Language Understanding

01 - Introduction

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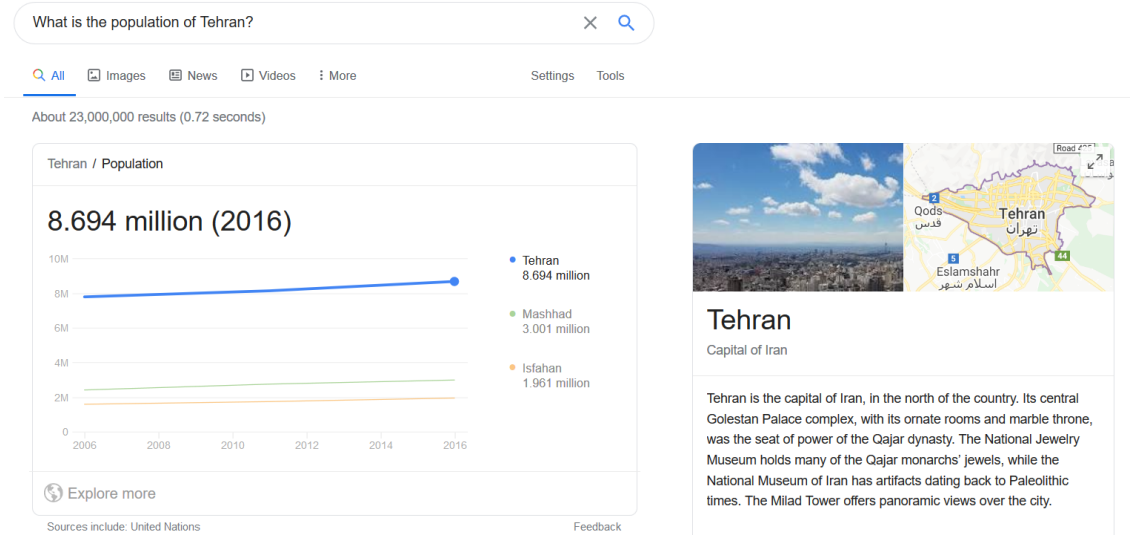
What is Language Understanding?

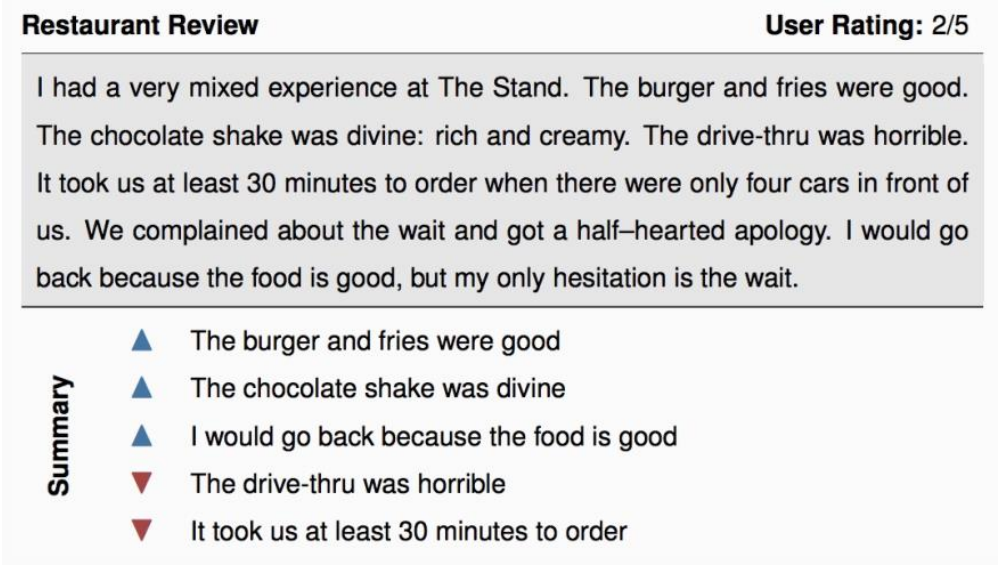
- **Application**: Virtual assistants
  - **Input**: A command in natural language
    - E.g. Turn on the light
  - **Output**: Code to carry out that command

What is Language Understanding?



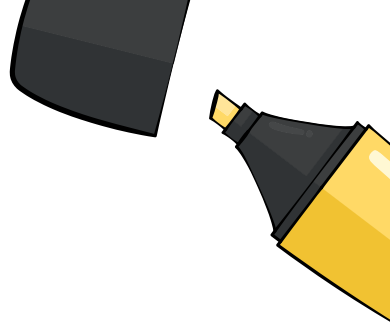
- **Application**: Question answering
  - **Input**: A question in natural language
  - **Output**: A natural language answer to that question

What is Language Understanding?



- **Application**: Sentiment analysis
  - **Input**: Natural language sentence
  - **Output**: Classification of sentence as positive, negative, or neutral towards its subject

What is Language Understanding?



What countries border France?

$$\lambda x.\text{country}(x) \cap \text{borders}(x, \text{France})$$

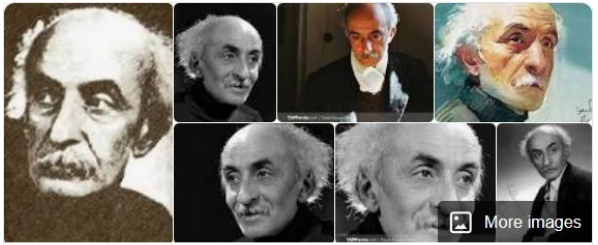
- **Core NLP problem**: semantic parsing
  - **Input**: A natural language sentence
  - **Output**: A logical form expressing the meaning of that sentence

What is Language Understanding?

- **Application** : Conversational Agents (Chatbots)

What is Language Understanding?

- **Application** : Knowledge Graphs



Nima Yooshij

Persian poet

Nimā Yushij, also called Nimā, born Ali Esfandiāri, was a contemporary Persian poet. He is famous for his style of poetry which he popularized, called she'r-e now, also known as she'r-e nimaa'i in his honour after his death. He is considered as the father of modern Persian poetry. Wikipedia

Born: November 11, 1897, Yush, Iran

Died: January 3, 1960, Shemiran, Iran

Spouse: Alieh Meftah (m. 1926–1960)

Place of burial: Imamzadeh Abdollah, Tehran, Iran

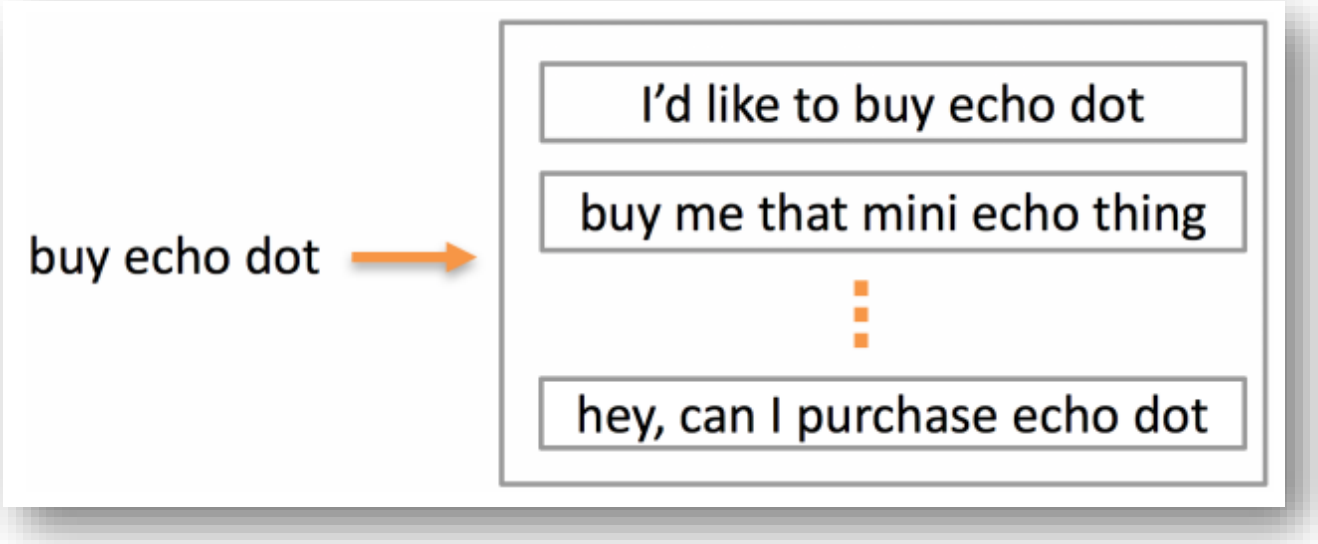
Books: The neighbor says

Children: Sheragim Yooshij

Feedback

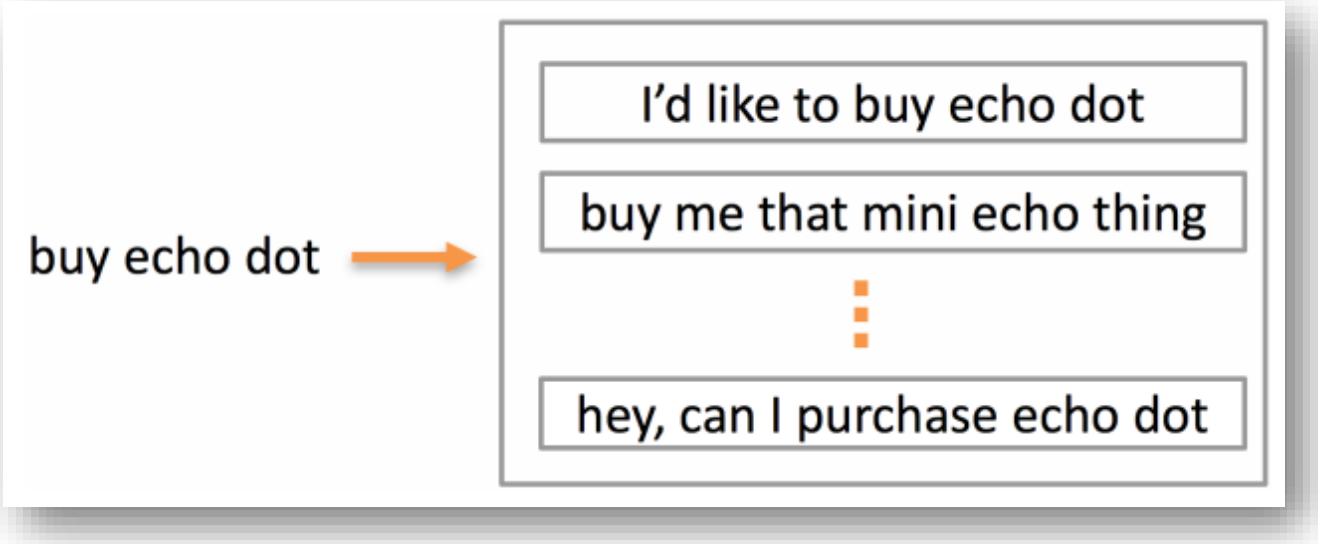
What is Language Understanding?

- **Application** : Paraphrasing



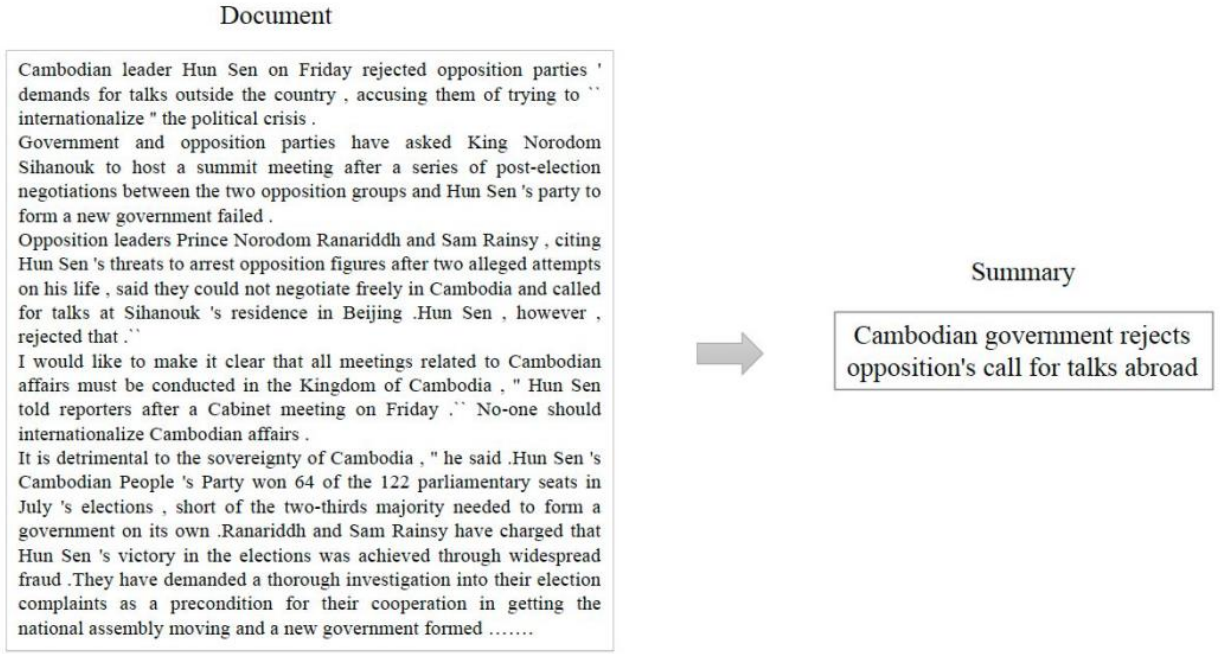
What is Language Understanding?

- **Application** : Paraphrasing



What is Language Understanding?

- **Application** : Single-document Summarization



What is Language Understanding?

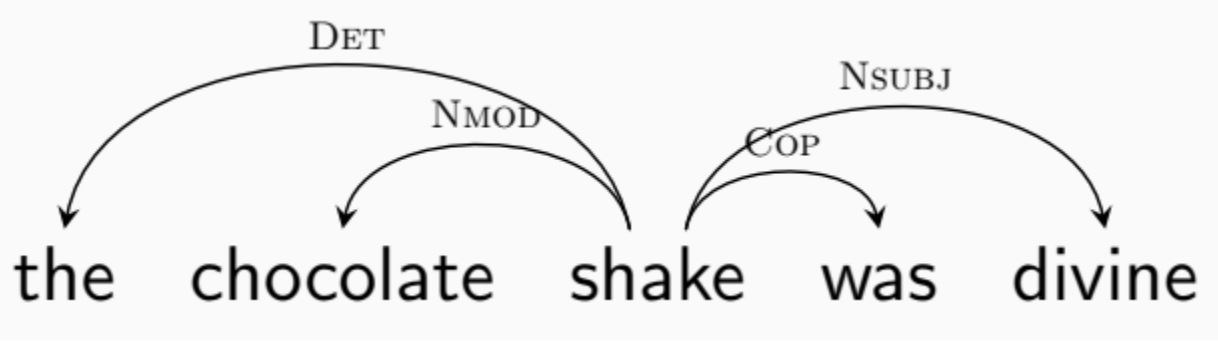
- **Application** : Natural Language Inference (NLI)

$\mathbf{P}^a$	A senior is waiting at the window of a restaurant that serves sandwiches.	Relationship
$\mathbf{H}^b$	A person waits to be served his food.	Entailment
	A man is looking to order a grilled cheese sandwich.	Neutral
	A man is waiting in line for the bus.	Contradiction
$^a\mathbf{P}$, Premise. $^b\mathbf{H}$, Hypothesis.		

What is Machine Translation?

- **Example**: Persian-English machine translation
  - **Input**: A sentence in Persian
  - **Output**: A sentence in English expressing the same meaning

What is Language Understanding?



- **Core NLP problem**: Syntactic/Dependency Parsing
  - **Input**: A natural language sentence
  - **Output**: A dependency analysis of the sentence

Summary of Language Understanding

- Language Understanding:
  - Natural Language Understanding (NLU)
  - Spoken Language Understanding (SLU)
- Which problems fall under the language understanding area?
  - Any computational problem where the input is natural language (spoken/text), and the output is structured information that can be processed (store or execute) by a computer.

What is Natural Language Generation?

- **Natural-language generation (NLG)** is a software process that transforms structured data (non-linguistic data) into natural language.
  - Produce long form content for organizations to automate custom reports
  - Produce custom content for a web or mobile application
  - Generate a short text in interactive conversations (a chatbot) which might even be read out by a text-to-speech system.
- We will cover some aspects of NLG
- **Application**: Data-to-text generation
  - **Input**: Structured data (e.g. database tables)
  - **Output**: A natural language description of that data

What is Natural Language Generation?

Two small dogs run through the grass.

- **Application**: Image captioning
  - **Input**: Image
  - **Output**: A natural language description of that image

Application: Data-to-Text Generation

TEAM	WIN	LOSS	PTS	FG_PCT	RB	AST
Nuggets	8	15	85	41	45	24
Wizards	8	13	92	45	35	21

PLAYER	H/V	AST	RB	PTS	FG	CITY
Bradley Beal	H	5	3	26	8	Washington
John Wall	H	5	7	15	5	Washington
Markieff Morris	H	4	3	15	5	Washington
Nikola Jokic	V	1	11	17	6	Denver
Jusuf Nurkic	V	1	7	13	6	Denver
...	...	...	...	...	...	...

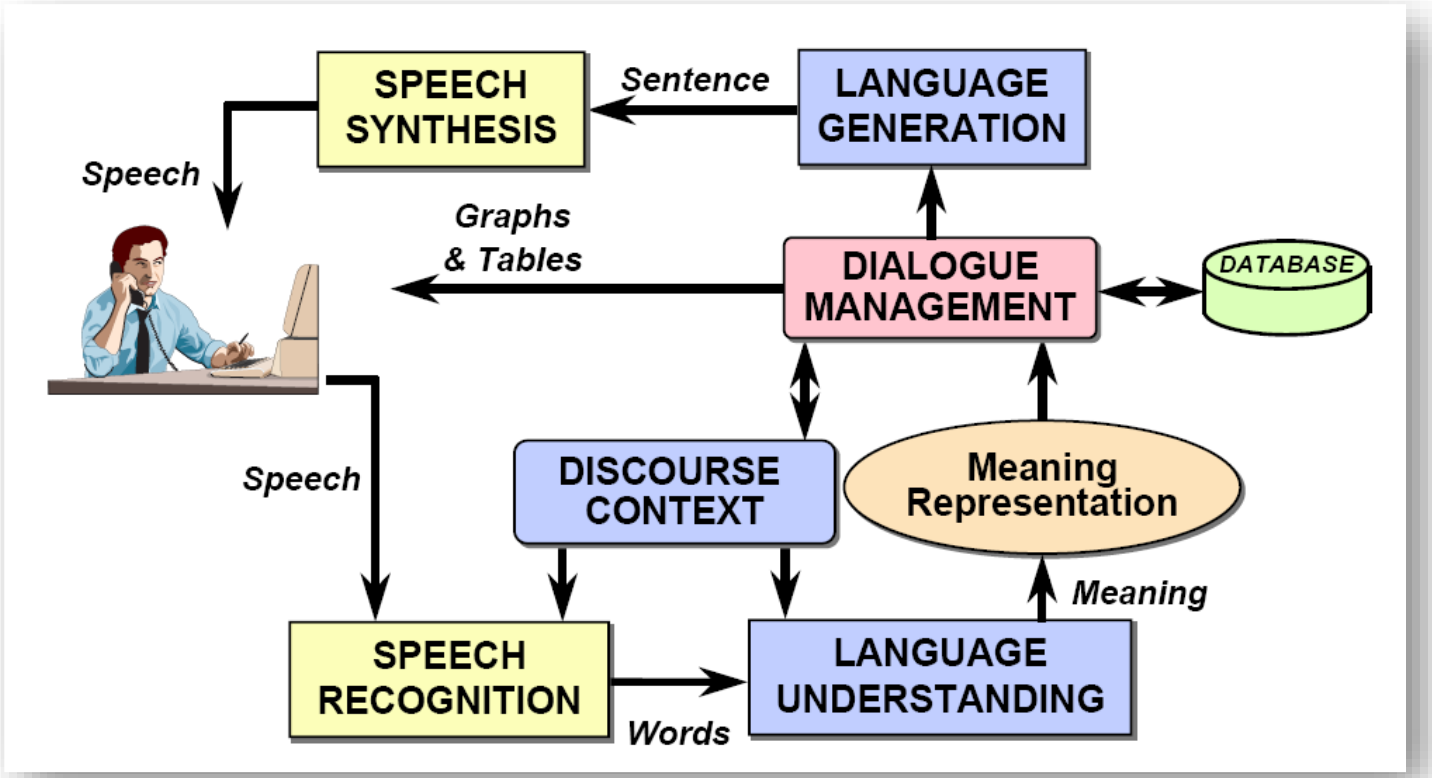
PTS: points, FT_PCT: free throw percentage, RB: rebounds, AST: assists, H/V: home or visiting, FG: field goals, CITY: player team city.

Input: Structured data (e.g. database tables)

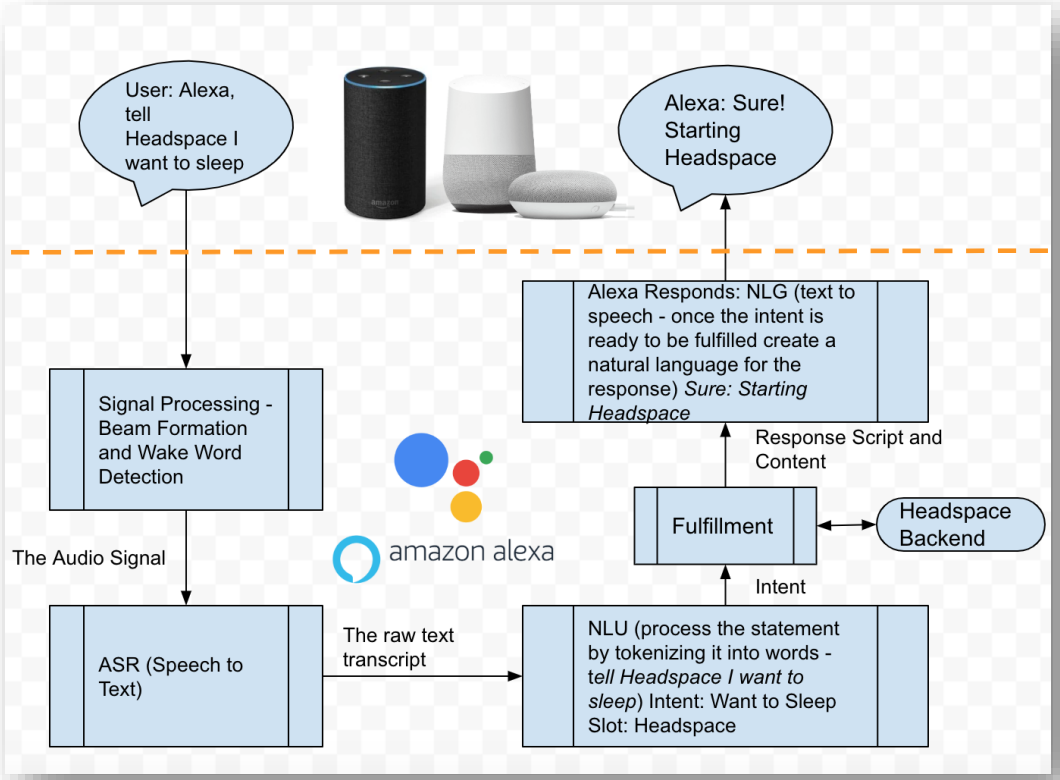
Output: A natural language description of that data

These two teams have really struggled this season and the 48 combined turnovers shows just that. **Denver** was the more inept team though, as they set an NBA season-high with 29 turnovers of their own. The shooting wasn't any better, as they shot **41** percent from the field, **67** percent from the free-throw line and **22** percent from three-point range. **Bradley Beal** was the best player in this game, tallying **26** points, **three** rebounds and **five** assists. **John Wall** went just **5**-of-**14** from the field, but still finished with **15** points, **seven** rebounds, **five** assists and **three** steals. **Markieff Morris** also scored **15** points, as all five starters played at least 33 minutes. **Nikola Jokic** was the only effective Nugget on offense, finishing with **17** points and **11** rebounds. **Wilson Chandler** had a game to forget, as he went just **2**-of-**16** from the field, en route to five points.

Speech Chain



Voice Assistant Technologies



Fundamental Methods of the Course

- The primary tool will be probabilistic models. Due to the big success of deep learning methods, our main focus is on Deep Neural Networks such as:
  - Feed-forward neural networks
  - Recurrent neural networks
  - Attention models
    - Transformer, BERT, GPT, etc.

- DNN has the state-of-the-art performance in most of the area in NLP

Learning Paradigms

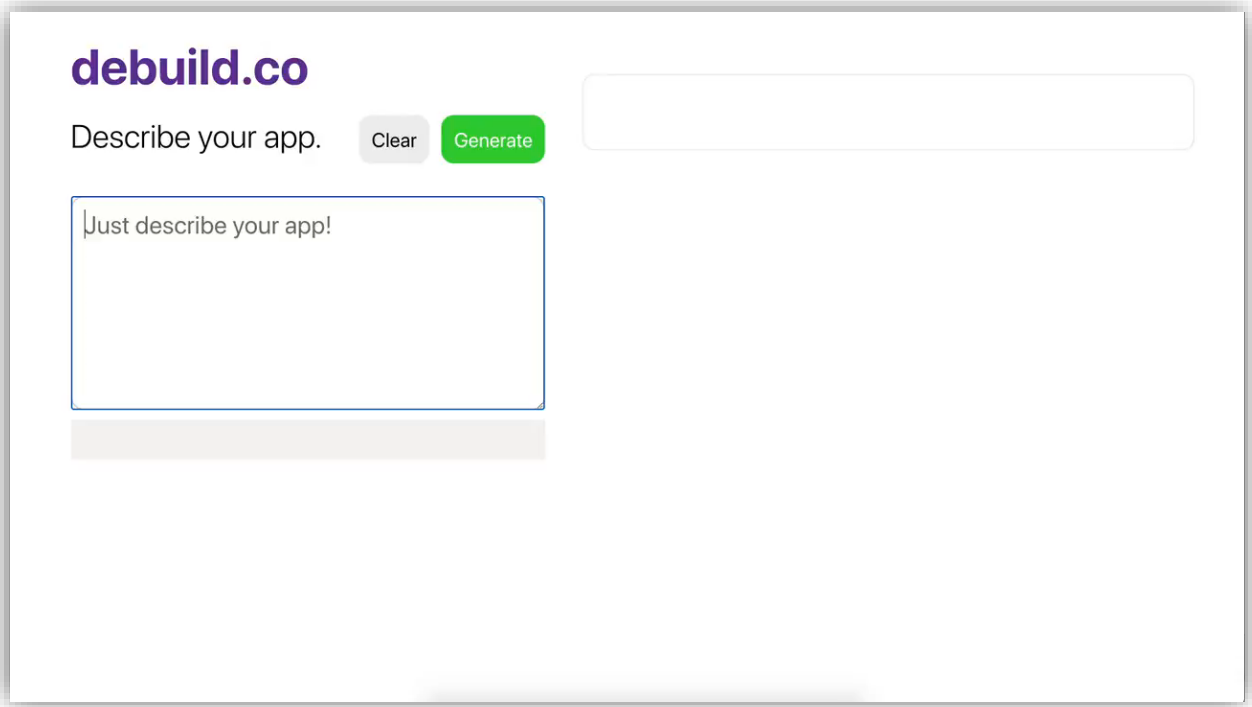
- In standard NLP tasks, usually **supervised paradigm** is used
  - Train the system using labeled data and used it to predict the label of the test data
- But, there are not enough labeled data for some tasks, especially for low recourse languages
  - **Unsupervised paradigm** fits to some of this problems
  - **Semi-supervised paradigm** is also can be used
- We will see **self supervised learning** as well that can be considered as a kind of unsupervised learning

GPT3 Demos for NLU&NLG

```
Q: What is your favorite animal?
A: My favorite animal is a dog.

Q: Why?
A: Because dogs are loyal and friendly.

Q: What are two reasons that a dog might be in a bad mood?
A: Two reasons that a dog might be in a bad mood are if it is hungry or if it is hot.

Q: How many eyes does a giraffe have?
A: A giraffe has two eyes.

Q: How many legs does a frog have?
A: A frog has four legs.

Q: Are there any animals with three legs?
A: No, there are no animals with three legs.

Q: Why don't animals have three legs?
A: Animals don't have three legs because they would fall over.
```

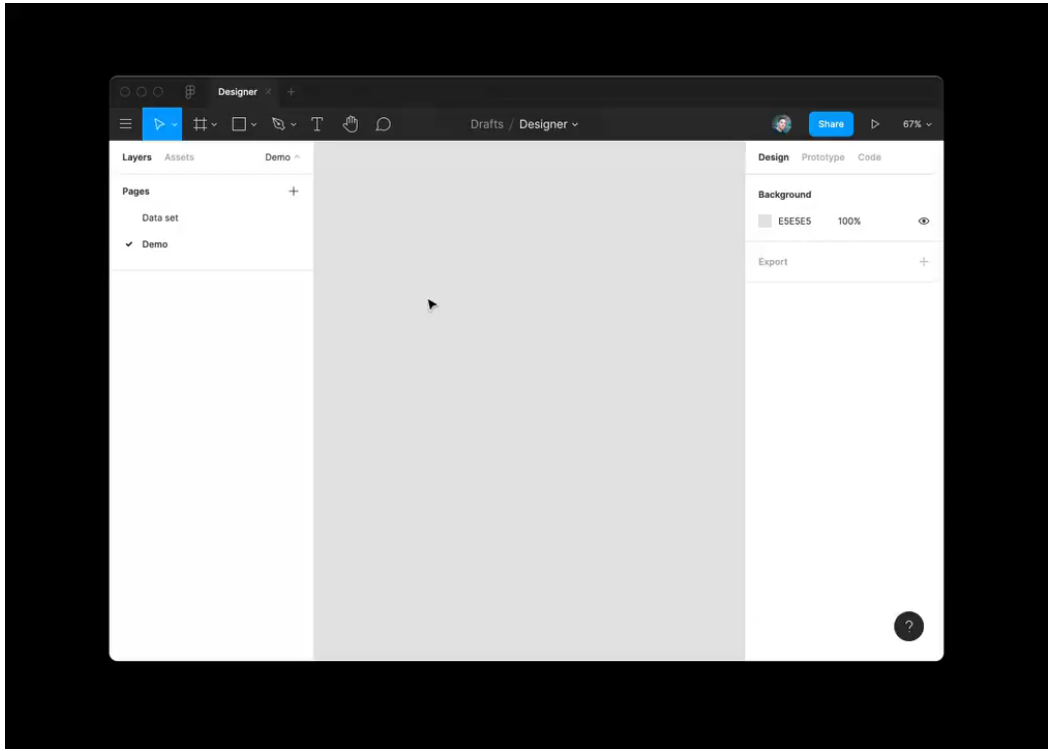
- **Giving GPT-3 a Turing Test**
  - https://lacker.io/ai/2020/07/06/giving-gpt-3-a-turing-test.html

GPT3 Demos for NLU&NLG



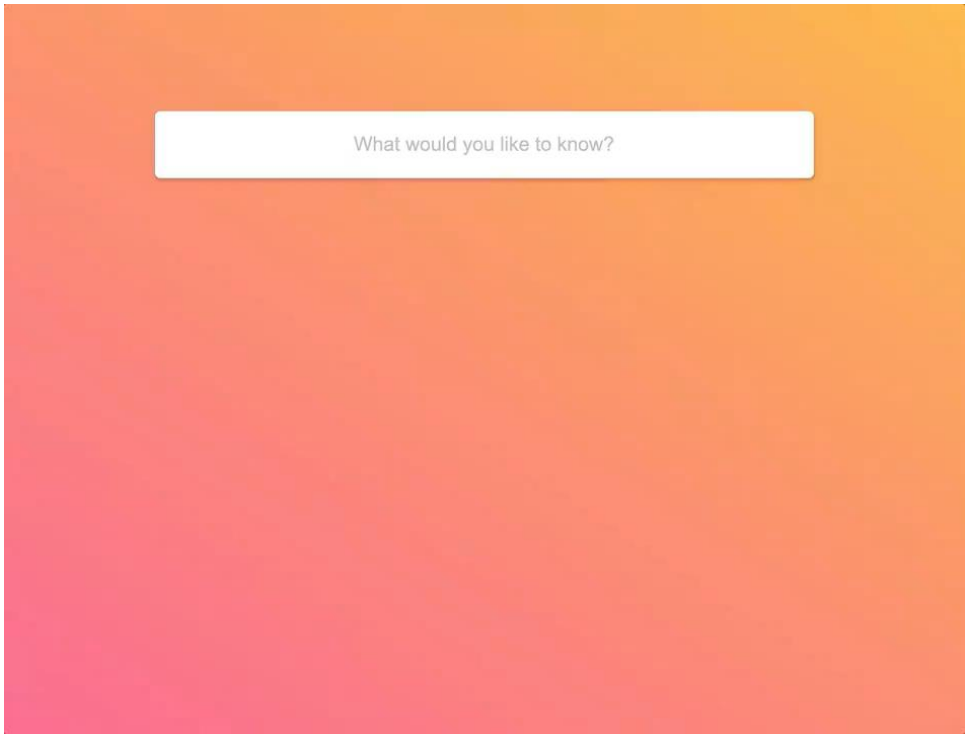
- **Building a simple todo list**
  - https://twitter.com/sharifshameem/status/1284421499915403264

GPT3 Demos for NLU&NLG



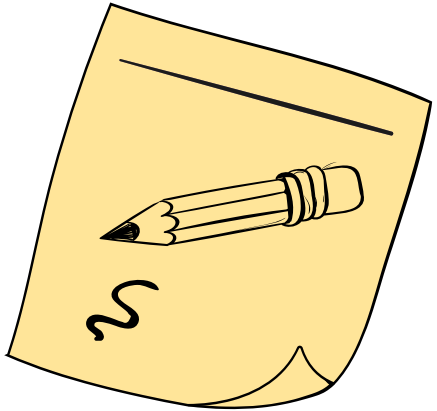
- **Using GPT-3 to design with Figma**
  - https://twitter.com/jsngr/status/1284511080715362304

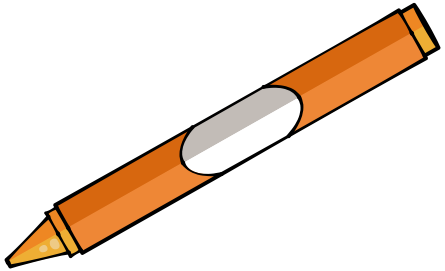
GPT3 Demos for NLU&NLG



- **Writing SQL queries**
  - https://twitter.com/FaraazNishtar/status/1285934622891667457

Course Logistics





General Information

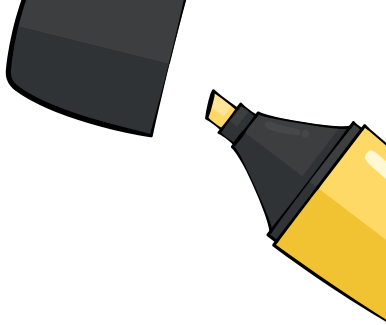
- Instructor: Hossein Zeinali
  - Research interests: speech processing and NLP (mainly on NLU and NLG)
  - Emails: hzeinali@aut.ac.ir , hsn.zeinali@gmail.com
  - Skype: hsn.zeinali
  - Telegram: @hsn_zeinali
  - AUT CE department, room 431

- Teacher assistant:
  - I will manage this as well!

Grading Policy

- DNN Short Exam: 1
- Midterm exam: 4
- Final exam: 8
- 4 assignments: 2.5
- Implementation Project: 2
- Research Project: 2
- Proposing new idea: 0.5 **+ 1.5** (for implementation and results)
  - It should has problem solving property
- All may include bonuses

Delay and Cheating Policies



- All assignments have restricted deadline
  - There is an acceptable delay policy. By that, you will lose grades proportional to your delay.
  - After the final deadline, the grade will be totally zero in any conditions

- We have a strong cheating policy as follow:
  - By the first cheating, you will earn a **100 % negative grade**.
  - By the second cheating, your final grade will be **zero**.

- Due to the number of students, participating in online classes is obligatory. You have permission for 3/16 absent.

Syllabus (1)

- Introduction
- Introduction to Neural Networks
  - Perceptrons and Backpropagation
  - Feedforward
  - Recurrent Neural Networks (RNN)
  - Convolution Neural Networks (CNN)
- Introduction to NLP
  - Text Normalization
  - Tokenization
  - Language Models
    - DNN Based Language Models
  - POS Tagging
  - Named Entity Recognition
  - Sequence Tagging and Labeling
- Sequence-to-sequence models with attention
- Transformers
  - Positional encoding
- Pre-training and Fine-tuning
  - Self-supervise Learning
  - Few-shot, One-shot, and zero-shot learning

Syllabus (2)

- Word representations and morphology
  - Compositional character representations
  - Word embeddings (Distributed word representations)
  - Contextual Word Embeddings
    - TagLM, ELMo, ...
  - BERT (Bidirectional Encoder Representations from Transformers)
  - Open vocabulary models, and Byte pare encoding
  - Word Sense Disambiguation
- GPT2 and GPT-3: Language Models Are Few-Shot Learners
- Semantic Parsing
  - Semantic Role Labeling
  - Semantic Frame Based Spoken Language Understanding
  - Intent Determination and Spoken Utterance Classification
  - Intent Detection and Slot Filling
  - Relation Extraction
  - Evaluation Metrics
- Conversational Agents
  - Human/Human Conversation Understanding
  - Spoken Dialog Systems

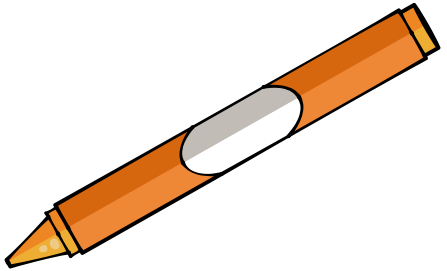
Syllabus (3)

- Paraphrasing and Question Answering
  - Spoken Question Answering
  - Data-to-text Generation
- Natural Language Inference
  - Information Access and Text Mining
- Information Extraction and Knowledge Graphs
- Summarization
  - Speech Summarization
- Sentiment Analysis and Opinion Mining
- Parsing
  - Dependency Parsing
- Active Learning
- Bias in NLP
  - Word embeddings are biased
- Applications:
  - Voice Search
  - Topic Identification
  - Speech Retrieval

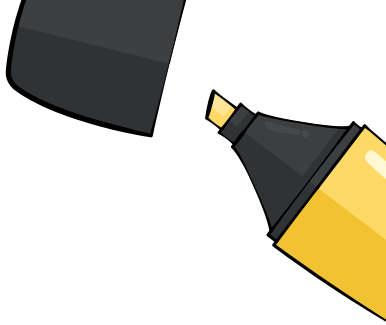
References

- There is no complete text-book for this course
- Books:
  - Tur, Gokhan, and Renato De Mori. “Spoken language understanding: Systems for extracting semantic information from speech.” John Wiley & Sons, 2011.
  - Dan Jurafsky and James H. Martin, “Speech and Language Processing (3rd ed.)”, 2019
  - Kamath, U., Liu, J., & Whitaker, J. “Deep learning for NLP and speech recognition.” Springer, 2019.
- Selected papers
  - The course materials are prepared using lots of papers. See the end of each slide.

Thanks for your attention



References and IP Notice



- Some slides were selected from Lopez's slides.
- Some graphics were selected **Slidesgo template**