Building a service-oriented platform for online physiological data analysis

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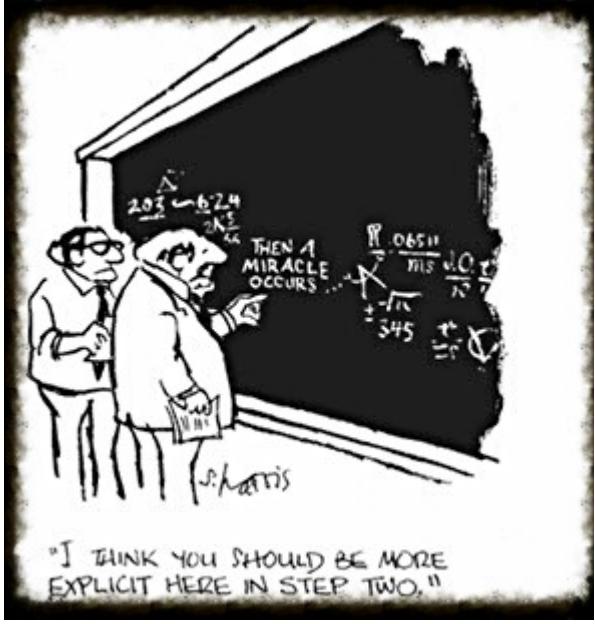
Reproducible Research



- **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

CMLA
Centre de Mathématiques et de Leurs Applications

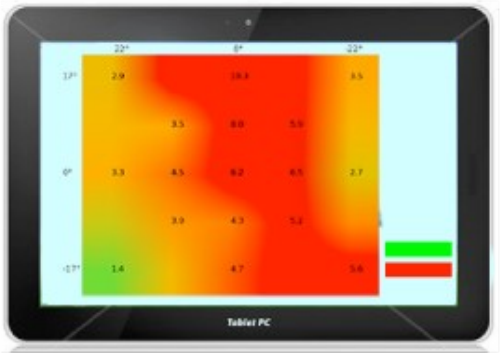
CognAc.G
Cognition & Action Group

- 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

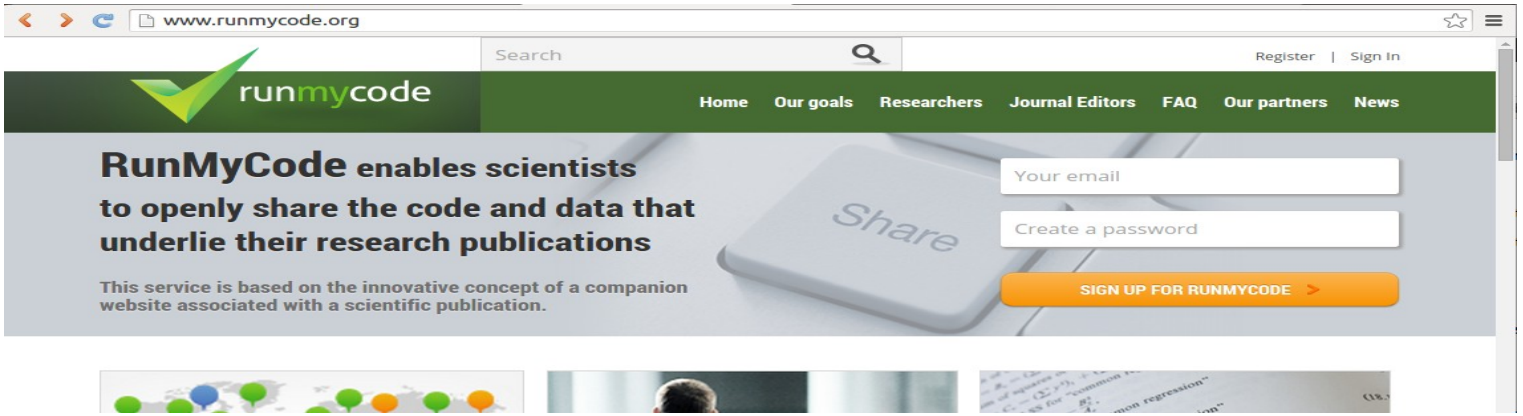
IR recording

Databases

Similar projects

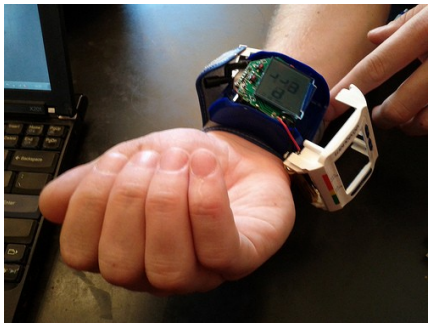
IPOL

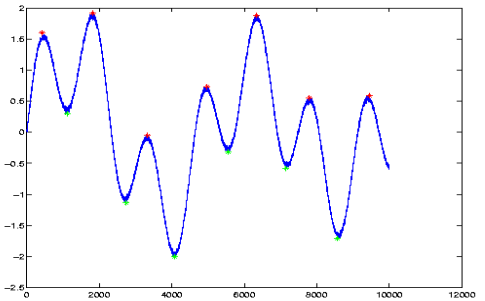
Run My Code



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 The demos are a valuable tool, but not peer-reviewed.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





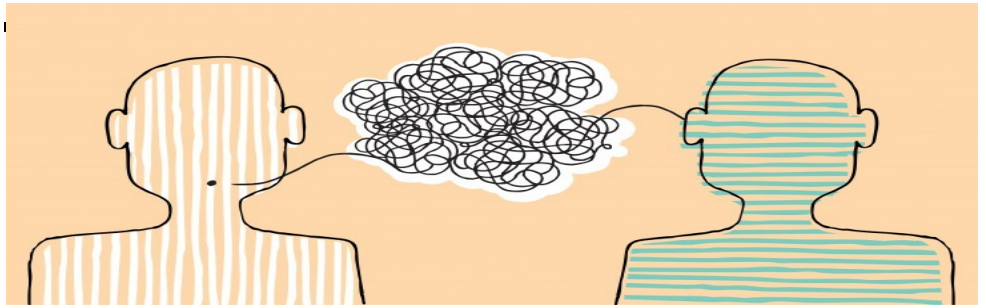
A technical challenge?

- 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.

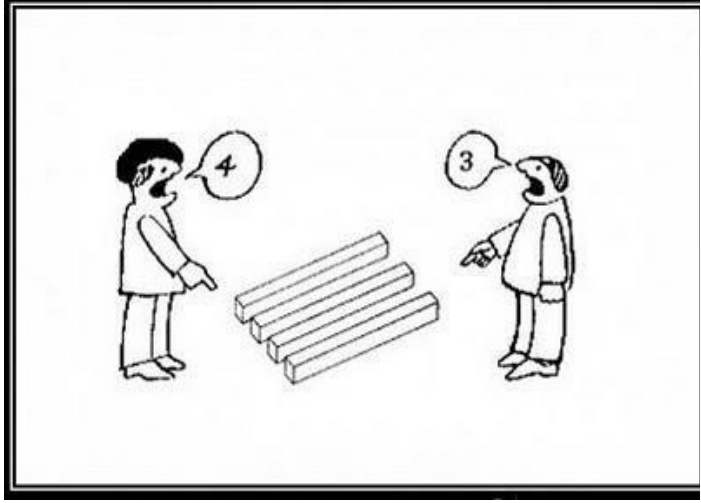
- So, the main difficulties are **technical**? **NO**

An agreement 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.**

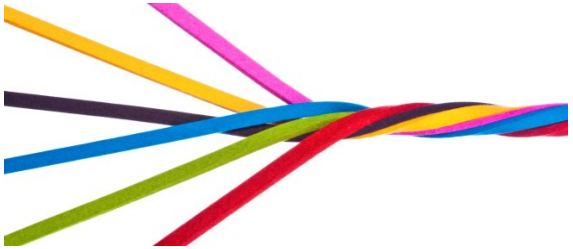


A dual point of view



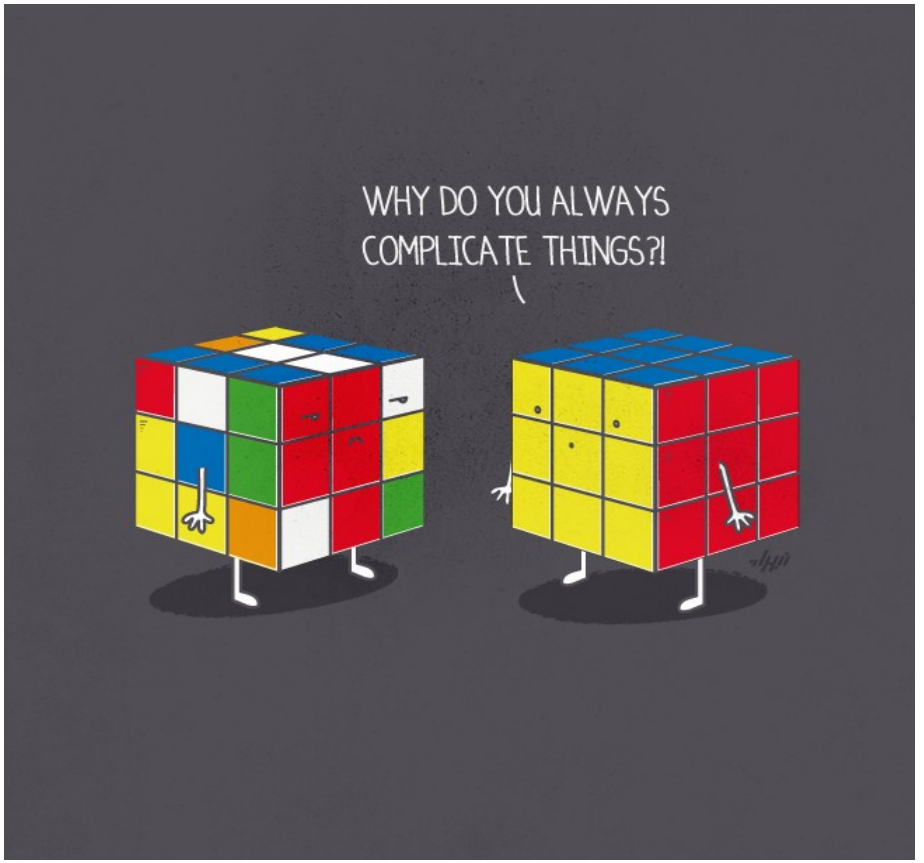
- It's **the same problems**, but seen from **different angles**
- For example,
  - Physicians interested in: fall assessment, balance of patients, eye tracking, walk of patients, ...
  - Mathematicians/engineers interested in: models, classification, regularization, generalization, automatic learning,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

- **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**.



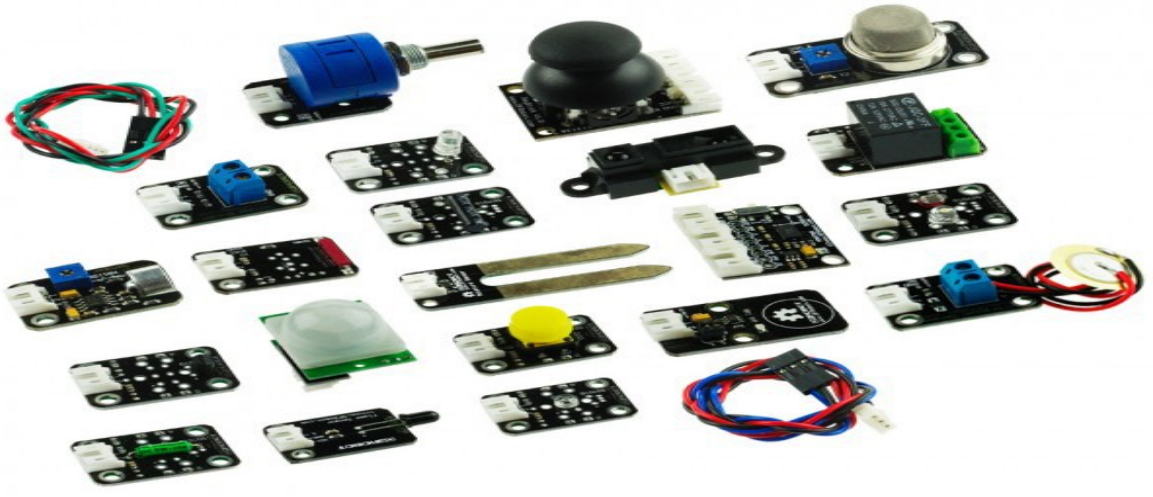
Only an “agreement problem”?

- 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**



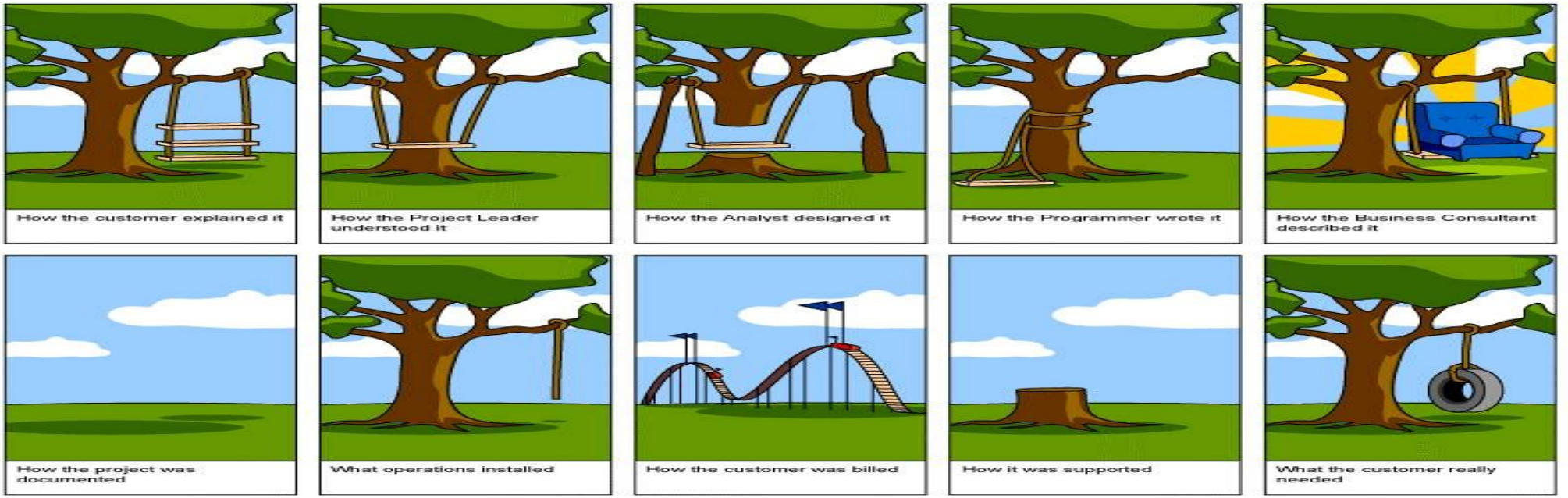
Other issues: **privacy**

- 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?

- **<u>Reproducible Research</u>**
- **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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