OpenCDS: a Clinical Decision Support Infrastructure Based on Drools

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Agenda

- HL7 Decision Support Service (DSS) standard
- HL7 Virtual Medical Record (vMR) standard
- OpenCDS
- Demo
- Discussion

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HL7 Decision Support Service (DSS) Standard
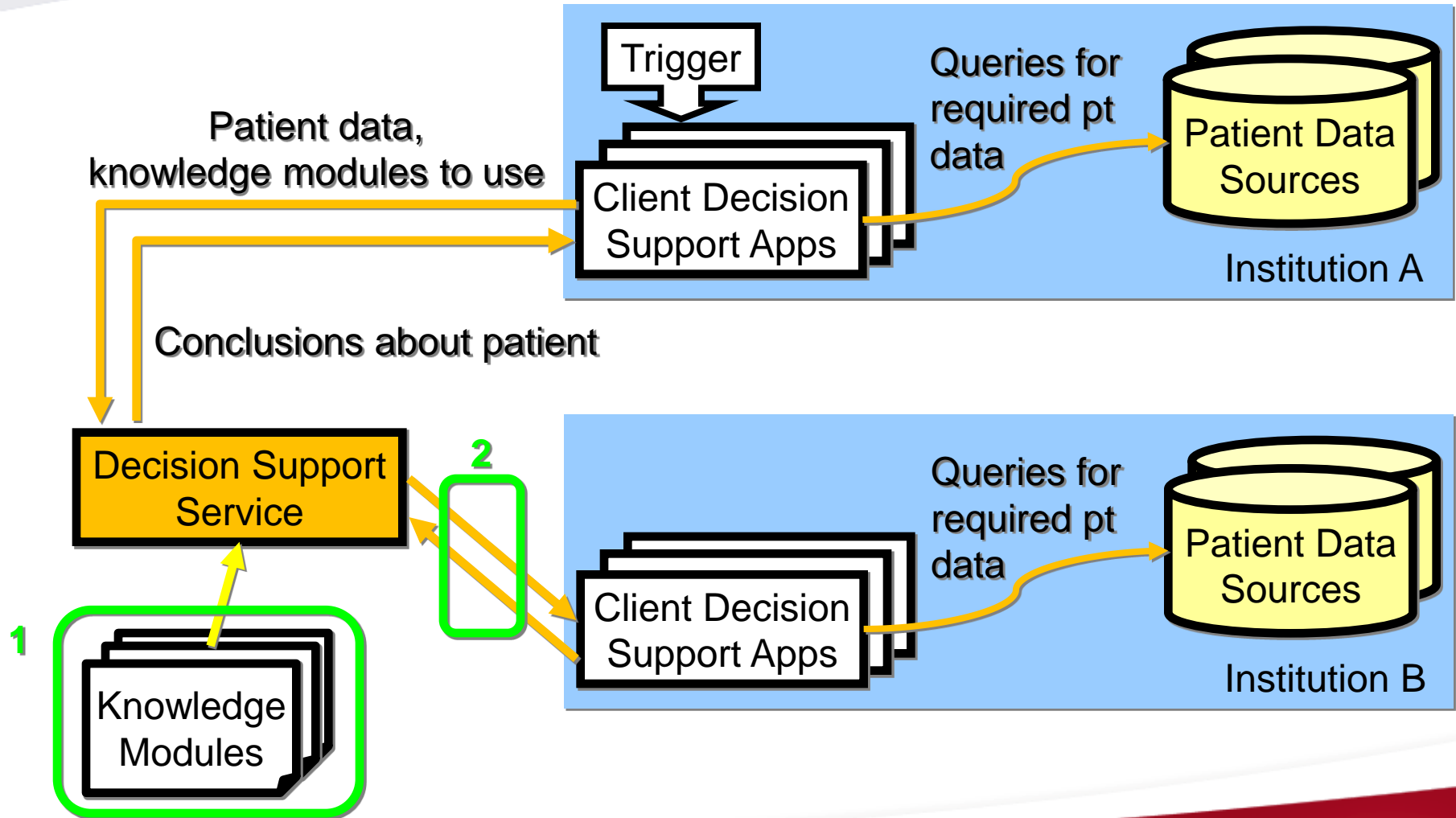
Decision Support Service (DSS) – Overview

- Business purpose:
  - To facilitate implementation and maintenance of clinical decision support (CDS) applications
- Approach:
  - Evaluates patient data (inputs) using knowledge modules and returns machine-interpretable conclusions (outputs)
- Normative HL7/ANSI standard

DSS – Architectural Overview

DSS Knowledge Module (KM) – Components

- Descriptive traits
  - E.g., authors, keywords, purpose, explanation
- Data requirements
  - Example
    - Input: patient's list of active problems and medications
    - Output: disease management recommendations
- Semantic requirements
  - Example
    - Input Requirement: HL7 Continuity of Care Document (CCD), HL7 vMR Input
    - Output Requirement: HL7 Care Plan, HL7 vMR Output

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DSS: SOAP Envelope

```xml
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:dss="http://www.omg.org/spec/CDSS/201105/dss">
    <SOAP-ENV:Header/>
    <SOAP-ENV:Body>
        <dss:evaluateAtSpecifiedTime>
            <interactionId scopingEntityId="edu.utah" interactionId="123"
                    submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
                            version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
                        <containingEntityId scopingEntityId="edu.utah" businessId="ABLData"
                                version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                                version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluateAtSpecifiedTime>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

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DSS: evaluateAtSpecifiedTime

```xml
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                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                                version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
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    <SOAP-ENV:Body>
        <dss:evaluateAtSpecifiedTime>
            <interactionId scopingEntityId="edu.utah" interactionId="1234567890"
                submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
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                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
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                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                            version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
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    <SOAP-ENV:Body>
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            <interactionId scopingEntityId="edu.utah" interactionId="1234567890"
                submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
                        version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
                        <containingEntityId scopingEntityId="edu.utah" businessId="ABLData"
                            version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                            version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
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    xmlns:dss="http://www.omg.org/spec/CDSS/201105/dss">
    <SOAP-ENV:Header/>
    <SOAP-ENV:Body>
        <dss:evaluateAtSpecifiedTime>
            <interactionId scopingEntityId="edu.utah" interactionId="1234567890"
                    submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
                            version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
                        <containingEntityId scopingEntityId="edu.utah" businessId="ABLData"
                                version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                                version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluateAtSpecifiedTime>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

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DSS: dataRequirementItemData (may repeat)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:dss="http://www.omg.org/spec/CDSS/201105/dss">
    <SOAP-ENV:Header/>
    <SOAP-ENV:Body>
        <dss:evaluateAtSpecifiedTime>
            <interactionId scopingEntityId="edu.utah" interactionId="1234567890"
                submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
                        version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
                        <containingEntityId scopingEntityId="edu.utah" businessId="ABLData"
                            version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                            version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluateAtSpecifiedTime>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

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DSS: driId (a label identifying the payload element)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:dss="http://www.omg.org/spec/CDSS/201105/dss">
    <SOAP-ENV:Header/>
    <SOAP-ENV:Body>
        <dss:evaluateAtSpecifiedTime>
            <interactionId scopingEntityId="edu.utah" interactionId="1234567890"
                    submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
                            version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
                        <containingEntityId scopingEntityId="edu.utah" businessId="ABLData"
                                version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                                version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluateAtSpecifiedTime>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

DSS: data (contains a semantic identifier and the base64 encoded data)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:dss="http://www.omg.org/spec/CDSS/201105/dss">
    <SOAP-ENV:Header/>
    <SOAP-ENV:Body>
        <dss:evaluateAtSpecifiedTime>
            <interactionId scopingEntityId="edu.utah" interactionId="1234567890"
                submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
                        version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
                        <containingEntityId scopingEntityId="edu.utah" businessId="ABLData"
                            version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                            version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluateAtSpecifiedTime>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

DSS: base64EncodedPayload (contains data whose structure is specified by the SSId)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:dss="http://www.omg.org/spec/CDSS/201105/dss">
    <SOAP-ENV:Header/>
    <SOAP-ENV:Body>
        <dss:evaluateAtSpecifiedTime>
            <interactionId scopingEntityId="edu.utah" interactionId="1234567890"
                    submissionTime="2012-01-20T07:59:35.123"/>
            <specifiedTime>2012-01-01T00:00:00.000</specifiedTime>
            <evaluationRequest clientLanguage="" clientTimeZoneOffset="">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="edu.utah" businessId="AcuteBloodLoss"
                            version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="testPayload">
                        <containingEntityId scopingEntityId="edu.utah" businessId="ABLData"
                                version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId="org.opencds.vmr" businessId="VMR"
                                version="1.0"/>
                        <base64EncodedPayload>BASE64ENCODEDPAYLOAD</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluateAtSpecifiedTime>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

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PD94bWwgdmVyc2lvbj0iMS4wIiBlbmNvZGluZz0iVVRGLTgiIHN0YW5kYWxvbmU9InllcyI/Pgo8bnM0OmNkc091dHB1dCB4b
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lbWEuY2Rzb3V0cHV0IiB4bWxuczpuczU9Im9yZy5vcGVuY2RzLnZtci52MV8yb3XIiPgogICAgPHZtck91dHB1
dD4KICAgICAgICA8dGVtcGxhdGVJZCByb290PSIyLjE2Ljg0MC4xLjExMzg4My4zLjE4MjkuMTEuMS4yLjIiIGV4dGVuc2lvb
j0iIi8+CiAgICAgICAgPHBhdGllbnQ+CiAgICAgICAgICAgIDx0ZW1wbGF0ZUlkIHJvb3Q9IjIuMTYuODQwLjEuMTEzODgzLj
MuMTgyOS4xMS4yLjEuMSIvPgogICAgICAgICAgICA8aWQgcm9vdD0iMi4xNi44NDAuMS4xMTM4ODMuMy43OTUuNS4yLjEuMSI
gZXh0ZW5zaW9uPSJkYXZlIi8+CiAgICAgICAgICDxkZW1vZ3JhcGhpY3M+CiAgICAgICAgICAgICAgICA8YmlydGhUaW1l
IHZhbHVlPSIxOTkyMDcxMzAwMDAwMC4wMDAtMDYwMCIvPgogICAgICAgICAgICAgICAgPGdlbmRlciBjb2RlPSJGIiBjb2RlU
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gPGNsaW5pY2FsU3RhdGVtZW50cz4KICAgICAgICAgICAgICAgIDxvYnNlcnZhdGlvblJlc3VsdHM+CiAgICAgICAgICAgICAg
ICAgICAgPG9ic2VydmF0aW9uUmVzdWx0PgogICAgICAgICAgICAgICAgICAgICAgICA8aWQgcm9vdD0iMi4xNi44NDAuMS4xM
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<snip>

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ZW5DRFMgY29uY2VwdHMiIGRpc3BsYXlOYW1lPSJJcyBjb250YWluZWQgYnkiLz4KICAgICAgICAgICAgICAgICAgICAgICAgI
CAgIDxvYnNlcnZhdGlvblJlc3VsdD4KPGlkIHJvb3Q9IjIuMTYuODQwLjEuMTEzODgzLjMuNzk1LjUuUy4xIgY2h0ZW5zaW9uPS
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W50PgogICAgPC92bXJJdRwdXQ+Cjwvbm00OmNkc091dHB1dD4K

vMR: decoded payload

```xml
<cdsInput>
    <templateId root="2.16.840.1.113883.3.1829.11.1.1.1"/>
    <vmrInput>
        <templateId root="2.16.840.1.113883.3.1829.11.1.2.2"/>
        <patient>
            <templateId root="2.16.840.1.113883.3.1829.11.2.1.1"/>
            <id extension="dave" root="2.16.840.1.113883.3.795.5.2.1.1"/>
            <demographics>
                <birthTime value="19920713000000"/>
                <gender code="F" codeSystem="2.16.840.1.113883.1.11.1"/>
            </demographics>
            <clinicalStatements>
                <encounterEvents>
                    <encounterEvent>
                        <templateId root="2.16.840.1.113883.3.1829.11.4.3.2"/>
                        <id extension="testVMRoneLowHct" root="2.16.840.1.113883.3.795.5.2"/>
                        <dataSourceType code="Administrative"
                                    codeSystem="2.16.840.1.113883.3.795.12.2.5.1"/>
                        <encounterType code="I" codeSystem="2.16.840.1.113883.3.795.12.2.6.1"
                                    displayName="Inpatient"/>
                        <encounterEventTime high="" low="20130301"/>
                        <relatedClinicalStatement>
                            <targetRelationshipToSource code="COMP"
                                        codeSystem="2.16.840.1.113883.3.795.12.1.2"/>
                            <observationResult>
                                <templateId root="2.16.840.1.113883.3.1829.11.6.3.6"/>
                                <id extension="test1" root="2.16.840.1.113883.3.795.5.2.3.4"/>
                                <dataSourceType code="Clinical"
                                        codeSystem="2.16.840.1.113883.3.795.12.2.5.1"/>
                                <observationFocus code="20570-8" codeSystem="2.16.840.1.113883.6.1"
                                        displayName="Hematocrit"/>
                                <observationEventTime high="20130329" low="20130329"/>
                                <observationValue><physicalQuantity unit="%" value="45.7"/>
                                </observationValue>
                            </observationResult>
```
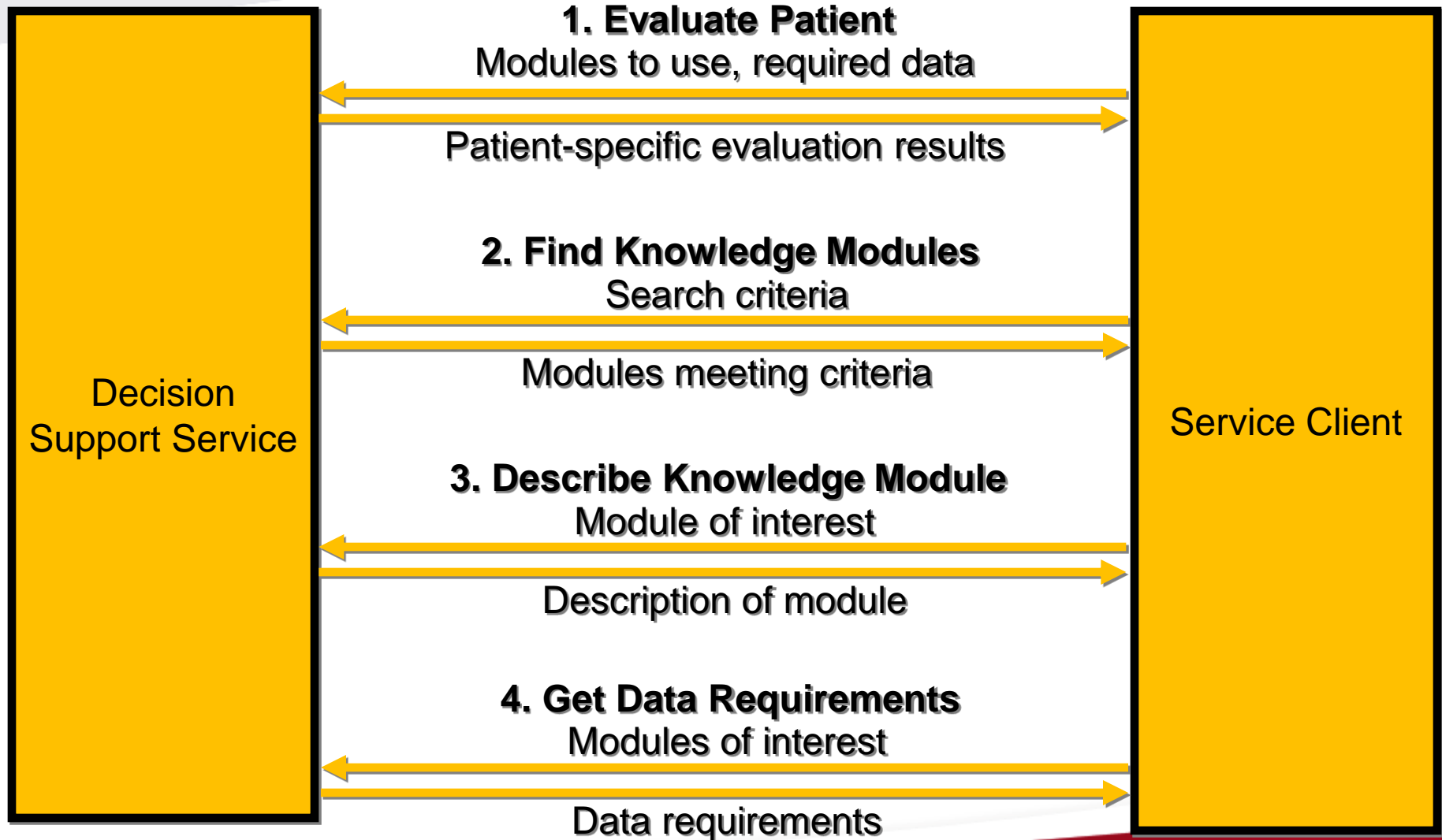
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DSS KM – Sample Inferences

Sample Evaluation Input	Sample Evaluation Output
Patient age, gender, past health maintenance procedures	List of health maintenance procedures due or almost due
Medication identifier, age, gender, weight, serum creatinine level	Recommended maximum and minimum doses for medication given patient's estimated renal function
Insurance provider, data relevant to prescription	Prior authorization to prescribe medication
CCD	Wide range of care recommendations

DSS – Primary Service Operations

Decision Support Service

Service Client

1. Evaluate Patient
Modules to use, required data

Patient-specific evaluation results

2. Find Knowledge Modules
Search criteria

Modules meeting criteria

3. Describe Knowledge Module
Module of interest

Description of module

4. Get Data Requirements
Modules of interest

Data requirements

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HL7 Virtual Medical Record (vMR) Standard

Background

- A "holy grail" of clinical informatics is scalable, interoperable CDS

- Key requirement for interoperable CDS and re-use of CDS knowledge resources = use of a common patient data model
  - Referred to as a "Virtual Medical Record" or vMR (Johnson *et al., AMIA Annu Symp Proc*, 2001)

- Lack of a common vMR has been a major barrier to sharing knowledge and scaling CDS

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Example Challenge without VMR

Observation
  Code = BP
  Value = 120/80 mmHg

Blood Pressure
    Systolic = 120 mmHg
    Diastolic = 80 mmHg

Observation
  Code = BP
    Observation
      Code = SBP
      Value = 120 mmHg
    Observation
      Code = DBP
      Value = 80 mmHg

Vital Sign
    Type = BP
    Value = 120/80
    Units = mmHg

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vMR Goal

- Provide common information model upon which interoperable clinical decision support resources (e.g., rules) can be developed

Project History

- Analysis of data required by 20 CDS systems from 4 countries (Kawamoto *et al.*, AMIA 2010)

- Refinement of vMR via implementation within OpenCDS

- Adopted in September 2011 as Informative Specification

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Why Not Just Use the CCD as the vMR?

- CCD does not include all needed information
  - E.g., Family history model suitable for CDS
- CCD is not sufficiently intuitive for direct use by CDS knowledge authors

Problem Model – CCD vs. VMR

```xml
<entry typeCode="DRIV">
  <act classCode="ACT" moodCode="EVN">
    <templateId root="2.16.840.1.113883.10.20.1.27"/>
    <!-- Problem act template -->
    <id root="6a2fa88d-4174-4909-aece-db44b60a3abb"/>
    <code nullFlavor="NA"/>
    <entryRelationship typeCode="SUBJ">
      <observation classCode="OBS" moodCode="EVN">
        <templateId root="2.16.840.1.113883.10.20.1.28"/>
        <!--
        <id
        <co
        <st
        <ef

        </e
        <va
```

```xml
<problem>
  <id root="6a2fa88d-4174-4909-aece-db44b60a3abb"/>
  <problemCode codeSystem="2.16.840.1.113883.6.96" code="195967001" displayName="Asthma"/>
  <problemEffectiveTime low="1950"/>
  <diagnosticEventTime low="20110825" high="20110825"/>
  <problemStatus codeSystem="2.16.840.1.113883.6.96" code="55561003" displayName="Active"/>
</problem>
```

```xml
      <entryRelationship typeCode="REFR">
        <observation classCode="OBS" moodCode="EVN">
          <templateId root="2.16.840.1.113883.10.20.1.50"/>
          <!-- Problem status observation template -->
          <code code="33999-4" codeSystem="2.16.840.1.113883.6.1" displayName="Status"/>
          <statusCode code="completed"/>
          <value xsi:type="CE" code="55561003" codeSystem="2.16.840.1.113883.6.96" displayName="Active"/>
        </observation>
      </entryRelationship>
    </observation>
  </entryRelationship>
  </act>
</entry>
```

Simplified ISO 21090 Data Types

iso-21090-datatypes-simplified-vmr::
ANY

iso-21090-datatypes-simplified-vmr::
QTY

iso-21090-datatypes-simplified-vmr::IVL_INT

+ high :INT [0..1]
+ highIsInclusive :boolean [0..1]
+ low :INT [0..1]
+ lowIsInclusive :boolean [0..1]

iso-21090-datatypes-simplified-vmr::AD

+ part :ADXP [1..*]
+ use :CS [0..*]

iso-21090-datatypes-simplified-vmr::INT

+ value :int

iso-21090-datatypes-simplified-vmr::IVL_PQ

+ high :PQ [0..1]
+ highIsInclusive :boolean [0..1]
+ low :PQ [0..1]
+ lowIsInclusive :boolean [0..1]

iso-21090-datatypes-simplified-vmr::CD

+ code :string [0..1]
+ codeSystem :string [0..1]
+ codeSystemName :string [0..1]
+ displayName :ST [0..1]
+ originalText :string [0..1]

iso-21090-datatypes-simplified-vmr::PQ

+ unit :string
+ value :decimal

iso-21090-datatypes-simplified-vmr::CS

+ code :string

iso-21090-datatypes-simplified-vmr::
REAL

+ value :decimal

iso-21090-datatypes-simplified-vmr::IVL_RTO

+ high :RTO [0..1]
+ highIsInclusive :boolean [0..1]
+ low :RTO [0..1]
+ lowIsInclusive :boolean [0..1]

iso-21090-datatypes-simplified-vmr::EN

+ part :ENXP [1..*]
+ use :CS [0..*]

iso-21090-datatypes-simplified-vmr::
RTO

+ denominator :PQ
+ numerator :PQ

HEALTH CARE

Example Clinical Statement
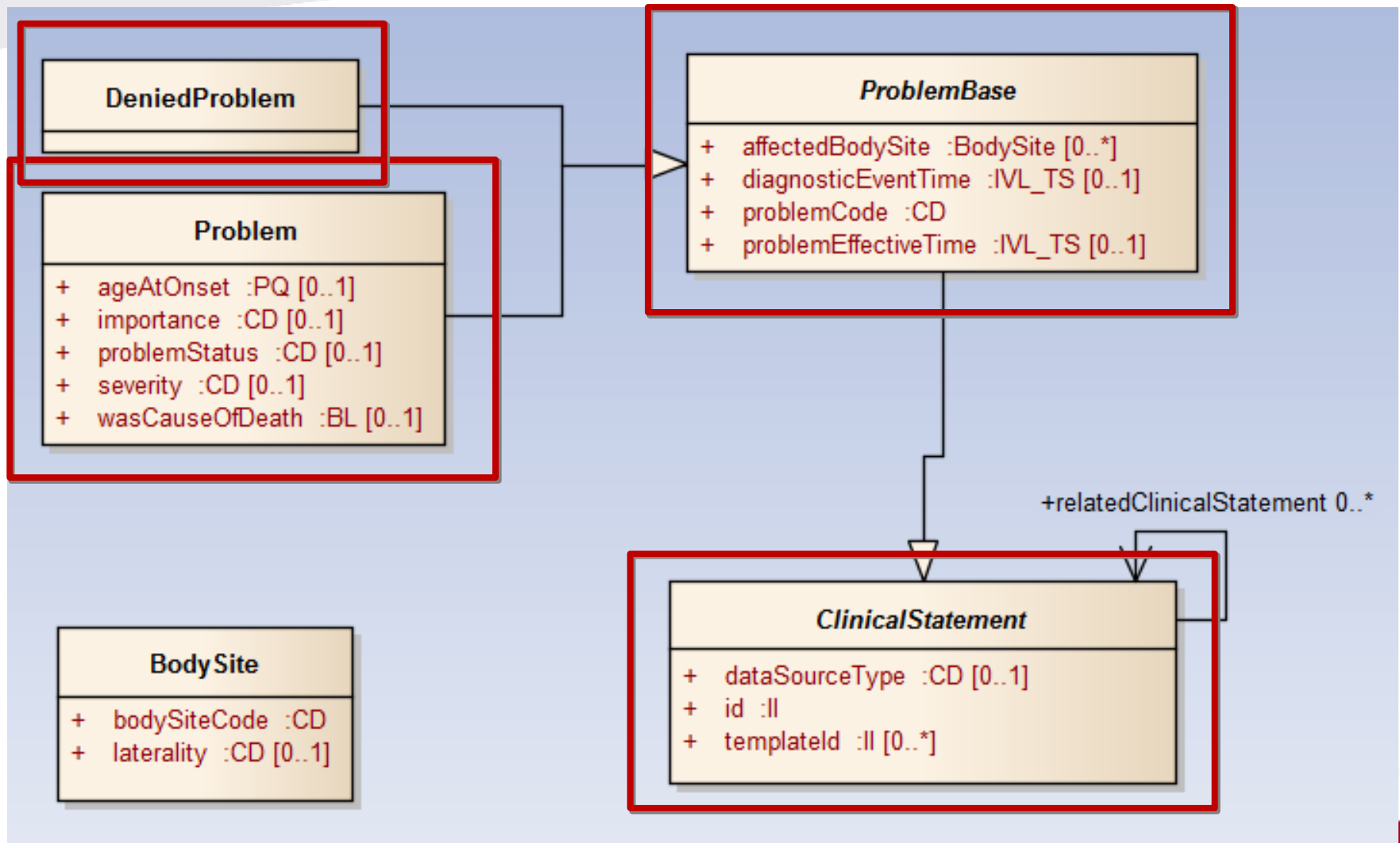
Further Information

DSS:

http://hssp-dss.wikispaces.com/hl7_specification

vMR:

http://wiki.hl7.org/index.php?title=Virtual_Medical_Record_(vMR)

OpenCDS

OpenCDS

- Goal
  - Facilitate widespread availability of advanced CDS capabilities through open-source, collaborative development of standards-based DSS infrastructure, tooling, and high-value services

- Methods
  - Support HL7 DSS and vMR standards
  - Leverage JBoss Drools and jBPM
  - Develop all components required to author, test, and operationally support standards-compliant DSSs

- 1.1 release freely available under Apache 2 open-source license

Collaborators

OpenCDS – Architectural Overview

Standard Interface:
HL7 Decision Support Service Standard
(http://hssp-dss.wikispaces.com)

Standard Data Models:
HL7 Virtual Medical Record (vMR) Standard
[http://wiki.hl7.org/index.php?title=
Virtual_Medical_Record_(vMR)]

Patient
knowledge m...

Conclusion...

Decision Support
Service

Knowledge
Modules

Queries for
required pt
data

Client Decision
Support Apps

Patient Data
Sources

Institution B

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```xml
<entry typeCode="DRIV">
  <act classCode="ACT" moodCode="EVN">
    <templateId root="2.16.840.1.113883.10.20.1.27"/>
    <!-- Problem act template -->
    <id root="6a2fa88d-4174-4909-aece-db44b60a3abb"/>
    <code nullFlavor="NA"/>
    <entryRelationship typeCode="SUBJ">
      <observation classCode="OBS" moodCode="EVN">
        <templateId root="2.16.840.1.113883.10.20.1.28"/>
        <id root="d11275e7-67ae-11db-bd13-0800200c9a66"/>
        <code code="ASSERTION" codeSystem="2.16.840.1.113883.5.4"/>
        <statusCode code="completed"/>
        <effectiveTime>
          <low value="1950"/>
        </effectiveTime>
        <value xsi:type="CD" code="73211009" codeSystem="2.16.840.1.113883.6.96" displayName="Diabetes mellitus"/>
        <entryRelationship typeCode="REFR">
          <observation classCode="OBS" moodCode="EVN">
            <templateId root="2.16.840.1.113883.10.20.1.50"/>
            <code code="33999-4" codeSystem="2.16.840.1.113883.6.1" displayName="Status"/>
```

```xml
<observationResult>
  <id root="670dded2-53ac-43ff-a74a-2000c59d5d9e"/>
  <observationFocus codeSystem="2.16.840.1.113883.3.795.12.1" code="12982" displayName="Need for Hemoglobin A1c test"/>
  <observationEventTime low="20110825" high="20110825"/>
  <observationValue xsi:type="dt:CD" codeSystem="2.16.840.1.113883.3.795.12.1" code="93291" displayName="Not due"/>
</observationResult>
```

https://clinapp6.duhs.duke.e

Patient **Activity** **Rounding** O

Du

All Results   Dictated Reports
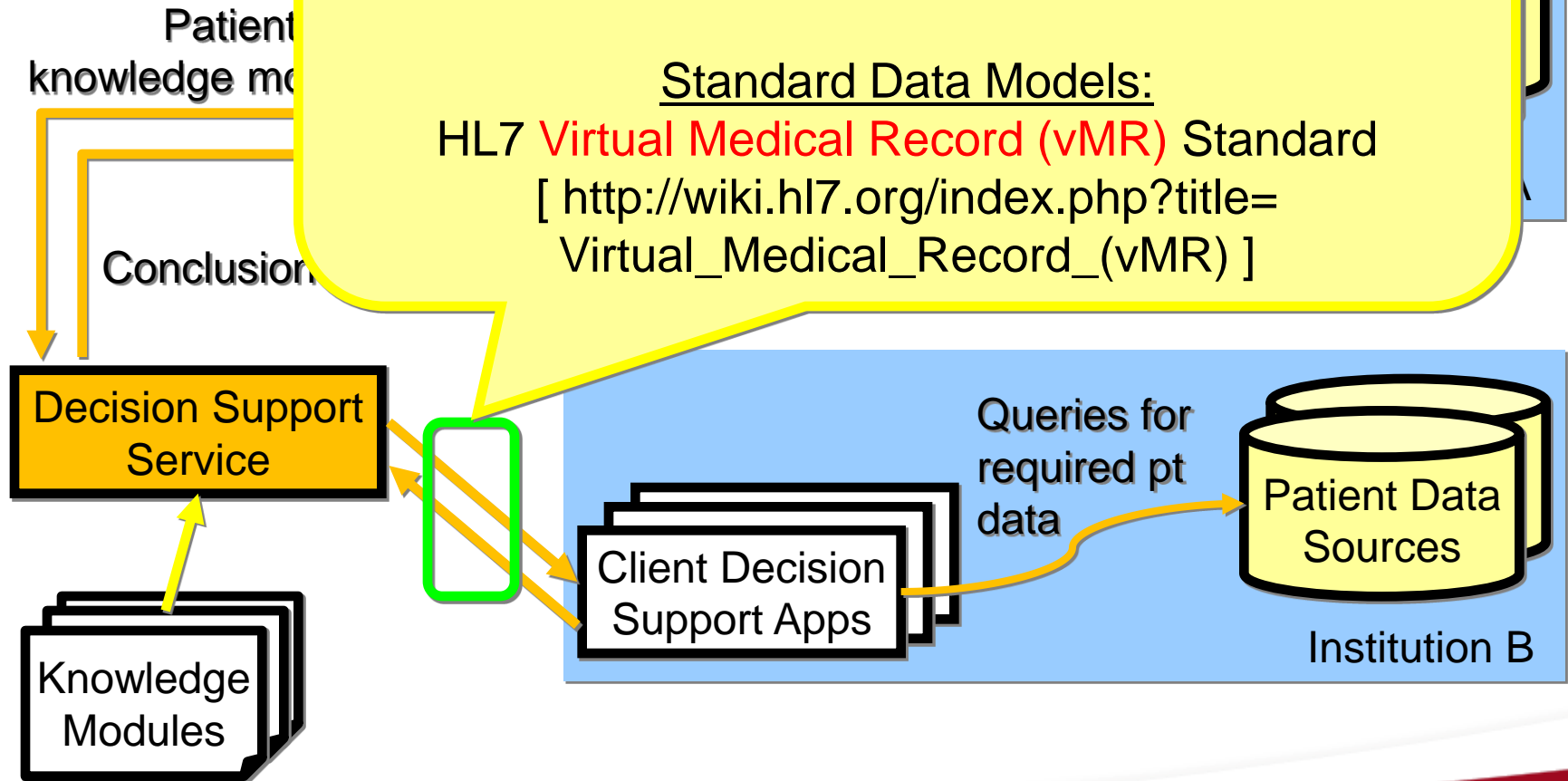
Report Type
Comprehensive Clinic Note
GLYCATED HEMOGLOBIN (HBA1C)
CHOLESTEROL, TOTAL
LDL-CHOLESTEROL (DIRECT)
FAM Endocrinology Follow Up
MICROALBUMIN/CREATININE RATIO
GLYCATED HEMOGLOBIN (HBA1C)
LIPID PAN
OP4 (TBIL
OP7 (CO2
Endocrino
MAMMOG
Clinic Not
MAMMOGRAPHY SCREENING EXAM

Pneum. Vacc.	N		01/01/06 (3y 0m ago)	once; revacc if >=65 and last 5+ yrs ago when <65
ASA (81 mg)	M	known to be allergic to aspirin	40+yo: no contraindications
		rin listed as prescribed	

Eval. Result

CCD

Pt data

Decision Support Service

EHR System

Patient Data Sources

NQF Measure 31 for Meaningful Use

- **Initial Patient Population =**
    - AND: "Patient characteristic: birth date" >= 41 year(s) and <= 68 year(s) starts before start of "Measurement period"
    - AND: "Patient characteristic: Gender Female"
- **Denominator=**
    - AND: "Initial Patient Population"
    - AND: "Encounter: encounter outpatient" <= 2 year(s) starts before or during "Measurement end date"
    - AND NOT:
        - AND:
            - OR: "Procedure performed: bilateral mastectomy"
            - OR:
                - AND: "Procedure performed: unilateral mastectomy CPT"
                - AND: "Procedure performed: bilateral mastectomy modifier"
            - OR:
                - AND: > 1 count(s) of
                    - AND: "Procedure performed: unilateral mastectomy"
                - AND:
                    - AND NOT: FIRST:"Procedure performed: unilateral mastectomy" concurrent with SECOND :"Procedure performed: unilateral mastectomy"
            - starts before or during "Measurement end date"
- **Numerator =**
    - AND: "Diagnostic study performed: breast cancer screening" <= 2 year(s) starts before or during "Measurement end date"
- **Exclusions =**
    - None

OpenCDS Implementation – Denom.

Find ✕ | Business rule asset ✕ | **DenomCriteriaM** ✕

Save changes   Save and close   Select Working Sets   Va

WHEN   ✚

1. Initialize - Note that all criteria below must be met for the rule to fire.

2. Pt.Age.Low - Patient age is greater than or equal to [42] years

3. Pt.Age.High - Patient age is less than or equal to [69] years

4. Pt.Gender - Patient gender is [Female ▼]

5. Pt.Enc.Past.Count -   [Outpatient encounter ▼] [1]   or more   [2] [year(s) ▼]
    Patient has had a   times in the
                                                                past

6. [not (   ]

7. Pt.Proc.Past - Patient has had a [Bilateral mastectomy ▼]

8. [or   ]

9. Pt.Proc.Past.Lat - Patient has had a [Mastectomy ▼] with a laterality of [Bilateral ▼]

10. [or   ]

11. Pt.Proc.Past.Count - Patient   [Unilateral mastectomy ▼] [2] or more times in [200] [year(s) ▼]
    has had a   the past

12. [ )   ]

THEN   ✚

1. Assert that [NQF 0031 denominator criteria met ▼]

(show
options…)

OpenCDS Implementation – Numerator

OpenCDS Implement. – Underlying Details

Viewing source for: DenomCriteriaMet

```
1.  | rule "DenomCriteriaMet"
2.  |    dialect "java"
3.  |    lock-on-active true
4.  |    when
5.  |       (EvalTime($evalTime : evalTimeValue) and FocalPersonId($focalPersonId : id)) //DslUsed==InitializeVariablesDsl
6.  |       ($PatientAgeLowDsl_focalPerson : Person(isFocalPerson == true) and PersonAgeAtEvalTime(personId == $PatientAgeLowDsl_focalPerson.id ,
        ageUnit == "year" , age >= 42)) //DslUsed==PatientAgeLowDsl|||n==42
7.  |       ($PatientAgeHighDsl_focalPerson : Person(isFocalPerson == true) and PersonAgeAtEvalTime(personId == $PatientAgeHighDsl_focalPerson.id ,
        ageUnit == "year" , age <= 69)) //DslUsed==PatientAgeHighDsl|||n==69
8.  |       ($PatientGenderDsl_focalPerson : Person(isFocalPerson == true) and GenderConcept(conceptTargetId == $PatientGenderDsl_focalPerson.id,
        openCdsConceptCode == "C31")) //DslUsed==PatientGenderDsl|||X==C31
        ($PatientEncounterEventCountDsl_encounterTypeConcepts_C44 : java.util.List (size >= 1 ) from collect ( EncounterTypeConcept(
        openCdsConceptCode == "C44" ) ) and $PatientEncounterEventCountDsl_encounters_C44 : java.util.List( size >= 1 ) from collect (
        EncounterEvent(subjectIsFocalPerson == true, subjectEffectiveTimeEnd <= $evalTime, id memberOf
9.  | (LogicHelperUtility.getConceptTargetIds($PatientEncounterEventCountDsl_encounterTypeConcepts_C44)),
        eval(org.opencds.common.utilities.DateUtility.getInstance().timeDifferenceLessThanOrEqualTo($evalTime, subjectEffectiveTimeBegin, 1, 2)))) and
        (eval($PatientEncounterEventCountDsl_encounters_C44.size() >= 1)) )
        //DslUsed==PatientEncounterEventCountDsl|||X==C44|||n1==1|||n2==2|||timeUnits==1
10. |      not (
        ($PatientProcedureEventDsl_procedureConcept_C46 : ProcedureConcept(openCdsConceptCode == "C46") and ProcedureEvent(id ==
11. | $PatientProcedureEventDsl_procedureConcept_C46.conceptTargetId, subjectIsFocalPerson == true, subjectEffectiveTimeEnd <= $evalTime))
        //DslUsed==PatientProcedureEventDsl|||X==C46
12. |      or
        ($PatientProcedureEventLateralityDsl_procedureConcept_C49 : ProcedureConcept(openCdsConceptCode == "C49") and
        $PatientProcedureEventLateralityDsl_bodySite_C49 : BodySite (clinicalStatementId ==
13. | $PatientProcedureEventLateralityDsl_procedureConcept_C49.conceptTargetId) and LateralityConcept(openCdsConceptCode == "C51",
        conceptTargetId == $PatientProcedureEventLateralityDsl_bodySite_C49.id) and ProcedureEvent(id ==
        $PatientProcedureEventLateralityDsl_procedureConcept_C49.conceptTargetId, subjectIsFocalPerson == true, subjectEffectiveTimeEnd <=
```

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OpenCDS Implementation – Decision Table

		#	Desc	Vaccine	Gender	Dose #	Min Age	Units1	Max Age	Units2	Index Dose #	Min Interval	Units3	Rec Interval	Units4
+	■	1		HPV	Female	1	9	Yr	26	Yr					
+	■	2				2					1	24	Day	61	Day
+	■	3				3					2	80		121	
+	■	4									1	164		182	
+	■	5			Male	1	11								
+	■	6				2					1	24	Day	61	Day
+	■	7				3					2	80		121	
+	■	8									1	164		182	

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Web-Based Authoring – Flow Control

Testing Environment

Batch Regression Testing

Scenarios for package:NQF_0031_v1_v1_0_0

Run all scenarios

Overall result: **SUCCESS**

Results:	100%	0 failures out of 38 expectations.
Rules covered:	75%	75% of the rules were tested.
Uncovered rules:	Post_CreateOutput	

Scenarios

001. Test_Pre_RequireConceptDeterminationMethod_NQF:	100% [0 failures out of 2]	Open
002. Test_NQF_42yoF:	100% [0 failures out of 3]	Open
003. Test_NQF_42yoF_OutptEnc_12_31_2009:	100% [0 failures out of 3]	Open
004. Test_NQF_42yoF_OutptEnc_12_30_2009:	100% [0 failures out of 3]	Open
005. Test_NQF_42yoF_OutptEnc_01_01_2012:	100% [0 failures out of 3]	Open
006. Test_3_Plus_Bilateral_Mastectomy_2011_01_01:	100% [0 failures out of 3]	Open
007. Test_3_Plus_Mastectomy_with_Bilateral_Laterality_2011_01_01:	100% [0 failures out of 3]	Open
008. Test_3_Plus_1_Unilateral_Mastectomy_2011_01_01:	100% [0 failures out of 3]	Open
009. Test_3_Plus_2_Unilateral_Mastectomy_2011_01_01_and_2011_01_01:	100% [0 failures out of 3]	Open
010. Test_3_Plus_2_Unilateral_Mastectomy_2011_01_01_and_2011_03_01:	100% [0 failures out of 3]	Open
011. Test_NQF_Breast_Cancer_Screening_12_31_2009:	100% [0 failures out of 3]	Open
012. Test_NQF_Breast_Cancer_Screening_12_30_2009:	100% [0 failures out of 3]	Open
013. Test_NQF_Breast_Cancer_Screening_01_01_2012:	100% [0 failures out of 3]	Open

Close

www.opencds.org

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  - NHGRI K01 HG004645 (PI: K. Kawamoto)
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  - University of Utah Information Technology Services
  - Utah Beacon Community Subcontract (PI: Bruce Bray)
- Numerous OpenCDS collaborators
  - https://sites.google.com/site/opencdspublic/collaborators

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Questions?

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