Building a service-oriented platform for online physiological data analysis

M. Colom
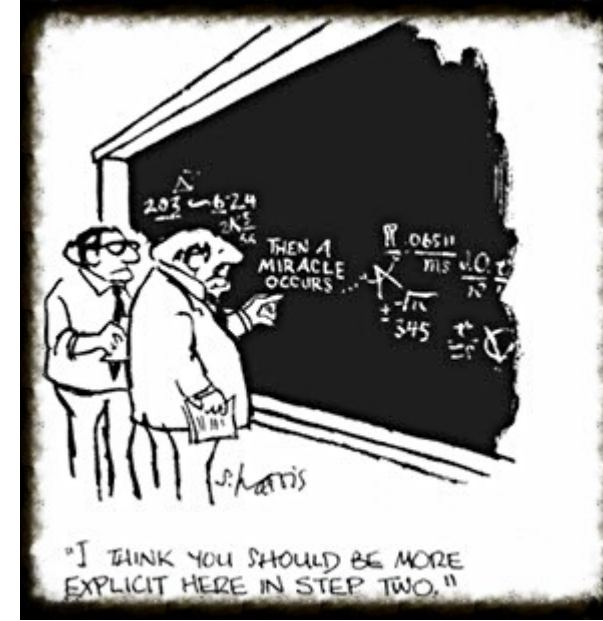
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CMLA, ENS-Cachan

Reproducible Research

"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

- **Redefine** the product of research:
  - Article, source code, data
- **Why** do we need it? → **Trust results**
- **Applicable** to all disciplines? Cosmology, Biology, Computer Science...?
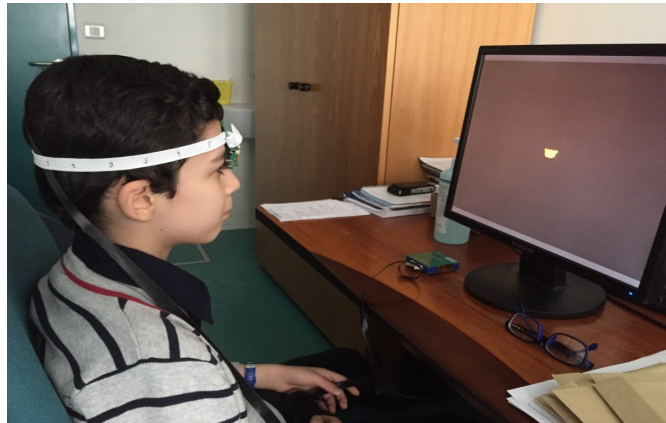- What if we **combine** RR with **Clinic Research**?

SmartAlgo

- A new **platform** for **RR** in algorithms applied to **Clinical** <u>**Research**</u>

- A joint project

- Which kind of medical problems/algorithms?

    - Balance and movement

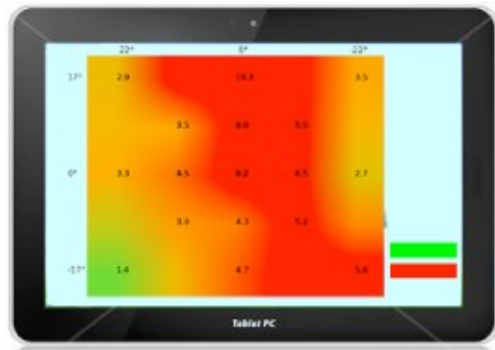   - Eye tracking (Infantile Nystagmus Syndrome, Spasmus Nutans-type nystagmus)

    - ...

→ Online prototype demo: *Animated Statos*

SmartAlgo: Oculo project
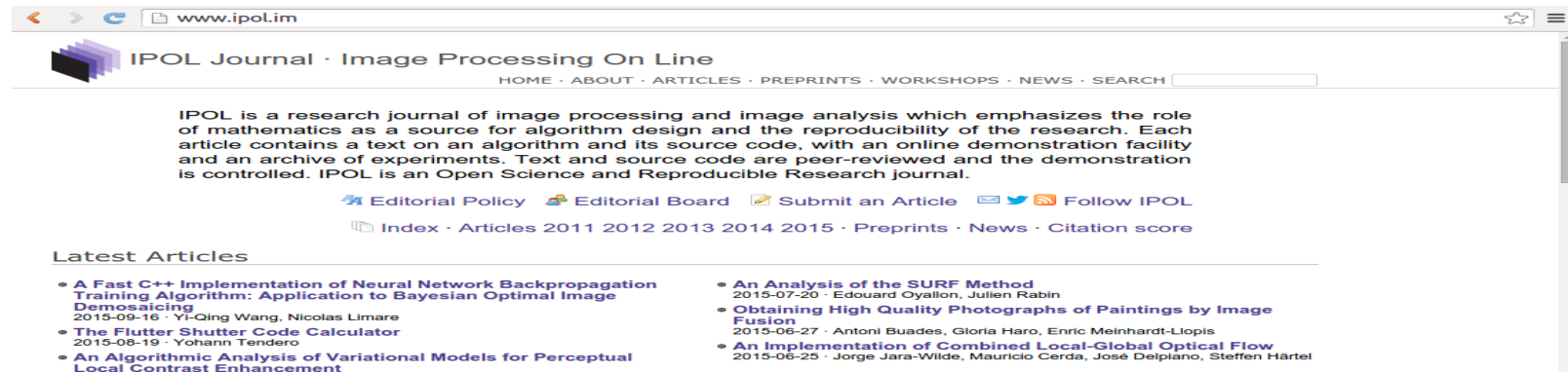
Quantitative assessment in daily clinic

Tablet

Wi Fi
few seconds
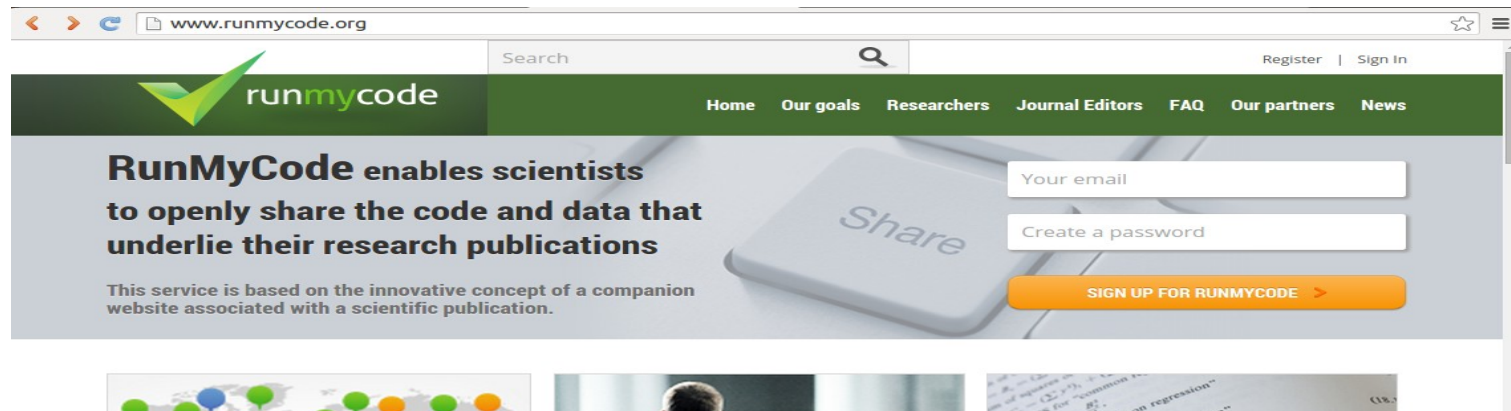
Data processing center

IR recording

Databases

Similar projects

IPOL

Run My Code

Some differences...

- **IPOL** is a **full RR journal**, with **peer-reviewed** article and source code. The demos are a valuable tool, but not peer-reviewed.

- The aim of RunMyCode is to give **visibility** to the results of the research. They publish **non-peer-reviewed** source code and data.

- SmartAlgo is somewhere in the middle.

  - **Peer-reviewed**

  - A **platform** for **clinical research**. Not just a repository of code or demos

  - **Data** is **real** and come from actual physiological signals obtained with **sensors**

  - Data needs to be **standardized** because of the different kinds of sensors (for example: different sampling rates, formats, etc)

  - **Validated** and **annotated** data
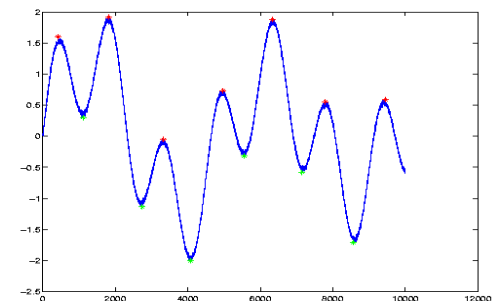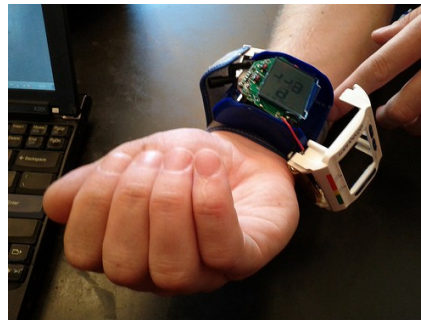
A technical challenge?

- Of course. It's a **complex** system which includes:
    - Signal preprocessing and standardization
    - Multiple kind of signals
    - Annotation of signals
    - Storing and retrieving efficiently all the information
    - Complex interface interactions (web, tablets)
    - Etc.

- So, the main difficulties are **technical**? **NO**

An <u>agreement</u> challenge!

- It's mainly an **agreement problem**, not just technical
  - **Physicians** normally are far away from algorithms, mathematics, formal methods
  - **Mathematicians and engineers** are not familiar with neurological pathologies or diagnostic methods
  - (*Of course!*)
  - But the problem needs a **multidisciplinary** approach to apply advanced techniques of **signal-processing** and **machine-learning** to obtain results in **clinical research**.
  - But physicians and mathematicians/engineers usually **talk very different languages.**

A dual point of view
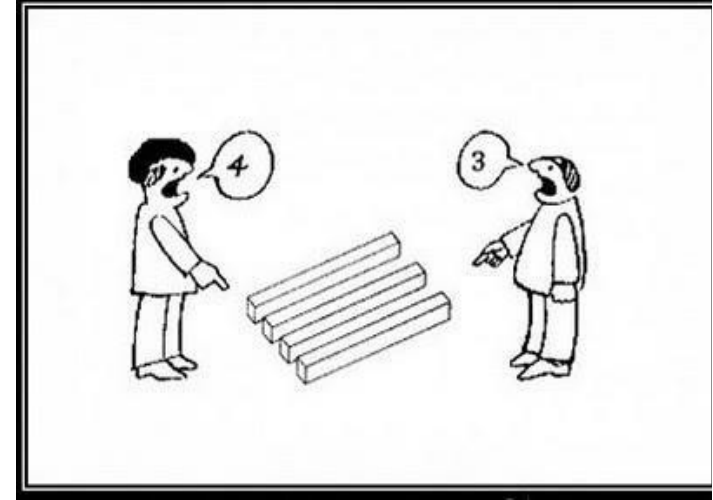
- It's **the same problems**, but seen from **different angles**
- For example,
  - Physicians interested in: fall assessment, balance of patients, eye tracking, walk of patients, ...
  - Mathematicians/engineers interested in: models, classification, regularization, generalization, automatic learning, ...

- **Problem**: *which kind graphical interface should be show?* Something in the middle?
- **Solution**:
  - Each user has a **role** (physician, mathematician/engineer)
  - The graphical interface **first matches the general role**
  - But it must be **adaptive**: it should be *customizable* and remember the preferences of the user.
  - Why this way? Two "different worlds", but the same problem → They should **converge**.

Only an "agreement problem"?

- Not only!
- Other issues, very particular of this project
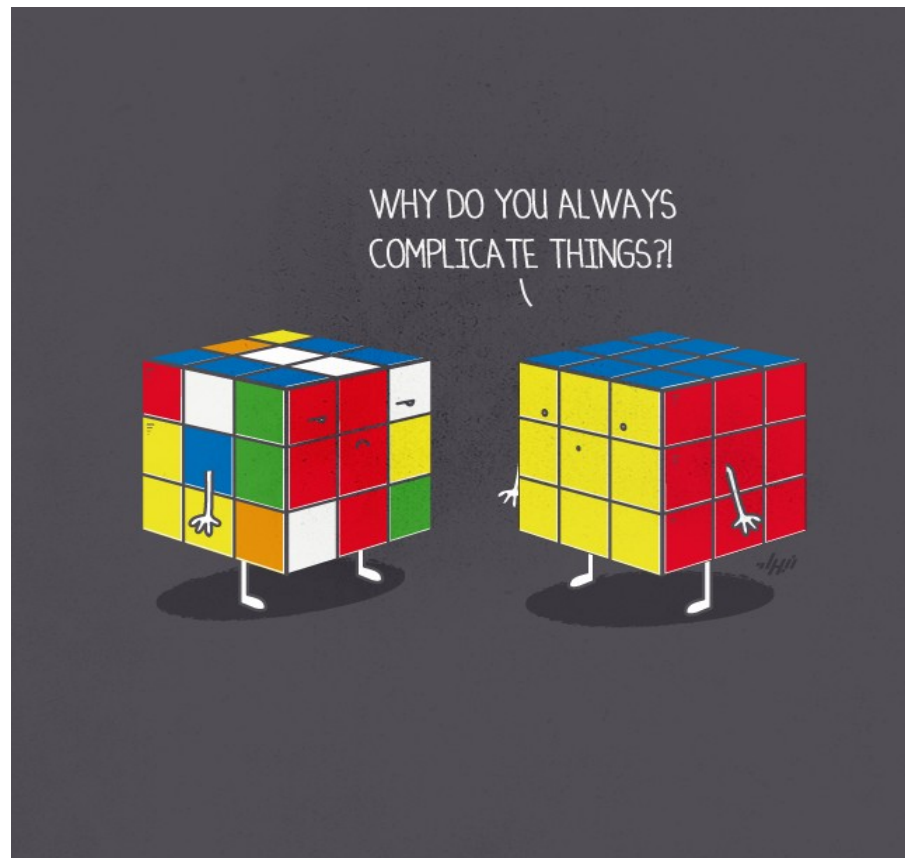
Other issues: **input data**

- **Real data** from **physiological signals**
  - Sometimes **incomplete**
  - Might be **inaccurate**
  - Characteristics of the sensor might be **undocumented**
  - **Many different captors and devices**
  - Need to **preprocess** the input data
 - Need to **standardize** all data in a **common format**
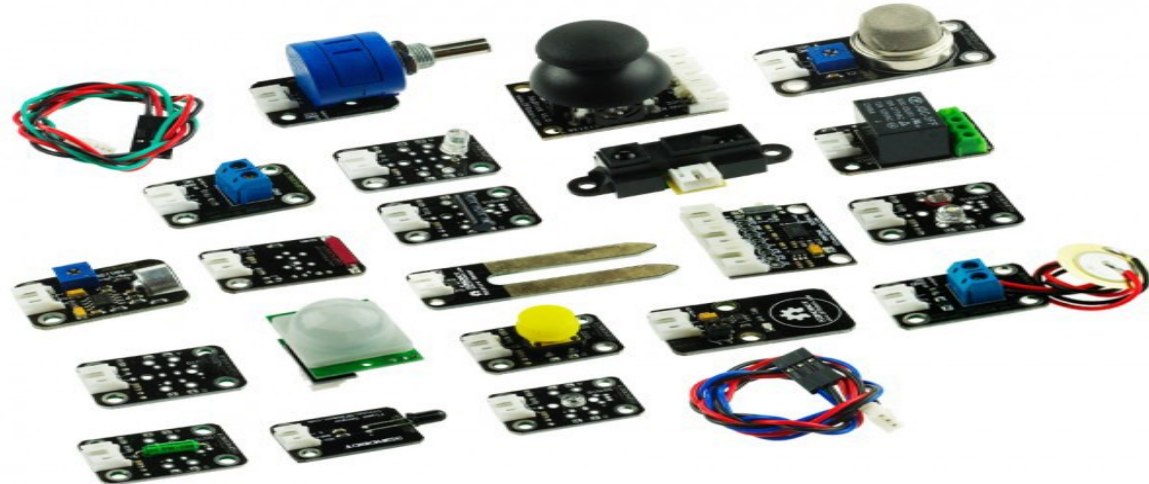
Other issues: **privacy**

* It's data from real patients!
* This kind of data can not be
  - Stored
  - Made public
  - ...
* **Very strict usage conditions**
* **Legal framework**:
  - l'article 8 de la convention europeenne de sauvegarde des droits de l'homme
  - la directive 95/46ce
  - la loi du 6 janvier 1978
  - le decret n°2006-6 du 4 janvier 2006 sur l'hebergement de donnees de sante a caractere personnel sur support informatique
  - l'ordonnance n°2010-177 du 23 fevrier 2010 – article 19
  - ...

* So? **Any solution**?
  - We're within the special case of **clinical research**:
    * Low-level signals
    * Need to anonymize data, absolutely

Development cycle

- Designing **usable interfaces** and **proper data visualizators** is **difficult**:
  - Physicians and mathematicians/engineers have **different interests**
  - It's difficult to have an **idea** of a new system **until you see a usable prototype**
  - Even **designing** and **modifying** a prototype is **expensive** in terms of **time** and **human resources**
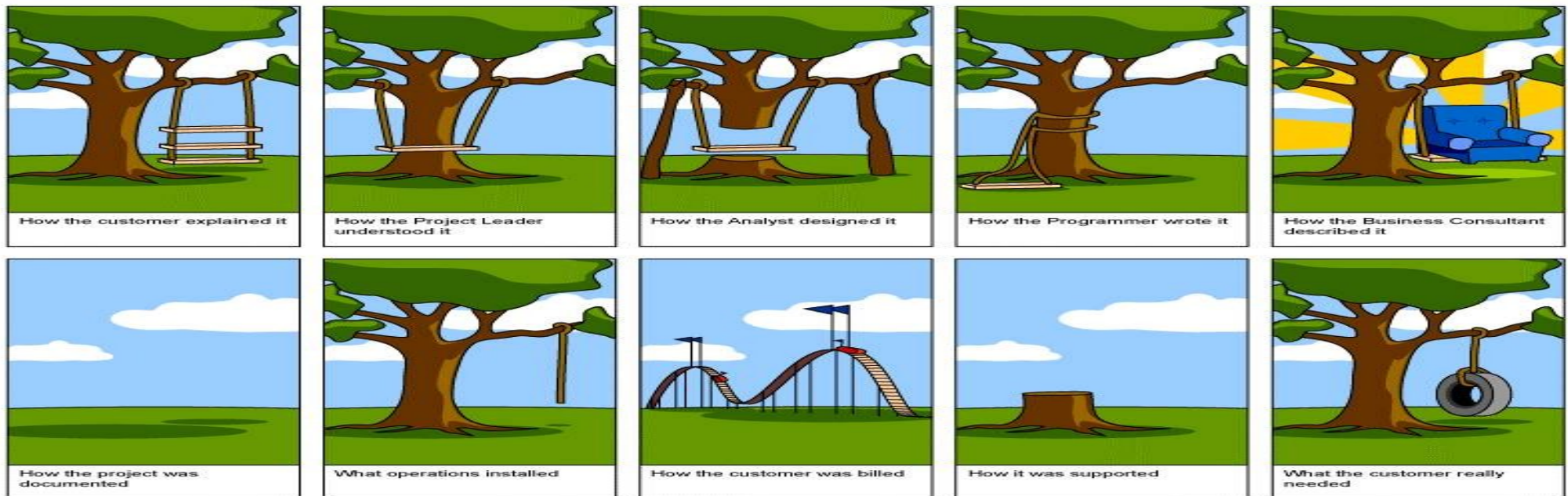
Our proposal: User eXperience Design (**UXD**)

- **Interviews** with the physicians to understand their needs and the particular problems in their field

- The same with mathematicians/engineers

- Imagine **use scenarios**

- Design **wireframe** or **mockup interfaces** → Show ours

- **Discuss** these interfaces with the users

- **Iterate** the prototypes until **agreement**

- When agreement: write **better prototypes** (real HTML5/CSS), **integrate code**, **iterate**.

At which point are we now?

- **Designing** **use scenarios**

- **Writing** **machine-learning** and **signal-processing** **algorithms**

- **Designing** **adaptive** **user interfaces**

- **Building** a **development team** → Need of a *large team of engineers,* in UX, design, machine learning, integration, coding, … Big project!

  – **Antecedents**: we have the experience of have been building **IPOL** at **CMLA**. *But still very different!*

What do we expect of SmartAlgo?

- **Reproducible Research**

- **Provide** Clinical Research with a **platform** with the best machine-learning and signal-processing **algorithms**. **And data!**

- Have **methods** and **data** we can **trust**

- Create a **large network** of clinical and non-medical researcher contributing with data

- Give the **technical means** (**platform**, **data**, **algorithms**) to establish a **Clinical Reproducible Research community.**

Thank you very much for your attention

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