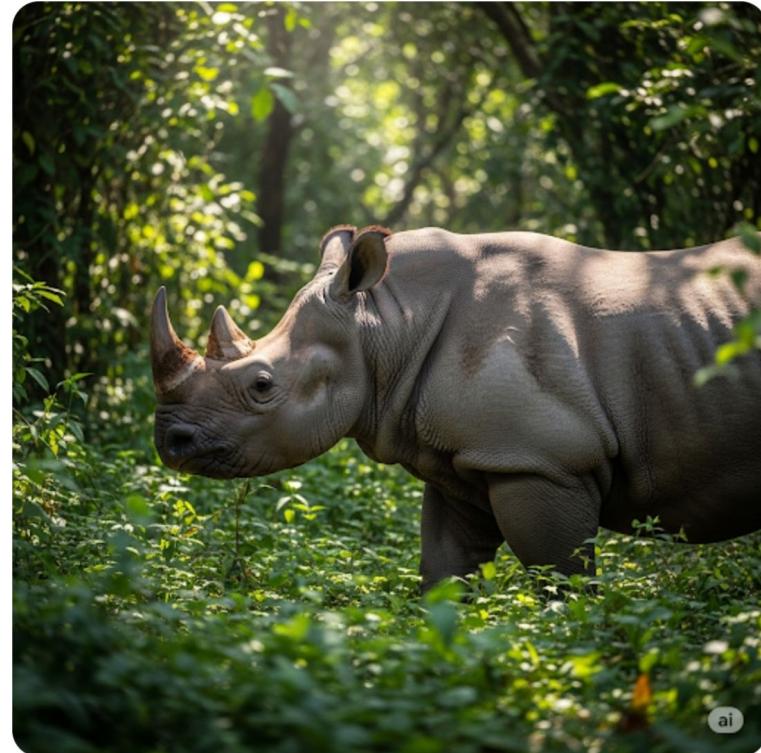
Instructor(s): Neeraj Sharma, IIT Guwahati



generate an image of one horned rhino



Sure, here is an image of a one-horned rhino:



# A course on $\Phi$

## **Syllabus:**

Definitions and perspectives on intelligence; Biological vs. artificial intelligence; History of modeling intelligence; McCulloch & Pitts neuron model; Neural signaling and basic brain structures; Visual and auditory systems in humans and animals; Sensory processing and pattern recognition; Case studies in animal intelligence (tool use, navigation, communication); Symbolic vs. connectionist approaches to AI; Intelligence and learning mechanisms; Introduction to embodied cognition; Measuring intelligence: IQ, psychometrics, and the Turing Test; Comparing human and machine intelligence; Historical milestones in AI development; Interdisciplinary perspectives (psychology, neuroscience, philosophy, computer science); Ethics and social implications of intelligent systems; Current limitations of AI and open questions; Future directions: AGI, brain-computer interfaces, and intelligence augmentation.



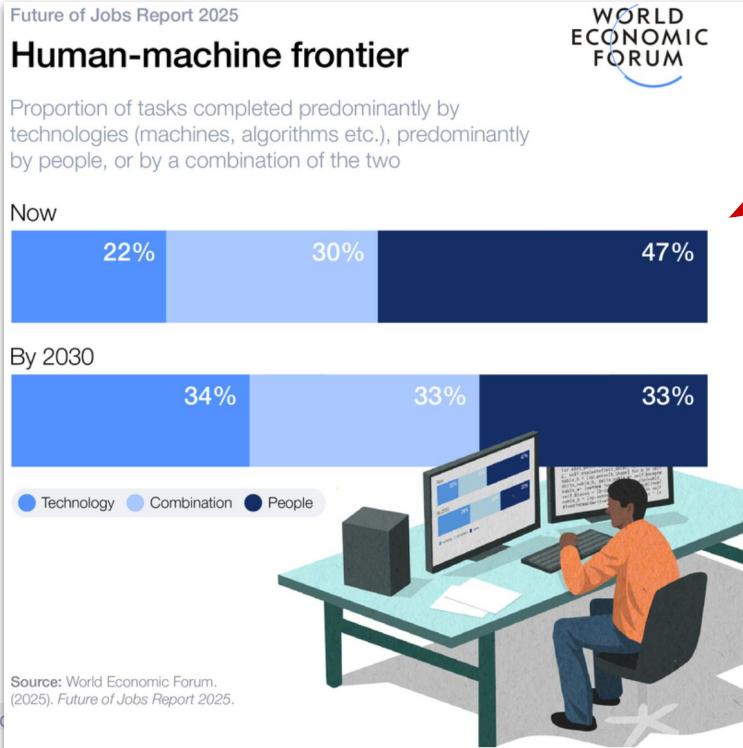
**“90% of the data in the world was created in just the last 2 years.”**

This showcases the explosive growth of data — a perfect hook to discuss the relevance of data science today.

Reference:

<https://www.pcmag.com/news/90-percent-of-the-big-data-we-generate-is-an-unstructured-mess>

# Future of Jobs Report 2025



# Future of Jobs Report 2025



Future of Jobs Report 2025

## Human-machine frontier

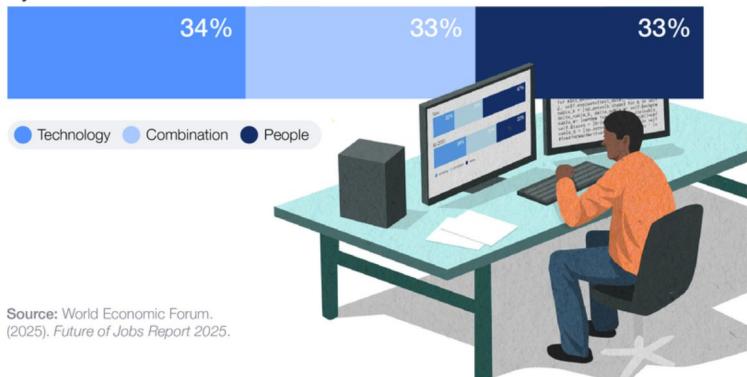


Proportion of tasks completed predominantly by technologies (machines, algorithms etc.), predominantly by people, or by a combination of the two

Now



By 2030



Future of Jobs Report 2025



## Top 10 fastest growing skills by 2030

1. AI and big data
2. Networks and cybersecurity
3. Technological literacy
4. Creative thinking
5. Resilience, flexibility and agility
6. Curiosity and lifelong learning
7. Leadership and social influence
8. Talent management
9. Analytical thinking
10. Environmental stewardship

Cognitive skills   Self-efficacy   Working with others   Management skills   Technology skills   Ethics

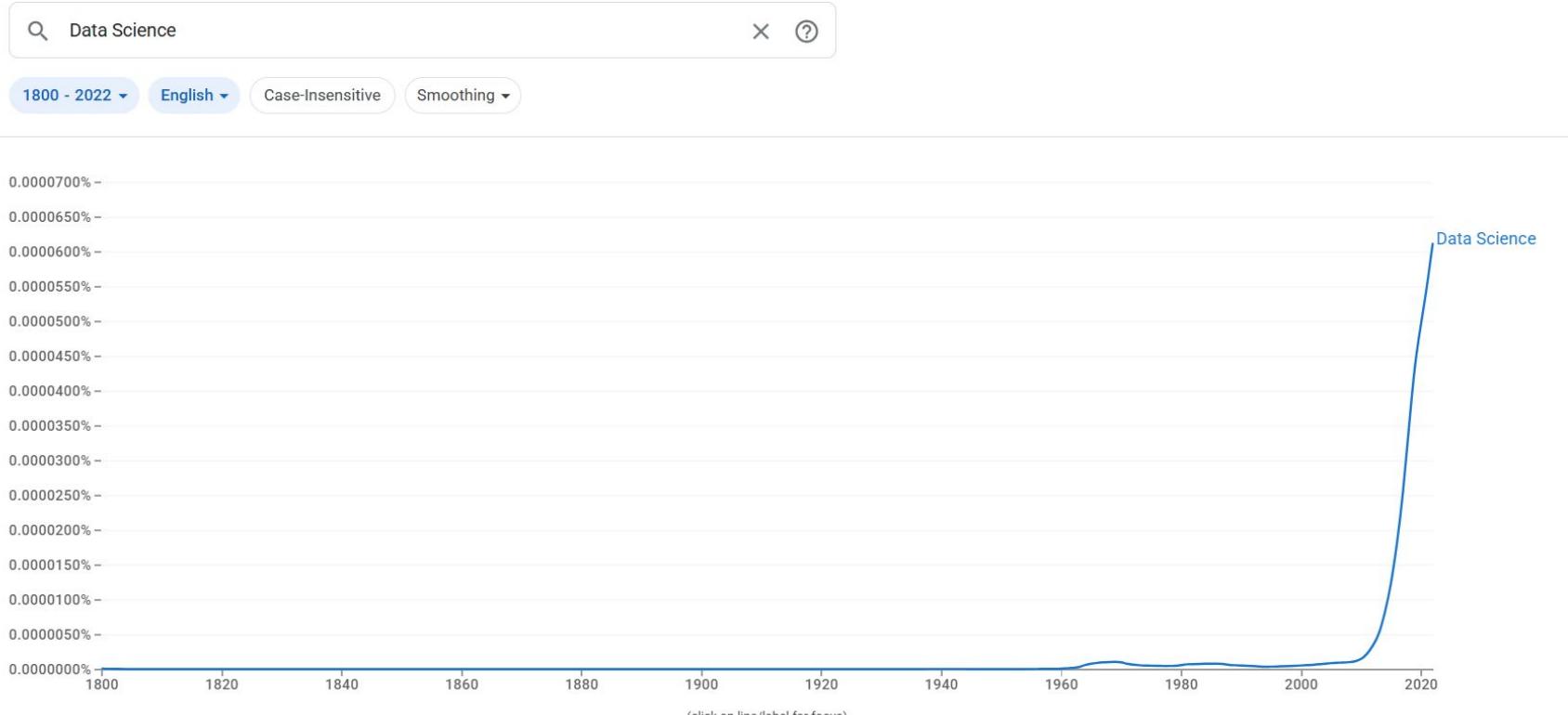
Note: The skills selected by surveyed organizations to be increasing most rapidly in importance by 2030.

Source: World Economic Forum. (2025). Future of Jobs Report 2025.



# Is the word Data Science trending?

Google Books Ngram Viewer



Reference: [https://books.google.com/ngrams/graph?content=Data+Science&year\\_start=1800&year\\_end=2022&corpus=en&smoothing=0&case\\_insensitive=false](https://books.google.com/ngrams/graph?content=Data+Science&year_start=1800&year_end=2022&corpus=en&smoothing=0&case_insensitive=false)





# Is Data Science new?

Check out this work!

JOURNAL OF COMPUTATIONAL AND GRAPHICAL STATISTICS

2017, VOL. 26, NO. 4, 745–766

<https://doi.org/10.1080/10618600.2017.1384734>

## 50 Years of Data Science

David Donoho

Department of Statistics, Stanford University, Standford, CA

<https://www.tandfonline.com/doi/full/10.1080/10618600.2017.1384734>





# Where is Data Science heading?

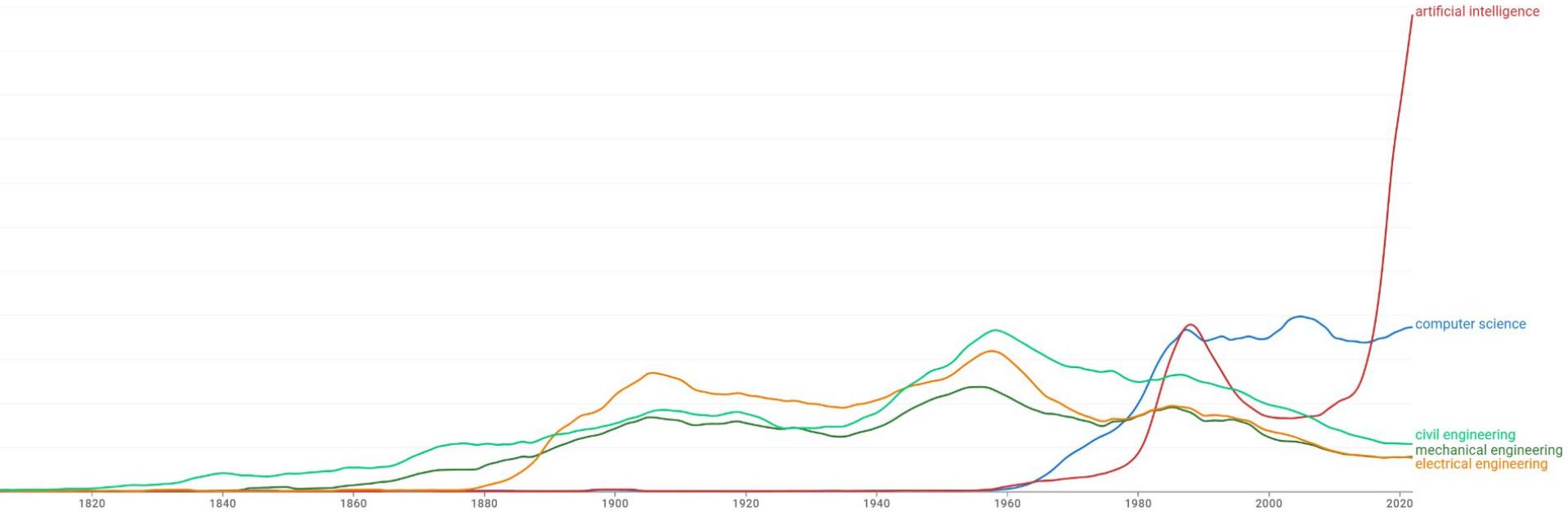
Check out this work!

## Data Science at the Singularity

by David Donoho

Published on Jan 29, 2024

<https://hdsr.mitpress.mit.edu/pub/g9mau4m0/release/2>





# Congratulations on choosing an impactful BTech program

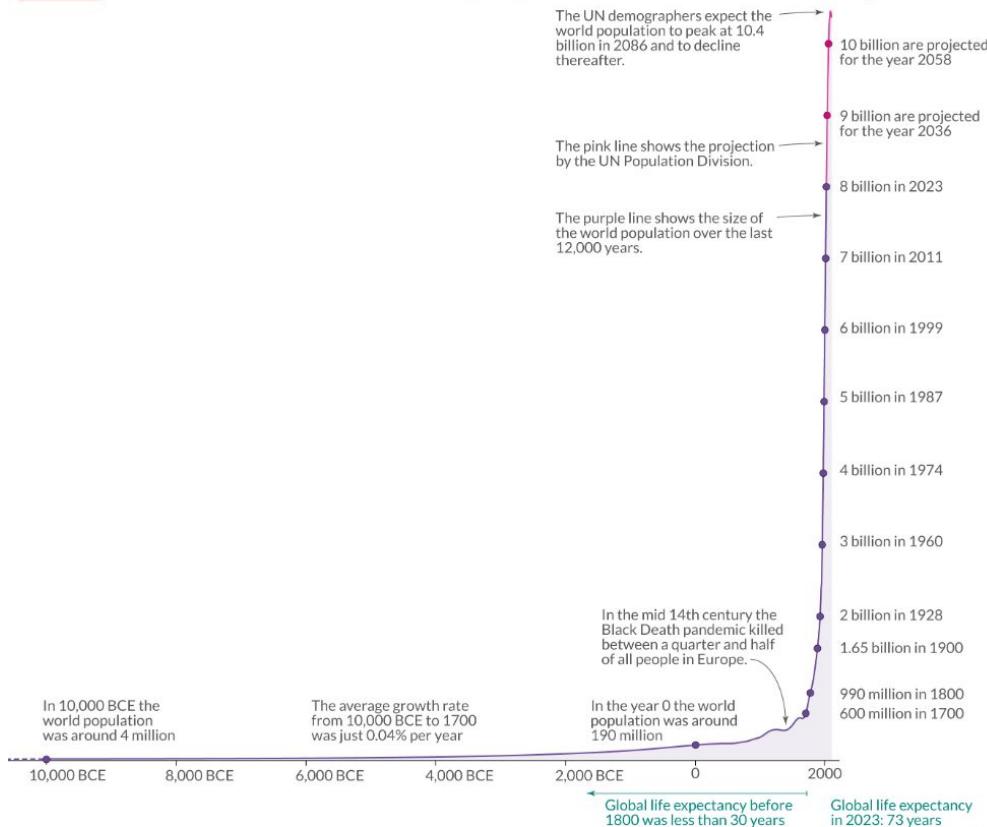
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one that holds immense promise for  
shaping the future of India and the  
world.



# Let's discuss a bit about the world around us ...

# The size of the world population over the long-run



Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations.

This is a visualization from OurWorldInData.org.

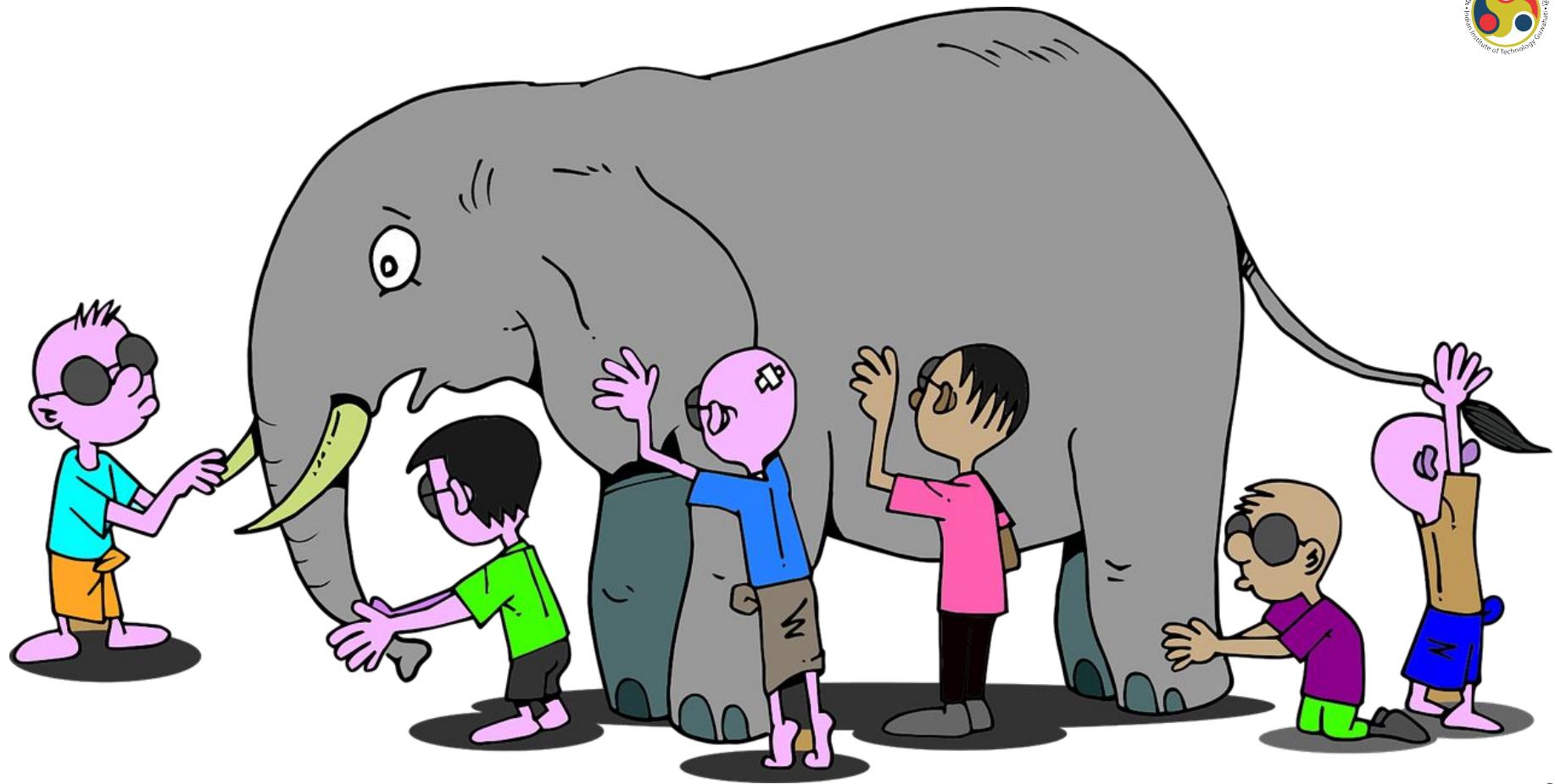
Licensed under CC-BY-SA by the author Max Roser.

55 <https://ourworldindata.org>

**Our World  
in Data**

OXFORD MARTIN SCHOOL | UNIVERSITY OF OXFORD | GGD





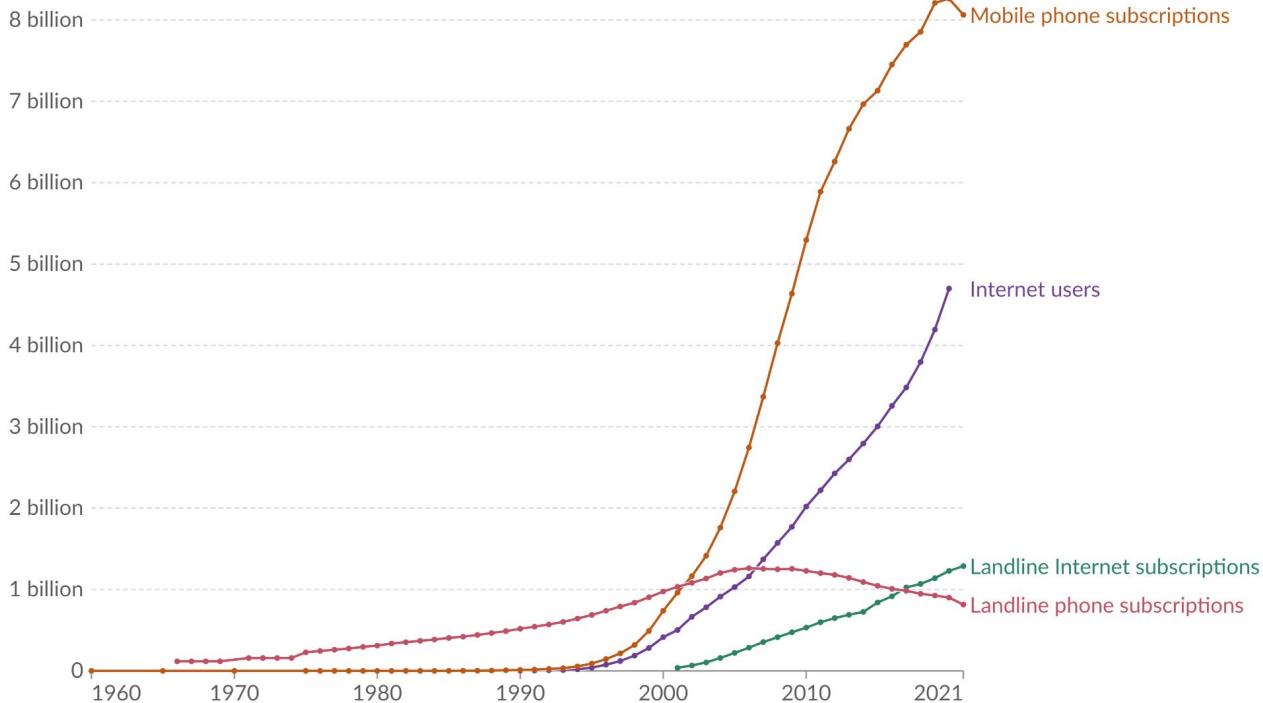
# Communication has been a key aspect aiding human development

- Smoke
- Riders on horseback
- Carrier pigeons
- Semaphore
- Writing

- Telegraph
- Telephone
- Cell phone

- Internet
- Social media

# Adoption of communication technologies, World



Data source: International Telecommunication Union (via World Bank)

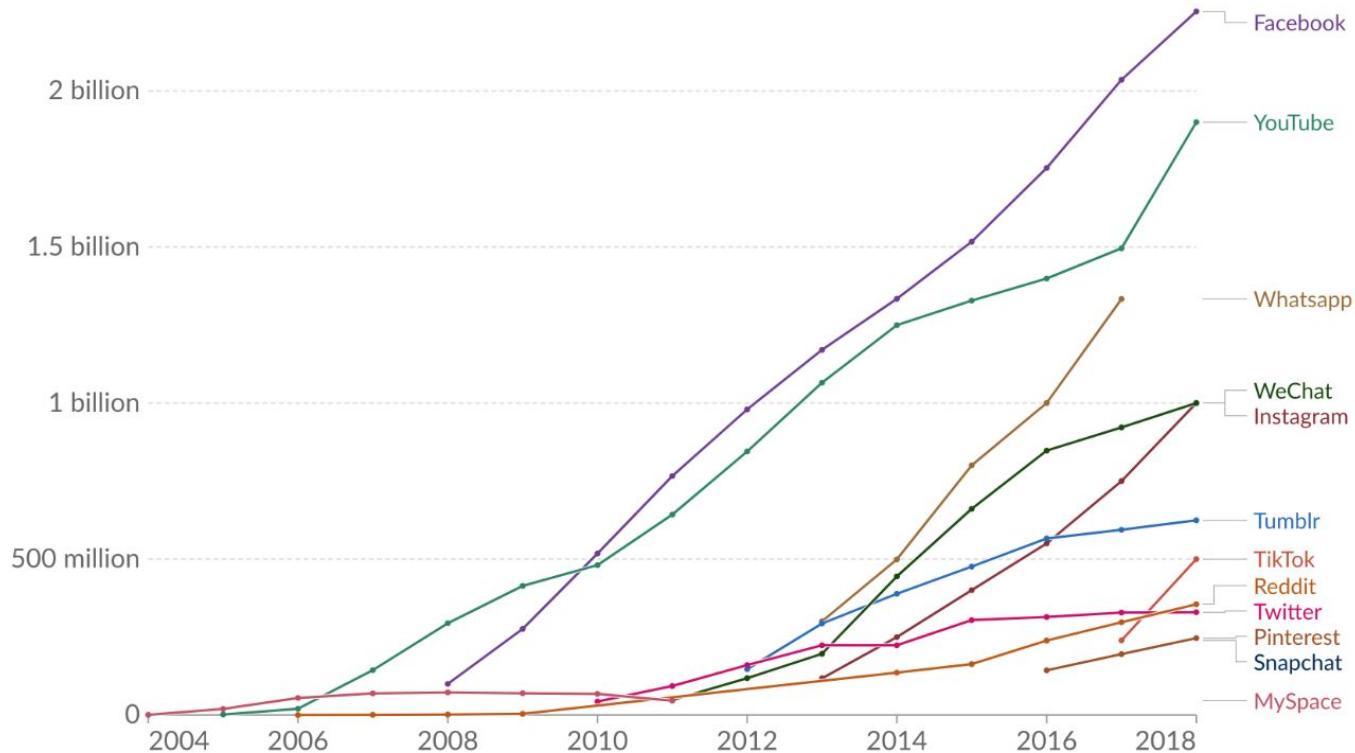
[OurWorldInData.org/technological-change](https://OurWorldInData.org/technological-change) | CC BY

Note: Landline Internet subscriptions are defined as a fixed access to the public Internet with a download speed of at least 256 kbit/s.

Internet users are people who have accessed the Internet from any location in the last three months.

# Number of people using social media platforms, 2004 to 2018

Estimates correspond to monthly active users (MAUs). Facebook, for example, measures MAUs as users that have logged in during the past 30 days. See source for more details.



Source: Statista and TNW (2019)

[OurWorldInData.org/internet](http://OurWorldInData.org/internet) • CC BY



# World Around Us

- Is getting massively digitized
- Is getting filled with smart systems that communicate interdependently
- Is witnessing a decrease in the cost of computing power
- Is witnessing an increasing ease in communicating rich content across distances
- Industry norms and business models are getting re-written





# Can computer help us

# Can computer help us



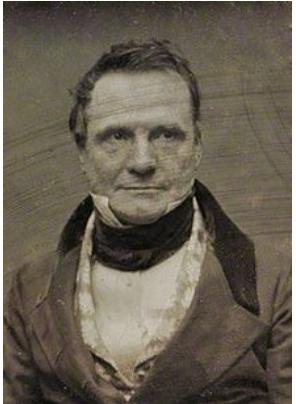
## But why computers?



# Key Contributors behind Computers

# Key Contributors behind Computers

Charles Babbage  
1791-1871

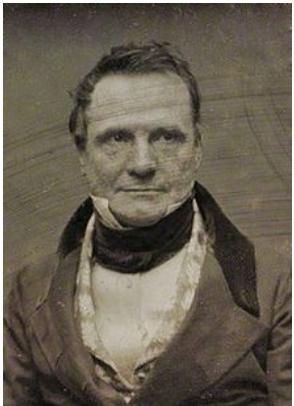


Presented ideas on building mechanical systems which can help in performing complicated computations, quickly.

- Mechanical Difference Engine
- Analytical Engine

# Key Contributors behind Computers

Charles Babbage  
1791-1871



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Ada Lovelace  
1815-1852

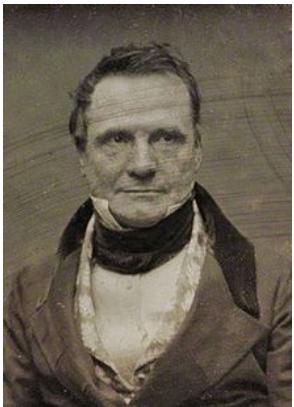


Presented ideas on how an Analytical Engine can do logical things beyond only computing mathematical formulas

- Wrote an algorithm which can be implemented on Analytical Engine

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- Wrote an algorithm which can be implemented on Analytical Engine

Alan Turing  
1912-1954



Formalized concepts of algorithm and computation

- Presented the theory for design of a general-purpose computer

# Computers



**Storage Capacity:** Computers can store vast amounts of data in various forms. From text and numbers to images, videos, and complex datasets, computers offer unparalleled storage capacity.

**Processing Speed:** Computers can execute instructions and process data at incredible speeds, performing complex calculations in fractions of a second.

**Precision and Accuracy:** Computers operate with high precision and accuracy, following instructions meticulously.

**Automation and Repetition:** They can execute the same set of instructions consistently without getting tired or making errors due to fatigue.

**Connectivity and Networking:** Computers can connect to each other through networks, enabling communication and data exchange.



# What is AI?

Some exciting outcomes ...

# Artificial Intelligence?

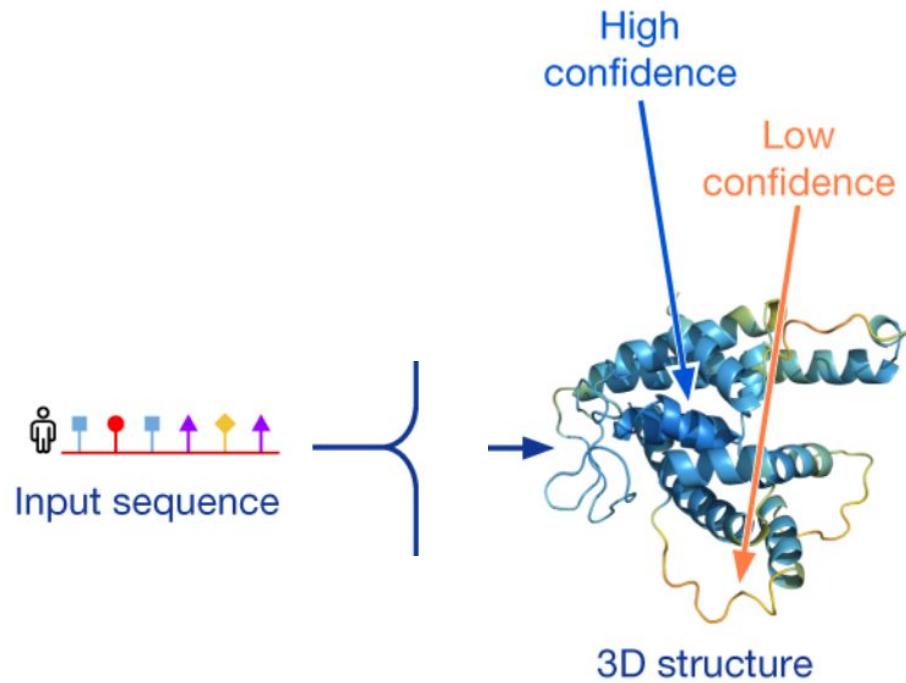


Self-driving vacuum cleaner (2002)



# Artificial Intelligence?

Predicting 3-D structure of proteins  
from their amino acid sequences



Ref: AlphaFold 2

# Artificial Intelligence?

Synthesizing human-like faces

Timeline of images generated by artificial intelligence

These people don't exist. All images were generated by artificial intelligence.

2014



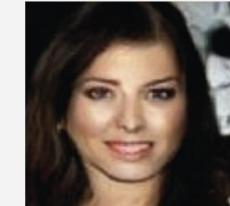
Goodfellow et al. (2014) – Generative Adversarial Networks

2015



Radford, Metz, and Chintala (2015) – Unsupervised Representation Learning with Deep Convolutional GANs

2016



Liu and Tuzel (2016) – Coupled GANs

2017



Karras et al. (2017) – Progressive Growing of GANs for Improved Quality, Stability, and Variation

2018



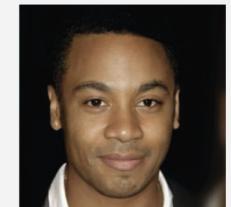
Karras, Laine, and Aila (2018) – A Style-Based Generator Architecture for Generative Adversarial Networks

2019



Karras et al. (2019) – Analyzing and Improving the Image Quality of StyleGAN

2020



Ho, Jain, & Abbeel (2020) – Denoising Diffusion Probabilistic Models

2021



Image generated with the prompt: "a couple of people are sitting on a wood bench"

2022



Saharia et al. (2022) – Photorealistic Text-to-Image Diffusion Models with Deep Language Understanding (Google's Imagen)



# Artificial Intelligence?

Several more interesting accomplishments.

1. Enigma broken with AI (1942)
2. Test for machine intelligence by Alan Turing (1950)
3. The father of AI – John McCarthy (1955)
4. The industrial robot – Unimate (1961)
5. The first chatbot – Eliza (1964)
6. Shakey – the robot (1969)
7. The chatbot ALICE (1995)
8. Man vs Machine – DeepBlue beats chess legend (1997)
9. The emotionally equipped robot – Kismet (1998)
10. The vacuum cleaning robot – Roomba (2002)
11. Voice recognition feature on the iPhone and Siri (2008)
12. The Q/A computer system – IBM Watson (2011)
13. The pioneer of Amazon devices – Alexa (2014)
14. The first robot citizen – Sophia (2016)
15. The first AI music composer – Amper (2017)
16. A revolutionary tool for automated conversations – GPT-3 (2020)





# Artificial Intelligence?

Does it imply each of those problems are solved?

Lets using the Gemini tool to generate some images using text prompt.

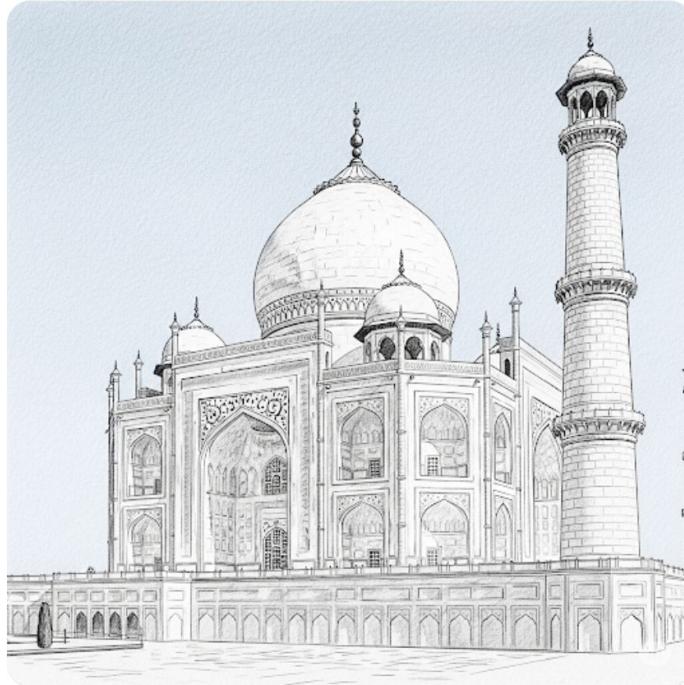
generate a sketch of taj mahal

<https://gemini.google.com/>

It gives a beautiful output!



Sure, here is a sketch of the Taj Mahal:



Lets using the Gemini tool to generate some images using text prompt.

<https://gemini.google.com/>

It gives a beautiful output!

Generate an image of horse riding an elephant

◆ Sure, here is an image of a horse riding an elephant:



Lets using the Gemini tool to generate some images using text prompt.

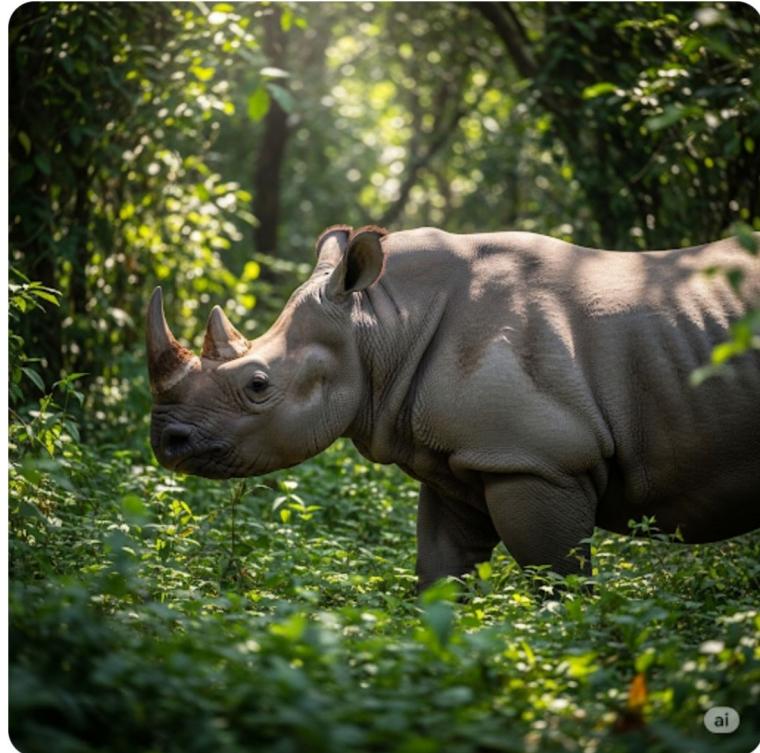
<https://gemini.google.com/>

It gives a beautiful output!

But, with two horns!

generate an image of one horned rhino

Sure, here is an image of a one-horned rhino:





# About this Course

How do we define *learning*?

Was *learning* an evolutionarily essential ability?

What is intelligence?

Can intelligence be modelled?

Pioneers in AI

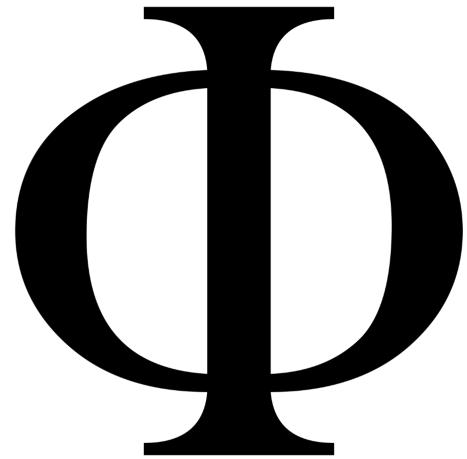
Brain as an inspiration

Sensory Processing and Pattern recognition

Symbolic vs Connectionist Approaches

Modeling learning

More



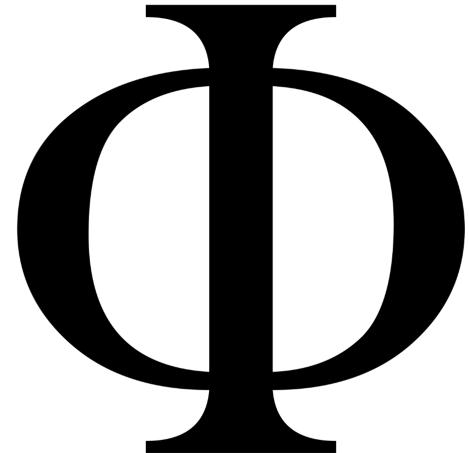
**DA103  
DSAI**





## Syllabus:

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**DA103  
DSAI**





# All the best for the journey ahead!

- Stay healthy
- Organize your time
- Enjoy learning new skills





Welcome aboard — we're here to support and grow with you throughout this journey.

**Thank you**

Neeraj Kumar Sharma and the TAs

