Notes by Izam Mohammed

NLP

- ➢ NLP basics
  - Working - pipeline
  - Application
    - Chatbot
    - Sentiment analysis
    - NER
    - Email spam detection
  - Challenges
    - Handling informal words
    - Ambiguity in words
    - Dialects (wannabe and all)
    - Lack of data in different languages
- ➢ Tokenization
  - What is it
  - Types
    - Word tokenization
    - Subword tokenization (Bite pair encoding -> BPE)

      BPE ensures that the most common words are represented in the vocabulary as a single token while the rare words are broken down into two or more subword tokens and this is in agreement with what a subword-based tokenization algorithm does.

      Subword → sub, word

      Smarter → smart, er
    - Sentence
    - Character level
  - Why tokenization, over 'split the sentence'
  - OOV words (Out of vocabulary)
- ➢ Corpus
  - What is it → collection of documents
  - Corpora → plural of corpus
  - Types
    - General
    - Special → specific topic
    - Multilingual
    - Monolingual
    - Parallel → same content, multiple languages
    - Balanced, imbalanced → category
    - Annotated → dedicated to NLP
- ➢ Stemming
  - What is it → Reduce the word into root form

- Types
    - Porter → simple
    - Lancaster → extreme stemming, faster
    - Snowball → multiple languages
- Challenges
    - Over stemming → remove too many affix (prefix + suffix)
    - Under stemming → not enough
- Purpose / Importance
    - Reduce data redundancy → duplicates in data
    - Information retrieval
    - Normalization

- Lemmatization
    - What is it → consider the context and meaning of words
    - Types
        - WordNet Lemmatizer → nltk

          Utilize the Wordnet lexical database to find the lemma
        - Spacy Lemmatizer → spacy

          Use rule-based and statistical-based methods to find the lemma
    - *Challenges*
        - *Slower, computationally intensive*
        - *Need dictionary lookup*
- *NER*
    - *What is it → Identify and categorize the entities in the corpus*
    - *Goal → extract structured info in unstructured data*
    - *Types of entity → Person, Org, Place, Money, Date, Time, Percentage*
    - *Usecase*
        - *Chatbot*
        - *Q&A*
        - *Information Extraction*
        - *Identify hashtags*
    - *Techniques*
        - *Rule-based*
        - *Statistical approach → ml model*
        - *Deep learning approach*
    - *Challenges*
        - *Ambiguity*
        - *Model generalization → biased to a domain*
        - *Language variation*
- *POS tagging*
    - *What → Assign grammatical categories (pos)*
    - *Types*
        - *Noun (N) → cat*

        - *Verb (V) → walk*
        - *Adverb (ADV)→ very   *describes a verb*
        - *Adjective (ADJ) → happy   *describes a noun*
        - *Pronoun (PRON)→ he, it*
        - *Preposition (PREP)→ in, on*
        - *Conjunction (CONJ)→ and, but*
        - *Interjection (INTJ)→ wow, oh*

- *Ngrams*
    - *What → continuous sequences of n items*
    - *Types*
        - *Unigrams*
        - *Bigrams*
        - *Trigrams*
        - *4-gram, 5-grams …*
    - *Application*
        - *Text prediction*
        - *Spell checker*
        - *Translation*
    - *Python from scratch implementation*

- *Vectorization*
    - *What → Convert word to numeric format*
    - *Types*
        - *Label Encoding*
        - *One-hot-encoding*
        - *CountVectorizer (BOW)*
        - *TF - IDF*
            - *TF(t, d) = No. of times the term appeared in doc / Total No. terms in the doc*
            - *IDF(t, D) = log((no. of documents/*
              No of the documents contain t) +1)
        - *Word2Vec*
          Represent word as a vector trained with an FFN network
            - *CBOW*
              *Context → word   *fake problem solving*
            - *Skip-grams*
              Word → word (negative sampling)
        - *Glove → Global Vectors for Word Representation*
          Use a Co-occurrence matrix
        - *Fasttext*
          Operate on sub-word level. excels in handling rare words or words not seen during training

- *Stop words*

    - *Words that have no meaning*

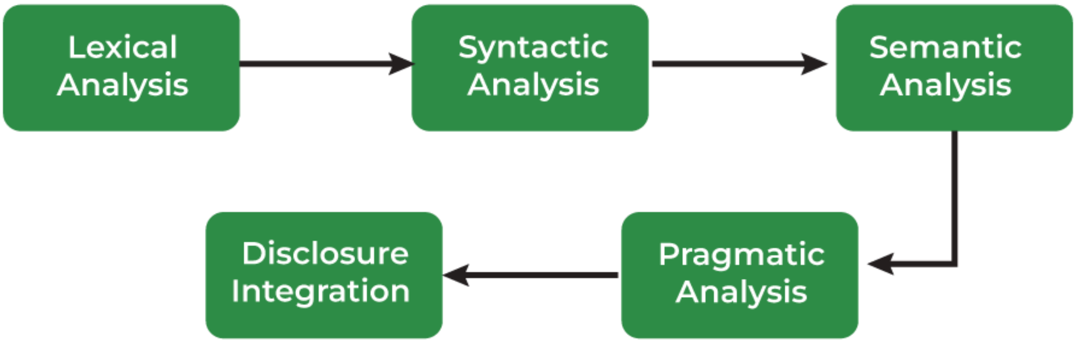
- *Parsing*

  process of analyzing the grammatical structure of a sentence and how they relate to each other.
- *NLU vs NLP vs NLG*
    - *NLP → NLU + NLG*
    - *NLU → Natural Language Understanding*

      Speech recognition, sentiment analysis
    - *NLG → Natural Language Generation*

      Chatbots, Voice assistants

- *Phases of NLP*



    - *Lexical Analysis → tokenization*
    - *Syntactic Analysis → Parsing*
    - *Semantic Analysis → focuses on extracting the meaning of words.*
    - *Pragmatic Analysis →*

      involves considering the context, speaker's intentions, and shared knowledge to interpret the true message
    - *Discousure Integration →*

      Connects individual sentences into a logical discourse
- *Cosine Similarity*

$$\cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum\limits_{i=1}^{n} A_i B_i}{\sqrt{\sum\limits_{i=1}^{n} A_i^2} \sqrt{\sum\limits_{i=1}^{n} B_i^2}}$$

- *Visualize the text*
    - *t-SNE → t-Distributed Stochastic Neighbor Embedding*

the goal of t-SNE is to take a high-dimensional dataset and project it into a lower-dimensional space (usually 2D or 3D)

- *What are the options for a chatbot*
  - *Rasa nlu*
  - *Google dialogue flow*
  - *Amazon alex*
  - *Microsoft Luis*
  - *Use a pre-trained transformer from Huggingface*
  - *Use a LSTM model and train*
  - *Use any LLM and RAG system*
  - *Take an LLM and finetune*