An Introduction to GLIF

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Outline

- Computer-interpretable guidelines
- Sharing computer-interpretable guidelines
- Requirements for a shared guideline model
- GLIF
Computer-interpretable guidelines

In this talk, we address computer-interpretable guidelines that
- deliver patient-specific recommendations
- are integrated with EMRs and Health Information Systems
  » Automated reminders/alerts
  » Decision support and task management
  » Order entry appropriateness, referral criteria…
  » Background monitoring, care plans, quality review
Benefits of computer-interpretable guidelines

• Provide automatic decision support
  - Applied to individual patients
  - Can be during the clinical encounter
• Guidelines can be better designed
  - Software tools and guideline models used to specifying logic precisely
  - Ambiguities reduced
• Can integrate guidelines into workflow
  - Patient-specific guideline knowledge available at point of care, to person or entity needing it
Benefits, cont’d

• Can be used for quality assurance
  - Guideline defines gold-standard of care
  - Perform retrospective analysis to test if patients were treated appropriately

• Simulations for educational purposes

• Can aid in human visualization
  - interactive, dynamic display of guideline pathways
  - allows one to focus on relevant sections of flowchart
  - useful for authoring as well as for use
Assume:
Health care will benefit

Assume:
Practitioners will internalize and thereby follow the guideline

Assume:
Practitioners will read the guideline

Benefits: development & dissemination

Literature Review
Consensus Process
Evidence Evaluation

Guideline Creation,
Review, and Approval

Guideline Publication
(article or monograph)

Guideline Dissemination
Outline

• Computer-interpretable guidelines
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• Requirements for a shared guideline model
• GLIF
Why share computer-interpretable guidelines?

- Leverages cost of guideline development
- Provides consistency in guideline interpretation
- Can minimize misinterpretations and errors through the process of public review
- Facilitates execution rather than just read-only use
- Can provide common basis before local adaptation
Challenges in sharing guidelines by different institutions

- Local adaptation of guidelines
  - Availability of resources and expertise
  - Local workflow issues
  - Practice preferences
- Integration with information systems
  - Match patient data in EMR to GL terms
  - Match recommendations in guideline to actions in order entry system
- Every guideline model needs to address these issues
Obstacles to sharing

• Multiplicity of:
  - conceptual guideline models
  - intended applications
  - authoring tools (separate conceptual from formal, and implementation-specific models?)
  - dissemination formats (XML, RDF...)

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Common shared model

• Ability to share guideline encodings across:
  - different platforms and systems (e.g., EMRs)
  - different guideline models

• Joint development of:
  - shared model that incorporates features of different models
  - tools to support entire guideline life cycle
    » authoring, validation, local adaptation & mappings, execution, revision and update
Outline

• Computer-interpretable guidelines
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• Requirements for a shared guideline model
• GLIF
Functional requirements

• The shared model must be based on a set of functional requirements for sharable guidelines

• The functional requirements are organized according to the life-cycle of a computer-based guideline

• These requirements guide the design of GLIF, although we have not satisfied all of them yet
Life cycle of a computer-interpretable guideline

USE
Use and maintenance
Performance analysis

DEVELOPMENT
Authoring
Encoding
Validation

IMPLEMENTATION
Dissemination
Local adaptation and implementation
Testing

Life cycle of a computer-interpretable guideline

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Development requirements

• Expressiveness
• Comprehensibility
Expressiveness

• Ability to express knowledge content of different types of guidelines
  - Structural parts
    » Definitions, recommendations, algorithms
  - Decision-support guideline tasks
    » Expressive decision model
    » Goal setting
    » Specifying work to be performed
    » Data interpretation
    » Generating alerts and reminders
Comprehensibility

• Guideline visualization and readability
• Complexity management
• Coherence facilitation (e.g., support material)
Implementation Requirements

- Ease of guideline integration into clinical environments
- Ease of sharing actual specifications
Guideline integration into clinical environments

• Local adaptation of guideline content
• Integration with EMR
  – Mapping references to patient data to entries in the medical record
  – Mapping recommendations to implementable actions
    » e.g. linking to order entry system
    » printing a prescription
• Workflow integration
Ease of sharing actual specifications

• Easy to transport specifications among collaborators
  - Text format
  - XML/RDF

• Standard representations should not contain proprietary, application-dependent details
  - e.g., devoid of visualization details
Use requirements

• Support different usage modes
  – Interactive use
  – Batch processing

• Version control
Outline

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GLIF

- GuideLine Interchange Format
- A format for sharing clinical guidelines independent of platforms and systems
- Based on an object-oriented logical model of concepts
- Has an XML-based syntax (RDF Schema)
An Approach to Enhance Sharing

- A multi-level representation
- Designed to support multiple vocabularies and medical knowledge bases
- InterMed: multi-institutional development process
- GLIF is evolving as an open standard
  - Cooperation with other guideline modeling groups (Arden, USAM, GEM)
GLIF model

- Object-oriented representation model for guidelines
- Flowchart representation of a temporal sequence of clinical steps

Guideline
name
author

... Has parts

Guideline Step

Has specializations

Action Step
Decision Step
Branch Step
Synchronization Step
Patient State Step

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GLIF F classes

• **Action steps**: recommendations for clinical actions to be performed
  - e.g., Prescribe aspirin
• **Decision steps**: decision criteria for conditional flowchart traversal
  - e.g., if patient has pain then ...
• **Branch and synchronization steps** allow concurrency
• **Patient-state step**: characterizes patient’s clinical state
GLIF3 Modeling Process

3 Representation Levels
A. Author/viewer level
   - Conceptual flowchart of clinical actions and decisions
   - Aids in human understanding
B. Abstract machine representation
   - Can be executed by an interpreter
   - Correctness can be analyzed
C. Integration into application environments
   - Application-specific mappings and modifications
   - Not yet supported
Abstract Machine Representation

- Unambiguous syntax for logical expressions
  - based on Arden Syntax
- All logical expressions & actions refer to defined concepts (medical ontology)
- Allowed values, ranges, & time constraints
- Can be interpreted and analyzed for correctness
  - syntax, type, and range checking
Eligibility Criteria

Name
Chronic cough in immunocompetent adults

Specification

\[
((\text{now} - \text{cough}\_\text{start}\_\text{time}) > 3 \text{ weeks}) \text{ and } \\
((\text{now} - \text{date}\_\text{of}\_\text{birth}) > 18 \text{ years}) \text{ and } \\
\text{not immunocompromised}
\]

Encoding Language
GLIF_Arden

Didactics

Get Data Items
- Get cough\_start\_time
- Get date\_of\_birth
- Get immunocompromised
GLIF example: Guideline

- **Title**: Managing cough as a defense mechanism and as a symptom
- **Author**: Richard S. Irwin, MD, FCCP
  - Worcester, MA
- **Encoded by**: Mor Peleg, PhD
- **Authoring Date**: August 1996
- **Encoded Last Modification Date**: 10/25/2000
- **Developing Institution**: American College of Chest Physicians
  - American Thoracic Society
  - Canadian Thoracic Society
- **Guideline Version**: 2.0
- **Guideline Status**: published
- **GLIF Version**: GLIF3
- **Representation Status**: production
Algorithm

Main Cough guideline

- **<patient state>**
  - Chronic Cough

- **<action>**
  - History
  - Physical

- **<decision>**
  - Suspecting smoking or ACEI as cause of cough
    - yes: Reason to withhold Chest X-ray?
    - no: Cessation of smoking/ACEI
      - Cough gone?
        - yes: Cough gone
        - no: Chest X-Ray

- **<synchronization>**
  - Evaluate PNX, GERD, Asthma
  - Chest X-Ray

- **<branch>**
  - a1
Patient state step

Display Name
Chronic Cough

Name
chronic cough in immunocompetent adults

Patient State Description (+values)

Name
Chronic cough in immunocompetent adults

Specification
((now-cough_start_time) > 3 weeks) and
((now - date_of_birth) > 18 years) and
not immunocompromised

Next Step
parallel

New Encounter

Strength Of Evidence

Didactics
Branch Step

Or “any order”
Synchronization step

Instead, can write a Boolean expression of (input) guideline steps
**Action step**

<table>
<thead>
<tr>
<th>Name</th>
<th>Triggering Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order X-Ray</td>
<td></td>
</tr>
</tbody>
</table>

**Tasks**

- Chest X-Ray

**Next Step**

- [ ]

**Iteration Info**

- [ ]

**Didactics**

- [ ]

**Duration Constraint**

- [ ]

**Strength Of Evidence**

- [ ]

**Strength Of Recommendation**

- [ ]
Action tasks

Action tasks specify work to be performed
• Medically-Oriented
  – Prescription
  – Lab test order
• Programming-Oriented
  – Call sub-guideline
  – Send message
  – Get patient data (from EMR or User)
Medically-oriented tasks

• Refer to a medical domain ontology that supports:
  - Standard vocabularies
  - Standard data models for representing patient data
    e.g., HL-7’s Unified Service Action Model (USAM)
A medically-oriented task
Calling Sub-guidelines: Nesting

Diagram showing a flowchart with nodes labeled as Chronic cough, Treatment, No bronchoscopy for normal X-ray and common conditions, No non-invasive cardiac studies, No modified Barium Swallow with videofluoroscopy, wait for 4, and End of guideline. The diagram also includes an interaction with a window titled "CoughNested4_00022 (instance of Algorithm)" and "CoughNew1_01554 (instance of Subguideline_Action)".
Get data task
Get knowledge task

- **Name**: Get Contraindicated drugs for the patient
- **Intention**
- **Attribute To Be Assigned**
  - concept_from
- **Variable Name**
  - contraindicated_drugs
- **Input Relationships**
  - ACEI has_contraindication pregnancy
  - beta-blocker has_contraindication Chronic-Obstruct
  - beta-blocker has_contraindication Second degree atric
  - beta-blocker has_contraindication Third degree atric
- **Temporal Constraint**
- **Where Constraint**
  - patient has the indication
Decision model

• Case Step
  - represent decisions that can be automated by directly evaluating logical criteria based on data items from the EMR

• Choice Step
  - represent choices that should be made by the user since they are either safety-critical or require knowledge that is not specified by the guideline
**Case step**

**Level B**

**Education and risk Factor modification**

**LDL-Cholesterol > 160 mg/dL**

- **Case step**: Level B

  - **Initiate educational program**
  - **Aspirin 81 to 325 mg QD**
  - **Serious adverse effects of contraindication?**
    - **yes**: **Clopidogrel or Warafin**
    - **no**: **Cigarette Smoking?**
      - **yes**: **Smoking Cessation Program**
      - **no**: **High Cholesterol?**
        - **yes**: See NCEP Guidelines
        - **no**: **High Blood Pressure?**
          - **yes**: See JNC VI Guidelines
          - **no**: **Routine Follow-Up**

**Options**:
- **V C + -**
### Specifying patient data

**Observation**

<table>
<thead>
<tr>
<th>Name</th>
<th>LDL Cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referring Concept</td>
<td>C0023824</td>
</tr>
<tr>
<td>Ontology</td>
<td>UMLS</td>
</tr>
<tr>
<td>RIM</td>
<td>USAM</td>
</tr>
</tbody>
</table>

- **Data Value**
  - LDL Cholesterol
  - **Summary Information**
    - This slot currently has 1 value.
  - **Service Cd**
    - LDL_Cholesterol
  - **Mood Cd**
    - event
  - **Critical Time**
    - (07-18-00, 07-18-00)
  - **Activity Time**
    - (07-18-00:21:00)
  - **Recording Time**
    - (07-18-00:21:00)
  - **Value**
    - 80 mg/dL
  - **Normal Range**
    - < 130 mg/dL
  - **Id**
    - 360-78-7920
  - **Method Cd**
    - serum, 12h fast
  - **Severity**
    - high
  - **Status Cs**
    - completed
  - **Interpretation Cd**
    - normal

(Created by the Protégé authoring tool)
Choice Step

Option 1
(transplant)
**StrictRuleIn**
availability of a donor kidney

Choice Step
(Pre-ESRD evaluation)

Option 2
(hemodialysis/HD)

Option 3
(Peritoneal dialysis/PD)

**RuleIns**
Patients who prefer PD or will not go to HD

...  
**RuleOuts**
Peritoneal leaks

...
**StrictRuleOuts**
Documented loss of peritoneal function or extensive abdominal adhesions that limit dialysate flow

...
GLIF3: Summary

• GLIF3 is a language designed to allow sharing of clinical guidelines across different platforms and systems

• GLIF3 enables encoding of the logic of guidelines in a way that is computable
  - Highly structured specification
  - Formal expression syntax (based on Arden Syntax)
  - Medical domain ontology (vocabularies, USAM)

• For more information see www.GLIF.org
Architecture for software tools

- Guideline server
  - Execution engine
    - Protocol-based care
    - Consultation
    - Disease management
  - Validation
    - Risk assessment
  - Authoring
    - Web browser
GLIF: a proposed basis for a shared representation

- GLIF addresses authoring & dissemination
- InterMed’s major focus now is on:
  - mapping to clinical information systems
  - tools to facilitate validation and execution
- Under the HL7 GLIF SIG:
  - collaborative refinement and extension to support the needs of the guideline life cycle
  - reconciliation of functional requirements of different models and identification of those most important for supporting implementation
Macro Step

• Subclasses of action and decision steps
• Declaratively specify a procedural pattern

MLM-Macro

<table>
<thead>
<tr>
<th>evoke:</th>
<th>logic:</th>
<th>action:</th>
</tr>
</thead>
</table>

Underlying GLIF

<table>
<thead>
<tr>
<th>Decision Step</th>
<th>Events</th>
<th>criterion</th>
</tr>
</thead>
</table>

| T | Action tasks |

• Benefits for authoring, visual understanding, and execution of guidelines