A data science observatory

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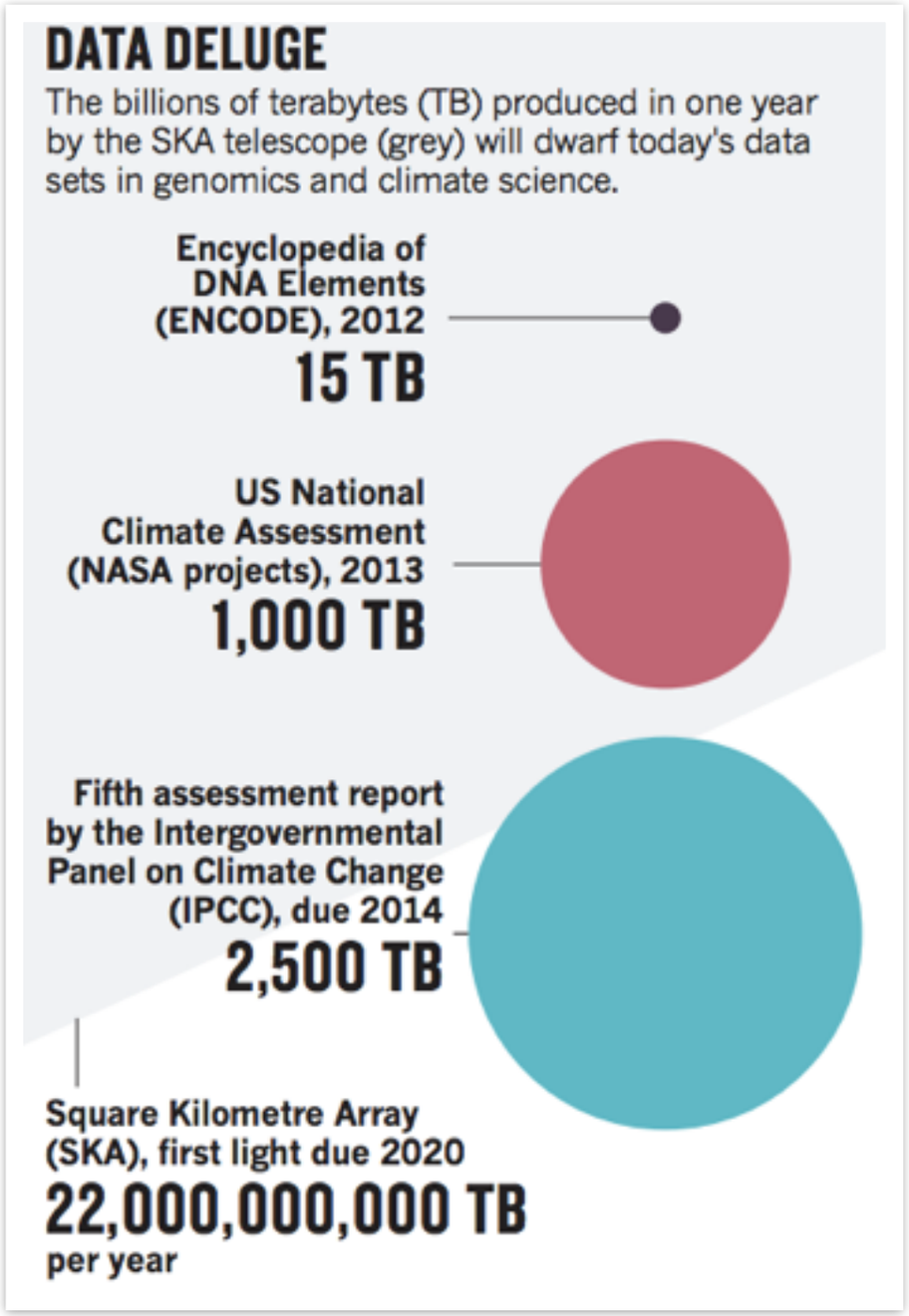
The research objective & questions

Enough with the chairs

- Design research is falling behind in dealing with **contemporary challenges**
  - Claim 1a: Too much in-breeding and repetition
  - Claim 1b: Huge amount of work is based on ideas from 80s'

- Design is **not about objects, but about reasoning**

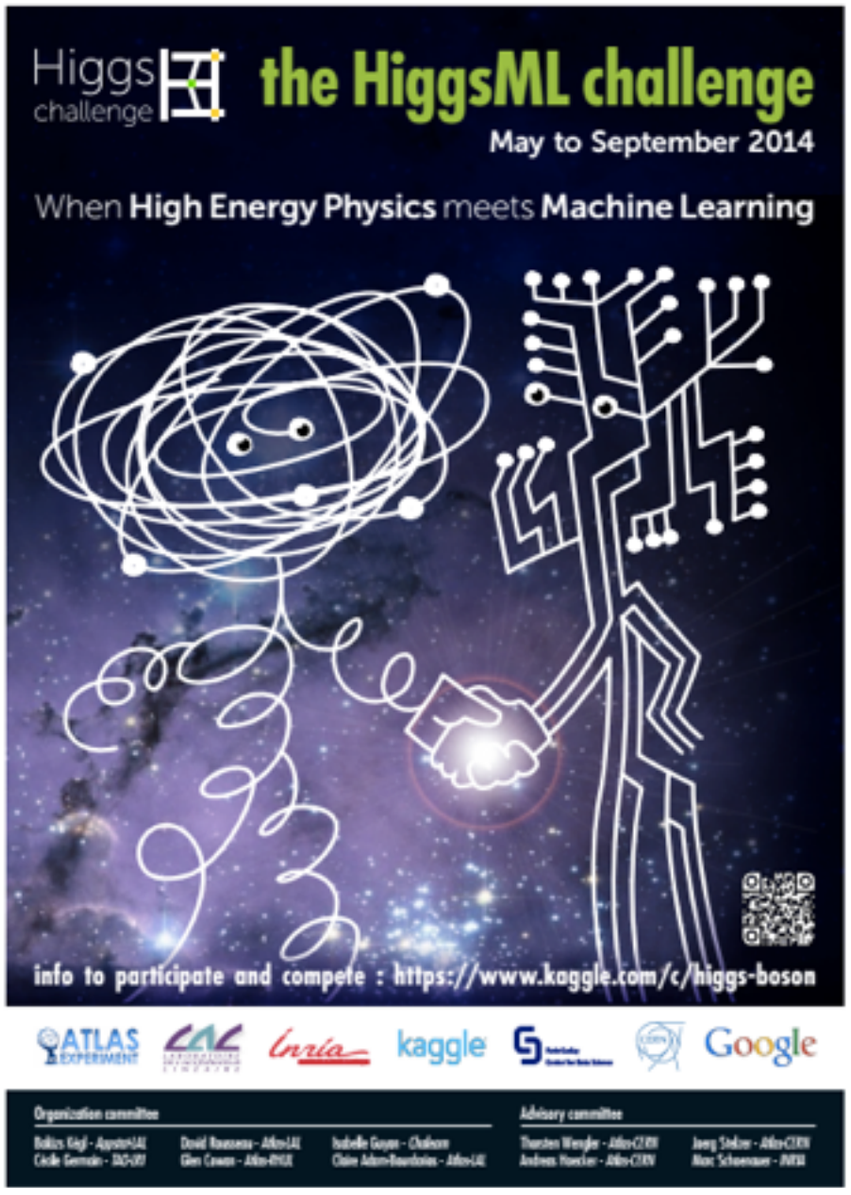
Revealing the potential of data: what role for design?

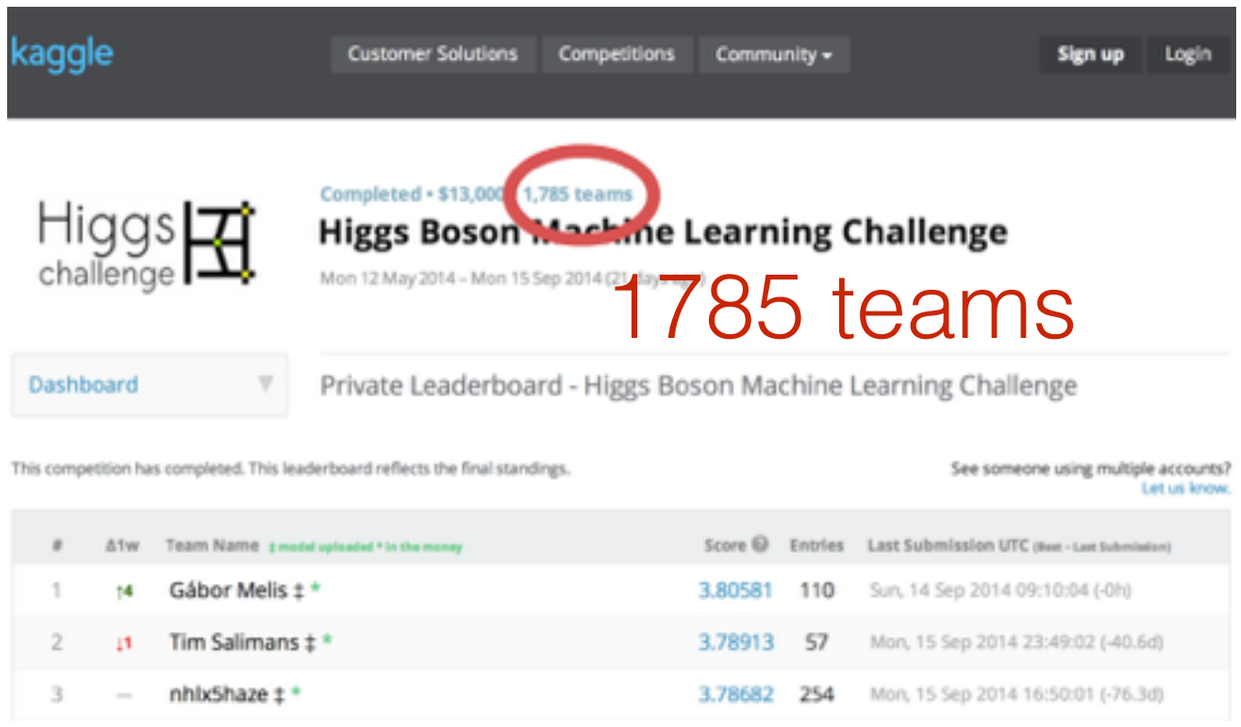


- Physics (Particle physics, Plasma physics, astrophysics…)
- Biology (Genetics, Epidemiology…)
- Chemistry
- Economics, Finance, Banking
- Manufacturing, Industrial Internet
- Internet of things, Connected Devices
- Social media
- Transport & Mobility
- …

There is not enough data scientists to handle this much data

Last year: Crowdsourcing data challenges





1785 teams

Reasonable doubts about the effectiveness of data science contests

Kazakci, A., Data science as a new frontier for design, ICED'15, Milan

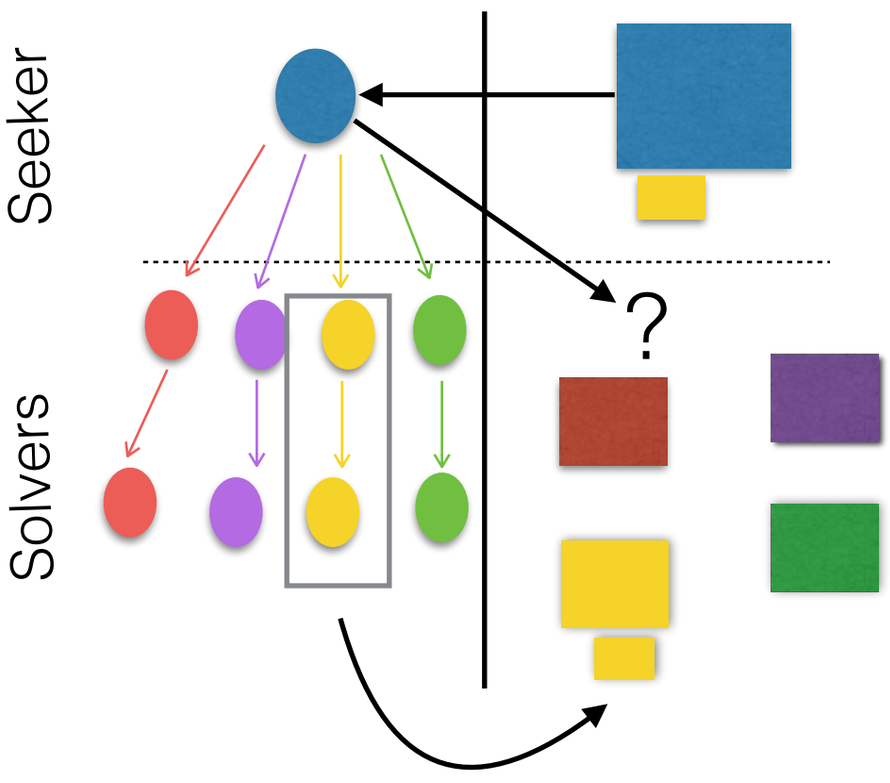
Crowdsourcing /?/ Design

crowd
/kraʊd/ noun
1.a large number of people gathered together in a *disorganized or unruly way*

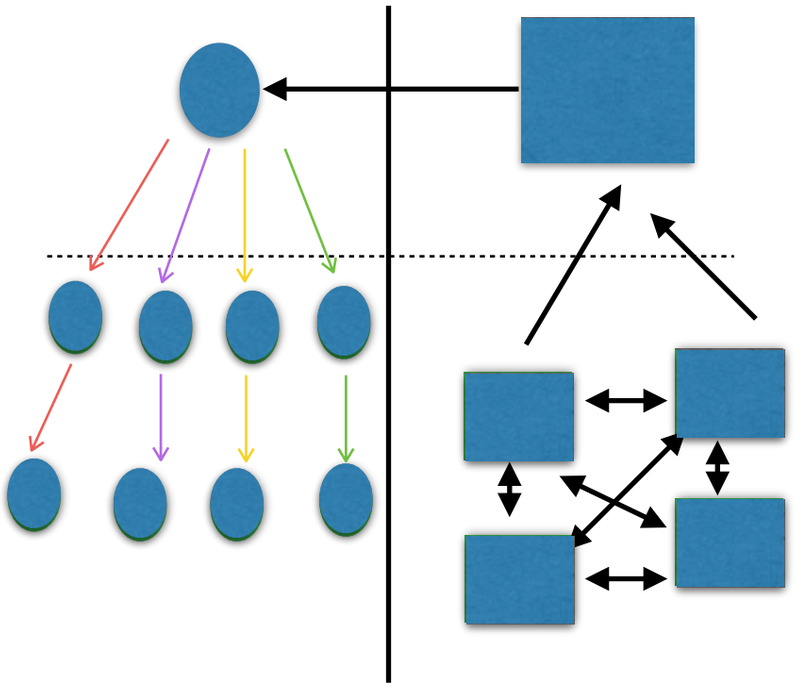
1. How to study the design process of a crowd?
2. How to manage the design process of a crowd?

Crowdsourcing: C-K dynamics

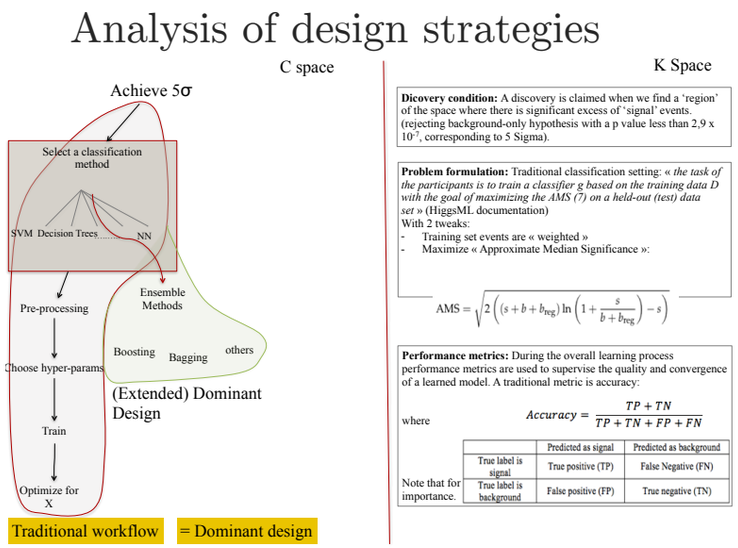
Crowdsourced contests

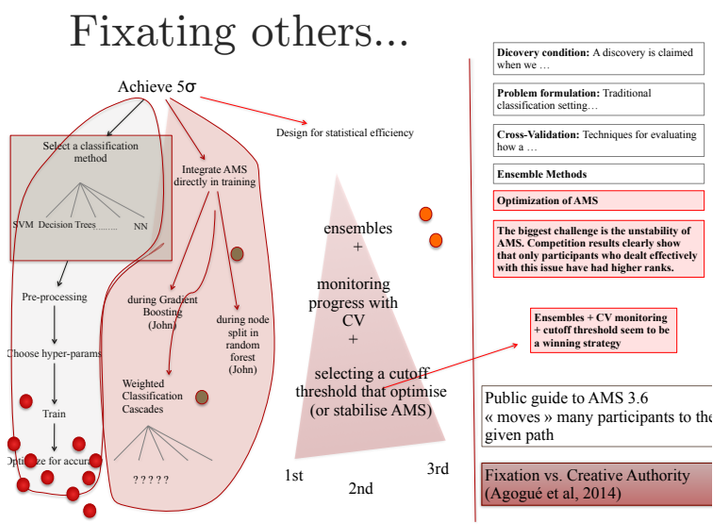


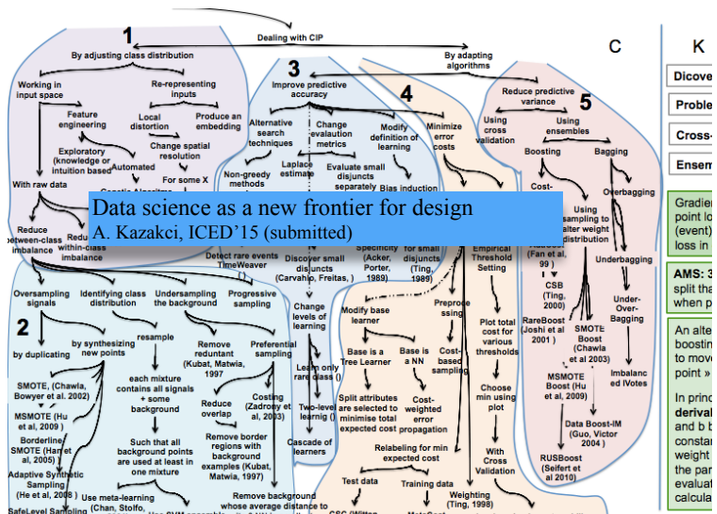
Crowdsourced collaboration



Data challenges are hard to analyze







- Available data for HiggsML
  - Forums ➔ 136 topics, 1400+ posts
  - Documentation
  - Participants' blog entries
  - GitHub codes
- Qualitative interpretation combined with C-K modelling of participants' strategies

How do you put a crowd under a microscope?

2 The research instrument

RAMP - Rapid Analytics and Model Prototyping

A Collaborative Development Platform for Data Science

RAMP
Rapid Analytics and Model Prototyping

Number of air passengers prediction

my submissions
new submission
leaderboard
log out

Instant access to all submitted code - for participants & organizers

Combined score: 0.227

Combined test score: 0.225

Private leaderboard

team	submission	public bag
mouhcine_taoufiq	First submition	0.244
robin_vogel	sparse and spurious	0.237
baptiste_roziere	INOPA	0.263
nicolas_legroux	second_try	0.260
youcef_sebiat	last_sub	0.242
youcef_sebiat	HMM_2	0.241
pierre_fournier	firstTryOKLM	0.257
youcef_sebiat	HMM_3	0.241

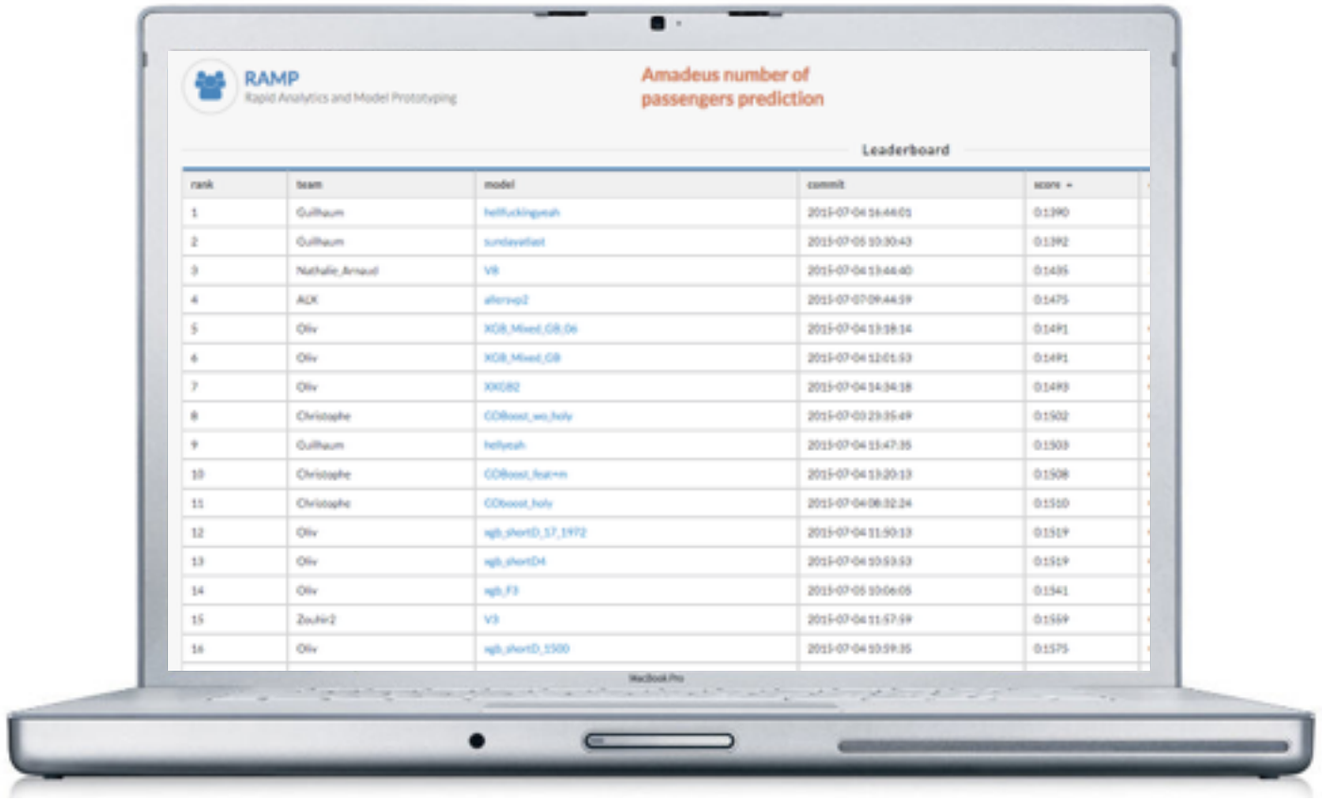
Databoard

Leaderboard › kegl › MF.AB(20;RF(100;5))_d1 › model.py

```python
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
from sklearn.preprocessing import Imputer
from sklearn.pipeline import Pipeline
from sklearn.base import BaseEstimator

class Classifier(BaseEstimator):
    def __init__(self):
        self.clf = Pipeline([('imputer', Imputer(strategy='most_frequent')),
        ('rf', AdaBoostClassifier(base_estimator=RandomForestClassifier(max_depth=5,
n_estimators=100),
                                  n_estimators=20))])

    def fit(self, X, y):
        self.clf.fit(X, y)

    def predict(self, X):
        return self.clf.predict(X)

    def predict_proba(self, X):
        return self.clf.predict_proba(X)
```

RAMP - Rapid Analytics and Model Prototyping

A Collaborative Development Platform for Data Science



RAMP allows us to collect data on the data science model development process

1. We prepare a ‘starting kit’
2. Continuous access to code:
   - Participants can analyse and build on every submission
   - Organizers can follow real-time what’s happening - and react
3. Submissions are trained and performances are displayed
4. Users actions and interactions are recorded
5. Main Output: Dozens of predictive models and performance benchmark

Collecting data with RAMP

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Rapid Analytics and Model Prototyping

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timestamp (UTC)	user	team	interaction	submission	file	code similarity	diff
2016-01-31 16:26:06 Sun	akazakci	akazakci	looking at user				
2016-01-31 16:24:56 Sun	kegl	kegl	looking at leaderboard				
2016-01-31 16:24:09 Sun	akazakci	akazakci	looking at user				
2016-01-31 16:23:47 Sun	akazakci	akazakci	looking at user				
2016-01-29 18:00:39 Fri	kegl	kegl	looking at submission	mouhcine_taoufiq/First submition	feature_extractor		
2016-01-29 15:27:56 Fri	eliot_barril	eliot_barril	looking at submission	mouhcine_taoufiq/First submition	regressor		
2016-01-29 15:27:38 Fri	eliot_barril	eliot_barril	looking at leaderboard				
2016-01-29 15:27:38 Fri	eliot_barril	eliot_barril	looking at leaderboard				
2016-01-29 14:05:12 Fri	eliot_barril	eliot_barril	looking at submission	eliot_barril/aftercompetition2	regressor		
2016-01-29 14:05:00 Fri	eliot_barril	eliot_barril	looking at submission	eliot_barril/GlouGlou_2	regressor		
2016-01-29 1							
2016-01-29 1				mou			
2016-01-29 1				mou			
2016-01-29 1							
2016-01-29 1							
2016-01-29 0							
2016-01-28 1			board				
2016-01-28 1							
2016-01-28 0				ivay			
2016-01-28 0				ivay			
2016-01-28 0				tian			
2016-01-28 09:14:31 Thu	eliot_barril	eliot_barril	looking at leaderboard				
2016-01-27 14:26:37 Wed	basile_calderan	basile_calderan	looking at submission	robin_vogel/sparse and spurious	feature_extractor		
2016-01-27 14:26:24 Wed	basile_calderan	basile_calderan	looking at private leaderboard				

- Number of submissions
- Frequency of submissions
- Timing of submissions
- User interactions
- Performance of submissions
- Submitted code
- …

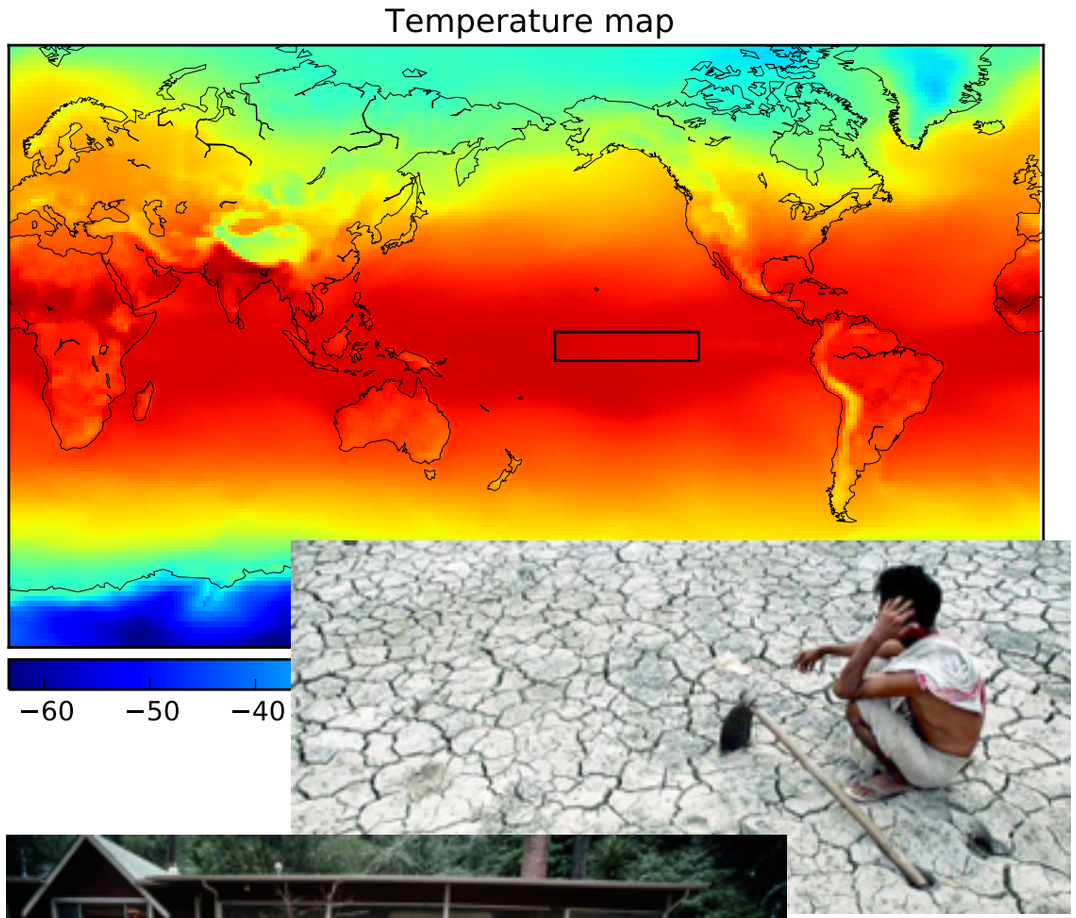
We are interested in

- the variety (code space + prediction space)
- the mutual influences and inheritance (code space)
- score and delta score (impact)
- …

3

Some applications, preliminary observations & findings

Climatology



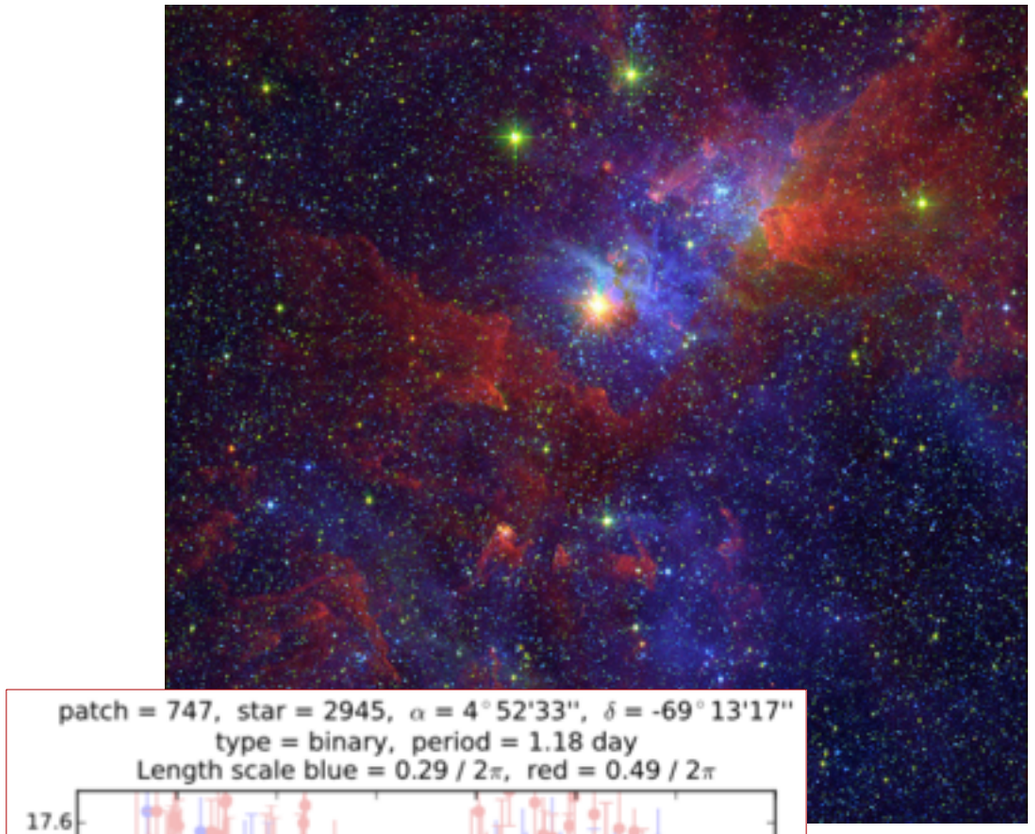
Time Series Based Event Prediction on Geo-tagged data

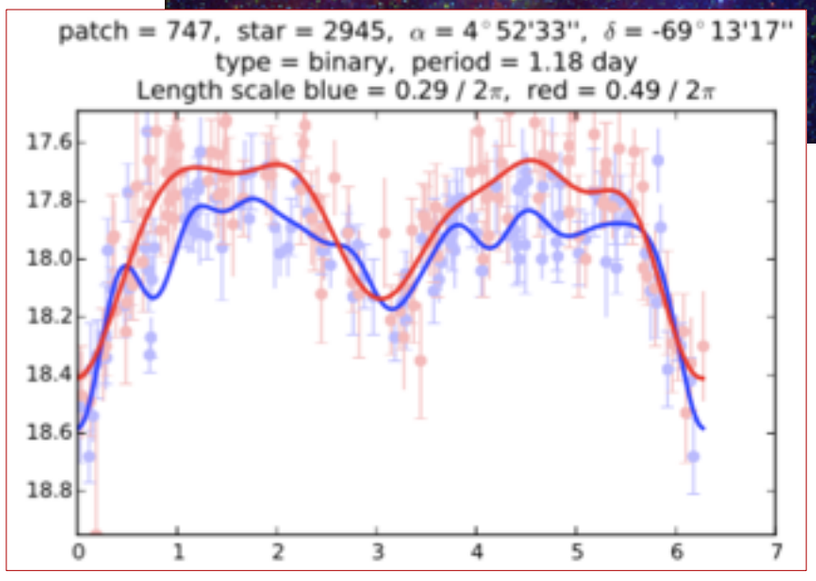
George Washington University
George Mason University

EI Nino Prediction
- Temperature data
- Geo-tagged time series
- Prediction: 6 months ahead

Two workshops: Improvement in RMSE score: from 0.90 to 0.43

Astrophysics





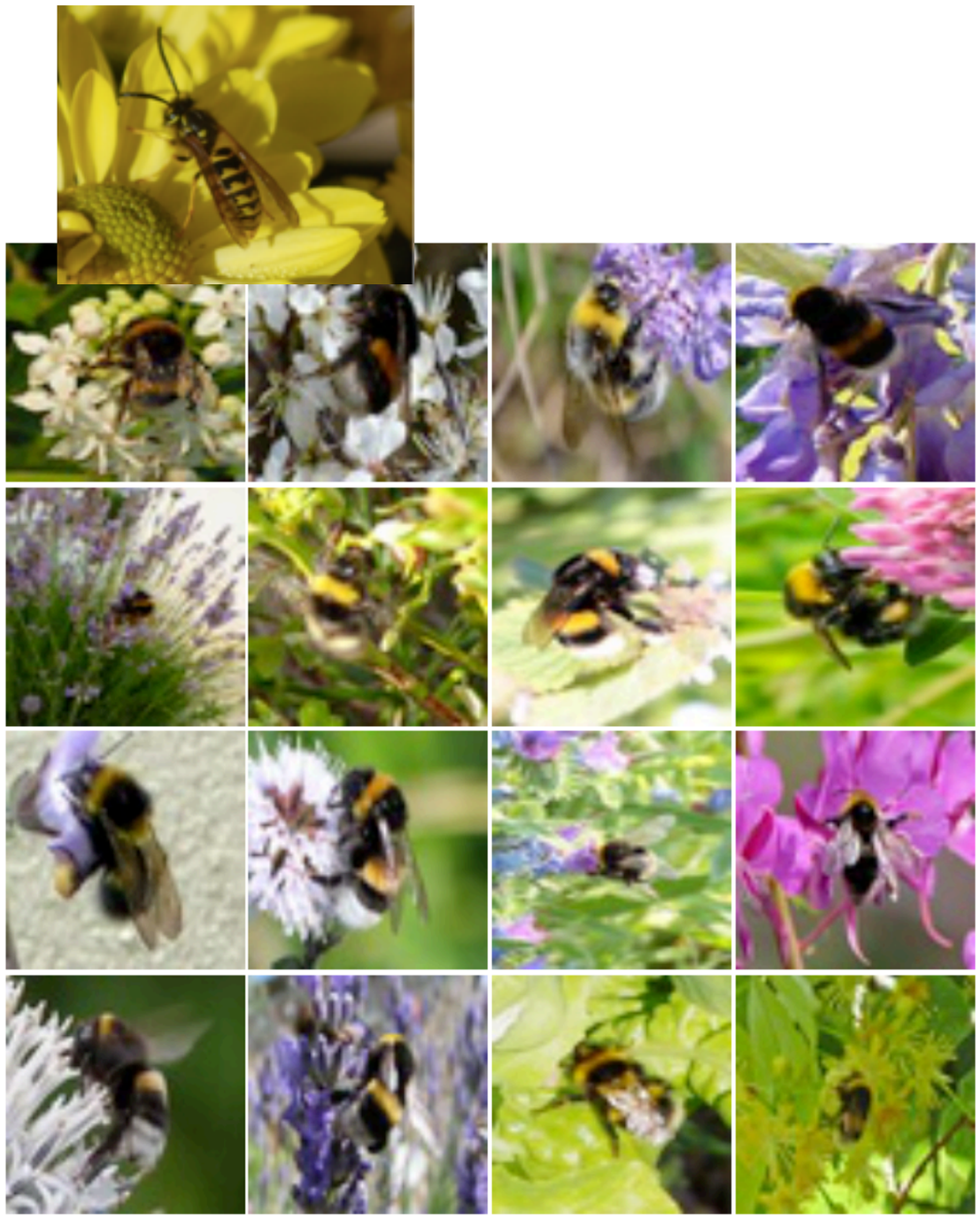
Classification of variable stars

Marc Monier (LAL),
Gilles Faÿ (Centrale-Supelec)

Light curves (luminosity vs time profiles)
- Static features
- Functional data

One day workshop: Accuracy improvement: %89 to %96

Ecology



Finding & Classifying Insects from Image Data

Paris Museum of Natural History, SPIPOLL.org, NVDIA, Université de Champagne-Ardenne ROMEO HPC Center

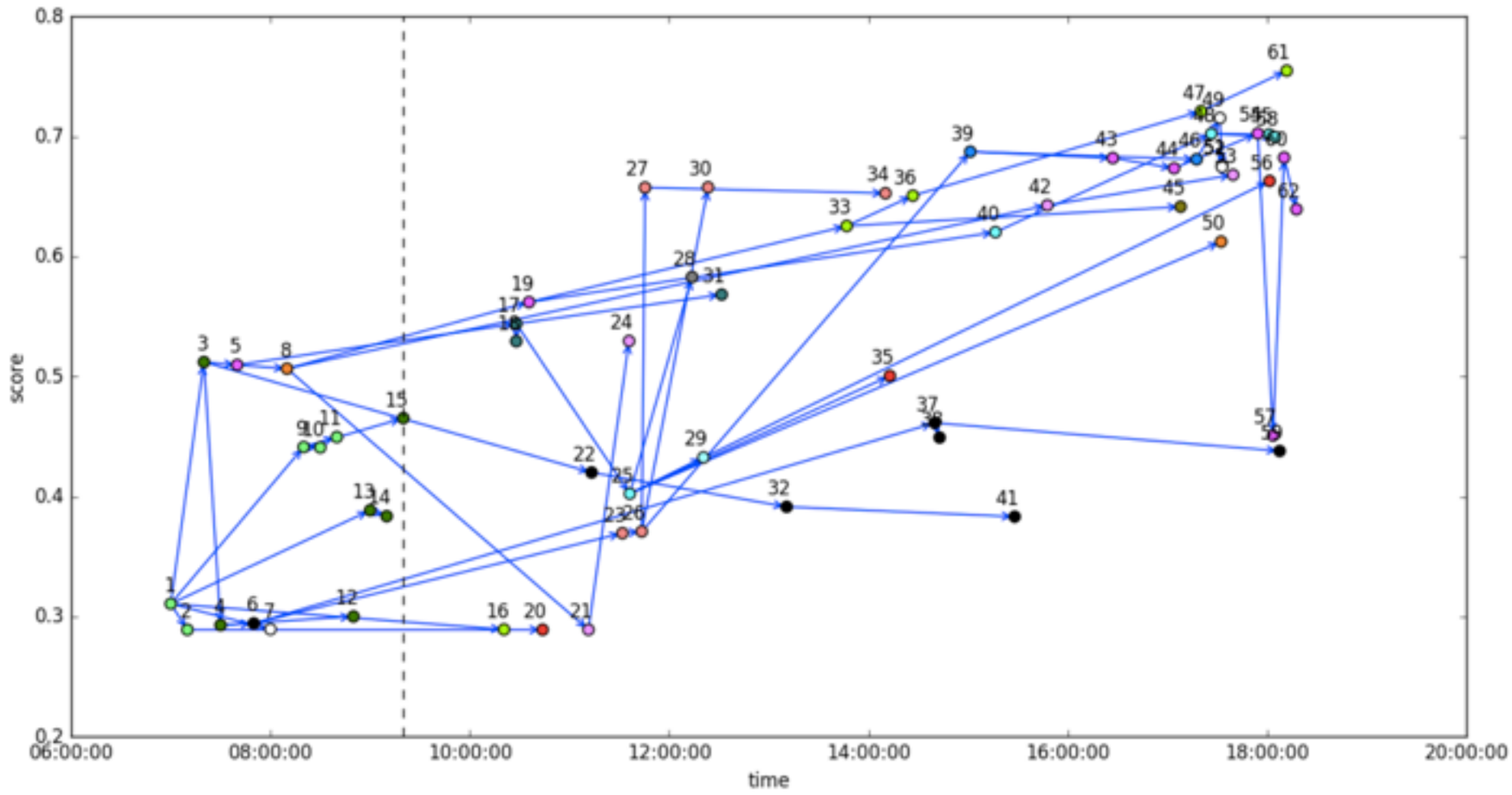
Pollenating Insects
- Image data (20K images)
- 18 types of insects
- Deep neural net models

One day event:
Improvement in prediction accuracy: from 0.31 to 0.70

Cancer Research

Epidemium est un programme de recherche scientifique participatif et ouvert dédié à la compréhension du cancer grâce aux Big Data, qui se concrétisera sous la forme d'un *data challenge*.

A graph of model similarities



Some observations

- **Steady progression**. They have built systematically on a submission they previously created, without being influenced by the others. Their performance may go either up (constantly) or down (constantly).
- **Breakdowns or jumps**. There are other groups, where the performance increased or decreased strongly from one modification submission to the next). There may be some robustness/vulnerability issue with their approach - to be further investigated.
- **Successful expansions.** An important “break” has happened at 12:00. This corresponds to “cropping” idea. Strangely, two very similar submissions (small distance) have been submitted at the same time - one of them did not improve the score at all (around 0.35, while the leader was around 0.55), whereas the other improved considerably (0.65).
- Currently, **we see no dependency between this break and the winning solution**. This might be related to the way we have measured the code similarity.

"Note that, following the RAMP approach, this model is the result of **a succession of small improvements made on top of other participants' contributions**. We did not reach a prediction score of 0.71 in one shot, but after applying several tricks and manually tuning some parameters."

Heuritech,
Winner of Insect Challenge
Blog entry

How to compare design concepts - represented as code?

RAMP
Rapid Analytics and Model Prototyping

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my submissions
new submission
leaderboard
log out

Leaderboard > hien-long-bruno_ly > GBYTES > feature_extractor.py

```python
import pandas as pd
import os


class FeatureExtractor(object):
    def __init__(self):
        pass

    def fit(self, X_df, y_array):
        pass

    def transform(self, X_df):
        X_encoded = X_df
        path = os.path.dirname(__file__)
        data_weather = pd.read_csv(os.path.join(path,
"external_data.csv"))
        X_weather = data_weather[['Date', 'AirPort', 'Max
TemperatureC']]
        X_weather = X_weather.rename(
            columns={'Date': 'DateOfDeparture', 'AirPort': 'Arrival'})
        X_encoded = X_encoded.set_index(['DateOfDeparture', 'Arrival'])
        X_weather = X_weather.set_index(['DateOfDeparture', 'Arrival'])
        X_encoded = X_encoded.join(X_weather).reset_index()

        X_encoded = X_encoded.join(pd.get_dummies(
            X_encoded['Departure'], prefix='d'))
        X_encoded = X_encoded.join(
            pd.get_dummies(X_encoded['Arrival'], prefix='a'))
        X_encoded = X_encoded.drop('Departure', axis=1)
        X_encoded = X_encoded.drop('Arrival', axis=1)

        X_encoded = X_encoded.drop('DateOfDeparture', axis=1)
        X_array = X_encoded.values
        return X_array
```

~

?

RAMP
Rapid Analytics and Model Prototyping

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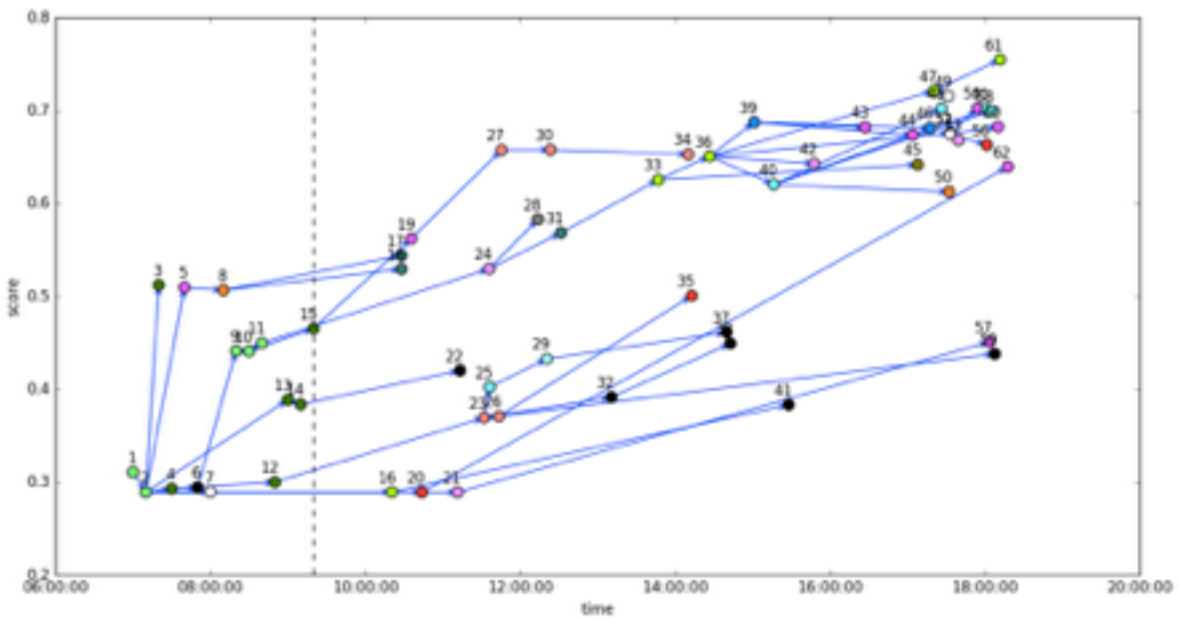
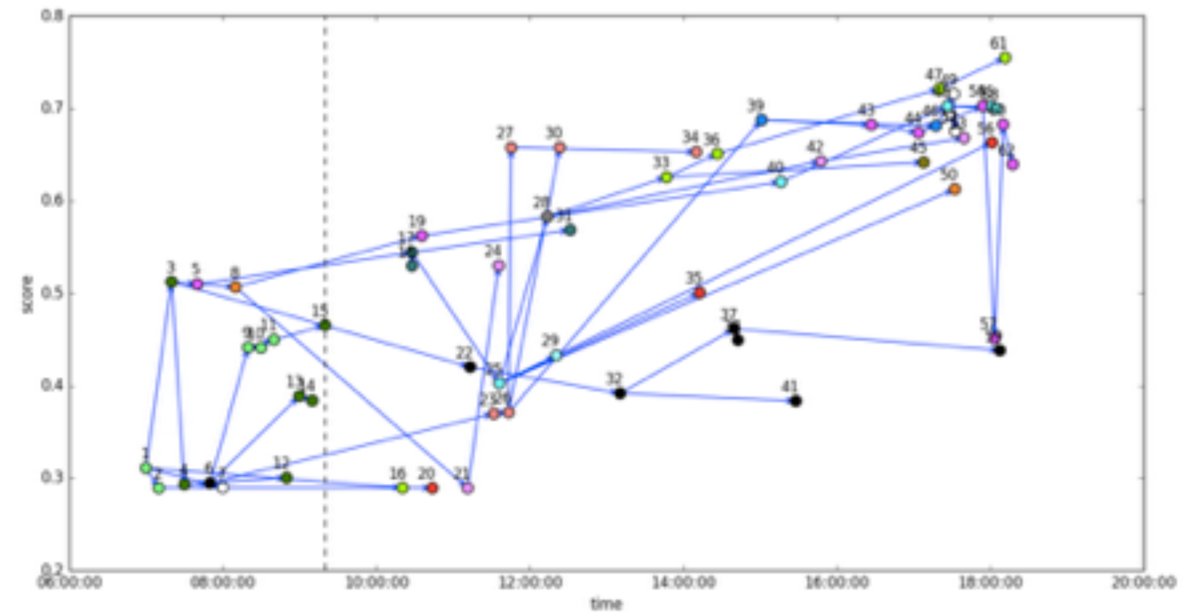
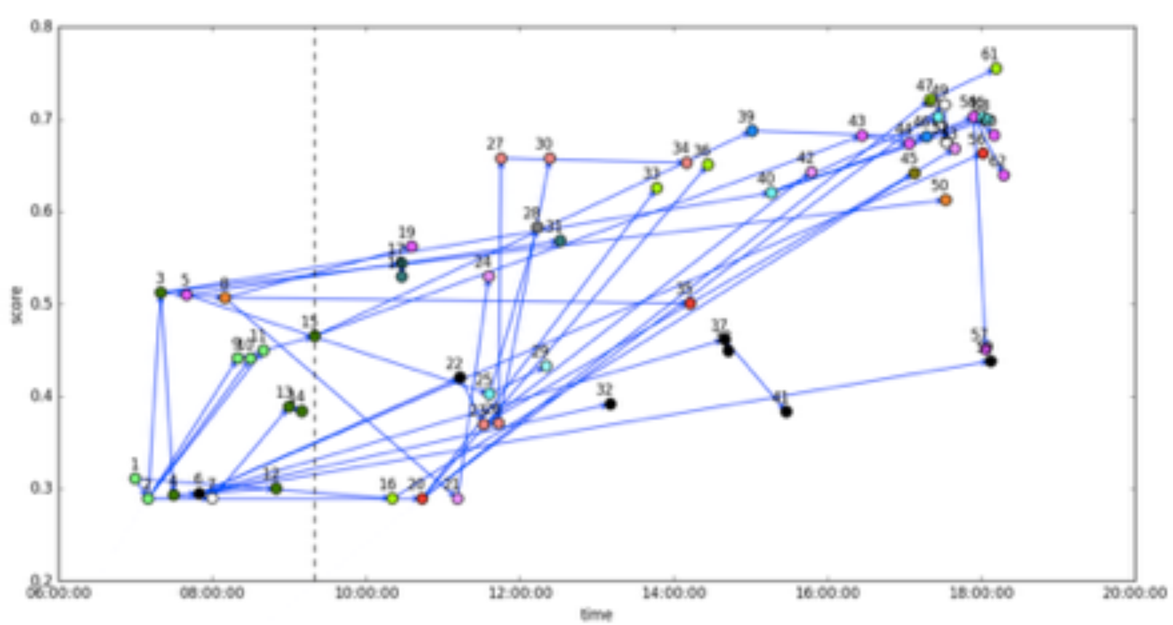
Leaderboard > djabbz > NdirouUnJob > feature_extractor.py

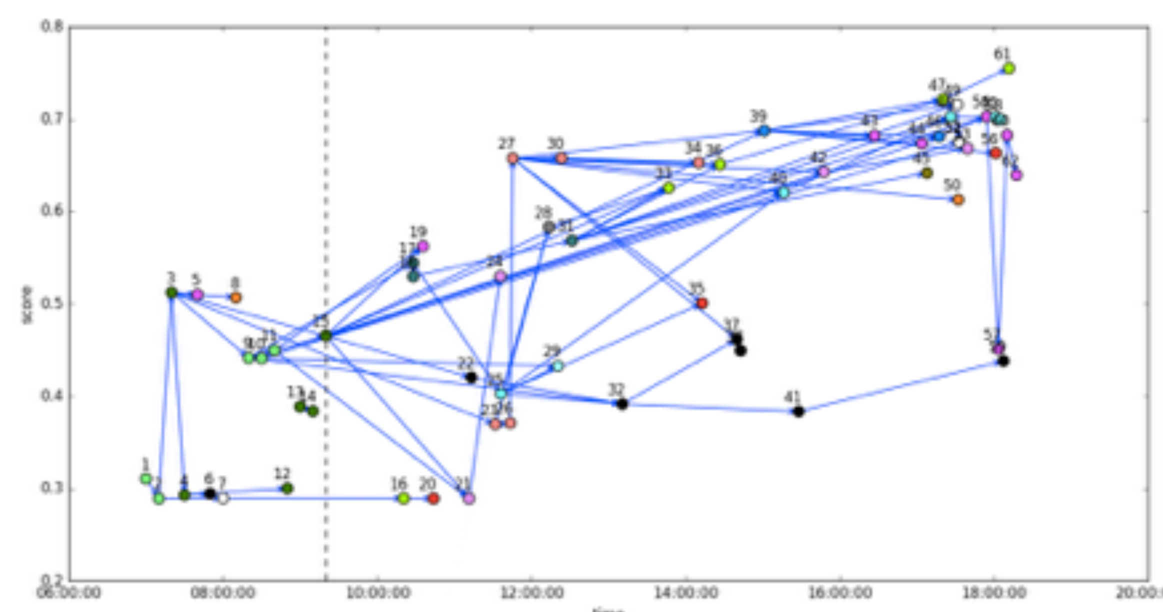
```python
import pandas as pd
import os

def get_binary_var(data, prefix=None, prefix_sep='_'):
    from pandas.tools.merge import concat
    import numpy as np

    data = data.astype('category')
    length = data.cat.categories.size
    length = int(np.ceil(np.log2(length)))
    code_string = data.cat.codes.map(lambda x:
'{0:b}'.format(x).rjust(length, '0'))

    codes = []
    for i in range(length):
        codes.append(code_string.str[i])

#     levels = data.cat.categories
    if prefix is None:
        prefix = data.name
    cols_name = ['%s%s' %(prefix, prefix_sep, i) for i in range(1,
length + 1)]
    df = concat(codes, axis=1)
    df.columns = cols_name
    return df.astype(np.int8)

class FeatureExtractor(object):
    def __init__(self):
        pass

    def fit(self, X_df, y_array):
        pass

    def transform(self, X_df):

        data_encoded = X_df

        state_pop = pd.DataFrame([('ATL', 9.9),
                                  ('BOS', 6.6),
                                  ('CLT', 9.7),
                                  ('DEN', 5.2),
                                  ('DFW', 26.6),
                                  ('DTW', 9.9),
                                  ('EWR', 8.9),
                                  ('IAH', 26.6),
                                  ('JFK', 19.5),
                                  ('LAS', 2.7),
                                  ('LAX', 38),
                                  ('LGA', 19.5),
                                  ('MCO', 19.3),
                                  ('MIA', 19.3),
                                  ('MSP', 5.4),
                                  ('ORD', 12.9),
                                  ('PHL', 12.8),
                                  ('PHX', 6.9),
                                  ('SEA', 6.9),
                                  ('SFO', 38)], columns=['airports',
'pop'])
        data_encoded = data_encoded.merge(state_pop, how='outer',
left_on='Departure', right_on='airports').drop('airports', axis=1)
        data_encoded = data_encoded.merge(state_pop, how='outer',
left_on='Arrival', right_on='airports').drop('airports', axis=1)

        data_encoded =
data_encoded.join(get_binary_var(data_encoded['Departure'],
prefix='dep'))
        data_encoded =
data_encoded.join(get_binary_var(data_encoded['Arrival'],
prefix='arr'))
        data_encoded = data_encoded.drop('Departure', axis=1)
        data_encoded = data_encoded.drop('Arrival', axis=1)

        data_encoded['DateOfDeparture'] =
pd.to_datetime(data_encoded['DateOfDeparture'])
        data_encoded['year'] = data_encoded['DateOfDeparture'].dt.year
        data_encoded['month'] =
data_encoded['DateOfDeparture'].dt.month
        data_encoded['day'] = data_encoded['DateOfDeparture'].dt.day
        data_encoded['weekday'] =
data_encoded['DateOfDeparture'].dt.weekday
        data_encoded['week'] = data_encoded['DateOfDeparture'].dt.week
        data_encoded['n_days'] =
data_encoded['DateOfDeparture'].apply(lambda date: (date -
pd.to_datetime('1970-01-01')).days)

        data_encoded = data_encoded.drop('DateOfDeparture', axis=1)

        data_encoded =
data_encoded.join(get_binary_var(data_encoded['year'], prefix='y'))
        data_encoded =
data_encoded.join(get_binary_var(data_encoded['month'], prefix='m'))
        data_encoded =
```

Various distance measures

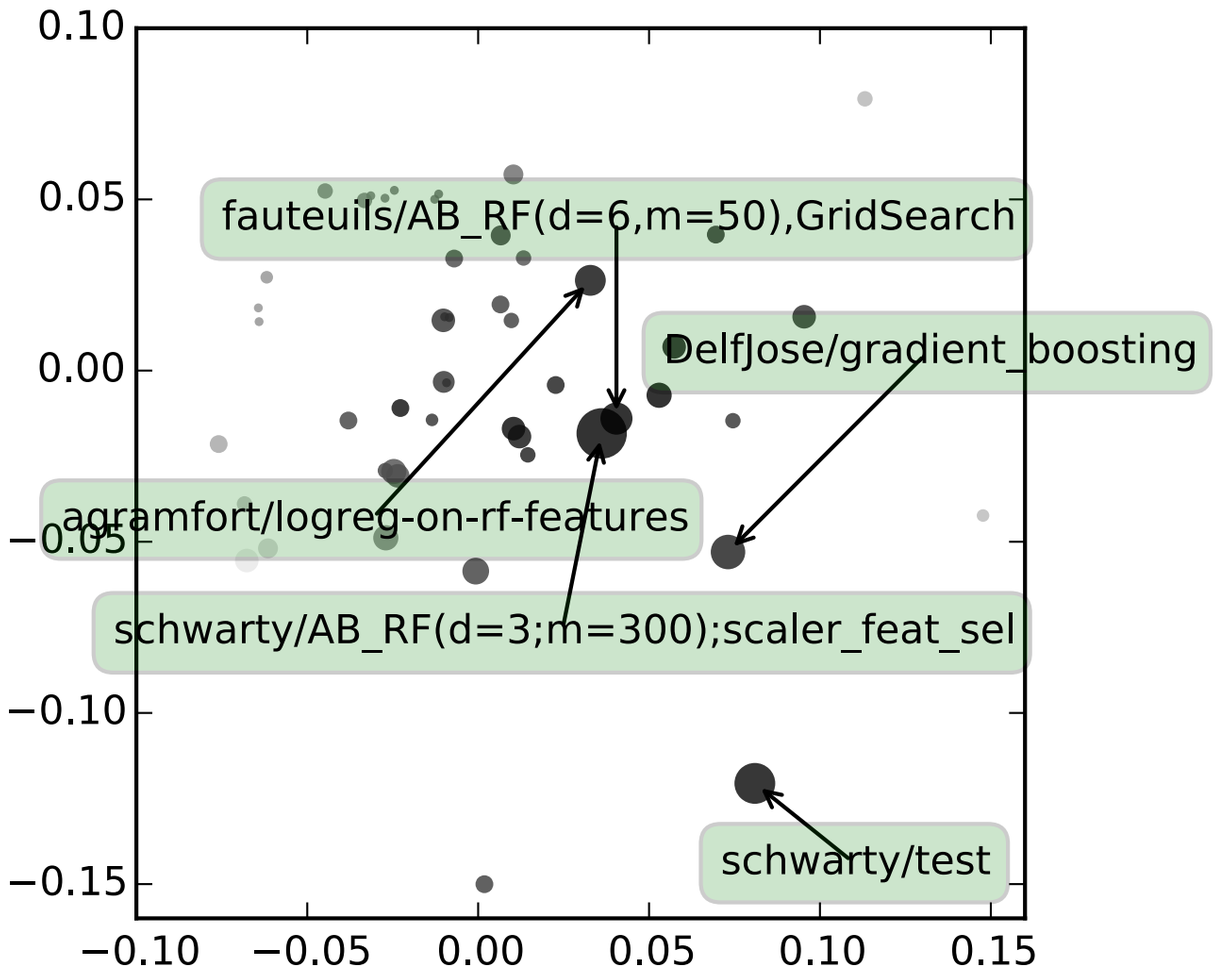








Comparing performance profiles: Promoting novelty search



2D projection (MDS) of model's prediction profiles

- Greyness: Model's raw score
- Size: model's contribution
- Position: similarity/dissimilarity in predictions

We Found (to be validated by further studies):

- Gravitation: following a given submission, others are hovering around the same coordinates, by incremental adjustments
- Repulsion: new submission using out-of-the-box code to explore the white space (no previous close-by submissions exist)
- Hybridation: opportunistic integration of previous submissions, involving/inspired by at least two different source of code.

In progress:

- Monitoring & Modelling “contribution”
  (Pierre Fleckinger, Economic Agents & Incentive Theory)
- Pushing towards “Novelty Search”
  (Jean-Bastiste Mouret, Novelty Search)
- Controlled experiments

RAMP platform

- RAMP platform is meant to be a free tool for researchers and students; this opens up new perspectives (pedagogy & research) and hopefully brings closer different communities

Thank you

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MINES ParisTech

d t m i design theory and methods for innovation

Paris-Saclay Center for Data Science

cnrs