



UNIVERSITAT ROVIRA I VIRGILI

Departament d'Enginyeria

[DΣIM]

Informàtica i
Matemàtiques



Smart Health: Improving Health services within Smart Cities



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Outline

- **Electronic Health**
 - Electronic Health definition & basics
 - Examples
- **Mobile Health**
 - m-Health definition & basics
 - Example: The SIMPATIC Project
- **The Smart Health Paradigm**
 - Smart Cities & Context-Awareness
 - SMART HEALTH definition and basics
 - Challenges & Opportunities
- **A Glimpse of Cognitive Health**
 - What, Why and When
- **Conclusions**



Electronic Health

Definition & Basics

e-Health is an emerging field in the **intersection of medical informatics**, public health and business, referring to health services and information delivered or enhanced through the **Internet and related technologies**.

(2001)

J Med Internet Res 2001;3(2):e20



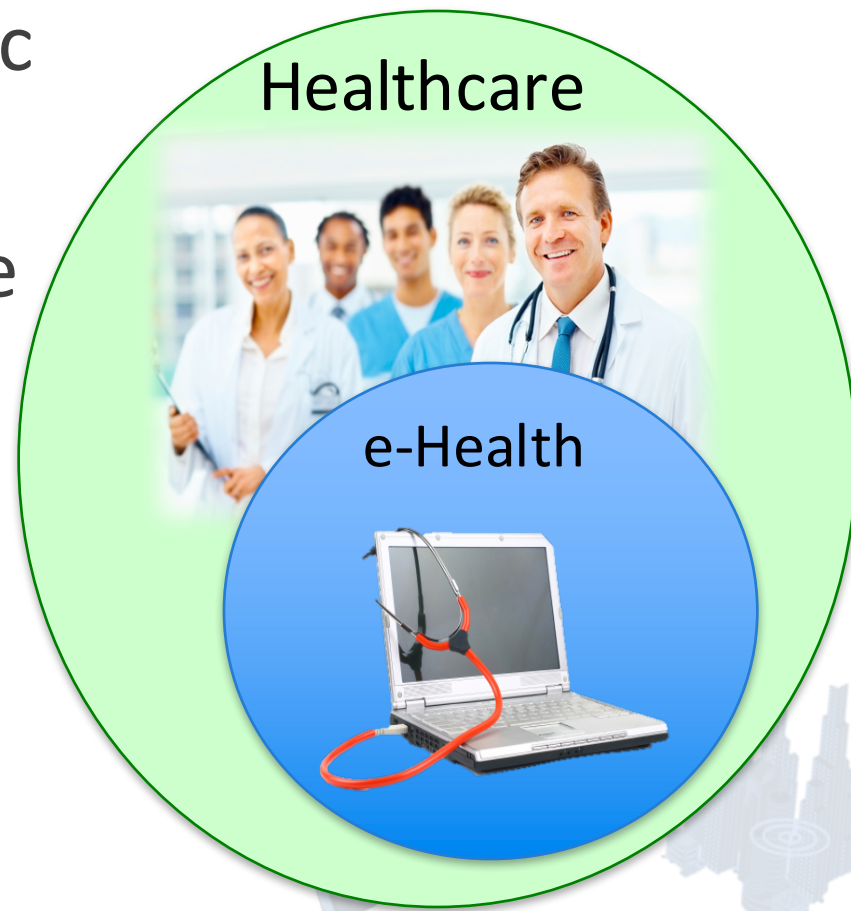
Gunter Eysenbach



Electronic Health

Definition & Basics

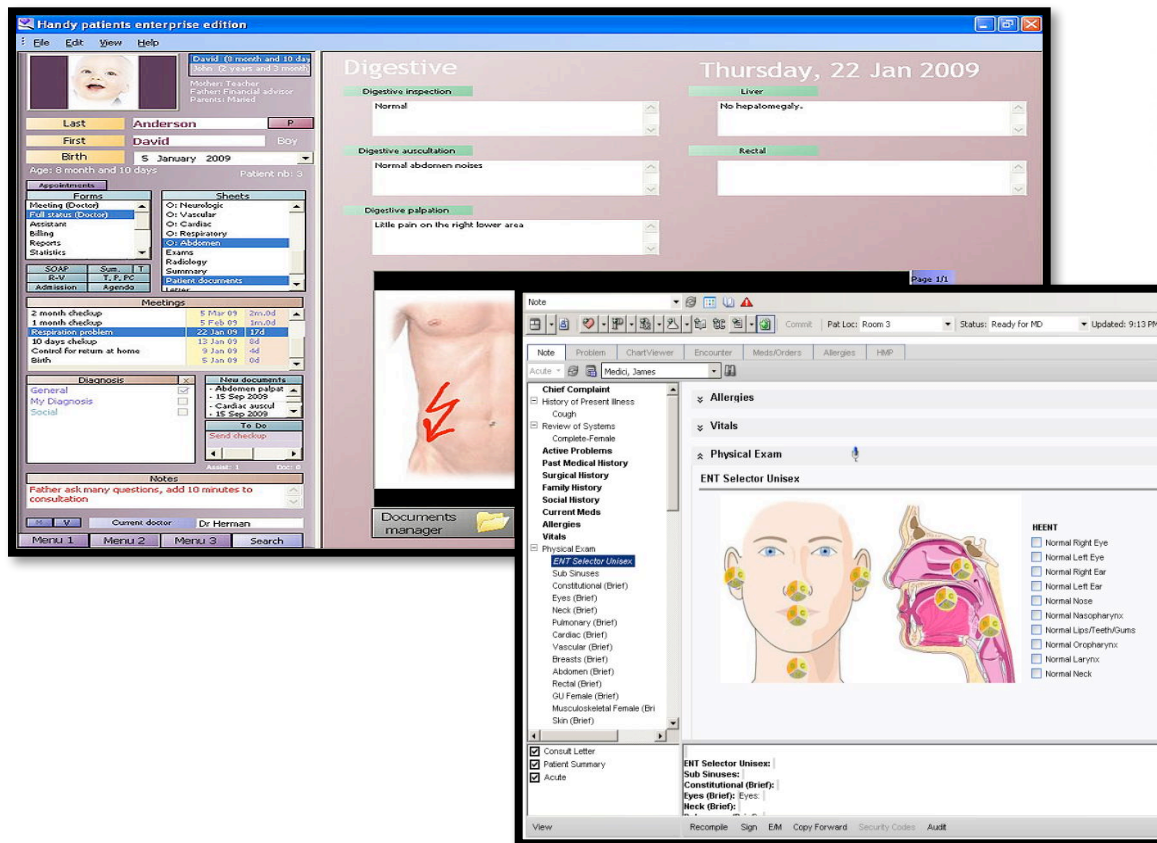
- Electronic Health is clearly a subset of classic healthcare.
- It is characterised by the use of **Information and Communication Technologies (ICT)**



Electronic Health

Examples: Electronic Health Records

One of the most well-known examples of e-Health are **Electronic Health Records**

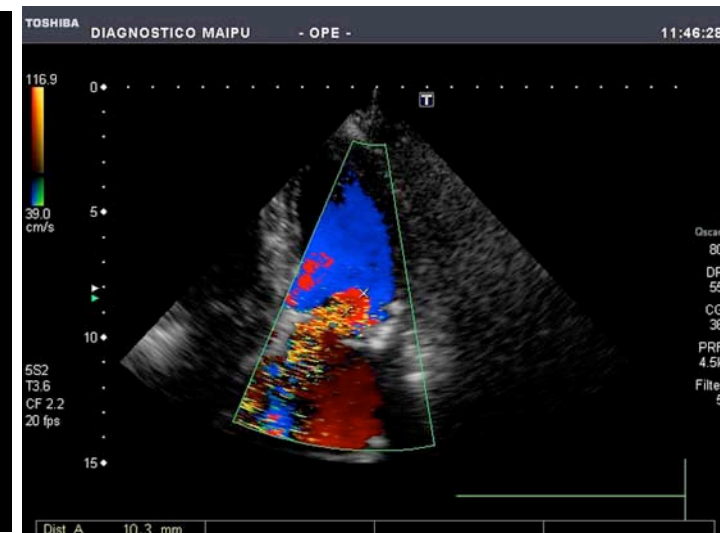
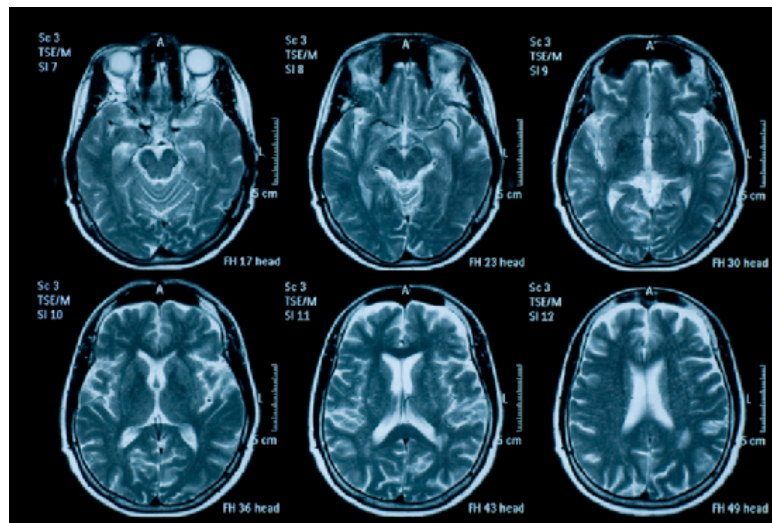
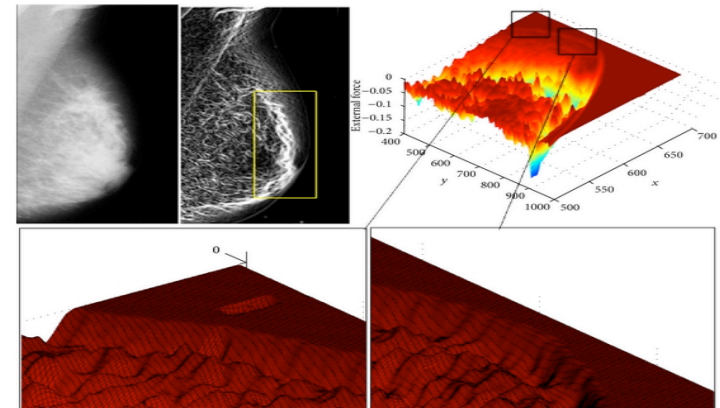


Electronic Health

Examples: Medical Imaging

Well-known examples of e-Health are related to **medical imaging**:

- **Mammography**
- **Magnetic Resonance (MRI)**
- **Eco-Doppler**
- **etc.**



Electronic Health Examples



Control unit



Alarm button



Fall detector



Gas detector



Door exit sensor



Temperature sensor



Flood detector



Bed or chair
occupancy sensor



Smoke detector/alarm



Pressure mat



Alarm pill dispenser



Pull cord alarm

- Hundreds of gadgets



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Mobile Health

Definition & Basics

Mobile health can be defined as ...
<< emerging mobile communications
and network technologies for
healthcare systems. >>

2006



Robert Istepanian

R. Istepanian, S. Laxminarayan, and C. S. Pattichis, "Preface,"
M-Health: Emerging Mobile Health Systems, Topics in
Biomedical Engineering, Int'l. Book Series, Springer.



Mobile Health

Definition & Basics

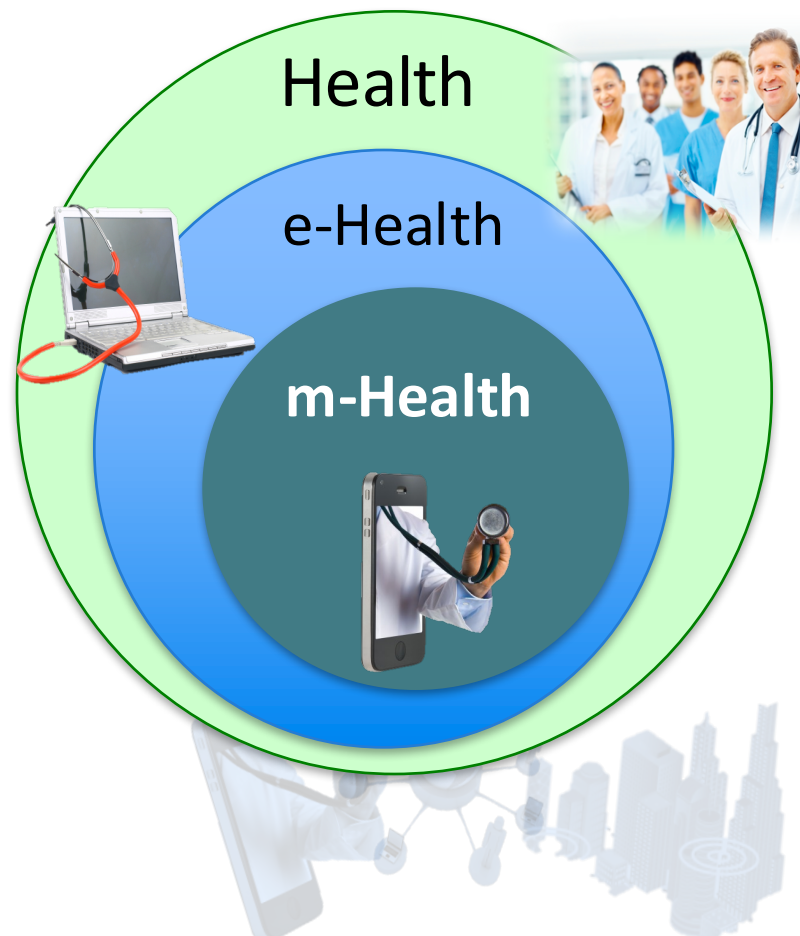
- Also, **m-Health** could be understood as the discipline founded on the use of **mobile communication devices in medicine.**
- The delivery of **healthcare services** via **mobile communication devices**



Mobile Health

Definition & Basics

- **Mobile Health** is based on **mobile devices** that are indeed electronic.
- Mobile health is, thus, a clear subset of electronic health
- The new intrinsic characteristics of m-health are
 - **Mobility**
 - **(Ubiquity)**



Mobile Health

Definition & Basics

- **4.000 millions** of smartphones in the world
- About 30% of mobile phones are **smartphones**
- They are affordable (from 50€)
- 25% of mobile phones are constantly connected to the Internet
- **More than 9% of Smartphone users have downloaded health-related apps.**

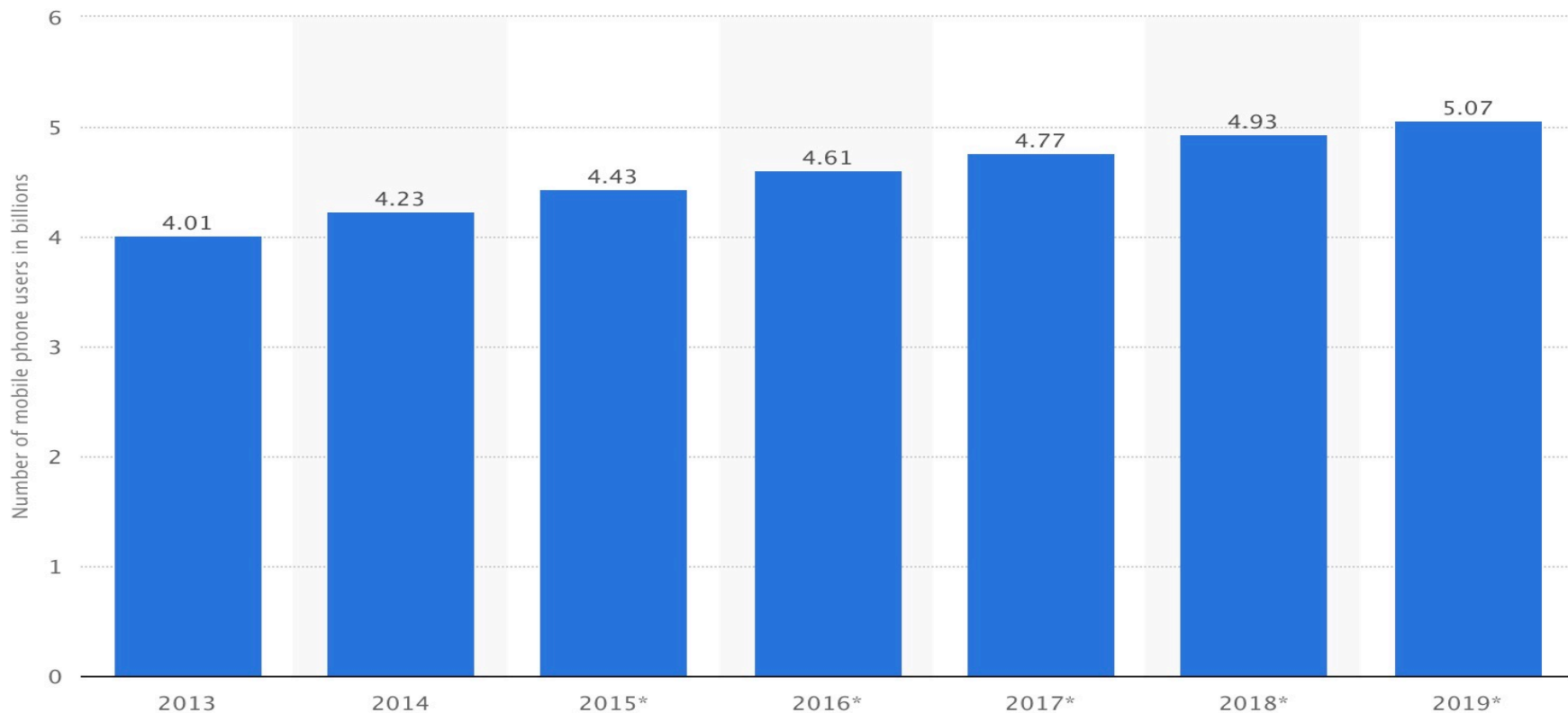


Mobile Health

Definition & Basics

Number of mobile phone users worldwide from 2013 to 2019 (in billions)

The statistic shows the total number of mobile phone users worldwide from 2013 to 2019. For 2017 the number of mobile phone users is forecast to reach 4.77 billion.

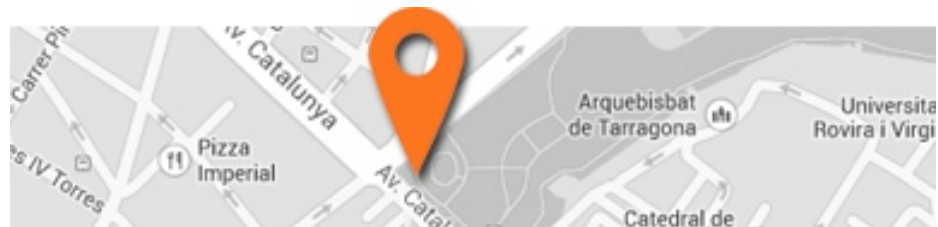
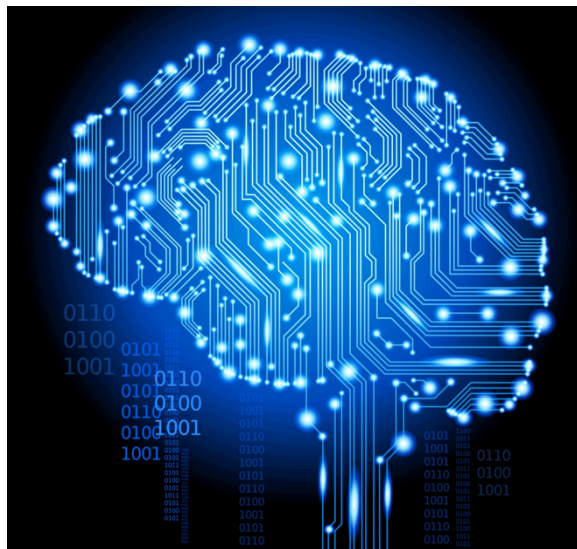


© Statista 2015

Mobile Health

Example: The SIMPATIC Project

System for the Autonomous,
Private and Intelligent Monitoring
based on ICTs.



Mobile Health – SIMPATIC Project

Dementia: More than a memory loss

- **About 5.3 million** people in the US experience some form of dementia. By 2050 the affected population is projected to triple.
- In the UK, dementia affects about **850,000** people.
- In September 2015, George McNamara, head of policy at Alzheimer's Society, stated that:



“Dementia is already the biggest health challenge this country faces. It costs the UK in excess of £26bn, which equates to £30,000 a person with dementia – more than the cost of either cancer or heart disease.”



<http://www.theguardian.com> by Dasha Kiper

Mobile Health- SIMPATIC Project

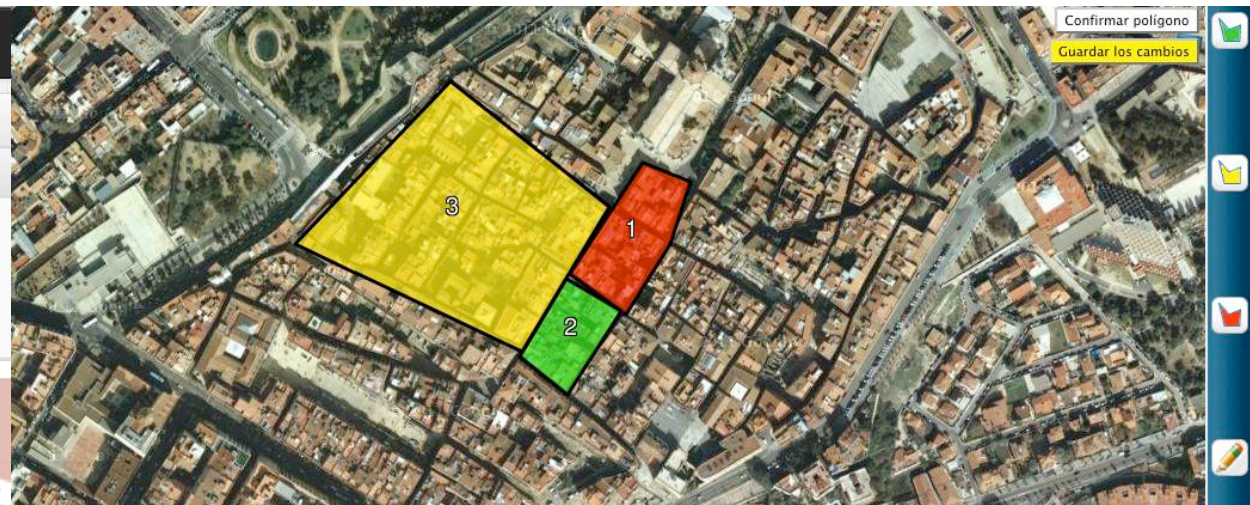
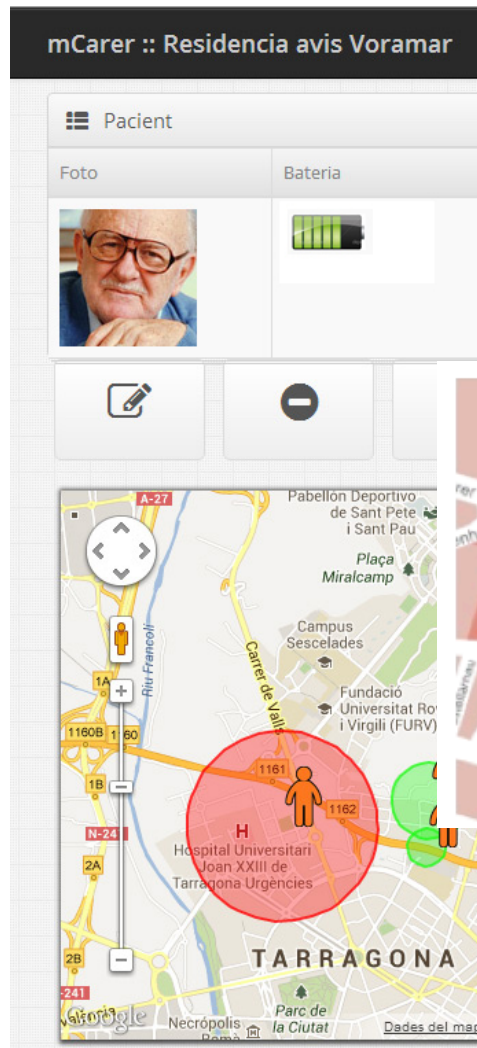
An m-Health example

- The SIMPATIC Project pays attention to MCI
 - MCI: Mild Cognitive Impairments
- Patients with MCI and in initial stages of dementia might suffer from:
 - Disorientation
 - Memory loss
 - Increase dependency
 - Loss of freedom
 - Reduced quality of life



Mobile Health- SIMPATIC Project

An m-Health example



- Patient centric


Mobile Health- SIMPATIC Project

An m-Health example

ADMINISTRADOR Profile Definition of alarms Alarm history Filter

Settings Log out

Profile of Jose [REDACTED]



Jose

[REDACTED]

[REDACTED]

Key icon Password

Key icon Confirm password

Patient photo
Choose File no file selected

Patient phone
[REDACTED]

Carer phone
[REDACTED]

Blood group A+ [v]

Language: Catalan [v]

Disease:
☐ Diabetes
☐ Hearing problems
☐ Blood pressure
☐ Osteoporosis
☐ Visual problems

Change defined alarms

Delete account

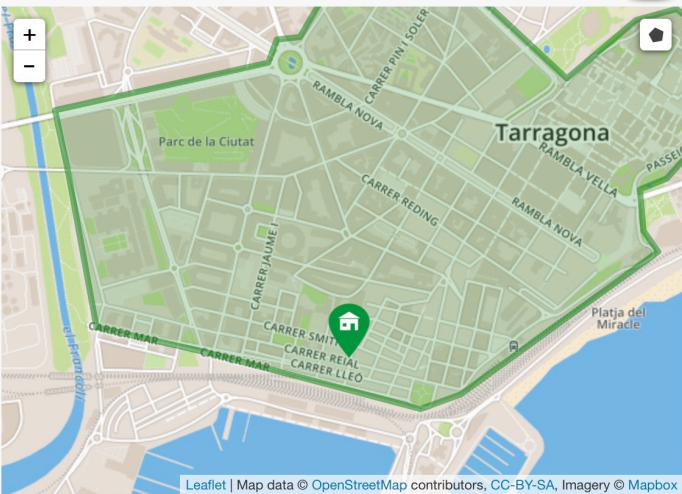
Refresh

Mobile Health- SIMPATIC Project

An m-Health example

ADMINISTRADOR Profile Definition of alarms Alarm history Filter

Settings Log out



Delete area

Warning for no movement

☒ Times: 10:00 - 14:00 Estimated time: 1 hora

☒ Times: 15:00 - 18:00 Estimated time: 1 hora

☐ Times: 00:00 - 00:00 Estimated time: 30 min

Warning for speed

☐ Without warn ☒ Urban transport ☐ Interurban transport

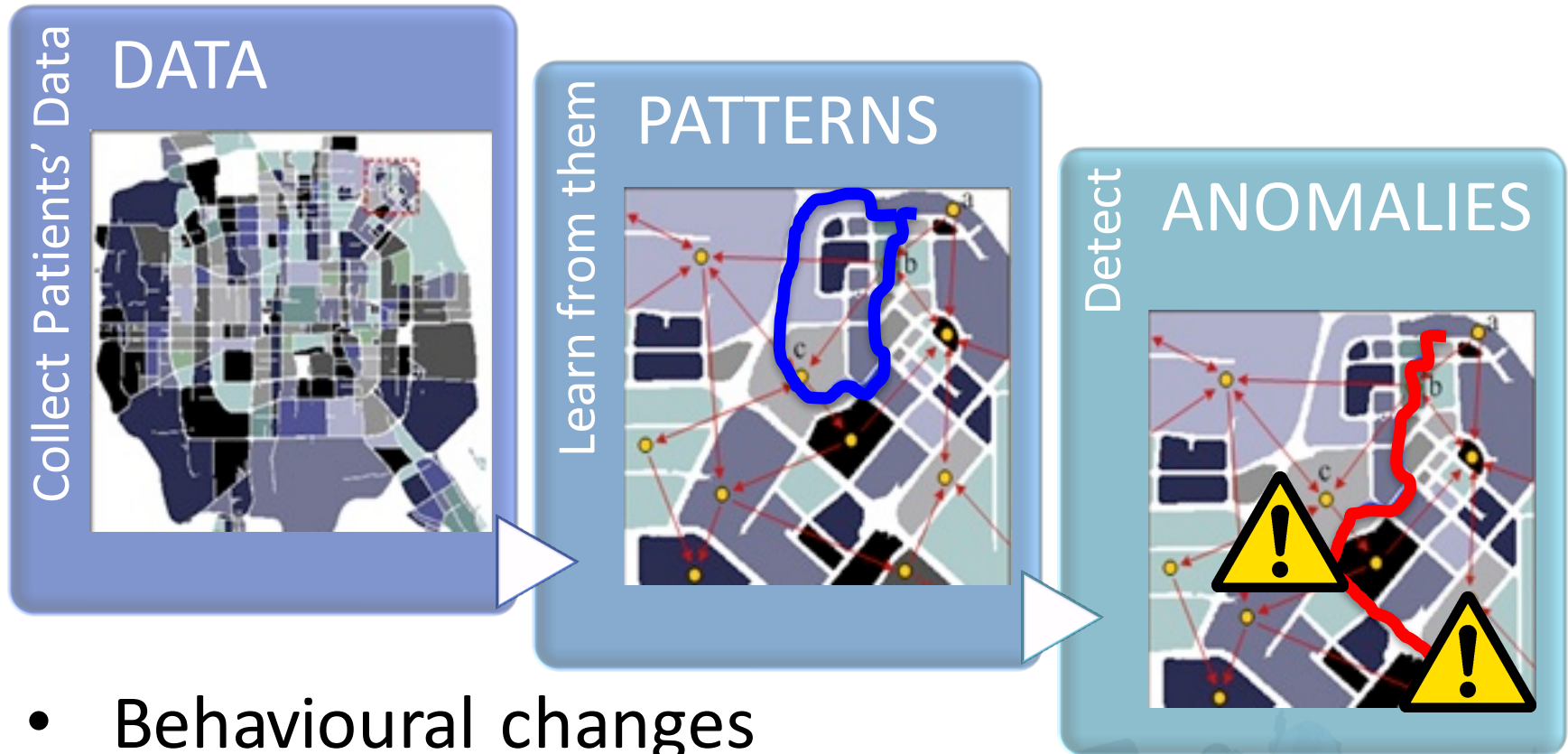
Warning for low battery

☐ Without warn ☒ Warn

Refresh the alarms

Mobile Health- SIMPATIC Project

An m-Health example



- Behavioural changes
- Wandering

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The Smart Health Paradigm

Smart Cities

- **Smart cities** are becoming commonplace.
 - Amsterdam (Holland)
 - Barcelona (Spain)
 - Edmonton (Canada)
 - Fort Lauderdale (USA)
 - Guadalajara (Mexico)
 - Rio de Janeiro (Brazil)
 - Trento (Italy)
 - Wuxi (China)
 - etc...



An architectural rendering of the buildings that will make up the Ciudad Creativa Digital (CCD) site, in Guadalajara, Mexico.

<http://theinstitute.ieee.org/technology-focus/technology-topic/an-urban-reality-smart-cities>

The Smart Health Paradigm

Smart Cities - Definition

Smart Cities are cities strongly founded on information and communication technologies that invest in

- **human and social capital** to improve the quality of life of their citizens by
- fostering **economic growth**,
- **participatory governance**,
- wise management of **resources**,
- **sustainability**, and
- efficient **mobility**,
- whilst they guarantee the **privacy and security** of the citizens.



2013

P. Pérez, A. Martínez,
and A. Solanas,
“Privacy in Smart
Cities -A Case Study of
Smart Public Parking,”
Proc. 3rd Int’l Conf.
PECCS, 2013, pp. 55–
59.

The Smart Health Paradigm

Context-Aware Health

- Smart Cities provide us with very rich sensing capabilities to understand the “context” in which patients are
- The “context” could be defined as:

<< the environmental states and settings that either determines an application’s behaviour or in which an application event occurs and is interesting to the user>>



G. Chen and D. Kotz, “A Survey of Context-Aware Mobile Computing Research,” tech. rep. TR2000-381, Dept. of Computer Science, Dartmouth College, 2000.

The Smart Health Paradigm

Definition & Basics

- What if we could have more than mobility data?
- What if we could collect data from the environment?
- What if we could use the smart city context?

Smart
Health
Appears



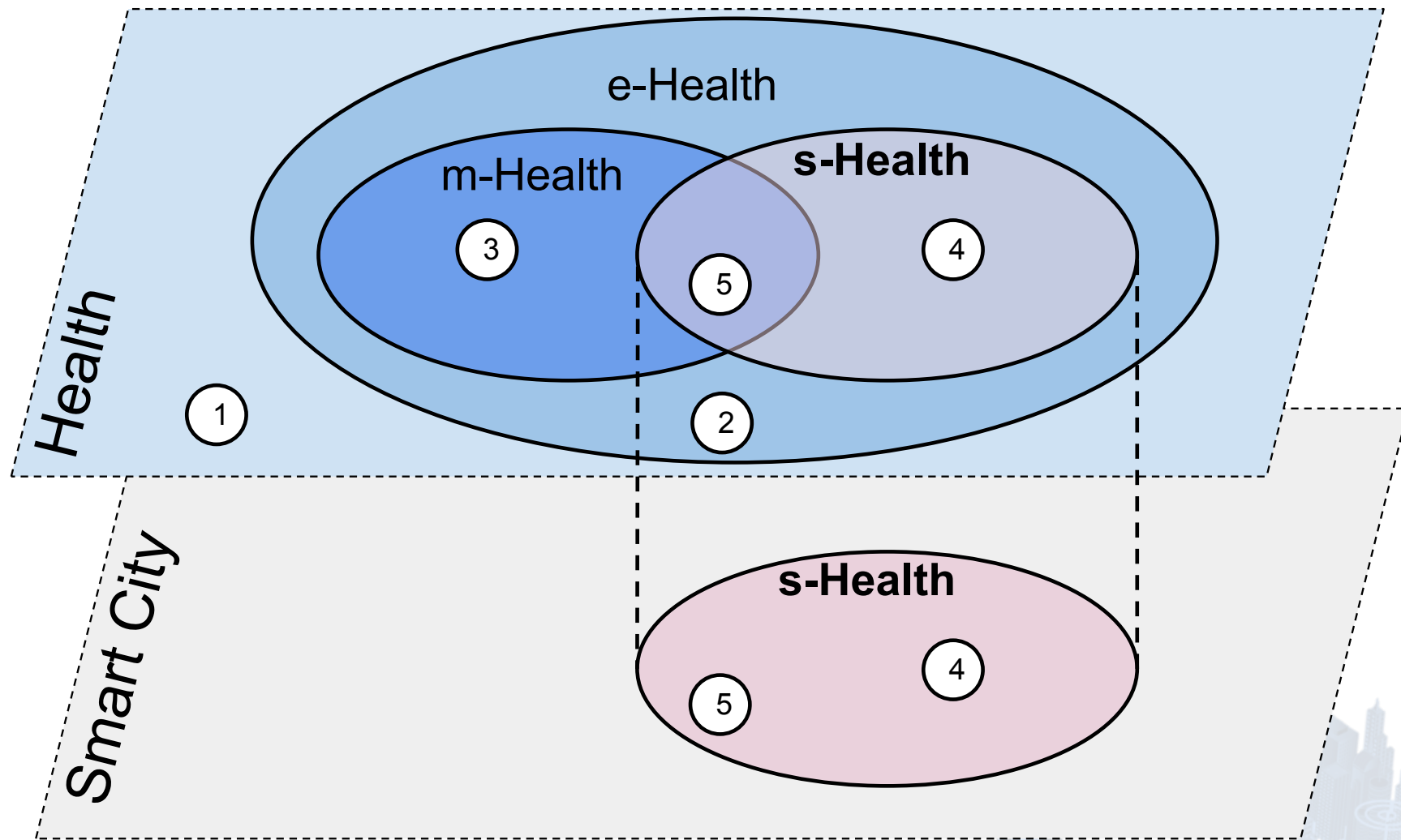
*<< Smart health is the provision of health services by using the **context-aware** network and sensing infrastructure of **smart cities**. >>*

Agusti SOLANAS. et al.,
“Smart Health: A Context-Aware Health Paradigm within Smart Cities” *IEEE Communications Magazine*. August, 2014



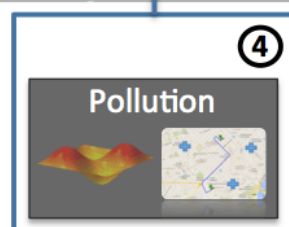
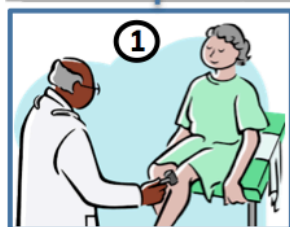
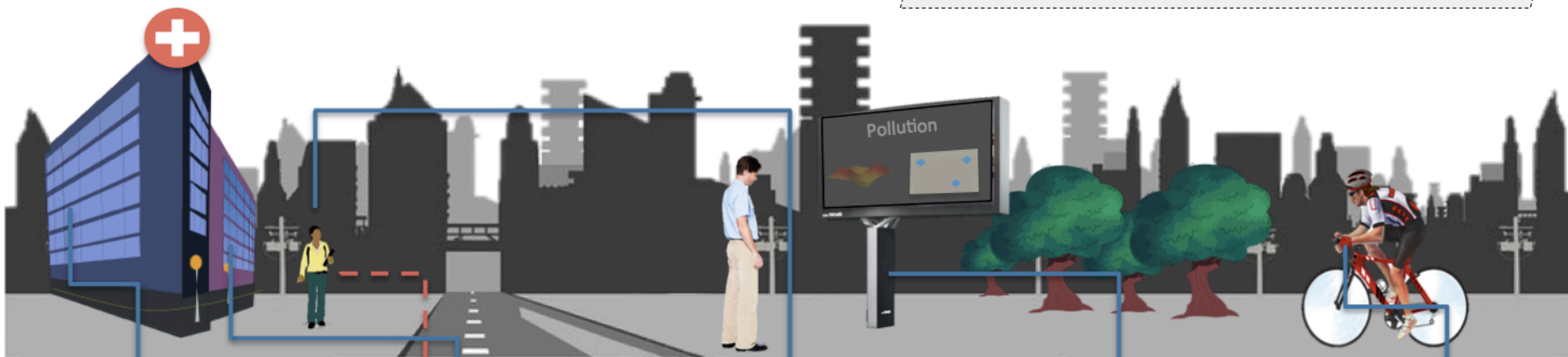
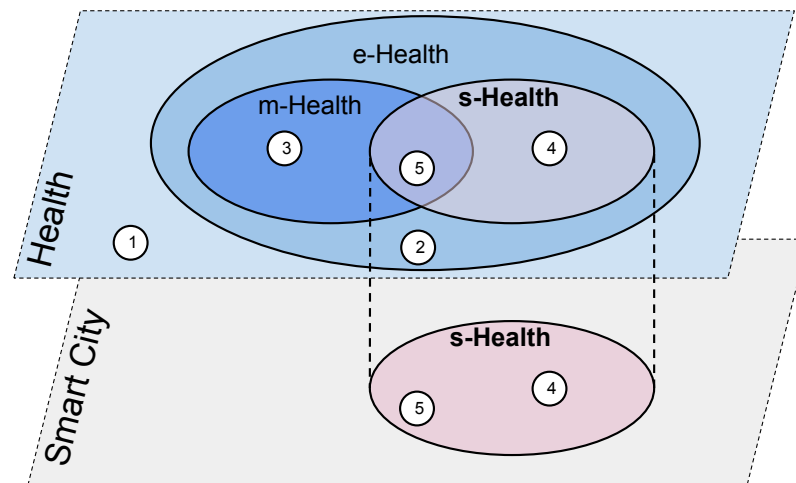
The Smart Health Paradigm

Definition & Basics



The Smart Health Paradigm

Definition & Basics



The SMART HEALTH Paradigm Challenges

- Smart Health will have to overcome a number of challenges in order to be a reality:
 - Multidisciplinary research
 - Security and Privacy
 - Sensor integration
 - Big data management and Cloud
 - Usability and HCI
 - Other...



The SMART HEALTH Paradigm Opportunities

- The Smart Health paradigm opens the door to a variety of opportunities for people, companies and governments:
 - Data collection, presentation and analysis
 - Prevention of critical incidents
 - Effectiveness and environmental assessment
 - Engaging patients and families
 - Improving policy decisions
 - Epidemic control
 - Cost savings



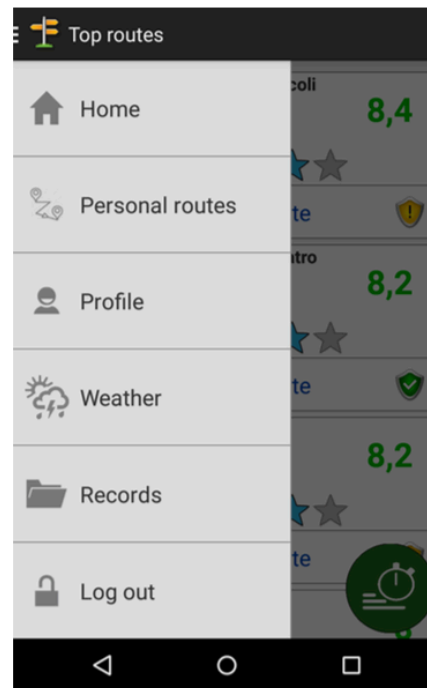
The SMART HEALTH Paradigm

A REAL Example

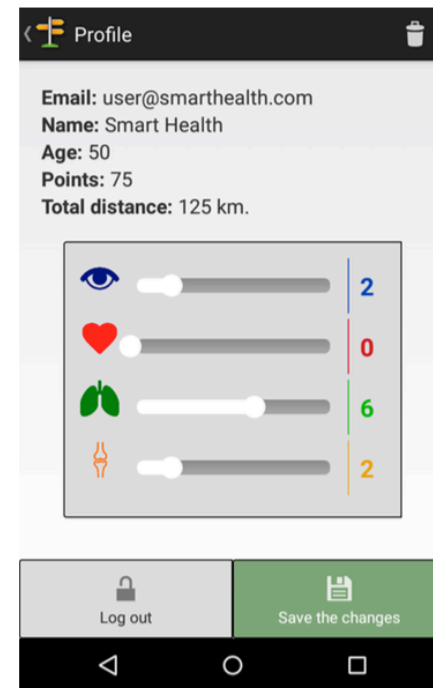
- The Smart Healthy Route APP



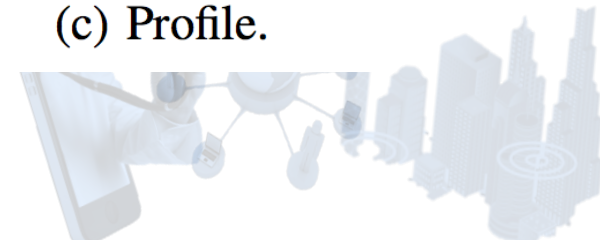
(a) Home.



(b) Menu.



(c) Profile.



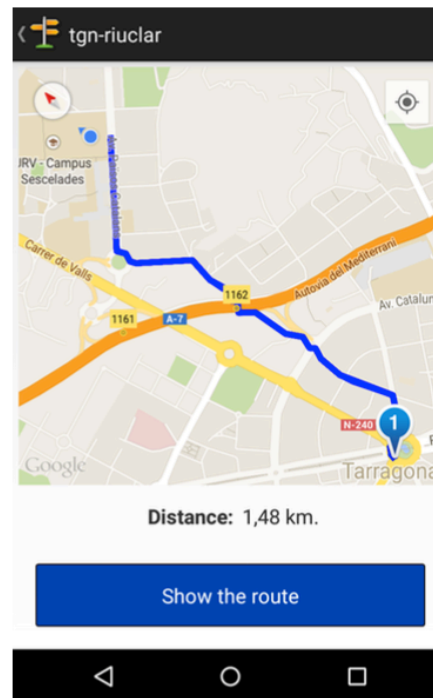
The SMART HEALTH Paradigm

A REAL Example

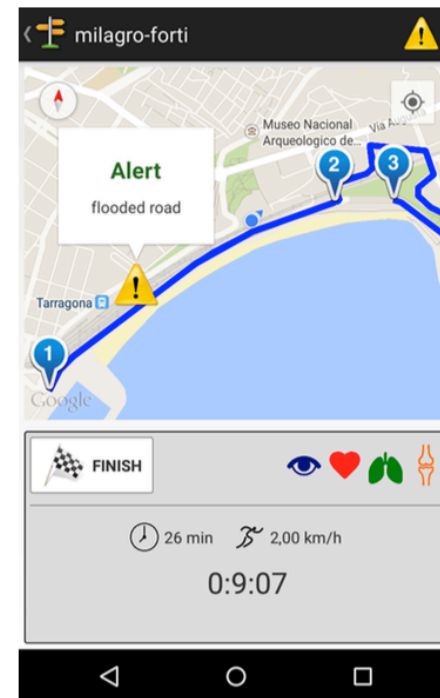
- The Smart Healthy Route APP



(d) Weather and air



(e) Route info.



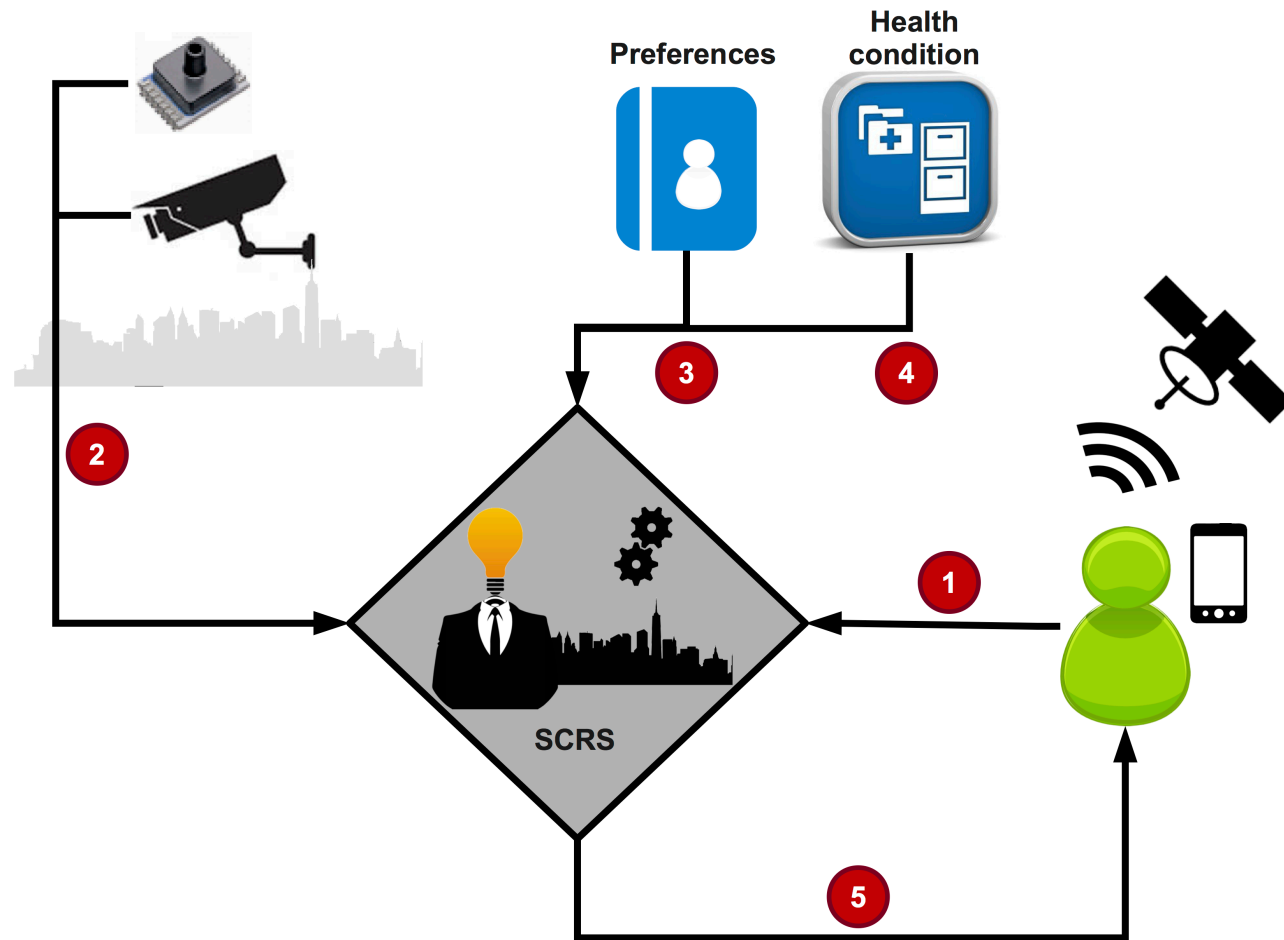
(f) Route session.



The SMART HEALTH Paradigm

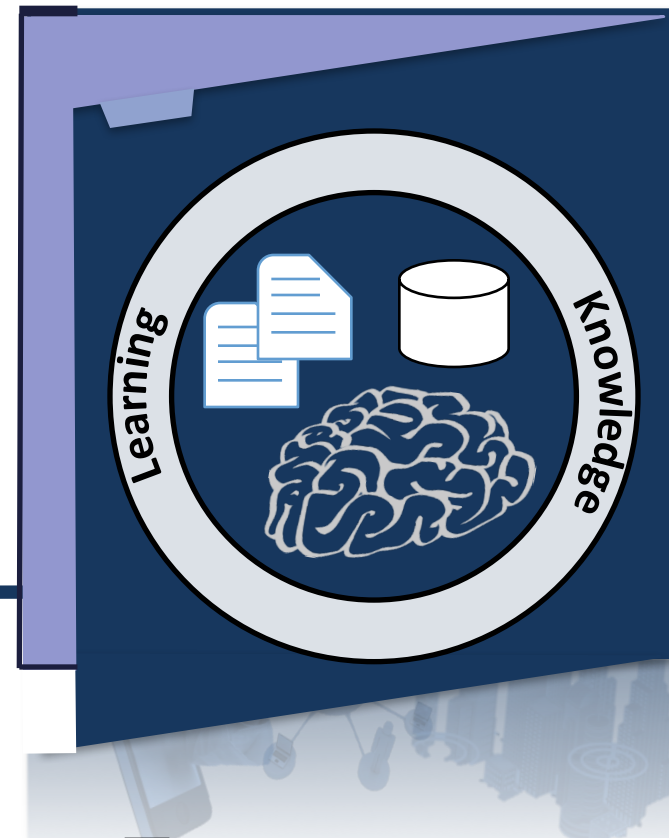
A REAL Example

- The Smart Healthy Route APP



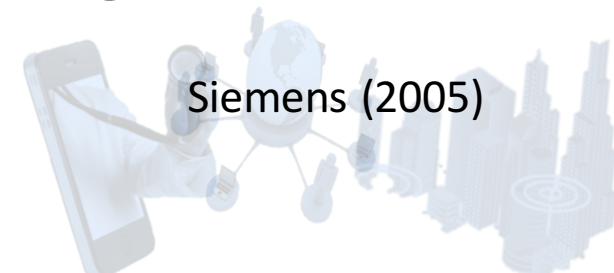
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What is Cognitive Healthcare?

- **Connectivism** is the integration of principles explored by chaos, network, and complexity and self-organization theories. Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual.
- Learning (defined as actionable knowledge) can reside outside of ourselves (within an organization or a database)
- Learning is focused on connecting specialized information sets, **and the connections that enable us to learn more are more important than our current state of knowing .**



Siemens (2005)

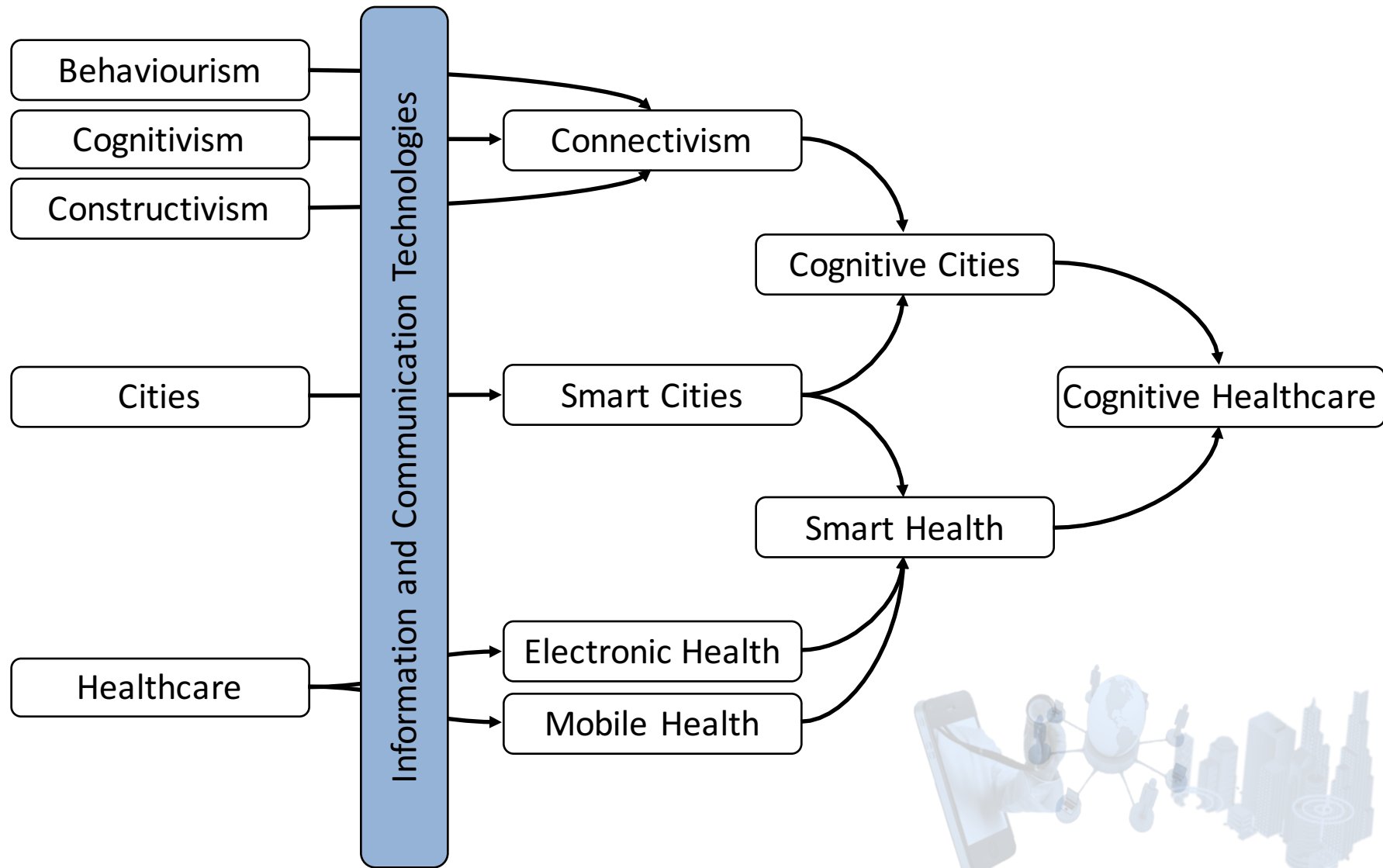
What is Cognitive Healthcare?

- **Cognitive City** is “*one that learns and adapts its behaviour based on past experiences and is able to sense, understand and respond to changes in its environment*”.

Mostari et al.(2011)



What is Cognitive Healthcare?



What is Cognitive Healthcare?

- Cognitive Healthcare (c-health) can be defined as those **healthcare services** and infrastructures provided within a context-aware cognitive city, where the infrastructures are able to **adapt to changes in the environment, learn and make decisions** based on experience and accessible knowledge.



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Conclusions

- We have witnessed a clear evolution of the concept of Healthcare
 - Classic Healthcare
 - Electronic Healthcare (2001)
 - Mobile Healthcare (2006)
 - Smart Healthcare (2014)
 - Cognitive Healthcare (2015)



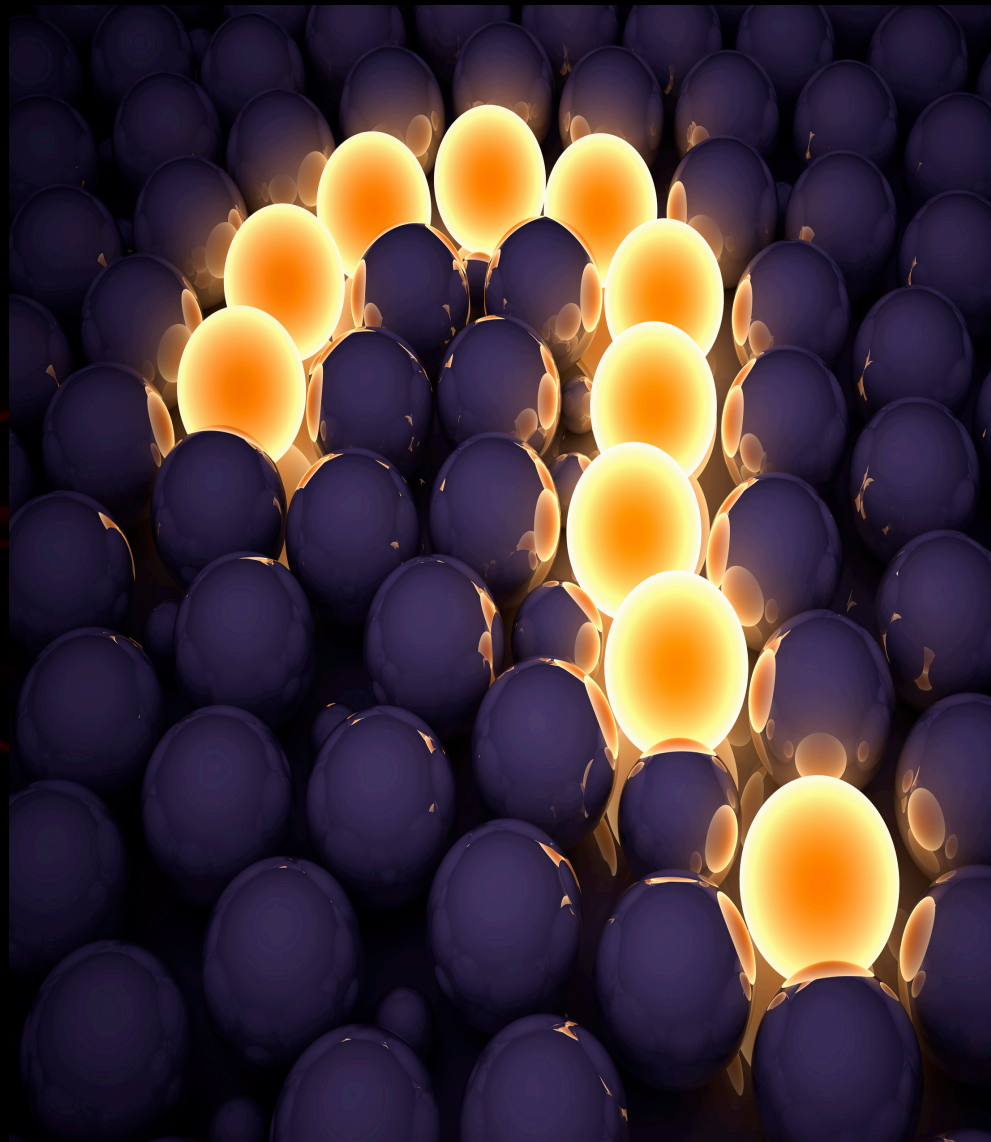
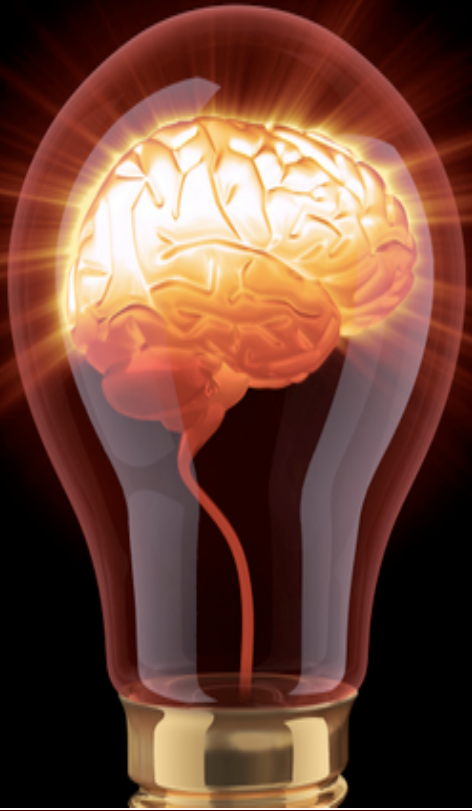
Conclusions

- The concept of Smart Health will grow in parallel with Smart Cities.
 - With more sensing capabilities in SC comes more and diverse Smart Health applications.
- The right steps towards the consolidation of the idea must be taken NOW.
- More advanced/complex concepts like cognitive healthcare are still a vision for the future
 - But serious and focussed research is also required NOW



Thanks for your attention!!

Questions and final thoughts





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