

**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

		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

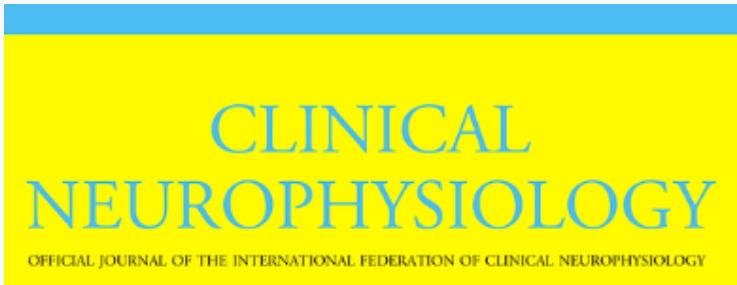


## I Self-Introduction & Motivation

### 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; ...



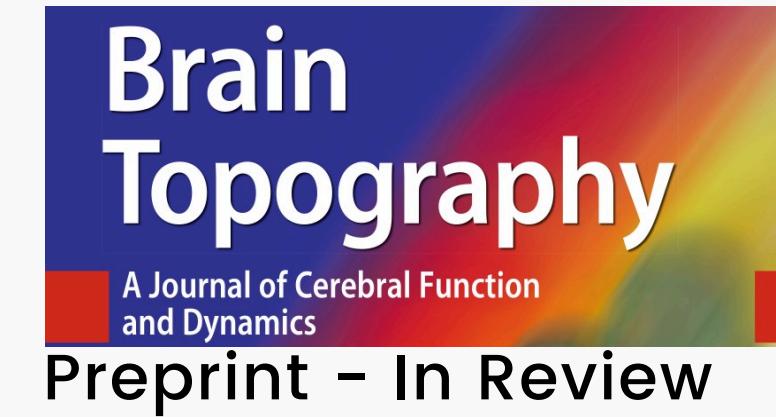
#### **Tackling EEG test-retest reliability with a pre-processing pipeline based on ICA and wavelet-ICA**

[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 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

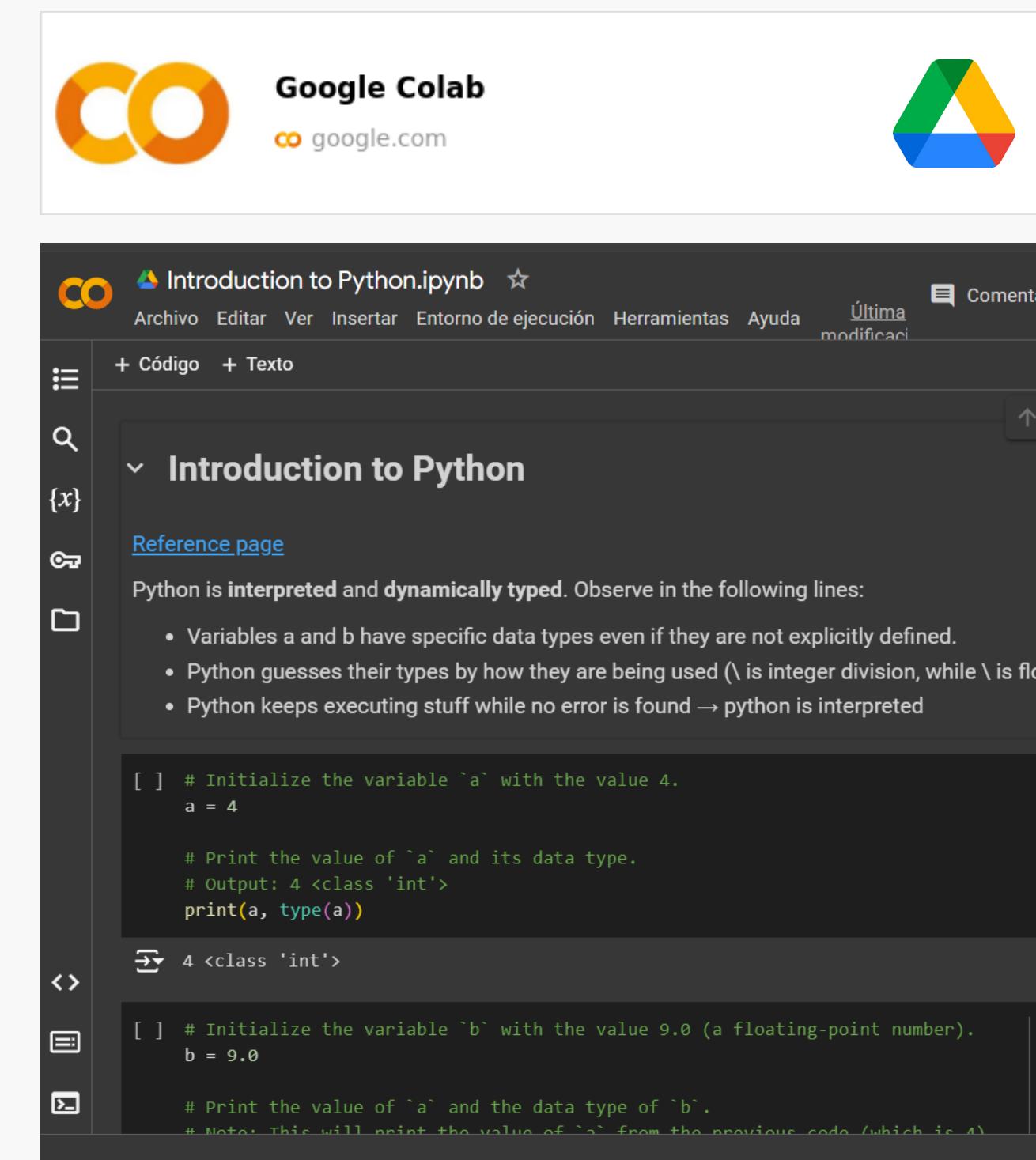


vhenaoi/Python-Machine-Learning-Techniques: 4 Hands-on Seminars: Python Machine Learning Techniques for Classifying Patients with Neurodegenerative Disorders and Controls based on EEG, MRI, and Clinical Markers - vhenaoi/Python-Machine-Learning-Techniques: 4 Hands-on Seminars: Python Machine Learning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

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

Contributor 1 Issues 0 Star 1 Forks 0

[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



vhenaoi/**Python-Machine-Learning...**

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

1 Contributor 0 Issues 1 Star 0 Forks

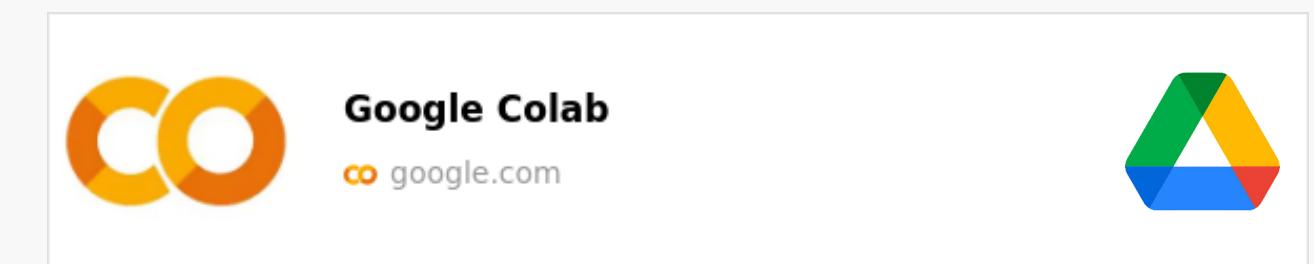
**vhenaoi/Python-Machine-Learning-Techniques: 4 Hands-on Seminars: Python Machine Learning Techniques for...**

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

 GitHub

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.

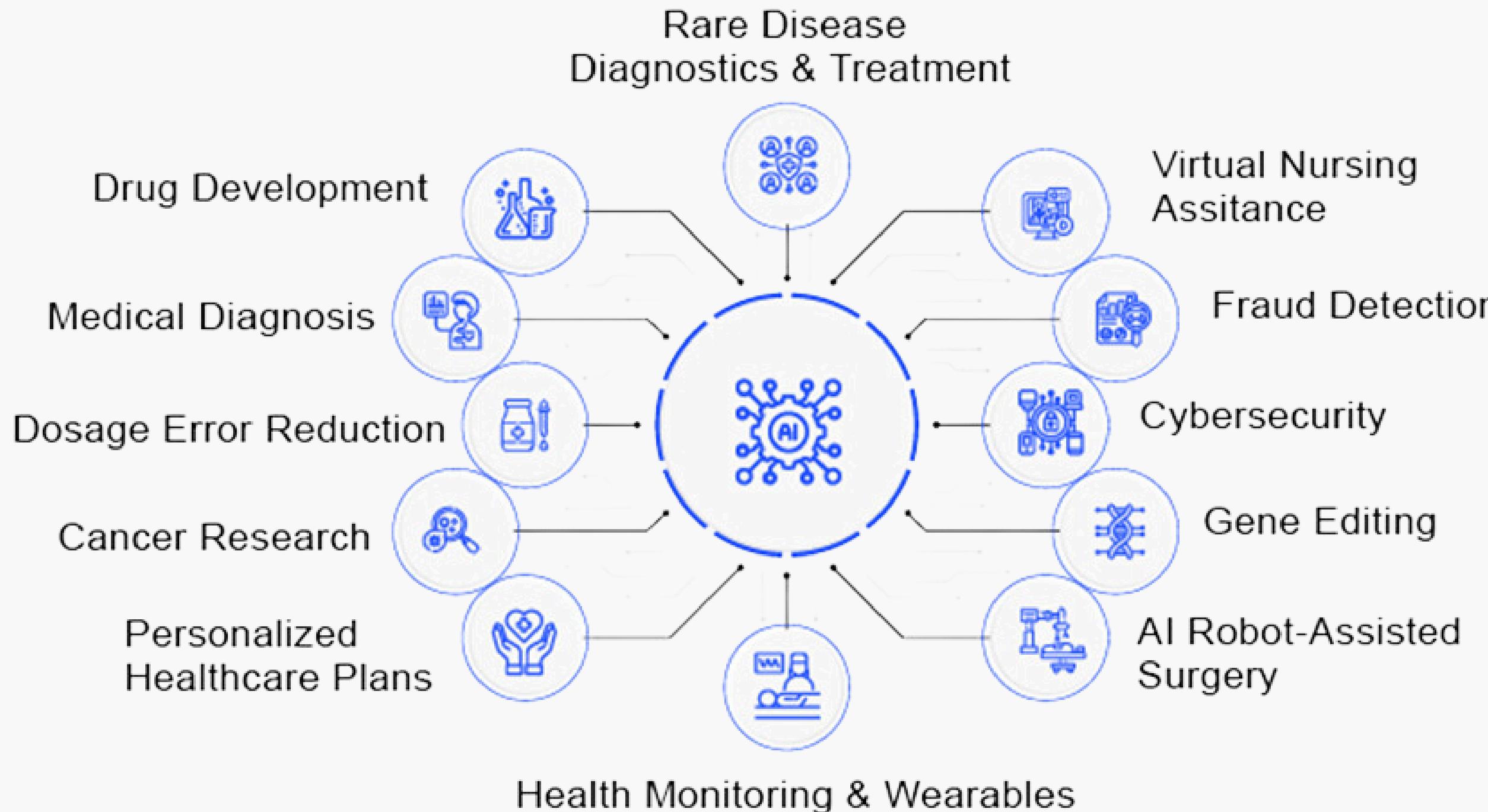
Google Colab is a cloud-based development environment that allows users to write and run Python code directly in their web browser. It's popular for data science, machine learning, and data analysis projects, offering free access to powerful computational resources like GPUs and TPUs.



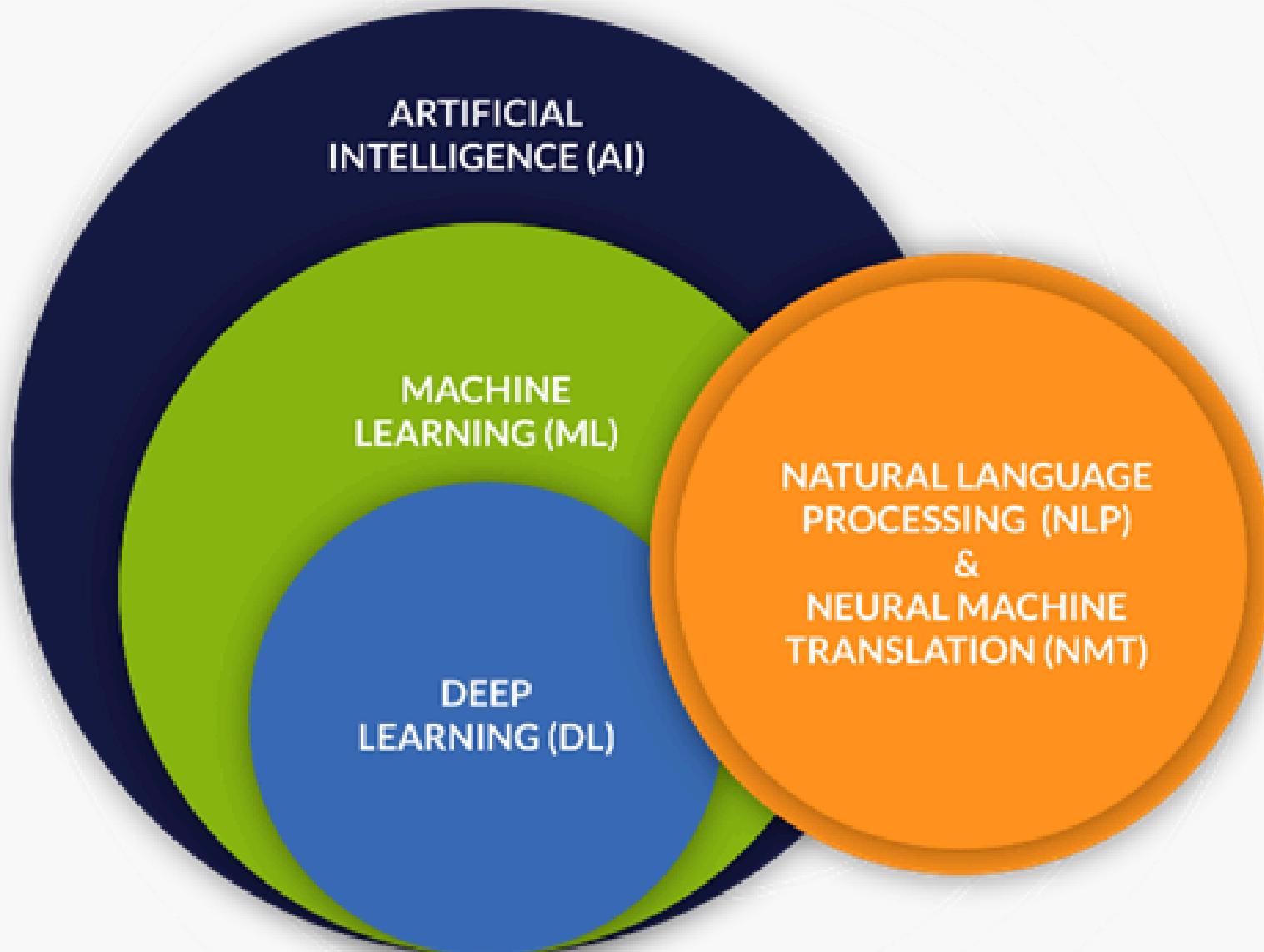
IV

## Concepts

# Applications of AI in Healthcare



# Types of AI in health care



## Linear Models

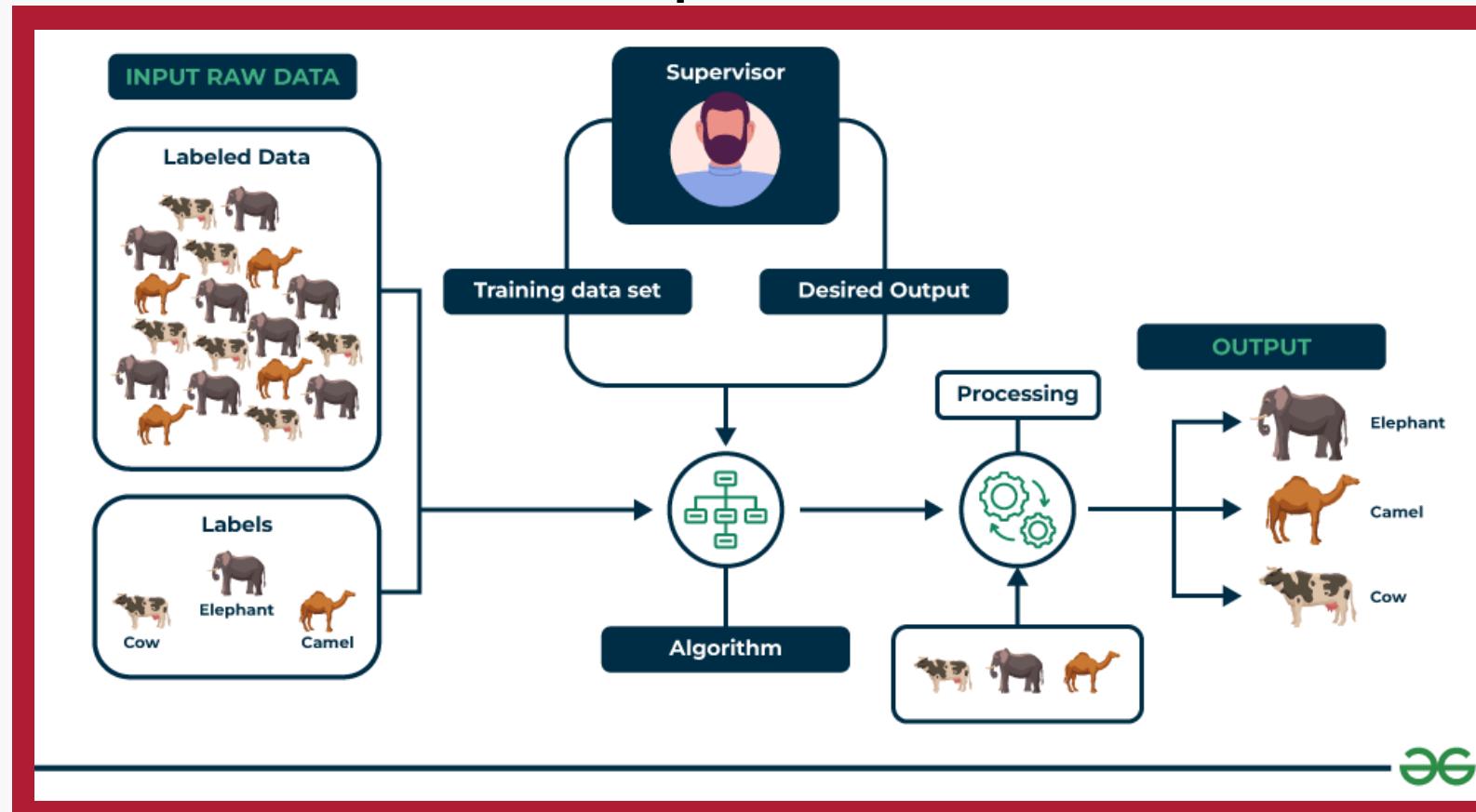
- Logistic Regression
- SupportVectorMachines (SVM)

## Non-Linear Models

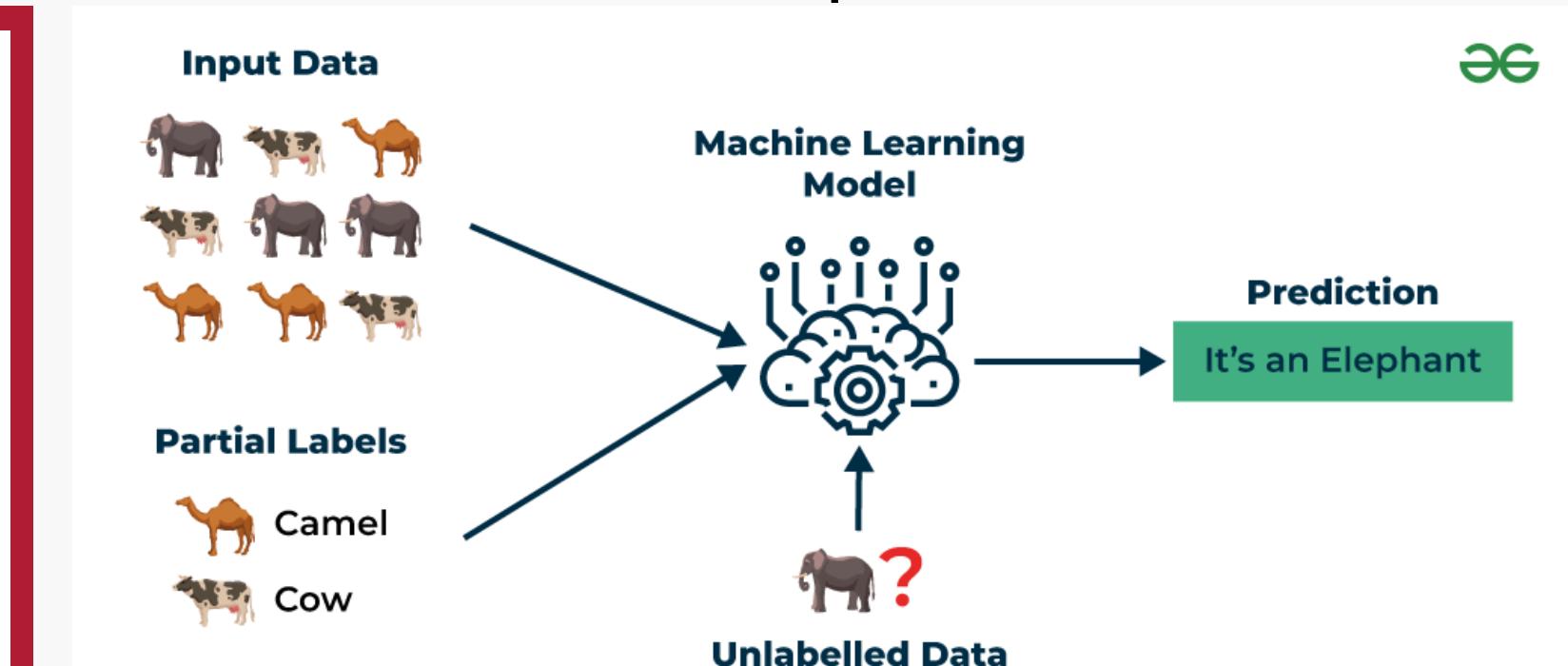
- k-Nearest Neighbors
- Kernel SVM
- Bayesian Classification
- Decision Trees
- RandomForestClassification

# Machine Learning

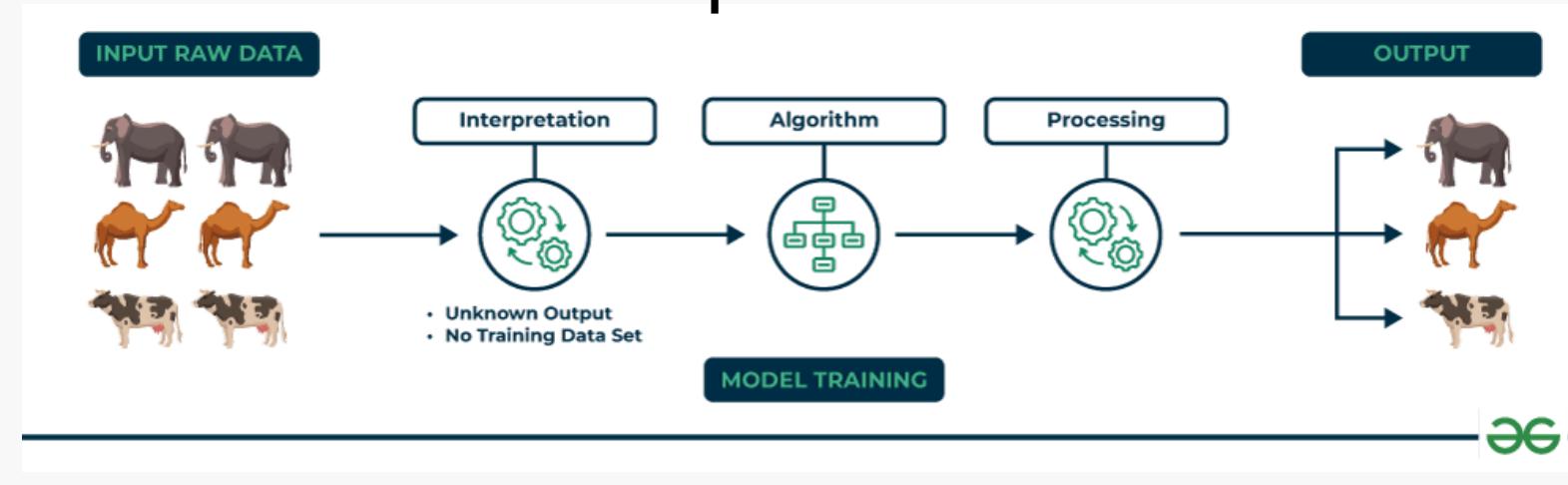
## Supervised



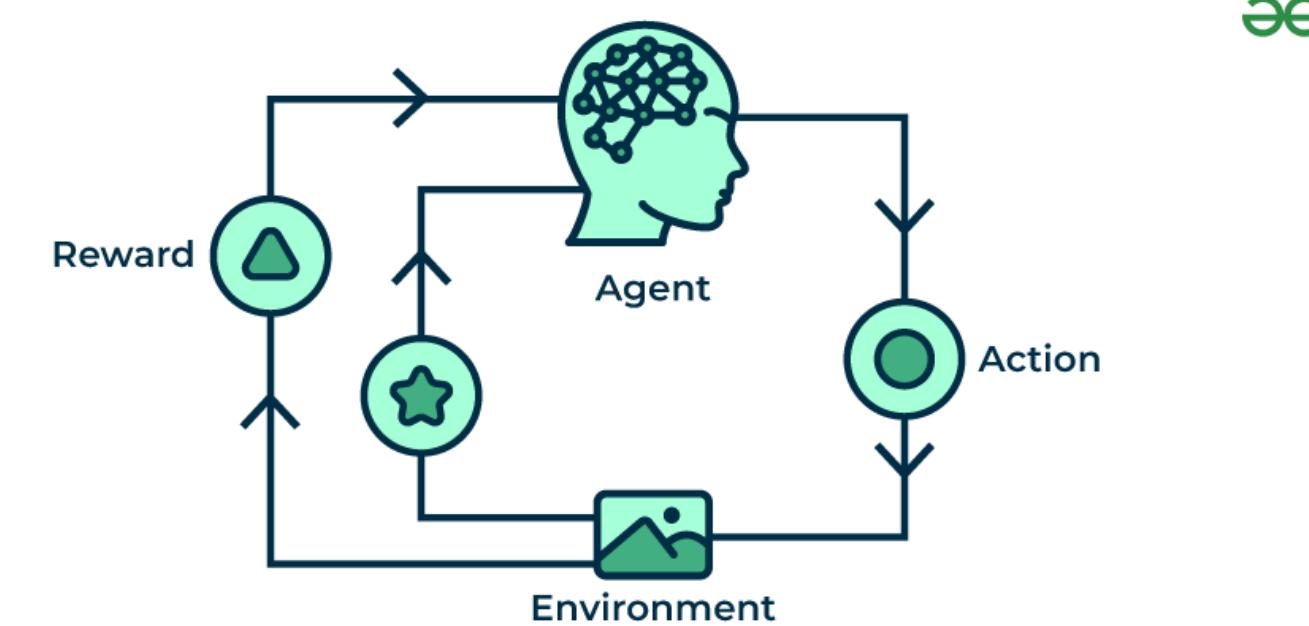
## Semi-Supervised



## Unsupervised



## Reinforcement

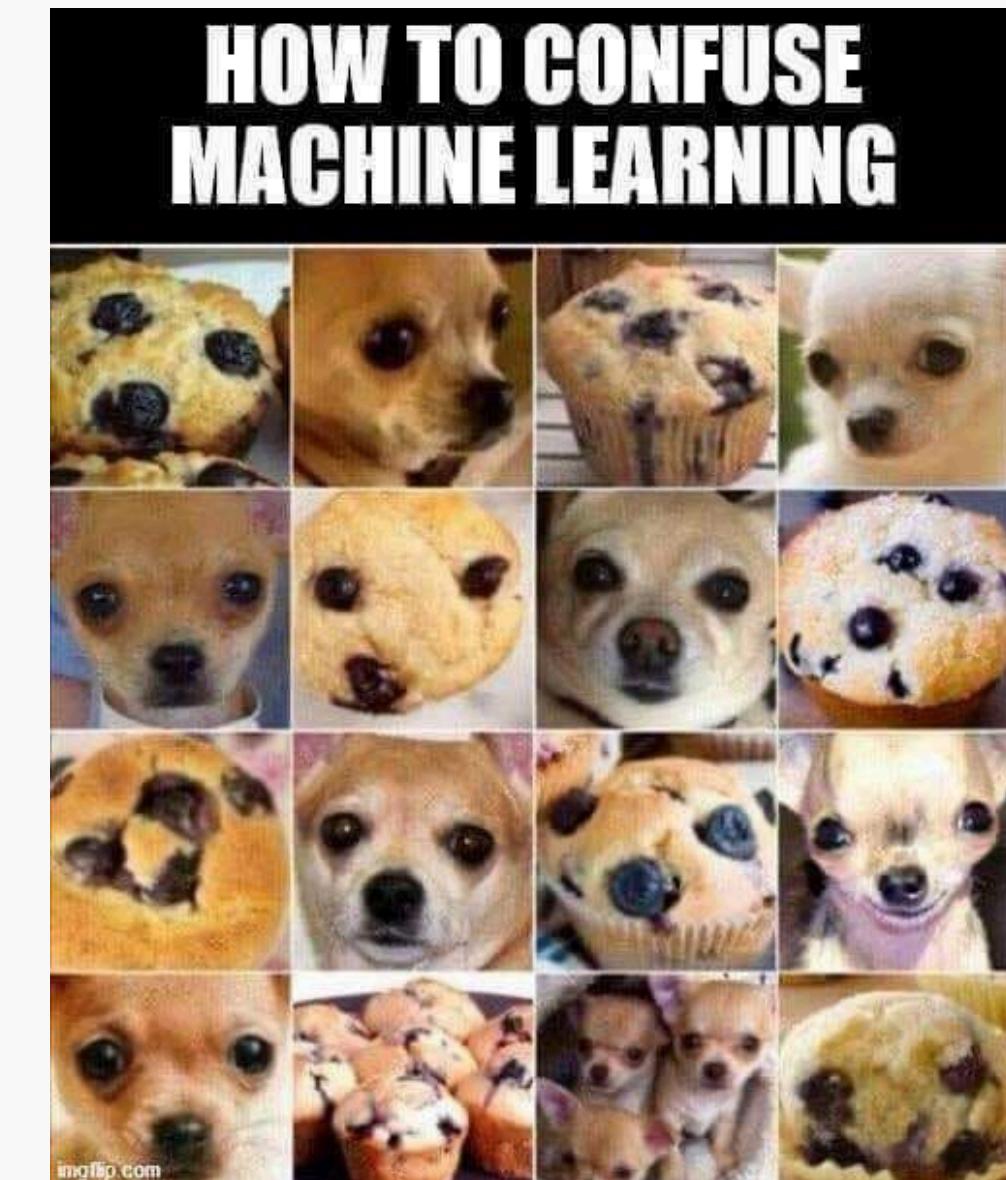


# Importance of data quality

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

Performance, overfitting, generalization, evaluation.

20-80  
30-70

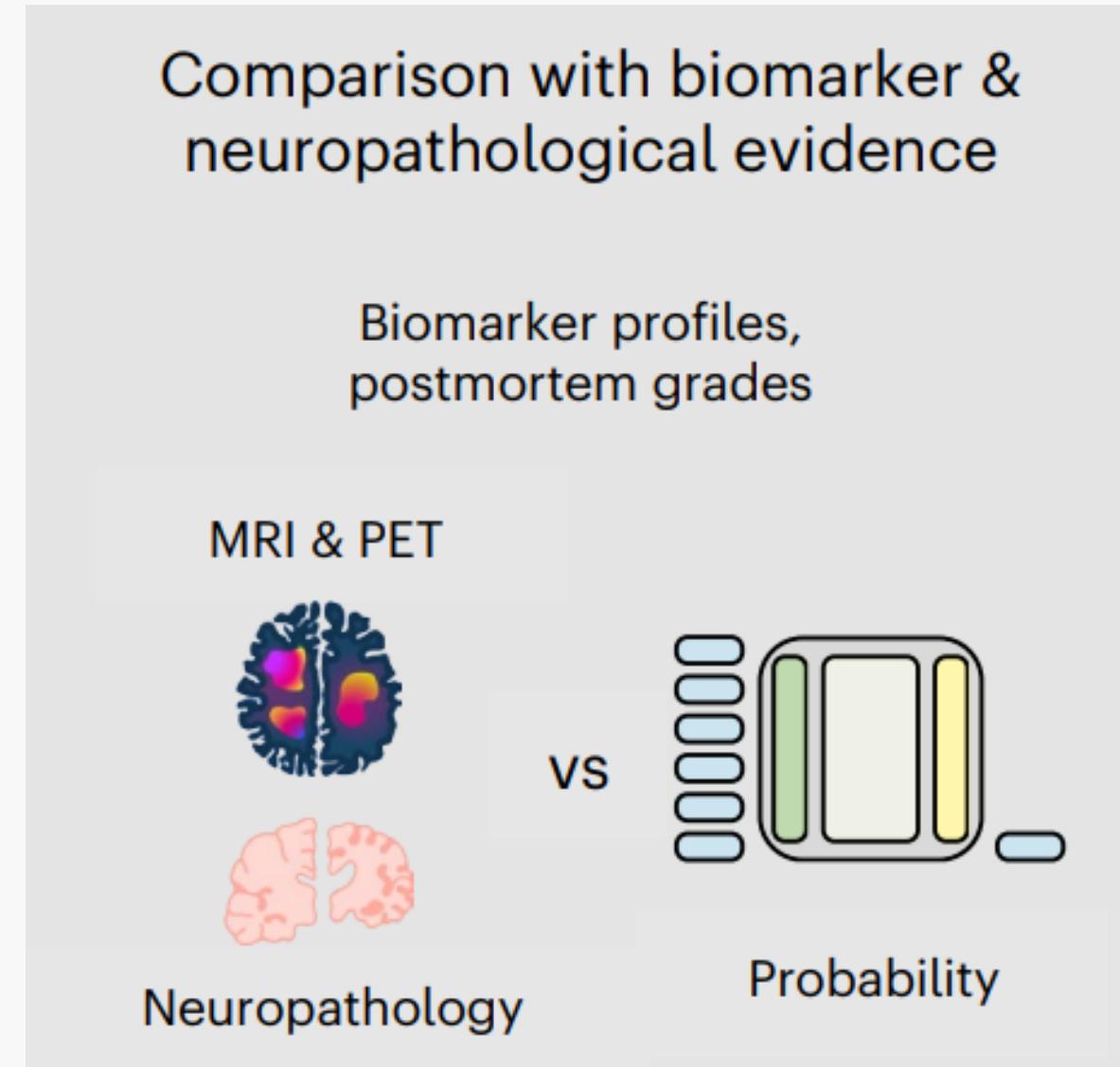
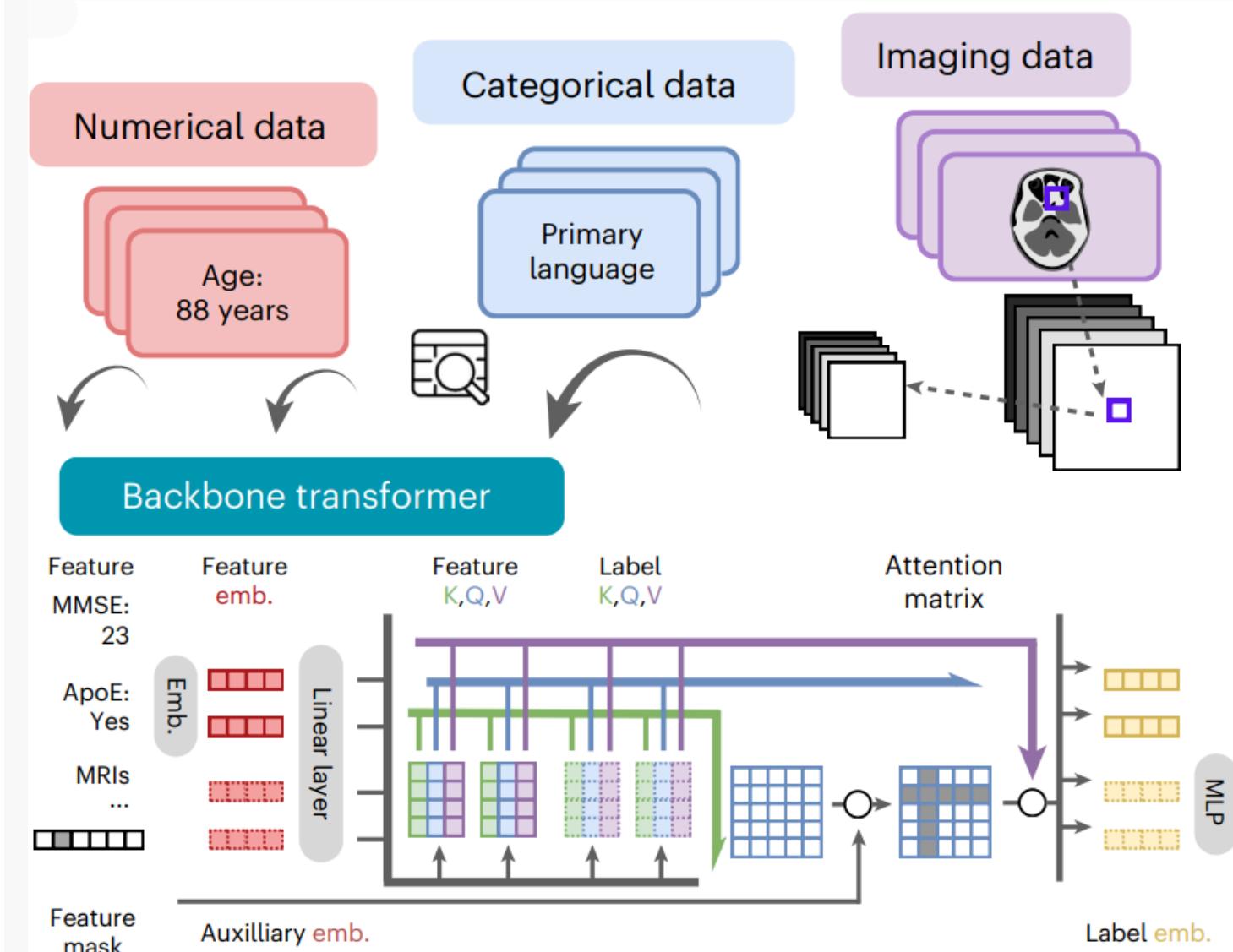
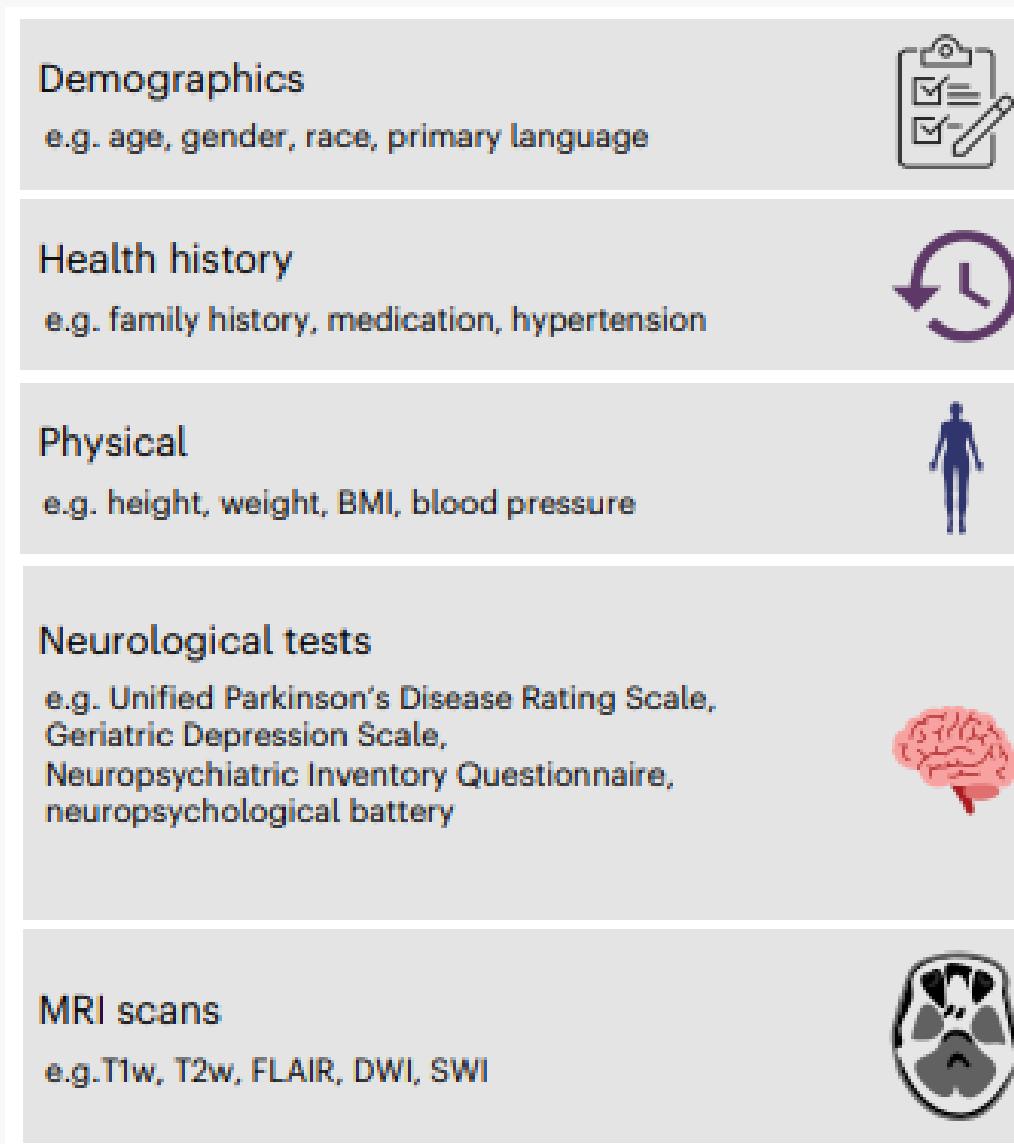


Adversarial Examples, Data Poisoning,  
Bias and Imbalanced Data,  
Limited Training Data

V

## Relevance in Neurosciences

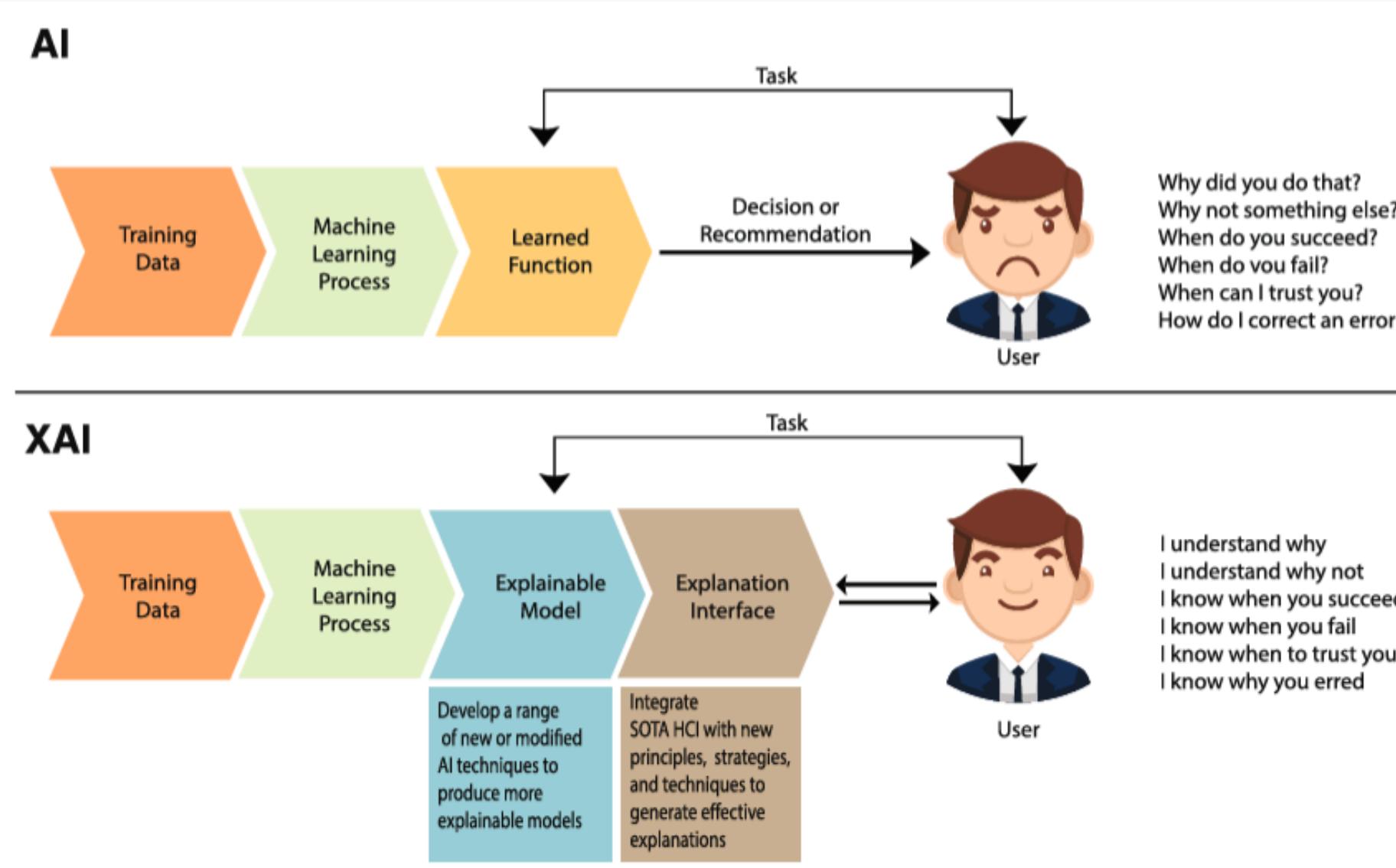
# Relevance in Neurosciences



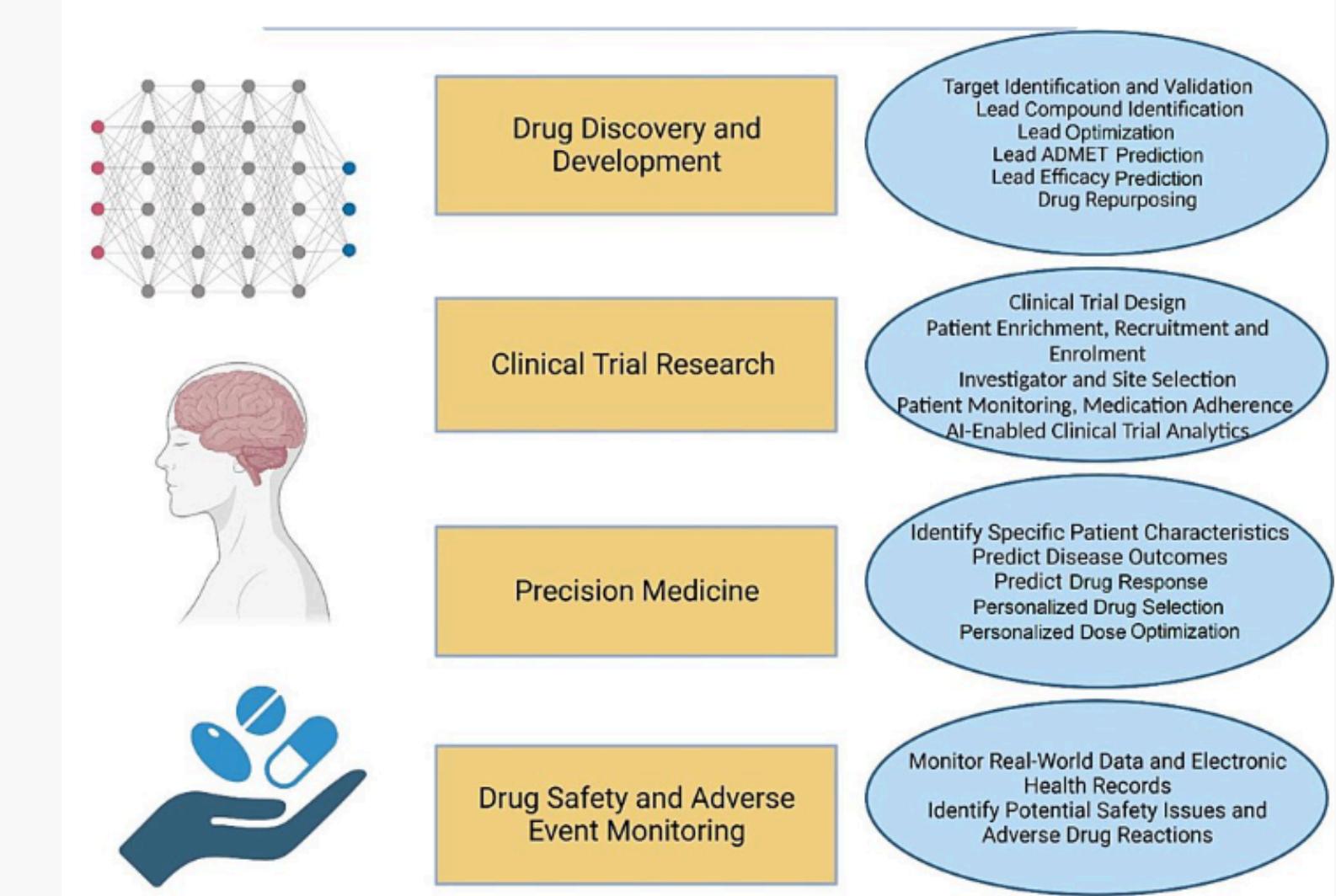
Xue, C., Kowshik, S.S., Lteif, D. et al. AI-based differential diagnosis of dementia etiologies on multimodal data. Nat Med (2024).  
<https://doi.org/10.1038/s41591-024-03118-z>

# Examples of Artificial Intelligence Applications

## AI in Clinical Decision-Making

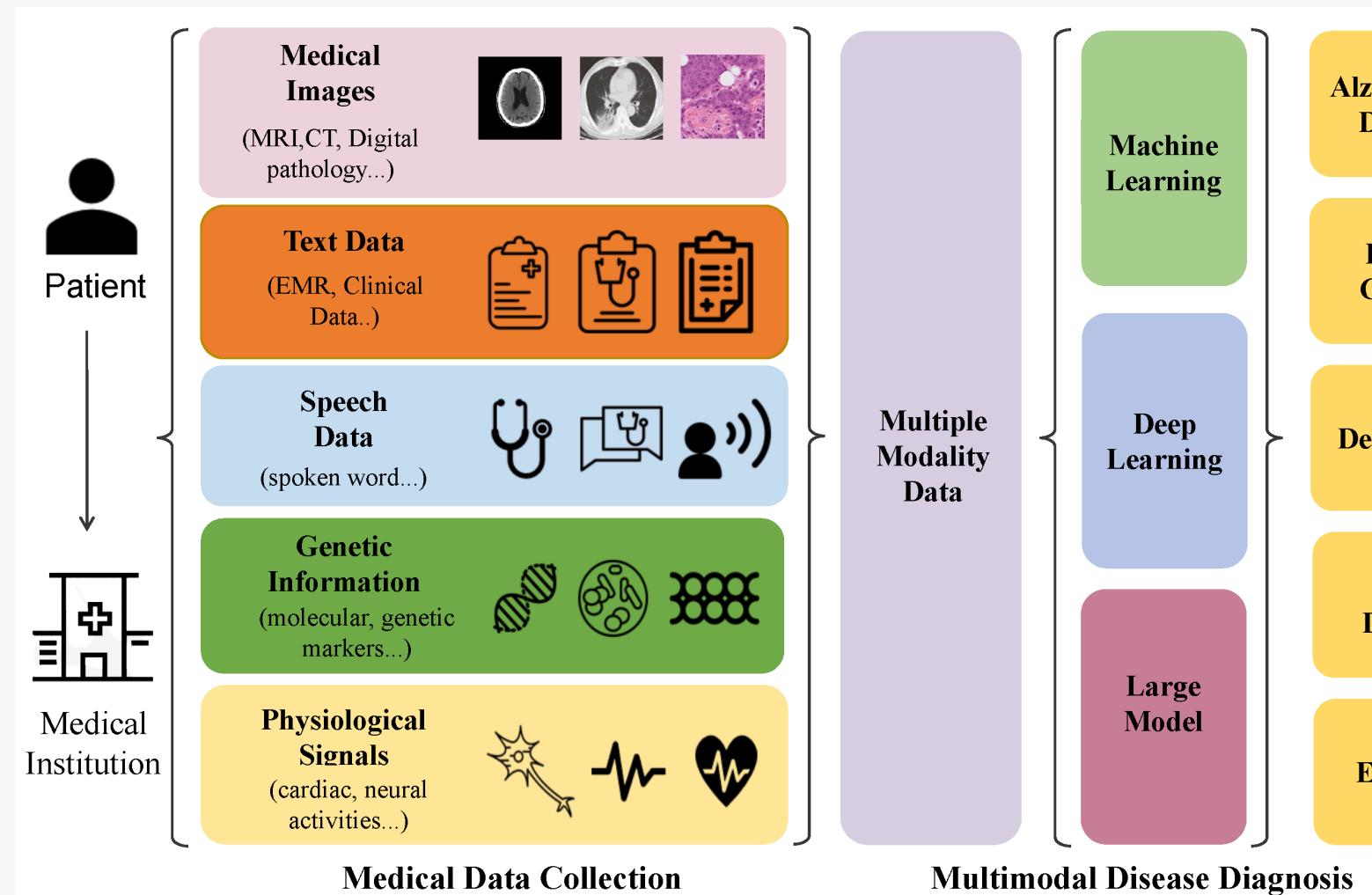


## AI in Personalized Medicine



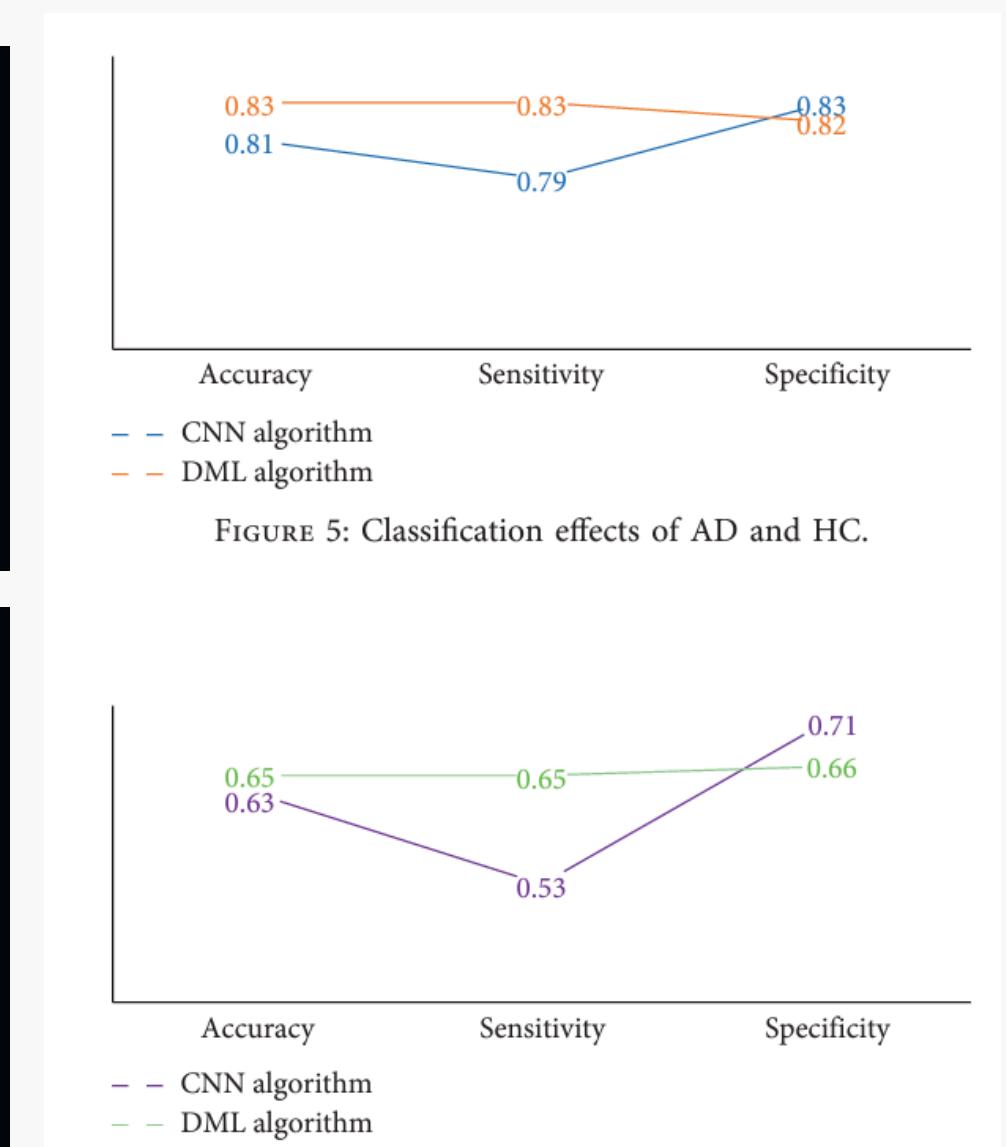
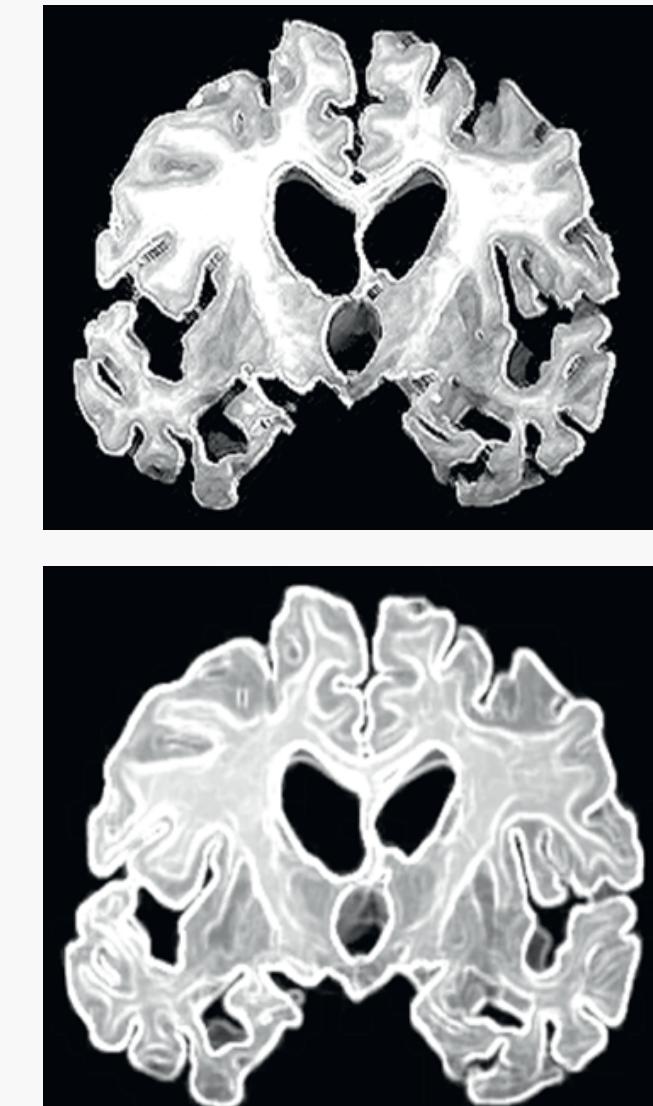
# Examples of Artificial Intelligence Applications

## AI in Medical Diagnosis



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

## AI in Imaging Diagnosis



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

VI

## Example of a Personal Project

## VI Example of a Personal Project

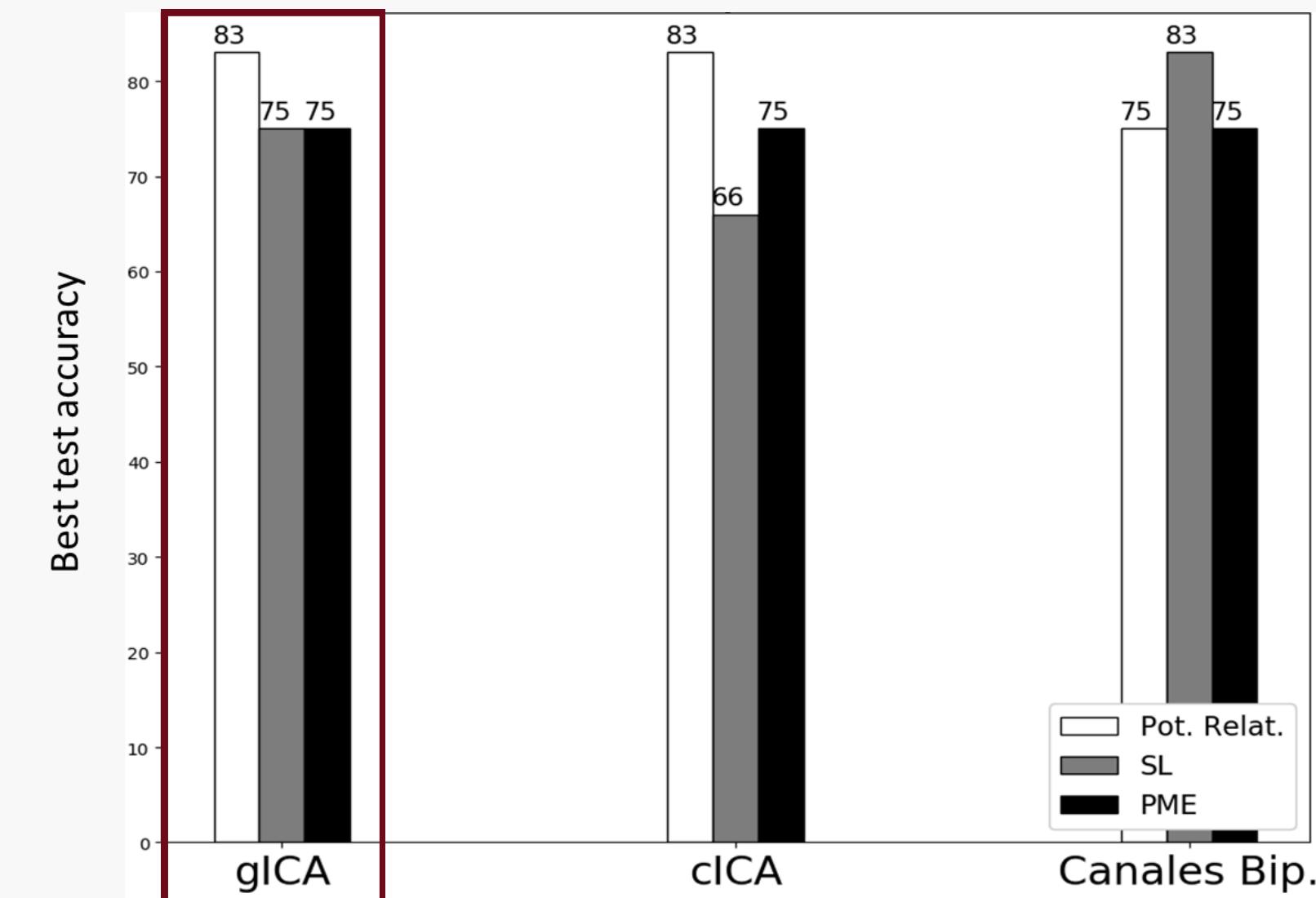
# Example of a Personal Project

### 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	$32.44 \pm 5.800$	$32.70 \pm 5.828$	0.868	-0.043
Gender (M/F)	11/16	13/20	1.000	0.020 (Cramer)
Education level (years)	$10.81 \pm 2.936$	$13.21 \pm 2.759$	0.001	-0.833
Verbal Fluency	$21.74 \pm 3.829$	$22.67 \pm 3.688$	0.346	-0.244
Boston Naming Test	$12.33 \pm 3.101$	$13.61 \pm 1.116$	0.032	-0.562
MMSE	$29.30 \pm 0.953$	$29.64 \pm 0.822$	0.044	-0.38
Word List Recall	$7.59 \pm 1.551$	$8.39 \pm 1.171$	0.048	-0.584
Word List Recognition	$9.78 \pm 0.506$	$10.00 \pm 0.000$	0.011	-0.647
Constructional Praxis	$9.96 \pm 1.160$	$10.39 \pm 0.827$	0.171	-0.43
Delayed Constructional Praxis	$9.04 \pm 1.720$	$9.82 \pm 1.776$	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

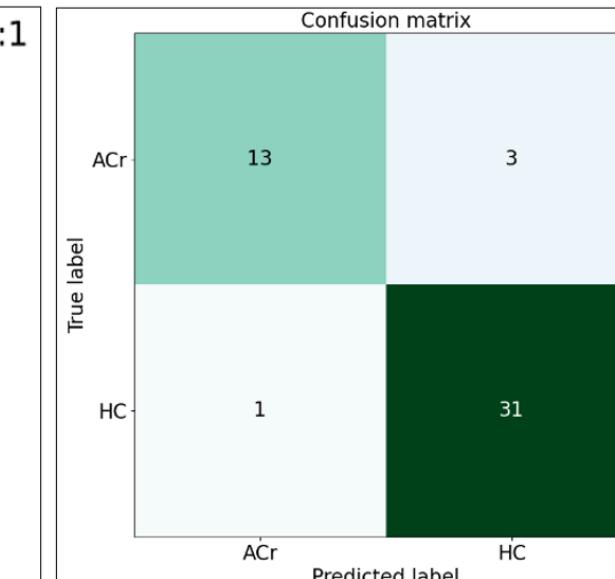
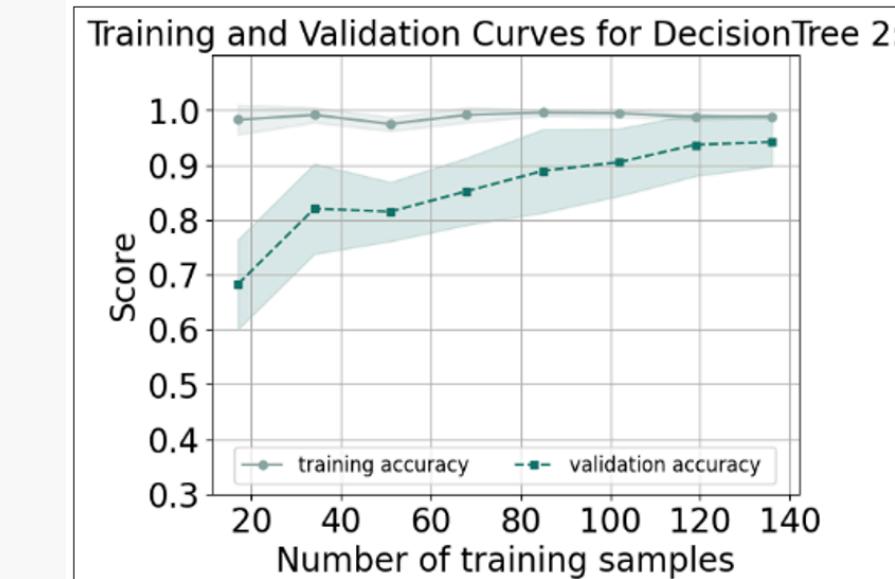
### Comprehensive Methodology for Sample Augmentation in EEG Biomarker Studies for Alzheimer's Risk Classification

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

**Table 1.** Summary characteristics of the databases

	<b>Database</b>	<b>Group</b>	<b>Count</b>	<b>Age (Mean ± SD)</b>	<b>Sex (F/M)</b>
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
<b>Total</b>		<b>237</b>		<b>147/90</b>	
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
<b>Total</b>		<b>189</b>		<b>111/78</b>	
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
<b>Total</b>		<b>173</b>		<b>102/71</b>	

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



**Table 2.** Evaluation of Model Performance Using Computer Precision

<b>2:1</b>	<b>5:1</b>	<b>10:1</b>
<b>Accuracy:</b> 91%	<b>Accuracy:</b> 98%	<b>Accuracy:</b> 96%
<b>Precision:</b> 91%	<b>Precision:</b> 97%	<b>Precision:</b> 97%
<b>Recall:</b> 97%	<b>Recall:</b> 100%	<b>Recall:</b> 100%
<b>F1-score:</b> 94%	<b>F1-score:</b> 98%	<b>F1-score:</b> 98%
<b>AUC:</b> 92%	<b>AUC:</b> 99%	<b>AUC:</b> 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/>

## Seminar Guide

**vhenaoi/Python-Machine-Learning-...**

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

1 Contributor 0 Issues 1 Star 0 Forks

**vhenaoi/Python-Machine-Learning-Techniques: 4 Hands-on Seminars: Python Machine Learning Techniques for...**

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

[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

**DATES**

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

**ASSEGNISTA**

Verónica Henao Isaza

**SEMINAR**

First Seminar

# Thank you for listening!

About me

