DATES

2nd, 3rd, 6th, and 9th of September 2024.

ASSEGNISTA

Verónica Henao Isaza

SEMINAR

First Seminar

Python Machine Learning Techniques for Classifying Patients with Neurodegenerative Disorders and Controls based on EEG, MRI, and Clinical Markers

4 Hands-on Seminars:

SAPIENZA
UNIVERSITÀ DI ROMA

Table of Contents

I Self-Introduction & Motivation

I Self-Introduction & Motivation

Verónica Henao Isaza

MSc in engineering, Date: Dec 15, 2023
Bioengineering, Date: Sept 11, 2020

Age: 29
Colombian

I would like to pursue a career in research and development, focusing on creating innovative solutions for applied engineering within academic health centers.

ACADEMIC WORK EXPERIENCE

Approx. 2 years (27 months) of academic experience to date.

Sapienza Università di Roma, Italy, Research Fellow (2024)
Universidad de Antioquia, Lecturer (2023)
Sapienza Università di Roma, Italy, Internship (2022)
Universidad de Antioquia, Instructor student (2021-2022)

INDUSTRY WORK EXPERIENCE

Approx. 2 years (27 months) of industry experience to date

Gropius Innovación S.A.S, Director of innovation and development (2020-2022)
Meridiano S.A.S, Technical advisor in the development of medical devices (2020)

I Self-Introduction & Motivation

EXPLORING THE VISUAL CORTEX (PORTABLE DEVICES)

SSVEP study in monocular and binocular vision

Daniela Ortega, Verónica Henao Isaza, and John Ochoa-Gómez

Captura y análisis de potenciales visuales en estado estacionario usando tecnología portable y de bajo costo

Valeria Cadavid, Eliana Salas, Santiago González,Verónica Henao Isaza, and John Ochoa-Gómez

Development of a tool for the acquisition of SSVEP using portable and low-cost electroencephalography

Verónica Henao Isaza, Eliana Salas, Valeria Cadavid, and John Ochoa-Gómez

Unveiling Visual Physiology and Steady-State Evoked Potentials using Low-Cost and Transferable Electroencephalography for Evaluating Neuronal Activation

Verónica Henao Isaza, Valeria Cadavid, Eliana Salas, Santiago González, and John Ochoa-Gómez

I Self-Introduction & Motivation

ALZHEIMER'S AND PARKINSON'S DISEASE RISK

Spectral features of resting-state EEG in Parkinson's Disease: A multicenter study using functional data analysis

Alberto Jaramillo-Jimenez; Verónica Henao Isaza; Valeria Cadavid Castro; Yorguin-Jose Mantilla-Ramos; John Fredy Ochoa Gómez; ...

CLINICAL NEUROPHYSIOLOGY
OFFICIAL JOURNAL OF THE INTERNATIONAL FEDERATION OF CLINICAL NEUROPHYSIOLOGY

Tackling EEG test-retest reliability with a pre-processing pipeline based on ICA and wavelet-ICA

Verónica Henao Isaza; Valeria Cadavid Castro; Luisa María Zapata Saldarriaga; Yorguin-Jose Mantilla-Ramos; Jazmin Ximena Suarez Revelo; Carlos Andrés Tobón Quintero; John Fredy Ochoa Gómez.

Biomedical Signal Processing and Control

Preprint – In Review

Reproducible Neuronal Components found using Group Independent Component Analysis in Resting State Electroencephalographic Data

Ochoa-Gómez, J. F., Mantilla-Ramos, Y. J., Isaza, V. H., Tobón, C. A., Lopera, F., Aguillón, D., & Suárez, J. X.

Brain Topography
A Journal of Cerebral Function and Dynamics

Preprint – In Review

Comprehensive Methodology for Sample Augmentation in EEG Biomarker Studies for Alzheimer's Risk Classification

Verónica, Henao Isaza; David, Aguillon; Carlos Andrés, Tobón Quintero; Francisco, Lopera; John Fredy, Ochoa Gómez.

JOURNAL OF NEURAL ENGINEERING

Unsent – In Review

II Objectives

II Objectives

1. Introduction and **Application of Basic Machine Learning** Techniques for Neuropsychological Data Classification.

2. **Optimization and Validation of Machine Learning** Models for Predicting Cognitive Markers from Telemonitoring Data.

3. **Analysis and Visualization of Machine Learning** Results for the Association Between Telemonitoring Markers and Clinical Data.

III Methodology

III Methodology

4 Hands-on Seminars:
Python Machine Learning Techniques for Classifying Patients with Neurodegenerative Disorders and Controls based on EEG, MRI, and Clinical Markers

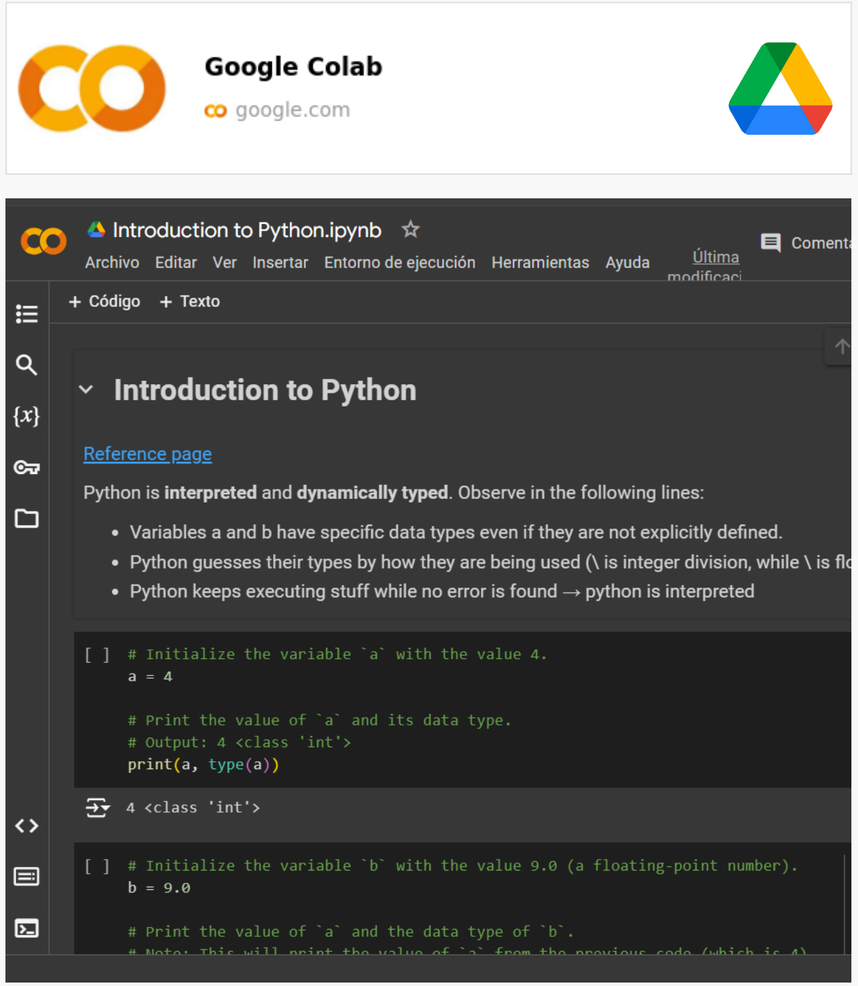
Responsible

Verónica Henao Isaza,
MSc in engineering, BSc Bioengineering
Emphasis on Neurosciences
Grupo Neuropsicología y Conducta GRUNECO
Universidad de Antioquia
Medellín, Colombia.

Related Project (Thesis):
Machine Learning model for the classification of individuals at risk of Alzheimer's dementia from multimodal databases of EEG and clinical information.

https://veronicahenaoisaza.my.canva.site/

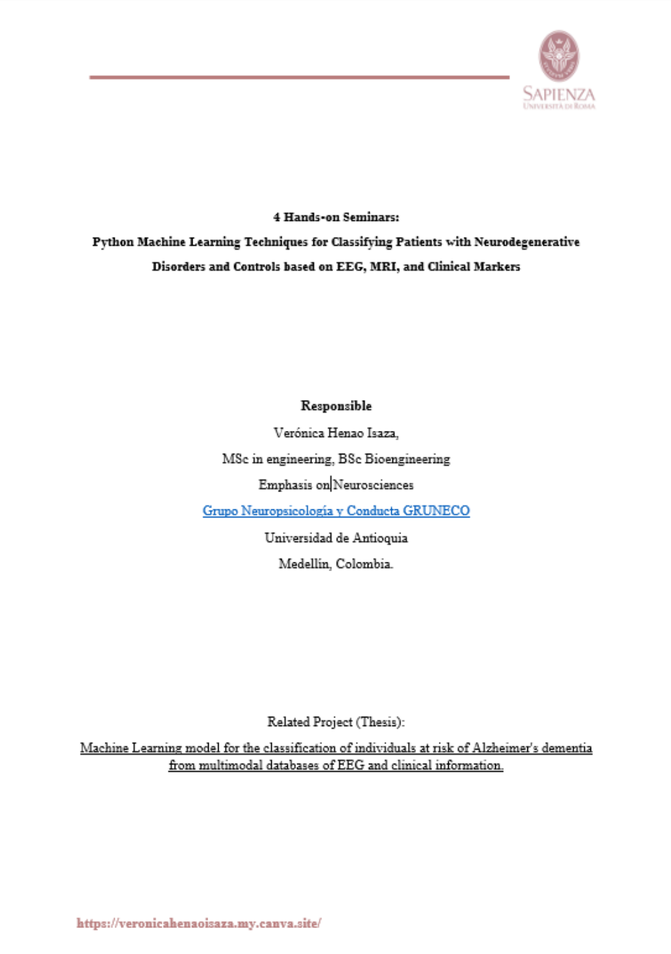
Seminar Guide



Workshops on web-based interactive computing platform

https://colab.research.google.com/drive/1_ILb-GESMlWyxtrCekn7gmekfK-sSQMW?usp=drive_link

III Methodology



4 Hands-on Seminars:
Python Machine Learning Techniques for Classifying Patients with Neurodegenerative Disorders and Controls based on EEG, MRI, and Clinical Markers

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Seminar Guide

Concepts

Examples

Types of AI

Workshops

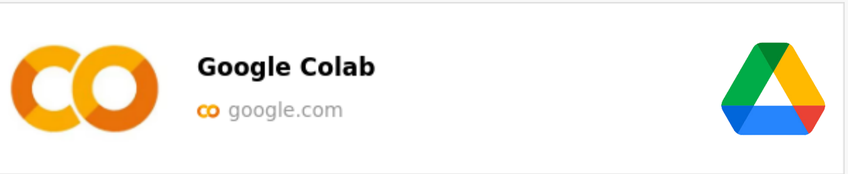
Results

Final activity

III Methodology

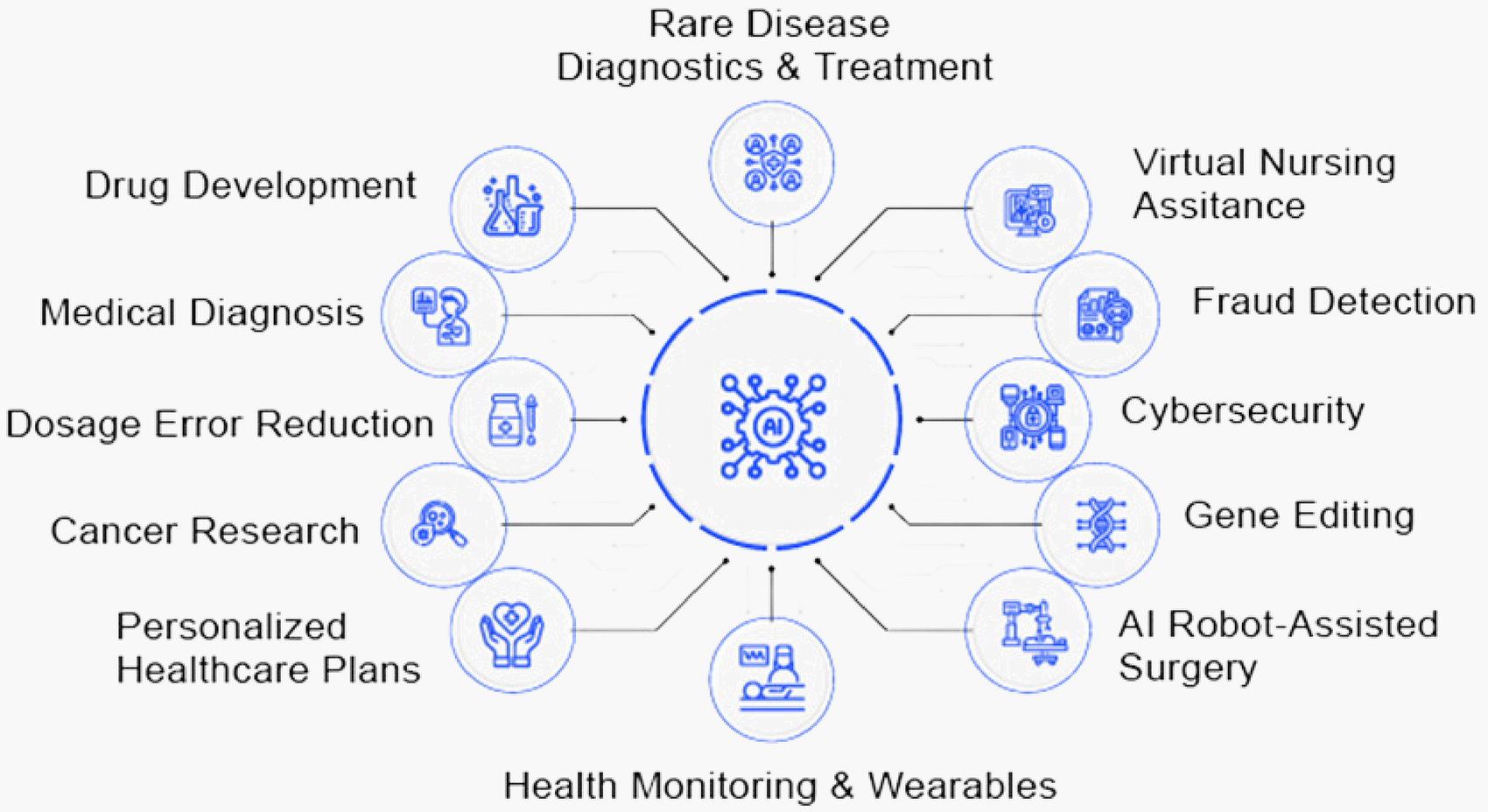
GitHub is a web-based platform that allows developers to store, share, and collaborate on code projects. It's built around Git, a version control system that tracks changes in code over time.

Google Colab is a cloud-based development environment that allows users to write and run Python code directly in their web browser. It's popular for data science, machine learning, and data analysis projects, offering free access to powerful computational resources like GPUs and TPUs.

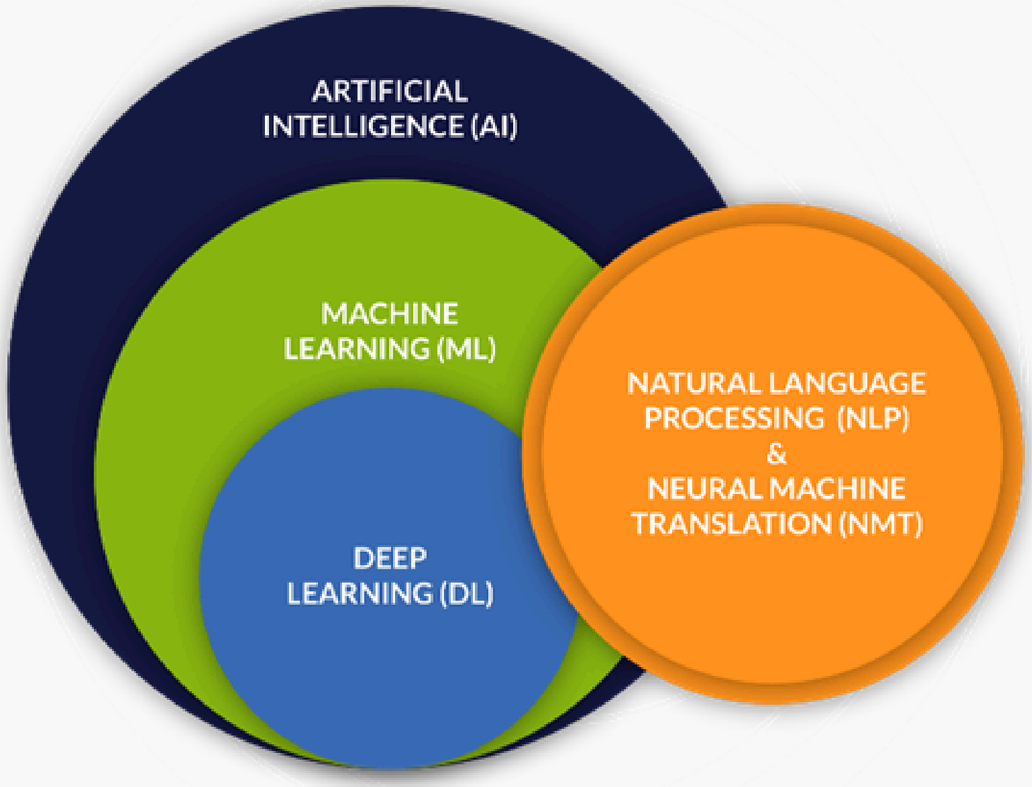


IV Concepts

Applications of AI in Healthcare



Types of AI in health care



Linear Models

- Logistic Regression
- SupportVectorMachines (SVM)

Non-Linear Models

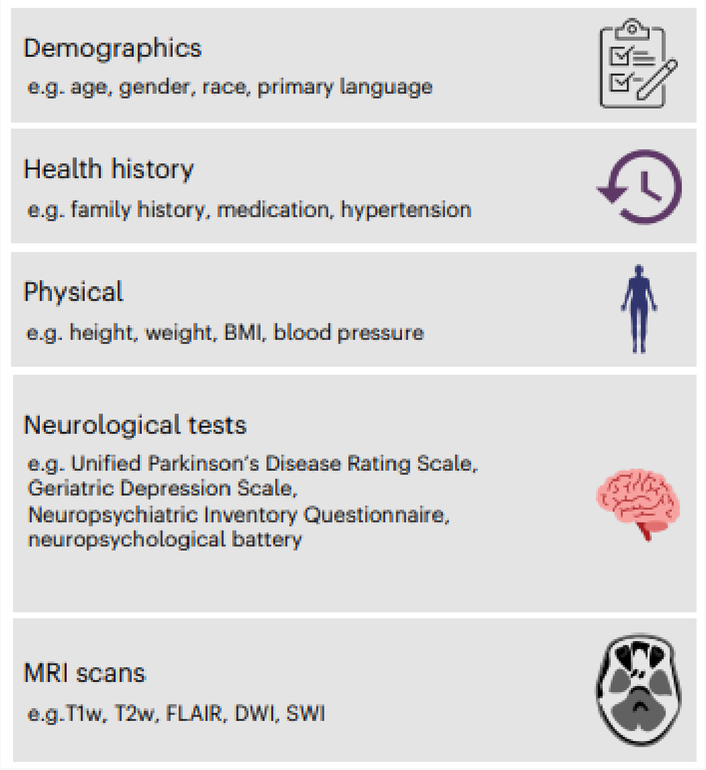
- k-Nearest Neighbors
- Kernel SVM
- Bayesian Classification
- Decision Trees
- RandomForestClassification

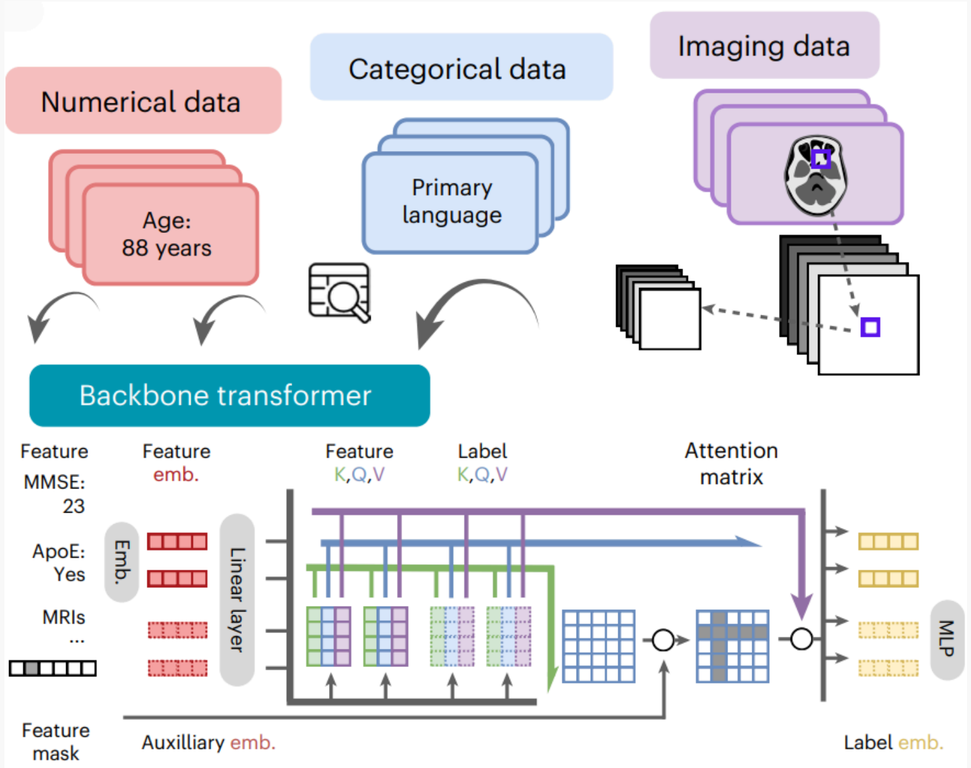
Machine Learning

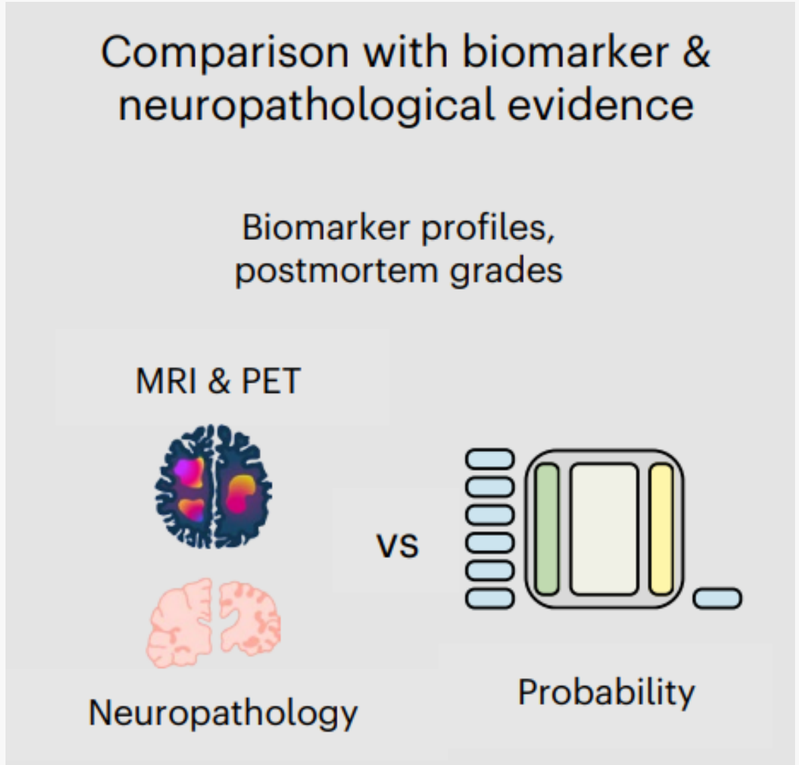
Machine Learning (ML) includes various techniques:
1. Supervised Learning: Predicts outcomes based on known data, such as classifying patient records to determine disease risk.
2. Unsupervised Learning: Identifies hidden patterns or groupings in data without predefined labels, like clustering patients with similar symptoms.
3. Reinforcement Learning: Learns through trial and error, balancing exploration and exploitation, useful when labeled data is not available and can be combined with supervised learning for enhanced results.

V Relevance in Neurosciences

Relevance in Neurosciences



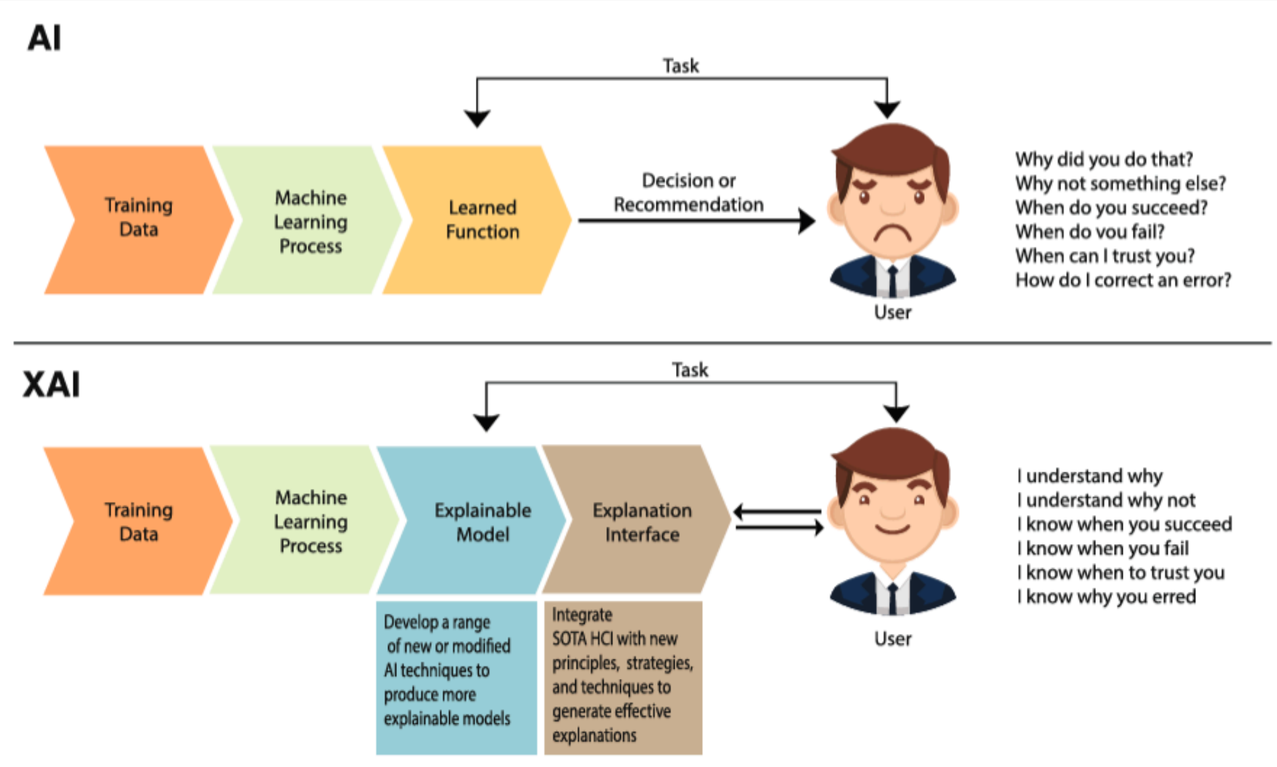




Xue, C., Kowshik, S.S., Lteif, D. et al. AI-based differential diagnosis of dementia etiologies on multimodal data. Nat Med (2024). https://doi.org/10.1038/s41591-024-03118-z

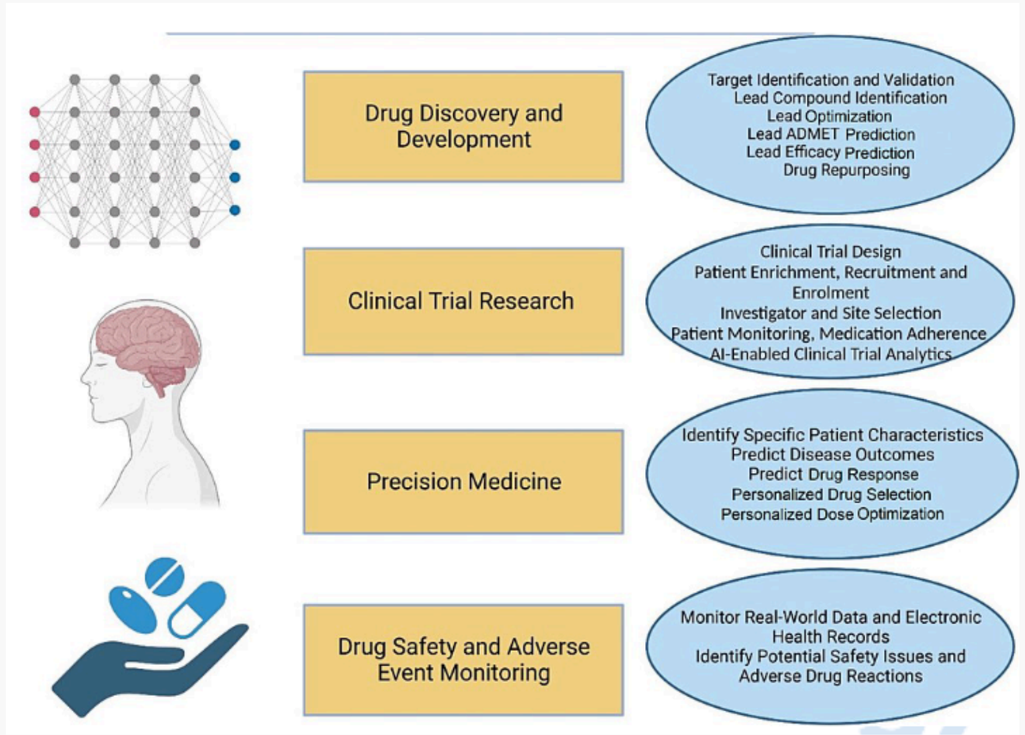
Examples of Artificial Intelligence Applications

AI in Clinical Decision-Making



https://link.springer.com/article/10.1007/s12559-023-10192-x

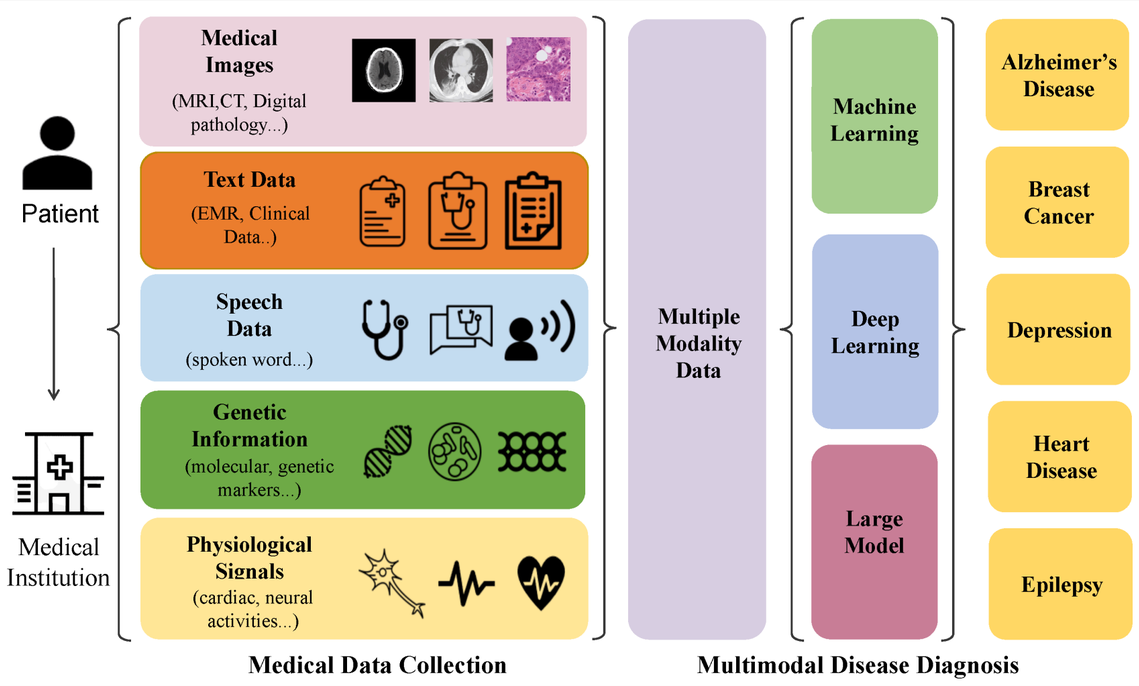
AI in Personalized Medicine



https://thesciencebrigade.com/jst/article/view/124

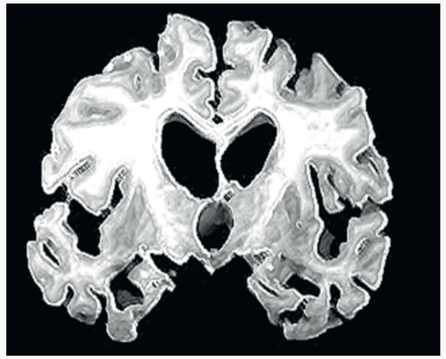
Examples of Artificial Intelligence Applications

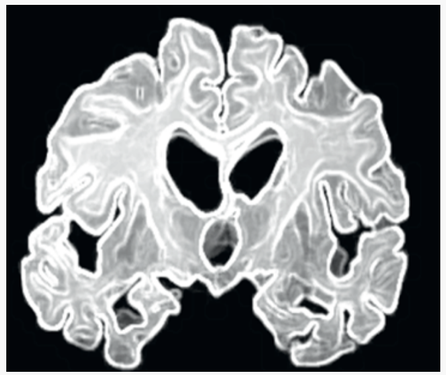
AI in Medical Diagnosis



https://www.mdpi.com/2306-5354/11/3/219

AI in Imaging Diagnosis





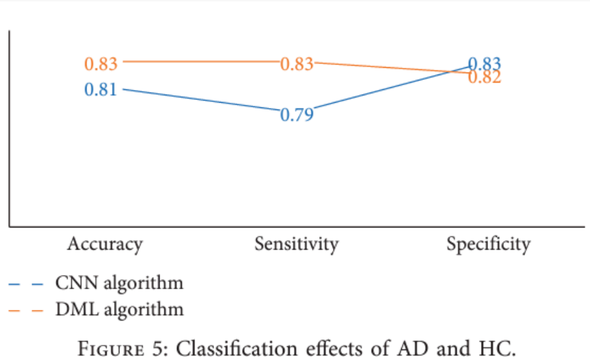


FIGURE 5: Classification effects of AD and HC.

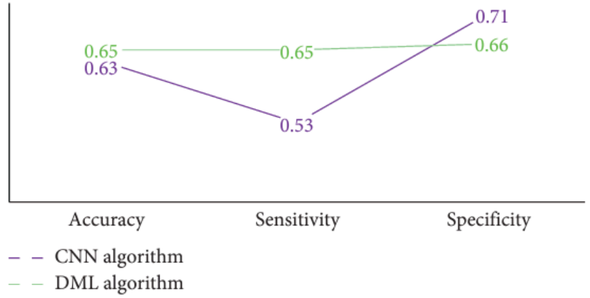


FIGURE 6: Comparison of classification effects between MCI and HC.

https://onlinelibrary.wiley.com/doi/10.1155/2021/8198552

VI Example of a Personal Project

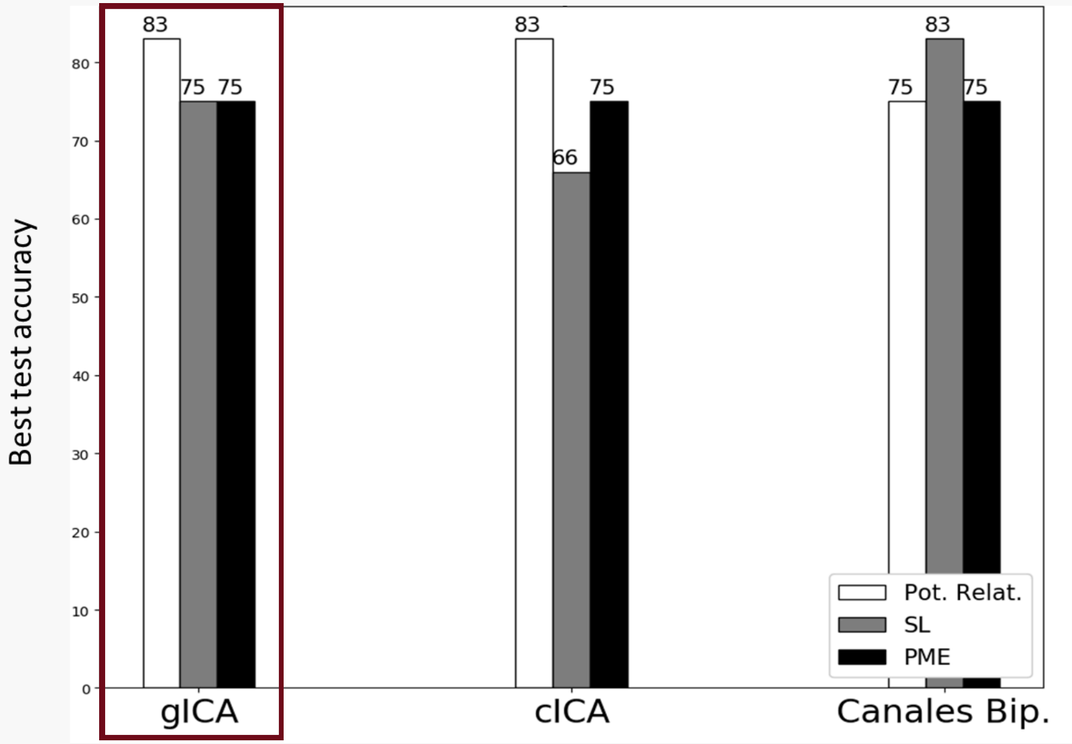
Example of a Personal Project

Automatic Classification of Subjects of the PSEN1-E280A Family at Risk of Developing Alzheimer's Disease Using Machine Learning and Resting State Electroencephalography

García-Pretelt FJ, Suárez-Relevo JX, Aguillon-Niño DF, Lopera-Restrepo FJ, Ochoa-Gómez JF, Tobón-Quintero CA.

Table I. Subjects demographics.

	ACr	*NonCr*	*ACr vs NonCr (p-value)*	*Effect size (hedges)*
N	27	33	NA	NA
Age	32.44 ± 5.800	32.70 ± 5.828	0.868	-0.043
Gender (M/F)	11/16	13/20	1.000	0.020 (Cramer)
Education level (years)	10.81 ± 2.936	13.21 ± 2.759	0.001	-0.833
Verbal Fluency	21.74 ± 3.829	22.67 ± 3.688	0.346	-0.244
Boston Naming Test	12.33 ± 3.101	13.61 ± 1.116	0.032	-0.562
MMSE	29.30 ± 0.953	29.64 ± 0.822	0.044	-0.38
Word List Recall	7.59 ± 1.551	8.39 ± 1.171	0.048	-0.584
Word List Recognition	9.78 ± 0.506	10.00 ± 0.000	0.011	-0.647
Constructional Praxis	9.96 ± 1.160	10.39 ± 0.827	0.171	-0.43
Delayed Constructional Praxis	9.04 ± 1.720	9.82 ± 1.776	0.018	-0.44



García-Pretelt FJ, Suárez-Relevo JX, Aguillon-Niño DF, Lopera-Restrepo FJ, Ochoa-Gómez JF, Tobón-Quintero CA. Automatic Classification of Subjects of the PSEN1-E280A Family at Risk of Developing Alzheimer's Disease Using Machine Learning and Resting State Electroencephalography. J Alzheimers Dis. 2022;87(2):817-832. doi: 10.3233/JAD-210148. PMID: 35404271.

Example of a Personal Project

Comprehensive Methodology for Sample Augmentation in EEG Biomarker Studies for Alzheimer's Risk Classification

Table 1. Summary characteristics of the databases

	Database	Group	Count	Age (Mean ± SD)	Sex (F/M)
2:1	CHBMP	HC	38	27.63 ± 6.67	13/25
	SRM	HC	31	30.77 ± 5.21	19/12
	UdeA1	ACr	68	35.81 ± 4.36	49/19
	UdeA1	HC	77	30.45 ± 4.81	47/30
	UdeA2	ACr	11	33.45 ± 3.64	9/2
	UdeA2	HC	12	31.42 ± 7.15	10/2
	Total		**237**		**147/90**
5:1	CHBMP	HC	38	27.63 ± 6.67	13/25
	SRM	HC	31	30.77 ± 5.21	19/12
	UdeA1	ACr	30	39.78 ± 2.85	21/9
	UdeA1	HC	77	30.45 ± 4.81	47/30
	UdeA2	ACr	1	43.0 ± nan	1/0
	UdeA2	HC	12	31.42 ± 7.15	10/2
	Total		**189**		**111/78**
10:1	CHBMP	HC	38	27.63 ± 6.67	13/25
	SRM	HC	31	30.77 ± 5.21	19/12
	UdeA1	ACr	14	41.86 ± 2.35	12/2
	UdeA1	HC	77	30.45 ± 4.81	47/30
	UdeA2	ACr	1	43.0 ± nan	1/0
	UdeA2	HC	12	31.42 ± 7.15	10/2
	Total		**173**		**102/71**

HC: Healthy non-carrier subjects. ACr: Asymptomatic E280A mutation Alzheimer's disease carriers.

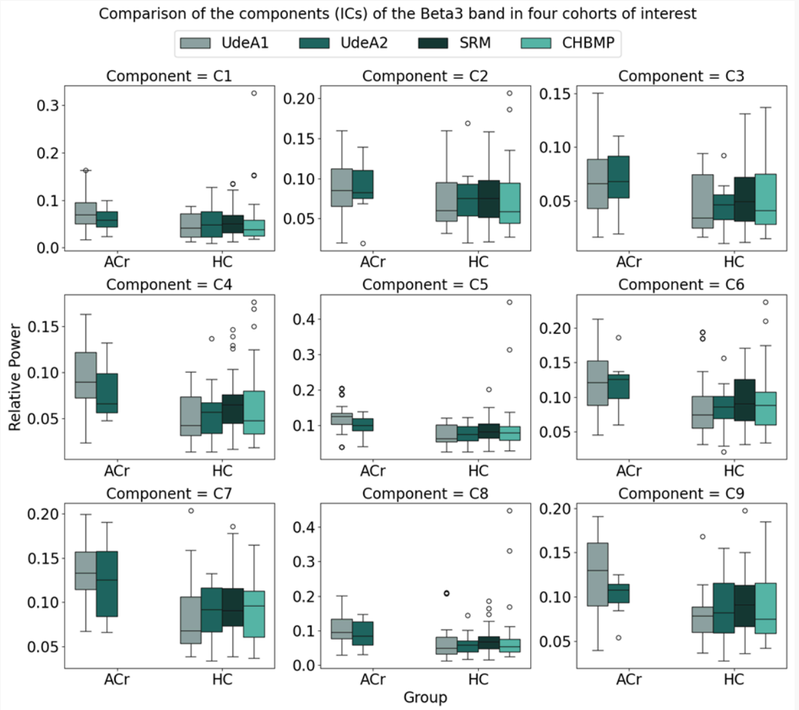


Table 2. Evaluation of Model Performance Using Computer Precision

2:1	5:1	10:1
Accuracy: 91%	**Accuracy: 98%**	**Accuracy: 96%**
Precision: 91%	**Precision: 97%**	**Precision: 97%**
Recall: 97%	**Recall: 100%**	**Recall: 100%**
F1-score: 94%	**F1-score: 98%**	**F1-score: 98%**
AUC: 92%	**AUC: 99%**	**AUC: 93%**

VII Workshops 1

VI Concepts

4 Hands-on Seminars:
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Responsible

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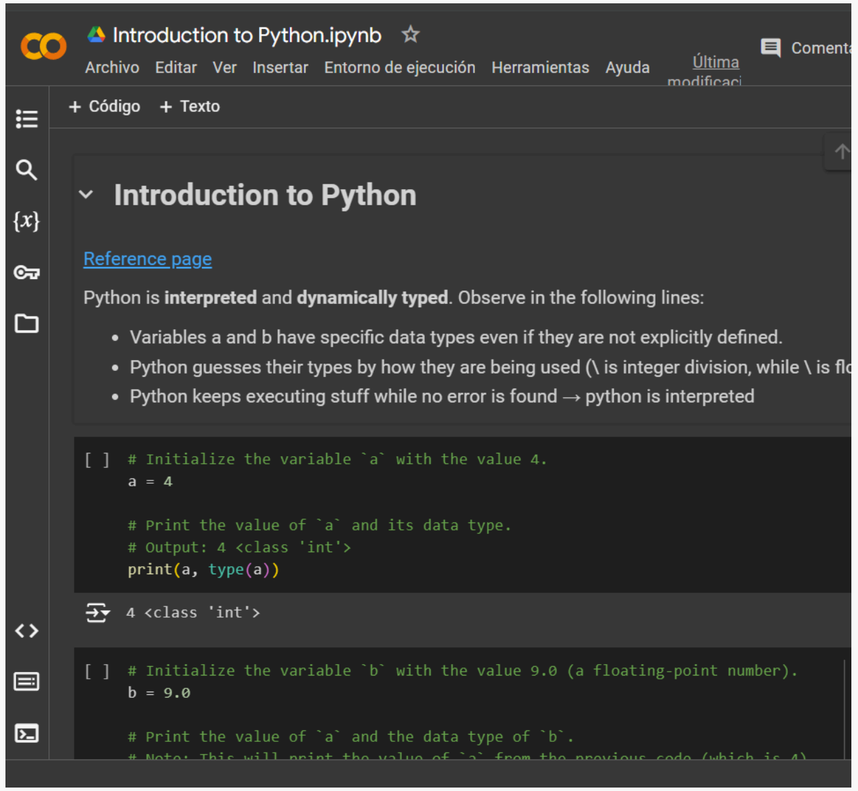
Seminar Guide



Workshops on web-based interactive computing platform

https://colab.research.google.com/drive/1_ILb-GESMlWyxtrCekn7gmekfK-sSQMW?usp=drive_link

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02/09/2024	Verónica Henao Isaza	First Seminar

Thank you for listening!

About me