



Language Understanding

01 - Introduction

Hossein Zeinali

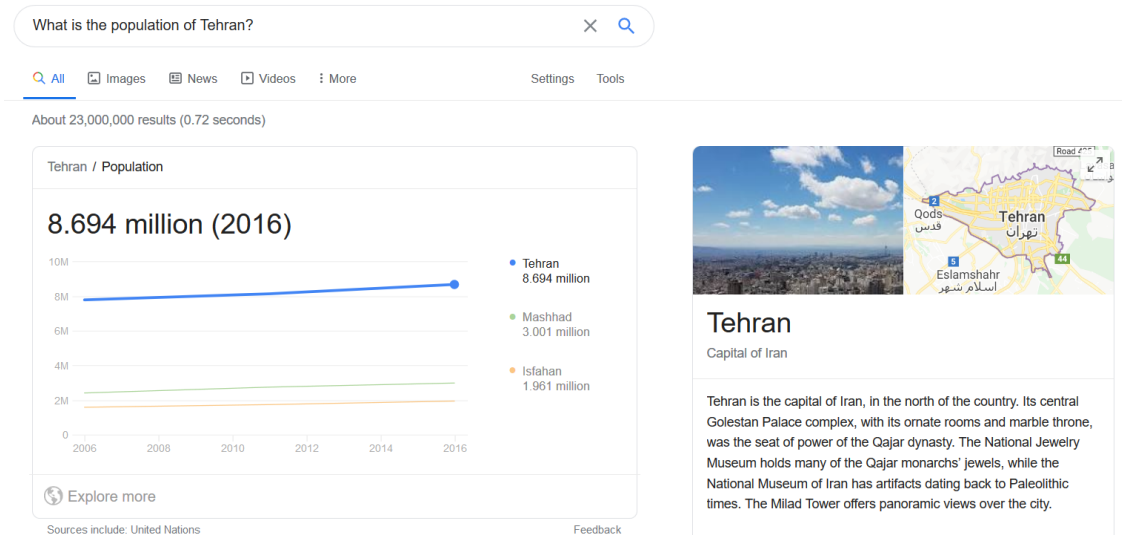
What is Language Understanding?



- **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?

Restaurant Review

User Rating: 2/5

I had a very mixed experience at The Stand. The burger and fries were good. The chocolate shake was divine: rich and creamy. The drive-thru was horrible. It took us at least 30 minutes to order when there were only four cars in front of us. We complained about the wait and got a half-hearted apology. I would go back because the food is good, but my only hesitation is the wait.

Summary

- ▲ The burger and fries were good
- ▲ The chocolate shake was divine
- ▲ I would go back because the food is good
- ▼ The drive-thru was horrible
- ▼ It took us at least 30 minutes to order

- **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

buy echo dot



I'd like to buy echo dot

buy me that mini echo thing



hey, can I purchase echo dot



What is Language Understanding?

- Application : Paraphrasing

buy echo dot



I'd like to buy echo dot

buy me that mini echo thing



hey, can I purchase echo dot



What is Language Understanding?

- Application : Single-document Summarization

Document

Cambodian leader Hun Sen on Friday rejected opposition parties ' demands for talks outside the country , accusing them of trying to " internationalize " the political crisis .

Government and opposition parties have asked King Norodom Sihanouk to host a summit meeting after a series of post-election negotiations between the two opposition groups and Hun Sen 's party to form a new government failed .

Opposition leaders Prince Norodom Ranariddh and Sam Rainsy , citing Hun Sen 's threats to arrest opposition figures after two alleged attempts on his life , said they could not negotiate freely in Cambodia and called for talks at Sihanouk 's residence in Beijing .Hun Sen , however , rejected that ."

I would like to make it clear that all meetings related to Cambodian affairs must be conducted in the Kingdom of Cambodia , " Hun Sen told reporters after a Cabinet meeting on Friday .'" No-one should internationalize Cambodian affairs .

It is detrimental to the sovereignty of Cambodia , " he said .Hun Sen 's Cambodian People 's Party won 64 of the 122 parliamentary seats in July 's elections , short of the two-thirds majority needed to form a government on its own .Ranariddh and Sam Rainsy have charged that Hun Sen 's victory in the elections was achieved through widespread fraud .They have demanded a thorough investigation into their election complaints as a precondition for their cooperation in getting the national assembly moving and a new government formed

Summary

Cambodian government rejects opposition's call for talks abroad



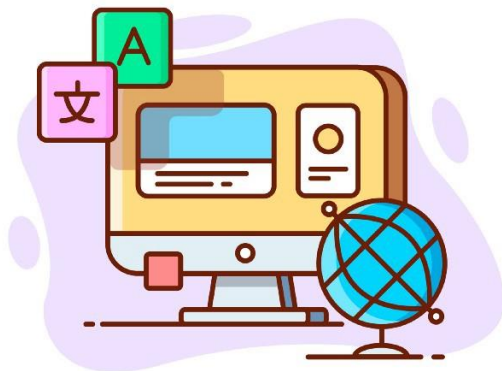
What is Language Understanding?

- Application : Natural Language Inference (NLI)

P^a	A senior is waiting at the window of a restaurant that serves sandwiches.	Relationship
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
^aP, Premise. ^bH, Hypothesis.		



What is Machine Translation?

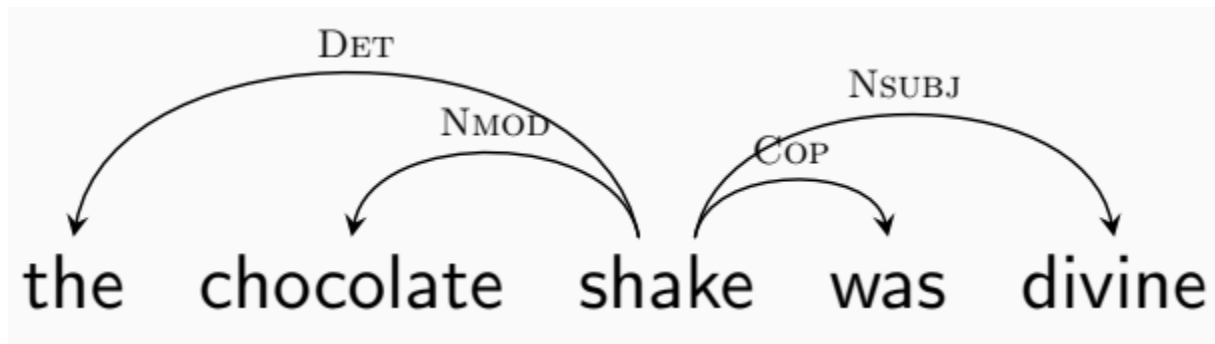


WILLKOMMEN स्वागत
欢迎 BIENVENIDA
WELCOME
BIENVENUE ようこそ
добро пожаловать
ترحيب BEM-VINDO

- **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.

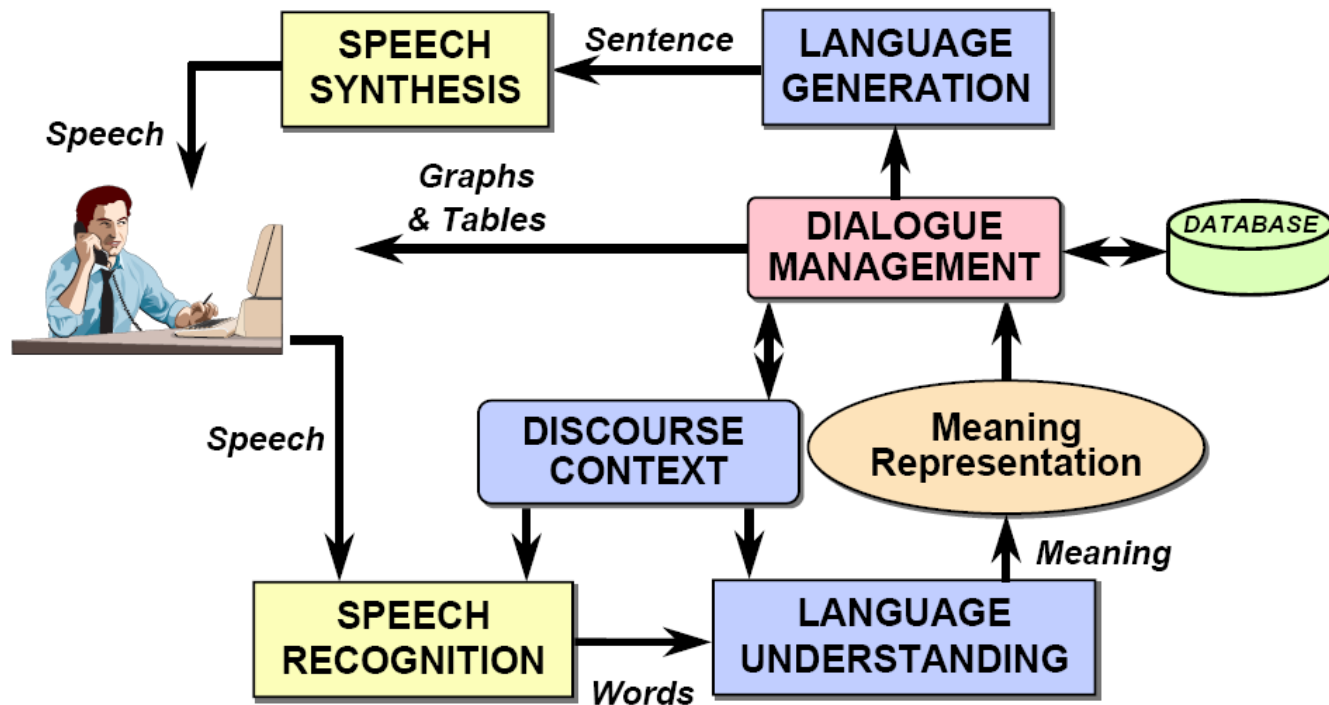
Input: Structured data (e.g. database tables)

Output: A natural language description of that data

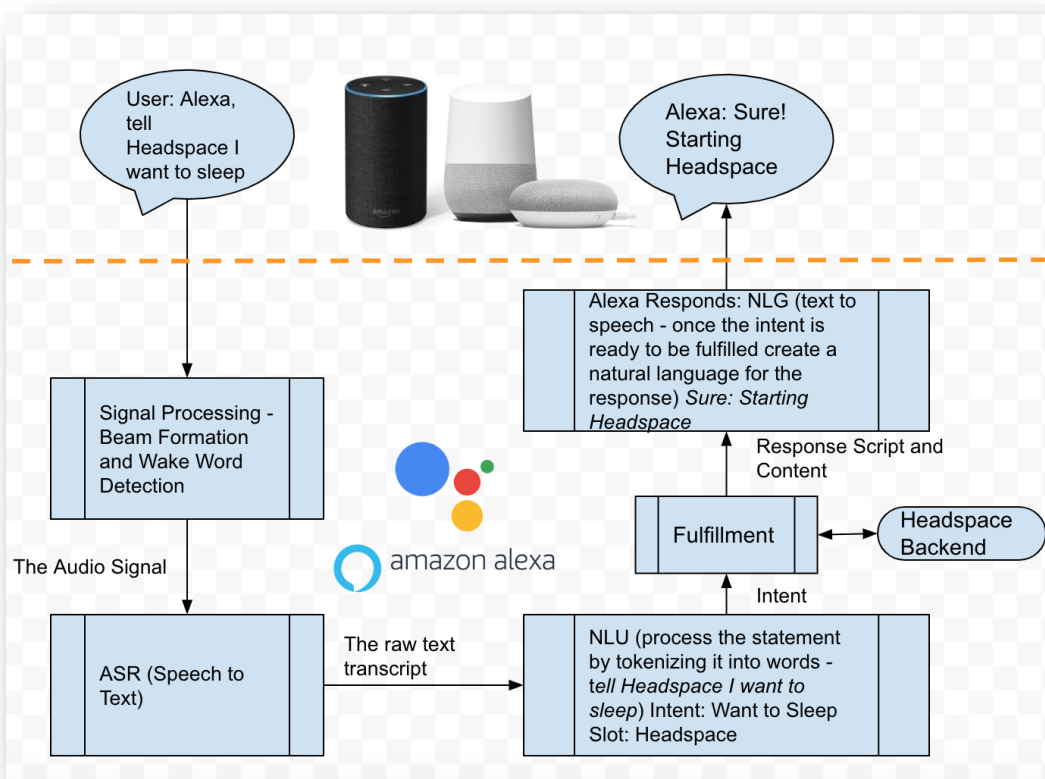
These two teams have really struggled this season and the 48 combined turnovers shows just that. **Denver** was the more inept team though, as they set an NBA season-high with 29 turnovers of their own. The shooting wasn't any better, as they shot **41** percent from the field, **67** percent from the 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?

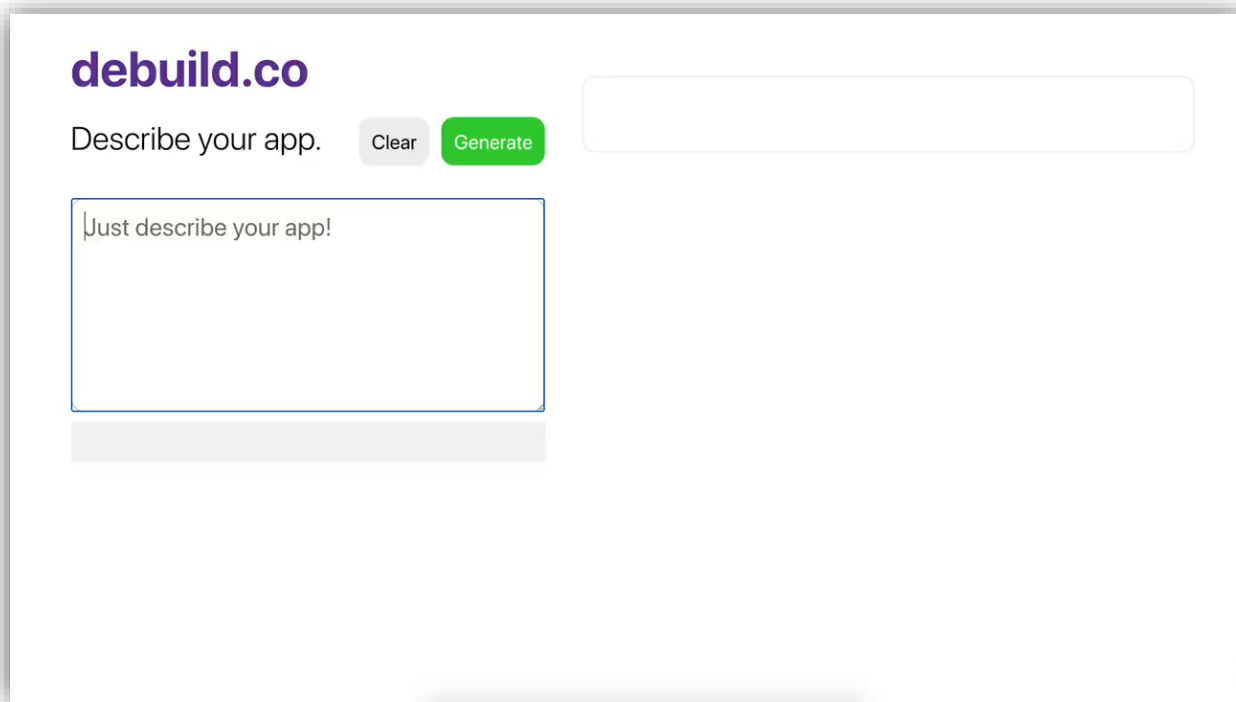
A: Animals don't have three legs because they would fall over.

- **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



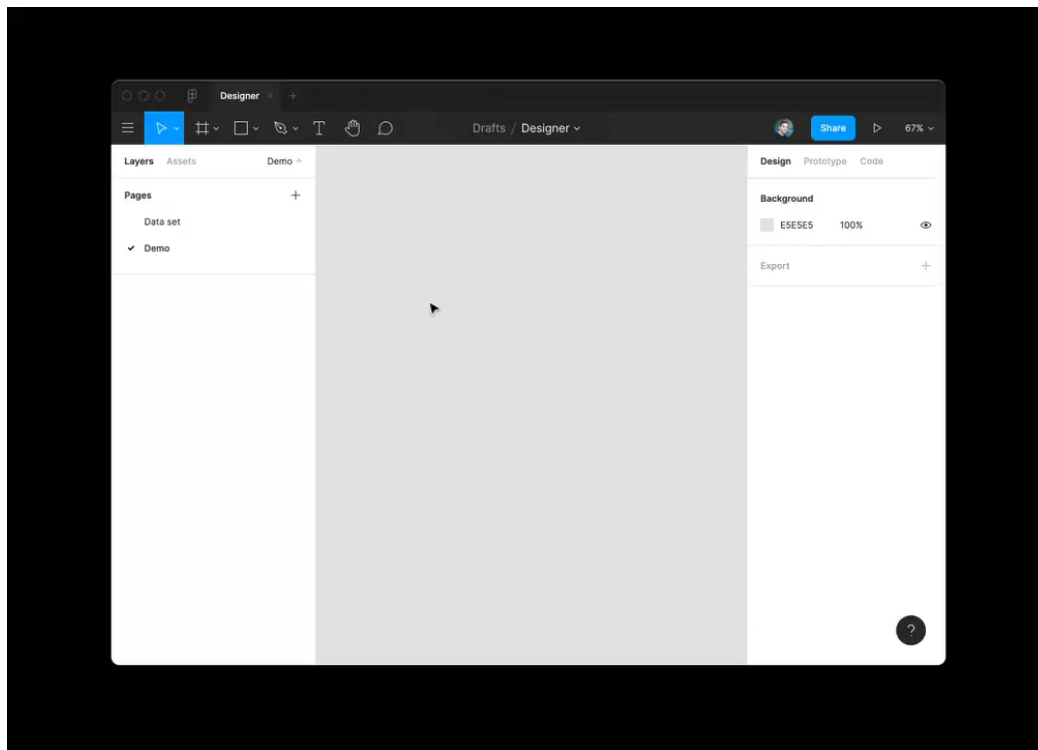
The screenshot shows the debuild.co website interface for a GPT3 demo. At the top left is the logo 'debuild.co' in purple. Below it is the text 'Describe your app.' followed by a 'Clear' button and a green 'Generate' button. To the right of these buttons is a small, empty rectangular input field. Below the 'Describe your app.' text is a larger text area with a placeholder that says 'Just describe your app!'. The entire interface is enclosed in a light gray border.

- 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

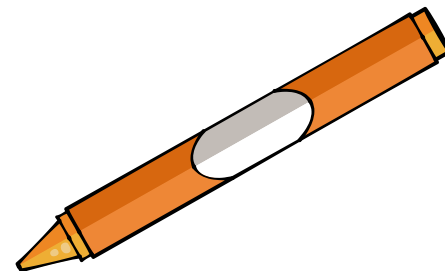
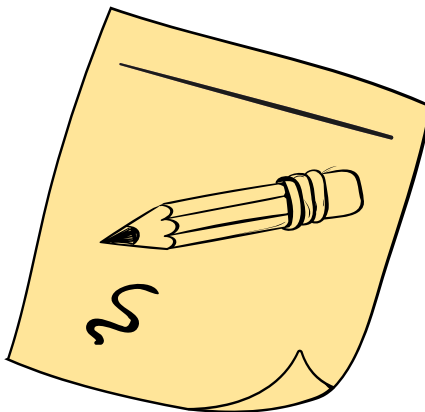
What would you like to know?

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





Course Logistics



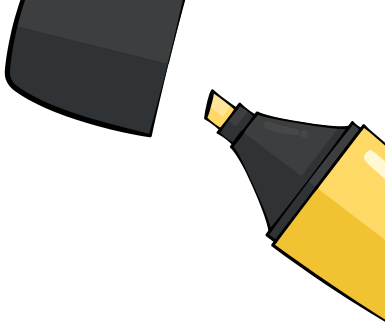
General Information

- 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 pair 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

