

The EON Guideline Modeling System

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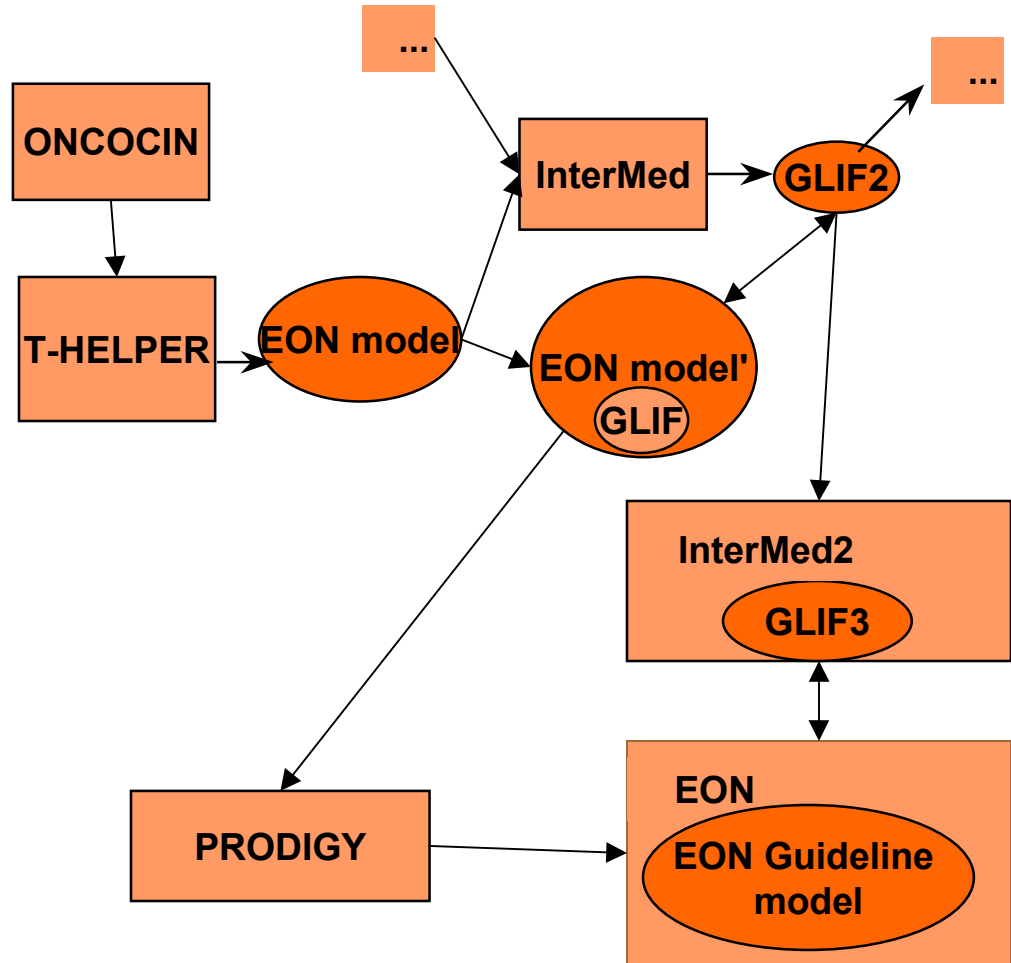
Overview



- ➔ ■ Introduction to EON architecture for creating DSS for guideline-based care
- Components of EON guideline modeling system
 - ◆ Concept model
 - ◆ Patient data model
 - ◆ Expression language
 - ◆ Guideline model
- Questions

Genealogy of EON Guideline Model

- Successive projects to develop guideline-based decision-support



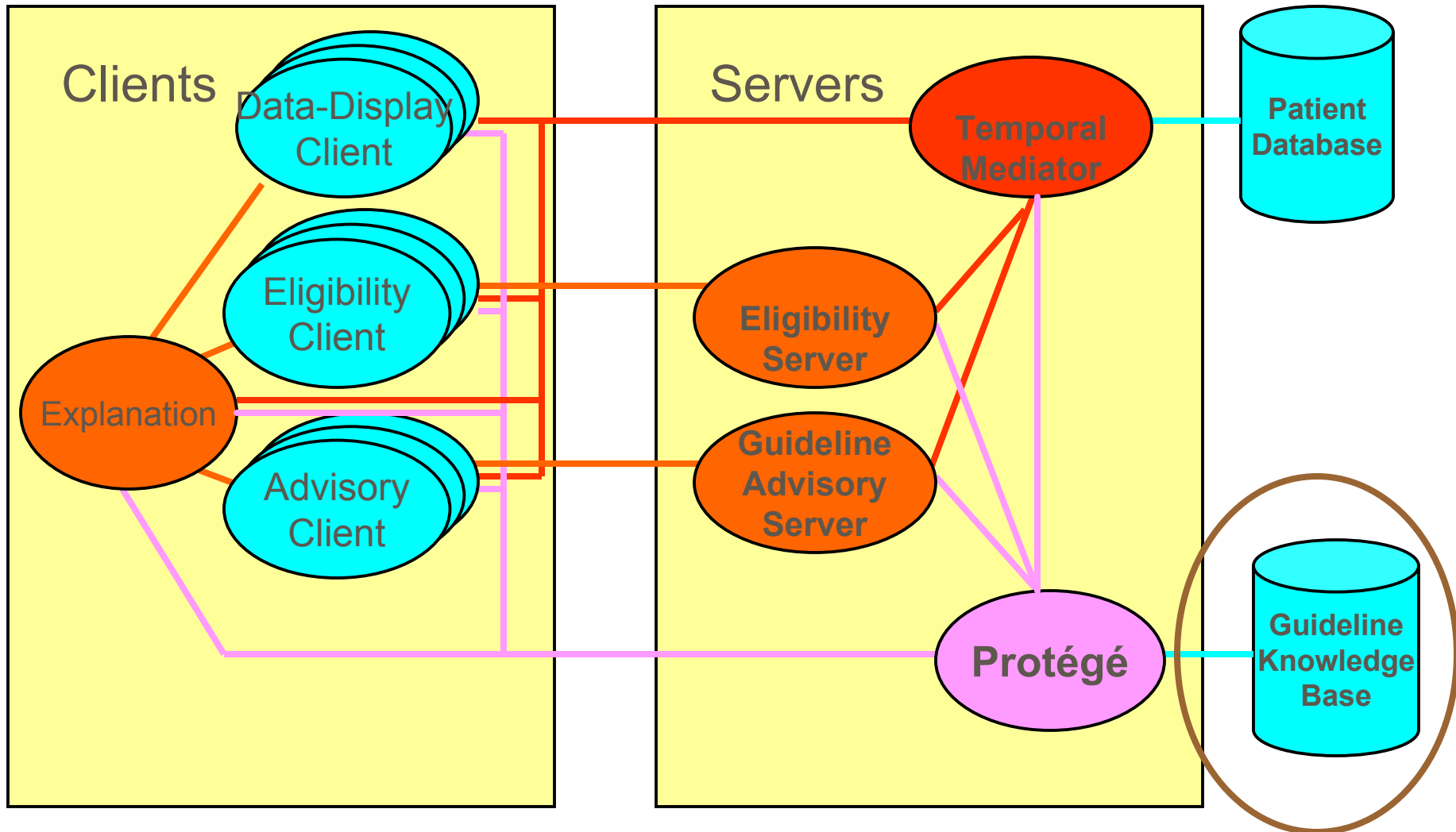
EON Research Problems



- How to model clinical guidelines and protocols to provide patient-specific DS?
- How to create a knowledge-engineering environment to facilitate encoding of guidelines and protocols?
- How to represent, reason with, and visualize time-oriented patient data?
- How to present and explain DS recommendations and conclusions?

EON 2.0

A Component-Based Architecture



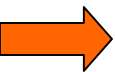
EON Modeling Approach



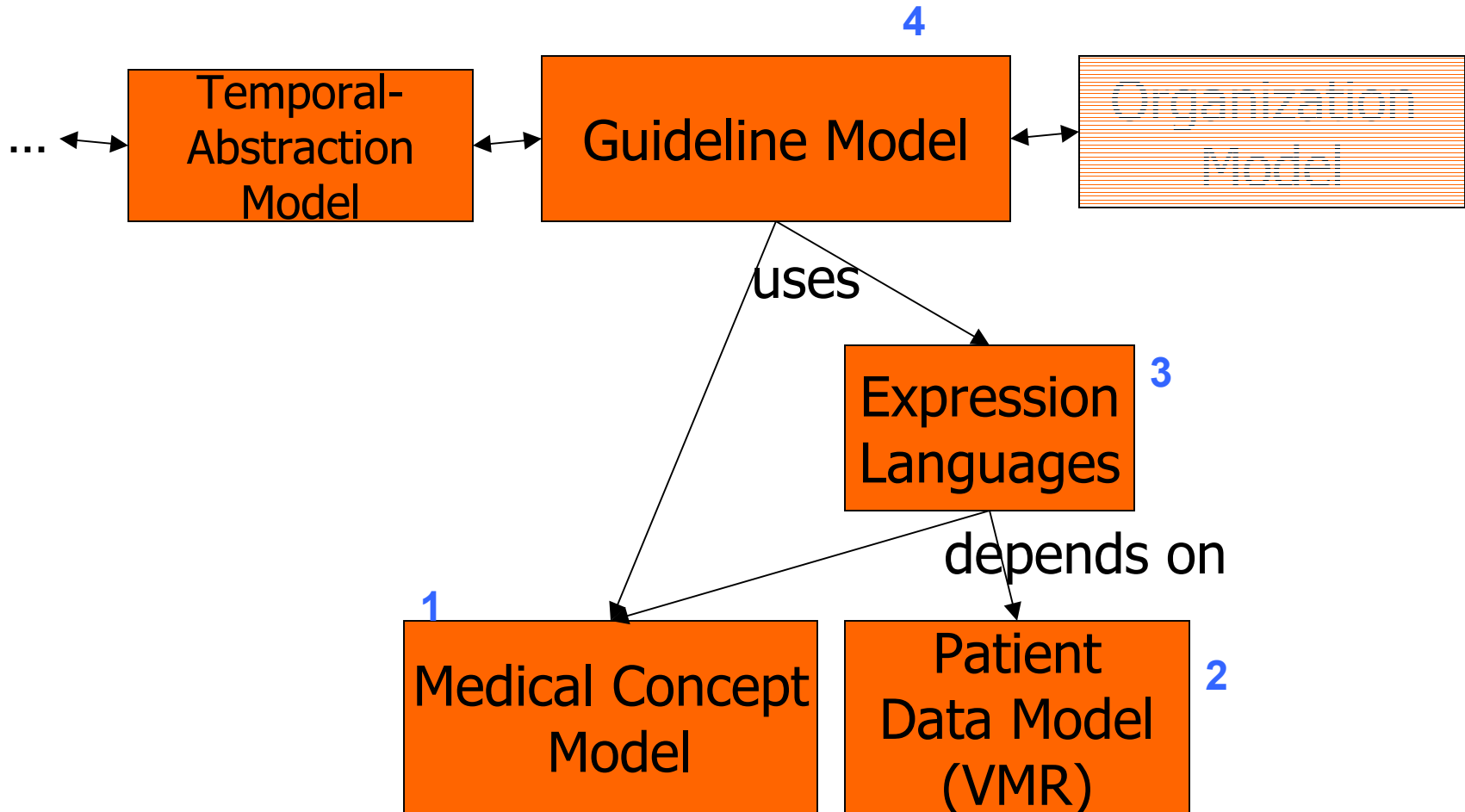
- Modeling, not programming
 - ◆ Encoding guidelines is a modeling process requiring training
 - ◆ Guideline encoders tell the system appropriate domain knowledge
- Allow alternative methods for performing a task
 - ◆ Goal: plug in only those knowledge structures needed to solve a particular problem
- Ease of use (by clinical collaborator) a design criterion
 - ◆ But sometimes making something easy makes other things hard

Overview

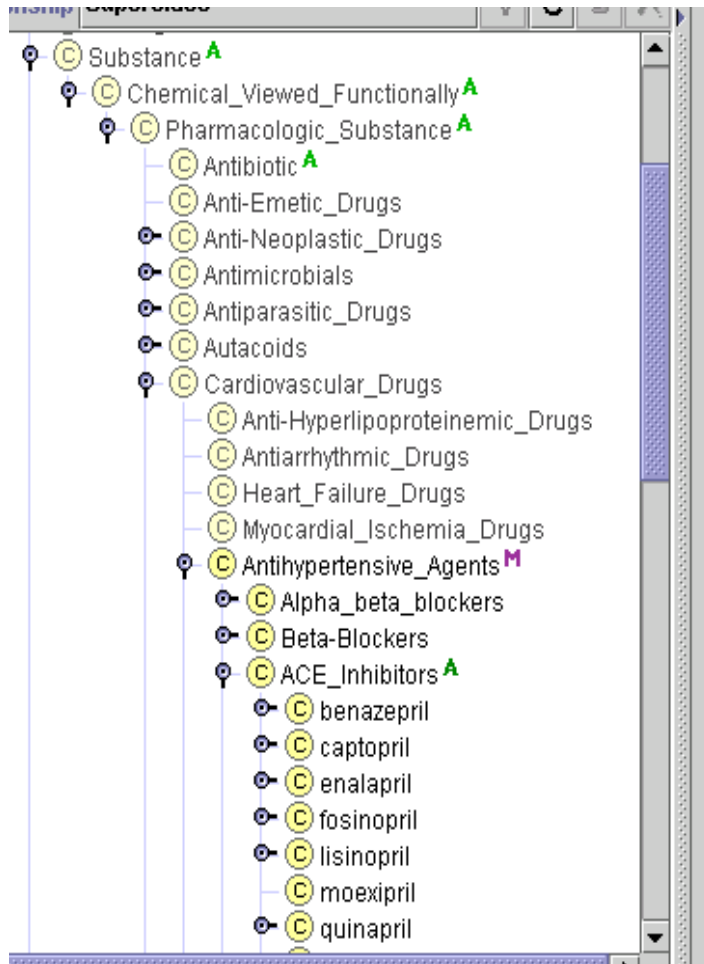


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Guideline Modeling as Creation of a Set of Interacting Models



1. EON Guideline Component: Medical Concept Model



■ Defines

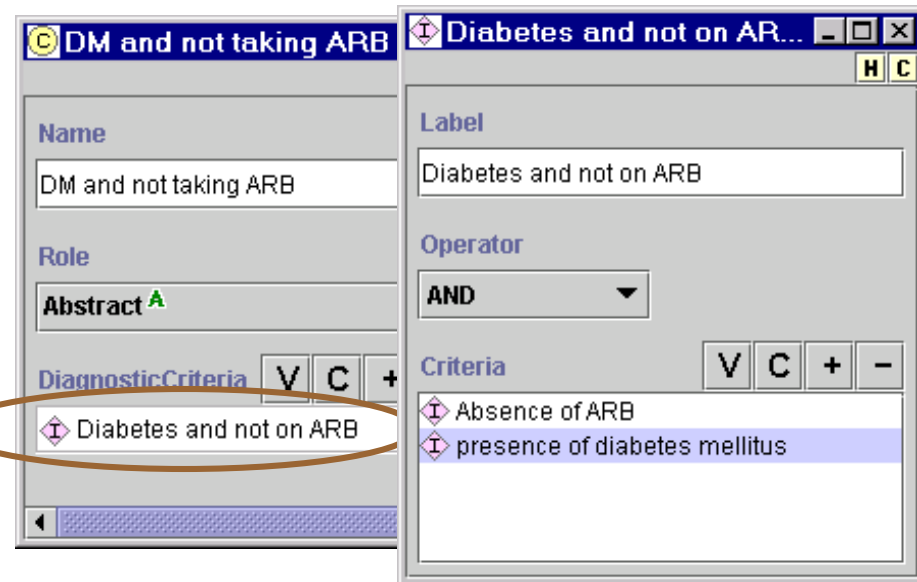
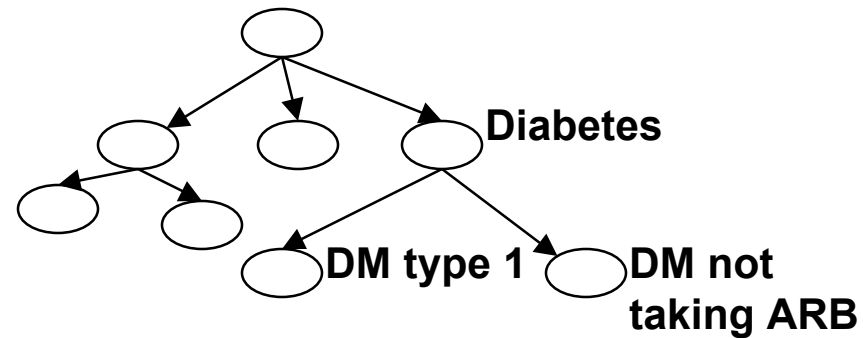
- ◆ Taxonomic hierarchy of concepts (e.g., ACE inhibitor) used in guidelines
- ◆ Relationships among concepts (e.g., indications for ACE inhibitor)

■ Supplies

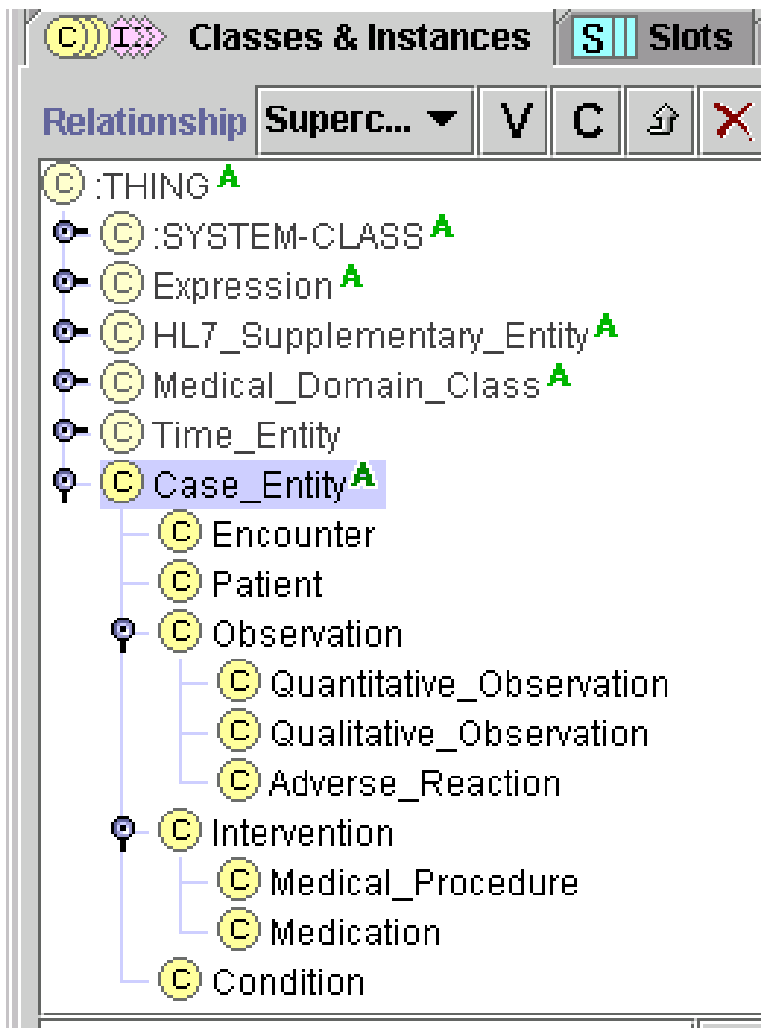
- ◆ Controlled terminology for guideline encoding

Why Not Use Standard Vocabulary Directly?

- Need for strict is-a classification hierarchy
- Need to index medical and guideline knowledge
- Need for definition of guideline-specific concepts and axis of classification
 - DM not taking ARB:
 - Presence of DM and absence of prescription for ARB
- Need to organize mappings to host-system data dictionary



2. EON Guideline Component: Patient Data Model



- Simplified model of patient information
 - ◆ Focus on clinical and demographic information needed for clinical decision making
 - ◆ Flat hierarchy for easier mappings to relational database
 - ◆ Data are time-stamped, interval-based, or static

Use of Patient Data Model



- Patient data model defines the types of assertions that can be made about patient situation
- Patient data model allows alternative expression languages
 - ◆ Template-based
 - ◆ Temporal
 - ◆ Logic-based

3. EON Guideline Component: Expression Language

- Template-Based Criterion Language
 - ◆ Fill-in-blank templates to encode relatively simple expressions

The screenshot shows a window titled "absence of K+ (Presence_Criterion)". The interface is divided into several sections:

- Label:** A text box containing "absence of K+".
- Mood:** A text box with a dropdown menu (V) and buttons (+) and (-).
- Presence:** A checkbox labeled "Presence" which is currently unchecked.
- Filter:** A text box with a dropdown menu (V), a button (C), and buttons (+) and (-).
- Domain Term:** A text box containing "Potassium" with a dropdown menu (V), a button (+), and a button (-).
- Period:** A text box containing "last 7 days" with a dropdown menu (V), a button (C), a button (+), and a button (-).
- Entry Type:** A text box containing "Quantitative_Observation" with a dropdown menu (V), a button (+), and a button (-).

*Absence of
potassium lab result
within the last 7
days*

3. EON Guideline Component: Expression Language

■ Temporal Query and Criterion Language

◆ *an episode of uncontrolled blood pressure that overlaps with use of lisinopril and starts within two weeks of initiating lisinopril*

```
TEMPORAL SELECT domain_name
VALID INTERSECT(Condition, Medication)
FROM Condition, Medication
WHERE domain_name = "UNCONTROLLED_BP" AND
      drug_name = "lisinopril"
WHEN start(Condition) AFTER start(Medication) AND
start(Condition) BEFORE
      (start(Medication) + weeks(2))
```

3. EON Guideline Component: Expression Language

- Logic-Based Query and Criterion Language
 - ***No current medication is contraindicated***

```
(defrange ?current_med :FRAME Medication)
(defrange ?med_class :FRAME Drug_Class)
. . .
(not (exists ?current_med
  (exists ?med_class
    (and (subclass-of
      (drug_name ?current_med) ?med_class)
      (exists ?contraindication
        (and (Absolute_Contraindications
          ?med_class ?contraindication)
          (exists ?problem
            (subclass-of
              (domain_term ?problem)
              ?contraindication)))))))))
```

Why Three Expression Languages?

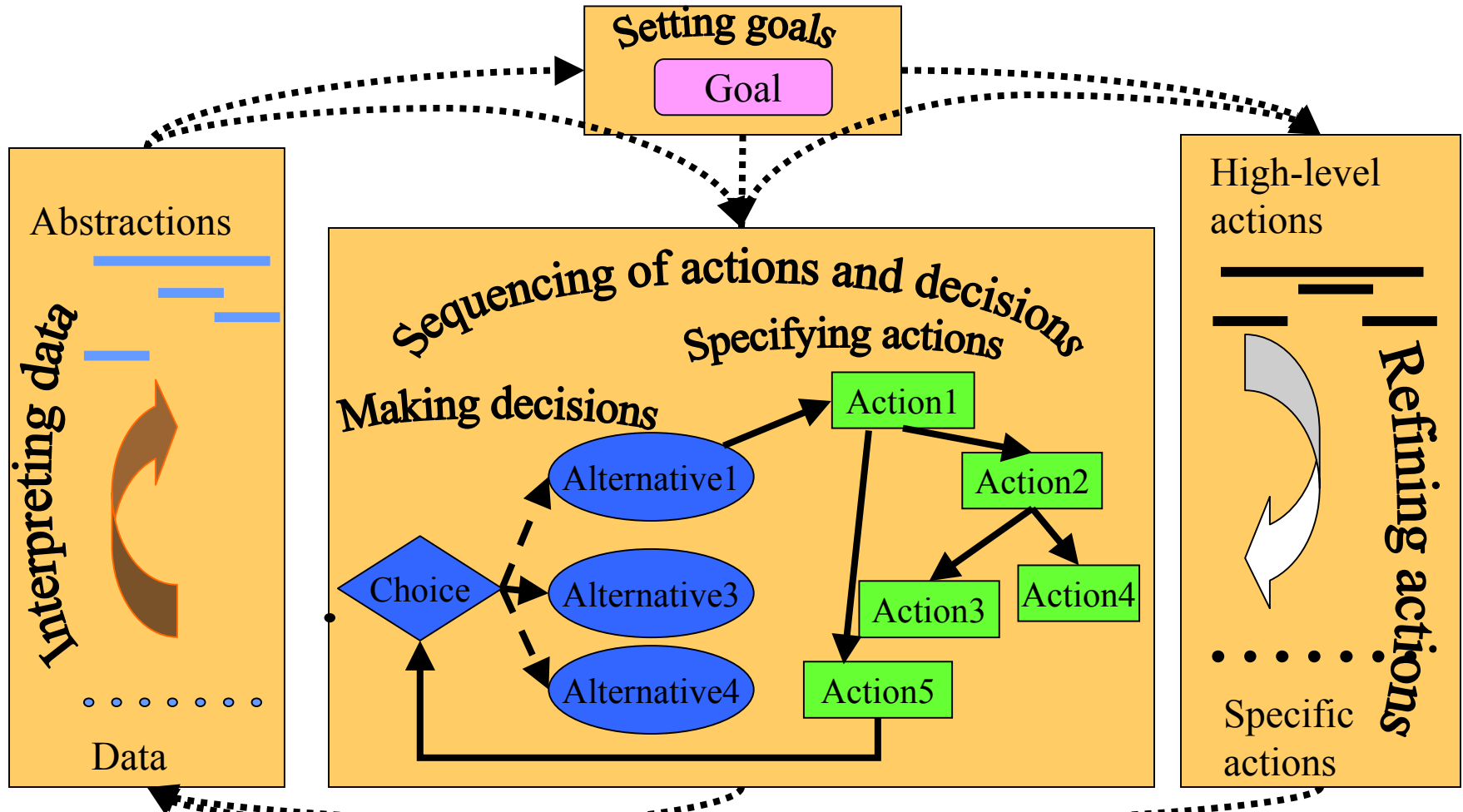
- Knowledge-acquisition requirement
 - ◆ Clinicians feel comfortable encoding template criteria with little training!
- Expressiveness requirement
 - ◆ Need to detect complex temporal patterns
 - ◆ Need to write general expressions that range over a set of objects (forall, exists)
- Component-orientation
 - ◆ Temporal query/abstraction engine made a component usable by various applications
- Synergy with sister project
 - ◆ Use Protégé constraint language as expression language

4. EON Guideline Component: Guideline Model



- Task-oriented view
 - ◆ Must contain concepts and relations for encoding guideline knowledge needed to perform specific task
 - Patient-specific decision support
- Domain-oriented view
 - ◆ Must use domain-oriented abstractions sensible to clinical collaborators
 - e.g., model indications and contraindications as relations among drugs and medical conditions

Task-Based Approach to Defining Guideline DS Functionalities



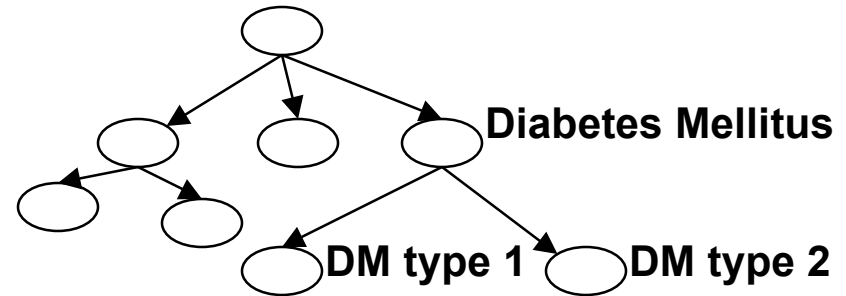
4.1 EON Guideline Model: Setting Goals

For diabetic patients, the target blood pressure is 135/80 mm Hg

- Each guideline or subguideline has an AND/OR goal tree
 - ◆ OR subgoals modeled as a set of conditional goals
 - ◆ Conditional goal
 - Selection criteria: *"presence of diabetes"*
 - Goal criteria: *"systolic BP < 130 mm Hg and diastolic BP < 80 mm/Hg"*
- Criteria language allows query of whether goals are satisfied
- Satisfaction of goal as reason for making choice

4.2 EON Guideline Model: Interpreting Data

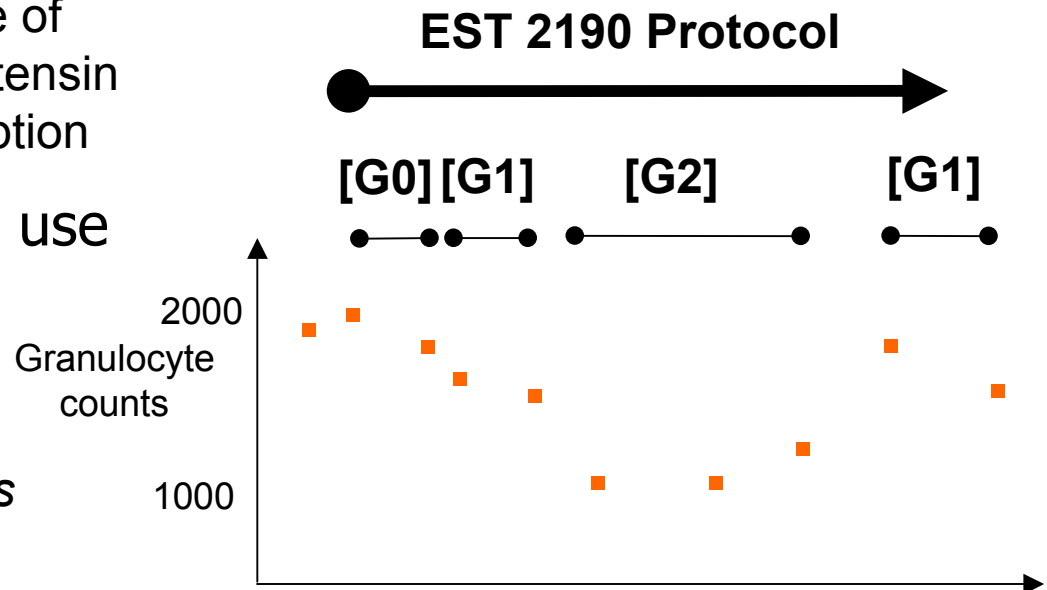
- Terminological abstraction: use is-a hierarchy of concept model
- Non-temporal abstraction: use concept-definition capability



“DM not ARB” := presence of DM and absence of angiotensin 2 receptor blocker prescription

- Temporal abstraction: use Resume/RASTA

Does there exist grade 2 granulocytopenia that lasts for more than 2 weeks?



4.3 EON Guideline Model: Sequencing Decisions and Actions

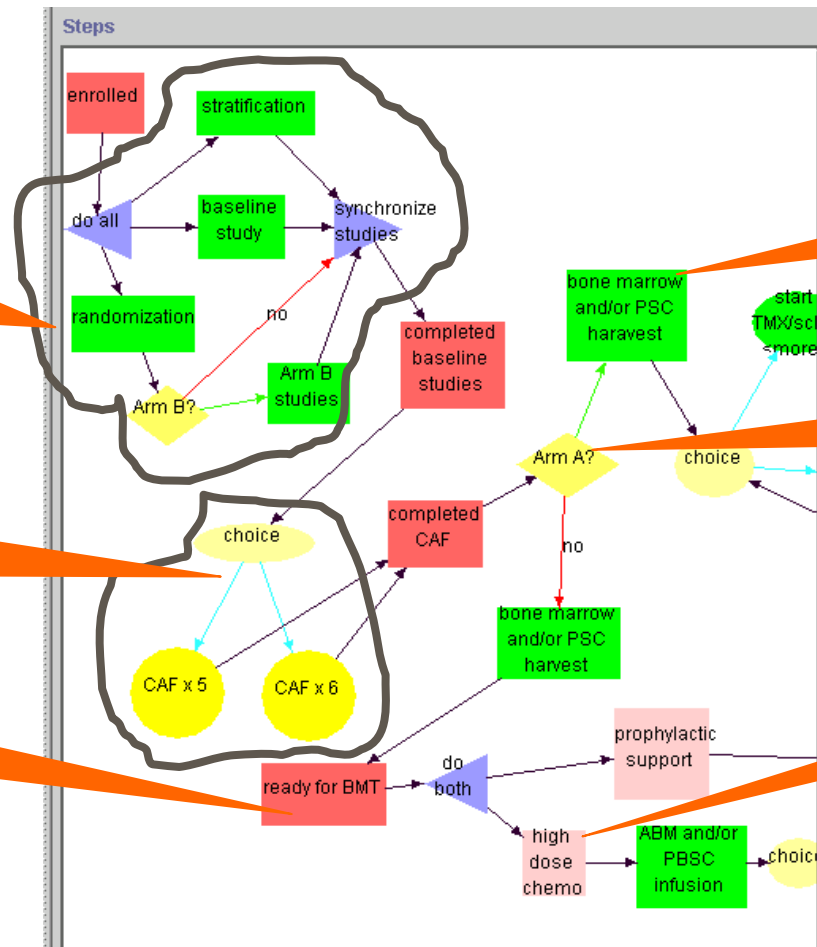
- A process model that organizes scenarios, decisions and actions over time
 - ◆ Scenario: landmark patient states where
 - real patient situation can be synchronized with process state
 - context-specific actions are specified
 - decisions need to be made
 - ◆ Flow-of-control: sequencing, repetition and concurrency of actions and decisions
 - ◆ Nesting: Hierarchical decomposition of processes
- Represented as diagrammatical flowchart

Example of Guideline Management Process

Concurrent actions

Alternative choices

Patient scenario



Action step

If-then-else decision

Subguideline

4.4 EON Guideline Model: Action Specification



- Specification of acts to be performed
 - ◆ Actions that change states of activities
 - start, stop, change attributes (, abort, delay, suspend, resume)
 - ◆ System and medical actions
 - e.g. send a message vs. order a test
 - ◆ Temporal specification
 - e.g. return appointment in 3 months
 - ◆ Use of standard medical terminology
 - e.g. ordering a specific lab test

4.5 EON Guideline Model: Action Refinement

ACE_Inhibitors (Drug_Categories_Metaclass)

Name: ACE_Inhibitors

Documentation: class effects: common: cough. rare: angioedema, hyperkalemia, rash, loss of taste, leukopenia.

Role: Abstract

Absolute Contraindications: Pregnancy

Relative Contraindications: Renovascular_Disease

Compelling Indications: Heart Failure not taking ARB, DM not taking ARB

Relative Indications: CRI

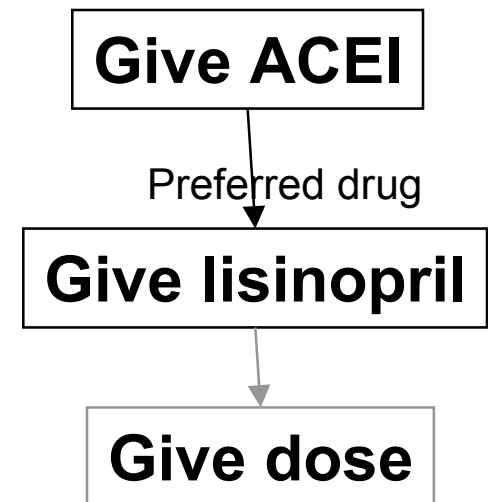
Bad Interactions: Potassium-Sparing_Diuretics

Synergistic Interactions:

Concept Reference: C0003015

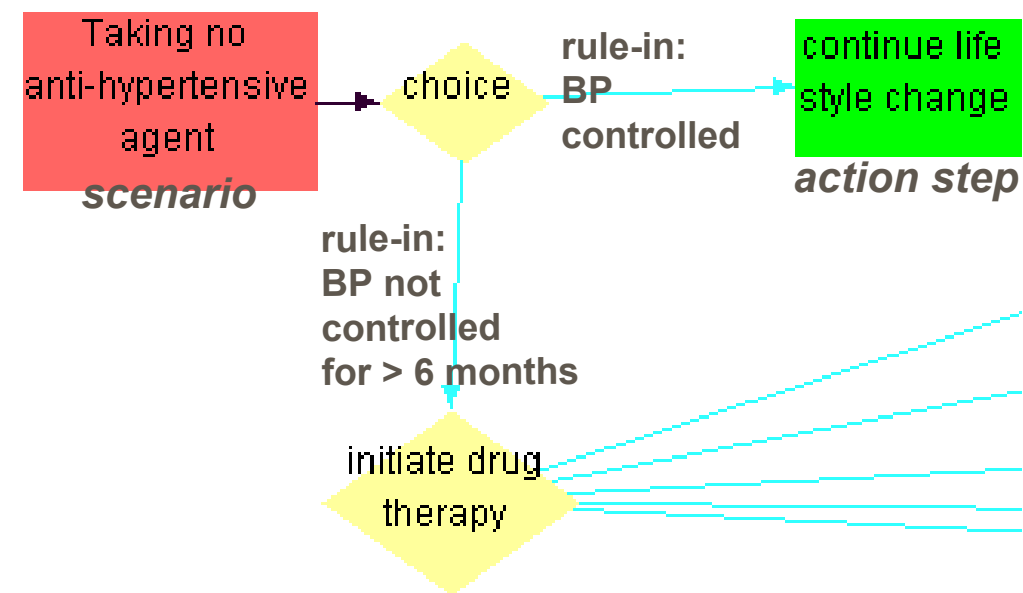
Formulary Preferred Drug In Class: lisinopril

Left Panel (Drug List): ACE_Inhibitors, benazepril, captopril, enalapril, fosinopril, lisinopril, moexipril, quinapril



4.6 EON Guideline Model: Making Decisions

- Extensible decision architecture
- Decision step
 - ◆ Choice based on conditional rule
 - ◆ Choice based on pros-and-cons argumentation
 - ◆ ...



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Questions

- How to represent and use goals?
- Are there different “process” models?
 - ◆ Is scenario necessary?
- Where do you draw the line
 - ◆ between general medical knowledge and guideline knowledge?
 - ◆ between terminological ontology and knowledge base?
- Are HL7 Act classes sufficient as the basis for action specification?
- Why not model action refinement as subguidelines?
- Should expression language be declarative?
- How to use standard vocabularies?