THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

COMP4434 Big Data Analytics

Lecture 1 Introduction to Big Data Analytics

HUANG Xiao
xiaohuang@comp.polyu.edu.hk

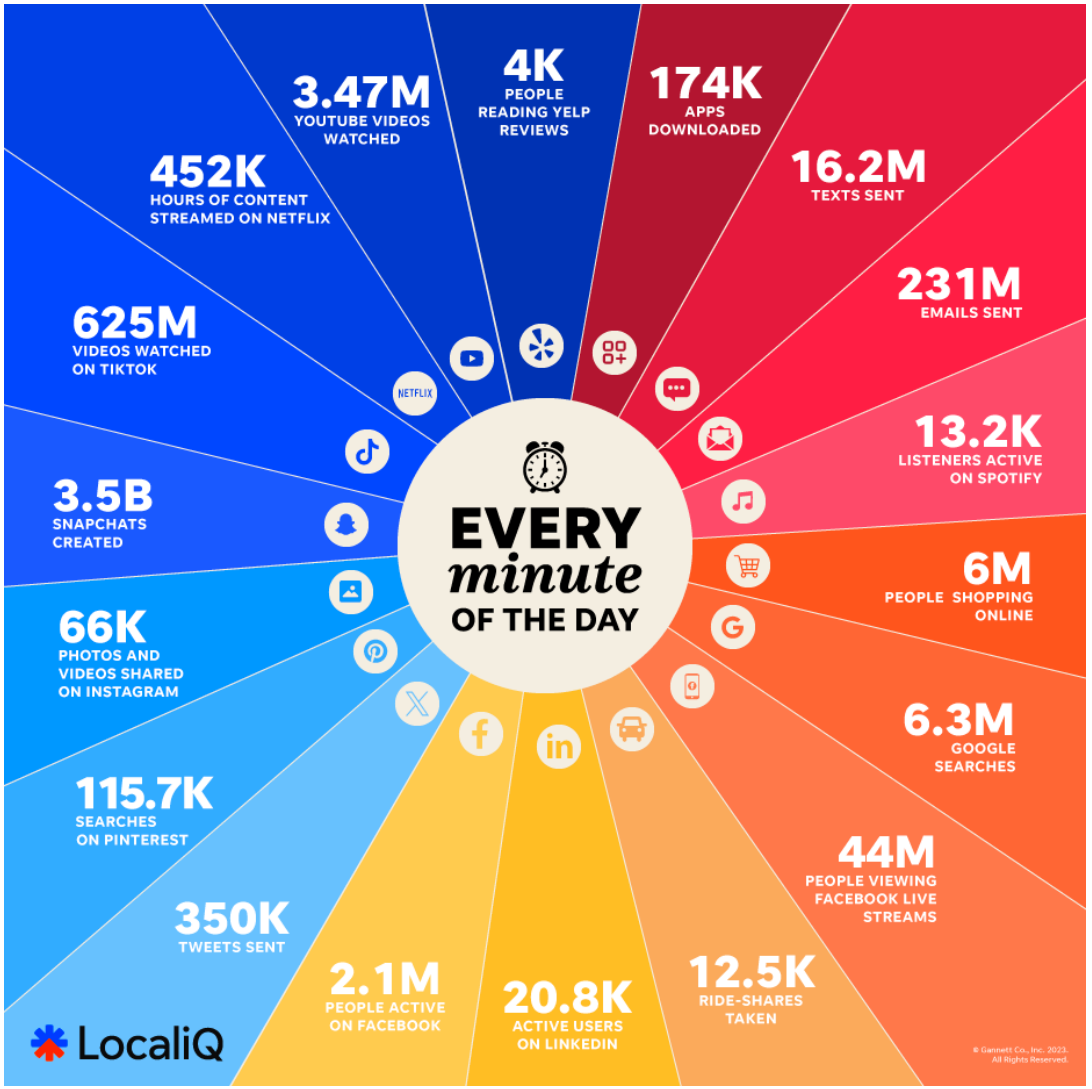
Arrangement

- Prerequisites:
  - Basic statistics, probability, linear algebra
  - Basic Computer Science fundamentals
    - programming (Python)
    - data structures
    - algorithms
    - database systems

- 26 hours Lectures + 13 hours Lab
  - Five lab sessions

What is big data?

- Posts on social media sites
- Purchase transaction records
- Digital pictures and videos
- Software logs
- Microphone & camera recordings
- Cell phone GPS signals
- Sensing data
- Scans of government documents
- Traffic data
- …



Definition of big data

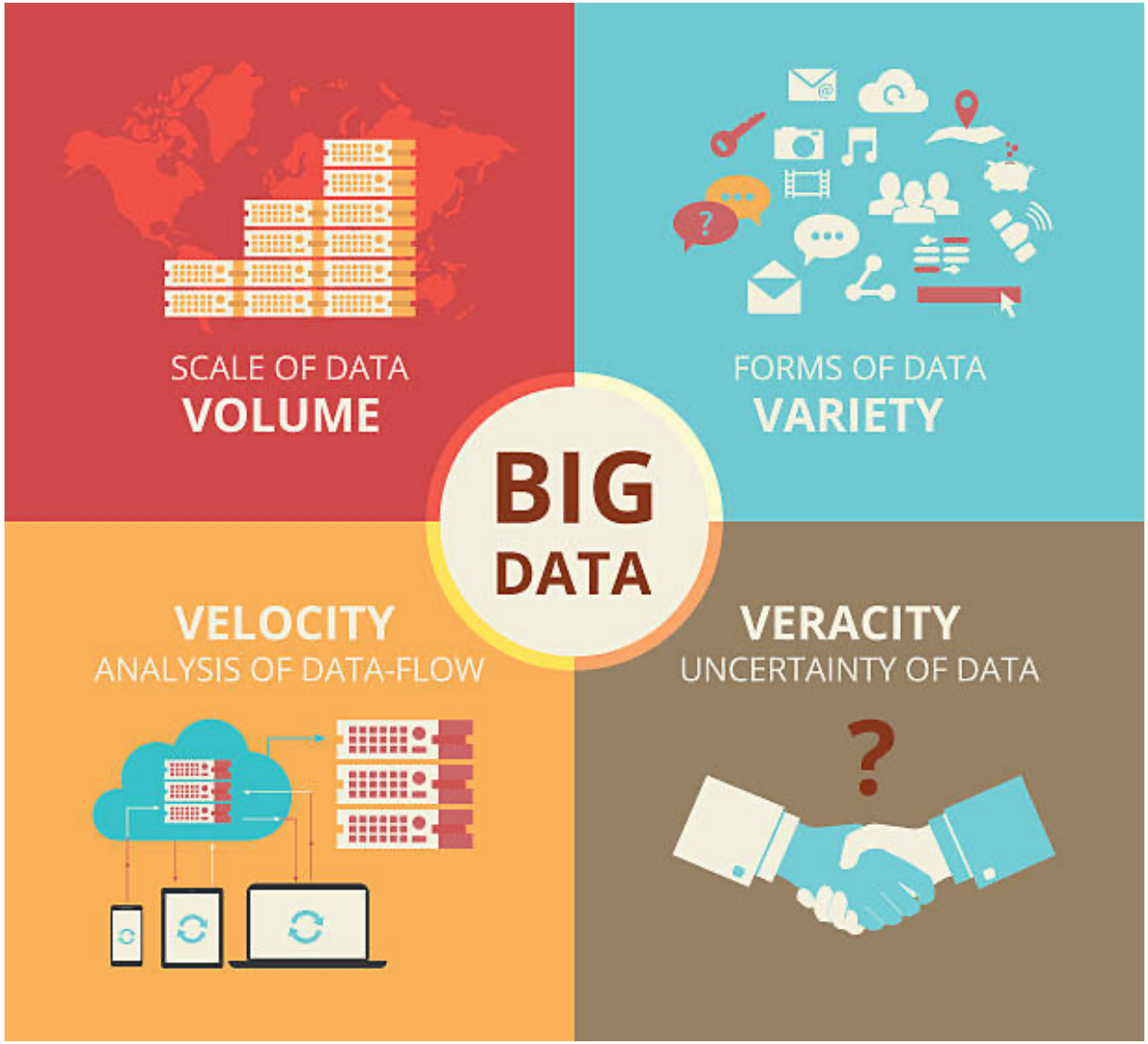
- Definition 1: a combination of structured, semi-structured and unstructured data collected by organizations that can be mined for information and used in machine learning projects, predictive modeling and other advanced analytics applications.

- Definition 2: “Big data is high-**volume**, high-**velocity** and high-**variety** information assets that demand **cost-effective**, **innovative** forms of information processing for **enhanced insight and decision making**.” -- Gartner

- Characteristics of big data (**4V**s)
  - **Volume, Velocity, Variety, Veracity**

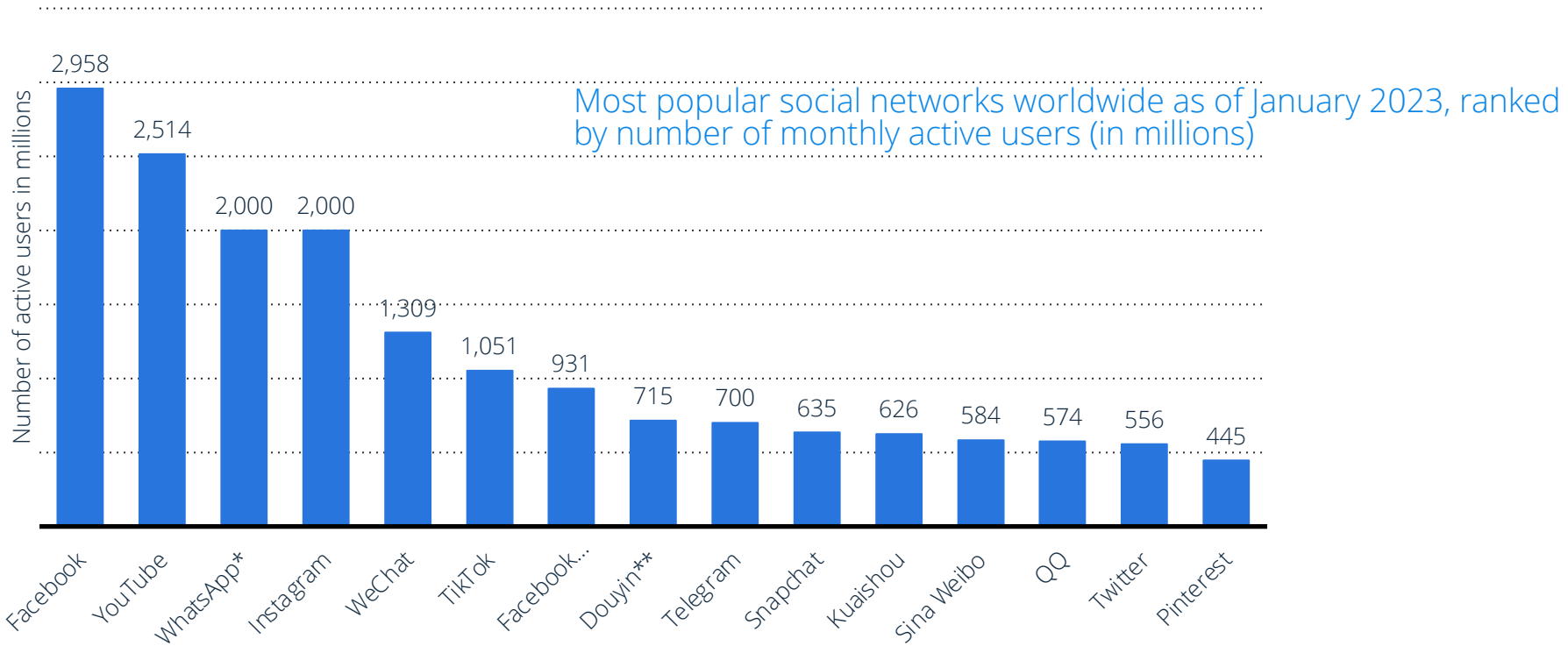
Characteristics of big data (4Vs)

- **Volume, Velocity, Variety, Veracity**



Volume: scale of data

- Data volume is increasing exponentially
- Generated by huge number of devices and sensors
  - The number of smartphone mobile network subscriptions worldwide reached almost 6.4 billion in 2022



Velocity: speed of data generation

- Data is generated fast
- Data need to be processed fast
  - Online Data Analytics: late decisions mean missing opportunities
  - e.g., 1: Based on your current location and your purchase history, send promotions right now for store next to you
  - e.g., 2: Sensors monitoring your activities and body, notify you if there are abnormal measurements

	Amount per minute
Emails sent	231400000
Cryptocurrency purchased (USD)	90200000
Texts sent	16000000
Searches conducted on Google	5900000
Snaps shared on Snapchat	2430000
Pieces of content shared on Facebook	1700000
Swipes on Tinder	1100000
Hours streamed	1000000
USD spent on Amazon	443000
USD sent on Venmo	437600
Tweets shared on Twitter	347200
Hours spent in Zoom meetings	104600
USD spent on DoorDash	76400

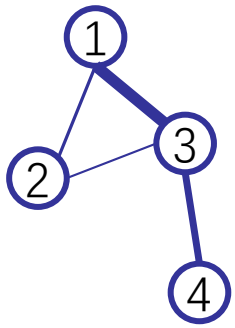
Media usage in an internet minute as of April 2022

Variety: data in many forms

- A single application may generate/collect many types of data, e.g., types of data are stored in emails
  - Tabular data: attributes like subject, to, from
  - Text (in email body)
  - Image (in attachment)
  - Hyperlinks
- Types of data
  - Relational Data (e.g., Tables)
  - Text Data (e.g., comments)
  - Semi-structured Data (e.g., XML)
  - Graph Data (e.g., social network)
  - What else?

Data in Many Forms

John likes to watch movies. Mary likes movies too.



Text

Tuple	x_1
1	John also likes to watch football games.
2	John likes to watch movies. Mary likes movies too.

Signal (Voice, Audio)

signal1	signal2
13.58	7.24
12.11	12.50
13.49	8.66
11.25	10.98
14.57	13.75
13.22	9.02

Image

125	200	225
105	150	255
15	75	175

Graph

A	1	2	3	4
1	0	1.2	4.3	0
2	1.2	0	0.8	0
3	4.3	0.8	0	2.6
4	0	0	2.6	0

E	Node1	Node2	Weight
1	1	2	1.2
2	1	3	4.3
3	2	3	0.8
4	3	4	2.6

Veracity: uncertainty of data

- Is the data accurate?
  - Measurement error
  - Human errors like typos in names/addresses
- Does the data come from a reliable source?
- What if data from different sources are not consistent?

Lumia 650 Case, CoverON [HexaGuard Series] Slim Hybrid Hard Phone Cover Case for Microsoft Lumia 650 - Black & Black

Visit the CoverON Store

5 ratings

Currently unavailable.

We don't know when or if this item will be back in stock.

Color: **Black & Black**

Material	Silicone, Rubber, Polycarbonate
Brand	CoverON
Color	Black & Black
Compatible Phone Models	Microsoft Lumia 650

About this item

- CoverON [HexaGuard Series] protective hard hybrid case for the Microsoft Lumia 650
- Hard polycarbonate outer layer combined with a soft flexible rubber silicone inner layer
- Enhanced "basketball" grip on the back
- Shock absorbing and protective yet thin and lightweight
- 90 day manufacturer warranty

Roll over image to zoom in

Fake, Paid-For Reviews in Amazon

This case is really good, it looks very nice and doesn't add bulk ...

By [redacted] on January 16, 2016

Color: Black & Black

The case is lightweight and slick. This case is really good, it looks very nice and doesn't add bulk or excessive size to my phone.It is so easy to get in and out of my pocket and the color is nice. It fits snuggly and provides good protection. It's so pretty and it seems durable. I receive this product to give honest review.

2 comments | 0 of 8 people found this helpful. Was this review helpful to you? Yes No Report abuse

It protects well and feels good on my phone

By [redacted] on January 20, 2016

Color: Black & Black

This case fits my phone well and is very durable. It protects well and feels good on my phone. I received this for free for doing this review.

2 comments | 0 of 8 people found this helpful. Was this review helpful to you? Yes No Report abuse

Full phone protection.

By [redacted] on January 17, 2016

Color: Black & Black

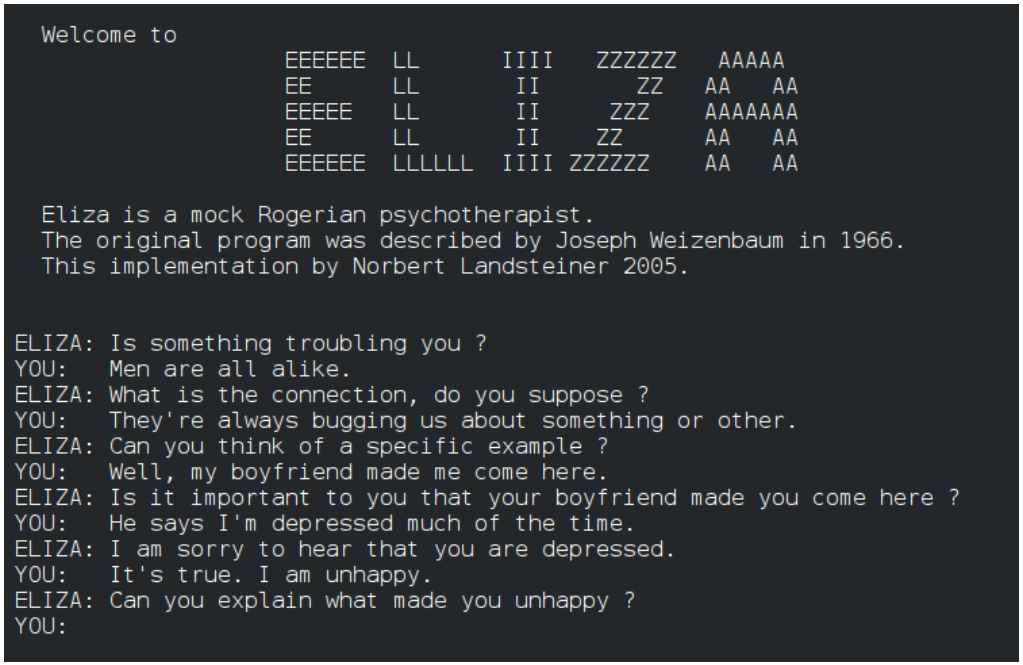
I receive this case yesterday and give this CoverON HexaGuard series hybrid case for the Microsoft Lumia 650 for a family member. This case really protects the phone and this case is an excellent choice for those who want the protection of a 2-layer hybrid case, however it does add some bulkiness to the phone. The tittle said its slim, but for me it's a little thick but to whom I've given it to, he said it's great. This case has a flexible rubber silicone skin as inner shell with thicker extra padding on the corners. Then a tough polycarbonate outer shell. I got this at a discounted price.

Applications of big data in AI

- Artificial Intelligence: the theory and development of computer systems able to perform tasks normally requiring human intelligence

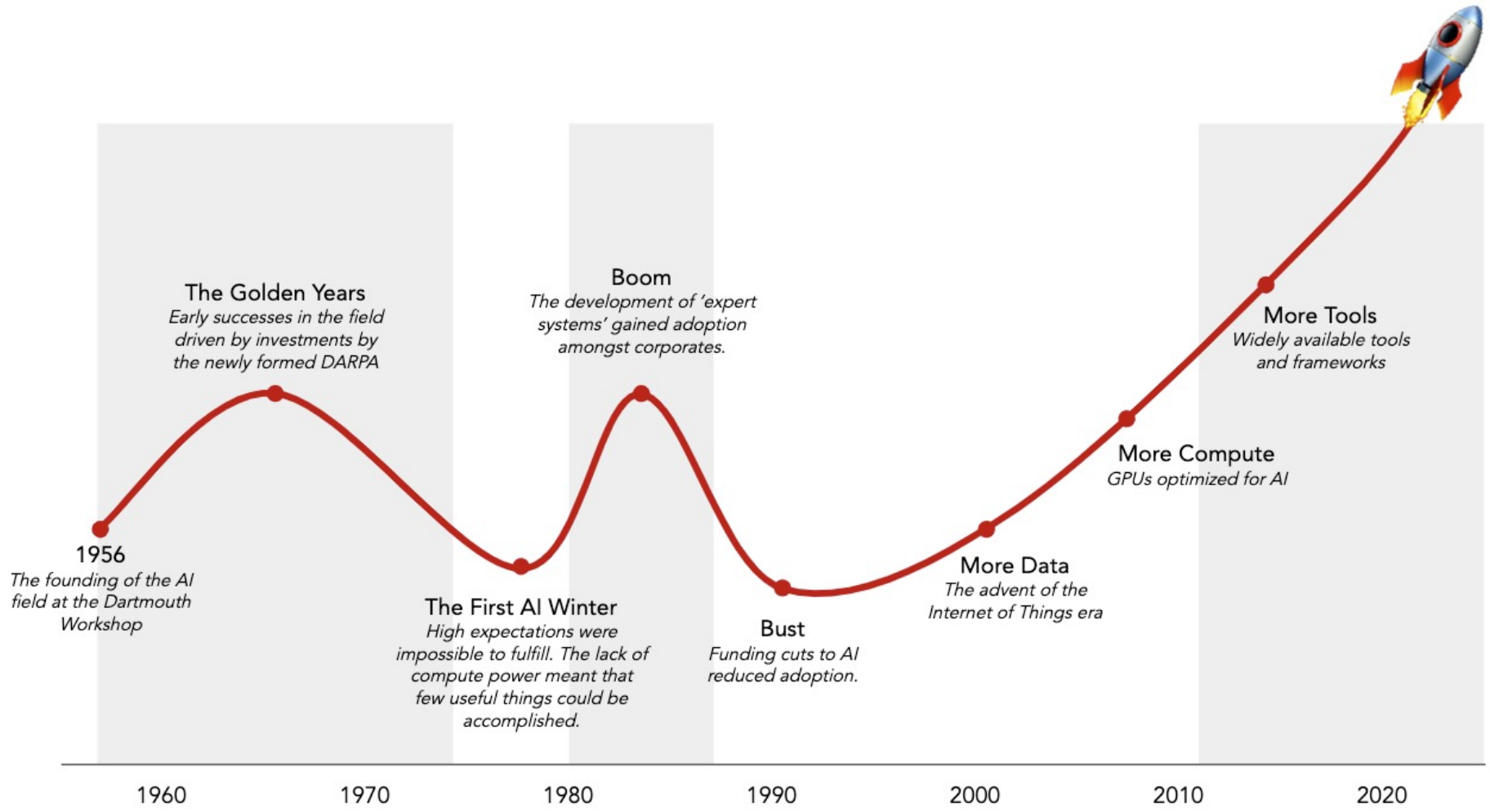
- Before the Age of “big data”

- ELIZA is an early natural language processing computer program created from 1964 to 1967 at MIT
- On May 11, 1997, an IBM computer called IBM Deep Blue beat the world chess champion after a six-game match

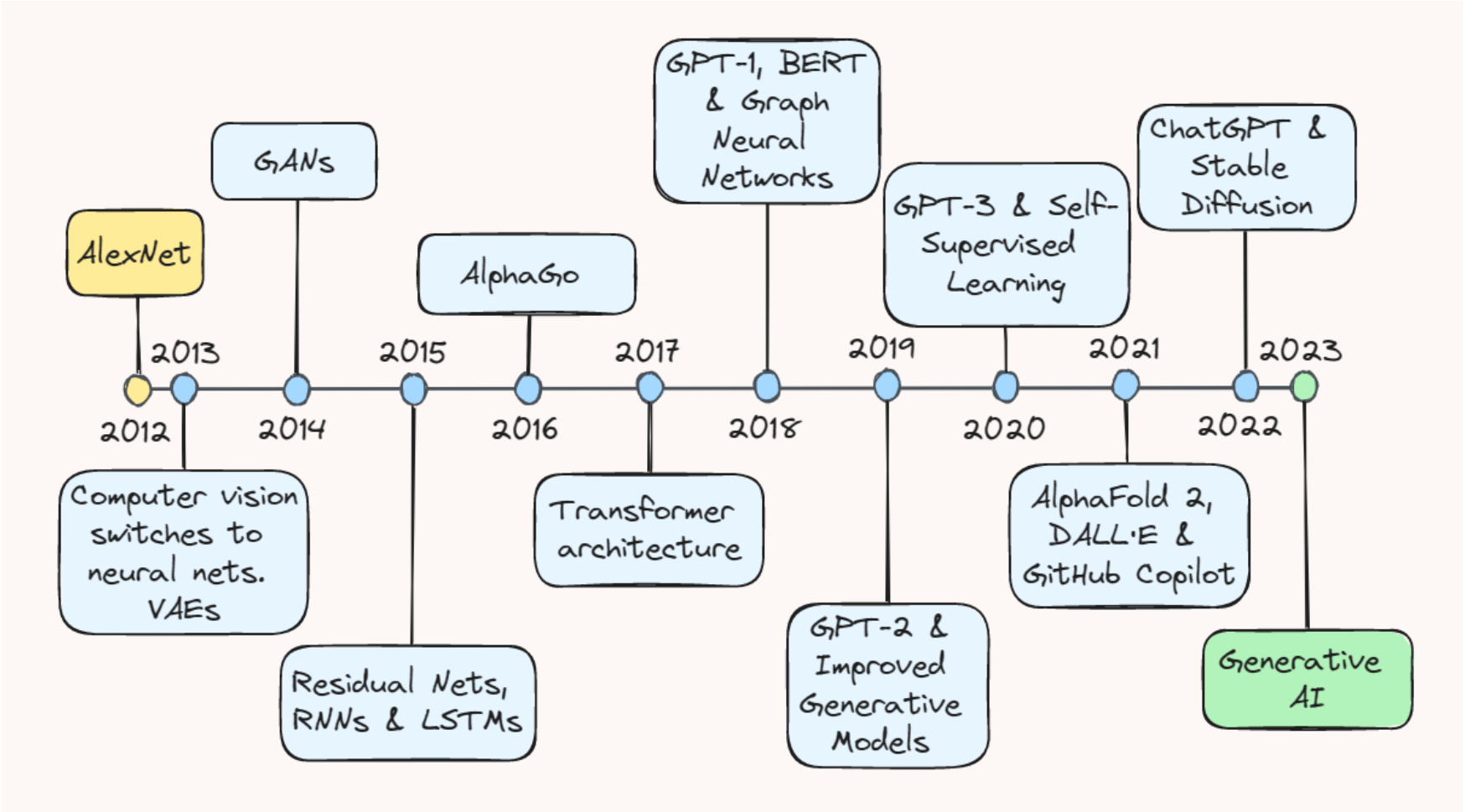


- Big data has changed AI: “AI Would Be Nothing Without Big Data”
  - “Data is the new oil”

Big data and the development of AI



Recent breakthroughs in AI



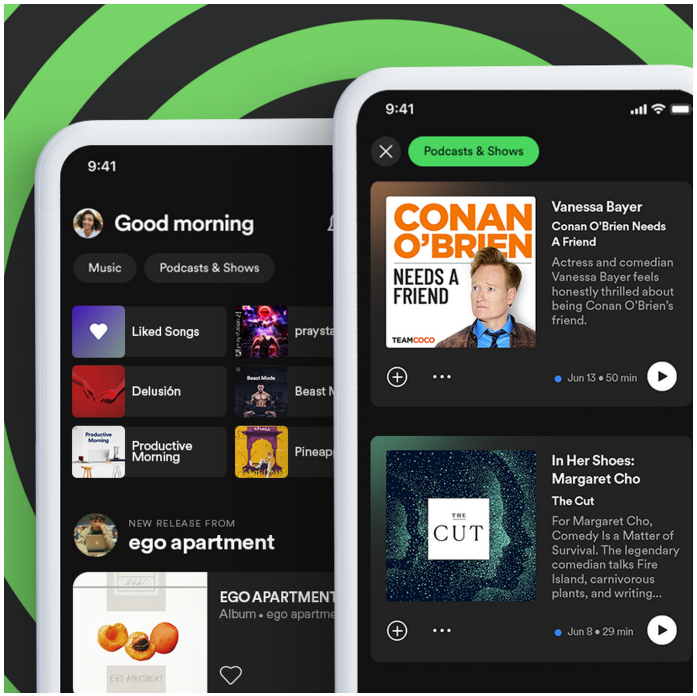
- At the 2017 Future of Go Summit, the Master version of AlphaGo beat Ke Jie, the number one ranked player in the world at the time, in a three-game match, after which AlphaGo was awarded professional 9-dan by the Chinese Weiqi Association

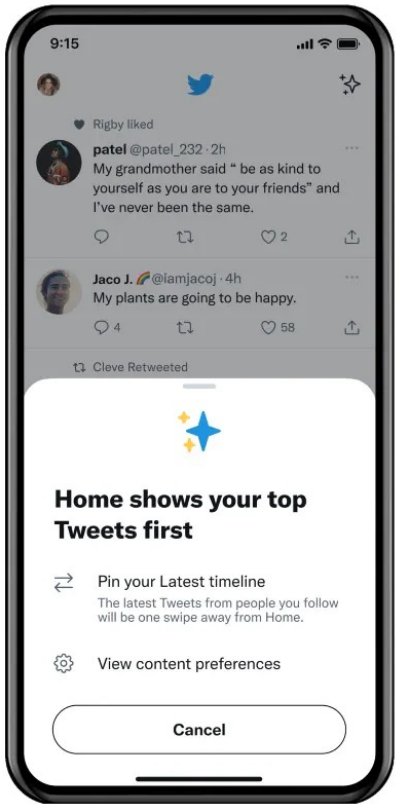
Application 1: Recommender system

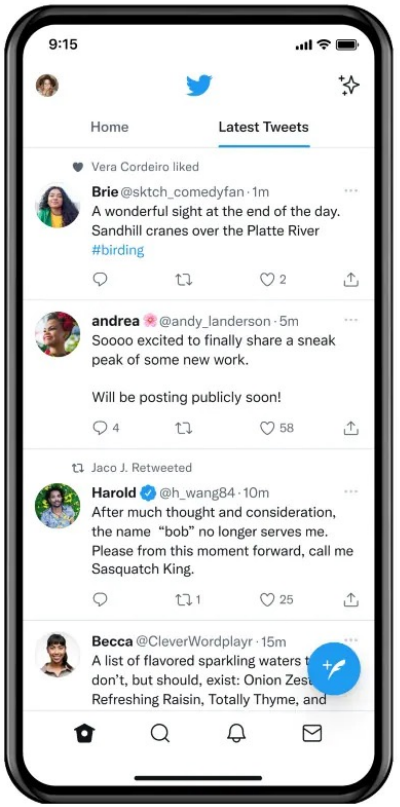
- Recommendation
  - Ex: Amazon, YouTube, Netflix, ……
  - What item for what people?
  - How to improve users' satisfaction?

Application: Recommender system

- More recommender systems:
  - News feed
  - Music feed
  - Twitter feed

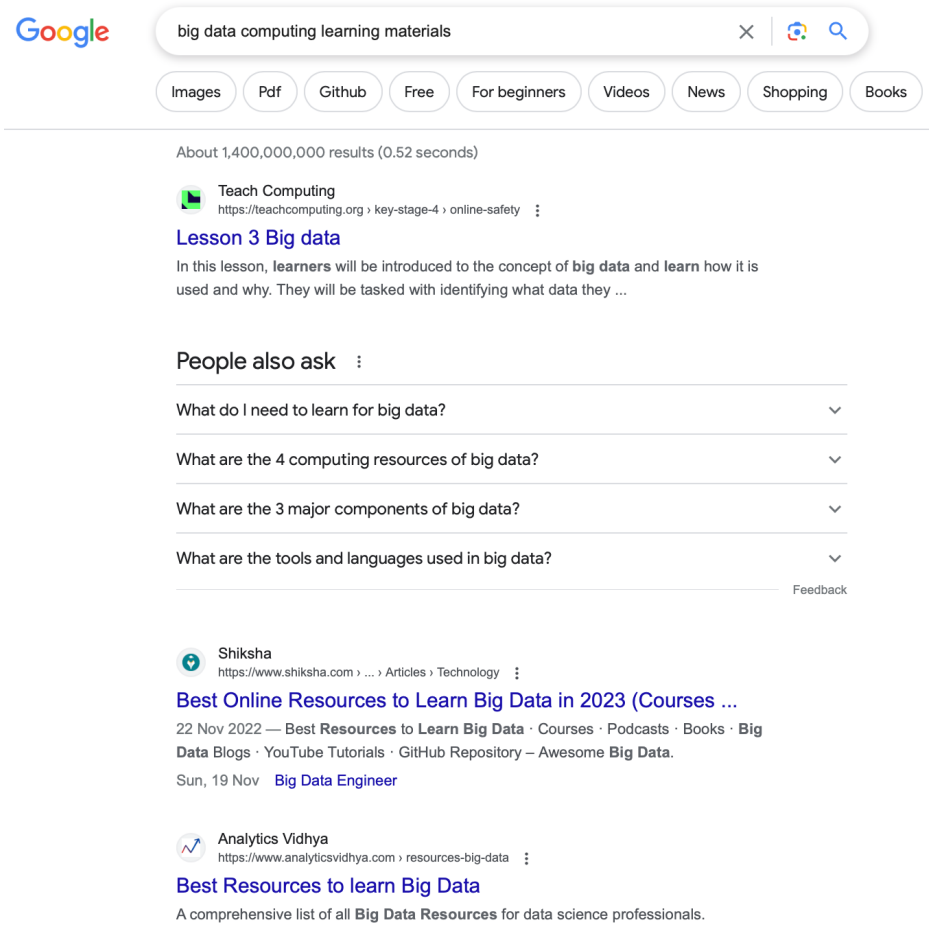






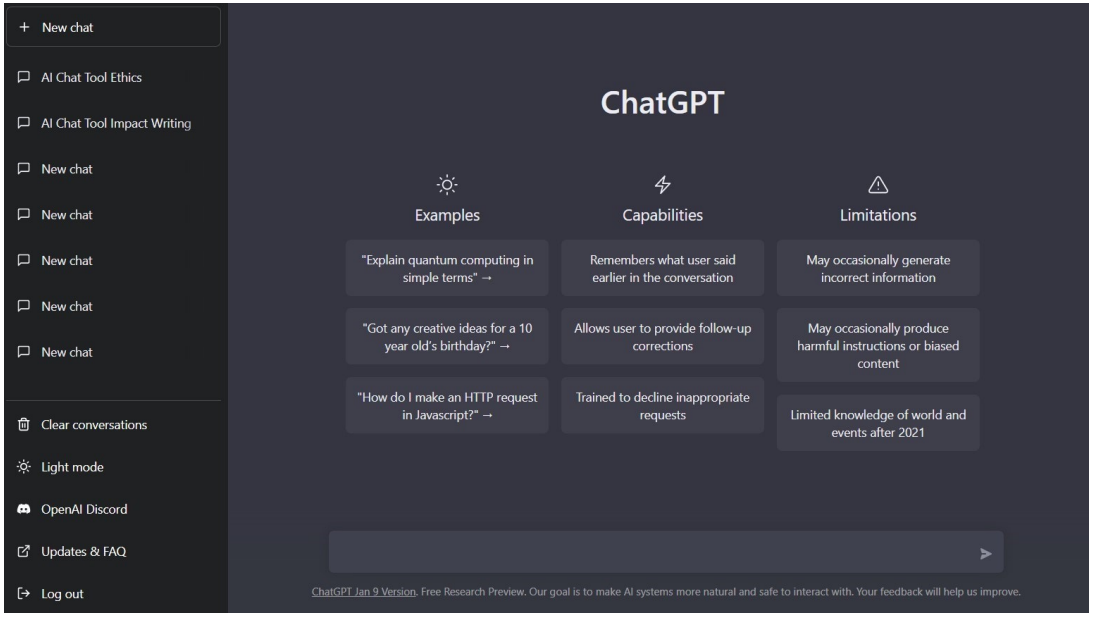
Application: Web search

- Web search
- Image search
- Virtual assistant
- High-frequency trading



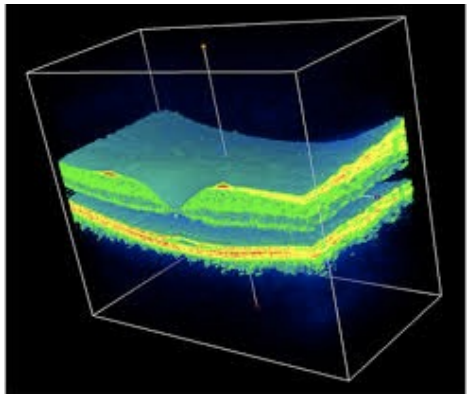
Application: Chatbot (e.g., ChatGPT)

- Write essays:
  https://youtu.be/oLjZva6JvLI
- Programming:
  https://youtu.be/TIDA6pvjEE0
  https://youtu.be/B3yuK2XHmvM
- Conversation:
  https://youtu.be/GYeJC31JcM0



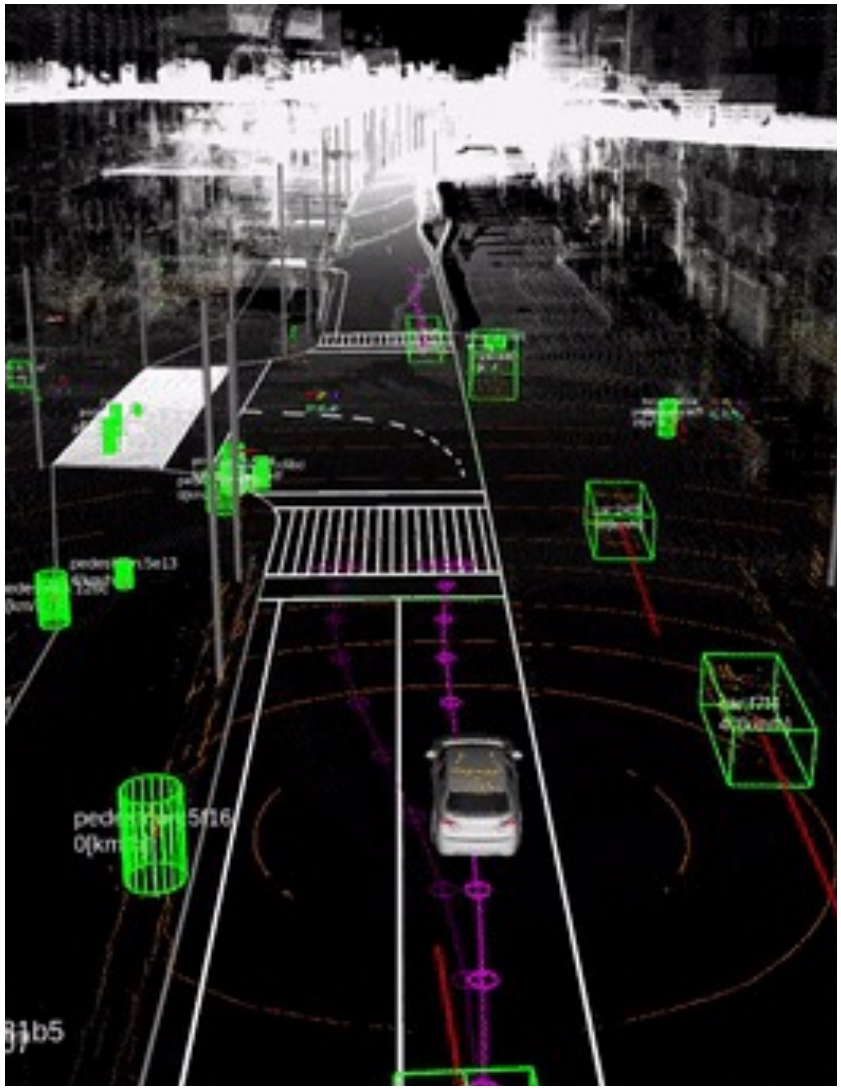
Application: Disease treatment

- Disease Treatment: Joint research between Google DeepMind and Moorfields Eye Hospital
  - Eyecare professionals diagnose eye conditions by using optical coherence tomography (OCT) scans (over 1,000 a day at Moorfields alone)
  - Achieving expert error rate 5.5% comparably to the two best retina specialists (6.7% and 6.8% error rate)

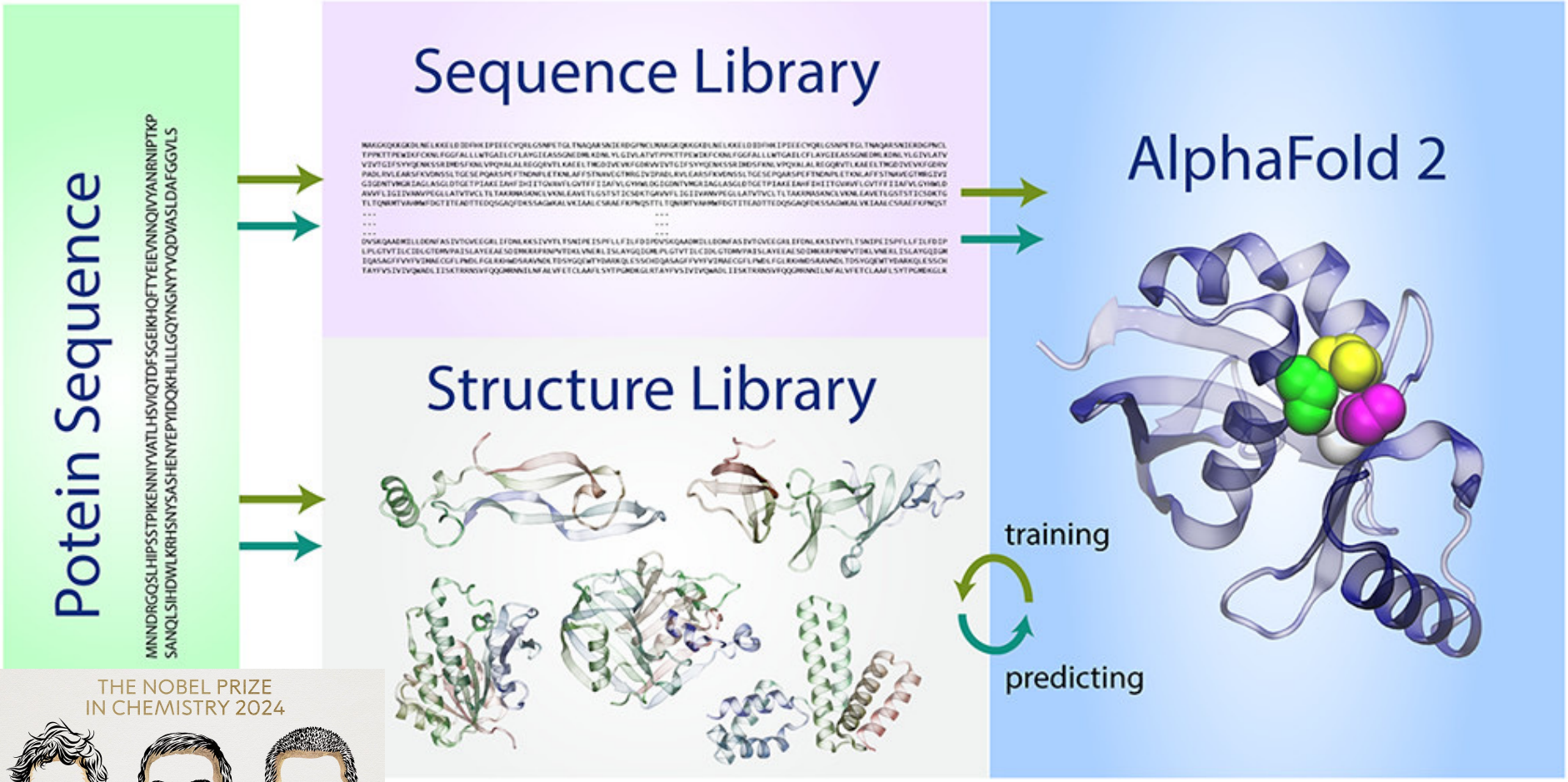


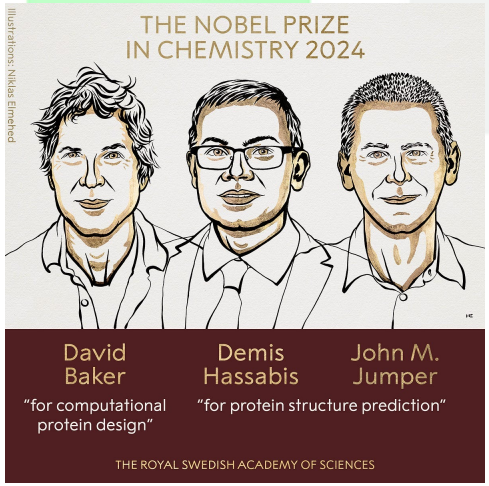
Application: Autonomous driving

- https://www.notateslaapp.com/news/1579/musk-live-steams-fsd-v12-and-it-s-too-human-why-that-s-a-problem-video



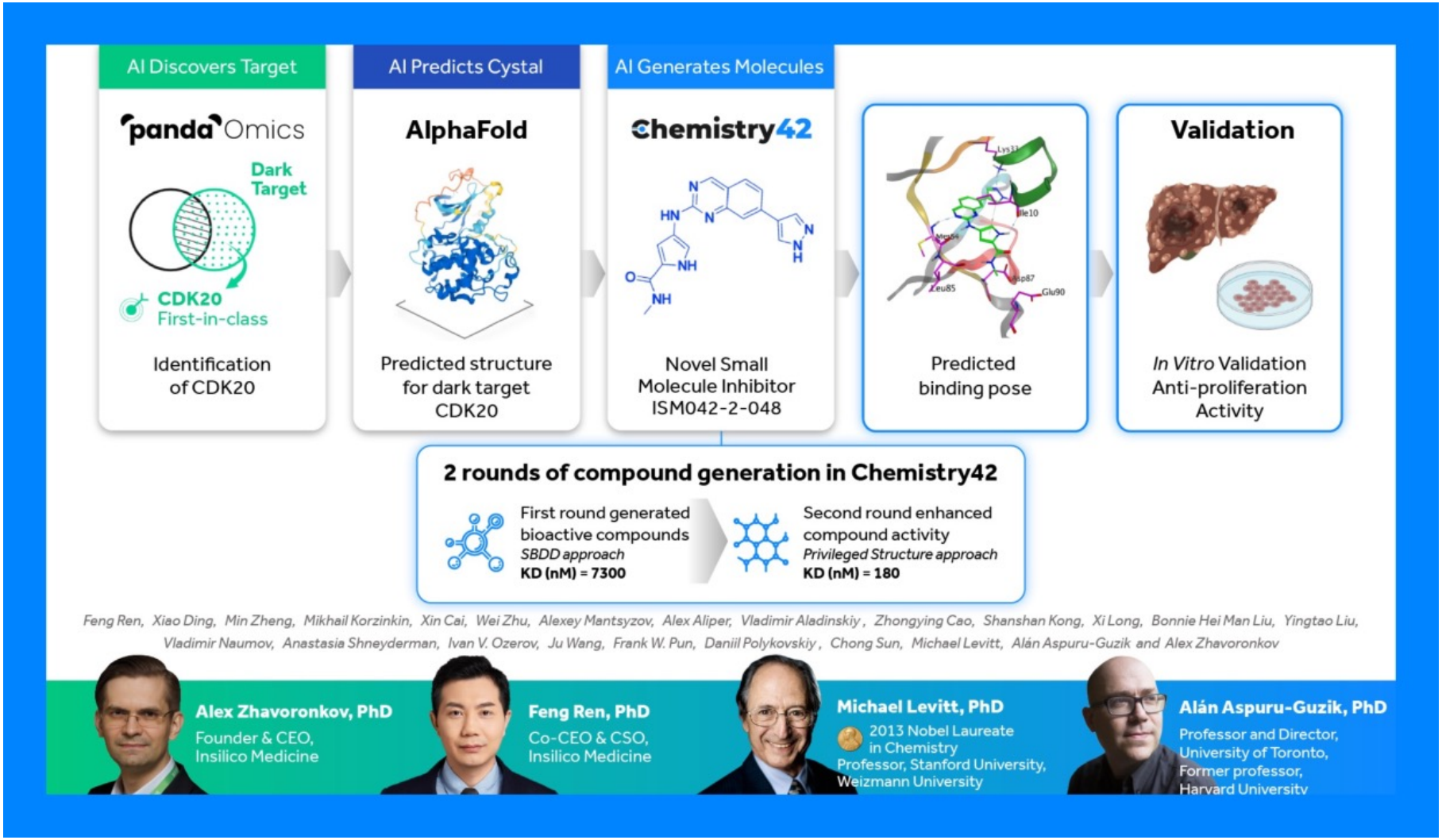
Application: Drug design (e.g., AlphaFold)



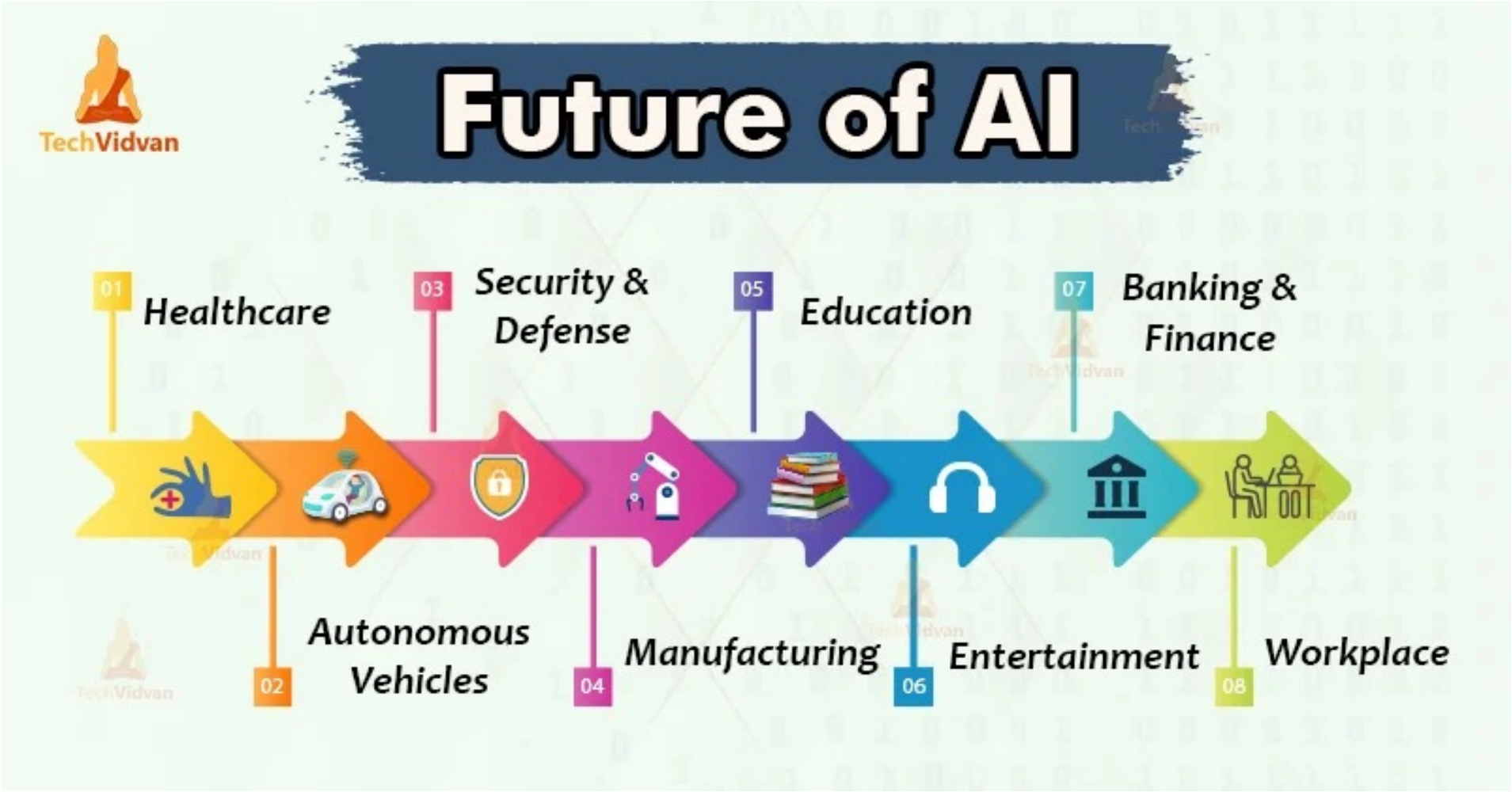


- A solution to a 50-year-old grand challenge in biology

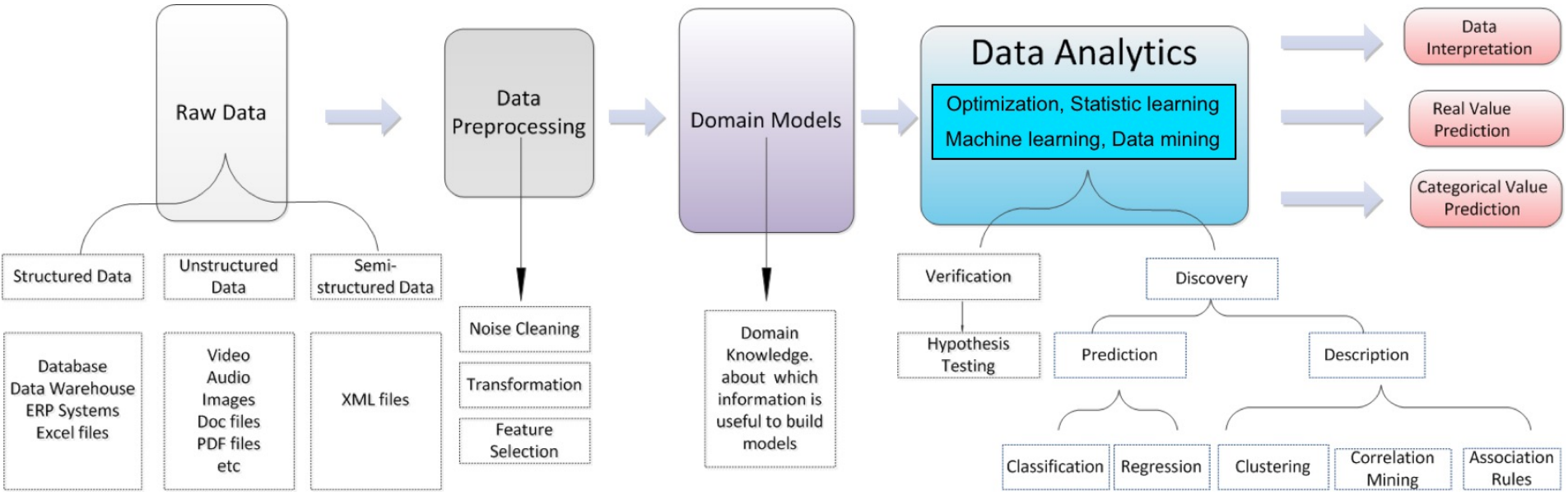
An example in drug design

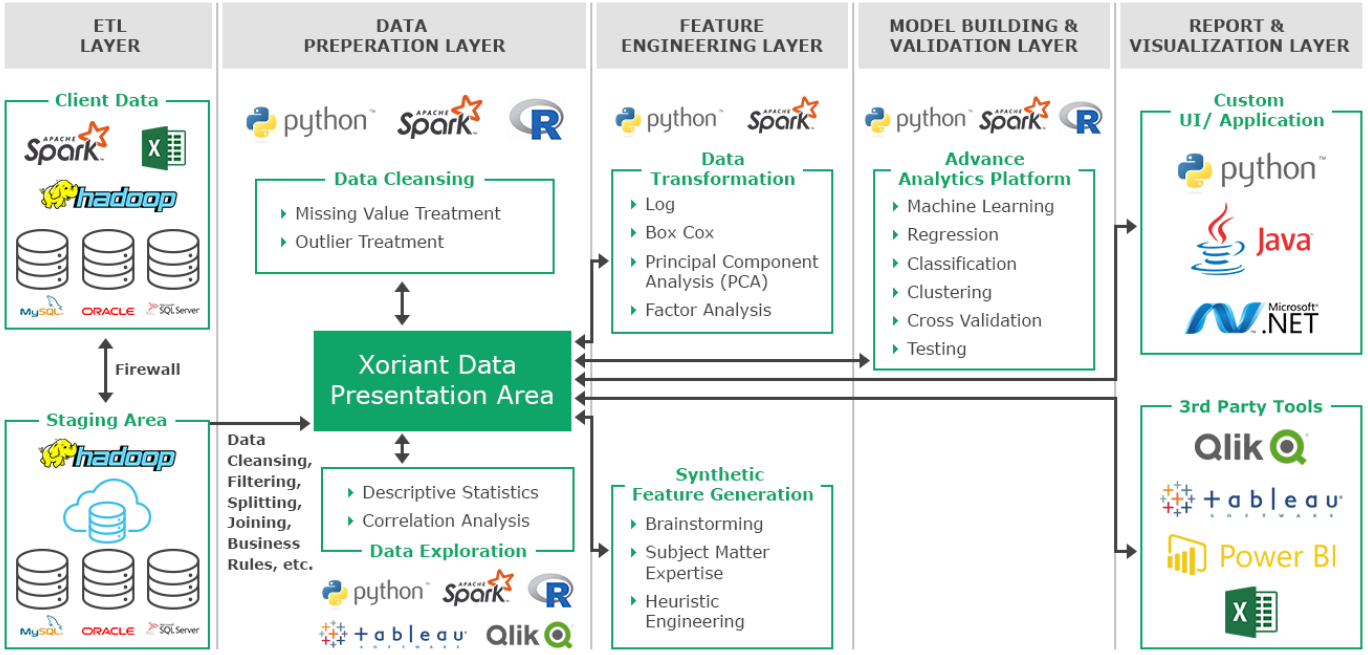


We can do more

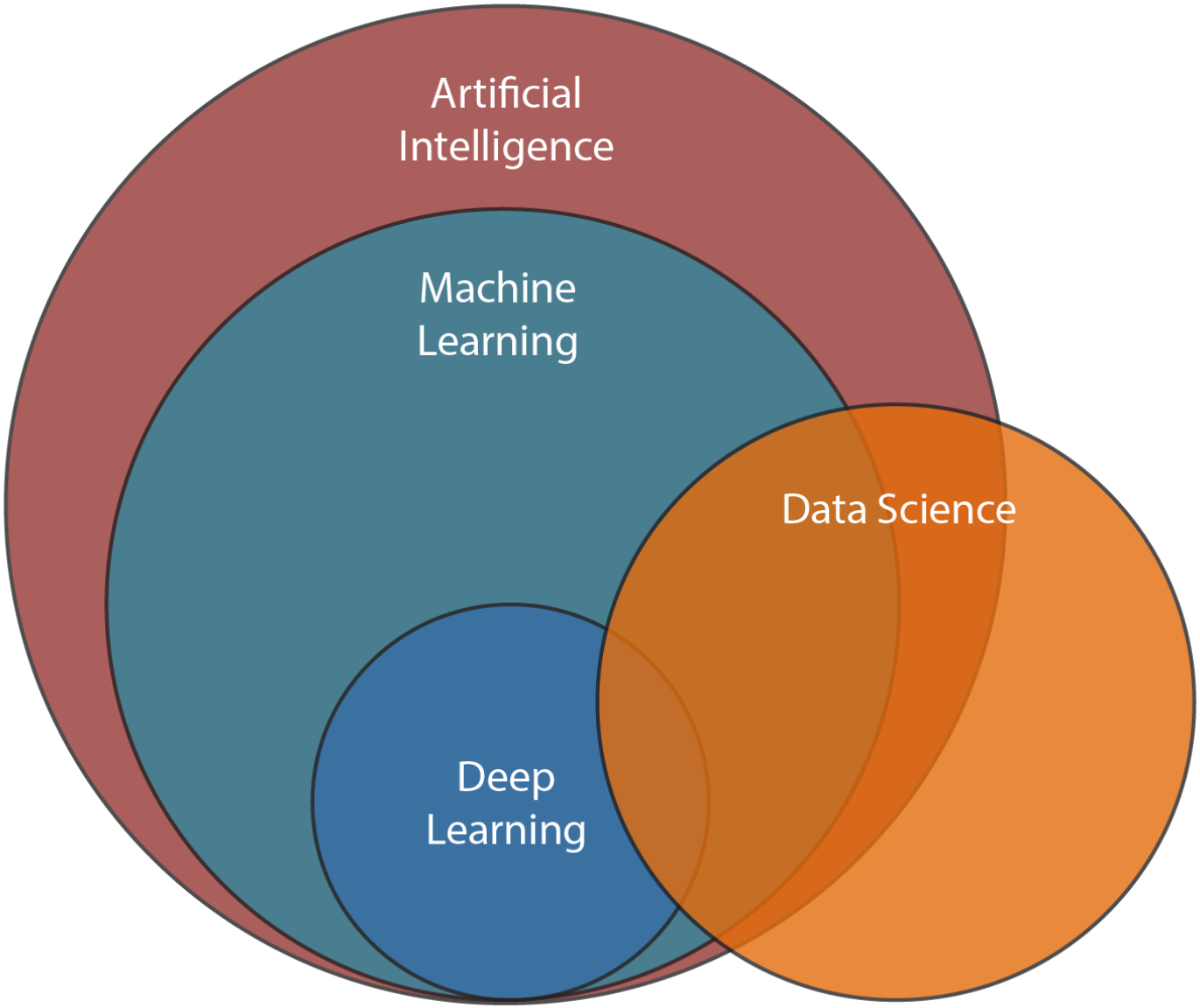


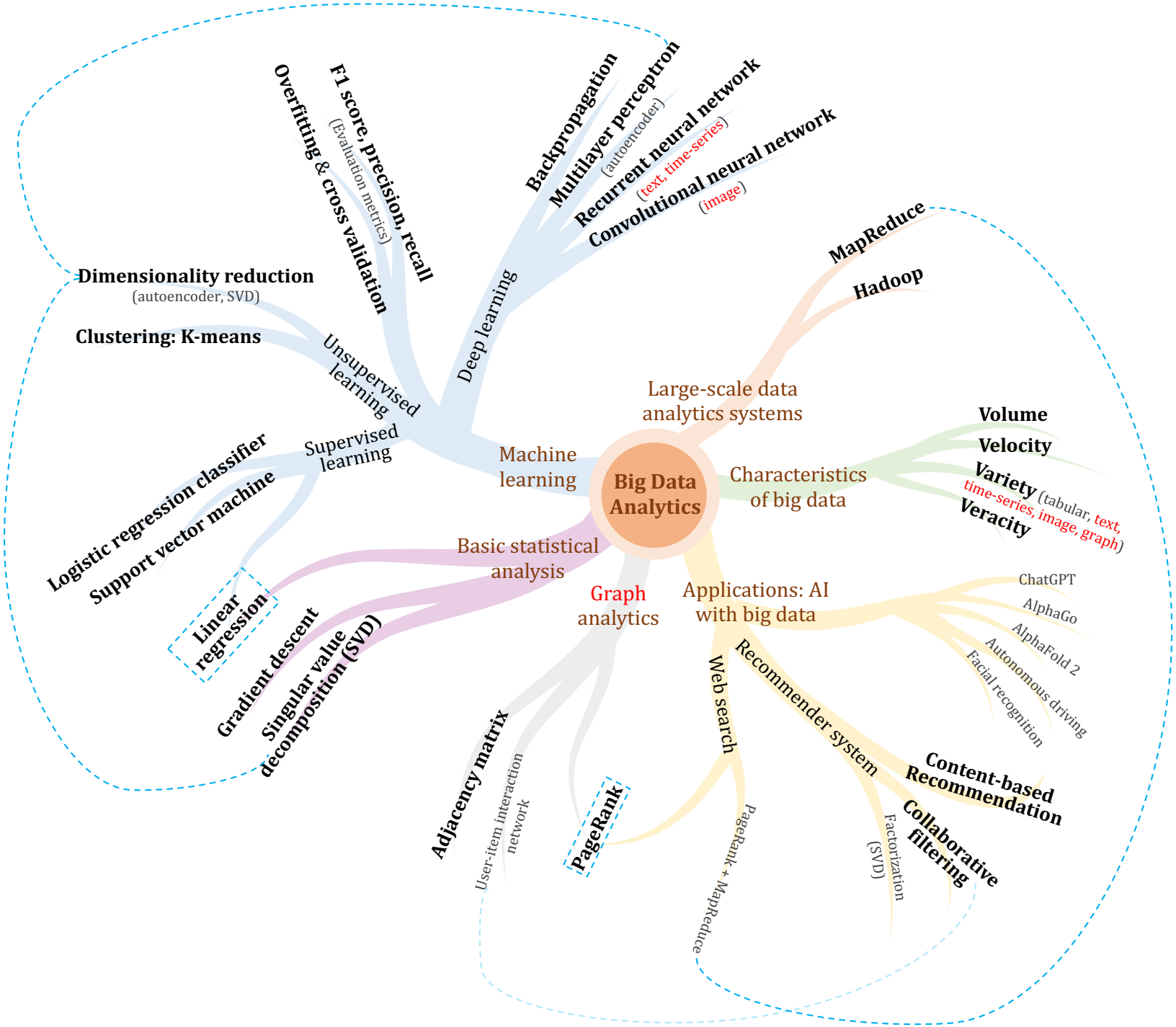
Big Data Analysis Procedure





Relations among big data analytics and AI




Big Data Analytics
Machine learning
Deep learning
Backpropagation
Multilayer perceptron
(autoencoder)
Recurrent neural network
(text, time-series)
Convolutional neural network
(image)
Overfitting & cross validation
F1 score, precision, recall
(Evaluation metrics)
Unsupervised learning
Dimensionality reduction
(autoencoder, SVD)
Clustering: K-means
Supervised learning
Logistic regression classifier
Support vector machine
Linear regression
Basic statistical analysis
Gradient descent
Singular value decomposition (SVD)
Large-scale data analytics systems
MapReduce
Hadoop
Characteristics of big data
Volume
Velocity
Variety (tabular, text, time-series, image, graph)
Veracity
Graph analytics
Adjacency matrix
User-item interaction network
PageRank
Applications: AI with big data
Web search
PageRank + MapReduce
Recommender system
Content-based Recommendation
Collaborative filtering
Factorization (SVD)
ChatGPT
AlphaGo
AlphaFold 2
Autonomous driving
Facial recognition