Provenance-based Trust Model for Assessing Data Quality during Clinical Decision Making

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Agenda

1. **Research Problem**
   - Data Quality assessment
     during clinical decision making

2. **Proposed Solution**
   - Data Quality Trust Model and
     Assessment Method

3. **Implementation Example**
   - Modified BP Centiles app with DQ Trust
     for Pediatric Hypertension Use Case

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Research Problem

Research Problem

- Data quality assessment during clinical decision making is important for patient safety
- Most data quality assessment methods not real-time, do not consider contextual data quality of individual data items

- **Need for a new approach that assesses trustworthiness of individual data items <u>during</u> clinical decision making**

- New approach must address platform interoperability and interface usability challenges as well

Proposed Solution

Data Quality Trust Model
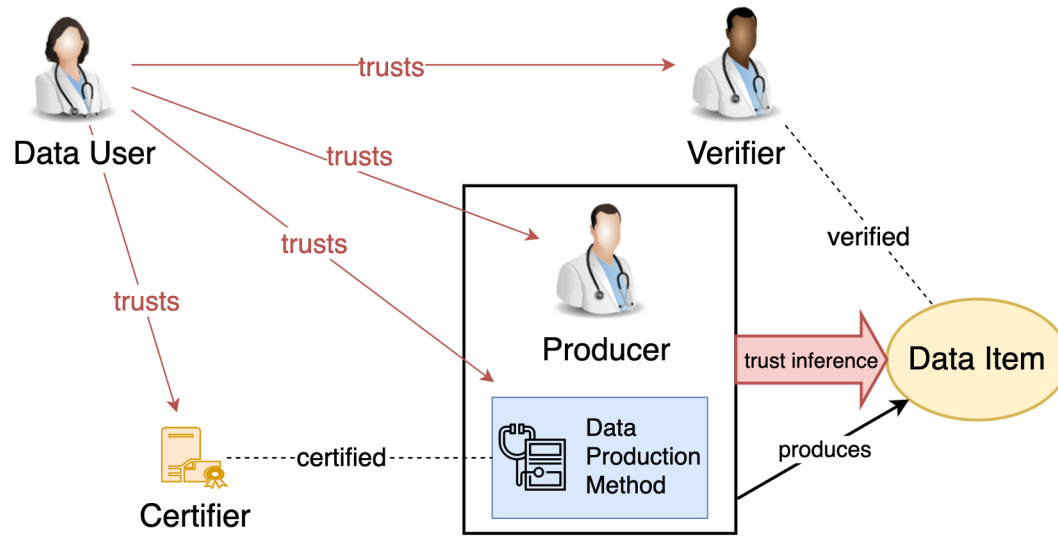
Data Quality Trust

Defined as user trust in quality of data item based on
- trust in the data production method
- trust in the individual producer that generated data
- trust in individuals that independently verified data
- trust in organisations that certified the production method

Trust with Fuzzy Logic

- Fuzzy logic can represent uncertain variables through fuzzification
- Defined through fuzzy membership functions
- Allows for linguistic computing "with words"

Types of trust in model:
- **Producer Trust** in Capability of Data Producers
- **Reliability Trust** in Data Production Methods
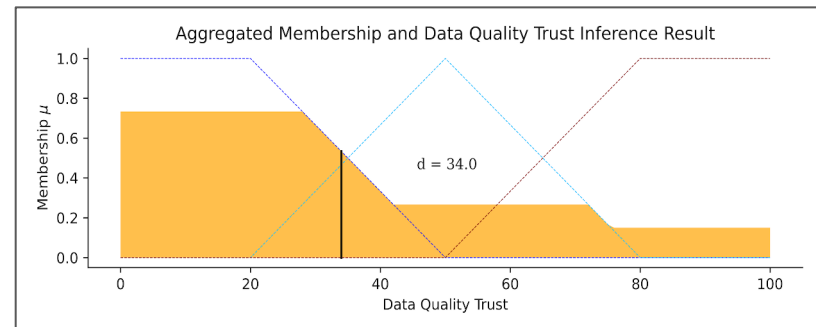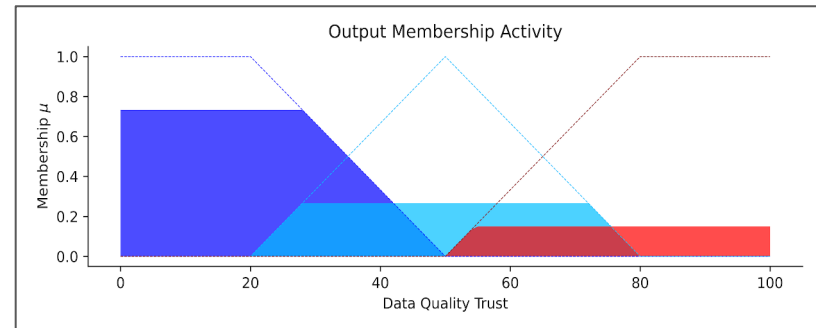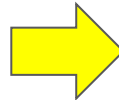- **Data Quality Trust** in produced data items
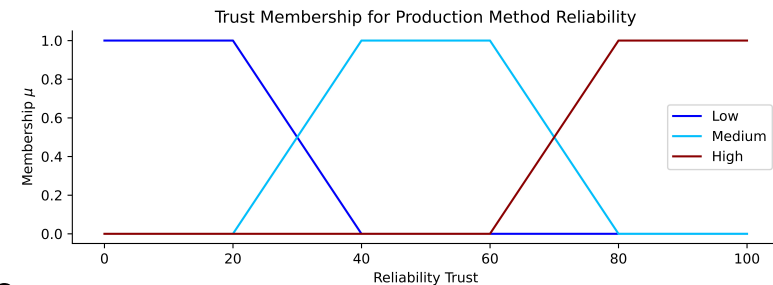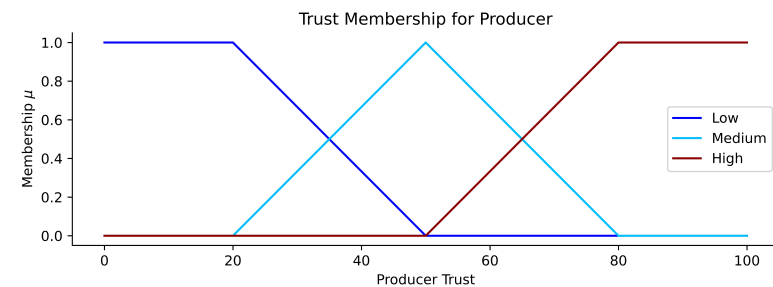
Data Quality Trust Inference with Mamdani Method

Fuzzified Producer Trust and Reliability Trust

Fuzzy Association Rules

Rule	Reliability Trust	Producer Trust	DQ Trust
1	high	medium	high
2	high	high	high
3	high	low	high
4	medium	medium	medium
5	medium	high	high
6	medium	low	low
7	low	medium	low
8	low	high	low
9	low	low	low

Output Membership Activity

Aggregated Membership and Data Quality Trust Inference Result

d = 34.0

Defuzzified Data Quality Trust (centroid method)

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Interoperability with FHIR

- Custom extensions to FHIR standard v4.0.1
- New Valuesets for three trust membership functions
- Extensions to FHIR Practitioner for trust preferences of practitioners
- FHIR Observation extension for data quality trust

| Identifier [Cardinality]	FHIR Extension Type
Practitioner.ProducerTrust [0..*]	BackboneElement
.producer [1..1]	Reference (Practitioner)
.producer-trust [1..1]	Decimal
Practitioner.ReliabilityTrust [0..*]	BackboneElement
.methodcode [1..1]	CodeableConcept (LOINC)
.device [0..1]	Reference (Device, DeviceMetric)
.reliability-trust [1..1]	Decimal
Practitioner.TrustedVerifier [0..*]	BackboneElement
.verifier-practitioner [1..1]	Reference (Practitioner)
Practitioner.TrustedCertifier [0..*]	BackboneElement
.certifier-organization [1..1]	Reference (Organization)
Observation.DQTrust [0..*]	BackboneElement
.practitioner [1..1]	Reference (Practitioner)
.dq-trust [1..1]	Decimal
producer-trust-levels	ValueSet
reliability-trust-levels	ValueSet
dq-trust-levels	ValueSet

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Dual Process Theories in User Interface Design

- Screens for <u>Heuristic Processing Mode</u>
    - Use of intuition to make quick decisions with limited cognitive effort
    - Lack of expertise in decision task, time constraints and distractions may increase reliance on heuristic processing

- Screens for <u>Systematic Processing Mode</u>
    - Requires higher cognitive effort to process ambiguous decision tasks systematically
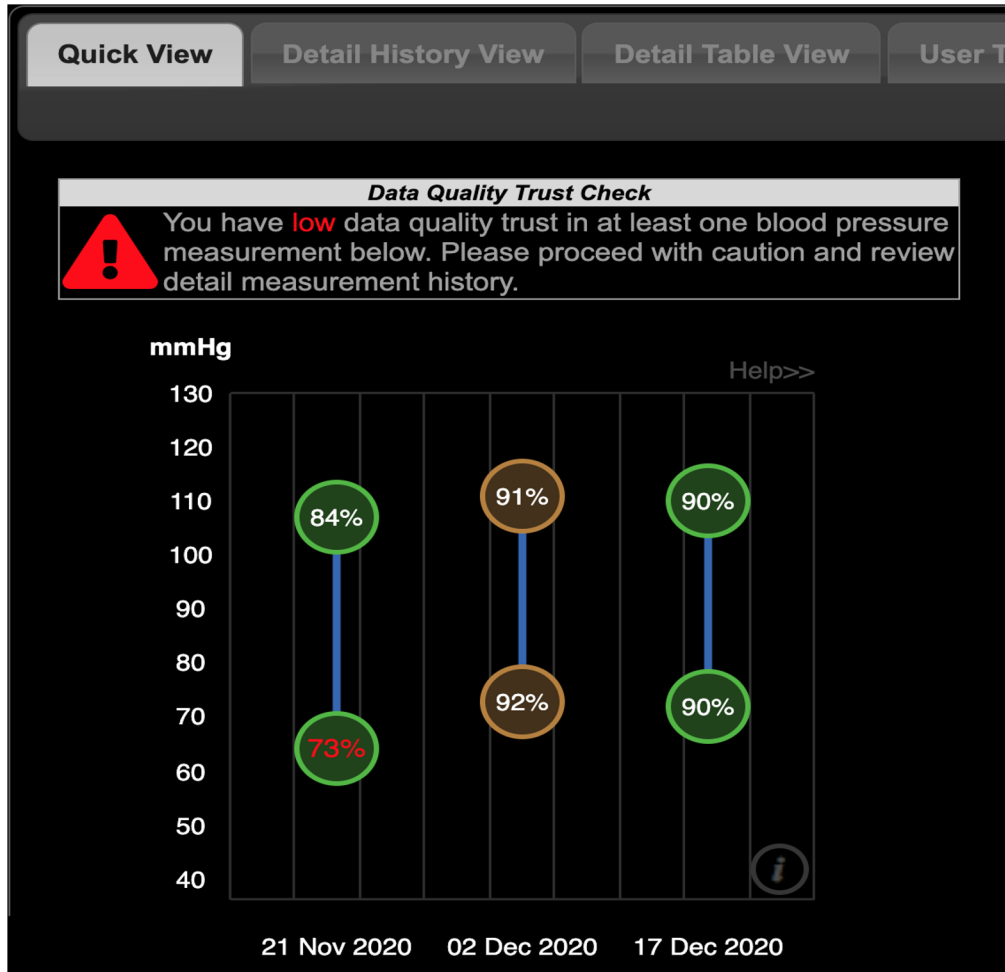   - Detailed analysis of decision tasks required

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Implementation Example

Data Quality Trust with SMART-on-FHIR App

- Adaptation of existing SMART on FHIR **Blood Pressure Centiles** app to demonstrate feasibility of data quality trust with a clinical data use case
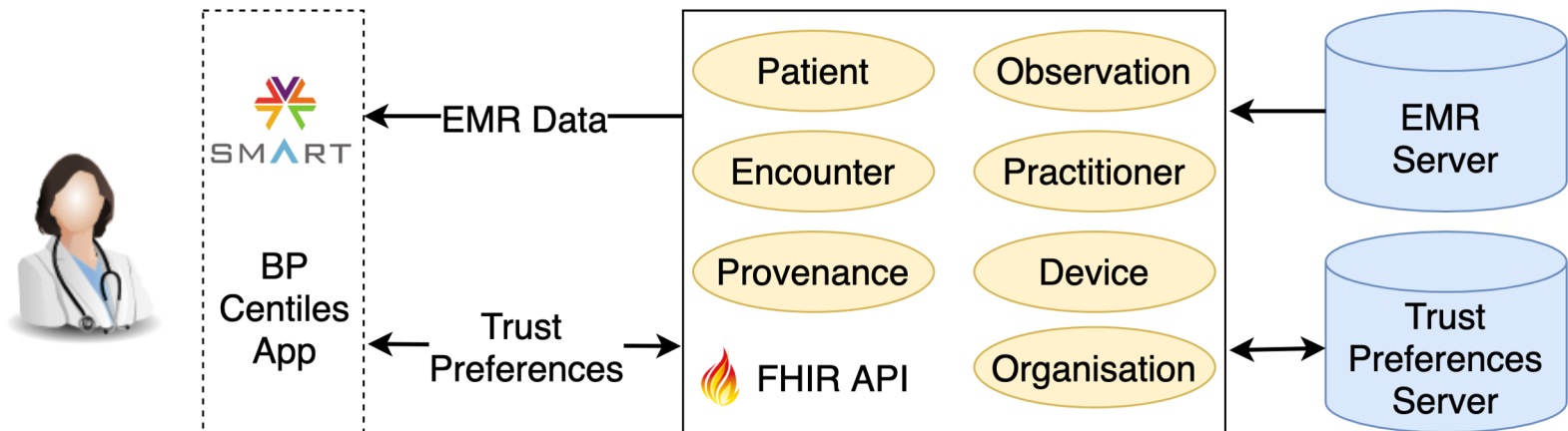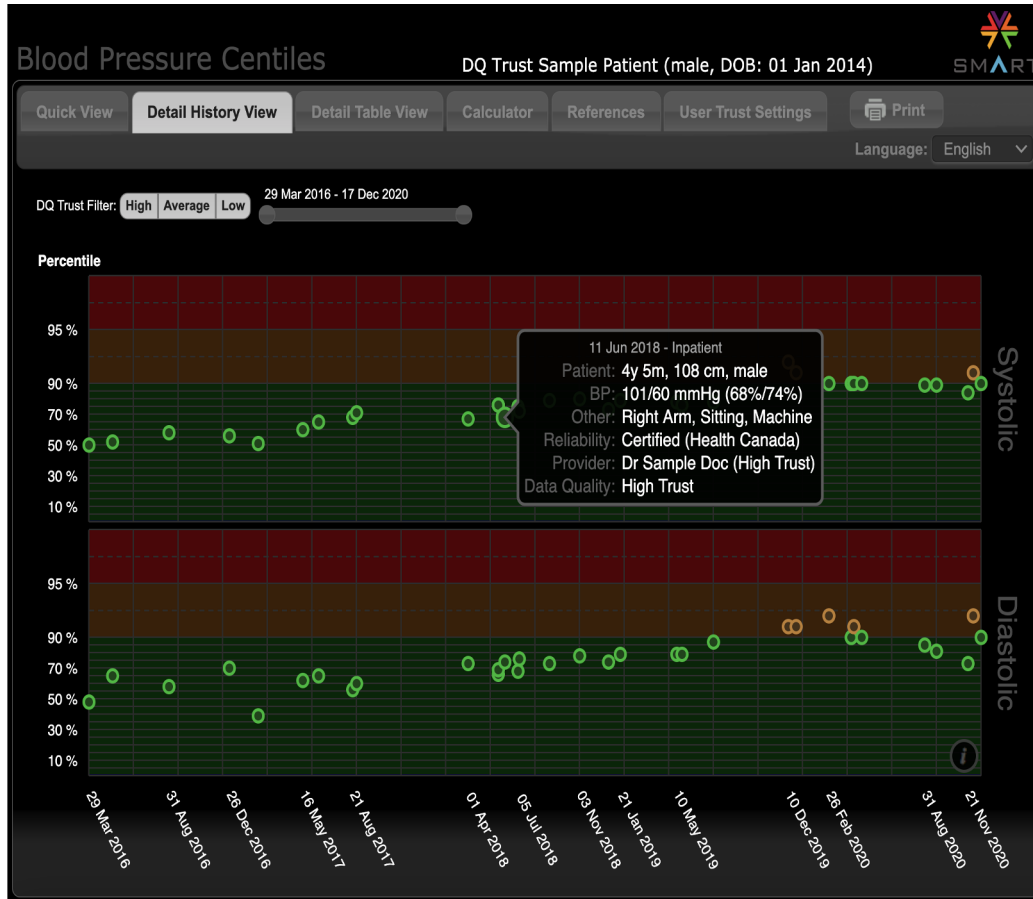
Heuristic Processing with Data Quality Trust

- Quick View supports hypertension diagnosis with 3 most recent blood pressure centiles

- Data Quality Trust check analyses data provenance for data quality issues

Systematic Processing with Data Quality Trust

- Detail history view with measurement filter for low, medium, high data quality trust

- Provenance Detail popup shows data producer, production method, other provenance details

Data Quality Trust User Settings

- Sliding scales for agent trust and reliability trust user preferences
- Selection of trusted verifiers for blood pressure measurements
- Selection of trusted certifying organisations for data production methods

Questions?