





An ontology to semantically annotate the M2M data

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Motivation

Enrich M2M data to build cross-domain M2M applications



How to get M2M data?

Get M2M data:

- E.g.: temperature, food, blood glucose level
- Sensor Web Enablement (SWE)
- SenML protocol [draft-jennings-senml-10]
- Semantic Sensor Networks ontology (SSN)





| Zone: R-313 in: Aix | | | What are you watching? |
|---|---|--------------------------|--|
| Temperature 106-2c12f6f8c9f6 | measure name value | acidity add a Measure | What is the sensor type? |
| temperature: (kind: temperature) 19 °C @ now | {"v":"19","u":"Cel","t":0,"n <mark>:"temperature"}</mark> | | What is the measurement type? |

The M3 ontology (Machine to Machine Measurement)

- Extension of the W3C SSN ontology to explicitly describe the data
- Classify all the concepts in the M3 ontology
 - Domain (health, smart building, weather, room, city, etc.)
 - Measurement type (t = temp = temperature)
 - Sensor type (rainfall sensor = precipitation sensor)

How to deduce new knowledge?

Rules example:

- If Domain == Health && MeasurementType == Temperature then NewType = BodyTemperature
- If BodyTemperature > 38°C then "Flu"
- BodyTemperature and Flu are already described in domain ontologies or datasets!

What is the meaning of the new measurement type?

Reuse the domain ontologies already designed and defined by experts

- "flu" has a meaning in health ontologies
- "hot" has a meaning in weather ontologies

How to reuse domain ontologies and datasets?

- How to find domain ontologies or datasets?
- In a specific domain, which ontology or dataset do we choose?
- How to use the complementarity of existing ontologies and datasets?



M3: our proposed approach

How to interconnect the data provided by heterogeneous domains?



M3: a hub for cross-domain ontologies and datasets

We propose M3 as a hub for cross-domain ontologies and datasets





Combine cross-domain datasets?

Existing domain datasets:



We propose cross-domain datasets

- Naturopathy (weather & ingredient & recipe & emotion & color)
- Vacation & Weather

New M2M cross-domain applications

- Suggest you a recipe according to user's diseases, diets, allergies, the weather, the mood!
- Suggest activities according to the weather

> ...

Scenario 1: Body Temperature Convert into semantic measurements (M3 ontology)

- A first prototype to validate the M3 approach
 - <u>http://sensormeasurement.appspot.com/</u>

Infer a new type

Find food recommended when you are sick

- SenML API (Simulate M2M measurements): Simulate temperature measurements
- 2. M2M Aggregation Gateway (Convert Health Measurements into Semantic Data): Convert health measurements
- We deduce that the temperature corresponds to the body temperature.
- We deduce that the person is sick.
- We propose all fruits/vegetables according to this disease.
- M2M Application: Temperature => Cold => Food: (Wait 10 seconds!) Food if you are sick

<rdf:Description rdf:about="http://sensormeasurement.appspot.com/m3#Measurement5"> <m3:hasUnit rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Cel</m3:hasUnit> <m3:hasDateTimeValue rdf.datatype="http://www.w3.org/2001/XMLSchema#dateTime">0.0</m3:hasDateTimeValue> <m3:hasValue rdf:datatype="http://www.w3.org/2001/XMLSchema#decimal" 39.0 /m3:hasValue> <m3:hasName rdf:datatype="http://www.w3.org/2001/XMLSchema#string">temperature</m3:hasName> Semantic M2M <rdf:type rdf:resource="http://sensormeasurement.appspot.com/m3#Measurement"/> <rdf:type rdf:resource="http://sensormeasurement.appspot.com/m3#BodyTemperature/> Measurements </rdf:Description>

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Scenario 1: Body Temperature Enrich Semantic M2M Data

- Link our semantic M2M measurements to the Linked **Open Data** Linked Open Data
- Naturopathy dataset: a cross-domain dataset

Find food recommended when you are sick

- 1. SenML API (Simulate M2M measurements): Simulate temperature measurements
- M2M Aggregation Gateway (Convert Health Measurements into Semantic Data): Convert health measurements
- We deduce that the temperature corresponds to the body temperature.
- We deduce that the person is sick.
- We propose all fruits/vegetables according to this disease.
- 6. M2M Application: Temperature => Cold => Food: (Wait 10 seconds!) Food if you are sick
- Value = 39.0, Unit = Cel, Type = Body Temperature, Disease = Cold, Food = Kiwi
- Value = 39.0, Unit = Cel, Type = Body Temperature, Disease = Cold, Food = Lemon
- Value = 39.0, Unit = Cel, Type = Body Temperature, Disease = Cold, Food = Honey
- Value = 39.0, Unit = Cel, Type = Body Temperature, Disease = Cold, Food = Ginger
- Paper: Honey as Complementary Medicine A Review [Singh et al. 2012]

Scenario 2: Weather Temperature

Weather & Activity

- 1. SenML API (Simulate M2M measurements): Simulate Weather measurements
- 2. M2M Aggregation Gateway (Convert weather Measurements into Semantic Data):

Convert weather measurements

- 3. We deduce the weather outside.
- 4. We propose activities according to the weather.



- Value = 39.0, Type = Weather Temperature, Unit = Cel, Weather = Sunny, Activity = BeachSunbathing
- Value = 39.0, Type = Weather Temperature, Unit = Cel, Weather = Sunny, Activity = BeachVolley

Semantic-based M2M Architecture



 Paper: A Machine-to-Machine Architecture to Merge Semantic Sensor Measurements [Gyrard et al., WWW 2013]

Conclusion & Future works

- The M3 approach to combine heterogeneous M2M data and reason on them
- M3 to build cross-domain applications

STAC (Security Toolbox: Attacks & Countermeasures)

- Help developers to design secure M2M applications
- http://securitytoolbox.appspot.com/



Thank you!



