Language and AI

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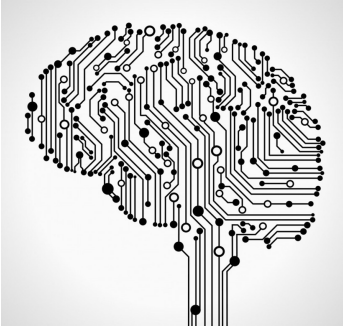
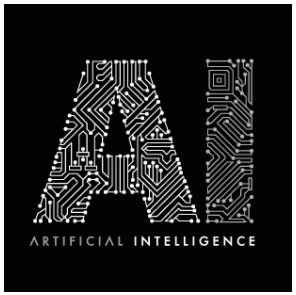
(Natural) Language

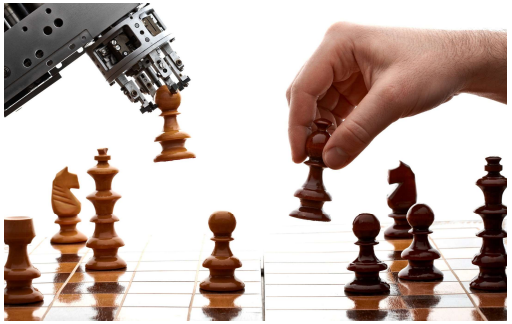
- Linguistics is the study of Language, that studies it from a range of perspectives
- We will limit our study to some of the more modern theories
- We will consider 4 aspects of language :
  - Syntax : study of structure
  - Semantics : study of (the structure of) meaning (construction)
  - Pragmatics : study of contextualized language
  - Phonetics : study of the spoken form of language
- Language as a mode of self-realization (so what?)

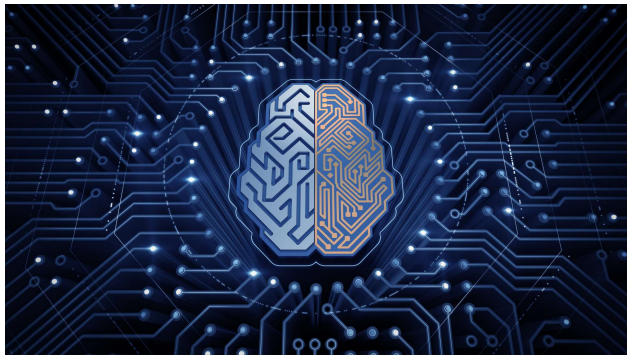
Artificial Intelligence

- What are machines?
- Why do we need machines?
- What can (can not) machines do?
- Why does it matter?









Modes of AI

- Sensing and recognition
- Understanding and extrapolation
- Communication and dialog
- Strategy and hypothesis testing

Sensing and Recognition

- Mainly works with taking input and detecting the underlying values
- Multi modal activity
- Humans do it in multiple settings :
  - Speech
  - Vision
  - Touch
  - taste
- And we infer :
  - Shape
  - Colour
  - Phones?
  - Size (relatively / absolute)

Sensing and recognition

- Detector : takes the waves and inputs them as a representation and passes them on, de-noises and focuses on relevant parts
- Convertor : realizes the output into a format which faculties can interpret
- Classifier : realizes the interpretation of the convertor output in a way that it is able to differentiate between different things
- Representation : represent the classifier's realization into a free – form representation which can be universally used and interpreted

Sensing and recognition

- But what about Natural Language?
  - Natural language has phones (in speech), script (in text) and signs (in sign language)
  - Diverse and independent
  - Have recursive structure
  - Have context based structure
  - Requires focus on some parts
  - Requires differentiation between similar entities
  - Requires segmentation
  - Requires continuous and discrete differenciation

Understanding and Extrapolation

- We have all interaction represented in universally acceptable representations
- But what do we do with this?
- Understanding vs Sensing
  - (table, computer, keyboard, wires) vs (keyboard connected to the computer kept on the table) [VISION]
  - (noticing a losing position) vs (realising the reason why it is a losing position) [GAMES]
  - (realizing phones and constructing a sentence) vs (recogonizing dependencies in the sentence)
  - (content) vs (structure)

Understanding and Extrapolation

- Representation vs Extrapolation
  - Existence of trivial representation
  - Co-occurrence vs correlations
  - Distribution vs prediction
  - Association of structure vs Association of meaning
  - Fine grained structure vs an overview

Understanding and Extrapolation

- What do humans do about it ?
  - Convert words into meanings
  - Use meaning to parse dependencies
  - Infer a logic form
- Is that it? No. It is in all forms.
- How do we understand what we see?
  - We observe signals
  - We recognise them as objects
  - We construct relations
  - We infer meaning from spatial and temporal distance
  - We recognise transformations and infer them as motion

Understanding and Extrapolation

- But does it end there?
- Of course not!
- We go one step ahead :
  - We infer the motivation from the motion, the words and visuals
  - Using them we build a hypothesis of the world
  - Using this hypothesis we make inferences
- What are inferences?
  - Converting a representation into a form that can be realized with some rules and representations to give us some conclusions
  - But why do these really matter?
  - TO EXTRAPOLATE

Understanding and Extrapolation

- Is intelligence only in one time frame? NO
  - Needs history
  - Needs context
  - Needs future deciphering (or prediction / understanding)
- The observation when internalized with it's motivation is powerful
  - We can generalize
  - We can generate
  - We can innovate
  - Most importantly, we can realize
- We can understand the future
- We can infer the past
- We can correlate in the present, by inferring the past, and understanding the future

Understanding and Extrapolation

- In order to use a language, we must understand it's meanings
- We need to understand dependencies
- We need to understand word orders
- We need to understand the representation of ideas in that language
- We need to be able to infer the meaning in the observed phrases of a sentence in order to attempt complete sentences by predicting future phrases
- We need to have a "theory" of understanding
- We must have a hypothesis of spoken or written form and only then can we understand the sentences

Dialog and Communication

- Dialog : the ability to transfer concepts, ideas and observation *effectively*
- Communication : the process of this transfer, by conversion into a form which can be understood

Dialog and Communication

- So this is definitely in the setting of language solving!
- But is it a natural language that must be solved?
- Communication and dialog must have features
  - Deixis
  - External Context
  - Minimalism
  - Compactness
  - Feedback
  - Co-operation
  - Memory
  - (Dual) Knowledge

Dialog and Communication

- Natural Language
  - Embodies social context into understanding
  - Embodies context in language
  - Associates meaning
  - Gives interpretation for first order and higher order forms
  - Evolves naturally and encodes large amount of representations
  - (**Pragmatics)**
  - Implicit anaphoric resolution
  - Social context

Strategy and Hypothesis Testing

- Strategy involves coming up with approach
  - It may be model free or model specific
  - It may be reward optimization based
  - It may be subjective
  - Strategy vs Goal
  - Strategy vs Methodology

Hypothesis

- Hypothesis :
  - An iterative process of theorising
  - A process of abstraction
  - Designing application to test and observing the solution
  - An implicit learning process

Hypothesis Testing and Strategy

- Natural Language strategies :
  - Sentence construction
  - Paraphrasing
  - Abstractive natural language generation