
Alameda
Bridging the Early Diagnosis and Treatment Gaps of Brain Diseases

Project **goal**

The primary objective of **ALAMEDA project** is the delivery of better care for patients with brain disorders through the development of **Big Data Analytics** and **Machine Learning** methods that can provide clinically actionable information to complement medical recommendations and foster better treatments.

The success of such applications will grant clinicians with the opportunity to better monitor patients, understand disease progression and modify treatment and rehabilitation plans based on **personalised data recordings**.

The project's innovations will takes advantage of new AI models, built upon lifestyle retrospective data as well as new streams of patient data that involve the monitoring of everyday activities, such as **sleep behaviour** and **emotional status**.

Focus on **three life-altering brain diseases**

ALAMEDA acknowledges that the care of patients with brain disorders is complex and manifestations of certain diseases could worsen over time and seriously impair the quality of life of patients and their caregivers: regular assessments of the rehabilitation and treatment plans are essential to detect early deterioration signs and design effective medical interventions.

Study of the use of sensors in advanced **Parkinson's Disease**

How to early detect meaningful worsening of either global patient status or specific motor/non-motor aspects?

The goal is to correlate the recordings from technology-assisted devices in **patients diagnosed with advanced PD** to measurements in classical PD scales, such as the Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) and quality of life-related measures, as well as to correlate simple device recording during sleep to specific PD-related sleep scales and to polysomnographic recordings.

Multiple Sclerosis and the risk of disease relapse

How to improve the capacity to predict the evolution of relapsing-remitting forms of Multiple Sclerosis?

The goal is to test a Machine Learning/AI algorithm able to predict the risk of developing a relapse in MS. **Patients diagnosed with Relapsing-Remitting MS (RRMS)** are equipped with wearables able to capture gross motor function and sleep characteristics.

The information provided by the devices are correlated with the already existing data from the electronic Patient Reported Outcomes (ePRO) and the electronic Performance Measure (ePM).

Digitally enhanced rehabilitation treatment monitoring for **stroke** patients

How to improve the capacity to predict post-stroke functional independence measured according to mRS?

The goal is to develop a set of metrics, which along with the accompanying software analysis toolkit, can extend the monitoring capabilities of neurologists for **patients that have suffered from a stroke**.

The purpose of this extended monitoring is to allow physicians to have a continuous update on the patient's recovery process and his/her functional independence progress according to the modified Rankin Scale (mRS), in between clinical visits.

Three major brain diseases and corresponding pilot sites are targeted in ALAMEDA: **Parkinson's Pilot in Greece**, at the Movement Disorders Clinic of the First Department of Neurology at Eginition Hospital, Athens University Medical School; **MS Pilot in Italy** by the Italian MS Society Foundation which is the leading funding agency of research in Multiple Sclerosis (MS) field in Italy and the third funding agency worldwide; and **patients with stroke in Romania** at the Neurology Department of University and Emergency Hospital of Bucharest.

How does the **shared decision-making approach** work in ALAMEDA?

The **patient data collection** journey details the operationalization of the sensing modalities available in ALAMEDA (physical devices, patient self-reported outcomes, interactions with the ALAMEDA digital companion) in a way that befits the particularities of the **Parkinson**, **Multiple Sclerosis** and **Stroke** (PMSS) care journeys.

In ALAMEDA the pilot research studies – and the specific data collection journey in each of them - are set up following a **shared decision-making approach** built on the principle laid out by the **MULTI-ACT project**[1] which defines guidelines to achieve meaningful engagement of patients and other research beneficiaries in the design, conduction, evaluation and even the dissemination of the research studies themselves.

We set up a so-called **Engagement Coordination Team** (ECT), whose job it is to oversee that the interests of all the stakeholders are taken into consideration and incorporated in the research project's governance.

The ECT in turn has defined routes to set up and engage three so-called **Local Community Groups** (in Greece, Italy and Romania), i.e., groups of people representing the project's end users in the three pilot sites. Their concerns, preferences as well as suggestions are collected using questionnaires and discussed within focus groups with reference to the data collection journey options.

[1]**MULTI-ACT project**: A Collective Research Impact Framework and multi-variate models to foster the true engagement of actors and stakeholders in Health Research and Innovation. **https://www.multiact.eu**

ALAMEDA **Architecture**

ALAMEDA's full stack infrastructure will contribute to the vision of digital transformation for healthcare service provision, generating a factory of ideas for digital health solutions addressing brain diseases care and rehabilitation, collecting data outside clinical practice, deploying specialized Machine Learning and AI methods, and improving patients' experience and quality of life.

The ALAMEDA architecture is anchored to **three layers**:

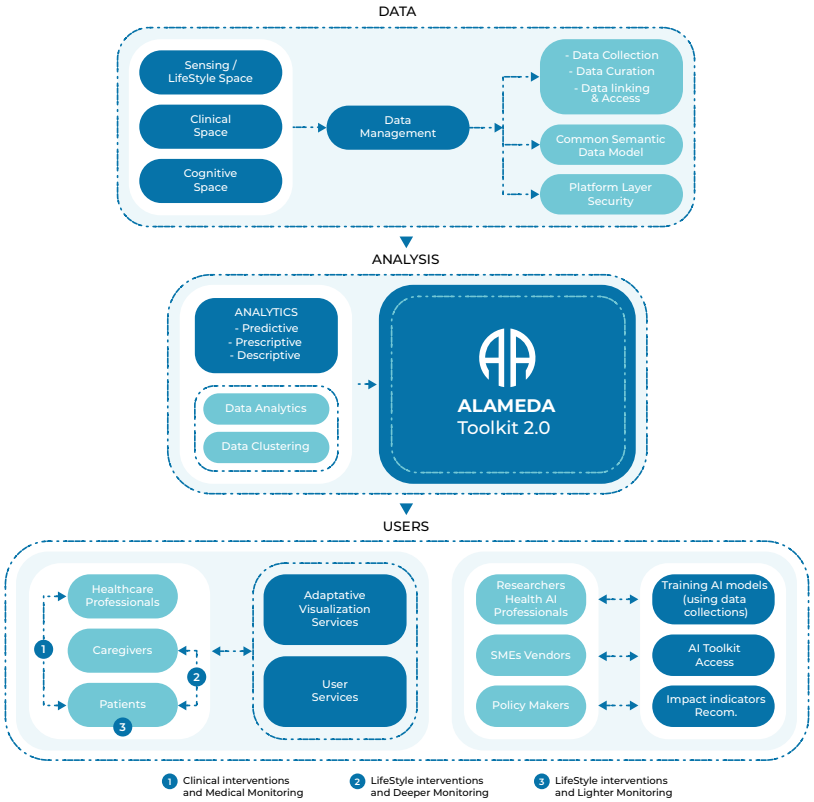
(i) The **Data Collection and Management** layer, where connected sources at the point of care (health records, medical examination results) at the home environment, as well as from mobile apps and wearable activity trackers can be integrated. At this layer, data is collected and stored so that processing, curation, governance and security policies are enforced.

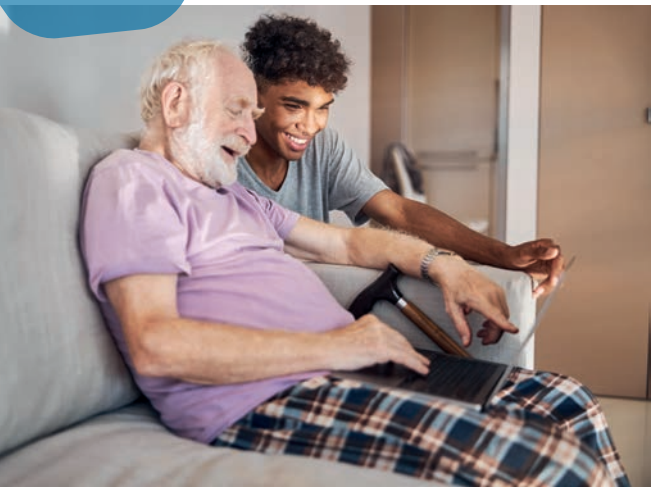
(ii) The **Data Processing and Analytics** is the layer where algorithmic and computational techniques and tools for handling large data sets and deploying the ML and AI algorithms are implemented. In addition, methods for handling batch and real-time data feeds are provided;

(iii) The **Visualization and applications** layer hosts the implementation of dashboards and ALAMEDA's family of applications, as presented to end users (clinicians, patients and caregivers).

The overarching **ALAMEDA Innovation Hub** will employ the **ALAMEDA AI Toolkit** and make available methods of the Data Processing & Analytics and the Visualisation and Applications layers. Using this approach, external digital healthcare stakeholders will be able to experiment with selected datasets and historic data sources (e.g., patient cohorts) and also to develop new applications using the ALAMEDA algorithms and ML/AI methods that will be exposed through the ALAMEDA AI Toolkit.

A **Patient-Centric** AI-empowered System





The ALAMEDA techn

Innovative data collection approach co-desi

mHealth apps

The Digital Companion is ALAMEDA's application component that comprises of the **mobile applications** that the ALAMEDA patient users operate

WellMojo

The **WellMojo mobile application**, developed by **Wellics** and customised for the ALAMEDA brain diseases' use cases, **acts as a personal health coach**, **motivates**, **rewards** and **helps the users attain personal goals**.

Chatbot

The chatbot android application developed by **UNIC** will provide a user-friendly graphical interface for patients and caregivers **to interact with the ALAMEDA Conversational agent**. Our aim is to offer a conversational interface mimicking human communication to personalize the patients' journey.

Mood Estimation Android App

Catalink is developing **MEAA** responsible for monitoring the user while s/he is interacting with other ALAMEDA core modules. MEAA's goal is to analyze the **facial expressions of the users and assess their overall mood while they are conducting the related tasks**.

Virtual Keyboard

The software, developed by **CERTH**, **captures keystroke-related data** as well as typing metadata, i.e., **number of deletes, number of characters typed, typing session duration**, deliberate long-press events, and the application where the user typed, while the content of the typed text is not recorded.

Virtual Supermarket Test Application

The VST is an app designed by **CERTH** to assess older adults' cognition through a **simple task modeled** on an everyday activity. The latest version of the VST includes advanced navigation metrics with the virtual space divided into three zones that **represent different deviations.**

Line tracking test application

The LTT is an app designed to assess older adults' **hand dexterity**. Developed within the **NoTremor EU project**, the Line Tracking Test measures the **ability to follow a randomly moving target while ignoring the distracting target**.

ological ecosystem

igned with patients, clinicians and caregivers

Smart devices

Multi-source data related to **ALAMEDA** use cases is collected from devices such as Fitbit, sleep mattress, smart insoles, smart bracelet and smart belt

Smart bracelet

This wearable allows to **collect high-resolution raw acceleration data** which are fused with raw data obtained from other specialized sensors to provide inputs for **ALAMEDA algorithms**. It also offers a **variety of activity and sleep metrics** using publicly available and validated algorithms.

Sensorised insoles

Shoe pressure sensors are used to gather data that **help assess the kinetics characteristics** and **fluctuations of ALAMEDA patients.** They accurately measure the plantar force detected inside the shoe during all static and dynamic activities.

Smart watch/FitBit

A smartwatch that monitors daily activities, **heart rate data** and **possibly raw acceleration signals**. The scope of this research is to enhance the provided **sleep assessment by Fitbit.** ICCS focuses on: sleep stages classification (Hypnograms creation), estimation of sleep quality, monitor/assess the sleep properties along time.

Smart belt

The smart belt sensor, designed by NTNU, is a wearable device that is used to record patient motion activity during the day. **One belt is composed of three motion tracking sensors** mounted on a wearable belt for a patient's (user's) motion identification.

Smart mattress

A **prototype mattress topper**, that uses pressure sensors to model the patient's movement on the bed and produce heatmaps of the movement, has been developed by ENORA and distributed to the 3 pilots along with a commercial sleep analysis sensor.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017558

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Methodology & Design Principles of **ALAMEDA AI Toolkit Version 1.0**

AI can bring improvements and cost savings to several processes within healthcare operation and delivery.

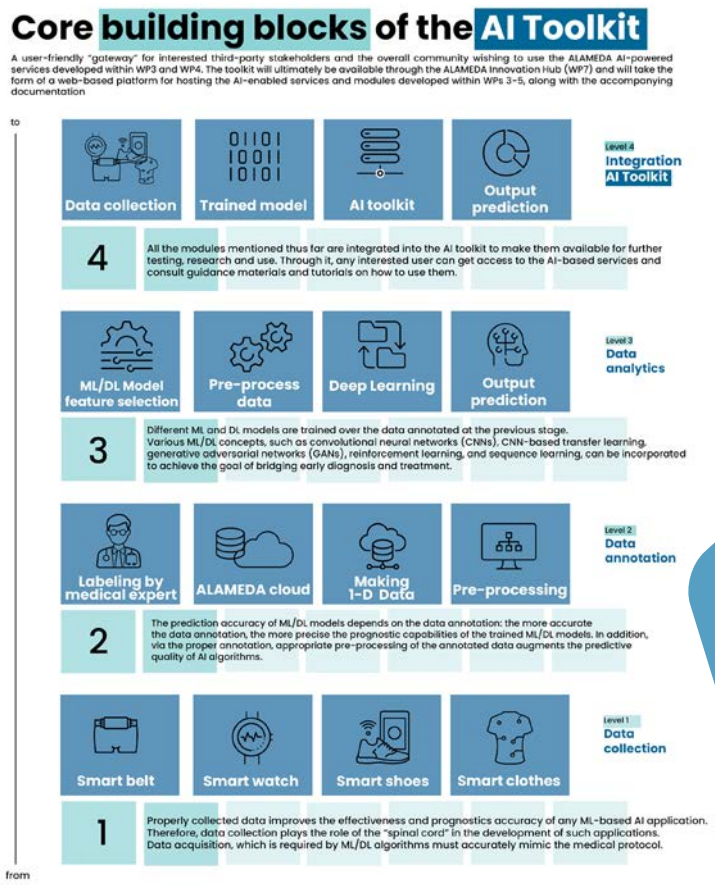
The use of **AI methods** (Big Data Analytics, Machine and Deep Learning) as predictive tools is particularly relevant for brain diseases as, in many cases, by the time all the clinical symptoms manifest, the outcomes are essentially irreversible.

In this light, **better tools for assisting continuous monitoring and early detection are needed**.

Algorithms may find hidden patterns in data, identify anomalies in "expected" patterns as well as common features and are able to highlight associations between patients, conditions and therapeutical options.

ALAMEDA's Machine Learning and AI methodology will ensure that the algorithms are interpretable and explainable.

The **ALAMEDA AI Toolkit** will materialise the models, share the Data Processing and Analytics methods and the Visualisation and Applications layers. It will enable the healthcare community to benefit from the project outcomes working as an Open-Source SW.



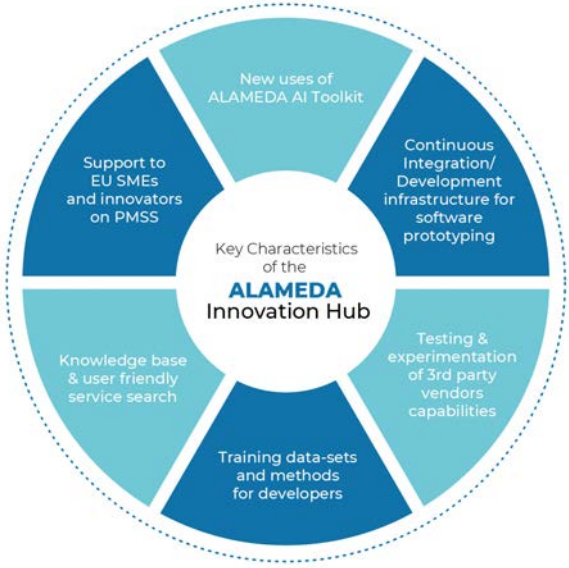
Digital Health **Innovation Hub**

A key component of **ALAMEDA** exploitation and sustainability strategy will be the launch of a multi-side market information platform, the **ALAMEDA Digital Health Innovation Hub**.

The aim of the platform is:

1. to integrate the outputs generated by the project and make them **openly available to researchers and developers**;

2. to promote the **research findings**, **guidelines** and **evaluation results** to the relevant healthcare professionals, decision makers and the broader project's audience.



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https://alamedaproject.eu

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