The Internet of Things for Dementia Care

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P. Barnaghi et al., "Digital Technology Adoption in the Smart Built Environment", IET Sector Technical Briefing, March 2015.
IoT data challenges

• Multi-modality and interoperability
• Noise and incompleteness
• Time and location dependency
• Dynamicity and quality
• Requires (near-) real-time analysis
• Data alone may not give a clear picture → we need contextual information, background knowledge, multi-source information and data analytics solutions
IoT applications and services

Source: https://datafloq.com/read/internet-of-things-more-than-smart-things/1060
Healthcare challenge: dementia

• More than 46 million people with dementia around the world
• Around 850,000 dementia patients in the UK (estimated to grow to 1 million by 2025)
• Estimated to cost £26bn p/a in the UK (Alzheimer’s Society): health and social care (NHS and private) + unpaid care
• Develop innovative living environments which helps dementia patients and their carers to enjoy better health and quality of life, with reduced dependence on institutional care.
TIHM: An IoT testbed for dementia

- Technology Integrated Health Management (TIHM)
- Monitoring elderly homes to provide personal healthcare applications for predictive solutions.
Technical challenge

- Security (hardware and software)
- Interoperability, integration
- Data governance
- Scalability
Semantic modelling: FIHR4TIHM

FHIR4THIM - Data Model

Working Draft

Latest version:
http://lot.ee.surrey.ac.uk/thim/models/fhir4thim/ (FHIR-JSON samples, HyperCat-JSON samples, Terminologies)

Last Update:
Date: 17:00:00 19/08/2016 BST

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See Acknowledgements

Abstract

Health Level-7 for HL7 refers to a set of international standards for transfer of clinical and administrative data between software applications. HL7 specifies a number of flexible standards, guidelines, and methodologies by which various healthcare systems can communicate. These rules allow information to be shared and processed in a uniform and consistent manner.

In particular, the Fast Healthcare Interoperability Resources (FHIR) is a new standard from HL7 International designed to be easier to implement and extendable than other versions of HL7. The FHIR leverages a modern web-based suite of API technology, including a HTTP-based RESTful Style Sheets for user interface integration, and a choice of JSON or XML for data representation.

Status of this Document

This is a work in progress and as such is subject to change. Comments are very welcome, please send them to First Author.

1. Introduction
   1.1 Types of elements
   1.2 Cardinality

2. FHIR UML Diagrams
   2.1 Patient
Alert: Bedroom humidity is out of range. Humidity is recorded as 35.0. The preset threshold value is 40.
### CRC Living Lab

#### Alerts

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Author</th>
<th>Data Description</th>
<th>Issue Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>🚨</td>
<td>Missing readings for the last three hours.</td>
<td>Organisation</td>
<td>Missing Measurement</td>
<td>23/02/2017 11:47:30</td>
</tr>
<tr>
<td>🚨</td>
<td>Alert: XX humidity sensor has low battery. Current battery level is: 49%.</td>
<td>Organisation</td>
<td>Room temperature</td>
<td>24/02/2017 12:04:15</td>
</tr>
<tr>
<td>🚨</td>
<td>Alert: Bedroom humidity sensor has low battery. Current battery level is: 12%.</td>
<td>Organisation</td>
<td>Room temperature</td>
<td>24/02/2017 12:04:18</td>
</tr>
<tr>
<td>🌹</td>
<td>Alert: Excessive chair movement has been detected during the day.</td>
<td>Organisation</td>
<td>Mobility</td>
<td>24/02/2017 12:24:15</td>
</tr>
</tbody>
</table>

#### Follow Ups

<table>
<thead>
<tr>
<th>Regarding</th>
<th>Initial Mitigation Date/Time</th>
<th>Last Mitigation Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert: Bedroom humidity sensor has low battery. Current battery level is: 39%.</td>
<td>10/01/2017 17:20:58 (1 month ago)</td>
<td>10/01/2017 20:20:58 (1 month ago)</td>
</tr>
<tr>
<td>Patient is either unwell or really worried</td>
<td>17/01/2017 17:27:02 (1 month ago)</td>
<td>18/01/2017 17:27:02 (1 month ago)</td>
</tr>
<tr>
<td>Missing readings are: [BP pulse oximeter body weight body temp.]</td>
<td>26/01/2017 11:10:26 (1 month ago)</td>
<td>26/01/2017 14:10:26 (1 month ago)</td>
</tr>
</tbody>
</table>
Combinatory insights and predictive models

• Extracting meaningful information from a combination of clinical and environmental measurements
  • Machine learning for detecting Urinary Tract Infection (UTI)
  • Machine learning for detecting Agitation/Irritation/Aggression (AIA)

• Pattern identification for state prediction in dynamic data streams
  • Used for pattern analysis of home appliances use and daily activity data
In conclusion

• Great opportunities and many applications
• Enhanced and (near-) real-time algorithms to extract actionable information.
• Supporting more automated decision making and in-depth analysis of events and occurrences by combining various sources of data.
• Providing more and better information to clinicians/citizens.
• Data management issues (privacy, security, trust,...);
• Reliability and dependability of the systems
Thank you

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