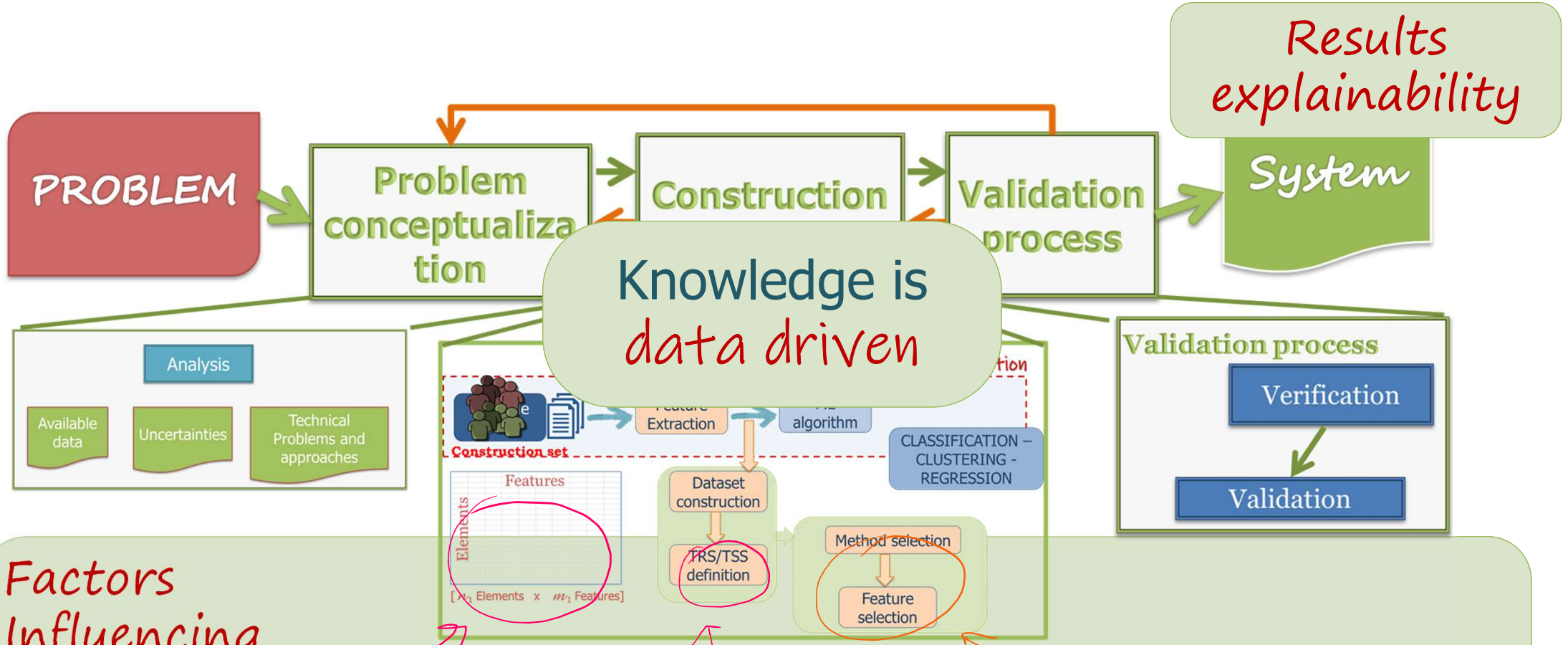
Lezione 9

19 Maggio 2023

Artificial Intelligence

The steps to construct an intelligent systems



Dimensionality Reduction

A new problem is: if we have a great number of variable are we sure that all of them are useful?

There are a lot of different applications (multiple regression, classification, clustering)…

…. and also different methods to solve the problem.

Dimensionality Reduction (DR) of multivariate data represents a set of powerful methods for automatically

- ✓ deleting those attributes that are not predictive of the final state of the system (*irrelevant*) or highly correlated with other variables and interchangeable with them (*redundant*),
- ✓ highlighting the features relevant for the system description.

Dimensionality Reduction

Two different approaches are available for performing DR on datasets:

Feature construction

generates a completely new set of features from the original ones;

it results in a more difficult interpretation because the new features do not correspond to the original ones;

since the new attributes are obtained as a linear or non-linear combination of all initial ones, all features needed to be always collected

Feature selection

selects a minimal number of relevant and informative features from the initial set of variables;

the amount of information with respect to the original variables is kept intact;

the meaning of the features is preserved.

Feature selection

It is quite possible for two features to be useless individually, and yet highly predictive if taken together.

In FS terminology, they may be both redundant and irrelevant on their own, but their combination provides invaluable information.

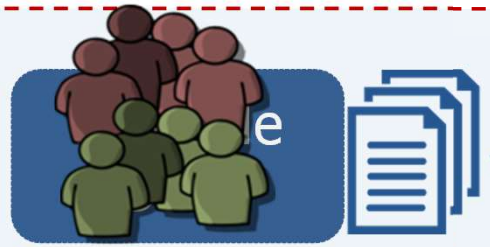
The selection of features can be achieved in two ways:

- ✓ ***Ranking*** the features according to some criterion and select the top k features
- ✓ ***Selecting*** a minimum subset of features without learning performance deterioration.

Subset selection algorithms can automatically determine the number of selected features, while feature ranking algorithms need to rely on some given threshold to select features.

Classification means…

Construction



Construction set

Feature Extraction

ML algorithm

CLASSIFICATION

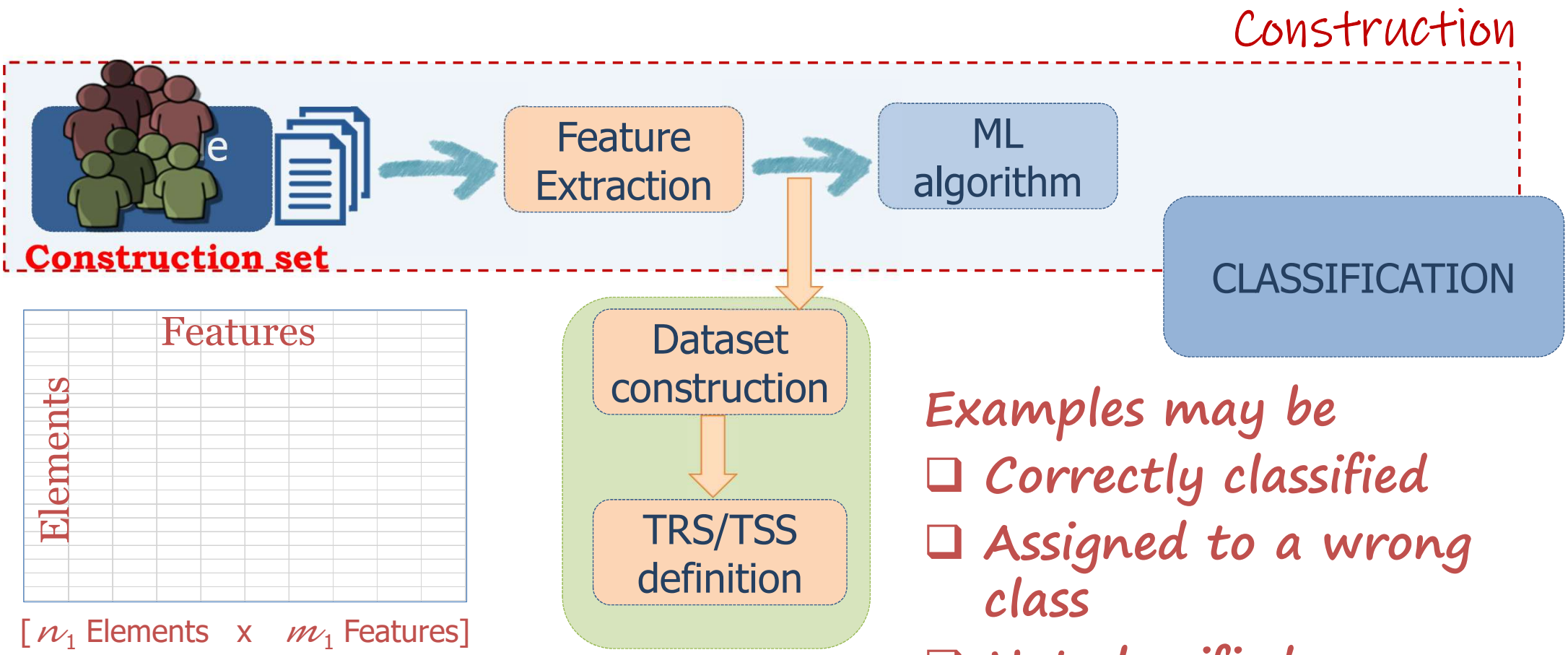
[n_1 Elements x m_1 Features]

Dataset construction

TRS/TSS definition

Given a set of classes and an element, the element must be assigned to a class.

Classification results

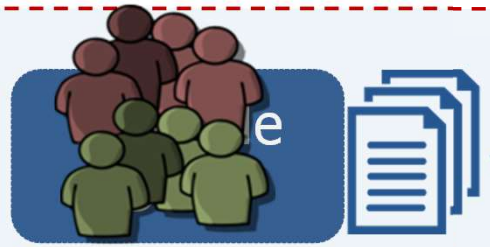


Examples may be

- Correctly classified
- Assigned to a wrong class
- Not classified

Clustering means…

Construction



Construction set

Feature Extraction

ML algorithm

CLUSTERING

Features

Elements

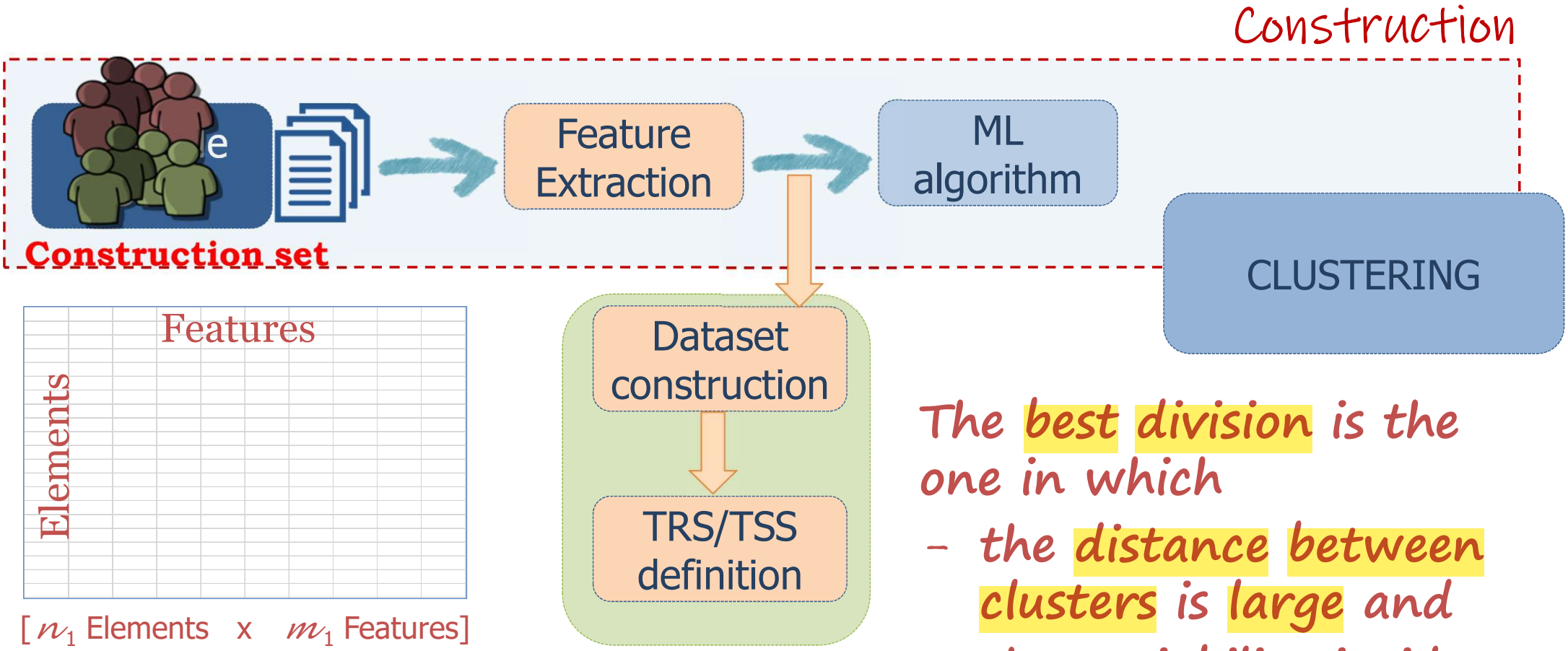
[n_1 Elements x m_1 Features]

Dataset construction

TRS/TSS definition

Given a set of elements we want to divide them in groups called clusters.

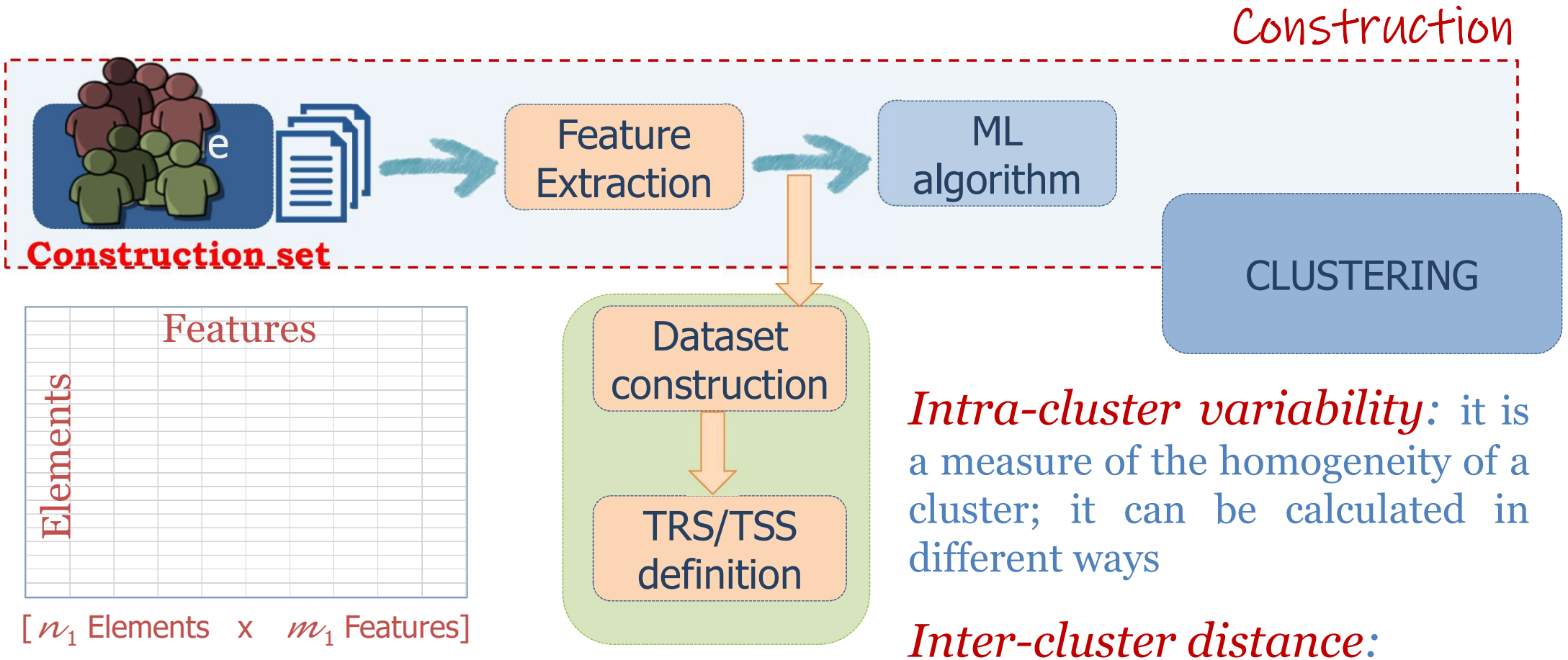
Clustering results



The best division is the one in which

- the distance between clusters is large and
- the variability inside each cluster is small.

Clustering methods

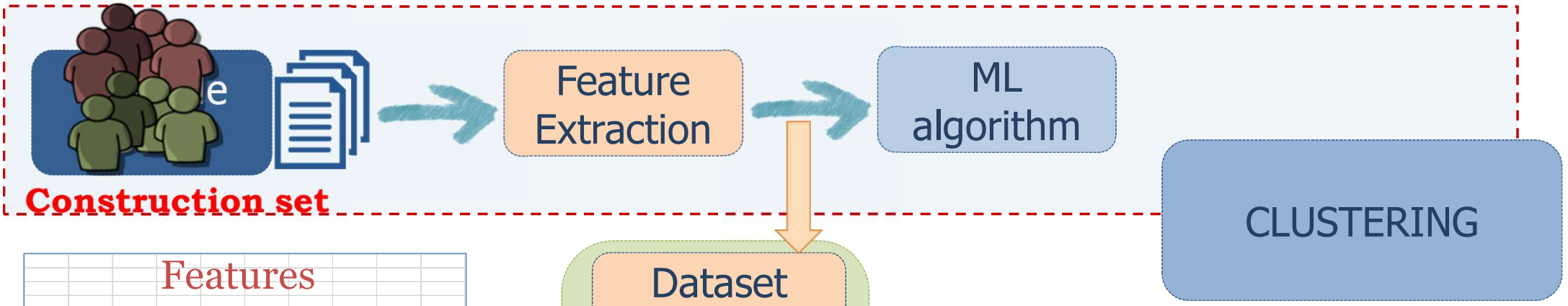


Intra-cluster variability: it is a measure of the homogeneity of a cluster; it can be calculated in different ways

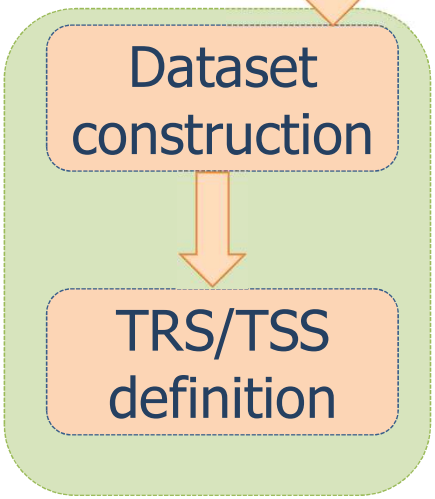
Inter-cluster distance: distance between two clusters

Clustering methods

Construction



[n_1 Elements x m_1 Features]

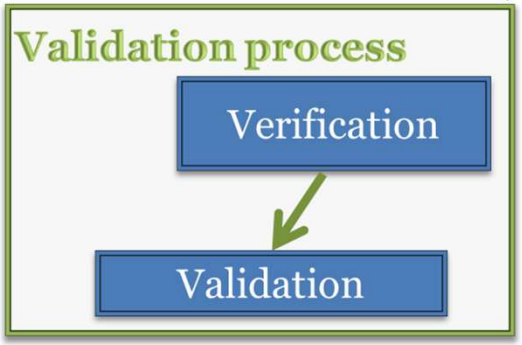


Types of clustering methods

- ❑ Centroid-based clustering
- ❑ Density-based clustering
- ❑ Distribution based clustering
- ❑ Hierarchical clustering

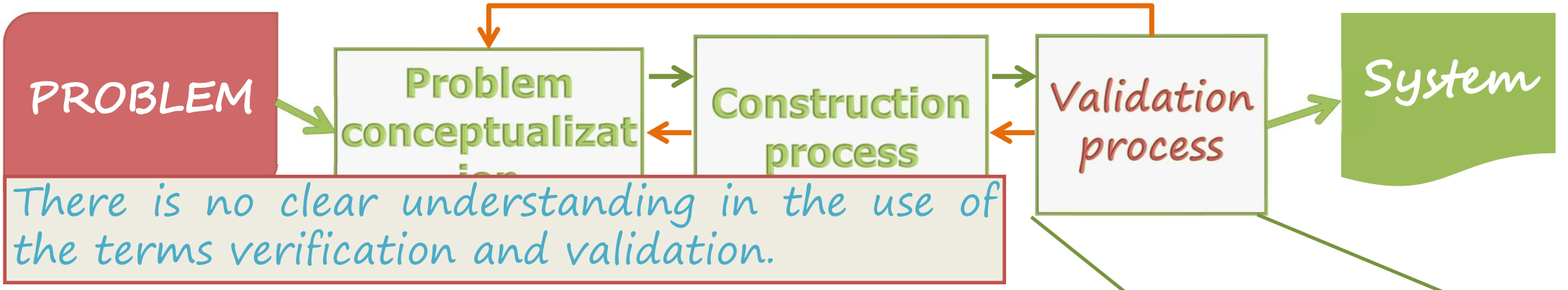
Intelligent Systems Development

There is no clear understanding in the use of the terms verification and validation.



Results explainability

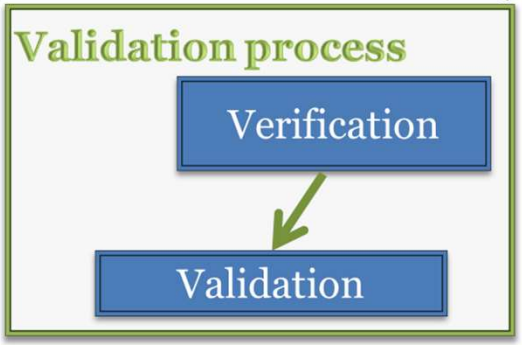
Intelligent Systems Development



There is no clear understanding in the use of the terms verification and validation.

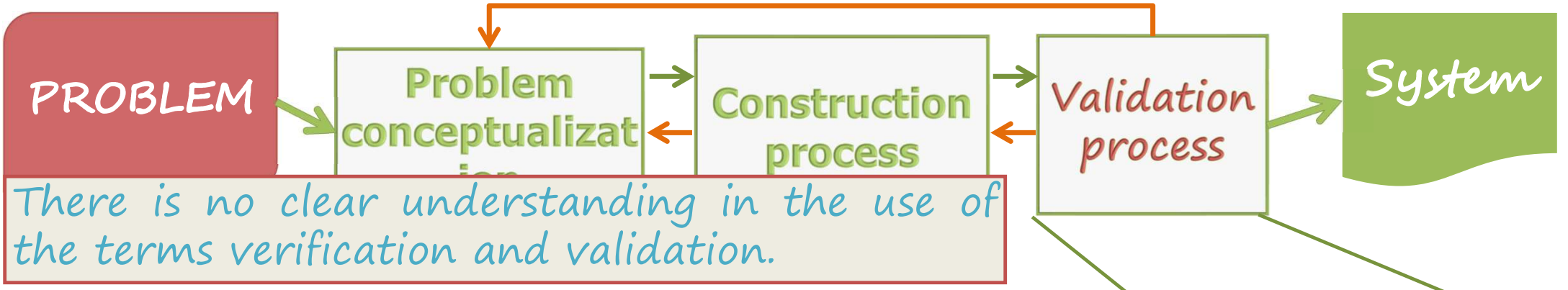
The difference between verification and validation is:

- ✓ **Verification** is the experimental process of ensuring that *you did things right*, e.g. the system meets the requirements
- ✓ **Validation** is the experimental process of demonstrating that the design implementation (e.g., the actual product, process, or service) meets the user needs; it is the process of ensuring that *you did right thing*.



Results explainability

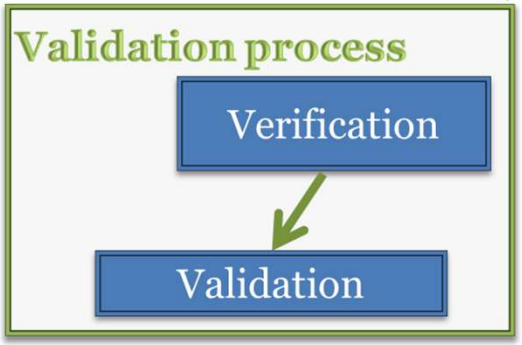
Intelligent Systems Development



There is no clear understanding in the use of the terms verification and validation.

The difference between verification and validation is:

- ✓ **Verification** (the system meets the requirements) possible checks: every example we have is classified, performances are satisfactory, clusters are homogeneous and well separated, …
- ✓ **Validation** (the system meets the user needs) possible checks: generalization performances, clusters have clinical meaning, …



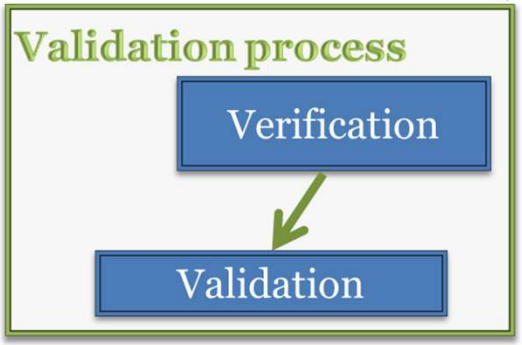
Results explainability

There is no clear understanding in the use of the terms verification and validation.

Different activities are performed during the **Verification** process and the **Validation** process

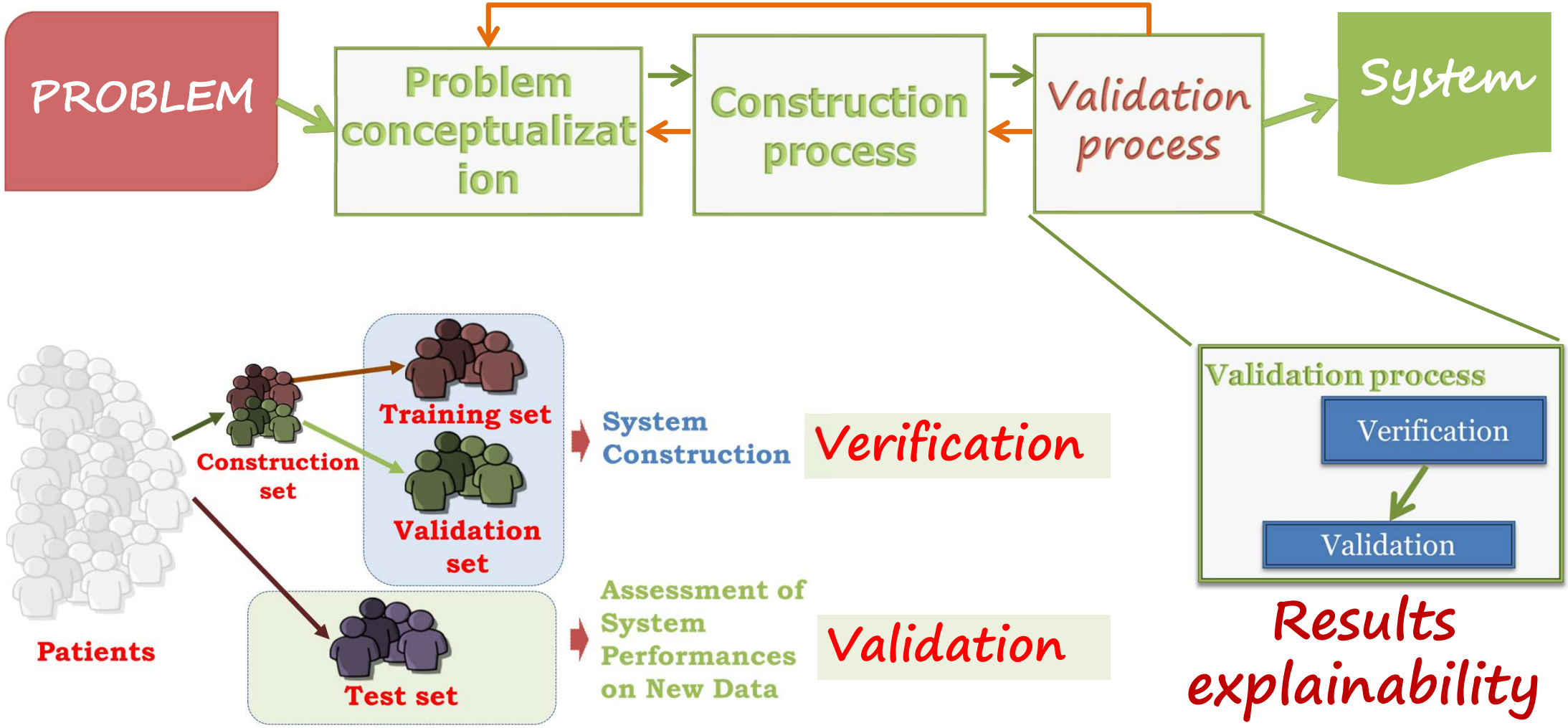
In general, **we use the term testing to refer to these activities**

Activities related to the verification process are performed both during and at the end of the construction process.

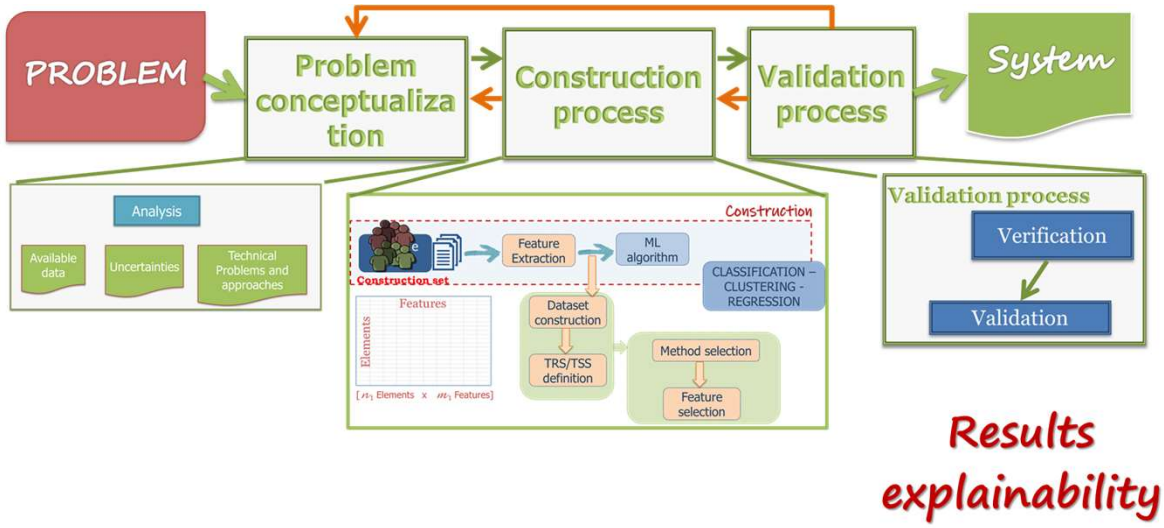


Results explainability

Intelligent Systems Development



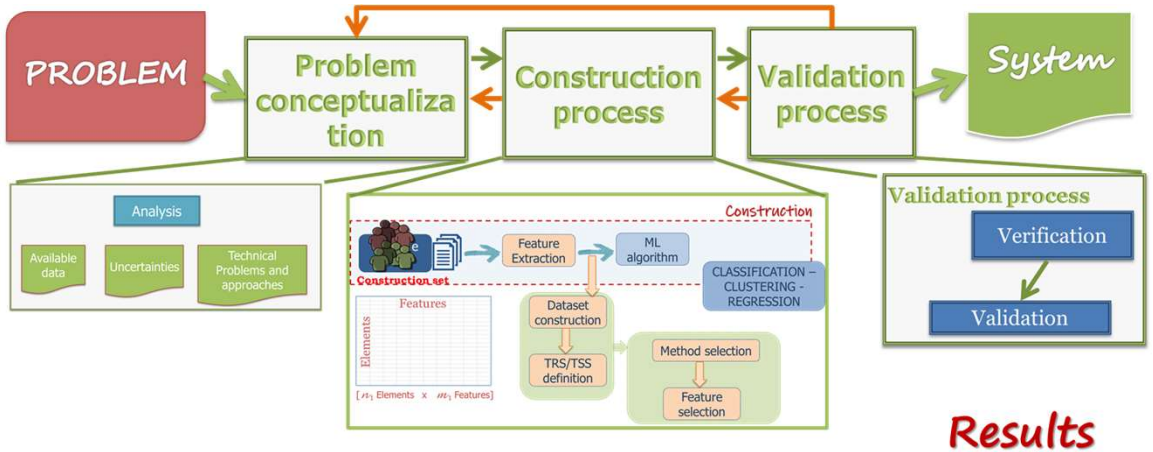
Explanaibility: an open problem



Results explainability

The are methods that are more suited for giving explanation of their results but not always they give the better results

Explanaibility: an open problem



Results explainability

The are methods that are more suited for giving explanation of their results but not always they give the better results

Rules as a knowledge representation technique

vs

Black box as a knowledge representation technique

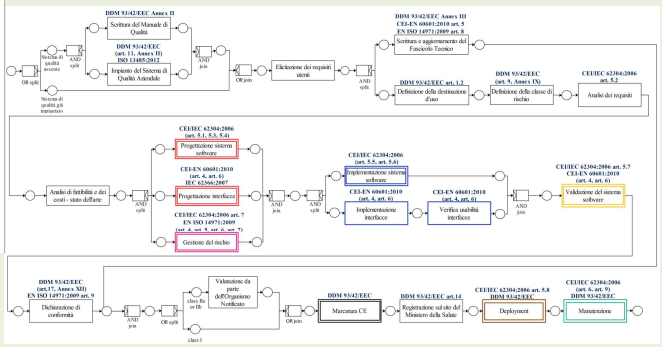
MEDICAL DEVICE SOFTWARE

Requirements Elicitation | Requirements Analysis | Software construction | Testing | Certification | Deployement

Prepare the technical documentation
necessary to demonstrate the conformity to MDR745: CE Technical File

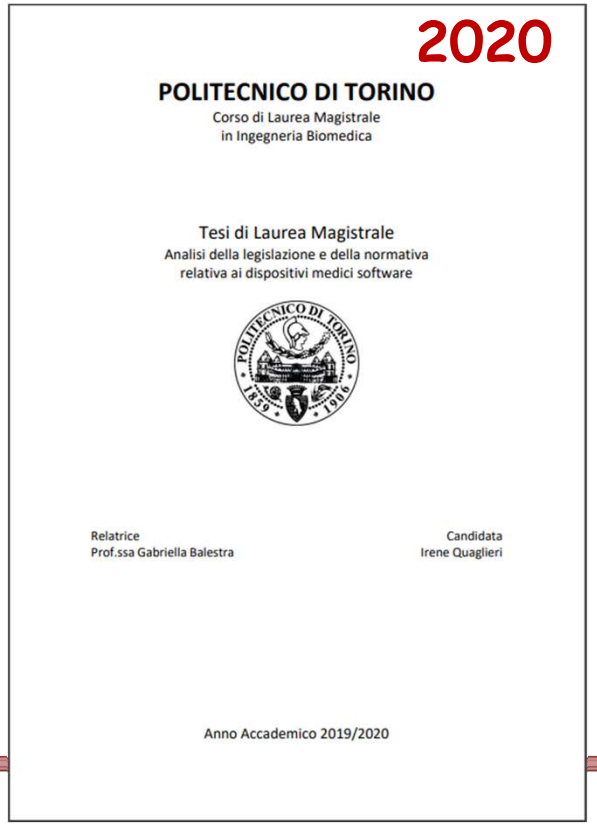
MEDICAL DEVICE SOFTWARE

2014

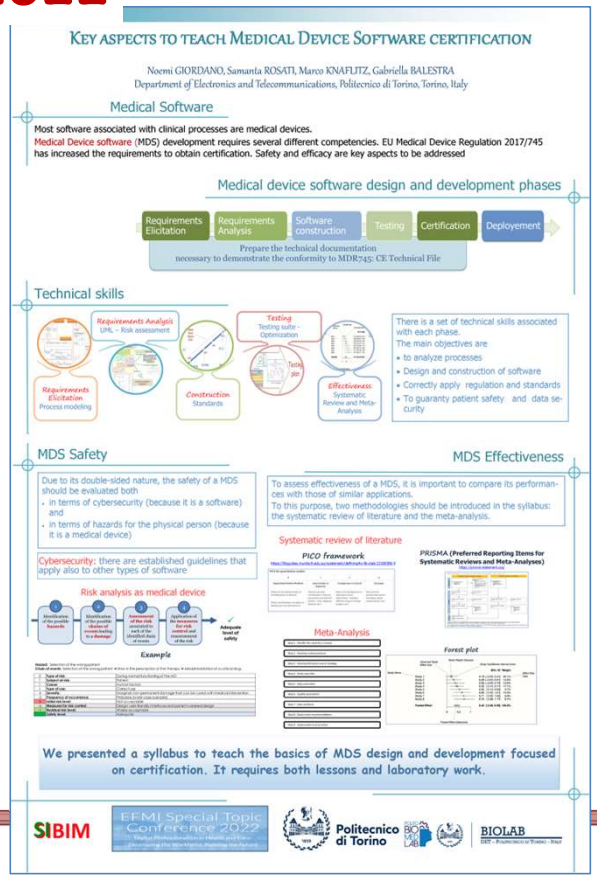


Developing medical device software in compliance with regulations
M Zema, S Rosati, V Gioia, M Knaflitz, G Balestra
2015 37th Annual International Conference of the IEEE Engineering in …

2020



2022




Healthcare IT News TOP

Global Edition Artificial Intelligence

FDA action plan puts focus on AI-enabled software as medical device

The agency plans to take a "multi-pronged approach" to advancing oversight of machine learning-enabled devices – with an eye toward ensuring patient safety, algorithm transparency and real-world results.

Healthcare IT News

The Diverse Roles of AI & ML Global Edition

FDA issues landmark clearance to AI-driven ICU predictive tool

CLEW Medical's ICU tool uses machine learning models to identify patients whose conditions are likely to deteriorate.

By Kat Jercich | February 04, 2021 | 11:42 AM

The U.S. Food and Drug Administration has authorized the use of CLEW Medical's artificial intelligence tool to predict hemodynamic instability in adult patients in intensive care units, the company announced on Wednesday.

The tool, CLEWICU, uses AI-based algorithms and machine learning models to identify the likelihood of occurrence of significant clinical events for ICU patients.

9 novembre 2021

Ministero della Salute

Consiglio Superiore di Sanità

Sessione LII (2019-2022)

Presidente: Prof. Franco Locatelli

Sezione V*

Presidente: Prof. Giuseppe Remuzzi
Segretario tecnico: Dr. Franco Abbenda

"I sistemi di intelligenza artificiale come strumento di supporto alla diagnostica"

L'Intelligenza Artificiale (Artificial Intelligence, AI nella dizione anglosassone), in questi ultimi anni, ha rivoluzionato la quotidianità dei cittadini e, considerando la velocità dello sviluppo tecnologico, ne modificherà i comportamenti e le abitudini anche nel prossimo futuro.

Il mondo sanitario in generale, e quello della diagnostica per immagini in particolare, seppur con comprensibile ritardo data la maggior complessità dei processi, sta subendo il medesimo sconvolgimento. La prospettiva, più o meno a breve termine, sarà di doversi confrontare con sistemi esperti in grado di modificare significativamente i percorsi diagnostici e terapeutici, le modalità decisionali del Medico e, in ultimo, anche il rapporto Medico-Paziente.

INDICE

… la comunità internazionale ha definito delle procedure standard per il reporting degli studi che coinvolgono l'AIM.

Fra questi, lo *standard MINIMAR (MINimum Information for Medical AI Reporting)* richiede che vengano sempre rispettati i seguenti principi:

(1) includere informazioni sulla popolazione che fornisce i dati di addestramento, in termini di fonti di dati e principi di selezione della coorte;

(2) includere i dati demografici della popolazione da cui è stato appreso il modello, in un modo che consenta un confronto con il proprio gruppo di pazienti o la nuova popolazione a cui si vuole applicare il modello stesso;

(3) fornire dettagli sull'architettura computazionale e sullo sviluppo del modello in modo che sia chiara la finalità del modello di AI, sia possibile confrontarlo con modelli simili e sia possibile la replica dello studio; e

(4) venga riportata in modo trasparente la procedura di valutazione statistica del modello e le procedure impiegate per la stima dei parametri liberi, sempre al fine di poter replicare i risultati.

Healthcare applications of Digital Twin technology

Digital Twin Thechnology

Digital twins may be defined as

artificial

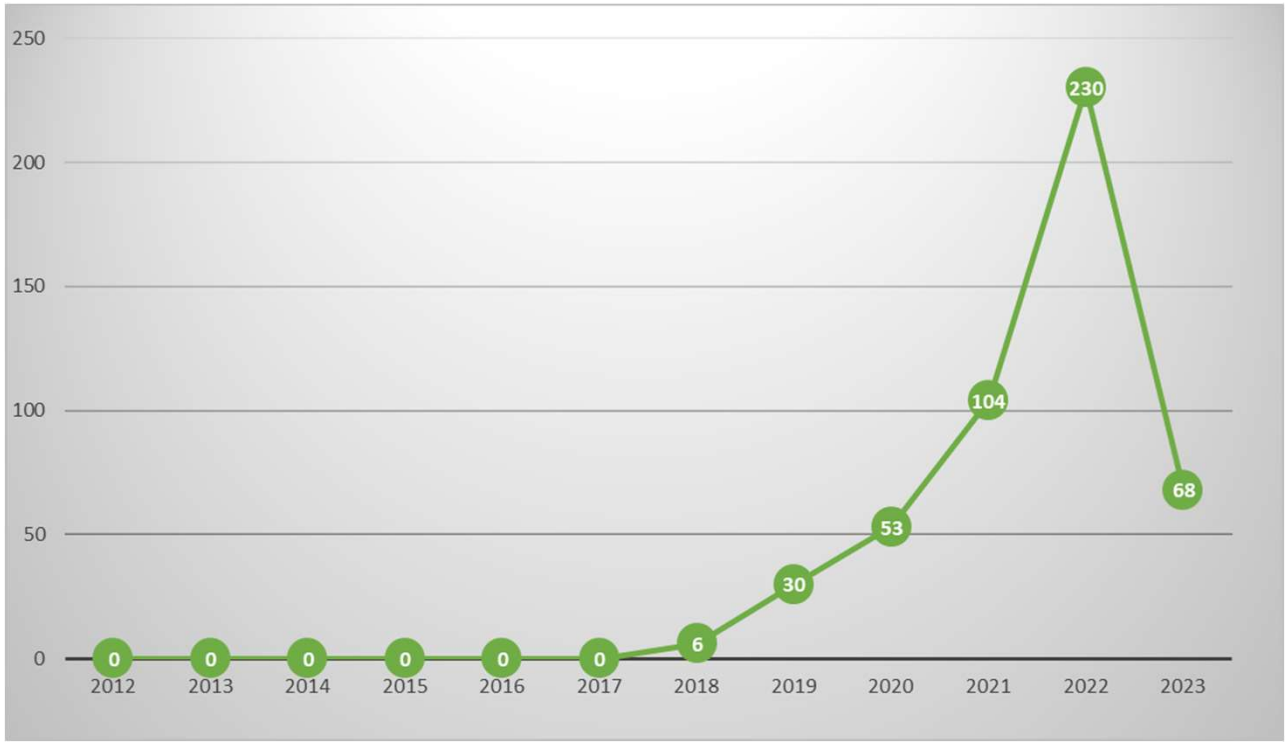
intelligent

virtual

replicas of physical systems.

SCOPUS search 12/05/2023

Digital Twin and (Medical or Healthcare)



491 documenti

Digital Twin Thechnology

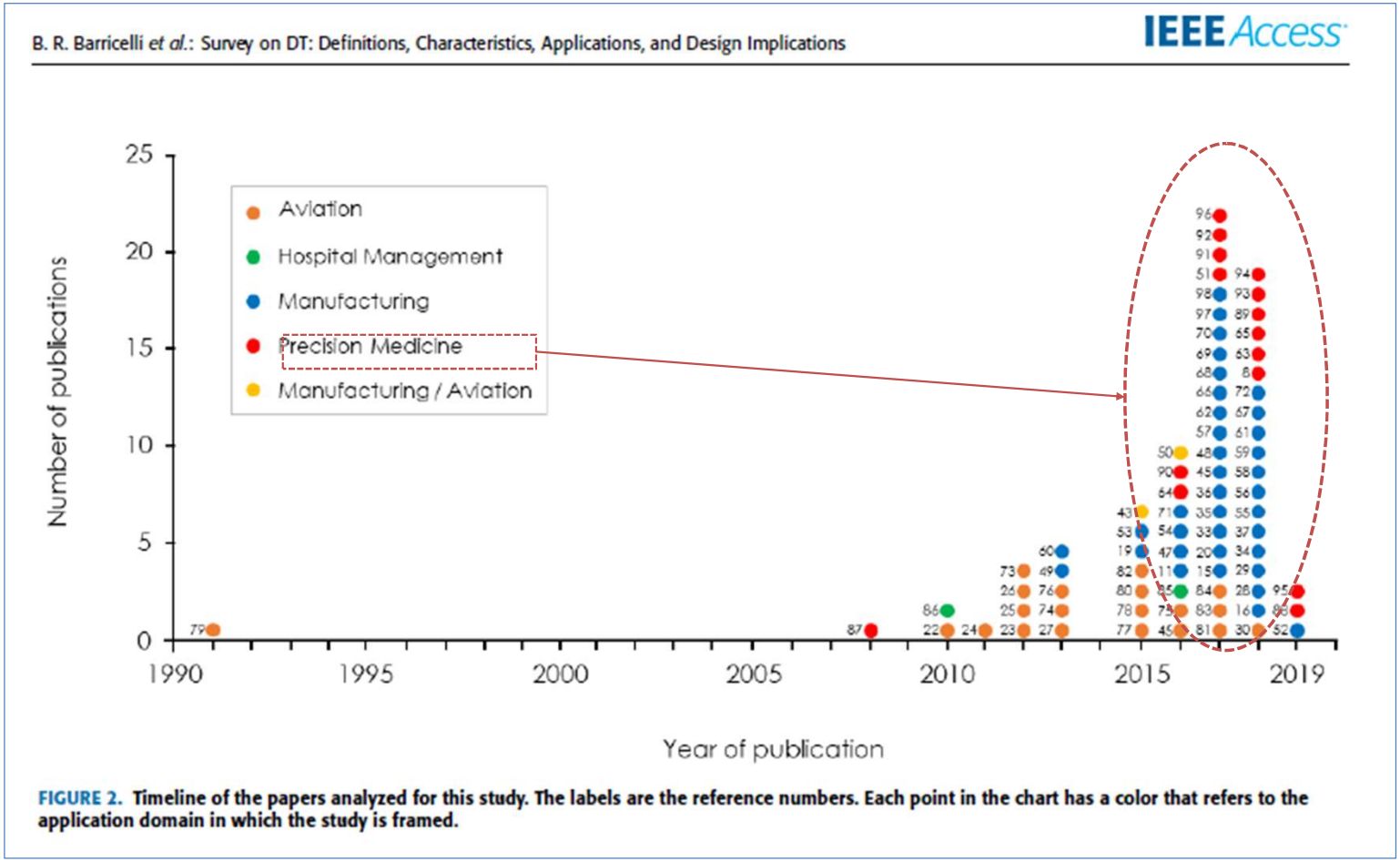


FIGURE 2. Timeline of the papers analyzed for this study. The labels are the reference numbers. Each point in the chart has a color that refers to the application domain in which the study is framed.

A survey on digital twin: Definitions, characteristics, applications, and design implications, Barricelli, B.R., Casiraghi, E., Fogli, D., IEEE Access, Volume 7, 2019, Article number 2953499

Digital Twin Thechnology

Digital Twin

Digital Twin and Healthcare

YouTube IT

Digital Twin and Healthcare and Artificial Intelligence

Application: Cardio Twin

Cardio Twin: A Digital Twin of the human heart running on the edge
Martinez-Velazquez, R., Gamez, R., Saddik, A.E.
Medical Measurements and Applications, MeMeA 2019

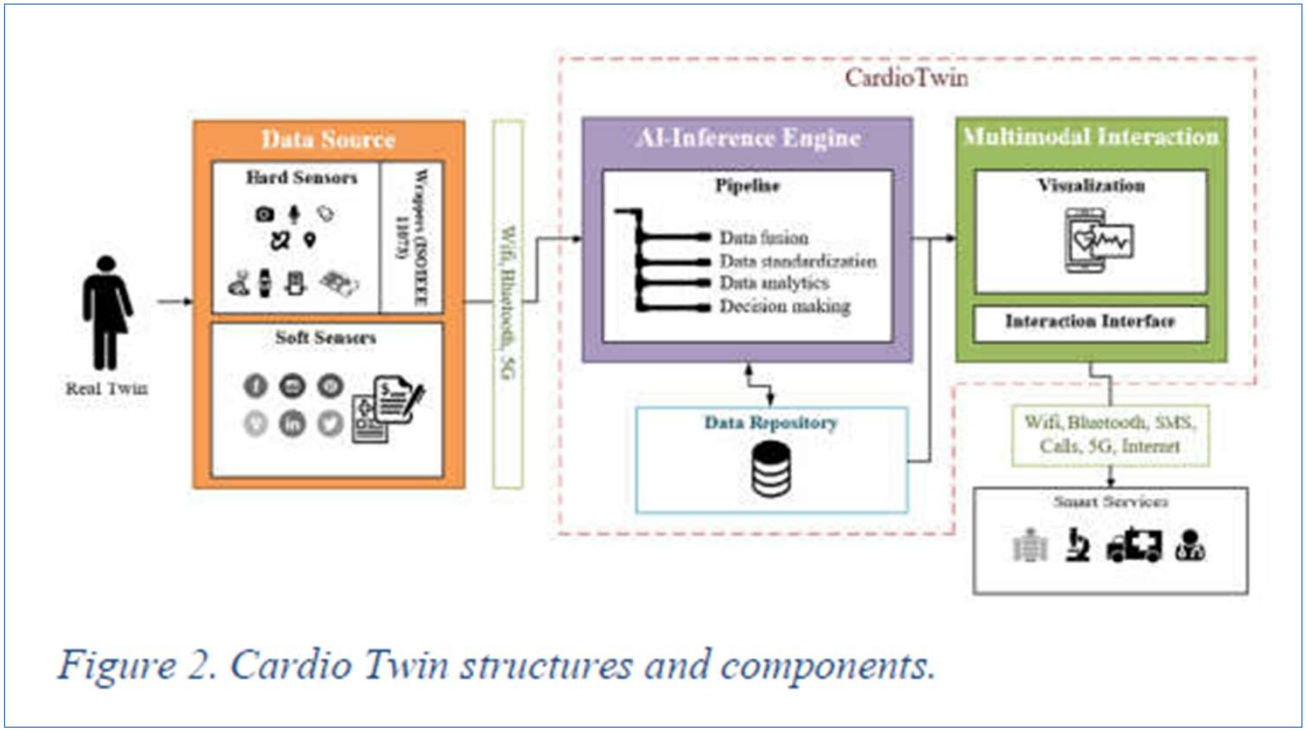


Figure 2. Cardio Twin structures and components.

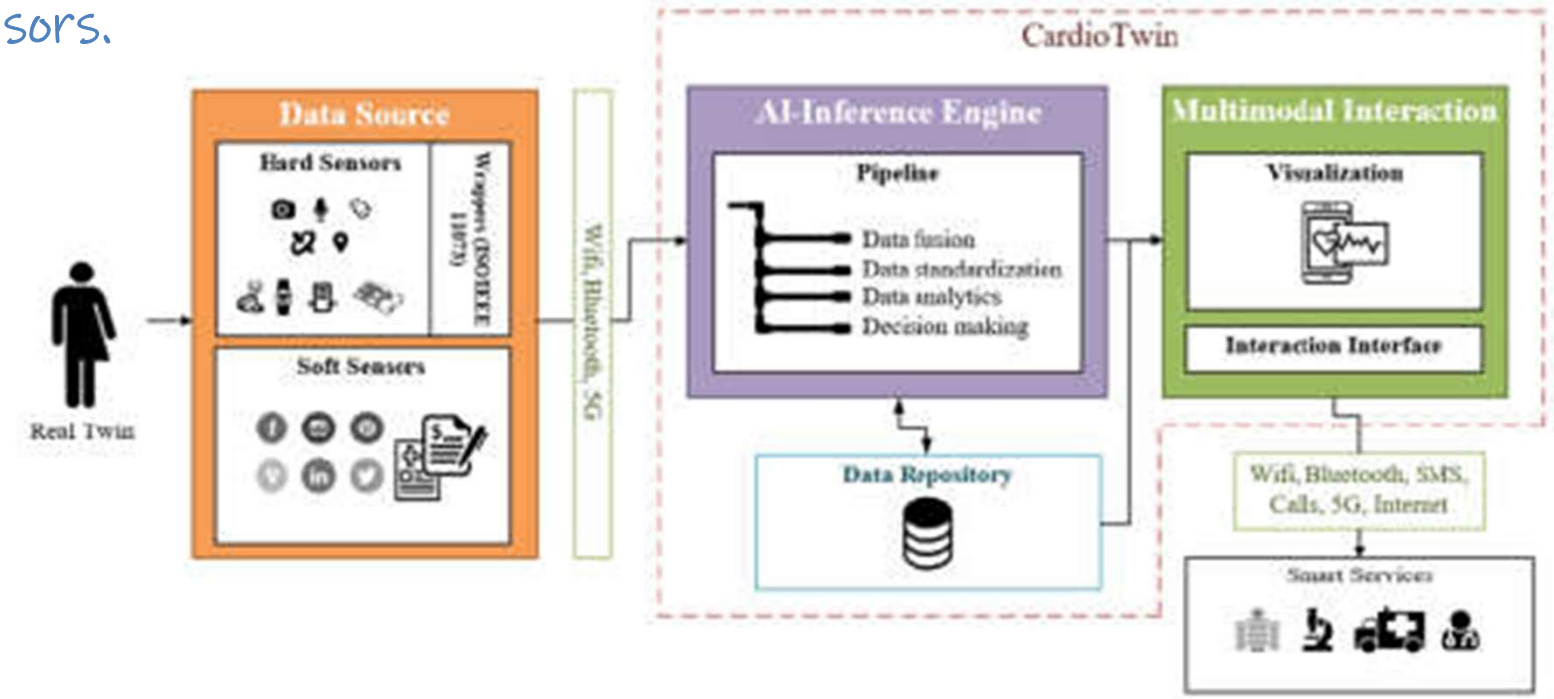
AIM

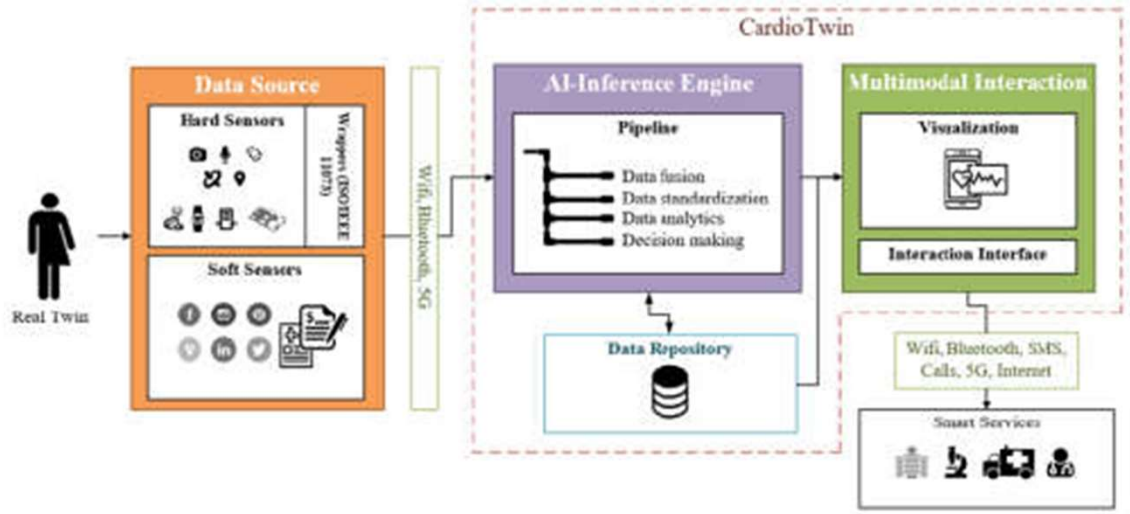
Cardio Twin is an architecture of a Digital Twin for healthcare and well-being running on the edge to help in the event of a IHD (Ischemic Heart Diseases) situation.

It is a platform conceived as a twin of a human heart with the idea of detecting, preventing and reduce the risk of suffering heart diseases.

Cardio Twin collects data from sensors (body area network), medical records, social networks and external sensors.

Machine learning interprets all the collected data and take appropriate action through the execution of instruction pipelines.

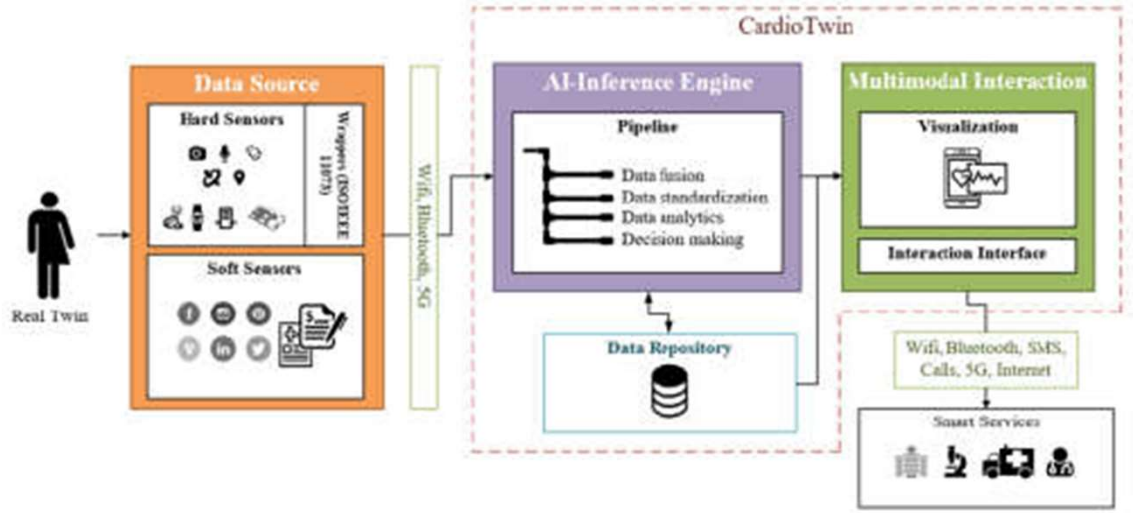




Imagine that a doctor wants to see the patient heart's current condition during a visit in the screen of his/her office.

The interaction interface and the visualization service will take care of the data transmission and the whole process.

With this feature, a patient could be virtually present in the doctor's office regardless of distance and the actual visit might not even be necessary.



Even if the authors do not explicitely declare it

among the possible actions of the platform we can imagine that

the system can assist the subject

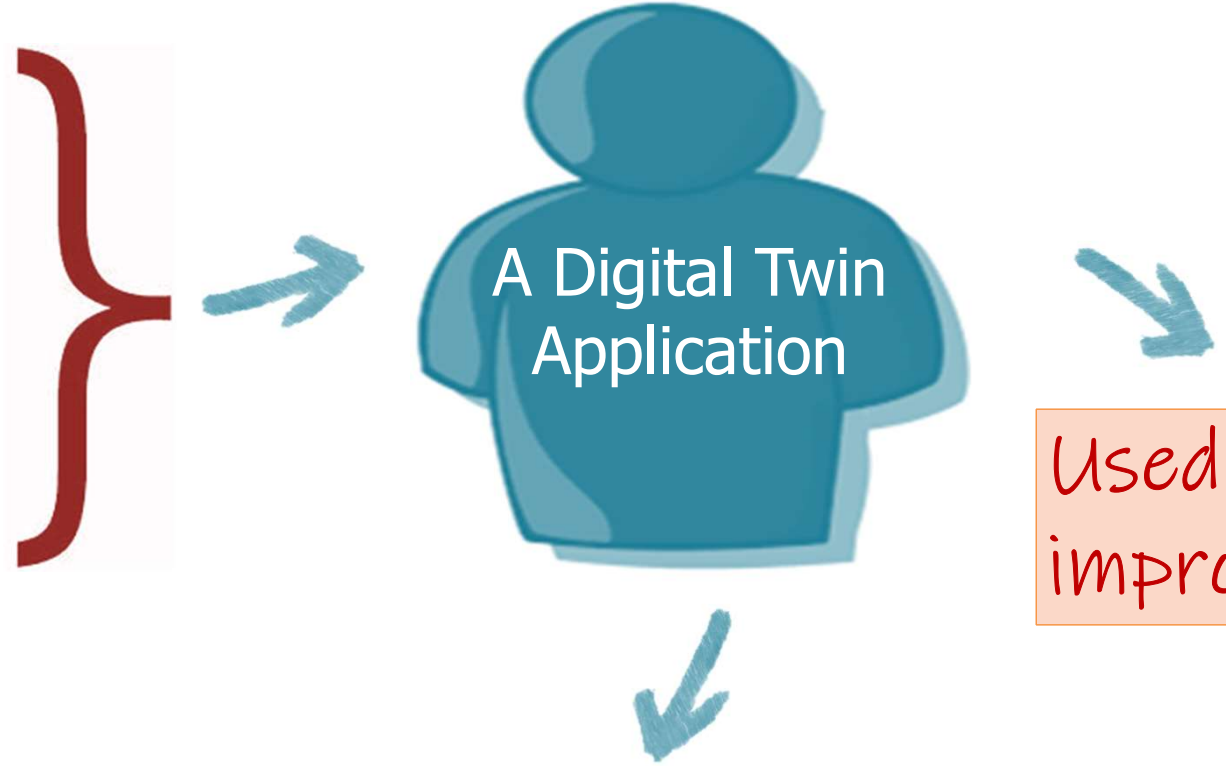
in taking care of her/his cardiac problems

… the future

Artificial Intelligence

Sensors

Medical Software

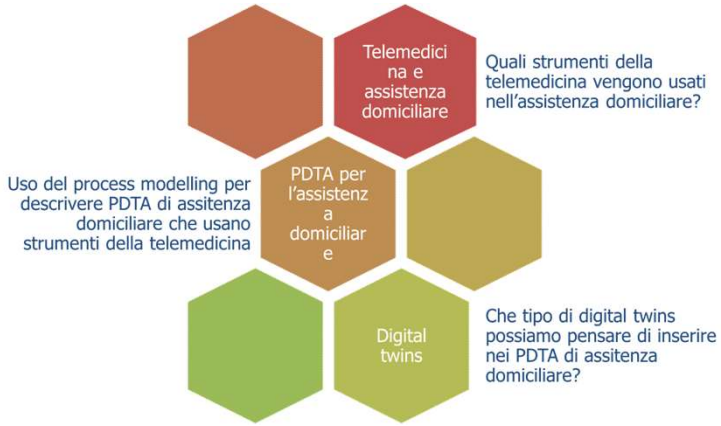


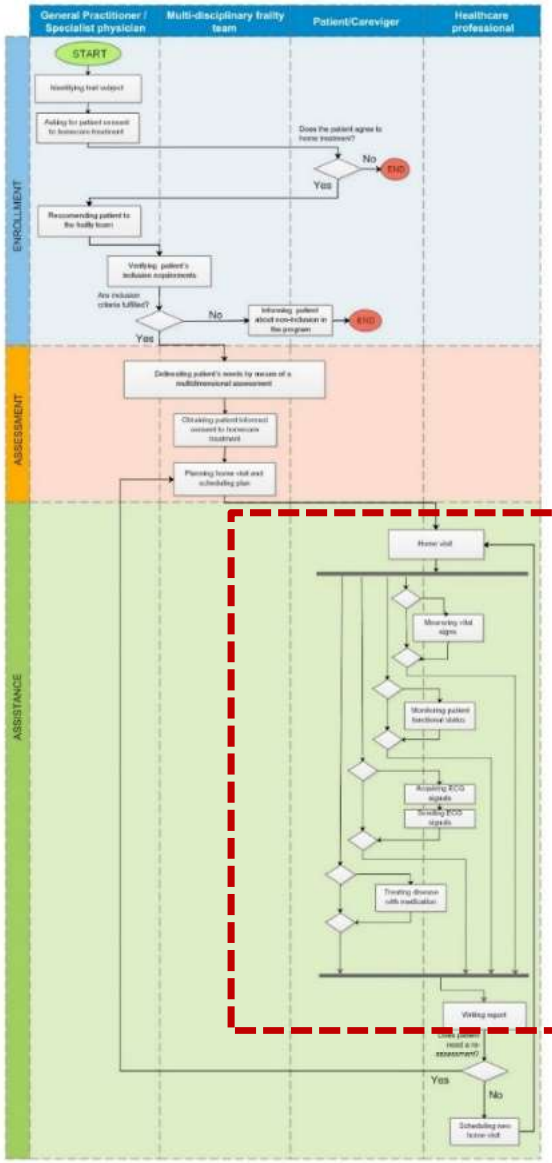
Used to improve care

Patient Empowerment


Lavoro di gruppo

Lavoro di gruppo





personalizzare