OpenML

TAKING MACHINE LEARNING RESEARCH ONLINE

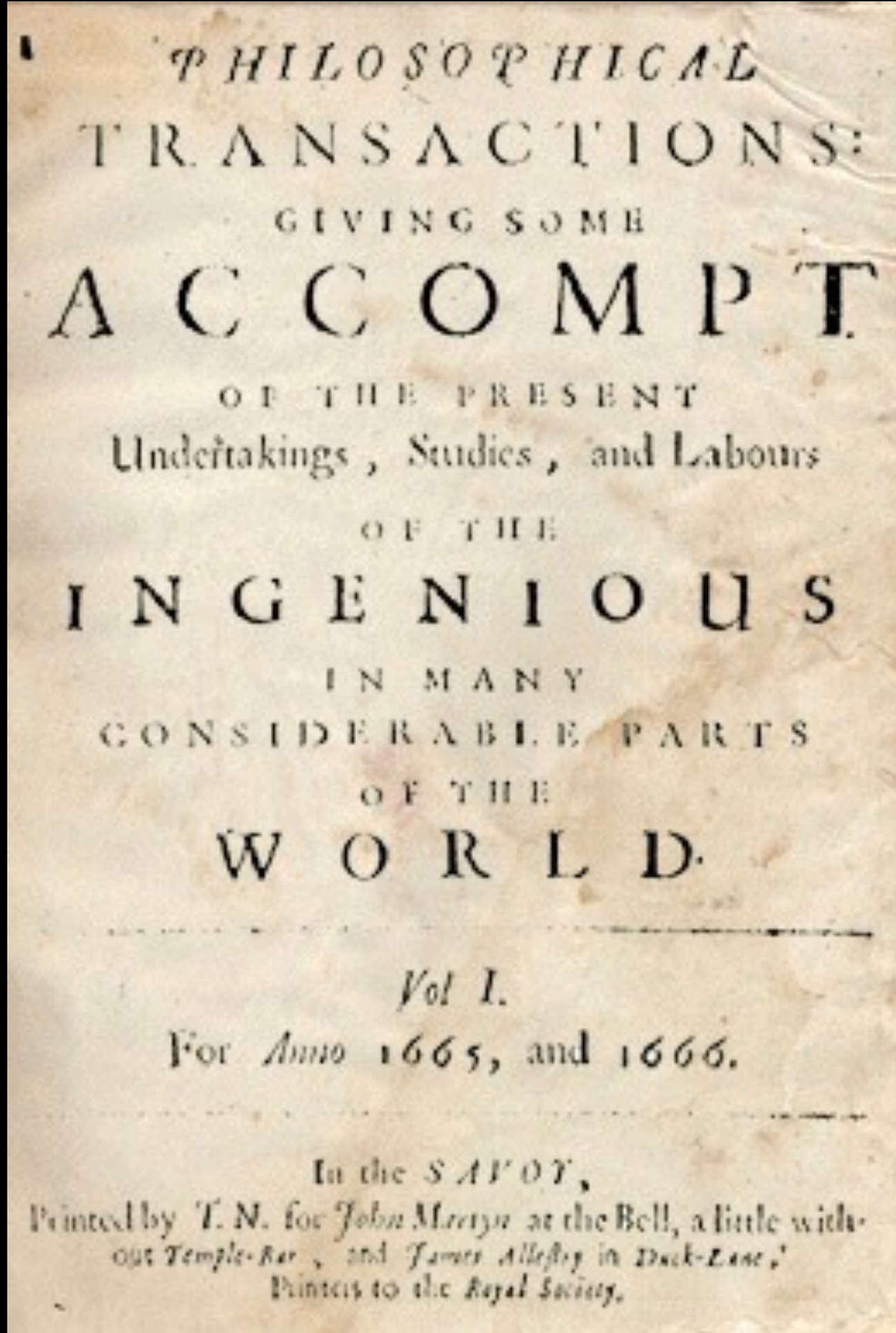
Joaquin Vanschoren (TU/e) 2015

AFTER 300 YEARS

IS PRINTING PRESS STILL THE BEST MEDIUM?

FOR MACHINE LEARNING?

- Code too complex (online)
- Data sets too large (online)
- Experiment details scant
- Results unactionable, hard to reproduce, reuse
- Papers not updatable
- Slow, limited impact tracking
- Publication bias
- No online public discussion



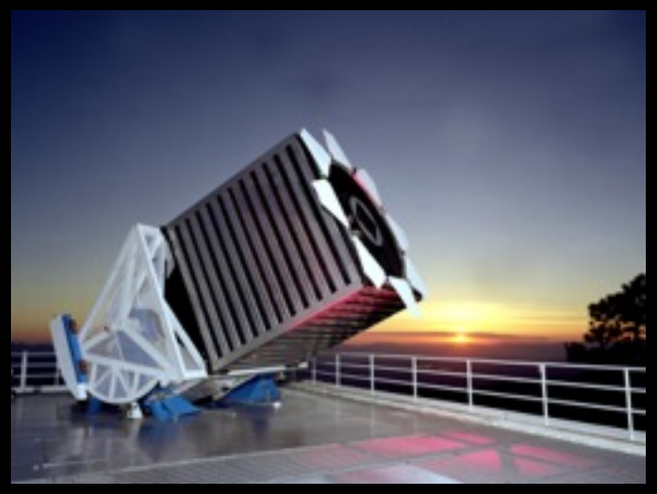
PHILOSOPHICAL
TRANSACTIONS:
GIVING SOME
ACCOMPT
OF THE PRESENT
Undertakings, Studies, and Labours
OF THE
INGENIOUS
IN MANY
CONSIDERABLE PARTS
OF THE
WORLD.

Vol I.
For Anno 1665, and 1666.

In the SAVOY,
Printed by T. N. for John Martyn at the Bell, a little without Temple-Bar, and James Allestry in Duck-Lane,
Printers to the Royal Society.

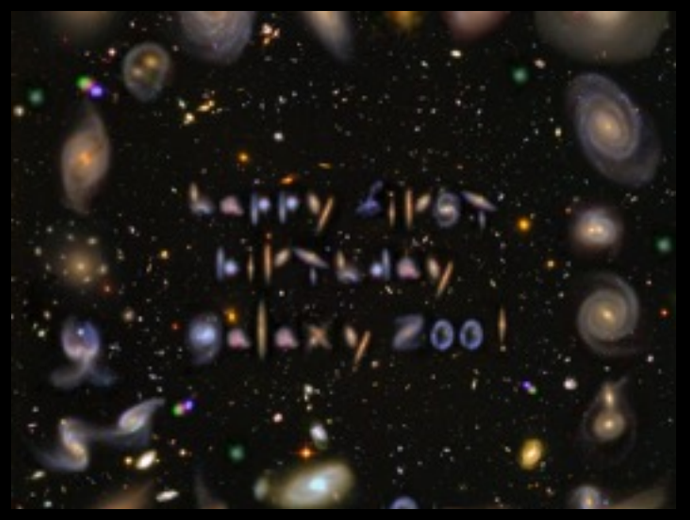
NETWORKED SCIENCE

Polymaths: Mathematicians solved centuries-old problems within weeks by collaborating online



SDSS: Thousands of astronomical papers published on organised, online data from one single telescope

Galaxy Zoo: Amateur astronomers made new discoveries by simply looking through thousands of images of galaxies



Why? Designed serendipity

Broadcasting data (and questions)
fosters spontaneous discoveries

What's hard for one scientist
is easy for another

What's surprising for one scientist
sparks ideas in another

Network effects:
studies become cheaper, faster

Only works of you remove friction

Organised body of compatible scientific data (and tools)

Micro-contributions: seconds, not days

Easy, organised communication

Measure impact (altmetrics)
Give credit when credit is due

OpenML

A REALTIME, WORLDWIDE LAB

FRICTION-LESS ENVIRONMENT FOR MACHINE LEARNING RESEARCH

Organized: Easy to find datasets, code, experiments. All connected, uniform. Linked to people. Reproducible.

Easy to use: Automated download/upload within your ML environment

Micro-contributions: Upload single dataset, algorithm, experiment

Easy communication: Online discussions per resource (+github)

Reputation: Auto-tracking of downloads, reuse, likes.

Autonomy: Work openly or in circles of trusted people (preliminary work)

OpenML Search

OpenML beta

Exploring machine learning better, together

1340 data sets

Find or add **data** to analyse

4828 tasks

Download or create scientific **tasks**

1346 flows

Find or add data analysis **flows**

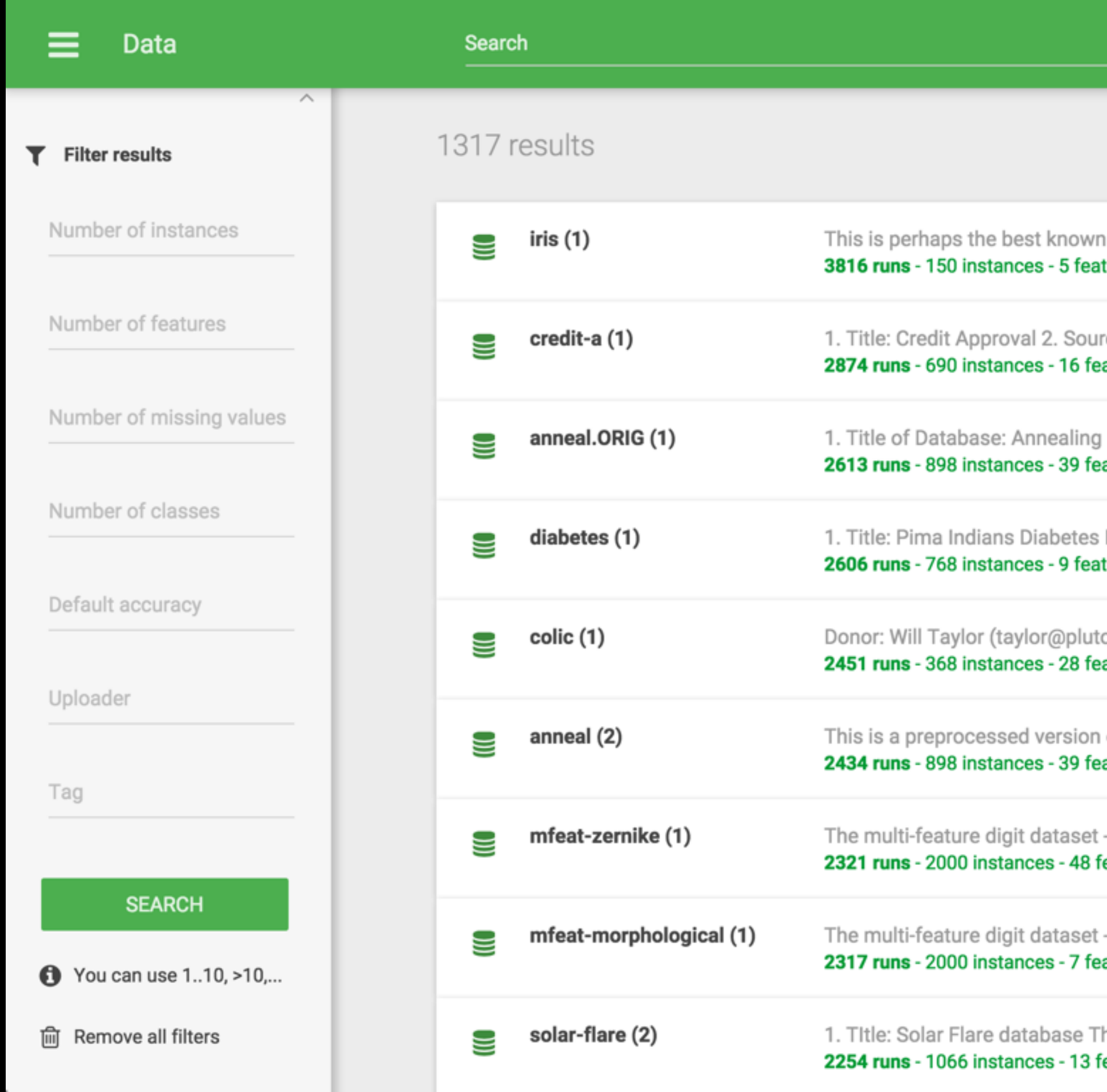
434613 runs

Upload and explore all **results** online.

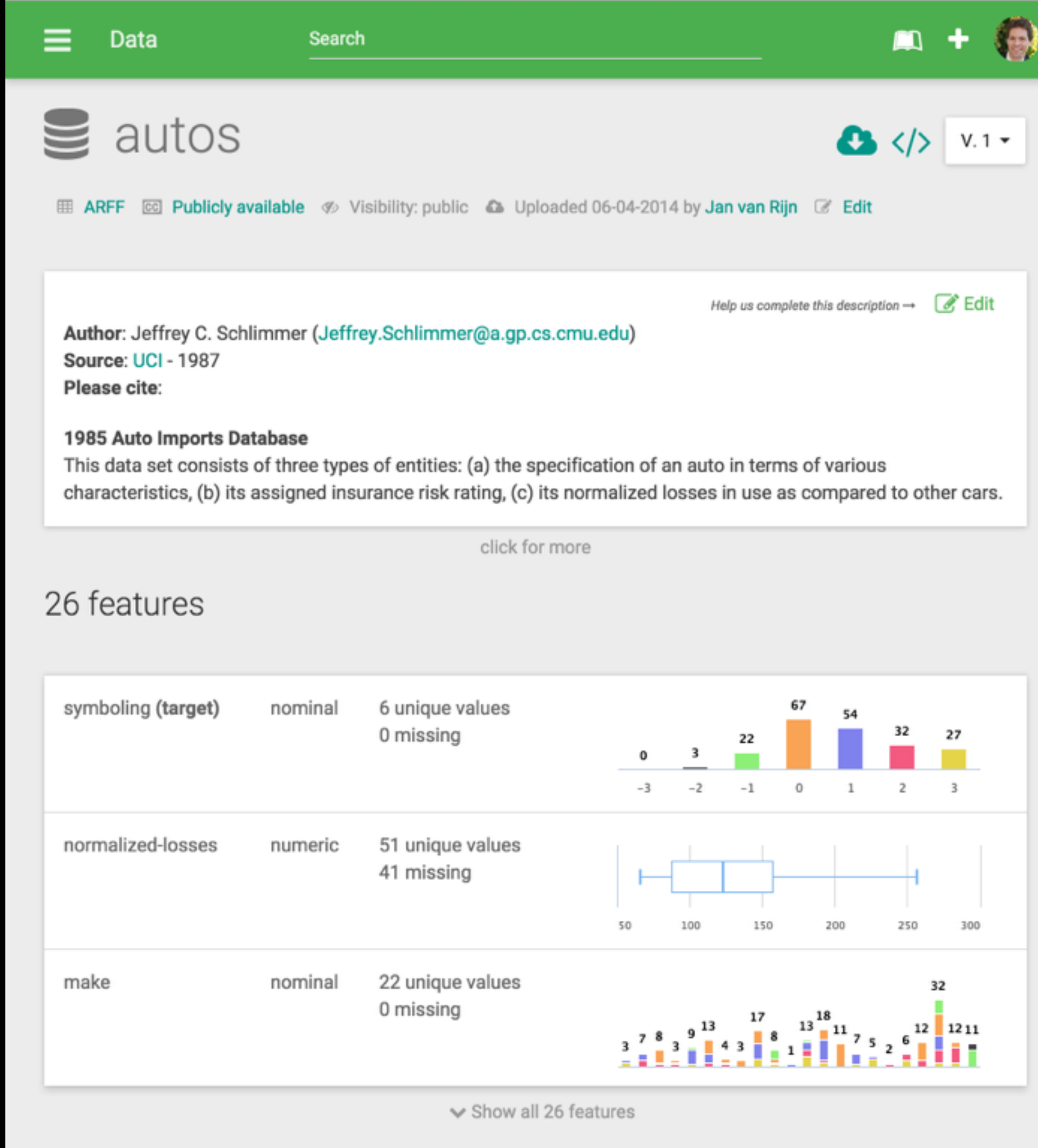
Data from
various sources
analysed and
organised online
for easy access

Scientists can **broadcast data** by uploading or linking from existing repositories. OpenML will (for known data formats) **automatically analyze the data**, compute data characteristics, **annotate, version and index it for easy search**

- Search datasets by keywords or properties
- Filters
- Tagging
- Through website or API



- Wiki-like descriptions (add what you know about it)
- Analysis and visualisation of features to spot problems
- Auto-calculation of large range of meta-features

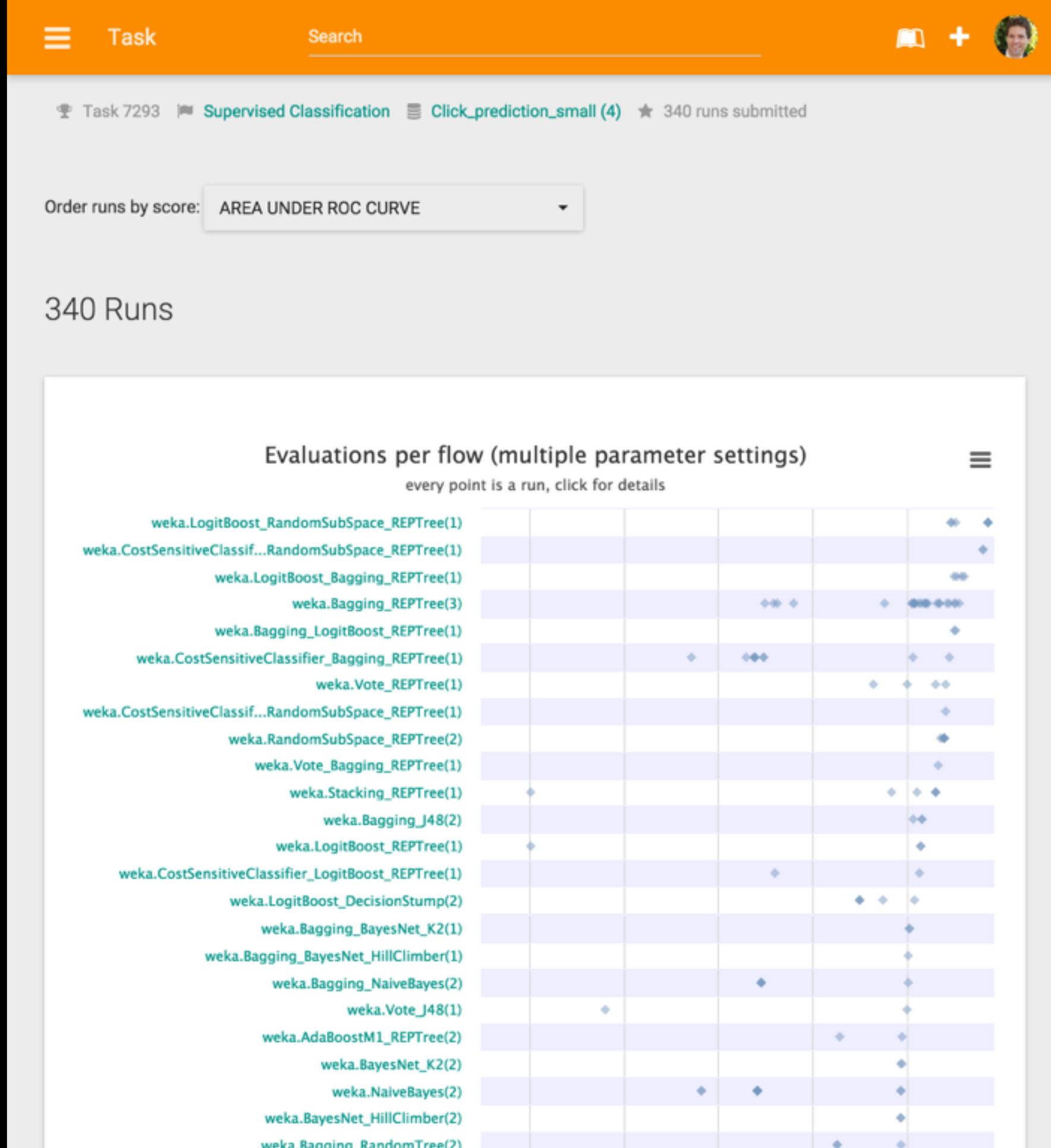


Scientific tasks that can be **interpreted by tools** and **solved collaboratively**

Scientists can create *tasks* for certain problems (e.g. classification): containers with all data and **machine-readable descriptions** so that tools can **automatically download data,** use the correct procedures, and **upload all results**.

All results are organized online, creating **realtime (collaborative) data mining challenges** where anyone can build on previous results.

- People submit results (e.g. predictions, models), obtained on their machines
- OpenML computes large range of performance metrics, depending on task type
- All results organized online
- Online visualizations: every dot is a model obtained by specific solution and parameter variations.



Task

Search

Details

Overview

All runs

Results

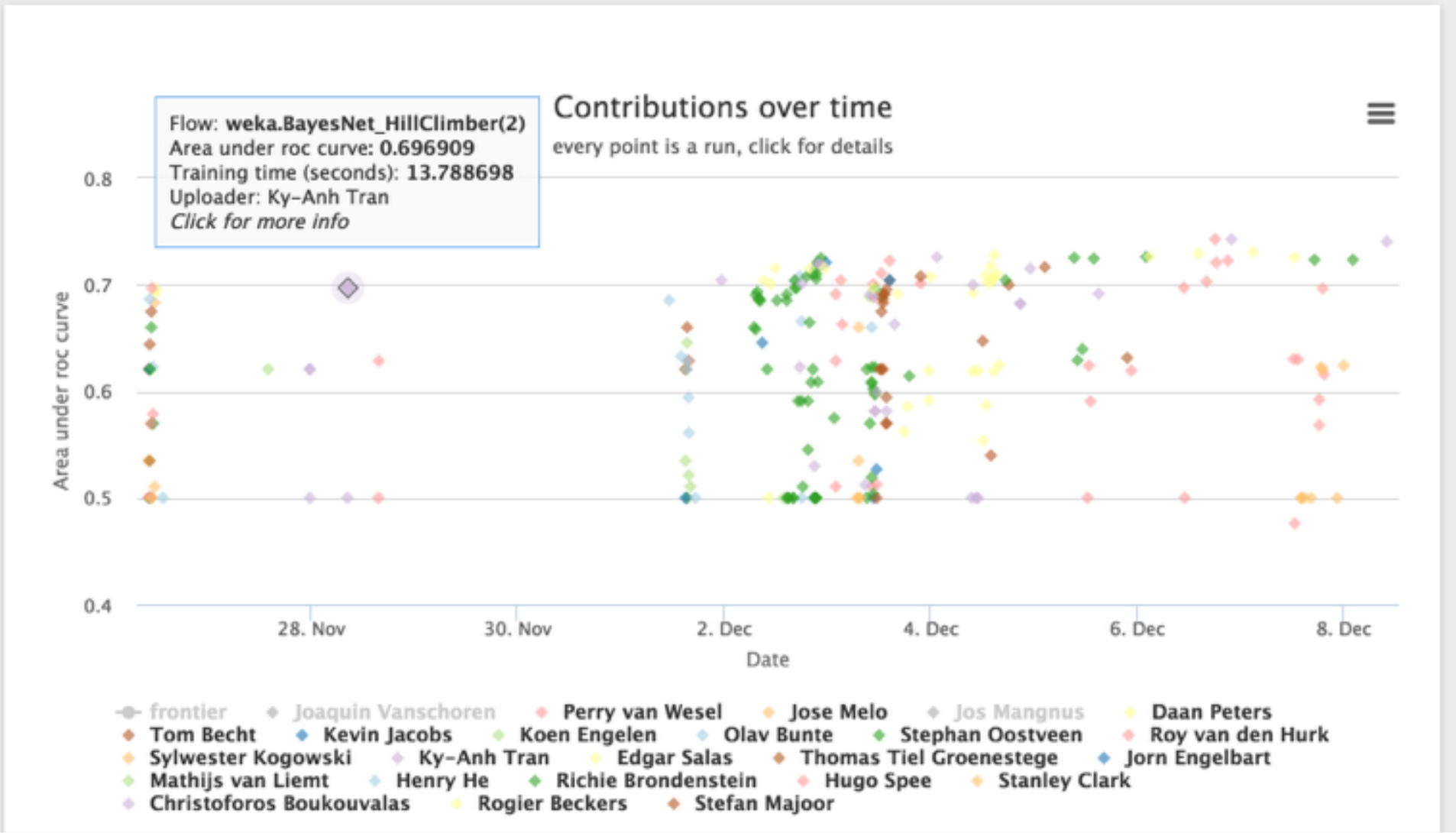
Leaderboard

Discuss

Tags

Add tag

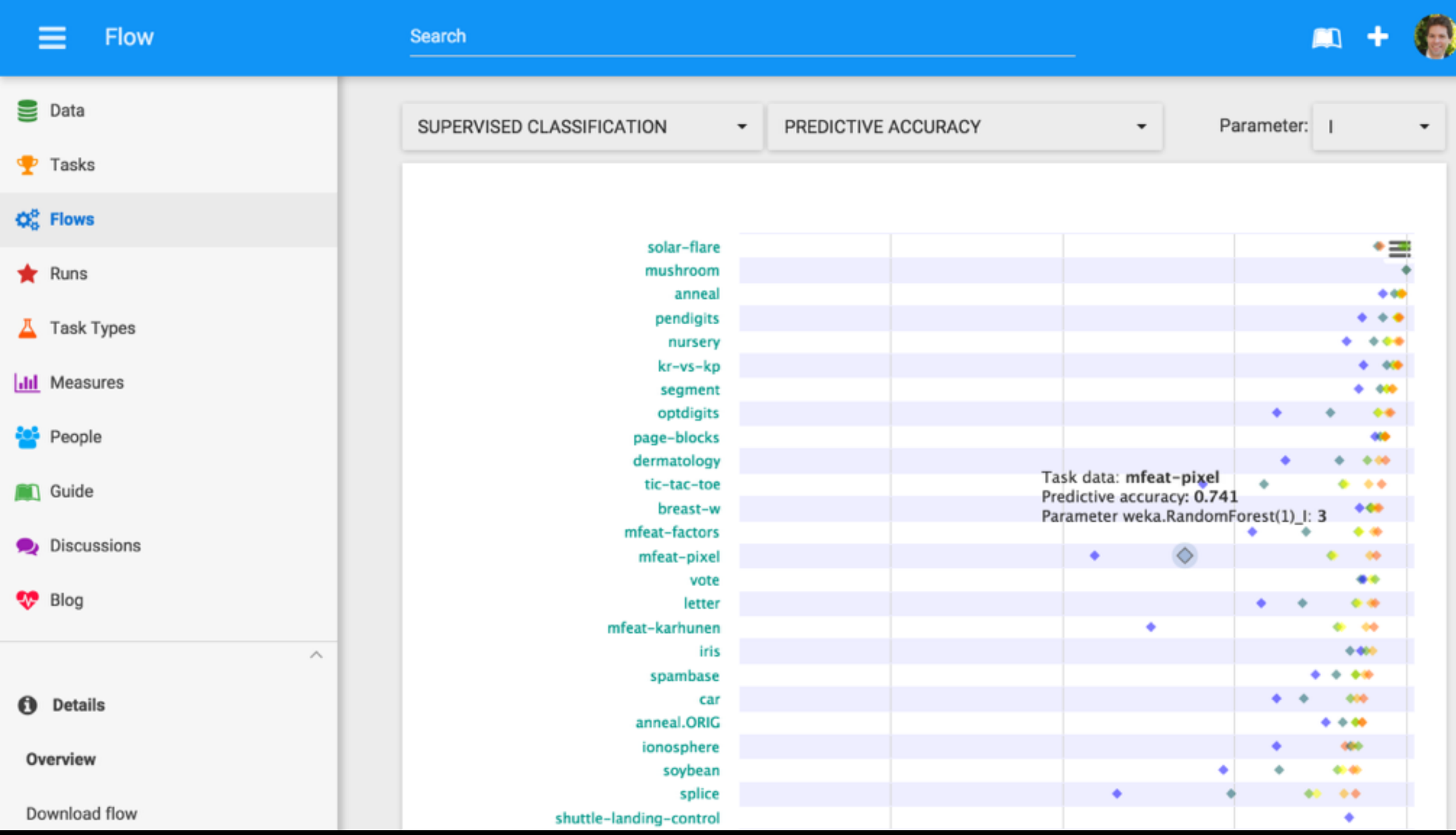
Timeline



- Leaderboards with visualisation of progress over time: who delivered breakthrough results, who build on top of previous solutions
- Collaborative setting: you can see details of other solutions, rerun, learn from others
- Real-time: who submits first gets credit, others can improve immediately

Machine learning flows (code) that can **solve tasks** and **report results.**

Scientists upload code used in experiments, or link from existing repositories. OpenML keeps track of **flow details and versioning**, **organizes all results** for easy comparison, even across tools. Tool integrations allow automated **data download, flow upload** and **experiment logging and sharing.**



- All results obtained with the same flow organised online
- Results linked to data sets, parameter settings, other details
- Also visualised online (dots are models, color-coded by parameter setting)

Experiments auto-uploaded, linked to **data, flows** and **authors**, and organised for easy reuse

Runs contain the results that **flows** obtained on specific tasks. Runs are **fully reproducible**, linked to the underlying data, tasks, flows and authors. OpenML **organizes all results online** for **discovery, comparison and reuse**

- All experiment (run) details stored
- Author, date, flow, parameter settings, result files, links to underlying data
- Computed evaluations, also for individual folds, samples

Run

Run 84087

JSON XML

Task 7293 (Supervised Classification) Click_prediction_small Uploaded 01-01-2015 by Ky-Anh Tran

Flow

weka.Bagging_BayesNet_K2(1)	Leo Breiman (1996). Bagging predictors. Machir
weka.Bagging_BayesNet_K2(1)_P	100
weka.Bagging_BayesNet_K2(1)_S	1
weka.Bagging_BayesNet_K2(1)_num-slots	8

Result files

Description
XML file describing the run, including user-defined evaluation measures.

Model readable
A human-readable description of the model that was built.

Model serialized
A serialized description of the model that can be read by the tool that generated it.

Predictions
ARFF file with instance-level predictions generated by the model.

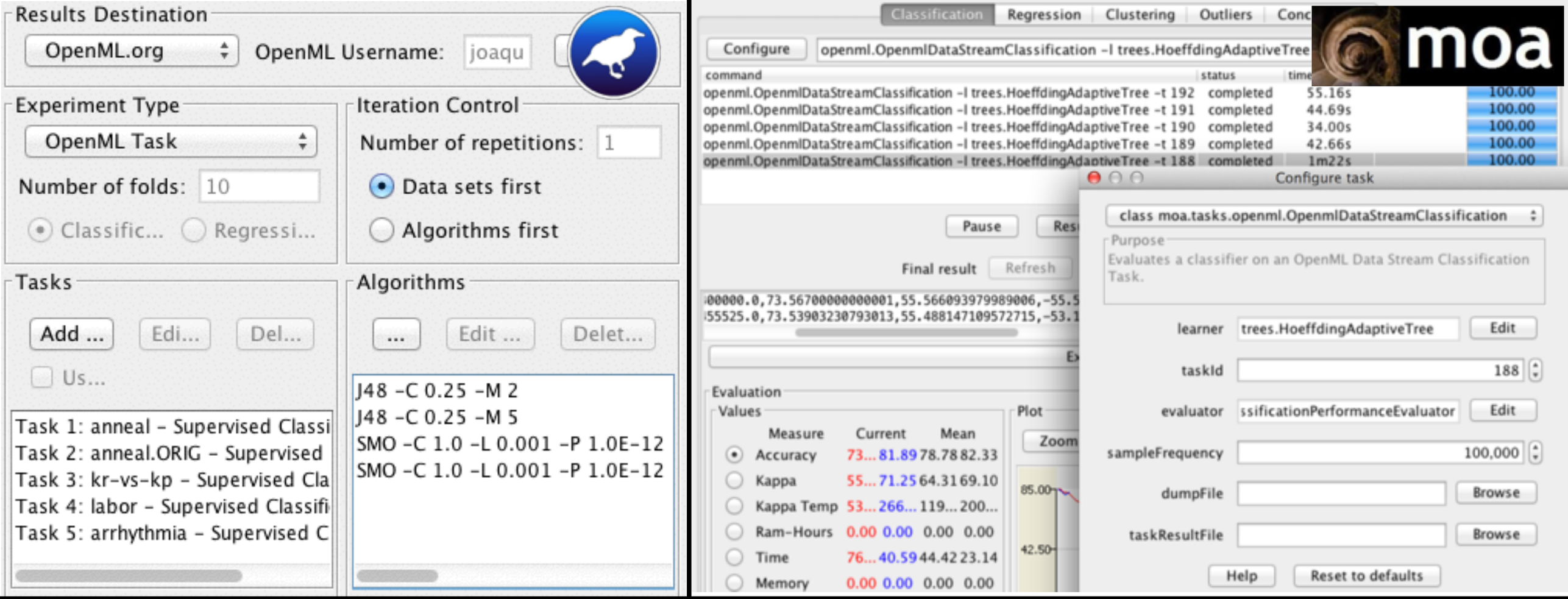
Area under ROC curve

0.7007 ± 0.0023

Per class

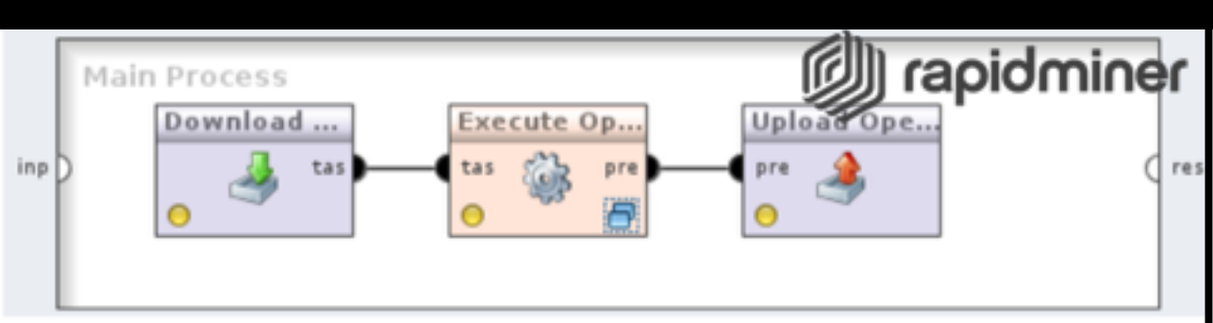
0	1
0.7007	0.7007

Cross-validation details (10-fold Crossvalidation)

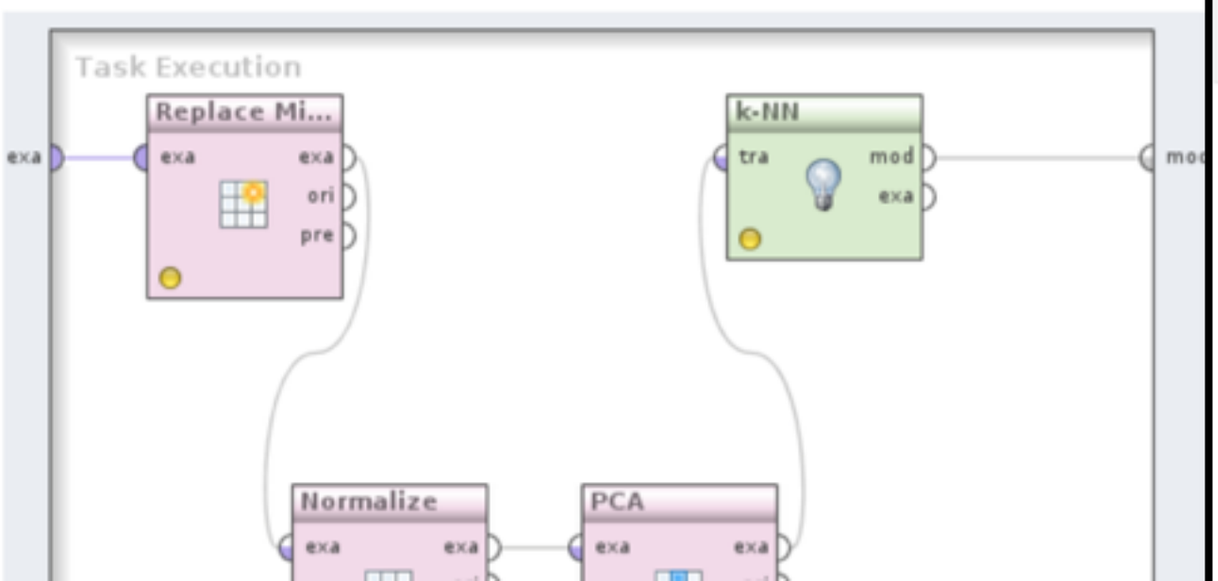


- REST API + language specific APIs in Java, R, Python
- Download all data, flows, previous results in your favorite ML environment, automatically upload all your results
- WEKA/MOA: Available as plugin

- Also support for workflow-based tools (RapidMiner, ADAMS)
- R/Python: download data, run machine learning algorithms and upload results in just a few lines of code.



(a) Main Workflow

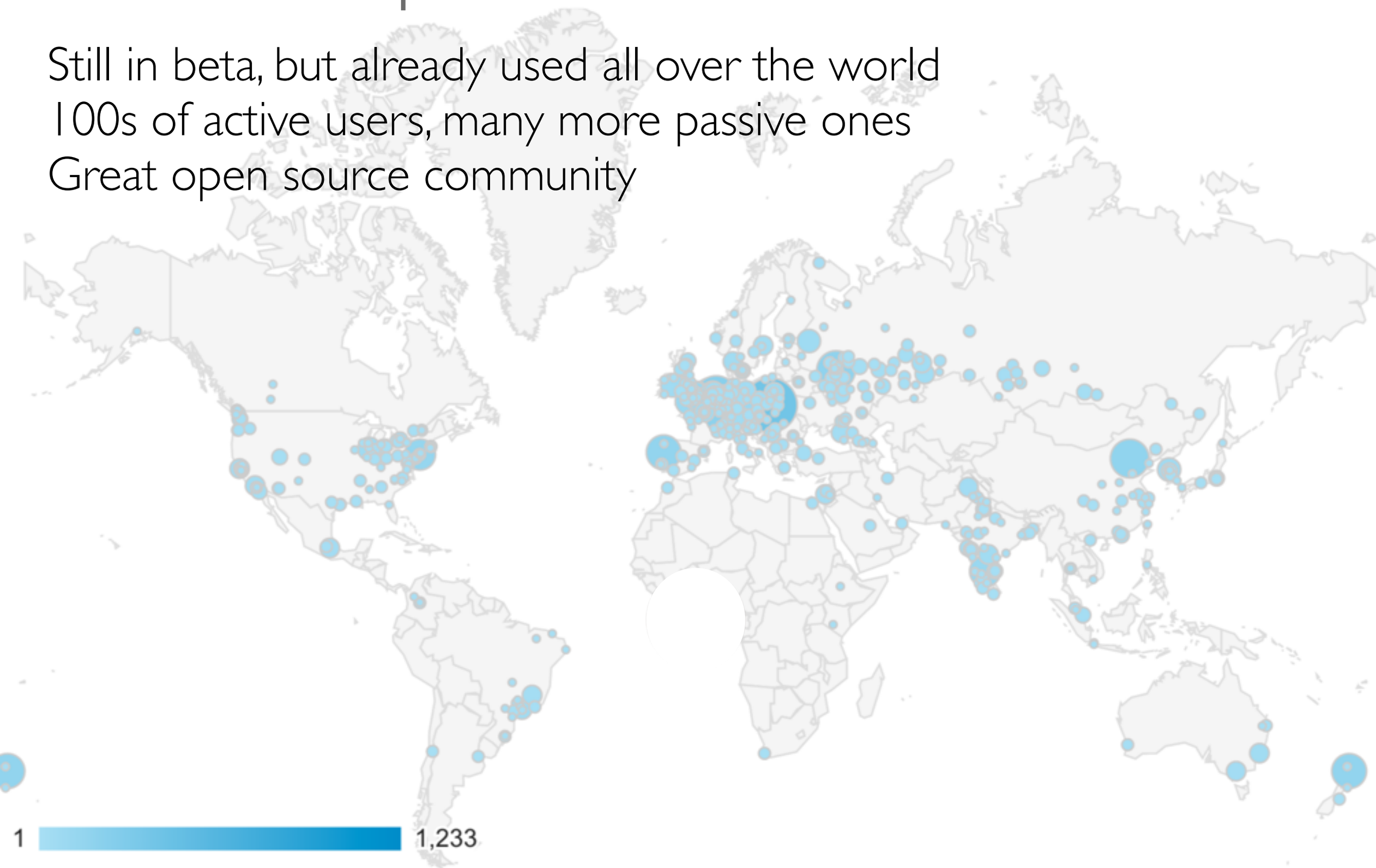



```python
from openml.apiconnector import APIConnector
from sklearn import preprocessing, ensemble
connector = APIConnector(username=username, password=password
dataset = connector.download_dataset(31)
X, y, categorical = dataset.get_pandas()
enc = preprocessing.OneHotEncoder(categorical_features=catego
X = enc.transform(X).todense()
clf = ensemble.RandomForestClassifier()
clf.fit(X, y)
```

```r
library(OpenML); library(mlr)
authenticateUser(username = "user", passw
task = getOMLTask(task.id = 1L)
lrn = makeLearner("classif.randomForest")
run.mlr = runTaskMlr(task, lrn)
run.id = uploadOMLRun(run.mlr)
```

Global impact

Still in beta, but already used all over the world
100s of active users, many more passive ones
Great open source community



Jan-Jun 2015

Things we're working on

Circles

Create collaborations with trusted researchers
Share results within team prior to publication

Projects (e-papers)

- Online counterpart of a paper, linkable
- Merge data, code, experiments (new or old)
- Public or shared within circle

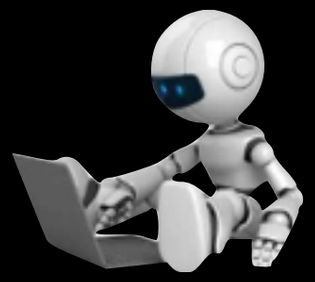
Altmetrics

- Measure real impact of your work
- Reuse, downloads, likes of data, code, projects,…
- Online reputation (more sharing)

Things we're working on (please join)

Distributed computing

- Create jobs online, run anywhere you want
- Locally, clusters, clouds



Algorithm selection, hyperparameter tuning

- Upload dataset, system recommends techniques
- Model-based optimisation techniques
- Continuous improvement (learns from past)

Things we're working on (please join)

Data repository connections

- Wonderful open data repo's (e.g. rOpenSci)
- More data formats, data set analysis

Algorithm/code connections

- Improved API's (R,Java,Python,CLI,…)
- Your favourite tool integrated

Statistical analysis

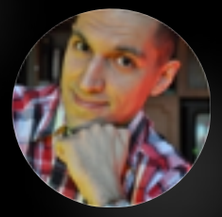
- Proper significance testing in comparisons
- Recommend evaluation techniques (e.g. CV)

Online task creation

- Definition of scientific tasks
- Freeform tasks or server-side support

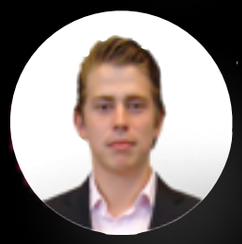
THANK YOU

#OpenML

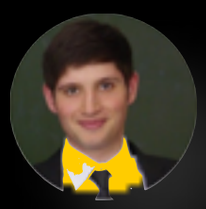


Nenad Tomašev

Luis Torgo



Jan van Rijn



Giuseppe Casalicchio

Joaquin Vanschoren

Michel Lang

Bernd Bischl

Matthias Feurer

You?