Machine learning

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Machine learning

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Artificial Intelligence

?

Machine Learning

Deep Learning

Machine learning

Alan Turing, 1950

"Turing Test“, where a human interrogator would try to distinguish between a computer and human text response.

"It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable."

John McCarthy, 2004

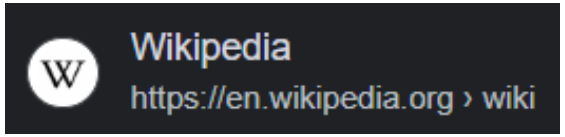
Stuart Russell and Peter Norvig, 2003 -> 2022

Human approach:
- Systems that think like humans
- Systems that act like humans

Ideal approach:
- Systems that think rationally
- Systems that act rationally

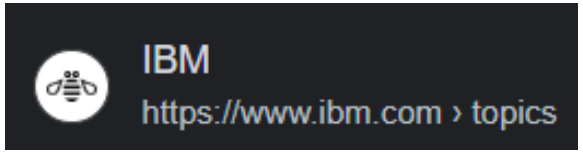
Machine learning

Artificial Intelligence or AI is “created intelligence” that can acquire, learn, and solve problems. AI system is constituted of an agent and environment. An agent, i.e., human or robot is capable of perceiving and collecting input through sensors from the environment and giving out the output through its effectors. The agent is capable of learning from experiences, set and achieve targets, and take into consideration the consequences of its actions. AI systems serve to be fast, reliable, and safer to use in high-risk areas and public utilities.



Artificial intelligence (**AI**) is the ability of machines to perform tasks that are typically associated with human intelligence, such as learning and problem-solving. AI applications include advanced web search engines (e.g., Google Search), recommendation systems (used by YouTube, Amazon, and Netflix), understanding human speech (such as Siri and Alexa), self-driving cars (e.g., Waymo), generative or creative tools (ChatGPT and AI art), and competing at the highest level in strategic games (such as chess and Go).[1]

Artificial intelligence is a field that combines computer science and robust datasets, to enable problem-solving. It also encompasses sub-fields of machine learning and deep learning, which are frequently mentioned in conjunction with artificial intelligence. These disciplines are comprised of AI algorithms which seek to create expert systems which make predictions or classifications based on input data.



Machine learning

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think and act like humans. This encompasses a wide range of tasks such as problem-solving, understanding natural language, perception, and decision-making. The ultimate goal of AI, often considered a lofty one, is to develop systems that can perform tasks that would normally require human intelligence.

AI can be categorized into two main types:

1. **Narrow or Weak AI**: This type of AI is designed and trained for a particular task. Personal digital assistants, like Apple's Siri or Amazon's Alexa, are examples of narrow AI.
2. **General or Strong AI**: This form of AI would outperform humans at nearly every cognitive task. It's an idea mostly in the realm of science fiction and philosophy for now, but it's what many AI researchers are ultimately aiming for.

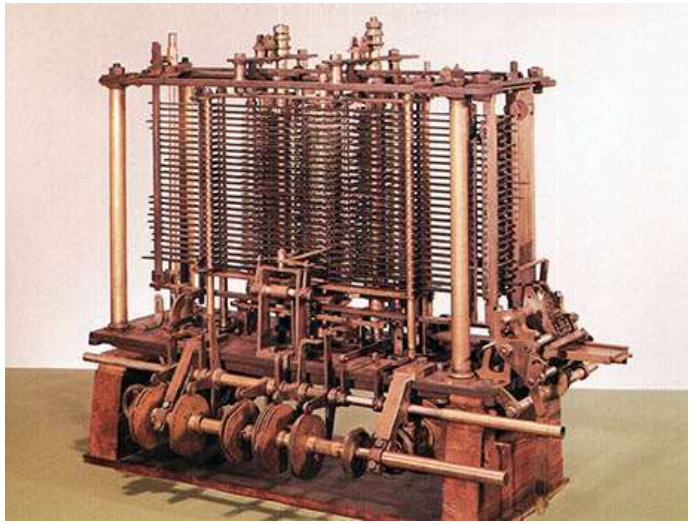
Machine learning

Artificial intelligence, or AI, is a field of computer science that became established in the 1950s. It was described at the time as a new science which would systematically study the phenomenon of ‘intelligence’. This goal was to be pursued by using computers to simulate intelligent processes. The central assumption of AI was that the logical operations of computers could be structured to imitate human thought processes. Because the workings of a computer are understood while those of the human mind are not, AI researchers hoped in this way to reach a scientific understanding of the phenomenon of ‘intelligence’.

Intelligence is conceived of in AI as a general mental ability that encompasses several more specific abilities, such as the ability to reason, plan, solve problems, comprehend ideas, use language, and learn. AI research commonly focuses on a specific ability and attempts to develop programs that are capable of performing limited tasks involving that ability. The highest goal of AI was to construct a computer system with the intelligence and reasoning ability of an adult human being. Many early AI researchers claimed that this goal would be reached within only a few decades, thanks to the invention of the digital computer and to key breakthroughs in the fields of information theory and formal logic. In 1965, the noted AI researcher Herbert Simon predicted that computers would be able to execute any task that human beings could by 1985 [Simon, 1965].

Philip Brey, Johnny Hartz Søraker, in Philosophy of Technology and Engineering Sciences, 2009

Machine learning

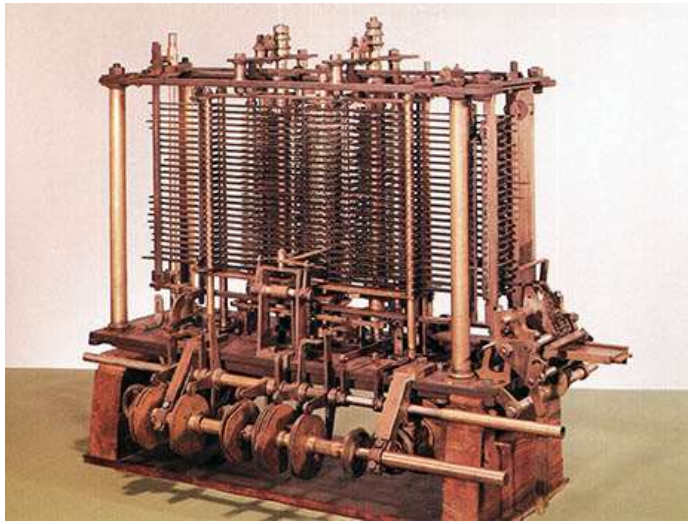


1842-43
Charles Babbage
Ada Lovelace

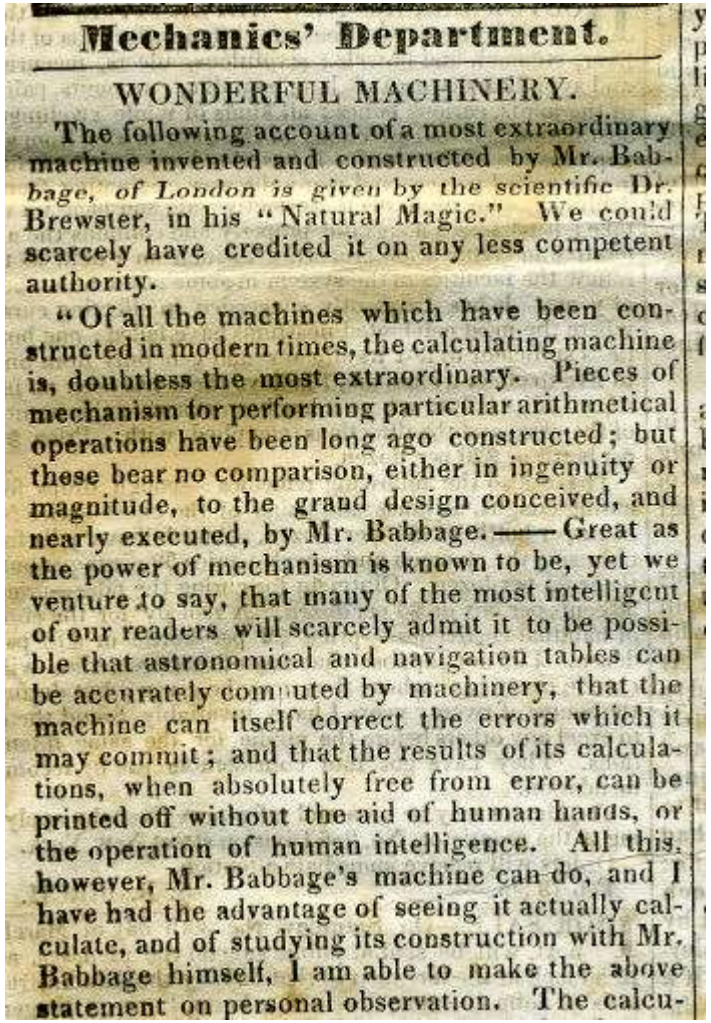
Machine learning


NEW YORK WEEKLY MESSENGER.

VOL. II.—NO. 29. NEW-YORK, WEDNESDAY MORNING, FEBRUARY 12, 1834. WHOLE NO. 82



~1833
Charles Babbage
Ada Lovelace

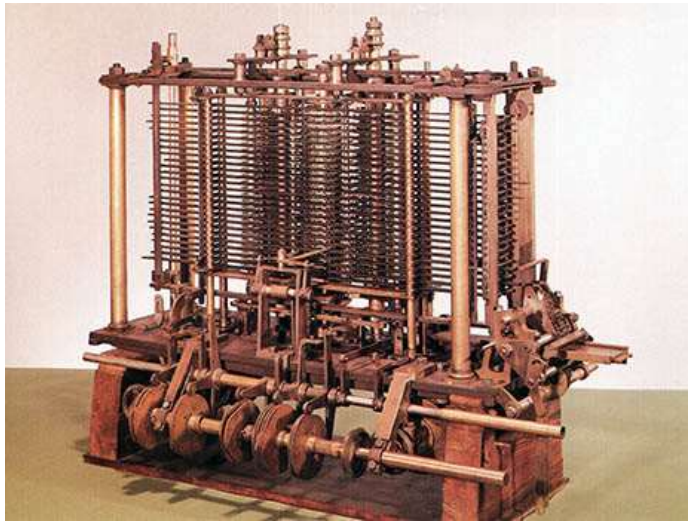

Mechanics' Department.

WONDERFUL MACHINERY.

The following account of a most extraordinary machine invented and constructed by Mr. Babbage, of London is given by the scientific Dr. Brewster, in his "Natural Magic." We could scarcely have credited it on any less competent authority.

"Of all the machines which have been constructed in modern times, the calculating machine is, doubtless the most extraordinary. Pieces of mechanism for performing particular arithmetical operations have been long ago constructed; but these bear no comparison, either in ingenuity or magnitude, to the grand design conceived, and nearly executed, by Mr. Babbage. —— Great as the power of mechanism is known to be, yet we venture to say, that many of the most intelligent of our readers will scarcely admit it to be possible that astronomical and navigation tables can be accurately computed by machinery, that the machine can itself correct the errors which it may commit; and that the results of its calculations, when absolutely free from error, can be printed off without the aid of human hands, or the operation of human intelligence. All this, however, Mr. Babbage's machine can do, and I have had the advantage of seeing it actually calculate, and of studying its construction with Mr. Babbage himself, I am able to make the above statement on personal observation. The calcu-

Machine learning



~1833
Charles Babbage
Ada Lovelace

Bull. Sci. Tech. Soc., Vol. 10, pp. 68-76, 1990. Printed in the USA.
0270-4676/90.

CHARLES BABBAGE AND THE DESIGN OF INTELLIGENCE:

Computers and Society in 19th-Century England

Gordon L. Miller

Introduction

The design of a machine is typically shaped by the needs and ambitions of its social and technological environment, no less than the structure of a leaf or a seashell is formed by the physical and chemical forces at work in nature. A well-designed machine embodies the insight and creativity of its maker, and stands as material proof of his grasp of certain physical laws and principles of mechanical operation. It is, in a sense, intelligence externalized, the inventor's intellectual offspring, having been born in stages, usually after years of labor, with the features and functions characteristic of its particular cultural milieu. Charles Babbage (1791-1871), mathematician, natural philosopher, and advocate of social and economic reform, devoted much of his life to designing machines to perform mathematical calculations. In doing so, he found it necessary to build into his calculating machines operational structures analogous to those found in many factories of the time, as well as operations resembling particular mental processes. Babbage incorporated these functions into his Difference Engine and Analytical Engine in a way that enabled this new order of machines to exhibit somewhat more fully the qualities of intelligence, and thus to transcend the capabilities displayed by simpler mechanisms then in use.

The implementation of such machines could, in Babbage's view, not only provide an easy and efficient means of making calculations and producing error-free mathematical and astronomical tables for use in navigation, it could also, in his expanded vision, help to usher in a new and more desirable order of society. These wider aspects of Babbage's scientific program are relatively unknown today because of the tendency to interpret his work, in Whiggish fashion, solely in terms of its possible anticipation of and influence on the design of twentieth-century computers. As a result of such an interpretation, many of the most essential aspects of nineteenth-century English culture that inspired and informed Babbage's work, and helped to give his machines their characteristic structure and their potential larger significance, are often obscured or ignored. The following discussion will, it is hoped, help to remedy this myopic distortion in our historical awareness.

Machinery and the Methods of Manufacturing

The introduction of machinery into the processes of production is rarely, if ever, an isolated technological

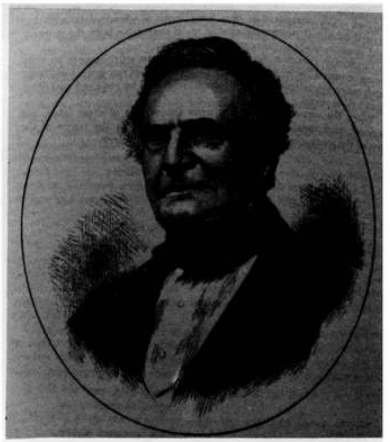
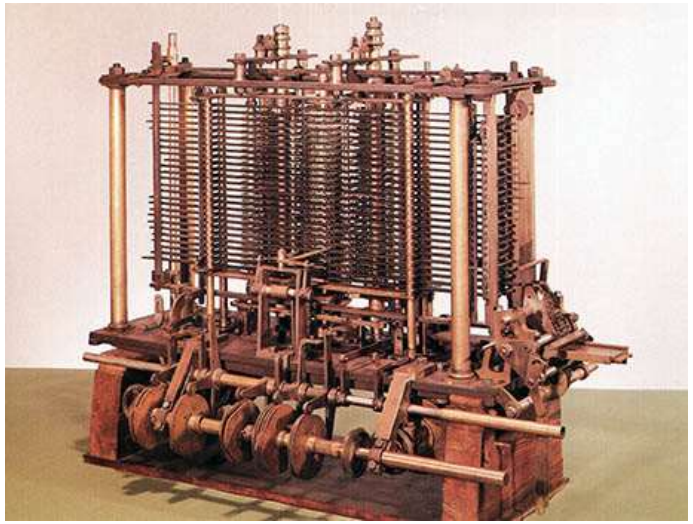


Fig. 1. **Charles Babbage,** 1792-1871. Portrait from the *Illustrated London News*, Nov. 4, 1871. (Taken from Charles Babbage: On the Principles and Development of the Calculator, P. Morrison and E. Morrison, editors. New York: Dover, 1961, p. 158)

Machine learning

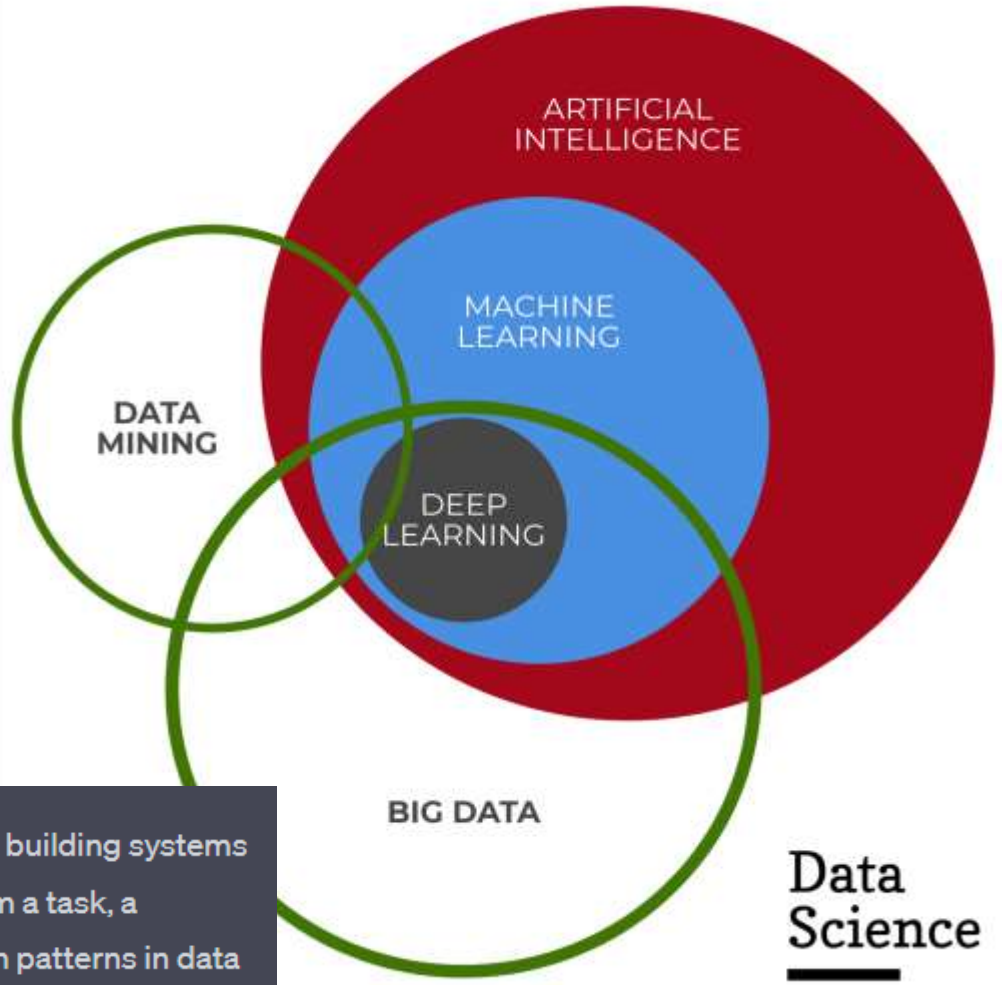


~1833
Charles Babbage
Ada Lovelace

Machine learning

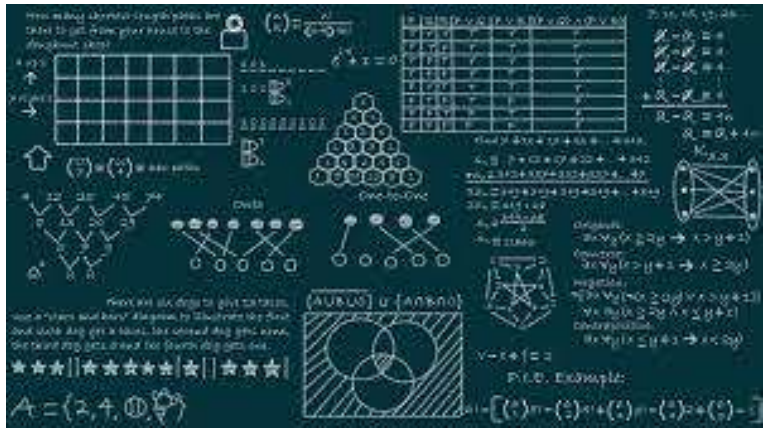
Machine learning is the subfield of computer science that gives "**computers the ability to learn without being explicitly programmed**"

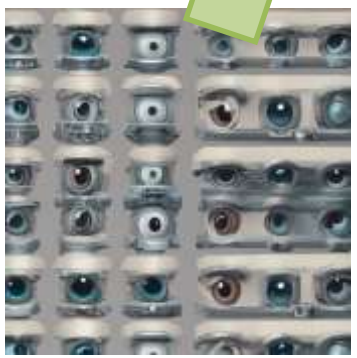
Arthur Samuel, 1959



Machine Learning (ML) is a subfield of artificial intelligence (AI) focused on building systems that can learn from data. Instead of being explicitly programmed to perform a task, a machine learning model uses algorithms and statistical techniques to learn patterns in data and make decisions based on it.

Machine learning





Machine learning

Artificial Intelligence

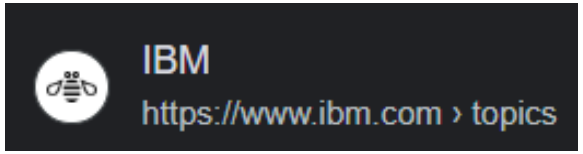
Machine Learning

?

Deep Learning

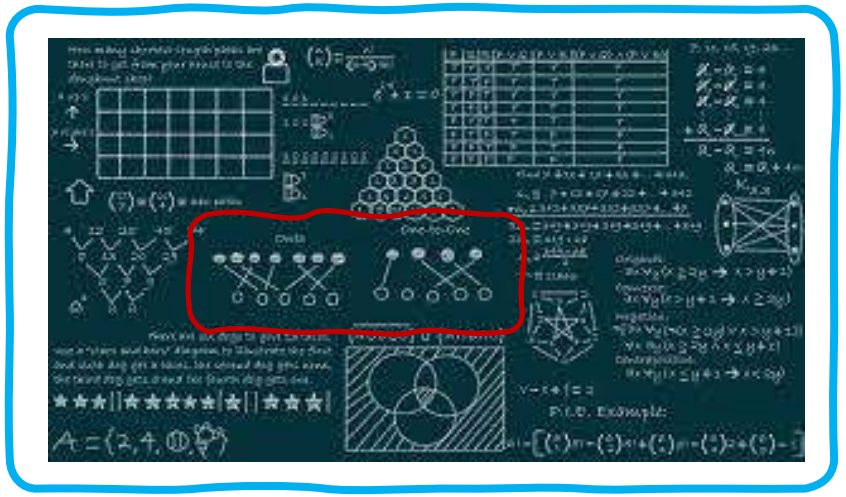
Machine learning

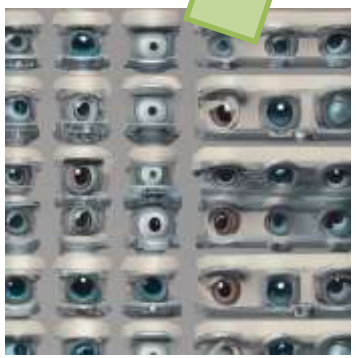
Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to “learn” from large amounts of data. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy.



Deep Learning

Machine learning





How is ML different from classical statistics?

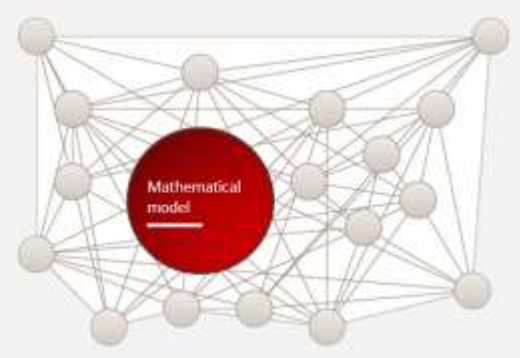
It is focused on ***classification/prediction*** *rather than inference*

Distribution-free approach

High-dimensional problems

Algorithmic and computational aspects play a central role

Machine learning

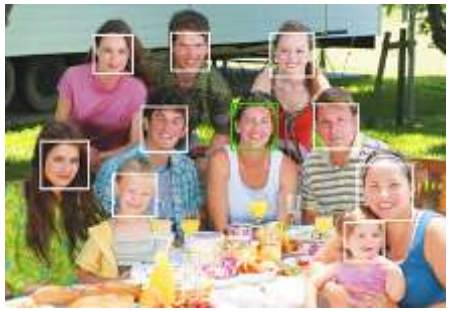


Designing mathematical models able to…

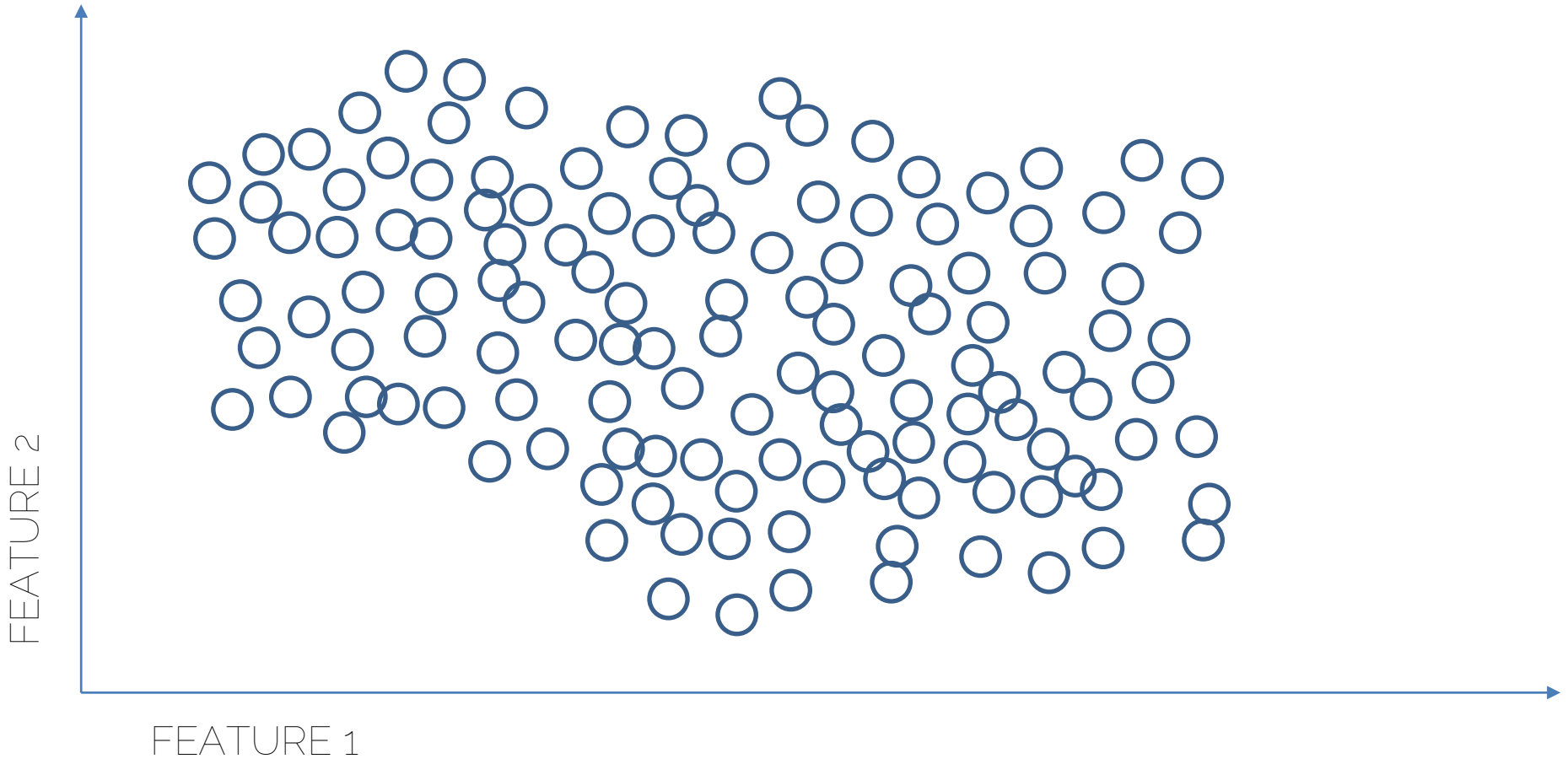
1. identify hidden patterns in data
2. handle and summarize a great quantity of data into a model
3. use that model to perform automatic classification

Machine learning

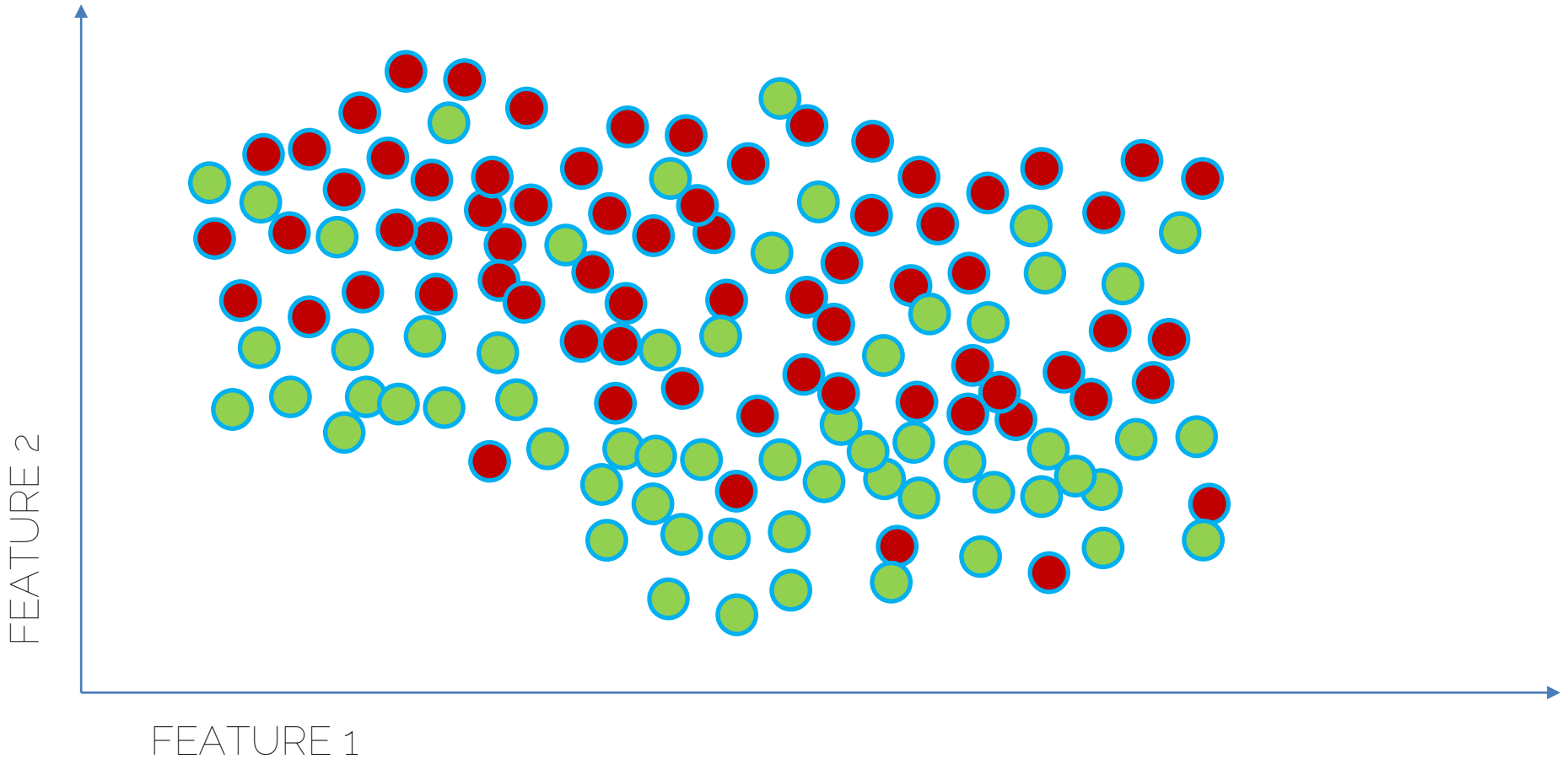
Training data		Target variable
From the trend registered during the last years	PREDICT	Future market performance
From a set of images	DETECT	Faces (in new images)



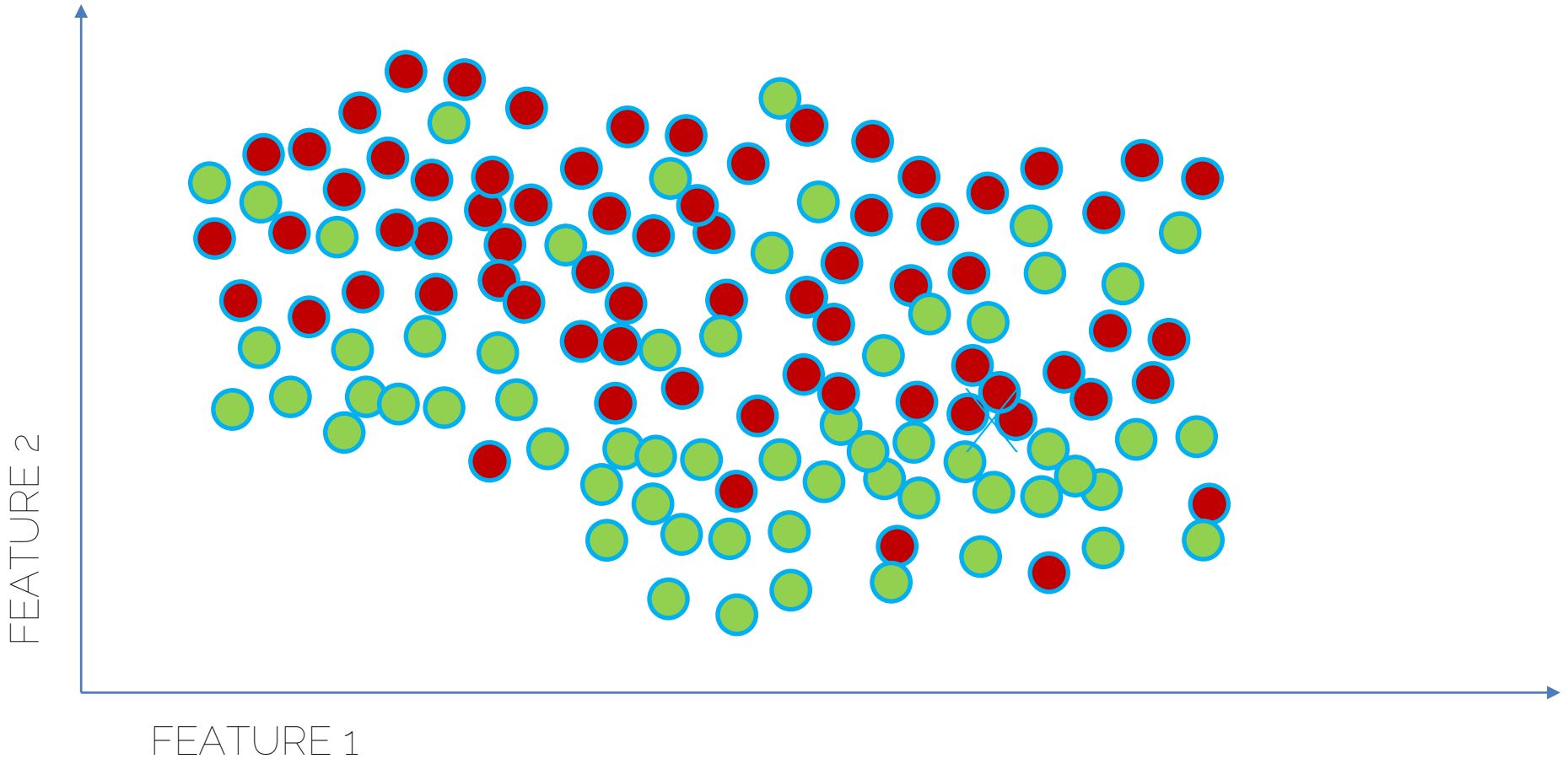
Classification



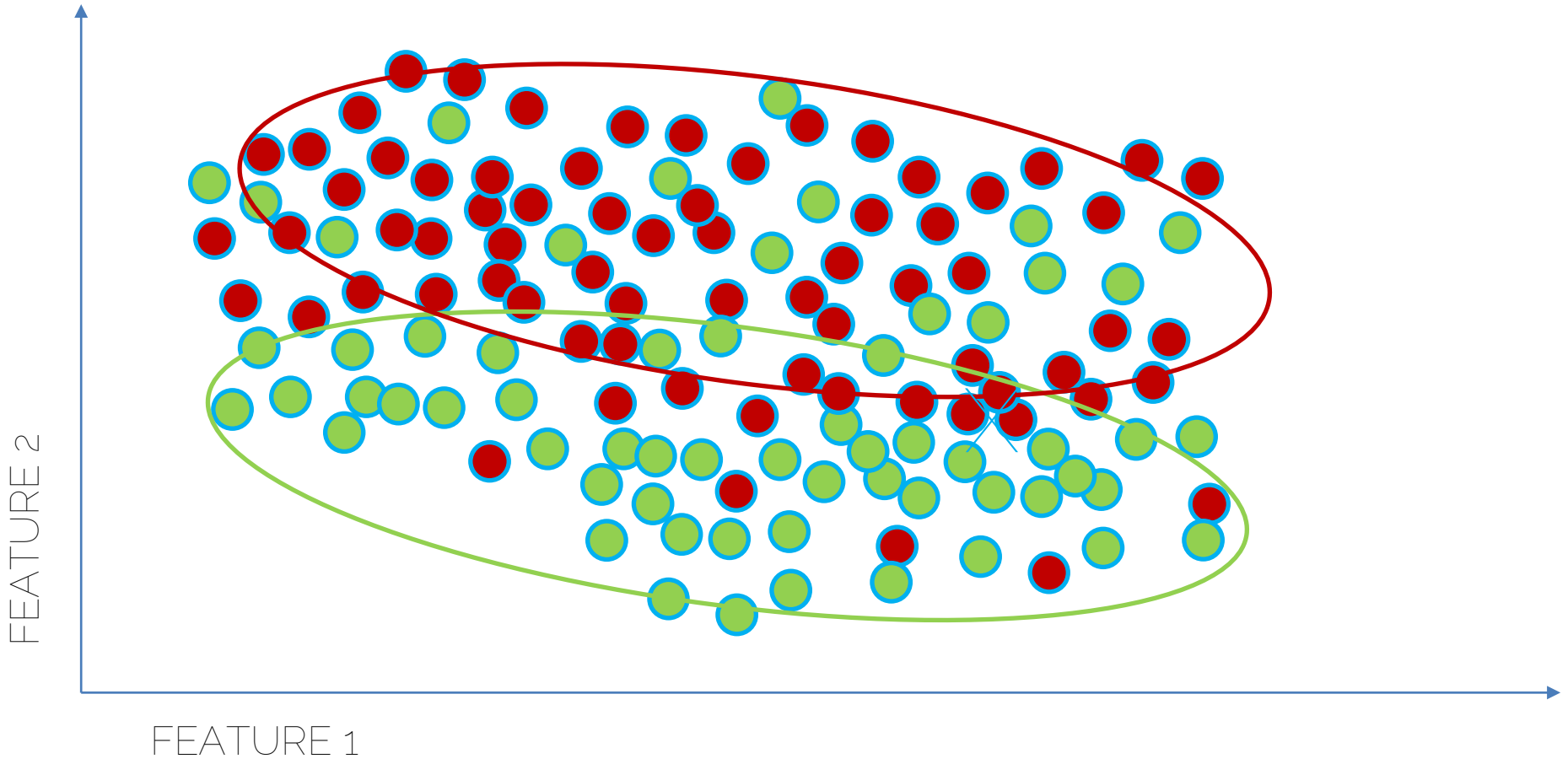
Classification



Classification



Classification



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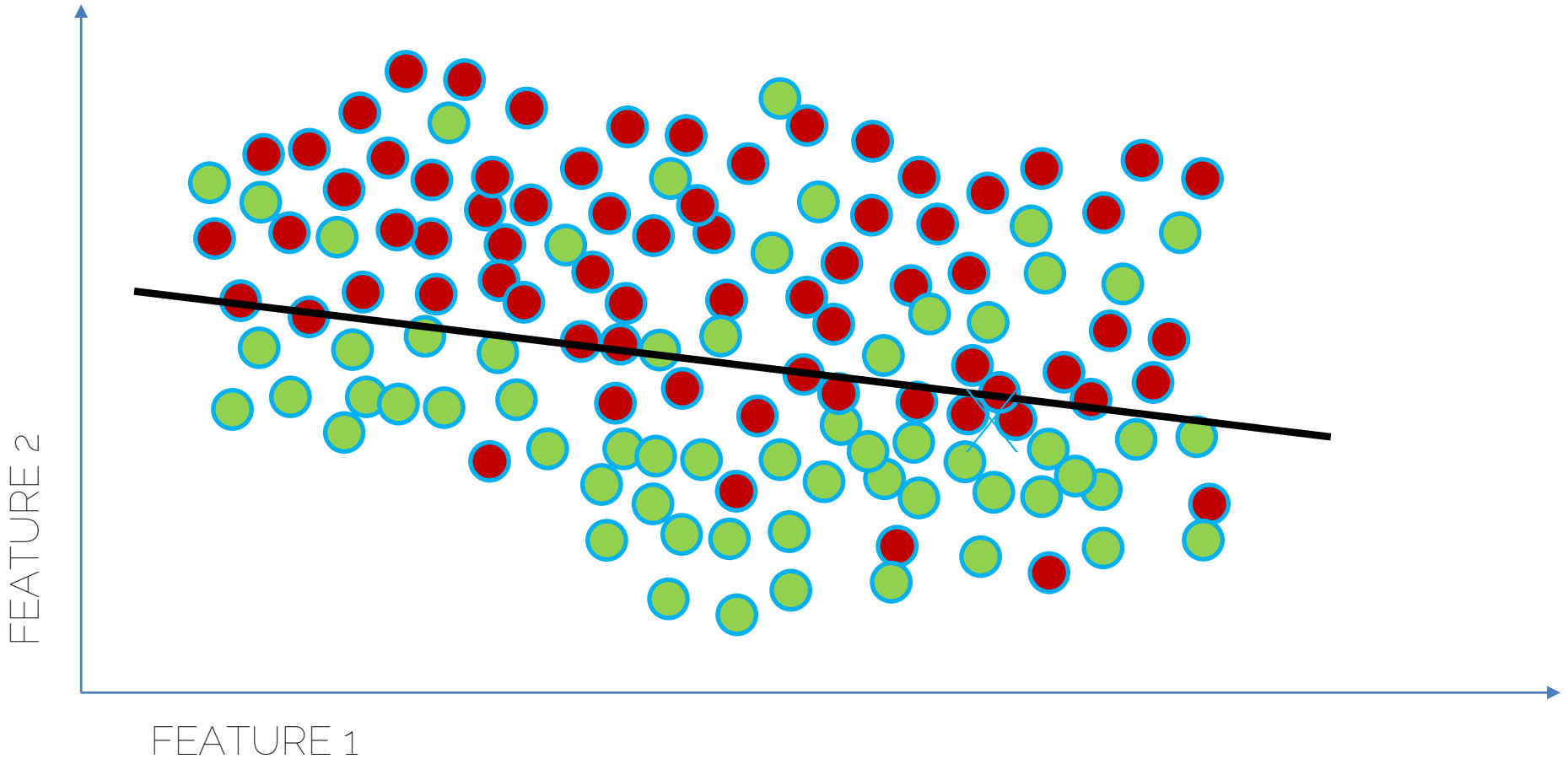

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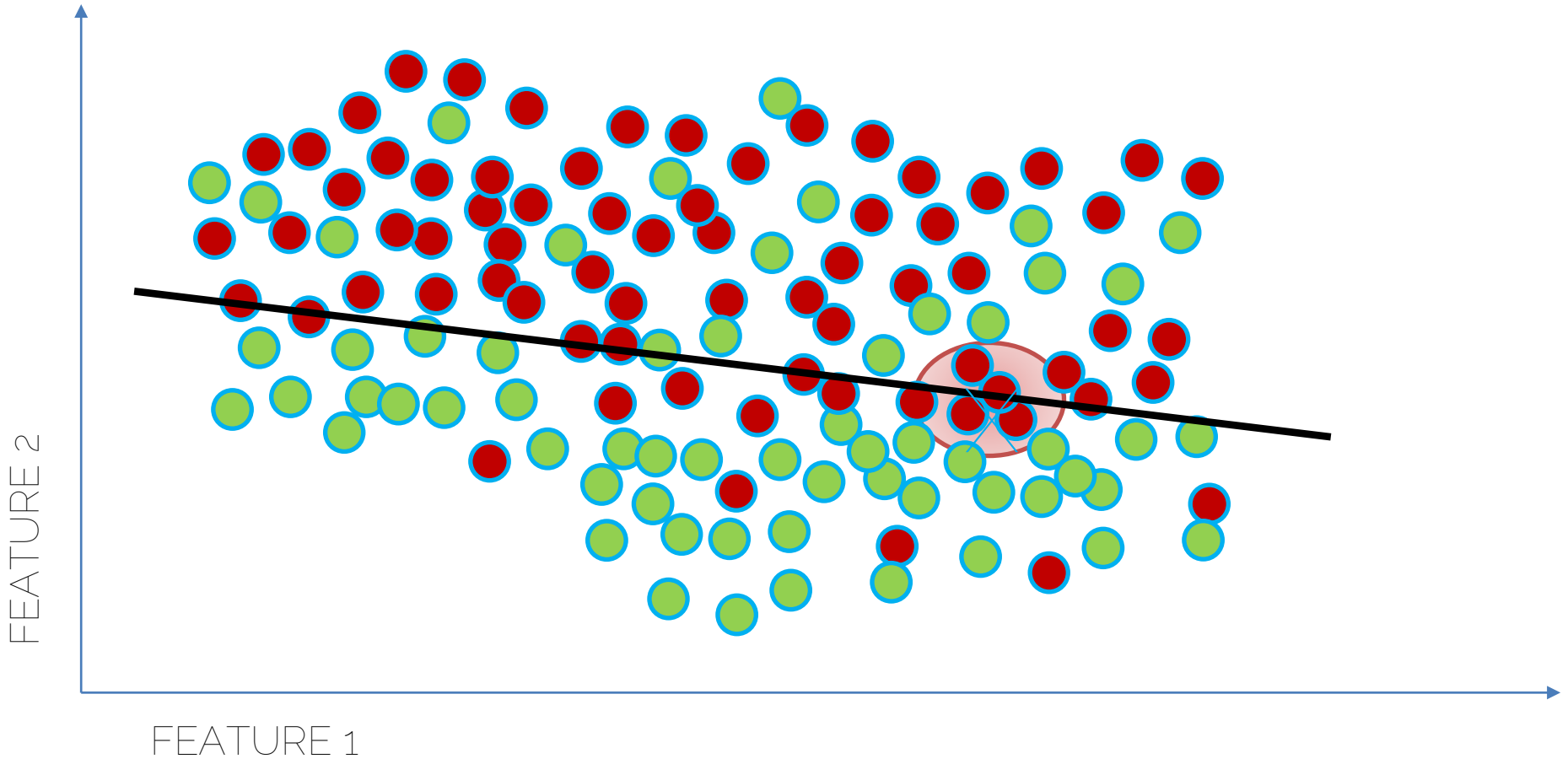
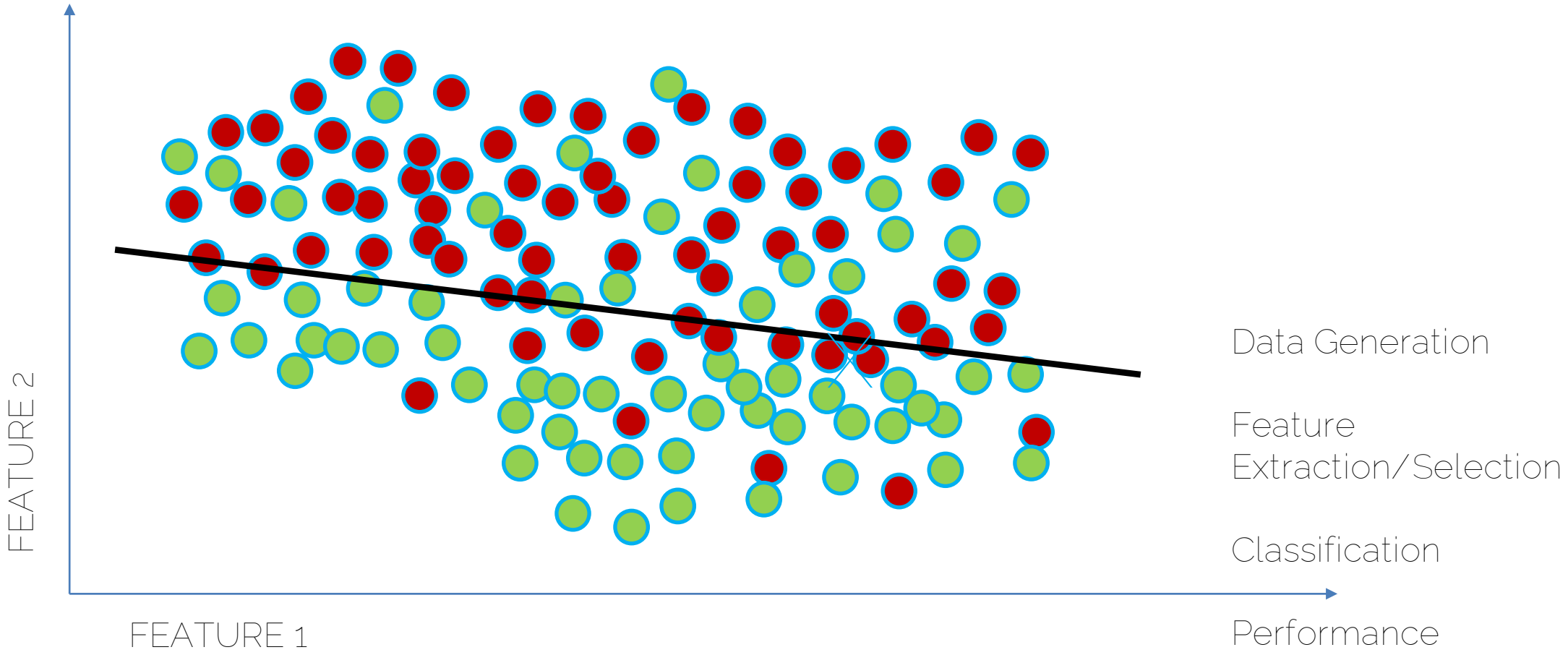


Classification



Vocabulary

DATASET

FEATURES
VARIABLES

SAMPLES

LABEL

TRAINING
VALIDATION
TESTING

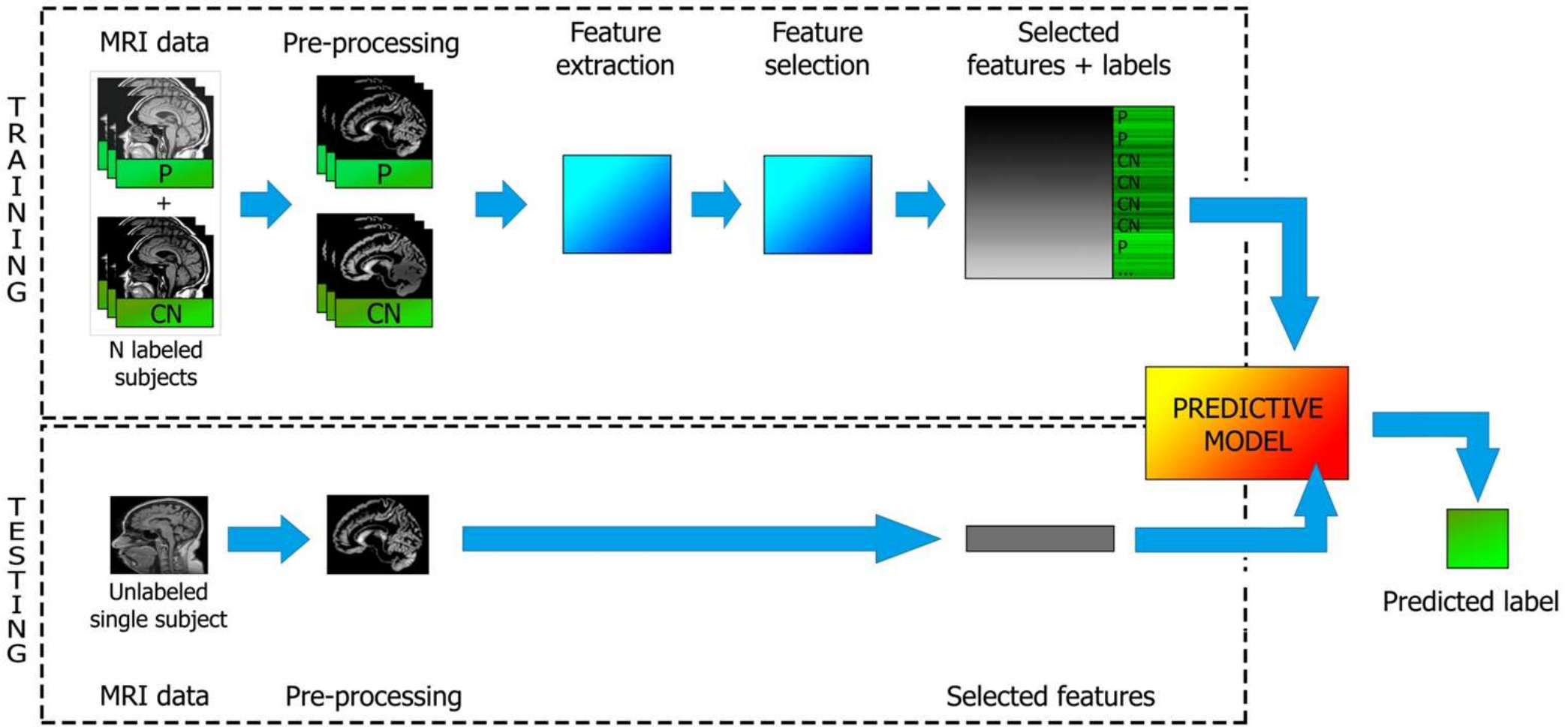
CLASSIFICATION
PREDICTION
GENERATION

TRAINING SET / DATA
VALIDATION SET / DATA
TESTING SET / DATA

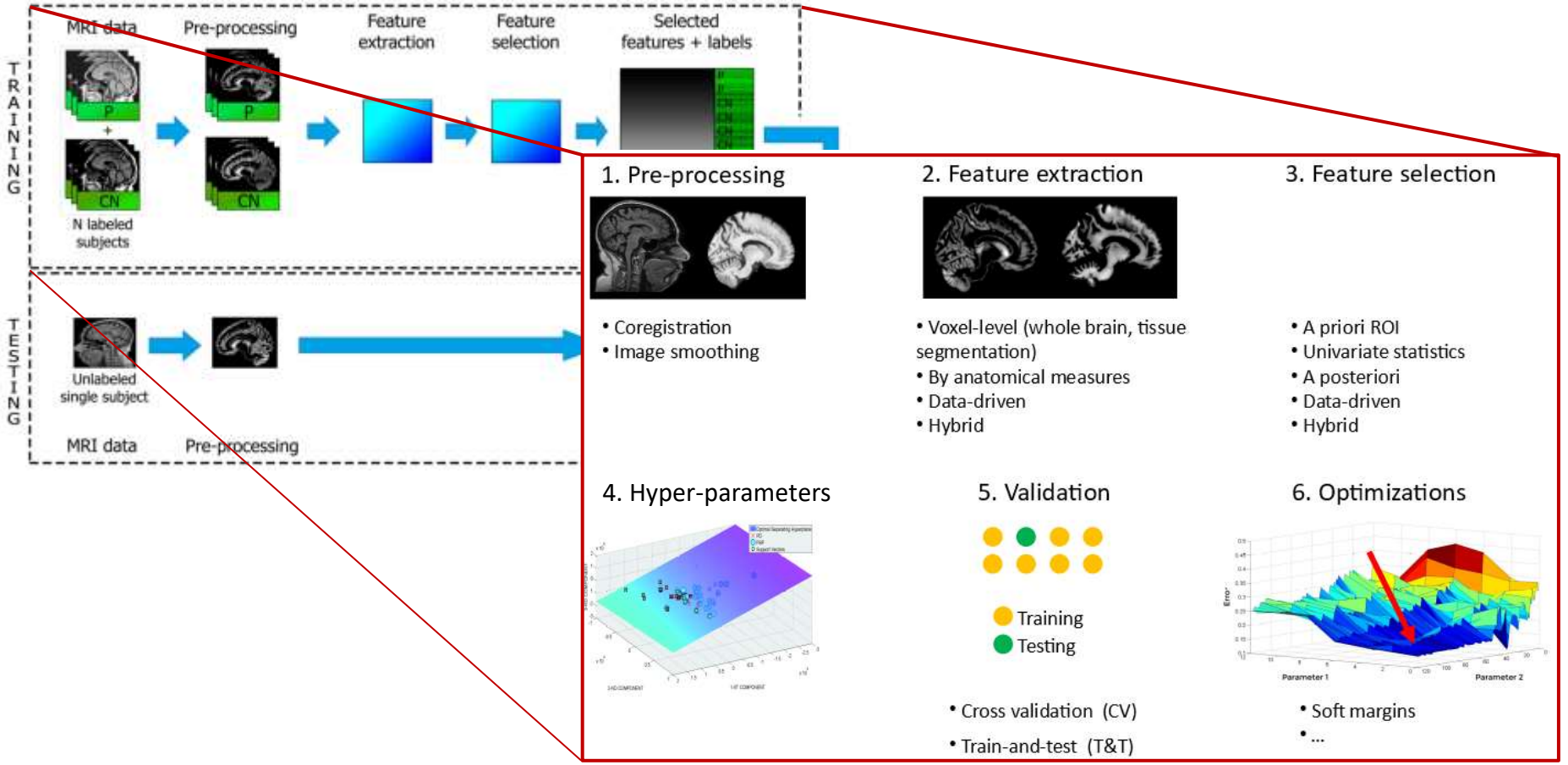
TARGET

TRAINING PERFORMANCE
VALIDATION PERFORMANCE
TESTING PERFORMANCE

Machine Learning Applied to Imaging Data

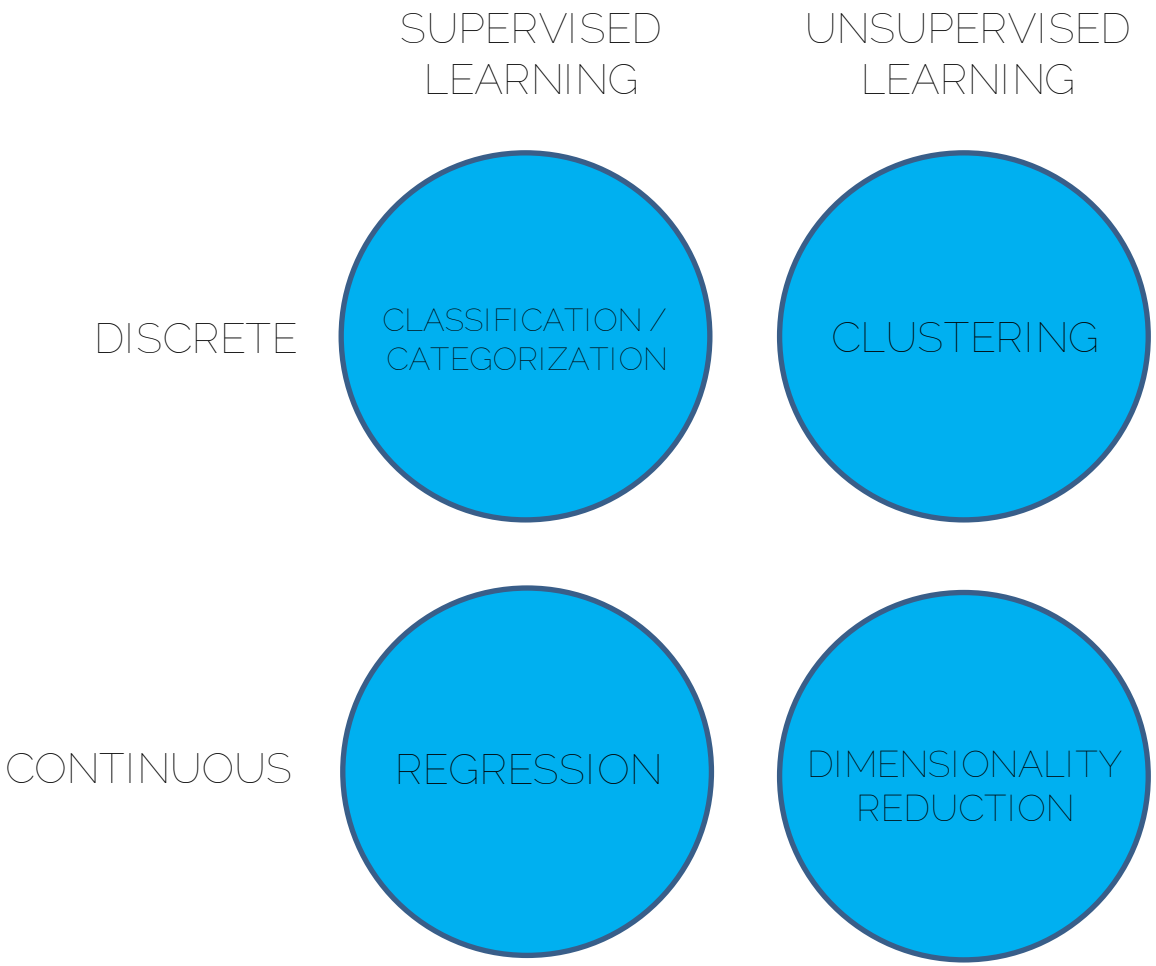


Machine Learning Applied to Imaging Data



Machine learning

Categorization by the output of the algorithm



Machine learning

Categorization by the nature of the feedback