Deep Learning for NLP - Focus on Medical Applications

General Overview

zeljko.kraljevic@kcl.ac.uk

Basic Information

- The sessions will be held once every two weeks
- Our current schedule is Tuesday from 13:00-16:00h
- We will send an email, before each session, with the topics that will be covered. You are free to skip whatever is not interesting to you (I will try to warn which sessions are completely independent and which not).
- Each session will have recommended reading materials
  - Completely up to you, nothing is obligatory
- It would be good if you already had:
  - Intermediate knowledge of Python
  - Basic knowledge of linear algebra, probability and statistics
- Finally, if anything changes we will let you know.

Today

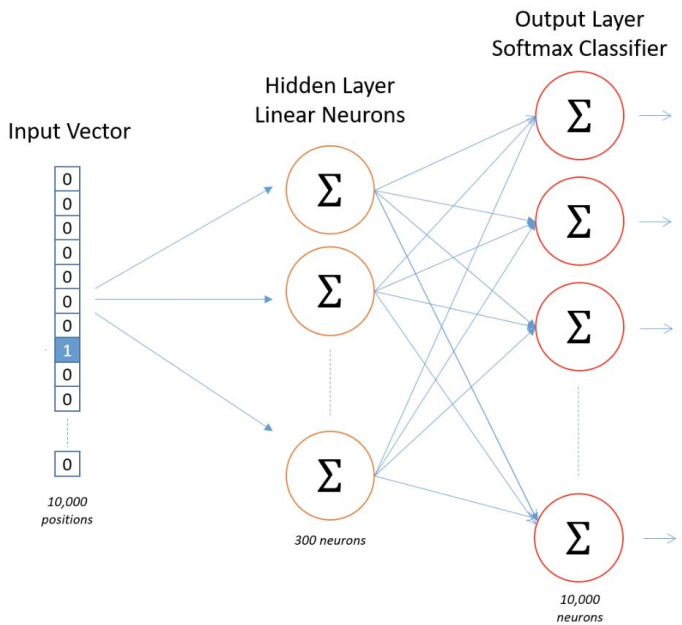
1. Training Overview
    a. What is the goal
    b. ML/DL topics we are going to cover
    c. Topics we are not going to cover
2. Introductions
    a. Google Collab
    b. Linear algebra
    c. Machine Learning / Deep Learning
    d. Neural Networks
    e. Probability and statistics

What is the goal

- Trends
  - Plug and Play
  - Easy/Simplified/Demystified
  - Fast
- How to do it
  - Understand the data
    - Is it possible to train a model using this data
  - Understand the models
    - Is the model good for my task
  - Understand the training/testing
    - Training fails without a warning or error
    - Why and where is the model making mistakes
- Tricks
  - Word2Vec

Overview of Topics That Will Be Covered

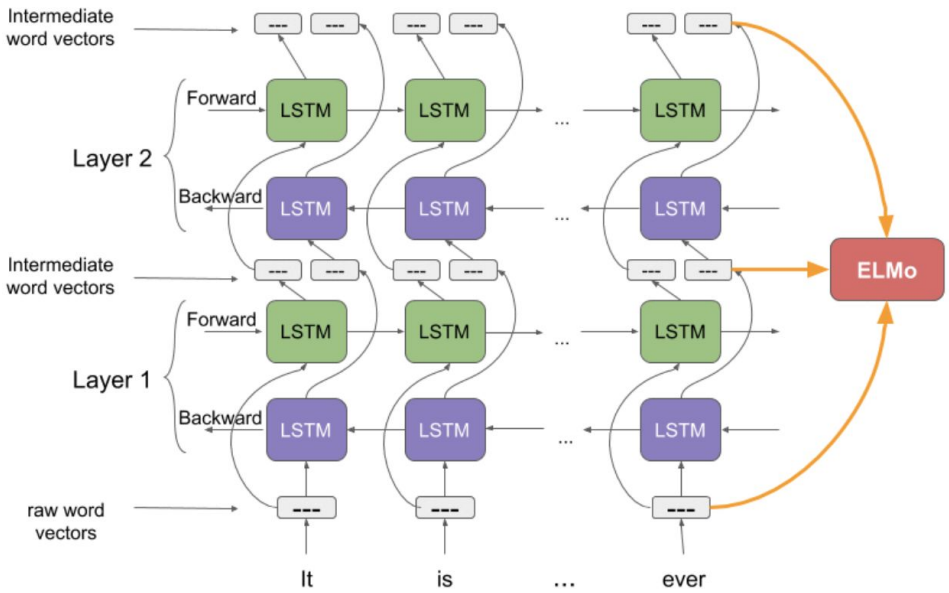
Showcase 1: Word Embedding - Word2Vec



*Vectors trained by CAT, the video is made using https://projector.tensorflow.org/

*Image Credits to: https://towardsdatascience.com/word2vec-skip-gram-model-part-1-intuition-78614e4d6e0b

Showcase 1: Word Embedding - ELMO



He had a light **fever**.

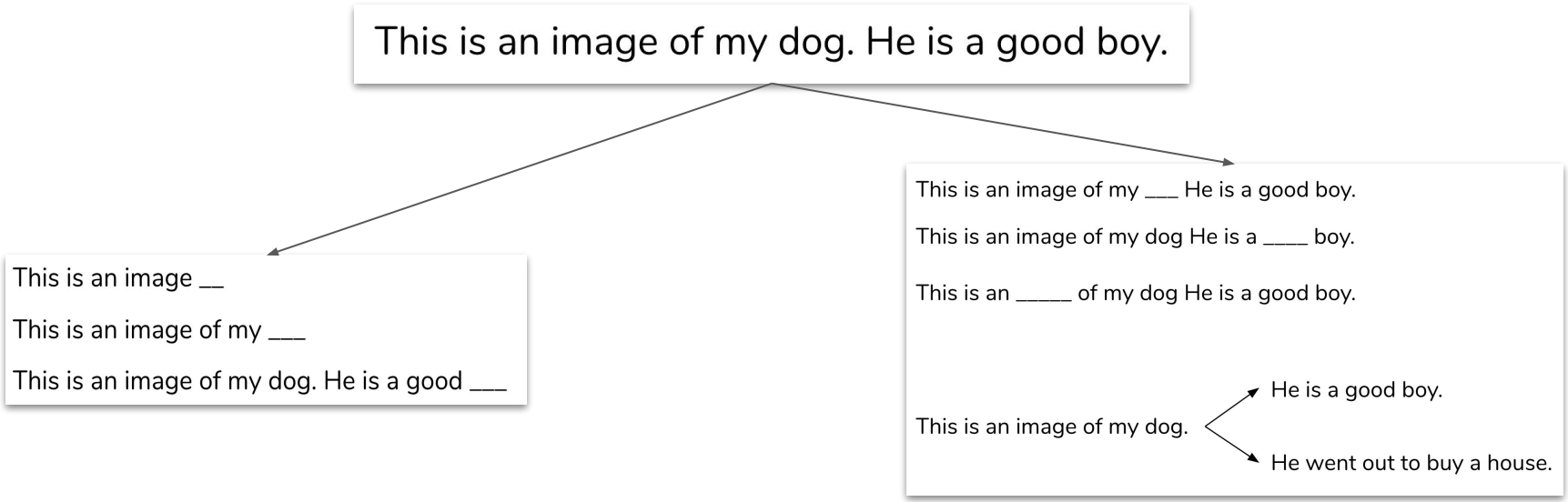
He had an extremely high **fever**.

- Dynamic
- Context Dependent
- LSTM
- Slower
- Resources

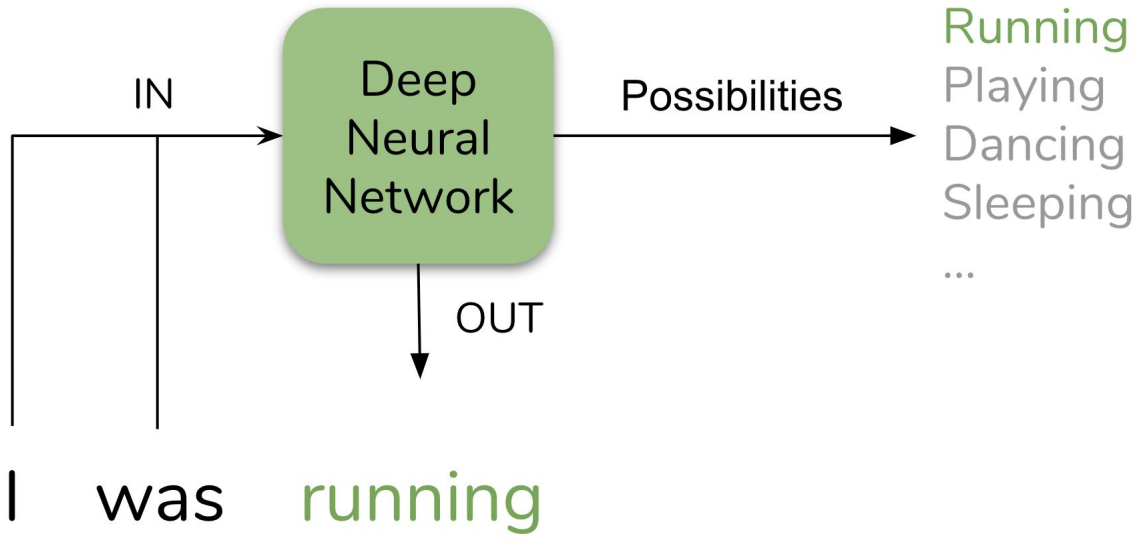
*Image credits: https://www.analyticsvidhya.com/blog/2019/03/learn-to-use-elmo-to-extract-features-from-text/

Showcase 2: Language modeling - Idea

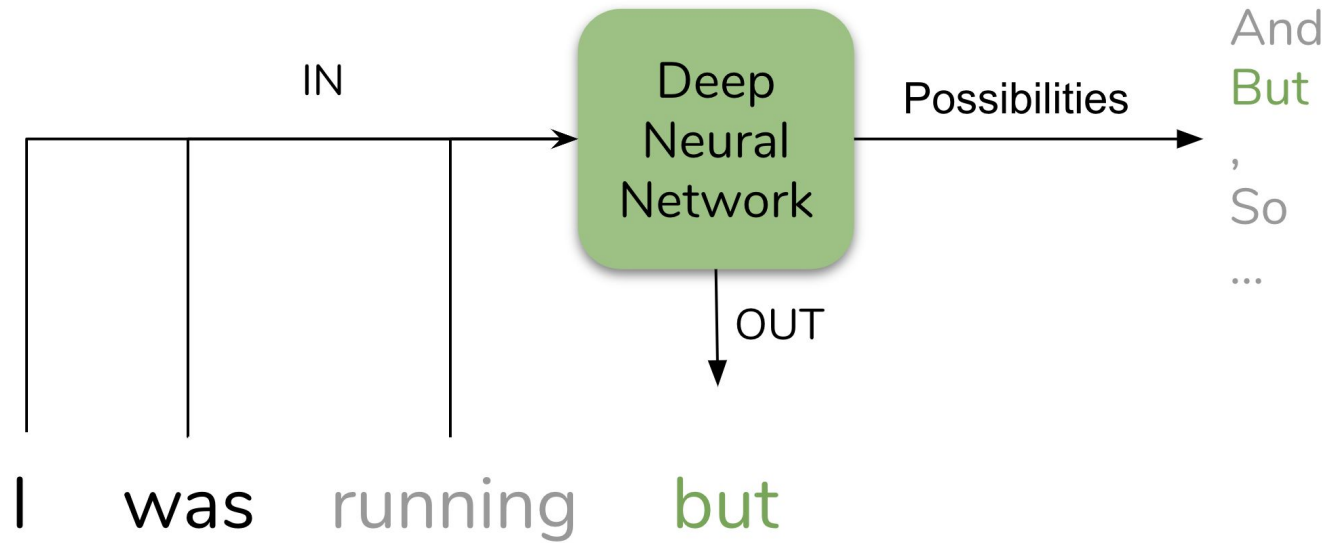
- Today LM is the core of many NLP problems
- How to learn a language
  - Syntax
  - Semantics



Showcase 2: Language modeling - Idea



Showcase 2: Language modeling - Idea - Generation



Showcase 2: Language modeling - GPT v2

Why are you talking to me?"

He stared at her.

She looked at him, stunned, like he had never heard her voice before. "What are you talking about. Is my voice not enough for you? I've given enough to you. You deserve a girlfriend, and I would hate to deprive you of a woman." She looked at him as if he were nothing more than a tool to be used in her whimsical, carnal fantasies.

**Example taken from* https://talktotransformer.com/

Showcase 2: Language modeling - GPT v2

The patient was diagnosed erythrocytesplenic keratosis, which was confirmed by myeloperoxidation and biopsy. The biopsy was also negative for erythrocytespermic cancer (IPC), malignant melanoma of the skin (MPH) and leiomyoma (LMY). The patient is currently receiving the treatment that is currently recommended by his surgeon.

Dr. Schreiber and his team have been in contact with the patient after his visit so I will share the above information with all of you, so as this case becomes public knowledge, please keep a careful eye on your doctor to get information on their specific recommendations. As of today, the patient is receiving the treatment recommended by this surgeon; a combination of radiotherapy, chemotherapy and palliative chemotherapy. This is the result of many days of conversations with the patient himself, including him explaining his decision to pursue this surgery. When you take into

**Example taken from* https://talktotransformer.com/

Showcase 3: Named Entity Extraction

When Sebastian Thrun started working on self-driving cars at Google in 2007, few people outside of the company took him seriously.

When Sebastian Thrun PERSON started working on self-driving cars at Google ORG in 2007 DATE , few people outside of the company took him seriously.

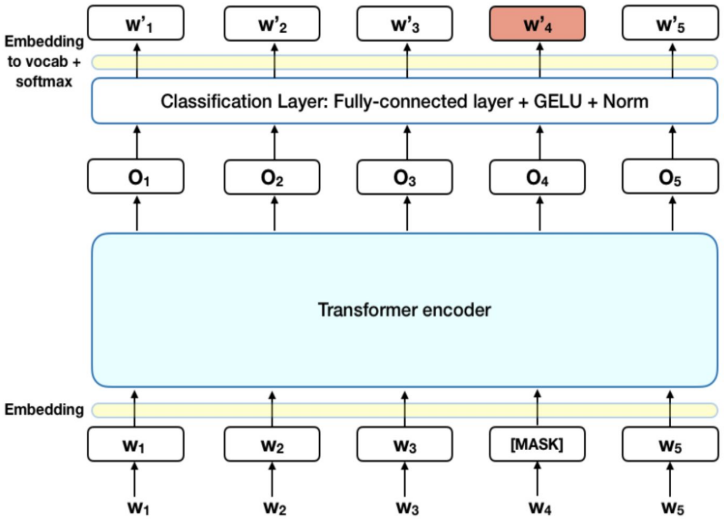
**Example generated using* https://explosion.ai/demos/

Showcase 3: Medical Entity Extraction and Linking

DCTN4 **AMINO ACID, PEPTIDE, OR PROTEIN - 0.4** as a modifier of chronic Pseudomonas aeruginosa infection **DISEASE OR SYNDROME - 0.5** in cystic fibrosis **DISEASE OR SYNDROME - 0.5** Pseudomonas aeruginosa (Pa) infection **DISEASE OR SYNDROME - 0.5** in cystic fibrosis **DISEASE OR SYNDROME - 0.5** (CF **DISEASE OR SYNDROME - 0.5**) patients is associated with worse long-term pulmonary disease **DISEASE OR SYNDROME - 0.5** and shorter survival, and chronic Pa infection **DISEASE OR SYNDROME - 0.5** (CPA) is associated with reduced lung function, faster rate of lung decline, increased rates of exacerbations and shorter survival. By using exome sequencing and extreme phenotype design, it was recently shown that isoforms of dynactin 4 **AMINO ACID, PEPTIDE, OR PROTEIN - 0.5** (DCTN4 **AMINO ACID, PEPTIDE, OR PROTEIN - 0.4**) may influence Pa infection **DISEASE OR**

**Example generated using* https://github.com/w-is-h/cat

Showcase 4: Text Classification - BERT



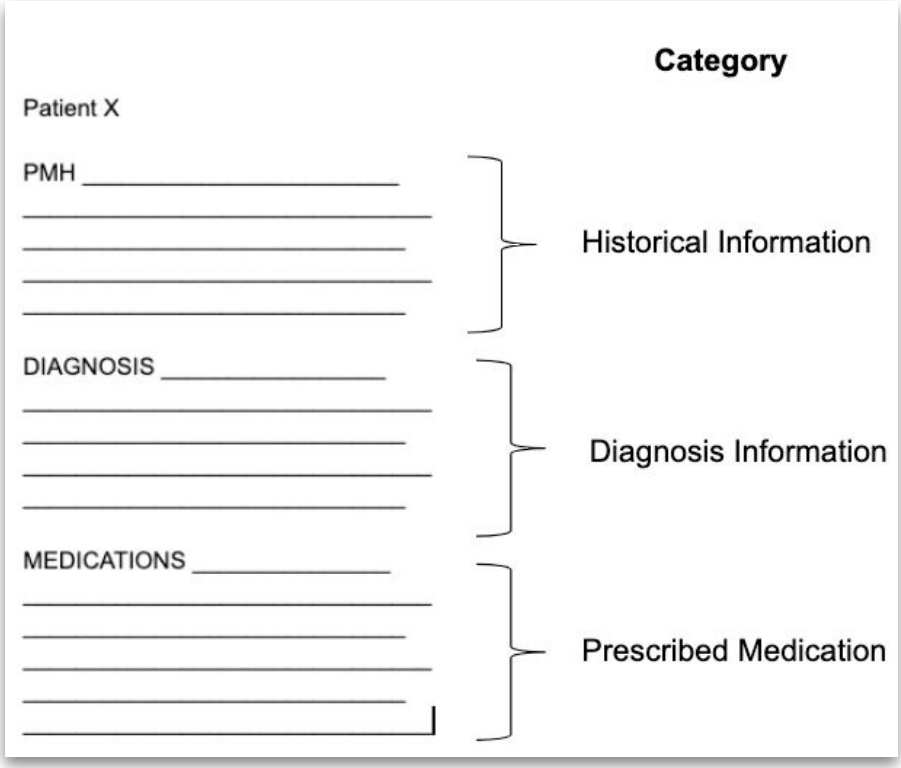
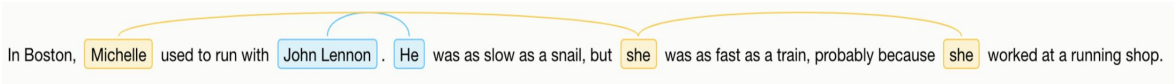
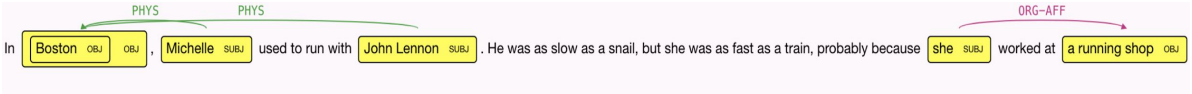
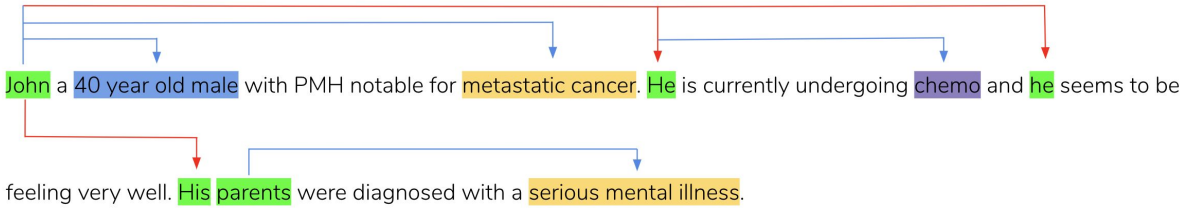


Image credits: https://towardsdatascience.com/bert-explained-state-of-the-art-language-model-for-nlp-f8b21a9b6270

Showcase 5: Coreference resolution and relation extraction - HMTL







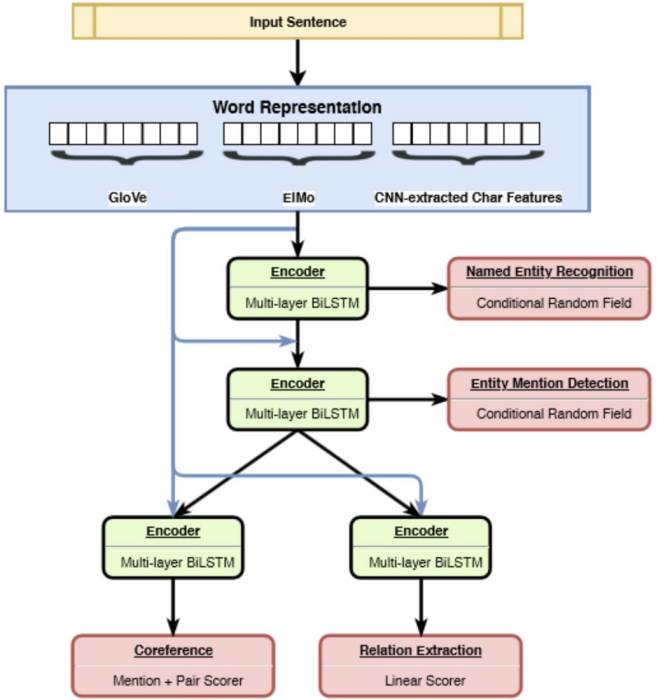
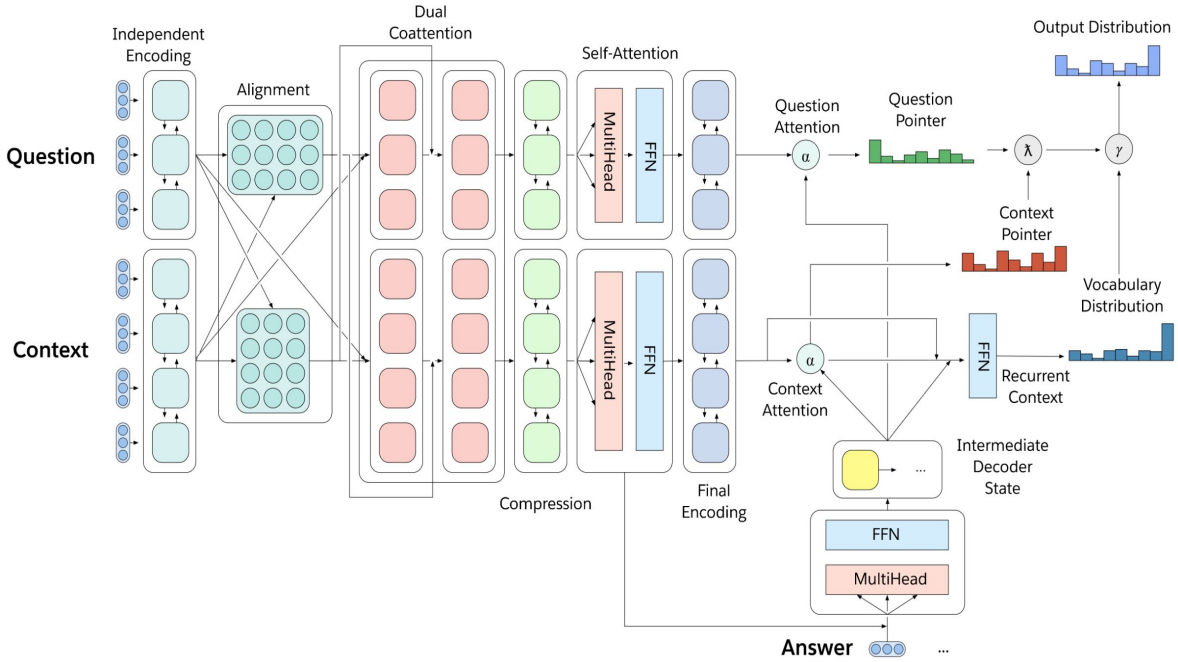


Image credits: https://medium.com/huggingface/beating-the-state-of-the-art-in-nlp-with-hmtl-b4e1d5c3faf

Showcase 6: Multi-Task Learning - DecaNLP



- Question answering
- Machine translation
- Summarization
- Natural Language Inference
- Sentiment analysis
- Semantic role labeling
- Relation extraction
- Goal-oriented dialogue
- Semantic parsing
- Commonsense pronoun resolution

Image credits: https://blog.einstein.ai/the-natural-language-decathlon/

Showcase 7: Describe the Image / Image Captioning

"construction worker in orange safety vest is working on road."

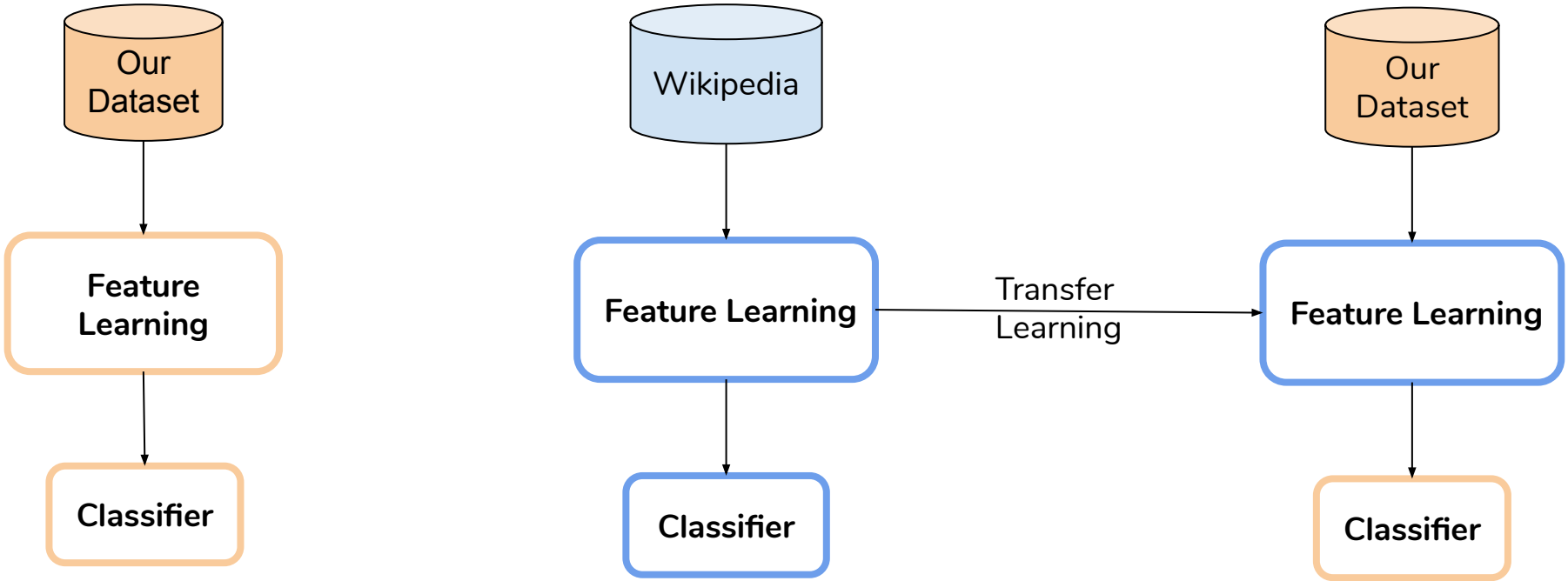
Impression:
No acute cardiopulmonary abnormality.

Findings:
There are no focal areas of consolidation.
No suspicious pulmonary opacities.
Heart size within normal limits.
No pleural effusions.
There is no evidence of pneumothorax.
Degenerative changes of the thoracic spine.

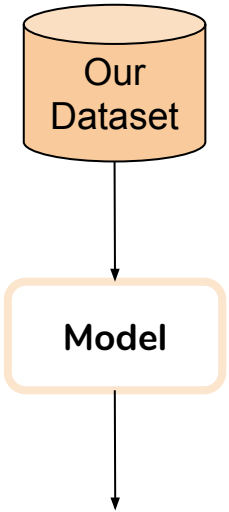
MTI Tags: degenerative change

*Image credits: https://medium.com/@Petuum/on-the-automatic-generation-of-medical-imaging-reports-7d0a7748fe3d
*Image credits: https://towardsdatascience.com/image-captioning-in-deep-learning-9cd23fb4d8d2

Showcase 8: Transfer Learning



Showcase 9: Meta Learning



Patient classification

Patient Classification

D = {(0.3, 0.2),
(0.7, 0.1),
...
}

One example (case) is (0.3, 0.2) and it corresponds to one patient.

B = A random sample from D

Main Idea: One training task is one training example (case)

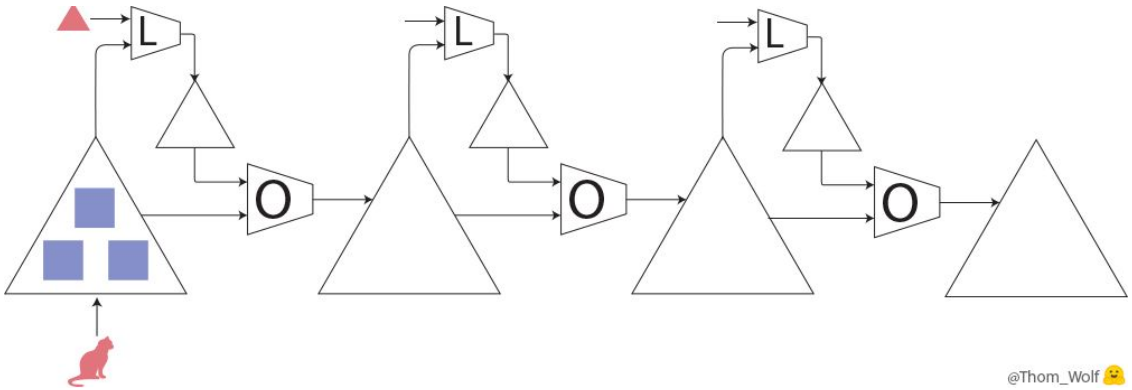
T1 - Is healthy or not
T2 - Has cancer or not
T3 - Feels good or not
T4 - Was ill recently or not
....

Each task has a dataset D_{Ti}

D = {T1, T2, T3, ...}

B = A random sample from D

Showcase 9: Meta Learning - Image Classification



Main Idea: One training task is one training example (case)

T1 - Recognize Cats
T2 - Recognize Dogs
T3 - Recognize Pandas
....

Each task has a dataset D_{Ti}

D = {T1, T2, T3, ...}

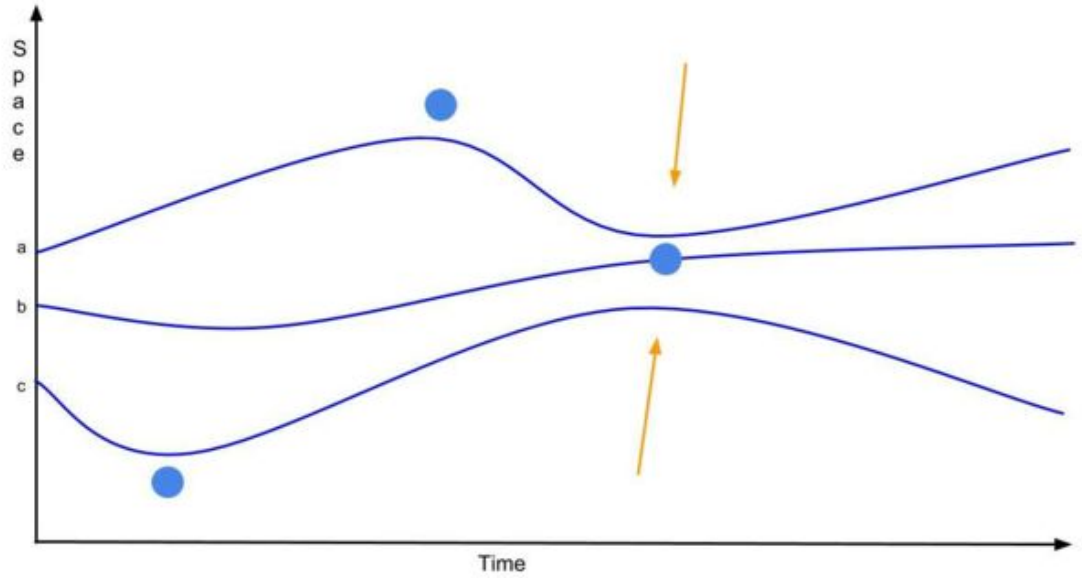
B = A random sample from D

Image credits: https://medium.com/huggingface/from-zero-to-research-an-introduction-to-meta-learning-8e16e677f78a

Showcase 9: Meta Learning - Robots

Video credits: https://openai.com/blog/generalizing-from-simulation/

Showcase 9: Temporal Modeling & Causal Reasoning



- Three people a, b, c
- Changes for each over time
- Closer/Further away

- Memory Networks
- Meta Learning

Other applications not covered here

- Question Answering
- Chatbots
- Abstract Summarization
- Topic Modeling
- Document Comparison
- Translation
- ...

Summary

- Deep Learning is not complicated, it is very intuitive and fairly easy
- It is extremely important to understand your data and the model you are using
- It is usually helpful to use a pre-trained network instead of going from the ground up
- It makes a lot of sense to combine similar tasks and train one model on all of them
- If we want to be able to learn new tasks quickly or from a few examples, we train the model to learn tasks

- Entity Extraction
- Relation Extraction
- Coreference Resolution
- Sentence/Paragraph Classification
- Learning to Learn
- Temporal modelling

For Next Time

For those of you who have a bit of time and want to learn, I would recommend that before the next lecture you do a short course in python for data science and read a chapter of a book.

https://www.datacamp.com - Introduction to Python

https://www.deeplearningbook.org/ - Part I: Applied Math and Machine Learning Basics

Don’t do an introduction to PyTorch tutorial - at least not yet. Usually that intro includes a lot of deep learning and best is to do that a bit later.