

DATES

2nd, 3rd, 5th, 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

		Page
I	Self-Introduction	3
II	Objectives	7
III	Methodology	9
IV	Concepts	13
V	Relevance in Neurosciences	18
VI	Example of a Personal Project	22
VII	Workshops 1	25

I

Self-Introduction & Motivation

I Self-Introduction & Motivation

Verónica Henao Isaza

MSc in engineering, Date: Dec 15, 2023

Bioengineering, Date: Sept 11, 2020

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)



Age: 29
Colombian

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

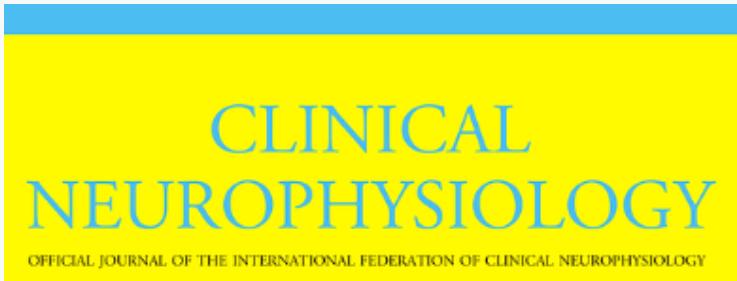


I Self-Introduction & Motivation

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; ...



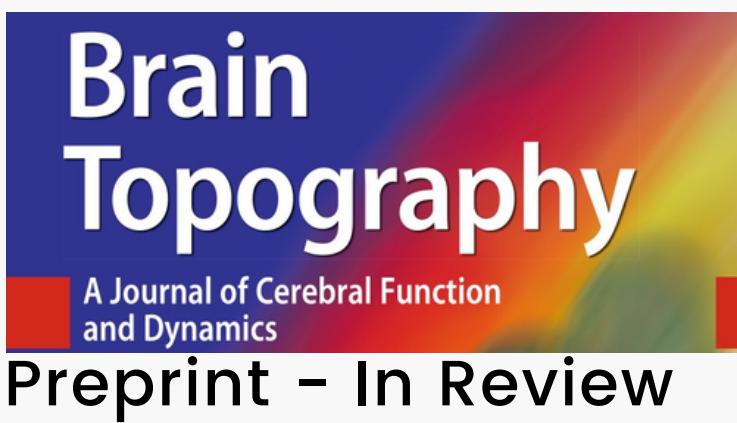
Tackling EEG test-retest reliability with a pre-processing pipeline based on ICA and wavelet-ICA

[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.



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.



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.



II

Objectives

II Objectives

- 1. Introduction and Application of Basic Machine Learning Techniques for Neuropsychological and Neurophysiological Data Classification**
- 2. Optimization and Validation of Machine Learning Models for Classification and Predicting Cognitive Markers**
- 3. Analysis and Visualization of Machine Learning Results for the Association Between Telemonitoring Markers and Clinical Data**

III

Methodology

III Methodology


SAPIENZA
UNIVERSITÀ DI ROMA

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



vhenaoi/Python-Machine-Learning-Techniques: 4 Hands-on Seminars:...
4 Hands-on Seminars: Python Machine Learning Techniques for Classifying Patients with...
[GitHub](#)



 **Google Colab**
google.com



 Introduction to Python.ipynb ☆

Archivo Editar Ver Insertar Entorno de ejecución Herramientas Ayuda Última modificación Comentarios

+ Código + Texto

▼ **Introduction to Python**

[Reference page](#)

Python is **interpreted** and **dynamically typed**. Observe in the following lines:

- Variables `a` and `b` have specific data types even if they are not explicitly defined.
- Python guesses their types by how they are being used (`\` is integer division, while `\.` is floating-point division)
- Python keeps executing stuff while no error is found → python is interpreted

```
[ ] # Initialize the variable `a` with the value 4.  
a = 4  
  
# Print the value of `a` and its data type.  
# Output: 4 <class 'int'>  
print(a, type(a))
```

4 <class 'int'>

```
[ ] # Initialize the variable `b` with the value 9.0 (a floating-point number).  
b = 9.0  
  
# Print the value of `a` and the data type of `b`.  
# Note: This will print the value of `a` from the previous code (which is 4).
```

Workshops on web-based interactive computing platform

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

Concepts

Examples

Types of AI

Workshops

Results

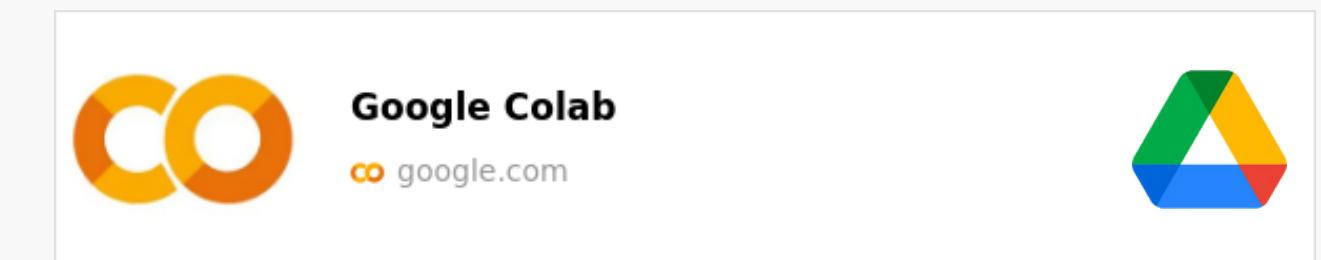
Final activity

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.

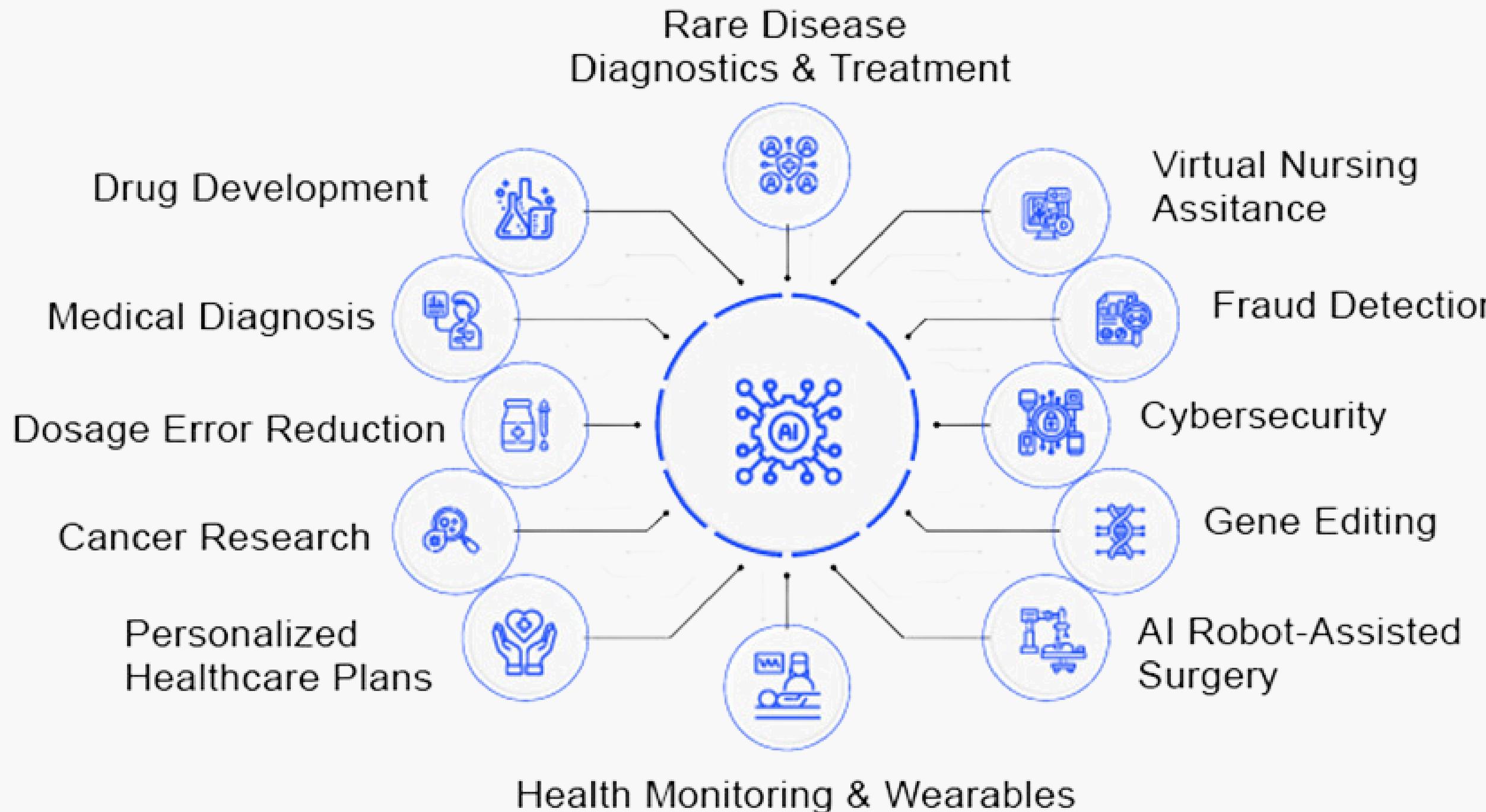
Google Colab is a cloud-based development environment that allows users to write and run Python code directly in their web browser. It's popular for data science, machine learning, and data analysis projects, offering free access to powerful computational resources like GPUs and TPUs.



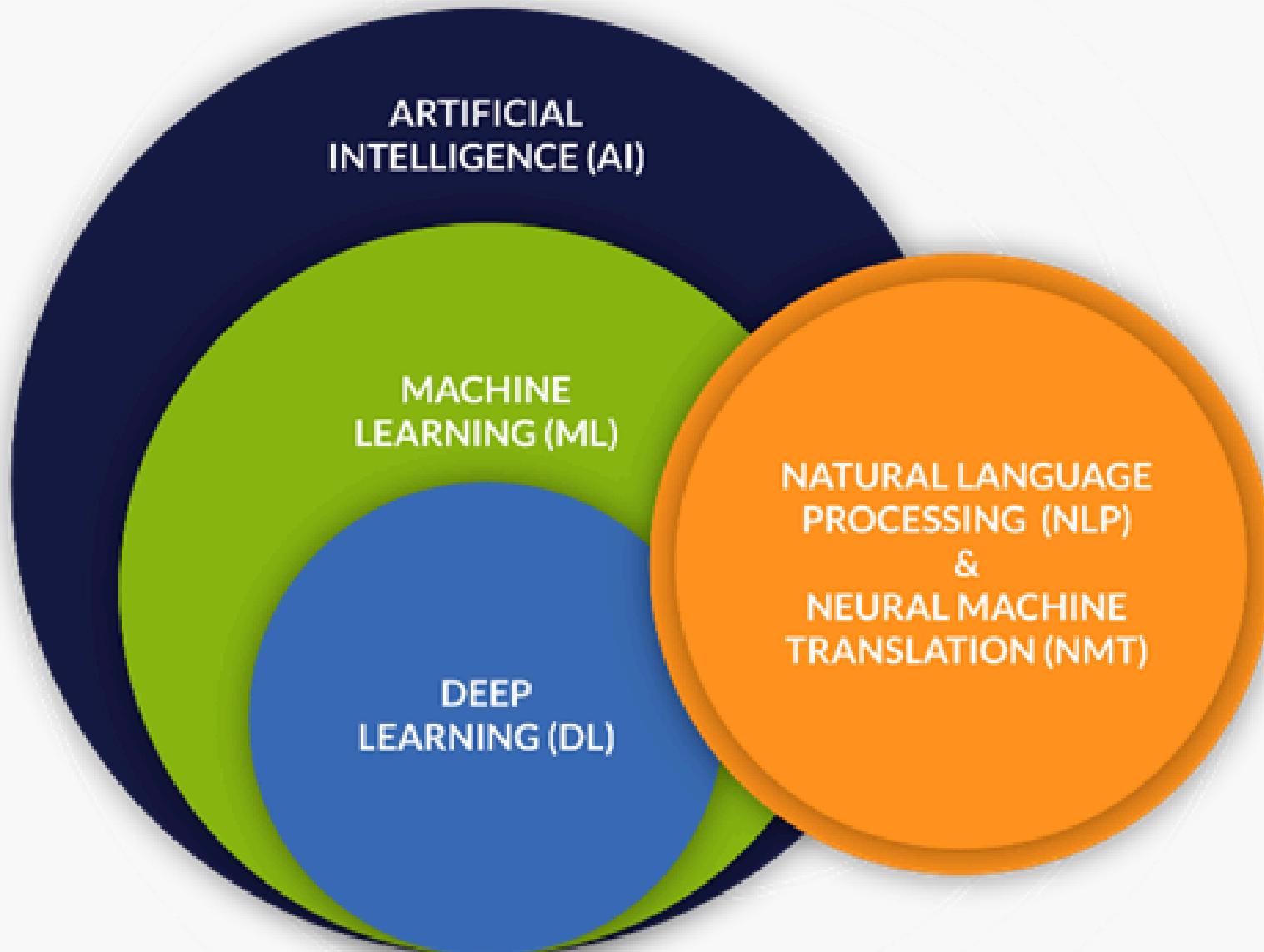
IV

Concepts

Applications of AI in Healthcare



Types of AI in health care



Linear Models

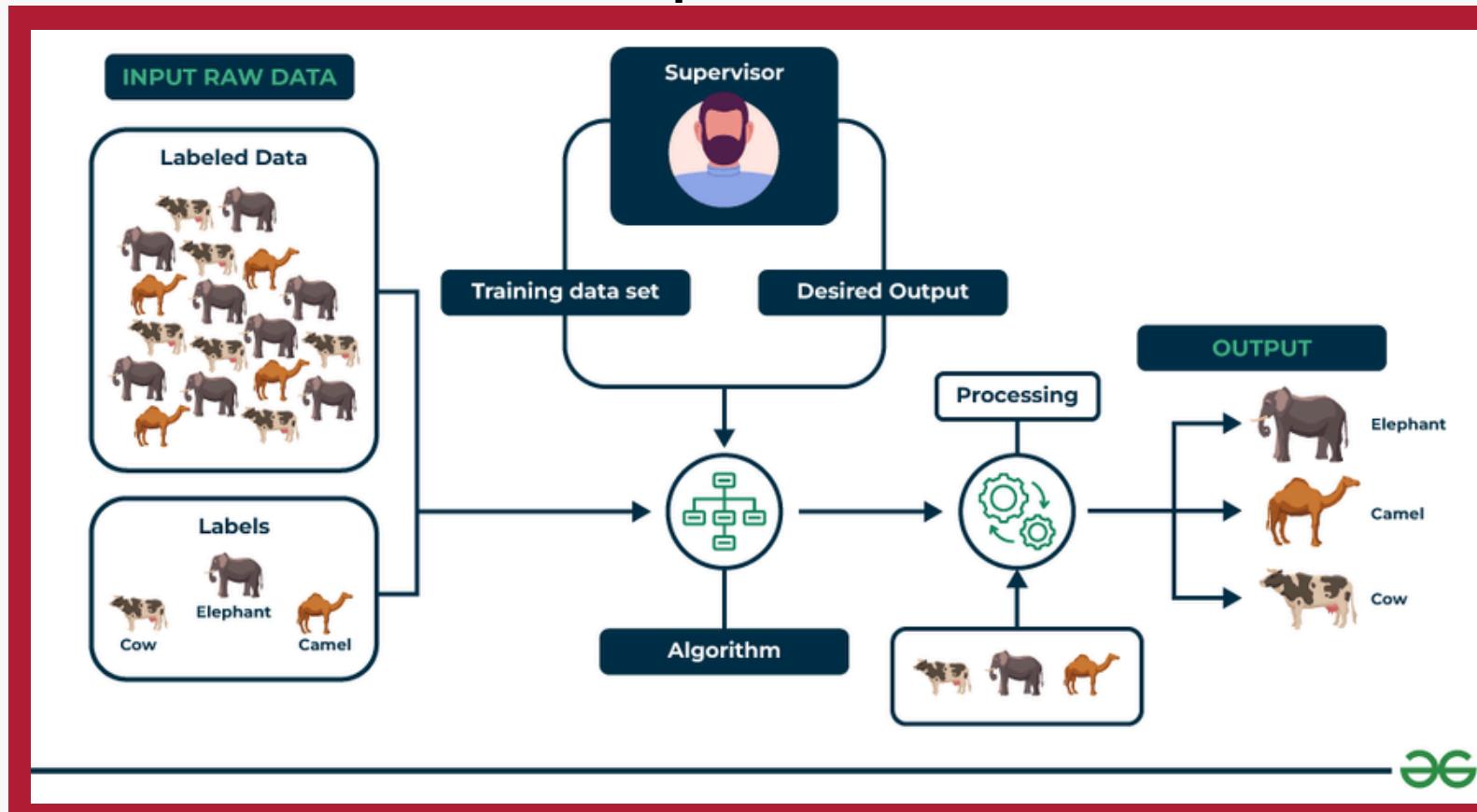
- Logistic Regression
- SupportVectorMachines (SVM)

Non-Linear Models

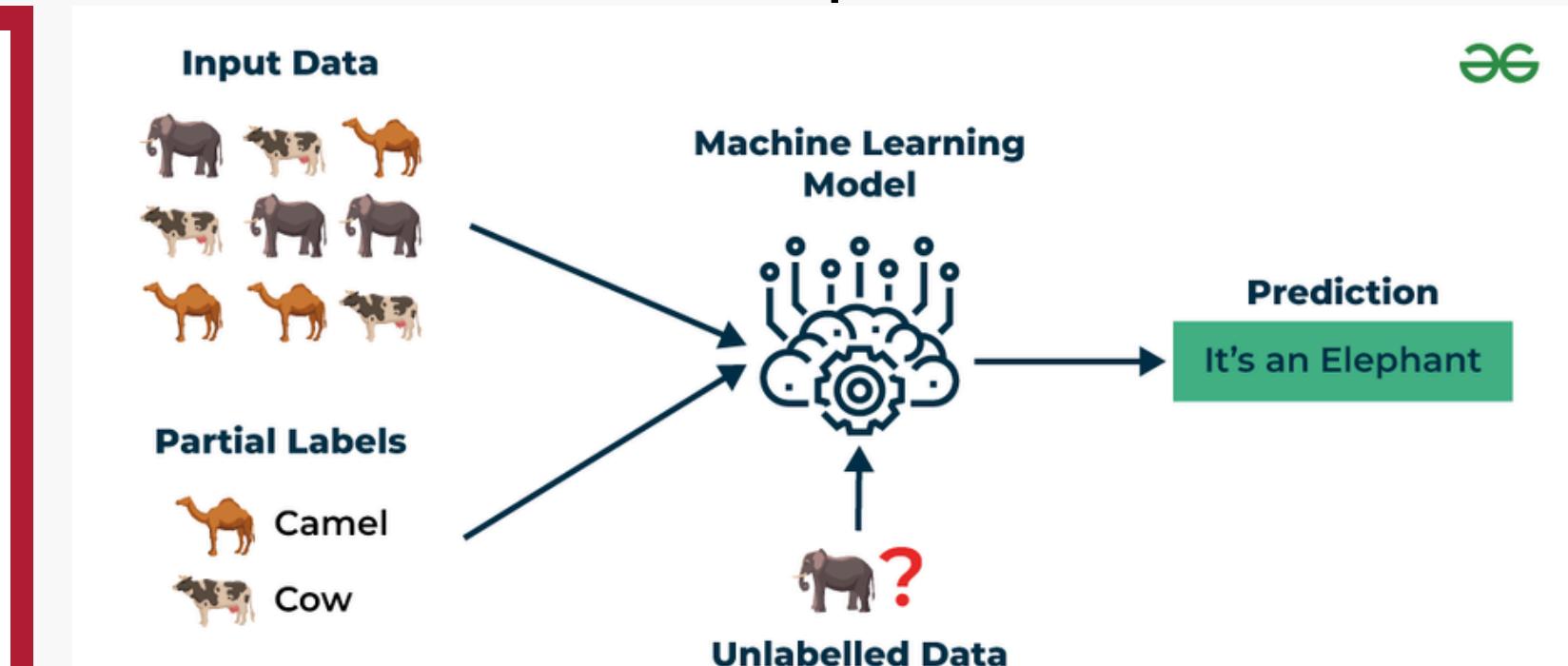
- k-Nearest Neighbors
- Kernel SVM
- Bayesian Classification
- Decision Trees
- RandomForestClassification

Machine Learning

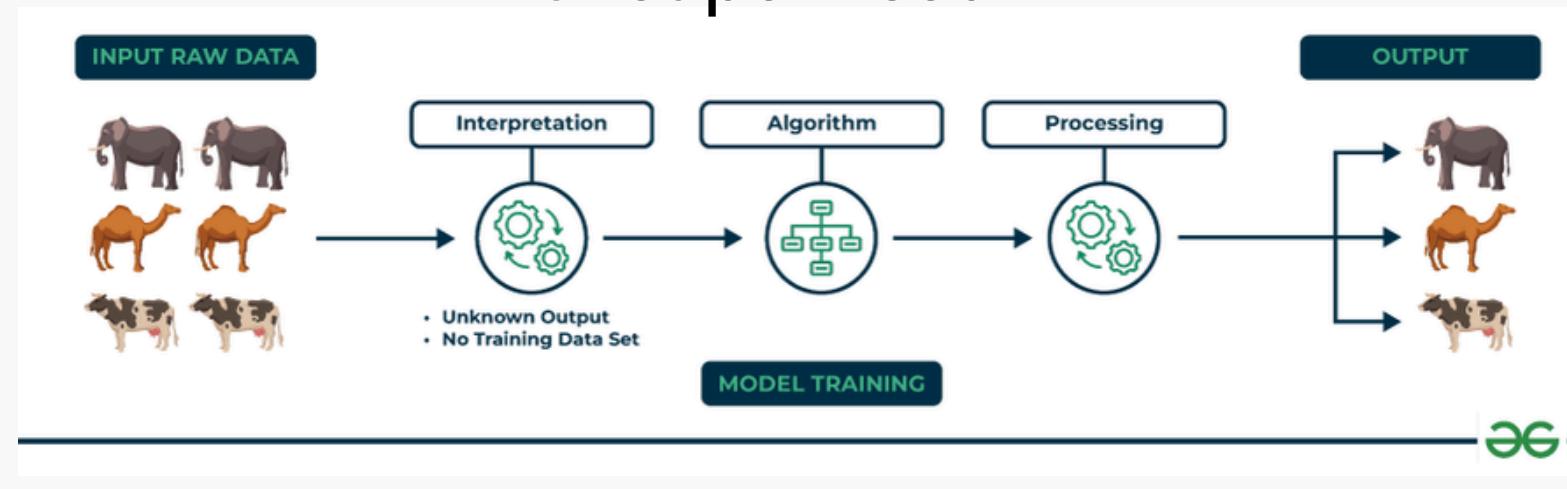
Supervised



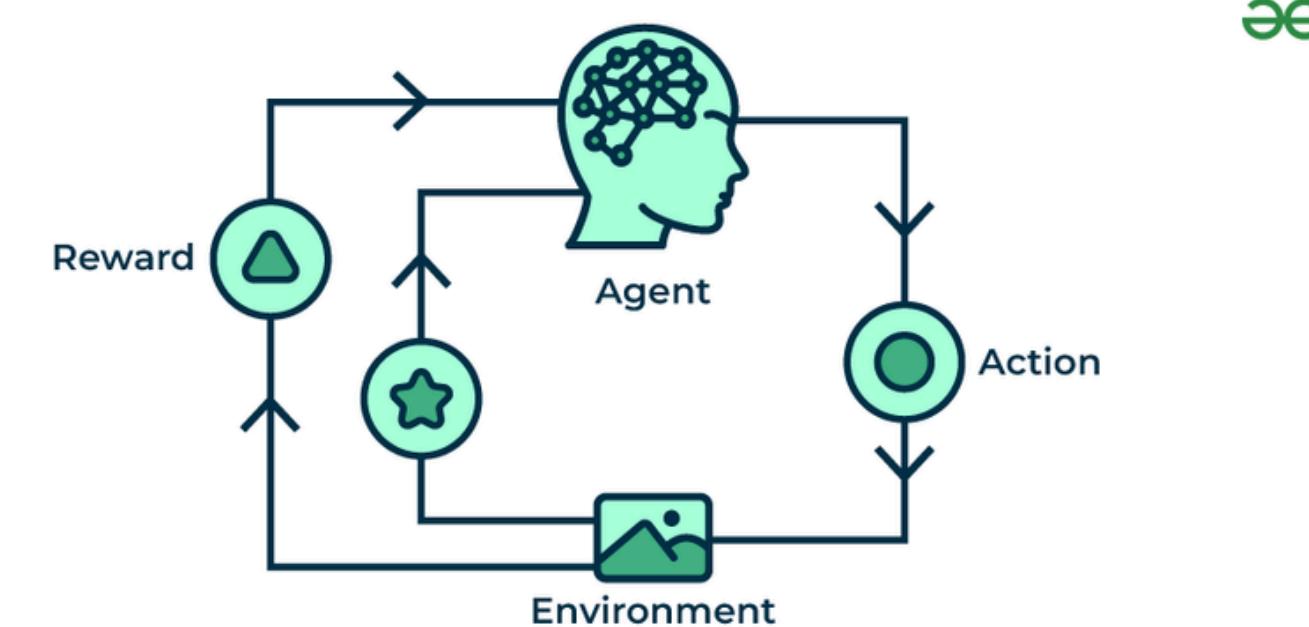
Semi-Supervised



Unsupervised



Reinforcement

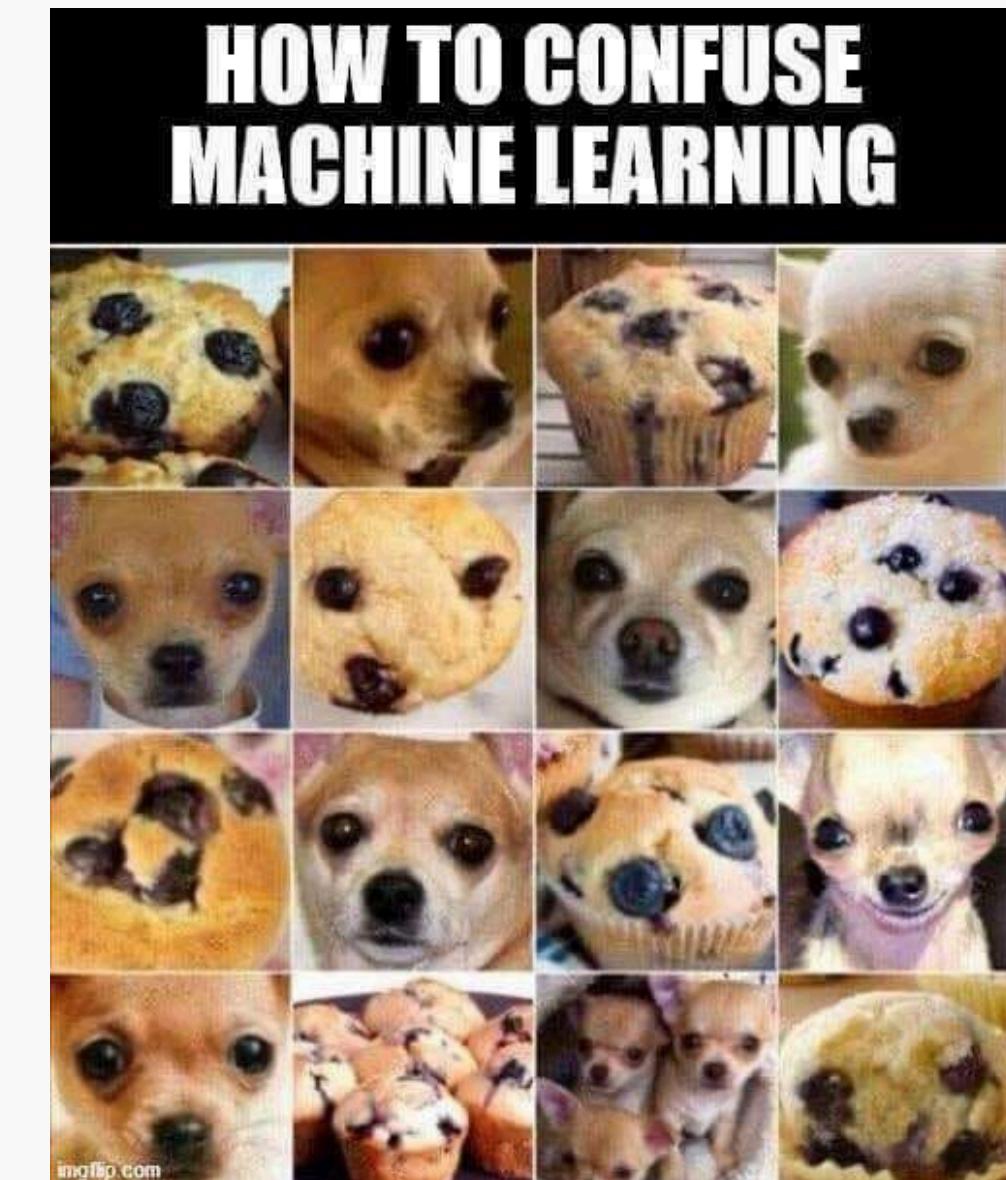


Importance of data quality

		Actual Values	
		Positive (1)	Negative (0)
Predicted Values	Positive (1)	TP	FP
	Negative (0)	FN	TN

Performance, overfitting, generalization, evaluation.

20-80
30-70

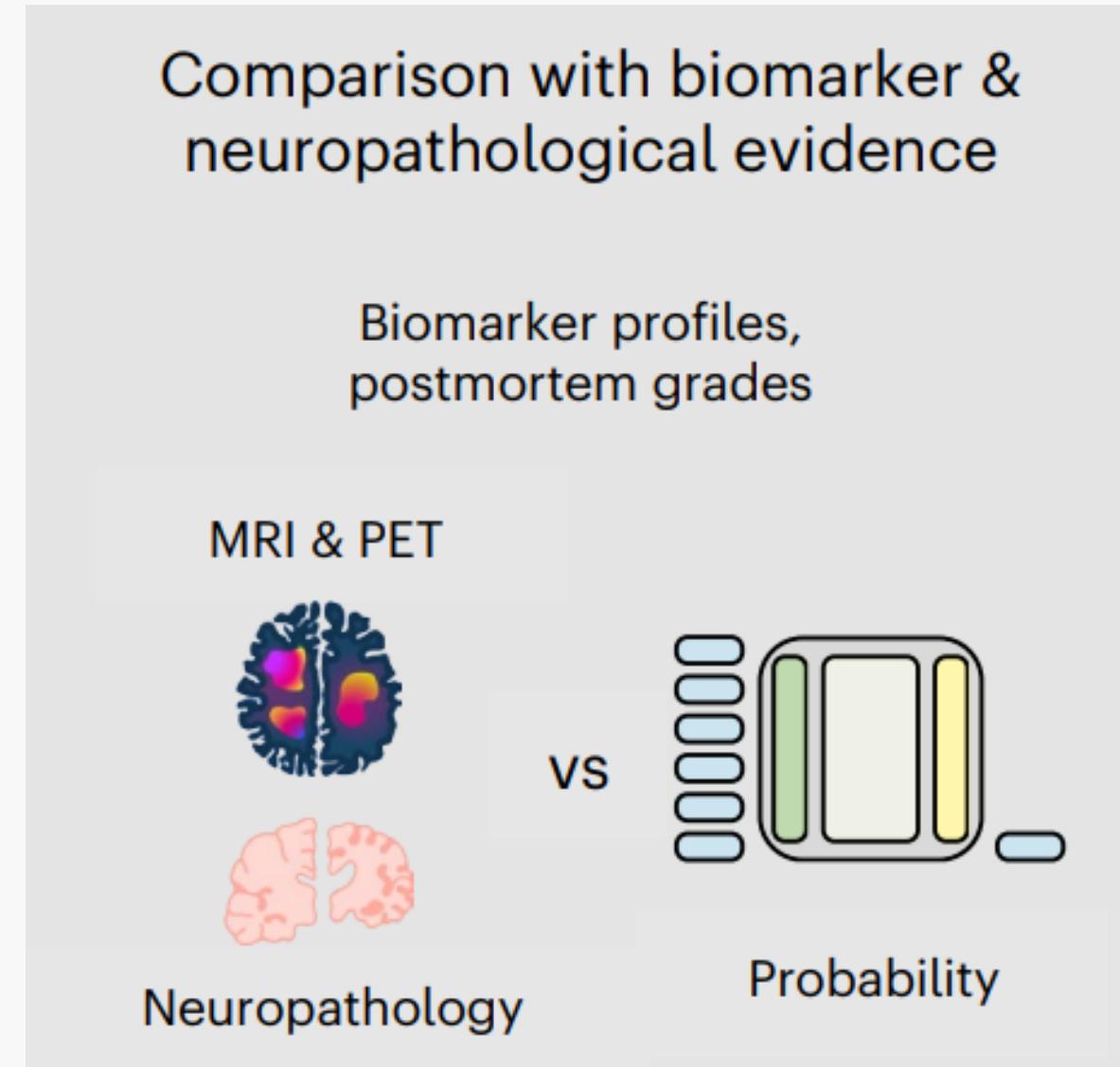
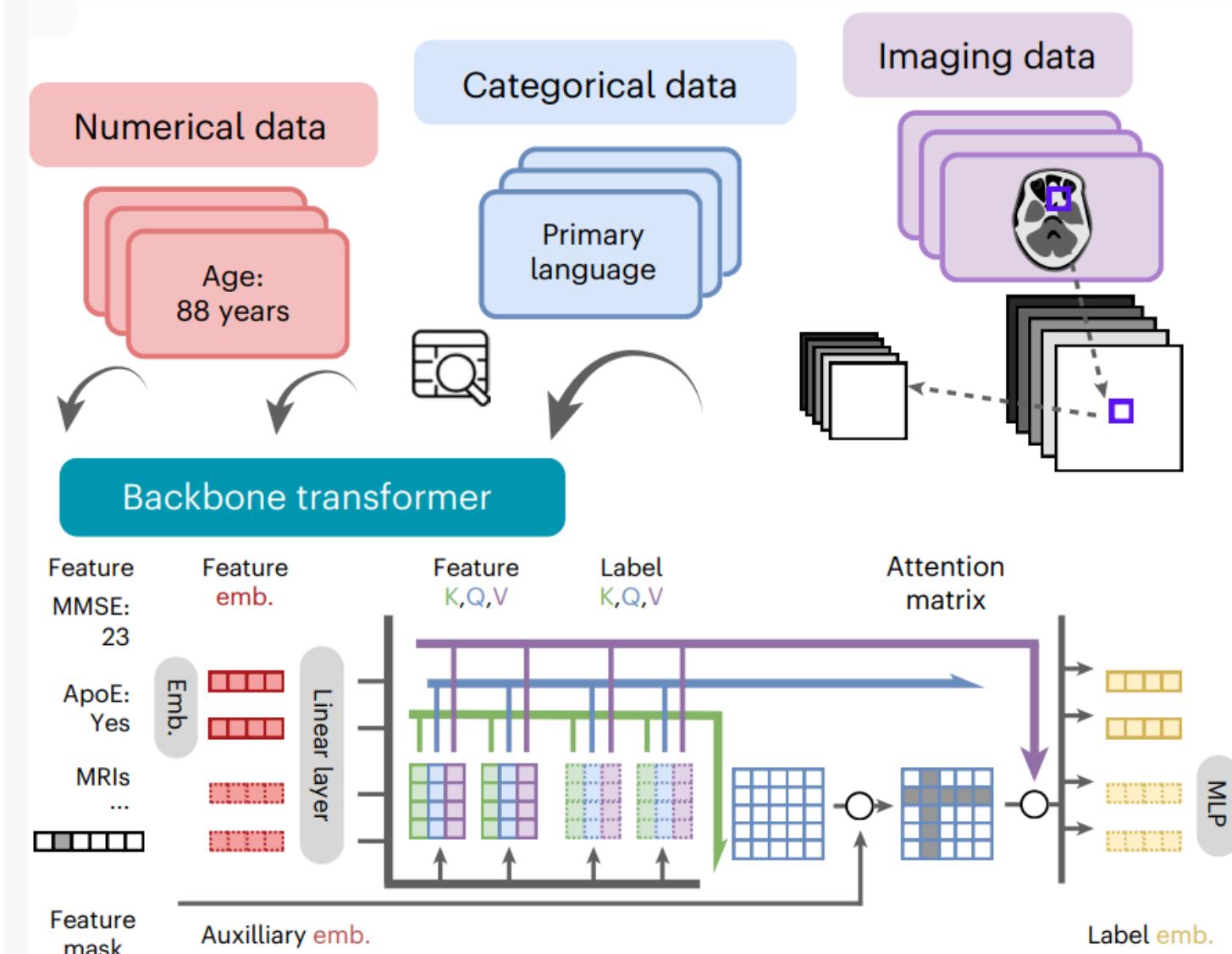
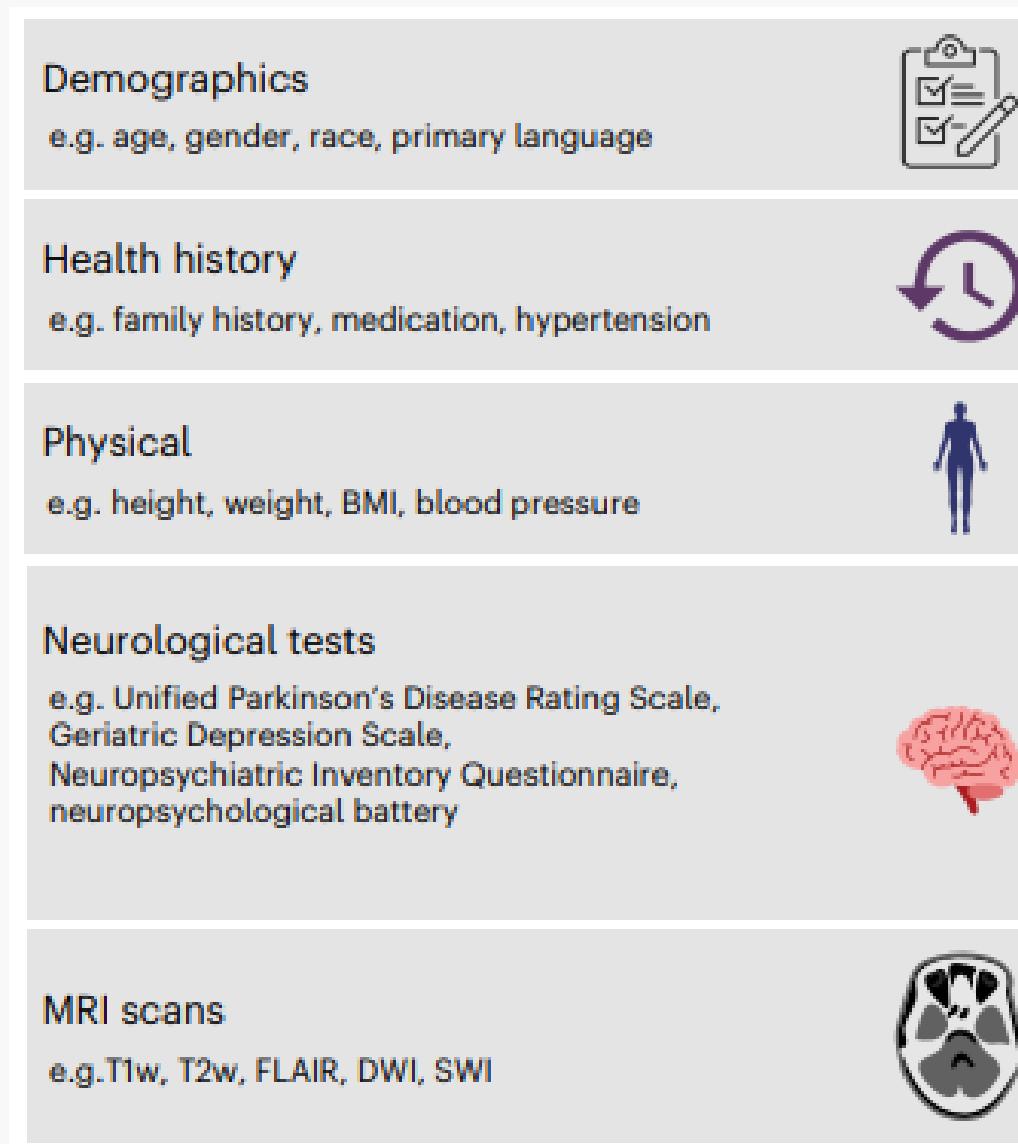


Adversarial Examples, Data Poisoning,
Bias and Imbalanced Data,
Limited Training Data

V

Relevance in Neurosciences

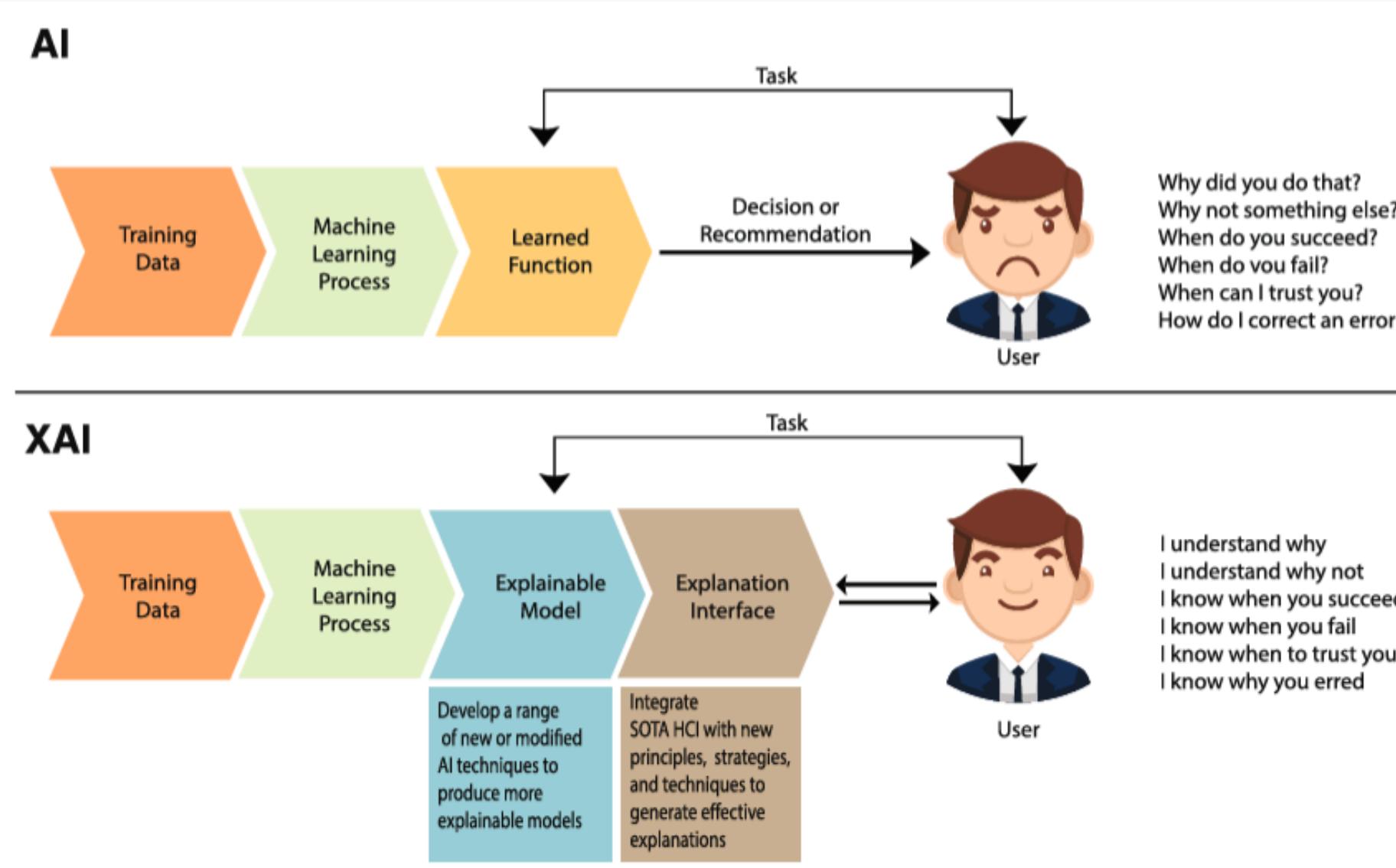
Relevance in Neurosciences



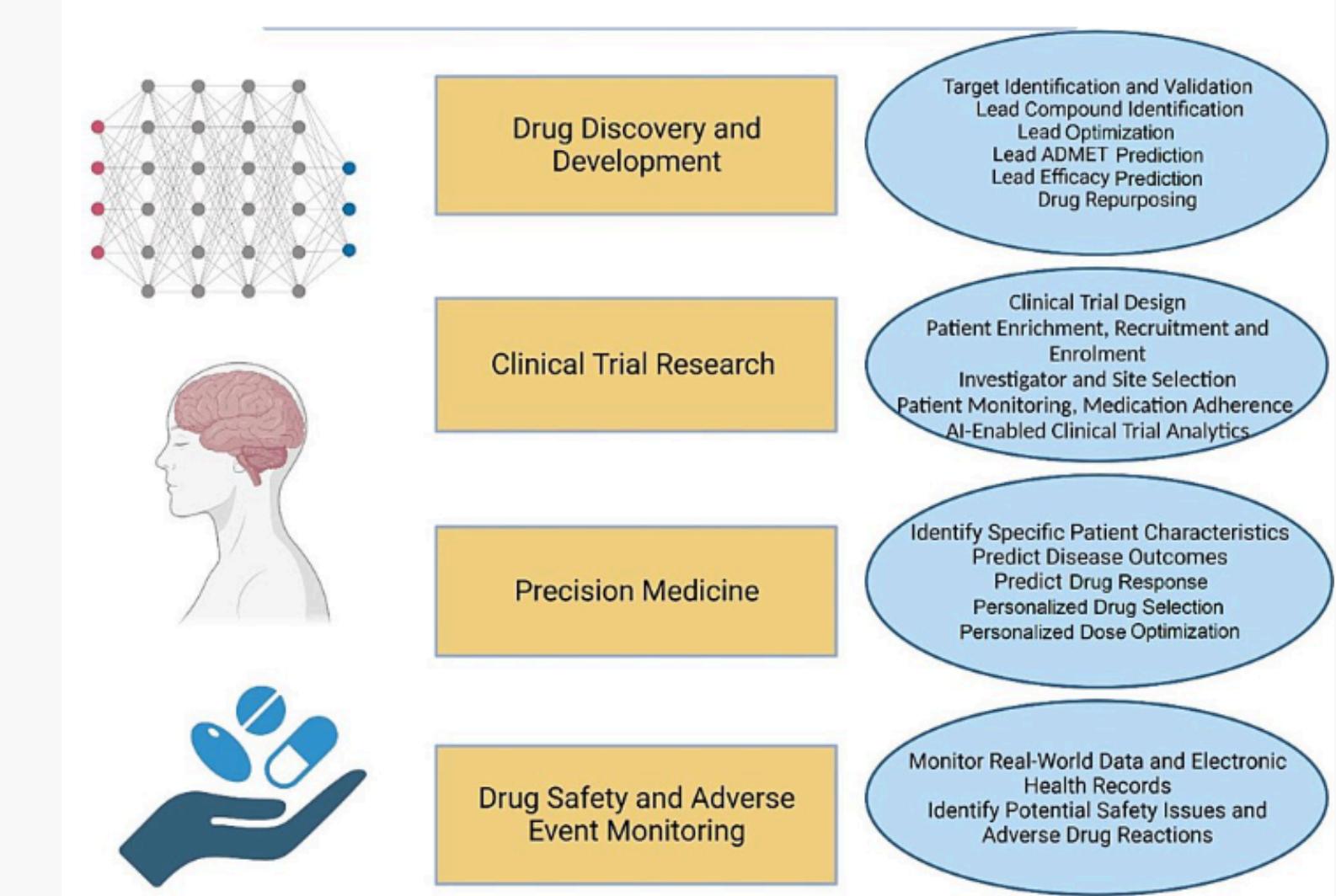
Xue, C., Kowshik, S.S., Lteif, D. et al. AI-based differential diagnosis of dementia etiologies on multimodal data. Nat Med (2024).
<https://doi.org/10.1038/s41591-024-03118-z>

Examples of Artificial Intelligence Applications

AI in Clinical Decision-Making

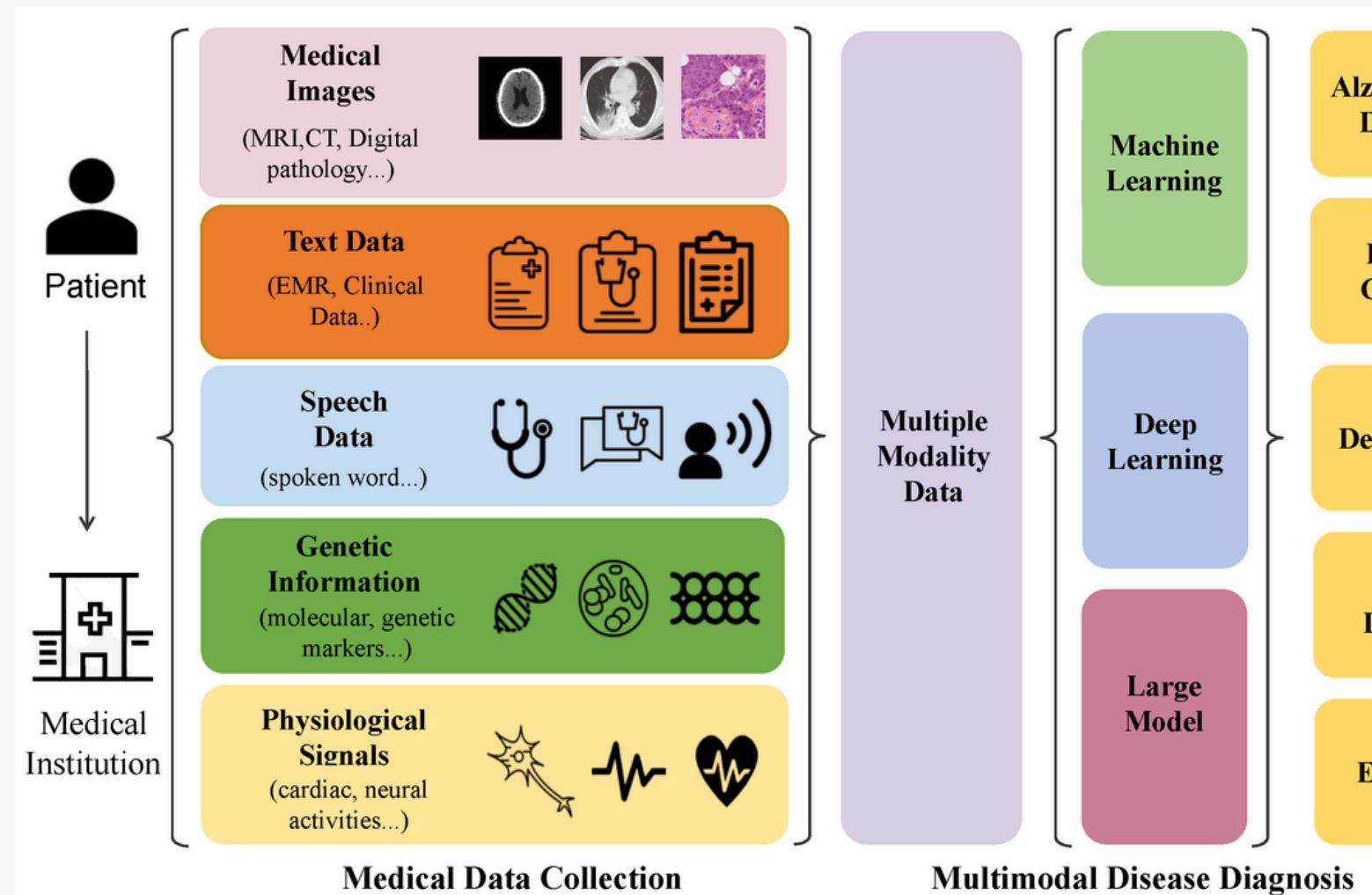


AI in Personalized Medicine



Examples of Artificial Intelligence Applications

AI in Medical Diagnosis



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

AI in Imaging Diagnosis

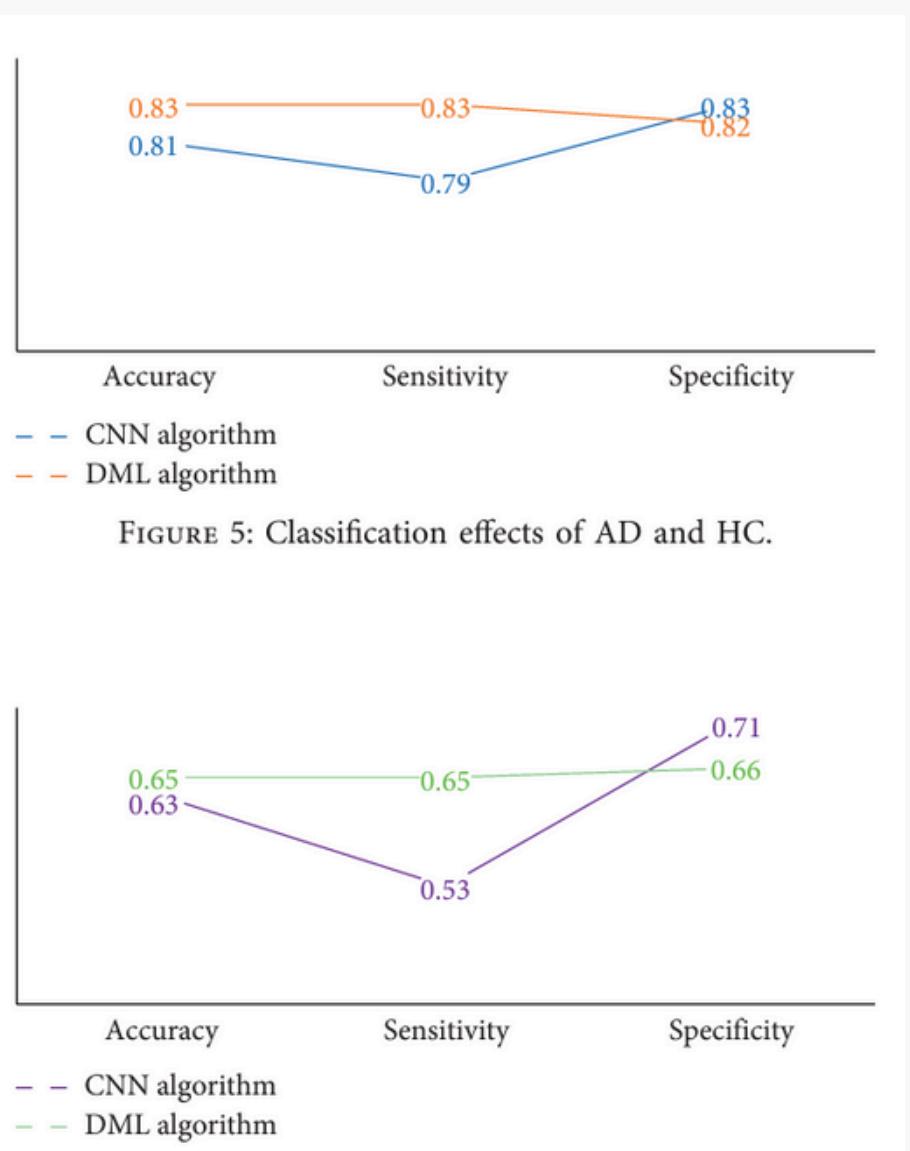
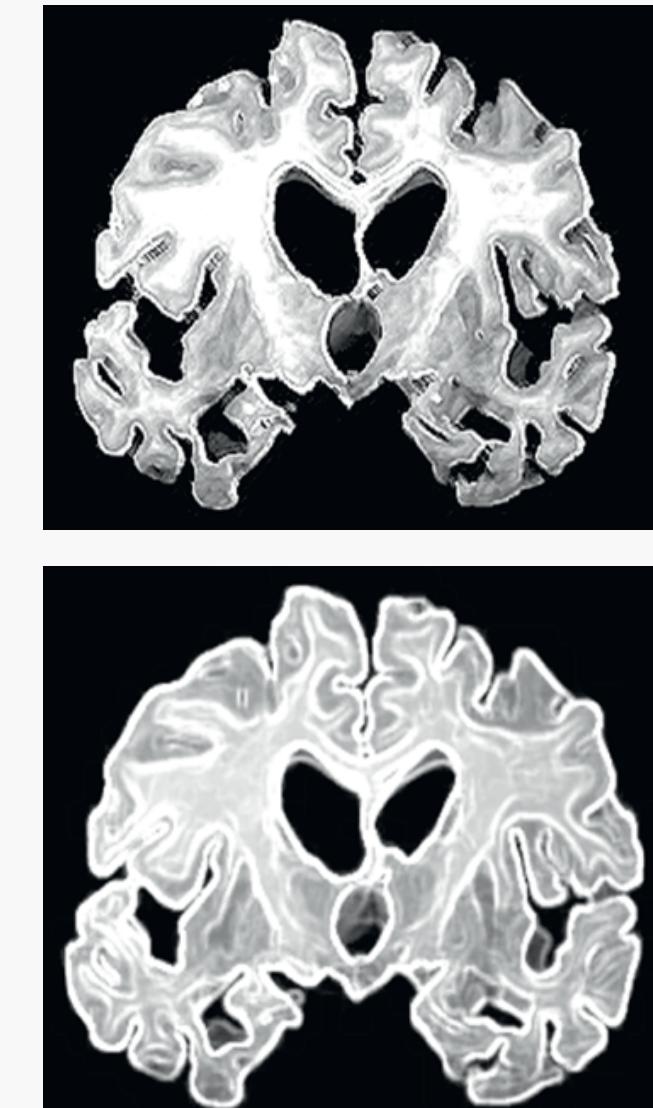


FIGURE 5: Classification effects of AD and HC.
FIGURE 6: Comparison of classification effects between MCI and HC.

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

VI

Example of a Personal Project

VI Example of a Personal Project

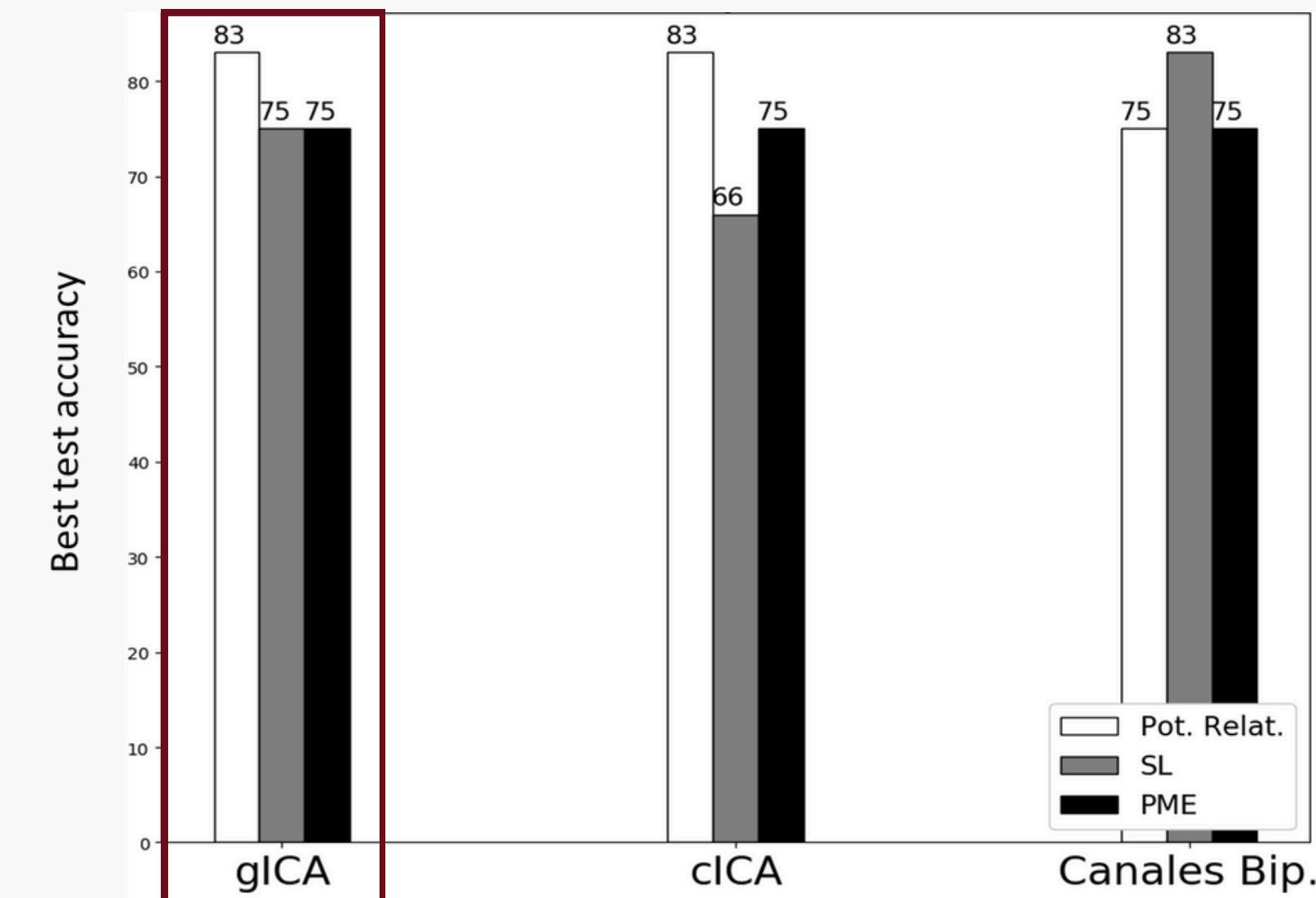
Example of a Personal Project

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, Aguilón-Niño DF, Lopera-Restrepo FJ, Ochoa-Gómez JF, Tobón-Quintero CA.

Table I. Subjects demographics.

	<i>ACr</i>	<i>NonCr</i>	<i>ACr vs NonCr</i>	<i>Effect size</i>
			(<i>p-value</i>)	(<i>hedges</i>)
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, Aguilón-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.

VI Example of a Personal Project

Example of a Personal Project

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

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

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.

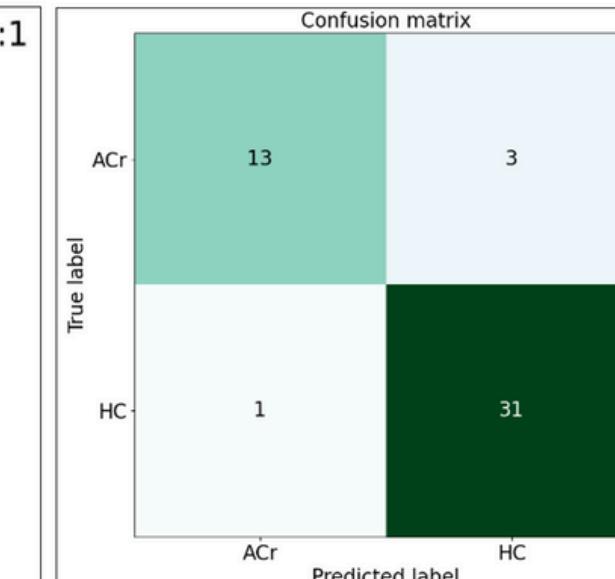
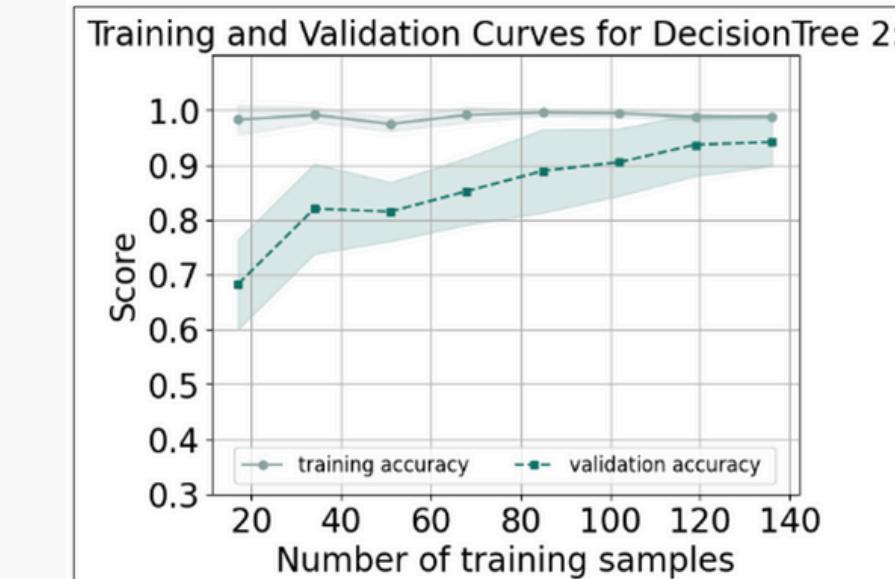


Table 2. Evaluation of Model Performance Using Computer Precision

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

 SAPIENZA
UNIVERSITÀ DI ROMA

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/>



vhenaoi/Python-Machine-Learning-Techniques: 4 Hands-on Seminars:...
4 Hands-on Seminars: Python Machine Learning Techniques for Classifying Patients with...
GitHub

 Google Colab
google.com



Introduction to Python.ipynb ☆
Archivo Editar Ver Insertar Entorno de ejecución Herramientas Ayuda Última modificación Comentarios

+ Código + Texto

Introduction to Python

[Reference page](#)

Python is **interpreted** and **dynamically typed**. Observe in the following lines:

- Variables `a` and `b` have specific data types even if they are not explicitly defined.
- Python guesses their types by how they are being used (`\` is integer division, while `\` is float division).
- Python keeps executing stuff while no error is found → python is interpreted

```
[ ] # Initialize the variable `a` with the value 4.
a = 4

# Print the value of `a` and its data type.
# Output: 4 <class 'int'>
print(a, type(a))

4 <class 'int'>

[ ] # Initialize the variable `b` with the value 9.0 (a floating-point number).
b = 9.0

# Print the value of `a` and the data type of `b`.
# Note: This will print the value of `a` from the previous code (which is 4).
```



Seminar Guide

https://colab.research.google.com/drive/1_ILb-GESMIWyxtrCekn7gmekfK-sSQMW?usp=drive_link

Workshops on web-based interactive computing platform

DATES

2nd, 3rd, 5th, and 9th of
September 2024.

ASSEGNISTA

Verónica Henao Isaza

SEMINAR

First Seminar

Thank you for listening!

About me

