AI504: Programming for Artificial Intelligence

Week 1: Introduction

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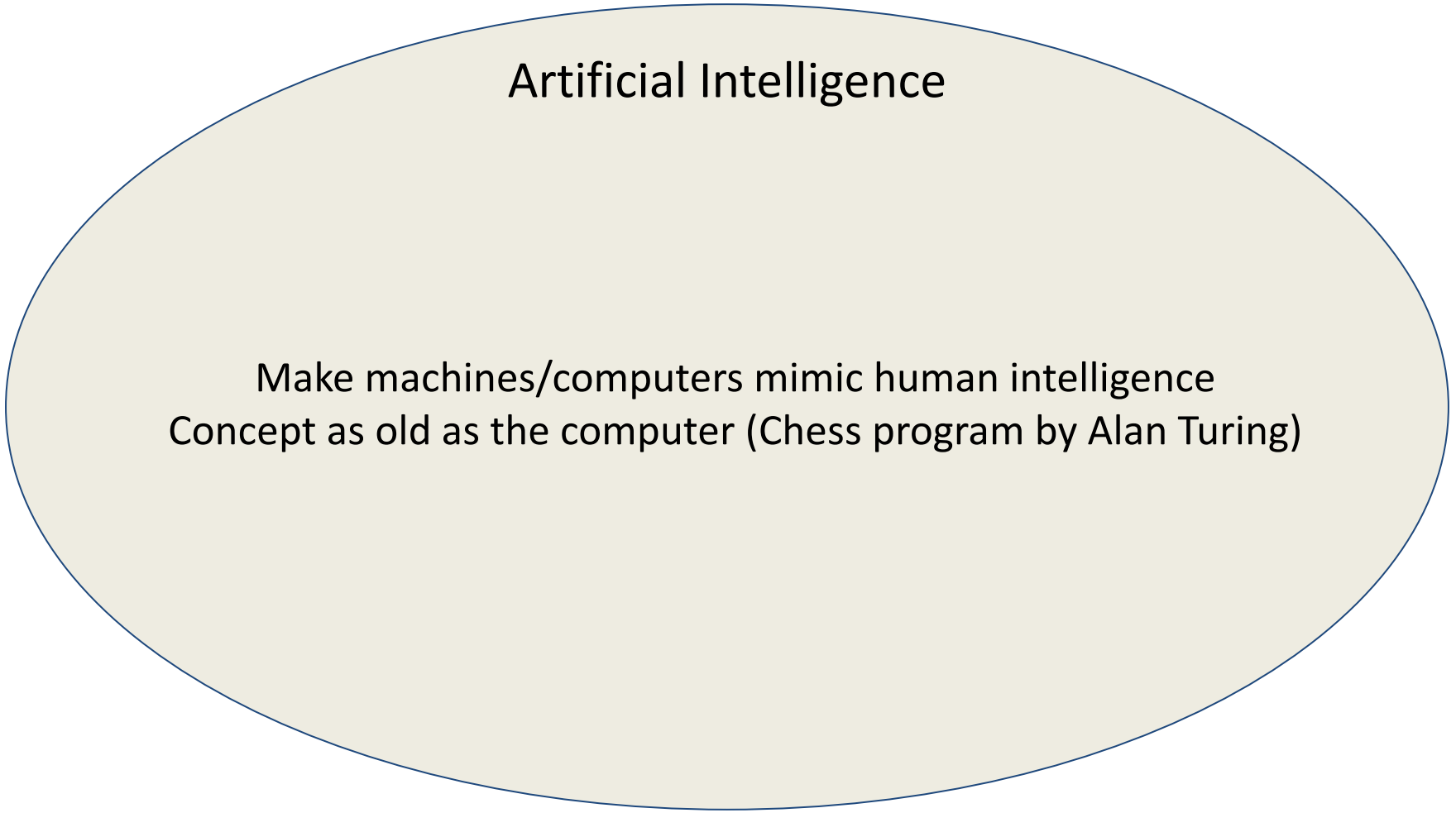
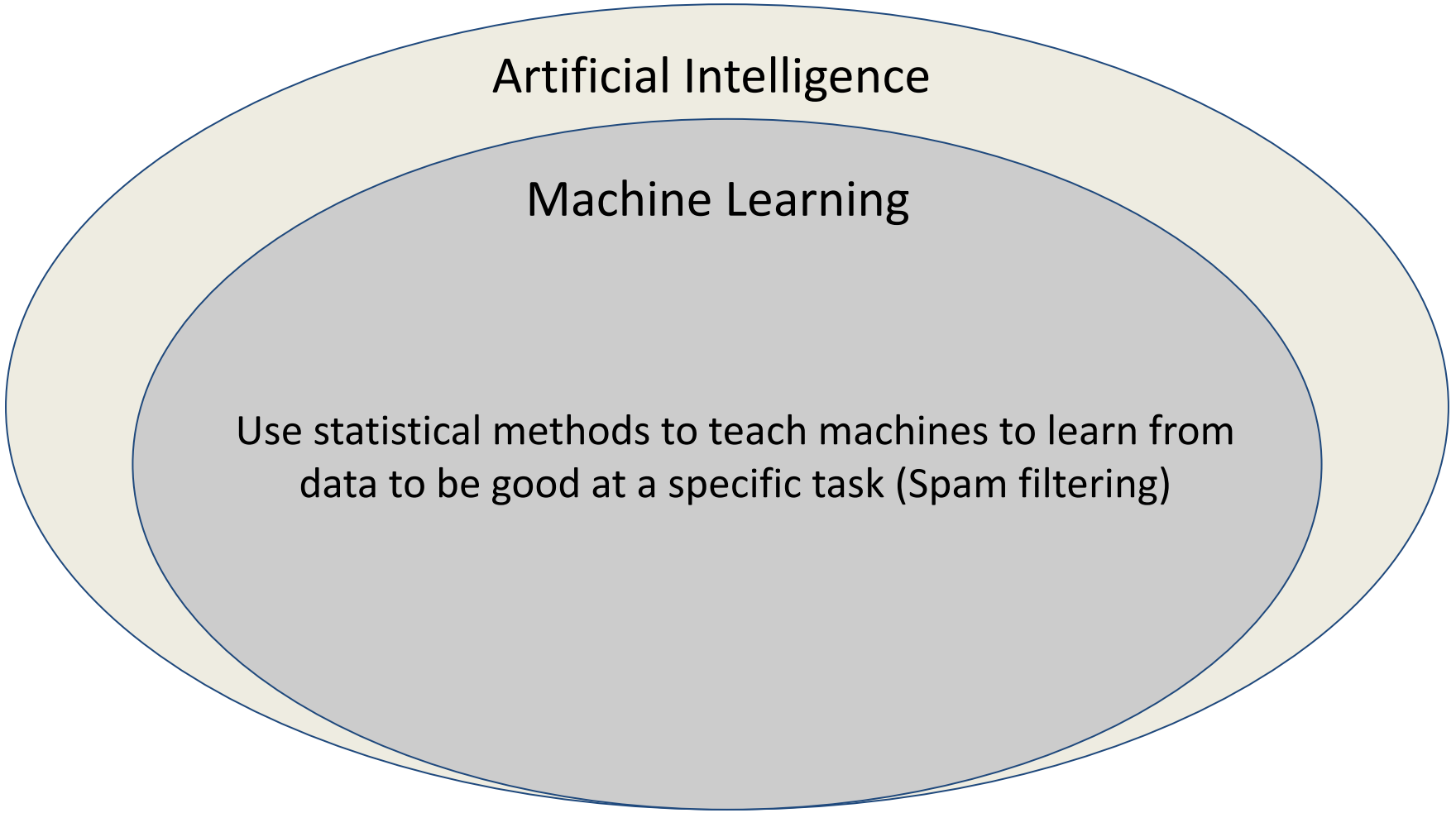
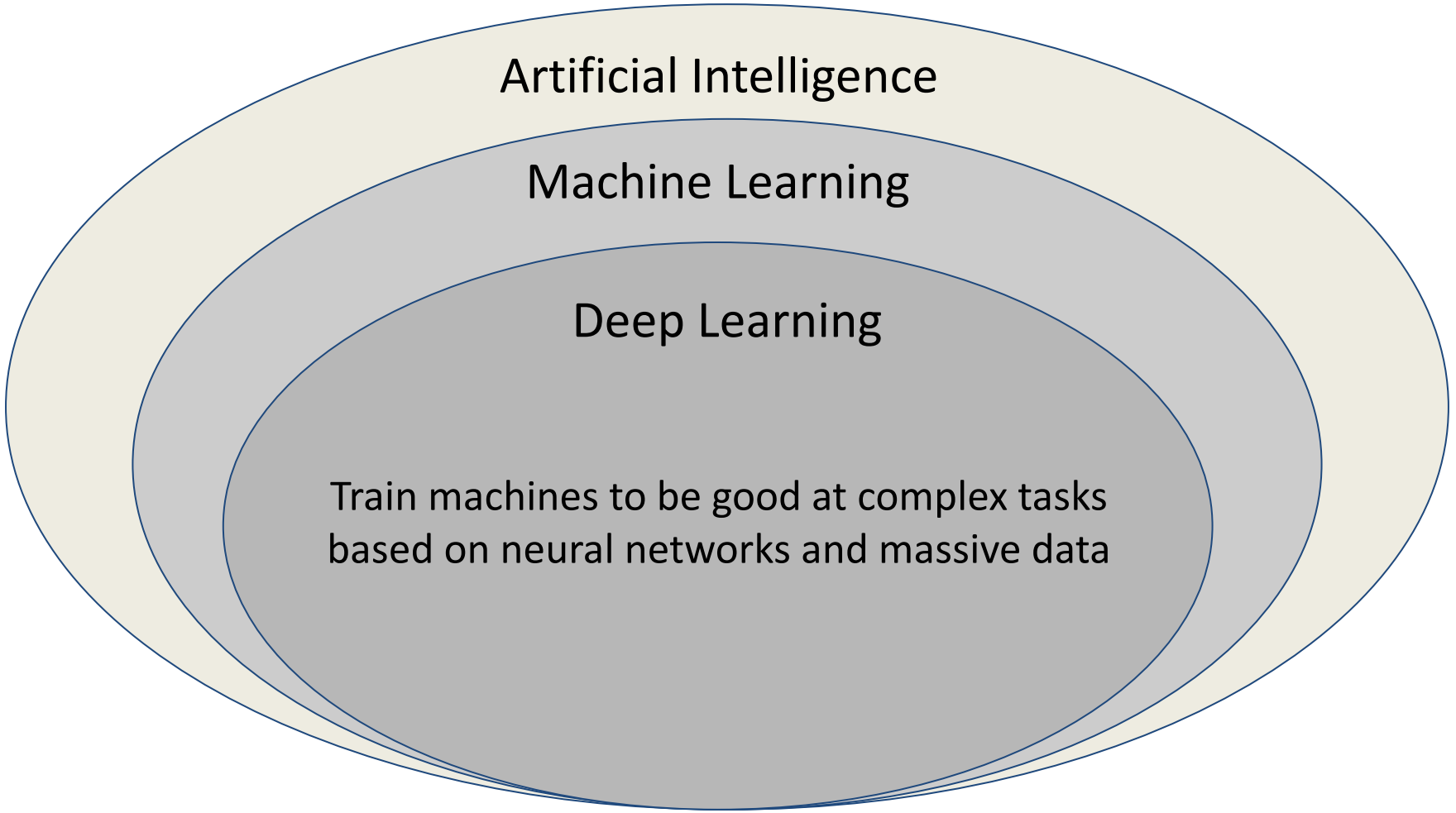
What is AI?


Artificial Intelligence
Make machines/computers mimic human intelligence
Concept as old as the computer (Chess program by Alan Turing)

What is Machine Learning?

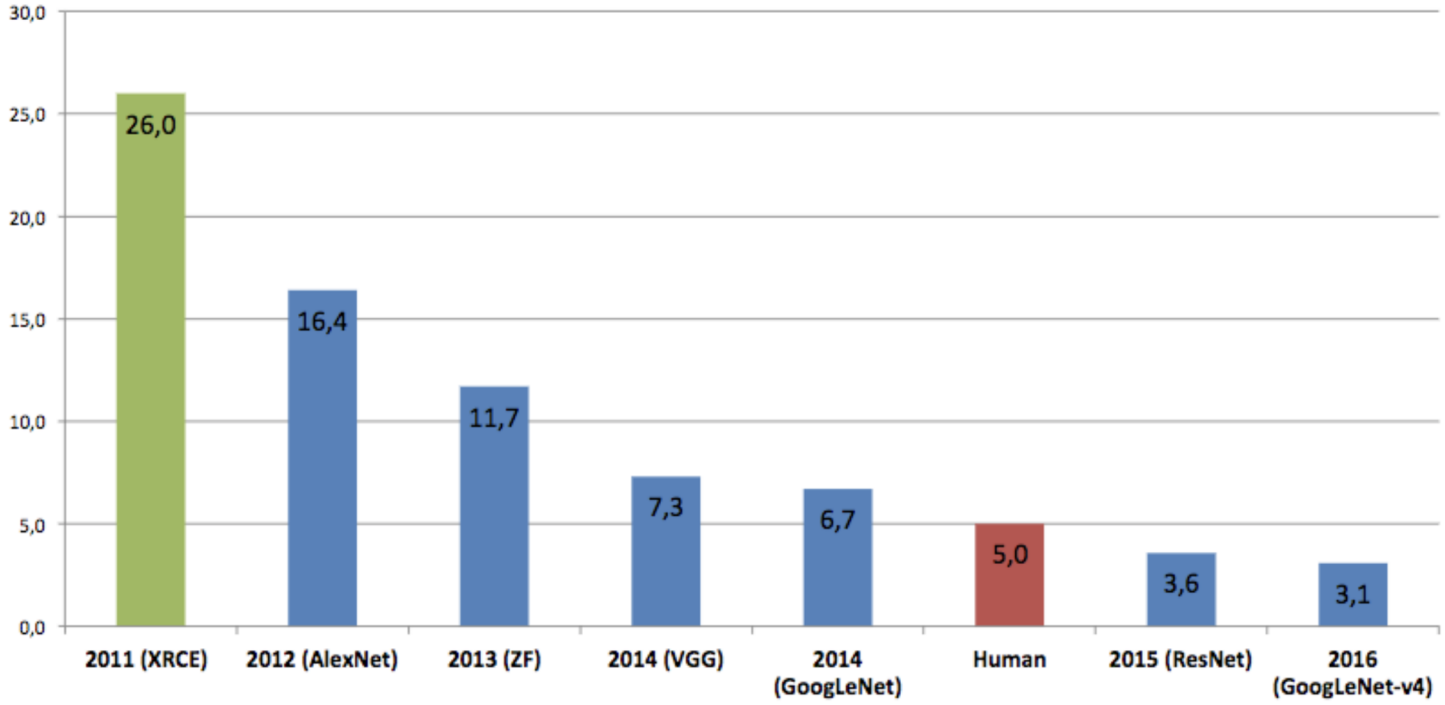


What is Deep Learning?



Why Deep Learning?

State-of-the-art performance



ImageNet Classification Error

Survey of neural networks in autonomous driving, Gustav von Zitzewitz,
Advanced Seminar SS 2017: Survey of Neural Networks in Autonomous Driving

Why Deep Learning?

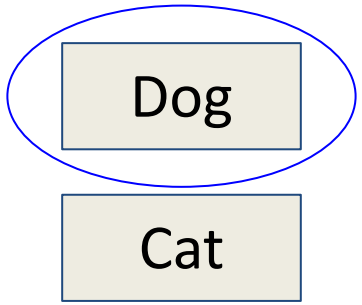
Less feature enginnering

Input Feature Extraction Classification

Classical machine learning process

Why Deep Learning?

Less feature engineering



Input

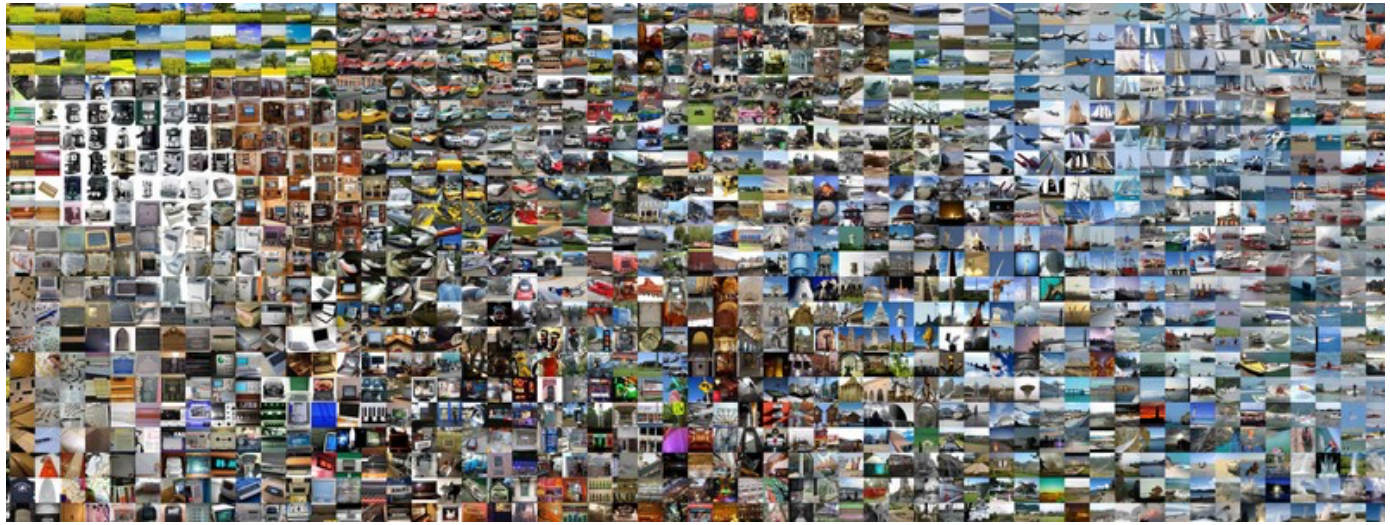
Feature Extraction + Classification

Deep learning process

How is this Possible?

Large data

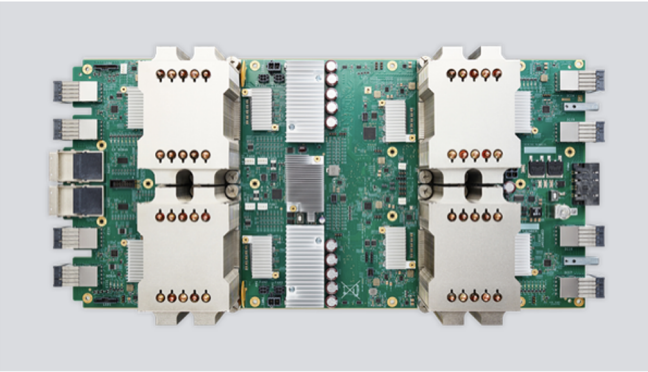
- Social network services
  - Youtube, Instagram, Twitter
- Collective intelligence
  - Wikipedia
- Mass media
  - News articls



ImageNet

How is this Possible?

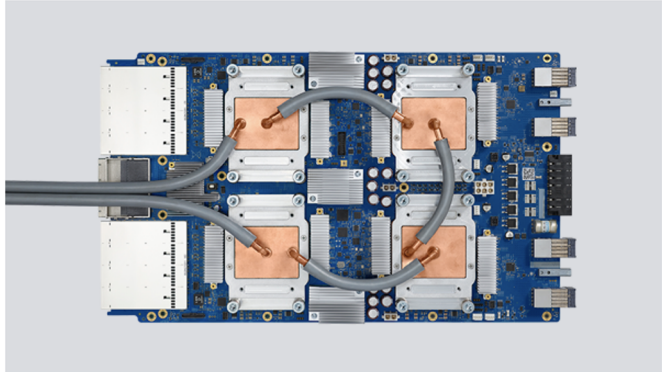
Large data + Powerful machines



Cloud TPU v2

180 teraflops

64 GB High Bandwidth Memory (HBM)



Cloud TPU v3

420 teraflops

128 GB HBM

Cloud TPU v2 Pod (alpha)

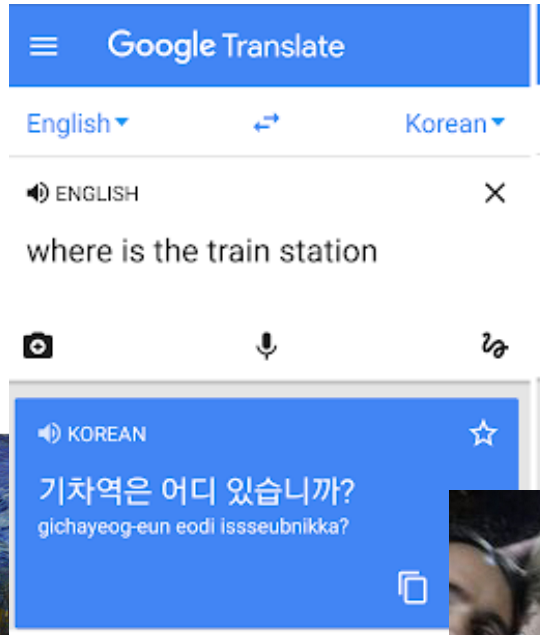
11.5 petaflops

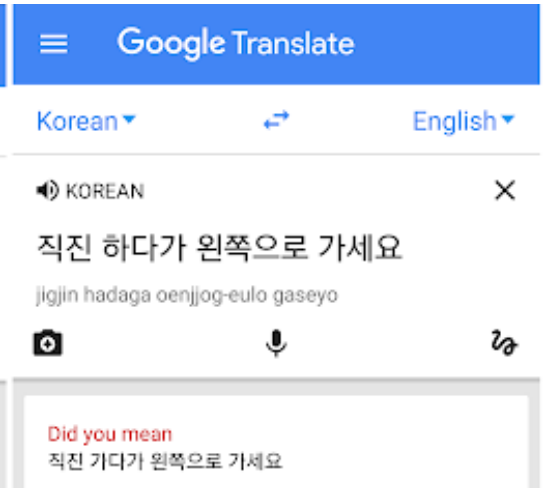
4 TB HBM

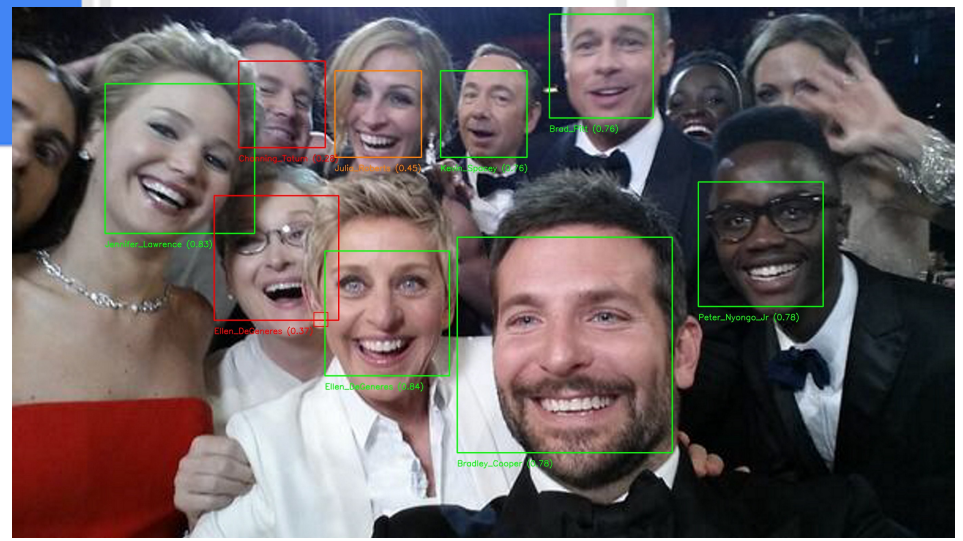
2-D toroidal mesh network

Modern AI


ALPHAGO
BFI LONDON FILM FESTIVAL
WINNER
MILL VALLEY FILM FESTIVAL
Official Selection


Google Translate
English
Korean
ENGLISH
where is the train station
KOREAN
기차역은 어디 있습니까?
gichayeog-eun eodi issseubnikka?

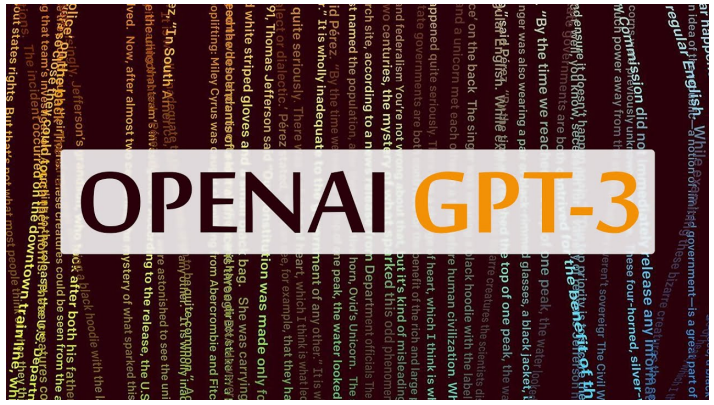

Google Translate
Korean
English
KOREAN
직진 하다가 왼쪽으로 가세요
jigjin hadaga oenjjog-eulo gaseyo
Did you mean
직진 기다가 왼쪽으로 가세요



(Almost) Infinite Compute + (Almost) Infinite Data

Probably >1000 V100's

570GB Text (400 Billion Tokens)



175B Parameters
$4~5 Million for Training

GPT3

- Open AI's unsupervised generative language model
  - Using 96 layers of Transformer
  - BERT uses 24 layers

Title: United Methodists Agree to Historic Split
Subtitle: Those who oppose gay marriage will form their own denomination
Article: **After two days of intense debate, the United Methodist Church has agreed to a historic split - one that is expected to end in the creation of a new denomination, one that will be "theologically and socially conservative," according to The Washington Post. The majority of delegates attending the church's annual General Conference in May voted to strengthen a ban on the ordination of LGBTQ clergy and to write new rules that will "discipline" clergy who officiate at same-sex weddings. But those who opposed these measures have a new plan: They say they will form a separate denomination by 2020, calling their church the Christian Methodist denomination.**
The Post notes that the denomination, which claims 12.5 million members, was in the early 20th century the "largest Protestant denomination in the U.S.," but that it has been shrinking in recent decades. The new split will be the second in the church's history. The first occurred in 1968, when roughly 10 percent of the denomination left to form the Evangelical United Brethren Church. The Post notes that the proposed split "comes at a critical time for the church, which has been losing members for years," which has been "pushed toward the brink of a schism over the role of LGBTQ people in the church." Gay marriage is not the only issue that has divided the church. In 2016, the denomination was split over ordination of transgender clergy, with the North Pacific regional conference voting to ban them from serving as clergy, and the South Pacific regional conference voting to allow them.

A "whatpu" is a small, furry animal native to Tanzania. An example of a sentence that uses the word whatpu is:
We were traveling in Africa and we saw these very cute whatpus.

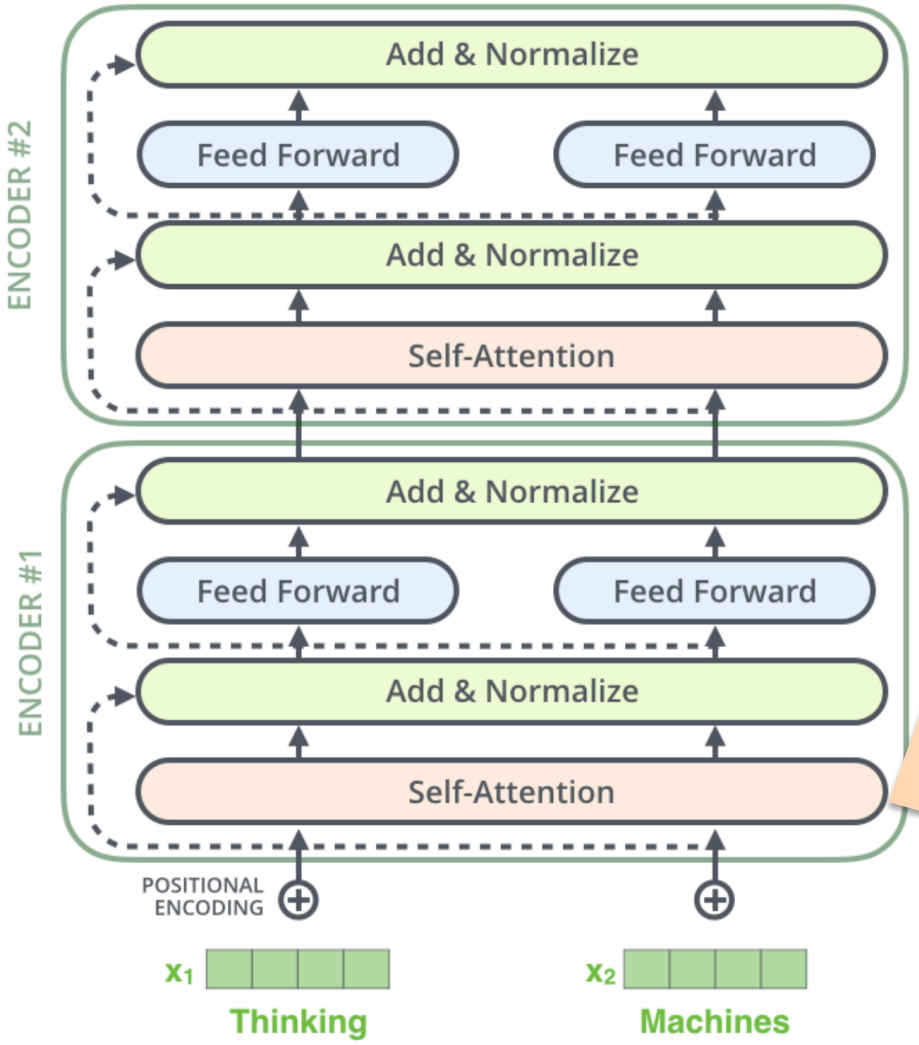
To do a "farduddle" means to jump up and down really fast. An example of a sentence that uses the word farduddle is:
One day when I was playing tag with my little sister, she got really excited and she started doing these crazy farduddles.
A "yalubalu" is a type of vegetable that looks like a big pumpkin. An example of a sentence that uses the word yalubalu is:
I was on a trip to Africa and I tried this yalubalu vegetable that was grown in a garden there. It was delicious.

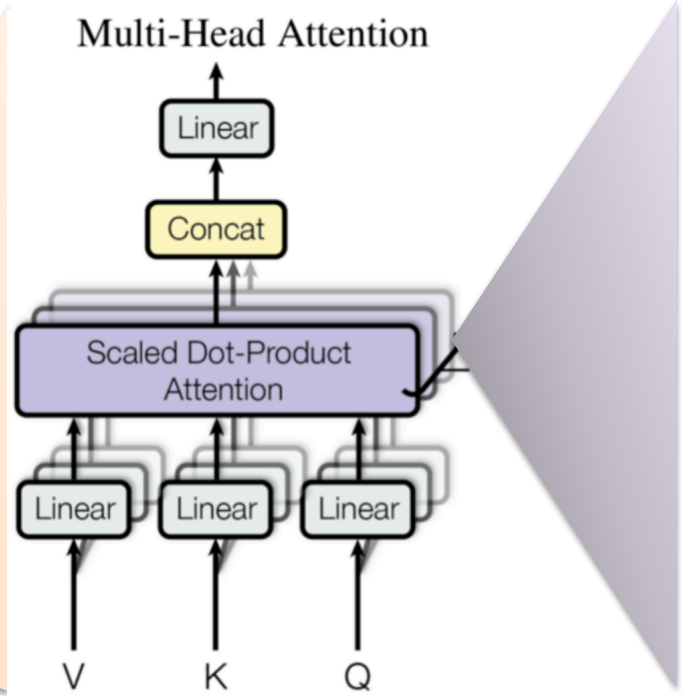
A "Burringo" is a car with very fast acceleration. An example of a sentence that uses the word Burringo is:
In our garage we have a Burringo that my father drives to work every day.

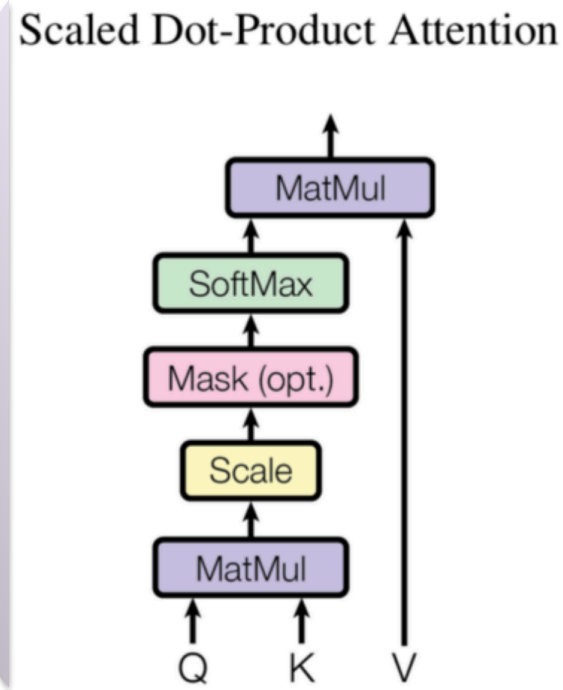
A "Gigamuru" is a type of Japanese musical instrument. An example of a sentence that uses the word Gigamuru is:
I have a Gigamuru that my uncle gave me as a gift. I love to play it at home.

To "screeg" something is to swing a sword at it. An example of a sentence that uses the word screeg is:
We screeghed at each other for several minutes and then we went outside and ate ice cream.

Transformer Architecture







Goal

- Learn to build deep learning models.
  - So that you can replicate papers
  - So that you can realize your ideas
  - So that you can conduct AI research

- This course teaches only the very basics.
  - Practice makes perfect!

Structure

- Schedule:
  - Lecture on Tuesday
    - Conducted by the lecturer
  - Practice on Thursday
    - Conducted by the TA
- Assignments
  - Project 1
    - Image synthesis using GAN
  - Project 2
    - French-English Translation using Transformers
- Grading
  - Pass or fail
  - Complete two projects ➔ Pass
  - No attendance score (Can’t roll call 260 people)

Weekly Plan

1. Intro + Numpy
2. Basic Machine Learning + Scikit-learn
3. PyTorch Intro
4. Logistic Regression + Multi-layer Perceptron
5. Autoencoders (& Denoising Autoencoders)
6. Variational Autoencoders
7. Generative Adversarial Networks
8. Midterm Week (Project 1)
9. Convolutional Neural Networks
10. Word2Vec + Subword Encoding
11. Recurrent Neural Networks & Sequence-to-Sequence
12. Image-to-Text
13. Transformers & BERT
14. Graph Neural Networks
15. Neural Ordinary Differential Equations
16. Final Week (Project 2)

Material & Discussion

- No textbook
- Materials will be posted on Classum if necessary.

- Classum
  - Join as Participant Link: www.classum.com/exyirx

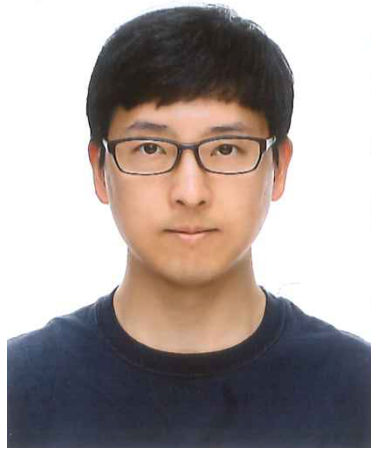
Expectation

- Lecture: Your are expected to attend
- Project
  - Individual effort
  - Deliverables:
    - Link to the model weights
    - Your model will be evaluated automatically
      - Project 1: FID score
      - Project 2: BLEU score

Teaching Team

- Lecturer
  - Edward Choi
    - edwardchoi@kaist.ac.kr
    - https://mp2893.com
- TA
  - Sung-Jin Park (Head TA)
    - zxznm@kaist.ac.kr
  - Hyun-Tak Cha
    - hyuntak.cha@kaist.ac.kr
  - Ji-Hoon Tak
    - reallifehoon@kaist.ac.kr
  - Won-Cheol Shin
    - swc1905@kaist.ac.kr
  - Seong-Jun Yang
    - seongjunyang@kaist.ac.kr
  - Ji-Young Lee
    - jiyounglee0523@kaist.ac.kr

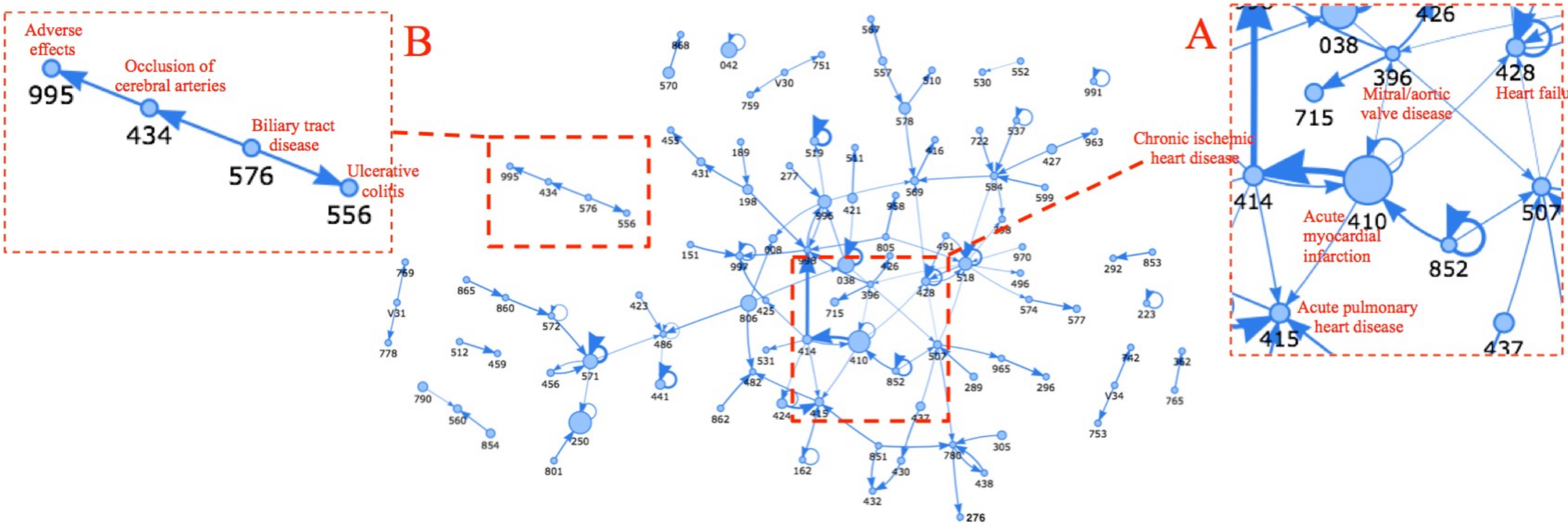
Edward Choi, 최윤재



- Education
  - Ph.D. (computer science), Georgia Tech, 2014-2018
    - Thesis: Interpretable deep learning for longitudinal electronic health records
- Professional Experience
  - ETRI (2010-2014)
  - Sutter Health (2015, 2016)
  - DeepMind & Google (2017)
  - Google Brain & Google Health (2018-2020)
- Research Area
  - Machine Learning, Healthcare, NLP, Multi-modal

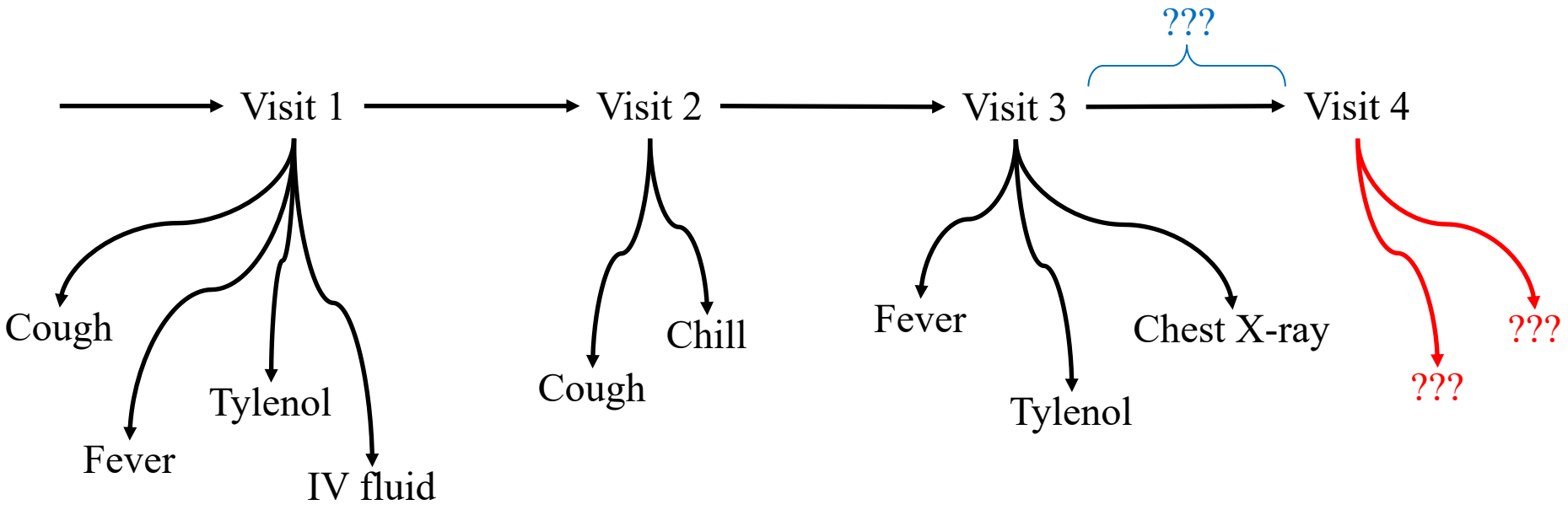
cHawkes (ICDM 2015)

- Constructing disease network and temporal progression model via context-sensitive Hawkes process
  - Edward Choi, Nan Du, Robert Chen, Le Song, Jimeng Sun, 2015, ICDM



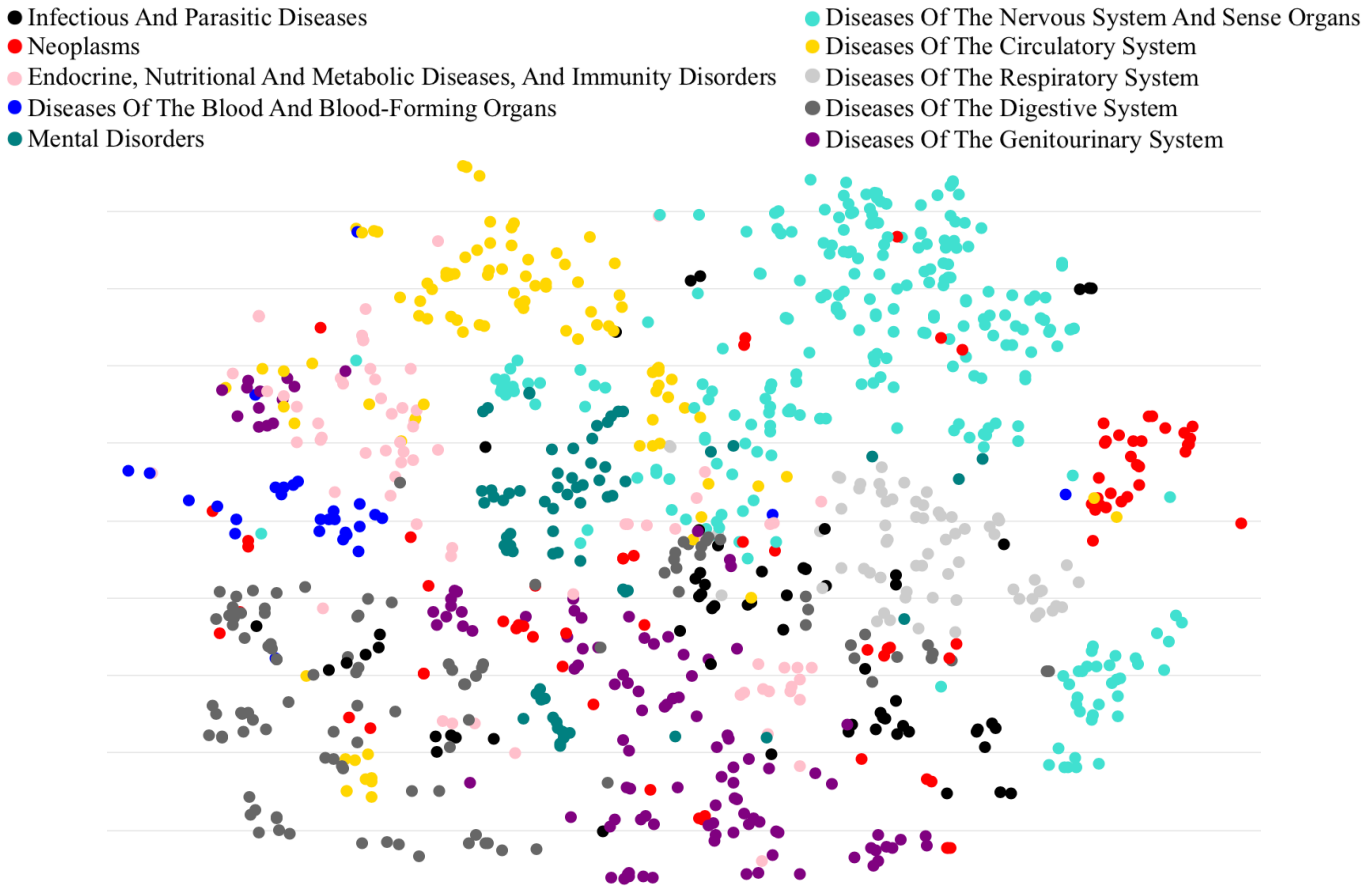
Doctor AI (MLHC 2016)

- Doctor AI: Predicting clinical events via recurrent neural networks
  - Edward Choi, Mohammad Taha Bahadori, Andy Schuetz, Walter F. Stewart, Jimeng Sun, 2016, MLHC



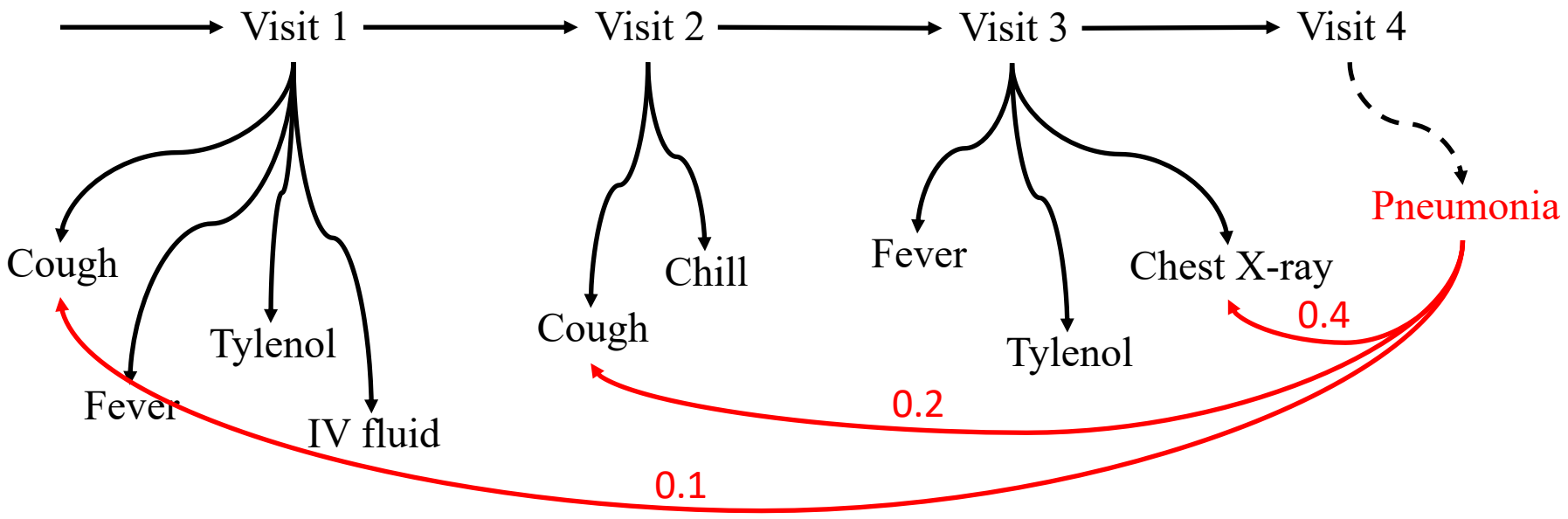
Med2Vec (KDD 2016)

- Multi-layer representation learning for medical concepts
  - Edward Choi, Taha Bahadori, E.Searles, C.Coffey, M.Thompson, J.Bost, J.Tejedor-Sojo, Jimeng Sun, 2016, KDD



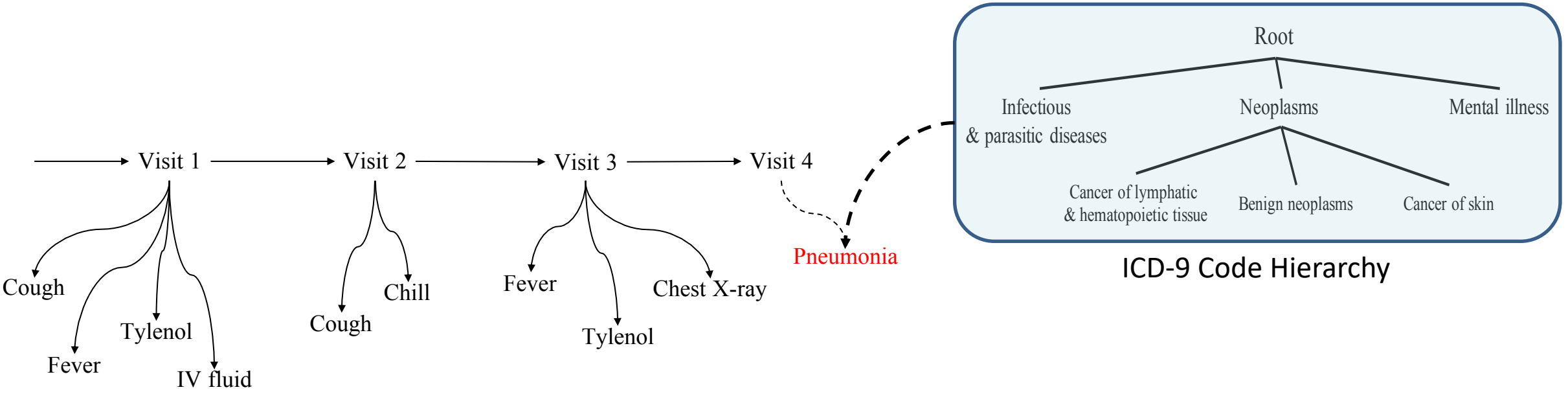
RETAIN (NIPS 2016)

- RETAIN: An interpretable predictive model for healthcare using reverse time attention mechanism
  - Edward Choi, Mohammad Taha Bahadori, Joshua A. Kulas, Andy Schuetz, Walter F. Stewart, Jimeng Sun, 2016, NIPS



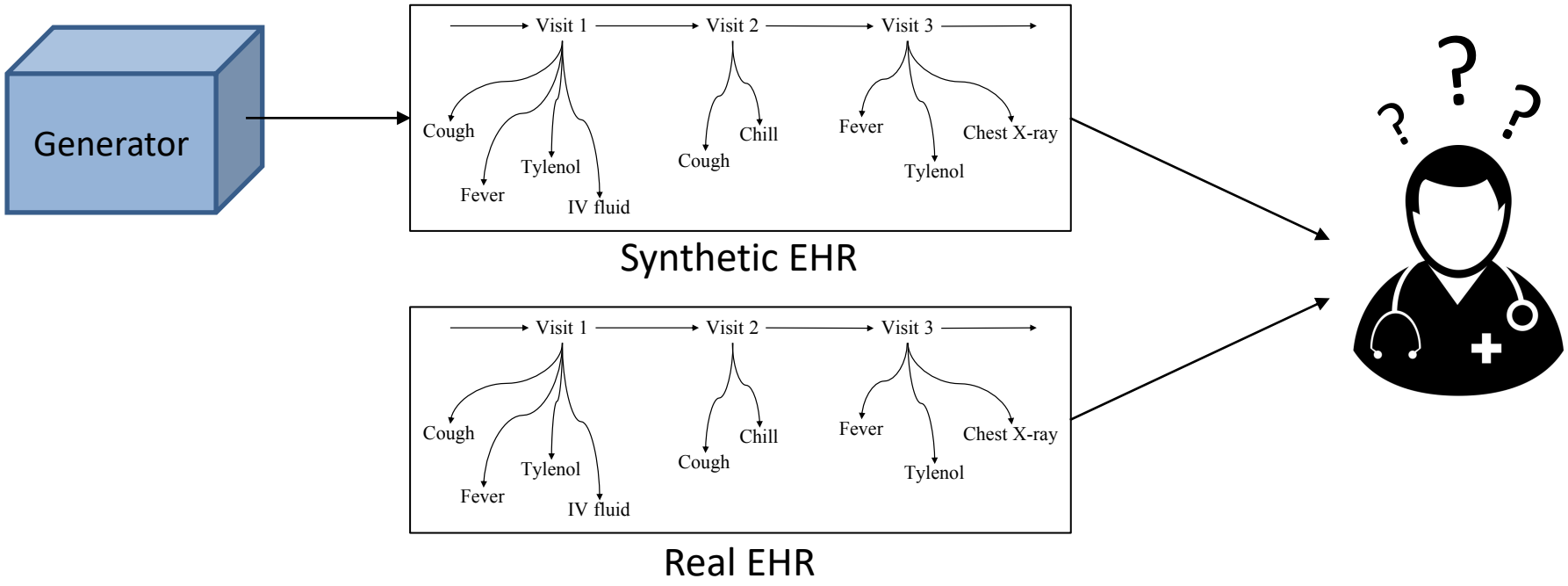
GRAM (KDD 2017)

- GRAM: graph-based attention model for healthcare representation learning
  - Edward Choi, Mohammad Taha Bahadori, Le Song, Walter F. Stewart, Jimeng Sun, 2017, KDD



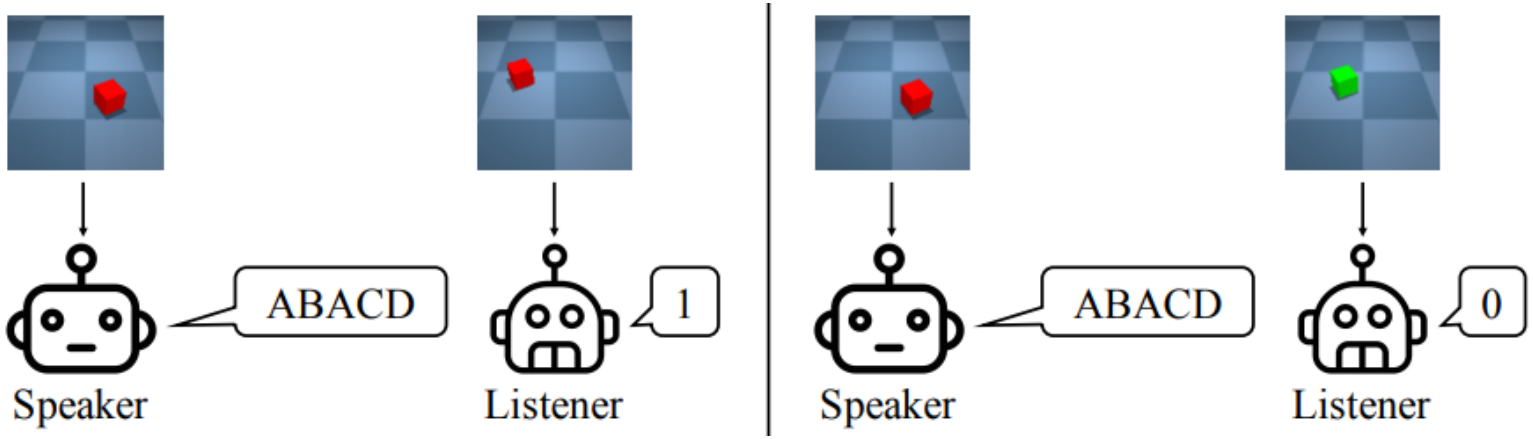
medGAN (MLHC 2017)

- Generating multi-label discrete patient records using generative adversarial networks
  - Edward Choi, Siddharth Biswal, Bradley Malin, Jon Duke, Walter F. Stewart, Jimeng Sun, 2017, MLHC



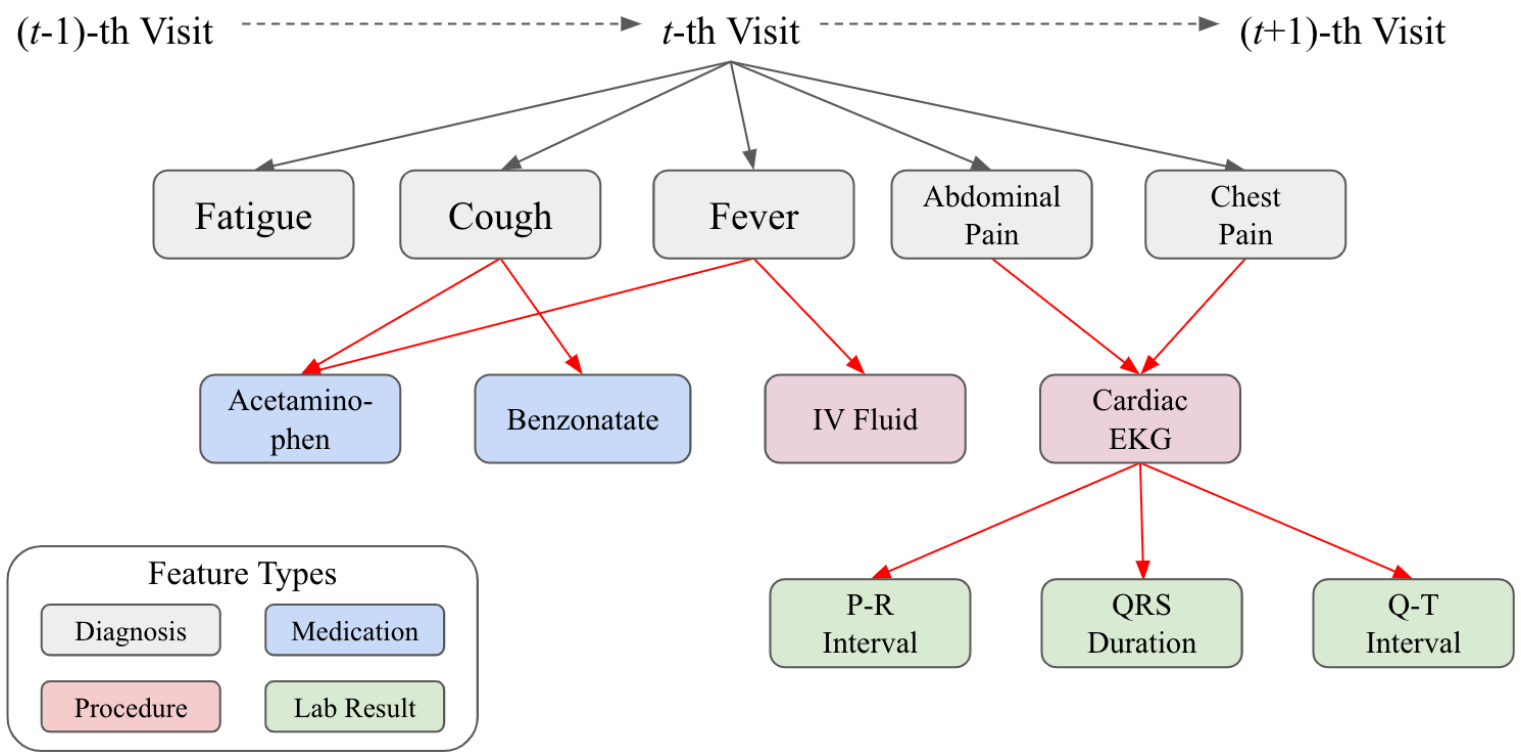
Neural Language Evolution (ICLR 2018)

- Compositional Obverter Communication Learning from Raw Visual Input
  - Edward Choi, Angeliki Lazaridou, Nando de Freitas, 2018, ICLR



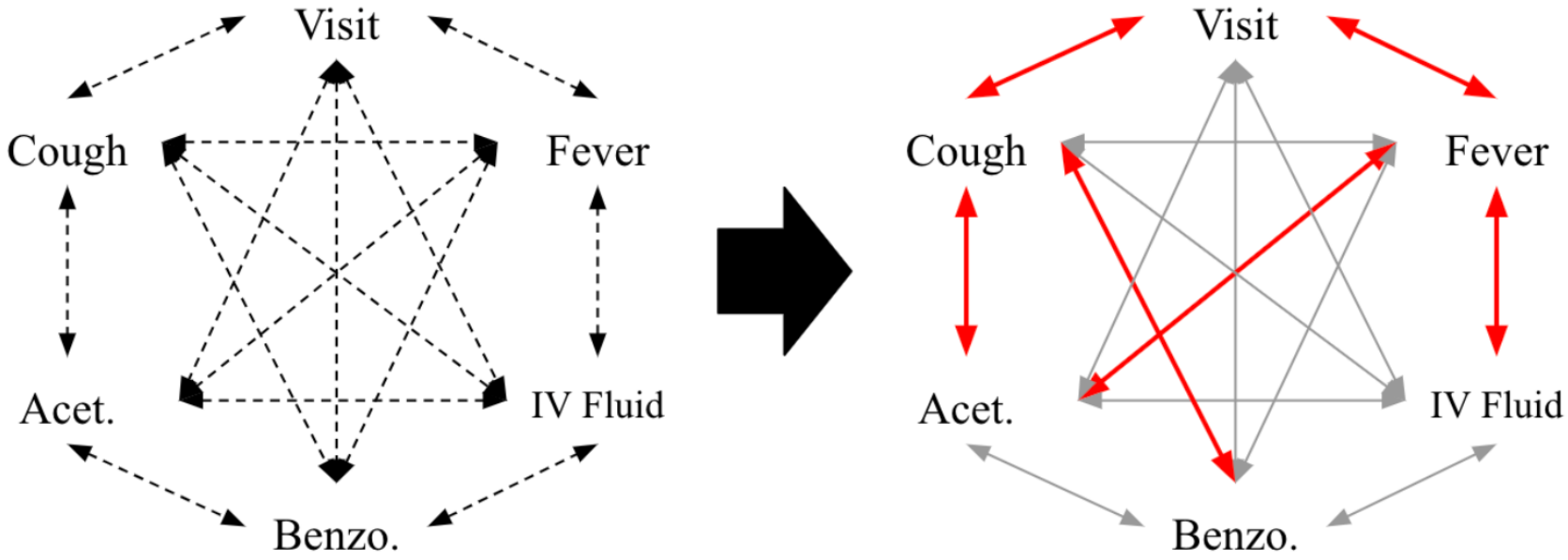
MiME (NIPS 2018)

- MiME: Multilevel Medical Embedding of Electronic Health Records for Predictive Healthcare
  - Edward Choi, Cao Xiao, Walter F. Stewart, Jimeng Sun, 2018, NIPS



GCT (AAAI 2020)

- Learning the Graphical Structure of Electronic Health Records using Graph Convolutional Transformer
  - Edward Choi, Zhen Xu, Yujia Li, Michael W. Dusenberry, Gerardo Flores, Yuan Xue, Andrew M. Dai, 2020, AAAI



First Assignment

- Install Anaconda
  - Python package for data science
  - Includes Jupyter, Numpy, Scikit-Learn, TensorFlow, PyTorch
  - https://www.anaconda.com/products/individual

- All practice sessions will be conducted with Google Colab
  - Python Notebook on the web
  - Can train models using Google's GPU/TPU
  - Session-based (why you need Anaconda)

Questions?

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