A Generalisable Model of Diagnostic Knowledge

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Presentation Overview

• Design goals of implementing an evidence service

• Diagnostic evidence service description

• Infrastructure to support data mining and knowledge generation

• How we develop trust in decision support tools
Design objective 1 – EHR Integration

Vision EHR
Demographics, risk factors, recording recommendations

Decision Support Tool Interface
Patient consultation - evidence gathering

Web based Evidence Service

Internet web queries

Diagnostic Model and Clinical Knowledge

Decision Support Tool

Translational Research and Patient Safety in Europe
Design objective 2 - Open source technologies used for evidence knowledgebase

- **Client Layer**: REST Web Service Client – Dynamic Linked Library
  - **Service Application Layer**: Jersey REST Web Services, Java Objects, Sesame API
    - **Persistence Layer**: SPARQL Queries, Ontology Triple Store, OWL / RDF Ontology
      - **Java**
      - **Sesame**
      - **Protégé**
      - **C#**
Design objective 3 – Reusable model of evidence independent of Code Binding

Ontology RFE, cue or Diagnosis
- IrritableBowelSyndromeHistory

CodeBinding
- 14CF.00
  - ‘History of Irritable Bowel Syndrome’

Synonym
- Synonym1
  - ‘HO IBS’
Patient case XML extracted from EHR – trigger

  - <RFES>
    - <RFE>
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      - <Codes>
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          - <Value>182.00</Value>
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      - <Value>F</Value>
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  - <Cues>
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</PatientEvidenceSet>

PATIENT PRESENTING PROBLEMS

PATIENT DEMOGRAPHICS

PATIENT CONSULTATION

DIAGNOSTIC CUES
XML, JSON or RDF results returned through web queries

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An evidence service request to describe symptoms of Urinary Tract Infection

http://<server>/ClinicalEvidenceRESTService/interfaces/query/differentials/symptoms/UrinaryTractInfection
Data Mining – Transhis EHR Structure

Diagram showing the relationship between Patient, Clinician, and Episode of care. The diagram illustrates how RFEs (Request for Evidence) lead to encounters and diagnoses through diagnostic cues.

- **Patient**
  - RFEs 1
  - RFEs 2
  - RFEs n

- **Clinician**
  - Encounter 1
    - Diagnostic cues
    - Diagnosis 1
  - Encounter 2
    - Diagnostic cues
    - Diagnosis 2
  - Encounter n
    - Diagnostic cues
    - Diagnosis n

**Episode of care**

**Time**
Data Mining: Steps

- **KNIME tool**
  1. Derive association rules
  2. Calculate quality measures

- **Web tool (RuleViewer)**
  3. Filter based on high quality rules
  4. Clinical review
  5. Evidence transfer to ontology

- **Web tool (clinical evidences)**
  - Import from XML
Association Rules Structure

RFEs, Diagnostic Cues, Demographic Features --------> Diagnosis

Antecedent Variables --------> Consequent Variable

e.g. Abdominal Pain, Dysuria, Fever, Female \(\rightarrow\) Urinary Tract Infection

\{ICPC2 Coded = D06, U01, A03, F\} \(\rightarrow\) U70

Apriori Algorithm implemented using tool called KNIME
### Rule Viewer & Annotator

#### Antecedents - RfEs
- U70

#### Antecedents - Anams
- A02
- A03
- A04
- A05

#### Support
- <
- >

#### Confidence
- <
- >

#### Specificity
- <
- >

#### Sensitivity
- <
- >

#### LR+
- <
- >

#### LR-
- <
- >

#### Odds
- <
- >

#### Score
- <
- >

#### Provenance
- <
- >

#### Scenario
- <
- >

---

#### Number of rules: 29

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1,271,784 records in the TRANSHIS EHR database - 93,606 for Malta and 1,178,178 for the Netherlands.

Quantified association rules to identify strong relationships between ICPC2 coded patient data elements – RFEs, demographics, cues, diagnoses.

Strong associations matched well with clinical literature - Bayesian reasoning to suggest likely diagnoses becomes possible.
How do we develop trust required for diagnostic decision support?

- Curation and governance process to clinically review and approve generated data mined evidence

- Traceable and Reproducible Evidence – established connections to the TRANSFoRm Provenance service

- Provenance establishes automatic computable graph record of how diagnostic evidence is being used by the Decision Support Tool
Provenance Graph exploration

MATCH (n:AGENT {Ontology: "OPM_SoftwareProfile", Concept: "UserNameAgent", Value: "6440"}) RETURN n;

ARTIFACT
PROCESS
AGENT

**ARTIFACT [107218]**

Properties

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http://www.w3.org/1999/02/22-rdf-syntax-ns#type
http://123.45.67.89:55060/TRANSFeRm/ontologies/OPM_profiles/OPM_Transform_rctpo.owl#DSS_Recommendation

Translational Research and Patient Safety in Europe
In Conclusion

- TRANSFoRm evidence service directly supports the goal of improving diagnostic process in family practice to enhance patient safety:
  - Reusable web accessible evidence base
  - Built on openly available standards
  - Computable and generalisable to other diagnostic scenarios and other clinical settings
  - Platform for evidence generation through data mining
  - Traceable recommendations through provenance
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Thank you – Questions?

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