MEDEA
Multidimensional seismic risk assessment through explainable artificial intelligence

Co-funded by the European Union

UNIVERSITÀ DI PISA

Multidimensional seismic risk assessment combining structural damages and psychological consequences using explainable artificial intelligence

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Francesco Pistolesi
University of Pisa (UNIPI)
Department of Information Engineering
francesco.pistolesi@unipi.it

European Union

Union Civil Protection Knowledge Network

Work packages

Work package WP4 – XAI to estimate EDP values, structural/psychological damages, and losses

Work Package Number	WP4	Lead Beneficiary	2. UNIPI
Work Package Name	XAI to estimate EDP values, structural/psychological damages, and losses		
Start Month	4	End Month	18

Work package WP5 – Implementation of the website and web application

Work Package Number	WP5	Lead Beneficiary	2. UNIPI
Work Package Name	Implementation of the website and web application		
Start Month	1	End Month	24

Milestones and Deliverables

Milestones

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
6	XAI models	WP4	2-UNIPI	XAI models successfully implemented and trained.	15
7	Data fusion	WP4	2-UNIPI	Data fusion techniques developed	18
8	Website	WP5	2-UNIPI	The website is online.	2
9	Web application	WP5	2-UNIPI	The web application is online.	24

Deliverables

Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
D4.1	XAI models	WP4	2 - UNIPI	R — Document, report	PU - Public	15
D4.2	Data fusion	WP4	2 - UNIPI	R — Document, report	PU - Public	18
D5.1	Web application manual	WP5	2 - UNIPI	OTHER	PU - Public	24

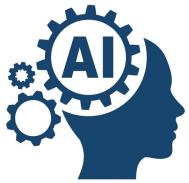
© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

What MEDEA can do?

Performs a **multi-dimensional risk assessment** considering the potential damage to structures and psychological consequences

Helps experts and Civil Protections understand **which structures need immediate attention** after an earthquake

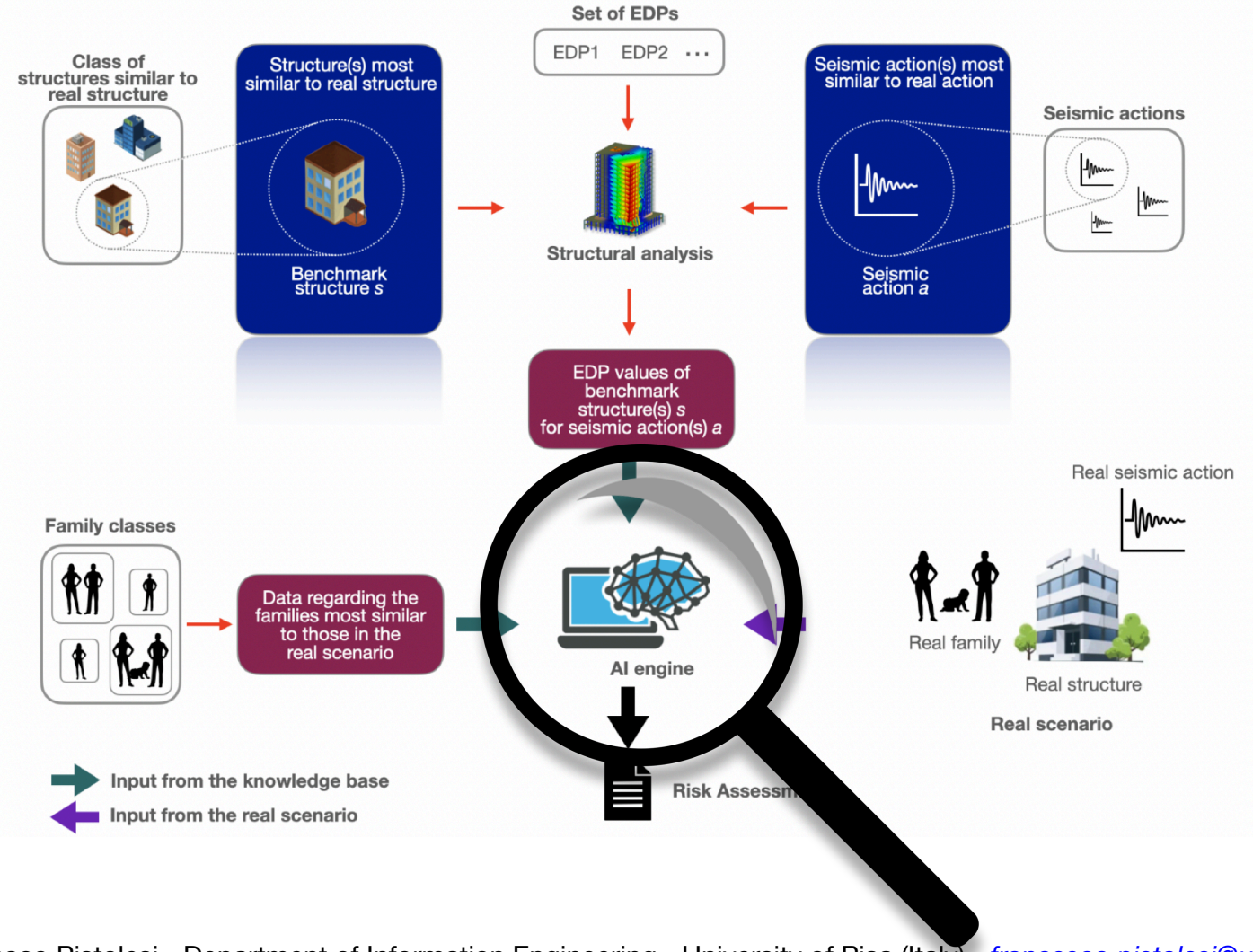
Helps psychologists understand **how to prevent people's PTSDs** in areas where an earthquake occurred



Learns continuously from new data in order to **refine predictions**

© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

Role of the University of Pisa



© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

Multidimensional data

Building data

structural parameters characterizing the building

(Structural measures)

Citizens' data

past traumatic experiences, diseases, factors influencing how people react to disasters

(Well-assessed tests in the Psychology literature)

MEDEA

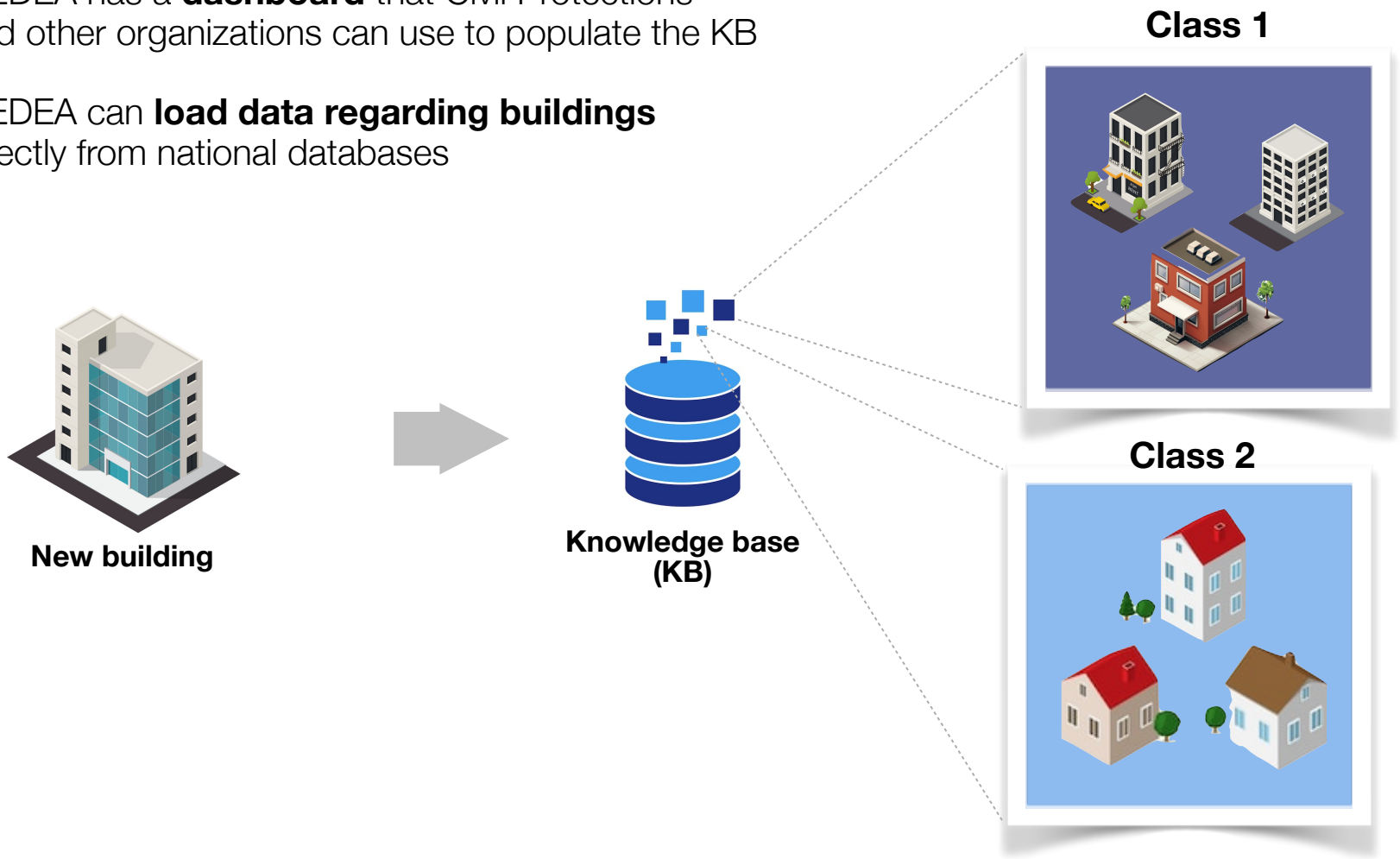
Knowledge base

contains data regarding a large set of structures located in various areas and people living there

© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

Data regarding structures

- MEDEA has a **dashboard** that Civil Protections and other organizations can use to populate the KB
- MEDEA can **load data regarding buildings** directly from national databases



© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

Data regarding people

1. Elderly Individual with Past Seismic Trauma

- **Age**: 72
- **Trauma history**: Experienced a major earthquake 30 years ago, where she lost her home and a close friend.
- **Living situation**: Lives alone in a small, older apartment.
- **Social support**: Limited contact with family; relies on a small circle of friends.
- **Risk factors for PTSD**:
  - **Age**: Older adults may have a reduced ability to recover from traumatic events.
  - **History of trauma**: Previous exposure to a traumatic earthquake increases vulnerability to PTSD
  - **Living alone**: Social isolation can amplify feelings of fear

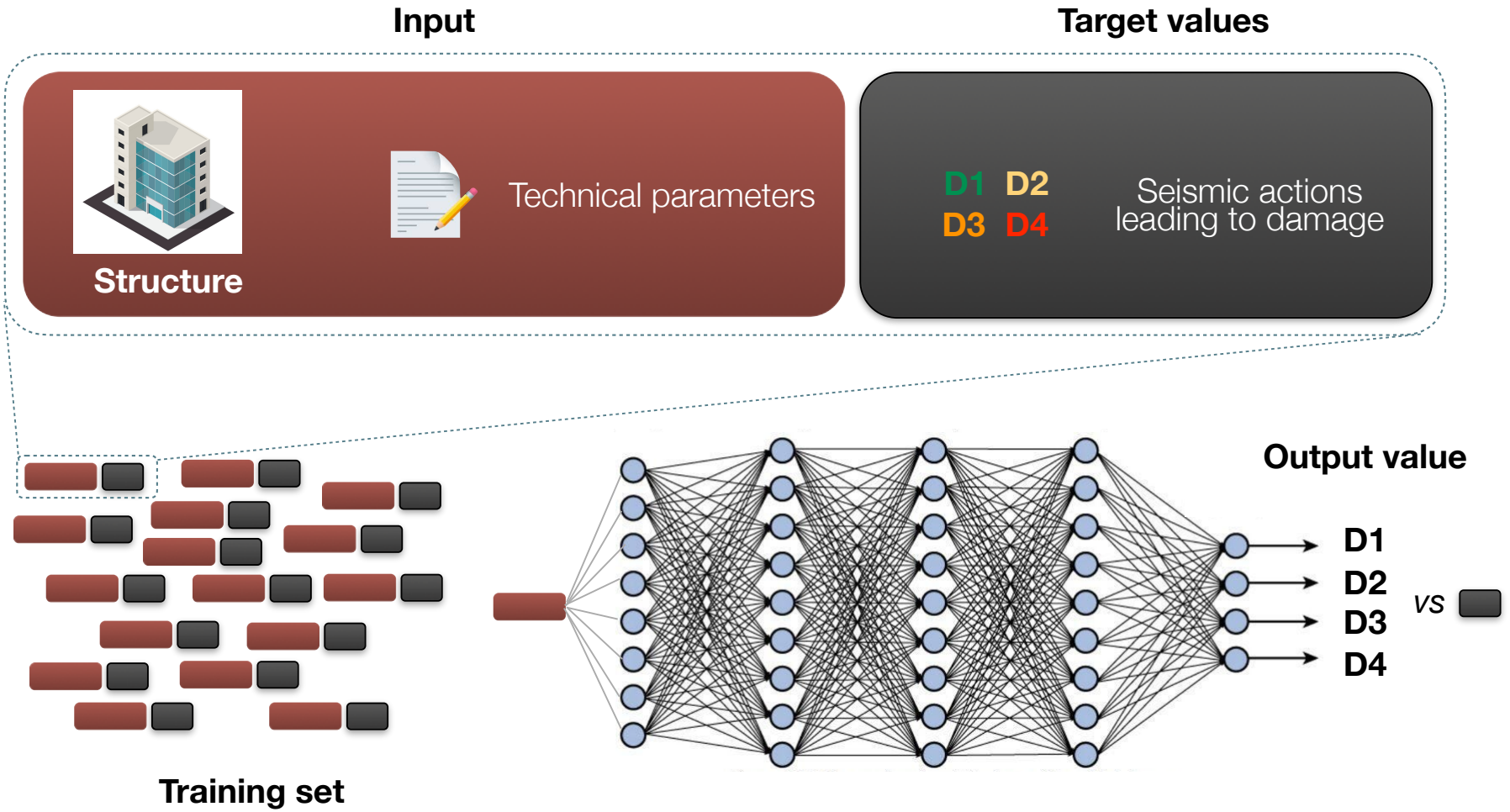
Knowledge base

3. Middle-Aged Professional with Strong Support System

- **Age**: 45
- **Income level**: Upper-middle class, stable job with health benefits
- **Housing**: Lives in an earthquake-resistant home built to stringent safety codes.
- **Family structure**: Married, with one teenager, strong relationship.
- **Health status**: Physically healthy.
- **Social support**: Active in the community
- **Factors contributing to low risk for PTSD**:
  - **Stable financial situation**: Financial security reduces anxiety.
  - **Secure housing**: Living in a house well-constructed, earthquake-resistant
  - **Strong support network**: A solid family and community support system

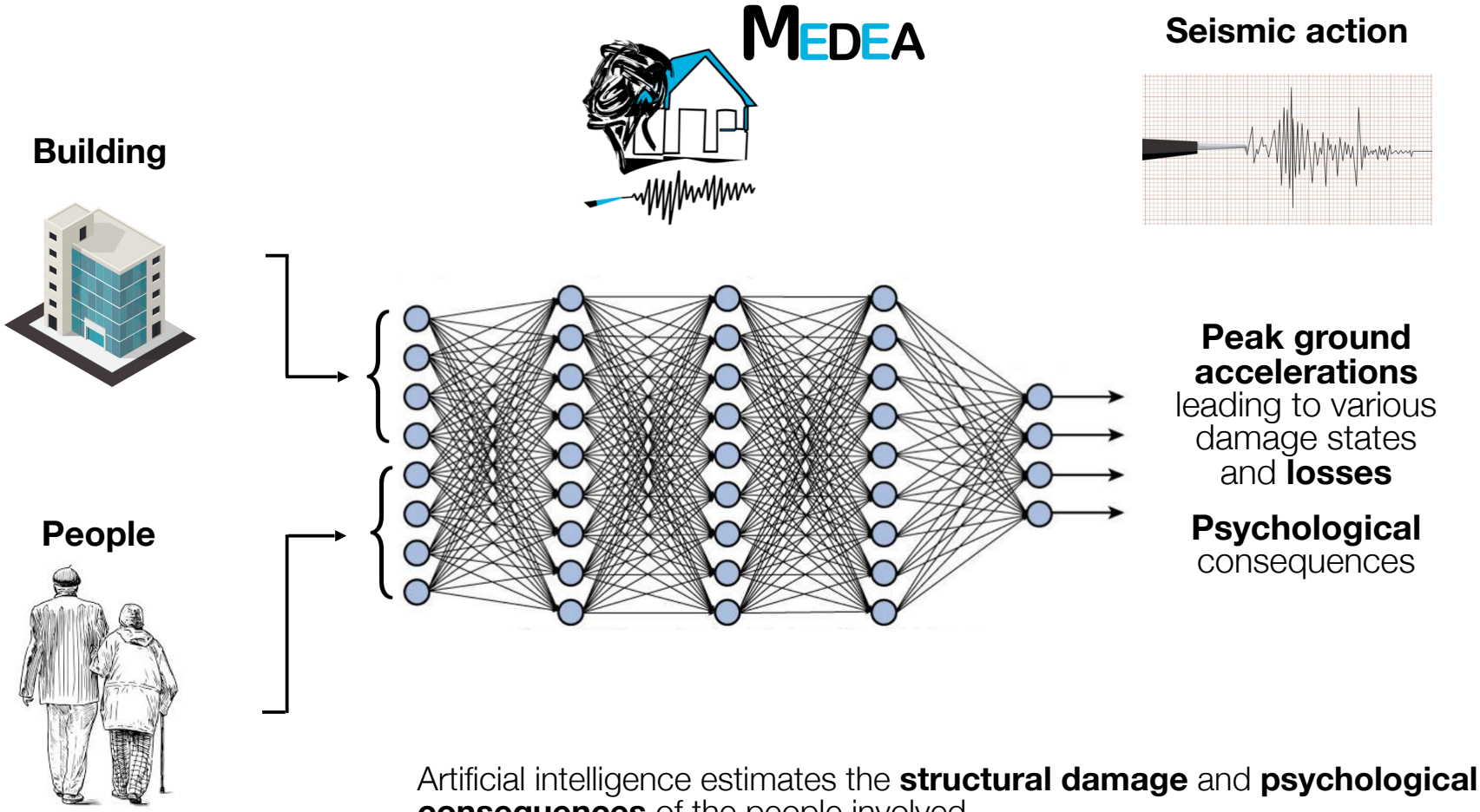
© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

Training



If predicted values are too different from target values, the network uses the error to learn

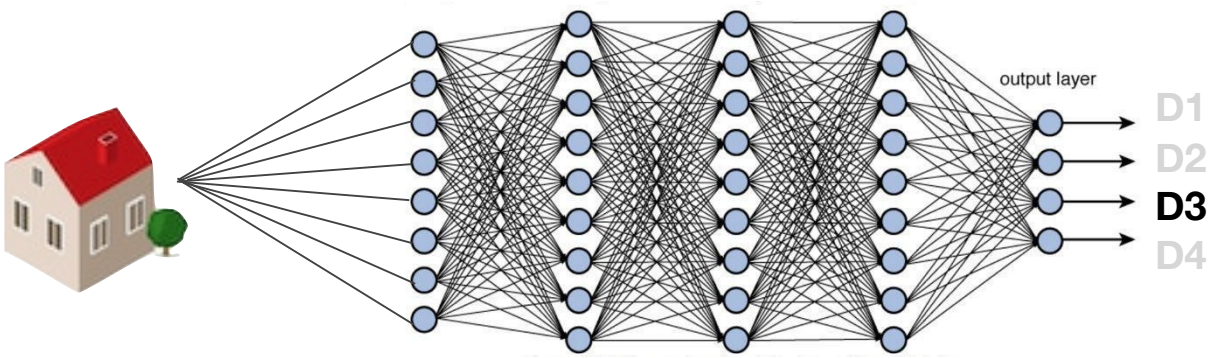
Once trained…

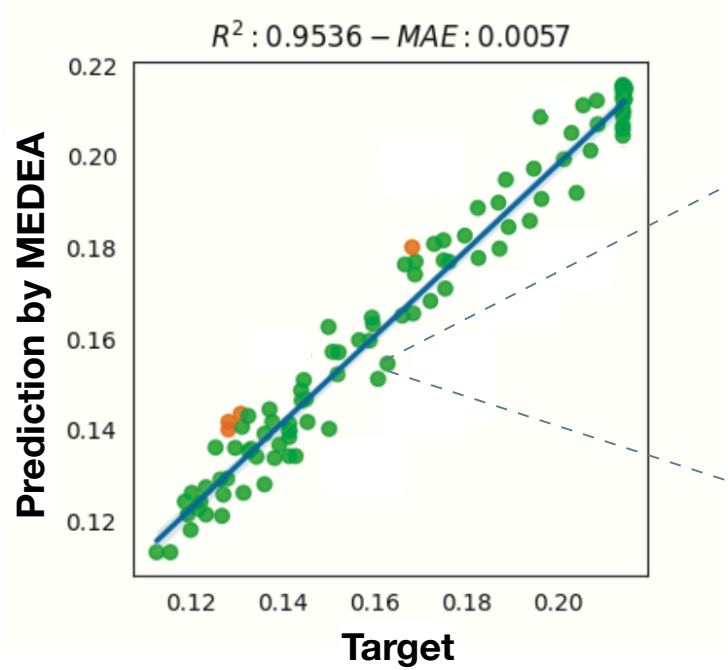


Artificial intelligence estimates the **structural damage** and **psychological consequences** of the people involved.

© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

Structural risk

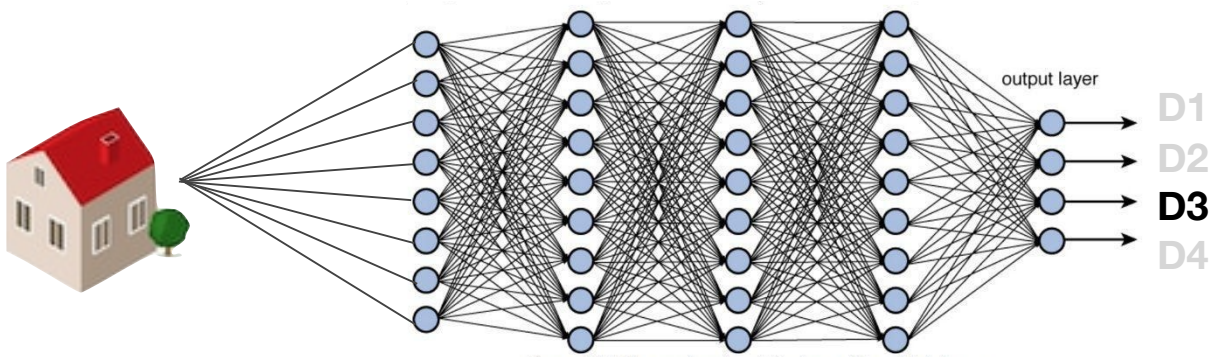


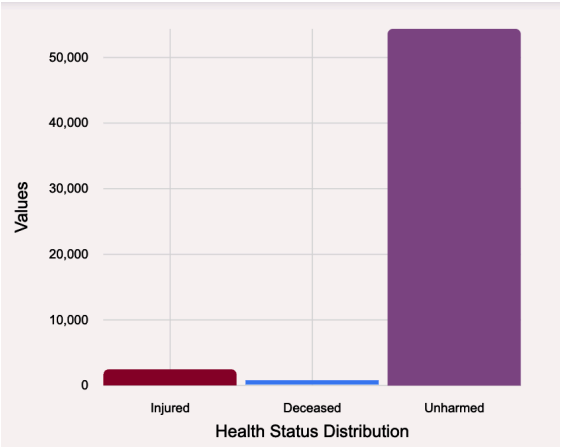


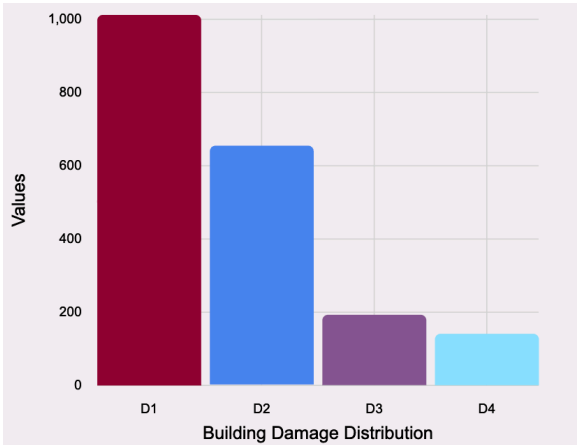
0.1609 vs 0.15992

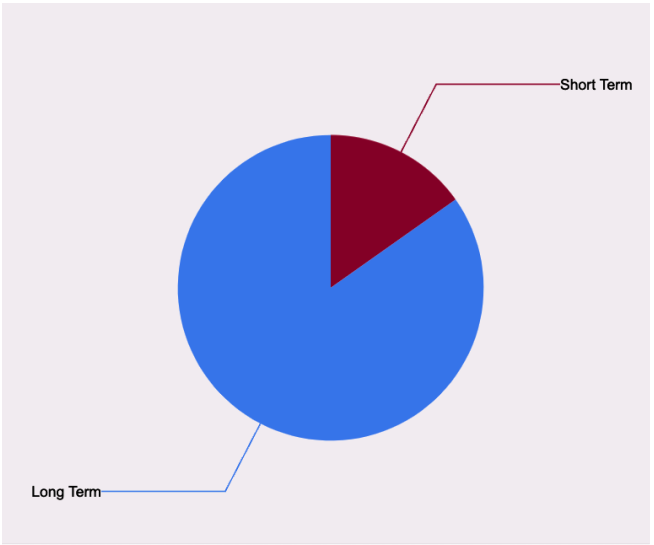
This is the D3 limit state estimate for a house of the test set

Structural risk



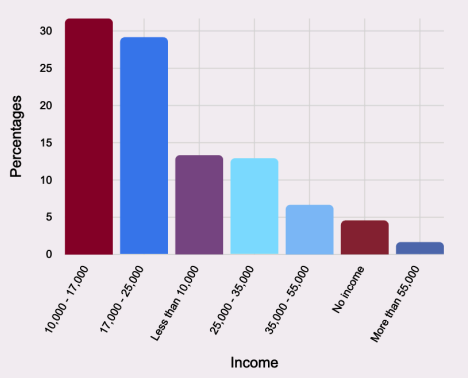


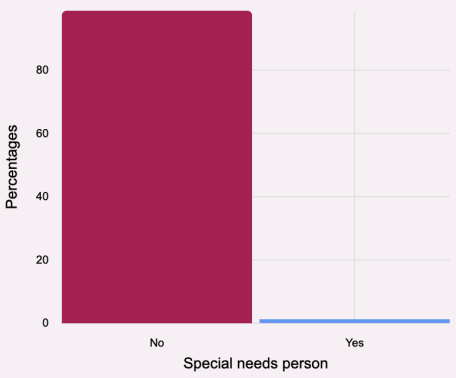


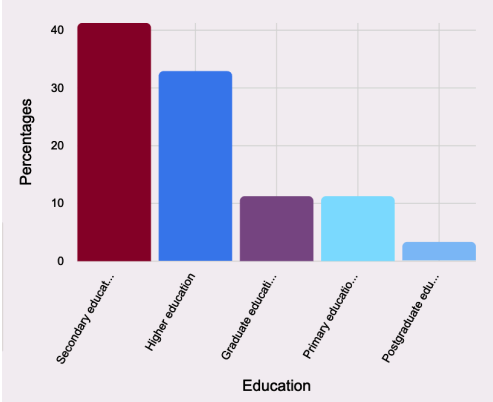


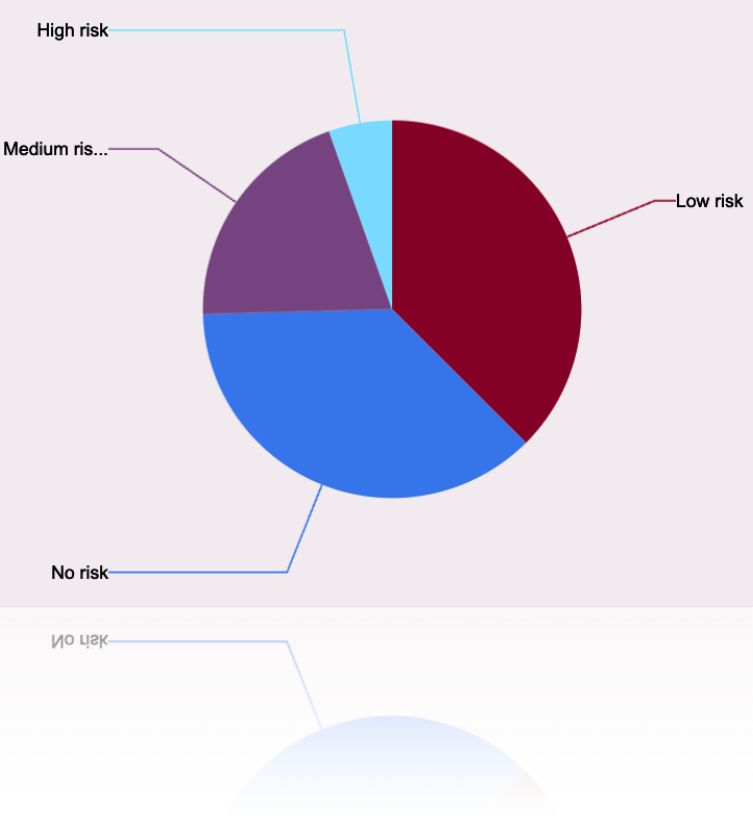
© Francesco Pistolesi • Department of Information Engineering • University of Pisa (Italy) • francesco.pistolesi@unipi.it

Psychological risk









MEDEA
Multidimensional seismic risk assessment through explainable artificial intelligence

Co-funded by the European Union

UNIVERSITÀ DI PISA

Thank you

European Union

Union Civil Protection Knowledge Network