



# *The Hebrew University of Jerusalem*

## *Syllabus*

### *Introduction to Machine Learning - 67577*

*Last update 19-08-2023*

*HU Credits: 5*

*Degree/Cycle: 1st degree (Bachelor)*

*Responsible Department: Computer Sciences*

*Academic year: 2024*

*Semester: 2nd Semester*

*Teaching Languages: Hebrew*

*Campus: E. Safra*

*Course/Module Coordinator: Dr. Gabriel Stanovsky*

*Coordinator Email: [gabriel.stanovsky at mail.huji.ac.il](mailto:gabriel.stanovsky@mail.huji.ac.il)*

*Coordinator Office Hours: Wed 12:00-13:00*

*Teaching Staff:*

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Dr. gabriel satanovsky,  
Dr. roy schwartz,  
Ms. Amit Benartzy,  
Ms. Gili Lior,  
Mr. Reshef Mintz,  
Mr. eitan wanger

Course/Module description:

*This is an introductory course to the field of machine learning. The course will cover the foundations of statistical learning, and the applicability of machine learning to real world problems. In particular, we'll focus on the PAC model, and will address fundamental questions like: What is machine learning? What type of concepts are learnable? How can we learn from data? We will also build a machine learning toolbox and will also cover additional models of learning such as online learning, unsupervised learning, clustering, generative models and parameter estimation. Besides the theoretical foundations, we will cover tools which were found efficient in solving practical problems. In particular: Decision trees, deep learning, SVM and kernel methods, Lasso, Nearest Neighbor, Boosting, PCA, Perceptron, Weighted Majority. The course will include theoretical exercises as well as empirical projects.*

Course/Module aims:

*Understand the foundation of learning theory and the major algorithms*

Learning outcomes - On successful completion of this module, students should be able to:

*define PAC learning.  
employ algorithms learnt in class.  
choose the appropriate algorithm for a given problem.  
prove basic results in the theory of learning.*

Attendance requirements(%):

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*Teaching arrangement and method of instruction: lectures, recitations, programming labs, home exercises, hackathon*

Course/Module Content:

*Probability: review  
Measure Concentration*

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*Introduction and Gentle Start*  
*A formal Learning Model*  
*PAC Model*  
*Learning Via Uniform Convergence*  
*The Bias-Complexity Tradeoff*  
*No-Free-Lunch*  
*VC-dimension*  
*Linear Predictors*  
*Boosting*  
*SVM*  
*Deep neural networks*  
*Validation*  
*MDL and SRM*  
*Convex Optimization*  
*Convex Learning Problems*  
*Stochastic Gradient Descent*  
*Regularized loss minimization*  
*Ridge Regression*  
*SVM*  
*Kernels*  
*Decision Trees*  
*Nearest Neighbor*  
*Online Learning*  
*Clustering*  
*Dimensionality Reduction*  
*Spectral Clustering*  
*Generative Models*

*Required Reading:*

*N.A*

*Additional Reading Material:*

*1. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press*

*2. Jerome Friedman, Robert Tibshirani, and Trevor Hastie, The Elements of Statistical Learning 2nd Edition. Springer*

*Grading Scheme:*

*Written / Oral / Practical Exam 65 %*  
*Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 35 %*

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Additional information:

N.A