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Big and Small data

The FOG.

Olga Ferrer-Roca

Unesco Chair of Telemedicine. Faculty of Medicine.
University of La Laguna. Tenerife. Spain.

catai@teide.net

Ruben Tous

Barcelona Supercomputing Center (BSC) and the
Universitat Politècnica de Catalunya(UPC) - BarcelonaTech
Barcelona, Spain. rtous@ac.upc.edu

Rodolfo Milito

Senior Technical Leader CTAO. Fog computing platform.
Cisco Systems. ConSentry networks.

romilito@cisco.com

Abstract—

Health 4.0 applications in the IoE (Internet of Everything) framework generate and use both “Small Data”, and “Big Data”. While “Big Data” is processed in the Cloud, we advocate for “Small Data” to be processed in the Fog, which is an extension of the Cloud to the edge of the network (close to the IoT devices that stream private health-related information). Processing and storing Small Data close to the sources has enables tighter control of the data ownership, response time, and semi-autonomy require by critical applications.

Keywords—*Small data; Health 4.0; mHealth; The Fog; The Cloud.*

I. INTRODUCTION

The Global Health 2035 vision calls for Digital and Ubiquitous Health, and Equitable access. Realization of the vision requires the incorporation of advanced Big Data and Analytics techniques, including Data Mining and Machine Learning, making information the center piece of the advances. Natural questions emerge regarding the preservation of privacy, and keeping the control of the information in the hands of the patient. Towards these goals this paper proposes that the data generated by wearables and personal devices be processed and stored in the Fog.

II. CONCEPTS

A. Small data

Small Data refers to patient data. The patient, who is the owner of his/her data, must be in control of what is shared, with whom, for what purpose, and during which period. In general this data come from devices (medical or not) connected to Internet as part of the IoT (Internet of the Things) providing information that supports data of interest conducive to a healthy life.

B. Health 4.0

As defined in 2012 [1] Health 4.0 is the integrated health framework that incorporates four main innovations:1°.- Applications that meet three availability criteria: a) Anytime connections: On the move, indoors and outdoors,

day-&-night. b)Anyplace connection: On the move, outdoors, indoors, at any PC. c) Anything connection: At any PC, H2H (human to human), H2T (human to thing), T2T (thing to thing). 2°.- Applications that include image enhancement & RFID readings to be use for: a) People by faces recognition and access to relevant information (home, work, medical, HER, PHR, medical schedule...). b) Object by use and by owner recognition. c) Food by principle content & by diet requirements. d) Medication by principle & by indication-contraindication. 3°.-Application that includes quality controlled Web 3.0 items such as: a) HCQ Health Care Quality: ISO 13485-ISO 2700 or security. b) 3S: Social-Semantic-Services. c) Cloud accessing (SAAS, pCloud or personal Cloud were the iPhone can be included). 4°.-Applications taking Web 4.0 items such as: a) KBL o Knowledge base learning, including literature base learning (LBL), Evidence Based learning (EBL), trial base learning (TBL), Image based learning (IBL) etc...b) QBE o Query by example, including query by image (QBI) etc...c) CoLD or Cloud of link data with Artificial intelligence.”

C. The Fog

Fog [3] extends Cloud resources (processing, compute, and networking) to the edge of the network. Through virtualization, the Fog enables the user to control his/her own data. The user determines the engagement policies of his/her PHA (personal health assistant), including what and with whom to share data, whom to associate (possibly including electric PHAs, e-PHAs) with the purpose to maintain a healthy life.

D. PHAs

The living Personal Health Assistants are highly trained nurses (e.g. midwives) capable to be informed and empathic, advice for every-day life, and to act as a coach. Their role goes well beyond the standard tasks of prescribing medicines and issuing orders. Nurses that handle the administrative complexity of healthcare delivery can also advise users on the use public and private care, on how to prevent complications, choose the best hospital, call an ambulance and prepare the entrance in emergency rooms, etc. PHAs follow well-designed protocols based on decision trees (“given this and that, take this course”). The protocols are based on Bayesian inference or Markovian models.

E. Intelli-agents and e-PHAs

Intelligent agents, judiciously trained on the patient Small Data, and rigorously tested and validated on the available Big Data, could eventually graduate to e-PHAs able to give recommendations in specific individual situations. The criterion for graduation should be to meet or exceed the performance of the live PHAs following the existing protocols. Rather than e-PHAs issuing rote recommendations we envision them delivering Knowledge on Demand (KoD) [6], based on the data stored in the Fog, and in respond to the stimuli of the diverse sensors that measure the individual and the environment.

III. SAHA (SMART AGENTS HEALTH ARENA)

The components of the system include avatars as embodiment of people, the Smart Agents Health Arena (SAHA) [4] as the environment in which the avatars and intelligent agents interact with the traditional professionals, medical devices and IoT in general in the health arena, including the Fog [7].

Some of this exists today although in a very primitive Health 2.0 or even analog form (see Fig 1)



Fig. 1. Existing avatars-<http://sense.ly/> in <http://sco.lt/4pv0KH>.

A. Digital Health

Digital data is essential in Digital Health, this is the reason why we have to define also the type of data, for what is taken and to whom it belongs. See table I [8].

TABLE I. THE FOG AND THE SMALL DATA

	BIG DATA	SMALL DATA
<i>Belongs to</i>	Government/State	Individuals/Patient
<i>Anonymized</i>	YES	NO
<i>Encrypted</i>	NO	YES
<i>Processed in</i>	The Cloud	The Fog
<i>Response</i>	Months / Years	Minutes / On time
<i>Obtained from</i>	Institutions/EHRs	Sensors / At home / PHR ^a
<i>Processed by</i>	DB tools-DBaaS	Parallel C/e-Agents
<i>Stored</i>	By Govern/Distributed	By Individuals/ PHAs
<i>Useful</i>	for Decision makers	for Individuals

^a Personal Health Record

B. Global Health

Following the Lancet Global Health 2035 [1], our next generation will require not only to study but also to implement a secure digital health environment and a new way to provide medicine.

This include the possibility of de-localized treatment and follow up by Centers of Excellence spread all over the world, possibility that should be assume not only by private insurance but also by public health.

IV. CONCLUSIONS

In this new Healthcare delivery context empower citizens in their own health control and delivery in several front-ends: 1) Disease and complications prevention. 2) Healthy and happiest life. 3) Humanize health [10] providing PHAs. 4) Integrate primary and secondary care. 5) Improve healthcare resources. 6) Lower health cost and health demands from tertiary care. 7) Know the center of excellence for specific diseases.

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References

- [1] Global health 2035: a world converging within a generation. The Lancet, Volume 382, Issue 9908, Pages 1898 - 1955, 7 December 2013
- [2] O.Ferrer-Roca. "Health 4.0 in the i2i era" Intern J Reliable and Quality E-Healthcare, 1(1), 43-57, January-March 2012; <http://www.teide.net/catai/Health%204.0%20HD.pdf>.
- [3] F.Bonomi, R. Milito, J.Xhu, S.Addepalli, "Fog Computing and its Role in the Internet of Things," SIGCOMM 2012, <http://conferences.sigcomm.org/sigcomm/2012/paper/mcc/p13.pdf>
- [4] R. Milito. F. Bonomi and P. Monclus. Architecture for Intelligent agents/avatars in Healthcare. CTECH Forum 2010. (not published)
- [5] D. Lake, Milito R., Morrow M. and Vangheese R: Internet of Things: Architectural framework for eHealth security. Journal of ICT, vol. 3&4, pp: 301-330, 2014, doi: 10.13052/jicts2245-800X.133
- [6] O.Ferrer-Roca, A.Figueroa, K.Franco, A.Cardenas. Telemedicine intelligent Learning. Ontology for agent technology. Trans. on Adv. Res. Jul 2005, Vol 1, N. 2, 46-54
- [7] O.Ferrer-Roca. (2014) Fog computing in Health 4.0. <http://catai.net/blog/2014/05/fog-computing-in-health-4-0/>
- [8] O. Ferrer-Roca. (2014) Big Data versus Small Data. <http://catai.net/blog/2014/06/big-data-versus-small-data/>
- [9] O. Ferrer-Roca. (2014) Artificial Intelligence in Health 4.0 <http://sco.lt/6ntTyz>
- [10] O. Ferrer-Roca (2014) Humanization of the Healthcare. Moving into the right direction. <http://sco.lt/5BfRdh>
- [11] R. Tous, J. Delgado, T. Zinkl, P. Toran, G. Alcalde, M. Goetz and O. Ferrer-Roca. The Anatomy of an Optical Biopsy Semantic Retrieval System. IEEE Multimedia. April-June 2012 (vol. 19 no. 2). pp. 16-27.