

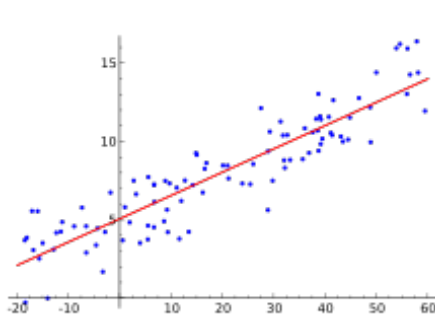
Machine Learning

CCOM, UPR Río Piedras

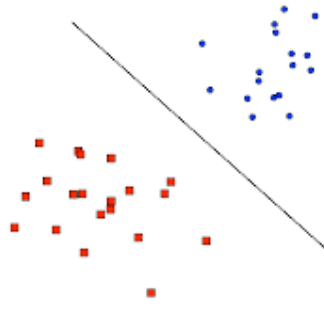
How can a machine perform a task *without being programmed explicitly*?

Let the machine learn the task from data

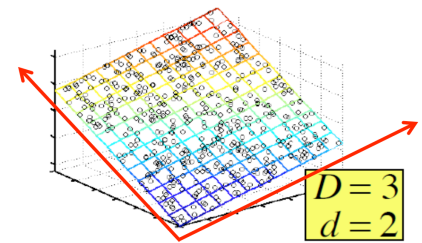
From the theory of the fundamental linear models...



Regression

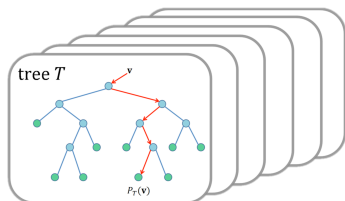


Classification

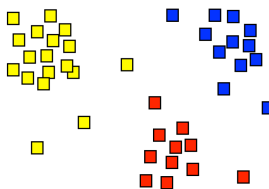


Dimensionality reduction

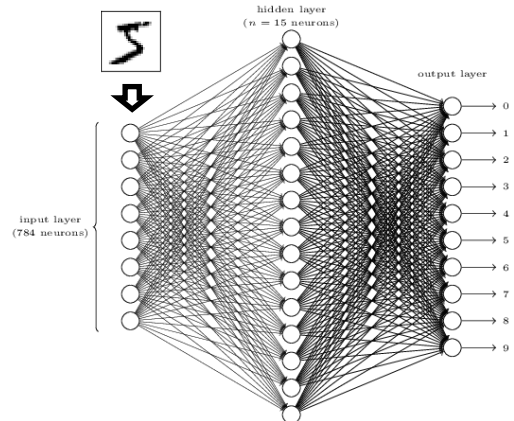
... through the understanding of practical approaches...



Random Forests



K-Means clustering



Neural Networks

... to the applications

We will discuss how Machine Learning turned out to be used in as diverse fields as cancer diagnostics, voice assistants, automatic machine translation, computer vision or game AI...

Any question?

Contact Prof Rémi Mégret
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<http://ccom.uprrp.edu/~rmegret/teaching>

Practice labs in **python**, using **sklearn**,
tensorflow/Keras libraries.

**University of Puerto Rico
Río Piedras campus
College of Natural Sciences
Computer Science Department
Undergraduate program**

- 1. Title – Machine Learning / Aprendizaje Automático**
- 2. Course Code – CCOM4995-??? (temporary code)**
- 3. Credits – 3**
- 4. Pre-Requisites, Co-Requisites and other requirements –**
 - Data Structures (CCOM 3034)**
 - Linear Algebra (MATE4031) or equivalent Numerical Linear Algebra (CCOM4065)**
 - Probability (MATE5001)**

5. Course Description

Elective course designed for senior undergraduate students in Computer Science, organized as lectures with programming and interactive exercises. Machine Learning is the field of study to give computers the ability to perform tasks without being explicitly programmed. The goal of this course is to provide an introduction to Machine Learning, from both a theoretical and practical point of view. Main approaches in supervised and unsupervised machine learning styles will be discussed. Particular focus will be given to the linear model for the theoretical insights it provides, and the deep neural network models, which have become recently the best performing approach for many complex learning tasks. The mathematical foundations of selected approaches will be discussed, as well as the practical implementation of an end-to-end learning system.

6. Learning Objectives

At the successful completion of the class, the students will be able to

- Explain what is a Machine Learning system and its typical applications
- Explain the different styles of learning (supervised, unsupervised, reinforcement...)
- Explain the main learning algorithms and models
- Train models computationally and use them for predictions on test data
- Evaluate the performance of learned models
- Explain the theoretical trade-offs and limits of learning from data
- Appreciate the use of mathematics to represent and solve Machine Learning problems
- Present an analysis of recent advances in the domain from a literature review
- Identify the ethical and societal impact of Machine Learning technology

7. Content Outline and Time Distribution

Schedule:

Units	Modules	Time
Introduction	Overview of the field and applications	3h
Supervised Learning	- Linear models for regression and classification - Performance evaluation - Non-linear decision models: Kernel machines, Decision trees, Random Forests - Theory of generalization	12h
Neural Networks	- Perceptron and Multi-layer Perceptron Learning - Deep Networks, Convolutional Networks	9h
Unsupervised Learning	- Dimensionality reduction: PCA, manifold learning - Clustering: K-means	6h
Project Discussions	- Literature Review - End-to-end project	15h
	Total	45h

8. Instructional Techniques

Concepts and theory presented in lectures and in-class discussion and deepened through a literature review Project.

Practice trained through programming laboratory assignments and a final end-to-end implementation Project of a Machine Learning system.

The course uses high-level machine learning programming frameworks, such as python libraries Scikit-Learn, Pandas, matplotlib, TensorFlow and Keras.

9. Minimum Available or Required Resources

Laboratories require machine learning software libraries.

10. Evaluation Techniques

Participation in class	5%
4 assignments (theory + implementation)	40%
1 literature review presentation (oral presentation)	15%
1 final project (dataset, software, oral presentation, written report)	40%

11. Special Accommodation

The University of Puerto Rico complies with federal and state laws, norms and regulations about discrimination including the American Disabilities Act 1990 (ADA) and Law 31 Commonwealth of Puerto Rico. Students receiving services from Vocational Rehabilitation must communicate with his or her professor at the beginning of the course in order to plan reasonable accommodations and necessary assistive equipment following recommendations from the Office of People with Disabilities Affairs (OAPI in Spanish) located at the Dean of Students Affairs. Students with special needs who require any type of assistance or accommodation must communicate with his or her professor at the beginning of the course as well.

12. Institutional policy against sexual harassment.

The University of Puerto Rico prohibits discrimination based on sex and gender, in all its forms, including sexual harassment. According to the institutional policy against sexual harassment at the University of Puerto Rico, Certification Number 130 2014-2015 of the Governing Board, if a student is being or was affected by conduct related to sexual harassment, he / she may go to the Office of the Student Attorney. (787-764-0000, extensions 86600, 86601 or 86603), the Student Deanship (extension 86000) or the Title IX compliance coordinator (extensions 84013 or 84005) for guidance and / or filing a complaint.

13. Academic Integrity

The University of Puerto Rico promotes the highest standards of academic and scientific integrity. Article 6.2 of the General Student Regulations of the UPR (Certification No. 13, 2009-2010, Board of Trustees) states that "academic dishonesty includes, but is not limited to: fraudulent actions, obtaining grades or academic degrees using false or fraudulent simulations, copying in whole or in part the academic work of another person, totally or partially plagiarizing the work of another person, copying totally or partially the answers of another person to the questions of an examination, doing or getting another person to take on their behalf any oral or written test or examination, as well as assistance or facilitation for another person to engage in said conduct. " Any of these actions will be subject to disciplinary sanctions in accordance with the disciplinary procedure established in the General Regulations of Students of the UPR in force.

14. Grading System A, B, C, D, F

15. Bibliography

Textbooks:

- Aurélien Géron. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media, 2017. ISBN 1491962291.
- Yaser Abu-Mostafa, Magdon-Ismael Malik, and Hsuan-Tien Lin. Learning from Data – A Short Course. AMLBook, 2012. ISBN 1600490069.

Additional books:

- Ethem Alpaydin. *Introduction To Machine Learning*, 3rd Edition, Phi 2015. ISBN13: 978-8120350786.
- Christopher M. Bishop. Pattern Recognition and Machine Learning. Information Science and Statistics, Springer, 2011. ISBN13: 978-0387310732.
- Trevor Hastie, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning*. Springer, 2016. ISBN13: 978-0387848570.
- Mehryar Mohri, Afshin Rostamizadeh and Ameet Tawalkar. *Foundations of Machine Learning*. Adaptive Computation and Machine Learning, The MIT Press, 2012. ISBN13: 978-0262018258.
- Ian Goodfellow, Yoshua Bengio and Aaron Courville. *Deep Learning*. Adaptive Computation and Machine Learning, The MIT Press, 2016. ISBN13: 978-0262035613.
- Francois Cholet. *Deep Learning with Python*. Manning Publications, 2017. ISBN 1617294438.

Electronic references:

- Scikit-learn machine learning library: <http://scikit-learn.org/stable/documentation.html>
- Pandas data analysis library: <https://pandas.pydata.org/>
- Matplotlib visualization library: <https://matplotlib.org/>
- Tensorflow machine learning framework: <https://www.tensorflow.org/>
- Keras deep learning library: <https://keras.io/>
- Machine Learning Crash course: <https://developers.google.com/machine-learning/crash-course/ml-intro>