Applications of ML

Real life Machine Learning Applications

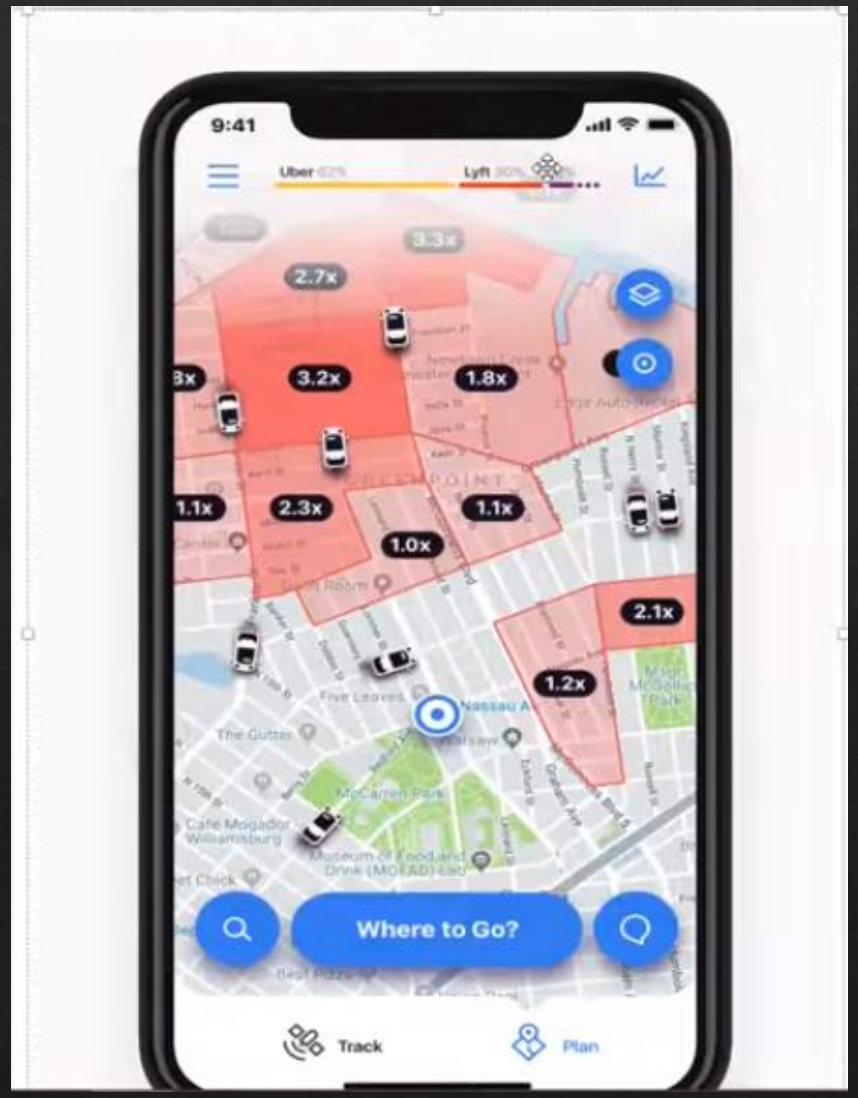
- Retail- Amazon , Big Bazaar

Amazon Big billion sale
Big Bazar-phone number
Association rule base

Banking and Finance

Transport

- OLA

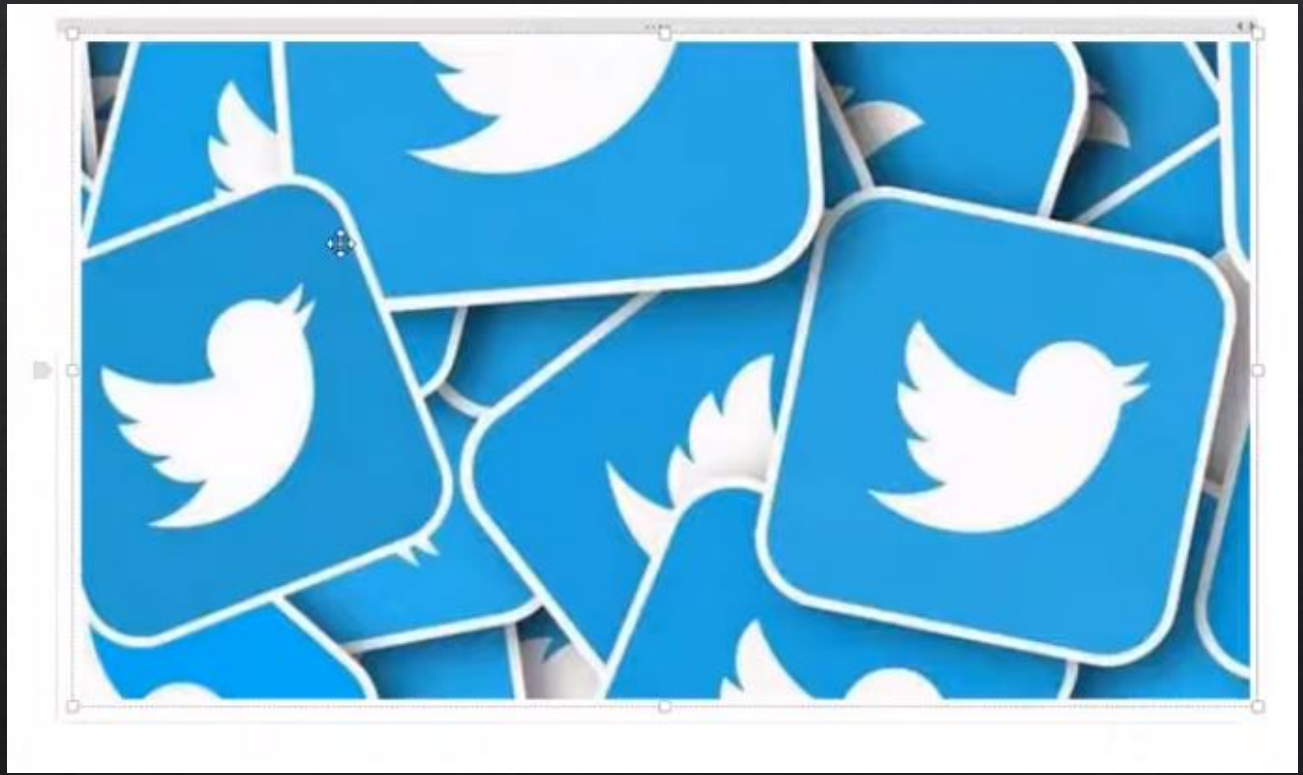


Manufacturing

- Tesla

Consumer Internet

- Twiter

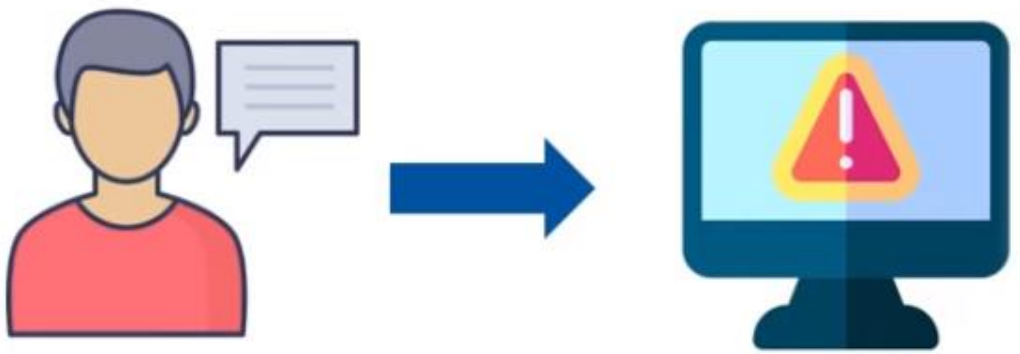


Natural Language Processing

And Machine Learning Application

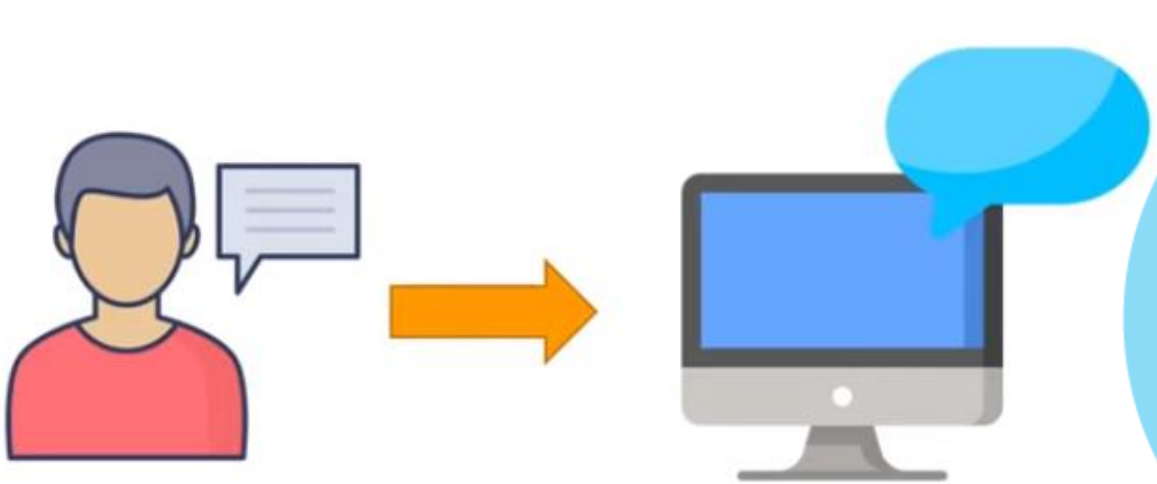
What is NLP?

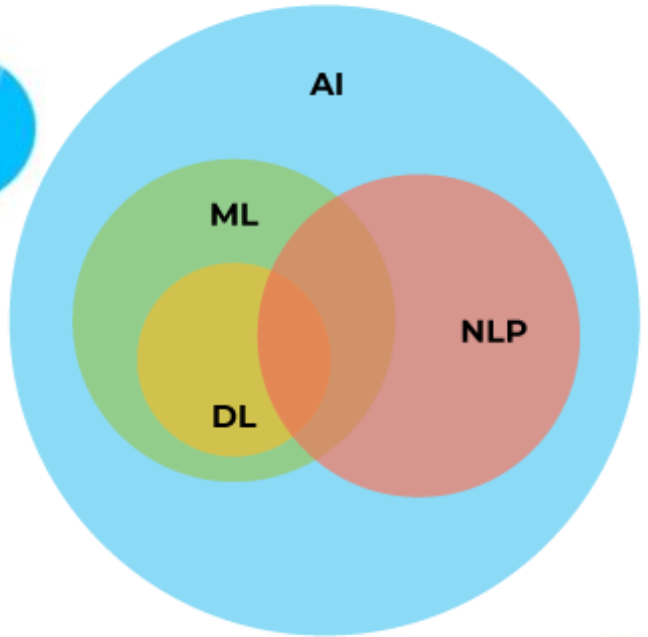
Natural Language refers to the human way of communicating, i.e., through text and speech



What is NLP?

Natural Language Processing refers to the branch of Artificial Intelligence that allows machines to understand human language





- Artificial Intelligence
- Machine Learning
- Language Processing
- Deep Learning

What is NLP

- Natural language processing (NLP) is a machine learning technology that gives computers the ability to interpret, manipulate, and comprehend human language.
- Organizations today have large volumes of voice and text data from various communication channels like emails, text messages, social media newsfeeds, video, audio, and more.
- They use NLP software to automatically process this data, analyze the intent or sentiment in the message, and respond in real time to human communication.

Why is NLP important?

- Natural language processing (NLP) is critical to fully and efficiently analyze text and speech data.
- It can work through the differences in dialects, slang, and grammatical irregularities typical in day-to-day conversations.

- Companies use it for several automated tasks, such as to:
- Analyze customer feedback or call center recordings
- Run chatbots for automated customer service
- Answer who-what-when-where questions
- Classify and extract text

- You can also integrate NLP in customer-facing applications to communicate more effectively with customers.
  - For example, a chatbot analyzes and sorts customer queries, responding automatically to common questions and redirecting complex queries to customer support. This automation helps reduce costs, saves agents from spending time on redundant queries, and improves customer satisfaction.

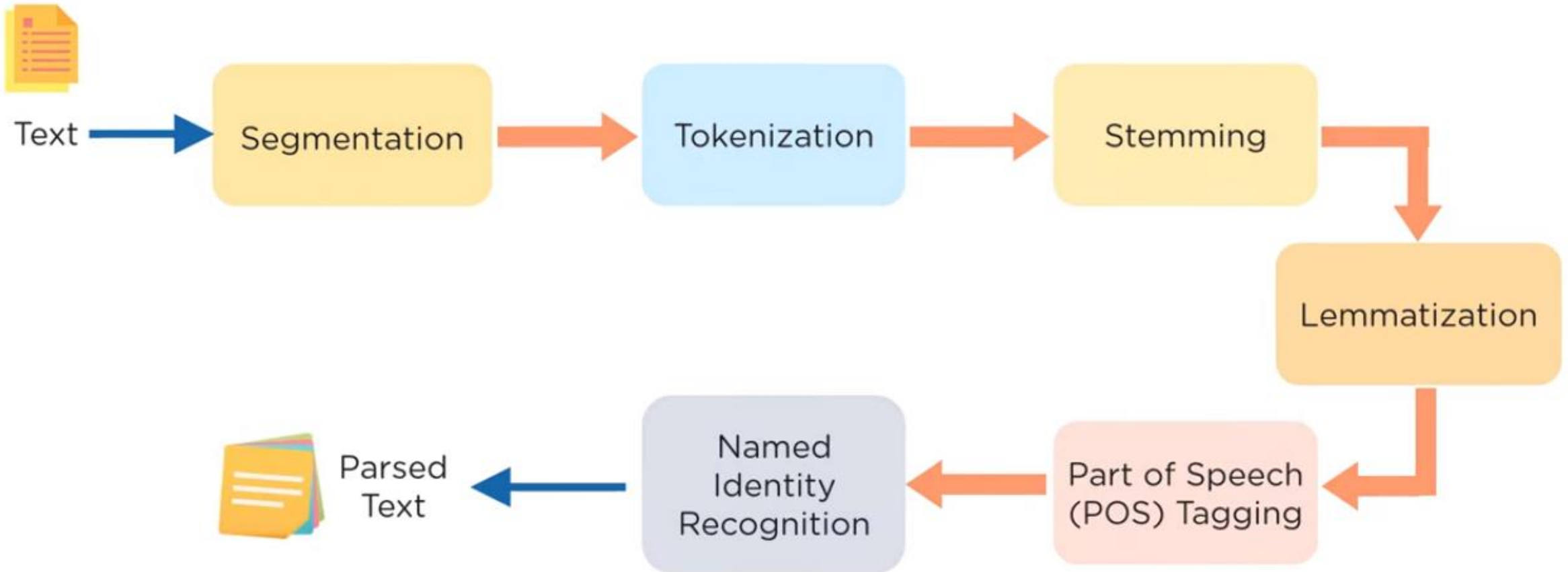
How does NLP work?

Natural language processing (NLP) combines computational linguistics, machine learning to process human language

- Computational linguistics
- Computational linguistics is the science of understanding and constructing human language models with computers and software tools.
- Researchers use computational linguistics methods, such as syntactic and semantic analysis, to create frameworks that help machines understand conversational human language.
- Tools like language translators, text-to-speech synthesizers, and speech recognition software are based on computational linguistics.

- Machine learning
- Machine learning is a technology that trains a computer with sample data to improve its efficiency. Human language has several features like sarcasm, metaphors, variations in sentence structure, plus grammar and usage exceptions that take humans years to learn.
- Programmers use machine learning methods to teach NLP applications to recognize and accurately understand these features from the start.

NLP Pipeline



NLP Pipeline

Segmentation

The process of dividing a sentence into its component sentences, usually along punctuation marks

The lemonade quenched her thirst, but not her longing.

The lemonade quenched her thirst

but not her longing

NLP Pipeline

Tokenization

The process of splitting sentences into their constituent words is called Tokenization

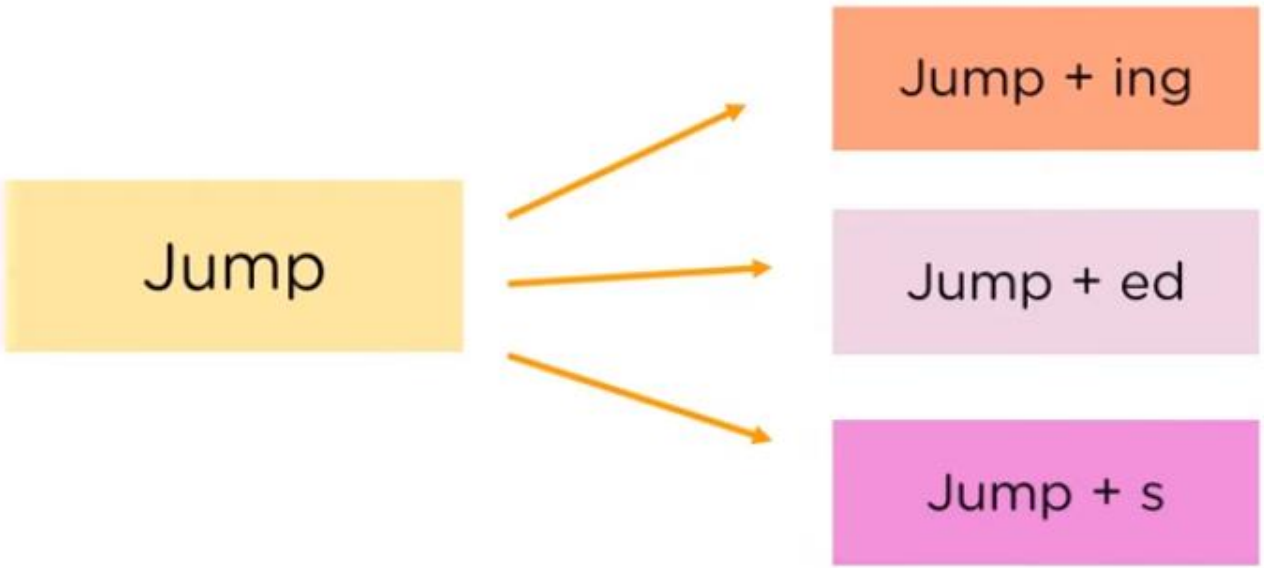
The lemonade quenched her thirst

- The
- lemonade
- quenched
- her
- thirst

NLP Pipeline

Stemming

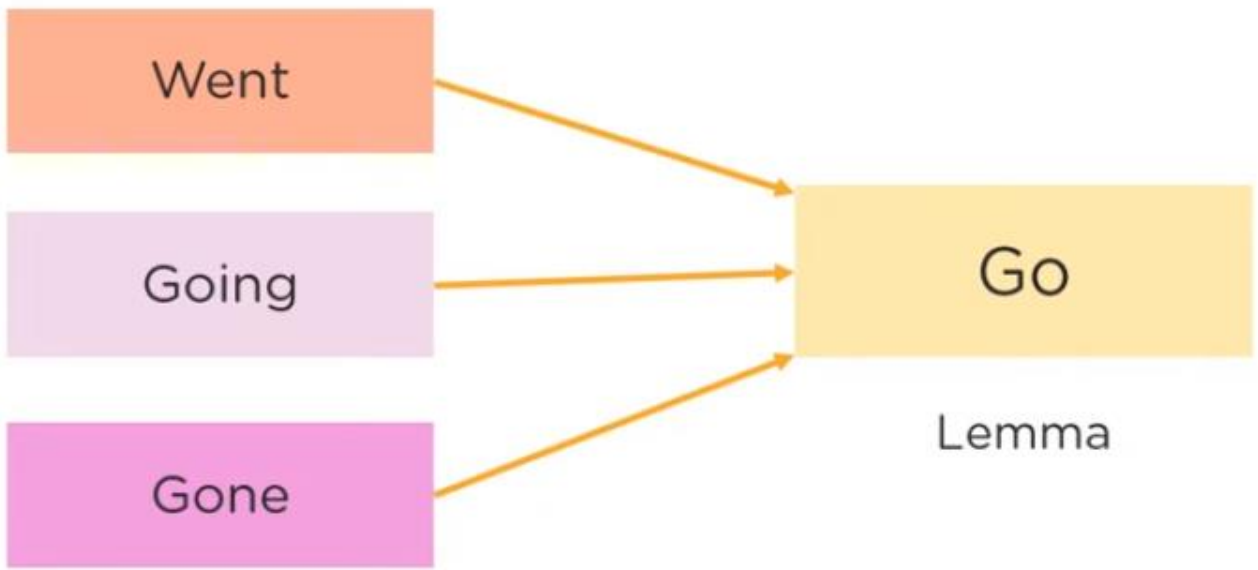
The process of obtaining the Word Stem of a word. Word Stem give new words upon adding affixes to them



NLP Pipeline

Lemmatization

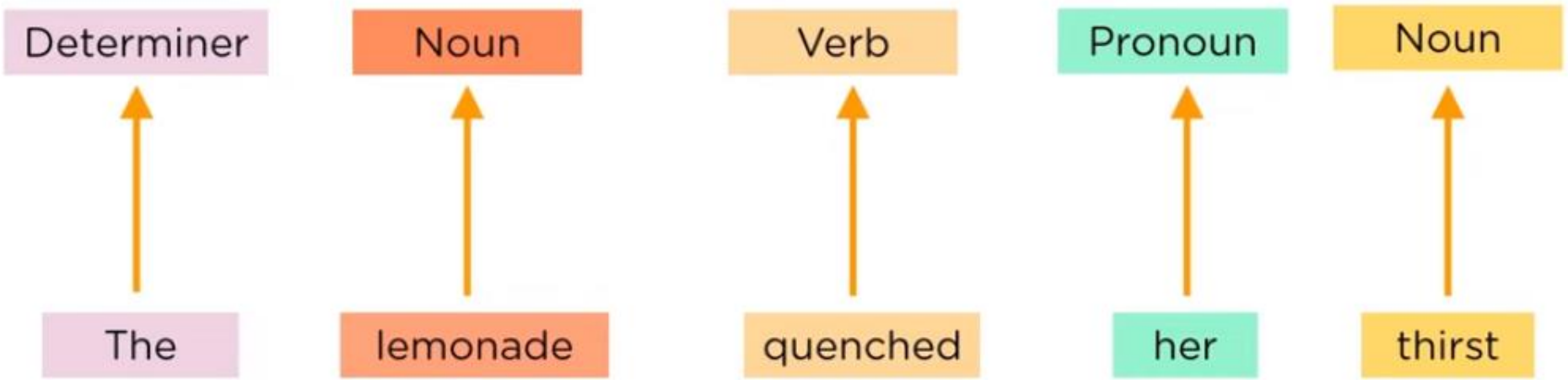
The process of obtaining the Root Stem of a word.
Root Stem give new base form of a word



NLP Pipeline

Part of Speech tagging

Identifies which part of speech a word belongs to.
It tags a word as a verb, noun, pronoun etc.



NLP Pipeline

Named Entity Recognition

Classifying the words into subcategories.
The subcategories are :

Person

Quantity

Location

Organization

Movie

Monetary Value

What are NLP tasks?

Part-of-speech tagging

This is a process where NLP software tags individual words in a sentence according to contextual usages, such as nouns, verbs, adjectives, or adverbs.

It helps the computer understand how words form meaningful relationships with each other.

- **Word-sense disambiguation**
- Some words may hold different meanings when used in different scenarios.
- For example, the word "bat" means different things in these sentences:
  - A bat is a creature.
  - Baseball players use a bat to hit the ball.
- With word sense disambiguation, NLP software identifies a word's intended meaning, either by training its language model or referring to dictionary definitions.

What are NLP tasks?

Speech recognition

Speech recognition turns voice data into text. The process involves breaking words into smaller parts and understanding accents, slurs, and nonstandard grammar usage in everyday conversation. A key application of speech recognition is transcription, which can be done using speech-to-text services like Amazon Transcribe.

- **Machine translation**
- Machine translation software uses natural language processing to convert text or speech from one language to another while retaining contextual accuracy. The AWS service that supports machine translation is Amazon Translate.

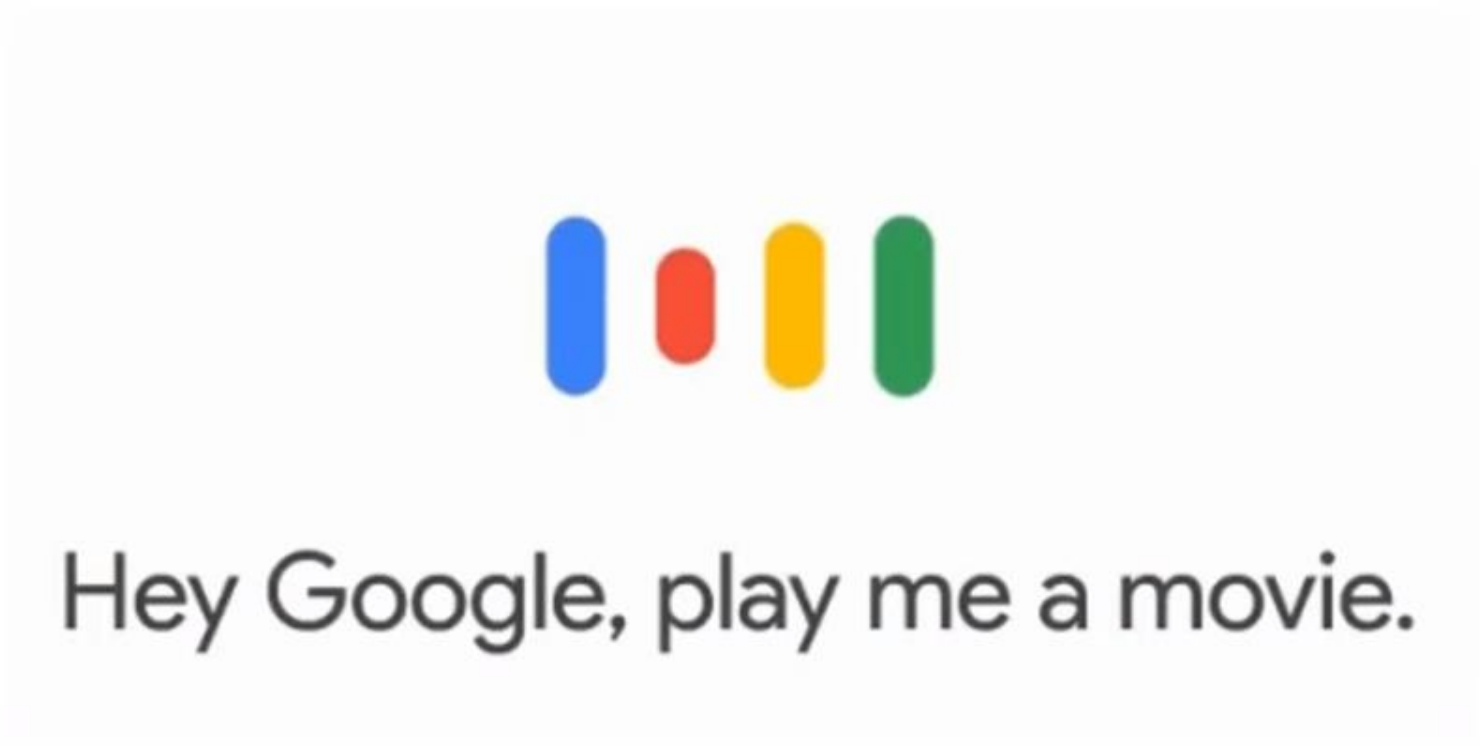
What are NLP tasks?

Sentiment analysis
Sentiment analysis is an artificial intelligence-based approach to interpreting the emotion conveyed by textual data. NLP software analyzes the text for words or phrases that show dissatisfaction, happiness, doubt, regret, and other hidden emotions.

Applications of NLP

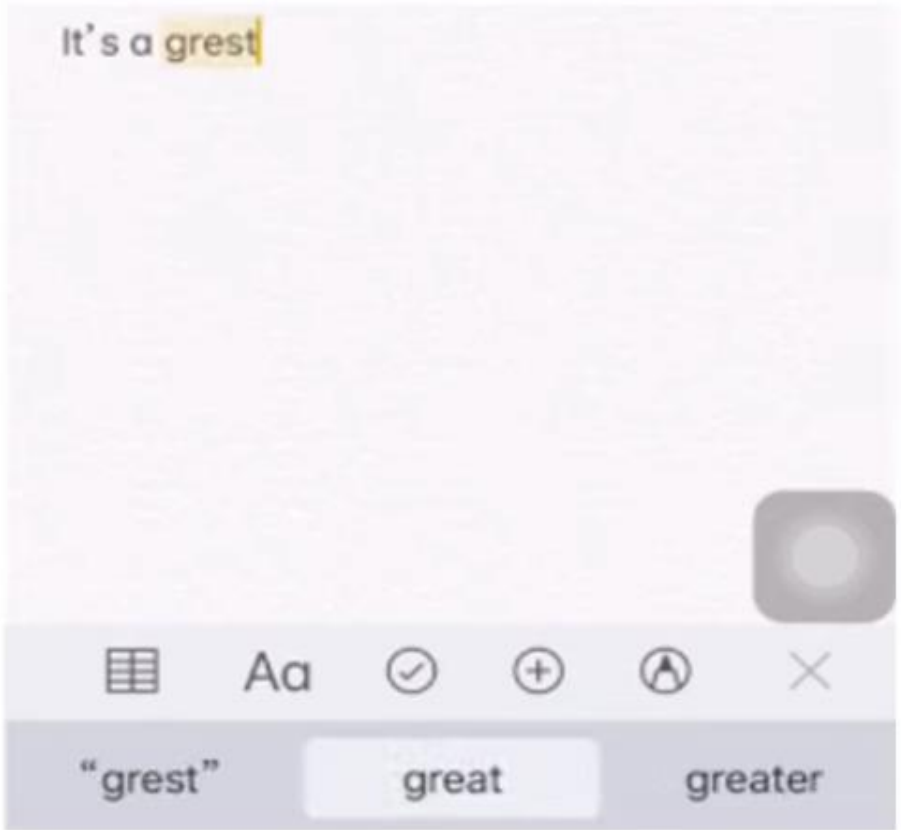
Chatbot

Applications of NLP



Speech Recognition

Applications of NLP



Autocorrect

How can AWS help with your NLP tasks?

- AWS provides the broadest and most complete set of artificial intelligence and machine learning (AI/ML) services for customers of all levels of expertise..

- For customers that lack ML skills, need faster time to market, or want to add intelligence to an existing process or an application, AWS offers a range of ML-based language services. These allow companies to easily add intelligence to their AI applications through pre-trained APIs for speech, transcription, translation, text analysis, and chatbot functionality.

- Here's a list of AWS ML-based language services:

- Amazon Comprehend helps discover insights and relationships in text
- Amazon Transcribe performs automatic speech recognition
- Amazon Polly turns text into natural-sounding speech
- Amazon Lex helps build chatbots to engage with customers
- Amazon Kendra does an intelligent search of enterprise systems to quickly find the content one is looking for

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Sentiment Analysis

Using Machine Learning NLP

Listening to customers is rewarding for businesses

Your most unhappy customers are your greatest source of learning.

-Bill Gates

Customer feedbacks may take multiple forms

Structured Feedbacks

- Mix of Ratings & Reviews
  - Google, Amazon, Zomato, etc.
- Ratings are proxy to sentiments
  - <3 - Negative, 3 - Neutral, >3 - Positive
- Aggregation of feedbacks is very much possible

Customer feedbacks may take multiple forms

Structured Feedbacks

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  - Google, Amazon, Zomato, etc.
- Ratings are proxy to sentiments
  - <3 - Negative, 3 - Neutral, >3 - Positive
- Aggregation of feedbacks is very much possible

Unstructured Feedbacks

- Plain Text Feedbacks
  - Facebook, Instagram, Twitter, etc.
- No Ratings to understand sentiments
- Aggregation of feedbacks not possible

Social media reviews are unstructured

Restaurant review on Twitter	Review Sentiment (with manual reading)
Reviewer 1 My life will forever be marked as "BEFORE Domino's Chocolate Lava Crunch Cakes with Icing" and "AFTER Domino's Chocolate Lava Crunch Cakes with Icing." No joke. I- I-- 😍😋🍫🤎 @dominos #Dominos	
Reviewer 2 ... Just got my order of 4 italian sausage pastas from **#Dominos**	
Reviewer 3 ... Almost 2.5 hours and still waiting on one pizza and one order of breadsticks **#Dominos**	
No aggregation possible	

That's where machine learning comes in...

- NLP-based Sentiment Analysis technique can predict sentiments for such reviews
- Allowing businesses to analyse customer feedbacks at scale
  - *and resolve customer complaints, if there's any*

Business Case: Sentiment Analysis

- ABC Restaurant intends to build a binary classification model (positive/ negative) for customer reviews received on their facebook page
- Business intends to build an inhouse customer support team to call-back customers who gave negative feedbacks, and resolve their issues/complaints, ensuring they revisit
- Restaurant has shared following datasets:
  - Historical reviews - along with labels
  - Fresh reviews - without labels
    - Client wants us to generate labels for this

Customer Reviews	Review Label
Review 1	Positive
Review 2	Negative
Review 3	Positive

ABC Restaurant has shared couple of datasets with us

- **Historical review dataset** - with positive/negative (1/0) labels for model preparation - 900 observations

Review	Liked
Wow... Loved this place.	1
Crust is not good.	0
Not tasty and the texture was just nasty.	0
Stopped by during the late May bank holiday off Rick Steve recommendation and loved it.	1
The selection on the menu was great and so were the prices.	1

- **Current week's review dataset** - for which labels are to be generated - 100 observations

Review	Liked
I'm super pissd.	
And service was super friendly.	
Why are these sad little vegetables so overcooked?	
This place was such a nice surprise!	
They were golden-crispy and delicious.	

Intuition - Data Cleaning

1. Wow... Loved this place.
2. Crust is not good.
3. Not tasty and the texture was just nasty.
4. Also there are combos like a burger, fries, and beer for 23 which is a decent deal.
5. I would definitely recommend the wings as well as the pizza.
6. Highly recommended.

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5. i would definitely recommend the wings as well as the pizza
6. highly recommended

Stop words

To-be-stemmed words

Intuition - Data Cleaning

1. wow love place
2. crust not good
3. not tasti textur nasti
4. also combo like burger fri beer decent deal
5. would definit recommend wing well pizza
6. highli recommend

Intuition - Data Transformation

1. wow love place
2. crust not good
3. not tasti textur nasti
4. also combo like burger fri beer decent deal
5. would definit recommend wing well pizza
6. highli recommend

Review	Liked
wow love place	1
crust not good	0
not tasti textur nasti	0

Intuition - Data Transformation

Original Reviews → Dropping Special Characters & #'s → Converting to small-case → Dropping Stopwords & Stemming → Bag of words

Review	Liked
wow love place	1
crust not good	0
not tasti textur nasti	0

1. Bag of words representation discards information on order and sequencing of words
2. Dropping tokens (unique words) that only reflect in only a few reviews, reduces sparsity

wow	love	place	crust	not	good	tasti	textur	nasti	Liked
1	1	1	0	0	0	0	0	0	1
0	0	0	1	1	1	0	0	0	0
0	0	0	0	1	0	1	1	1	0

Intuition - Naive Bayes Classification

- Naive Bayes Classifier works on conditional probabilities

Model prediction for sentiment:

1. This place is wow
    a. place wow

Model Prediction for Liked = Max (Prob(+ve | [101000000]), P(-ve| [101000000]))

wow	love	place	crust	not	good	tasti	textur	nasti	Liked
1	1	1	0	0	0	0	0	0	1
0	0	0	1	1	1	0	0	0	0
0	0	0	0	1	0	1	1	1	0

Intuition - Naive Bayes Classification

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wow	love	place	crust	not	good	tasti	textur	nasti	Liked
1	1	1	0	0	0	0	0	0	1
0	0	0	1	1	1	0	0	0	0
0	0	0	0	1	0	1	1	1	0
1	0	1	0	0	0	0	0	0	?

Intuition - Naive Bayes Classification

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1	1	1	0	0	0	0	0	0	1
0	0	0	1	1	1	0	0	0	0
0	0	0	0	1	0	1	1	1	0
1	0	1	0	0	0	0	0	0	?

Image Processing

And Machine Learning Applications

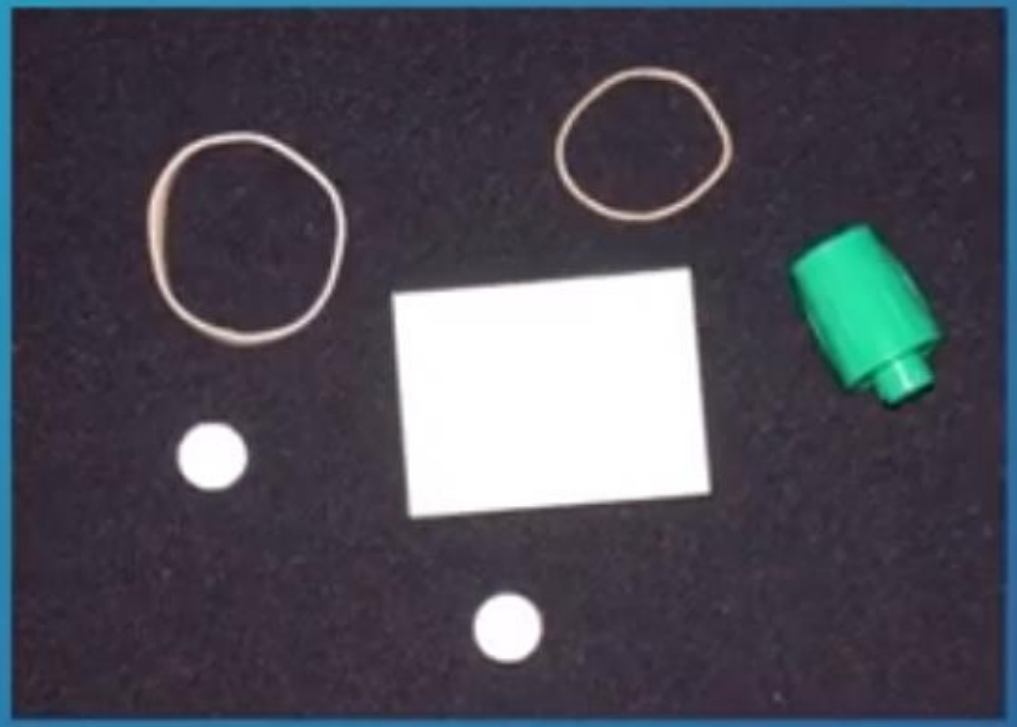
What Is an Image?

- Before we jump into image processing, we need to first understand what exactly constitutes an image.
- An image is represented by its dimensions (height and width) based on the number of pixels. For example, if the dimensions of an image are 500 x 400 (width x height), the total number of pixels in the image is 200000.

- This pixel is a point on the image that takes on a specific shade, opacity or color.
- It is usually represented in one of the following:

- Grayscale - A pixel is an integer with a value between 0 to 255 (0 is completely black and 255 is completely white).
- RGB - A pixel is made up of 3 integers between 0 to 255 (the integers represent the intensity of red, green, and blue).
- RGBA - It is an extension of RGB with an added alpha field, which represents the opacity of the image.

How Computers see Image



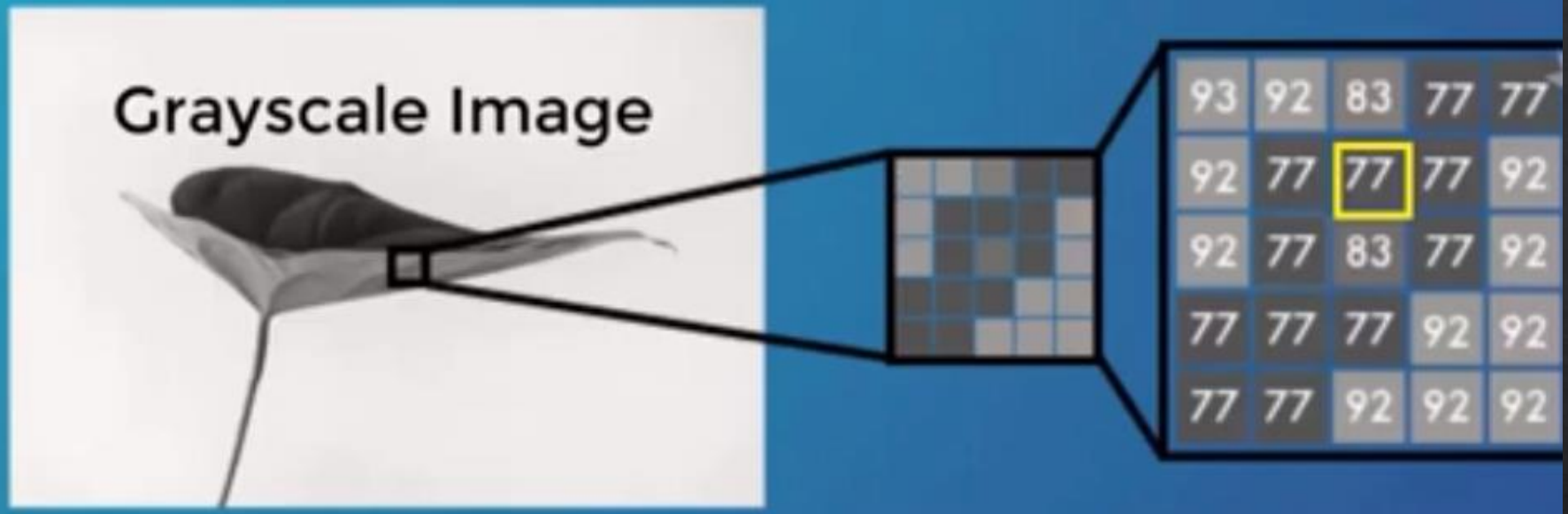
How Computers see Image

PIXELS

[10, 250 ,0]

Pixel Intensity

How Computers see Image



How Computers see Image

Color Image

[240, 10, 20]

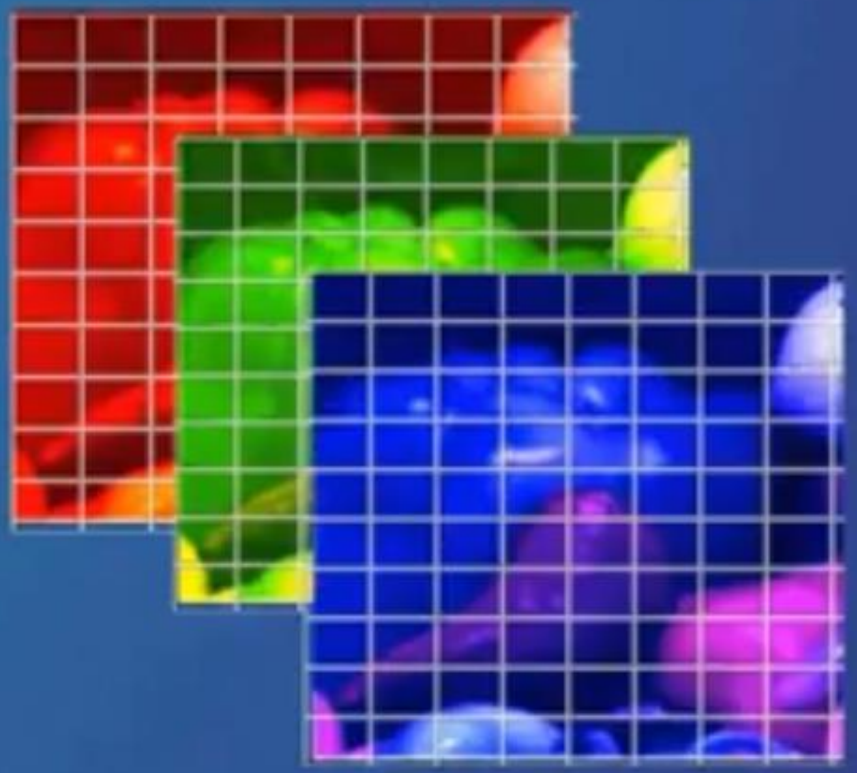


Image Processing

- Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it.
- Image processing is the process of transforming an image into a digital form and performing certain operations to get some useful information from it.

Types of Image Processing

- There are five main types of image processing:

- Visualization - Find objects that are not visible in the image
- Recognition - Distinguish or detect objects in the image
- Sharpening and restoration - Create an enhanced image from the original image
- Pattern recognition - Measure the various patterns around the objects in the image
- Retrieval - Browse and search images from a large database of digital images that are similar to the original image

IMAGE PROCESSING TECHNIQUES

- Image Enhancement
- Color Image processing
- Image Restoration
- Image Segmentation
- Morphological Operations
- Object Detection

- Image Enhancement
- Image enhancement is the process of bringing out and highlighting certain features of interest in an image that has been obscured. This can involve changing the brightness, contrast, etc.
- Image Restoration
- Image restoration is the process of improving the appearance of an image. However, unlike image enhancement, image restoration is done using certain mathematical or probabilistic models.
- Color Image Processing
- Color image processing includes a number of color modeling techniques in a digital domain. This step has gained prominence due to the significant use of digital images over the internet.

Image Enhancement

Image Restoration

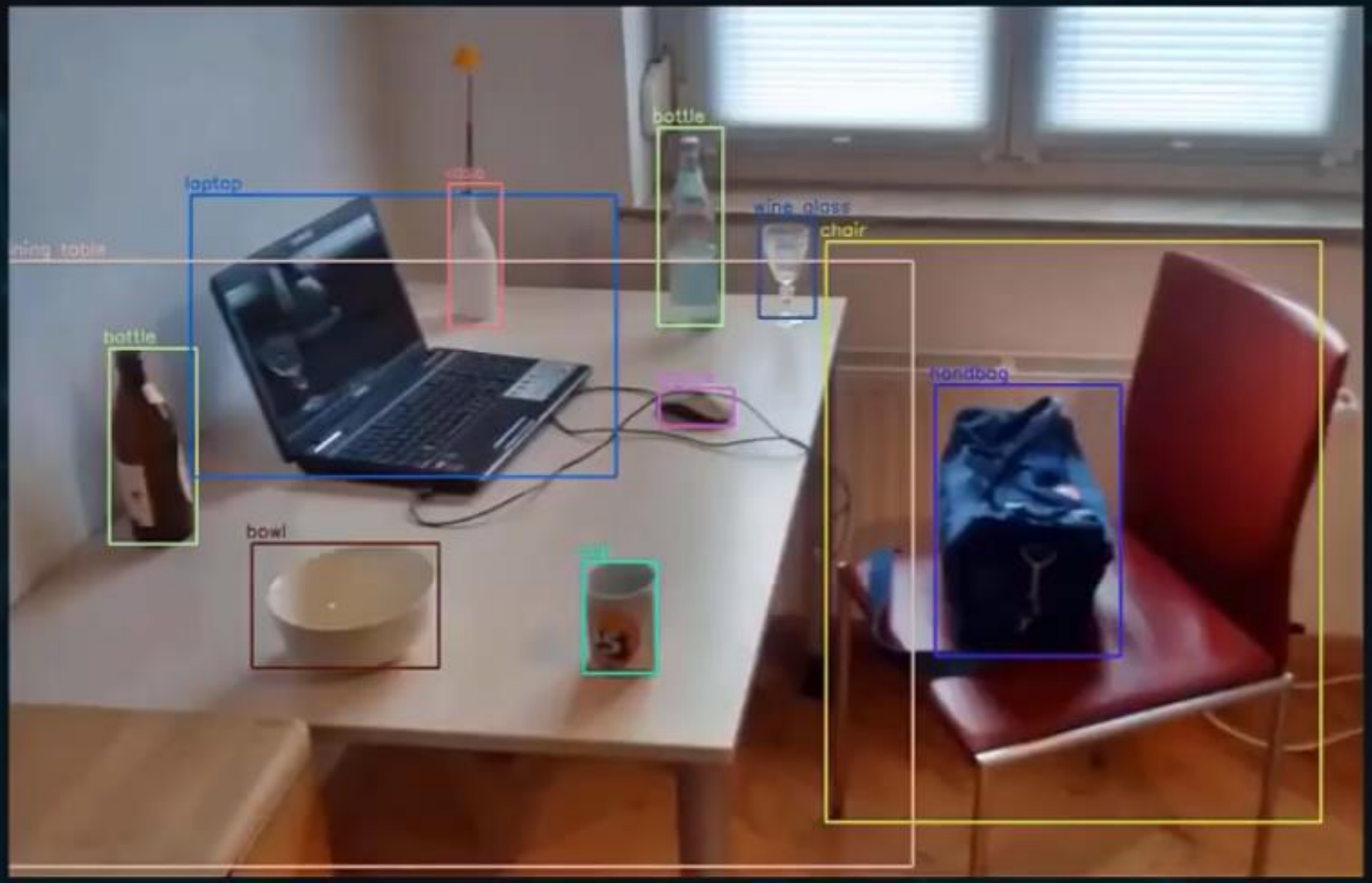
Color Image Processing

- Morphological Processing
- Morphological processing is a set of processing operations for morphing images based on their shapes.
- Segmentation
- Segmentation is one of the most difficult steps of image processing. It involves partitioning an image into its constituent parts or objects.

Image Morphing

Image Segmentation

Object Detection



COLOR IMAGE PROCESSING

Image Blurring and Edge Detection

Bokeh Effect

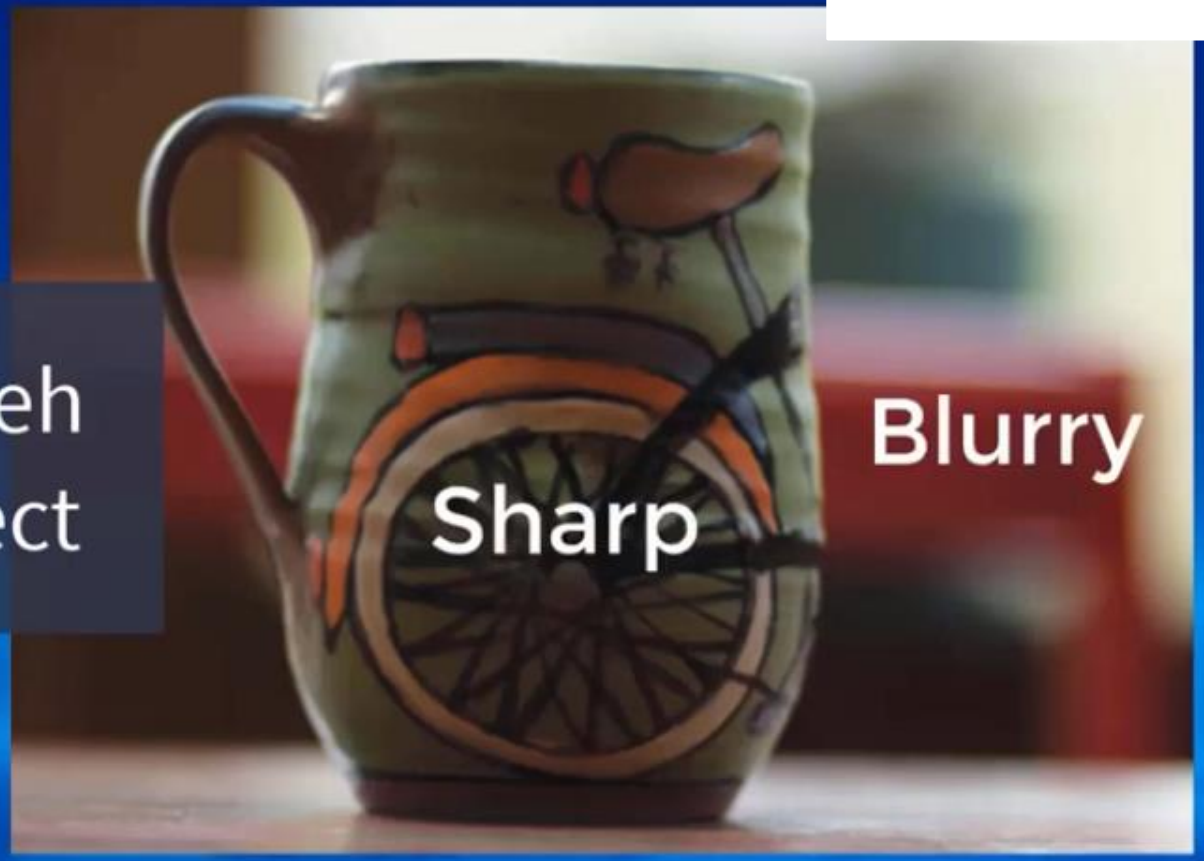


Image Blurring and Edge Detection

Edge Detection

Image Blurring

Image processing using machine learning has a wide range of applications

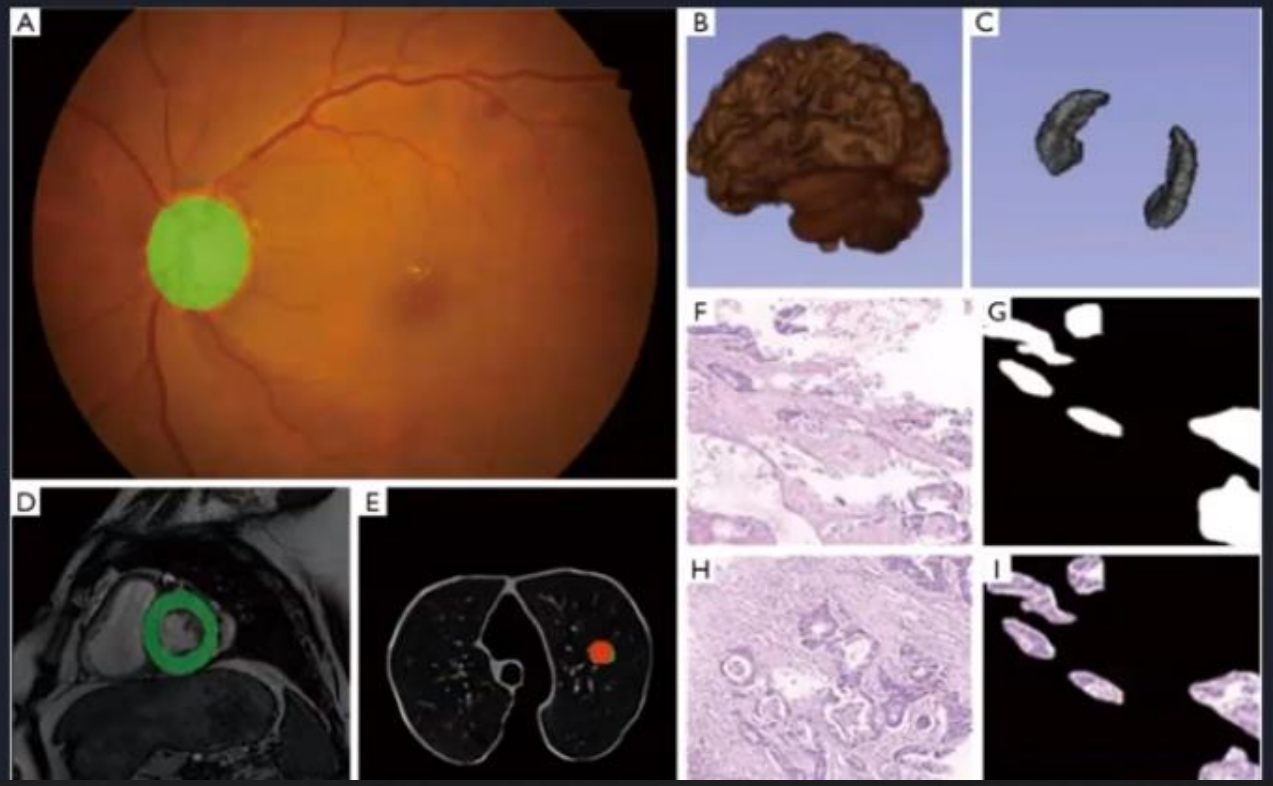
- Medical Imaging:

- Medical Image Segmentation: Machine learning models can segment medical images to identify and isolate regions of interest, such as tumors or organs.
- Disease Diagnosis: ML models can assist in diagnosing diseases by analyzing medical images like X-rays, MRIs, and CT scans.

Medical Image Processing

Image classification can be used in the medical field in order to identify and notify diseased patients.

- Identify Cancer
- Identify any other disease from an image



- Computer Vision:

- Object Detection and Recognition: ML models can detect and recognize objects within images or video streams, which is useful in applications like autonomous vehicles and surveillance.
- Facial Recognition: ML can be used for facial recognition for security, access control, and user authentication.

Facial Recognition

Two main types:

- Authentication (Binary Classification)
  - Phones
  - Door access
  - Banking
- Recognition (Multiclass Classification)
  - Criminal identification
  - Card Counter recognition in casinos

- Remote Sensing:

- Land Cover Classification: Machine learning models can classify land cover types from satellite or aerial images for applications like urban planning and environmental monitoring.
- Change Detection: ML can identify changes in remote sensing data over time, such as deforestation or urban expansion.

- Natural Language Processing (NLP):
- Image Captioning: Combining image processing with NLP, models can generate textual descriptions of images.

- Agriculture:
- Crop Monitoring: Machine learning can analyze images from drones or satellites to monitor crop health and yield prediction.

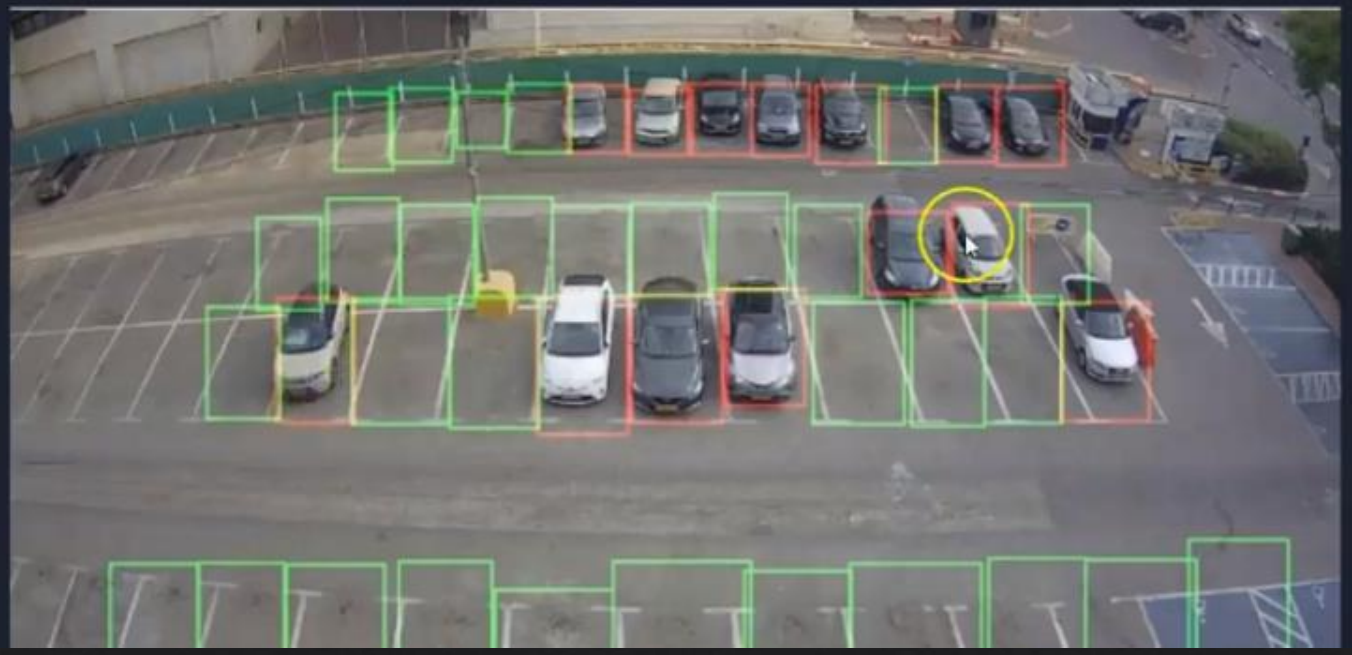
- Retail and E-commerce:
- Visual Search: ML-based image recognition helps customers find products by uploading images, improving the online shopping experience.
- Document Processing:
- Automating data extraction from documents, forms, or invoices.
- Recognizing and digitizing handwritten text.

Other applications of machine learning using image processing

- Agriculture:
  - Animal Monitoring
  - Insect Detection
  - Disease Detection
  - Flowering Detection
  - Automatic Harvesting/Weeding
- Retail:
  - People Counting
  - Theft Detection
  - Waiting Time Analysis
- Sports:
  - Ball tracking
  - Goal-line Tech
  - Player performance
  - Pose Tracking
- Transportation
  - Parking Availability
  - Traffic detection
  - Driver Attentiveness

Parking Availability

- This is the use of image classification in order to detect which spots are vacant and which spots are occupied.
- This is a type of binary classification.



Airports

- Security footage to recognize known criminals?
- X Ray imagery to identify weapons?
- Can we automate these planes such that they were capable of flying on their own?
- Is it possible to automate the traffic control such that one application is able to view an image of all flying and landed planes, and give out instructions to each plane based on this image of the traffic?
- Can we install cameras inside each plane in order to ensure that each person in the seat is the same person that owns the ticket to that seat, along with recognizing possible missing attendants?
    - Notify people who purchased a ticket, but missed the flight.

Is Image Processing Part of Machine Learning?

Is Image Processing Part of Machine Learning?

- Image processing and machine learning are related fields, but they are not the same. Image processing is a broader field that involves manipulating and analyzing images to enhance their quality, extract information, or perform various operations on them.
- Image processing techniques include tasks like filtering, edge detection, noise reduction, and image enhancement. These operations are often performed using traditional computer vision techniques and signal processing methods.

Is Image Processing Part of Machine Learning?

- On the other hand, machine learning is a subfield of artificial intelligence that focuses on developing algorithms and models that can learn from data and make predictions or decisions without being explicitly programmed.
- In practice, machine learning is often applied to image processing tasks to perform more complex tasks, such as image classification, object detection, facial recognition, and image segmentation. Deep learning techniques, particularly convolutional neural networks (CNNs), have been highly successful in these applications.
- In this context, machine learning is used as a tool within image processing to automate the extraction of meaningful information from images.

- So, while image processing and machine learning are distinct fields, they frequently overlap, and machine learning is a valuable tool for image processing tasks that involve complex recognition, classification, and interpretation of visual data.

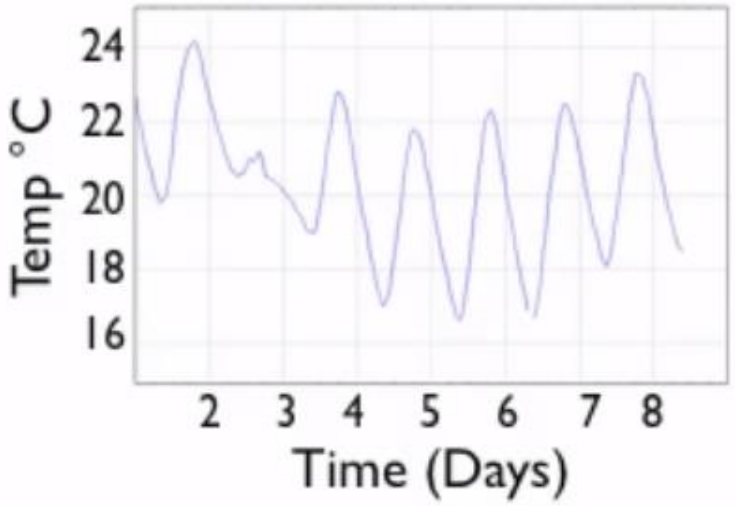
Signal Processing

And Machine Learning Applications

Signals

- A "signal" describes how some physical quantity varies over time and/or space

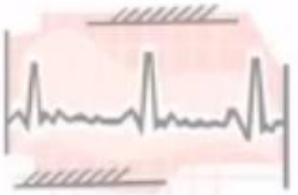
River Temperature



Alpine Lake Image

Examples of Signals

- Sound pressure
- Radio or television broadcast
- Movie
- Electrocardiogram
- Sunspot count
- Accelerator position

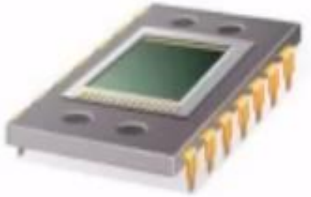


Signal Processing

- Signal processing involves converting or transforming data in a way that allows us to see things in it that are not possible via direct observation.
- Signal processing allows engineers and scientists to analyze, optimize, and correct signals, including scientific data, audio streams, images, and video.

Signal Processing

- Manipulating a signal to change its characteristics or extract information
- Performed by
  - ➡ Computer



  - ➡ Special purpose integrated circuits
  - ➡ Analog electrical circuits

Signal Processing Applications

- Telecommunications: Signal processing techniques are used in telecommunications to transmit, receive, and process signals over communication channels. This includes tasks such as modulation, demodulation, error correction, and signal amplification.
- Audio and video processing: Signal processing techniques are used to enhance the quality and clarity of audio and video signals, as well as to extract features such as speech, music, and moving objects.
- Image processing: Signal processing techniques are used to improve the quality and resolution of images, as well as to extract features such as edges, shapes, and textures.
- Speech recognition: Signal processing techniques are used to analyze and interpret speech signals, enabling the development of systems that can transcribe speech or recognize spoken commands.

- Control systems: Signal processing techniques are used in control systems to stabilize and optimize the performance of systems by processing feedback signals from sensors and actuators.
- Biomedical engineering: Signal processing techniques are used in biomedical engineering to analyze and interpret signals from medical devices such as electrocardiograms (ECGs) and magnetic resonance imaging (MRI) scanners.
- Financial engineering: Signal processing techniques are used in financial engineering to analyze and interpret financial data and to develop predictive models for financial markets.

The signal processing process

Signal acquisition: The first step in signal processing is to acquire the input signal. This may involve using sensors to measure physical quantities such as temperature, pressure, or acceleration, or it may involve capturing audio, video, or other types of data.

Signal conversion: If the input signal is in an analog format, it may need to be converted into a digital format using an analog-to-digital converter (ADC). This allows the signal to be processed using digital techniques, such as mathematical operations and algorithms.

Signal representation: The input signal is then represented in a suitable form for processing. This may involve representing the signal as a discrete sequence of samples or as a continuous function.

The signal processing process

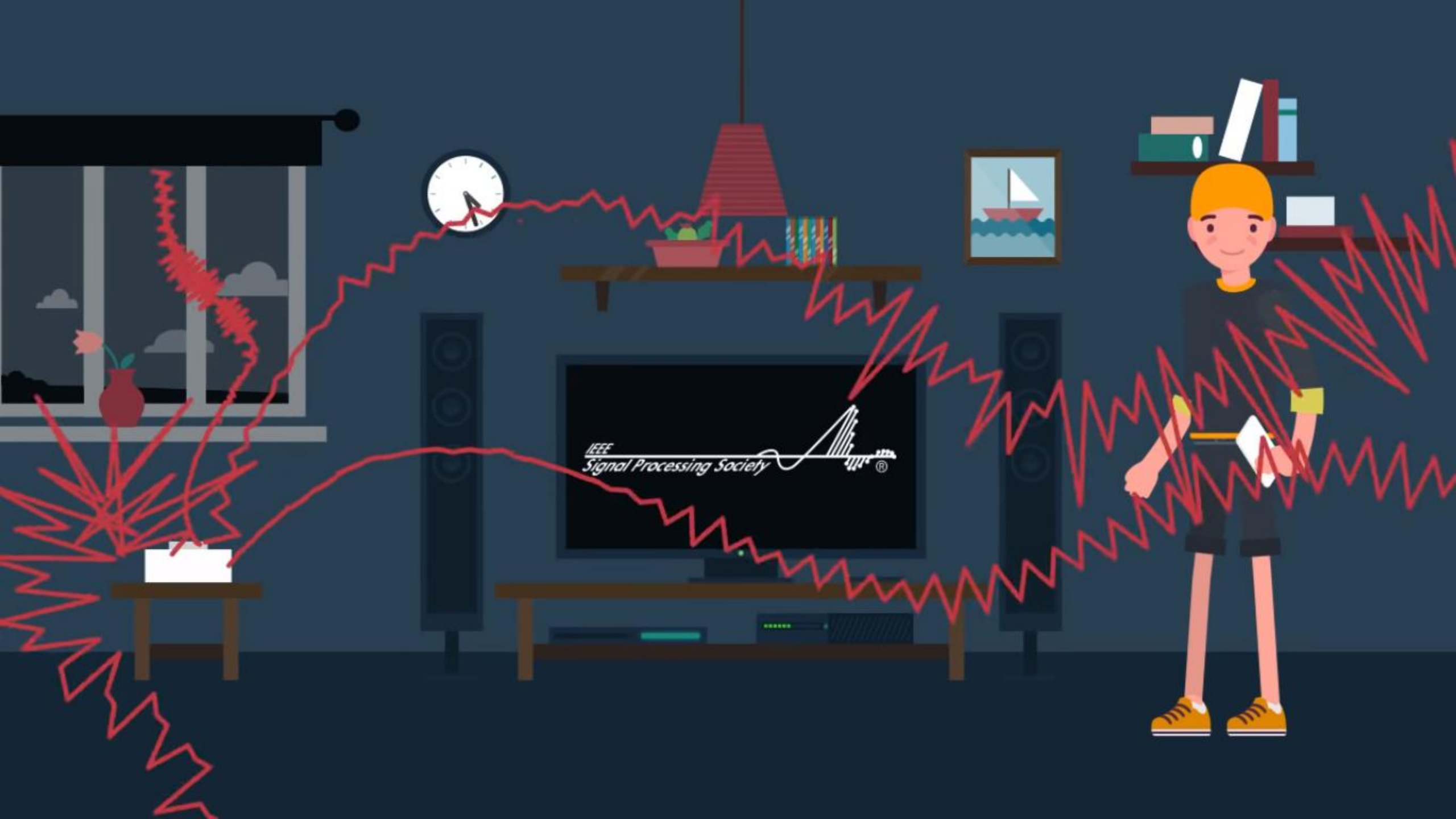
Signal manipulation: The input signal is then manipulated using various techniques such as filtering, noise reduction, compression, and feature extraction. These techniques can be implemented using algorithms and mathematical operations.

Signal analysis: The manipulated signal is then analyzed to extract useful information or to make decisions. This may involve detecting patterns or features in the signal, classifying the signal into different categories, or estimating the values of certain parameters.

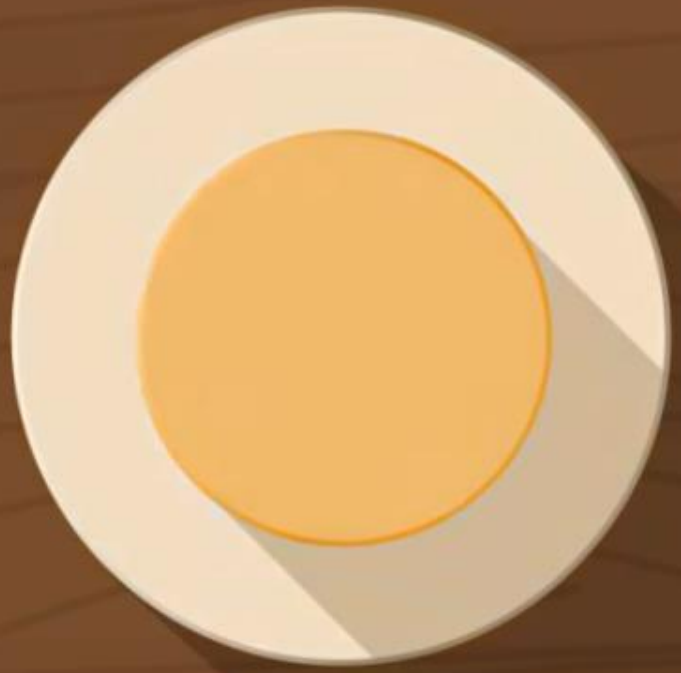
Signal output: The final step in signal processing is to output the resulting signal. This may involve converting the signal back to an analog format using a digital-to-analog converter (DAC) or displaying the signal on a screen or speaker.


How do Amazon Echo & Google Home understand my questions?


How do Amazon Echo & Google Home understand my questions?
Signal Processing
IEEE Signal Processing Society

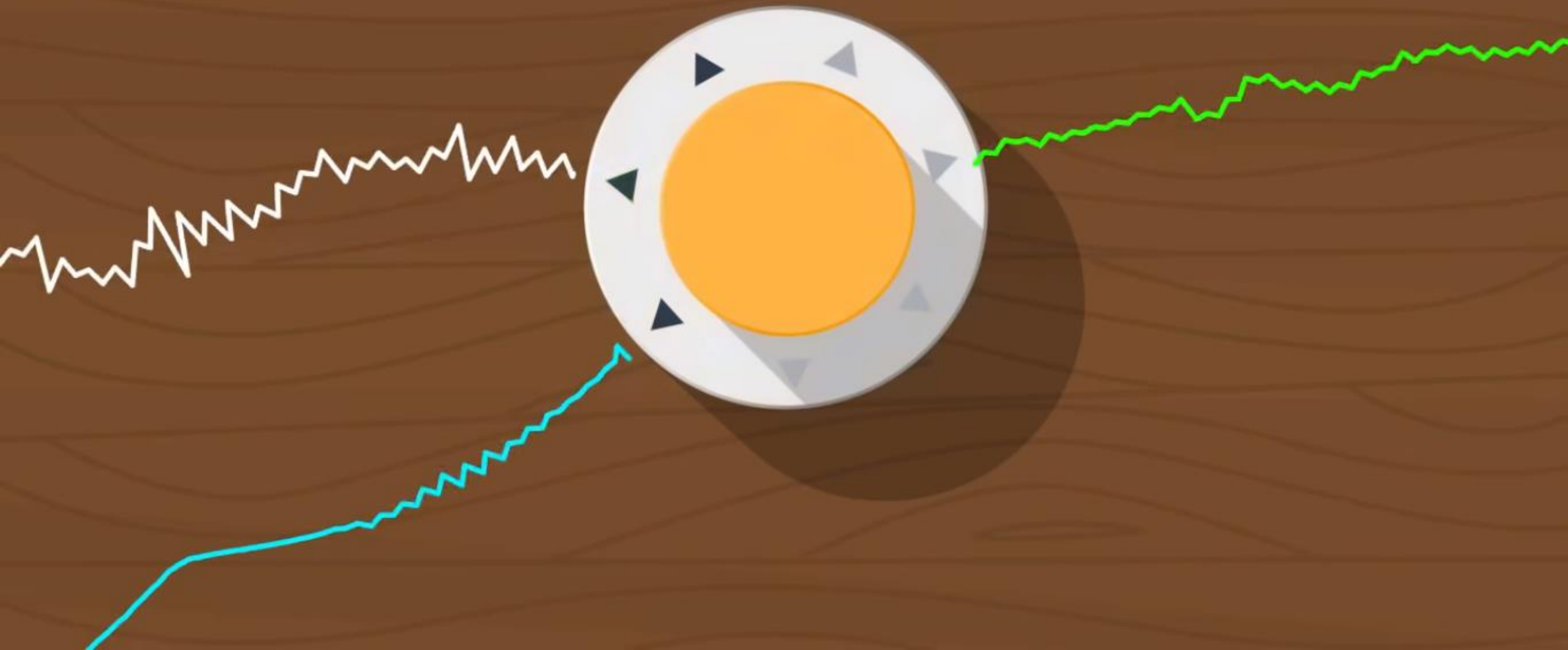

IEEE
Signal Processing Society

+ Multi-Channel Speech Processing +

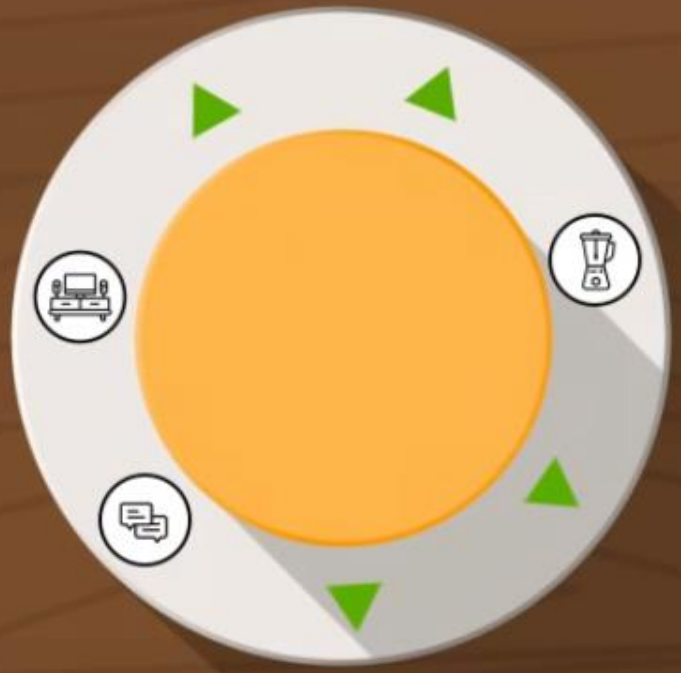


specific machine learning techniques

+ Multi-Channel Speech Processing +



+ Multi-Condition Training



What are the current trends and applications of machine learning in signal processing

- Wireless communication
- Wireless communication is the process of transmitting and receiving data over the air using electromagnetic waves, such as radio, microwave, or optical signals.
  - ML can help to enhance wireless communication, as it can learn from the channel conditions and optimize the communication parameters, such as modulation, coding, power, and frequency.
  - ML can also help to detect and mitigate interference, improve security, and enable cognitive radio.
- Radar detection
- Radar detection is the process of using radar signals to locate and identify objects, such as aircraft, ships, or missiles.
  - ML can help to improve radar detection, as it can learn from the radar data and extract relevant features and signatures.
  - ML can also help to classify and track the objects, reduce clutter, and enhance resolution.

What are the current trends and applications of machine learning in signal processing

- Speech recognition
- Speech recognition is the process of converting human speech into text or commands that can be understood by machines. ML plays a vital role in speech recognition, as it can learn from large amounts of speech data and extract useful features and patterns. ML can also help to reduce noise, enhance quality, and adapt to different accents and languages.
- Image compression
- Image compression is the process of reducing the size of an image file without compromising its quality or information.
  - ML can help to improve image compression, as it can learn from the original images and generate compact representations that can be reconstructed with minimal distortion. ML can also help to optimize the compression parameters, such as bit rate, quality, and format.