The CONSULT System: Demonstration

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ABSTRACT

This short paper describes the design of the CONSULT system, a decision-support tool intended to help patients suffering from chronic conditions self-manage their health. The system takes input from multiple sources, including commercial wellness sensors and patient's electronic health record, to inform an intelligent back-end that reasons about day-to-day health management decisions, customised for individual patients. The architecture of the system features a modular structure for allowing input from a range of different sources, a reasoning engine underpinned by *computational argumentation* that constructs weighted opinions using these inputs and knowledge about their sources, and an interaction agent driven by *argumentation-based dialogue* that responds to user queries.

CCS CONCEPTS

• **Computing methodologies** → **Knowledge representation and reasoning**;

KEYWORDS

Computational Argumentation, Human-Agent Interaction, Decision Support

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1 INTRODUCTION

The *CONSULT** project explores the feasibility of employing a collaborative decision-support tool to help patients suffering from chronic diseases self-manage their treatment plans. The CONSULT system exhibits the following key properties: (1) integration of data from commercial wellness sensors, a patient's *Electronic Health Record (EHR)*, input from *Health Care Professionals (HCPs)*, and treatment guidelines to produce an adaptive care plan customised to the patient's current circumstances; (2) application of *computational argumentation* to structure and track the data from these disparate sources and identify reinforcing and conflicting information; and (3) interaction with patients via *argumentation-based dialogue* to ensure understanding of the information gathered in (1) and to address, and potentially resolve, any conflicts found in (2). An overview of the system is illustrated in Figure 1.

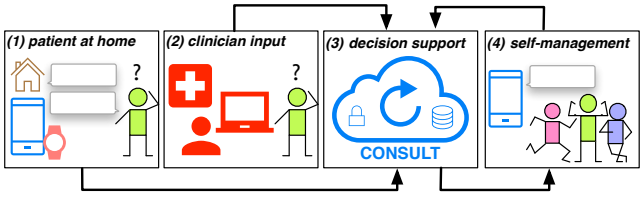

Figure 1: An overview of the CONSULT system

Research has established that involving patients in the management of their own disease has long-term health benefits [3]. Advances in commercial wireless sensor technology mean that it is practical for patients to monitor a wide range of health and wellness data at home, including blood pressure and heart function, without direct supervision by medical personnel. However, such sensor data is currently disconnected from a patient's EHR and personalised treatment plan; treatment plans do not adapt dynamically to changes in patient circumstances; and a record of patient decisions about and responses to daily care is not routinely captured in a standardised way, preventing learning about treatment effectiveness from such a record. The long-term and overarching aim of the CONSULT project is address these issues.

Our approach is founded on the use of *computational argumentation* to model relationships between elements of information, represented as logic predicates, and the sources of that information, tracked using data provenance. Argumentation [2, 4] is a well-founded formal methodology with roots in philosophy and has been applied in *artificial intelligence (AI)* and *multi-agent systems (MAS)* as a structured technique for reasoning where conclusions are drawn by analysing evidence that supports (or refutes) the conclusions. Different from model-driven and other formal systems, argumentation-based systems have the ability to explain why a decision was made in a particular context. Further, argumentation-based systems can incorporate models of *trust* [5], *provenance* [1] and user preferences to modulate reasoning.

*CONSULT stands for *Collaborative mObile decisioN Support for managing mULtiple morbidiTies.*

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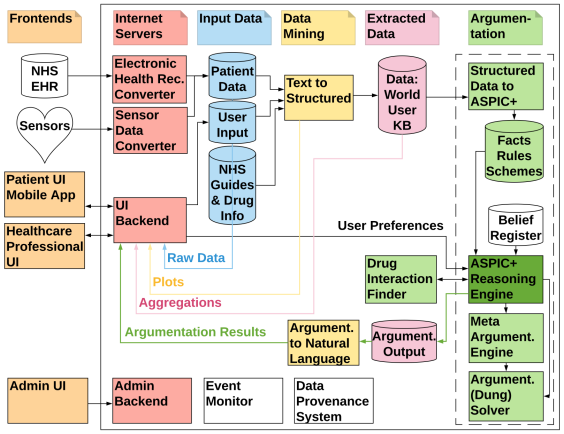

Figure 2: CONSULT system architecture. See text for explanation.

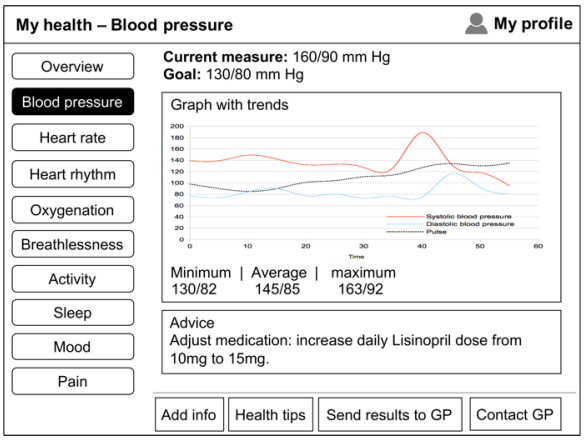

Figure 3: An example design for the CONSULT dashboard

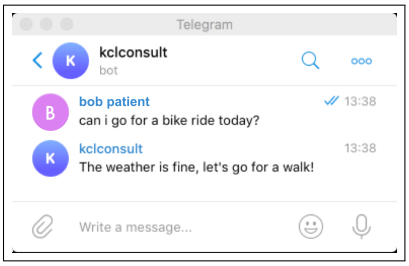

Figure 4: An example interaction with the CONSULT agent

2 CONSULT SYSTEM

An overview of the system architecture is illustrated in Figure 2. There are seven primary building blocks comprising the system: (a) the input sources, including biometric data gathered by commercial wellness sensors and a patient's EHR (blocks in upper left corner of figure); (b) servers for transmitting input data (red blocks in figure); (c) internal databases for storing data (blue blocks); (d) arguments mined from raw data (yellow blocks); (e) models of trust, provenance and preferences (pink blocks); (f) computational argumentation engine and associated sub-components (green blocks); and (g) user interfaces (orange blocks). The entire system includes an interface for patients, as well as an interface for HCPs and a third interface for system administrators. The demonstration proposed here will show the patient interface, highlighted in the figure (orange block in the vertical middle at the far left).

The patient interface features two key components: (a) a *dashboard*, as illustrated in Figure 3, where patients can view the data collected by their wellness sensors, as well as summarised data from their EHR; and (b) an interactive agent, implemented via a *chatbot* style interface, as illustrated in Figure 4. The patient can "talk to" the agent and ask a range of questions, for example, requesting explanations about the data in the dashboard or recommendations for undertaking activities such as walking or cycling.

3 DEMONSTRATION

We illustrate a particular scenario, below, and show how a fictitious patient could interact with the system. The patient interface is implemented on an Android tablet and allows users to interact with the agent and query the data and condition of the fictional patient.

The fictional patient is called "Bob". He is a 66-year old male who has suffered a stroke. He has also been diagnosed with Osteoarthritis (OA) and Hypertension for which he is prescribed *thiazide*. In order to manage OA related pain, Bob uses *ibuprofen* (an over the counter pain medication). Bob also monitors his overall wellbeing using wellness sensors. After taking *ibuprofen* during a flare up of OA, Bob's CONSULT app alerts him that his blood pressure is high.

The CONSULT agent leverages *computational argumentation* to consider the relevant clinical guidelines and Bob's information to assist and support Bob in deciding what he should do. In this situation, Bob can consider alternative pain killers (from the clinical guidelines) and, with the assistance of the CONSULT agent, be supported through an argumentation-based dialogue to reason through the different options, their pros and cons given his specific situation and all the relevant clinical guidelines.

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