The Structure of Guideline Recommendations: A Synthesis
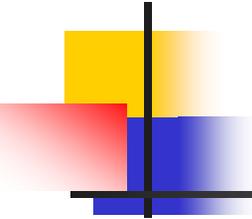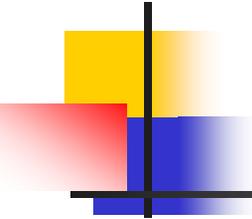
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Outline

- Motivation
- Recommendation set formalism
- Validation
  - SAGE implementation
  - Comparisons with other models
- Conclusion

Motivation: HL7 CG SIG work item

- To develop standardized "flowchart" model for human understanding and computer encoding
    - Expressive process model
        - allows sequencing, repetition, and concurrency (branching and synchronization)
    - Integration of decision making and activity specification
    - Visual clarity
    - Well-understood semantics
- However: not all guideline recommendations are "flowcharts"
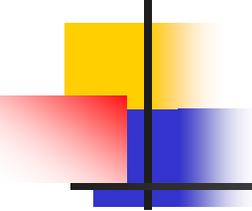
Reformulated work item

- To define structure and organization for sets of guideline recommendations
- Recommendation consists of
    - Context: clinical setting, patient state, current therapy, provider role, triggering event
    - Decision: choice among alternatives based on evidence/preference
    - Action: computer or clinical actions
- Two classes of "recommendation set"
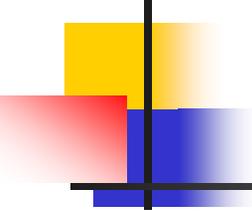   - activity graph
    - decision map

Activity graph
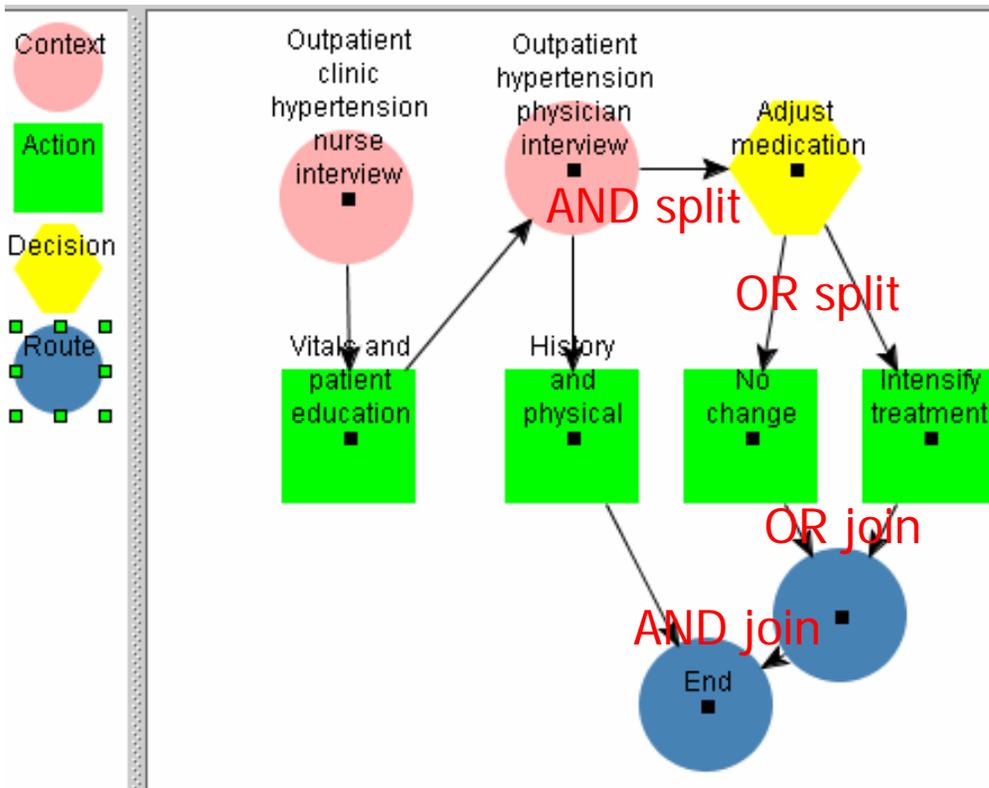
- **Used to specify processes**
  - computational and care processes
- **Directed graph of**
  - context
  - decision step
  - action step
  - route: purely for branching and synchronization
- **Adapted from Workflow Management Coalition process model**
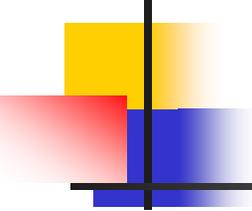
Decision map
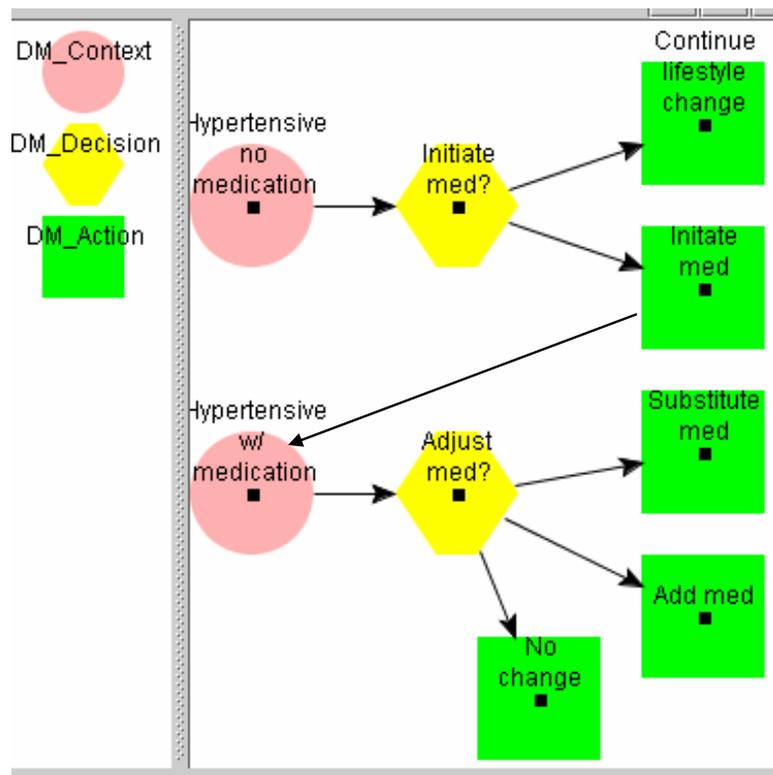
- **Not all guidelines are process-oriented**
- **Collection of decision points**
  - Context, decision, action nodes
  - No interpretation as activities in a process
- **Alternative computational models**
  - If/then statements
  - Augmented transition network
    - Connected graph
   - One alternative allowed at decision point

Outline

Validation: SAGE implementation

- SAGE project
    - Consortium of IDX, Apelon, IHC, Mayo, Nebraska, Stanford to develop infrastructure for guideline-based decision-support systems
- SAGE guideline modeling methodology
    - Select guideline
    - Develop usage scenarios
    - Specify guideline logic and terminology
    - Encode guideline in Protégé-2000
    - Simulate implementation in IDX clinical information system (CIS)
- Example guideline: immunization

# Encoding of guideline in Protégé-2000: Top-level processes

- Top-level activity graphs model processes in which DSS interactions with providers through clinical information system
- Highly dependent on expected clinical workflow
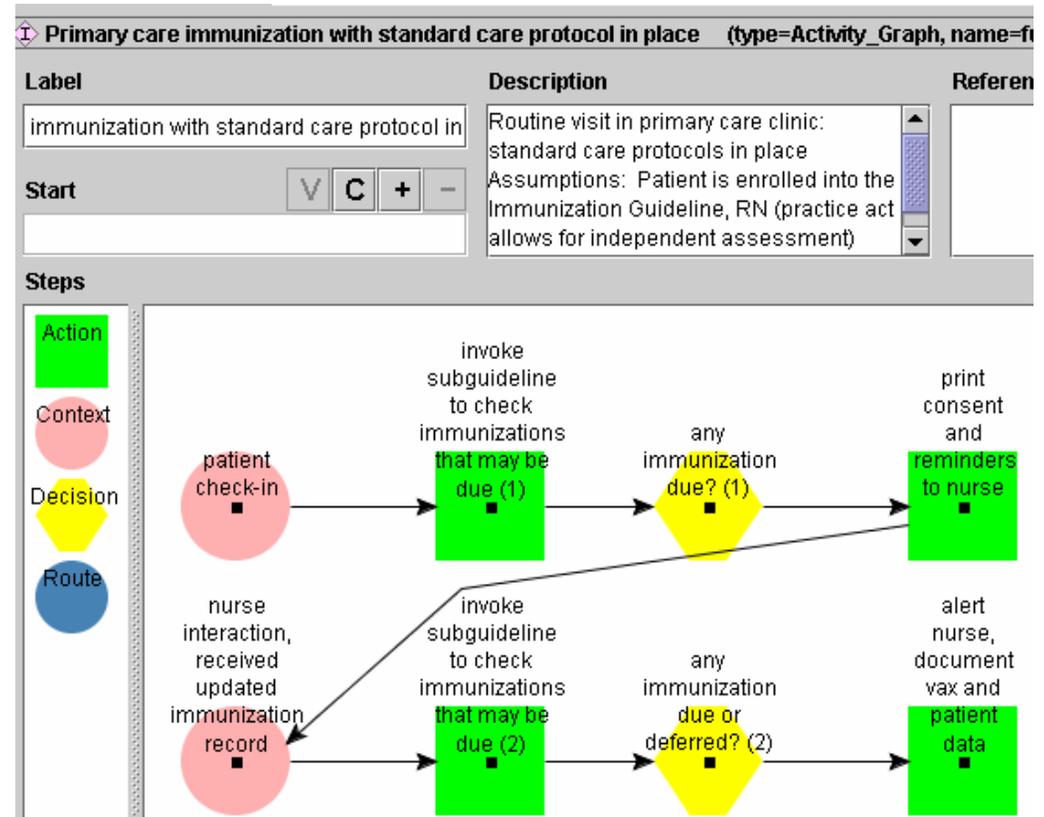
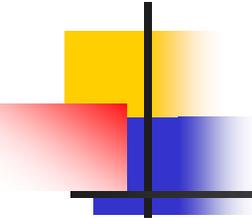# Immunization guideline logic as decision map

- Decisions involve choices of assertion to make about an immunization
  - Possibly due
  - Contraindicated
- Assertion about immunizations tested at top-level activity graph
- RE-usable medical logic called as subguidelines
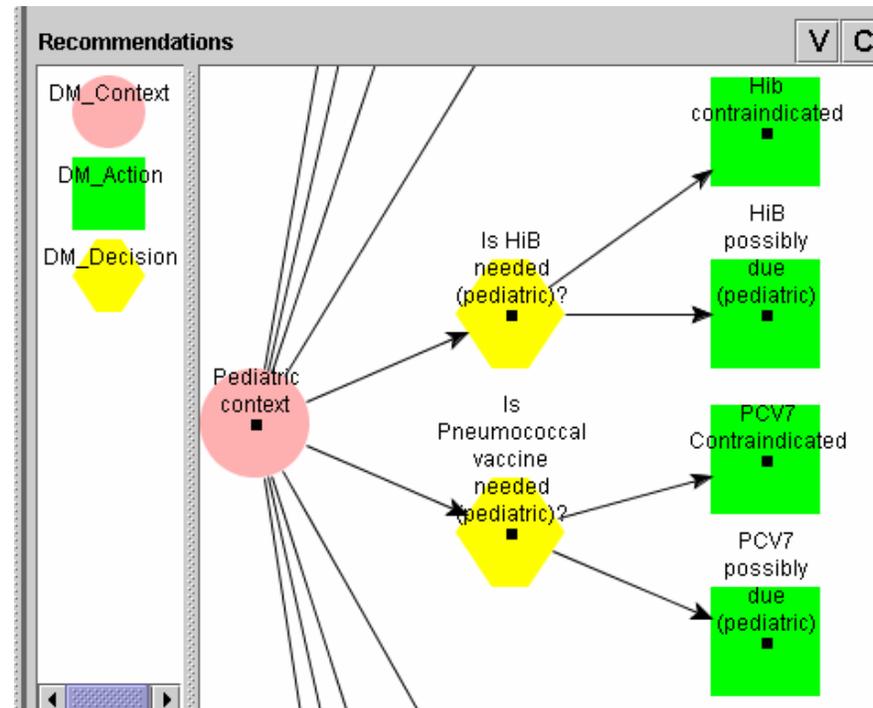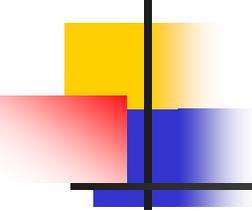
Outline

Comparison with Arden Syntax

- Arden Syntax and Medical Logic Modules
  - Evoke: Events that trigger MLMs =>Context
    - e.g. storage of serum creatinine
  - Logic: Condition to be tested => Decision
    - e.g. if current_creatinine > baseline_creatinine+0.3 then conclude true;
  - Action: Action to be performed if logic slot "conclude true" => Action
    - e.g. write "The patient's serum creatinine level may signify worsening renal function"
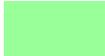- A decision map analogous to a collection of MLMs
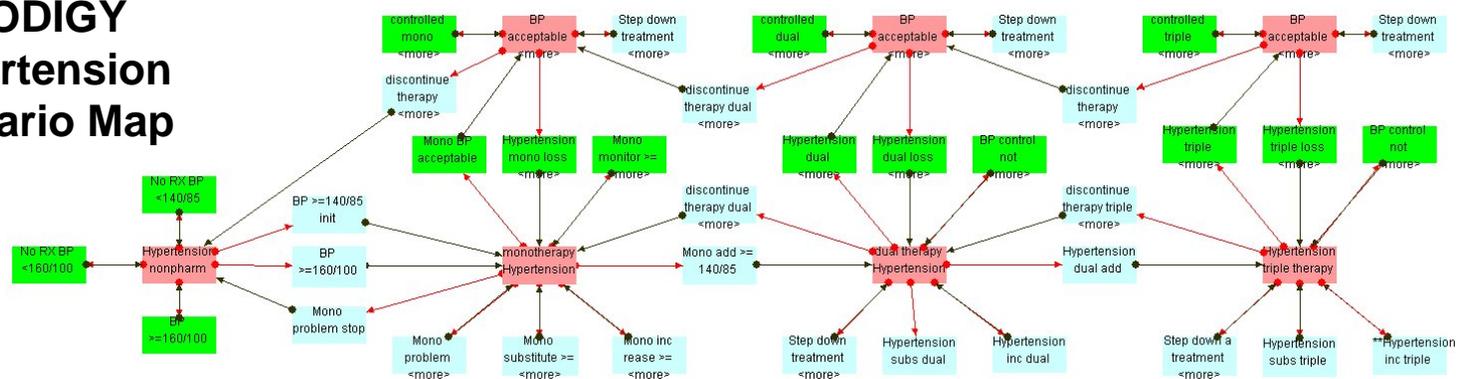
Comparison with PRODIGY scenario map

- PRODIGY
  - Guideline-based decision-support system for primary care developed at University of Newcastle
  - Release One available on UK GP systems
- Scenario map => Decision map with augmented transition semantics


**PRODIGY Hypertension Scenario Map**

scenario

action

subguideline

Comparison with GLIF

- GLIF
  - Guideline modeling formalism developed by InterMed (collaboratory of Columbia, Harvard, Stanford)
- GLIF algorithm => Activity graph
- GLIF patient-state step a specialization of Context node
- GLIF synchronization uses a complex expression (a series of Route nodes)

GLIF algorithm
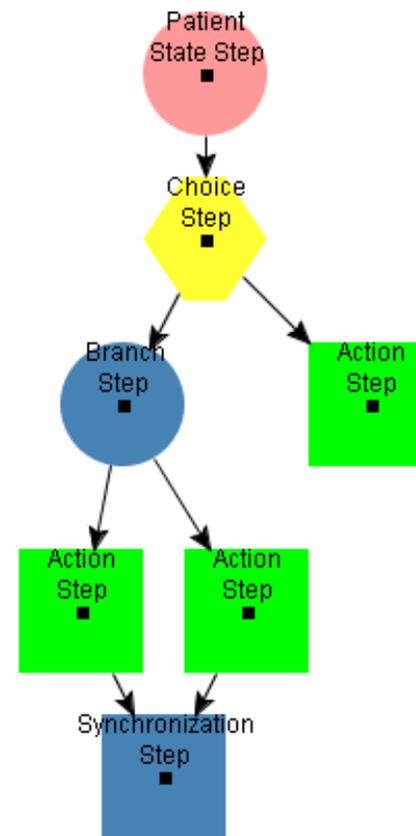
Activity graph

Comparison with HL7 RIM

Act relationship
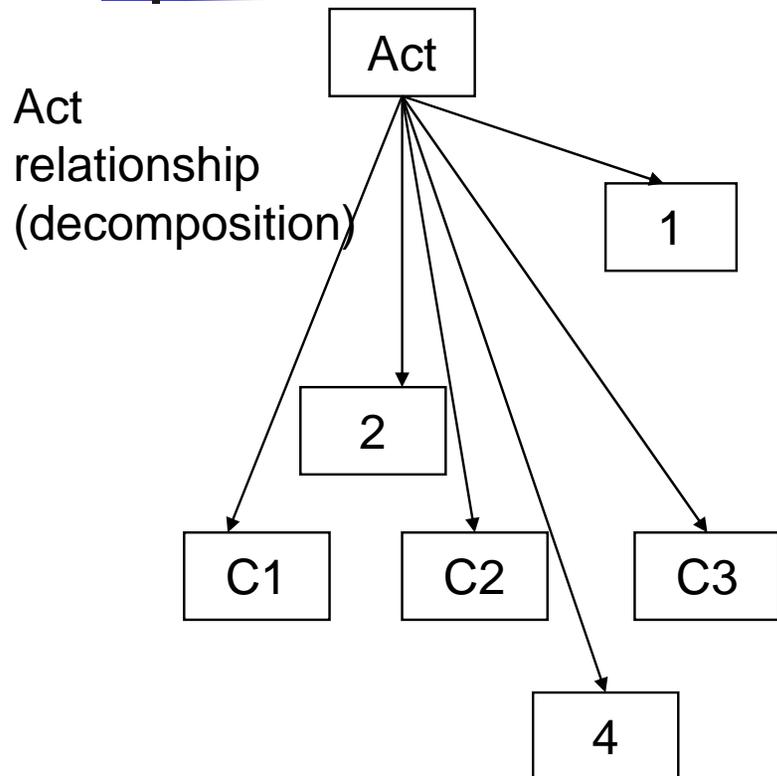(decomposition)
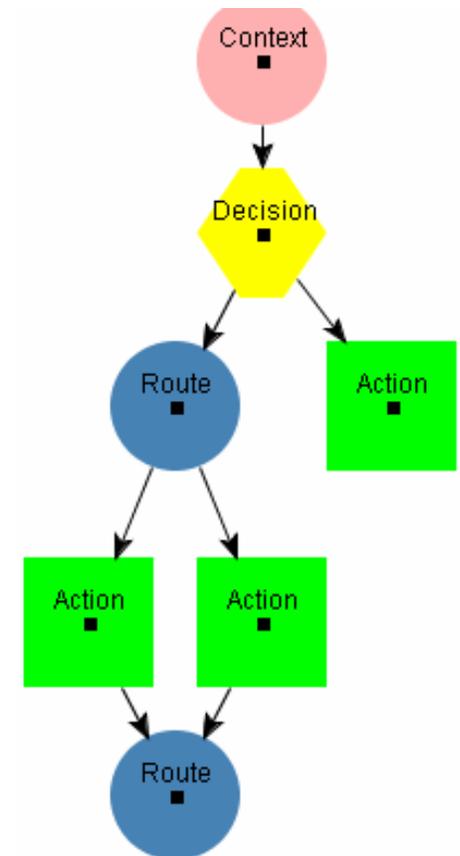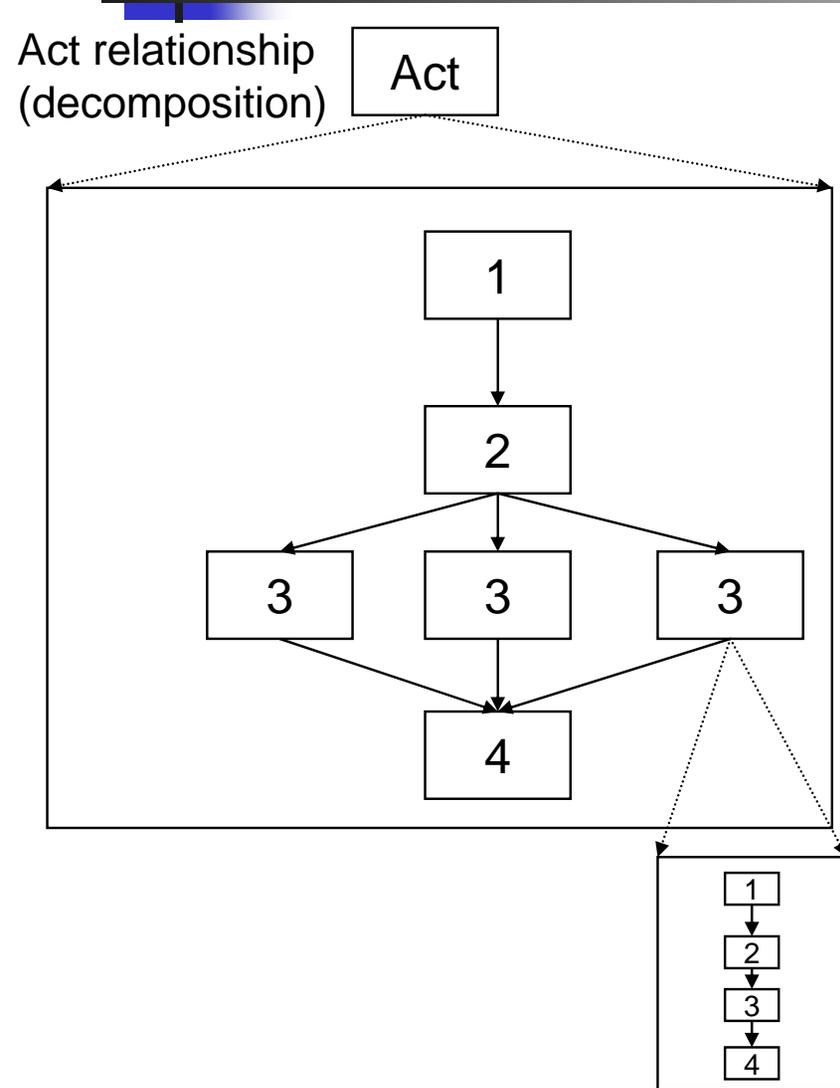
- **HL7 RIM Act decomposition**
  => Activity graph
  - Numerical ordering of acts (sequence_nbr) implies a particular structure
  - A syntactic variant of activity graph where
    - Splits and joins are balanced
    - Sequences between branching and synchronization points is expressed as additional decomposition

HL7 split and join properties

Act relationship (decomposition)

```
        ┌──────┐
        │ Act  │
        └──────┘
         ↙ ↓ ↓ ↘
              ┌─────┐
              │  1  │
              └─────┘
       ┌─────┐
       │  2  │
       └─────┘
  ┌─────┐  ┌─────┐  ┌─────┐
  │ C1  │  │ C2  │  │ C3  │
  └─────┘  └─────┘  └─────┘
        ┌─────┐
        │  4  │
        └─────┘
```

- **HL7 RIM split and join properties different from those of WfMC**
  - Can be simulated using WfMC's splits and joins
- **Specifies split and join properties as attributes of Act relationship**
  - Possible to specify split and join properties of individual subact (e.g. C1 may have a join property different from C2 and C3)
  - Need to work out relationship with WfMC process model used by activity graph
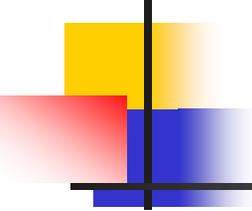
Conclusion

- **Recommendation set formalism**
    - Defines structure of guideline recommendations
    - Makes distinction between processes (activity graph) and collections of decisions (decision map)
    - Tested in SAGE implementation
    - Mapped to several guideline modeling formalisms
- **Next steps**
    - Specification of execution semantics
    - Further reconciliation with HL7 RIM?
    - Proposal as an HL7 informative document
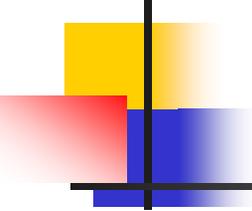
Thank you
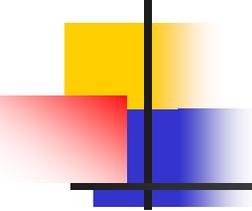
Lessons from SAGE experiment

- **Activity graphs**
    - Model reactions and interactions of guideline DSS with clinical information systems
    - Guideline DSS reacts to events in workflow
- **Decision maps**
    - Provide good cognitive correspondence with rule-like recommendations (e.g. whether hepatitis B vaccine due)
    - Reusable in different settings