New York University Tandon School of Engineering  
Department of Electrical and Computer Engineering  
**Introduction to Machine Learning**  
**Fall 2019**  
Instructor: Anna Choromanska

**Course Prerequisites**
1) Undergraduate Probability  
2) Mathematical maturity:  
   https://en.wikipedia.org/wiki/Mathematical_maturity

**Course Description**
Machine Learning is nowadays one of the most rapidly developing technical fields both in the academia and industry. It is also a fundamental tool used in a wide range of different data science fields. This course presents the basic concepts, techniques, and algorithms in machine learning from both theoretical and practical perspective. The program of the course includes empirical risk minimization, support vector machines, kernels, clustering, principal component analysis, Expectation-Maximization, graphical models, and neural networks.

**Textbook**
There is no textbook required. The list of recommended texts:
- *Pattern recognition and machine learning*, C.M. Bishop  
- *Pattern classification*, R. O. Duda, P. E. Hart, and D.G. Stork  
- T. Jebara. *Course notes, Machine Learning*  
- S. Dasgupta. *Course notes, CSE 291: Topics in unsupervised learning*

**Homeworks**
For coding, preferred environments is Matlab. **Homeworks are due at 9 am on the given day.**

**Course Work and Grading**
Your final grade will be determined roughly as follows:

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<thead>
<tr>
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<th>Percentage</th>
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<tbody>
<tr>
<td>Homework</td>
<td>30%</td>
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<tr>
<td>Midterm</td>
<td>30%</td>
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<tr>
<td>Final</td>
<td>40%</td>
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**Tentative Schedule**
• Week 1: Regression, Empirical Risk Minimization, Least Squares, Higher Order Polynomials, Under-fitting / Over-fitting, Cross-Validation, Additive Models and Linear Regression, Sinusoids and Radial Basis Functions, Classification, Logistic Regression, Gradient Descent
   Homework 1 is released and due 09.21.2018.

• Week 2: Perceptron, Online & Stochastic Gradient Descent, Convergence Guarantee, Perceptron vs. Linear Regression, Multi-Layer Neural Networks, Back-Propagation, Demo: LeNet, Deep Learning

• Week 3: Generalization Guarantees, VC-Dimension, Nearest Neighbor Classification (infinite VC dimension), Structural Risk Minimization, Support Vector Machines
   Due date for Homework 1.
   Homework 2 is released and due 10.05.2018.

• Week 4: Kernels and Mappings and Introduction to Probability Models

• Week 5: Discrete Probability Models, Independence, Bernoulli Distribution, Text: Naïve, Bayes, Categorical / Multinomial Distribution, Text: Bag of Words and (Topic 9) Continuous Probability Models, Gaussian Distribution, Maximum Likelihood Gaussian, Sampling from a Gaussian
   Due date for Homework 2.
   Homework 3 is released and due 10.19.2018.

• Week 6: Classification with Gaussians, Regression with Gaussians, Principal Components Analysis and Maximum Likelihood as Bayesian Inference, Maximum A Posteriori, Bayesian Gaussian Estimation

• Week 7: Mixture Models and Hidden Variables, Clustering, K-Means, Expectation Maximization and Expectation Maximization
   Due date for Homework 3.
   Homework 4 is released and due 11.02.2018.

• Week 8: MIDTERM

• Week 9: Structuring Probability Functions for Storage, Structuring Probability Functions for Inference, Basic Graphical Models, Graphical Models, Parameters as Nodes
Due date for Homework 4.
Homework 5 is released and due 12.14.2018.

- Week 10: Bayes Ball Algorithm and Junction Tree Algorithm
- Week 11: Junction Tree Algorithm
- Week 12: JTA and HMM
- Week 13: HMM
- Week 14: Introduction to Deep Learning and CNNs

Due date for Homework 5.

- Week 15: FINAL EXAM