Reproducible Biometrics Evaluation and Testing with the BEAT Platform

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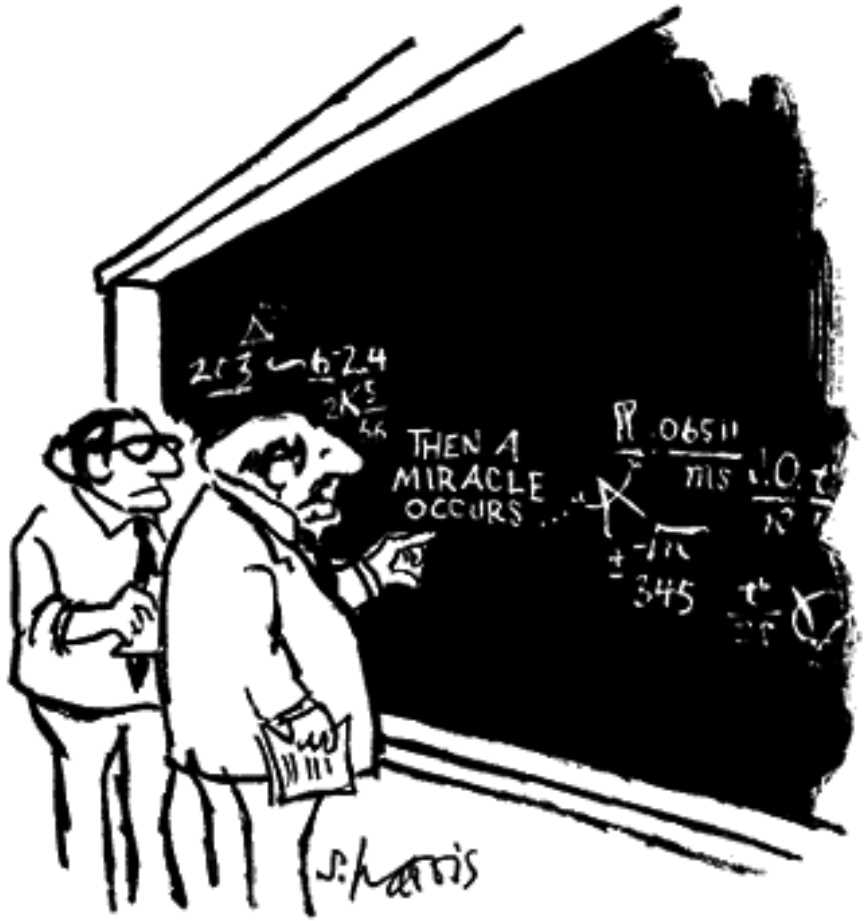
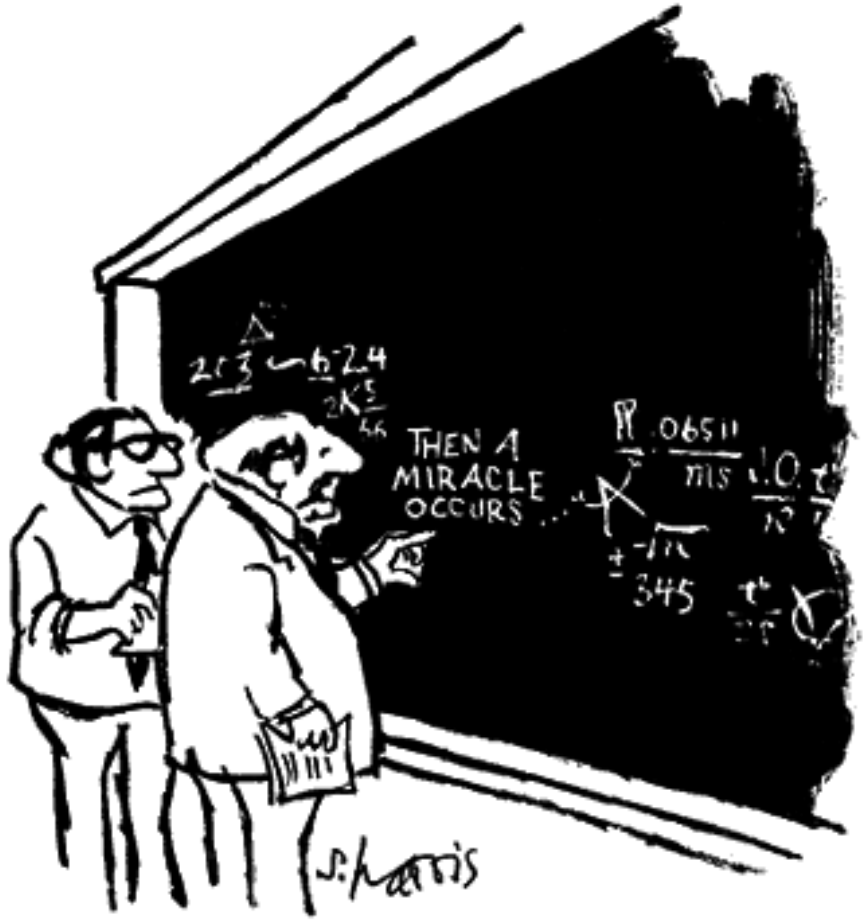


"I think you should be more explicit here in step two."

How many times?



"I think you should be more explicit here in step two."

Crossed a publication and openly decided to ***ignore it because it would be too hard to apply*** *those doubtful results on your research?*

*Worked day and night to **incorporate some results** on your own work but:*

- There were **untold parameters** that needed adjustment and you couldn't get hold of them?
- Realized the proposed algorithm **worked only on the specific data** shown at the original paper?
- Realized that something did **not quite add up** in the end?

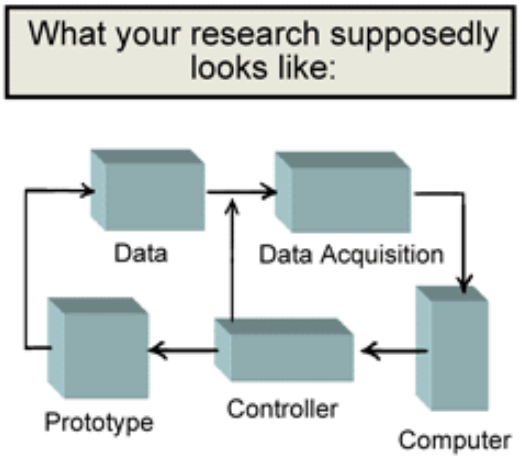


Figure 1. Experimental Diagram

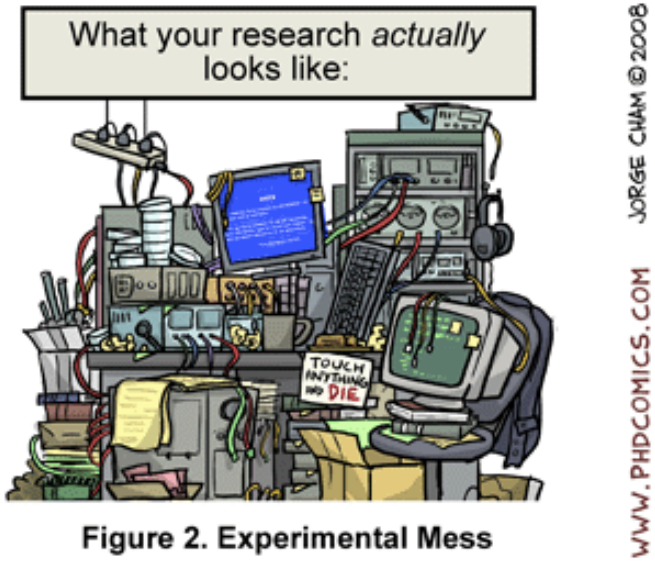
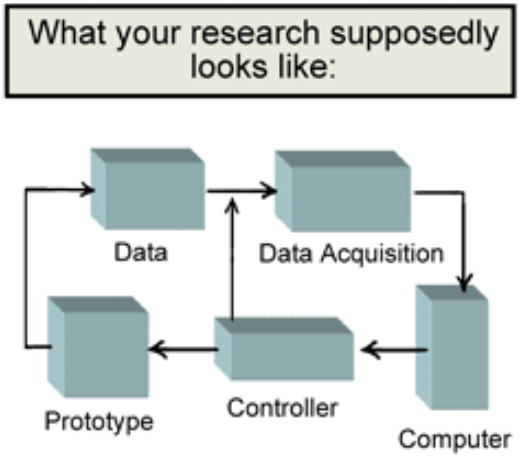


Figure 2. Experimental Mess

*Had a **new student to take over** the work from another student that left and had to start from scratch - months into programming to make things work again?*



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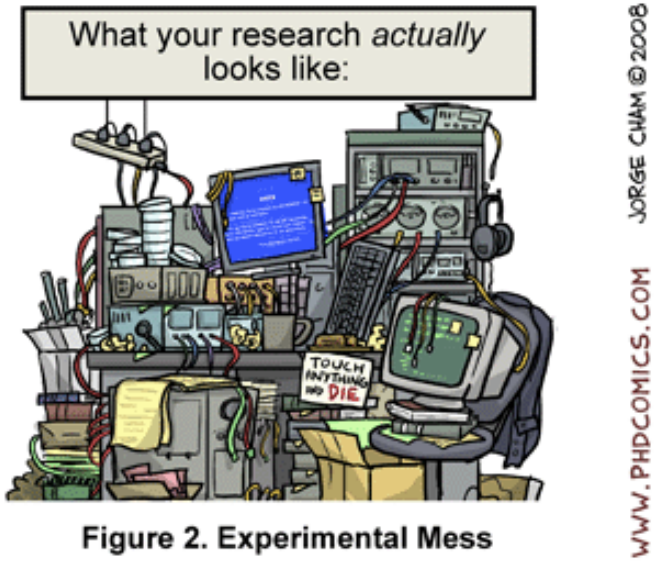


Figure 2. Experimental Mess

Would have liked to ***replay to someone about your work****, but you couldn't really remember all details when you first made it work? Or you* ***could not make it work*** *at all?*

Enter "Reproducible Research" (RR)[1]

One term that aggregates work comprising of:

- a **paper**, that describe your work in all relevant details
- **code** to reproduce all results
- **data** required to reproduce the results
- **instructions**, on how to apply the *code* on the *data* to replicate the results on the *paper*.

[1] `http://reproducibleresearch.net`

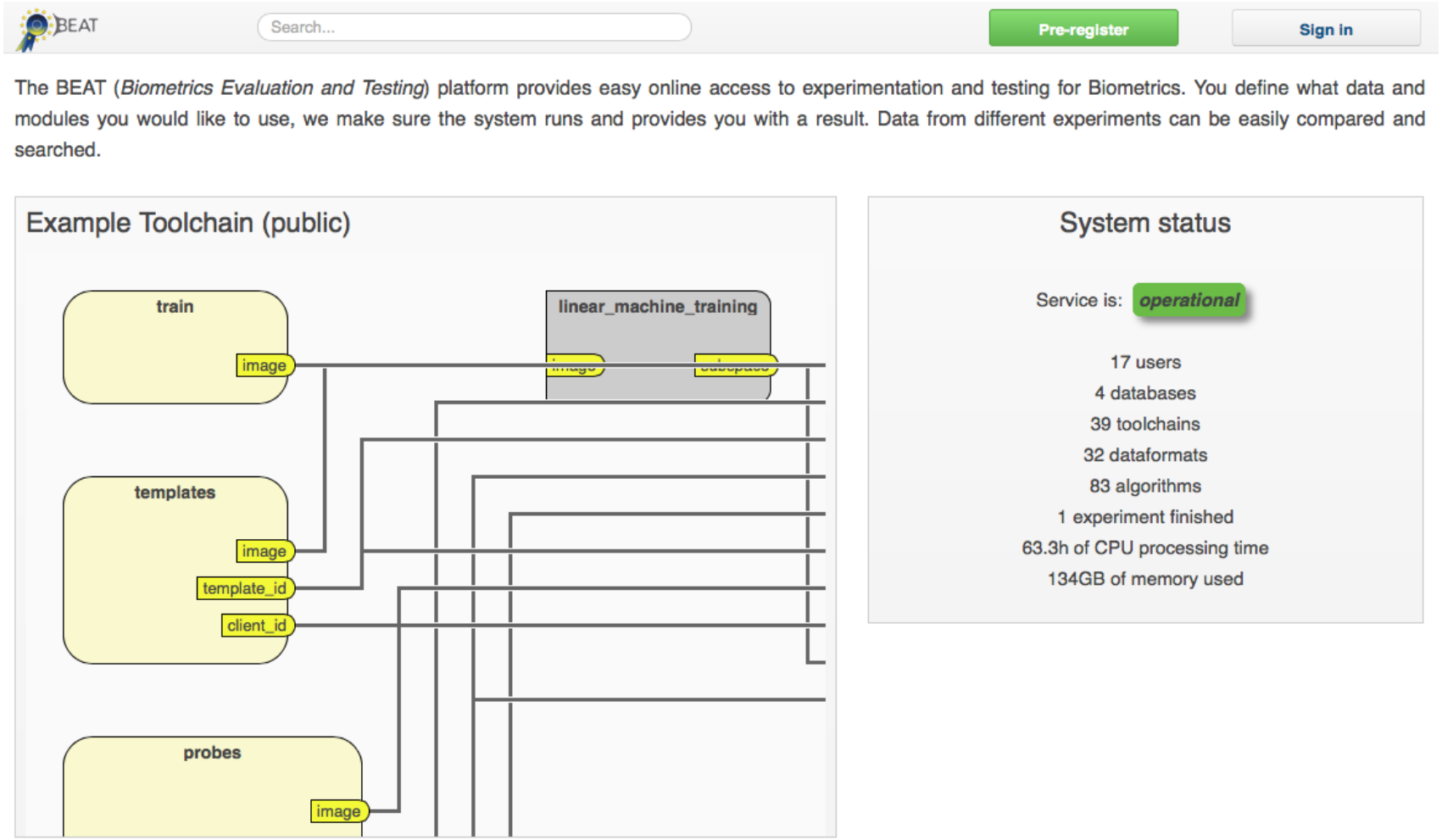
Levels of Reproducibility[2]

With respect to an independent researcher:

0. Irreproducible
1. Apparently unable to reproduce
2. Reproducible, with extreme effort ($>$ 1 month)
3. Reproducible, with considerable effort ($>$ 1 week)
4. Easily reproducible ($\sim$ 15 min.), but requires proprietary software (e.g. Matlab)
5. Easily reproducible ($\sim$ 15 min.), only free software
6. **Easily reproducible ($\sim$ seconds), only requires a web-browser**

[2] *Reproducible Research in Signal Processing: What, why and how*, Vandewalle, Kovacevic and Vetterli, 2012

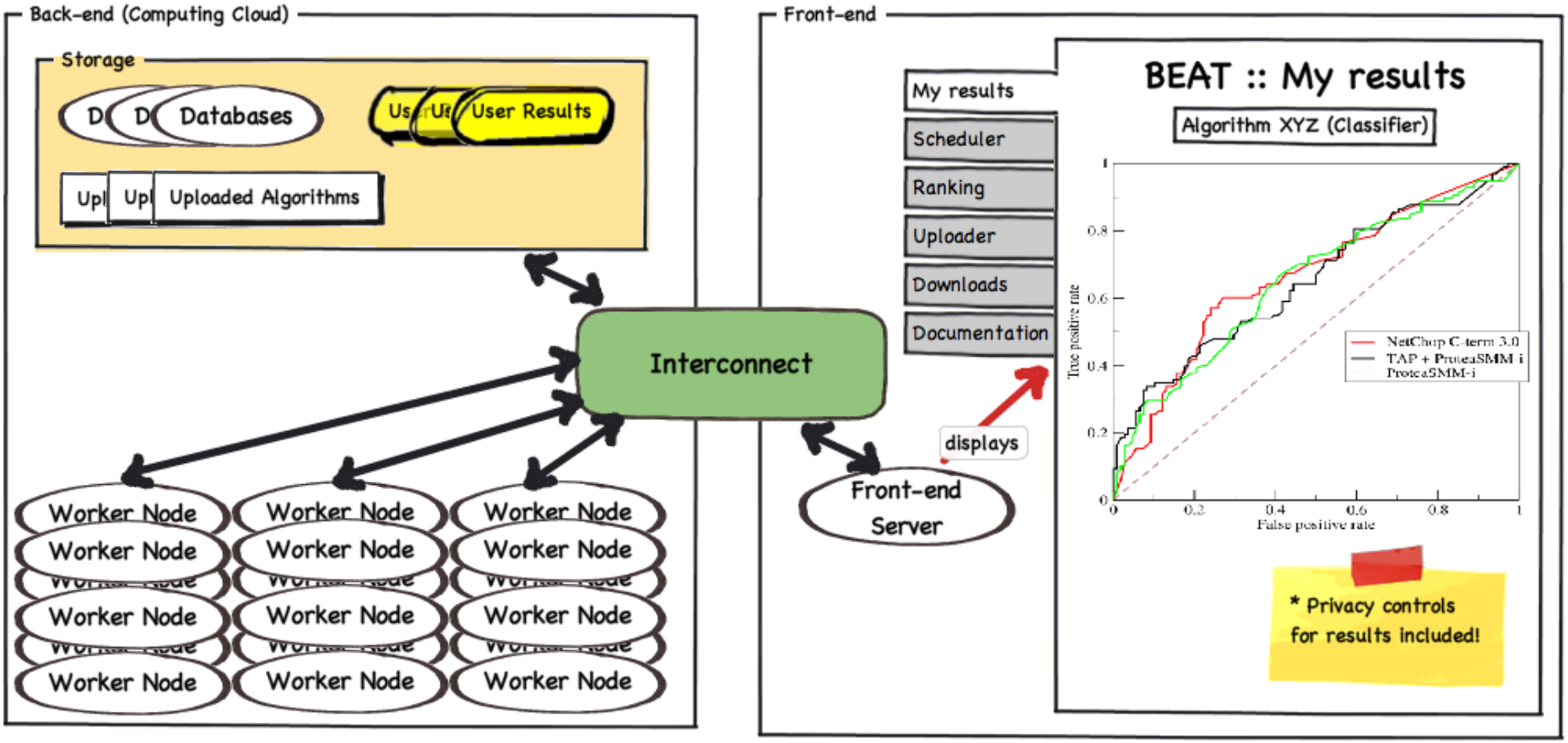
Taking RR to the next level: the BEAT platform



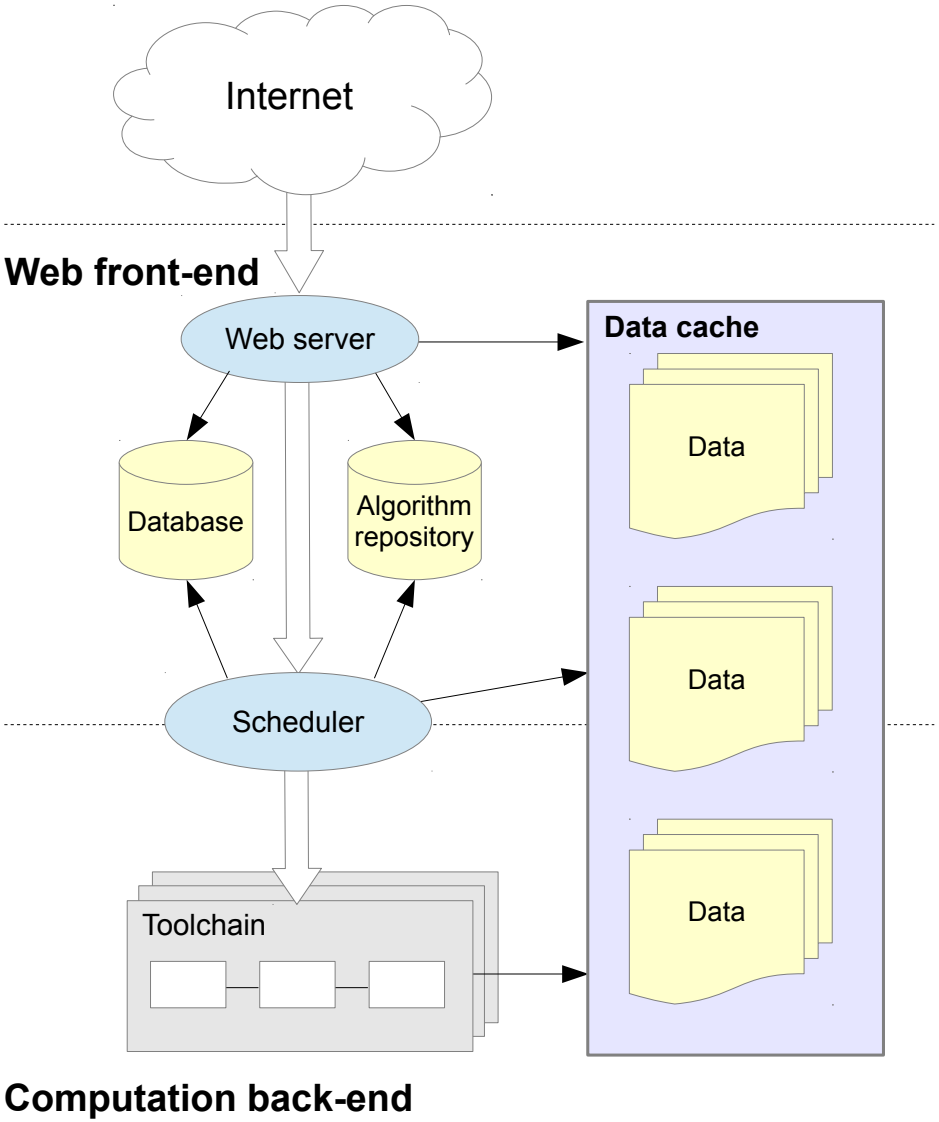
Taking RR to the next level: the BEAT platform

- Web platform: always **accessible**, no need to install extra software
- Intuitive: **graphically** connect blocks to run experiments
- Social: **engagement** gets you **more processing power**
- Productive: search the state-of-the-art by any filtering criteria
- Private:
  - No need to handle large-scale databases
  - Can run on *un*-distributable data (e.g. forensic databases)
- Assurance
  - **fair (reproducible) evaluations** of algorithms
  - **online certifications** for all produced results
- Free: build on **open-source** software and standards

BEAT Platform: Original Concept

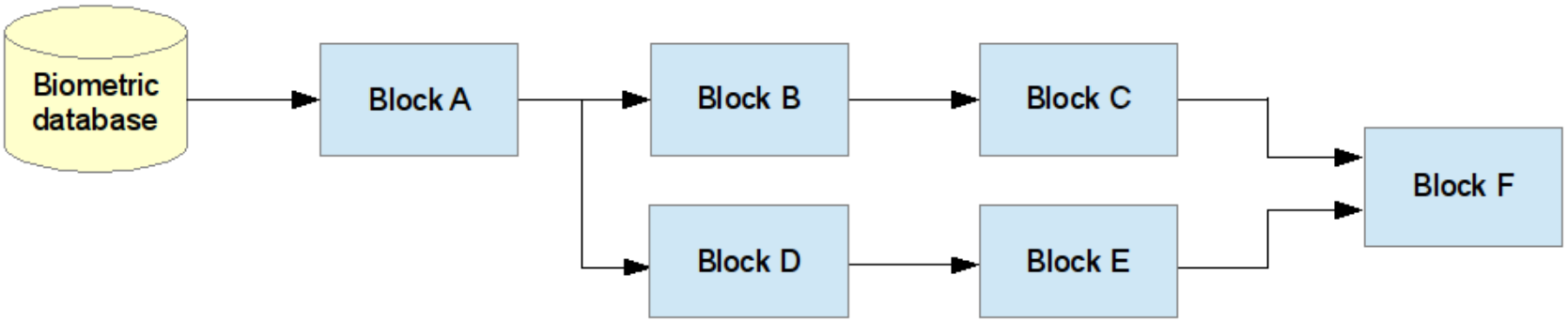


Architectural Choice



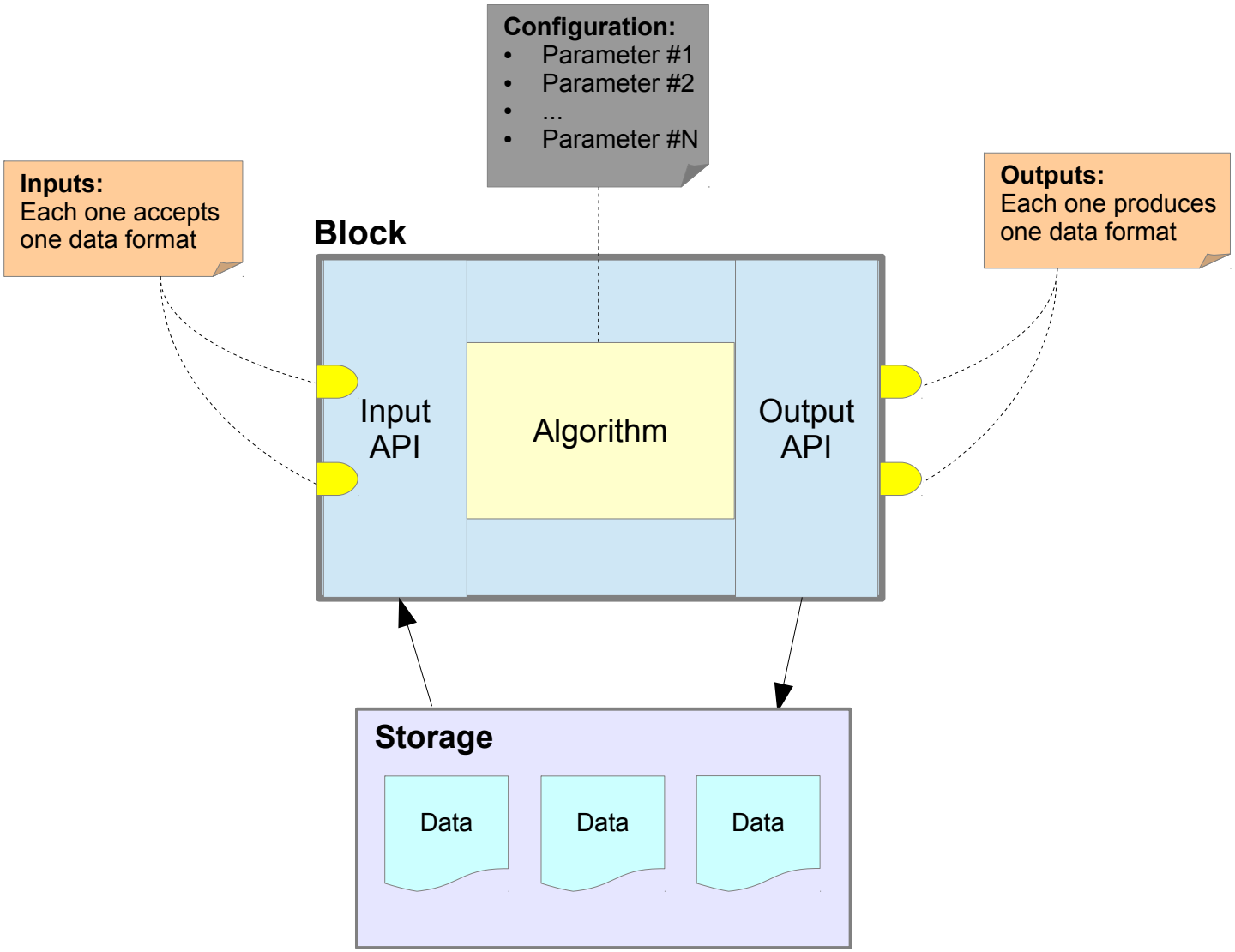
Toolchains

A key concept in experimentation is the idea of *Toolchains*.



Blocks

Toolchains are composed of interconnections of *Blocks*



Blocks: Features

- Blocks can run **arbitrary** code
  - Potential to implement back-ends to support compiled code, any scripting language
  - We picked Python as a default back-end to start the project
  - The platform itself, is also written in Python
- Blocks typically have inputs and outputs
- Data transmitted from block to block is formally defined (*Data Formats*)
- Database blocks are special - they only have outputs, provided by administrators of the platform
- Result blocks don't output to any other block

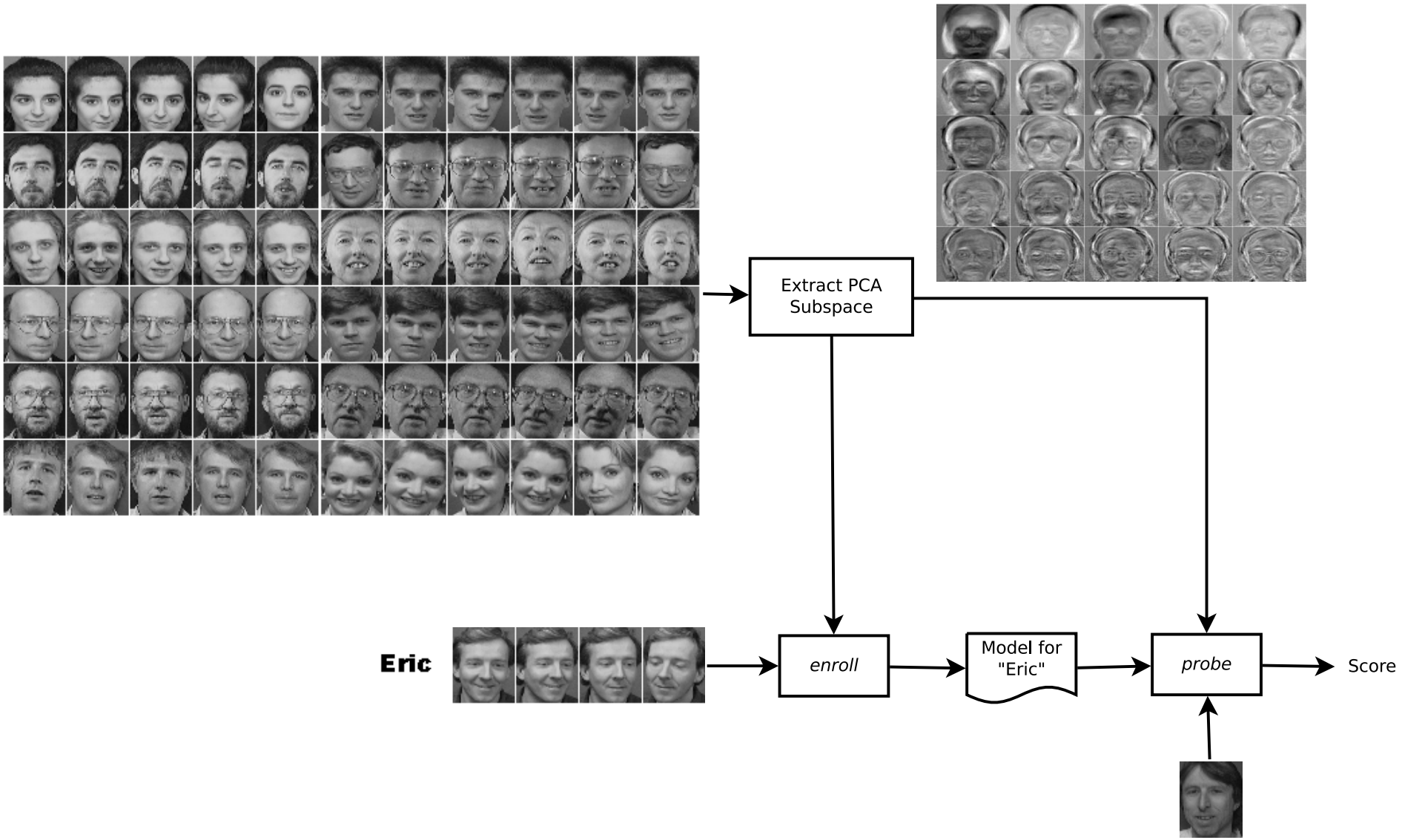
Confidentiality

BEAT is designed as an *opt-in* platform

- All your actions and results are kept private until you choose to change visibility
- Once you change the visibility of any item, associated items are *frozen* so your results are kept reproducible
- If anything changes on the underlying platform (OS, packages, toolchains, databases), your results are *outdated* - but still valid

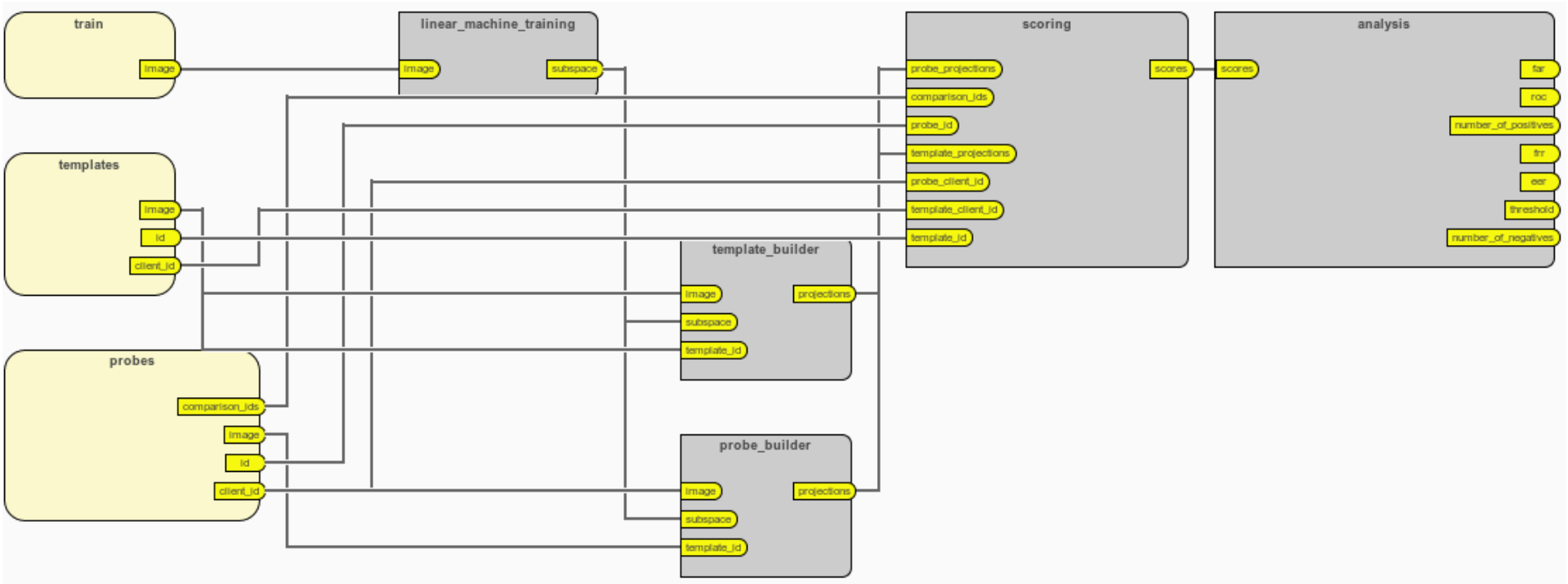
Toolchain Example: trivial Eigen-faces

Simple: no evaluation (test) set, threshold *a posteriori*



Toolchain Example: trivial Eigen-faces

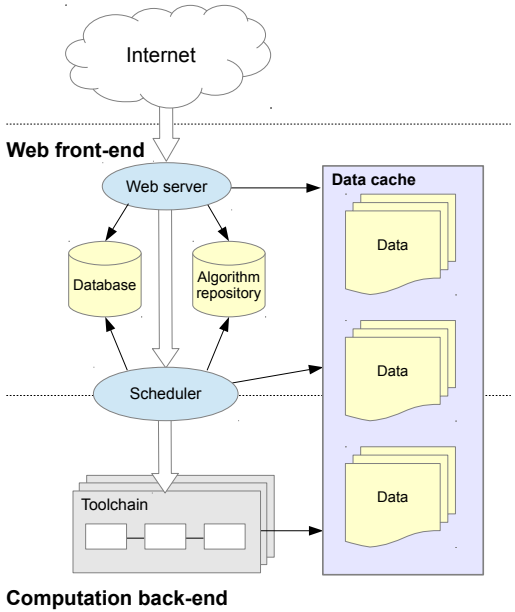
Translation as a BEAT toolchain



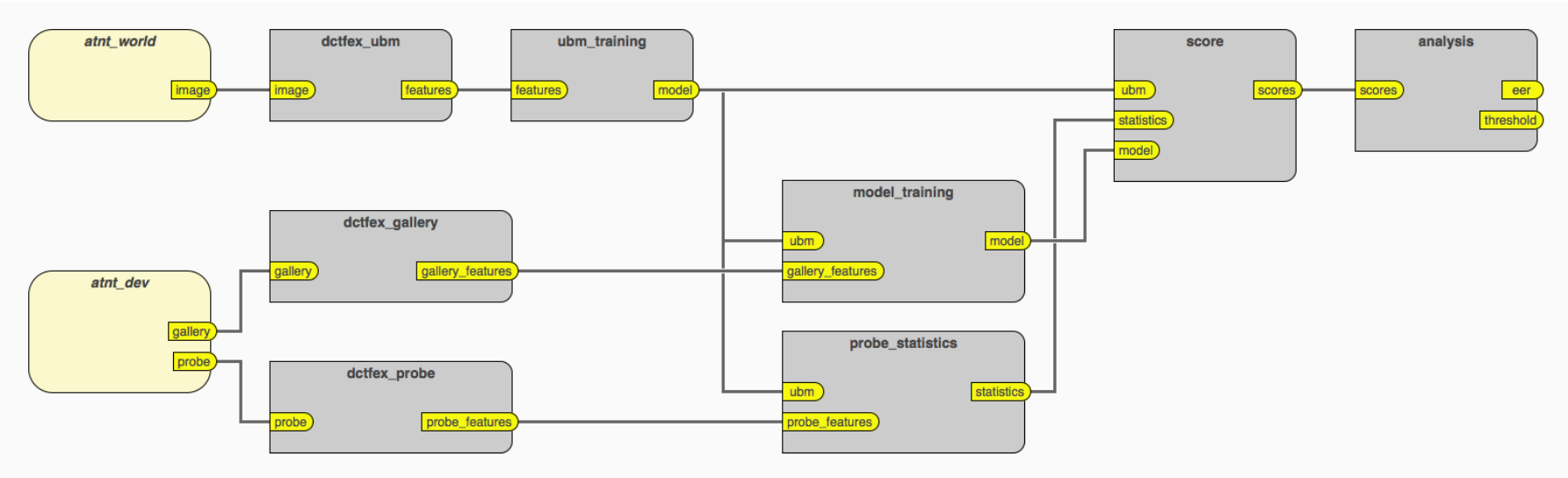
- All relations are explicit: data and algorithms
- *Expected* database is divided into three-blocks leading to the training data, and validation data (split into gallery and probing sets)
- Notice that a Toolchain only defines the connections and data types into and out of Blocks
- Check for yourself: `https://www.beat-eu.org/platform/toolchains/bob/eigenface/`

Caching

- BEAT keeps track of data transmitted through all stages of the processing
- It caches the data in a large disk array (~10 Tb)
- The cache is invalidated automatically when things change:
  - Operating System or installed packages are updated
  - Toolchain changes
  - Database version changes
- One cached item is valid for a specific combination of all of the above
- If a cached item is available, it is used to speed-up processing.



Proof of Concept: DCT+GMM Face Recognition

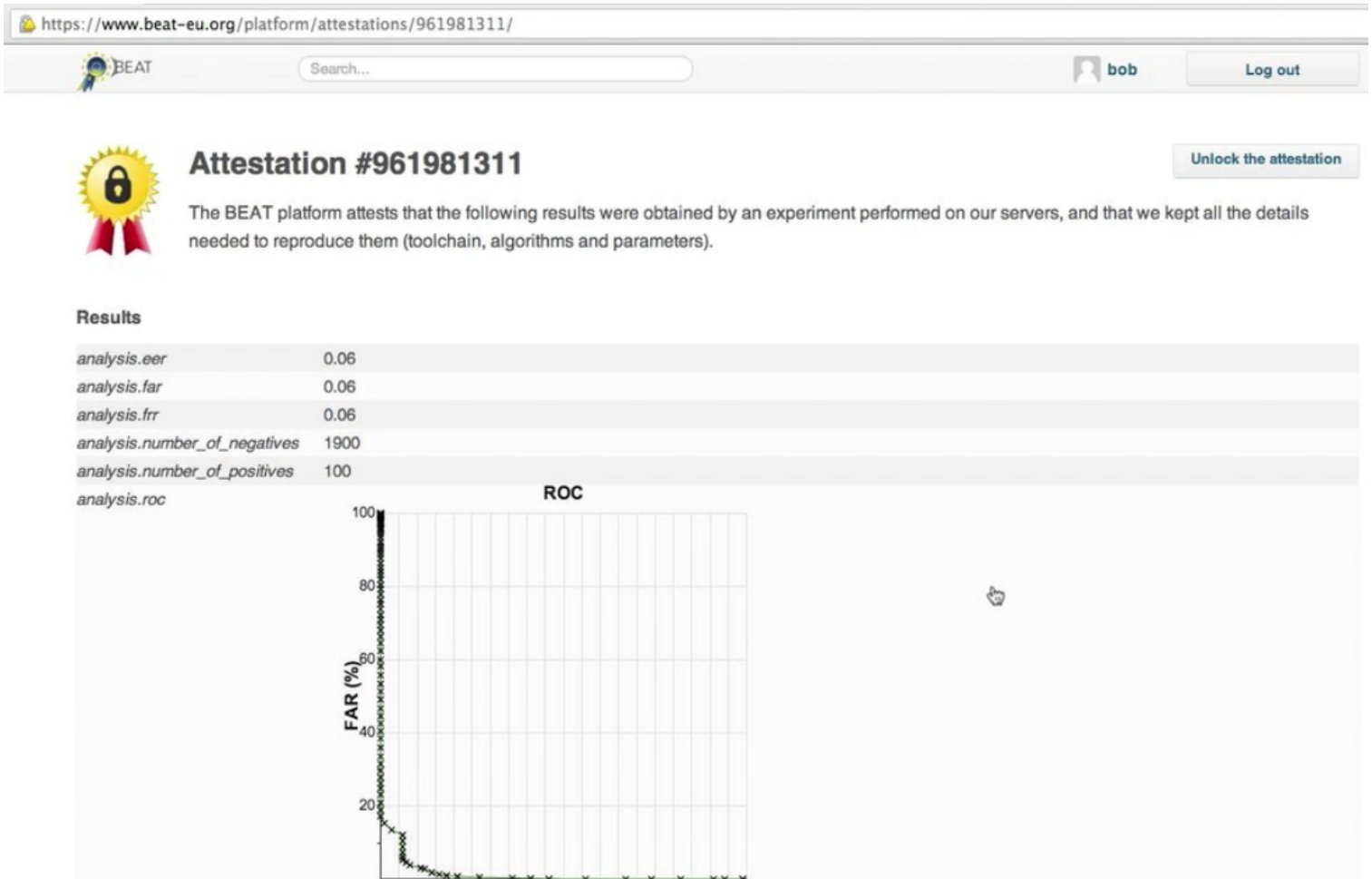


(Click to launch external video)

Attestation ("Certification")

An attestation mechanism is available in the platform.

- Allow 3rd. party verification of results obtained with a given configuration
- Allow for a scientific *review* process to take place in confidentiality

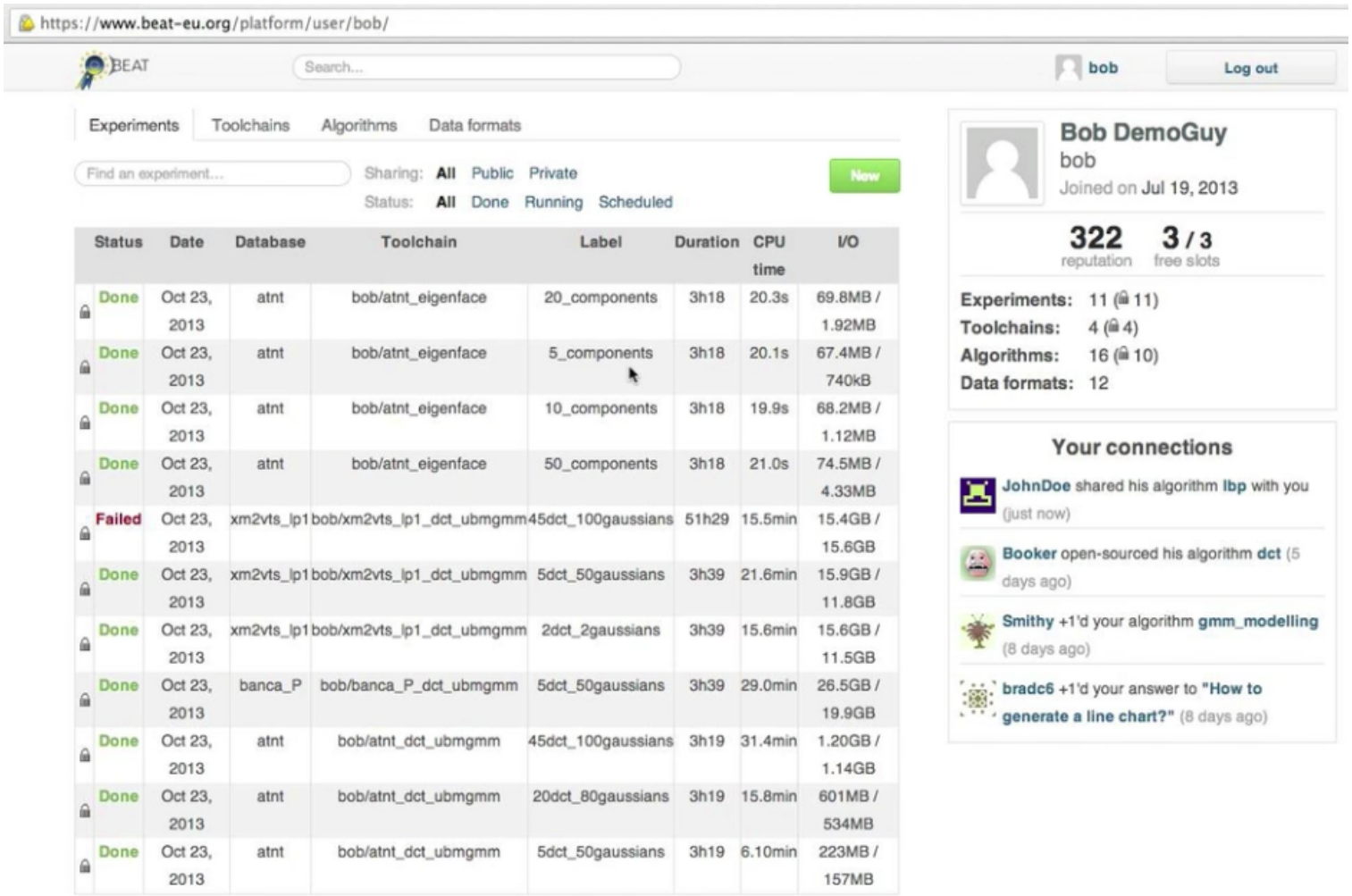


Forking and Modification

- One of the main mechanisms for *sharing* is the ability to *fork* a toolchain
- By *forking*, you get a new toolchain that shares all properties of a given toolchain, except the ownership
- You can modify only your own forks for toolchains

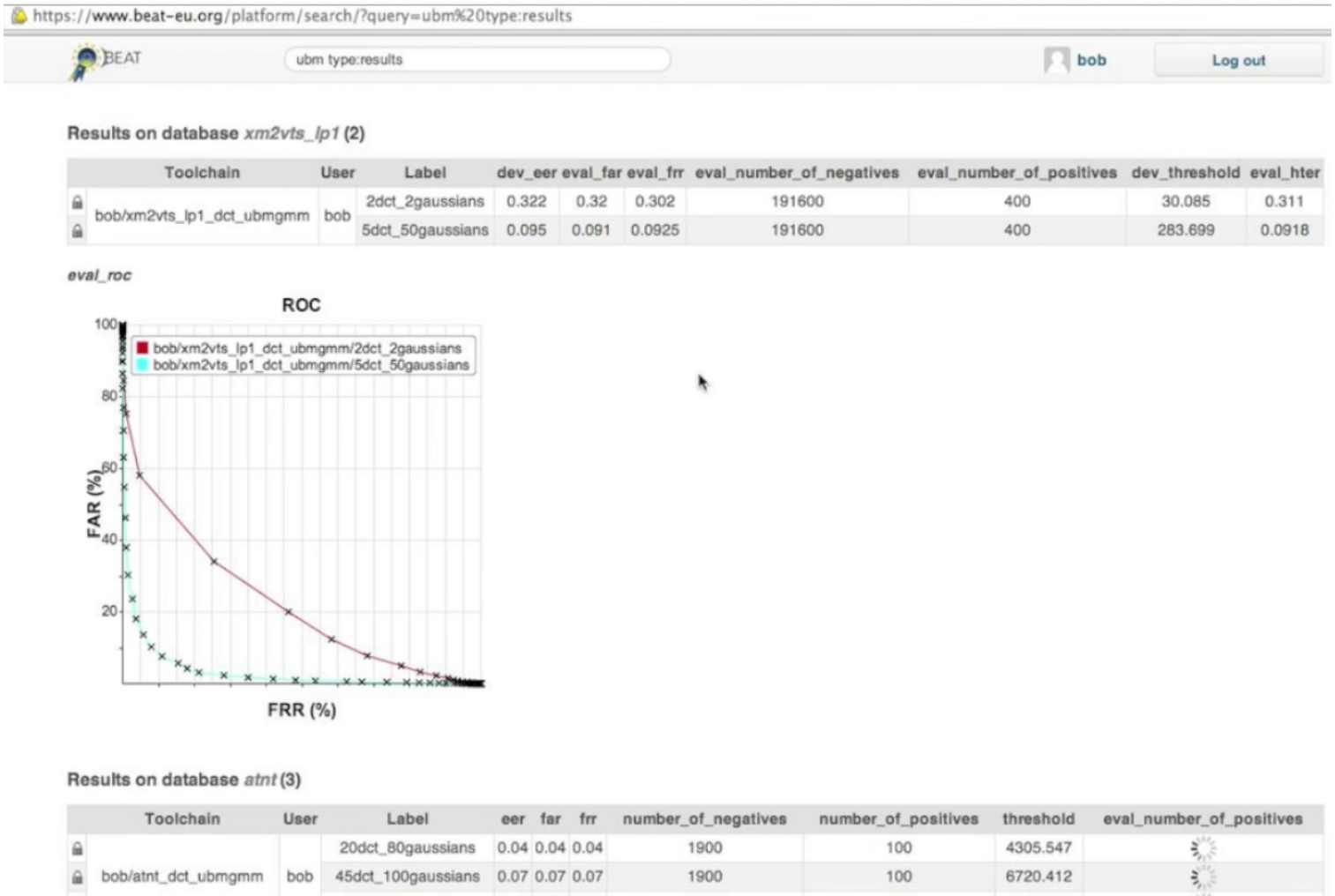
User Page

One of the jobs of BEAT is to keep track of details for all experiments posted



Omni-search

You can use the Omni-search bar (on the top) to type-in query strings.



Open for pre-registration (now)

Pre-registered users will benefit from early platform access when the service becomes available.

`https://www.beat-eu.org/platform/preregister/`

- In-browser graphical toolchain and code editors
- More social features: notifications, reputation system, discussion forum
- Better search result categorization. Output search results into data to re-use on your publications
- Full parallelization support
- Initial Hardware commissioning (end of April/2014):
  - 120 dedicated processing cores with 8 Gb RAM per core
  - 20 Tb of cache
  - 10 Gb/s link between cache and processing nodes

Acknowledgement for support

European Commission

Biometrics Evaluation and Testing (BEAT)

`http://www.beat-eu.org`

Swiss State of Wallis

Swiss center for biometrics research and testing

`http://www.biometrics-center.ch`