The GLARE Approach to Clinical Guidelines: Main Features

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- The GLARE system
- Advances: the “what if” facility
- Advances: managing temporal constraints
**Introduction**

Clinical guidelines are a means for specifying the “best” clinical procedures and for standardizing them.

Adopting (computer-based) clinical guidelines is advantageous.

Different roles:
- support
- critique
- evaluation
- education
- ......

Many different computer systems managing clinical guidelines (e.g., Asgaard, GEM, Gliff, Guide, PROforma, ...).
GLARE
(GuideLine Acquisition Representation and Execution)

- Joint project:

- Domain independent
  (e.g., bladder cancer, reflux esophagitis, heart failure)

- User-friendly (limited number of primitives)
Representation Formalism

Tree of graphs
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Tree of graphs

Atomic actions
Representation Formalism

Tree of graphs

Atomic actions

Composite actions (plans)
Representation Formalism

Tree of graphs

Atomic actions

Composite actions (plans)

Control relations between actions:
- sequence
Representation Formalism

Tree of graphs

Atomic actions

Composite actions (plans)

Control relations between actions:
- sequence
- “controlled” (e.g., during)
Representation Formalism

Tree of graphs

Atomic actions

Composite actions (plans)

Control relations between actions:
- sequence
- “controlled”
- alternative
Representation Formalism

Tree of graphs

Atomic actions

Composite actions (plans)

Control relations between actions:
- sequence
- “controlled”
- alternative
- repetition (e.g. “3 times each 2 days for a month”)
Representation Formalism
Hierarchy of Action Types

Plan → Action
  ↓
Clinical action

Work action → Action
  ↓
Pharmacol. prescription

Query → Action
  ↓
Diagnostic decision

Decision → Action
  ↓
Therapeutic decision

Conclusion → Action
Representation Formalism

description of a work action

- basic description
  - name
description (text)
- preconditions
  - logical
    - must include
    - may include
    - must exclude
    - may exclude
    - conflicts
    - cost
time
resources
- goals (text)
- cycles
  - frame time
  - granularity
  - grouping
  - repetition
  - execution time
delay
exit_condition
## Therapeutic decisions

(Example from a symptomless gallbladder stones guideline)
Architecture of the system

Clinical DB → Acquisition Interface → Knowledge Manager → Guidelines DB
Pharmac. DB → Acquisition Interface → Knowledge Manager → Guidelines DB
Resource DB → Acquisition Interface → Knowledge Manager → Guidelines DB
ICD DB → Acquisition Interface → Knowledge Manager → Guidelines DB

Expert Physician

User Physician

Execution Interface

Execution Module

Guidelines Instantiation DB
Patient DB
Acquisition
Graphical Interface
Advanced features in GLARE: 
Supporting medical decision making

“local information”: considering just the decision criteria associated with the specific decision at hand

“global information”: information stemming from relevant alternative pathways in the guideline
Advanced features in GLARE: 
Supporting medical decision making: 
the “What if” facility

Facility for gathering the chosen parameter (e.g., resources, costs, times) from the “relevant” alternative paths on the guideline

It provides an idea of what could happen in the rest of the guideline if the physician selects a given alternative for the patient, and supports for comparisons of the alternatives
Syntomless gallbladder stones
treatment choice: “global information”

Treatment choice

- Surgical treatment
  - Choice of surgical appr.
    - Laparoscopy
    - Laparotomy

- Expectant management
  - Litholitic therapy
  - Litholitic treatment
  - Laparotomy
  - Laparotomy
Advanced features in GLARE: Supporting Temporal Constraints

Temporal constraints are an intrinsic part of clinical knowledge (e.g., ordering of the therapeutic actions)

Different kinds of temporal constraints, e.g.,
- duration of actions (min / max)
- qualitative constraints (e.g., before, during)
- delays (min / max)
- periodicity constraints on repeated actions
Advanced features in GLARE: Supporting Temporal Constraints

**WHEN Temporal Reasoning is useful in Guidelines?**

**ACQUISITION**
- to check consistency

**EXECUTION**
- to compare the duration of paths, in hypothetical reasoning (simulation) facilities
- to check that the time of execution of actions on patients is consistent with the constraints in the guideline
Managing Temporal Constraints: the Problem

DESIDERATA for the Representation formalism

- expressiveness → capture most temporal constraints in GL

DESIDERATA for Temporal Reasoning Algorithms

- tractability → “reasonable” response time
- correctness → no wrong inferences
- completeness → reliable answers

No approach in the literature supplying
- the desired expressiveness
- the above properties
Labeled tree of STPs

Tree of STPs for the multiple myeloma chemotherapy guideline. The overall therapy (node N1) is composed by 6 cycles of 5 days plus a delay of 23 days. In each cycle (node N2), two therapies are executed in parallel: Alkeran (node N3: Sa and Ea are the starting and ending nodes), to be repeated twice a day, and Deltacorten (node N4: Sd and Ed are the starting and ending nodes), to be repeated once a day. Arcs between any two nodes X and Y in a STP (say N2) of the STP-tree are labeled by a pair [n,m] representing the minimal and maximal distance between X and Y.
Discussion and conclusions

The GLARE system (sketch)

- Decision making “What if” facility
- Treatment of temporal constraints

Related approaches in the literature

- representation formalism & acquisition ~ PROforma, Asbru (time)

Work in progress:

- Enhancing the “What If” facility with Decision Theory
- Advances in temporal reasoning
- Making GLARE independent of Patient DB and Clinical Ontologies
Digression 1
Why don’t we put “global info (about paths)” locally in the decision actions?

Given “local info” in each node, collecting & storing might be authomatical

HOWEVER:
- exponential space in each node
- data duplication (consistency after updates?)
- not user friendly (too many data!)
  - not all alternatives are “relevant”
  - data not always necessary

>>> global data only at execution time, on request
Digression 2

Why (Complete) Temporal Reas. is fundamental?

(1.1) the end of A is equal to the start of B
(1.2) the end of B is equal to the start of C
(1.3) the duration of A is between 10 and 20 m
(1.4) the duration of B is between 10 and 20 m
(1.5) the duration of C is between 10 and 20 m

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
<td>10-20</td>
<td>10-20</td>
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Implied constraint (temporal reasoning):
(1.6) C ends between 30 and 60 m after the start of A

Suppose that temporal reasoning is NOT complete, so that (1.6) is not inferred

The answer to query (Q1) might be: YES
(Q1) Is it possible that C ends more than 70 m. after the start of A?

Complete Temporal Reasoning is NEEDED in order to grant correct answers to queries!