A2 An Introduction to Machine and Deep Learnings with Applications.
PARTE II

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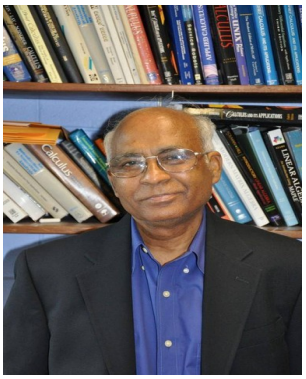

Resumen:

Machine Learning is a subfield of Artificial Intelligence (AI). While AI is the ability of the Machine (Computer) to think like a humans, Machine Learning is the ability of the machine to learn from the data without any explicit expressions. It is, thus, intimately related to Data Science.

In fact, these two terms are interchangeably used in industries. Both of them aim at making useful predictions from the data. Data Science is more involved with preprocessing from the data and gaining insights from it. Whereas, Machine Learning is concerned with development of mathematical models and algorithms to extract useful information from the data.

Specifically, Machine Learning is a scientific study of numerical algorithms and statistical models that computer systems use to effectively predict a specific task without using specific human instructions. It is an emerging area of study and research, and has found applications in solutions of a variety of real-life problems, arising , for instance, in computer vision, handwritten recognition, image and speech recognitions, medical diagnosis, health care, social media, manufacturing , and many more.

Three principal types of Machine Learning are: Supervised, Unsupervised and Deep Learning
The purpose of supervised learning is to make a meaningful prediction given a set of input and output data. Two statistical techniques, Regression and Classification, are used for this purpose.

Regression is used to predict the output that is quantitative, such as blood pressure or blood sugar of a person, age or height of a person or price of a stock. On the other hand, Classification is used to predict the output that is qualitative in nature , such as the type of an email (spam or not), color of an eye, or diagnosis of disease of a person : heart attack or stroke or any other disease.

Implementations of regression and classification techniques give rise to unconstrained and constrained optimization problems which in turn require sophisticated techniques of numerical linear algebra.
Unsupervised Learning deals with data which are not labeled. The machine learns from the hidden pattern and by discovering insights from the data.

An advanced type of machine learning, called DEEP LEARNING, has now become a state-of the art in research and education and is routinely used to solve complex practical problems.

It is based on neural network which mimics human brain. It differs from traditional Machine Learning in that it works on complex, varied and unstructured data, such as, voices, images, audio or text files. It is , therefore, nowadays routinely used in Image Processing, Speech Recognition, Biometric Identification, such as Facial and Fingerprint Recognitions, etc.
Detection of Pedestrians and Traffic Lights in Automated Car Driving , virtual assistants like SIRI in I-Phone and Apple Watch; Amazon's ALEXA, voice-enabled TV Remote are all
cloud-based applications of Deep Learning.

The Course will be divided into two parts.

Part II will concentrate on discussions of two advanced topics of Machine Learning; namely, REGRESSION and CLASSIFICATION for supervised learning and their applications.
Some essential backgrounds in Numerical Linear Algebra and Numerical Optimization will also be covered in this part.

Part II : Regression and Classification Techniques for Supervised Learning and Their Applications

(i) **Linear Regression**

Least-Squares Estimation of Linear Regression Problem
Properties of the Least-Squares Estimator
Normal Equations for Linear Least-Squares problem and Numerically Effective Solutions using the QR and SVD methods.
Efficacy of Regression Models
Illustrations using Real-life Examples of Machine Learning
Dimension Reduction Techniques
Principal Component Analysis (PCA) : Computing PCA by SVD
Applications of PCA to Image Compression and Data Visualization

(ii) **Classifications**

Logistic Regression
Naïve Bayes Technique
K-Nearest Neighbor Algorithms
Support Vector Machines
Applications to E-mail Spam Detection, Fraud Detection, Sentimental Analysis, Loan Default, etc.

Requerimientos:

Students and Researchers in Mathematics, Computer Science, Statistics, Medical and Health Sciences, Signal and Image Processing Engineering, and others.

BACKGROUND - For Part II, basic and some advanced techniques of Numerical Linear Algebra and Numerical Optimization will be need for full comprehension of the Machine Learning Algorithms. However, essential ones needed for overall comprehension will be covered in the lectures.

Reference Books :

(i) Numerical Linear Algebra and Applications by Biswa Nath Datta, 2nd Edition, SIAM, 2010 (Indian Paperback Edition by Prentice Hall of India)

(ii) Analisis Numerico : Teoria y Practica (Spanish Edition) by Biswa Datta, Luis Ramos and Marcos Raydan , 2017, Amazon

(iii) Numerical Optimization by J. Nocedal and S. J. Wright , Springer Series in Operations Research, New York, 1999

(iv) An Introduction to Machine Learning by Gopinath Rebala, Ajay Ravi, Sanjay Churiwala, Springer, 2019

(v) An Introduction to Statistical Learning with Applications in R by Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani , Springer, 2017.