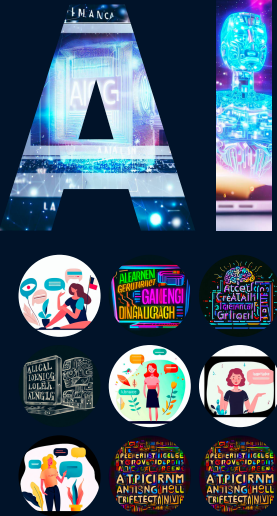

INTRODUCTION TO LANGUAGE MODELS

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INTRODUCTION TO LANGUAGE MODELS

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AI Cycle
Symbolic Reasoning
Probabilistic Reasoning

Generative AI
Neural Model-based Reasoning
Models

AI CYCLE

- **Perception** - ability to receive and evaluate information about an environment
- **Learning** - ability to find common patterns, organize the knowledge
  - Represent knowledge using Propositional and first-order logic - symbolic representation
  - Parameters using statistics and probability - probabilistic representation
- **Reasoning** - Draw conclusions from the knowledge and learnings such as facts, beliefs, observations/evidence, logical rules
- Use available/partial information for problem solving
- Interpretability of reasoning
- Planning and Execution

- Knowledge is available as types, relations and their complex relationship - represented in the form of first-order and propositional logic

  Who is an all rounder in cricket?

  $\exists x(\text{Bats well}(x) \wedge \text{Fields well}(x) \wedge \text{Bowls well}(x)) \Rightarrow \text{All Rounder}(x)$

The facts are hard facts - there could be no uncertainty

PROBABILISTIC REASONING

- Knowledge is available in the form of parametric relationships - cooccurrences, correlations, incidence matrix, conditional relationships
- Handles uncertainty well using the observed parameters
- $\exists w_i \exists w_j (\text{Similar Contexts}(x) \wedge \text{Similar Contexts}(y)) \rightsquigarrow \text{Similar}(x, y)$
- How are related in a corpus?
- Context words may differ and not fixed

GENERATIVE AI

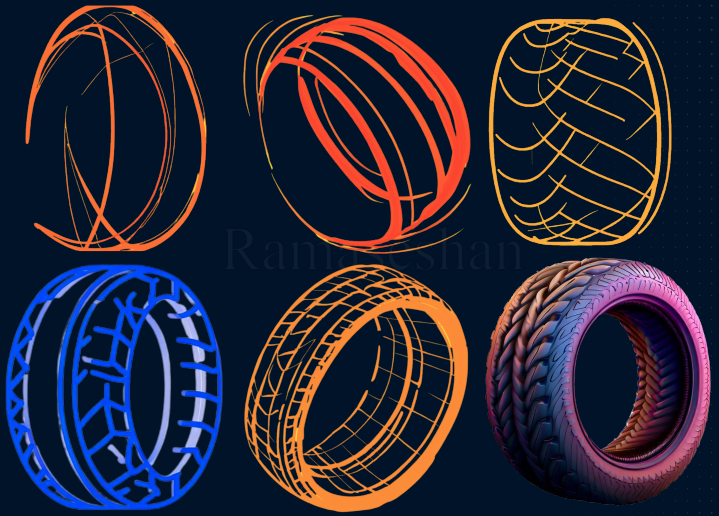
- Learns the patterns of existing content
- Creates new content such as text, images, or music using learned patterns
- Generates realistic text, images, and music
- Hallucinates on unknown areas with known keywords - Generates grammatically correct sentence but factually incorrect sentence like *The cat barks*

NEURAL MODEL-BASED REASONING

- Combines generalizations of symbolic and probabilistic reasoning
- Adds learning capabilities
- Backbox models

  Don't present decision making evidences and are difficult to interpret

MODELS



MODELS

- Represent encoded information collected from observed data
- Facilitates prediction of future events
- Possible next word in a sentence
  Lexical Knowledge
- Validates a sentence using learned parameters

- Representation of words as vectors
- Understanding word senses
  Semantic Knowledge
- Anaphora detection
- Unsupervised and Supervised
- No fixed procedural logic
- Learns input-output relationships

PROPERTIES OF A MODEL

- Uncovers latent patterns that is difficult to visualize using rigid procedural method
  - Information related correlations
  - n-gram frequencies, lexical and semantic relationships, word representations as vectors
  - Incidence matrix of n-grams
- Does not use any schema and no human annotation
- Helps in understanding and interpreting information for decision making/classification
- Allows open class queries
- Makes data driven decisions under uncertainty
- Presents Inferences based on the domain knowledge - conditional probability
- Store vast amount of linguistic and semantic as parameters knowledge
- Accesses the knowledge by using the context

Are you _____ in playing cricket?

Do you _____ football?

You went to a movie yesterday. How _____ the movie?

Do you _____ a car?

How are _____ ?

The subject was _____ . Most students understood it

UNSTRUCTURED CONTENT

- Big Data analysis includes both structured and unstructured data
- 90% of the data in the business and in the Web Internet is unstructured

  Text files, audio, video, web pages, pdf files, social media content, presentations, transcripts of audio, video, etc.

NL VS PL

Allows interaction among humans to share information using a set of words and sentences constructed using a finite set of alphabets and framed using a set of grammar rules

- Arbitrary
- Structured
- Generative
- Dynamic

Intended for Human Machine Communications. Instructions are

- Precise
- Unambiguous
- Mathematical equations

IS NLP HARD?

- Creative and analytical representation of thoughts
- What is added with 15 to get 45
- Juvenile court to try shooting defendant
- Safety experts say school bus passengers should be belted
- The king saw a rabbit with his glasses
- Local high school dropouts cut in half

COMMON LAYERS OF NLP APPLICATIONS

- Preprocessing layer
- Data extraction layer
- Analysis of extracted information
- Semantic understanding
- Human/automatic evaluation of word meaning, sentence structure using the content obtained from the previous layers
- Pre-training
- Fine tuning

BASIC OPERATIONS ON A CORPUS

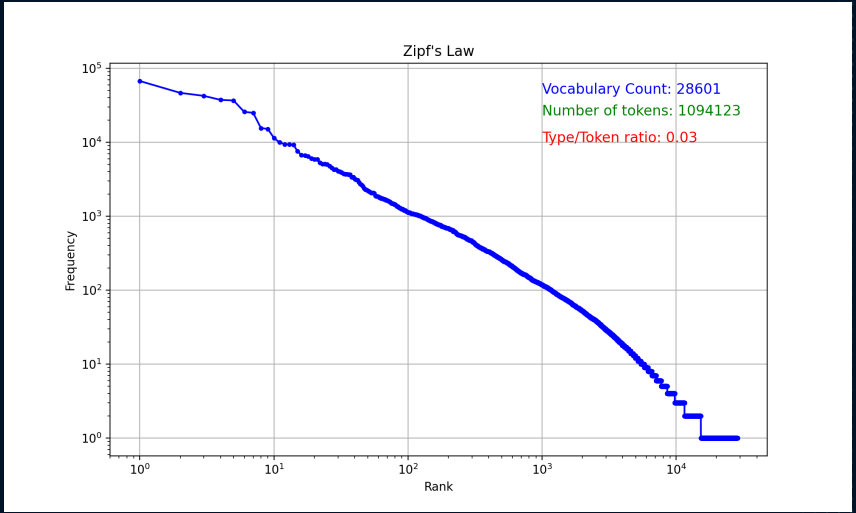
- Normalization - convert into a single canonical form
- Tokenization
- Counting

EMPIRICAL LAWS

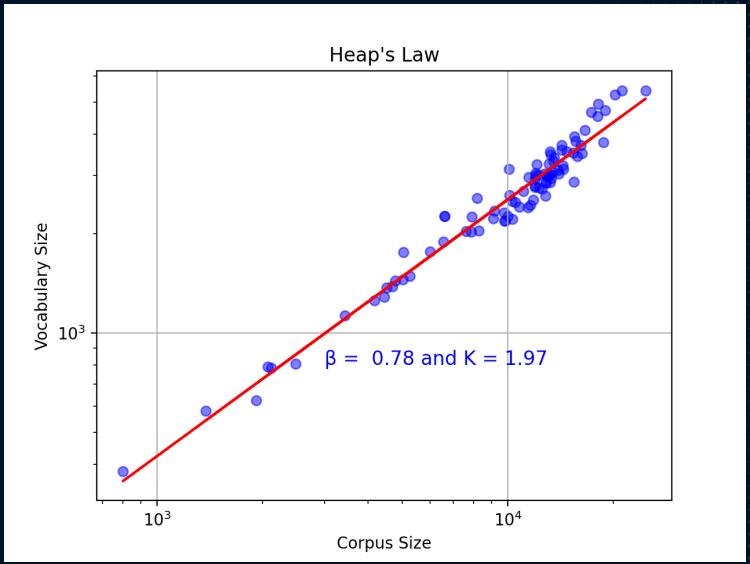
Describe word-rank and word-frequency distribution, vocabulary, and terms in a corpus

- Zipf's law - The frequency of any word is inversely proportional to its rank - $f \propto \frac{1}{r^{\alpha}}$ $\alpha \approx 1$ and r is the frequency rank of the word
- Heap's law - The number of unique words in a text of n words is
- $V \propto N^{\beta}$
- V is the number of unique terms/vocabulary and N is the total number of terms in the corpus

ZIP'S LAW


Zipf's Law
Vocabulary Count: 28601
Number of tokens: 1094123
Type/Token ratio: 0.03
Frequency
Rank
10^0
10^1
10^2
10^3
10^4
10^5

HEAPS'S LAW


Heap's Law
Vocabulary Size
10^3
β = 0.78 and K = 1.97
10^3
10^4
Corpus Size

Thank you

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