Machine Learning HW9
Explainable AI

ML TAs
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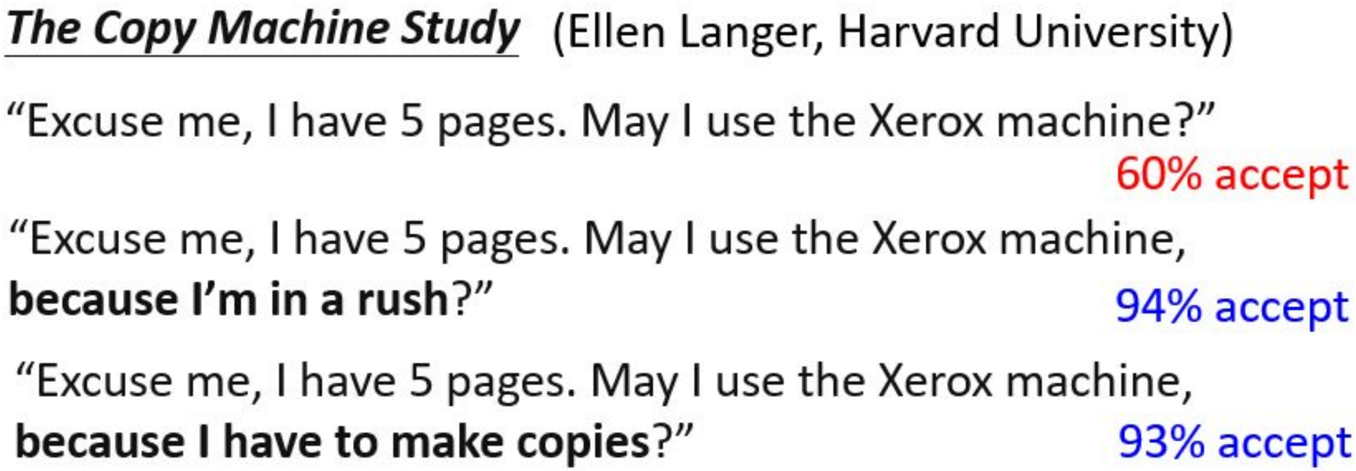
Outline

- Introduction
- Topic I: CNN (hw3)
  - Model & Dataset
  - Task
  - Lime
  - Saliency Map
  - Smooth Grad
  - Filter Visualization
  - Integrated Gradient
- Topic II: BERT (hw7)
  - Task
  - Attention Visualization
  - Embedding Visualization
  - Embedding Analysis

Introduction

Why we need Explainable AI?

- Correct answers ≠ Intelligent
- We can improve ML model based on explanation
- Make people comfortable since people need reasons



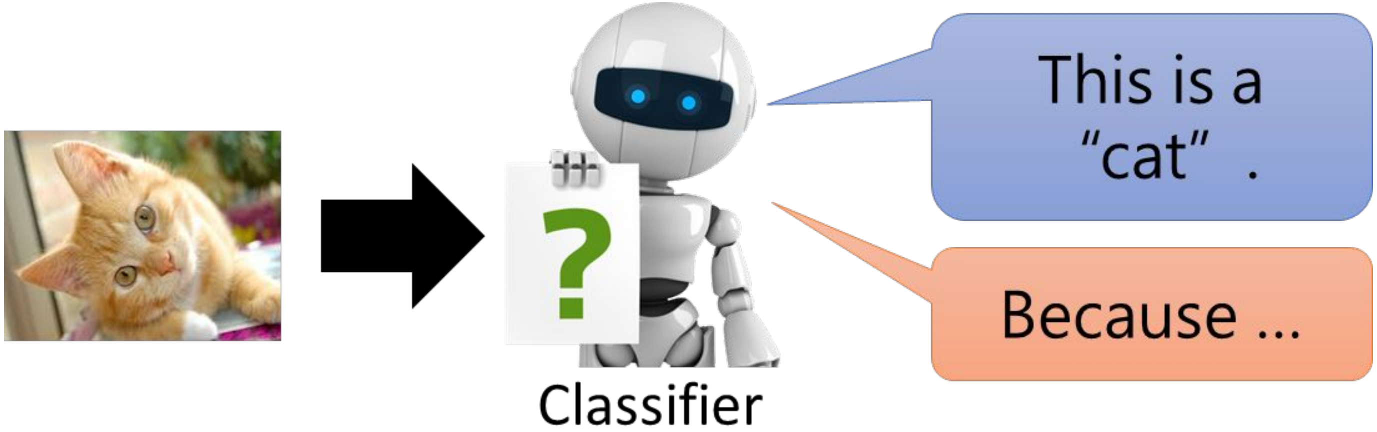
The Copy Machine Study (Ellen Langer, Harvard University)

"Excuse me, I have 5 pages. May I use the Xerox machine?"
60% accept

"Excuse me, I have 5 pages. May I use the Xerox machine, **because I'm in a rush**?"
94% accept

"Excuse me, I have 5 pages. May I use the Xerox machine, **because I have to make copies**?"
93% accept

Explainable AI



This is a "cat" .

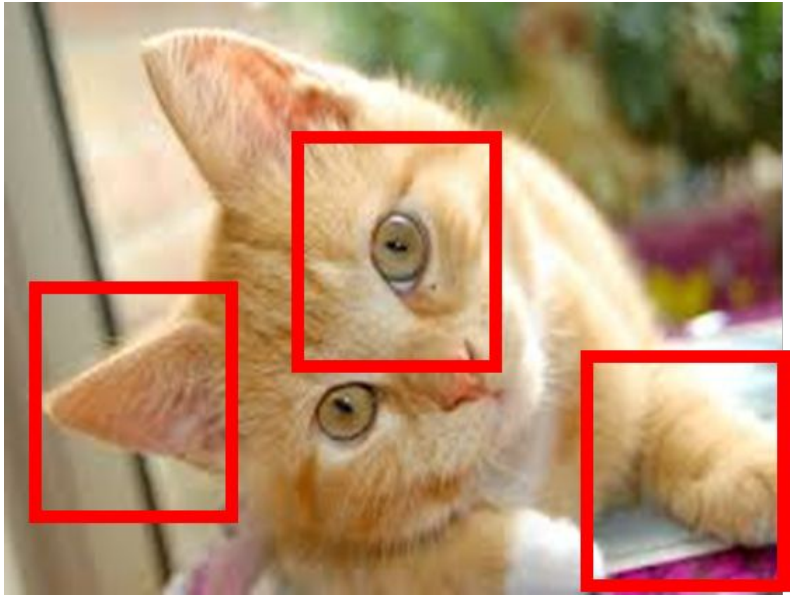
Because ...

Classifier

- Local Explanation
  - Why does the classifier think this image is a cat?
- Global Explanation
  - What does a "cat" look like? (not referred to a specific image)

Local Explanation

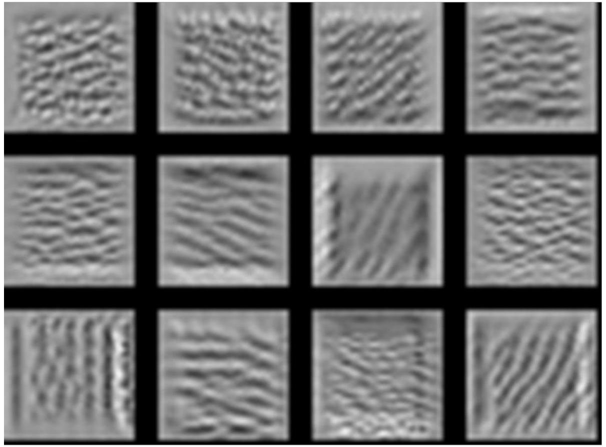
- Which component is critical for making decision?

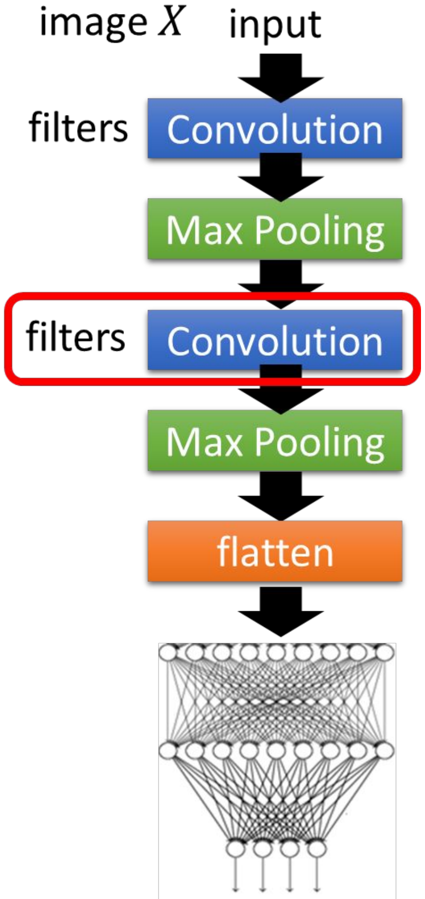


Global Explanation

- What does a filter detect?

X^* for each filter





Topic I: CNN explanation (hw3)

Model: Food Classification

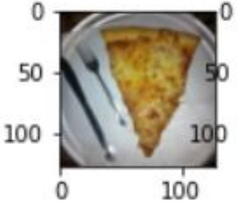
- We use a trained classifier model to do some explanations
- Model Structure: CNN model
- Dataset: 11 categories of food (same dataset in HW3)
  - Bread, Diary product, Dessert, Egg, Fried food, Meat, Noodles/Pasta, Rice, Seafood, Soup, and Vegetables/Fruit

Task

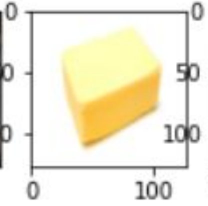
- Run the sample code and finish 20 questions (all multiple choice form)
- We'll cover 5 explanation approaches
  - Lime package
  - Saliency map
  - Smooth Grad
  - Filter Visualization
  - Integrated Gradients
- You need to:
  - Know the basic idea of each method
  - Run the code and observe the results
  - For some cases, you may need to modify a small part of the code

Task: Observation

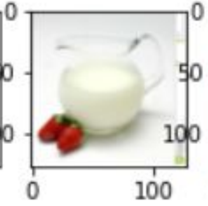
- In this homework, you only need to observe these 10 images.
- Please make sure **you got these 10 images in your code.**
- In the questions, the images are marked from **0 to 9**.
- We encourage you to observe other images!



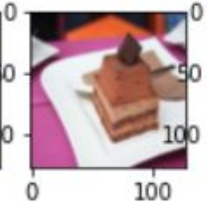
0



1



2



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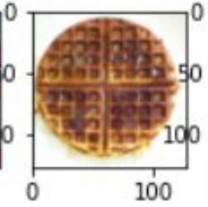

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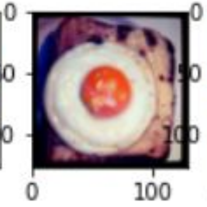

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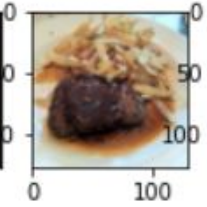

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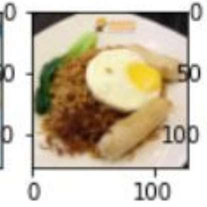

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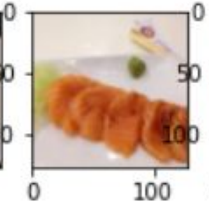
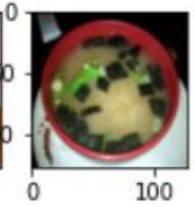


8



9

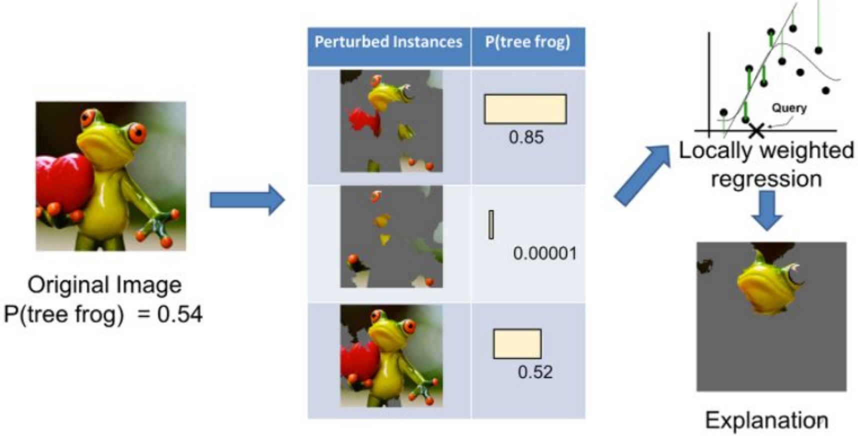
Lime

Question 1 to 4

- Install the Lime package -> *pip install lime==0.1.1.37*

GitHub repo: https://github.com/marcotcr/lime

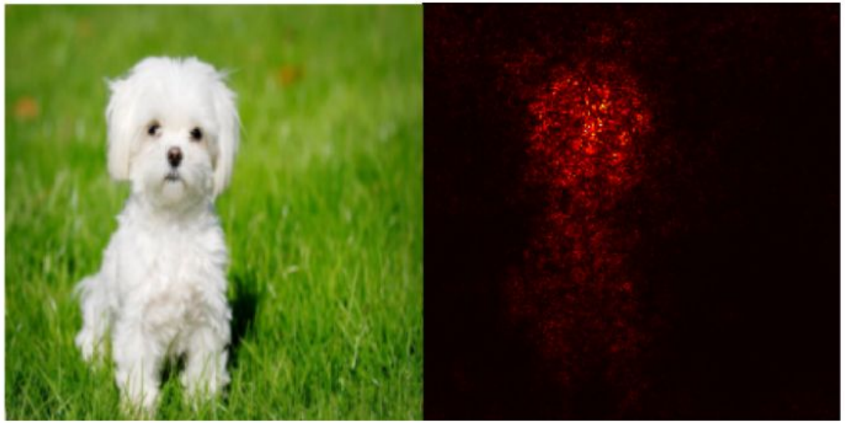
Ref: https://reurl.cc/5G8EGG



Saliency Map

Question 5 to 9

- Compute the gradient of output category with respect to input image.



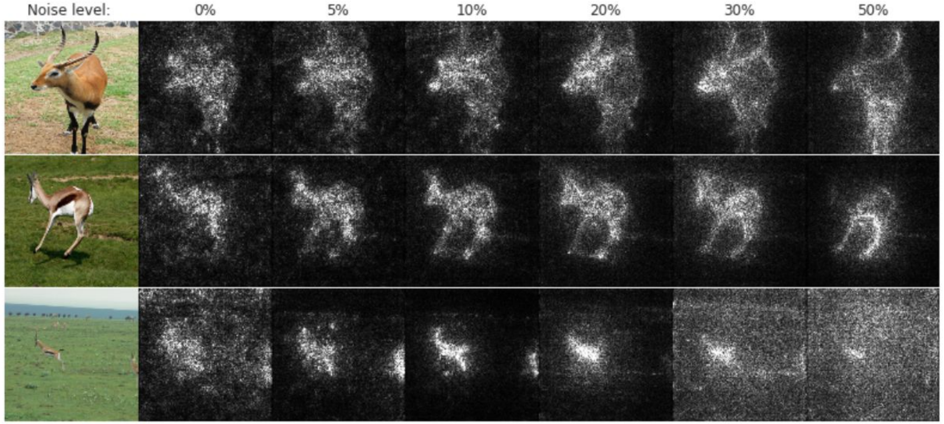
Ref: https://reurl.cc/6ELeLk

Smooth Grad

Question 10 to 13

- Randomly add noise to the input image, and get the heatmap. Just like what we did in the saliency method.

Ref: https://arxiv.org/pdf/1706.03825.pdf

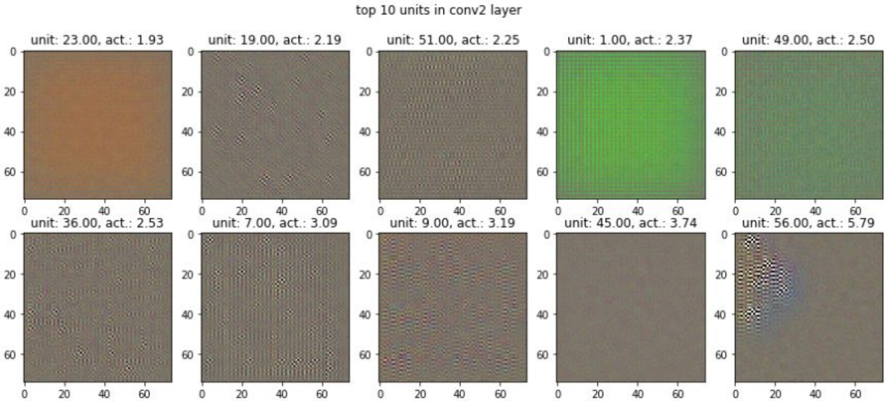


Filter Visualization

Question 14 to 17

- Use Gradient Ascent method to find the image that activates the selected filter the most and plot them (start from white noise).

Ref: https://reurl.cc/mGZNbA

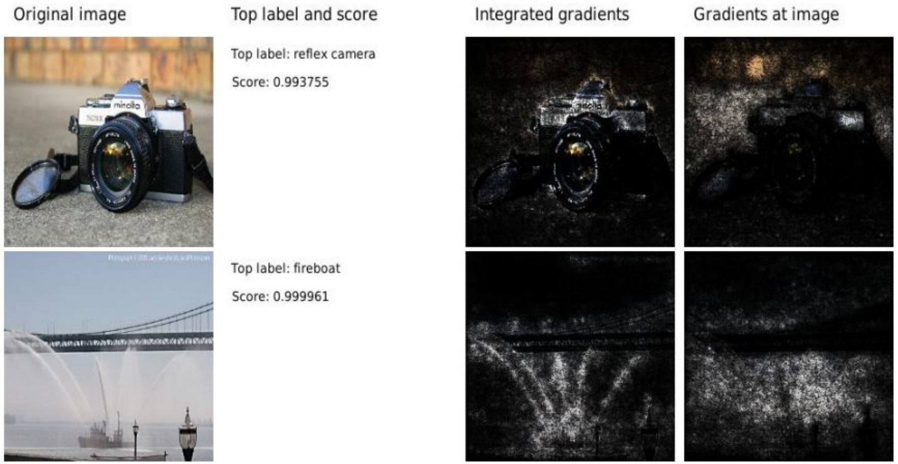


Integrated Gradients

Question 18 to 20

- Flexible baseline

$$\text{IntegratedGrads}_i(x) ::= (x_i - x'_i) \times \int_{\alpha=0}^{1} \frac{\partial F(x' + \alpha \times (x - x'))}{\partial x_i}\, d\alpha$$



Ref: https://arxiv.org/pdf/1703.01365.pdf

Topic II: BERT explanation (hw7)

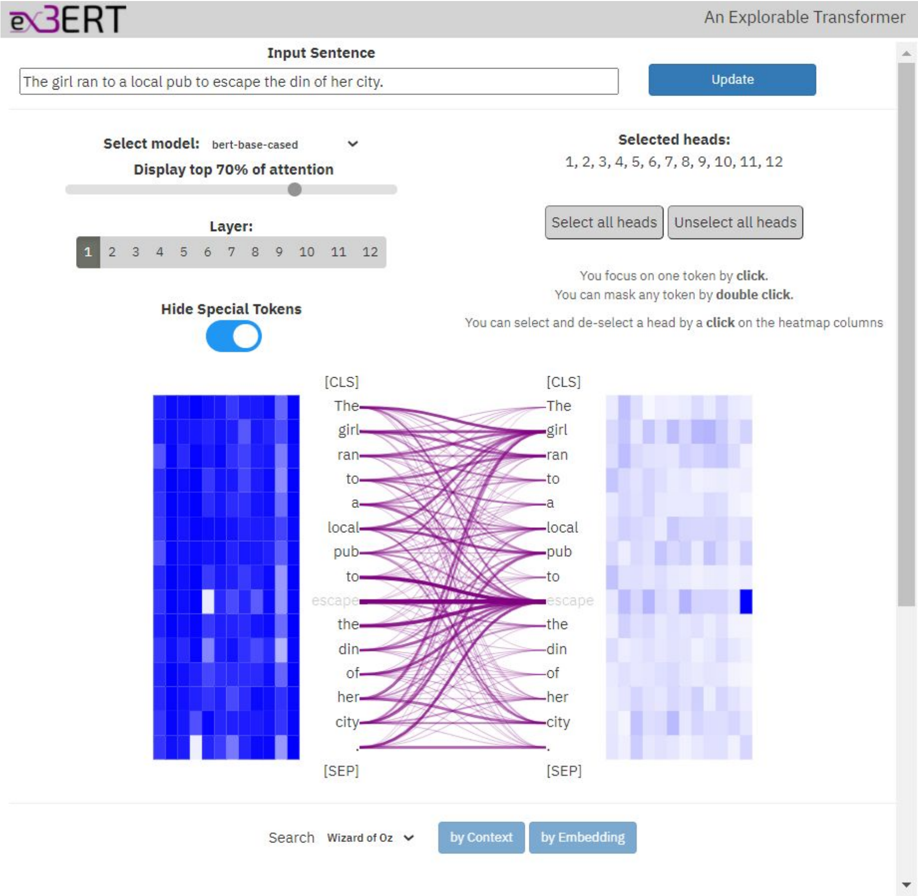
Task

- Run the sample code and finish 10 questions (all multiple choice form)
- We'll cover 3 explanation approaches
  - Attention Visualization
  - Embedding Visualization
  - Embedding analysis
- You need to:
  - Know the basic idea of each method
  - Run the code and observe the results
  - For some cases, you may need to modify a small part of the code

Attention Visualization

Question 21 to 24

- Visualize attention mechanism of bert using https://exbert.net/exBERT.html



Input Sentence

The girl ran to a local pub to escape the din of her city.

Select model: bert-base-cased

Display top 70% of attention

Layer: 1

Selected heads: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

You focus on one token by **click**.
You can mask any token by **double click**.
You can select and de-select a head by a **click** on the heatmap columns

Hide Special Tokens

Search Wizard of Oz

Alternative link: https://huggingface.co/exbert/

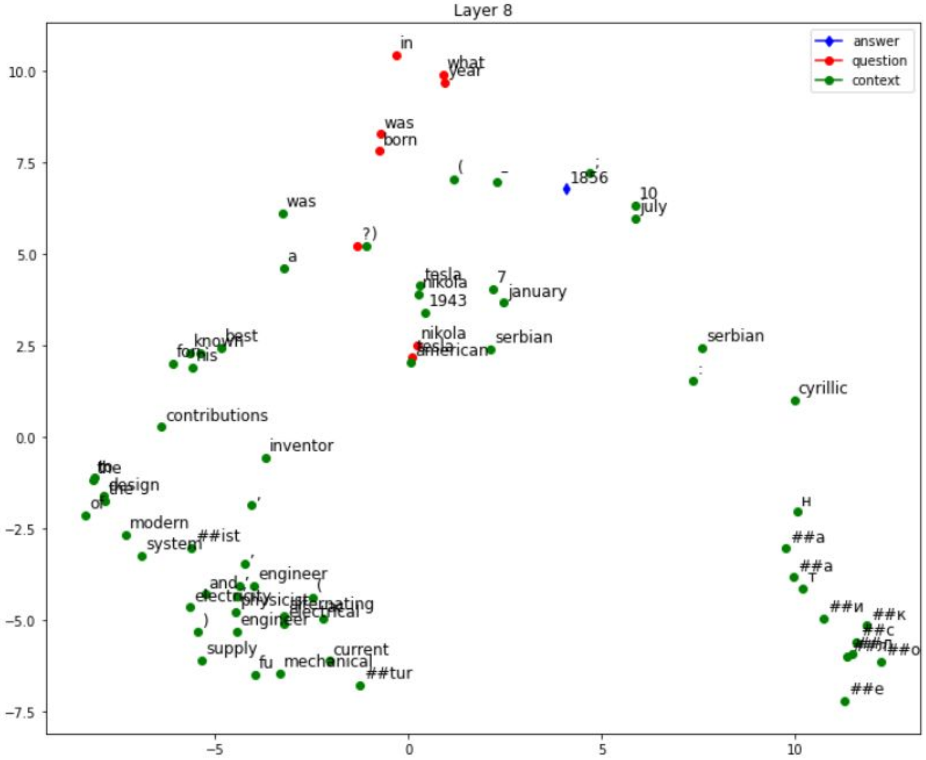
Ref: https://arxiv.org/pdf/1910.05276.pdf

Tutorial: https://youtu.be/e31oyfo_thY

Embedding Visualization

Question 25 to 27

- Visualize embedding across layers of BERT using PCA (Principal Component Analysis)
- Fine-tuned for Question Answering

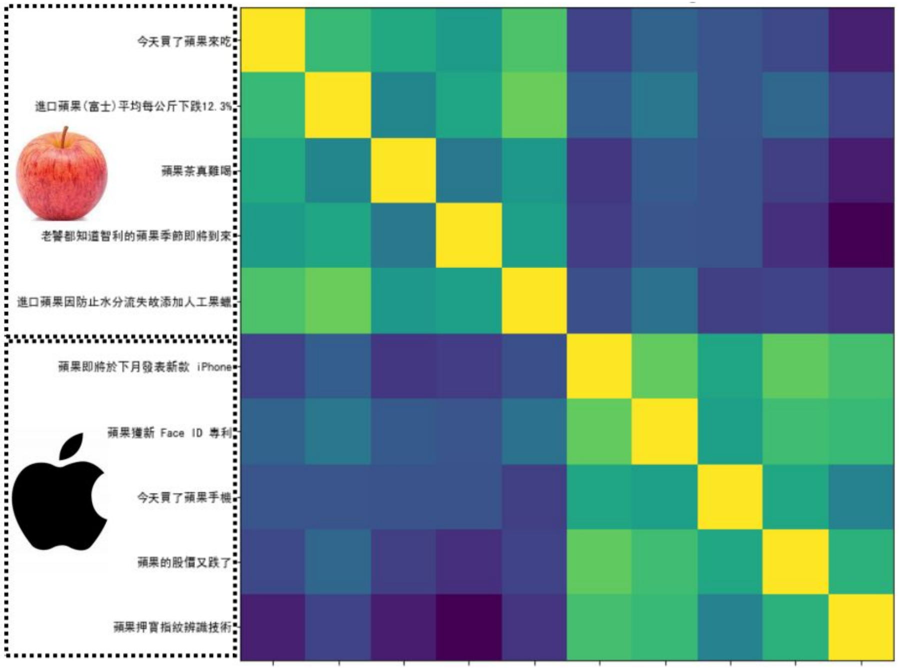


Embedding Analysis

Question 28 to 30

- Compare output embedding of BERT using:
    - Euclidean distance
    - Cosine similarity

You only need to change code in the section “TODO” !



Grading

- 30 multiple choice questions
- CNN: 20 questions
  - 0.3 pt for each question
- BERT: 10 questions
  - 0.4 pt for each question
- You have to choose ALL the correct answers for each question
- No leaderboards & reports are needed!!

Submission

- The questions are on **gradescope**
- Running the code may need some time!
- **No late submission!**
- You can answer the questions unlimited times
- The length of anwsering time of the assignment is unlimited
- We will consider the latest submission as the final submission
- **Remember to save the answer when answering the questions!**
- You will see the scores after the deadline only!
- Deadline: **2023/05/26 23:59 (UTC+8)**

Links

- Code: [Colab]
- Gradescope: [Gradescope]

Please don’t change the original code, unless the question request you to do so.

If any questions, you can ask us via...

- NTU COOL (recommended)
  - Homework 9 討論區
- Email
  - mlta-2023-spring@googlegroups.com
  - The title **must** begin with “[hw9]”
- TA hours
  - In-person: Each Friday during class
  - Online: Each Monday night on google meet
  - Link: HW9 TA hour
  - 19:00 - 20:00 (Mandarin)
  - 20:00 - 21:00 (English)