DEEPHEALTH

Deep-Learning and HPC to Boost Biomedical Applications for Health

An introduction to the project

Project Coordinator: Monica Caballero Galeote

Technical Manager: Jon Ander Gómez Adrián

DeepHealth Winter School – 24 January 2022

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

DEEPHEALTH, a H2020 European innovation Project that aims to push the use of technology for Health to boost new and more efficient biomedical image applications for the diagnose, monitoring and treatment of diseases.

A Project coordinated by NTT DATA UNIVERSITAT POLITÈCNICA DE VALÈNCIA

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Some key facts

Means to reach the goals

DEEPHEALTH

Duration: 42 months
Starting date: Jan 2019

Budget 14.642.366 €
EU funding 12.774.824 €

22 partners from **9 countries**:
Research centers, Health organizations, large industries and SMEs

Research Organisations

Universitat Politècnica de València
Barcelona Supercomputing Center – Centro Nacional de Supercomputación
list
UNIMORE – Università degli Studi di Modena e Reggio Emilia
Karolinska Institutet
CRS4
Università degli Studi di Torino
Otto von Guericke Universität Magdeburg

Health Organisations

Azienda Ospedaliero-Universitaria Città della Salute e della Scienza di Torino
Fundación para el Fomento de la Investigación Sanitaria y Biomédica de la Comunitat Valenciana
CHUV
Spitalul Clinic Prof. Dr. Theodor Burghele București
Stockholms läns landsting

Large Industries

NTT DATA
PHILIPS
THALES
SIMAVI – Software Imagination & Vision

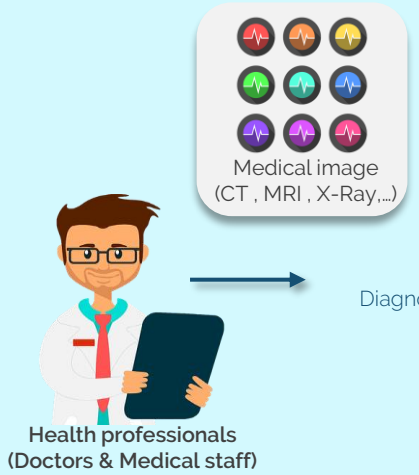
SMEs

WINGS ICT Solutions
TREE Technology
prodesign electronic gmbh
security Stelar research law

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

The scenario & Context

Introducing the project

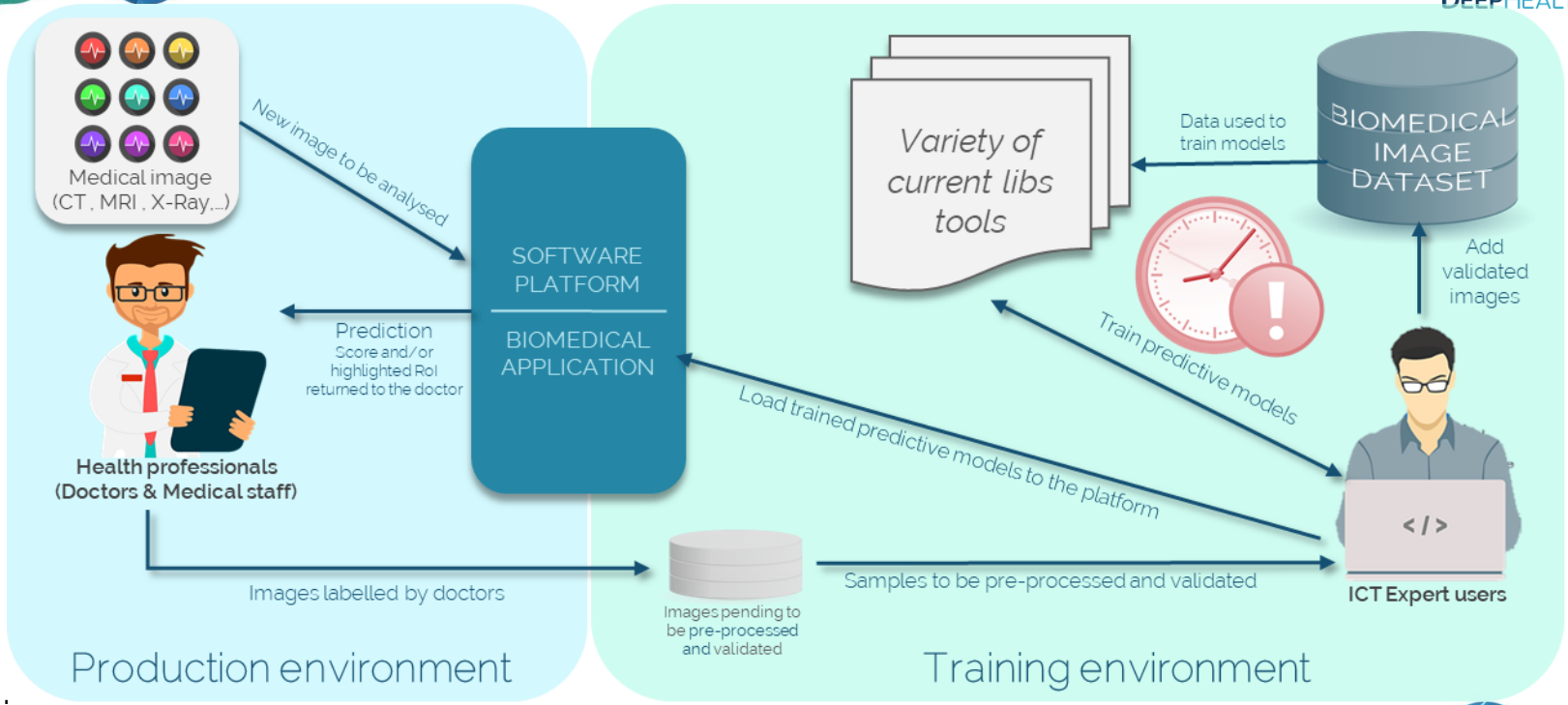


- **Healthcare:** key sector in the global economy
- Public health systems generate **large datasets of biomedical images** and other data
  - Large **unexploited** knowledge database
  - Interpretation of the clinical expert manually

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

The scenario: Use AI-DL

Introducing the project



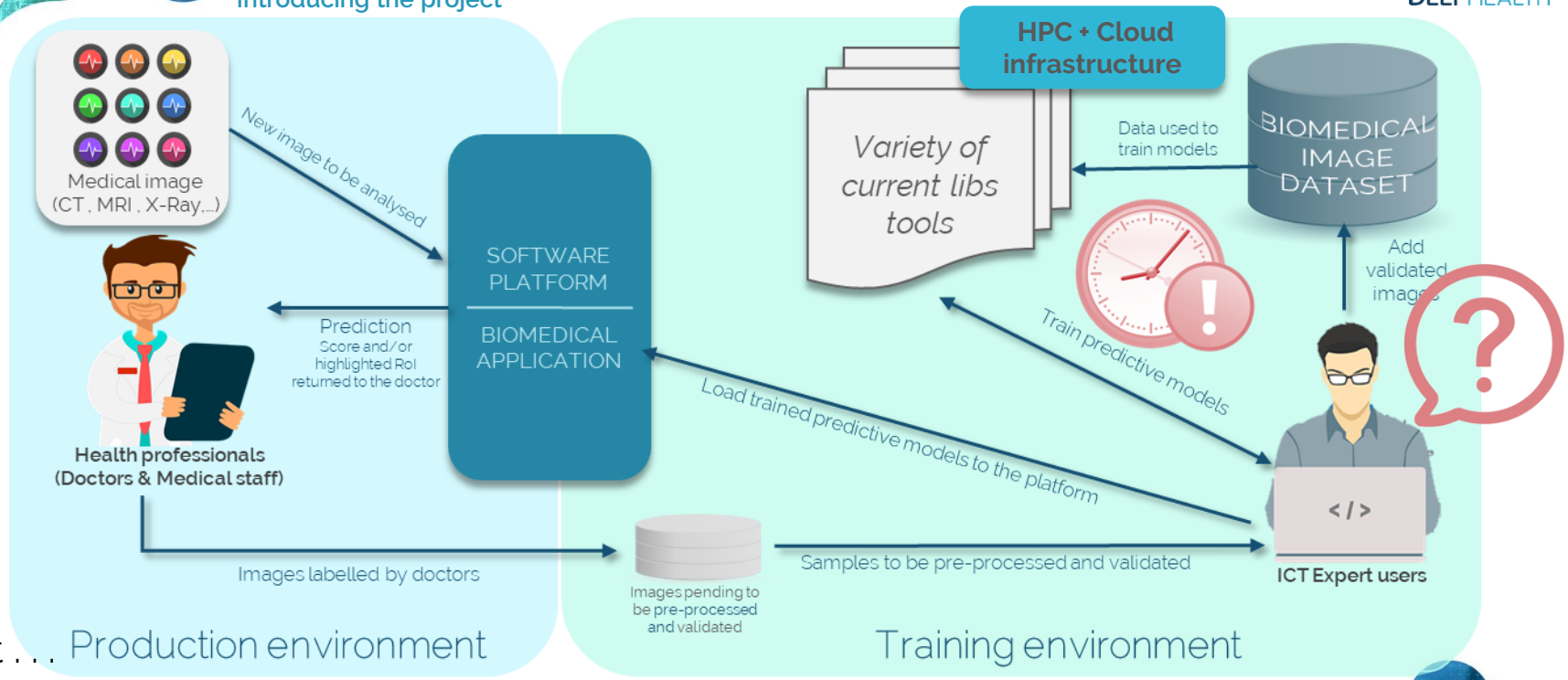
- but . . .
  - Need for advanced skills in AI and in different technologies and tools
  - Expensive processes in time and resources – Computational expensive algorithms & big data workloads

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

The scenario: Use AI-DL & HPC

Introducing the project

DEEPHEALTH



- but . . .
  - How to leverage HPC for DL purposes?
  - How to make it easy for health-application developers to exploit HPC resources?

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Aim and Goals

Project Objectives

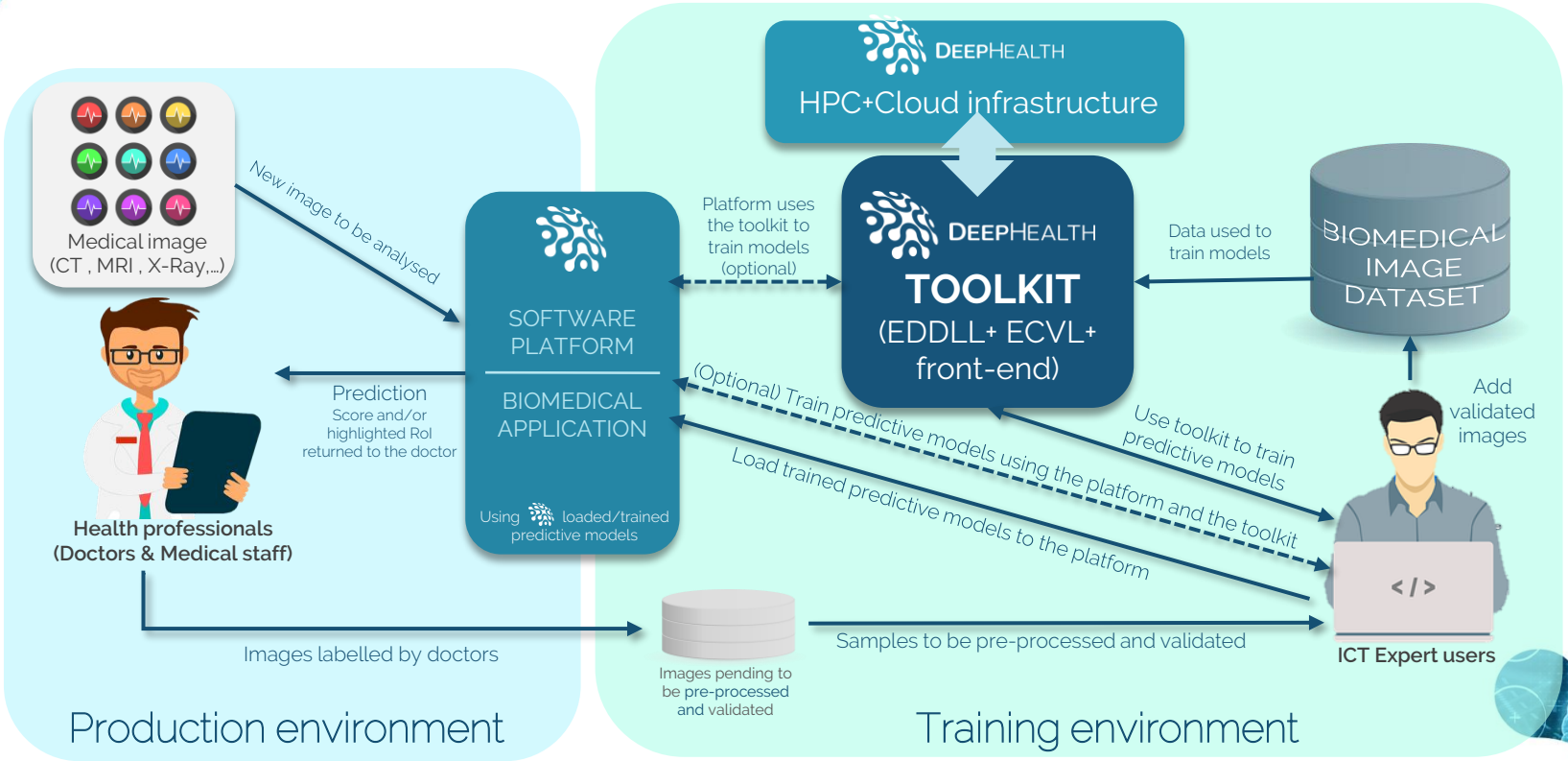
DEEPHEALTH

GLOBAL	**Put High Performance Computing power at the service of biomedical applications** with **DL** and **CV** needs to **support new and more efficient ways of diagnosis, monitoring and treatment of diseases**.
AI PERSPECTIVE	• **Increase the productivity** of IT professionals in terms of **training** image-based **predictive models** without the need of combining numerous tools. *(AI objective)*
AI + HPC PERSPECTIVE	• Offer a **unified framework** adapted to exploit underlying heterogeneous **HPC and cloud infrastructures** for supporting state-of-the-art and next-generation DL (AI) and CV algorithms *(AI + HPC objective)*
REACHING THE INDUSTRY AND SOCIETY	• Work towards **reducing the gap** between the availability of **cutting-edge technologies** and its **extensive use for medical imaging** - enhance European-based medical software platforms. *(reaching the industry and the society).*

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

The Concept

Introducing the project



The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Developments & Expected Results

DEEPHEALTH

The DeepHealth toolkit: Open Source libraries to leverage HPC/Cloud infrastructures to train AI/ML models using distributing computing. (+ back-end & front-end)

EDDLL: The European Distributed Deep Learning Library
ECVL: the European Computer Vision Library

HPC infrastructure support for an efficient execution of the libraries, making use of heterogeneous hardware in a transparent way (usability) and promoting portability. .

Integration of DeepHealth libraries into seven biomedical and AI software platforms to improve their potential (end-users: clinical and health data scientists)

Validation in 14 use cases (training DL models, inference)

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Developments & Results

DEEPHEALTH

- **The DeepHealth libraries**

  - ***EDDLL: The European Distributed Deep Learning Library***
  - ***ECVL:*** *the European Computer Vision Library*

C++ and Python

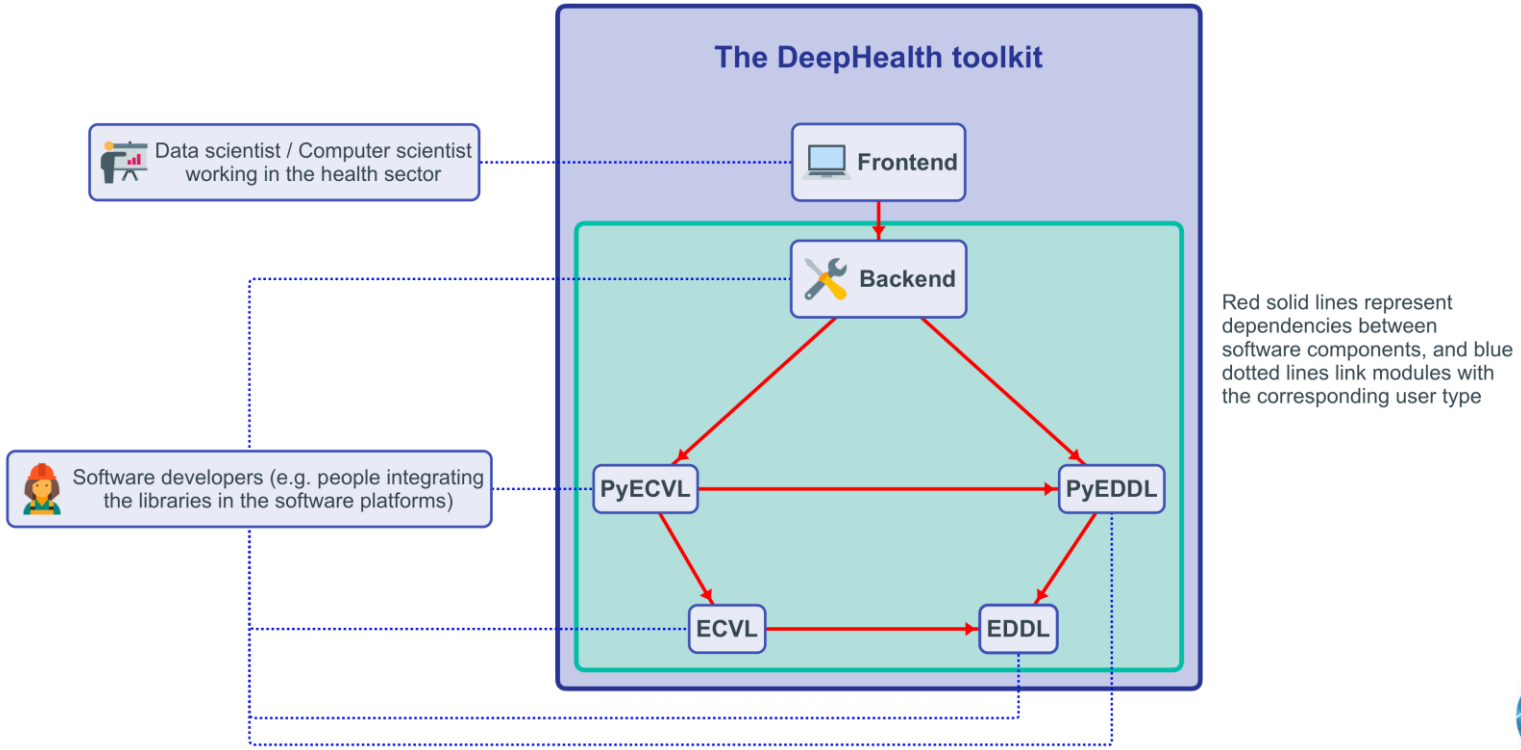
- **Distributed versions** that fully benefit from the performance capabilities of heterogeneous HPC infrastructures and compatibility with cloud technologies
  - **Parallelizing the training operations of AI/ML** use-cases models on top of HPC infrastructures.
  - Providing **layers that abstract** the parallel execution from the underlying infrastructure (COMPS-BSC, StreamFlow-Univ. Torino).
  - Promoting a "**cloudified approach**" to HPC
- Specific adaptations and optimizations to HW accelerators (GPU, FPGA) and cloud architectures
- Supporting back-end to load and transform images on the fly + GUI to ease their use.

Available on GitHub

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Developments & Results

The DeepHealth toolkit



The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Developments & Results

- **HPC infrastructure support** for an efficient execution of the libraries
  - Target heterogeneous HPC architectures:
    - Supercomputers (CPU based – Marenostrum BSC)
    - Clusters featuring GPU and FPGA-based accelerators
    - Hybrid cloud-HPC computing infrastructure.
- Focus on **usability** (hiding HPC complexities for developers), promoting **portability** and lock-in avoidance
- 3 main areas:
  - Improved-Tailored **SW architecture** (set of **run-times / Resource Managers**) to orchestrate the distributed and parallel execution on the whole HPC and cloud-based computing infrastructure – integrated in a common development framework
  - Optimization of heterogeneous computing units (CPU, GPU, FPGA) to libraries
  - HPC **communication optimizations** for efficient training

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Developments & Results

- Integration of DeepHealth libraries into seven **biomedical and AI software platforms** provided by NTT Data, PHILIPS, THALES, UNITO, WINGS, CRS4 and CEA to improve their potential
  - Platforms usage for inference (used by physicians)
  - Platforms usage for training and inference (used by health data scientists)
- **Validation** in 14 use cases (training DL models, inference), evaluation in terms of **time** and **accuracy.**

Neurological diseases	UC1. Migraine and Seizures prediction UC7. Major depression UC8. Dementia UC9. Study of structural changes in lumbar spine pathology UC10. Population model for Alzheimer's Disease UC13. Epileptic seizures detection UC14. Objective fatigue assessment for Multiple Sclerosis patients
Tumor detection and early cancer prediction	UC4. Chest cancer detection UC6. Prostate tumor diagnosis UC12. Skin cancer melanoma detection
Digital pathology and automated image annotation	UC2. Classification of whole-slide histological images of colorectal biopsy samples UC3. CT brain perfusion maps synthetization UC5. Deep Image Annotation UC11. Image Analysis and prediction for Urology

Key Performance Indicators

- time-of-pre-processing-images
- time-to-model-in-production
- time-to-train-models
- Speedup
- Efficiency of parallelism
- Specific KPIs of use cases

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Expected impact

DEEPHEALTH

For IT experts:

- **Increase the productivity of IT staff** working in the health sector by allowing them to design, train and test many more predictive models in the same period of time
- **Facilitate IT experts work** ease use/train of Deep Neural Networks on HPC with no profound knowledge on Deep Learning, HPC, distributed or cloud computing.

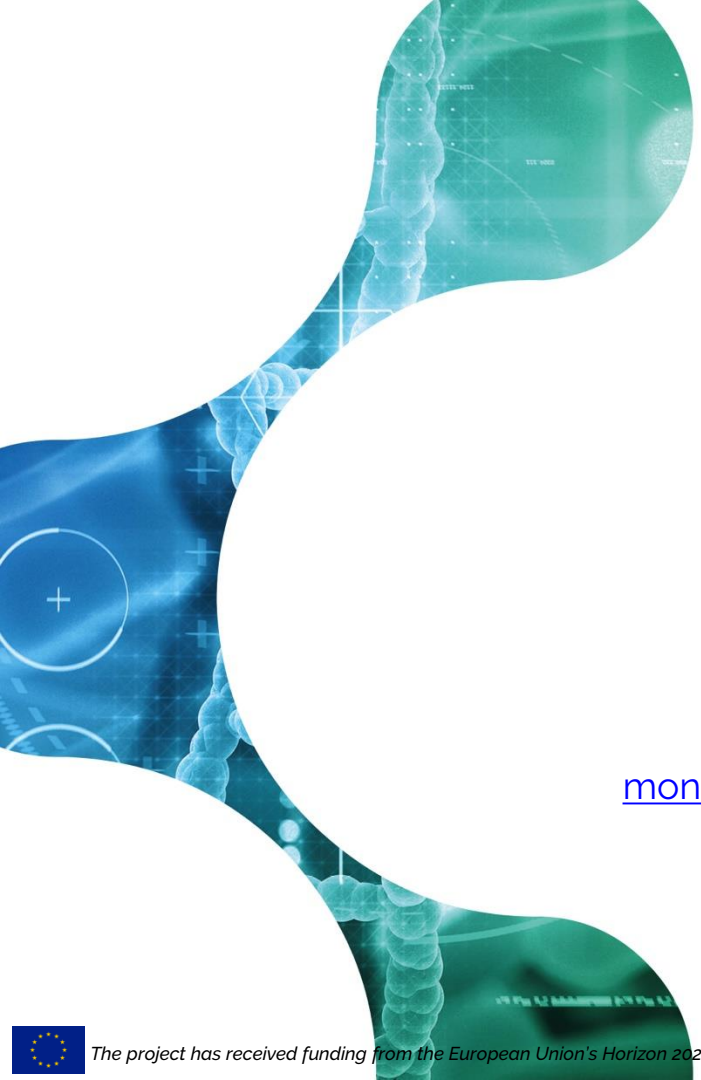
Health impact:

- Increase **early diagnosis and improving treatments**
- Extend the knowledge about diseases and pathologies
- Save direct and indirect **healthcare costs**

Beyond Health – Contributing to increase AI impact on the society

- **Applicable to other sectors** and applications
- Turn **AI + HPC as an enabling technology for Science**
- **Eases adoption by the industry**, following the trend **AI+HPC as a service for increasing number of applications**
  - Other DL-based applications & Graph-based applications such as data-discovery, digital Twins and more…

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.



DEEPHEALTH

Thank you!

Mónica Caballero Galeote

monica.caballero.galeote@nttdata.com

Jon Ander Gómez Adrián

jon@upv.es

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.