W3C Semantic Sensor Networks
Ontologies, Applications, and Future Directions

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http://www.iot-week.eu/
Once upon a time, there was the Web
... and then it grew (ca. 2012)
Who or what is the culprit?

User generated content, new types of media, etc.
A cross-country flight from New York to Los Angeles on a Boeing 737 plane generates a massive 240 terabytes of data

- GigaOmni Media

What happens when all THINGS go online?
(sensors, devices, and appliances begin to publish data)
How are machines supposed to make sense of this noisy, ambiguous, heterogeneous, deluge of data?
“Now! – *That* should clear up a few things around here!”
SW is now moving from academia into industry
In the last few years, we have seen many successes ...
Venice is a city in northeast Italy sited on a group of 118 small islands separated by canals and linked by bridges. It is located in the marshy Venetian Lagoon which stretches along the shoreline between the mouths of the Po and the Piave Rivers. Wikipedia

Area: 159 sq miles (412 km²)
Weather: 72°F, Wind E at 5 mph, 50% Humidity
Local time: 12:13pm Wednesday (CEST)

Points of interest

- Grand Canal of Venice
- Piazza San Marco
- Saint Mark's Basilica
- Rialto Bridge
- Doge's Palace

Venice - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/Venice
Venice (Italian: Venezia [veˈnɛttsja] (listen), Venetian: Venexia [veˈnɛsja]) is a city in northeast Italy sited on a group of 118 small islands separated by canals ...
→ History of the Republic of Venice - Venice, Los Angeles - Grand Canal

Venice Vacations, Tourism and Venice, Italy Travel Reviews ...
www.tripadvisor.com/Tourism-g187870-Venice_Veneto-Vacations.html
Venice Vacations: With 130000 reviews of Venice, Italy travel resources, TripAdvisor is the source for Venice information.

ItalyGuides.it: Virtual tour of Venice, Italy - travel information and city ...
www.italyguides.it/us/venice_italy/venice_travel.htm
Venice tourism and travel information: transport, attractions, maps, travel advice, pictures, audio guides, airport information, activities, hotels and more in Venice, ...
Now, what about the Sensor Web?
Sensor systems are too often *stovepiped*
We want to set this data free

With freedom comes responsibility
1. discovery, access, and search
2. integration and interpretation
Introducing the Sensor Web Enablement (SWE)

- All sensors reporting position
- All connected to the Web
- All with metadata registered
- All readable remotely
- Some controllable remotely
Introducing the **Sensor Web Enablement (SWE)**
We want to set this data free

With freedom comes responsibility

1. discovery, access, and search
2. integration and interpretation
So, again ...

How are **machines** supposed to **make sense** of this noisy, ambiguous, heterogeneous, deluge of **data**?
SSN Ontology
(i.e., General Sensor Knowledge)
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Semantic Annotation of SWE  
(backwards compatible)

<?xml version="1.0" encoding="UTF-8"?>
<sweis:offering xlink:role="http://purl.oclc.org/NET/ssnx/ssn#Observation"
xlink:arcrole="http://www.loa-cnr.it/ontologies/DUL.owl#hasSetting">
  <sos:ObservationOffering>
    <sweis:procedureIdentifier>
      xlink:href="http://purl.oclc.org/NET/ssnx/ssn-dev#rain gauge sth esk up esk rd bridge"
xlink:arcrole="http://purl.oclc.org/NET/ssnx/ssn#observedBy">
        http://csiro.au/sw/rain_gauge_sth_ esk_up_esk_rd_bridge
      </sweis:procedureIdentifier>
    <sweis:observableProperty>
      xlink:href="http://purl.oclc.org/NET/ssnx/cf/cf-property#thickness of rainfall amount"
xlink:arcrole="http://purl.oclc.org/NET/ssnx/ssn#observedProperty"
xlink:role="http://purl.oclc.org/NET/ssnx/qu/dim#Distance"/>
    </sweis:observableProperty>
    <sos:phenomenonTime>
      xlink:href="http://www.w3.org/2006/time-entry#Interval"
xlink:arcrole="http://purl.oclc.org/NET/ssnx/ssn#observationTime">
        <gml:TimePeriod xlink:href="#phenomenonTimell">
          <gml:beginPosition xlink:href="http://www.w3.org/2006/time-entry#begin">
            2001-01-11T16:22:25.00
          </gml:beginPosition>
          <gml:endPosition xlink:href="http://www.w3.org/2006/time-entry#end">
            2005-10-18T19:54:13.000Z
          </gml:endPosition>
        </gml:TimePeriod>
      </sos:phenomenonTime>
    </sweis:offering>
Interpretation (or abstraction/explanation) of sensor data
Applications of **SSN + intellego**

Weather

Rescue

Healthcare
50% savings in sensing resource requirements during the detection of a blizzard

order of magnitude resource savings between storing observations vs. relevant abstractions
SECURE: Semantics-empowered Rescue Environment
(detect different types of fires)
Mobile app to help reduce re-admission of patients with Chronic Heart Failure

- Observations:
  - Heart Rate: Current Heart Rate: 68 bpm
  - Instant Speed: Current Instant Speed: 0 mph
  - Active shortness of breath
  - Active lightheadedness
  - Active slow heart beat
  - Active discomfort in chest
  - Active mild swelling in feet and ankles

- Dialog:
  - Are you experiencing lightheadedness?
  - Are you experiencing swelling in the feet and/or ankles?
  - heart valve disorder
  - myocarditis
  - tachycardia

- Abstractions:
  - Normal
  - Severe
  - Mild
Passive Monitoring Phase

Observed Symptoms
- Abnormal heart rate
- Clammy skin

Possible Explanations
- Panic Disorder
- Hypoglycemia
- Hyperthyroidism
- Heart Attack
- Septic Shock

Electronic Medical Record
- Patient has history of Heart Disease

Health Alert
- Check phone for instructions
Active Monitoring Phase

Are you feeling lightheaded? yes

Are you have trouble taking deep breaths? yes

Do you have low blood pressure? yes

Have you taken your Methimazole medication? no

Observed Symptoms
- Abnormal heart rate
- Clammy skin
- Lightheaded
- Trouble breathing
- Low blood pressure

Possible Explanations
- Panic Disorder
- Hypoglycemia
- Hyperthyroidism
- Heart Attack
- Septic Shock

Electronic Medical Record
- Patient has history of Hyperthyroidism
- Patient has prescription for Methimazole

Health Alert
1. Take medication: Methimazole
2. See doctor: how about Tues. @ 11am?
In the next century, planet earth will don an electronic skin. It will use the Internet as a scaffold to support and transmit its sensations. This skin is already being stitched together. It consists of millions of embedded electronic measuring devices.


Thanks.

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