Translation Protégé Knowledge for Executing Clinical Guidelines

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Agenda

1. Motivation
2. How to translate
3. Implementation and Case study
4. Conclusion

Motivation

❖ Definition of CDSS

- any piece of software that takes as input information about a clinical situation and that produces as output inferences that can assist practitioners in their decision making and that would be judged.

❖ CDSS can

- give specific reminders at particular clinical situations
- give exact information to support drug choosing, dosing, preventing adverse drug effects
- support the health care management at the hospital level
- be used as educational systems for medical students or young doctors

Motivation

- **In CDSS, core component is guidelines.**
  - Computer-interpretable guidelines (CIG) have been developed for decision support during clinical process
  - evidence based guideline practice promises to improve health care quality.

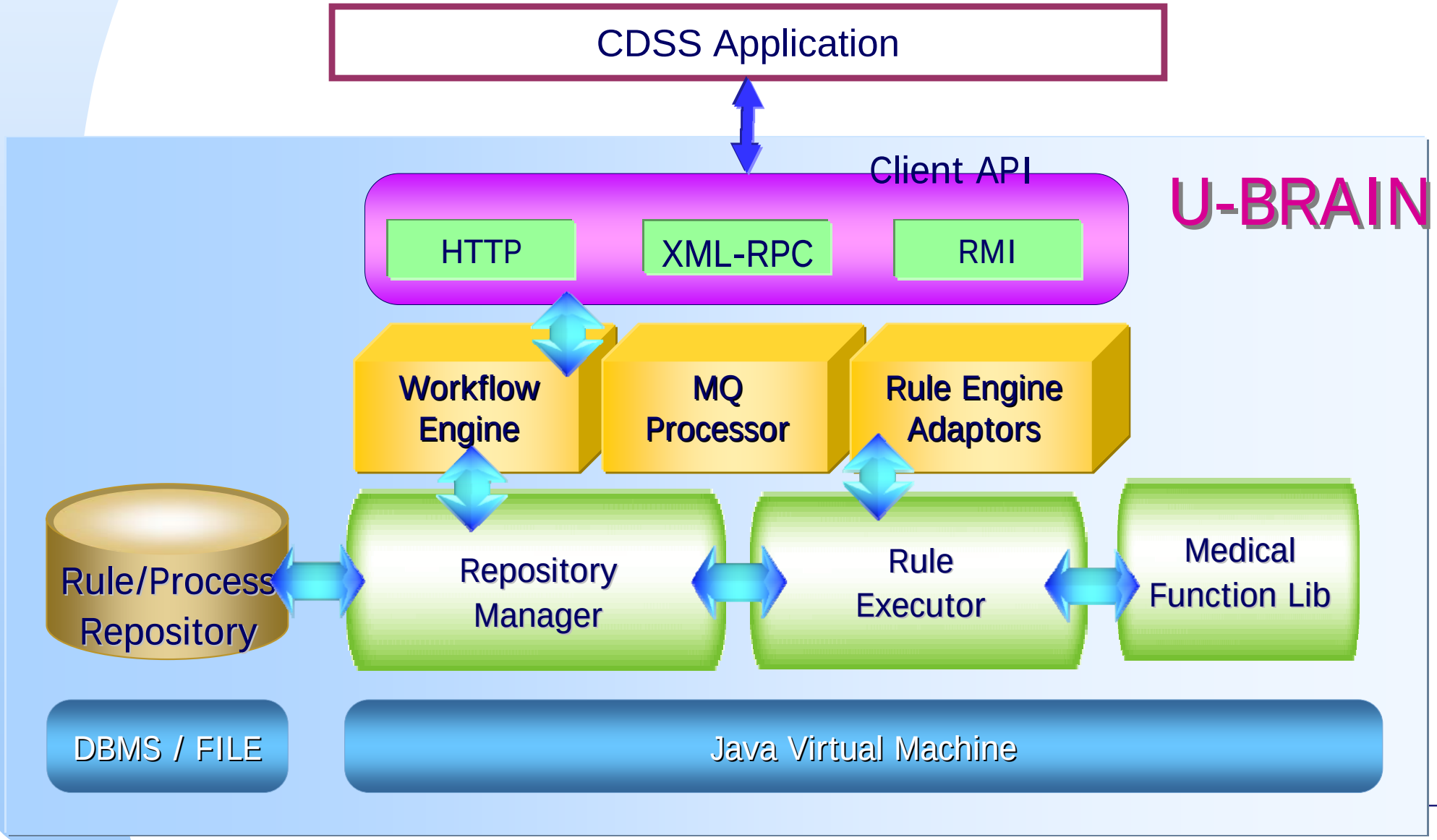
- **Several approaches for modeling the clinical guideline**
  - Arden syntax, EON, PRODIGY, GUIDE, GLIF,
  - SAGE (Standard-based Sharable Active Guideline Environment)

Motivation

- **SAGE**
  - uses standardized components that allow interoperability of guideline execution elements
  - Integrate guideline-based decision support with the workflow of care process
  - synthesizes prior guideline modeling work for encoding guideline knowledge
  - *A Suite of Models and Services to Support Guideline Modeling and Execution*
  - *Deployment-Driven Knowledge-Base Development Process*
  - there is not publically available execution engine yet

Motivation

❖ EHR Knowledge Engine

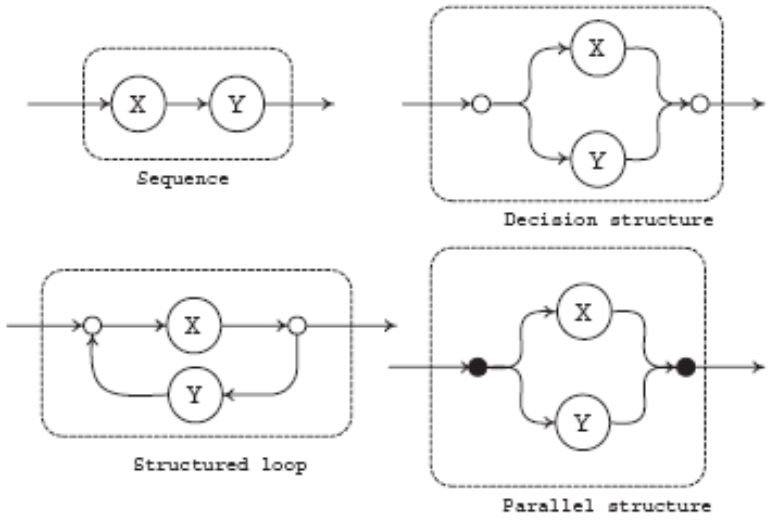


Motivation

❖ Knowledge Model of u-BRAIN

- Ontology-based
  - Domain Ontology defines the concepts and criterion value in each domain
  - Interface ontology define the required information from outside(ex: patient information stored in CIS)
  - Rule is defined to make the decisions with concepts in domain ontology and values in interface ontology
  - Each rule has identifier

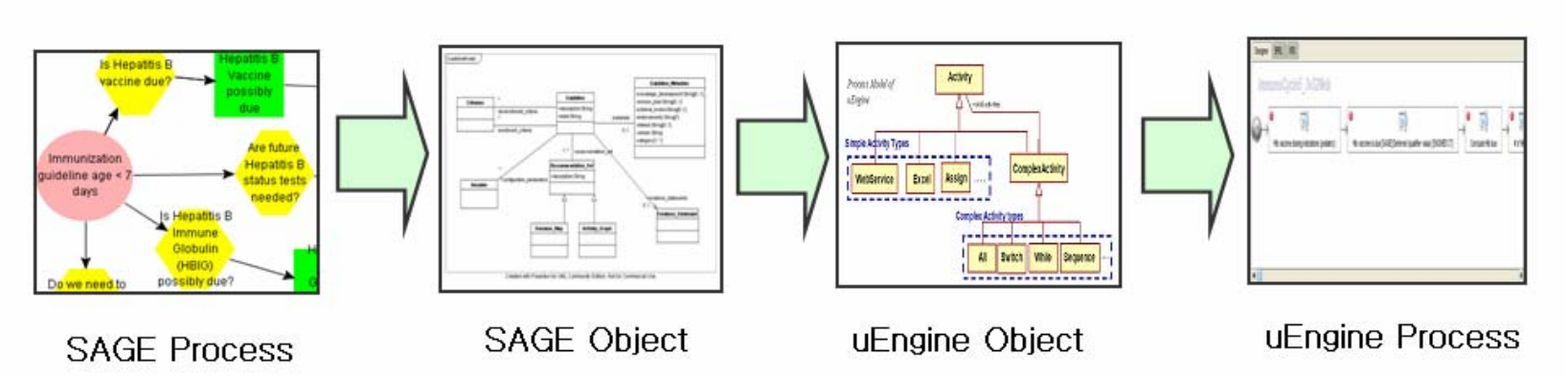
- Structured workflow based



How to translate

❖ Our approach

- Analyze the SAGE representation formalism
- Use protégé KnowledgeBase interface to get the SAGE object model
- Apply “Export” plug-in development method to integrate SAGE model and u-BRAIN converter and u-BRAIN execution engine
  - SAGE object(Knowledge base) -> uEngine Object mapping -> serialize -> Pulg-in Export -> XPD & XML for u-BRAIN representation



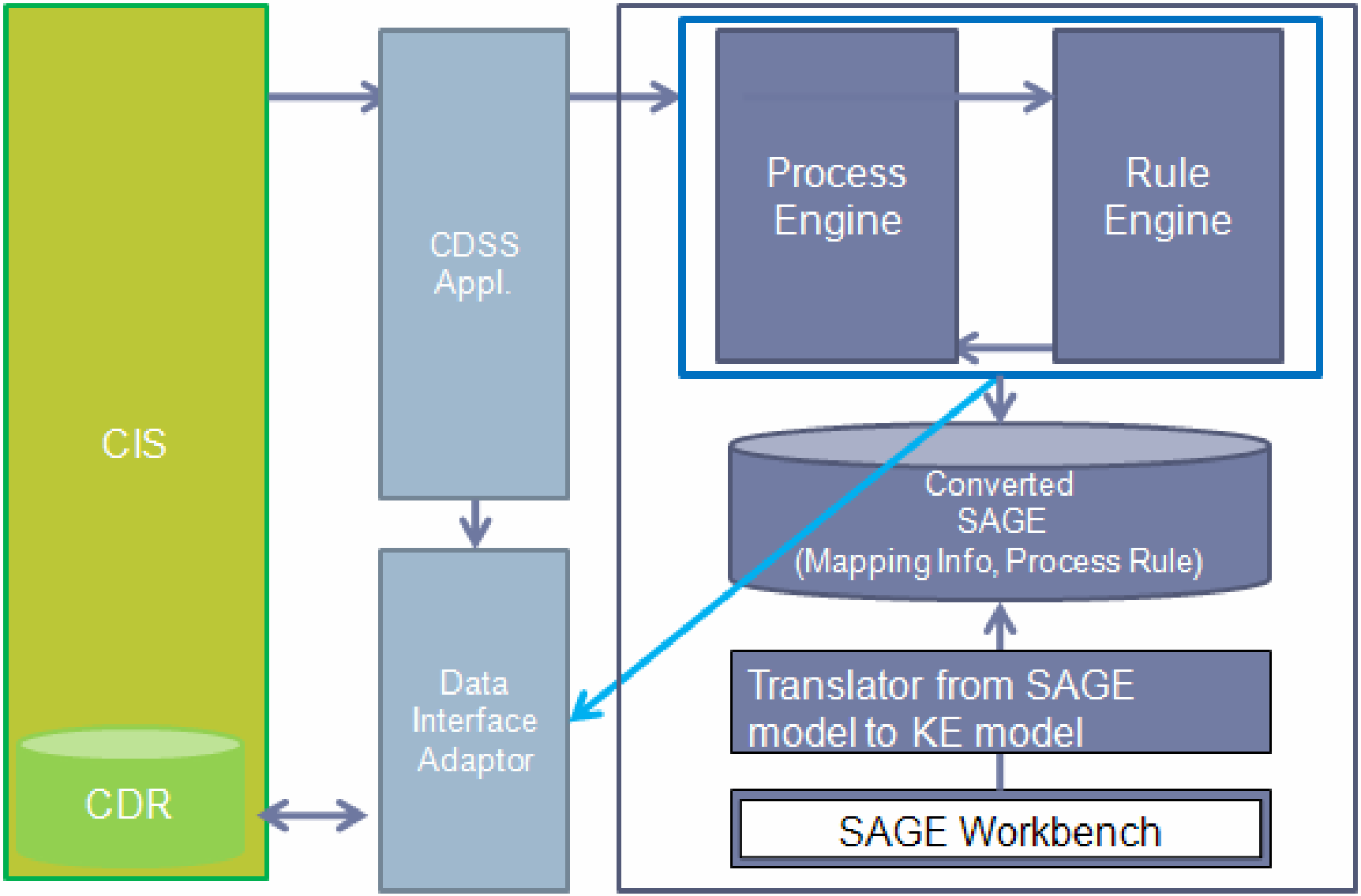
How to Translate

- **Object model of SAGE and mapping to uBRAIN object**

SAGE model	Meaning	features
Guideline	Collection of associated Recommendation Set	Process
Recommendation Set	Decision Map or set of activity graph	Sub-Process
Context	where the recommendations associated with the Context node is applicable.	Rule
Expression	expression language that can be used with any object-oriented model.	Rule
Concept	Constant atomic term	Rule
Variable	Meaningful result from executing the internal logic	Rule
Evidence Statement	represents a relationship between clinical conditions and interventions and additional contextual information and supporting references	Rule/Process
Activity graph	inter-related activities.	Process
Action	flow-of-control information	Process
Decision	representation of decision knowledge required to recommend a choice among alternatives	Rule/Process

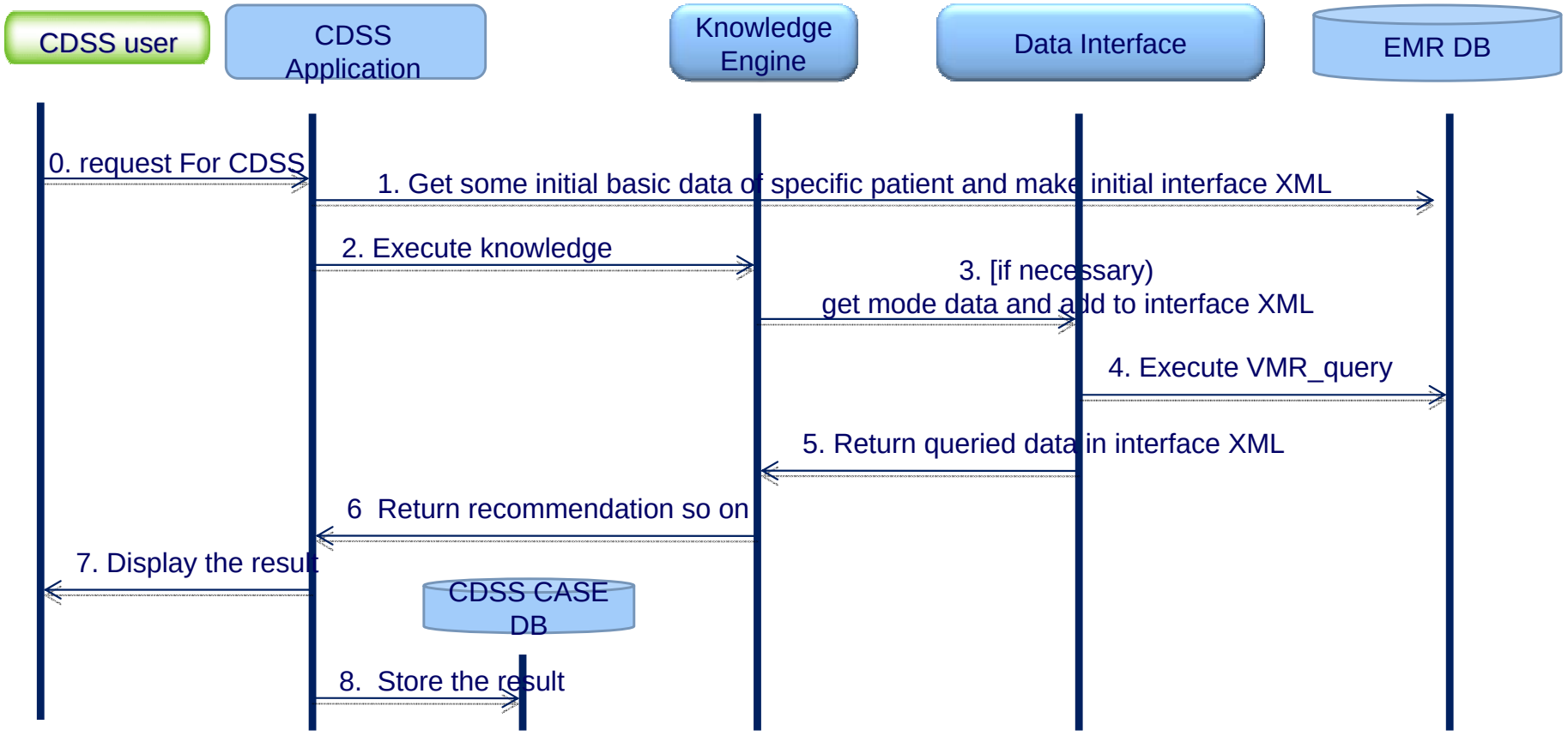
How to Translate

❖ New Architecture of u-BRAIN



How to translate

❖ Workflow at runtime



How to translate

- **SAGE Workflow to u-BRAIN activity**
  - Each action node is mapped to one activity node
  - Decision node is mapped to also u-BRAIN activity to invoke rule engine to do decision-making using rule
  - Complex action node is mapped one decision making node and decision structure of activity

- **SAGE decision to u-BRAIN rule**
  - Each expression is mapped to rule expression (if then else)
  - Generate the interface model to access the EMR (external data resource)

How to Translate

- **2 Kinds Expression in translation perspectives**
  - EMR database access is not required during rule execution
    - N-ary criterion, variable_comparison_criterion, VKB_Query
  - EMR Database access is required during rule execution
    - Prsence_criterion, adverse_reaction_prsence_criterion, observation_presence_criterion, medication_presence_criterion, comparison_criterion, VMR_query

How to translate

- **N-ary criterion**
  - Expression of BOOLEAN combination (AND, OR, or NOT) of simpler criterion expression
  - Each expression is mapped to one rule expression and connected with logical operator
  - Connected expression is another rule expression

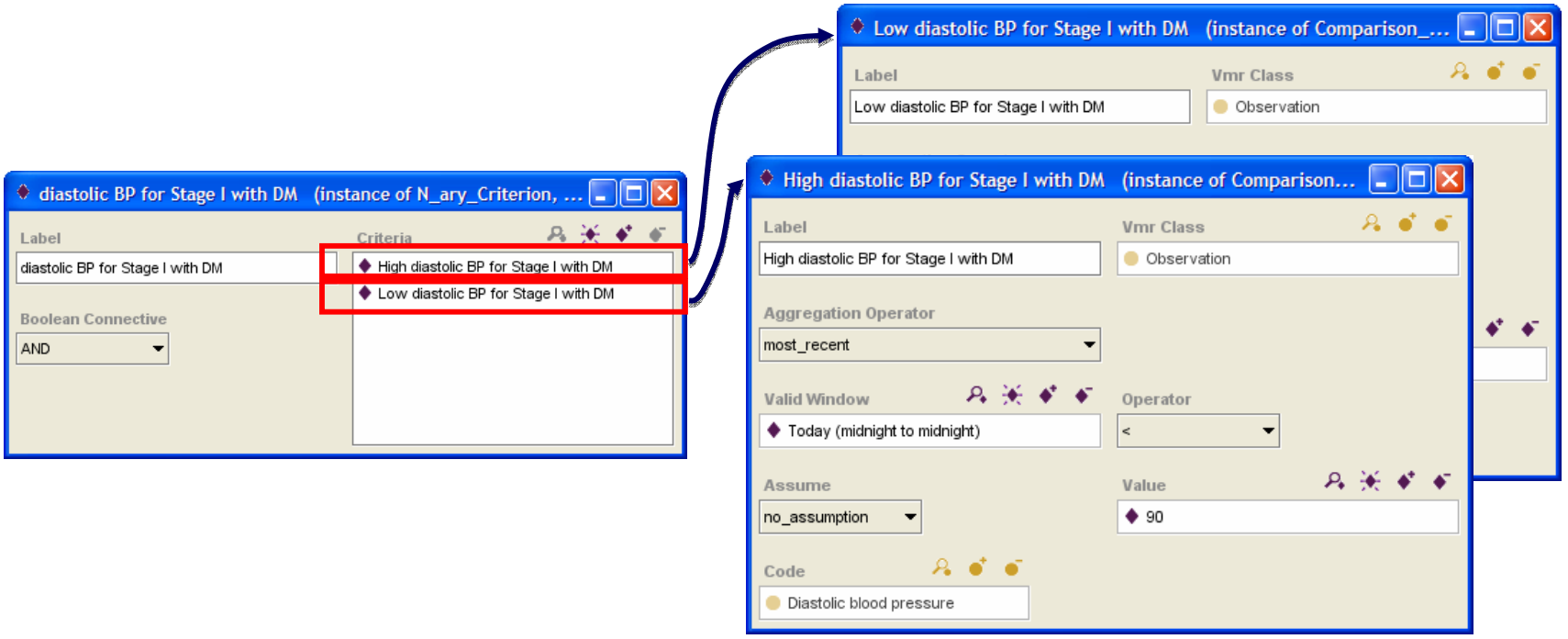
- **Variable_Comparison_Criterion**
  - compares the value of a variable to some other value.
  - Rule expression compare the value to element of interface XML
  - The value of ‘References As’ slot is translated into the element of interface XML
  - Interface XML is already made at the invocation time of CDSS service

How to translate

- **Presence_Criterion**
  - checks for presence or absence of coded concept in instances of a VMR class within the valid time
  - Translate the rule to check the value avaliability in interface XML
  - interfaceXML contains the data queried from EMR by ExecuteVMRQuery()
- **Comparison_Criterion**
  - Check for equality of data stored in EMR and variable or value
  - Translate the rule to compare the value in interface XML with defined operator

How to Translate

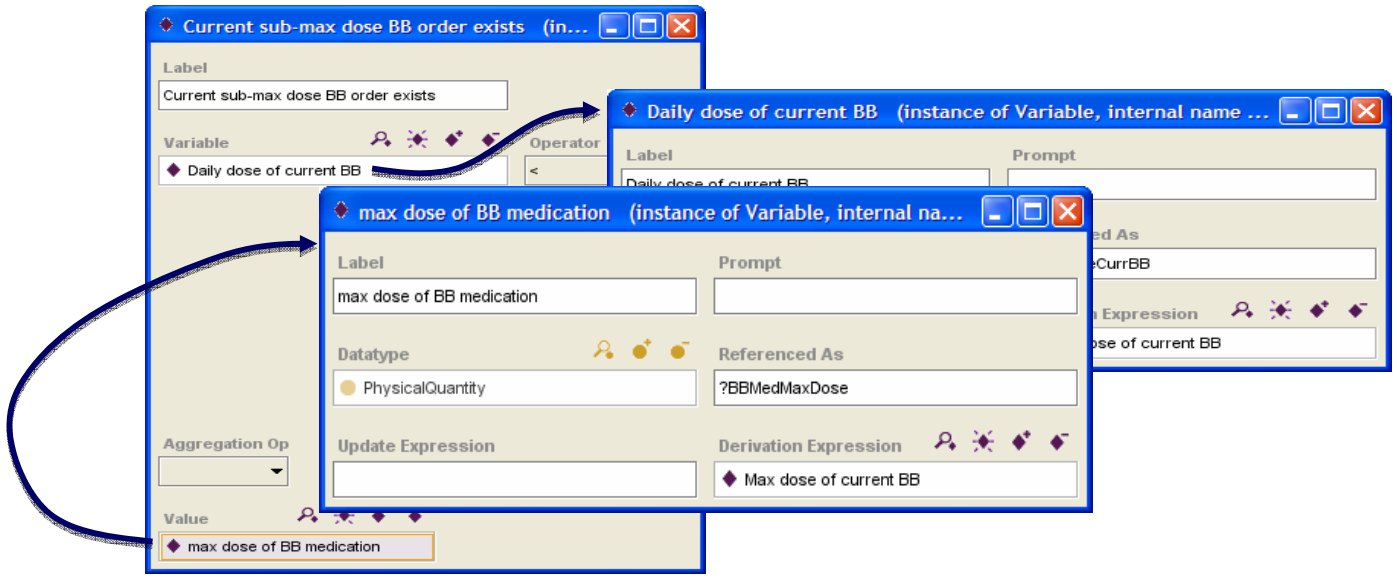
❖ N-ary criterion



RuleExpr	
Comment	diastolic BP for Stage I with DM
RuleExprObjec...	SAGE
RuleName	HTMgtV1_3_evaluation_Instance_72
RuleText	Boolean HTMgtV1_3_evaluation_Instance_72() {IF(FIRE("HTMgtV1_3_evaluation_Instance_73") and FIRE("HTMgtV1_3_evaluation_Instance_79")) THEN(true) ELSE(false) RESULTINFO(BOTH:"") }

How to Translate

- **Variable_Comparison_Criterion,**



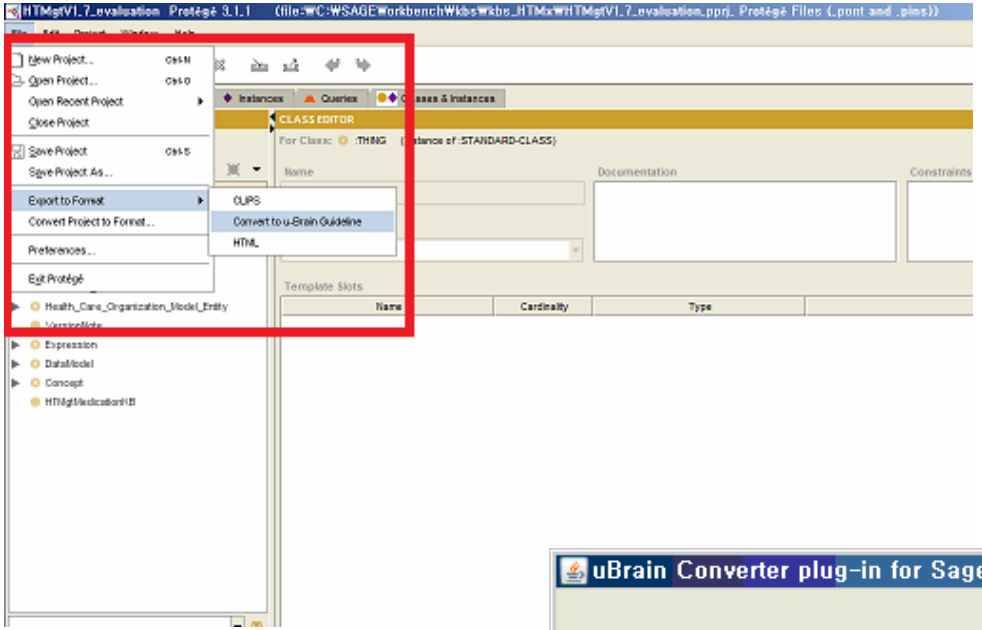
RuleExpr	
Comment	Current sub-max dose BB order exists
RuleExprObjec...	SAGE
RuleName	HTMgtV1_3_evaluation_Instance_198
RuleText	Boolean HTMgtV1_3_evaluation_Instance_198() {IF((input.element(label="Daily dose of current BB").value != "" and input.element(label="max dose of BB medication").value != "") and (input.element(label="Daily dose of current BB").value < input.element(label="max dose of BB medication").value)) THEN(true) ELSE(false) RESULTINFO(BOTH:"") }

How to translate

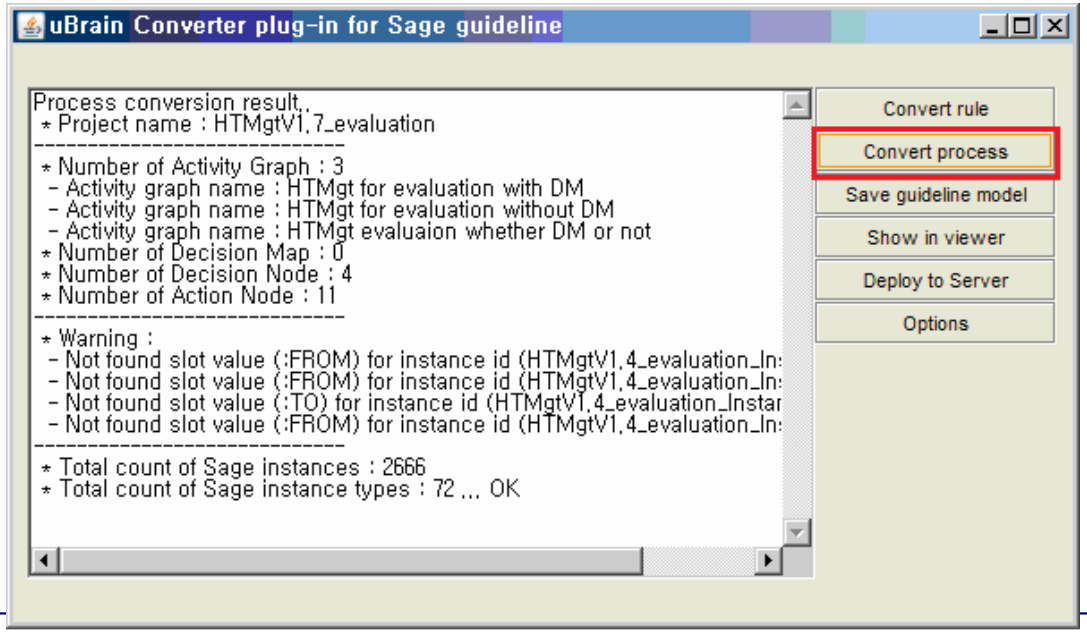
- **Workflow to translate**
  - Verify the guideline in SAGE according to SWM
  - Identify the logical error
  - Translate into u-BRAIN representation model
  - Viewing the translated representation model
  - Simulating the guideline

Implementation and Case study

❖ Pulgin Module

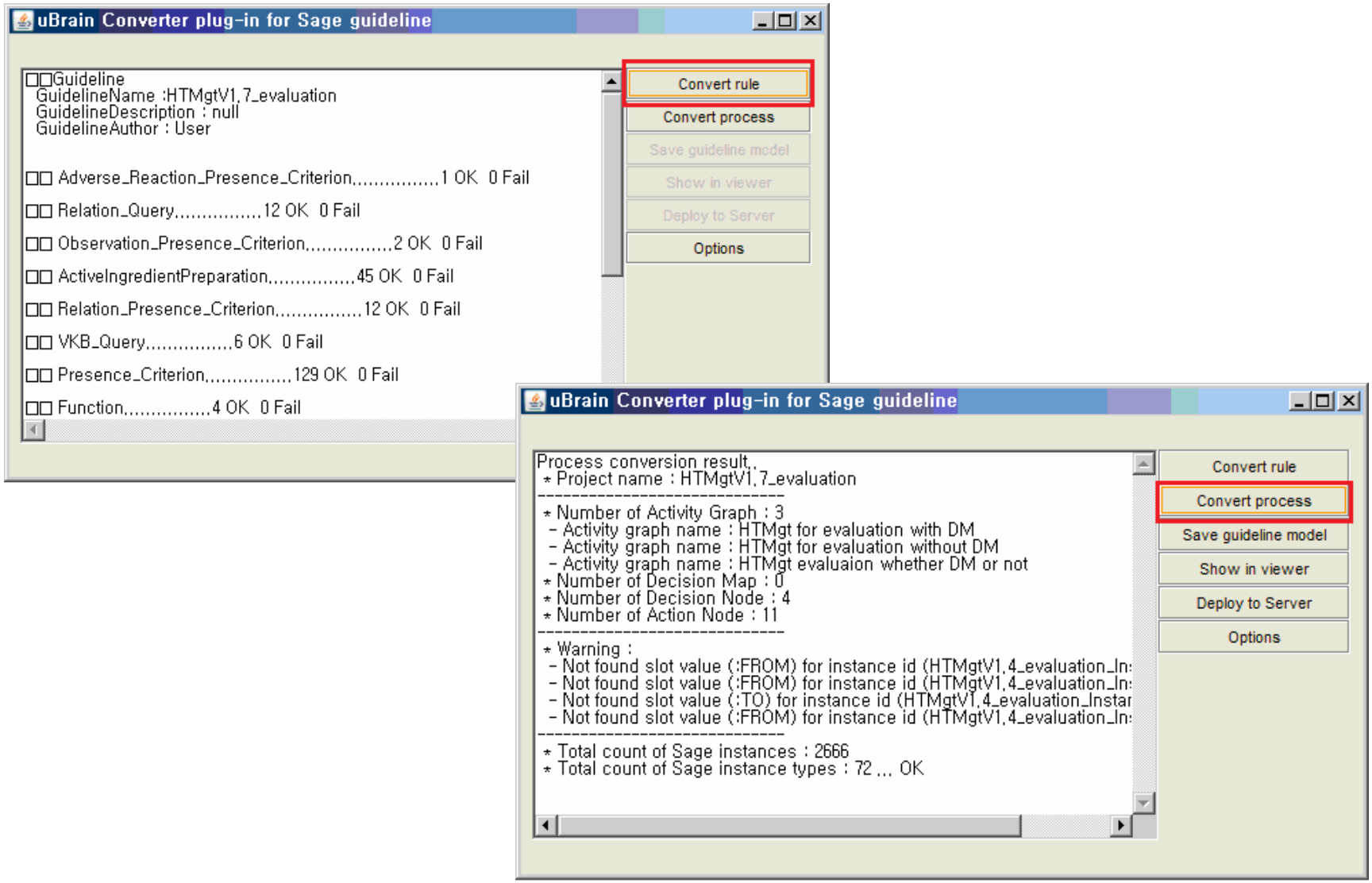


❖ Several Options



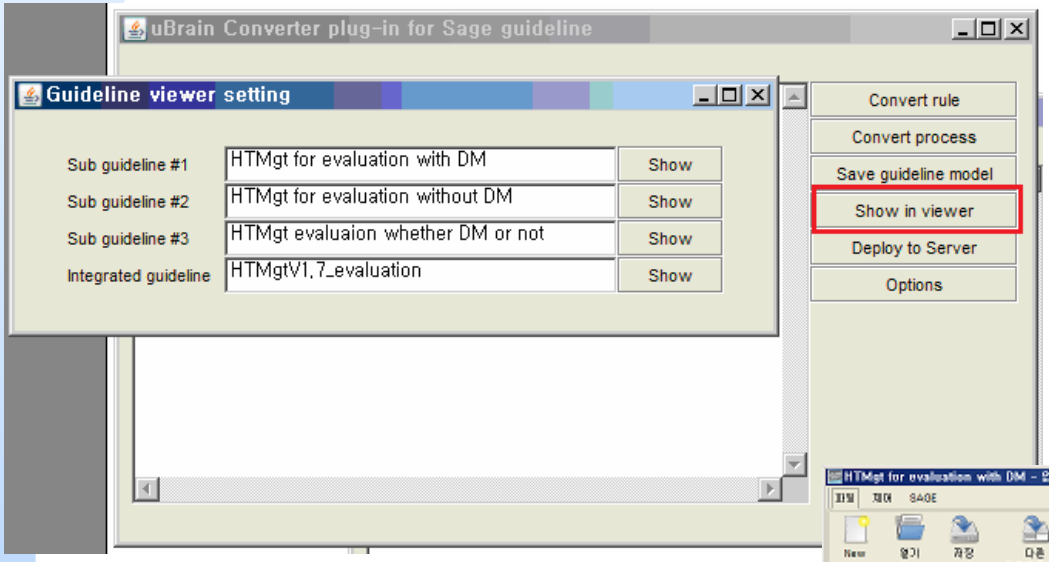
Implementation and Case study

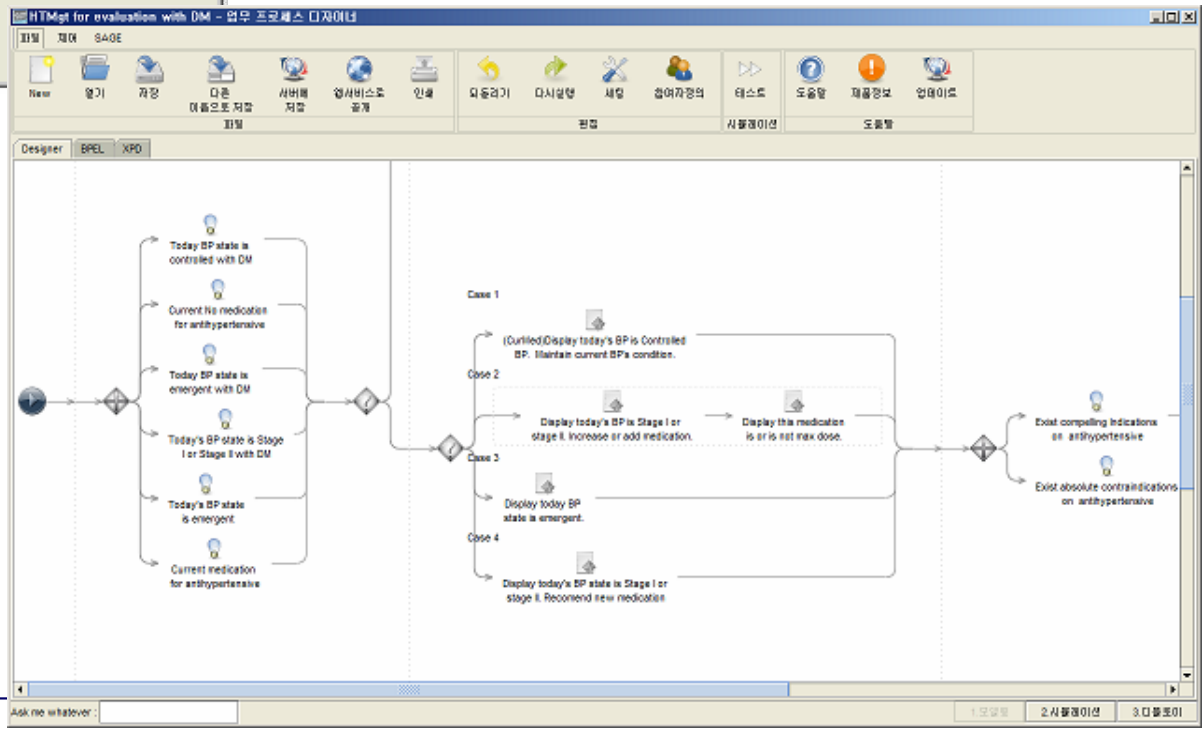
❖ Verification Report



Implementation and Case study

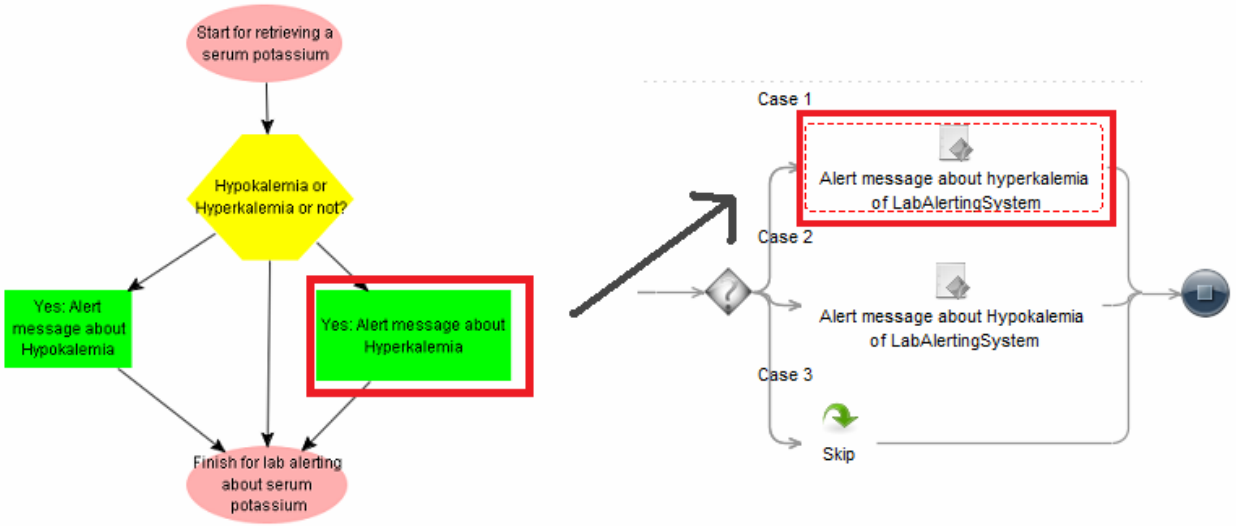
❖ Translated Guideline





Implementation and Case study

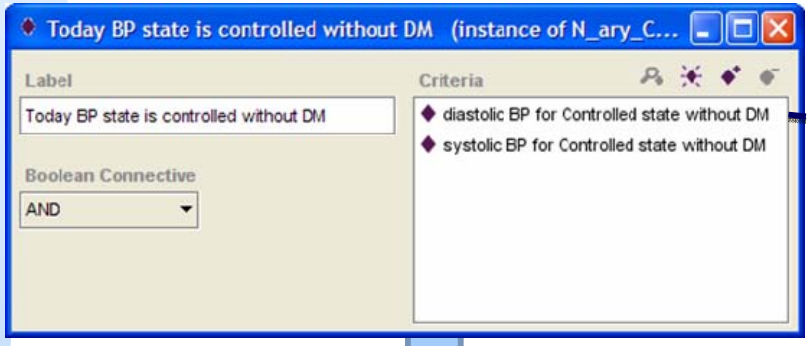
❖ Translated Results

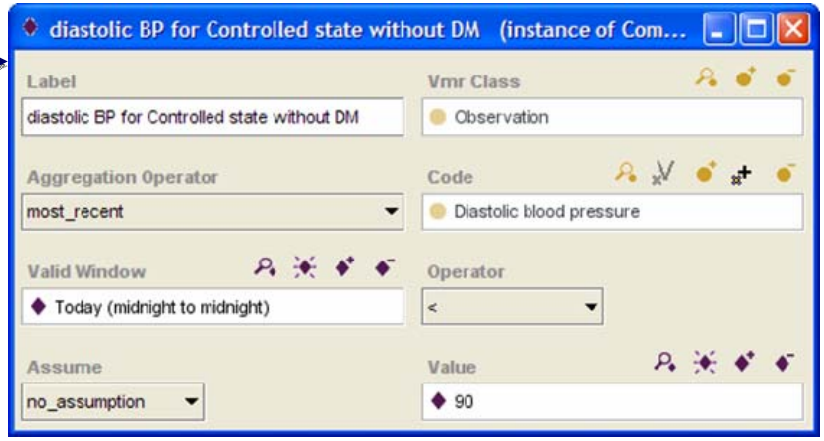


Implementation and Case study

❖ Translated Results

Criterion 2





Converted to

Rule

RuleExpr	
Comment	Today BP state is controlled without DM
RuleExprObjec...	SAGE
RuleName	HTMgtV1_3_evaluation_Instance_128
RuleText	Boolean HTMgtV1_3_evaluation_Instance_128() {IF(FIRE("HTMgtV1_3_evaluation_Instance_129") and FIRE("HTMgtV1_3_evaluation_Instance_135")) THEN(true) ELSE(false) RESULTINFO(BOTH:"") }

Converted to

Rule

RuleExpr	
Comment	diastolic BP for Controlled state without DM
RuleExprObjec...	SAGE
RuleName	HTMgtV1_3_evaluation_Instance_129
RuleText	Boolean HTMgtV1_3_evaluation_Instance_129() {IF(ExecuteVMRQuery_CC("HTMgtV1_3_evaluation_Instance_129","Observation","most_recent","EHR0052","EHR Concept","TimeInterval/low_label/Start of today variable/high_label/End of today variable/","TimeInterval/low_label/Start of today variable/high_label/End of today variable/","no_assumption") < 90.0) THEN(true) ELSE(false) RESULTINFO(BOTH:"") }

DTA Query

Comparison_Criterion_Query	
query_id	HTMgtV1_3_evaluation_Instance_129
evmr_class	Patient
agg_operator	most_recent
Text	Select EMR_PATIENT.DBP , EMR_PATIENT.VS_DATE from EMR_PATIENT where EMR_PATIENT.ID=input.pid

Implementation and Case study

❖ Evaluation in Lab alerting CDSS

- 10 kinds lab test

Env	Server	Test Server
	CPU	1.86GHz
	Memory	1.5GB
	OS	windows2003 SP1

Performance

Unit: ms

# of cases	Turnaround Time of DI	Turnaround Time of KE
323,445	346.16	51.90

Correctness

item	# of cases	Error ratio
DIA	323,445	0%
Knowledge engine	323,445	0%

Conclusion

- **SAGE Guideline execution environment is available**

- **In the future**
  - Several case studies is going now.
  - Verification environment will be added
    - So far, debugging utility verify the SAGE model corresponding structured workflow model
    - We have a plan to develop verification tool based on test case
  - develop knowledge repository management tools
    - Access control
    - Version control
    - Change control
    - Configuration management
    - Reuse

Thank You !

Executable Guideline