



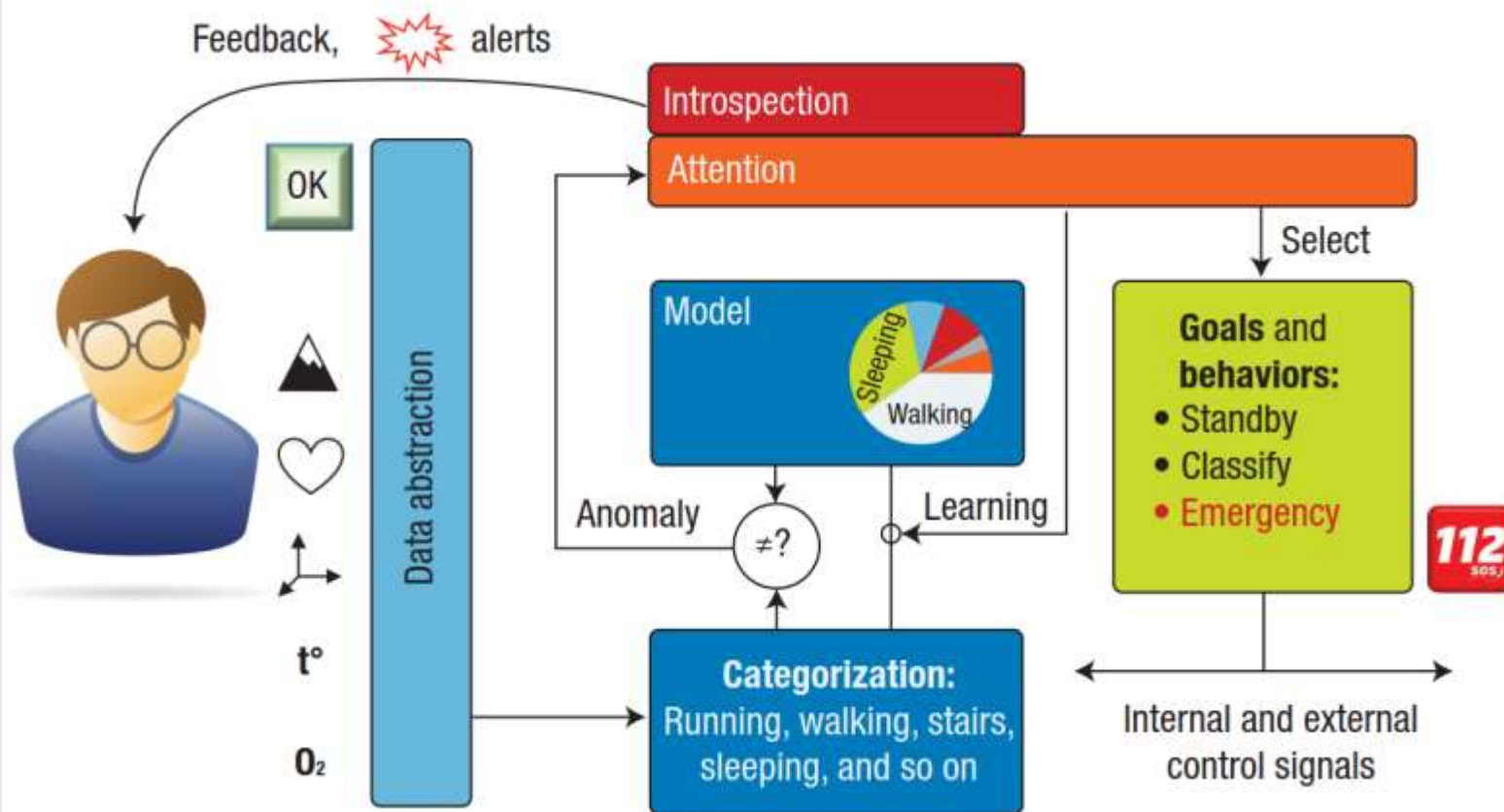
Service Quality Meter Design for Self-Aware Systems

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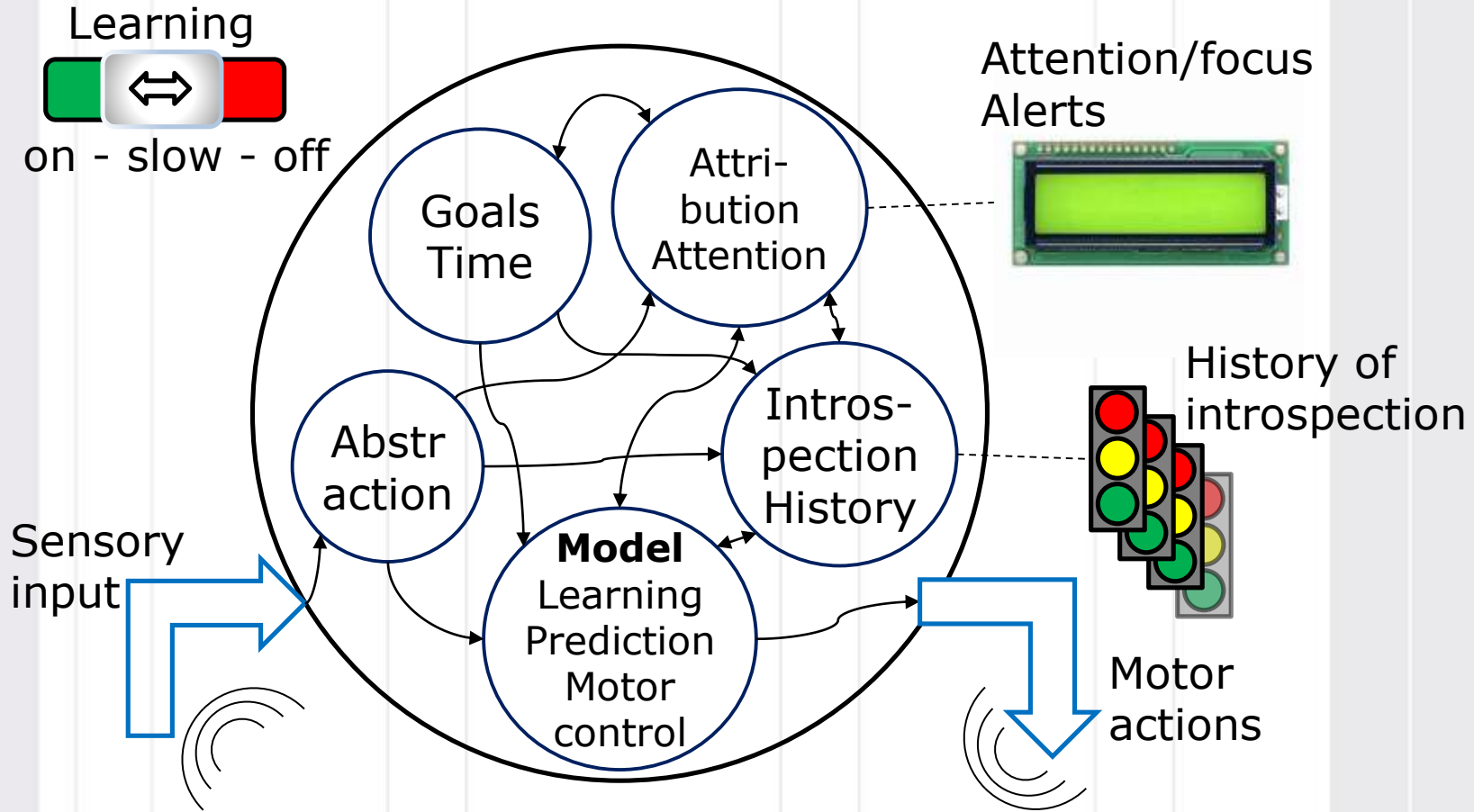
Architecture of Self Aware monitor



[J. S. Preden, K. Tammemäe, A. Jantsch, M. Leier, A. Riid, and E. Calis, "The Benefits of Self-Awareness and Attention in Fog and Mist Computing," IEEE Computer]



SA controller components



Subject, Environment, User



Self-aware health monitor components



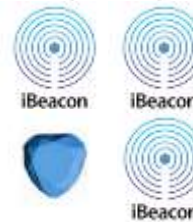
Database + SA decider



RasPi data acquisition



GPS + sensors + feedback



Sensors



Awareness of a Property and Subject

Condition for being aware of property P :

(C.1) The subject makes physical measurements or observations that are used to derive the values of P by means of a meaningful semantic interpretation (**Meaning Condition**)

(C.2) The semantic interpretation is robust (**Robustness Condition**)

(C.3) There is a semantic attribution which is meaningful (**Attribution Condition**)

(C.4) The subject's reaction to its perception of P is appropriate (**Appropriateness Condition**)

(C.5) A history of the evolution of the property over time is maintained, in particular of the increasing or decreasing deviations over time (**History Condition**)

To be aware of itself, Subject must relate to its goals and understand how well it meets them.

(C.6) The subject can assess how well it meets all its goals, thus it has an understanding which goals should be achieved and to which extent they are achieved (**Goal Condition**)

(C.7) The subject can assess how well the goals are achieved over time and when its performance is improving or deteriorating (**Goal History Condition**)

[A. Jantsch and K. Tammemäe, "A framework of awareness for artificial subjects," in Proceedings of the 2014 International Conference on Hardware/Software Codesign and System Synthesis, CODES '14]



Awareness levels

Awareness Level 3 A history sensitive self-aware subject fulfills all requirements of level 2 and, in addition, fulfills the history conditions (C.5) and (C.7)

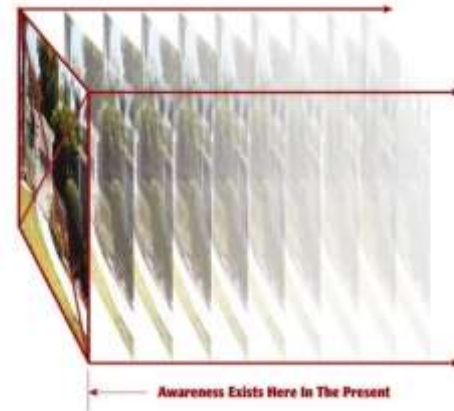
Awareness Level 4 A predictive subject is a history sensitive self-aware subject of level 3 and, in addition, its decision making process involves a simulation engine, that can simulate the effects of actions on the environment and on the subject, thereby predicting future states and behaviors of both the subject and its environment.

Ibid.

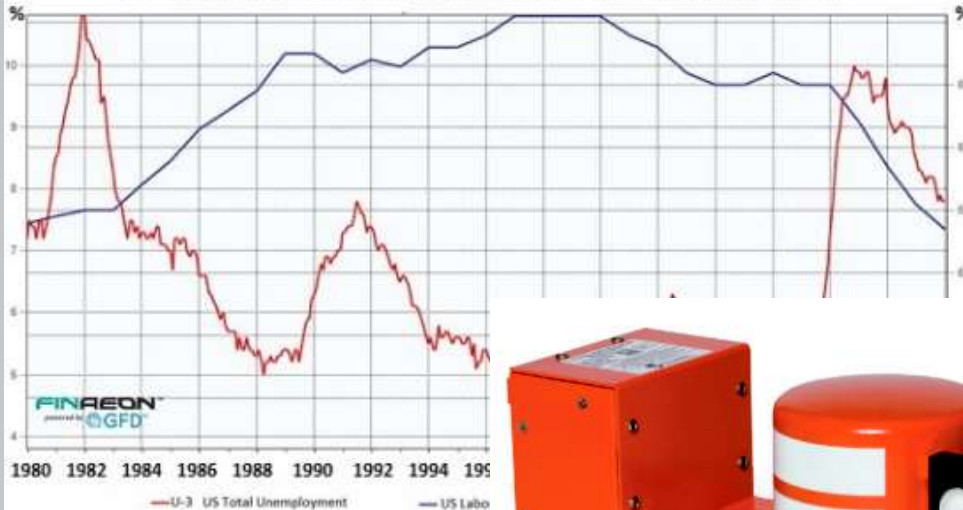


History representation

7/14/10 6:00,38.9
 7/14/10 7:00,40
 7/14/10 8:00,39.9
 7/14/10 9:00,45.4
 7/14/10 10:00,45.4
 7/14/10 11:00,47.3
 7/14/10 12:00,42.9
 7/14/10 13:00,42.7
 7/14/10 14:00,45.8
 7/14/10 15:00,45.8



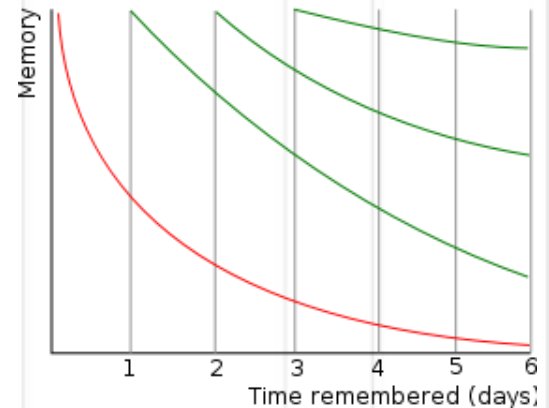
US Unemployment Rate (U-3) v. Labor Force Participation Rate



7/15/10 13:00,39
 7/15/10 14:00,43
 7/15/10 15:00,44
 7/15/10 16:00,40
 7/15/10 17:00,41
 7/15/10 18:00,46
 7/15/10 19:00,40
 7/15/10 20:00,39
 7/15/10 21:00,17



The Forgetting Curve



[https://en.wikipedia.org/wiki/Forgetting_curve]

Ibid. In 1885, [Hermann Ebbinghaus](#) extrapolated the hypothesis of the [exponential](#) nature of [forgetting](#).



Past events handling

- ❑ Not all of information is relevant for survival
- ❑ Very past events are less important than recent ones
- ❑ Exact timing of past events is not very important
(order of events is probably more important)
- ❑ We (our devices) should remember well important (anomalous) events
- ❑ (Bad) situation in past might occur again



Service quality value mapping (Desirability Scale)

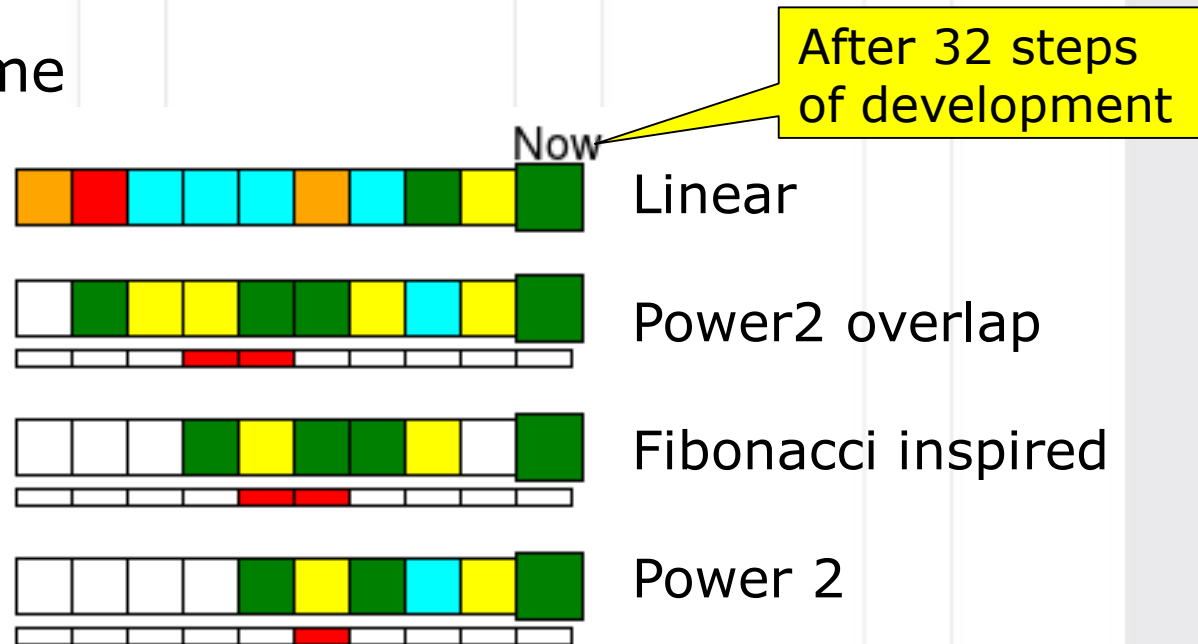
Excellent
Good
Satisfactory
Poor
Dangerous
No data

- ❑ Taking place at different levels:
 - Sensors
 - Aggregated over multiple sensors and abstracted
 - Goal matching
- ❑ The highest abstraction level will be presented over Human Machine Interface



„Lifeline“ design

- Linear
- Logarithmic
 - Base 2
 - Base 3 (e=2.71828...)
 - Fibonacci inspired: 1,1,2,3,5,8,13,21,...
 - etc.
- Real-time
- etc.

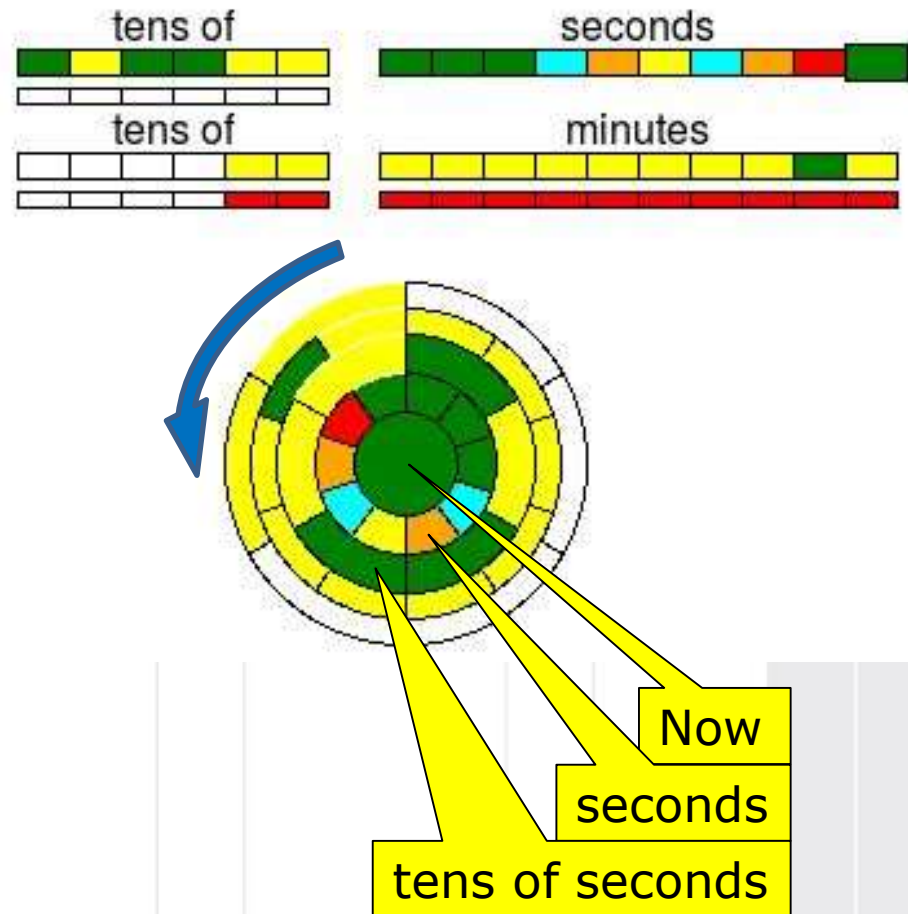




Lifeline – tree-ring inspired design



Japanese cedar (*Cryptomeria japonica*) on Azores





Capacity of representation using n -element long lifeline

Metrics	Capacity
Linear	n
Logarithmic base 2 overlap	$2^{\frac{n}{2}+1}$
Fibonacci	$F(n+2)$
Logarithmic base 2	$2^n - 1$
Real-time	depending of granularity of time...



Experiments

□ SW

- Linux VM
- Python 2.7; J.M.Zelle graphics library
- Random input generator
- File input

□ HW-close demo platform

- Microchip PIC16F88
- RGB LEDs
- Potentiometer input
- Temperature input
- Optional analog and I2C inputs

Not in paper



Open issues

- ❑ Perceptually proper representation
- ❑ Meaningful representation for majority of possible users
 - Color schemas
 - Symbols
 - Numbers
- ❑ Aggregating introspection from lower levels of system architecture to one general quality metrics
- ❑ Do we need such information at all - have we time and need to peek and analyse boring life of our gadgets?



Summary

- ❑ Some solutions provided to represent fading history of introspection
 - SW (Linux)
 - HW-close (microcontroller)
- ❑ New issues detected (bookkeeping of extreme anomalous situations)
- ❑ Human-like and Machine-like history “perception” and representation differences recognized
- ❑ Future research directions refined
- ❑ Real-time data based lifelines
- ❑ KISS ... but meaningful!



Thanks!



[https://cutreenuh.files.wordpress.com/2010/06/tumblr_kyu4xcgjl1qzabkfo1_500.jpg]

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