Translating Arden MLMs into GLIF Guidelines – A Case Study of Hyperkalemia Patient Screening

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Background

• Arden Syntax at CPMC
  – More than 200 MLMs
  – No longer executable due to Y2K
  – Need to re-examine the knowledge in MLMs

• GLIF/GLEE at CPMC
  – Representation format for guideline
  – Execution engine to interpret guideline knowledge when applied to specific patient cases

• Translating Arden MLMs into GLIF guidelines
Goal

• Study the feasibility of medical knowledge translation
  – Arden \(\rightarrow\) GLIF as an example
  – Hyperkalemia patient screening as a specific case
• Identify issues arose during the translation process
• Propose potential solutions
maintenance:
  title: Screen for hyperkalemia in critical value range (> 6.0);
  filename: HYPERKALEMIA;
  version: 1;
  institution: Columbia-Presbyterian Medical Center;
  author: Pete Stetson (peter.stetson@dbmi.columbia.edu);
  specialist: Jai Radhakrishnon, MD, John Crew, MD;
  date: 2003-09-16;
  validation: test;

library:
  purpose: To monitor for patients who have a critically elevated potassium level;
  explanation: When a potassium lab result is stored, a warning is sent if it is > 6.0 mg/dl. If the patient is in renal failure a lower threshold K+ value is used;
  keywords: potassium, hyperkalemia;

knowledge:
  type: data-driven;

data:
...
  raw_potassiums := read last 3 from {'dam'="PDQRES2";
  '1301','1608','1609','1610','1656','1698','32713','33803','35455','35975',
  '35993','35994'} where they occurred within the past 3 months);
...

evoke: k_storage_event;

logic:
...
  creatinine := last (raw_creatinine where it is number);
...
  if potassium >= cut_off then
    conclude true;
  else
    conclude false;
  endif;
...

action:
  write "This patient has a critically elevated K+ of " || potassium || " meq/dl on " ||
  time of potassium || " and is at risk for potassium toxicity.";
end:
Guiding Principles for Translation

• Top level
  – MLM instance $\rightarrow$ GLIF guideline instance

• Knowledge role mapping
  – Slots of MLM $\rightarrow$ slots of GLIF classes

• Procedure code translation
  – Logic slot of MLM $\rightarrow$ GLIF guideline steps
<table>
<thead>
<tr>
<th>MLM Slots and Statements</th>
<th>GLIF Entities</th>
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<tbody>
<tr>
<td>MLM (1)</td>
<td>Guideline (1)</td>
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<td>Guideline.maintenance_info.title (1)</td>
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<td>Variable_Data_Item (4)</td>
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<td>knowledge.evoke (1)</td>
<td>Triggering_Event (1)</td>
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<td>Action_Step (7), Variable_Data_Item (5)</td>
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<td>knowledge.logic.if_then_statement (5)</td>
<td>Case_Step (4), Three_Valued_Criterion (3)</td>
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<td>knowledge.action (1)</td>
<td>Patient_State_Step (2)</td>
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<tr>
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<td>Action_Step (1), Literal_Data_Item (1)</td>
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Translated GLIF Algorithm
Validity Testing

• Use GLEE as a tool
  – Simulate the application of the translated knowledge to specific patient cases

• Domain expert created 5 simulated cases
  – Represent typical patients
  – Cover all possible execution paths

• For each of the 5 cases, the actual result matched with the expectation (the gold standard developed by the domain expert who created the cases)
Problems Identified

- Mix-up of general medical knowledge and local policy in MLM
  - Need to use different approaches
- Flow control
  - Procedure translation
  - Insertion of patient state step implied
- Data definition
  - The curly braces problem
- Event-driven execution
  - Batch-mode processing to improve performance
Potential Solution

• Manual translation
  – Labor-intensive, error-prone, difficult to generalize
• Potential solution: automatic translation
  – Direct translation could be difficult (overlapping of different models)
  – Development of an intermediate layer as the target of translation
  – Formalize individual models (procedures, etc.)
  – The guiding principles as the starting point of a set of mapping rules that facilitate the translation
Conclusion

- Feasible to translate the medical knowledge embedded in the Arden MLMs into the GLIF format
- Significant efforts are necessary to handle the problems in the translation
- Automatic translation could be a more generalizable approach for future work
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  – Dr. Mor Peleg

All positive comments are attributed to the presenter. All negative comments are the author’s responsibility.