A MULTIAGENT SYSTEM TO SUPPORT AN INTERDISCIPLINARY HEALTHCARE TEAM
A CASE STUDY OF CLINICAL OBESITY MANAGEMENT IN CHILDREN

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**Introduction (1)**

- New patient management techniques – management workflows derived from clinical practice guidelines (CPGs)
- Typically a workflow needs to be executed by an interdisciplinary healthcare team (IHT)

*Interdisciplinary healthcare team* = a group of healthcare practitioners who work towards a common goal for the patient

- Achieving this common goal (provision of comprehensive care) requires collaboration and coordination

*Collaboration* = correct alignment of tasks from a workflow

*Coordination* = assignment of tasks to appropriate IHT members

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Introduction (2)

- Personnel and role variability of the IHT structure
  - Members may leave and join the IHT when executing the workflow
  - Members may play multiple and diversified roles in the IHT
- Support for such variability requires detailed characterization of practitioners (potential IHT members) and proper IHT creation and maintenance strategy
- Collaboration and coordination are required to build the next generation of healthcare IT systems

Research Goals

1. To define the **conceptual model** of an IHT executing a management workflow
2. To propose an IHT creation and maintenance **strategy**
3. To design and implement **MET4** – a multiagent system to support execution of workflows by an IHT
4. To implement a selected management workflow (**pediatric obesity**) within the MET4 system
IHT Conceptual Model

*Capability* = ability to perform a certain clinical task

- Capabilities associated with practitioners (*possessed capabilities*) and with workflow tasks (*required capabilities*)
- Capabilities additionally characterized by *competency score*
  - *Competency value* for possessed capabilities
  - *Competency threshold* for required capabilities
- Practitioner may be assigned a specific workflow tasks if
  1. She possesses all capabilities required by the task
  2. For all the required capabilities competency value ≥ threshold

IHT Creation and Maintenance Strategy

• A hybrid strategy that combines static and dynamic approaches to team creation and maintenance

1. Initially IHT has no members
2. Before executing a specific task check if IHT contains appropriate member
   • If yes, select the existing member
   • Otherwise, recruit a new member and select it
3. Assign the task to the selected member
4. After executing the task check if the selected member possesses capabilities required by subsequent tasks
   • If yes, retain the selected member in IHT
   • Otherwise, dismiss the selected member
5. Members may leave the IHT on their own

• Limited “idleness” of IHT members at the cost of pausing the workflow execution if no appropriate member can be recruited
Design of the MET4 System

- MET4 – a multiagent system to support workflow execution by IHT (cooperation, coordination, decision support)
- Builds on our experience with MET3 and significantly expands it to support a team and handle diversified workflows

- Designed using the O-MaSE method
  - Flexible method for analyzing and designing multi-agent systems
  - Strongly rooted in software engineering (modified UML)
  - Constructs a sequence of models that translate requirements into detailed design specifications
  - Available toolset (agentTool 3 – a plugin for Eclipse)

Agent Class Model for MET4

- Agent classes
- Non-agent components
Domain Model for MET4

- **Practitioner** has (competency value) **Capability**
- **Team** member-of **Workflow** executes
- **Workflow** includes **Decision** invokes **Activity** invokes **Task** has (competency threshold)
- **Disease** characterized-by **Episode** associated-with **Patient** experiences characterized-by
- **Result** described-by **Observation** associated-with
Implementation of MET4

• Functionality related to agents and workflows implemented using WADE (extension of JADE)
• Domain models and data repositories implemented using Protégé
• Touch-based interfaces for mobile devices (Android, iOS)
Obesity in Children

• Clinical obesity determined by the body mass index (BMI)
  • 99th percentile of children in the same age/gender
  • 95th percentile in case of comorbid conditions

• Management in dedicated facilities, e.g., Centre for Healthy Active Living at CHEO

• An organizational workflow used at CHEO requires IHT composed of multiple specialists

Pediatric endocrinologist
Registered nurse
Psychologist
Child and youth worker
Social worker
Exercise specialist
Dietitian
Obesity Management Workflow

Assessment Sub-workflow
- Physical Assessment
  - do_physical_assessment (3)
- Biochemical Assessment
  - do_biochemical_assessment (4)
- Dietary Assessment
  - do_dietary_assessment (5)
- Fitness Assessment
  - do_fitness_assessment (5)
- Psychological Assessment
  - do_psychological_assessment (5)

Initial Assessment
- Diagnosis
- Therapy Planning
- Therapy Reconciliation
- Therapy Implementation
- Repeated Assessment

Therapy Modification
- Therapy Successful?
  - Yes
  - No
Operations of MET4

IHT = \{ pa-md1 \}

pa-md1 : Practitioner Assistant
pa-md2 : Practitioner Assistant

do_physical_assessment (3)
do_biochemical_assessment (5)

do_physical_assessment (4)
do_biochemical_assessment (1)

Physical Assessment

Workflow Repository

Yellow Pages

tm : Team Manager
we : Workflow Executor

pa-md1 : Practitioner Assistant
dm : Data Manager
ds : Data Synchronizer

do_physical_assessment (3)

HIS

MD1

Physical Assessment

Biochemical Assessment

Dietary Assessment

Psychological Assessment

Fitness Assessment

Physical Assessment

Biochemical Assessment

Dietary Assessment

Psychological Assessment

Fitness Assessment

Biochemical Assessment

Dietary Assessment

Psychological Assessment

Fitness Assessment

Biochemical Assessment

Dietary Assessment

Psychological Assessment

Fitness Assessment

do_physical_assessment (3)
do_biochemical_assessment (4)
do_dietary_assessment (5)
do_fitness_assessment (5)
do_psychological_assessment (5)

reconcile_therapy (5)
do_diagnosis (5)
plan_medical_therapy (5)
implement_medical_therapy (5)
Conclusions

• Conceptual model of an IHT built around the concept of capability
• Hybrid strategy for IHT creation and maintenance
• Design and implementation of MET4 (O-MaSE, WADE, Protégé)
• Workflow for pediatric obesity

Support for cooperation and coordination
Support for IHT variability
Ongoing and Future Work

• Implementation of other management workflows (e.g., palliative care) within MET4
• Extensions of the IHT conceptual model and the creation and maintenance strategy
  • Emergency/priority tasks
  • “Bundles” of tasks executed by the same IHT member
  • Tasks executed simultaneously by several IHT members
• Clinical tests of the MET4 system
Thank you for your attention
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