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CHIST-ERA Project Periodic Report

XPECTATION

PERSONALIZED EXPLAINABLE ARTIFICIAL INTELLIGENCE FOR DECENTRALIZED AGENTS WITH HETEROGENEOUS KNOWLEDGE

Periodic report n°1 [12M]
[1/04/2022]

1. Progress Report

1.1. Project objectives and activities implemented *(Indicative length: 2 pages per period)*

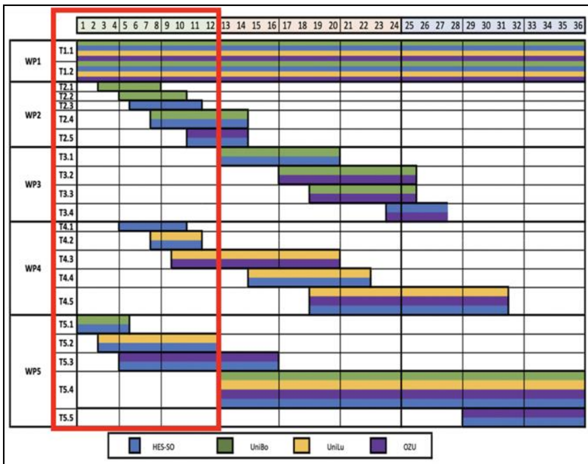

Figure 1 shows the EXPECTATION's Gantt chart, indicating with a color code the associations tasks -- partner. The HES-SO team is led by Prof. Michael Schumacher and composed of Dr. Davide Calvaresi (senior researcher – main expertise on distributed intelligent systems, real-time systems, and explainable AI) and Victor Contreras (Ph.D. student – main expertise on Machine Learning and medical imaging) since M1. The OZU team is led by Dr. Reyhan Aydoğan and composed of her graduate students Furkan Cantürk and Berk Buzcu at Özyeğin University. The UNIBO team is led by Prof. Andrea Omcini and composed of a number of PhD students and fixed-term research fellows working under his supervision, at University of Bologna. These include Giovanni Ciatto (Ph.D. student and WP leader since M1), Federico Sabbatini (who contributed during M1-8), A. Agiollo (PhD student, who contributed occasionally), and M. Magnini (research fellow, who contributed since M8). The UNILU team is led by Prof. Leon van der Torre and composed of Dr. Amro Najjar (since M1) and Igor Tchappi (since M10). The partners' contributions to the project are below organized per work package (WP).

WP1:

<u>[T1.1 – M1-M36 (ongoing)] Project coordination:</u>

All WP leaders (representing all the partners) have participated to the monthly meetings to steer the project. Each meeting, all the WP leaders or other members of their team have presented to the partners their advancements and contributions. Moreover, these latter have punctually been discussed generating further peer-to-peer follow-up collaborations/reviews.

<u>[T1.2 – M1-M36 (ongoing)] Dissemination & Exploitation:</u>

All the partners have worked to disseminate their achievements publishing 11 papers in total (see Section 2.1), organizing scientific panels (see short description below (a)), and realizing a video for general-public dissemination (b).

(a) Dr. Davide Calvaresi has led a scientific panel named "Distributed Intelligent Systems and XAI" hosted by the international workshop on EXplaiable and TRAnsparent AI and Multi-agent Systems (EXTRAAMAS), which was held in conjunction with AAMAS conference in May 2021 (https://extraamas.ehealth.hevs.ch/index.html) with the aim of promoting EXPECTATION. The speakers, core of the panel, have been Dr. Reyhan Aydoğan, Prof. Andrea Omicini, and Prof. Leon Van Der Torre.

(b) https://expectation.ehealth.hevs.ch/posts/promo/

WP2:

[T2.1 – M3-M8 (completed)] Symbolic knowledge extraction:

The UNIBO team performed an extensive literature exploration which led to the identification of nearly 90 methods for symbolic knowledge extraction (SKE) and nearly 70 methods for symbolic knowledge injection (SKI). These were then unified and jointly categorized in a coherent framework, as part of the activities required by T2.2. Furthermore, the SKE/SKI investigation enabled the realization of T2.4, as well as deliverables D2.1, D2.2, and D2.3 (cf. Section 1.6 below).

[T2.2 – M4-M10 (completed)] Generalization:

The UNIBO team generalized the information gathered by a deep analysis of the methods for SKE and SKI surveyed in T2.1. Hence, they produced a coherent and unified theoretical (conceptual) framework. Both the framework and the surveyed methods are discussed in detail in D2.1, composing a technical report (nearly 110 pages long). This report is currently being synthesised into a scientific paper describing the same topics in a more coarse-grained and scientifically accurate way. The paper shall represent the main outcome of D2.2 and it will be submitted to the "PeerJ Computer Science" open access journal (classified as Q1 by Scimago up to 2020).

[T2.3 – M6-M10 (concluding)]

The application scenario characterizing the project is interdisciplinary and spans over multiple concepts. Therefore, the HES-SO team has focused on identifying existing ontologies to be extended and reconciled (linked) for the very use case (i.e., nutrition virtual coaching). The existing ontologies collection include food, user demographic, user behaviours, user preferences, nutrition goal/ambitions, persuasion theories & techniques, health classes, ethical standing points, sustainability aspects, and legal aspects. The extension and integration of ontologies is taking place leveraging the software Protégé. The task was expecting to converge by M10. However, due to the difficulties in running the planned in-person focus groups involving external stakeholders (due to lockdown and related restrictive measure) expected in T4.1 and T5.3 this task is currently being finalized. We expect to converge by M14. Such delay has minimally impacted other tasks, whose convergency is under control. Moreover, the HES-SO team has designed and developed a zero-code tool running on a Web interface for nutrition professionals (i.e., doctors, nutritionists, and researchers) in the context of the underlying agent-based nutrition virtual coach. In particular, leveraging the underlying ontologies and persuasion schemas, professionals can define behavioural-change strategies per groups or single individuals. Such mechanisms will also enable the argumentation-based inter-agent explainability. Finally, HES-SO collaborated with UNIBO in designing and prototyping software extensions for PSyKE aimed at supporting interoperability among SKE and Semantic Web technologies (such as RDF, OWL, and SWRL). These extensions are described into the paper titled "Semantic Web-based Interoperability for Intelligent Agents with PsyKE" (see Section 2.1)

[T2.4 – M8-M14 (ongoing)] Intra-agent XAI library implementation:

The methods for SKE and SKI surveyed in T2.1 enabled the design and implementation of two (separate, yet interoperable) open-source software libraries for model-agnostic intra-agent XAI (cf. PsyKE and PsyKI).

Other than enacting well-known principles for software engineering, separations allowed the UNIBO team to focus on SKI and SKE separately, hence working in parallel on both sides. Such a libraries will be integrated within the nutrition virtual e-coach platform (named EREBOTS).

[T2.5 – M10-M14 (ongoing)] Transparency assessment:
In line with the plan, the OZU team and HES-SO are working on transparency metrics. In particular, the two partners are investigating existing related metrics for transparency of explanations, and then will define metrics to be used in our project. Such metrics will also be related and interconnected with the ontological schema characterizing the concepts within our system.

WP3:
In line with the project plan, no tasks within the 1st year.

WP4:
[T4.1 – M5-M10 (late)] User modelling:
Given the nutrition-related context, the HES-SO team has collaborated with a professional nutritionist in identifying the stakeholder classes (i.e., people with chronic diseases, food disorders, weight issues, food-related autoimmune diseases, gastric problems, wellbeing, sport, sustainable lifestyle oriented, nutrition experts, food explorers, on budget, families with children) and characterization, and their possible correlation with the use of nutritional virtual coaches. Moreover, to have a more comprehensive understanding of the users, we have realized two questionnaires (~60 and ~10 questions) that we are running as online forms. The investigation protocol foresees also several in-person meetings including stakeholders and expert nutritionists. Unfortunately, due to COVID-19-related restrictions, we are only now able to organize them. Finally, given the background and interests of the OZU team in creating models for predicting user's interests/preferences via machine learning, they took part into this task. In particular, HES-SO and OZU have collaborated in identifying the key features of the user's interests/preferences meaningful to generate recommendation and arguments (explanations). The task is expected to converge by M15.

[T4.2 – M8-M11 (completed)] Interaction Protocol:
The OZU team has collaborated with the UNILU and HES-SO teams to design 1-to-(1-to-n) negotiation protocol governing the user-agent and agent-agent(s) interactions (prototyping a dedicated framework).
To do so, the teams have co-designed the interaction protocol enabling inter-agent explainability and particularly focused on human-agent interaction. This interaction protocol brings out the communication between one given user and their personal food coaching agent as well as the explanation and motivation associated to the recommendation. Moreover, they have identified open issues of the interaction protocol based on intra-agent explainability. In this scenario, two main situations are considered: centralized interaction protocol and decentralized interaction protocol. Each of them having advantages and disadvantages. For example, centralized approach has the advantage to be easy to model; however, the central point is critic. The decentralized approach has the advantage to scale. However, it increases the negotiation's complexity.
Other activities carried out in this task include a survey of recommendation systems in the food domain, and a survey of Argumentation-based Negotiation approaches. As of today, the survey has been redacted in the form of technical reports. We envision to write a wrap-up paper when the including the results of T4.1.

[T4.3 – M10-M20 (ongoing)] Agent-based profiling:
The OZU team has surveyed existing explainable recommendation and preference elicitation techniques. The OZU team first focused on learning users' preferences on food attributes (e.g., whether the user (dis)likes given ingredients/combinations) and developed an active learning approach for eliciting such preferences. While facilitating the development of this preference elicitation technique, they manually created some synthetic users to assess the effectiveness of the underlying approach and consequently to

revise the approach accordingly. The UNILU team has started to model the user behaviour. The user is characterized by its age, sex, ethnicity, etc (full profiling obtained by T2.3 and T4.2). Moreover, they started to model the agent behaviour. The agent is rational that seeking to maximize the utility function governing its behaviour. This work is still ongoing.

WP5:

[T5.1 – M1-M5 (almost completed)] Architecture requirements:

The HES-SO and UNIBO teams collaborated into refining the requirements and sketching the architecture of the proof-of-concept system targeted by WP5. Moreover, both the teams collaborated into sketching the conceptual and software architecture of the prototype (whose actual development is currently ongoing). Moreover, the teams are about to conduct in-person focus groups (delay due to covid-19-related restrictions) to involve them into the cocreation of some features/interfaces and elaborate the expectations and related metrics.

[T5.2 – M3-M12 (concluding)] Identify ethical and societal concerns:

The HES-SO and UNILU teams have defined the proposed system as a nutrition virtual coach (NVC). The scope of an NVC goes beyond traditional recommender systems, since it seats at the overlap of informative systems, persuasion techniques/systems, argumentation techniques/systems, and personalized assistive systems. Therefore, the NVCs' ethical and legal challenges must take those four dimensions into consideration. The two teams have elaborated on both domain-specific and cross-domain challenges/criticalities and have identified possible strategies of mitigation and countermeasures to the elicited pitfalls of conventional systems. Such elaborations are redacted in a form of technical report and it is currently being shaped into a journal paper. The journal targeted is still under discussion among the participating teams. Nevertheless, the priority is to have it open access and Q1/Q2.

[T5.3 – M5-M16 (ongoing)]

The OZU team has investigated existing food ontologies and datasets. They have also examined some datasets to procure an initial prototype and determine which data properties are vital. A list of the datasets we have examined follows: FoodKG - A knowledge graph that contains the recipe, ingredients, cooking steps, and nutritional values; FoodOn - An OWL ontology with various food properties; BBC Food Ontology; Recipe1M+; WikiProjectFood/Taxonomy. The following websites can also be utilized to gather recipe related information: https://www.allrecipes.com/; http://www.foodsubs.com/; https://www.yummly.com/; https://www.food.com/

Together with HES-SO and UniBo, the OZU team started working on a survey preparation about argumentation-based negotiation approaches. Moreover, the HES-SO team is working on the platform designed in T5.1 to allow the inclusion of the several sub-components and the "virtual" knowledge encoded by this task. Soon a first deployment of the system EREBOTS 2.0 will take place, thus allowing the HES-SO team to collect real-user data and enable the autonomous agents' active learning designed by the OZU team.

1.2. Transnational collaboration

Describe the added value and synergies in the collaboration, any obstacles to the transnational collaboration, and the proposed solution (if necessary).

Concerning WP1:
The HES-SO, OZU, UNIBO, and UNILU teams attended the monthly steering meetings led by the project coordinator. In particular, all the partners have presented their periodical advancements which have been punctually discussed with the partners fostering the know-how sharing, obtaining feedback, and implementing new unplanned collaborations to guarantee the success of the task and actualized emerging opportunities.

Concerning WP2:
The collaboration among the UNIBO and HES-SO team has mostly regarded task T2.3. Here, interactions concerned eliciting mutual requirements w.r.t. semantic knowledge extraction and manipulation, which should, in turn, support a smooth integration of the software tools developed as part of task T2.4 with the any other software tool to be developed as part of WP3–5.

Concerning WP3:
Not started yet

Concerning WP4:
The HES-SO and OZU teams had weekly meetings on WP4 about user profiling aspects which were beneficial for aligning the tasks T4.1 and T4.3.
The OZU and the UNILU teams as well as HES-SO and UNILU have worked closely with weekly or bi-weekly meetings to discuss and generally develop the negotiation protocols as well as the initial strategies for the human agent negotiation.
The OZU, HES-SO, and UNIBO teams met (based on the need) to plan/work on the argumentation-based negotiation survey.

Concerning WP5:
The collaboration among the UNIBO and HESSO team has mostly regarded task T5.1. Here, the interactions concerned eliciting mutual requirements w.r.t. WP5's prototype as well as its conceptual and software architecture. It is worth highlighting that first year's tasks were mostly conceived as self-contained tasks, where the degree of required interaction was low, to let the teams work in parallel as much as possible. Such effort has to be merged and integrated in the second and third year, hence we expect interactions to progressively increase.

The HES-SO and OZU teams had meeting (based on the need) regarding WP2/5 - design of a collection of food ontologies that would feed the overall system.
The HES-SO and UNILU teams had (based on the need) meetings involving law & AI Ph.D. students visiting UNILU. Such a collaboration generated a paper (to appear in EXTRAAMAS 2022) and the delineation of legal boundaries for NVC.
The HES-SO and UNILU teams met in the occasion of BNAIC 2021 (conference) to present their joint papers and work InSite in the context of WP5.

Difficulties:
Due to the COVID-19 pandemic, all interactions among teams have occurred online (videoconference). Although this situation might have affected the collaboration negatively, we profited even more from such form of collaboration. Indeed, it allowed the teams to perform more fine-grained and fast-paced interactions. The remarkable increase of online meeting has smoothly blended within the partners schedules. Nevertheless, we are planning in-person events starting from June 2022.

1.3. Significant events and results

(Indicative length: 2-4 pages)

Describe the main achievements of the project. For example:

- *New ideas, new knowledge, new interpretative models of complex phenomena;*
- *Realization of new scientific instrumentation and/or advanced devices;*
- *Implementation of new advanced scientific methodologies;*
- *Realization of prototypes;*
- *Proposal of new technologies;*
- *Contribution to innovation in the production of goods and services;*
- *Development of innovative software;*
- *Economic impact and results exploitation.*

For each achievement, provide a description with factual and, if relevant, quantitative information.

For significant results you would like to publicise using the communication channels of CHIST-ERA, please feel free to forward the information to CHIST-ERA Joint Secretariat using the Toolbox dedicated to the funded projects: https://www.chistera.eu/toolbox

EREBOTS 2.0
EREBOTS 2.0 is an agent-based GDPR-compliant chatbots platform to deploy 1-to-1 (user-agent) assistive chatbots. Such chatbots (namely agents) can interact on the bases of structured interactions and actualized (zero-code) behavioral change strategies suggested by professional nutritionists. We are currently extending the agents capabilities getting the platform ready to allocate the other partners libraries and to enhance the interaction methods (i.e., moving towards NLP for selected interactions).

Active Learning approach with the orientation of explainability is deployed in the framework of interactive learning for user preference elicitation.
This design has a novel information acquisition strategy for Active Learning through explanations that users can understand and respond to. Besides, the OZU team has currently worked on developing novel uncertainty quantification and information incorporation into ML techniques for Active Learning.

A novel human-agent protocol tailored to food recommendation application, which allows an agent to generate both offers and the explanations why those offers are made and enables the users to give feedback on both given offers and explanations.
The collaboration between UNILU and OZU produced a first prototype of a Web application incorporating the designed interaction protocol where the user can specify her/his constraints and feedback in a structured way without requiring expressing them in natural language. In particular, the web app allows an agent to (i) generate both offers and the explanations why those offers are made and (ii) allows the users to give feedback on the given offers and criticize or comment on the explanations provided.

The idea of SKE and SKI as general mechanisms for XAI – coming with several possible methods handling particular situations (e.g., neural networks / support vector machines, classifiers / regressors, discrete / continuous data, etc.) – is indeed novel. Currently, SKE/SKI-related works from the literature focus on proposing particular methods for SKE/SKI or on improving existing methods. Poor care is devoted to make these contributions interchangeable, comparable, or interoperable. The conceptual and technological frameworks developed in WP2 serve exactly these purposes. With respect to XAI-related research, the software tools developed in T2.4 (namely, PSyKE and PSyKI from Section 1.1) can be simultaneously described as (i) new scientific instrumentation, (ii) prototypes of general-purpose technologies, and (iii) innovative software toolkits. In fact, to the best of our knowledge, analogous or similar software tools supporting either SKE or SKI were missing. This hindered the potential of XAI-related research, by hardening experiments in this field, and represented a challenge for the EXPECTATION project. For all these reasons, we argue the proposed software tools have the potential to outlive the project, other than being fundamental to the development of WP3-5.

The HES-SO and UNILU effort in the field of nutrition virtual coaches' (NVC) ethics and legal boundaries expanded and upgraded the existing literature of the ethics of recommender system (Milano et al., 2020) and the ethics of food recommender systems (Karpati et al. (2020)). In particular, a tech report (evolving in a journal paper) defines and the main ethical and legal challenges and implications for NVC.

1.4. Technology readiness level (TRL)

Describe the global positioning of the project (from 'idea to application', or from 'lab to market'). Refer to Technology Readiness Levels (see definition here) at the beginning and at the end of the project.

- As of now, EREBOTS 2.0 is advancing from TRL3 (current level) to TRL4.
- The implementation for an active learning for preference elicitation realized by OZU is between TRL2 and TRL3 and is not expected to evolve further since its mechanisms will be integrated into the EREBOTS 2.0 platform
- The interaction protocol is TRL2.
- As of now, SKE-SKI have TRL3 and we expect them to reach TRL4 within the end of the project. The tools are being developed following sound software engineering practices, including, but not limited to: distributed version control, unit tests, and continuous integration—guaranteeing they can work on most common operative systems (Windows, MacOS, and Linux).

1.5. Consortium meetings

Provide the cumulative list of consortium meetings from project start.

Meetings				
N°	**Date**	**Location**	**Attending partners**	**Purpose**
1.1 – 1.11	Monthly SC meeting (each first Friday of the month)	Virtual	All partners	Steering Committee meeting to monitor and update on technical advance
2.1 – 2.n	Weekly [M5– M12]	Virtual	UNILU - OZU	WP4
3.1 –3.n	(bi)weekly [M5 - M12]	Virtual	HES-SO - OZU	WP4 & WP5 & WP2
4.1 –4.n	(bi)weekly [M1 – M12]	Virtual	HES-SO - UNIBO	WP2 & WP5
5	10-14/11/2021	Luxembourg	HES-SO - UNILU	Attending BNAIC21 and working on T4.2 and WP5 (T5.2)
6.1 –6.n	(bi)weekly [M2 – M10]	Virtual	HES-SO - UNILU	WP5 (T5.2)
7	17/11/2021	Virtual	ALL	General Assembly
8.1 –8.n	[M1 – M5]	Virtual	UNIBO – OZU - HES-SO	WP5 (T5.1)

1.6. Deliverables

Provide the cumulative list of deliverables from project start.

Deliverables					
N°	**Title**	**Nature**	**Delivery date (month)**		**Partner in charge**
			Contractual	**Actual**	
Deliverables link (for the CHIST-ERA Commission): https://expectation.ehealth.hevs.ch/posts/deliverables/					
D1.1	Yearly Report	Report	M12	M12	HES-SO/ALL
D1.4	Data Management Plan	Document	M3	M3	HES-SO
D2.1	Tech report on symbolic knowledge extraction/injection	Tech Report	M8	M12*	UNIBO
D2.2	Scientific paper on symbolic knowledge extraction/injection	Paper (under submission)	M12	M13* (expected)	UNIBO
D2.3	Reusable Software library for intra-agent explainability	Software	M14	M14 (expected)	UNIBO

* See explanations of delays in section 1.1 (project objectives and activities implemented) and 3.1 (comments on expenses)

1.7. Free comments

Compliance with project objectives, interaction between the partners, issues, questions to CHIST-ERA...

To request a project modification, please use the dedicated form on the Toolbox: https://www.chistera.eu/toolbox

Dr. Amro Najjar moved from the University of Luxembourg (Uni Lu) to the Luxembourg Institute of Science and Technology (LIST) where he is now working on a permanent position and a full-time researcher. Since Dr. Najjar was the main contributor on the UNILU side, we requested that he continues to work on the project with his new affiliation at LIST. In addition, to complete the person-month freed by Dr. Najjar, Igor Tchappi has been hired as a UNILU postdoc. He started to work on the project from the 15th of February 2022. This amendment would not imply an increase of the budget, the university would transfer to LIST the personnel costs of Dr. Najjar's contribution. We discussed this with the FNR (the national funding agency), and with all of the project partners --- who unanimously agreed. The coordinator (HES-SO) is taking the contractual steps (update of DoA, CA and change request).

2. Dissemination of results, exploitation, impact

2.1. Scientific publications (conferences/workshops, book chapters, etc.)

Indicate the publications resulting from the project. Mention only those that result directly from the project (after it started, and which mention the support of CHIST-ERA and the project reference). Indicate whether they correspond to single or multi-partner communications (multi-partner means involving several project partners). Indicate if they are available in Open Access and linked to the respective underlying data. Provide the corresponding Digital Object Identifiers (DOI).

Distinguish the different categories of publications (journals/conference proceedings, technical reports, etc.). Use the usual citation standards for the field reference. If the publication is accessible on line, indicate the URL.

Please harmonise the bibliography and use only one font.

	Scientific publications					
Reference (list of authors, journal/conference proceedings/other, pages, year of publication, ...)	**Multi-project partners of same country (Yes/No)**	**Multi-project partners of different countries (Yes/No)**	**Open Access (Yes/No)**	**DOI**	**URL**	**DOI(s) of underlying data**
Federico Sabbatini, Giovanni Ciatto, Roberta Calegari, Andrea Omicini. “On the Design of PSyKE: A Platform for Symbolic Knowledge Extraction”. WOA 2021 – 22nd Workshop “From Objects to Agents”. CEUR Workshop Proceedings 2963, October 2021	**No**	**No**	**Yes**	**none**	http://ceur-ws.org/Vol-2963/paper14.pdf	
Giuseppe Pisano, Roberta Calegari, Andrea Omicini. “Towards cooperative argumentation for MAS: An actor-based approach”. WOA 2021 – 22nd Workshop “From Objects to Agents”. CEUR Workshop Proceedings 2963, October 2021	no	no	yes	none	TBD	
Andrea Agiollo, Giovanni Ciatto, Andrea Omicini. “Shallow2Deep: Restraining Neural Networks Opacity through Neural Architecture Search”. Explainable and Transparent AI and Multi-Agent Systems. Third International Workshop, EXTRAAMAS 2021	no	no	no	10.1007/978-3-030-82017-6_5	http://ceur-ws.org/Vol-2963/paper17.pdf	
Federico Sabbatini, Giovanni Ciatto, Andrea Omicini. “GridEx: An Algorithm for Knowledge Extraction from Black-Box Regressors”. Explainable and Transparent AI and Multi-Agent Systems. Third International Workshop, EXTRAAMAS 2021	no	no	no	10.1007/978-3-030-82017-6_2	https://doi.org/10.1007/978-3-030-82017-6_5	
Giovanni Ciatto, Amro Najjar, Jean-Paul Calbimonte, Davide Calvaresi. “Towards Explainable Visionary Agents: License to Dare and Imagine”. Explainable and Transparent AI and Multi-Agent Systems. Third International Workshop, EXTRAAMAS 2021	no	yes	no	10.1007/978-3-030-82017-6_9	http://dx.doi.org/10.1007/978-3-030-82017-6_2	

Davide Calvaresi, Giovanni Ciatto, Amro Najjar, Reyhan Aydoğan, Leon Van der Torre, Andrea Omicini, Michael I. Schumacher. “Expectation: Personalized Explainable Artificial Intelligence for Decentralized Agents with Heterogeneous Knowledge”. Explainable and Transparent AI and Multi-Agent Systems. Third International Workshop, EXTRAAMAS 2021	no	yes	no	10.1007/978-3-030-82017-6_20	http://dx.doi.org/10.1007/978-3-030-82017-6_9	
Andrea Agiollo, Giovanni Ciatto, Andrea Omicini. “Graph Neural Networks as the Copula Mundi between Logic and Machine Learning: A Roadmap”. WOA 2021 – 22nd Workshop “From Objects to Agents”. CEUR Workshop Proceedings 2963, October 2021	no	no	yes	no	http://dx.doi.org/10.1007/978-3-030-82017-6_20	
Yazan Mualla, Igor Tchappi, Timotheus Kampik, Amro Najjar, Davide Calvaresi, Abdeljalil Abbas-Turki, Stéphane Galland, Christophe Nicolle: The quest of parsimonious XAI: A human-agent architecture for explanation formulation. Artif. Intell. 302: 103573 (2022)	No	Yes	yes	https://doi.org/10.1016/j.artint.2021.103573	http://ceur-ws.org/Vol-2963/paper18.pdf	
Rachele Carli, Amro Najjar: Rethinking Trust in Social Robotics. CoRR abs/2109.06800 (2021)	No	Yes	Yes	https://doi.org/10.48550/arXiv.2109.06800	(link)	
Contreras, V., Aydogan, R., Najjar, A., & Calvaresi, D. On Explainable Negotiations via Argumentation	No	Yes	No	No	https://luis.leiva.name/tmp/bnaic2021_preproceedings.pdf	
Giovanni Ciatto, Roberta Calegari, Andrea Omicini. “2P-Kt: A Logic-Based Ecosystem for Symbolic AI”. SoftwareX 16, December 2021	Yes	No	Yes	https://doi.org/10.1016/j.softx.2021.100817	https://www.sciencedirect.com/science/article/pii/S2352711021001126	

URL of Data Management Plan (optional): D1.4-[M3]-DMP_195530-2021.pdf

2.2 Exploitation plan

Outline an exploitation plan of your most significant exploitable results including:

- *Who will exploit the result output (project participant/if someone else then who and how will they be informed);*
- *Use type (commercial/other use);*
- *Intellectual property rights arrangements if relevant;*
- *Target end user;*
- *Roadmap and goals during and after the project's lifetime (plan of actions to be taken to achieve exploitation);*
- *Timeframe.*

Use type, intellectual properties, and Licensing:

The **software tools produced in WP2** are freely available on the Web under an open-source license (Apache 2p) supporting both research and commercial exploitation. Contributions – in the form of bugfixes, feature requests, of original SKE/SKI algorithms implementations – are not only welcome but also encouraged via the GitHub Social Coding platform. Keeping the codebase open and publicly available is part of a deliberate strategy aimed at attracting researchers interested in experimenting with SKE and SKI.

Ad-hoc lectures concerning SKE and SKI have been scheduled as part of the "Intelligent System Engineering" and "Multi Agent Systems" courses held at University of Bologna as part of the Master's degree programmes in "Computer Science and Engineering" and "Artificial Intelligence", respectively.

EREBOTS 2.0 will be released at the end of the project with an open-source license (under evaluation – possibly BSD 3 clause).
While the basic versions of the software will always be kept free and open source, we expect to evaluate the possibility of producing a "premium" version of the software by the end of the project (in collaboration with possibly interested industrial partners).

Targeted Users:

The recipient(s) of our tools/software are academia, profiting from the algorithmic and implemented innovations, end-users (a selection of the stakeholders identified during this project), and professional nutritionists using the nutrition virtual coach system

RoadMap & Goals (post-project):
- G1) Applying the acquired knowledge to other research challenges
- G2) Writing other research proposals involving some current consortium partners (i.e., applying the obtained knowledge and actualized prototypes to tackle intra-/inter-agent explainability in other unexplored domains (i.e., neuroscience, sport, and energy domains)
- G3) Connecting with industrial partners (e.g., knowledge transfer via InnoSwiss projects)
- G4) Connecting with medical partners (e.g., conducting further investigations focusing on specific user groups and to fully assess the legal boundaries of intelligent assistive systems in real-world settings)
- G5) Investigating more robot-human interaction (RHI) as future assistive tools for instance for children

2.3 Exploitation overview (software, products, spin-offs, etc.)

Use the table below to outline your current progress in the exploitation plan (see previous section): achievements so far and next steps. Fill in the goals foreseen in your plan for every year of your project and 3 subsequent years after the end of your project (column 1) and actual exploited results up to date (column 2).

Period	Planned goals	Actual exploited results
Year 1	- SKE-SKI libraries	SKE-SKI libraries
Year 2	- First integration external libraries into EREBOTS 2.0 (generic prototype) - Additionally, G3	
Year 3	- Full working scenario-related prototype + open-source code - Additionally, G3, G4	
Project end + 1 year	- Writing of new research proposal to employ the generated new knowledge - Additionally, G1, G2, G4, G5	n/a
Project end + 2 years	- G3	n/a
Project end + 3 years		n/a

Describe project spin-off effects, for example:

- *Software and any other prototype;*
- *Standardization actions;*
- *National and international patents, licences, and other elements of intellectual property;*
- *Launching of product or service, new project, contract, etc.;*
- *Development of a new partnership;*
- *Creation of a platform available to a community;*
- *Company creation, spin-off companies, fund-raising.*

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2.4 Other dissemination of results

Mention any communication actions, including the project website creation and management and the target audience.

Project website: https://expectation.ehealth.hevs.ch/

Project video for general audience: https://expectation.ehealth.hevs.ch/posts/promo/

Round Table (scientific panel) about the EXPECTATION project at EXTRAAMAS 2022

EXTRAAMAS International workshop (CHIST-ERA special track): https://extraamas.ehealth.hevs.ch/

Deliverables: https://expectation.ehealth.hevs.ch/posts/deliverables/

3. Resources and Funding

3.1. Project level (from project start)

Budget used				
N°	**Partner**	**Person.months**	**Total costs**	**Percentage of requested budget**
1	HES-SO	16.2	110000.00 EUR	35%
2	UNIBO	9	47736.52	37%
3	OZU	18.6	6436.38 EUR	14.18 %
4	UNILU	4.5	41.244.37 EUR	15%

<u>*Comments on expenses*</u>

UNIBO:

The Italian partner (UNIBO) has, to this day, not yet received funds.
Somehow, the PI of UNIBO (Andrea Omicini) has managed to circumvent such a huge problem making use of some internal funds (anticipating the grant's money). This has led to minimal delays into delivering D2.1 and D2.2.
Nevertheless, the Italian partner has very well contained such a circumstance, managing to contribute as expected and not harming anyhow the project. Indeed, the reporting delays have not affected the production of the actual contents.
However, if the founds will not be released shortly, the Italian partner might not be able to sustain the schedule as planned.

OZU:

Given the highly variable exchange rate, the Turkish partner had enormous difficulties when it came to buying material from the European market. In the coming years, they may struggle to arrange their travel expenses for attending the project meetings to be held by other partners, especially when it is held in an expensive country like Switzerland due to the travel budget limitation. The travel budget should be reconsidered, and the CHIST-ERA organization could actualize possible support.