Designing an Agent to Support the Retrieval of Medical Evidence to Support Emergency Physician Decision Making at the Point of Care

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MET (Mobile Emergency Triage)

- Multi-purpose Clinical Decision Support System

- Current implementation is pediatric asthma
  - Provides Early Assessment for Asthma Severity
  - Supports Patient Management and Clinical Workflow
  - Multi-agent architecture to support complex care pathway
    - Clinical personnel, patient management tasks, hospital information systems
  - Point of care support
MET Multi-Agent Design
Issues and Challenges in Supporting Evidence-based Medicine

- **Issue**
  - How to provide the most relevant evidence in a concise manner at the point of care

- **Challenges**
  - Natural language processing/semantic understanding difficult for *highly specialized medical corpuses*
  - Difficult to locate “most relevant” documents due to *low precision* of text-based search methodologies
  - Ranked *presentation style* favored by many search engines not suitable for point of care support
Requirement and Solution

- **Requirement:**
  - Access to evidence must be integrated with existing clinical workflow
  - Evidence must be contextually relevant for the current patient-physician encounter
  - Evidence should be available at the point of care

- **Solution:**
  - Employ a logical concept-based query, where concepts relate to specific disease and patient state
  - Combine concept-based query for document retrieval with cluster-based approach for document presentation
### Use Case for Designing Evidence-based Agent (EBA)

#### 1(a) Physician evaluates child’s state (including asthma exacerbation severity)

1(b) MET displays in a structured manner all available patient data (history and recorded assessments) together with verified prediction

#### 2(a) Physician prescribes treatment

2(b) MET captures treatment (using structured format)

#### 3(a) Physician requests evidence for prescribed treatment and child’s state

3(b) MET looks for evidence by creating a query, consulting clinical practice guidelines, mining the Cochrane Library and clustering results. MET presents clusters to the physician

#### 4(a) Physician reads and reviews provided evidence

4(b) --

#### 5(a) Physician decides whether to check another treatment or to continue with the currently prescribed one

5(b) MET allows the physician to go back to step 2 or to continue with the prescribed treatment

#### 6(a) --

6(b) MET stores the prescribed treatment
O-MaSE

- Methodology for modeling agents in a multi-agent system (MAS)
- Allows for integration of sub-teams of cooperating agents
- MAS defined in terms of Organizational, Goal, Role, and Agent Models
- MET architecture is simplified – One organization and each agent has fixed capabilities
MET EBA and O-MaSE

Organisational Model ➔ Organisational State Model

- **Goal**: Provide Decision Support at the Point of care
- **Role**: Triage
  - **Capability**: Calculate Triage, Confirm Triage, Send Triage to Blackboard
  - **Agent**: Triage

- **Role**: Treatment
  - **Capability**: Capture Treatment, Confirm Treatment, Send Treatment to Blackboard
  - **Agent**: Treatment

- **Role**: Evidence
  - **Capability**: Construct Query, Consult Guideline, Mine Cochrane, Index Documents, Cluster Evidence, Send Evidence to Blackboard
  - **Agent**: Evidence

**Goal**: Provide Triage Assessment

**Goal**: Provide Evidence

- **Service**: Blackboard System for Message Passing

**Goal**: Provide Decision Support at the Point of care

**Goal**: Provide Triage Assessment

**Goal**: Provide Evidence

**Role**: Triage

**Role**: Treatment

**Role**: Evidence
MET EBA and O-MaSE
MET EBA and O-MaSE

Goal Model

- **Goal**: 1. Provide decision support at the point of care
  - Subgoals: 1. Provide triage assessment
    - Subgoals: 2.1.1. Capture triage assessment
    - Subgoals: 2.1.2. Capture treatment
    - Subgoals: 2.2. Construct query
    - Subgoals: 2.3. Consult guideline
  - Subgoals: Treat: Treatment
  - Subgoals: Triage: Triage
MET EBA and O-MaSE
MET EBA and O-MaSE

**Goal Model**

1. Provide triage assessment

**Role Model**

1. Provide decision support at the point of care

1. Triage

- Calculate triage
- Confirms final triage
- Sends final triage to Blackboard (recipient Evidence Agent)
- Sends final triage to Blackboard for (recipient EHR)

2. Treatment

- Displays recommended treatment(s)
- Captures selected treatment from user
- Sends treatment to Blackboard (recipient Evidence Agent)
- Sends final treatment to Blackboard (recipient CPOE)

3. Blackboard

- Receives triage from Triage Agent
- Receives treatment from Treatment Agent
- Sends triage to Evidence Agent
- Sends treatment to Evidence Agent
- Sends documents to Interface Agent
MET EBA and O-MaSE
Design of the EBA

- Retrieve most relevant patient-specific evidence and present at the point of care
- Select relevant Cochrane database using CPGs
- Construct concept-based query using disease terms (MeSH ontology) and patient terms (patient ontology)
- Search Cochrane for evidence
- Create clusters from query for document presentation
- Process documents and assign to clusters for point of care display
Planning an Evidence-Based Search

- **Formulate Concept-Based Search**
  - Instantiate disease and patient concepts with instances from MeSH ontology and underlying patient ontology respectively
  - Combine disease and patient concepts into text-based search using Boolean operators and specify Cochrane index to be searched

- **Create Clusters for Retrieved Documents**
  - Formulate labeled clusters by automatically extracting instances of the patient ontology used in the concept-based query
    - “treatment”, “severity and treatment”

- **Assign Retrieved Documents to Correct Clusters**
  - Formulate queries by extracting attribute names and values from instances of patient ontology used in the concept-based search
    - “treatment, β-agonists”, “severity, moderate, treatment, β-agonists”
  - Pass queries to local text search engine and assign documents to relevant clusters based on discovery of queries in documents
Conclusions and Future Work

- Concept-based framework for retrieving evidence
  - Integrated with asthma management workflow
  - Contextualizes evidence for current patient presentation
  - Clustering enhances precision and provides better presentation of information at the point of care

- Implementation and integration of the prototype EBA underway using JADE environment

- Integrating of EBA with Computerized Clinical Practice Guidelines

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