SYMPHONY

Eco-system for disease specific clinical workflow and data integration

DELIVERABLE D4.4

Algorithms for workflow decision support and analytics

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Smart Health

HISTORY

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V0.1	10/11/2025	Starting version, template
V0.2	28/11/2025	Integration of inputs from partners
V1.0	02/12/2025	Final version

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1 Introduction

1.1 Aim of the activity

The deliverable presents the outcomes of Task 4.4: AI Algorithms and Advanced Analytics. The task focused on developing a suite of AI-driven tools designed to enhance clinical decision-making and analytics. The tools enable dynamic workflow selection and provide supportive information for informed decisions across various healthcare scenarios.

1.2 Contributors

All technical partners have contributed to this deliverable.

1.3 Glossary

AA	Aortic Aneurysm
AF	Atrial Fibrillation
AI	Artificial Intelligence
AUMC	Amsterdam University Medical Centre
LUMC	Leiden University Medical Centre
MS	Multiple Sclerosis

2 AI Models (5)

nr	Partner Name	NAME	Description of Functionality	How to demonstrate/Integration with other results	Latest Status
1	AUMC	Unsupervised clustering of AF baseline patient characteristics	Will be used to form groups with very different characteristics and analyze differences in treatment outcome. If relation to outcome of subgroups this could be made into a tool.	The results will be published in a scientific journal. Running of the demonstrator. Presentation of the identified subgroups.	Ready for demonstration. Published in the journal Diagnostics.
2	ForteArGe	Sarcopenia detection & grading	A machine learning method will be implemented to detect and grade sarcopenia.		on track
3	Innova	MS lesion segmentation model	A deep learning-based model is used to segment MS lesions in the brain from MR images.	The model will be demonstrated as a part of clinical worklfow to prove that it has multiple ways to represent the results: - End-to-end both segmentation and comparison of lesions by Innova (DICOM SC), - End-to-end DICOM SR (hopefully SSO too) demonstration with Philips, - 3D display of lesion segmentation results with ARD, - Progress monitoring and displaying of lesion measurements in digital twin with ARD.	Status: READY - SC, SR and SSO integration is ready. - The integration part with 3D AI Results Viewer is done and validated with a physical demo. - The integration for progress monitoring and displaying of measurements in Digital Twin is almost ready.

					- Model performance improvement experiments are ongoing in parallel.
4	TAZI	Sarcopenia detection & grading	TAZİ AUTO-ML platform provides linear based, ensemble and ANN models for the detection of Sarcopenia case.	- Show the overall accuracy/precision of the model. - Show the detection results on subject and class basis	actual data acquired, is being processed
5	iClinic	Natural Language Processing for data extraction	Extraction of discrete data from documents using NLP pipelines based on trained Large Language Models	See AI Tools	In development.

3 AI Algorithms (16)

nr	Partner Name	NAME	Description of Functionality	Pluggability	Describe API you use	How to demonstrate/Integration with other results	Latest Status
1	AUMC	Conduction Velocity Algorithm	To calculate the conduction velocities from activation times and locations in an electroanatomical map of the left atrium. These conduction velocity maps can be used to predict outcome and understand differences between patients.	No	-	Using in-house data and visualizations of the conduction velocity maps. Results will be published in a scientific journal.	Ready for demonstration. Not yet published.
2	Sopheon/Wellspring	Atrial Fibrillation Algorithm	To diagnose AF patients based on certain parameters and their values. The algorithm is based in the European Guideline for AF and is basically a series of rules ad rule sets. It has been defined and edited by the AUMC partner. The algorithm contains rule sets for data interpretation and recommendations.	a 3rd party upload an Algorithm (JSON) into their system using the Accolade API.	Accolade Web API (Open API) based on OData2 protocol	see AI Tools sheet	The intention is to apply the algorithm to structured patient data from the iCLinic and AUMC combined. This works. There won't be physical integration with iClinic.

3	Sopheon/Wellspring	Aortic Aneurysm Algorithm	The Sopheon system will calculate outcomes based on diameter values, coming from measurements by LUMC with their Philips diagnosis system. This system gives its data in DICOM format. The Sopheon system will convert the DICOM format into JS format for the Calculator. The Algorithm is defined by the LUMC specialists. The algorithm contains rule sets for data interpretation and recommendations.	LUMC can upload a DICOM file to the Sopheon sustem and see the results of the calculation. LUMC can login on a secured way.	Accolade Web API (Open API) based on OData2 protocol	see AI Tools sheet	The technology works, we can apply the algorithm to patient data from a LUMC system in DICOM format. The DICOM integration works.
4	Sopheon/Wellspring		To diagnose MS patients based on certain parameters and their values. The idea is to implement an algorithm that is useful in the use case for patients. It will contain recommendations. The algorithm contains rule sets for data interpretation and recommendations.	A 3rd party can upload the Algorithm in JSON format into their system using the Accolade API.	Accolade Web API (Open API) based on OData protocol2	see AI Tools sheet	The idea is to apply the algorithm to patient data from the MS use case that will deliver patient data and receive the recommendations. (AICRUM IT and INNOVA). The integration works.
5	LUMC		Using DICOM images, an algorithm will detect the liver and tumors in CT data sets and write the results in DICOM files.	Yes, In theory it's DICOM in, DICOM out to a PACS system.	DICOM	In-house developed software for visualization of the results	Segmentation Algorithm for liver and tumors in CT data sets. 100% completed, working on integration into Symphony pipeline

6	LUMC	Segmentation Algorithm for dissection analysis in CT aorta data sets	In the aorta data from CT, an algorithm will identify true and false lumen and subsequently look for dissection locations. The input are the DICOM images. The output will be exported to DICOM files.	Yes, In theory it's DICOM in, DICOM out to a PACS system.	DICOM	In-house developed software for visualization of the results	In development. It still needs some user input. Not part of AA demonstrator.
7	LUMC	Measurement Algorithm for aneurysms	The algorithm will perform diameter and volumetric measurements on the defined aneurysm regions. The inputs are the segmentation results, the output will be exported to DICOM files.	Yes, In theory it's DICOM in, DICOM out to a PACS system.	DICOM	In-house developed software for visualization of the results	100% completed, working on integration into Symphony pipeline
8	AIC	Health monitoring, risk detection and prevention	A rule-based software generates insights (the value obtained through data processing) for risk detection and prevention and for decision support and derive actionable information from the caregivers. The data are collected from the patient through a fitness tracker through non invasive way (the patient only has to wear the device and data are collected automatically).	No		see AI Tools (CareMe).	Ready
9	Karolinska Institute	MS Severity Prediction	This algorithm predicts the transition probability into secondary progressive MS in 5, 10, and 15 years after the Clinical onset of the disease based on a	It can be pluggable via REST APIs	REST API	will be demonstrated as a decision support system for the physician, improving the clinical journey of synthetic patients.	Working on output FAHIR compliance

			selected number of clinical variables.				
10	Karolinska Institute	Complication prediction in cancer patients	Already established method will be implemented to be tested	It will be pluggable	REST API and in house (Data leave the original environment) implementation with encoding licence (Data does not leave the original environment)	will be demonstrated either as In-house developed solution or we might integrate in Cambio-Cuviva-Hospital pipeline and demonstrated as a decision support system for the physician	We have fully designed both approaches and validated that they are technically feasible.
11	Philips	Aorto-iliac wall segmentation algorithm	AI algorithm for automatic segmentation of the wall of the aorta and iliacs on CTA DICOM datasets. Based on this segmentation, diameters and other parameters of aortic/iliac aneurysms can be determined automatically (requires additional algorithm) or semi-automatically.	DICOM	DICOM	In-house developed software for visualization of the results	Integrated into the application, on track. Studies for regulatory approval are on-going

12	Innova	MS lesion segmentation algorithm with explanatory visualization option	AI algorithm that provides explicable deep learning methods for discovering MS-relevant features on contrast-enhanced T1 and FLAIR MRI images, with a particular focus on white matter lesion segmentation and disease variability modelling. Initially, the output is stored in DICOM SC (Secondary Capture), but the ultimate goal is to present radiological reports in DICOM SR (Structured Report) and segmentation results in DICOM SSO (Surface Segmentation Object).	Yes. It can be pluggable via DICOM UPS-RS and DICOMweb services with a standardized way.	We have REST APIs that can present different type of inference requests from our MS lesion segmentation model. (DICOMweb and DICOM UPS-RS)	Will be part of the clinical workflow and will be demonstrated as a decision support system for the physician, improving the clinical journey of synthetic patients.	The UPS integration is ready and the algorithm is working fine.
13	Innova	MS lesion comparison algorithm	AI algorithm that compares MS lesions from MRI images acquired at two different times and provides visual-textual information to monitor increases/decreases in lesion volume. The algorithm is intended to determine the locations and volumetric measurements of lesions in the brain and provide critical information to experts.	Yes. It can be pluggable via DICOM UPS-RS and DICOMweb services with a standardized way. Support for multiple simultaneous data exchanges are completed.	We have REST APIs that can present different type of inference requests from our MS lesion segmentation model. (DICOMweb and DICOM UPS-RS)	Will be part of the clinical workflow and will be demonstrated as a decision support system for the physician, improving the clinical journey of synthetic patients.	Ready. DICOM Parametric Map implementation for interactive comparison results will be appended.

14	TAZI		Detection of Sarcopenia from sensor measurements Extract temporal/sequential features from time series data. Train individual and ensemble models registered on TAZI AutoML.	No		see AI Tools sheet	Sarcopenia detection & grading
15	AUMC	Motion quantification of the left atrial appendage	Using dynamic CT scans (stored as a series of nifti files, one file for each of the 21 timepoints in the R-R interval of the cardiac cycle of a patient), we semi automatically segment the left atrium at every timepoint. We automatically extract the left atrial appendage and calculate a number of morphologic and dynamic parameters. We compare these parameters between patients with and without atrial fibrillation.	No	-	Using in-house data and visualizations of the segmentations and the obtained parameters. Results will be published in a scientific journal.	Still refining results. Preliminary results can be demonstrated. Not yet published.
16	iClinic	Atrial Fibrillation Algorithm	The translation of the guideline for treating Atrial Fibrillation into an algorithm within a newly developed algorithm configurator.	Yes, provided there is access to the data.	REST API	Forms a component of the Clinical Decision Support. See 'AI Tools'.	In development for incorporation into our EHR platform.

4 AI Tools (23)

nr	Partner Name	NAME	Description of Functionality	Pluggability	Describe API you use	How to demonstrate/Integration with other results	Latest Status
1	Sopheon/Wellspring	Special Rule Editor in 2 techniques (Excel and Web) -- as part of the Protocol Management system that we configured on an Accolade server. Accolade is our industrial Process Platform. A process implementation to manage Protocols that include the Algorithms.	The generic Rule Editor is used to edit algorithms (rules and rule sets) + recommendations) in human language, which under water is converted in computer code; the editor is configured on and for the Accolade platform (Sopheon's process platform) to allow product (lifecycle) management of the algorithms. The Rule Editor in its latest form has 2 options: a special Excel template for controlled authoring as well as a web page. The Excel is special because it has " smart" fields that talk bidirectionally to the Accolade database. The system keeps strict	The Protocol Management server will make a JSON file available for a 3rd party system. The JSON code is made available through an OData2 API.	Accolade Web API (OpenAPI, OData2 based); industry standard.	By showing the protocol management process end to end including creation/management of algorithms, and the calculation engine. Also by showing the RESTful API (OData standard), and by showing the created algorithm in JSON code; Ideally a 3rd party EHR type of system "invokes" an algorithm and further specifies it for a specific patient by changing some values. This is in discussion and development for the MS and the Aneurism use case (AICRUMIT and LUMC). If this cannot happen, we can demonstrate it on a separate server that simulates a EHR system. The adapted	Prototype finished. Needs productization.

			versions of the uploaded Excels. The user can add or delete parameters in the Editors. It configures the database dynamically. The Editor configures in fact automatically procedures in the database that later will be used for calculations.			algorithm will be used for the specific patient.	
2	Sopheon/Wellspring	Calculation Engine (as Accolade Integration Service)	Receives patient data via APIs and interpret these using the algorithms as edited with the rule editor. It converts these in code to perform the calculations on a SQL Database. It also generates notifications for the EHR system based on the calculations. These are explainable, the user can see why the system has fired a certain recommendation (parameters and values). The notifications can be sent to a mobile device as well.	It is plugged into the Protocol Management server to pick up the right protocol (rule sets). And, it can send Notifications to any 3rd Party system. (It can also be on another server, or a 3rd party server). It can receive or get patient data from a 3rd	Accolade Web API (OpenAPI, OData based); industry standard.	To be decided. We probably need to simulate patient data streams to show how the SQL database calculates and generates the notifications using the algorithms. AUMC has provided 2 patient profiles (data) that we can use in this case. Still to be decided how we will work with iCLinic, LUMC and AICRUM IT/INNOVA. There are several options where we will run the Calculation Engine.	Prototype finished. Needs productization.

				party system using API.			
3	Sopheon/Wellspring	NLP based Monitor	Compares a clinical protocol via a text mining technique with new publications in PubMed or Free Patents Online (FPO) ; plan to include the NICE journal; based on full text comparison using term extraction. The Monitor is embedded in the Protocol Management System.	Is pluggable with the Content Sources, to send queries and receive results. Is embedded in the Protocol Management system.	Uses the APIs of the Content Source (Pubmed, NICE, APO) -- NICE still to be done; NOTE: every content supplier offers specific API options in terms of query volumes and parallel quantities, subscription level, etc.	live demo of NLP/Monitor system -- show how automated term extraction is used as basis for complex search and precise outcomes. Using Pubmed and APO over their respective APIs.	Framework works, further development needed e.g.PUBMED API
4	ForteArGe	Python on Spyder	We do not have that intention to use auto ml tools for our newly designed algorithms. However, we are going to assess TAZI's auto ml tool for comparative purposes.				on track
5	LUMC	Contour editing tool.	Tool to check and edit the segmentation results from the AI algorithm, including the measurement locations.	Yes, In theory it's DICOM in, DICOM out to a PACS system.	DICOM	In-house developed software for visualization of the results	Finished

6	LUMC	Image registration tool	Tool for (semi-) automatic alignment of two CT aorta data sets to be able to measure and compare the changes at a location over time.	Yes, In theory it's DICOM in, DICOM out to a PACS system.	DICOM	In-house developed software for visualization of the results	Finished
7	LUMC	Dashboard	Tool to visualize the changes over time between two CT aorta data sets.	Yes, In theory it's DICOM in, DICOM out to a PACS system.	DICOM	In-house developed dashboard for AA use case	90%
8	AircrumIT (AIC)	Care Me	A Tele-medicine platform that, through the optimisation of resources such as time, costs or distance and facilitating access to new areas of care, brings numerous benefits to patients and strengthens the bond between patients and medical teams. Patients have the possibility of accessing all information related to their health, such as: calendars, medications, reminders, individualised recommendations (through AI-based techniques), as well as medical reports, analyses,	Stand alone application that manages patients information and that can support other health workflows.	Interface with other tools via access to databases. When a new patient is created, the info can be shared with CareMe. Then CareMe can provide its functionalities to the workflow. And the results from the workflow can be handled can be handled by CareMe, eg. diagnistics.	Communication channel between doctors and patients. Pilot with INNOVA and Sopheon	Prototype works, fully automated integration not yet

			or results, and interact directly with their medical professionals.				
9	AircrumIT (AIC)	Active and healthy aging	Stimulate older adults to engage in a more healthy lifestyle through physical activities with the supervision of a personal coach. This is achieved through the data collection from wearables, a non-invasive, cost-effective and innovative solution, performed in a very passive way, assuring the maximum comfort possible for the user. Rule-based software will derive actionable information and generate individualized training plans, and help in detection and prevention of health risks. Finally, the end user (older adult) and the caregiver (health personal coach) can chat via the dedicated communication channel.	Same as above	Same as above	Same as above	Finished

10	MEDrecord (MED)	HealthTalk	Automated speech to text into clinical reporting. After discussions with cardiology from AMC we are adding PubMed SubMed query here and also AI based suggestions for treatment.	Yes we get out all clinical vocabularies like Loinc,Snomed and ICD based on MeSH.	Work in progress for Swagger REST API	Show inside HealhTalk	Finished
11	MEDrecord (MED)	MedSafe Healthplan	We created a heartfailure Careplan based on the WP3 clinical workflow. This careplan will be integrated into the MedSafe PGO (Personal Health Environment)	Based on the clinical workflow we create a Healthplan for heartfailure	Swagger REST API available	Show inside MedSafe	Finished
12	MEDrecord (MED)	Motivational chatbot	We are integrating a motivational chatbot that is able to get information out of each FHIR based backend and moves that into Daily advice to the patient. The Doctor will be able to "educate" this chatbot accordingly.	We created a chatbot that is able to read your goals and task, as well as your medical files. The chatbot will give the patient a daily advice also even to take medication	Work in progress for Swagger REST API	Show inside MedSafe	Finished

13	Innova	PACS-based Inference system	A PACS-based inference system which serves as on-premises and cloud-based application to interact with healthcare systems. The system is DICOM compliant and will be used by radiologists to diagnose MS with visual and textual reports generated by detecting and comparing MS lesions with deep learning models. The system will be able to send, retrieve, store, delete, list and display DICOM images. In addition, detected lesions can be clearly displayed on the original DICOM images to support radiologists and reduce the time of the process. Furthermore, the system doesn't store patients' personal information, so identifiable data is anonymized.	Since the system has support for storing, exchanging, and displaying DICOMs through DICOMweb, it can be pluggable.	Open API that provides many kind of operations on DICOM such as exchange, query, upload, download, delete, etc.	Will be part of the clinical workflow and will be demonstrated as a decision support system for the physician, improving the clinical journey of synthetic patients.	Finished

16	TAZI	AutoML Platform	TAZI Platform will function as a tool to achieve a comparative study between what can be achieved with the built in algorithms and the custom algorithms used for the Sarcopenia Classification task.	Stand-alone tool, can be incorporated into an extended system.		AutoML Pipeline for Sarcopenia Classification Task. The work will comprise of Data Prep., Platform Configuration, Task Definitions and lastly, Model Training and Tuning	75% finished
17	Philips Healthcare Sytems BV	AI Results Viewer	Main purpose of this application is to visualize the results of the AI applications, together with the images that are used in the generation process of the result, to ensure the validity and the quality of the results. Main data exchange format will be DICOM SR and DICOM SSO. Also, the viewer could act as a tool for the human reviewer to accept or reject the results.	Since this viewer is not modality specific, as long as the result from AI algorithm is reported compliant with DICOM SR, it would be able to display it. In that case, this is pluggable in any use case or workflow.	The main API that will cause the viewer to be triggered once the results are stored is defined by IHE IID profile. Data to be displayed is expected in DICOM format.	We are planning to have an integrated demo system with the AI algorithm for MS use case from INNOVA, to display the results of the algorithm in order to acquire human review, before it is sent to permanent storage. Also integration with LUMC for the visualization of reconstruction results is planned.	DICOM SR and SSO Viewing with linked visualization is complete. IHE IID is also implemented successfully. Test datasets from INNOVA and LUMC has been verified to be visualized successfully. Cloud deployment has been tested with INNOVA, LUMC and ARD. Minor issues observed being worked on.

18	ARD Group	AI Results Viewer	A data visualization tool developed for 3D brain MRI images and 2D brain crosssection images that helps visualize segmented MS lesions identified by AI models developed by our partners. 3D AI Results Viewer Application has the following capabilities: (1) Opacity of both the brain and lesion tissues can be adjusted. (2) More than one lesion mask can be displayed at the same time or separately. (3) The desired masks can be seen on the screen with the on/off feature. (4) In addition to the 3D feature, sections of the relevant brain and lesion images can be examined layer by layer with the 2D Slice Viewer feature.	Since it is a web based tool, it can be plug into any web based application by using iframe and/or direct integration.	Viewer make use of API provided by DICOM server.	Live demonstration	The AI Result Viewer has been made ready for integration with Innova within the scope of the MS use case. Integration activities are still going on. As part of the release enhancements to the application, the data processing pipeline has been restructured to run natively on DICOM, removing the need to load NIfTI. DICOM SSO content is automatically processed and converted into .PLY-format surfaces, enabling multiple masks to be managed within a single session. Per-mask

							controls for color, opacity, and target panel (top/bottom/both) have been added. Features were added to enable comparison of multiple masks for the same patient, and UI refinements were made. Integration tests for MS use case were conducted with Innova and Philips. The tests were successfully completed.
19	Cambio	CDS Cambio Decision Support	A computerised clinical decision support service combines information that is specific to an individual patient, with regulations based on medical evidence, to provide guidance on compliance or advise on	CDS is based on international standards and has been designed for easy integration with underlying, local medical records. The			

			what is the best treatment for the patient.	product supports that medical rules can continuously be added and quickly put to use in clinical practice.			
20	Cambio	Cambio CDS App	Decision support applications, which are embedded in the local medical record system and are designed to support a particular clinical process.	Full interoperabillity with other EHR systems			Finished
21	Cambio	Cambio CDS Platform	A cloud-based platform for producing and deploying advanced and portable CDS apps leveraging on open standards. It consists of development tools, a knowledge repository and services for deployment and monitoring of Cambio CDS Apps. Clinical knowledge is broken down into machine readable rules based on international standards	Full interoperabillity with other EHR systems, CDRs and other applications			Fiished

			and reference terminologies, so that decision support rules can be shared between different decision support applications.				
22	iClinic	Data Extraction	Seamless extraction from documents utilizing NLP pipelines and population of data into iClinic's AF system to reduce manual entry of fields.	Fully interoperable with other data systems. Rest API, streaming, sFTP		As part of iClinic's AF system.	In progress
23	iClinic	Clinical Decision Support	A system to develop algorithms in a highly configurable fashion represented in a graph model for easier visualization - starting with the selection of parameters and ending with one or multiple endpoints for clinical decision support.	Fully interoperable with other data systems.	REST API	As part of iClinic's AF system.	In progress

5 Conclusions

This deliverable lists the AI models, AI algorithms and AI tools as a result of WP4 - *Pluggable AI application components and services*. With this outcome WP4 delivered the following assets: *5 AI Models, 16 AI Algorithms and 23 AI Tools*. These key assets will be demonstrated during the final review in March 2026.