A SEMANTIC WORKFLOW MANAGEMENT SYSTEM FOR INTERDISCIPLINARY HEALTHCARE TEAMS

Mounira Kezadri[1], Daniela Rosu[1], Szymon Wilk[2], Wojtek Michalowski[1], Craig Kuziemsky[1], Davood Astaraky[1]

1 Telfer School of Management, University of Ottawa, Canada

2 Institute of Computing Science, Poznan University of Technology, Poland

Outline

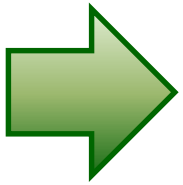
1. Motivation
2. Related work
3. Research agenda and results
4. Conclusions and future work

Motivation

- Healthcare systems objectives: sustainable, effective, efficient, collaborative and safe healthcare system.

- Increasing complexity of patient management asks for an interdisciplinary group of clinicians
  → Teams have been reported to reduce hospitalization time and costs, improve service provision and enhance patient satisfaction, staff motivation and team innovation

⇨ **The need for interoperability to facilitate team based care delivery will grow**
→ **Interoperability**: the ability of health information systems to work together (within and across organizational boundaries) in order to advance the effective delivery of healthcare.



The most comprehensive technology for improving the interoperability of complex interdependent activities is **semantic workflow management**.

What is a Healthcare Team?

A **team** is different from a **small group:** its members perform concerted, interdependent actions (part of team processes) in order to achieve a shared goal.

➔ Team members need adjust to one another, sequentially or simultaneously, in order to accomplish team goals.

- Teams consist of two or more individuals (team members).

  → Team members: - possess specialized knowledge and skills;
  - have specific roles
  - perform specific tasks, including making decisions
  - interact and coordinate with each other

Healthcare Teamwork

A sustained effort performed by members using their individual skills.

→ Team members do not have to work together permanently!

Effective Teamwork

- requires a shared knowledge of each member's roles and abilities

- depends on effective communications within the team

- relies adequate organizational resources and support

Healthcare Team Processes and Workflows

Describe the interactions and coordination necessary to achieve healthcare goals.

Workflows are - (technical) realizations of healthcare processes

- derived from clinical practice guidelines
- executed by interdisciplinary teams of clinicians

Successful execution of a healthcare workflow requires collaboration and coordination (e.g., assigning workflow tasks with appropriate team members,)

Requirements

- **Team formation and management**
  → appointing a leader (MRP=Most Responsible Physician) at the start of patient management
  → appointing team members
    - complex appointments, based on skills, as required by the tasks in the workflow, availability, further constraints (e.g., some groups of emergency tasks need to be executed by the same practitioner)
    - all decisions about team membership are made by the MRP (based on suggestions from the workflow management support system)

- **Resource allocation**

- **Planning for ad-hoc and exceptional situations**

- **Communication**, to ensure proper delegation and coordination of activities
  - explicit (verbal, e-mail, notes)
  - implicit (CPOE, EPR) channels

Research Agenda

Create a methodological foundation and practical tools for supporting IHTs in providing effective care according to medical workflows:

- develop expressive models for health care agents, teams and workflows

- design strategies for assigning agents to teams and tasks and coordinating workflows while accounting for patient preferences

- implement a Healthcare Workflow Management System that embodies all the above

Related Work

- K4CARE project aimed at providing knowledge-based e-services for managing elderly patients
  - -Ontological models of workflows, processed data and documents and practitioners (limited characteristics in terms of their abilities)
  - - Multi-agent system to support execution of workflows by an IHT
  - - Limited evaluation (in Pollenza, Italy)

- Resource Management for Complex, Dynamic Environments
  - - Formal resource management framework
  - - Simplified (in comparison to BMPN) description of processes
  - - Prototype system simulation

- Patterns for Collaborative Work in Health Care Teams
  - - Goal-based workflow representation (PROforma)
  - - State-based exceptions (and associated plans) for detecting obstacles and hazards
  - - Description of practitioners , but no notion of a team

[M. Batet, D. Isern, L. Martin, et al.: Knowledge-driven Delivery of Home Care Services. Journal of Intelligent Information Systems, 2012, 38 (1), 95-130.]

[M.S. Raunak, L.J. Osterweil: Resource Management for Complex, Dynamic Environments. IEEE Transactions on Software Engineering,2013, 39 (3), 384-402.]

[M.A. Grando, M. Peleg, M. Cuggia, D. Glasspool: Patterns for Collaborative Work in Health Care Teams. Artificial Intelligence in Medicine, 2011, 53 (3), 139-160]

Our Approach

Conceptual Model

- We use a First Order Logic-based representation.

- The model includes:

  - **concepts** for healthcare practitioners, patients, tasks, etc.

  - **relationships** that link the concepts into a coherent representation of a healthcare environment

  - **axioms** describing various aspects of the environment, e.g., team behaviour, task and workflow requirements, etc.

Conceptual Model -2-

- **Healthcare Agents**: *nurse*(“Jane Smith”), *physician*(“David Moore”), patients, *patient*(“John Doe”), etc.

- **Tasks**: *task*(“Start_dialysis”), etc.

- **Task requirements** and **practitioner’s skills** are represented as *capabilities* (i.e., the ability to perform a certain clinical task). Capabilities are characterized by competency score
  - competency level for capabilities possessed by practitioners
  - competency threshold for capabilities required by tasks

EXAMPLE:

task(“Start_dialysis”),

requiresCapability(“Start_dialysis”, “dialysis”, 2)

capability(“start_IV”), capability(“glucose_monitoring”), capability(“dialysis”),

hasCapability(“Jane Smith”, “dialysis”, 3);

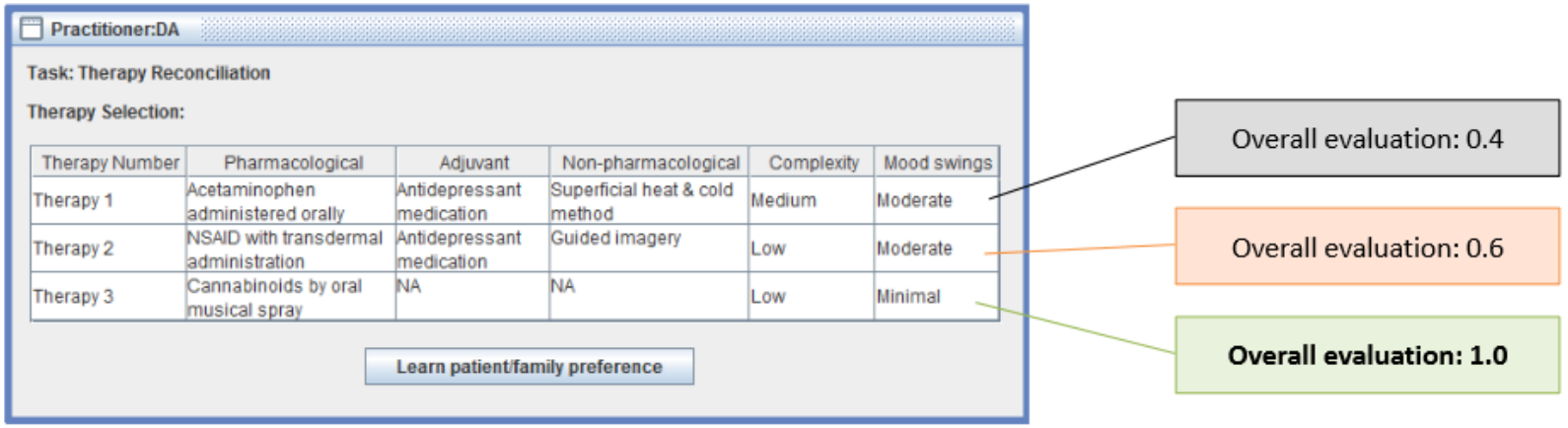
Conceptual Model -3-

Patient preferences: corresponding to specific types of decisions (e.g., selection of a therapy) and used to:

- present options to patient before making a decision
- evaluate alternatives

EXAMPLE: A patient prefers that the therapy he/she receives be on a level of less than 0.5 (on a predetermined scale).

*patient*_therapy_preference(, "John Doe", 0.5)
therapy("Acetaminophen administered orally + antidepressant")
hasEvaluation(Acetaminophen administered orally + antidepressant", 0.4)
therapy("NSAID administered orally + antidepressant")
hasEvaluation("NSAID administered orally + antidepressant", 0.6)



System Architecture

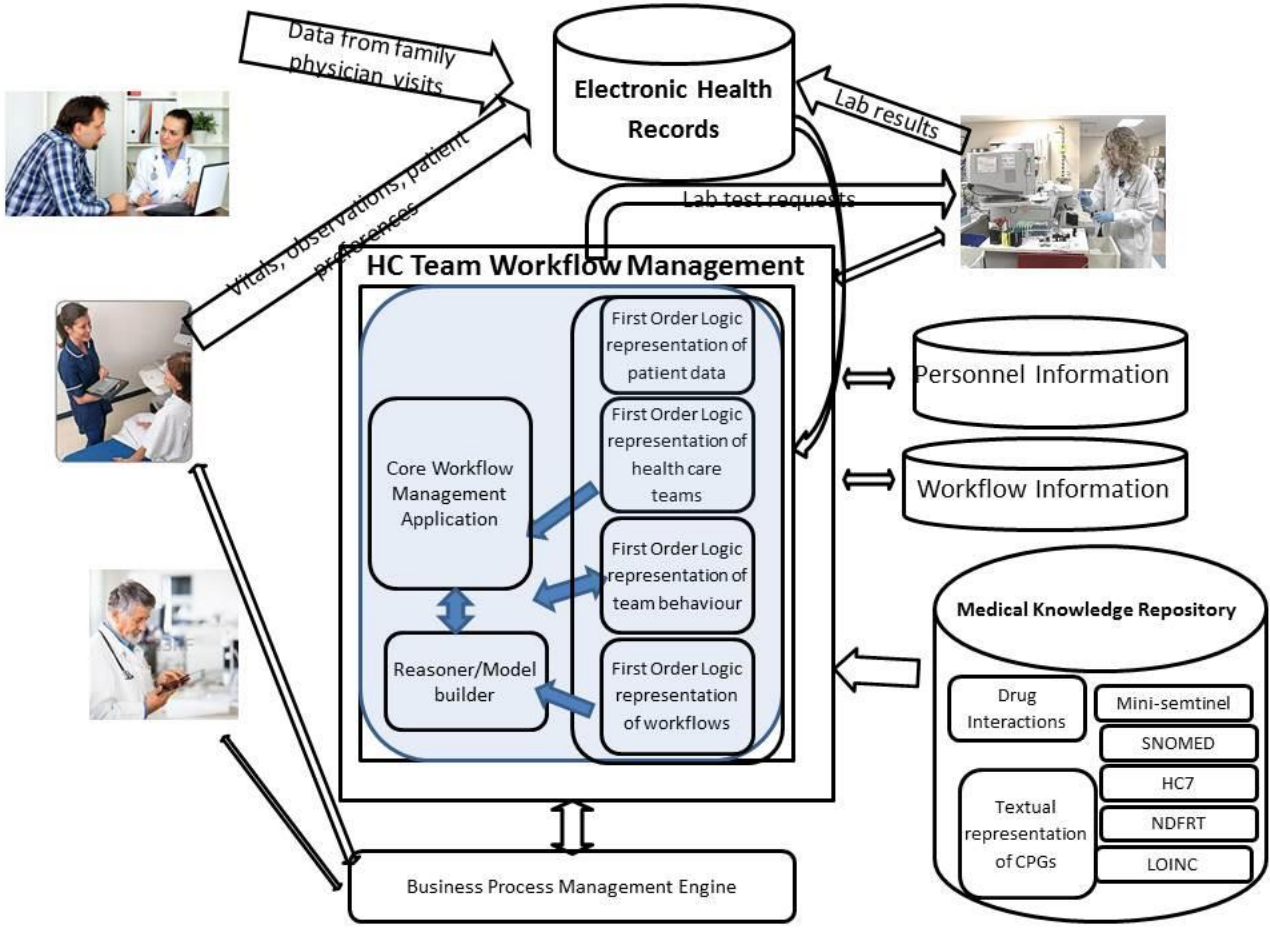
Multi-Agent Multi-Layer System

Builds on our experience with MET4 and significantly expands it to support an IHT and to handle diversified workflows.

Semantic Layer

- Agents and workflows described using a logic-based representation.

- Automated reasoning capabilities provided by an SMT solver (Z3)

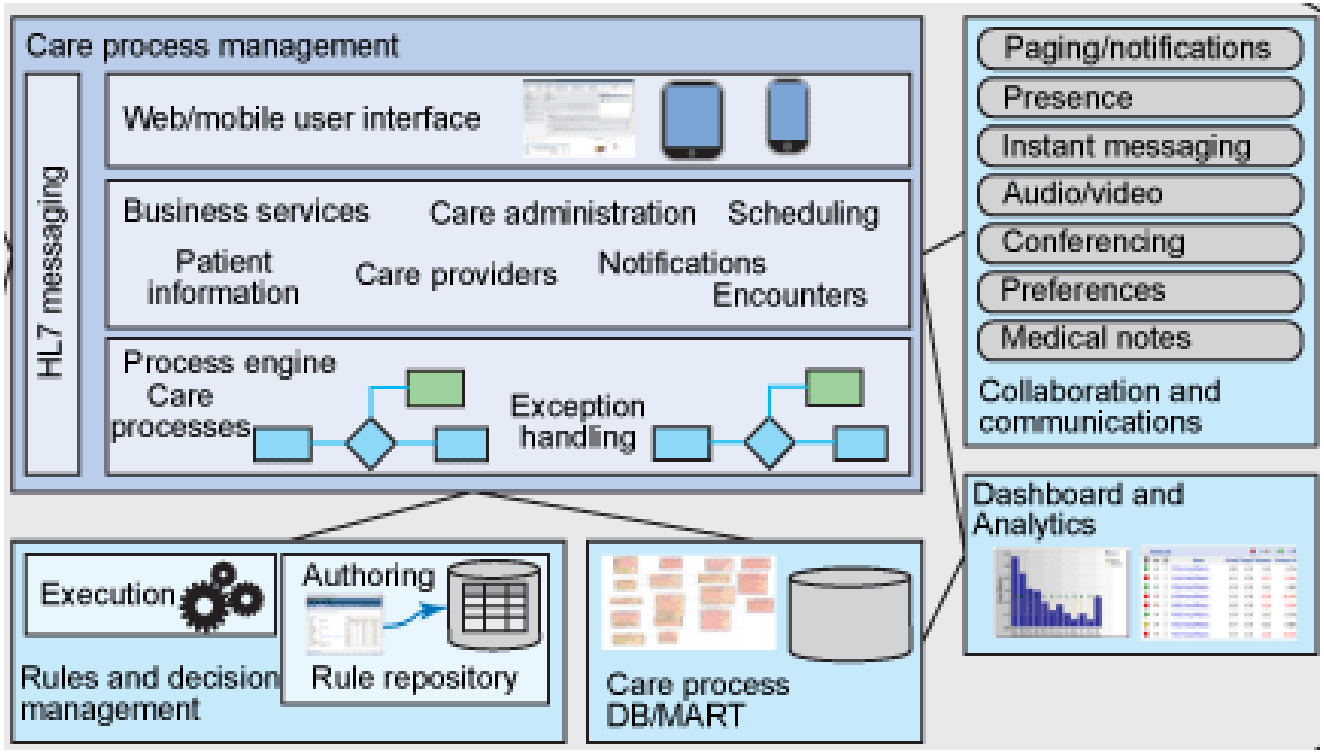


System Architecture – cont.

Execution Layer

Provided by IBM's Business Process Manager Engine

- Enacts the assignment of practitioners to tasks
- Notifies agents of theirs assignments
- Collects task completion data
- Coordinates the execution of the workflows, including concurrent access to resources.



IBM's CPM reference architecture

http://www.ibm.com/developerworks/bpm/bpmjournal/1212_dickman/1212_dickman.html

Conclusions

- **Conceptual model for representing IHTs and Healthcare Processes** that captures:
  → clinicians' competencies and expertise
  → team dynamics/behaviour
  → patient preference
  → interoperable healthcare process descriptions

- **A flexible system architecture** that supports :
  → dynamic capability-based assignment of practitioners to tasks
  → patient preference-based therapy selection
  → workflow tasks coordination

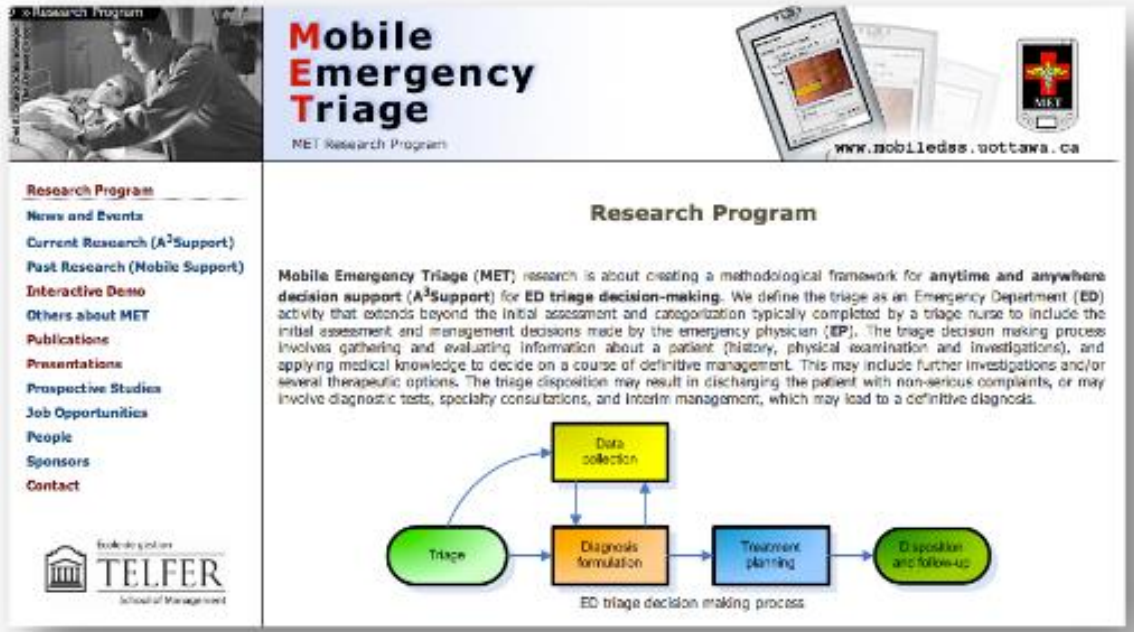
- **A (proof of concept) implementation**

Future Work

- Expand the Conceptual Model with:
  - more complex rules for handling of ad-hoc and exceptional situations
  - more extensive patient preference capabilities

- Deployment and testing of the implemented system

THANK YOU !



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