PROGRAMA DE CURSO

Código	Nombre			
IN7616	Theory of machine learning			

Nombre en Inglés				
Theory of machine learning				

SCT	Unidades Docentes	Horas de Cátedra	Horas Docencia Auxiliar	Horas de Trabajo Personal
6	10	3	1.5	5

Requisitos	Carácter del Curso
IN3701 or (alternatively) MA3701 or (alternatively) CC3001 or AUTOR	Electivo de Carrera, Magister y Doctorado.

Competencias a las que tributa el curso
The student knows algorithms in the area of machine learning and theoretical results about them, for example, theorems that show under which circumstances these algorithms work as desired.

Propósito del curso
Machine learning algorithms are powerful algorithms that can extract and learn information from data and predict future data. In particular, many machine learning algorithms work well in practise. This course focuses on theory for these algorithms, i.e., mathematical proofs showing under what conditions these algorithms perform well. For a student of this course, it is not necessary that she/he has any prior knowledge about machine learning. On the other hand, if the student has taken a practically oriented machine learning course before, she/he will still learn a lot of new material in this course. In particular, she/he will develop a better understanding for why machine learning algorithms work well and what their limits are.

Resultados de Aprendizaje
RA1: Knowledge of machine learning algorithms

RA2: Knowledge of theory about machine learning algorithms, in particular theorems that show what can and what cannot be learned by these algorithms |

Metodología Docente	Evaluación General
The class is based on active participation of the students, among the strategies for this are

- interactive classes
- regular assignments | The students are evaluated continuously during the semester via

- homeworks
- a mid-term exam
- a final exam |

Unidades Temáticas

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
1	RA1	Introduction	1
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
Introduction to machine learning		The student obtains a basic understanding about machine learning algorithms and different types of learning	[1] chapter 1

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
2	RA1	A Gentle Start	1
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
A formal model for statistical learning		The student understands basic definitions and concepts about machine learning such as training data, Empirical Risk Minimization, Overfitting, inductive bias	[1] chapter 2

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
3	RA1+RA2	PAC-learning	3
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
Probably Approximately Correct (PAC) learning and Uniform Convergence		The student learns the concepts of PAC learning, agnostic PAC learning, uniform convergence, sample complexity, and their implications for learnability of hypotheses	[1] chapters 3 and 4

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
4	RA1+RA2	Linear Predictors	1
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
Linear Predictors		The student understands linear regression and logistic regression	[1] chapter 9

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
5	RA1+RA2	Bias-Complexity Tradeoff and VC-dimension	2
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
Bias-Complexity Tradeoff No-Free-Lunch theorem VC-dimension		The student learns the bias-complexity tradeoff and its implications for the needed sample sizes for learning task. The student understands the concept of VC-dimension and the fundamental theorem of PAC learning	[1] chapter 9

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
6	RA1+RA2	Boosting	2
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
Boosting Weak Learnability AdaBoost		The student understands the concept of Boosting and the algorithm AdaBoost. He understands the relationship between the number of rounds of the AdaBoost algorithm and the VC dimension of the resulting hypothesis classes	[1] chapter 9

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
7	RA1+RA2	Nonuniform Learnability and Model Selection and Validation	2
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
Nonuniform Learnability Structural Risk Minimization Occam's Razor Model Selection and Validation		The student understands the concept of non-uniform learnability and the benefit of preferring hypotheses with smaller description length. The students understands how to use validation, hold-out sets, and k-fold cross validation in order to validate that a learning algorithm learned a task well.	[1] chapters 7 and 11

Número	RA al que tributa	Nombre de la Unidad	Duración en Semanas
8	RA1+RA2	Convex learning problems, Regularization and Stability	2
Contenidos		Resultados de Aprendizajes de la Unidad	Referencias a la Bibliografía
Convex learning problems Convexity, lipschitzness, and smoothness Surrogate Loss Functions Regularized loss minimization		The student understands what convex learning problems are, and basic related concepts like lipschitzness, and smoothness. He understands the benefit of surrogate loss functions and the (potentially) additional error due to them. The student learns the Regularized Loss Minimization (RLM) learning rule and the concept of stability of a learning algorithm.	[1] chapters 12 and 13

Bibliografía General
[1] "Understanding Machine Learning: From Theory to Algorithms", by Shai Shalev-Shwartz and Shai Ben-David

Vigencia desde:	Otoño 2021
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Revisado por:	