Unit - 5

Q1. AI Applications

Applications of AI include the following →

- Marketing
- Banking
- Finance
- Agriculture
- Healthcare
- Gaming
- Space Exploration
- Autonomous vehicles
- Information Retrieval
- Natural Language processing
- Machine Translation
- Speech recognition
- Chatbots
- Artificial creativity

1. Marketing →

- AI is used to suggest all relevant items and possible results in a matter of seconds when we search for an item in an e-commerce store.
- With the growing advancements of AI, it may be possible to buy products by snapping a photo of it, in the near future

2. Banking →

- A lot of banks have already adopted AI based systems to provide customer support, detect anomalies and credit card frauds.

eg. HDFC bank has developed an AI based chatbot called EVA (Electronic Virtual Assistant)

- AI solutions can be used to enhance security across several business sectors like retail and finance.

- By tracing card usage and endpoint access, security specialists can prevent fraud.
Companies such as MasterCard and RBS WorldPay rely on AI and Deeplearning to detect fraudulent transaction patterns and prevent card fraud.

3. Finance →

- Ventures rely on computers and data scientists to predict future patterns in market.

- Trading mainly depends on the ability to predict the future accurately

- Machines are great at this as they can crunch a huge amount of data in a short span. Machines can also observe patterns in past data and predict how those patterns may repeat in the future.

4. Agriculture →

- Organizations can use automation and robotics to help farmers find more efficient ways to protect their crops from weeds.

- Blue River Technology has developed a robot called See & Spray which uses computer vision technologies like object detection to monitor an precisely spray weedicide on cotton plants.
Precision spraying can help prevent herbicide resistance.

- The image recognition app identifies possible defects through images captured by the user's smartphone camera. Users are then offered soil restoration tips, techniques and other possible solution.

5. Health Care →

- AI can be used to give the physician a warning when the patient is at risk of having a heart stroke.

- It can help in preventive care

- It can help provide personalized medicine.

6. Gaming →

- One of the biggest accomplishments of AI is in the gaming industry.

- DeepMind's AI-based AlphaGo software, which is known for defeating Lee Sedol, the world champion in the game GO, is considered to be one of the most significant accomplishments in the field of AI.

- The actions taken by the opponent AI are unpredictable as they are designed in such a way as that the opponent gets better as the game gets harder. They are trained throughout the game and never make the same mistakes. This makes the game very challenging and prompts players to constantly switch strategies.

7. Space Exploration →

- Space expeditions and discoveries require analyzing vast amounts of data. AI and ML ~~make~~ is the best way to handle and process data on this scale.

- Nasa's AI based Mars rover called AEGIS is already on the red planet. It is responsible for autonomous targetting of cameras to perform investigations on Mars.
- After rigorous research, AI has been used by astronomers to sift through years of data obtained by the Kepler telescope in order to identify a distant eight planet solar system.

8. Autonomous Vehicles →

- Self-driving cars have been a buzzword in the AI industry.

- The AI system collects data from the vehicles radar, GPS, cameras etc. to produce control signals that operate the car

- Advance deep learning algorithms can accurately predict what the objects in the vicinity of vehicle are likely to do

- A famous example of an autonomous vehicle is Tesla's self driving car.

Q2. NLP

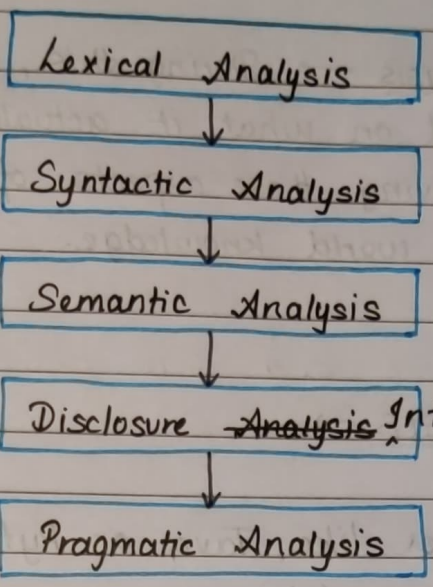
- NLP stands for Natural Language Processing
It involves taking some spoken / typed sentence and working out what it means (Natural Language Understanding) and taking a formal representation of what you want to say and working out a way to express it in natural human language (ie. English) (Natural Language Generation)

Applications of NLP →

- Information retrieval
- Machine translation
- Extracting data from text
- Database access
- Spoken language control systems
- Spelling and grammar check

NLP Steps →

- NLP has the following 5 steps in general →



Lexical Analysis → It involves identifying and analysing the structure of words. Lexicon of a language means the collection of words and phrases in a language. Lexical analysis involves dividing the whole chunk of text into paragraphs, sentences and words.

Syntactical Analysis → (Parsing) it involves analysing words in a sentence for grammar and ~~are~~ arranging words in a manner that shows the relationship among the words.

Semantic Analysis → It draws the exact meaning or dictionary meaning of text. The text is checked for meaningfulness.

Disclosure Integration → The meaning of a sentence depends upon the meaning of the sentence before it. In addition, it brings about the meaning of the immediately succeeding sentence.

Pragmatic Analysis → During this, what was said is re interpreted on what it actually meant. It involves deriving those aspects of language which require real world knowledge.

LANGUAGE MODELS →

Formal languages like Java or Python have precisely defined language models.
A language can be a set of strings
"print (2+2)" is a legal program in Python, but "2) + (2 print" is not. Since there are an infinite number of legal programs, they cannot be enumerated. Instead they are specified by a set of rules called grammar.
Formal languages also have rules that define the meaning or semantics of the program. eg the meaning of "2+2" is 4 and the meaning of "1/0" is that an error is signalled.

N-gram character models →

A written text is composed of characters - letters, digits, punctuations, spaces in English. A body of text is called corpus (plural : corpora) meaning body in Latin.
A model of. The probability ~~of~~ distribution of n-letter sequences is ~~thus~~ called an n-gram model.

Language identification →

Given a text, finding what natural language it is written in.

One approach to language is to build trigram character models for each candidate language. For each, ~~tr~~ model is built by counting trigrams in a corpus of that language.

Genre classification →

Deciding if a text is a story, a legal document, a scientific article, etc.

Name-entity recognition →

Involves finding names of things in a document and deciding what class they belong to. eg. In the text "Mr. John was prescribed aciphex", we should recognise "John" is the name of a person and "aciphex" is the name of a drug.

Smoothing n-gram models →

The major complication of n-gram model is that the training corpus provides only an estimate of the true probability distribution.
We will adjust our model so that sequences having count of zero in training ~~model~~ corpus will be assigned a small non zero probability, and other counts will be adjusted slightly downwards so that the total probability still sums to 1)
This process of adjusting the low frequency counts is called smoothing.

Model evaluation →

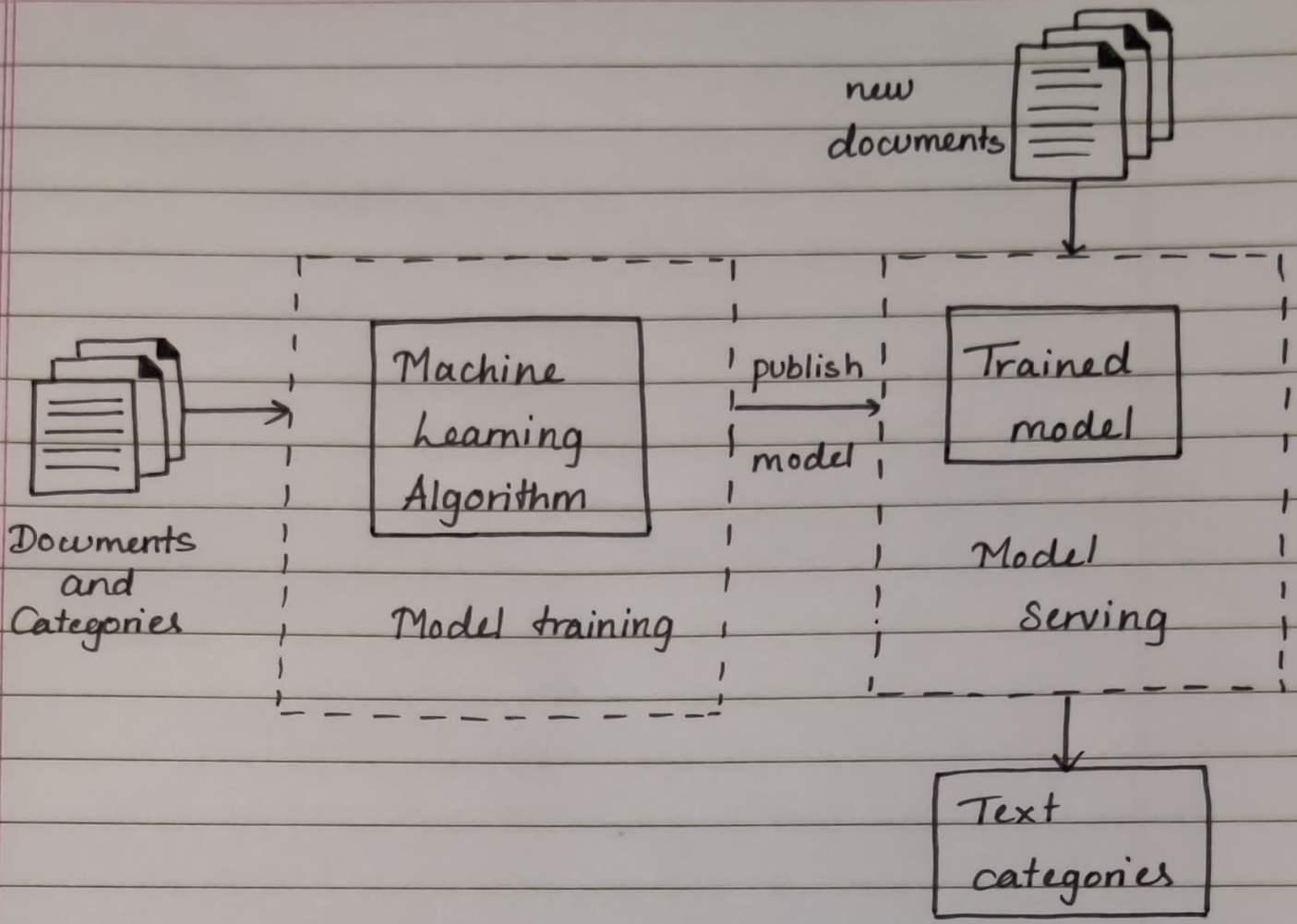
We can evaluate a model with cross validation. Split the corpus into training corpus and validation corpus. Determine the parameters of the model using the training data and then evaluate the model on the validation corpus.

N-gram word models →

With character models we dont need to worry about any new letters of the alphabet being created. But in word model we need to deal with out of vocabulary words as there is always a chance of a new word that was not seen in the training corpus, so we need to model that explicitly in our language model.

Text categorization →

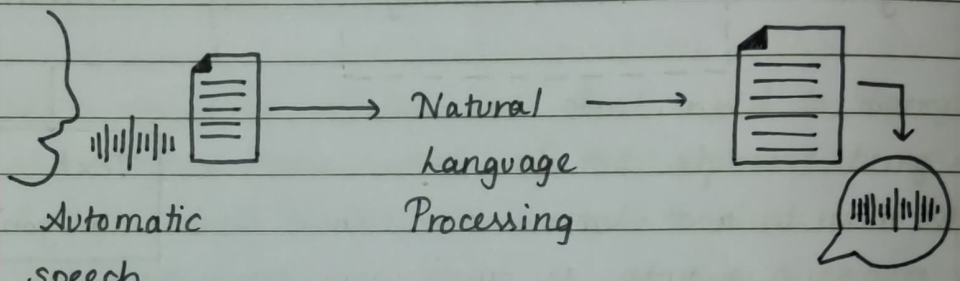
NLP techniques have proven successful in sorting text into fixed topic categories.
A subscriber can ask for all the news on a particular industry, company or geographic area for example.
The commercial providers of news wire stories have traditionally used human experts to assign these categories.
In the last few years, NLP systems have proven to be just as accurate, categorizing over 90% of news stories correctly.
They are also far faster and more consistent, so there has been a switch from humans to automated systems.


new documents
Machine Learning Algorithm
publish
model
Trained model
Documents and Categories
Model training
Model Serving
Text categories

Q3. Speech Recognition

- It is the task of mapping from digitally encoded acoustic signal to a string of words.

- Speech understanding is the task of mapping the acoustic signal all the way to an interpretation of the meaning of the utterance.



Automatic speech recognition

Text to speech

- All human languages are made up of a limited set of 40 - 50 sounds called phones.
A phone is the sound that corresponds to a single vowel or consonant, roughly speaking.

- Once we know what the possible sounds are, we must categorize them in terms of the features we can pick out of the acoustic signal, such as the frequency and amplitude of the sound waves.

- Then we find the words from the phones in a manner similar to looking up a dictionary that is arranged by pronounciations.

- 2 things make this process difficult -

1. homophones - different words that sound the same.
   eg. "two" and "too"
2. segmentation - determining where one word ends and the next word starts.

- After this we try to understand the meaning the speaker intends to express through those words through parsing and analysis methods.

Signal processing →

→ Sound is an analog energy source
→ When the sound hits the microphone it is converted into an electrical current which can then be passed through an analog-digital converter to yield a stream of bits. representing the sound.

sampling rate = the frequency at which we look at the signal.

quantization factor = the precision to which the energy at each sampling point is recorded.

→ samples are grouped together into frames, which makes it possible to analyze whole frames for the appearance of speech phenomenon such as rise or drop of frequency or sudden cessation of energy

→ within each frame we represent what is happening with a vector of features.

→ The final step in speech signal processing is vector quantization

Defining the overall speech recognition model →

- Speech recognition is the diagnostic task of recovering the words that produce a given acoustic signal.
- We can approach this diagnostic task with a casual model - the words that cause the signal
- We can break this into components with Baye's rule:

$$P(\text{words} \mid \text{signal}) = \frac{P(\text{words})\, P(\text{signal} \mid \text{words})}{P(\text{signal})}$$

- Given a signal, our task is to ~~maximize~~ find the words that maximize $P(\text{words} \mid \text{signal})$
- Of the three components ~~of~~ on the right hand side, $P(\text{words})$ is the language model, it tells us when we are not sure if we heard "bad boy" or "pad boy" that the former is more likely.
  $P(\text{signal} \mid \text{words})$ is the acoustic model, it tells us that "cat" is very likely to be pronounced as [kcet]
  $P(\text{signal})$ is the normalizing constant that we can ignore.

Bigram model → It says that the probability of any word is defined solely by the previous word in the string.

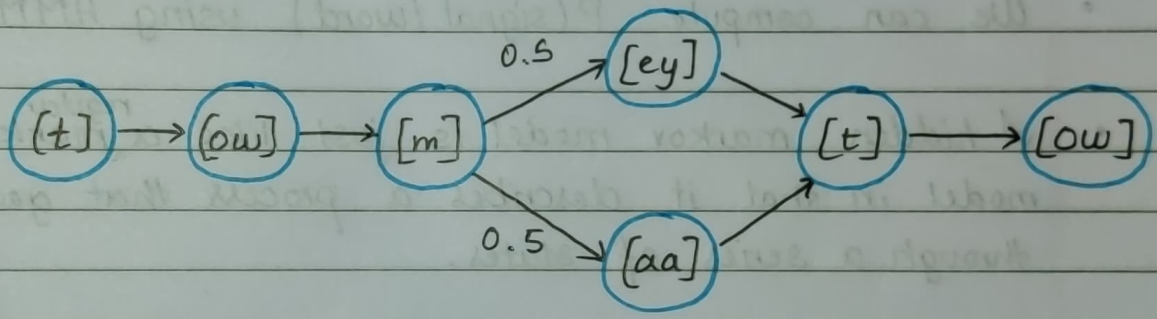
Trigram model → It is a more powerful language model that can determine that "ate a banana" is more likely than "ate a bandana".

There are so many parameters in trigram models that it is difficult to get enough training data to come up with accurate probability estimates.

Markov Model →

- Markov model is a way of ~~expressing~~ describing a process that goes through a series of states.

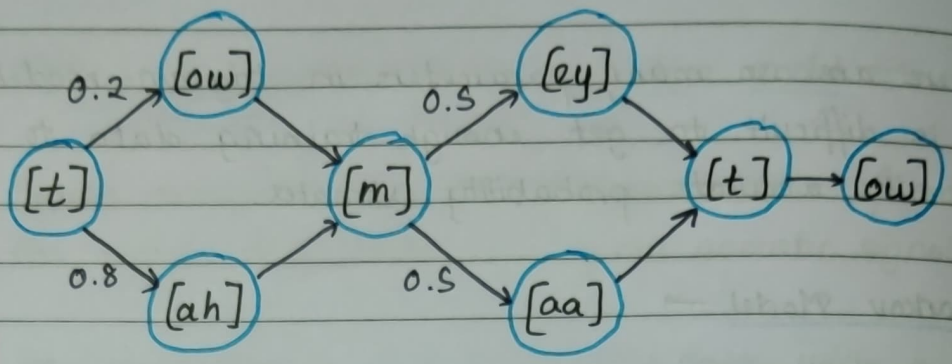
Word model with dialect variation →



- the markov model has seven states (circles), each corresponding to phone.
- The arrows denote allowable transitions between states and each transition has a probability associated with it.
- There are only two possible paths, one corresponding to the ~~pronounciation~~ phone sequence [towmeytow] and the other to [towmaatow]
- The probability of the path is the product of the probabilities on the arcs that make up the path

$$P([\text{towmeytow}] \mid \text{"tomato"}) = P([\text{towmaatow}] \mid \text{"tomato"}) = 0.5$$

Word model with coarticulation and dialect variation →



The second source of phonetic variation is coarticulation.

Hidden Markov model or HMM →

- We can compute P(signal/word) using HMM.
- A hidden markov model is just like a regular markov model in that it describes a process that goes through a series of states.
- The difference is that in the regular Markov model ~~describes a process that goes on~~ the output is a sequence of state names, and since the states have unique names, the output uniquely identifies the path through the model.
- In HMM, each state has a probability distribution of possible outputs, and same output can appear in more than one state.
- It is called hidden because the true state of the model is hidden from the observer.
- When you see the outputs of some symbol, you cannot be sure where the symbol came from.