Adapt, not Reinvent, the Common Sense

Reusing Senses by End-users in Live Data Visualizations

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The growing amount of objects with embedded sensors, mostly known as the Internet-of-Things (IoT), the ubiquitous rise of the Do-It-Yourself (DIY) movement, not only in sewing and knitting but also in programming, and the growth of personal informatics tools, are on the basis of the rise of platforms for connecting devices where real-time sensor data can be visualized (e.g. Pachube). For most people without programming skills it is still impossible to use these platforms in an interesting way. This because they need to use raw sensor data (e.g. acceleration) instead of end-user understandable data (e.g. a person is walking). As Bell Labs aims at making it possible for non-technical end-users to actively co-create the Internet-of-Things space we are researching different ways to make data acquired by sensors end-user understandable and in addition, make the transformations that are used for obtaining this understandable data reusable.

In this paper we reflect on how non-technical end-users[1] could tune and reuse existing transformations from raw data to understandable data for their own, but different, purposes. To overcome the only one-time-use of sensor data transformations we researched what the challenges were for the reuse of them. We encountered this problem while researching and developing an online IoT application creation platform named SenseTale[2]. To situate our problem we will start by briefly presenting the parts of SenseTale that are important to our problem.

The SenseTale catalog: choose what makes sense to you

The goal of SenseTale is to allow non-technical end-users to create, use and share live data visualizations (referred to as Tales in SenseTale). Figure 1a shows an example of such a visualization that constantly displays the number of letters in your letterbox. End-users can compose their personal visualizations in a PowerPoint-like way animating it with real time data gathered by self-installed sensors (Figure 1b).

[1] With non-technical end-users we refer to persons who are not trained in programming.
[2] http://www.sensetale.com

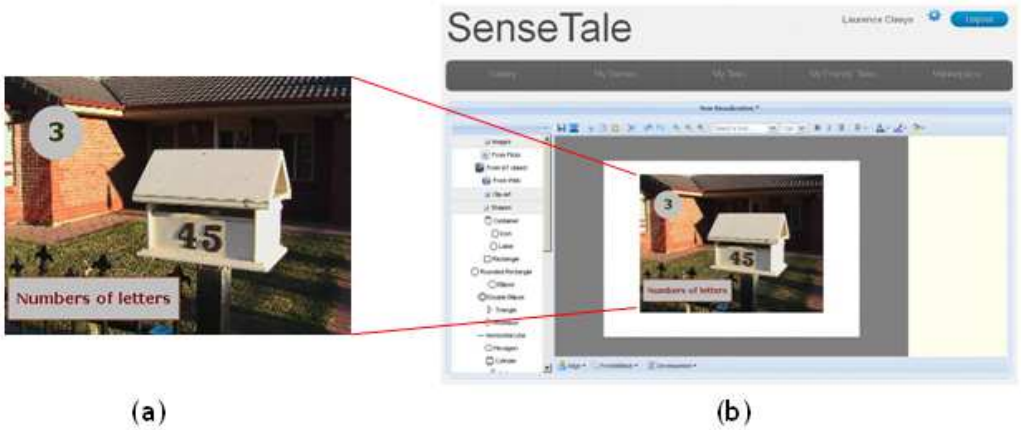

Figure 1: (a) Live data visualization and (b) Visualization editor

To enable end-users to work with understandable kinds of live data (referred to as Senses in SenseTale) in their visualizations, SenseTale provides a 'Sense catalog' that contains the possible Senses that can be measured by physical sensors supported by SenseTale. The aim of the catalog is to hide the complexity that comes with transforming raw, mostly very technical, data acquired by physical sensors into data meaningful to (and understandable by) end-users.

End-users can consult the Sense catalog and, once decided on the kind of information they want to monitor, the end-user is guided through an installation and configuration process that should ensure the correct measurement of the information.
Since a massive amount of possible Senses can be searched for and get used in creating visualizations, it is however impossible to have a catalog containing all of them. Enabling end-users to create and add their own Senses is a solution we believe in. Although currently the Senses added to the catalog are still mainly created by professionals and professional amateurs, we are exploring two different ways for the creation of new Senses by end-users: (1) providing the means to end-users to create Senses from scratch, (2) allowing end-users to reuse existing, similar Senses in a different context by adapting them. In this position paper we focus on the latter one.

Senses as adaptable transformation templates

In the previous section we briefly described Senses from a usage perspective. In this paragraph we look into the technical implementation we are developing. By deconstructing a Sense we describe some findings and challenges we encounter when implementing the adaption for reuse of Senses.

A Sense listed in the catalog corresponds to a data transformation template that can be applied to the data acquired by a (template compatible) sensor. A transformation template consist out of: (a) a semantic description that allows finding (based on an informal description) and understanding (based on a formal description) the kind of information provided (b) an installation guide, specific for a (set of) physical sensor(s) needed for gathering the actual raw data, to assists users with the installation a sense

(c) the logic (e.g. a set of inference rules) that describes the actual transformation of the raw sensor data into the higher abstracted data (d) a set of configuration parameters that allows fine-tuning the logic and setting user preferences. In figure 2 the different parts of two example Senses are shown.

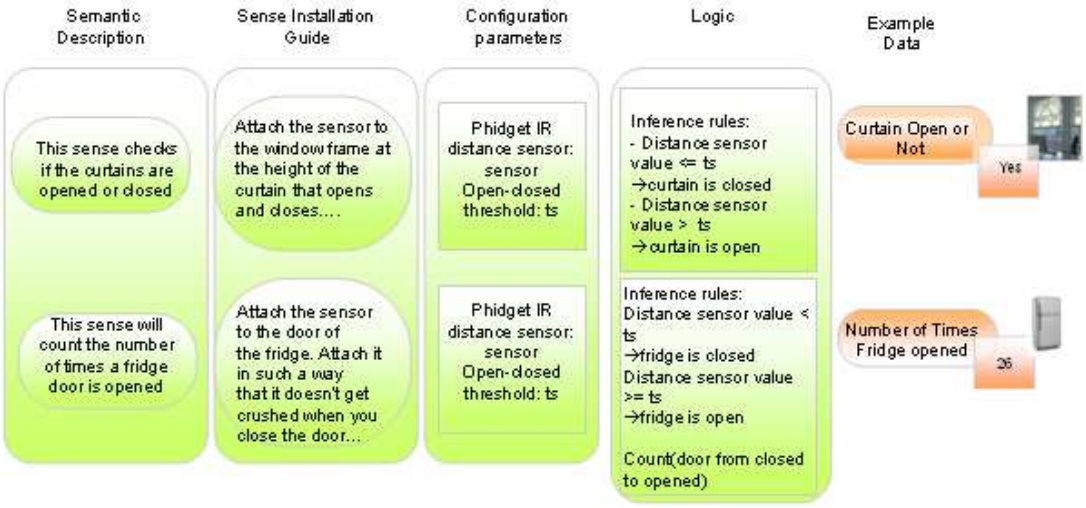

Figure 2: Different parts of transformation template for two example Senses

When an end-user wants to reuse a transformation template with a different goal, in a different domain, s/he has to adapt or recreate one or more parts of the template. When overlooking the re-usability of the different parts, the following observations were made:
(a) When a Sense is adapted to its new context of use, in almost all cases, the description and the installation guide should be rewritten.
(b) Changing the (logic) configuration parameters often satisfy for the creation of the adapted Sense.
(c) Changing the logic completely seems more difficult for end-users and should probably be part of a separate research. Moreover, we noticed that it was very difficult for end-users (but even for users with a more technical background) to foresee if a complete change of the logic/algorithm is mandatory or a parameter reconfiguration would satisfy for the creation of the adapted Sense.

Conclusion

In this position paper we presented our insights and current implementation on how to make data acquired by sensors end-user understandable and on making the transformations that are used for obtaining this understandable data reusable. We are still searching for the best ways to let re-use happen in a trustworthy way. By scrutinizing this problem we aim at empowering non-technical end-users to co-create the Internet-of-Things space.

Future work

Although the main focus in this paper is the personal use of the adapted Senses, the final aim is that these adapted Senses could also be reused by other users, meaning

that they become available in the catalog. Therefore it is also important to research on how end-users could be motivated and guided in writing the description and installation guide for their newly created Senses accurately to ensure that they are also findable, understandable and installable by other users.

Another research questions that we see as future work and would like to discuss during the workshop concerns the most efficient and appropriate ways for end-user to test their newly created Senses in the real physical or simulated environment and how to deal with the problem that (a) the inputs for most tests are based on the raw sensor data that are difficult to understand by non technical persons, and (b) the fact that the original logic was not written by the person who actually reuses the Sense.

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Publications related to the topic:

Johan Criel, Geert Vanderhulst Fahim Kawsar and Lieven Trappeniers "A Co-Creation Platform for Creative Engagement of End-Users in a Connected Object Space.". In: NOMe-IoT 2011: International Workshop on Networking and Object Memories in the Internet of Things @ UbiComp 2011, 18 Sep 2011, Beijing, China.

Geert Vanderhulst Fahim Kawsar, Johan Criel and Lieven Trappeniers "Prototyping Smart Objects for the Mass.". 13th IEEE International Conference on High Performance Computing & Communication, HPCC 2011, Banff, Alberta, Canada, September 2-4, 2011.

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Johan Criel, Marjan Geerts, Laurence Claeys and Fahim Kawsar "Empowering Elderly End-Users for Ambient Programming: The Tangible Way "; The 6th International Conference on Grid and Pervasive Computing (GPC 2011), Oulu, Finland, May 11-13, 2011.

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[3] A movie of the Casensa prototype: http://www.youtube.com/watch?v=OMVZIc_MWh8