Introduction to the AI4HF project

AI4HF

Trustworthy Artificial Intelligence
for Personalised Risk Assessment
in Chronic Heart Failure

AI4HF: Advancing Trust in AI for Heart Failure Care

Until now, existing artificial Intelligence (AI) solutions are not used in clinical practice. This is mainly due to the key limitation: accuracy and acceptance by cardiologists and patients have not been achieved. AI4HF is the first project to implement a human-centered, multi-stakeholder, inclusive approach to improve awareness, acceptance, and promotion of credible AI solutions for improved risk assessment for heart failure (HF) patients.

Clinicians, patients, researchers, and managers will work together to develop tools for the development of AI solutions for personal HF patient's risk profiles to improve patient results. The AI solutions will be evaluated using data from Europe, South-America and Africa to ensure applicability across populations, cclinical settings, and ethnic groups.

Patient

Clinician

AI4HF tools

Regulator

Researcher
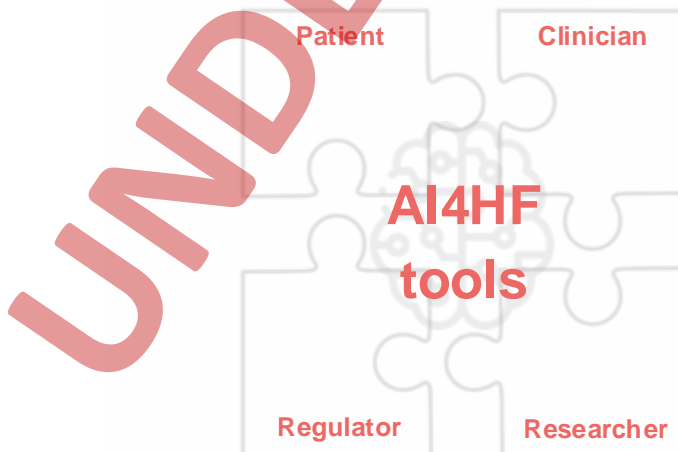
A brief introduction in AI

Artificial Intelligence (AI) involves making computer systems that can do things usually done by humans, like learning from experience. For example, AI can understand spoken requests like asking your phone to play a song, or it can tell the difference between a dog and a cat in a picture.

The main aim of AI is to create systems that can think, solve problems, see, and learn as humans do. In healthcare, AI can help find important new information in data that doctors or researchers might miss when looking at it. This information can help better patient care. To build AI tools, it's important to have good, high-quality data. The more data there is, and the more varied it is, the better the AI will work.
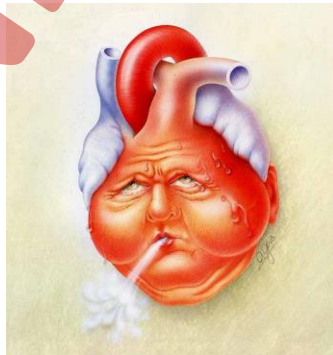
A brief introduction in HF

Each day, the heart continuously pumps blood around the body to deliver oxygen and nutrients to let organs and muscles work properly and carry unwanted waste products away from your organs. The heart consists of a left side and a right side. The right side of the heart receives blood that has just traveled through the body and it pumps the blood to the lungs to collect a fresh supply of oxygen. Then, the left side of the heart pumps the blood with oxygen to the rest of your body.

In heart failure (HF), the left side of the heart fails to pump enough blood through the body. Because of this, organs and muscles do not get enough oxygen and nutrients.

Typically, the heart function will worsen slowly and in the beginning, patients may hardly notice anything. First HF patients only have complaints (shortness of breath, swollen ankles, fatigue, reduced concentration and coughing) during exercise and later also at rest. The complaints can vary in severity over the days.

A brief introduction in HF (2/2)

There are many ways to diagnose heart failure. Various tests are done to evaluate patient status:

- **Signs and symptoms**: as mentioned before.

- **Laboratory measurements**: specific blood values may be increased, as these are released if the heart muscle performs under high pressure.

- **Electrocardiogram**: provides insight into disturbances in the heart rhythm, conduction, or signs of a previous heart attack.

- **X-thorax**: a picture of the upper body to evaluate the general shape and size of the heart, and the formation of fluid in the lungs.

- **Echocardiography**: provides information about the functioning and strength of the heart to confirm the diagnosis of heart failure and assess the condition of the heart.

During your visit to the HF outpatient clinic, the doctor will discuss the cause and treatment of HF. Treatment mainly consists of medications and lifestyle advice to support your heart, reduce the number of complaints, and reduce the risk of hospitalisation and death.

The aim and structure of AI4HF

The AI4HF project aims to create and test new AI tools to improve patient care, working closely with patients and healthcare professionals. To do this, they will use a large dataset of heart failure patients from Europe, South America, and Africa. This will help make sure the AI tools work safely and accurately for different groups of people and in various healthcare settings.

The project involves a team of people from different fields, including patients, healthcare professionals, researchers, and regulators. They all give feedback, which is shown in the figure below, to help develop trustworthy AI tools. The input from these different groups helps set the requirements for the AI tools.
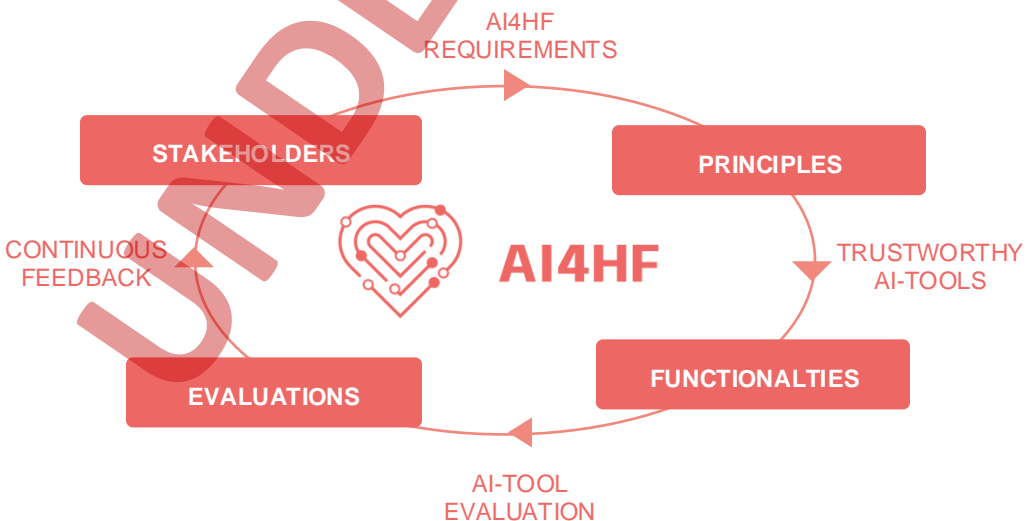
Trustworthy AI by design

The clinical use of AI tools is currently limited. The AI4HF project emphasizes trustworthiness and acceptance to address this. The project focuses on:
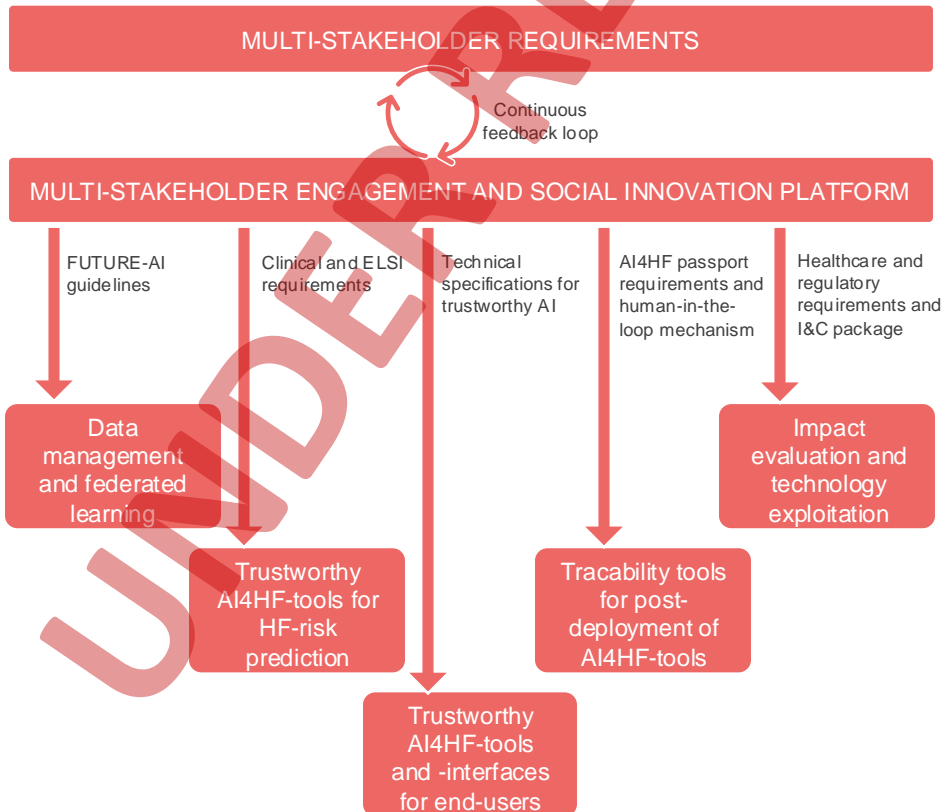
- **Validation**: Ensuring that AI tools work accurately and are relevant for different patient groups, clinical settings, and regions to confirm they are reliable and applicable in various situations.

- **Explainability**: Developing ways to make the AI models understandable, which helps build trust among clinicians and patients.

- **Evaluation**: Conducting thorough reviews by experts from different fields before using the AI tools in real-world settings, focusing on their effectiveness, safety, acceptance, and potential impact on patient care and clinical practices.

- **Integration**: Ensuring that the new AI tools fit well with existing tasks and digital systems, assessing how easy they are to use and how well they integrate.

The FUTURE-AI guidelines offer the consortium best practices and specific recommendations for creating trustworthy AI tools.

Fairness **U**niversality **T**raceability **U**sability **R**obustness **E**xplainability
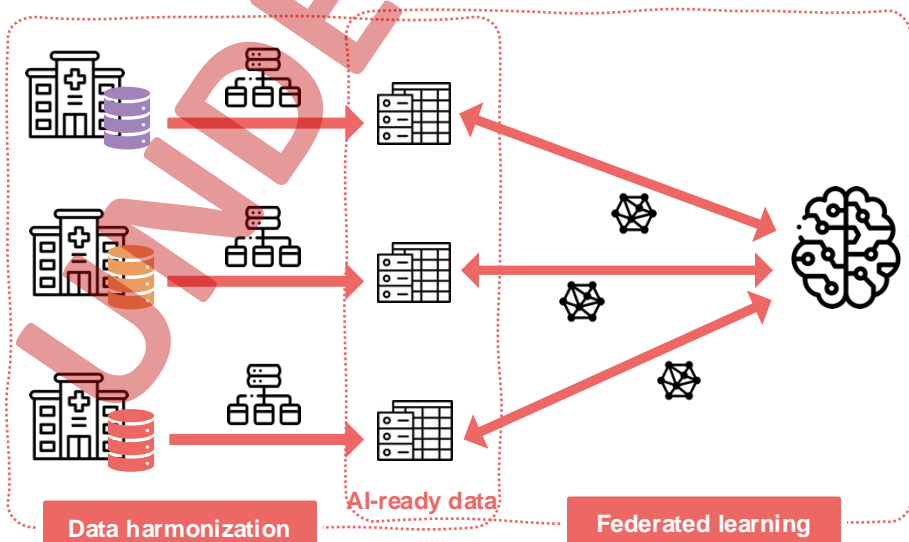
AI4HF will develop requirements

AI4HF wants to ensure that AI tools are designed, tested, and used to meet the diverse needs of real-world situations. They do this by involving different groups of people in co-creation sessions. These groups help gather functional, organizational, ethical, and regulatory requirements. The project focuses on understanding the challenges and finding solutions to use AI tools in real-life healthcare settings, helping move these tools from research to practical use in clinics.

MULTI-STAKEHOLDER REQUIREMENTS

Continuous feedback loop

MULTI-STAKEHOLDER ENGAGEMENT AND SOCIAL INNOVATION PLATFORM

FUTURE-AI guidelines

Clinical and ELSI requirements

Technical specifications for trustworthy AI

AI4HF passport requirements and human-in-the-loop mechanism

Healthcare and regulatory requirements and I&C package

Data management and federated learning

Trustworthy AI4HF-tools for HF-risk prediction

Tracability tools for post-deployment of AI4HF-tools

Impact evaluation and technology exploitation

Trustworthy AI4HF-tools and -interfaces for end-users

AI4HF will develop AI-tools

The AI4HF consortium will use a Federated Learning approach to create AI tools at multiple hospitals, making them more reliable and applicable to different situations. Federated Learning allows hospitals to train AI models together without sharing patient data, keeping it secure at each hospital. All data must be formatted according to the HL7-FHIR standard.

In this process, a global model is sent to each hospital, where it is updated using local data. The updated models are then sent back to a central server, where they are combined into a new global model. This updated global model is sent back to the hospitals for further training. This cycle repeats several times to improve the model's overall performance.

Data harmonization   AI-ready data   Federated learning

AI4HF will deliver tools to enhance trustworthiness

The project will use a human-centered approach to develop trustworthy AI tools. The first step is to set requirements for the AI tools by **involving patients and clinicians**. The AI algorithms will be continuously tested and adjusted based on feedback to meet the needs and preferences of end-users.

The project will focus on creating **inclusive user interfaces**, updating them based on input from patients, healthcare professionals, and data managers. Additionally, user manuals and training materials will be specifically designed for each group of end-users.

AI-passports will be created for developers, manufacturers, researchers, health organizations, and regulators. These will provide key information about the AI tools, including details about how they were made and maintained, their characteristics, training and testing data, evaluation results, biases and limitations, ethical approvals, and data governance. The AI-passports will also include information on monitoring and continuous evaluations.

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Heart Institute

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CITBM

ICRC
INTERNATIONAL CLINICAL
RESEARCH CENTER

Vall d'Hebron
Institut de Recerca

UMC Utrecht

Amsterdam UMC
Universitair Medische Centra

ehn
fighting heart disease
and stroke
european heart network

CERTH
CENTRE FOR
RESEARCH & TECHNOLOGY
HELLAS

SRDC
SOFTWARE
RESEARCH &
DEVELOPMENT
CONSULTANCY

BSC
Barcelona
Supercomputing
Center
Centro Nacional de Supercomputación

ESC
European Society
of Cardiology

R+ regenold

SHINE
2Europe

UNIVERSITY OF
OXFORD

MUHAS