

EECS4404
Introduction to Machine Learning
and Pattern Recognition
Lecture 1

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York University

September 4, 2019

Organization of the class

Basic Information

- Instructor: Amir Ashouri (aashouri@eecs.yorku.ca)
- Office Hours: Wednesdays (To be announced)
- Website: Currently being setup on wiki pages will be announced

Lectures

Lecture times Mon, Wed, 14:30 - 16:00

Place CB 129, CC2 11

First lecture Today :) September 4

Last lecture Monday, December 2

Reading week October 12-18

More info <https://registrar.yorku.ca/enrol/dates/fw19#2>

Evaluation

Assignments:

- 3 Assignments
- Roughly due end of September/October/November
- Mix of theoretical and programming questions

Tests:

- In-class midterm (tentatively October 23)
- Final exam (December 5 - 20)

Presentations (for graduate students)

- Short presentation (10-15 minutes) on a ML research paper
- Paper to be selected in discussion with instructor

Evaluation

EECS4404

- 30 % Assignments
- 30 % Midterm
- 40 % Final exam

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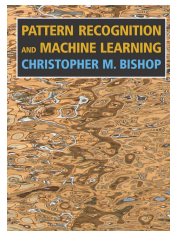
- 25 % Assignments
- 25 % Midterm
- 35 % Final exam
- 15 % Project/Paper presentation

Textbooks

Pattern Recognition and Machine Learning (PRML)

by Christopher M. Bishop. Springer. (2006).

- Available on Amazon.
- Available in bookstore



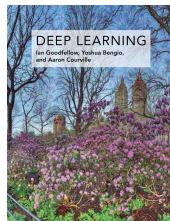
Deep Learning

by Ian Goodfellow, Yoshua Bengio and Aaron Courville.

www.deeplearningbook.org. (2016)

- Available on Amazon.
- Full content from deeplearning.org website:

<https://www.deeplearningbook.org/contents/TOC.html>



Material

Lectures will include a mixture of high level motivation and explanations and low-level derivations

Material in readings and lectures will overlap but won't be identical. **You are responsible for both!**

Slides used in class will generally be posted to the course website the day within 24 hours after lecture.

In cases where lectures are delivered on the board, these notes may not be posted. **Don't skip lectures and plan to catch up by looking at the posted notes!**

Programming

Assignments to be in done in **Matlab** and **TensorFlow**:

- We use Python/TensorFlow for our Deep Learning assignment
- We use Matlab for the other assignments
- Available on EECS lab machines and can be installed on your own computers
- If you are not familiar with it, start working your way through a tutorial

<https://www.tensorflow.org/tutorials>

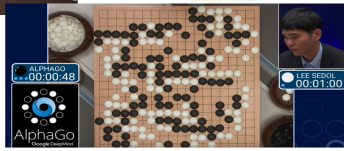
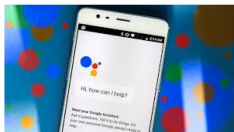
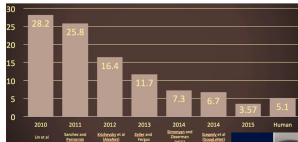
<https://www.mathworks.com/support/learn-with-matlab-tutorials.html>

Applications of ML

ImageNet Challenge

IMAGENET

- 1,000 object classes (categories).
- Images:
 - 1.2 M train
 - 100k test.



Natural language processing

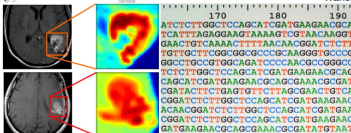
Capítulo primero. Que trata de la condición y ejercicio del famoso hidalgo don Quixote de la Mancha

En un lugar de la Mancha, de cuyo nombre no quiero acordarme, no ha mucho tiempo que vivió un hidalgo de los de lanza en astillero, adarga antigua, rocín flaco y galgo corredor. Una olla de algo más vaca que carnero, salpicón las más noches, dueros y guatemeros los sábados, lambas las vapores, algún pajarrico de afilaciones los domingos, consumían las tres partes de su hacienda. El resto della concluíanse en un venado, culebra de velludo para las fiestas, con sus puntillas de lo meyo, y los días de entremetido se horneaba con el vellón de la mala fía. Solo en su casa una ama que pasaba de los cuarenta, y una sobrina que no llegaba a los veinte, y un mozo de campo y plaza, que así ensillaba el mozo como lamaba la pascueta. Frecuente la visita de suadero mozo con los concuents amos, era de complexion moza, seica de carnos, enano de rostro, gran membradura y aringo de la cara. Cuarenta años que tenia el subcomendante de Guadalupe, o Quixote, así en todo hay alguna diferencia en los autores que desde que se escribió: sacaron, por costumbre repetitiva, su día en entender que se llaman Quixote. Pero esto importa poco a nuestro cuento; basta que en la narracion del no se ponga un punto de la verdad.

First chapter. Which deals with the condition and exercise of the famous hidalgo Don Quixote de la Mancha

It is a place of La Mancha, whose name I do not want to remember, there has not been a long time that lived a lord of the lance in a stinger, old park, thin rocin and greynish runner. A pot of something more like that, salt, meat, rigas, duels and breaks on Saturdays, giblets on Fridays, some pajarrico in addition to Sundays, consumed the three parts of his estate. The rest of the party concluded a velvet cone, many rigas for the parties, with three stripes of the same, and the days of misweek were honored with their velvet of the head, the head a housewren in his house who was in his forties, and a niece who was not in his twenties, and a boy in the country and a plaza, who saddled the mozo, as he has the pascueta. He emphasized the age of our hidalgo at the age of fifty, that of a hard complexion, dry of flesh, not of hair, great early set and travel of the furt. They mean that he had the nickname of Quixote, or Quixote, that in this there is some difference in the authors who in this case write. Although in previous connections, it is understood that it was called Quixote. But this matters little to our story. It is enough that in the narration of this a point of truth does not come out.

DIAGNOSTICS



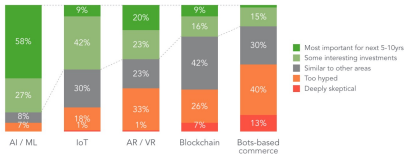
Google's Neural Machine Translation (Wu et al. 2016)



ML Growth

Most VCs are most excited about AI & Machine Learning as their most important investment theme for the coming 5-10 years.

Q. How do you feel about the following investment areas?



17 Source: Upfront Ventures survey of VCs (N=110), Jan 2017

upfront

Artificial intelligence startups are a global phenomenon

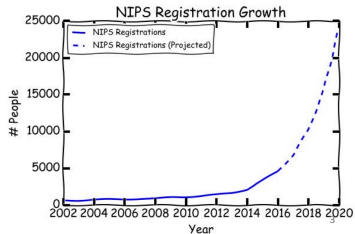
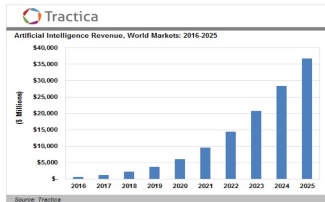
Artificial Intelligence Startups: Count by Country



Venture Scanner

0 Companies 475

Data as of April 2017



NIPS (NeurIPS) Attendance!

NIPS (NeurIPS)
2018 - Montreal



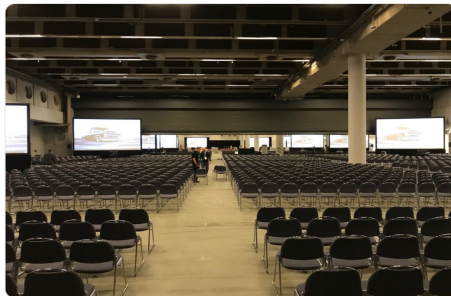
Neil Lawrence

@lawrennd

Follow



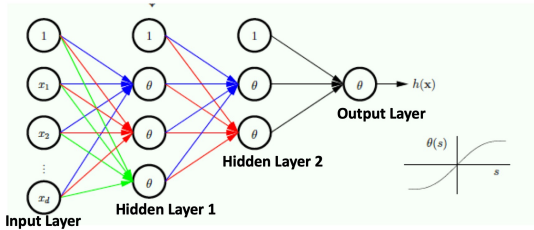
#NeurIPS plenary room 6500 seats ... there are overflow rooms for the other 1500.



3:21 PM - 2 Dec 2018

(Deep) Neural Networks

Neural Networks - Architecture



$$h_i^{(1)} = \theta \left(\sum_{j=0}^d w_{ji}^{(1)} \cdot x_j \right)$$

Output 'i' (Hidden Layer 1) Weights: Layer 1 Inputs

$$h_i^{(2)} = \theta \left(\sum_{j=0}^d w_{ji}^{(2)} \cdot h_j^{(1)} \right)$$

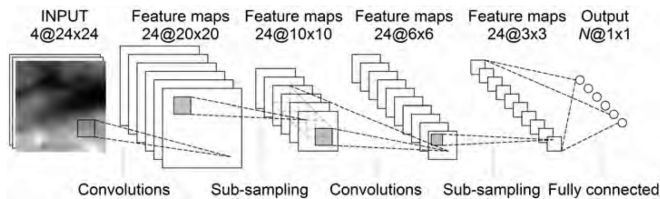
Output 'i' (Hidden Layer 2) Weights: Layer 2

$$y = \text{sign} \left(\sum_{j=0}^d w_{ji}^{(3)} \cdot h_j^{(2)} \right)$$

Output

Convolutional Neural Networks (CNNs)

Convolutional Neural Networks



- Image statistics are translation invariant (objects and viewpoint translates)
- Expect low-level features to be local (e.g. edge detector)
- Expect high-level features learned to be coarser

Tensor flow Assignments

- **Python based** ML Library released by Google in 2015
- Automatic Training for Neural Networks
- GPU Support (Not Required for Assignments in this courses)

- Installation through Anaconda Environment is Recommended (See Installation Guide on Course Webpage)

- Tons of Resources!
 - Tensorflow.Org Tutorials
 - CS231n Stanford Tutorial (<http://cs231n.stanford.edu/>)
 - See Course Webpage for a simple tutorial (Updated, Use Chrome Browser)

TensorFlow Example

Tensor flow Example (<https://www.tensorflow.org>)

```
import tensorflow as tf
x = tf.placeholder(tf.float32, [None, 784])
W = tf.Variable(tf.zeros([784, 10]))
b = tf.Variable(tf.zeros([10]))
y = tf.nn.softmax(tf.matmul(x, W) + b)
```

Initialize Computational Graph

```
cross_entropy = tf.reduce_mean(-tf.reduce_sum(y_ * tf.log(y), reduction_indices=[1]))
train_step = tf.train.GradientDescentOptimizer(0.5).minimize(cross_entropy)
```

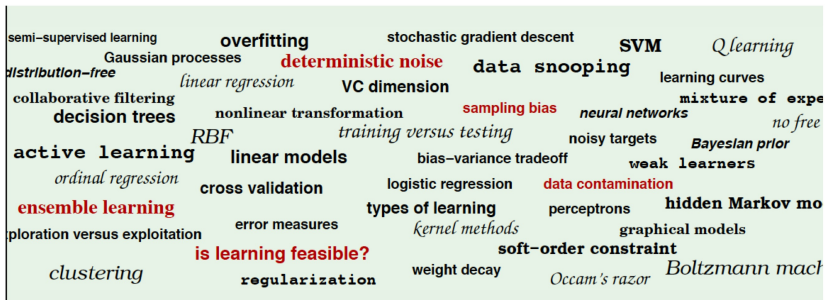
Loss Function
and Optimizer

```
sess = tf.InteractiveSession()
tf.global_variables_initializer().run()

for _ in range(1000):
    batch_xs, batch_ys = mnist.train.next_batch(100)
    sess.run(train_step, feed_dict={x: batch_xs, y_: batch_ys})
```

Training Routing

Bag of ML Jargons



Machine Learning examples

Machine Learning - examples

Self driving cars

Community detection

Fraud detection

Species preservation

Recommender systems

Logistics

Computational Biology

Consumer behavior analysis

Face recognition

Medical diagnosis

Speech recognition

Computer vision

Stock market prediction

Spam filters

Automated translation

Character recognition

Machine Learning

Machine Learning – Why do we need it?

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Some tasks are **too complex** to be implemented directly:

- Self driving cars
- Speech recognition
- Complex rules for classification tasks on high dimensional data
 - ▶ Fraud detection
 - ▶ Document classification

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- Self driving cars
- Speech recognition
- Complex rules for classification tasks on high dimensional data
 - ▶ Fraud detection
 - ▶ Document classification

→ Learn a program based on data!

What is machine learning?

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First explanation:

- Development of algorithms which allow a computer to “learn” specific tasks from training examples.
- Learning means that the computer should not just memorize the seen examples, but predict well on previously unseen instances
- Ideally, the computer should use the examples to extract a general “rule” how the specific task has to be performed correctly.