

Machine Learning for Geosciences

By Francisco Mendoza

mentofran@gmail.com



Course material:

<https://github.com/mathphysmx/teaching-ml>

What is ML

Machine Learning is the science (and art) of programming computers so they can *learn from data*.

Here is a slightly more general definition:

[Machine Learning is the] field of study that gives computers the ability to learn without being explicitly programmed.

—Arthur Samuel, 1959

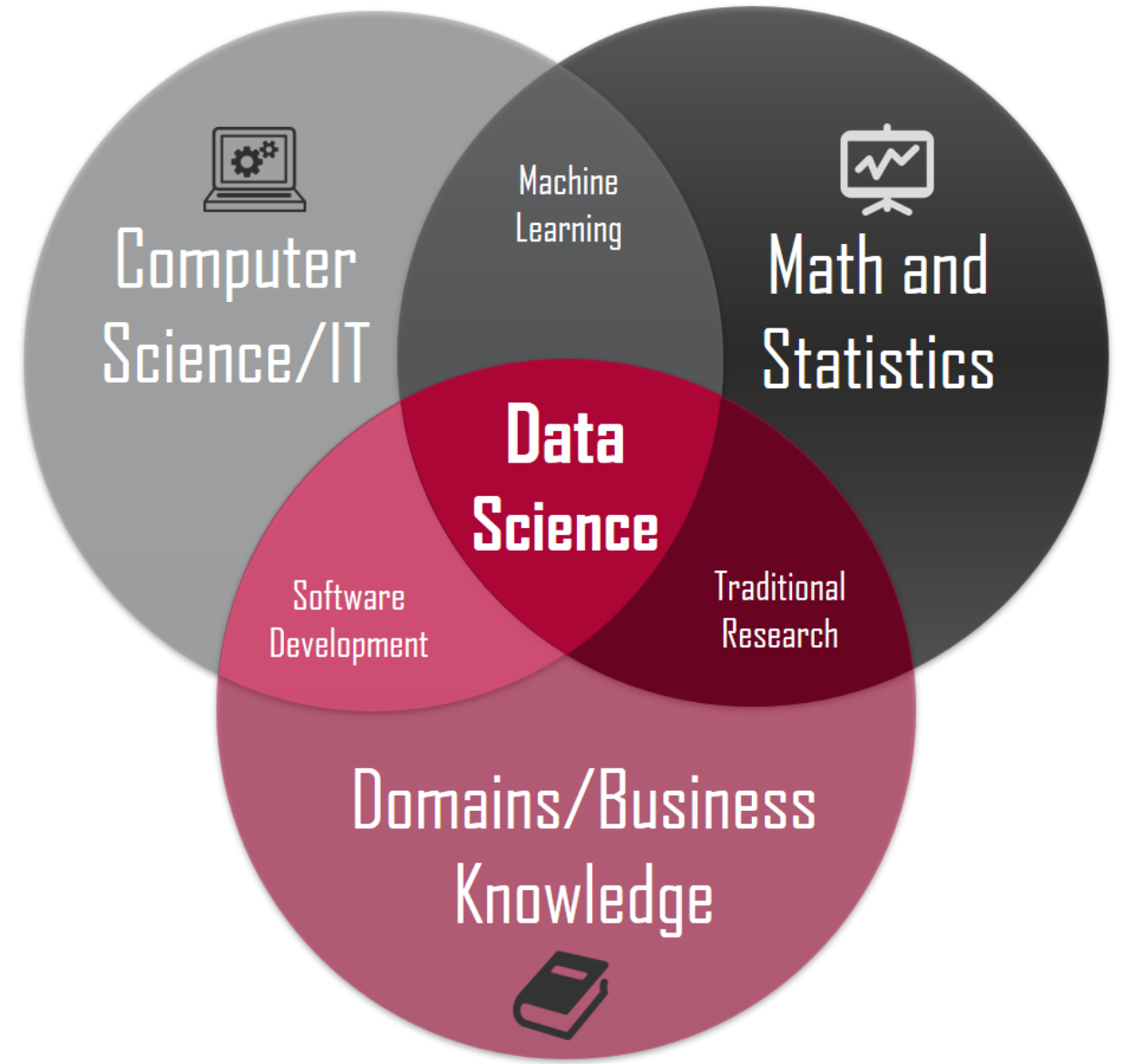
And a more engineering-oriented one:

A computer program is said to learn from experience E with respect to some task T and some performance measure P , if its performance on T , as measured by P , improves with experience E .

—Tom Mitchell, 1997

Related areas. Data Science

- Data manipulation (50 – 80 %)
- Machine Learning
- Deep learning



Applications in this course

Based on the book of Guangren Shi

Hydrology, geothermal, radioactive waste disposal, oil and gas,

Fluid volume production from a well ()

Porosity from depth (Pyrch)

Types of Machine learning algorithms

- Supervised

- k-Nearest Neighbors
- Linear Regression
- Logistic Regression
- Support Vector Machines (SVMs)
- Decision Trees, Ensemble methods
- Neural networks

- Unsupervised

- Clustering: K-means, Hierarchical Cluster Analysis (HCA)
- Visualization and dimensionality reduction (Kernel)? PCA, t-distributed Stochastic Neighbor Embedding (t-SNE)

- Reinforcement learning

- Batch and Online learning

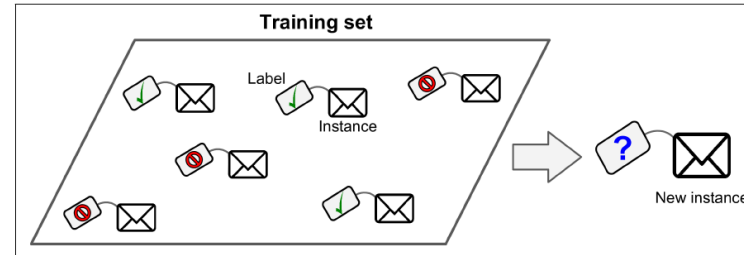


Figure 1-5. A labeled training set for supervised learning (e.g., spam classification)

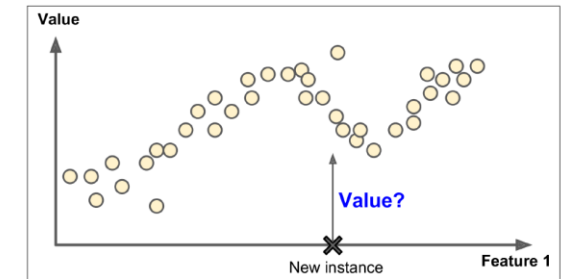
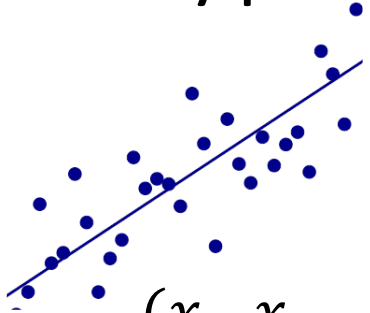


Figure 1-6. Regression

Type of problems, data types

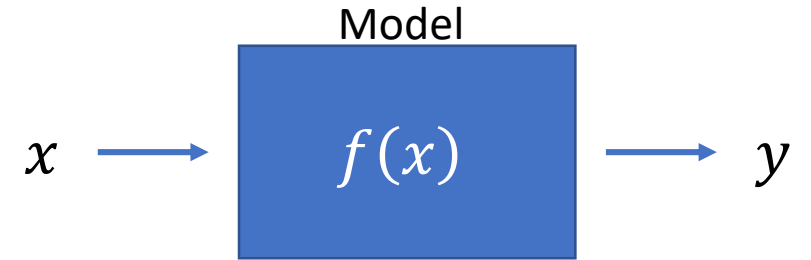


$$x \rightarrow y$$

$$(x_1, x_2, \dots, x_n) \rightarrow y$$

$$(x_1, x_2, \dots, x_n) \rightarrow (y_1, y_2, \dots, y_k)$$

Supervised



$$f: X \rightarrow Y$$

Unsupervised

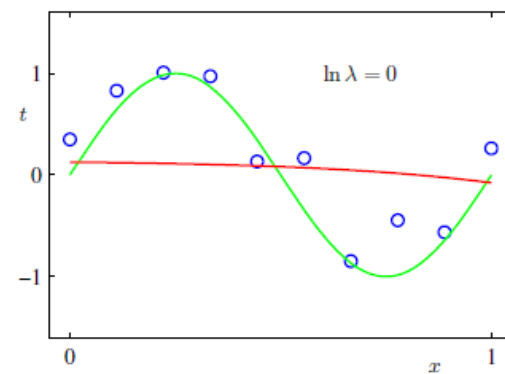
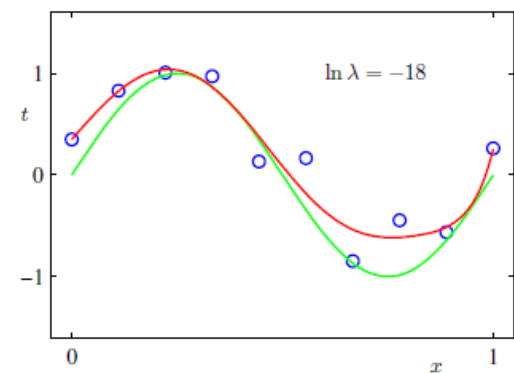
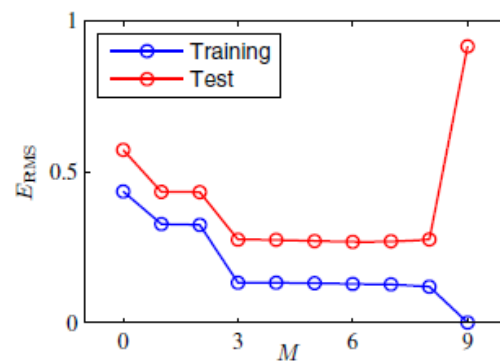
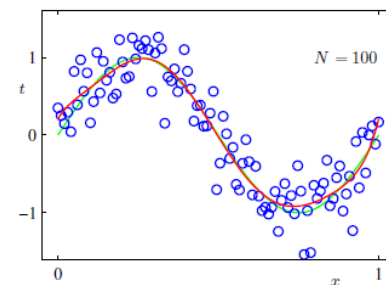
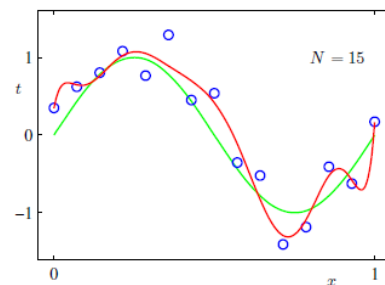
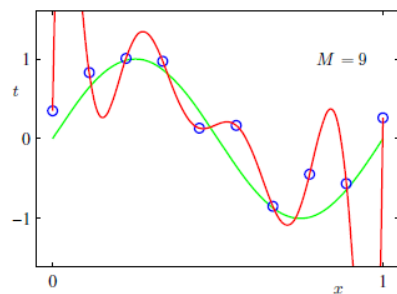
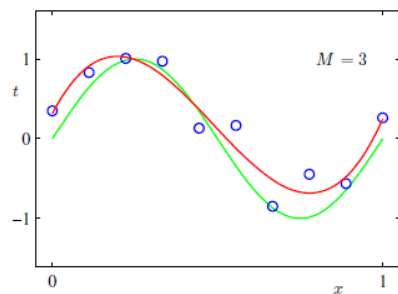
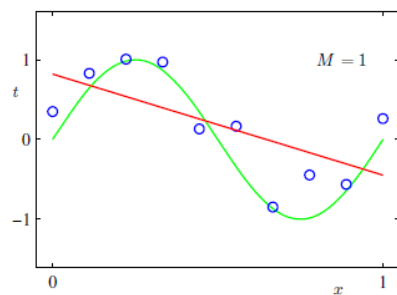
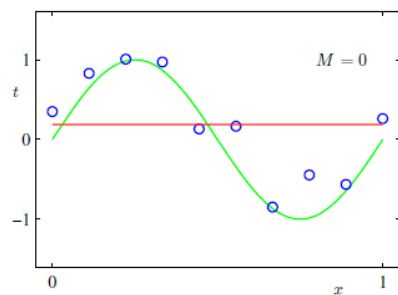
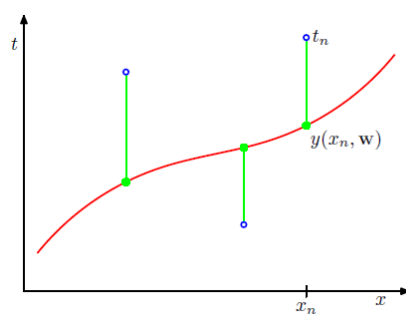
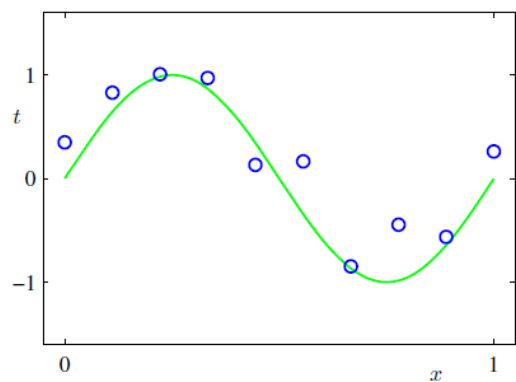
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2	7.234		H	Caty
⋮	⋮		⋮	⋮



ID	Cat y
1	aaa
2	hhh
⋮	⋮

Grading

- 20% Theoretical
- 20% Computational exercises
- 20% Exams
- 20% Oral presentation of application of ML in Geosciences
- 20% MOOC (Coursera, Udemy, ...)



Basic concepts

- Labels
- Training set
- Test set
- Feature (independent variable)
- Error

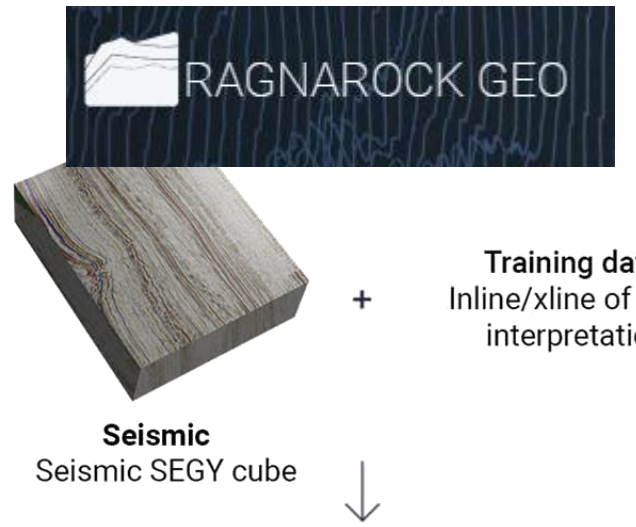
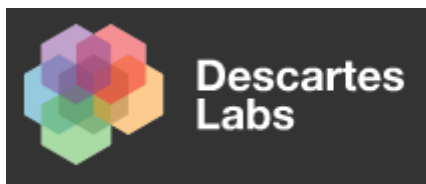
Table of Content (TOC)

Índice Temático			
Unidad	Tema	Horas	
		Teóricas	Prácticas
1	Panorama general sobre machine learning	2	0
2	Proyecto aplicado de machine learning	4	4
3	Modelos lineales y regresión logística	3	3
4	Máquinas de soporte vectorial (Support Vector Machines)	3	3
5	Métodos basados en árboles de decisión	6	6
6	Modelos basados en teoría de gráficas	3	3
7	Aprendizaje no supervisado	3	3
8	Reducción de la dimensionalidad	3	3
9	Redes neuronales y aprendizaje profundo	6	6
Total de horas:			
Suma total de horas:		64	

Bibliography

Companies

- All big companies +
- Well spacing
- Earth models
- Seismic horizons interpretation

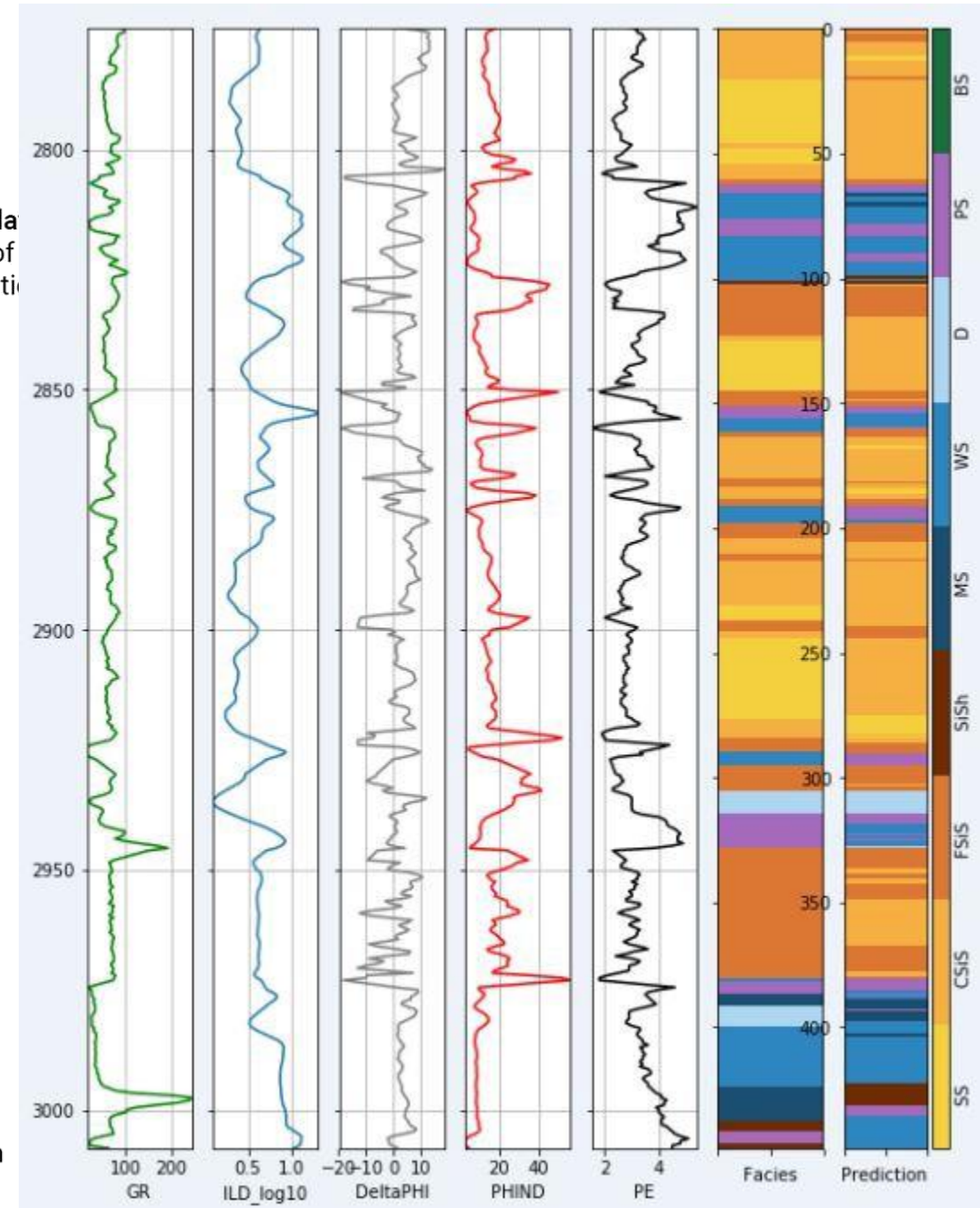


Artificial intelligence



Output

3D model in your seismic interpretation software with your interpretation throughout the cube



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