Intelligent Medical Services Over TEIN
(Head & Neck Cancer SILO)

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July 23rd, 2019
• Introduction to Clinical Decision Support System (CDSS)

• Smart CDSS – Head & Neck Cancer
  • Three Phase Knowledge Acquisition Model
  • Expert Driven Knowledge Acquisition using Knowledge Engineering Toolkit
  • Execution Engine

• Case Study
  • Head and Neck Cancer
• **CDSS** is a tool that helps in **making better medical decision** hereby **reducing clinical errors** and **improves quality of life**

• **CDSS** has potential applications in area of;
  * Generating alerts and reminders
  * Diagnostic assistance
  * Therapy critiquing and planning
  * Image recognition and interpretation
Motivation of CDSS

Social Needs

- Quality of Medical Services
- Reduce Medical Cost
- Efficiency & Safety

Solutions

CDSS

Expected Impacts

- Improve quality of healthcare delivery
- Save Medicare cost
- Reduce medical malpractices

Evidence-Based Medicine

Decision Making

Clinical Practice Guidelines

Efficiency of healthcare delivery

Patient Safety
CDSS in General

Knowledge Database

Decision Support Engine

Time Driver

Data Driver

Alerts
Suggestions
Computations
Interpretations
Protocols
Guidelines

Electronic Health Record

Infectious Disease
Pharmacy
ECG Lab
X-Ray
Blood Gas Lab
Surgery Schedule
Admitting
Medical Records
Respiratory Therapy
Physical Therapy
Pathology
Blood Bank
Financial System

Medical Devices
Ventilators
Pulse Oximeters
IV Pumps
Bedside Monitors

Laboratory/Microbiology

Information Review

Surgery
Clinical Decision Support System Requirements

- Rule (Knowledge) used in CDSS should be intact, have high adaptability, keep up to date, and guarantee reliability, which is not met in most of the commercial CDSS in the field.

<table>
<thead>
<tr>
<th>CDSS requirements</th>
<th>Details</th>
<th>CASE</th>
<th>Final requirements</th>
</tr>
</thead>
</table>
| **Integrity**     | Rule (Knowledge creation) should have no defect  
- Rule should reflect medical knowledge completely  
- Rule should be worth enough to be used in the actual medical environment | Rule DB constructed without enough medical knowledge is meaningless | Physicians should generate and maintain the knowledge themselves |
| **Adaptability**  | Rule must be customizable based on each of the hospital environment  
- It should be customizable based on available resources (medical device, inspection device, etc.) | Method of examination, treatment and operation differs based on the devices the hospital owns | |
| **Freshness**     | Update should be easy for new knowledge  
- Rule should be updated whenever new methods are released such as treatment, prescription, operation, etc. | Update of new rule should be easy | |
| **Reliability**   | Knowledge should have sufficient reliability  
- Utilized knowledge should have sufficient reliability based on certified thesis, clinical trial data, EMR inference data, etc. | It should be based on thesis, pharmaceutical company clinical trial data, EMR inference data, etc. | Evidence Based |
Application Domains in CDSS

Application areas in CDSS

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Percentage of Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP</td>
<td>64%</td>
</tr>
<tr>
<td>Reminder System</td>
<td>76%</td>
</tr>
<tr>
<td>Diagnostic System</td>
<td>40%</td>
</tr>
<tr>
<td>Disease Mgt System</td>
<td>62%</td>
</tr>
<tr>
<td>Drug Dosing System</td>
<td>66%</td>
</tr>
<tr>
<td>Prescription System</td>
<td>66%</td>
</tr>
</tbody>
</table>

Application Domains in Healthcare
Challenges & Solutions in CDSS

Challenges:
- Knowledge Management
- Misinterpretation of clinical dataset
- Lack of Evidence Support
- HIS workflow Integration
- Knowledge Maintenance
- Physician Fears

Solutions:
- Knowledge Engineering Toolkit
- VRM Standard data model and templates
- Evidence Support (KnowledgeButton)
- Adapters for Most widely Used standards such as HL7-CDA
- Runtime Validation and Verification using CBR techniques
- Individual ownership on knowledge
## Smart CDSS vs Existing Systems

<table>
<thead>
<tr>
<th>Products</th>
<th>Shareable KB (Arden Syntax)</th>
<th>Interoperability (vMR)</th>
<th>Standard Terminology</th>
<th>User Friendly</th>
<th>Scope of System</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAT (UMLS-Based)</td>
<td>√</td>
<td>X</td>
<td>√</td>
<td>X</td>
<td>Specific Domain</td>
<td>Construction of Domain Ontology By Clinicians</td>
</tr>
<tr>
<td>KAT (XML- Based)</td>
<td>X</td>
<td>CDA Document</td>
<td>X</td>
<td>X</td>
<td>Extendable</td>
<td>Executable information in CDA</td>
</tr>
<tr>
<td>Rule Editor-Arden Syntax</td>
<td>√</td>
<td>√</td>
<td>X</td>
<td>X</td>
<td>Specific Domain</td>
<td>Clinician understandability to vMR</td>
</tr>
<tr>
<td>KAT (Anesthesia)</td>
<td>X</td>
<td>Java Classes</td>
<td>X</td>
<td>X</td>
<td>Specific to Anesthesia</td>
<td>XML file for Parameters and values</td>
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<tr>
<td>CRE (EMR-base CDSS)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Specific Domain</td>
<td>More Primitives needed for single rule</td>
</tr>
<tr>
<td>Arden Suit (Medexter)</td>
<td>√</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Extendable</td>
<td>Physicians understandability to vMR</td>
</tr>
<tr>
<td>Smart CDSS</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>Extendable</td>
<td>Standard rules based on standard HL7 vMR and SNOMED CT terminologies</td>
</tr>
</tbody>
</table>
Smart CDSS: Architecture

**Consumer Systems**
- CDSS로부터 나온 결과물은
  - Electronic medical record (EMR)
  - Personal health record (PHR)
  - Hospital management system (HIS)
  등의 다양한 소비자 시스템에 사용

**Smart CDSS Framework**

**KET**
- 도메인 전문가를 위한 쉬운 지식 저작 환경을 제공하는 툴
  - Intelligent Knowledge Authoring Tool

**Execution Engine**
- 지식에 대한 추론을 통한 추천 정보 생성

**KnowledgeButton**
- PubMed 데이터베이스로부터 지식에 대한 근거 자료를 수집하여 지식의 신뢰성 확보

**Smart CDSS Consumer**
- EMR/PHR

**HIS**
- LIS
- Pharmacy
- Pat.Charting

**Adaptability Engine**
- Adapter
  - Interoperability Engine
  - Adapter - EMR/PHR

**Interface Engine**
- Standard Input Interface
  - Standard Output Interface

**CDSS Façade**
- Knowledge Manager
  - Knowledge Broker
    - MLMAugmentedCBR
    - Case Base
    - Methods
    - Similarity Function
    - Clinical Knowledge Base

**Knowledge Engine**
- KnowledgeButton
  - KnowledgeButton Manager
    - Input Request Handler
    - Output Response Handler
  - Knowledge Canvas
  - Terminology Binder

**Data Driven Acquisition**
- Data Exchange
  - DataExchange Web Service
  - HL7 Exchange Service

**Data Acquisition**
- Anonymization Service

**Knowledge**
- Resource 1
  - Resource 2

**Domain**
- Knowledge
  - KnowledgeAuthoring Environment

**MLM Repository**
- MLM1
  - MLMn

**Clinical Models**
- MLMAugmentedCBR
  - Medical Logic Module Augmented Case Base Reasoner

**Clinical Knowledge Base**
- Case Base
  - CB1
  - CBn

**CLINICAL KNOWLEDGE BASE**
- KET
  - KnowledgeButton
  - KnowledgeButton Manager
  - Input Request Handler
  - Output Response Handler

**Knowledge Button**
- KnowledgeButton
  - KnowledgeAuthoring Environment

**EMR:** Electronic Medical Record
**PHR:** Personal Health Record
**MLMAugmentedCBR:** Medical Logic Module Augmented Case Base Reasoner
**CKB:** Clinical Knowledge Base (Medical Logic Modules [MLMs])
CDSS Service for Head & Neck Cancer

Diagnosis

- **Biosy**
  - T: 3
  - N: 1
  - M: 0
  - Stage: ????

- **Staging**
  - T: 3
  - N: 1
  - M: 0
  - Stage: 3

Treatment Intervention

- **Chemotherapy Induction**
  - **Disease Type:** Non-resectable
  - **Drugs:** Pemetrexed disodium and Oxaliplatin
  - **Intervention:** Patients receive dose over 2 hours on day 1. Treatment repeats every 14 days for up to 4 courses.
  - **Intervention Result:** Patient progressed before receiving 4 courses of treatment.

- **Follow ups**
  - **Next Follow up**

- **Final Recommendation**

- **Chemo Recommendations**
  - **Chemotherapy**
  - **Surgery**
  - **Radiotherapy**

- **Stage:** 3

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Patient Encounter
Goal of our Knowledge Acquisition

Limitations (Data Driven)
- Knowledge Validation
- Accuracy Issue
- Evidence is missing (from standard guidelines)

Limitations (Expert Driven)
- Guidelines are not directly integrated into HIS
- Difficult to validate guidelines from practice datasets
Proposed Knowledge Acquisition: Three Phase Model

Phase I: Clinical Knowledge Model from Guideline

- Objectives for CDSS Intervention
- Clinical Knowledge Model (CKM)
- Clinical Data Pre-Processing
- HIS Medical Records
- Set of MLMs
- Clinical Knowledge Base
- Identification of Arden Artifacts and MLM creation
- Defining data requirements for each MLM in term of xMR and SNOMED
- Selection of candidate MLMs from R-CKM
- Selection of knowledge representation scheme (Arden Syntax)

Phase II: Prediction Model from patient medical record (Data Driven)

- Selection of machine learning algorithm
- Predictive Model (PM) creation
- Refined CKM (R-CKM) creation from PM by validating against CKM

Phase III: R-CKM Conversion into MLM (Expert Driven)

- Refined Clinical Knowledge Model after validation of PM from CKM (Guideline Enabled)
Proposed Knowledge acquisition

Guideline-based knowledge acquisition

Clinical guidelines

Rigorous Inspection
(NCCN, NICE, Staging)

Clinical Knowledge Model (CKM)

Combined (Guideline, data-driven) R-CKM

Combining CKM, PM

Refined Knowledge

Data driven knowledge acquisition

EMR (Medical data)

Machine Learning Algorithms
(CHAID, CRT, J48, QUEST, DFTree)

Prediction Model (PM)

Executable Knowledge Base
Clinical Knowledge Modeling (Phase-I)

Guidelines selection
- NCCN and TNM for Cancer

Objectives for CDSS Intervention
1. Treatment Plan for oral cavity tumor patients

Team Involved
- Oncologists
- Residents
- HIS Team
- Knowledge Engineers

Why CKM?
- Guidelines are semi-structured form (decision tree and description so needs to unify to single representation)
- Guidelines are too generic (hard to apply directly to practices)
- CKM are easy to manage and make knowledge explicit

Contribution
- Using Rigorous Inspection process
  - Marked the guidelines to explicit the knowledge concepts
  - Mapped the concepts into decision tree (DT) formalism
- DT represent more explicitly the clinical knowledge compared to mind-maps
Prediction Model (PM) (Phase-II)

Contribution

- **ML Selection algorithm (RankingDecisionTreeAlgorithm)** for PM which is comprehensive and understandable

**RankDecisionTreeAlgo**

Input: DTAlgos<List>
Output: RankedDTAlgos<List>

1. Let accuracyP, attributeA, numRulesR, ranking
2. ForEach dt in DTAlgos
3. Begin
4. accuracyP = getDTAccuracy(dt)
5. attributeA = getDTNoAttribute(dt)
6. numRulesR = getDTNoRules(dt)
7. ranking = RankingWSM-score(accuracyP, attributeA, numRulesR)
8. RankedDTAlgos.add(dt, ranking)
9. End
10. Return RankedDTAlgos

\[ \text{RankingWSM-score} = \sum_{j=1}^{m} (w_j \cdot a_{ij}) \quad \text{for} \quad i = 1, 2, 3, \ldots, m \]

Here \( \alpha \): 0.8 is scaling constant and \( a_{ij} \) are attributes with weight \( w_j \)

\[
\begin{pmatrix}
    a_{ij} & \text{Accuracy} (P) & \text{Number of rules} (R) & \text{Attributes} (A)
    \\
    w_j & 0.8 & -0.1 & -0.1
\end{pmatrix}
\]
Refined Clinical Knowledge Model after validation process (Phase-II)

**Validation Process**

Step 1: Validation Criteria setting
Step 2: Conformance of decision path of PM
Step 3: Refine and evolve of decision path into R-CKM

**Why R-CKM?**

- **R-CKM** provides refined knowledge which support both Standard guidelines (evidence) and Real practices data (integration), so it is easy to use with HIS

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**Criteria of validation Process**

- $\forall P_i \in PM: \text{Accuracy}(P_i) > N\%$
- $\forall P_i \in PM \land \forall P_j \in CKM : \text{Conflicting}(P_i, P_j)$
- $\forall P_i \in PM \land \exists P_j \in CKM: \text{Conform}(P_i, P_j) \rightarrow P_i \in \Delta RCKM$
- $\exists P_i \in PM \land \forall P_j \in CKM : \text{Conform}(P_i, P_j) \\
  \text{Evidence}(P_i) \land \text{Evidence}(P_j) \rightarrow P_i \in \Delta RCKM$

---

**Contribution**

- Validation process with multiple conformance criteria
  - Decision path level conformance
  - Conflict resolution
Transformation of R-CKM to CIG (Arden Syntax MLM) (Phase-III)

Why Arden Syntax Representation?
- Computer Interpretable Guideline (CIG) representation is required.
  - R-CKM is only knowledge representation – so called CPG (clinical practice guideline)
- Arden syntax is HL7 standard and commercially used CIG scheme

Contribution
- Multiple dependent MLMs with Root and Sub-MLMs
  - Re-usability
  - Modular approach
  - Single MLM invoke/event
- MLMs are well traceable to clinical knowledge model
  - Duplication of shared logic: Multiple MLMs are invoked
  - Independent MLMs: multiple requests for same data

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Knowledge representation scheme
- Medical Logic Module (MLM)
- Vocabulary (SNOMED)
- Data Model (HL7 vMR)

Knowledge Engineering Toolkit Support
- Multiple dependent MLMs with Root and Sub-MLMs
  - Re-usability
  - Modular approach: feasible for large clinical models
  - Single MLM invoke/event: Single request for data
  - Logic distribution among sub-MLMs is challenging

Candidate MLM Selection
- Multiple dependent MLMs with Root and Sub-MLMs
  - Re-usability
  - Modular approach: feasible for large clinical models
  - Single MLM invoke/event: Single request for data
  - Logic distribution among sub-MLMs is challenging

MLM Creation
- Knowledge representation model
Expert-Driven Knowledge Acquisition (Knowledge Engineering Toolkit)
Expert Driven Knowledge Acquisition with KET

Phase-I: Clinical Domain Selection
- Identification of Aden and MLM creation
- Defining data requirements for each MLM in terms of UMR and SNOMED

Phase-II: CLINICAL KNOWLEDGE MODEL
- Clinical Knowledge Model (CKM)
- Clinical Data Pre-Processing
- Selection of machine learning algorithm
- Predictive Model (PM) creation
- Refined CKM (R-CKM) creation from PM by validating against CKM

Phase-III: R-CKM Conversion into MLM (Expert Driven)
Motivation

How to make it Shareable?

Sharing Knowledge

- If Disease = Head and Neck cancer and Age >= 40
- Then Treatment Plan = Surgery

How to make it Interoperable?

EMR-1 Schema

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Schema Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>Illness</td>
</tr>
<tr>
<td>Head and Neck cancer</td>
<td>Head and Neck cancer</td>
</tr>
<tr>
<td>Treatment Plan</td>
<td>Treatment</td>
</tr>
<tr>
<td>Surgery</td>
<td>Surgical Treatment</td>
</tr>
</tbody>
</table>

EMR-2 Schema

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Schema Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>Disorder</td>
</tr>
<tr>
<td>Head and Neck cancer</td>
<td>HNC</td>
</tr>
<tr>
<td>Treatment Plan</td>
<td>Treatment Plan</td>
</tr>
<tr>
<td>Surgery</td>
<td>Surgical Procedure</td>
</tr>
</tbody>
</table>
**Motivation** - Tradeoff among shareability, interoperability and User-friendliness

**Shareable** and reusable Knowledge is cost and time effective for clinical communities

**Interoperable** knowledge

HL7 vMR and SNOMED CT terminologies makes the integration easy with legacy systems

**User friendly** rule authoring environment enhances the physician’s capability to acquire and maintain knowledge base
Solution 2: Structure Level Semantic Reconciliation (MLM Generation)

Standard Clinical knowledge representation
Using HL7 Arden Syntax MLM

Complexity, Interoperability, and Integration

If Treatment Intent = Palliative Then Treatment Plan = Radiotherapy

Solution: Structure level semantic reconciliation

- Proposed solution hides this complexity by automatic generation of MLM.

```sql
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```
## Results of Solution 2: System Centric

<table>
<thead>
<tr>
<th>Phase 1 Reduction</th>
<th>Phase 2 Enhancement</th>
<th>Phase 3 Interpretation</th>
<th>Phase 4 Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Removed technology-oriented and specific to CMT requirements</td>
<td>- Recommend new requirement of DCM tree and Intellisense window</td>
<td>- Interpret the CMT related requirements for knowledge Authoring tool</td>
<td>- Compare and evaluate with existing system based on output of phase 3.</td>
</tr>
</tbody>
</table>

### Initial Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Total (20)</th>
<th>Total (16)</th>
<th>Total (16)</th>
<th>Total (16)</th>
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<tbody>
<tr>
<td>Essential</td>
<td>R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19</td>
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<td>R1, R2, R3, R4, R5, R6, R8, R9, R10, R11, R13, R14, R16, R17, R18, R19</td>
<td>R1, R2, R3, R4, R5, R6, R8, R9, R10, R11, R13, R14, R16, R17, R18, R19</td>
</tr>
</tbody>
</table>

### Final Requirement set for evaluation of knowledge Acquisition Tool

- **Total (39)**
  - **Essential (16)**
  - **Recommended (18)**
  - **Optional (5)**

### Evaluations and Results

Evaluation of proposed system with exiting knowledge authoring tool [5] based on 40 requirements in the previous phase.

### Contribution 4

- The completeness evaluation of knowledge acquisition tool w.r.t. standard requirements.
Results of Solution 2: System Centric

Result Analysis

- **I-KAT**
  - has full support to 82.05% of requirements
  - Has partial support to 7.69% of requirements
  - Has no support to 10.25% of requirements

- **ArdenSuite**
  - has full support to 35.89% of requirements
  - Has partial support to 28.20% of requirements
  - Has no support to 35.89% of requirements

Results of Solution 2: System Centric

I-KAT has minimum number of requirements which are not supported. Essential 1, Recommended 2, Optional 1

I-KAT has less partial support to Essential 0, Recommended 3, Optional 0

I-KAT has maximum full support to requirements. Essential 15, Recommended 13, Optional 4

Results of Solution 2: User Centric

Experiments and Objectives

Experiments
- Experiment 1: User-friendliness
- Experiment 2: Shareability and Interoperability

Objectives
- Physicians’ performance w.r.t. time
- No. of errors in MLM creation

Testing MLM: Total 8 MLMs are tested
- 2 MLM with simple structure
- 2 MLM with intermediate
- 4 MLM with complex structure

<table>
<thead>
<tr>
<th>MLM ID</th>
<th>Associated Rule ID</th>
<th>Contents/Logic Complexity [No. of attributes, [No. of logical operators]]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLM1</td>
<td>Rule1</td>
<td>1, [And (0), Or (0)]</td>
</tr>
<tr>
<td>MLM2</td>
<td>Rule2</td>
<td>1, [And (0), Or (0)]</td>
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<td>MLM3</td>
<td>Rule3</td>
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<td>Rule4</td>
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<td>Rule5</td>
<td>7, [And (5), Or (1)]</td>
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<td>Rule6</td>
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<td>Rule7</td>
<td>17, [And (7), Or (0)]</td>
</tr>
<tr>
<td>MLM8</td>
<td>Rule8</td>
<td>29, [And (7), Or (21)]</td>
</tr>
</tbody>
</table>
Results of Solution 2: User Centric

Result Analysis

- Create eight MLMs by each participant
- I-KAT has increased **34 times** faster than ArdenSuite in simplest MLM 1, while **5 times** faster in complex MLM 8.
- The overall average performance showed an improvement of **15 times**.
- We provided high level abstraction and hide the complexity.

Results of Solution 2: User Centric

**Result Analysis**

- **Syntactic (S) and Logical (L) Errors**
  - Participants made on 4 errors on average in simplest MLM1 and 17 errors in complex MLM 8 using ArdenSuite, its success rate is 46.88%.
  - Participant made only logical error on average 1 error in all MLMs using I-KAT with overall Task Success Rate 90.625%.
  - We hide the structure and syntax of MLM from physicians.

- **Syntactic (S) Errors:**
  - Mistakes in syntax of Arden Syntax Language of MLM.

- **Logical (L) Errors:**
  - Mistakes of wrong concept selection, wrong operator selection, and wrong values selection.

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**I-KAT: Login Screen**

**Authentication**: I-KAT provides user login screen to authenticate domain experts.
- Domain experts can see the screens based on his/her role.
  - Enter user name
  - Enter password
**I-KAT: Dashboard Screen**

- **Dashboard**: facilitation for domain expert to view existing rules at a glance.
- **Create New Rule**: it is used to navigate domain expert to new rule creation environment.
- **View**: it is used to view and modify the existing rules.
Meta Information: Information about rule’s title, author, specialist, creation date, purpose, and explanation.

- Plane Rule: it is used to enter
  - Rule condition
  - Rule conclusion/Action

Domain Model: it facilitates experts to select desired standard domain concepts and values for rule condition and conclusion.
**I-KAT: Rule Editor with Intelli-sense**

- **Intelli-sense**: This functionality facilitates expert to select desired concepts and values in condition and conclusion writing at run time.
- It fetches concepts from domain model as well as standard terminologies of SNOMED CT.
• **Data Slot**: This slot represents the input data that requires from HMIS system to execute this MLM.
  - The input data in form of data model vMR and SNOMED CT codes enhances shareability and makes the integration easy.

• **Logic Slot**: This is main logic slot that represents all the conditions of created rule.
  - This slot also represent the conditions in combination of vMR and SNOMED CT.

• **Action Slot**: It represent final output of executed MLM in form of recommendation (conclusion).
  - This slot can represent in data model vMR or it can be some textual recommendation.
Contributions and Uniqueness

Knowledge Interoperability
- Semantic Reconciliation Model to enhance the knowledge shareability and Interoperability
- Explicit Semantic embedding to enhance ontology matching performance
- Enhance data and schema level interoperability by definition based mappings

Knowledge Shareability
- Automatic MLM generation with the help of structure interoperability using medical standards

System evaluation Method
- We introduced new system evaluation methodology based on standard requirements to fulfill during design and development of knowledge acquisition system
Conclusions and Future Works

Semantic Reconciliation Model (SRM) is proposed

- To make the standard and non-standard knowledge base as interoperable.
- To acquire shareable knowledge using standard knowledge representation.
- Transform the knowledge into executable format.

Standards Data Models, Terminologies, and Knowledge Representation

- In SRM, we used Standard Data Model vMR and Standard Terminology (SNOMED CT) to achieve Interoperability.
- We used standard knowledge representation HL7 MLM for shareability and Production rules for non-standard knowledge interoperability.

Future Works

- In future, we will validate the interoperability aspect with other knowledge representations such as GLIF
- Uncertainty control will handle in Medical Logic Module using Fuzzy Logic
Thanks

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