CMT307: Applied ML Session 9

Introduction to neural networks

Jose Camacho Collados

Outline

- Coursework 1 + Research opportunities
- Second semester: overview
- Lecture
  - Summary first semester
  - Introduction to neural networks
- Group projects (second semester)
- Mid-module feedback

Coursework 1

Coursework 1

Marks and feedback will be available in Learning Central **next week**.

Coursework 1: Revision dates

Two options:

- During office hours (**Monday February 10th from 2:30pm to 5pm**).

- Tuesday afternoon, **February 11th**, also possible **if pre-arranged via email**.

Coursework: Late submissions

Strict university policy

Late submissions (and incomplete submissions that have been re-submitted after the deadline) have been **capped at 60**.

Research opportunities

PhD Research Opportunities in Cardiff

3-year fully-funded PhD scholarships on any computer science topic.

Applicants need to contact a potential supervisor and prepare a short research proposal.

Application deadline: February 29. **Start date**: October.

Link:
https://www.findaphd.com/phds/programme/phd-scholarship-in-computer-science-and-informatics/?p4810

[Both EU/UK students and overseas students can apply]

Activities in Cardiff

- **AI Wales** (https://www.meetup.com/AI-Wales/): Monthly meetings about AI (machine learning, NLP, computer vision, etc.).

- **Pydata Cardiff** (https://www.meetup.com/PyData-Cardiff-Meetup/): Data analysis community around Python.

Both are free, including workshops, technical talks and refreshments.

Data and Knowledge Engineer (DKE) Seminars

Weekly seminars (on Mondays from 1pm to 2pm) about machine learning, knowledge representation and data mining.

Location: Room WX/3.07 (West extension, Queen's building)

➢ **Next (3 Feb):** *An overview of conversational AI (Ignacio Iacobacci - Huawei)*

Link:
https://www.cardiff.ac.uk/computer-science/events/data-and-knowledge-engineering-seminars

Second semester: overview

Module instructors, second semester

Yukun Lai

Jose Camacho Collados

Stefano Zappalà (TA)

Steven Arthur (TA)

Marc Roig Vilamala (TA)

Module plan: second semester

Session 9 (week 1, 30 Jan): Introduction to neural networks (Jose) **+ Coursework 2** (Selection of projects)

Session 10 (week 2, 6 Feb): Embeddings, shallow neural networks (Jose)

Session 11 (week 4, 20 Feb): Optimisation, stochastic gradient descent, loss functions (Yukun)

Session 12 (week 5, 27 Feb): Activation functions, regularization, dropout (Yukun)

Session 13 (week 7, 12 Mar): Autoencoders, convolutional neural networks (Yukun)

Session 14 (week 8, 19 Mar): Recurrent neural networks + Recap (Jose)

Session 15 (week 11, 30 Apr): Group presentations (Jose+Yukun)

Session 16 (week 12, 7 May): Group presentations (Jose+Yukun)

Class: time distribution from week 2

14:10-15:00 -> Lecture

15:00-15:40 -> Exercises/hands-on

15:40-15:55 -> Break (time to move to the group tables)

15:55-17:00 -> Group projects

This time distribution may vary from class to class.

Lectures could include practical activities as well.

Summary first semester: Recap

First semester: summary

Session 1: Basic introduction to Machine Learning + Basic Python + Data preprocessing

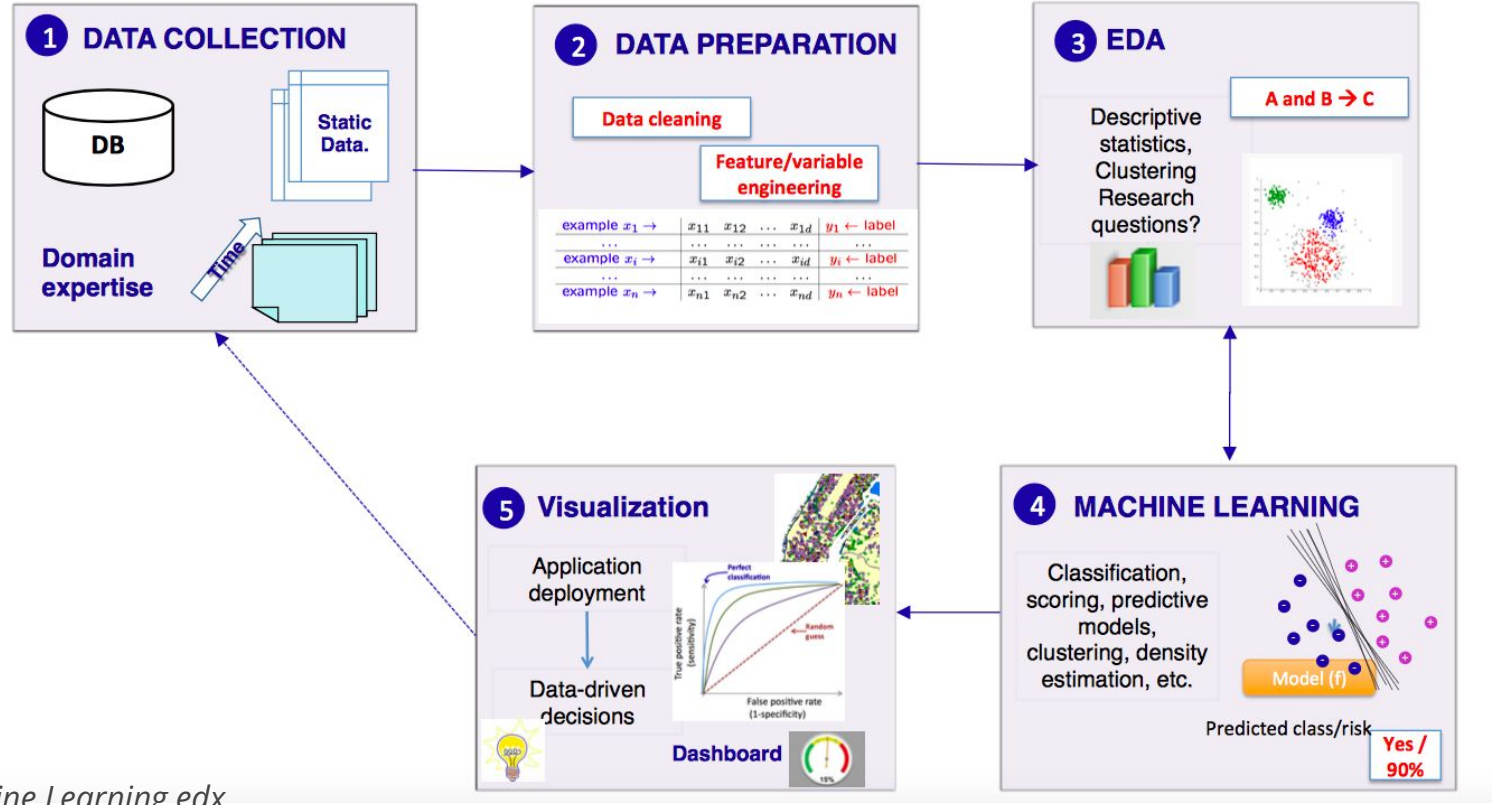
Session 2: Continue data preprocessing + Feature selection

Session 3: Machine learning evaluation (cross-validation, evaluation measures, etc.)

Sessions 4-7 (Dr. Yuhua Li): Linear machine learning models (overview + theoretical concepts + mathematical foundations)

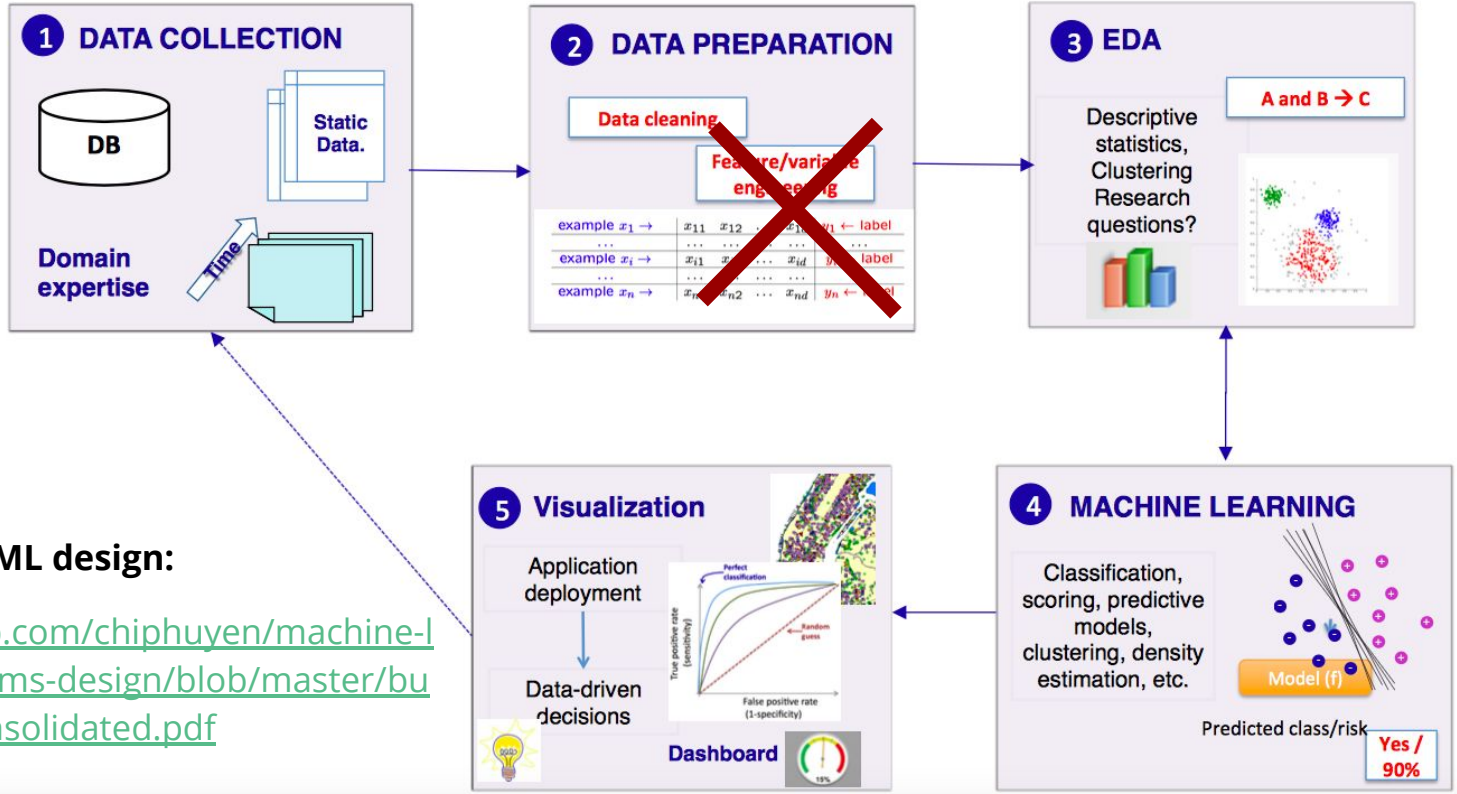
Session 8: Guest lecture + Ethics and bias

Machine Learning pipeline



Slide credit: *Machine Learning edx*

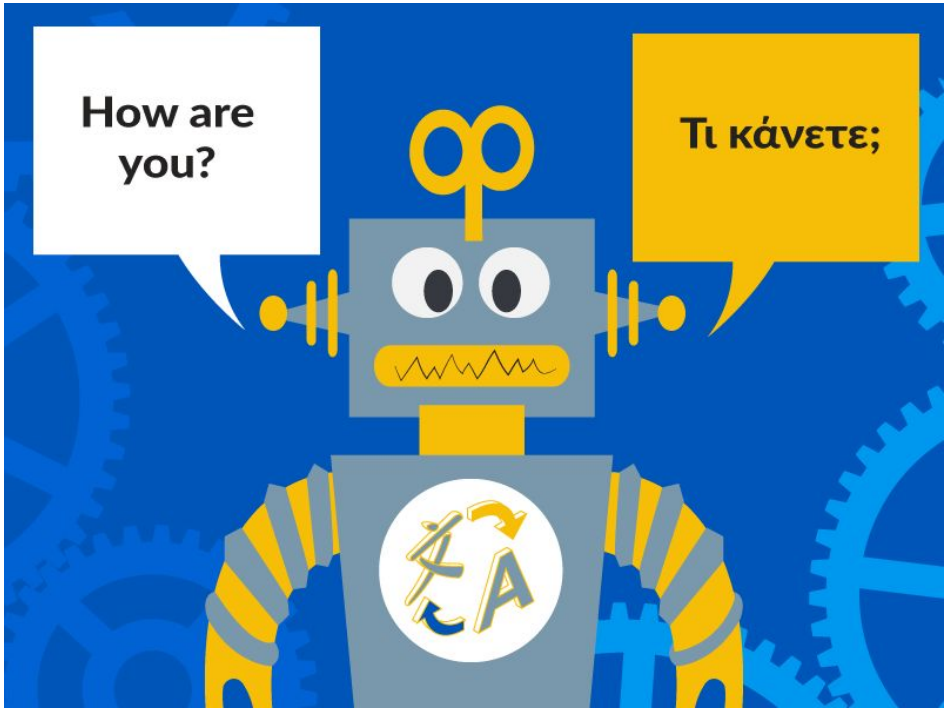
ML design: revisited with neural networks



More about ML design:

https://github.com/chiphuyen/machine-learning-systems-design/blob/master/build/build1/consolidated.pdf

Applications of Machine Learning



Machine Translation

Image credit: *Ciklopea*

Applications of Machine Learning

Question answering

Image credit: *Jeopardy Productions*

Applications of Machine Learning

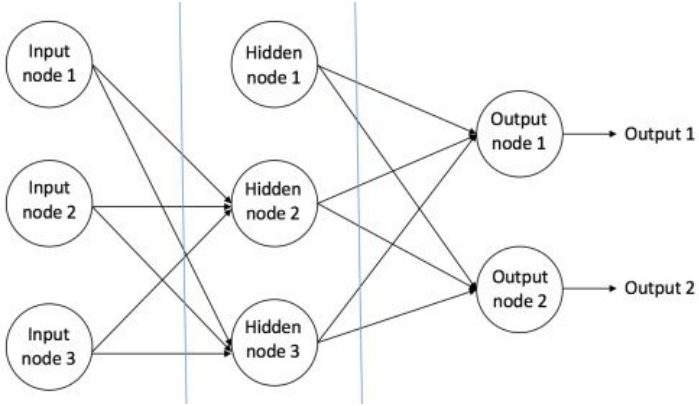
Self-driving cars

Vimeo screencap

Introduction to Neural Networks

Neural Networks

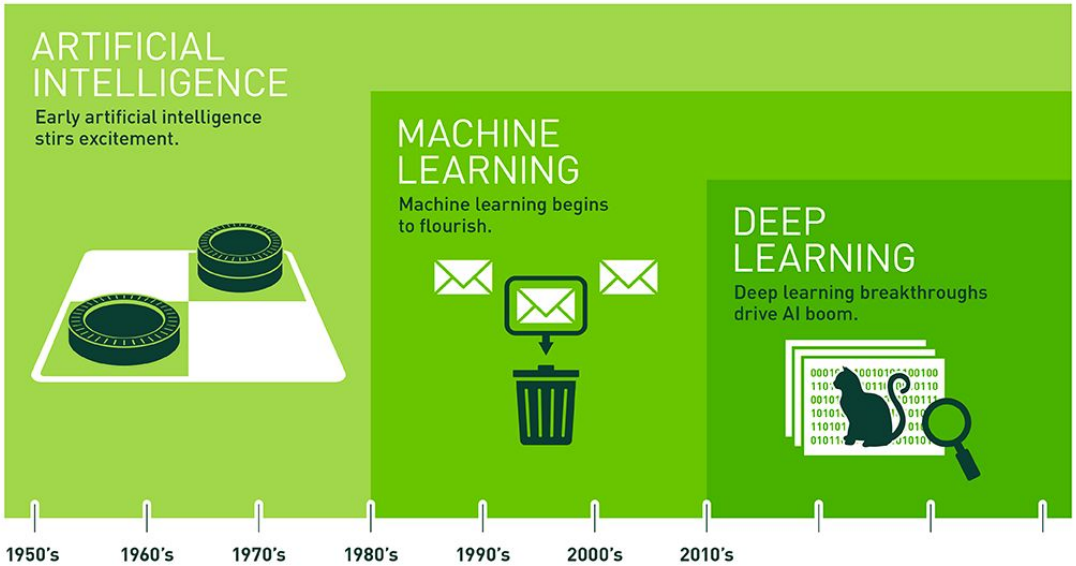
Neural networks is a branch of machine learning that is based on the interaction of **neurons** (nodes) and **weights** through mathematical functions (known as **activation functions**).



Neural networks are often referred to **deep learning**, especially for large (deep) networks.

Introduction to neural networks:
https://ujjwalkarn.me/2016/08/09/quick-intro-neural-networks/

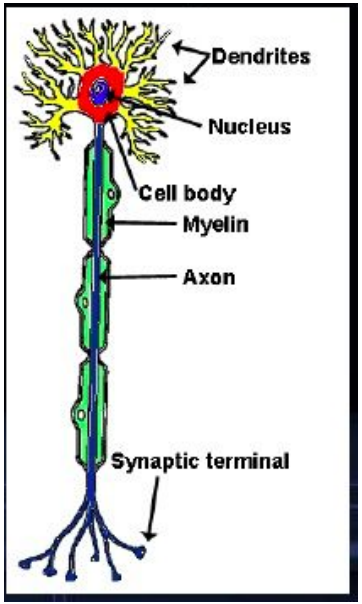
Deep Learning, Machine Learning and AI



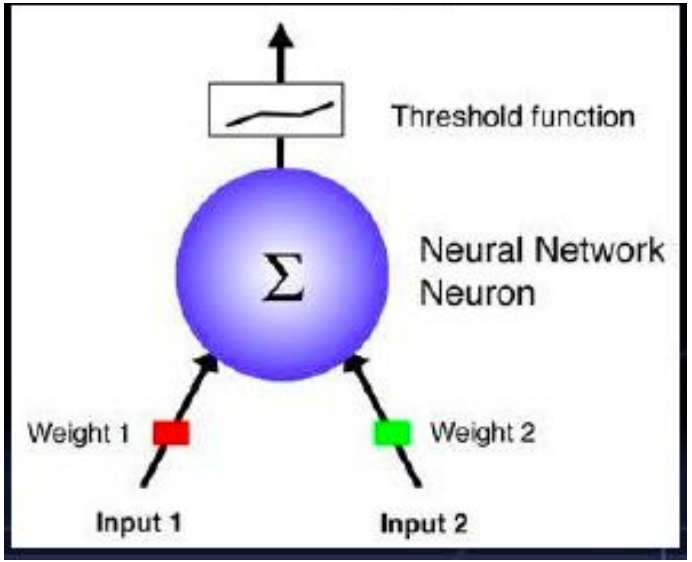
Slide credit: *NVidia*

Neural networks: inspiration in biological neurons

Biological



Artificial

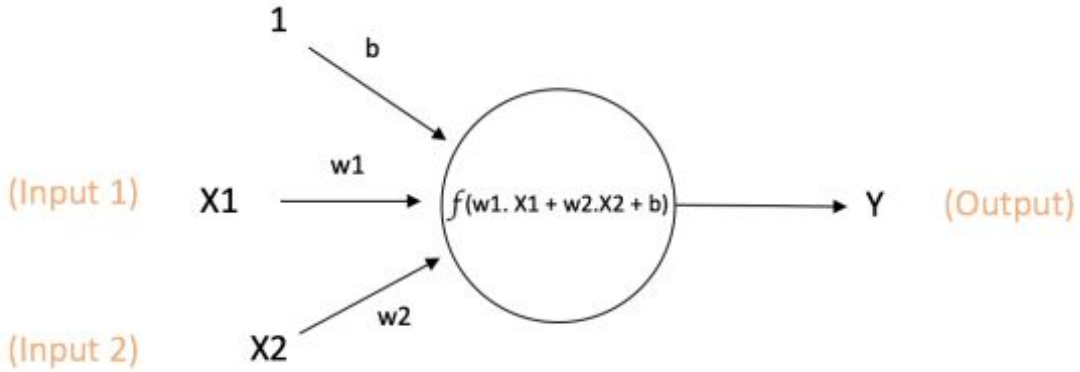


Brains and Neural networks: Same wiring?

“A single neuron in the brain is an incredibly complex machine that even today we don't understand. A single 'neuron' in a neural network is an incredibly simple mathematical function that captures a minuscule fraction of the complexity of a biological neuron. So to say neural networks mimic the brain, that is true at the level of loose inspiration, but really ***artificial neural networks are nothing like what the biological brain does****.”*

Andrew Ng, Machine Learning expert

Perceptron: the smallest neural network

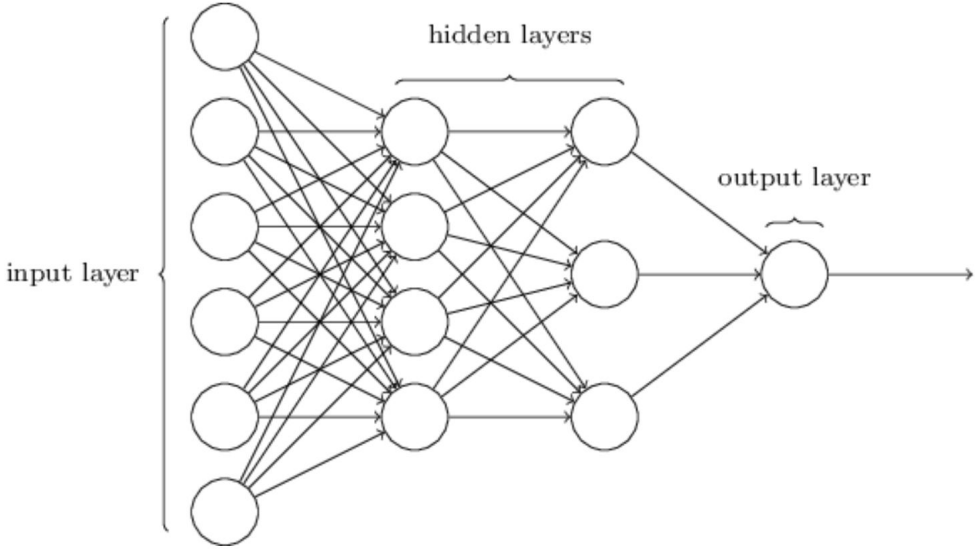


Output: *f(w1.X1+w2.X2+b)*

b is the bias, **X1** and **X2** are the input nodes, **w1** and **w2** are their associated weights and **f** is the activation function.

Image credit: *the data science blog*

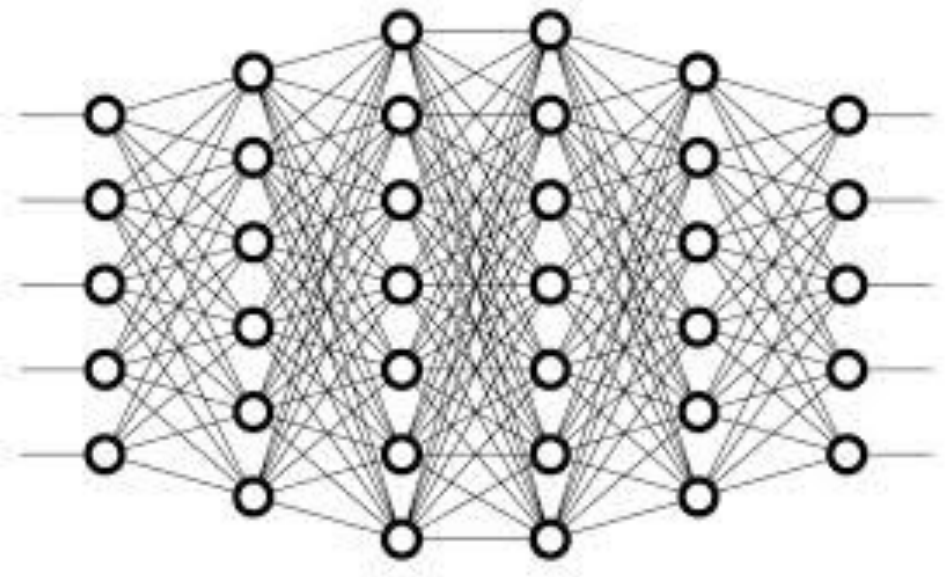
Standard neural networks



More about neural networks (video-introduction):

https://www.youtube.com/watch?v=aircAruvnKk

Neural network (deep)



More about neural networks (video-introduction):

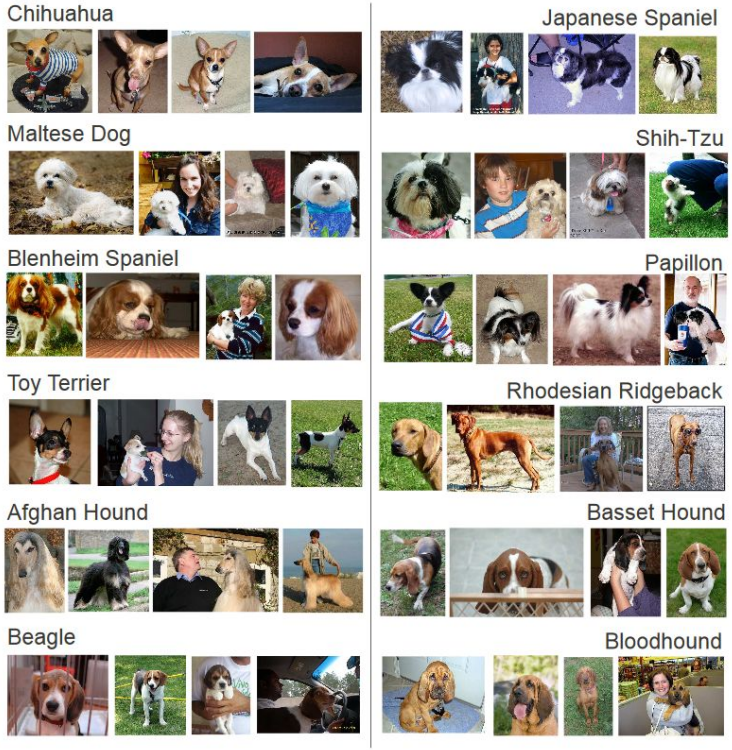
https://www.youtube.com/watch?v=aircAruvnKk

Deep Learning and latest developments

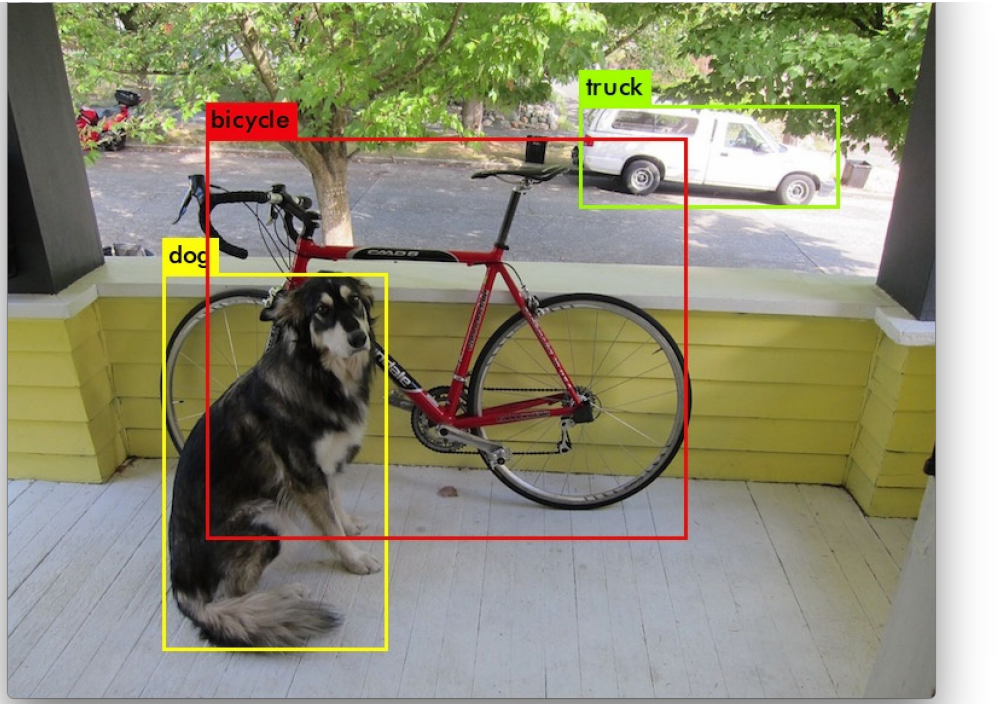
- **Natural Language Processing:** Pre-trained language models (ELMo, BERT, GPT-2) encode background information and can now be integrated in many tasks easily.
  - Applications in dialog systems, translation, information extraction, etc.
- **Computer vision:** Great progress in image recognition and videos. Currently going from 2D to 3D.
  - Applications in healthcare, retail, security, etc.
- **Reinforcement learning:** Promising in closed environments (e.g. games) and finding interesting results in robotics.

What are Important AI & Machine Learning Trends for 2020? (Forbes)
https://www.forbes.com/sites/mariyayao/2020/01/22/what-are--important-ai--machine-learning-trends-for-2020/#38b8f0332323

DL for Computer Vision: Image classification

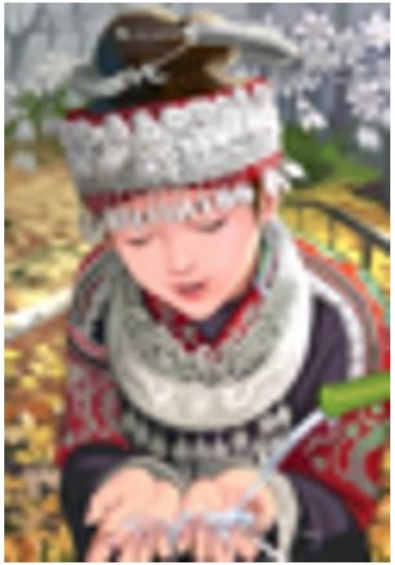


DL for Computer Vision: Object detection



DL for Computer Vision: Super-resolution

bicubic
(21.59dB/0.6423)

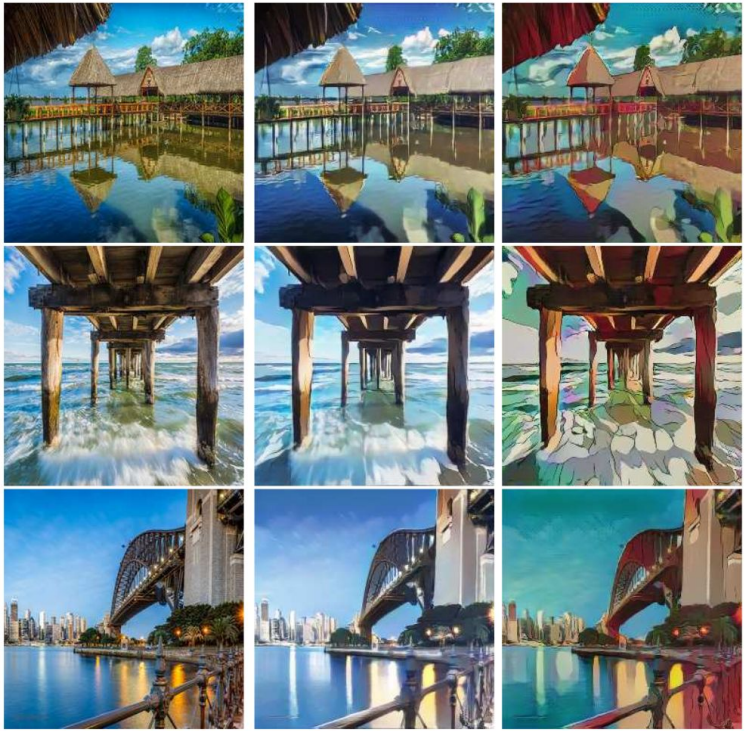


SRResNet
(23.53dB/0.7832)

SRGAN
(21.15dB/0.6868)

original

DL for Computer Vision: Photos to cartoons



(a) input photo (b) Shinkai style (c) Hayao style

DL for Computer Vision: Emotion recognition

"Sad"
λ_F: 0.31 / λ_C: 0.69

"Happy"
λ_F: 0.91 / λ_C: 0.09

"Fear"
λ_F: 0.26 / λ_C: 0.74

"Surprise"
λ_F: 0.62 / λ_C: 0.38

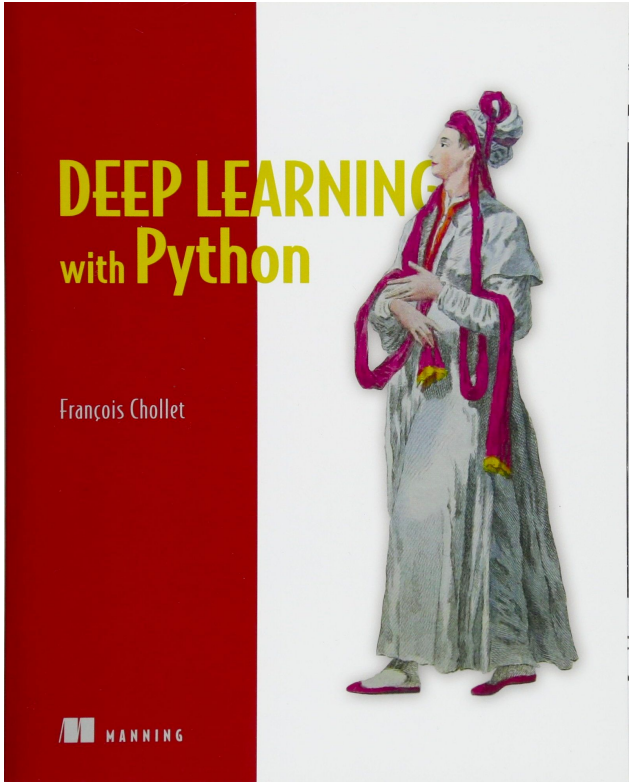
"Anger"
λ_F: 0.75 / λ_C: 0.25

"Sad"
λ_F: 0.13 / λ_C: 0.87

Main reference second semester

Deep Learning with Python,

by Francois Chollet



Reference Python library:
Keras (https://keras.io/)

Online courses for hands-on deep learning

- Introduction to Machine Learning for Coders (Fast.ai): http://course18.fast.ai/ml
- Machine Learning with Python (Coursera): http://tiny.cc/cz5bjz
- Advanced Machine Learning Specialization (Coursera): http://tiny.cc/3u5bjz
- Machine Learning (VU Amsterdam): https://mlvu.github.io/

Mid-module feedback

Mid-module feedback

Less than twenty answers so far (thanks to all who filled the form!)

Mid-module feedback form still open: https://bit.ly/2E7o1j0

In the following some comments are discussed.

Mid-module feedback so far: some comments

*I would shift **this module to SEM2 only and compress Computational Data Science in to SEM1**. I say this because there are concepts, packages and techniques taught from the beginning of Applied Machine learning which are expected as a given that are not touched upon until very late in SEM1 in Computational Data Science.*

*I started to be more familiar with some machine learning codes, when I understood the basics of python. Maybe, if we had **a week of code basics** it would be perfect from those who does not have computational background.*

Mid-module feedback so far: some comments

I liked the lab sessions where we are able to ask ***questions about the code***

Increase the practice time *with lecturer's help*

The lab practical sessions are ***not sufficiently interactive****.*

Mid-module feedback so far: some comments

*More literature or **links to interesting articles** would be nice.*

Mid-module feedback so far: some comments

*The **submission deadline on exam period**, I prefer if it is earlier (before Christmas break).*

Mid-module feedback: Still open!

If you haven't filled it already, **please answer the following form** to provide feedback about the module: https://bit.ly/2E7o1j0

It is anonymous and very short.

Any constructive feedback will be highly appreciated!

Module code: CMT307

Coursework 2: Group projects

Group projects: general information

In this semester the coursework will consist of **group projects** (of around 5-7 students each).

- **Goal:** Design and implement machine learning models for solving a problem.
- **Tasks:** Write a group report, give a presentation. Write an individual report.

We will **start at the beginning of the semester** and submission will be required end by the end of April. More detailed information in Learning Central next week.

Group projects: 14 options

There is a **variety of projects** to select from: 14 in total, with different variants. We will take your preferences into consideration and then split the groups automatically.

All projects will have a **similar level of difficulty** that has been adjusted with respect to the content of the module. Relevant content and exercises will still be provided throughout the module (e.g. focus on neural networks for computer vision this second semester).

Group projects: How to choose a project

You can find the title and a brief description of each project here: http://tiny.cc/l3ccjz

Please select a **minimum of three projects** by filling this form: shorturl.at/BJT39

Deadline for selection: Wednesday, 5 February at 9:30

Note: If enough variety, you will be allocated to one of your selected projects (the more projects you select, the more chances you have of being allocated a project of your choice!). If less than three projects are selected, you will be allocated to a project randomly.

Any questions about the group projects selection process?

School's private Stack Overflow (reminder)

https://stackoverflow.com/c/comsc

Post your questions related to the model and coursework here!

Add the tags ***cmt307*** (and optionally *machine-learning)* to your question.

Hands on!

Python notebook with exercises
about **introduction to neural networks** available at Learning Central.
Please fill **mid-module feedback** (https://bit.ly/2E7o1j0).

We are available for questions during this time