Indian Institute of Technology, Guwahati

Mehta School Of Data Science And Artificial Intelligence

Data Science: From Ancient India to Large Language Models

NSMADAI-2023, Guwahati

Dr. Chiranjib Sur

Assistant Professor

Mehta Family School of Data Science and Artificial Intelligence

Dec 2023

West's First Data Scientist

Florence Nightingale

113 languages

Article Talk | Read View source View history Tools

From Wikipedia, the free encyclopedia

"The Lady with the Lamp" redirects here. For the 1951 film, see The Lady with a Lamp. For other uses, see Florence Nightingale (disambiguation).

Florence Nightingale OM RRC DStJ (/ˈnaɪtɪŋɡeɪl/; 12 May 1820 – 13 August 1910) was an English social reformer, statistician and the founder of modern nursing. Nightingale came to prominence while serving as a manager and trainer of nurses during the Crimean War, in which she organised care for wounded soldiers at Constantinople.[4] She significantly reduced death rates by improving hygiene and living standards. Nightingale gave nursing a favourable reputation and became an icon of Victorian culture, especially in the persona of "The Lady with the Lamp" making rounds of wounded soldiers at night.[5][6]

Recent commentators have asserted that Nightingale's Crimean War achievements were exaggerated by the media at the time, but critics agree on the importance of her later work in professionalising nursing roles for women.[7] In 1860, she laid the foundation of professional nursing with the establishment of her nursing school at St Thomas' Hospital in London. It was the first secular nursing school in the world and is now part of King's College London.[8] In recognition of her pioneering work in nursing, the Nightingale Pledge taken by new nurses, and the Florence Nightingale Medal, the highest international distinction a nurse can achieve, were named in her honour, and the annual International Nurses Day is celebrated on her birthday. Her social reforms included improving healthcare for all sections of British society, advocating better hunger relief in India, helping to abolish prostitution laws that were harsh for women, and expanding the acceptable forms of female participation in the workforce.

Nightingale was a pioneer in statistics; she represented her analysis in graphical forms to ease drawing conclusions and actionables from data. She is famous for usage of the polar area diagram, also called the Nightingale rose diagram, equivalent to a modern circular histogram. This diagram is still regularly used in data visualisation.

Nightingale was a prodigious and versatile writer. In her lifetime, much of her published work was concerned with spreading medical knowledge. Some of her tracts were written in simple English so that they could easily be understood by those with poor literary skills. She was also a pioneer in data visualisation with the use of infographics, using graphical presentations of statistical data in an effective way.[7] Much of her writing, including her extensive work on religion and mysticism, has only been published posthumously.

Florence Nightingale
OM RRC DStJ

Nightingale, c. 1860

Born	12 May 1820 Florence, Grand Duchy of Tuscany
Died	13 August 1910 (aged 90) Mayfair, London, England
Nationality	British
Known for	Pioneering modern nursing Polar area diagram
Awards	Royal Red Cross (1883) Lady of Grace of the Order of St John (LGStJ) (1904) Order of Merit (1907)

Reality

People also ask

When did Harvard became coed?

In 1946, Harvard's classes became co-ed, though Harvard faculty members were responsible for the academic training of Radcliffe students, and played no part in their social or extracurricular involvements. Then-Radcliffe president Mary I. 27 May 2019

The Harvard Crimson
https://www.thecrimson.com › article › harvard-radclif...

When Harvard Met Radcliffe | News

1969

November 1968

The Yale Corporation secretly votes in favor of full coeducation, or accepting women into Yale College, in the fall of 1969. On November 4th, Coeducation week commences. 750 women from 22 colleges arrive on campus.

Yale University
https://celebratewomen.yale.edu › history › timeline-wo...

A Timeline of Women at Yale - 50WomenAtYale150 |

People also ask

Is Oxford University coed?

Most of Oxford's graduate colleges were founded as coeducational establishn 20th century, with the exception of St Antony's, which was founded as a men's 1950 and began to accept women only in 1962.

Wikipedia
https://en.wikipedia.org › wiki › University_of_Oxford

University of Oxford - Wikipedia

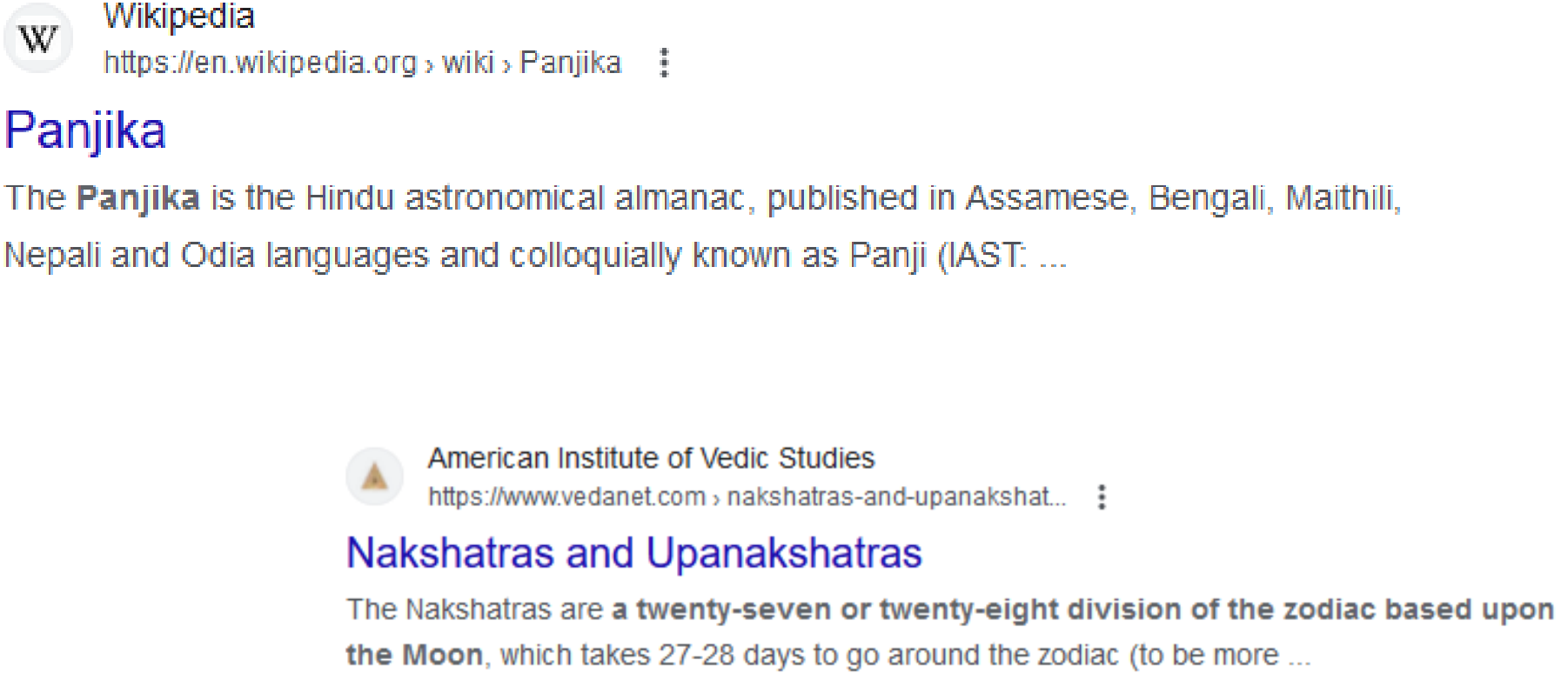
Search for: Is Oxford University coed?

Women were first admitted in 1947, and the university was racia integrated in 1958. Notable alumni include physicist John V. Ata developer of the electronic digital computer), Olympic swimm Caulkins, and Nobel laureate biochemist Marshall Nirenberg.

Britannica
https://www.britannica.com › ... › Education

University of Florida | Gainesville, Gators, SEC - Britannica

Data Science in Ancient India



Data Science in Ancient India

- Panjika
  - Patterns and Astronomical Calculations
  - Shubh Days and a-Shubh Days
  - Birth Characteristics and their influence in other years.
  - Defines Life Cycle.
- Nakshatra
  - Human Nature
  - Human Drawbacks
  - Human Compatibility

Corporate Training
Corporate Activities
Corporate Interview

Chinese Zodiac

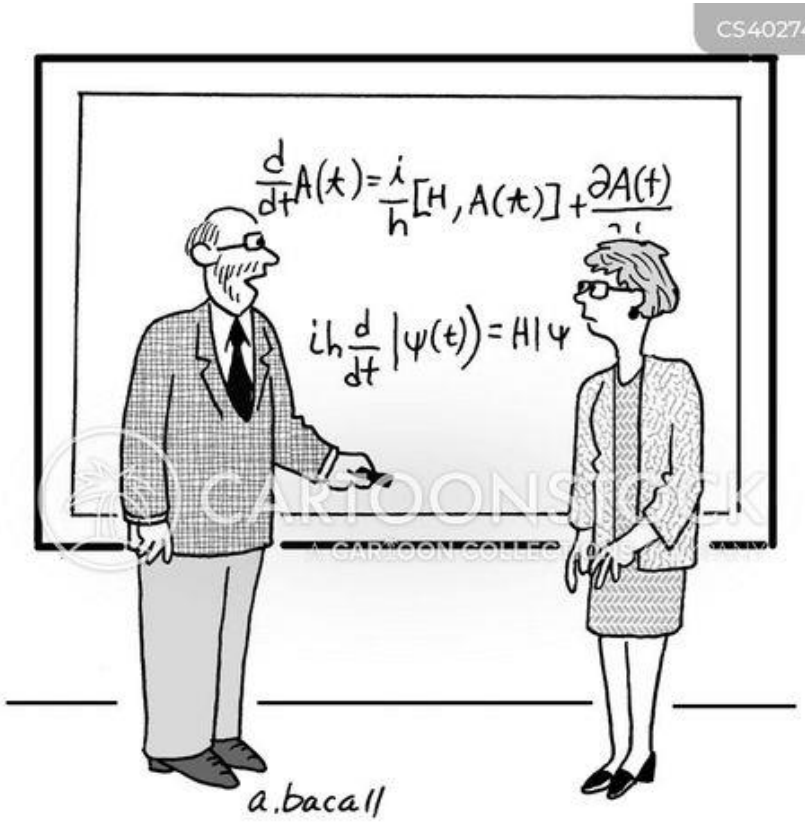
RAT	1924	1936	1948	1960	1972	1984	1996	2008
OX	1925	1937	1949	1961	1973	1985	1997	2009
TIGER	1926	1938	1950	1962	1974	1986	1998	2010
RABBIT	1927	1939	1951	1963	1975	1987	1999	2011
DRAGON	1928	1940	1952	1964	1976	1988	2000	2012
SNAKE	1929	1941	1953	1965	1977	1989	2001	2013
HORSE	1930	1942	1954	1966	1978	1990	2002	2014
SHEEP	1931	1943	1955	1967	1979	1991	2003	2015
MONKEY	1932	1944	1956	1968	1980	1992	2004	2016
ROOSTER	1933	1945	1957	1969	1981	1993	2005	2017
DOG	1934	1946	1958	1970	1982	1994	2006	2018
PIG	1935	1947	1959	1971	1983	1995	2007	2019

Data Science in Ancient India

- Years of Observations by Group of People
  - Nalanda
  - Vikramashila
  - etc
- Years of Validation
- Knowledge for society
- Documentation
  - Books
  - Transferable Contents for People

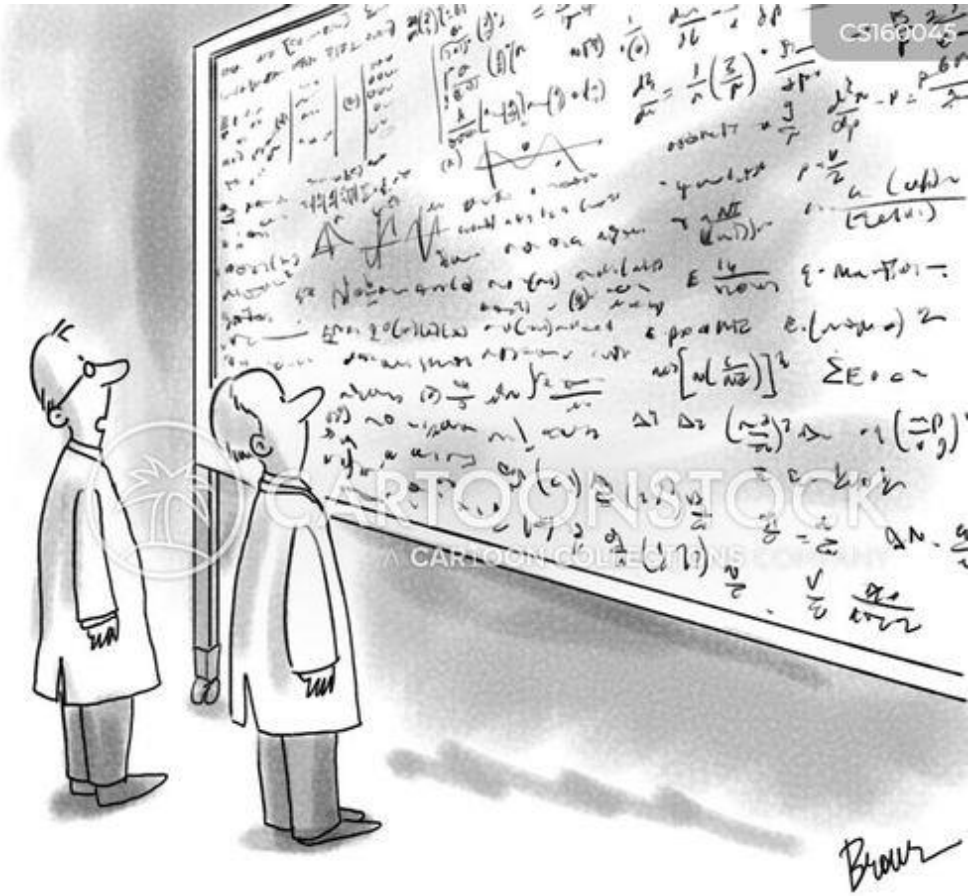
Vaccination In Ancient India

Role of Mathematicians



"I can understand Heisenberg's equation and Schrodinger's equation for quantum mechanics but I cannot understand derivative trading."

now that we have excellent mathematical proof, we need a problem to apply it.



Role of Mathematicians

Data Assumption: $y_i \in \mathbb{R}$

Model Assumption: $y_i = \mathbf{w}^\top \mathbf{x}_i + \epsilon_i$ where $\epsilon_i \sim N(0, \sigma^2)$

$$\Rightarrow y_i|\mathbf{x}_i \sim N(\mathbf{w}^\top \mathbf{x}_i, \sigma^2) \Rightarrow P(y_i|\mathbf{x}_i, \mathbf{w}) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(\mathbf{x}_i^\top \mathbf{w} - y_i)^2}{2\sigma^2}}$$

Closed Form: $\mathbf{w} = (\mathbf{X}\mathbf{X}^\top)^{-1}\mathbf{X}\mathbf{y}^\top$ where $\mathbf{X} = [\mathbf{x}_1, \ldots, \mathbf{x}_n]$ and $\mathbf{y} = [y_1, \ldots, y_n]$.

Regularization

$\mathbf{w} = (\bar{\mathbf{X}}\mathbf{X}^\top + \lambda\mathbf{I})^{-1}\mathbf{X}\mathbf{y}^\top$, where $\bar{\mathbf{X}} = [\mathbf{x}_1, \ldots, \mathbf{x}_n]$ and $\mathbf{y} = [y_1, \ldots, y_n]$.

Role of Mathematicians

Data Assumption: $y_i \in \mathbb{R}$

Model Assumption: $y_i = \mathbf{w}^\top \mathbf{x}_i + \epsilon_i$ where $\epsilon_i \sim N(0, \sigma^2)$

$$\Rightarrow y_i|\mathbf{x}_i \sim N(\mathbf{w}^\top \mathbf{x}_i, \sigma^2) \Rightarrow P(y_i|\mathbf{x}_i, \mathbf{w}) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(\mathbf{x}_i^\top \mathbf{w} - y_i)^2}{2\sigma^2}}$$

Closed Form: $\mathbf{w} = (\mathbf{X}\mathbf{X}^\top)^{-1}\mathbf{X}\mathbf{y}^\top$ where $\mathbf{X} = [\mathbf{x}_1, \ldots, \mathbf{x}_n]$ and $\mathbf{y} = [y_1, \ldots, y_n]$.

Regularization

$\mathbf{w} = (\bar{\mathbf{X}}\mathbf{X}^\top + \lambda\mathbf{I})^{-1}\mathbf{X}\mathbf{y}^\top$, where $\bar{\mathbf{X}} = [\mathbf{x}_1, \ldots, \mathbf{x}_n]$ and $\mathbf{y} = [y_1, \ldots, y_n]$.

Gradient Descent Methods

We are minimizing a *loss function*, $l(\mathbf{w}) = \frac{1}{n}\sum_{i=1}^{n}(\mathbf{x}_i^\top \mathbf{w} - y_i)^2$.

Expectation Maximization (EM)

Gaussian Mixture Models

Initialize

$$\theta_x = \{\Sigma_1, \Sigma_2, \Sigma_3, \mu_1, \mu_2, \mu_3\}$$

$$\theta_z = \{\pi_1, \pi_2, \pi_3\}$$

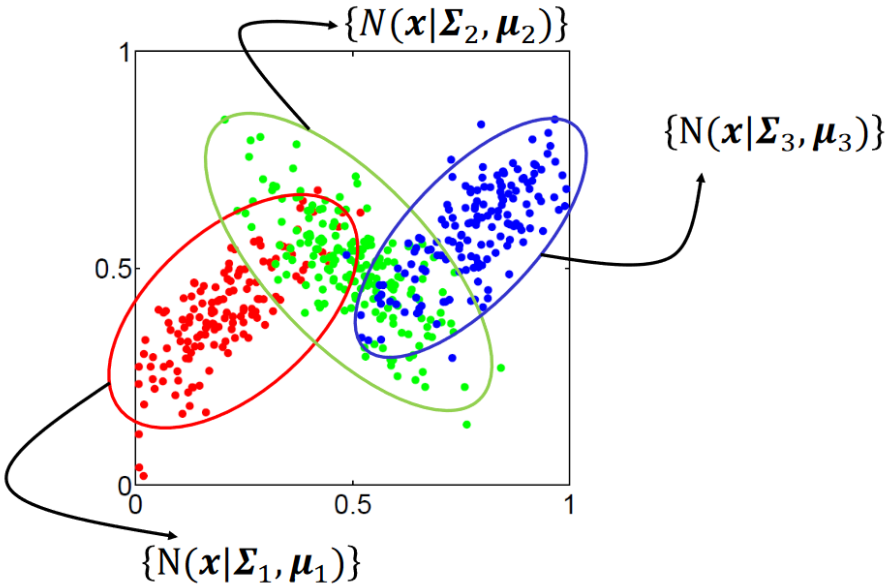
Expectation Step: $$\gamma(z_{nk}) = \frac{\pi_k N(\boldsymbol{x}_n|\boldsymbol{\mu}_k, \boldsymbol{\Sigma}_k)}{\sum_{l=1}^{3} \pi_l N(\boldsymbol{x}_n|\boldsymbol{\mu}_l, \boldsymbol{\Sigma}_l)}$$

Maximization Step: $$\pi_\kappa = \frac{\sum_{n=1}^{N} \gamma(z_{nk})}{N} \quad \mu_\kappa = \frac{\sum_{n=1}^{N} \gamma(z_{nk}) x_n}{\sum_{n=1}^{N} \gamma(z_{nk})}$$

$$\Sigma_k = \frac{\sum_{n=1}^{N} \gamma(z_{nk})(\boldsymbol{x}_n - \boldsymbol{\mu}_\kappa)(\boldsymbol{x}_n - \boldsymbol{\mu}_\kappa)^{\mathrm{T}}}{\sum_{n=1}^{N} \gamma(z_{nk})}$$

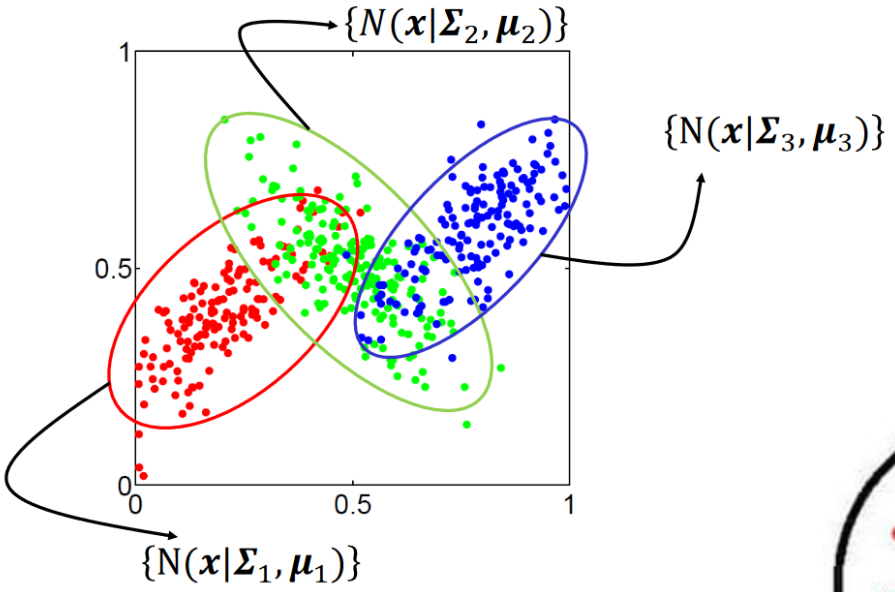
Expectation Maximization (EM)

Gaussian Mixture Models

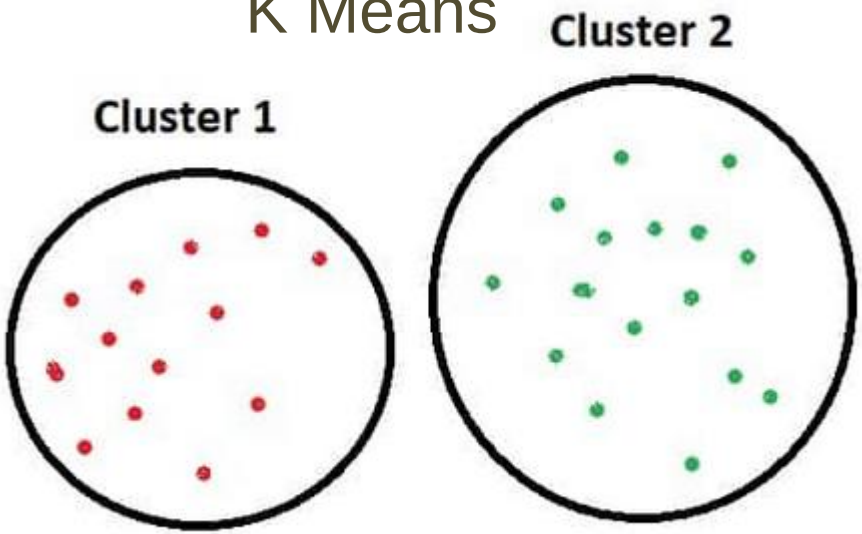


Expectation Maximization (EM) – K Means

Gaussian Mixture Models



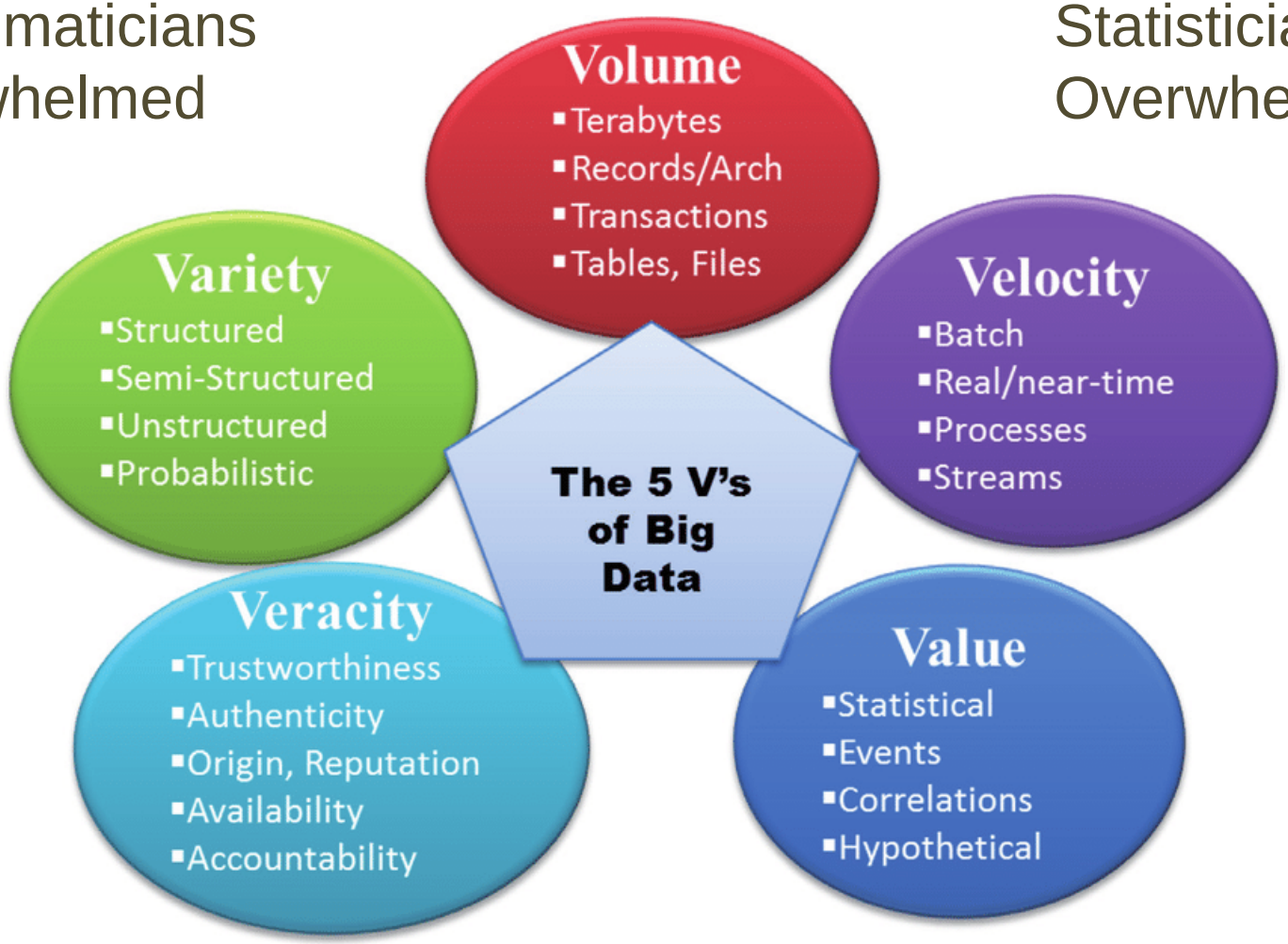
K Means



Era of Computation and Data

Mathematicians Overwhelmed

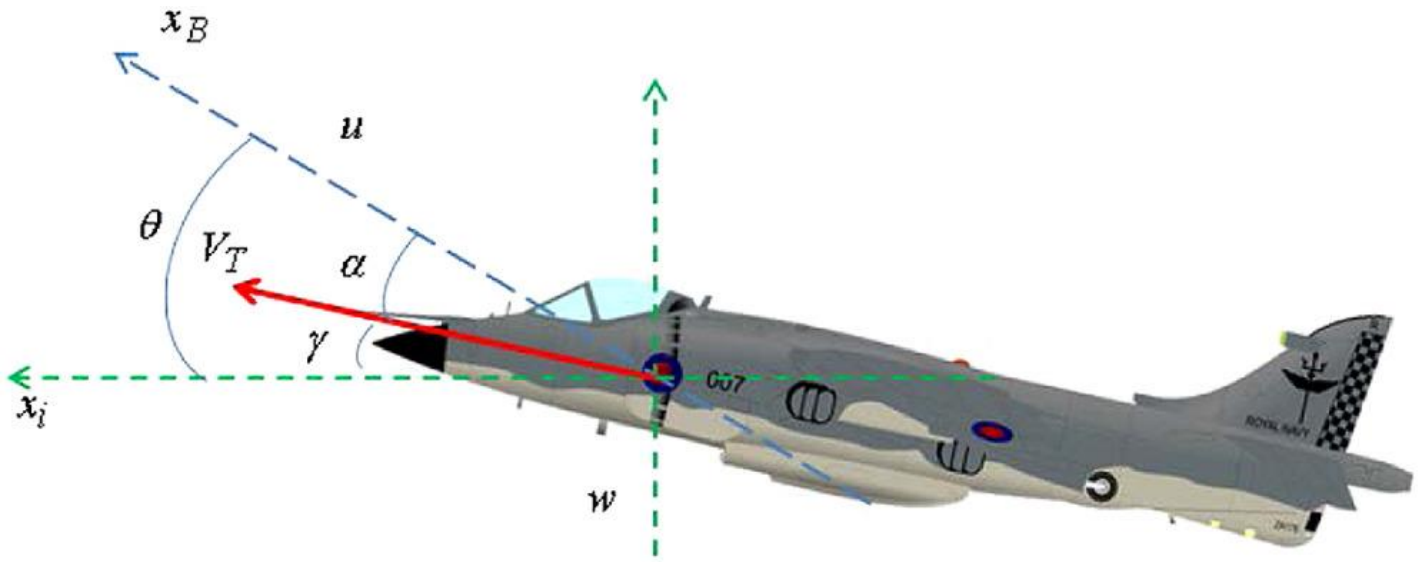
Statistician Overwhelmed



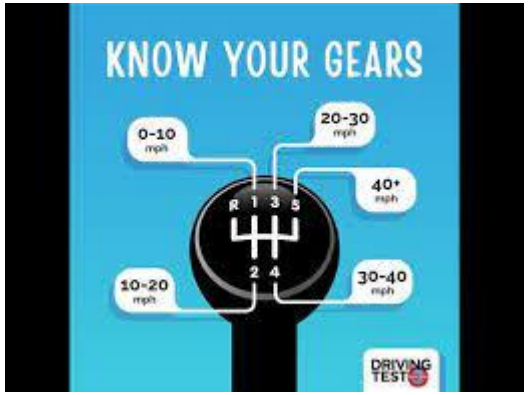
Computer Scientists Made an Entry

- Distributed Computation
- Reliability and Storage of Data
- Computational Efficiency
- Tools and User Interface
- Cheaper Circuits
- Etc.

Optimization Problems (Trajectory Flight)

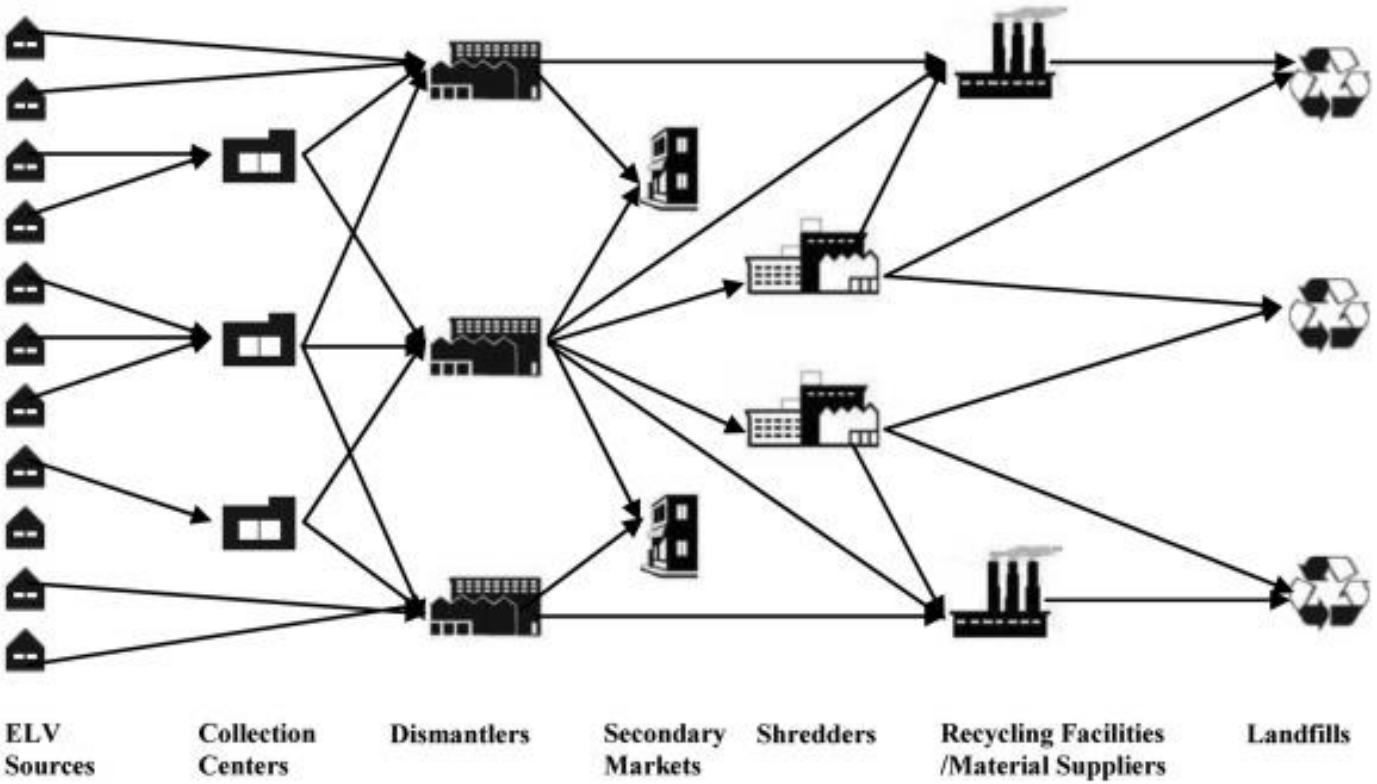


Optimization Problems (Automatic Gearing)



Gear shift pattern		$1 \rightarrow 2$	$2 \rightarrow 3$	$3 \rightarrow 4$	$4 \rightarrow 5$	$5 \rightarrow 6$
1	v [kmh^{-1}]	15	35	50	70	90
	rpm	2606	3203	2839	2877	2936
2	v [kmh^{-1}]	10	29	38	58	69
	rpm	1737	2654	2158	2384	2251
3	v [kmh^{-1}]	16.2	30	45.1	62.2	87.2
	rpm	2814	2746	2561	2556	2845

Optimization Problems (Logistics)



Optimization Problems (Network Science)

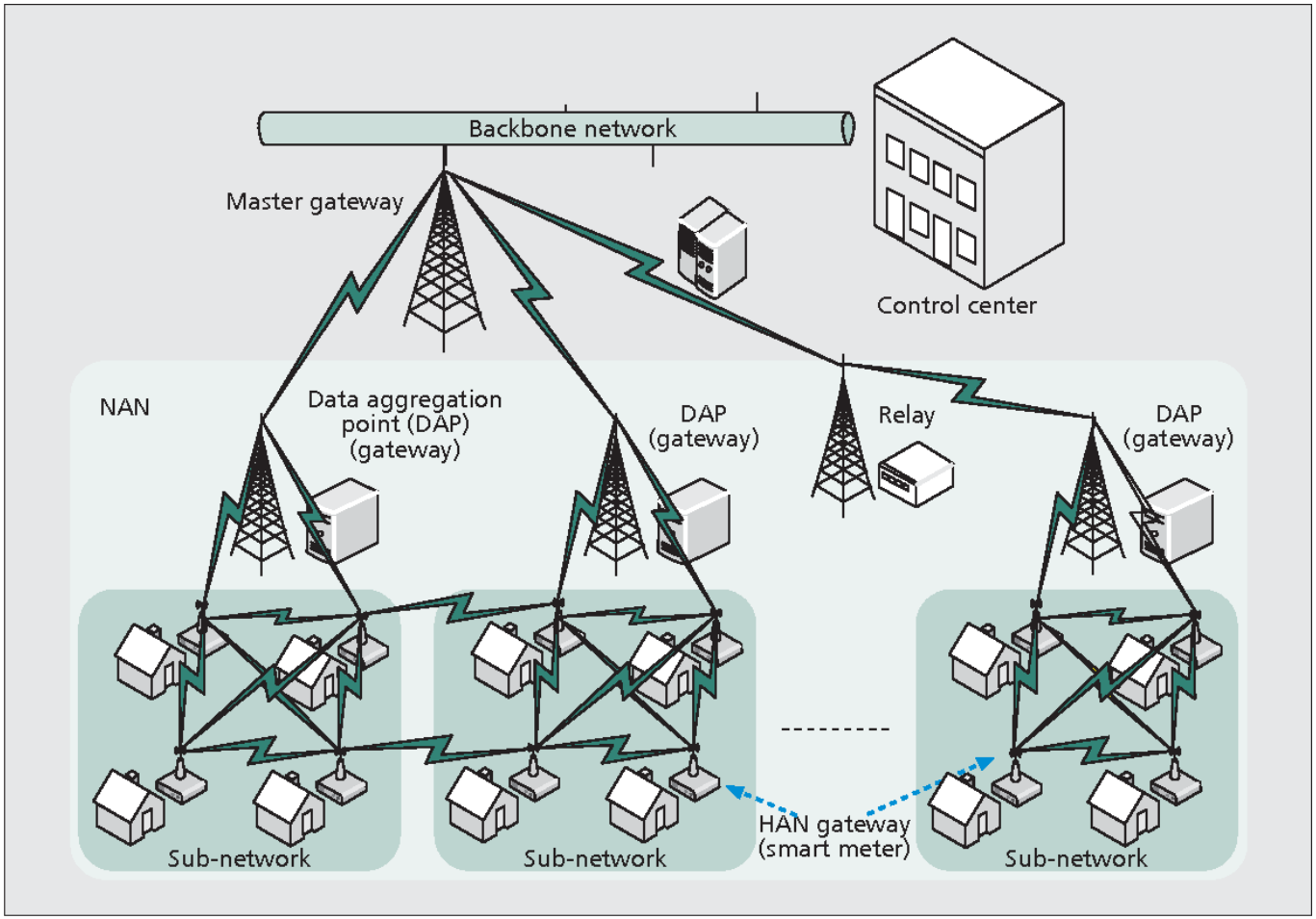
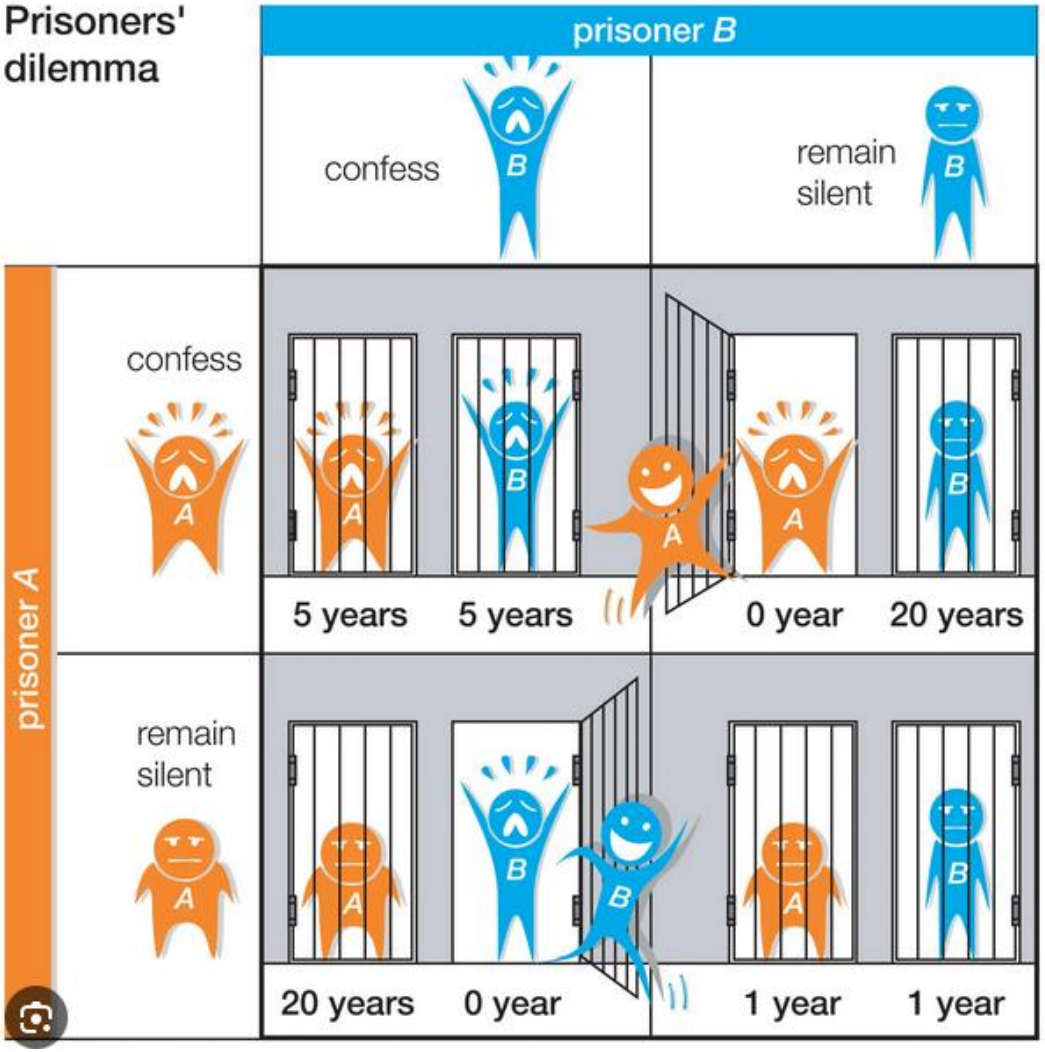
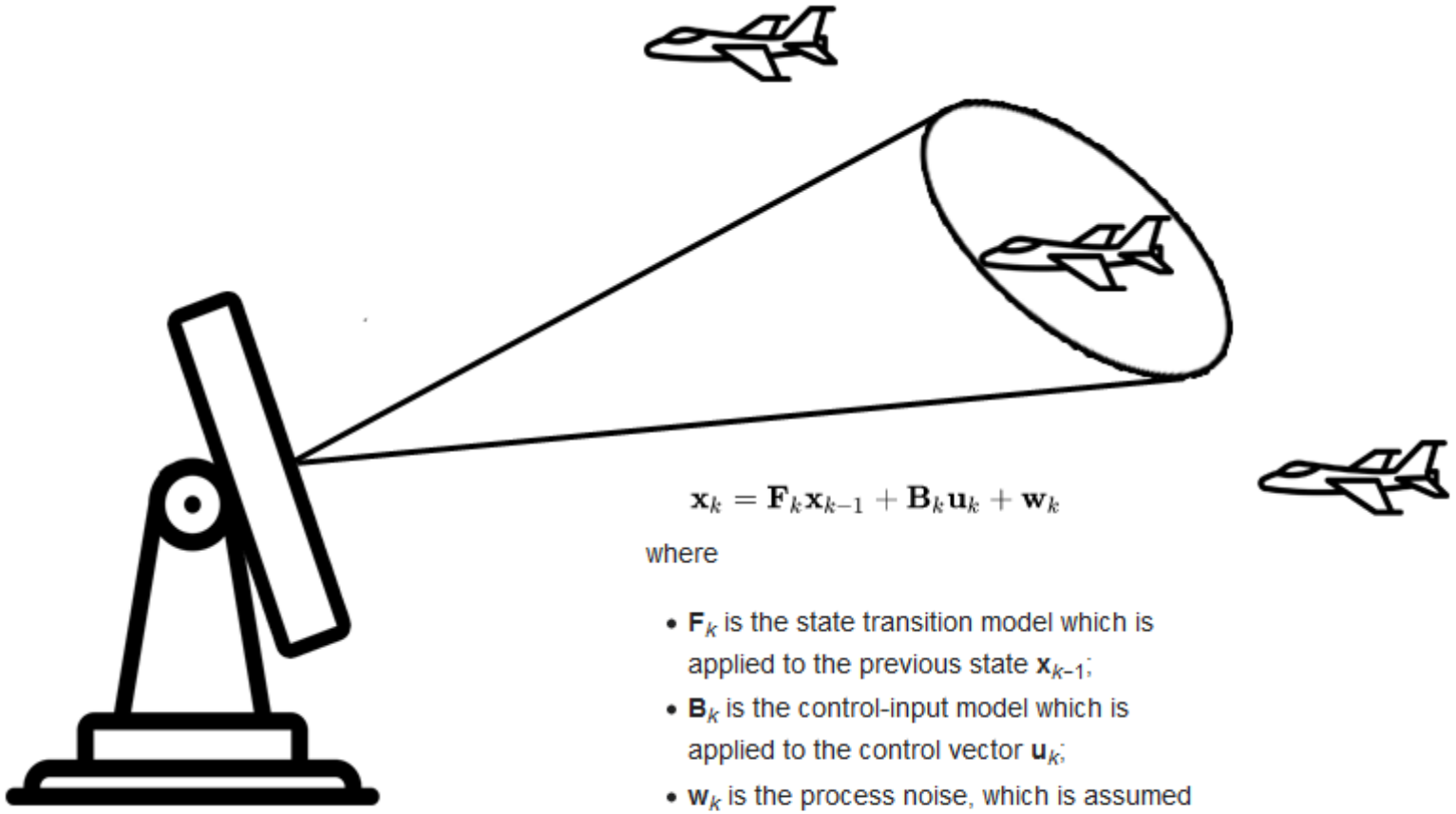


Figure 4. *Multiple-gateway mesh network topology for smart grid NANs.*

Game Theory


Prisoners' dilemma
prisoner B
confess
remain silent
prisoner A
confess
remain silent
5 years
5 years
0 year
20 years
20 years
0 year
1 year
1 year

Kalman Filter

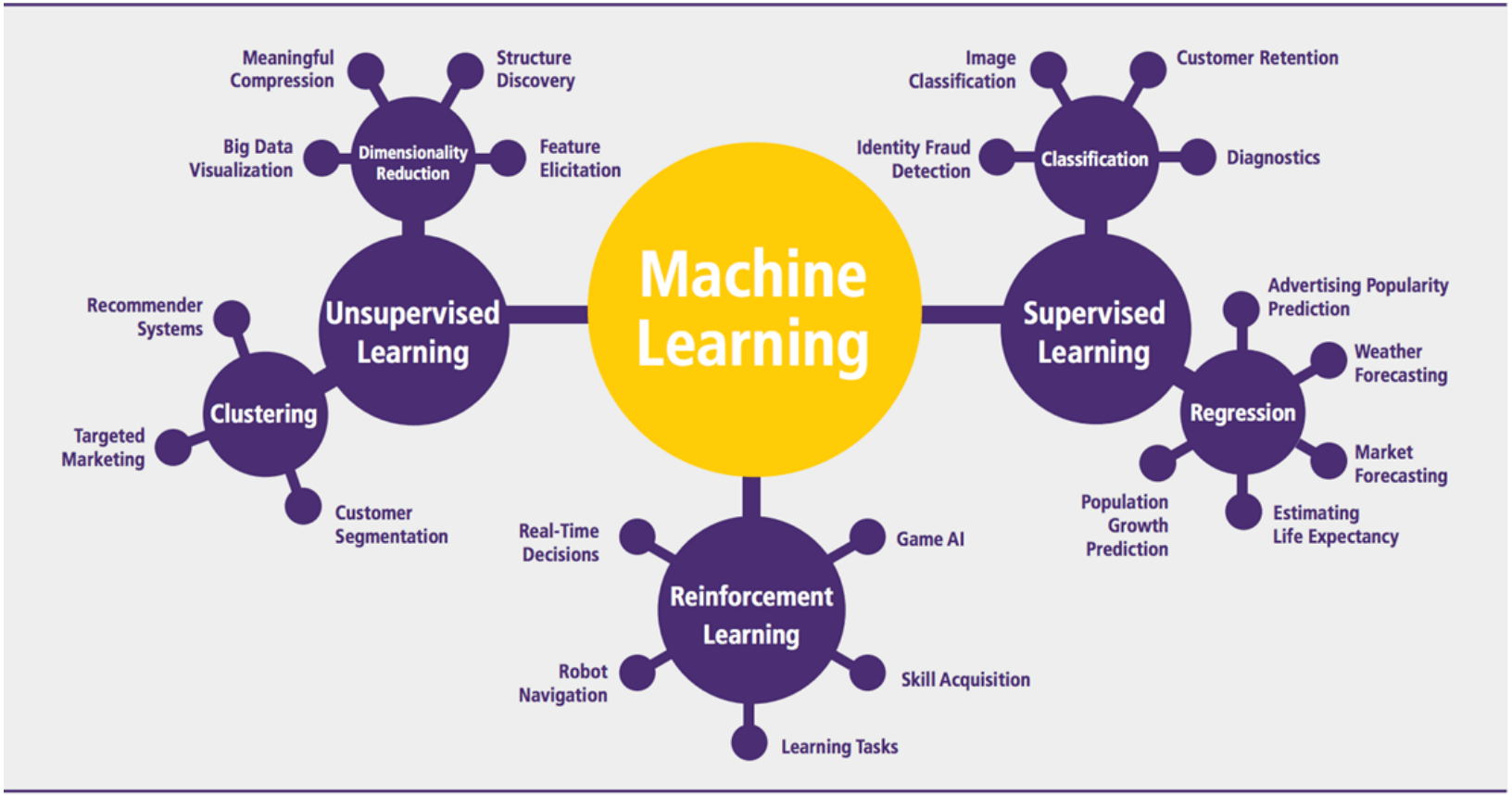


$$\mathbf{x}_k = \mathbf{F}_k\mathbf{x}_{k-1} + \mathbf{B}_k\mathbf{u}_k + \mathbf{w}_k$$

where

- $\mathbf{F}_k$ is the state transition model which is applied to the previous state $\mathbf{x}_{k-1}$;
- $\mathbf{B}_k$ is the control-input model which is applied to the control vector $\mathbf{u}_k$;
- $\mathbf{w}_k$ is the process noise, which is assumed to be drawn from a zero mean multivariate normal distribution, $\mathcal{N}$, with covariance, $\mathbf{Q}_k$: $\mathbf{w}_k \sim \mathcal{N}(0, \mathbf{Q}_k)$.

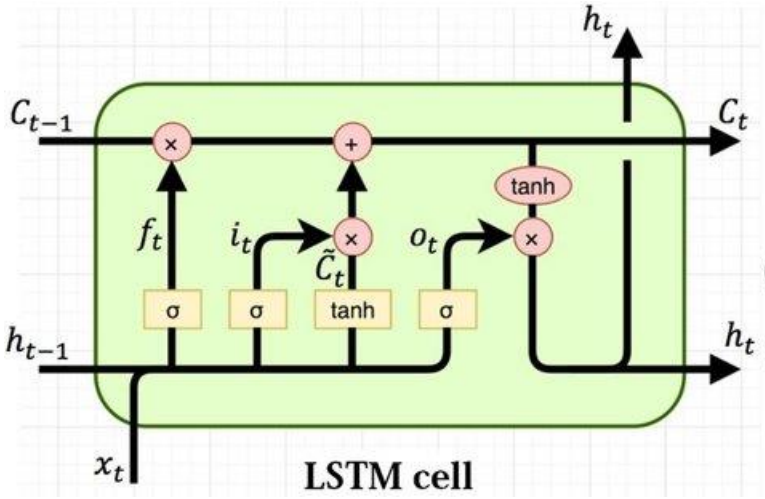
Machine Learning



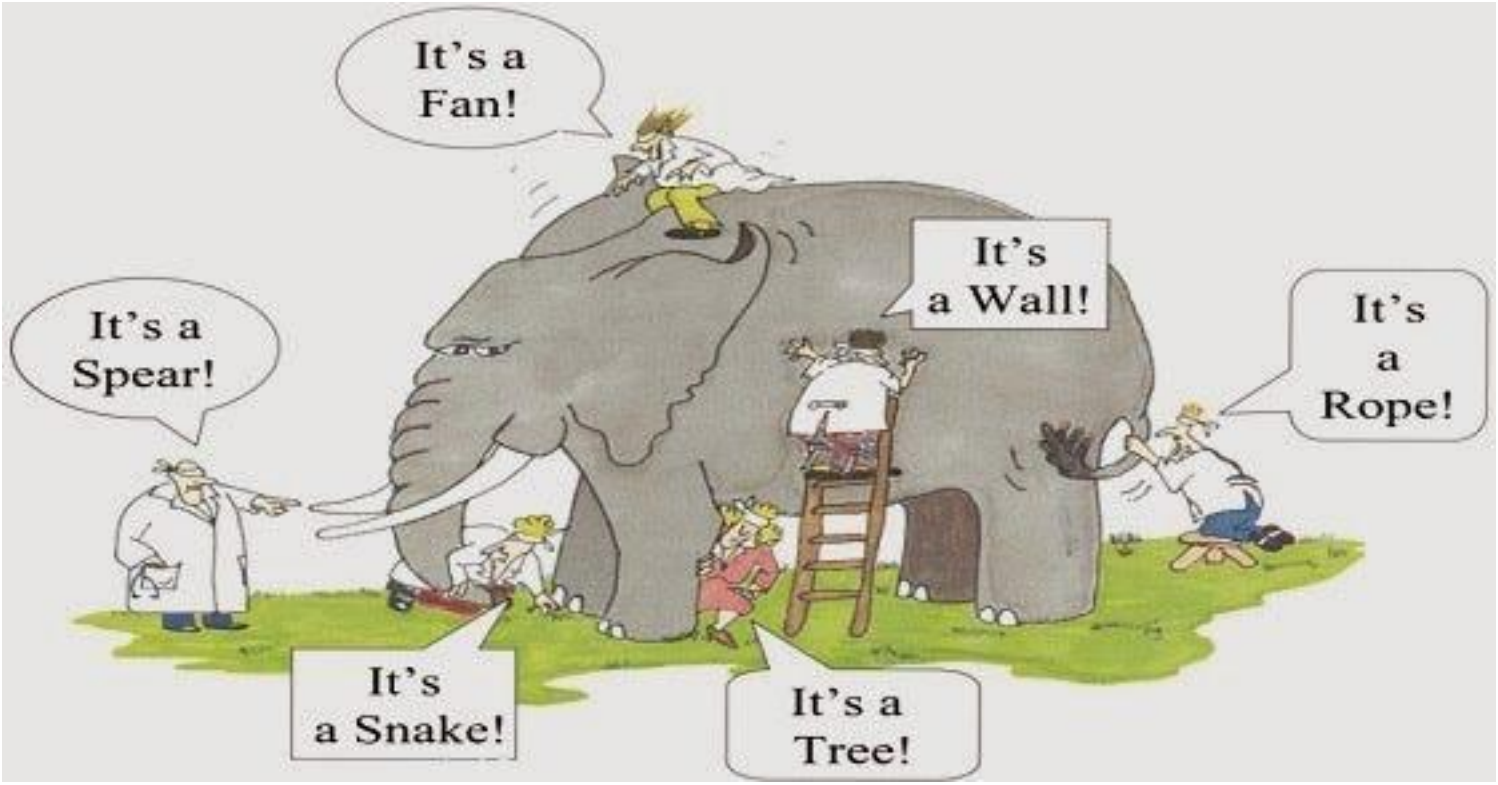
When data gives the wrong solution

- During World War II, researchers at the Center for Naval Analysis faced a critical problem

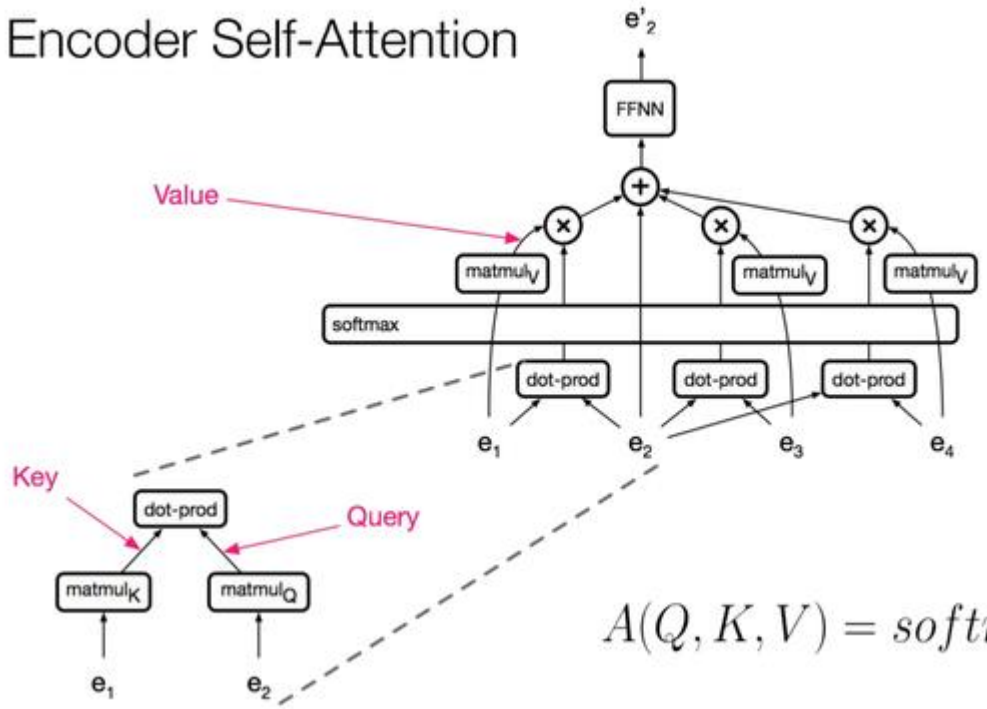
Deep Learning



$$i_t = \sigma\left(x_t U^i + h_{t-1} W^i\right)$$
$$f_t = \sigma\left(x_t U^f + h_{t-1} W^f\right)$$
$$o_t = \sigma\left(x_t U^o + h_{t-1} W^o\right)$$
$$\tilde{C}_t = \tanh\left(x_t U^g + h_{t-1} W^g\right)$$
$$C_t = \sigma\left(f_t * C_{t-1} + i_t * \tilde{C}_t\right)$$
$$h_t = \tanh(C_t) * o_t$$


It's a Fan!
It's a Spear!
It's a Wall!
It's a Rope!
It's a Snake!
It's a Tree!

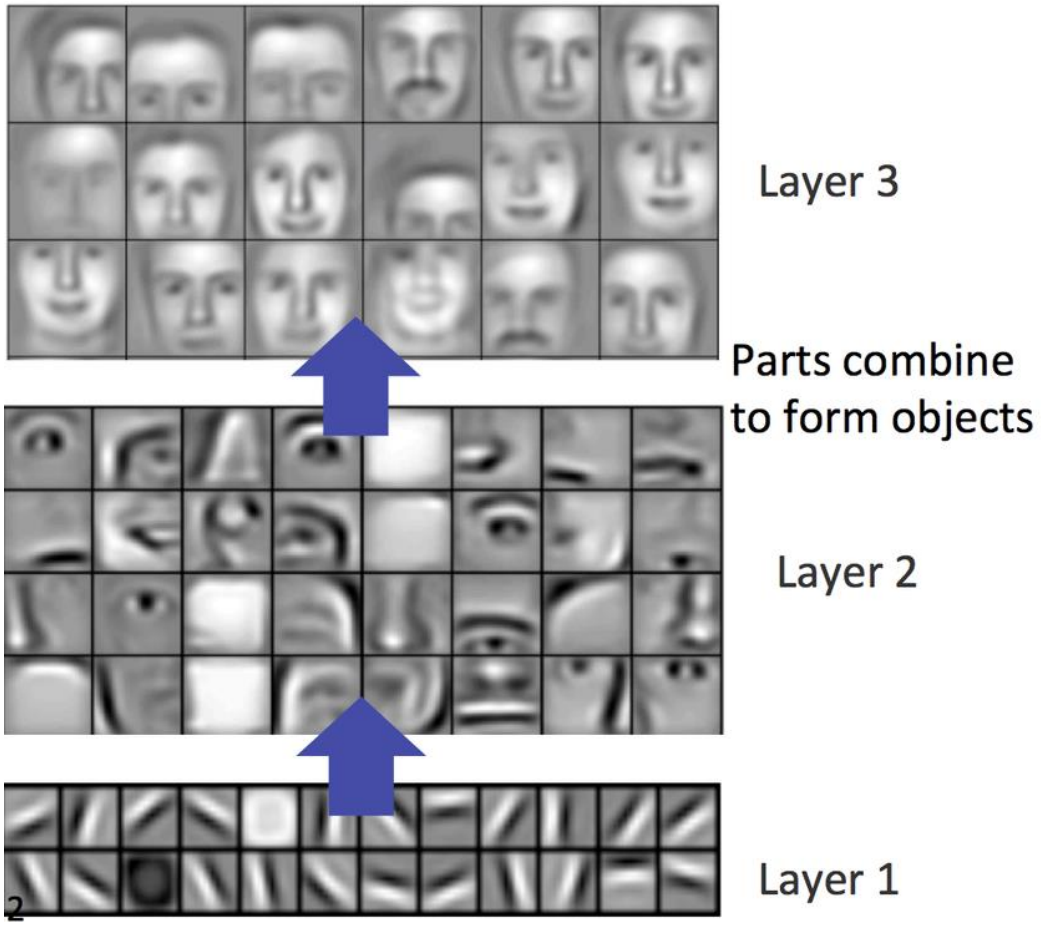
More Deep Learning



$$A(Q,K,V) = softmax(\frac{QK^T}{\sqrt{d_k}})V$$

Feature Visualization

- Images



Feature Engineering

- One Hot Vector

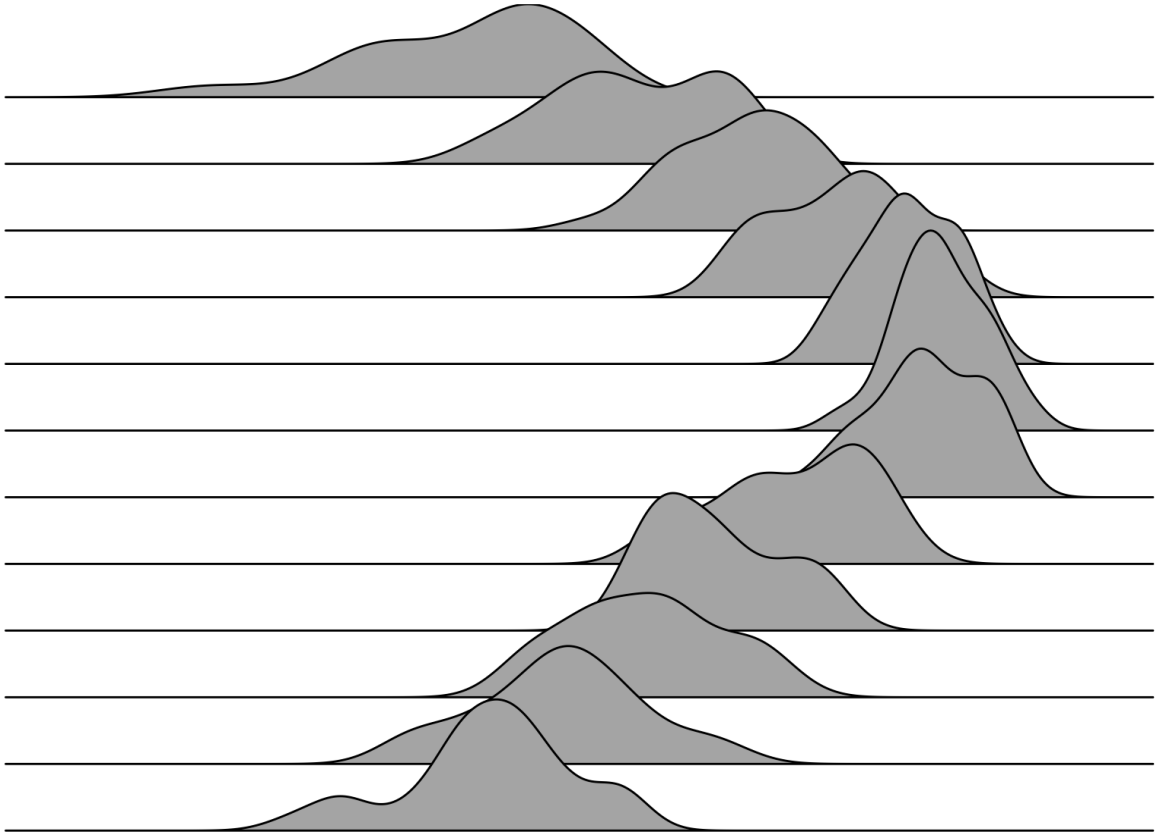
I ate an apple

I played an piano

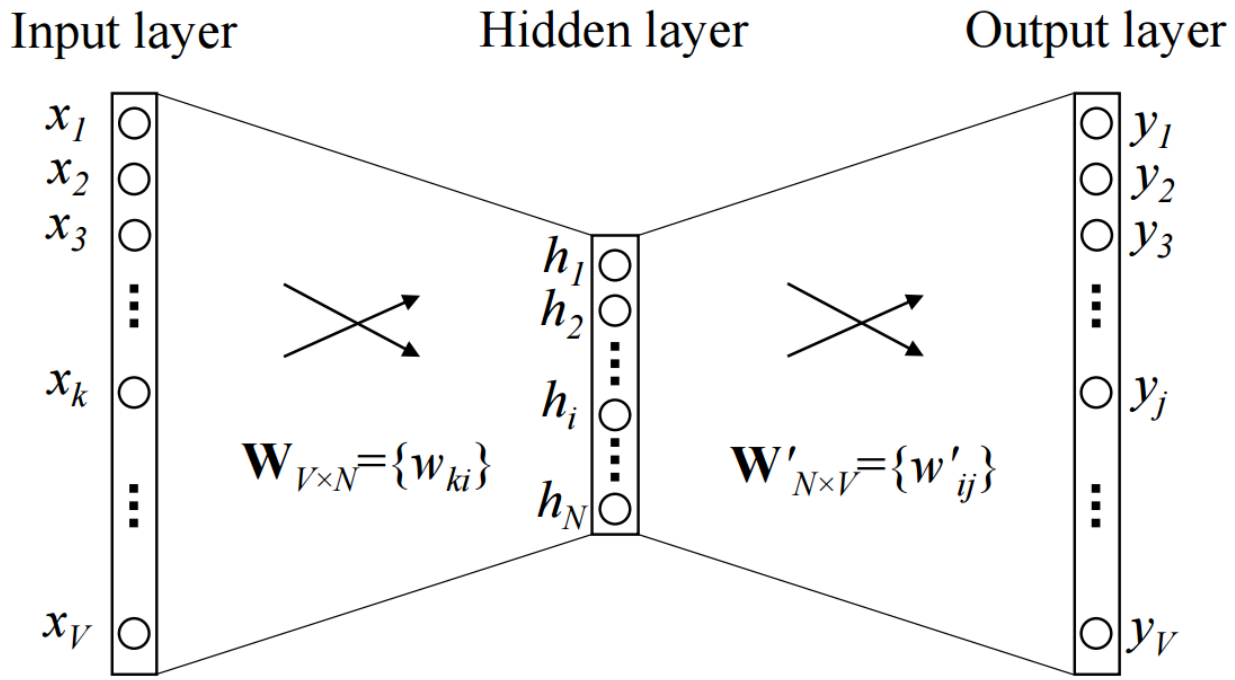
	1	2	3	4	5	6	7	8
I	1	0	0	0	0	0	0	0
ate	0	1	0	0	0	0	0	0
an	0	0	1	0	0	0	0	0
apple	0	0	0	1	0	0	0	0
and	0	0	0	0	1	0	0	0
played	0	0	0	0	0	1	0	0
the	0	0	0	0	0	0	1	0
piano	0	0	0	0	0	0	0	1

Feature Engineering

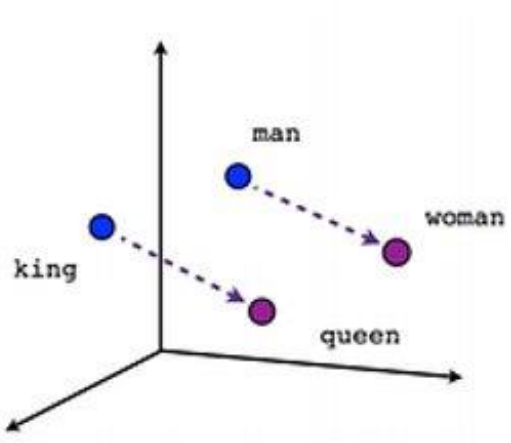
- Word Distribution



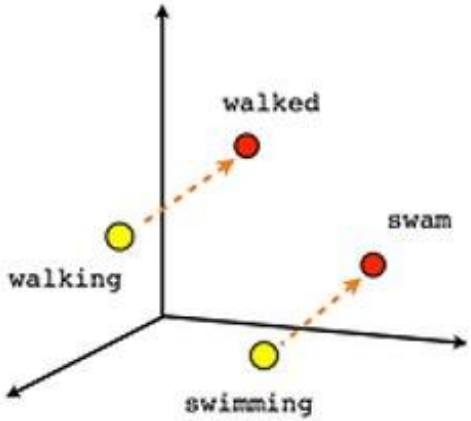
Word2Vec


Input layer
Hidden layer
Output layer
x_1
x_2
x_3
x_k
x_V
h_1
h_2
h_i
h_N
y_1
y_2
y_3
y_j
y_V
$\mathbf{W}_{V\times N}=\{w_{ki}\}$
$\mathbf{W}'_{N\times V}=\{w'_{ij}\}$

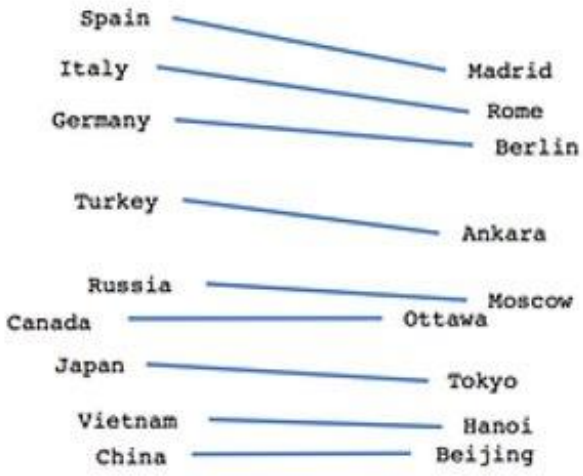
Word2Vec



Male-Female

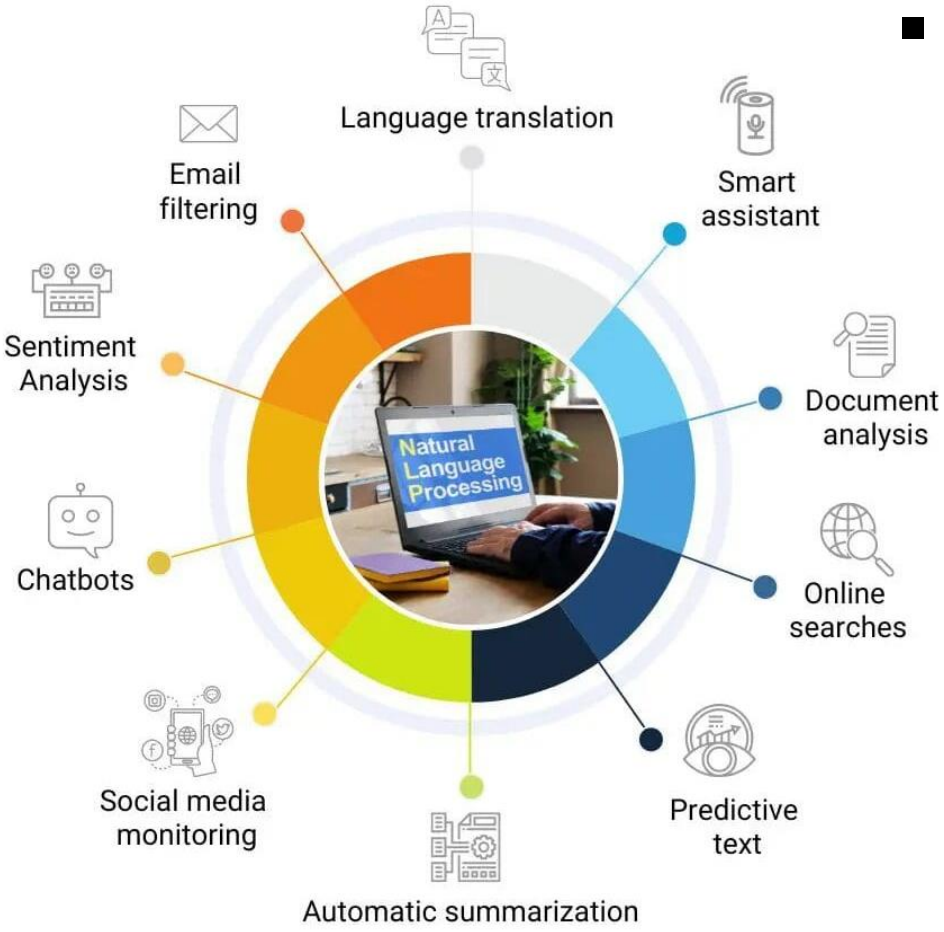


Verb tense



Country-Capital

Natural Language Processing (NLP)



- Ability to make a machine understand human language.

Language Visualization

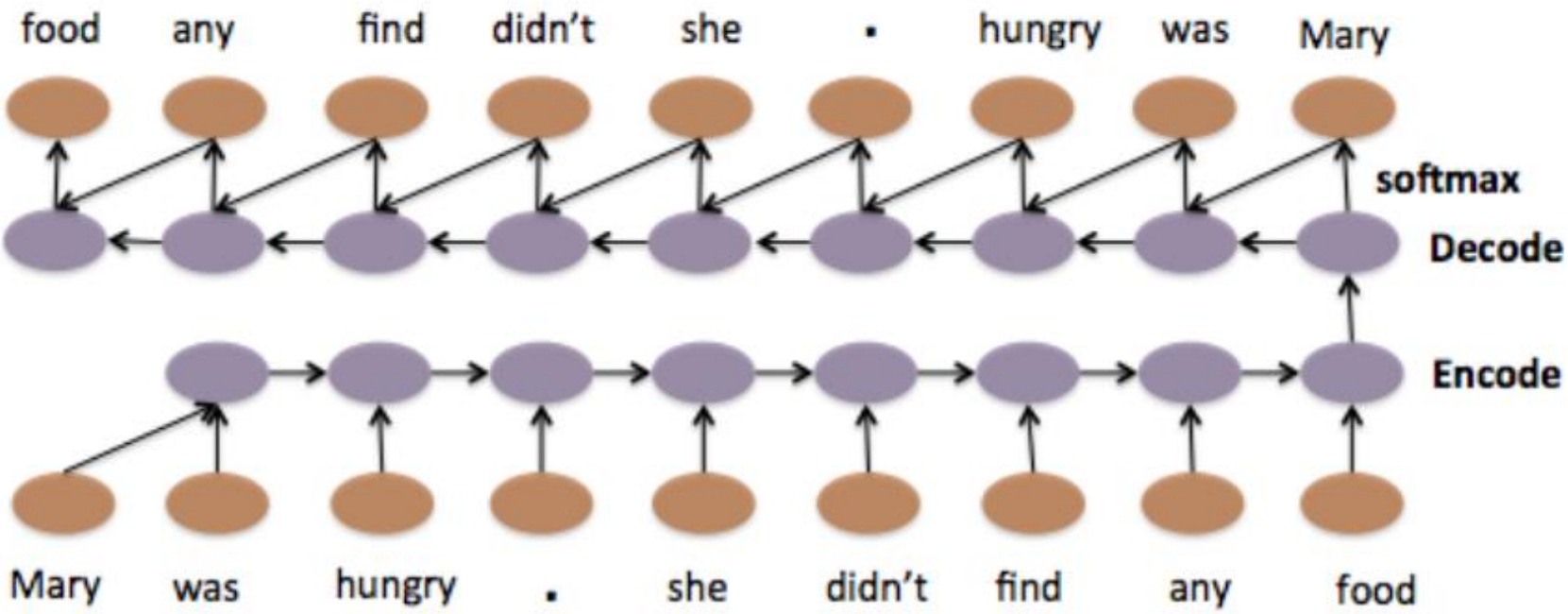
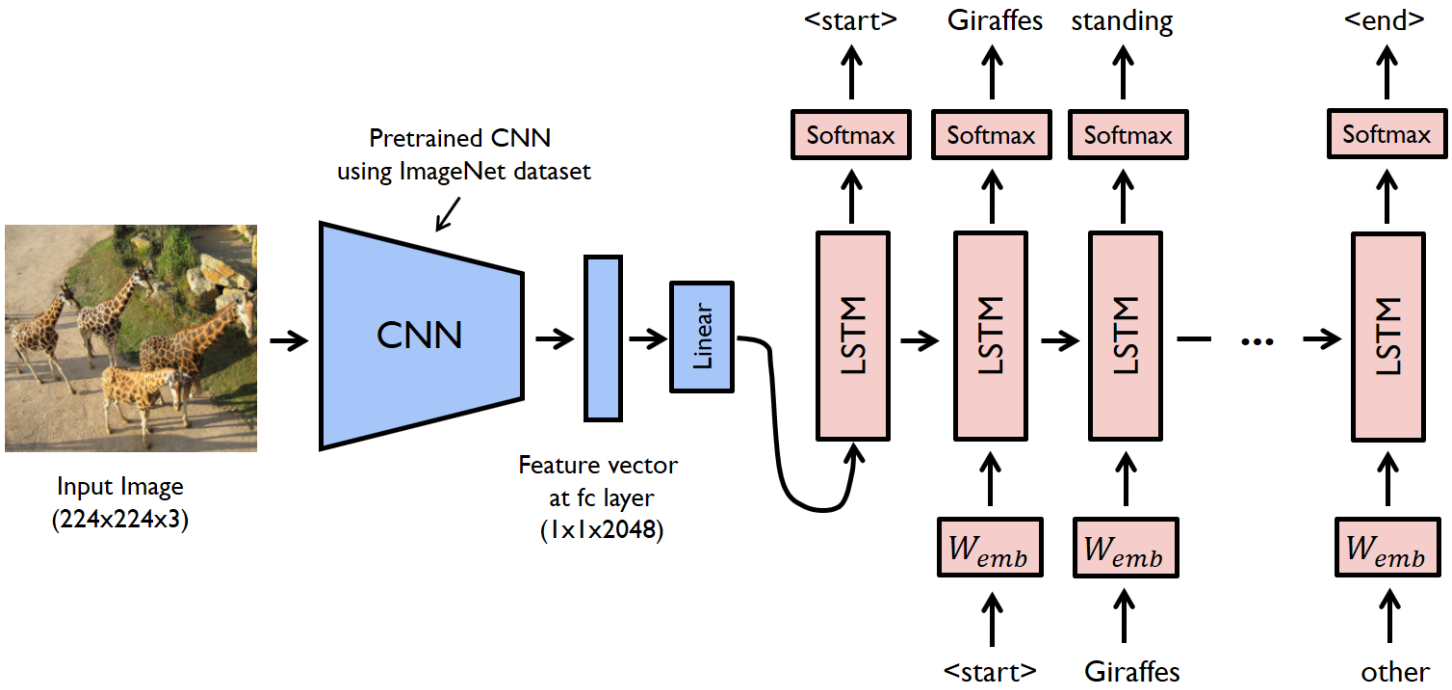


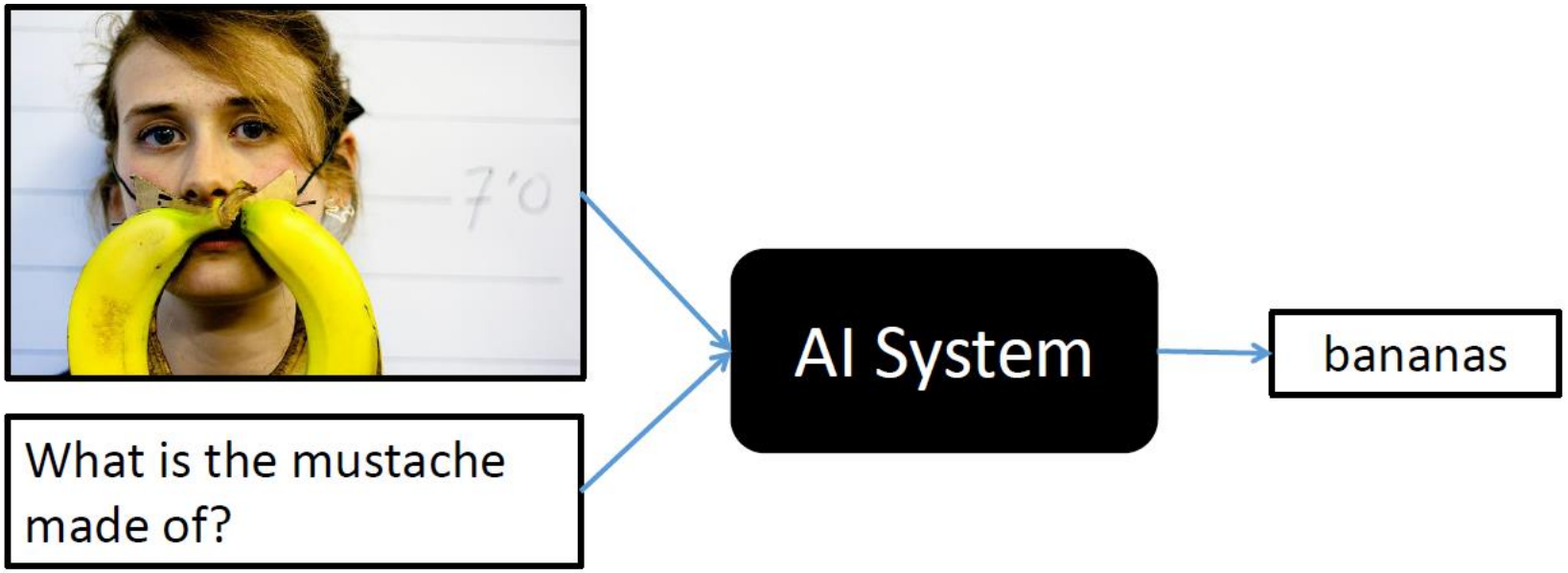
Figure 1: Standard Sequence to Sequence Model.

Natural Language Understanding

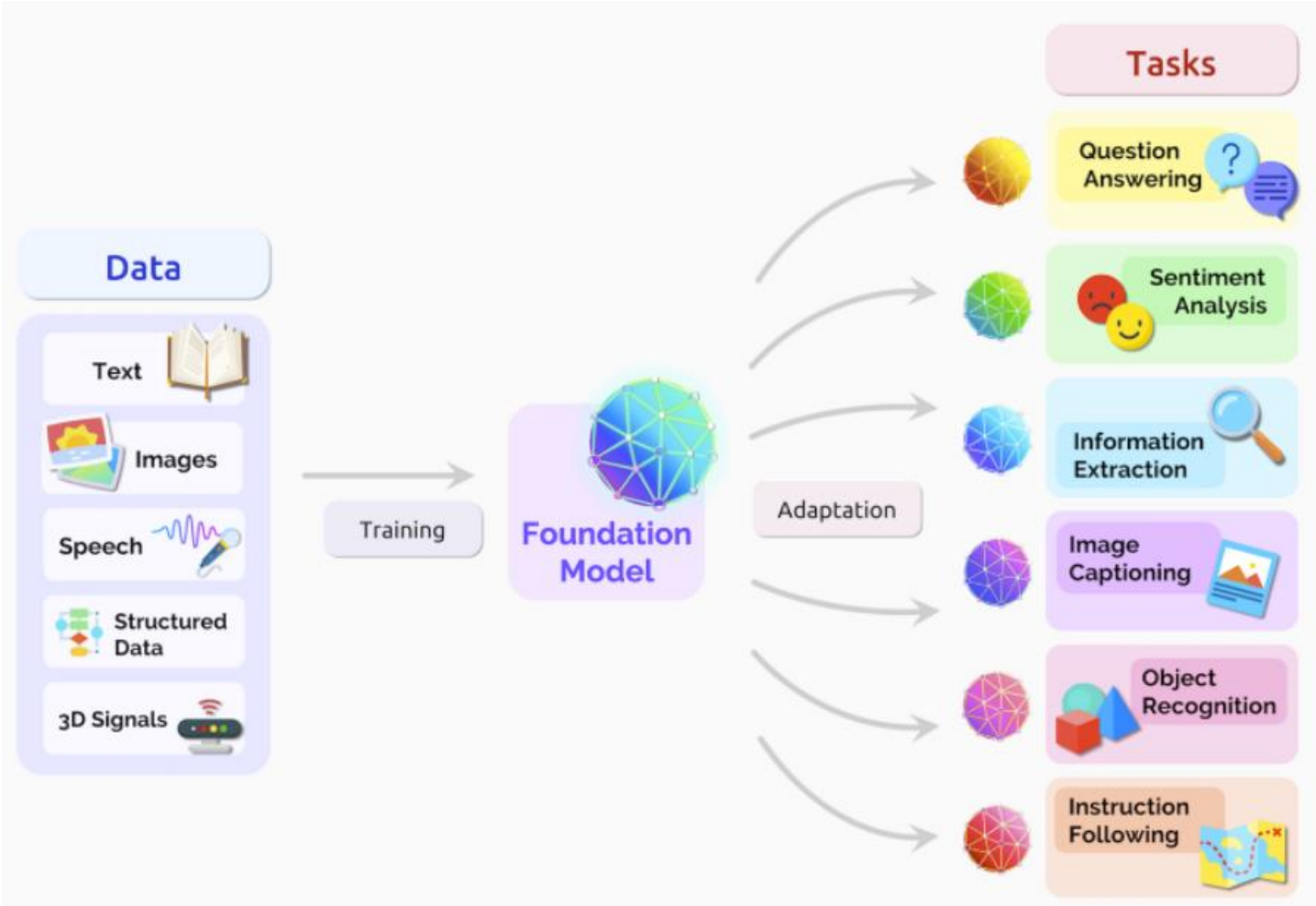
Natural Language Generation



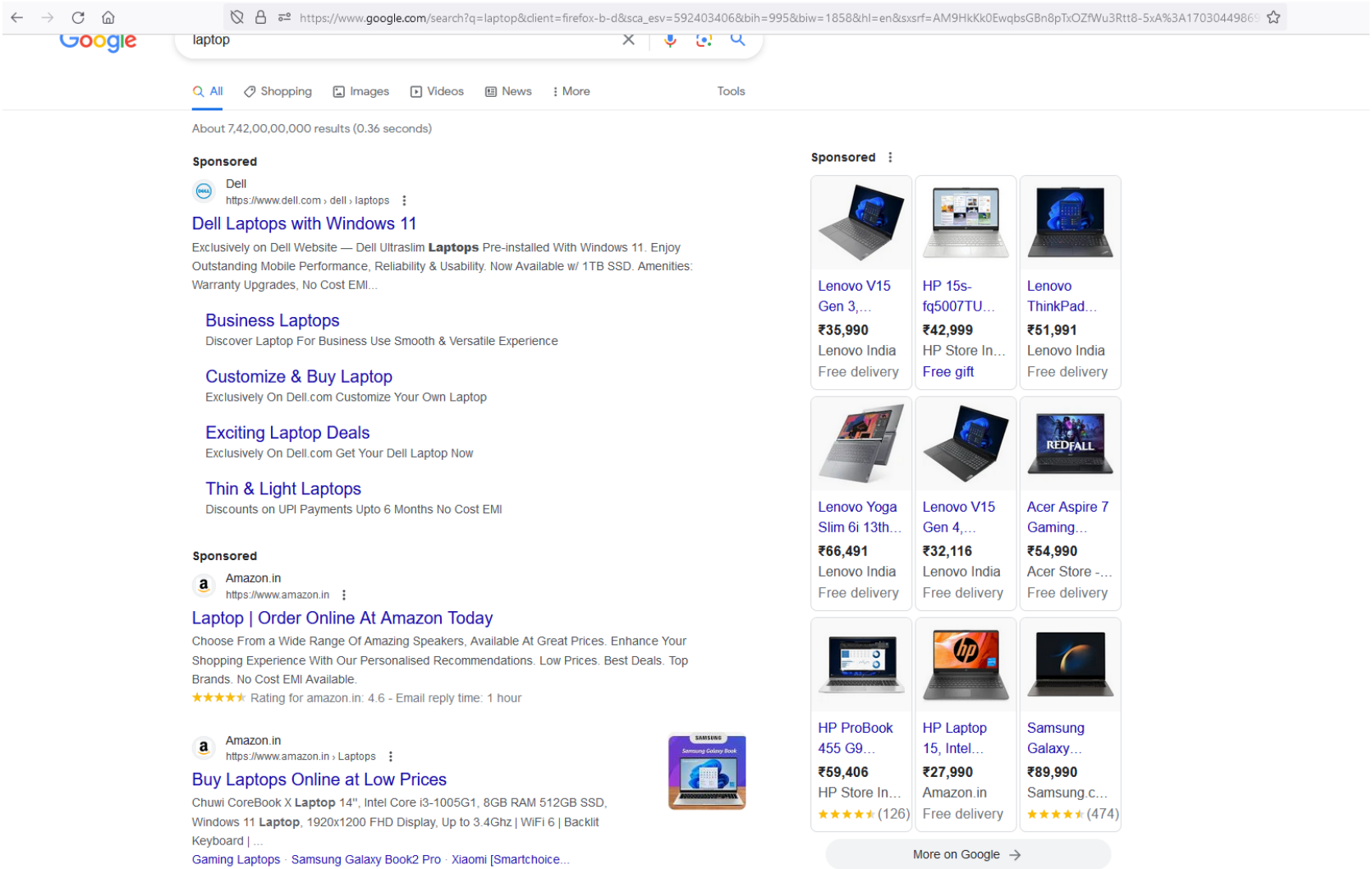
Natural Language Generation



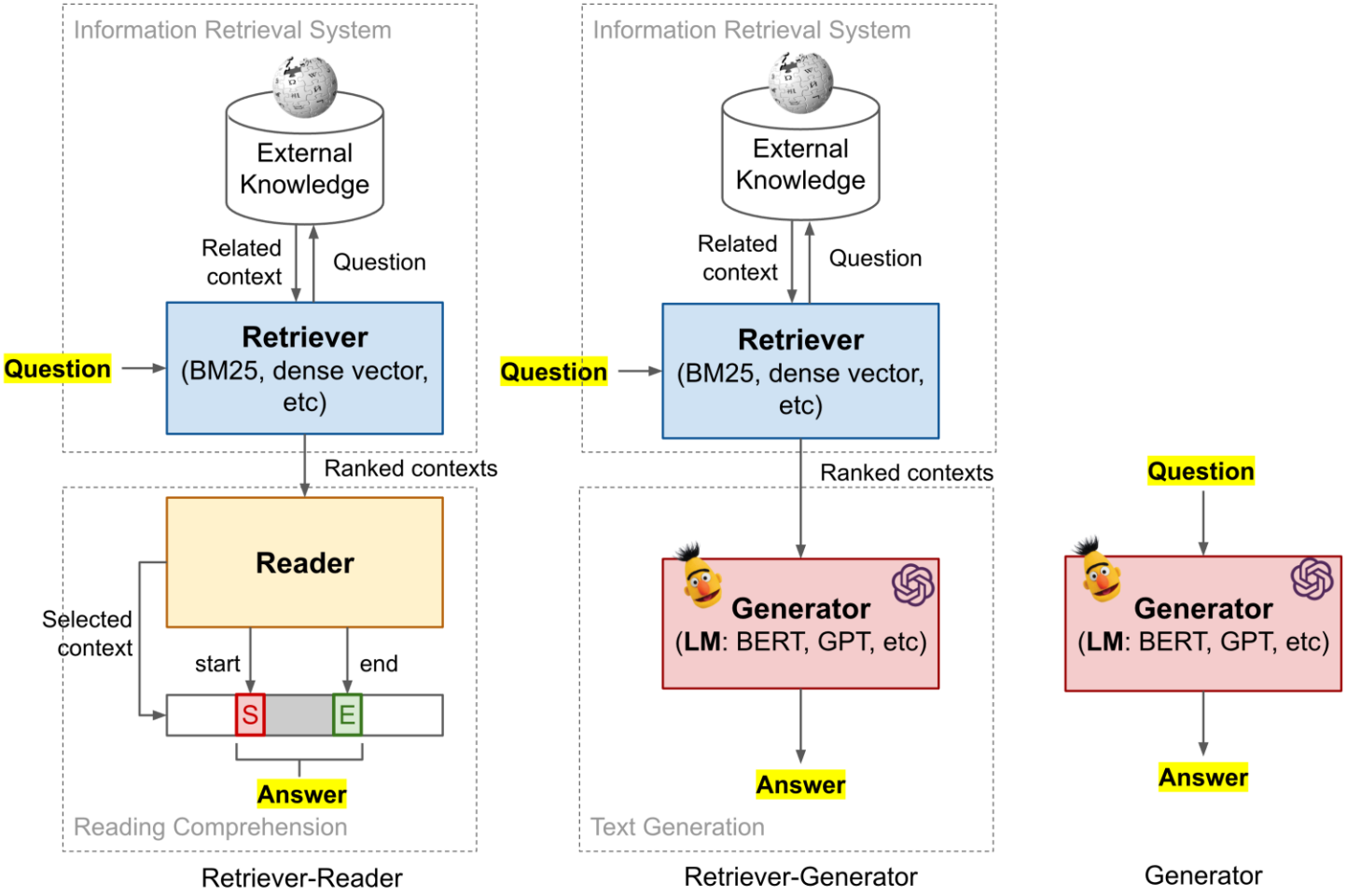
Large Language Models



Google


https://www.google.com/search?q=laptop&client=firefox-b-d&sca_esv=592403406&bih=995&biw=1858&hl=en&sxsrf=AM9HkKk0EwqbsGBn8pTxOZfWu3Rtt8-5xA%3A1703044986
Google
laptop
All
Shopping
Images
Videos
News
More
Tools
About 7,42,00,00,000 results (0.36 seconds)
Sponsored
Dell
https://www.dell.com › dell › laptops
Dell Laptops with Windows 11
Exclusively on Dell Website — Dell Ultraslim Laptops Pre-installed With Windows 11. Enjoy Outstanding Mobile Performance, Reliability & Usability. Now Available w/ 1TB SSD. Amenities: Warranty Upgrades, No Cost EMI...
Business Laptops
Discover Laptop For Business Use Smooth & Versatile Experience
Customize & Buy Laptop
Exclusively On Dell.com Customize Your Own Laptop
Exciting Laptop Deals
Exclusively On Dell.com Get Your Dell Laptop Now
Thin & Light Laptops
Discounts on UPI Payments Upto 6 Months No Cost EMI
Sponsored
Amazon.in
https://www.amazon.in
Laptop | Order Online At Amazon Today
Choose From a Wide Range Of Amazing Speakers, Available At Great Prices. Enhance Your Shopping Experience With Our Personalised Recommendations. Low Prices. Best Deals. Top Brands. No Cost EMI Available.
Rating for amazon.in: 4.6 - Email reply time: 1 hour
Amazon.in
https://www.amazon.in › Laptops
Buy Laptops Online at Low Prices
Chuwi CoreBook X Laptop 14", Intel Core i3-1005G1, 8GB RAM 512GB SSD, Windows 11 Laptop, 1920x1200 FHD Display, Up to 3.4Ghz | WiFi 6 | Backlit Keyboard | ...
Gaming Laptops · Samsung Galaxy Book2 Pro · Xiaomi [Smartchoice...
Sponsored
Lenovo V15 Gen 3,... ₹35,990 Lenovo India Free delivery
HP 15s-fq5007TU... ₹42,999 HP Store In... Free gift
Lenovo ThinkPad... ₹51,991 Lenovo India Free delivery
Lenovo Yoga Slim 6i 13th... ₹66,491 Lenovo India Free delivery
Lenovo V15 Gen 4,... ₹32,116 Lenovo India Free delivery
Acer Aspire 7 Gaming... ₹54,990 Acer Store -... Free delivery
HP ProBook 455 G9... ₹59,406 HP Store In... (126)
HP Laptop 15, Intel... ₹27,990 Amazon.in Free delivery
Samsung Galaxy... ₹89,990 Samsung.c... (474)
More on Google

ChatGPT


Information Retrieval System
External Knowledge
Related context
Question
Retriever (BM25, dense vector, etc)
Question
Ranked contexts
Reader
Selected context
start
end
S
E
Answer
Reading Comprehension
Retriever-Reader
Information Retrieval System
External Knowledge
Related context
Question
Retriever (BM25, dense vector, etc)
Question
Ranked contexts
Generator (LM: BERT, GPT, etc)
Answer
Text Generation
Retriever-Generator
Question
Generator (LM: BERT, GPT, etc)
Answer
Generator

Amazon

amazon.in | Delivering to Guwahati 781030 Update location | All | Search Amazon.in | EN | Hello, sign in Account & Lists | Returns & Orders | 5 Cart

All | Amazon miniTV | Sell | Best Sellers | Today's Deals | Mobiles | Customer Service | Electronics | New Releases | Prime | Home & Kitchen | Fashion | Gift Ideas | Amazon Pay | Computers | Shopping made easy | Download the app

Shopping Cart

Price

ViewSonic 32 Inch FHD IPS FreeSync Monitor 3-Side Borderless, Dual Speaker, HDMI,VGA, Wall Mount, Eye-Care, Flicker Free, Srgb104% and 5 Year Warranty Upon Registration-V...

₹13,910.00

In stock
Eligible for FREE Shipping
Fulfilled
This will be a gift Learn more
Style Name: 32 Inch With Speaker

Qty: 2 | Delete | Save for later | See more like this | Share

ViewSonic 32 inch FHD HDR10 sRGB 104% IPS Monitor with Slim Bezel & Metallic Triangle Sliver Stand, HDMI, DP, Speakerx2, Eye-Care, Flicker Free, & 5Year Warranty Up...

₹15,941.00

In stock
Eligible for FREE Shipping
Fulfilled
This will be a gift Learn more
Style Name: 32 INCH WITH HDR 10

Qty: 1 | Delete | Save for later | See more like this | Share

LG 32" (80 CM) UltraGear™ QHD Monitor (2560 X 1440 Pixels), 165 Hz, 1Ms, Nvidia G-Sync Compatible, Freesync Premium, HDR 10, Hdmi, Tilt, Height, Pivot Stand, VA Pan...

54% off Deal of the Day
₹22,999.00
M.R.P.: ~~₹49,500.00~~

In stock
Eligible for FREE Shipping
Fulfilled
This will be a gift Learn more
Size: 32" 2K QHD 165 Hz 1ms
Style Name: 32GN650-B.ATR

Qty: 1 | Delete | Save for later | See more like this | Share

Acer HA270 27 Inch (68.58 Cm) 1920 X 1080 Pixels, Full HD IPS LCD Monitor with LED

₹8,999.00

Your order is eligible for FREE Delivery.
Select this option at checkout. Details

Subtotal (5 items): ₹75,759.00
This order contains a gift

Proceed to Buy

EMI Available

Products related to items in your cart

Sponsored

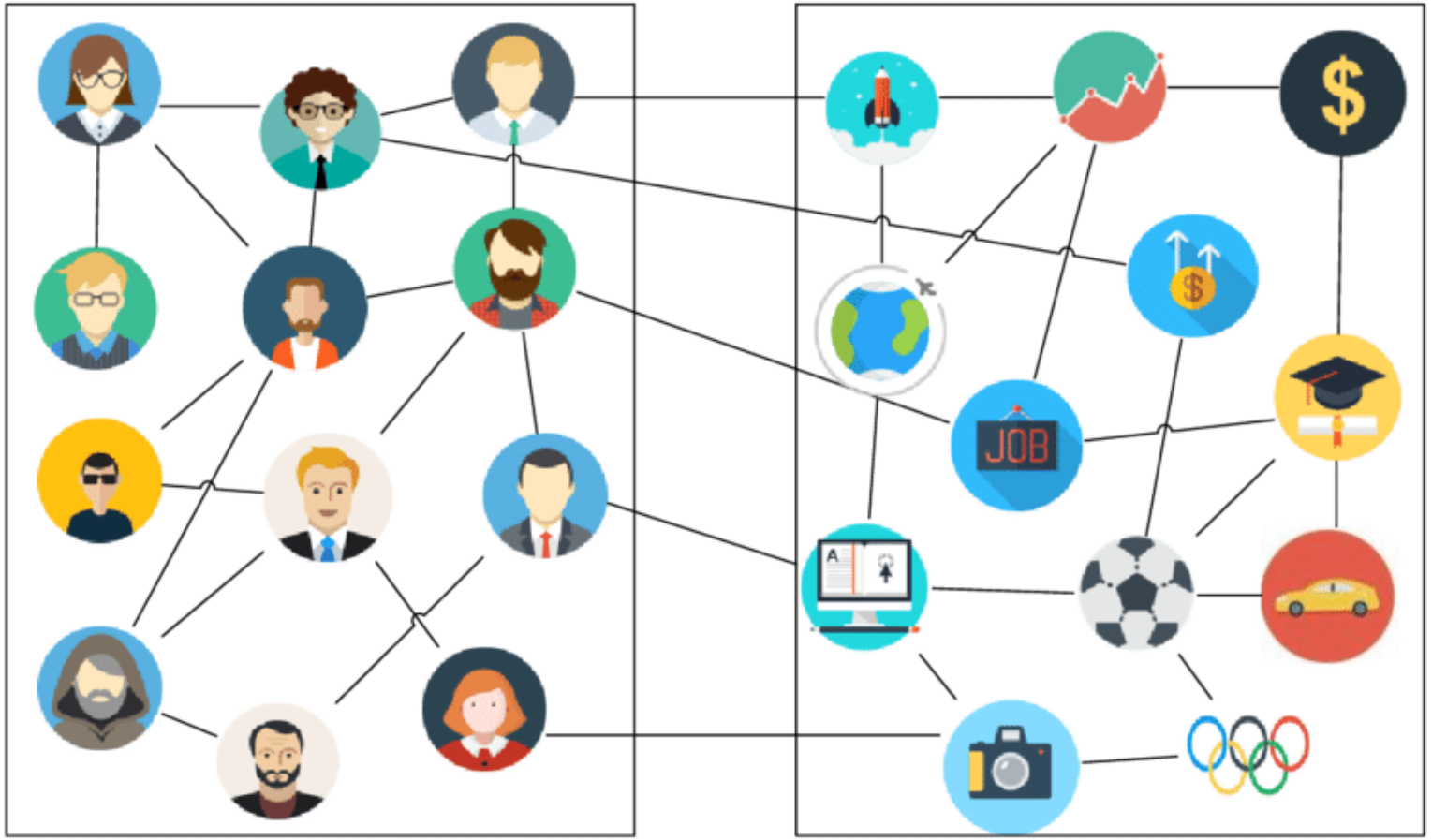
ZEBRONICS 68.5cms...
1,279
₹9,599.00
See all buying options

ZEBRONICS AC32FH...
1,281
₹12,429.00
See all buying options

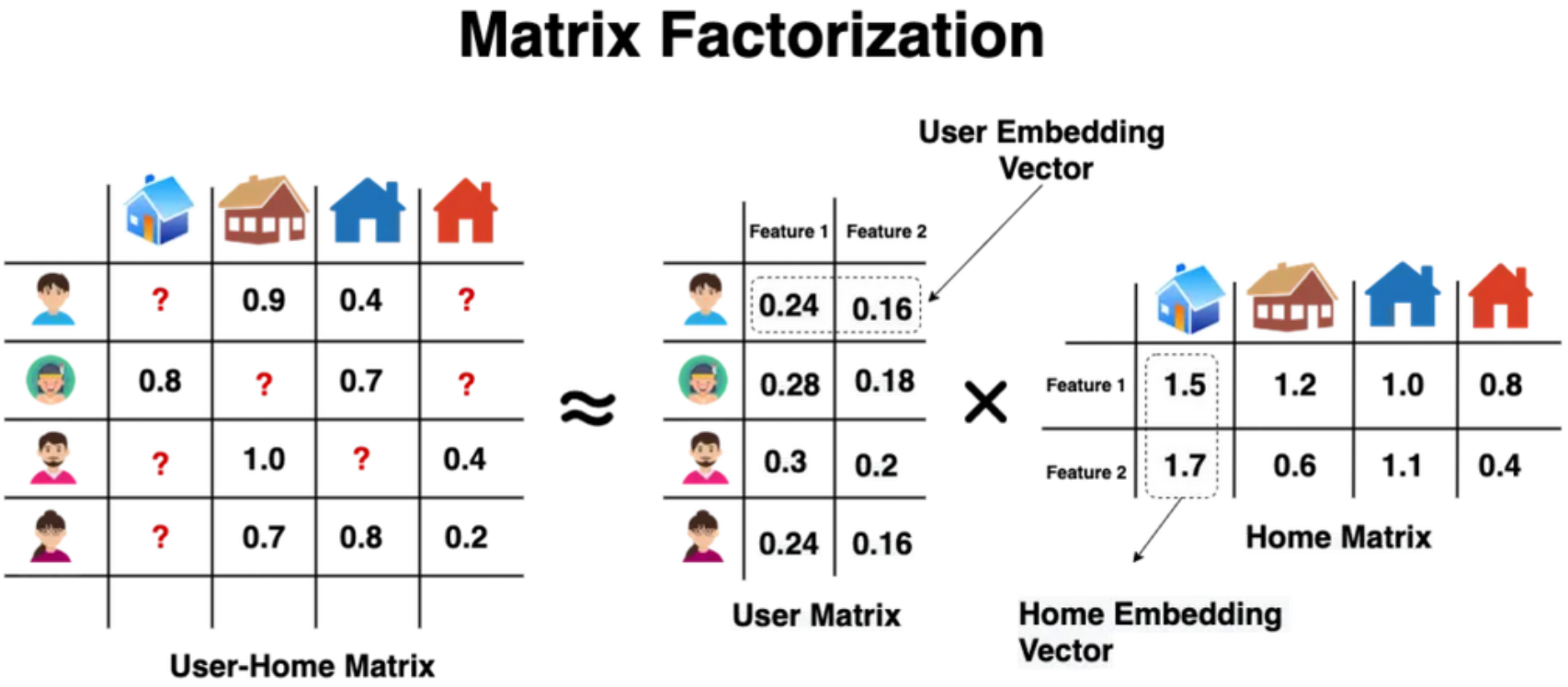
Acer HA240Y 23.8 In...
2,931
₹8,399.00
See all buying options

Acer Nitro VG240YS...
2,587
₹9,699.00
See all buying options

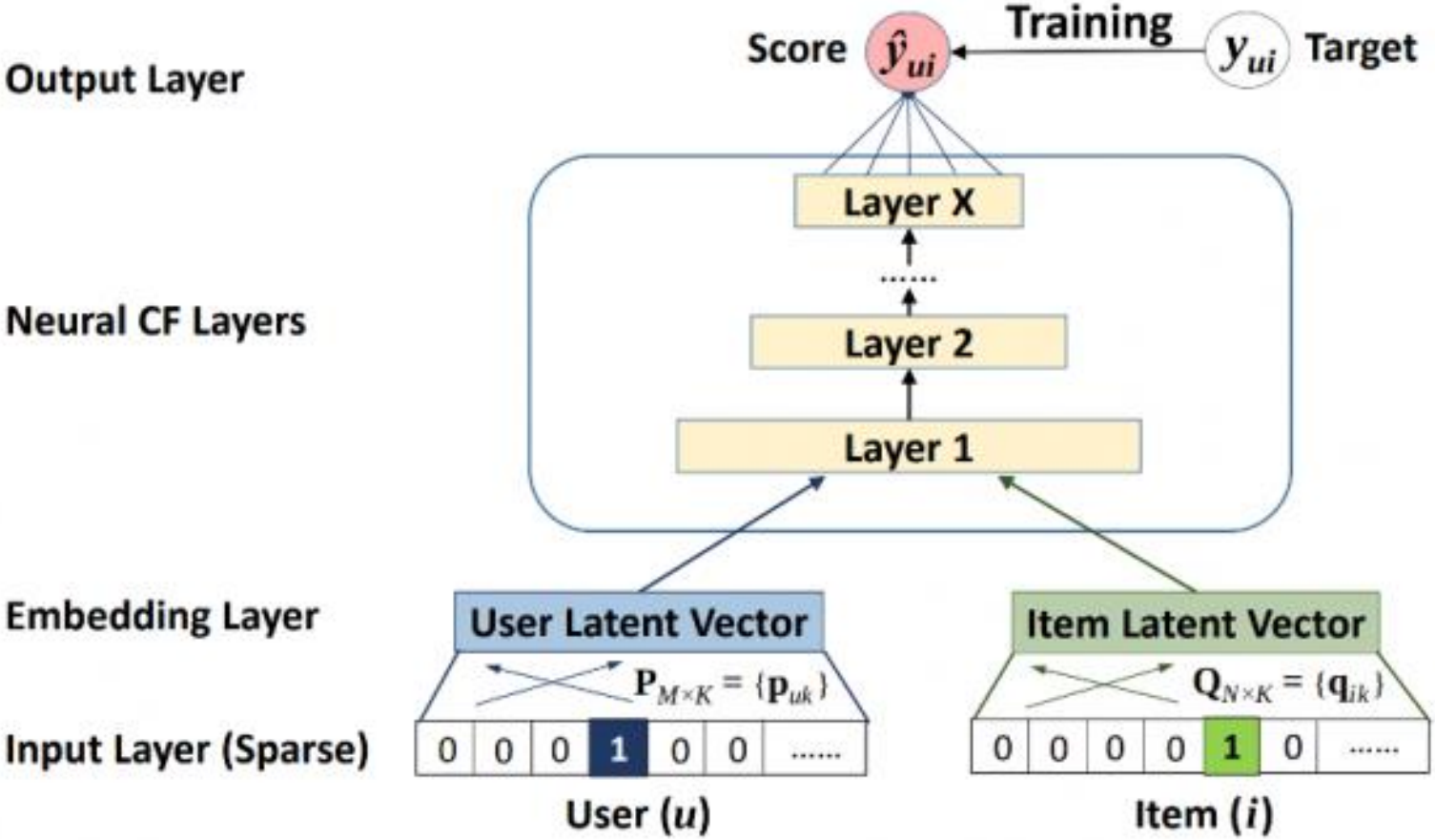
Interest Representation



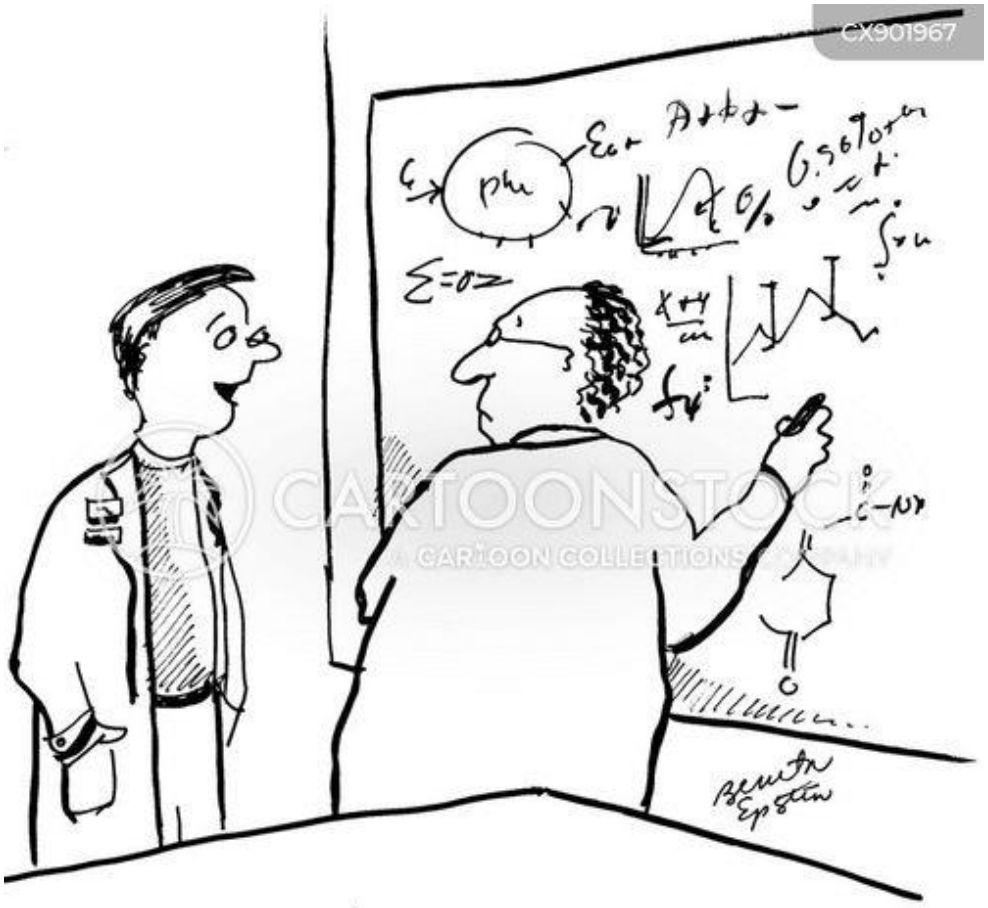
Matrix Factorization



Neural Recommendation System



Role of Mathematicians



"You've just proven that your job doesn't exist."

THANK YOU AND QUESTIONS