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Semantic Integration Prototype for Wearable Devices in Health Care

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WoT group goals

General goals

- Integration of semantic technologies
 - To augment sensor analysis
 - Support sensor plug and play, plug and automate
 - Support sensor interactions in M2M contexts
 - · Support vertical integration in siloed application contexts
- Event/Information platform
 - An Activity Streams model for lightweight data->event consumption/production
 - · A common Activity model to disambiguate activities from disparate sources
 - Semantic models addressable on demand, as needed
 - Support for event aggregation in vertical integration
 - Support for both 'offline' and 'online' type operations
- Approach
 - Build demonstrators for various use cases to flesh out the architecture
 - Today's topic: Health care



Prototype goals

- Use case: Healthcare professional to recommend wearable devices for a patient with a disease
- Needed information
 - · Wearable devices devices that measure biomedical quantities
 - Quantities
 - Anatomical parts
 - Symptoms
 - Diseases
- Intended usage
 - · Mate with wearable device sensor data indirectly
 - Provide background knowledge
 - Hypothesis generation from search (which devices would be appropriate?)
- Problems
 - · This information resides in different models/repositories and 'locations'
 - Models are large
 - · Health care professionals do not have the time to search for related information
 - · Information must be reliable
- Prototype solution
 - Integrate existing/curated models/information
 - Construct a single interface to access the information
 - Demonstrate ability to access wearable devices given a disease
 - Demonstrate ability to access background knowledge from lightweight sensor events



Wearable devices and SSN

- Wearable device: A device which can measure a biomedical quantity such as heart rate
- Suited to SSN
 - A composite of sensing devices (e.g., heart rate monitor, body temperature, blood pressure)
 - Observable phenomena
 - Measurable quantities
 - Want to later index more aspects of the Stimulus-Sensor-Observation (SSO) pattern



Prototype strategy for ontology selection

- Select domain ontologies
- Select ontologies that have the information we need (e.g., biomedical quantities)
- Select ontologies with rich content models (e.g., not Snomed)
- Select ontologies with unique identifiers
- Select integrated ontologies over independent ontologies
- Select ontologies that have instance repositories as well as a taxonomy over those that don't



Prototype ontologies selected

- Wearables Subclass **SSN** (semantic sensor network ontology w3.org)
- Quantities QUDT (quantities, units, dimensions and datatypes ontology qudt.org)
- Anatomical parts FMA (foundational model of anatomy ontology obofoundry.org)
- Symptoms SYMP (symptom ontology obofoundry.org)
- Diseases DOID (human disease ontology obofoundry.org)

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Use case semantic workflow

- Semantic Workflow for use case
 - Diseases exhibit symptoms and pertain to anatomical body parts
 - · Symptoms can be identified with measurable biomedical quantities
 - Wearable devices will have sensors that measure biomedical properties
 - There may be an intersection of these relationships





Model integration





Use case illustrated





Semantic integration issues

- Ontologies are generally dissimilar in design approach
 - Some have substantial structure representing content, others don't
 - Some provide only taxonomies
- The biomedical ontologies are standalone and not indexed to or integrated with one another
- The biomedical ontologies are large
- Some of these models are not domain ontologies
 - Hooks for integration but no actual integration
 - ssn:Property
 - doid:has_symptom



Integration issue resolution

- Automatic ontology matching/mapping not attempted
 - No existing/proposed approach is 100%
 - For usefulness generated mappings would have to be checked manually by SMEs anyway
- · Ontology sizes precluded using the full ontologies where they reside
 - First copied them locally and made TDB databases
 - · Ultimately used only a subset of the entire set of classes
- Wearable device model invented as a subclass to ssn:SensingDevice
 - Populated with Vandrico device data
- Ssn:Property indexed to qudt:Quantity
- Bridge ontologies created and populated from curated ontologies
 - Disease <-> Symptom
 - Symptom <-> Quantity
 - Disease/Symptom <-> Anatomy



Resolutions to integration issues

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$\mathsf{DOID} \leftrightarrow \mathsf{SYMP} \leftrightarrow \mathsf{FMA} \text{ bridge ontologies}$





Wearable device $\leftarrow \rightarrow$ QUDT, FMA bridge ontologies





Demo front end



The Open Biological and Biomedical Ontologies: http://www.obofoundry.org/ - QUDT: qudt.org - SSN: http://www/w3.org/2005/Incubator/ssn/ssn/ssn

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