COST CA15222 - European Network for cost containment and improved quality of health care

STSM Report:

IT support to Innovative Person Centred Care in data collecting and processing

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STSM dates: FROM 06th October 2019 TO 14th October 2019

PURPOSE OF THE STSM:

We have already agreed that information technologies in general, with special focus on artificial intelligence and machine learning have proven capabilities to collect and explore massive amount of medical data (coming from different sources) and deliver automatic medical diagnostics. ICT and AI could provide additional values to the PCC concept. According with that we have defined two ewseach objectives of my STSM:

- Exploring the potentials for creation of adaptable framework (to cultural, personal, environmental and other settings) for collecting, integration and presentation of patient's feelings, beliefs and preferences with heterogenous medical data (coming from different health systems) and domain knowledge (which could also include personalised approach, specific existing tacit or undocumented knowledge);
- Exploring the potentials for utilization of artificial intelligence and machine learning techniques for reasoning over collected data all aimed on providing support to shared decision making over clinicians and patients, as partners in the process.

In line with Project goals, specifically with WG3 tasks, we have defined 3 research hypotheses:

1. "Adaptable framework for collection, integration and presentation of heterogenous medical data and domain knowledge **could serve as a key starting point for automated large-scale testing which supports different evaluation measures and criteria."**
2. "Systematic presentation of variety of data coming from different sources that are processable by computers, **could be used for creating and testing different metrics, models and measurements."**
3. "Adaptable framework for collection, integration and presentation of data in PCC domain, **could identify and suggest specific requirements for evaluation protocols for large scale testing.**

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

In order to achieve defined objectives, during STSM we implemented the following steps:

- Intensive discussions with experienced researchers about understanding of different data sources;
- Comprehensive research on existing methods/techniques for data collection and processing;
- Modelling the process of data collection and processing;
- Creating theoretical foundations for adaptable framework for collecting, integration and presentation of patient's feelings, beliefs and preferences in PCC domain;

In order to building new knowledge about potentials of using AI techniques/methods/approaches for collection, presentation and exploitation of data in PCC domain, key focus have been put on analyses of well-known approaches coming from different fields of applications and research communities, such as: - Domain-specific knowledge representation with evidences from different resources, different representations and roles.

The semantically-enhanced families of services-oriented architectures approach [1] which is originally routed in modern software engineering with proven potentials in different areas (including learning analytics, cyber security over clouds, etc.) is expected to provide a framework for:

- Semantically enhanced representation of domain knowledge and patients as persons in general,
- Representation of requirements and preferences defined either by patients (in the form patient's attitudes, expectations, and preferences) or by professionals (as proven knowledge in specific domain and/or hidden knowledge about clinical routines) (e.g. stratified structure of concerns and qualifier tags [2]),
- Decision making approach implemented in the form of well- known algorithms (e.g. TCP nets [3], cp-nets [4], etc.) adopted based on created semantic structure for knowledge representation.

AI use for exploring data (data centric) to characterize problems and propose solutions. Despite the increasing availability of medical data from different sources, most of the applications of AI in the medical field are still mono-modality (utilizing one type of data at the time).

Thus, the proposed approach is routed in exploring the potential of AI applications over heterogeneous data about patients and capital knowledge in specific field of application with the associated benefits in PCC of increased accuracy for diagnostics, therapy planning and increased patient's well-being. To this end, data coming from different external devices have been analysed (e.g. devices for monitoring physical activities, etc.).

In parallel to the development of AI, digitalization of health-care has experienced a tremendous development. However, access and exploitation of both personal and medical data is considered a difficult endeavour, due to its sensitivity, particularly for institutions not directly linked to the healthcare sector. Therefore, our approach is also directed to facilitate collection, storage and exploitation of clinical data with emphasis on compliance with the new EU GDPR.

Furthermore, ethical issues are of key importance due to PCC focus on patients and persons, thus providing data about each individual (directly or indirectly by using different devices for monitoring health indicators, habits, etc.). Cybersecurity is a key issue in the collection, storage and sharing of medical data both on the cloud and on individual computers. Machine learning provides new solutions to address the challenge of cybersecurity of medical data collections.

[1] Brodie, Michael, et al., Semantically enabled service-oriented architectures: A manifesto and a paradigm shift in computer science, DERI-Digital Enterprise Research Institute, Tech. Rep. TR-2005-12-26 (2005).

[2] R.Šendelj, I.Ognjanović, Multi-criteria Decision Making for Optimal Configuration of Business Process Model Families, INFORMATION TECHNOLOGY AND CONTROL, 47(3), pp.532-563, 2018

[3] R. I. Brafman and C. Domshlak, Introducing variable importance tradeoffs into CP-nets, in The Eighteenth Conference on Uncertainty in AI, 2002.

[4] S. Chen, S. Buffett and M. W. Fleming, Reasoning with Conditional Preferences across Attributes, in The 20th Conference of the Canadian Society for Computational Studies of Intelligence on Advances in Artifical Intelligence,,Montreal, Canada, 2007.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The following results are delivered:

- **created semantically enhanced framework for presentation of patients in PCC concept**: by following the approach presented in [2] in which two-layered structure of concerns and qalifier tags is shown as a structure capable to present different characteristics of each decision-maker in different fileds of applications, we developed similar approach for presentation of patients' feelings, attitudes and own preferences/requirements in health care domain;
- Furthermore, since the structure of concerns and qualifier tags has strong capabilities in both qualitative and quantitative measurements, we suggested to use different questionanires in order to understand the needs of patients, how they can be further addressed, and further transformed into **measurable indicators**;
- **created semantically enhanced framework for presentation of health care indicators of each specific patients in PCC concept**: even similar two-layered structure of concern and qualifier tags is suggested to be used, after detailed domain analyses, we decided do create the structure completely independently to structure developed for presentation of patients' needs and attitudes. The structure will present key health indicators, medical treatments and therapies used/suggested for using, thus presenting both domain knowledge (in specific field of medicine) and doctors' as partners in PCC concept. Due to complexity of the whole process, developed approach suggests use of multiplied mutually linked structures of concerns and qualifier tags in cases where health issues of specific patients come from different fields of medicine.
- **created links between structures for presentation of specific patient and his/her health issues**: having in mind that , to the best of our knoeldge, suggested multiplied mutually linked structures of concerns and qualifier tags Is innovative, we worked on creation of links between multiply strcutures with assigned meanings and relations in accordance with PCC settings. To this end, some of good practices in feature modelling [5], e.g. relation of inclusion-exclusion, grouping relations AND, OR, XOR, etc. are used.The purpose of created links is mainly on assigning meanings to each health care indicator when it is linked with charactreitics of each specific patients, his/her behavior and lifestyle.
- **crated comprehensive analyses of available reasoning algorithms in the context of decision/making support to PCC over created semantically enhaced structure**: by having in mind that different reasoning algotihms have completely different potentials to be applied over different structures for. knowledge representation, we made comprehensive analyses of available algorithms and made cross-matching comparison of theoretically proven characteristics of available algorithms and characteristics of created innovative structure. We analysed both, qualitative and quantitative algorithms and identified clear directions how CSAHP algorithm could be further adopted to support decision making process over created structures.
- **identified cyber security and privacy issues over created innovative structure**: even created innovative structure have clear potentials to present both patients' characteristic and helath care domain knowledge, it has clear vulnerabilities if implemented in form of web services with private data and information that are stored. However, identified vulnerabilities are still a basis for further analyses and creation of protection systems.

[5] *Lee, Kwanwoo, Kyo C. Kang, and Jaejoon Lee. Concepts and guidelines of feature modeling for product line software engineering, International Conference on Software Reuse. Springer, Berlin, Heidelberg, 2002.*

FUTURE COLLABORATIONS (if applicable)

I am very interested to continue cooperation with Prof.dr John Mantas and his research team. As former president of the European Federation for Medical Informatics (https://www.efmi.org) Prof.dr John Mantas has huge experience in various aspects of medical data (e.g. information modelling, interoperability, architecture and relation to other essential information systems, usability, use by different professional groups, patients and their informal carers); personal(ized) portable devices, sensors and actuators as well as the underlying networks enable personal and even personalized health service provision going far beyond traditional care procedures; role of human and organisational factors in the use of healthcare technologies, and many others.

As next steps we are planning to perform the following activities:

- Prepare scientific paper(s) for international conferences/journals about created innovative structure for specification of characteristics of patients and health care domain knowledge;
- Continue with creation of each specific element in suggested innovative multiplied mutually linked structures of concerns and qualifier tags;
- Create and conduct case-studies in concrete specific domain of applications;
- Work on prototyping and further testing an identified potential specific field of application;
- By having in mind that Montenegro is very small country with one integral health information system, it could be very beneficial to test suggested innovative approach with real data and settings. To this end, new project proposal for using national/international/pre/accession funds will be prepared and submitted;
- Share experience and results with other WG3 and Action members;
- Invite our MSc and PhD students to participate in further research over created innovative structures in PCC settings;
- Present our research work in the form of scientific paper/poster with other WG3 and Action members.

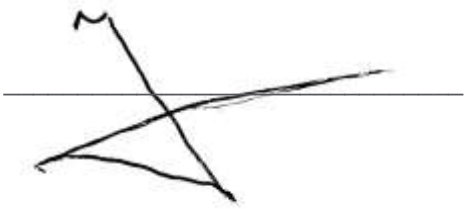
Confirmation by the host institution of the successful execution of the STSM:

We confirm that Prof. Ramo Sendelj, PhD has performed the research work as described above.

Contact Person of Host Institution

Prof. John Mantas, PhD

Signature



Name of researcher

Prof. Ramo Sendelj, PhD

Signature