The Ninth International Conference on Sensor Device Technologies and Applications
SENSORDEVICES 2018
September 16, 2018 to September 20, 2018 - Venice, Italy

Panel
Sensing Huge Data and IoT Systems

Sensing Huge Data and IoT Systems

Moderator

Paulo E. Cruvinel, Ph.D

Panelists

Underwater acoustics - Challenges and Applications.

Paulo Jorge Maia dos Santos, Ph.D

Challenges in the recognition of activities of daily living anywhere at anytime without special requirements using mobile devices.

Ivan Miguel Serrano Pires, Ph.D

Huge Data and IoT Applications in Precision Agriculture.

Paulo E. Cruvinel, Ph.D

Underwater acoustics – Challenges and Applications

The sound is the only practical way to propagate signals to great distances in the ocean. The sound is used, not only for communication between marine animals but also for underwater parameter estimation, localization of objects and sources, etc.

Although the ocean exploration is a complex challenge, underwater acousticians study the propagation of sound in water and its interaction with the ocean boundaries (surface and seafloor) to predict the characteristics of physical and biological parameters of the ocean.

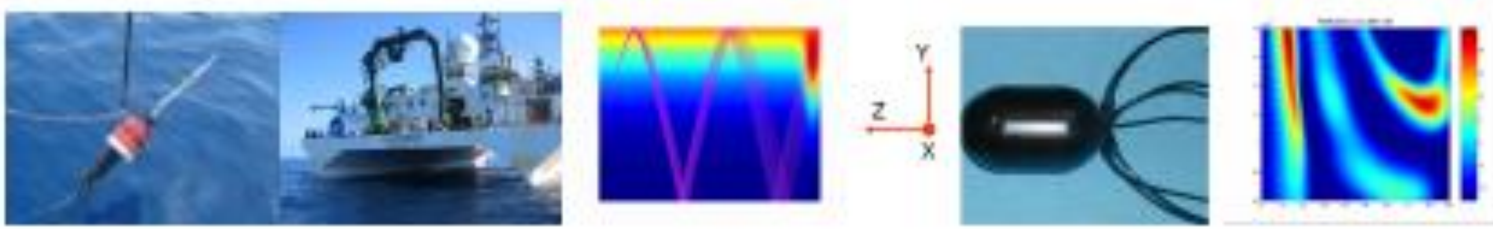
Basically, the signals are acquired by pressure sensors (hydrophones) and recently the use of vector sensors became a more advantage way for underwater applications.

Underwater Acoustics
Challenges and Applications

...to listen or not to listen ?

Paulo Santos (pjsantos@ualg.pt)
ISR, IST-ID, University of Algarve
(siplab.fct.ualg.pt)

Work

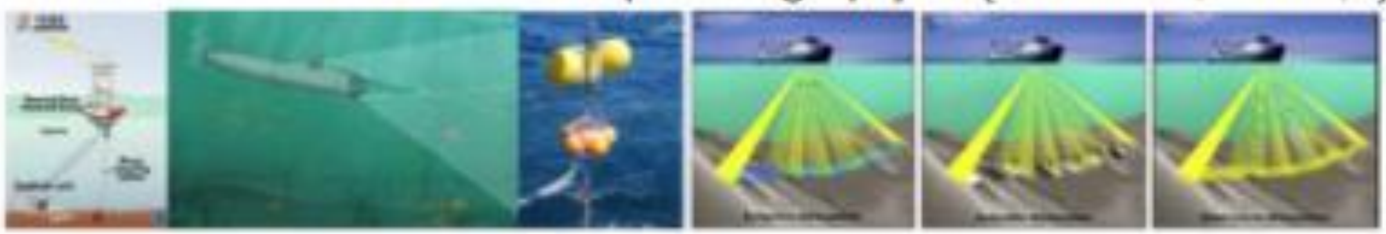


Team

Use sound to...

- **active:** improve technology for ocean exploration/exploitation

comms sonar adcp geophysics(multibeam,seismic,..)



- **passive:** monitor the ocean environment and resources

mammals fish and litoral shipping noise earthquakes

time-variable environment

$\Downarrow$

$$\mathbf{y} = \mathbf{H}\mathbf{s} + \mathbf{n}$$

$\Uparrow$

s known, unknown deterministic, random

Active

1. Underwater communications
   estimate $\mathbf{s}$ or $\mathbf{H}$ (knowing $\mathbf{s}$)
2. Geophysical exploration
   estimate $\mathbf{H}$ knowing $\mathbf{s}$

Passive

1. Water column temperature
   estimate $\mathbf{H}$ assuming $\mathbf{s}$
2. Bottom seagrass health
   statistical analysis of $\mathbf{y}$
3. Shipping noise
   estimate $\mathbf{y}$, assuming $\mathbf{s}$ and $\mathbf{H}$

Challenges

time-variable
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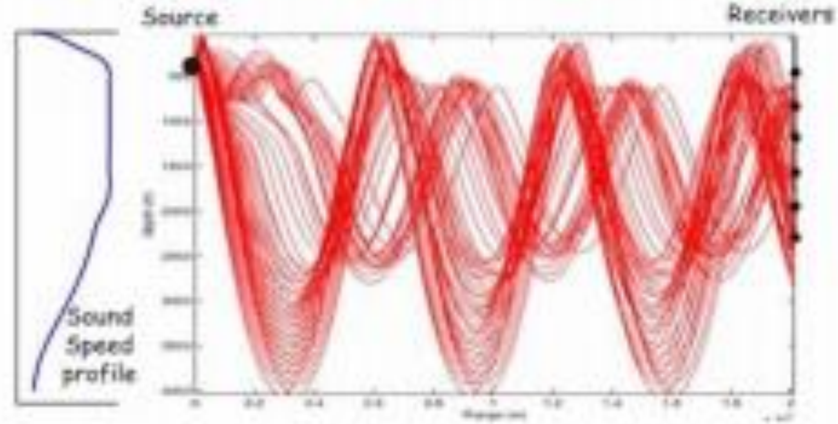
Complex underwater operations

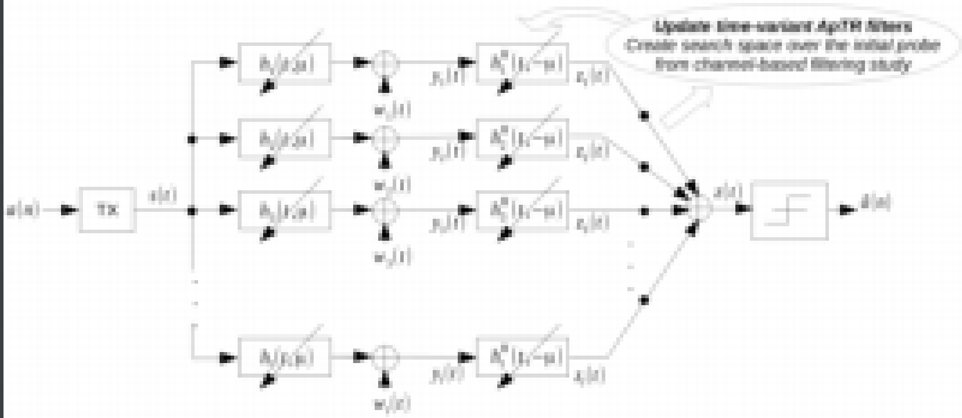
Refractions and Reflections



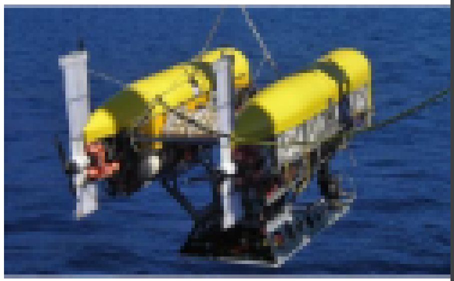
Useful equipment

Application 1: deep sea communications

Physical model-based Comms

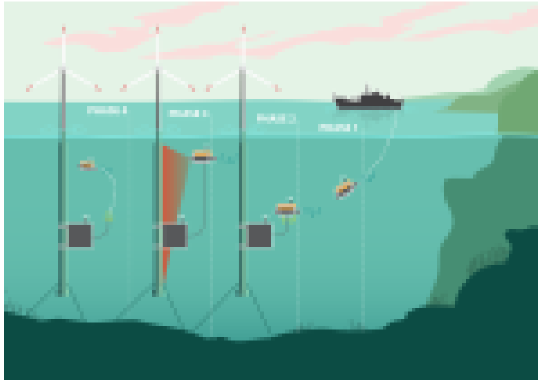


OceanTech project (2018-2020)



STRONGMAR project (2016-2019)

Exploration

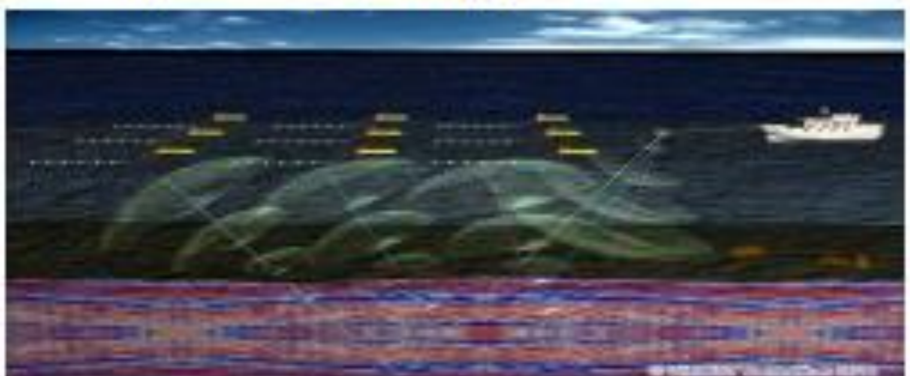


Caiti et. al., "Linking Acoustic Communications and network performance:...", IEEE JOE, 38(4), 2013

Maia et. al., "A perspective for time-varying channel compensation..", Sensors & Transducers, 189(6), 2015.

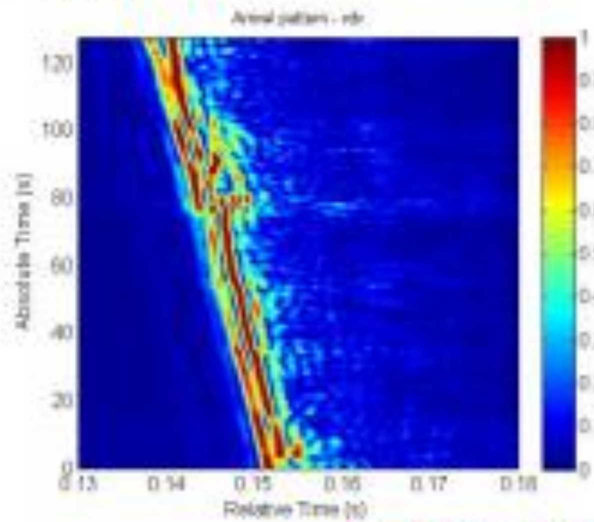
WiMUST project (2015-2018)

- reducing the complexity and cost of geophysical surveys
- operation in sensitive areas (coastal)
- optimal array configurations



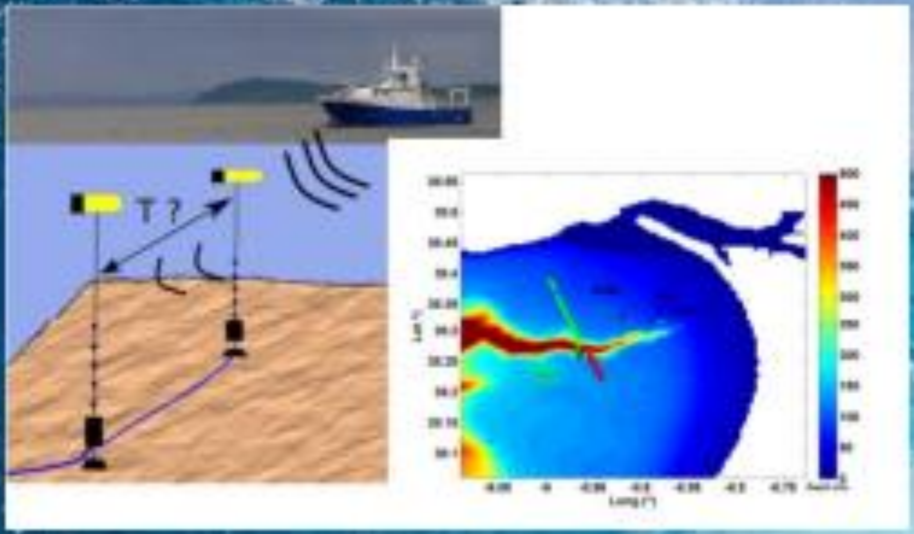
Vector sensor

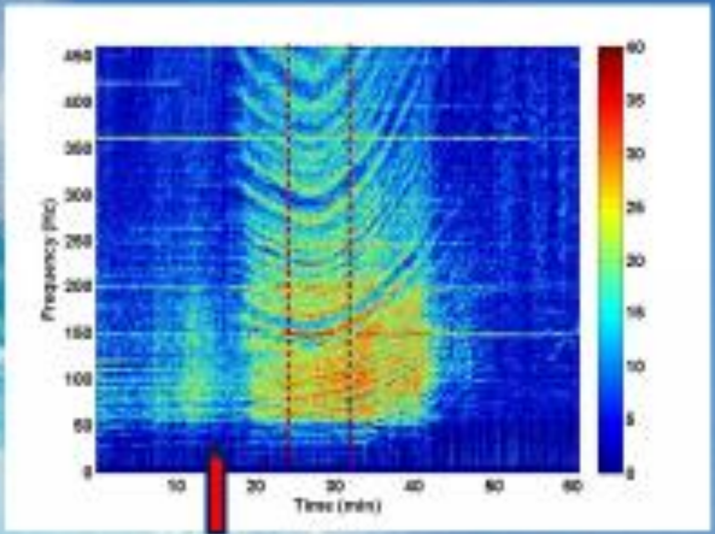
- measure pressure and particle velocity (field directivity)
- spatial filtering capabilities (deghosting, directional noise)
- large spatial discrimination with short arrays



P. Santos *et al.* "Seabed geoacoustic characterization with a vector sensor array", JASA, 128, No.5, 2010.

Application 3: ocean observatories





listening to the ocean

- understand biological, environmental and seismic processes
- estimating ocean proprieties from sources of opportunity
- integration with non-acoustical sensors

EMSODEV (2015-2019)

european multidisciplinary seafloor & water column observatory emso

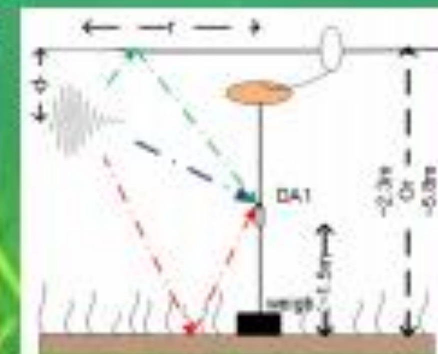
Horizon 2020 European Union Funding for Research & Innovation

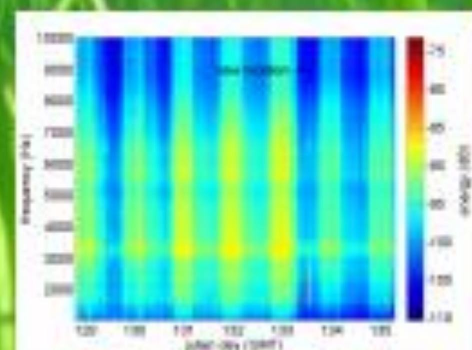
A. B. Santos et al. "Acoustic channel frequency response estimation ...", IEEE/EQS, COA 2016, China, 2016

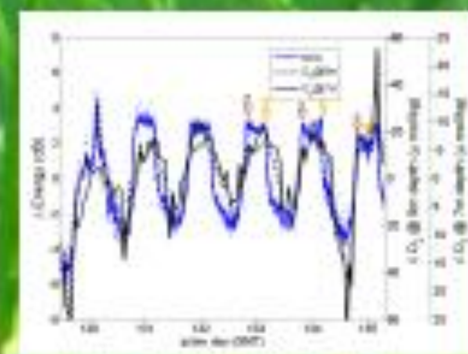
Application 4: littoral monitoring

- **Seagrass meadows**
  - O_2 production, fish habitat, shore line stabilization
- **Active acoustics**
  - bubbles assessment (not readily assessed by conventional methods → underestimation of O_2 production
- **Passive acoustics**
  - biological noise → to estimate populations (species, abundance, behavior)
  - link between O_2 production and noise variability

STARESO, Corsica, Oct. 2011, May 2013







SEAOX project (FCT - PTDC/EEI-PRO/2598/2014) focus on the "*Ria Formosa*" Lagoon ecosystem

Felisberto *et al.*, "Acoustic monitoring of O2 production of a seagrass meadow", J. Exp. Marine Biology Eco. 2015.

Sensing Huge Data and IoT Systems

Challenges in the recognition of activities of daily living anywhere at anytime without special requirements using mobile devices

The Assisted Living Computing and Telecommunications Laboratory (ALLab) is a research group created within the Network Architectures and Protocols Research Group of the Instituto de Telecomunicações pole at the University of Beira Inteiror, Covilhã, Portugal. In the context of IT@UBI, the Assisted Living Computing and Telecommunciations Laboratory is focused on research on Biosignal algorithms, Ambient Assisted Living, Biosignal aquisition and transmission, and Quality of Experience has been created.

Research staff has experience on development of Intelectual Property. We have also connections to other research groups in in the USA (Prof. Madalena Costa, Beth Israel Deaconess Medical Center, Harvard Medical School) and in Portugal (Polythecnique Institute of Castelo Branco, Superior Health School Dr. Lopes Dias, University of Trás-os-Montes and Alto-Douro, Center for Research in Sport, Health and Human Development, Lusophone University of Humanities and Technologies), and to QoE research groups in Europe through the IC0703 COST Action. Research cooperation with private companies is also implemented, either following a model of "research per request" or a "shared risk model".

Challenges in the recognition of activities of daily living anywhere at anytime without special requirements using mobile devices

One of our research studies is related to the research and development of a Personal Digital Life Coach (PDLC). It includes different components, including the recognition of Activities of Daily Living (ADL), recognition of environments, recognition of emotions and integration of all modules with Big Data. The recognition of ADL and environments is now finished with success, reporting the recognition of 16 events (ADL and environments) with more 2.97% of accuracy than the average accuracy reported in the literature.

The recognition of the emotions is now in the phase related to the research about the state-of-the-art, which should be finished in the next years. After that, the integration with Big Data will be performed. There are other ongoing projects related to the use of other sensors, including Electrocardiography and others, using the Bitalino sensors.

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Development of a Personal Digital Life Coach using Mobile devices' Sensors

Ivan Miguel Serrano Pires
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Altranportugal – Lisbon, Portugal
E-mail: impires@it.ubi.pt

September 2018

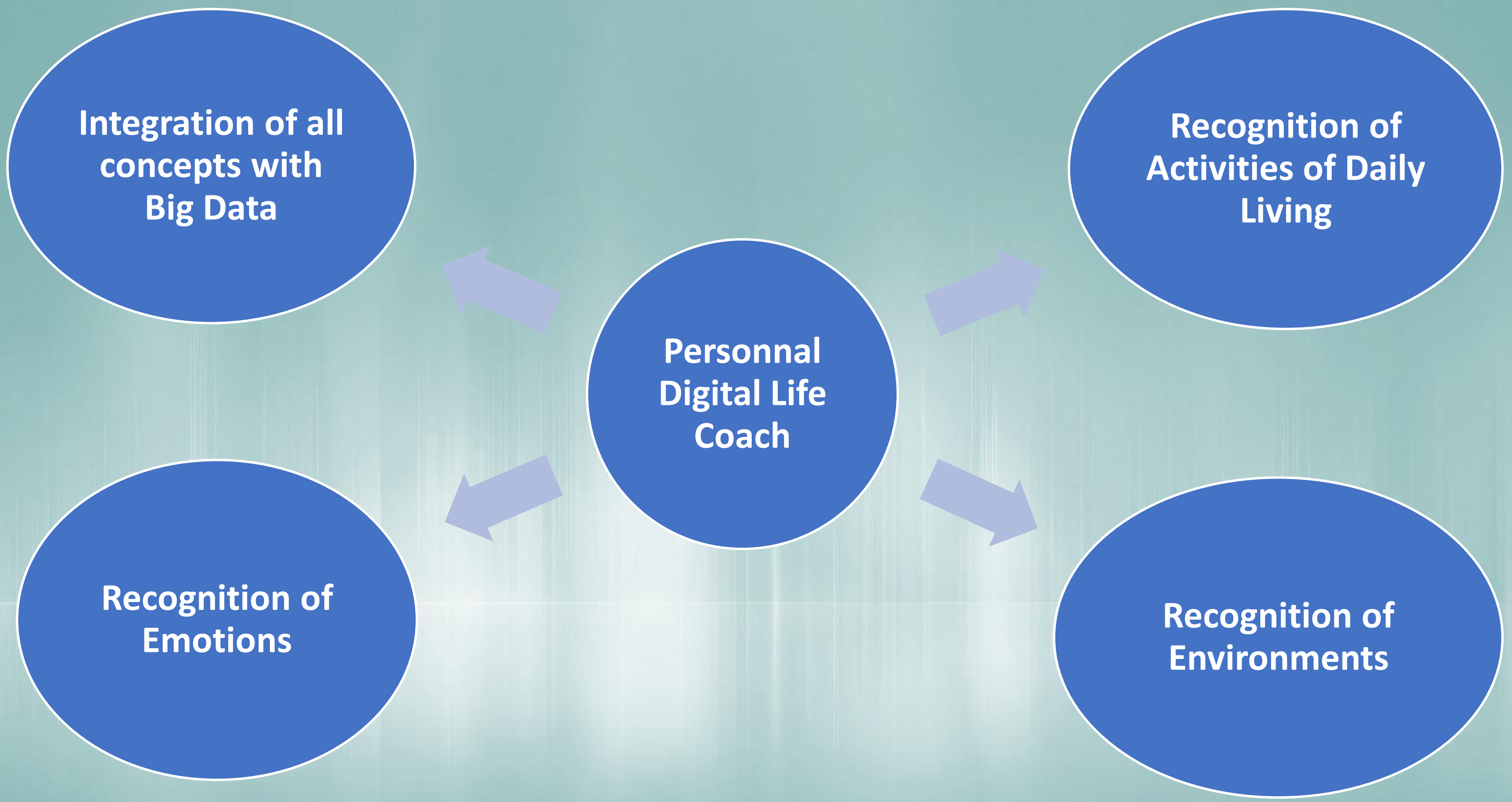
Agenda

- Background of Ambient Assisted Living Computing and Telecommunications Laboratory
- Development of a Personal Digital Life Coach – Concepts
- Framework for the Recognition of Activities of Daily Living using Mobile Devices' Sensors
- Limiting Resources for the Recognition of Activities of Daily Living
- Directions for Lightweight Data Fusion Methods
- Future Improvements for the Classification Methodologies
- Insights Development for the Personal Digital Life Coach

Background of Ambient Assisted Living Computing and Telecommunications Laboratory

- Different research studies related to the Mobile Health
- Different studies related to the development of a Personal Digital Life Coach
- Different studies related to the networking concepts
- We are placed in University of Beira Interior, Covilhã, Portugal

Development of a Personal Digital Life Coach



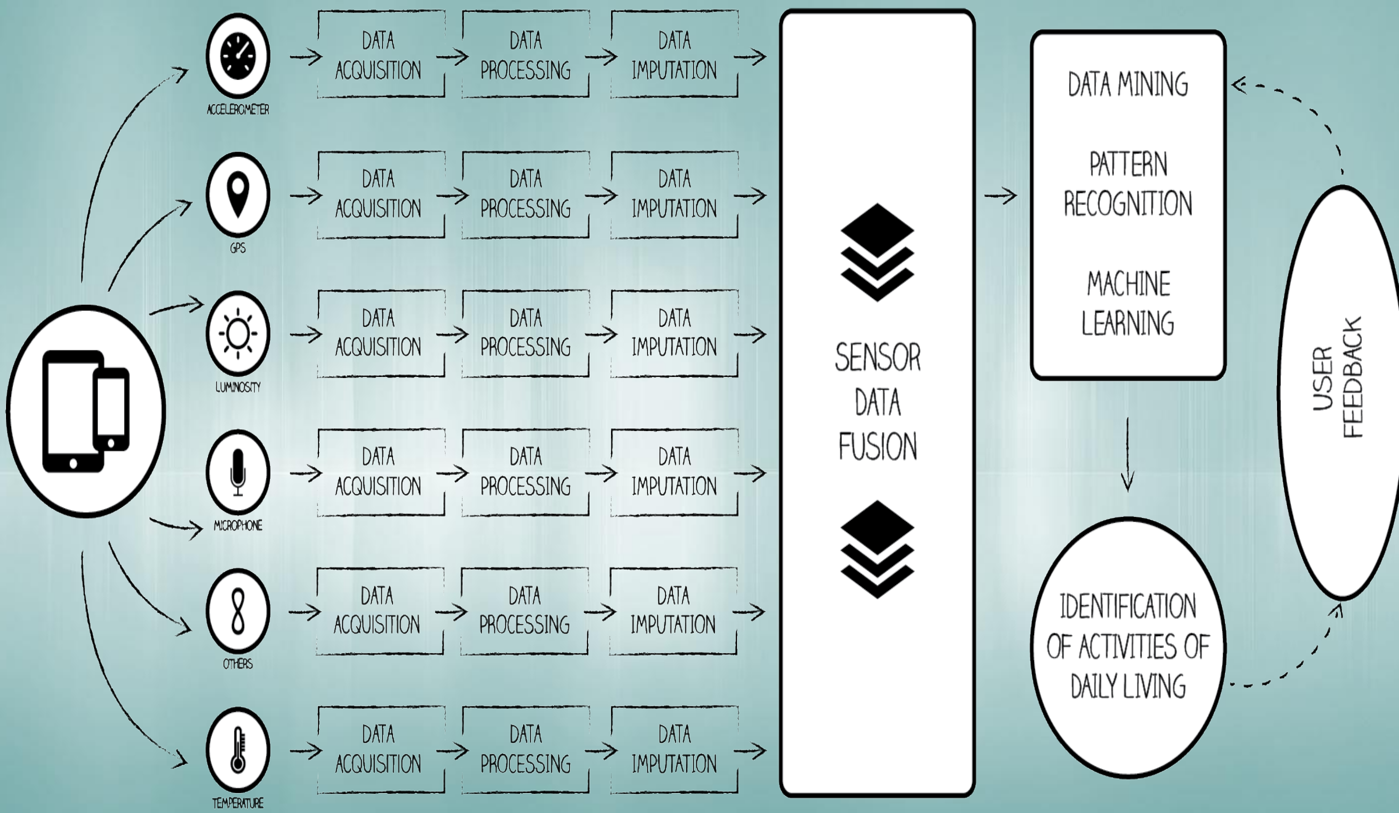
Framework for the Recognition of Activities of Daily Living using Mobile Devices’ Sensors

- Development of an Android Library using a Smartphone

- Components of the Framework:
  - Sensors
  - Data Acquisition
  - Data Processing
    - Data Cleaning
    - Data Imputation
    - Feature Extraction
  - Data Fusion
  - Classification

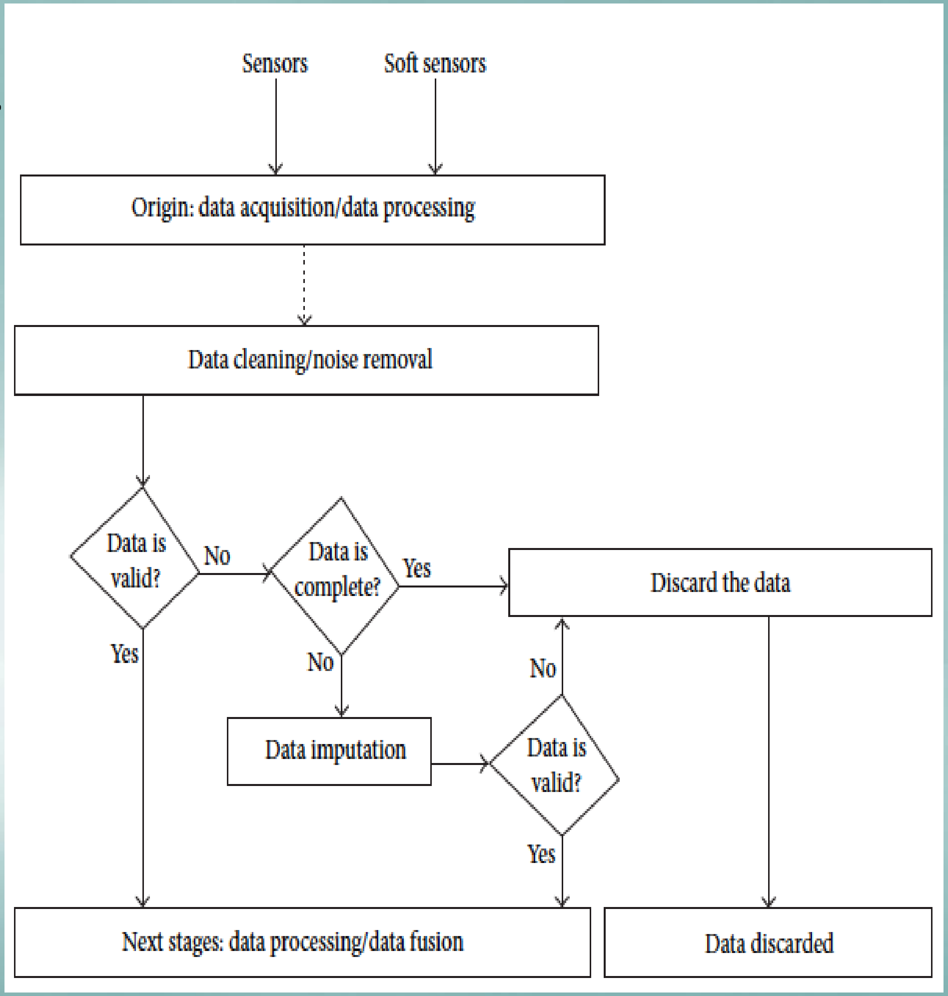
Framework for the Recognition of Activities of Daily Living using Mobile Devices' Sensors - Evolution

- First Proposal ➔ 2015



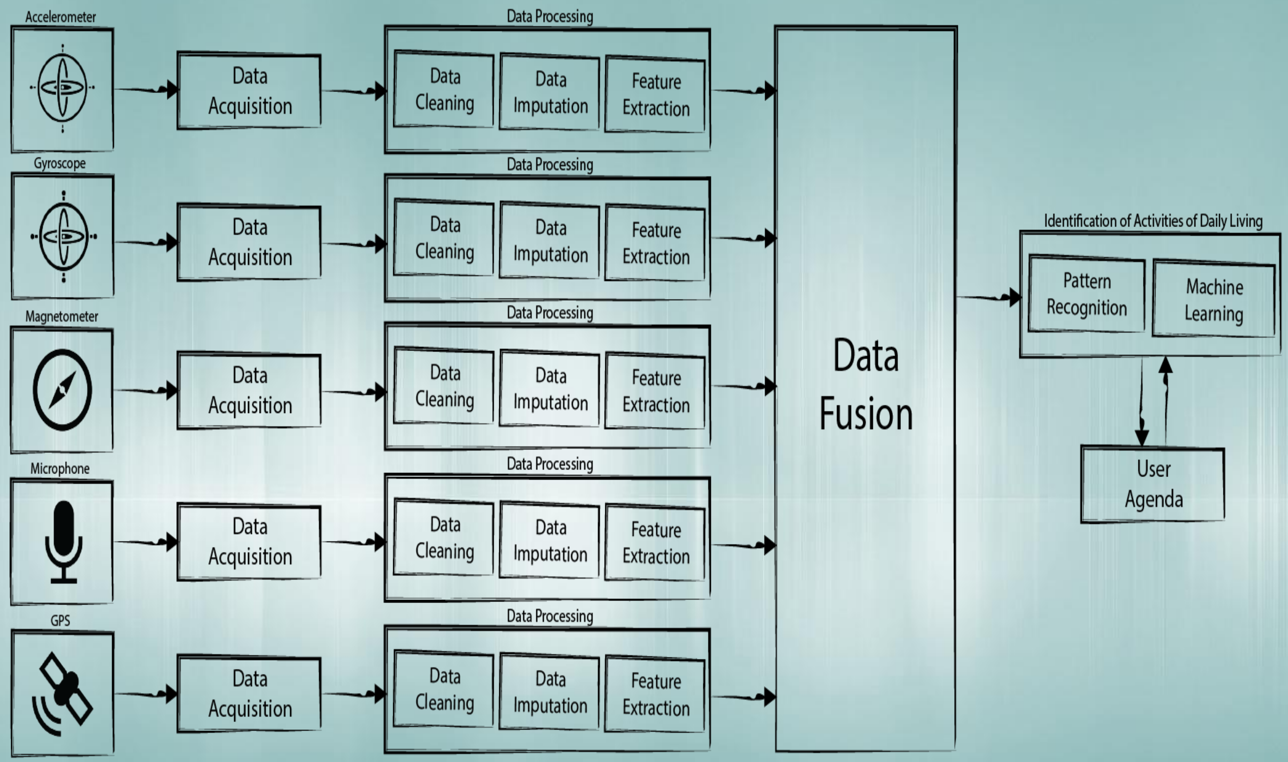
Framework for the Recognition of Activities of Daily Living using Mobile Devices' Sensors - Evolution

- Second Proposal ➔ 2



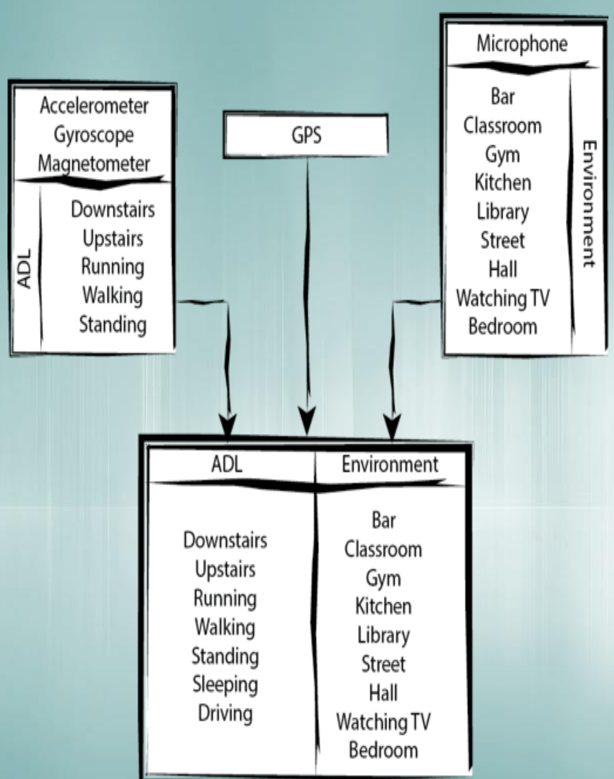
Framework for the Recognition of Activities of Daily Living using Mobile Devices' Sensors - Evolution

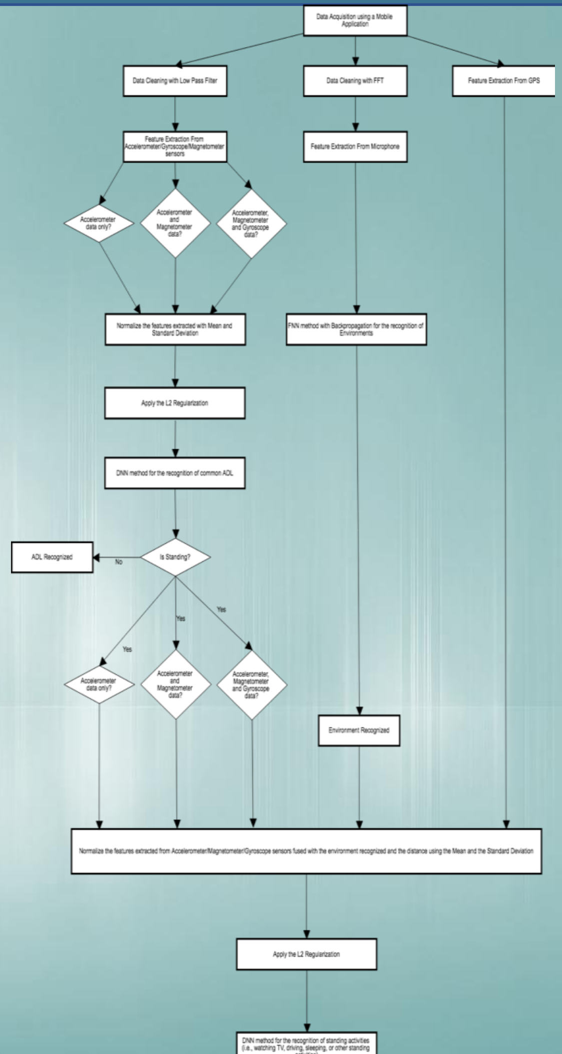
- Third Proposal ➔ 2017



Framework for the Recognition of Activities of Daily Living using Mobile Devices' Sensors - Evolution

- Final Proposal ➔ 2018





Limiting Resources for the Recognition of Activities of Daily Living

- Sensors - Minimalistic Approach
- Futuristic Active/Passive Devices for IoT
- Sequentiation of Concepts for the Recognition of Activities of Daily Living
- Ubiquitous Computing for Huge Data Processing

Directions for Lightweight Data Fusion Methods

- Data Fusion Methods - Cutting Edge
- Performance Indicators Improvement using Data Fusion Methods
- Heavyweight Algorithms Beaten by Lightweight
- Future of the Data Fusion using On-going Development Devices

Future Improvements for the Classification Methodologies

- Existing Classification Methodologies
- Different Approaches for Limited Resources
- Use of Cloud Computing Off-Load Techniques
- Knowledge Refinement using the Results Obtained with Different Techniques

Insights Development for the Personal Digital Life Coach

- Personalized methods for the Daily Activity Assistant
- Individualized Smart-Home Insight
- Importance of the Emotional Intelligence for the Personal Digital Life Coach
- Big Data for the Personal Digital Life Coach

Development for the Personal Digital Life Coach – Current State

- Studies Completed:
  - Recognition of Activities of Daily Living
  - Recognition of Environments
- Ongoing Research:
  - Recognition of Emotions
- Future Research:
  - Integration of all concepts with Big Data

Thank you!!!

Huge Data and IoT Applications in Precision Agriculture

Sensing Huge Data and IoT Systems

Precision agriculture (PA) is an approach to farm management that uses information technology to ensure that the crops and soil receive exactly what they need for optimum health and productivity. The goal of PA is to ensure profitability, sustainability and protection of the environment.

In this context, PA is a development that emphasizes the use of sensors, information and communication technology in the farm management cycle. New technologies such as the Internet of Things (IoT) and cloud computing are expected to leverage this development and introduce more automation based on robots and artificial intelligence in farming.

This is encompassed by the phenomenon of huge data, massive volumes of data with a wide variety that can be captured, analyzed and used for decision-making. Based on the concept of supply chain, huge data are being used to provide predictive insights in farming operations, drive real-time operational decisions, and redesign business processes for food production.

In the Panel it is discussed the present and the future of sensing huge data and IoT in PA based on scenarios. Also, further development of sensor´s networks, data quality, and application platforms are both presented together with models for data sharing and decision making processes.

Panel
Sensing Huge Data and IoT Systems

Huge Data and IoT Applications in Precision Agriculture

Paulo E. Cruvinel
paulo.cruvinel@embrapa.br
Embrapa

Needs for knowledge, science, industry & innovation in food safety?

As defined by the Food and Agriculture Organization (FAO) of the United Nations:

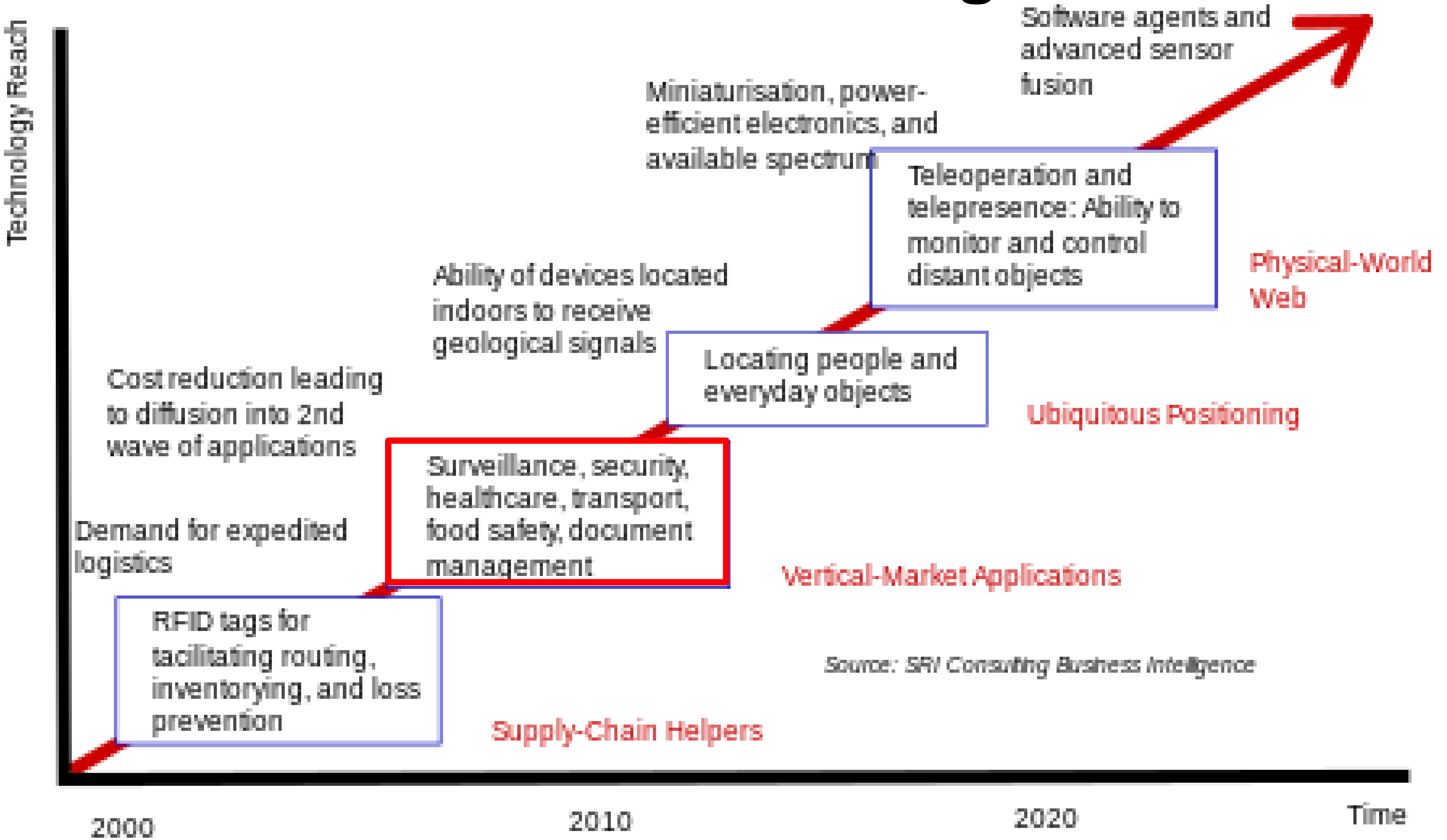
- Food safety "exists when all people at all times have both physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs for an active and healthy life."

Food and Agricultural Organization of the United Nations (2013). Hunger Portal: FAO. Date retrieved: June 10, 2018. Retrieved from: http://www.fao.org/hunger/en/

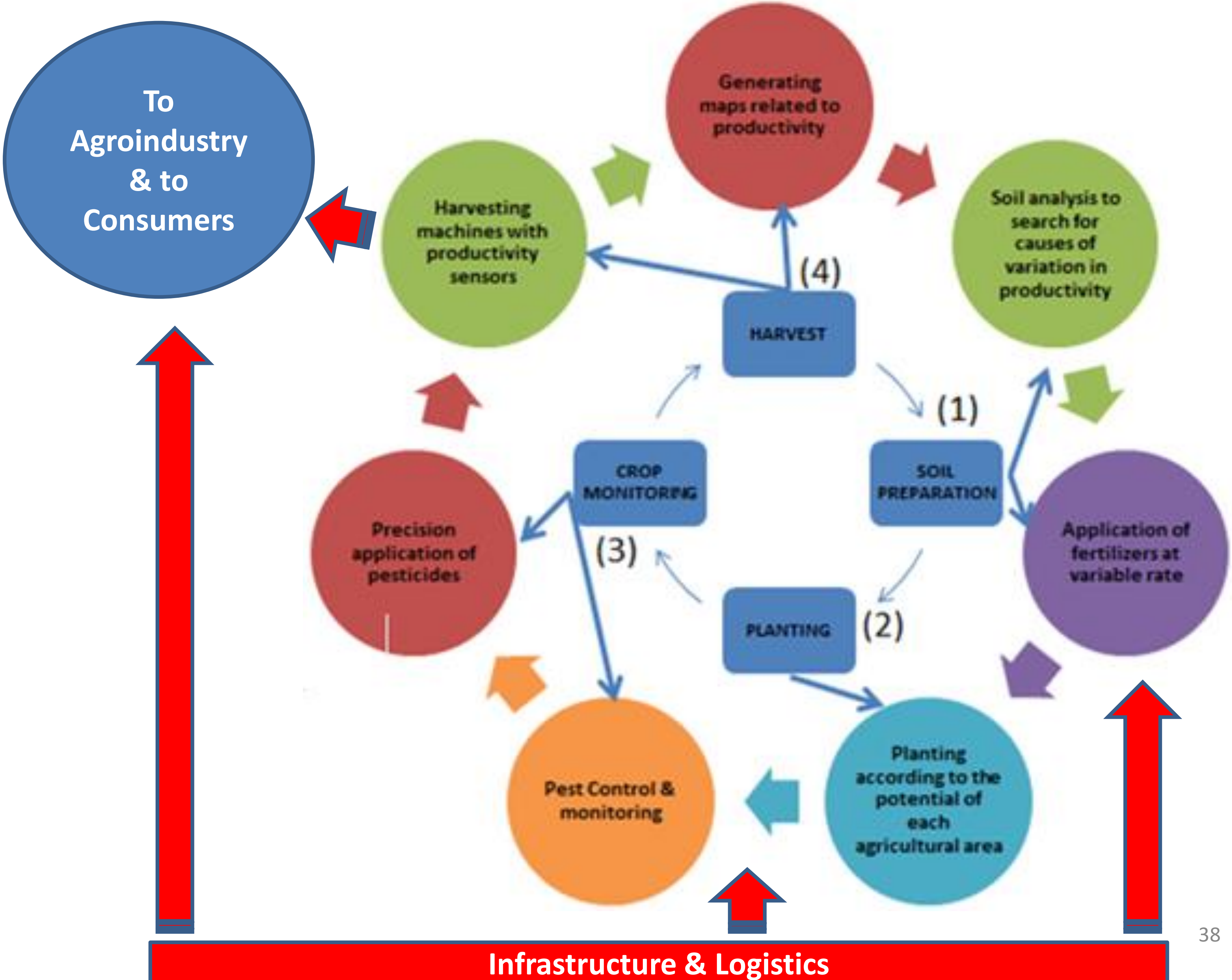
Challenges

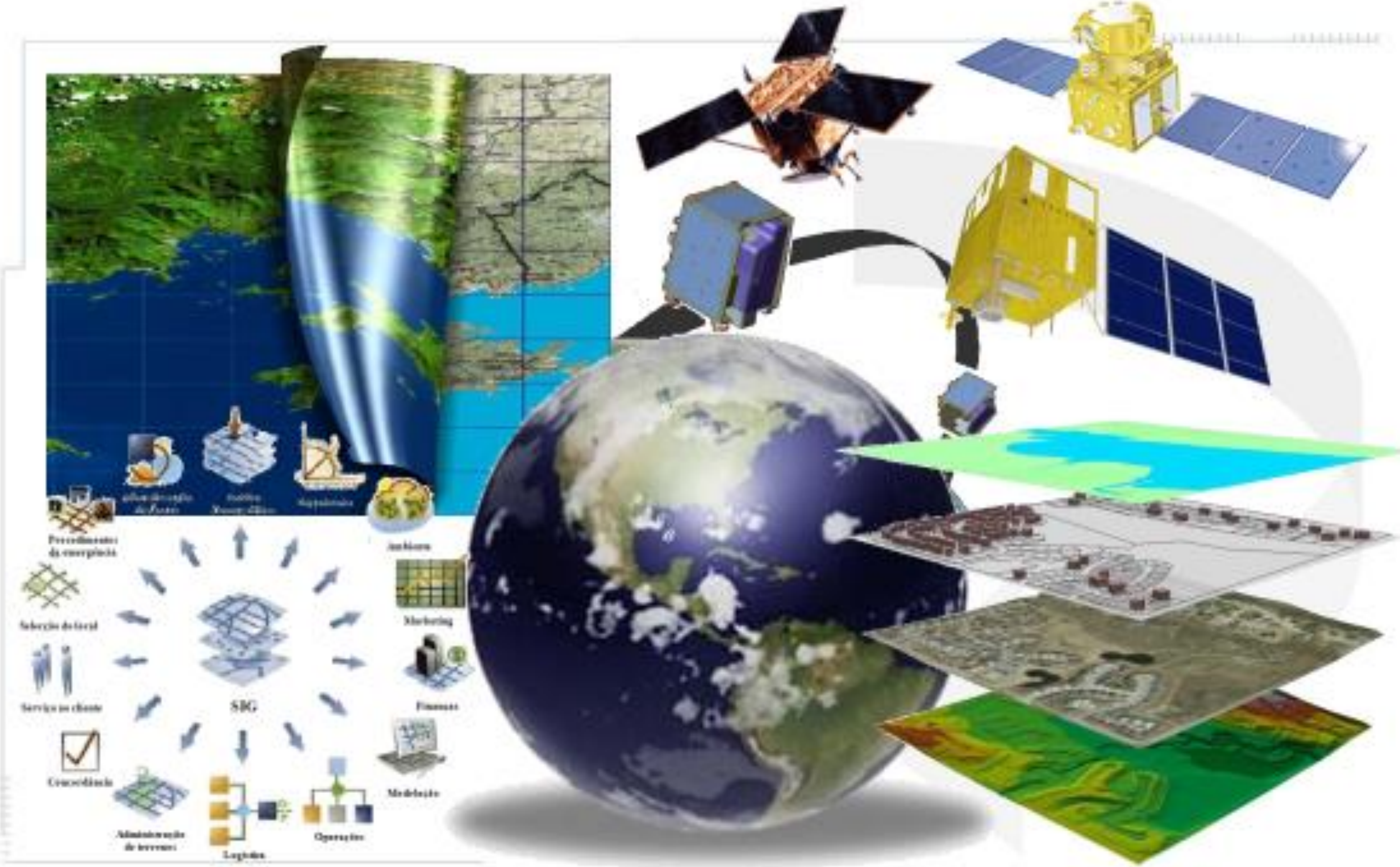
- An increasing global population, in combination with climate change, poses a threat to food safety as arable land becomes less available;
- **Global population**: Projected to be approaching 12 Billion People in the 2050s;
- **Food production**: needs to increase more than 60% in food production;
- **Degradation, Water use, Resilience of natural resources, Pest Control**: needs for sustainability;
- **Risk Control**: Biggest challenge, demanding huge data sensing and IoT systems to support decision making.

Technology roadmap:
The Internet of Things

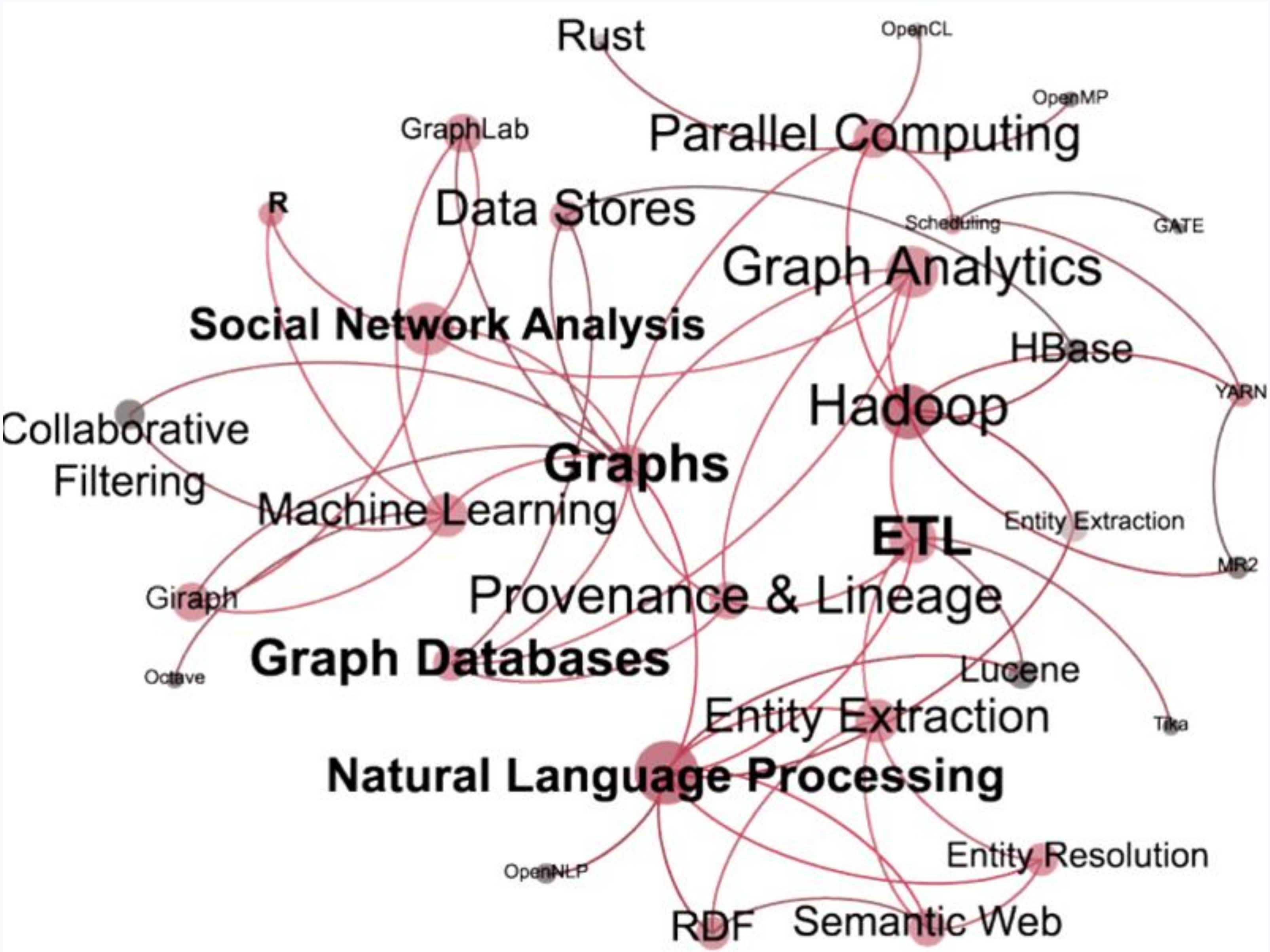


Source: SRI Consulting Business Intelligence, In: 3rd International Conference on Networks, Applications, protocols and Service (NetAPPS), Sept, 2012. Date retrieved: August 10, 2018


To Agroindustry & to Consumers
Generating maps related to productivity
Harvesting machines with productivity sensors
Soil analysis to search for causes of variation in productivity
(4)
HARVEST
(1)
CROP MONITORING
SOIL PREPARATION
Precision application of pesticides
(3)
Application of fertilizers at variable rate
PLANTING
(2)
Planting according to the potential of each agricultural area
Pest Control & monitoring
Infrastructure & Logistics


SIG
Marketing

Huge Data Landscape...



Food Safety….but also Food Security

RESEARCH ARTICLE OPEN ACCESS

Complexity of the International Agro-Food Trade Network and Its Impact on Food Safety

Article | Metrics | Related Content | Comments: 2

Mária Ercsey-Ravasz[1,2], Zoltán Toroczkai[1], Zoltán Lakner[3], József Baranyi[4*]

1 Interdisciplinary Center for Network Science and Applications (iCeNSA) and Department Physics, University of Notre Dame, Notre Dame, Indiana, United States of America, **2** Faculty of Physics, Babes-Bolyai University, RO-400084 Cluj-Napoca, Romania, **3** Department of Food Sciences, Budapest Corvinus University, Budapest, Hungary, **4** Institute of Food Research, Norwich Research Park, Norwich, United Kingdom

To **add a note**, highlight some text. Hide notes

Make a general comment

Jump to

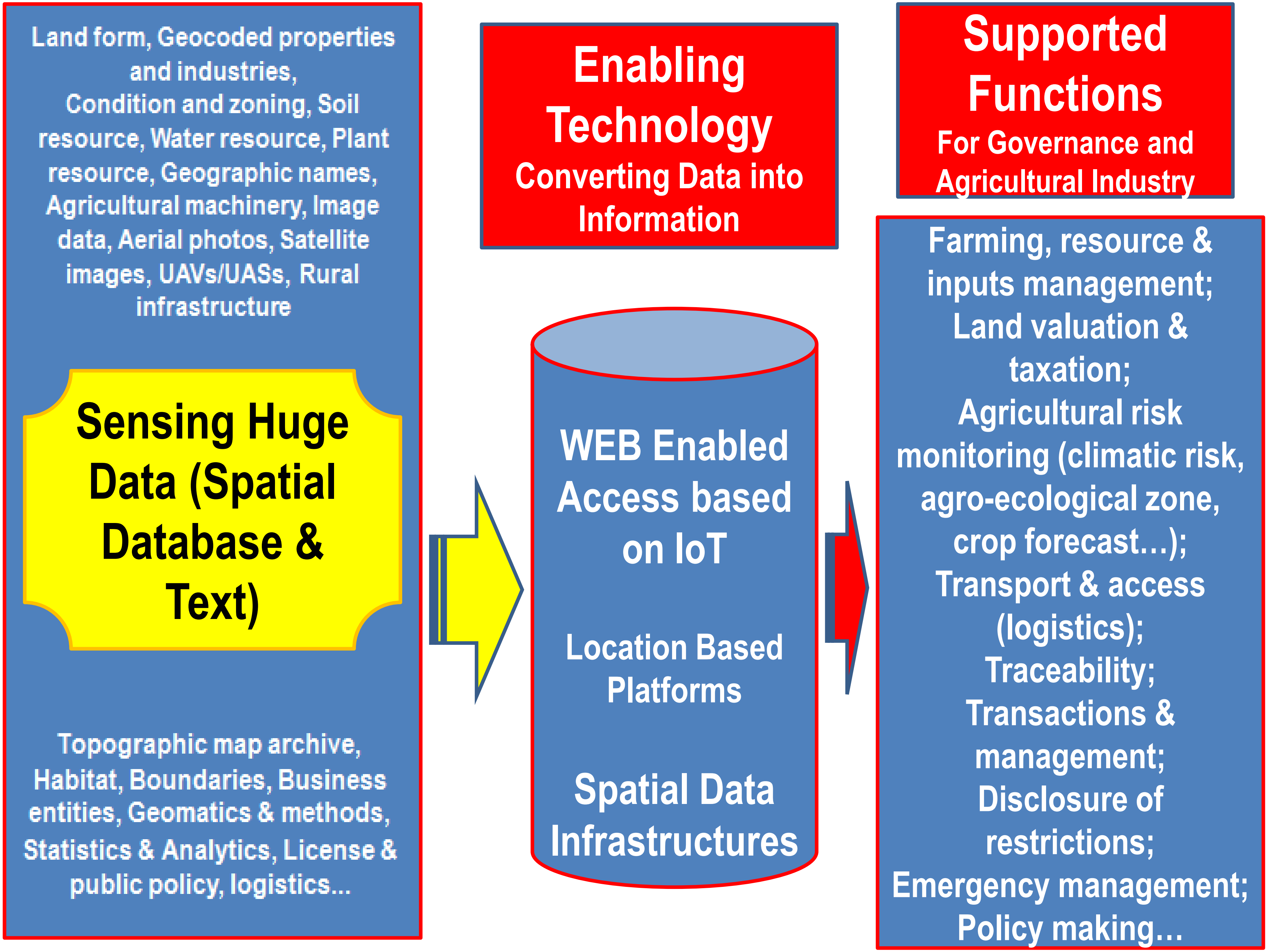
Abstract Top

With the world's population now in excess of 7 billion, it is vital to ensure the chemical and microbiological safety of our food, while maintaining the sustainability of its production, distribution and trade. Using UN databases, here we show that the international agro-food trade network (IFTN), with nodes and edges representing countries and import-export fluxes, respectively, has evolved into a highly heterogeneous, complex supply-chain network. Seven countries form the core of the IFTN, with high values of betweenness centrality and each trading with over 77% of all the countries in the world. Graph theoretical analysis and a dynamic food flux model show that the IFTN provides a vehicle suitable for the fast distribution of potential contaminants but unsuitable for tracing their origin. In particular, we show that high values of node betweenness and vulnerability correlate well with recorded large food poisoning outbreaks.

http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.phone.0037810

Analysis of the international food-trade network shows great vulnerability to the fast spread of contaminants.

Source: Ercsey-Ravasz M, Toroczkai Z, Lakner Z, Baranyi J (2012) Complexity of the International Agro-Food Trade Network and Its Impact on Food Safety. PLoS ONE 7(5): e37810. doi:10.1371/journal.pone.0037810


Land form, Geocoded properties and industries,
Condition and zoning, Soil resource, Water resource, Plant resource, Geographic names, Agricultural machinery, Image data, Aerial photos, Satellite images, UAVs/UASs, Rural infrastructure
Sensing Huge Data (Spatial Database & Text)
Topographic map archive, Habitat, Boundaries, Business entities, Geomatics & methods, Statistics & Analytics, License & public policy, logistics...
Enabling Technology
Converting Data into Information
WEB Enabled Access based on IoT
Location Based Platforms
Spatial Data Infrastructures
Supported Functions
For Governance and Agricultural Industry
Farming, resource & inputs management;
Land valuation & taxation;
Agricultural risk monitoring (climatic risk, agro-ecological zone, crop forecast…);
Transport & access (logistics);
Traceability;
Transactions & management;
Disclosure of restrictions;
Emergency management;
Policy making…

Sensing huge data & data quality

<table>
<tr><th>Data Management System
Processes / Procedures</th><th>Data Quality System
Processes / Procedures</th><th>Auditable System & Serviceability</th><th rowspan="7">Risk Verification</th></tr>
<tr><td>Source</td><td rowspan="6">Validity
Reliability
Integrity
Precision
Timeliness</td><td rowspan="6">verification of the entire process, i.e., data acquisition, architectures involved, data processing, information retrieval, decision making models, among others</td></tr>
<tr><td>Collection</td></tr>
<tr><td>Collation</td></tr>
<tr><td>Models and analyses</td></tr>
<tr><td>Reporting</td></tr>
<tr><td>Usage</td></tr>
</table>

Food Industry based on Huge Data, IoT Applications and Precision Agriculture

Zoning of Climatic Risks

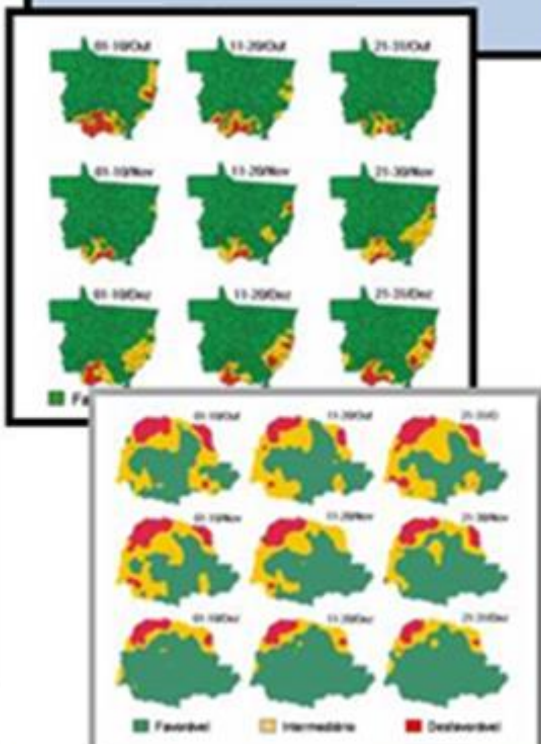
Regionalization of climatic claims to minimize losses in agricultural production, risks reducing from the rainfall regimes

Agroecological Zoning of Sugarcane

It defines suitable areas and exclusion zones for the cultivation of sugar cane in Brazil. Directs the policy of expansion and bioethanol production

Low Carbon Agriculture ABC Plan

Decarbonization of the agriculture processes by the incorporation of practices of low emission of greenhouse gases



Conclusions

There are many challenges in ongoing sensing huge data and IoT systems related with processes for decision making in agriculture. So far, the approach depends on the complex scenarios related to agriculture and food production, as well as from the level of data with quality required to support the value chain and the biomes diversity.

Thanks for your attention!

IARIA

Sensing Huge Data and IoT Systems

Panel´s Conclusions

Today, there are many needs to generate, organize and use huge data and the internet of things (IoT) related with processes for decision making. Such processes are related with environment, industry, defense, automation, robotics, storage, logistics, traceability, and agriculture, among others.

The approach used to tackle each one of these issues depends on the application scenario, as well as from the amount of data and quality required for the intended use, and of course due the sensors, IoT, and their performances. Therefore, in such scenario, there are needs for digital development associated with huge amount of data, interpretation, sensors‘ network, intelligence, and the IoT, which are now playing an important role, i.e., not only to find opportunities for business but also to allow sustainability to life quality for the world population.

Furthermore, in such realistic scenario the information retrieval and the decision making based on sensing huge data and IoT systems are still a big challenge and lead to opportunities at national, regional and global level.