The Shogun Machine Learning Toolbox

heiko.strathmann@gmail.com

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Outline

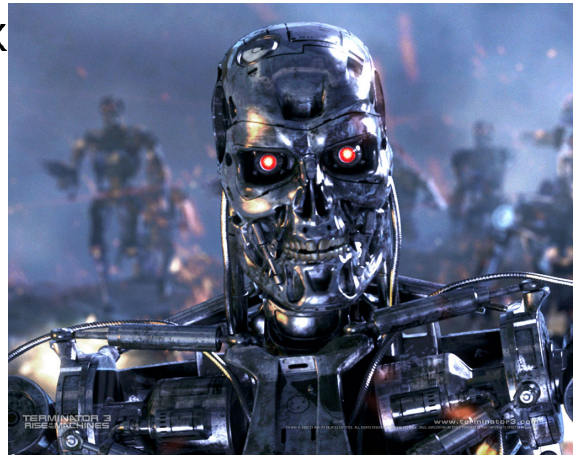
A bit about me

- Heiko Strathmann - `http://herrstrathmann.de/`
- 2004-2008 - Jazz guitar
- 2008-2013 - BSc in CS, MSc in ML

- Phd in Neuroscience & Machine Learning, UCL
- Kernels, Bayesian & MCMC, Bioinformatics, Open-Source
- Involved in Shogun since 2010

A bit about Machine Learning

- Science of patterns in information
- For example for recognising
  - Frauds in aeroplane wings
  - Skin cancer
  - Abuse of bank accounts
- ...or predicting
  - Treatment resistance of HIV
  - Brain activity
  - Products on Amazon/Spotify/Netflix
- Not limited to, but including
  - Statistics
  - Big Data & <place-buzzword>
  - Robot world domination



A bit about Shogun

- Open-Source tools for ML problems
- Made public in 2004
- Currently 8 core-developers + 20 regular contributors
- Originally academic background
- In Google Summer of Code since 2010 (29 projects!)
- **Upcoming workshop**: July 27, 28, c-base

Ohloh - Summary

In a Nutshell, SHOGUN...

... has had 25,187 commits made by 126 contributors
representing 588,445 lines of code

... is mostly written in C++
with a very low number of source code comments

... has a well established, mature codebase
maintained by a very large development team
with stable Y-O-Y commits

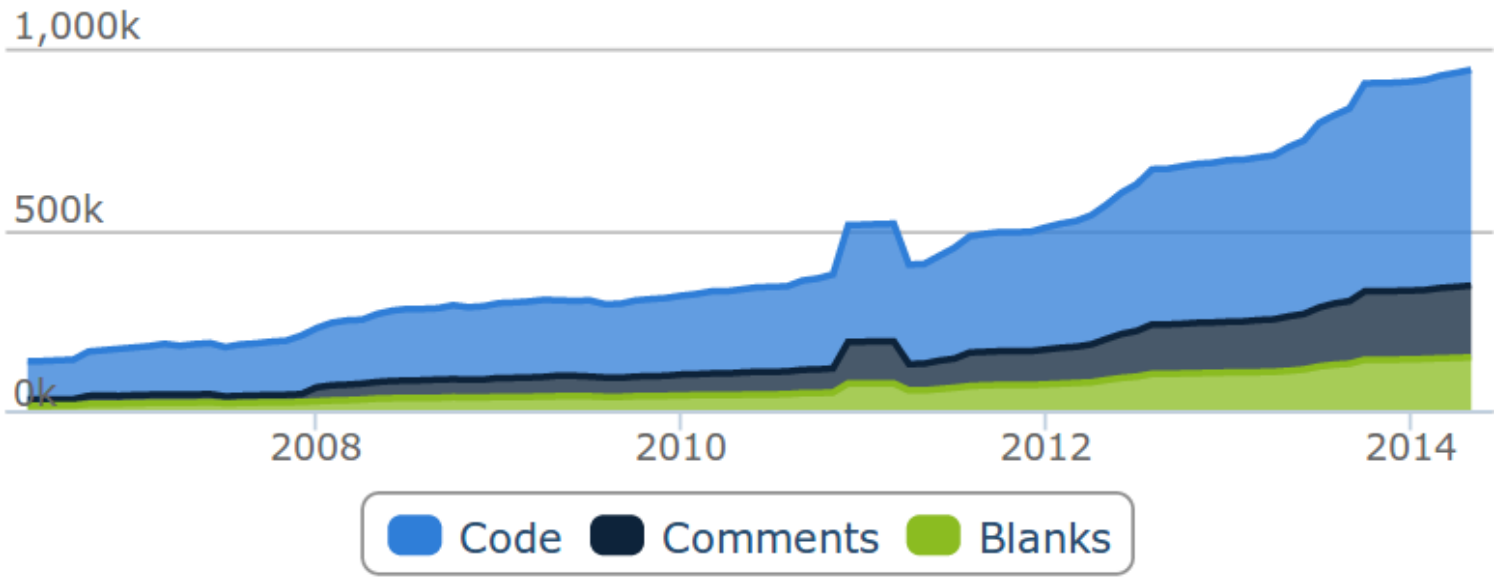
... took an estimated 162 years of effort (COCOMO model)
starting with its first commit in June, 2006
ending with its most recent commit about 3 hours ago

Ohloh - Code

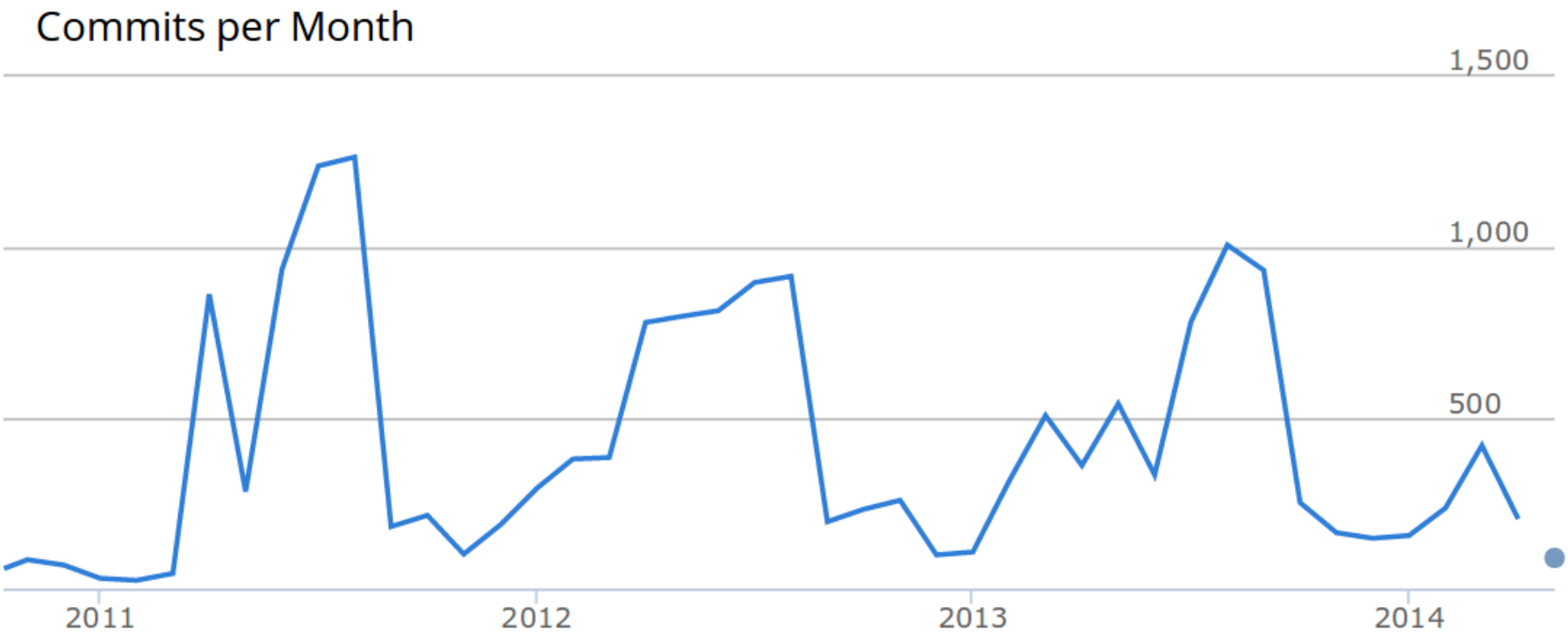
Languages

C++	50%	C	35%
Python	7%	12 Other	8%

Lines of Code



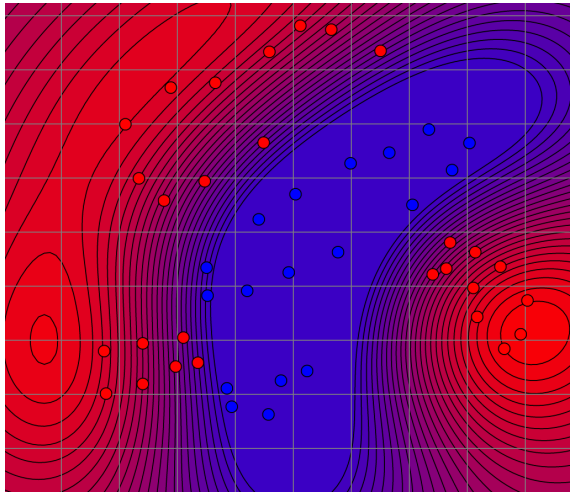
Ohloh - Commits

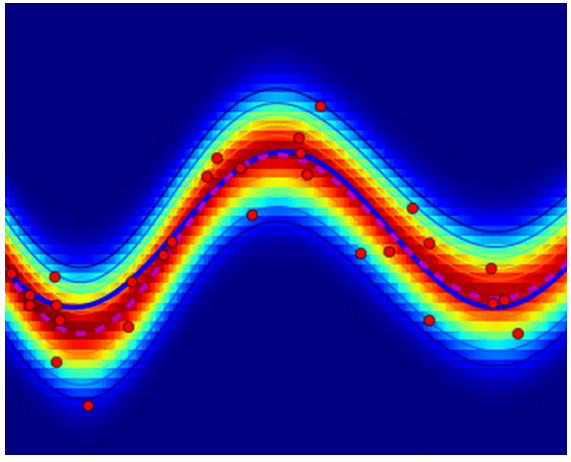


Outline

Supervised Learning

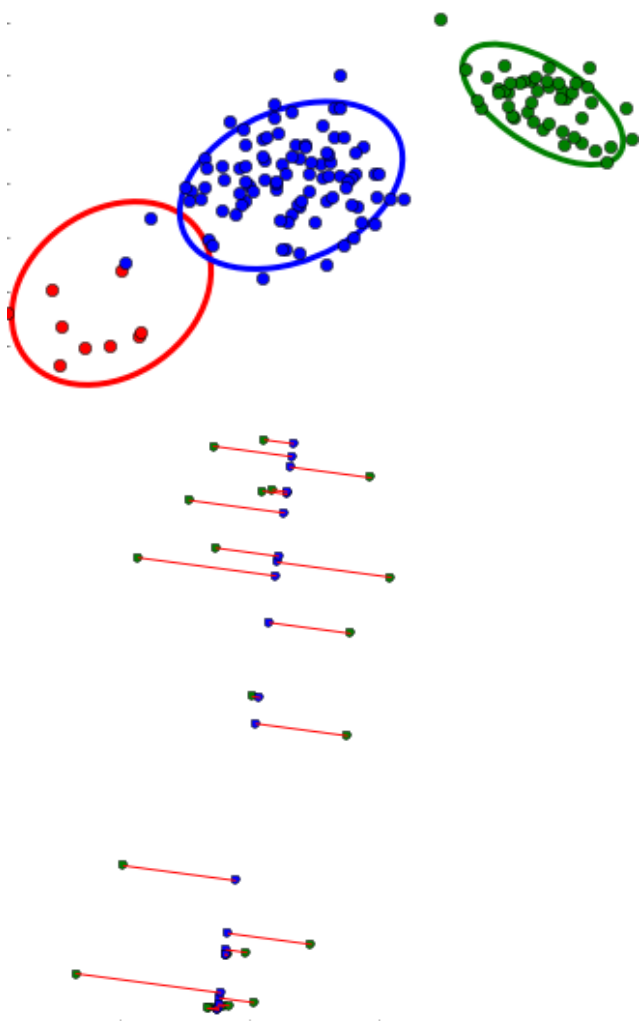
- Given: $\{(x_i, y_i)\}_{i=1}^n$, want: $y^*|x^*$
- Classification: y discrete
  - Support Vector Machine
  - Gaussian Processes
  - Logistic Regression
  - Decision Trees
  - Nearest Neighbours
  - Naive Bayes
- Regression: y continuous
  - Gaussian Processes
  - Support Vector Regression
  - (Kernel) Ridge Regression
  - (Group) LASSO





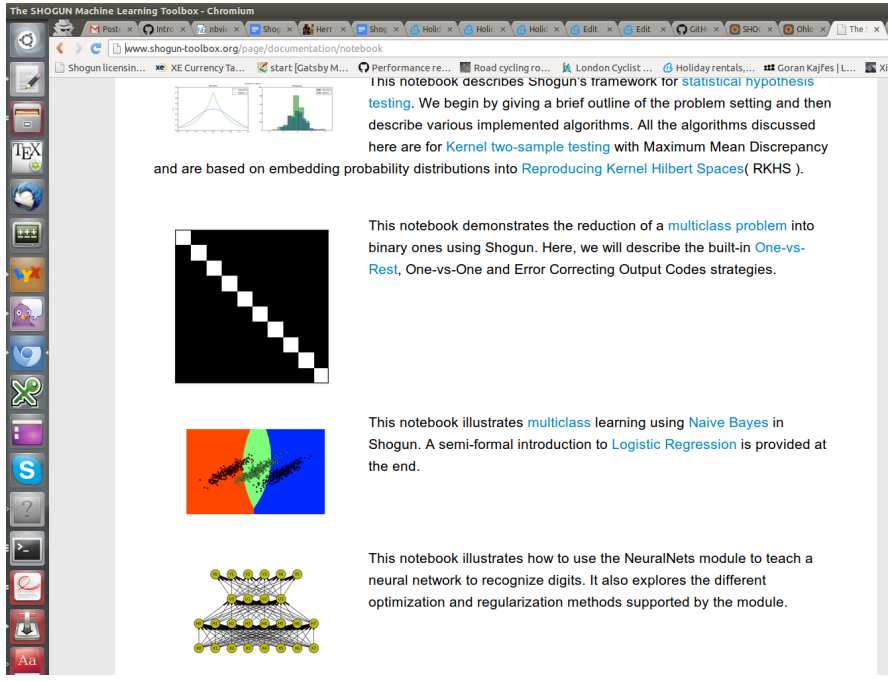
Unsupervised Learning

- Given: $\{x_i\}_{i=1}^n$, want notion of $p(x)$
- Clustering:
  - K-Means
  - (Gaussian) Mixture Models
  - Hierarchical clustering
- Latent Models
  - (K) PCA
  - Latent Discriminant Analysis
  - Independent Component Analysis
- Dimension reduction
  - (K) Locally Linear Embeddings
  - Many more...



And many more

- Multiple Kernel Learning
- Structured Output
- Metric Learning
- Large-Scale log-determinants
- Variational Inference
- Deep Learning (whooo!)
- ...



`http://www.shogun-toolbox.org/page/documentation/notebook`

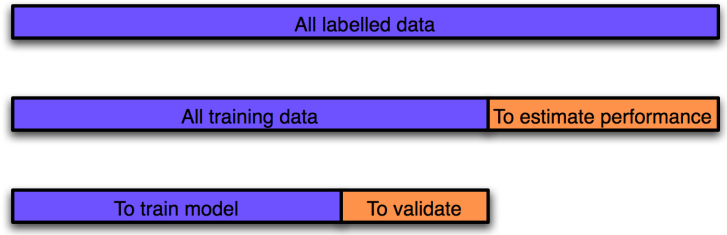
Some Large-Scale Applications

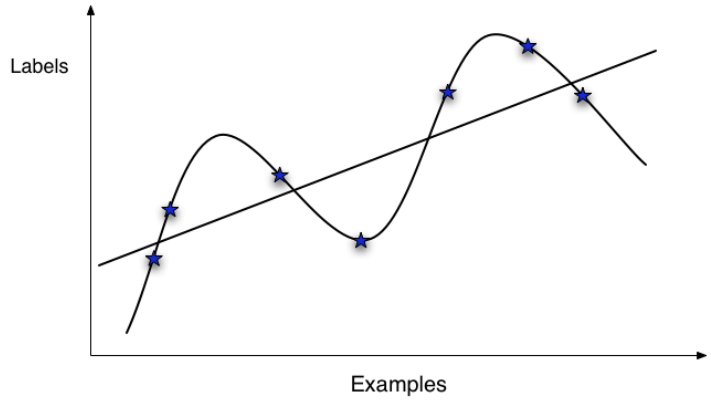
- Splice Site prediction: 50m examples of 200m dimensions
- Face recognition: 20k examples of 750k dimensions

AAACAAATAAGTAACTAATCTTTTAGGAAGAACGTTTCAACCATTTTGAG
AAGATTAAAAAAAAACAAATTTTTAGCATTACAGATATAATAATCTAATT
CACTCCCCAAATCAACGATATTTTAGTTCACTAACACATCCGTCTGTGCC
TTAATTTCACTTCCACATACTTCCAGATCATCAATCTCCAAAACCAACAC
TTGTTTTAATATTCAATTTTTTACAGTAAGTTGCCAATTCAATGTTCCAC
TACCTAATTATGAAATTAAAATTCAGTGTGCTGATGGAAACGGAGAAGTC

ML in Practice

- Modular data represetation
  - Dense, Sparse, Strings, Streams, ...
  - Multiple types: 8-128 bit word size
  - Preprocessing tools
- Evaluation
  - Cross-Validation
  - Accuracy, ROC, MSE, ...
- Model Selection
  - Grid-Search
  - Gradient based
- Various native file formats, generic multiclass, etc





Outline

Geeky details

- Written in (proper) C/C++
- Modular, fast, memory efficient
- Unified interface for Machine Learning
- Linear algebra & co: Eigen3, Lapack, Arpack, pthreads, OpenMP, recently GPUs

Class list:

`http://www.shogun-toolbox.org/doc/en/latest/namespaceshogun.html`

Modular language interfaces

- SWIG - `http://www.swig.org/`
- We write:
  - C/C++ classes
  - Typemaps (i.e. 2D `C++` matrix $\Leftrightarrow$ 2D `numpy` array)
  - List of classes of expose
- SWIG generates:
  - Wrapper classes
  - Interface files
- Automagically happens at compile time
- Identical interface for all modular languages:
  - C++, Python, Octave, Java, R, Ruby, Lua, C#
- We are in Debian/Ubuntu, but also Mac, Win, Unix

C/C++

```
#include <shogun/base/init.h>
#include <shogun/kernel/GaussianKernel.h>
#include <shogun/labels/BinaryLabels.h>
#include <shogun/features/DenseFeatures.h>
#include <shogun/classifier/svm/LibSVM.h>

using namespace shogun;

int main()
{
init_shogun_with_defaults();
...
exit_shogun();
return 0;
}
```

C/C++

```
DenseFeatures<float64_t>* train=new
    DenseFeatures<float64_t>(...);
DenseFeatures<float64_t>* =new DenseFeatures<
    float64_t>(...);
BinaryLabels* labels=new BinaryLabels(...);

GaussianKernel* kernel=new GaussianKernel(
    cache_size, width);
svm=new LibSVM(C, kernel, labels);
svm->train(train);

CBinaryLabels* predictions=CLabelsFactory::
    to_binary(svm->apply(test));
predictions->display_vector();

SG_UNREF(svm);
SG_UNREF(predictions);
```

Python

```
from modshogun import *

train=RealFeatures(numpy_2d_array_train)
test=RealFeatures(numpy_2d_array_test)
labels=BinaryLabels(numpy_1d_array_label)

kernel=GaussianKernel(cache_size, width)
svm=LibSVM(C, kernel, labels)
svm.train(train)

predictions=svm.apply(test)

# print first prediction
print predictions.get_labels()[0]
```

Octave

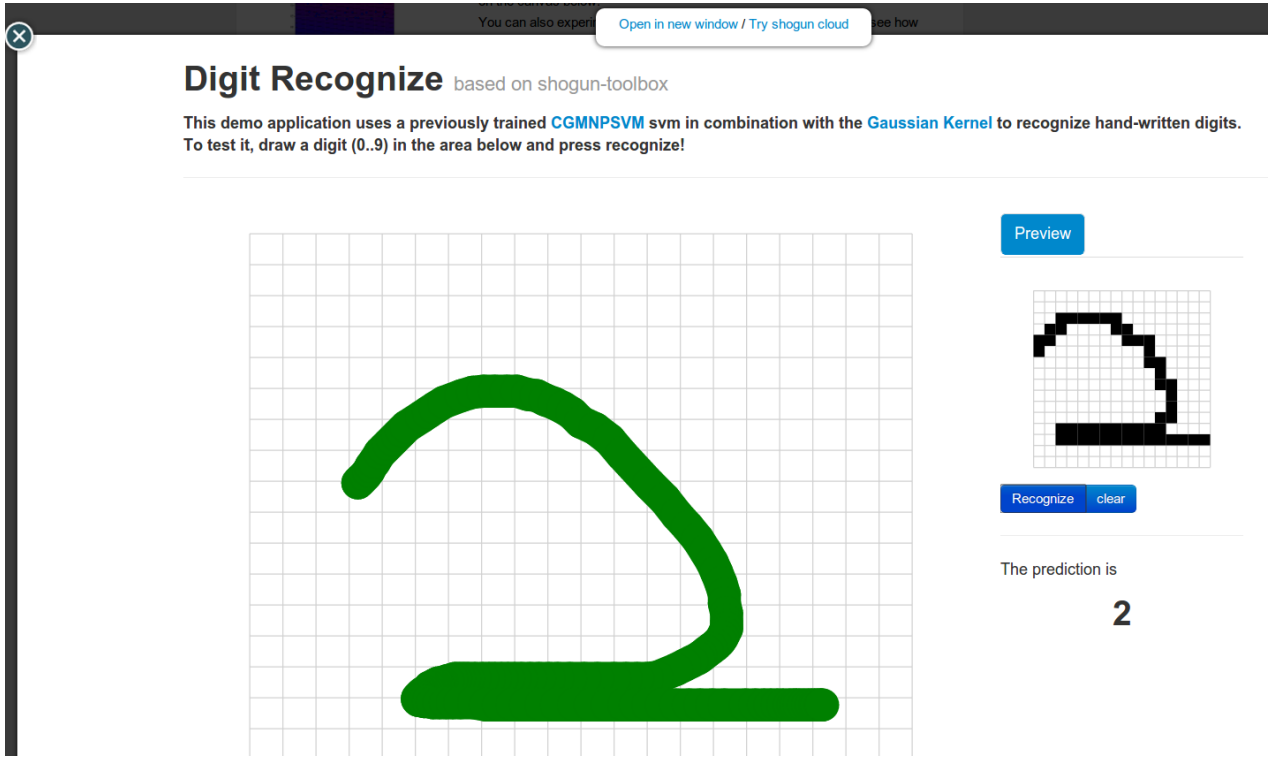
```
modshogun

train=RealFeatures(octave_matrix_train);
test=RealFeatures(octave_matrix_train);
labels=BinaryLabels(octave_labels_train);

kernel=GaussianKernel(cache_size, width);
svm=LibSVM(C, kernel, labels);
svm.train(train);

predictions=svm.apply(test);

% print first prediction
disp(predictions.get_labels()[1])
```

Java

```
import org.shogun.*;
import org.jblas.*;
import static org.shogun.LabelsFactory.to_binary;

public class classifier_libsvm_modular {
static {
System.loadLibrary("modshogun");
}

public static void main(String argv[]) {
modshogun.init_shogun_with_defaults();

RealFeatures train=new RealFeatures(new CSVFile(train_file));
RealFeatures test=new RealFeatures(new CSVFile(test_file));
BinaryLabels labels=new BinaryLabels(new CSVFile(label_fname));
GaussianKernel=new GaussianKernel(cache_size, width);
LibS svm=new LibSVM(C, kernel, labels);
svm.train(train);

// print predictions
DoubleMatrix predictions=to_binary(svm.apply(test)).get_labels();
System.out.println(predictions.toString());
}
}
```

Shogun in the Cloud

- We love (I)Python notebooks for documentation
- IPython notebook server: try Shogun without installation
- Interactive web-demos (Django)

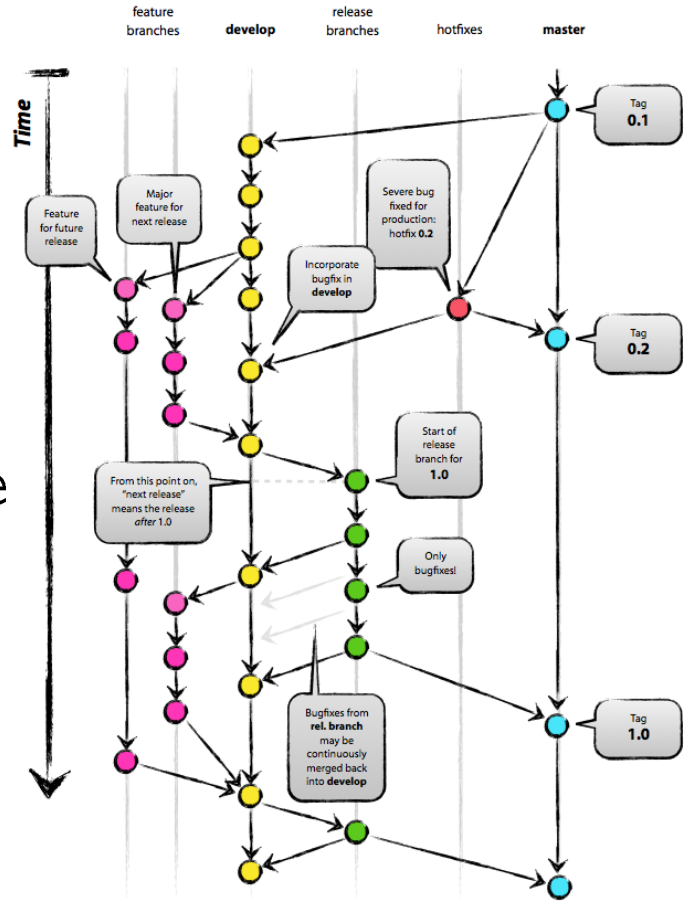


`http://www.shogun-toolbox.org/page/documentation/notebook`

`http://www.shogun-toolbox.org/page/documentation/demo`

Development model

- Github
  - Pull requests
  - Intense discussions
  - Git flow model
- Extensive test coverage
- Travis: Tests pass before merge
- Buildbot: All OS, nightly binaries, memory checks, notebooks, documentation



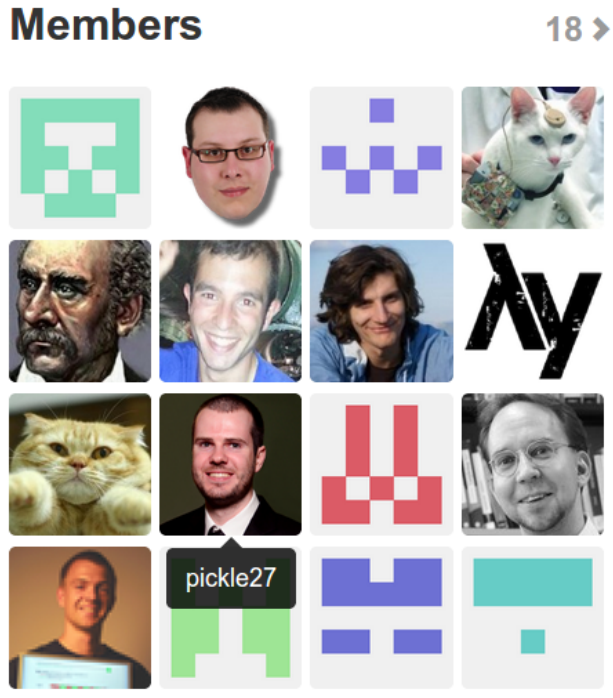
http://buildbot.shogun-toolbox.org/

shogun-toolbox	a4e7ce28b8dd... in develop	eb1f080e75db... in develop	67d55553fa37... in develop	d923cb10ed5e... in develop	4bfa55e61686... in develop
FC19 - libshogun	OK	OK		OK	OK
FCRH - libshogun	OK	OK		OK	OK
bsd1 - libshogun	OK	OK		OK	OK
clang34 - static analysis	OK	OK			OK
clang34 - thread analysis	warnings test	warnings test			warnings test
clang34 - undefined behaviour analysis	warnings test	warnings test	warnings test		warnings test
coverity analysis (waiting)					
cyg1 - libshogun (offline, plus 18)					
deb1 - libshogun	OK	OK		OK	OK
deb2 - static_interfaces	OK	OK			OK
deb3 - modular_interfaces	OK	OK			OK
deb4 - python3	OK	OK	OK	OK	OK
debian wheezy - memcheck	failed memory check	failed memory check			failed memory check
nightly_all (waiting)		OK			
nightly_default (waiting)		failed notebooks			
nightly_fedora (waiting)		failed git			
nightly_none (waiting)		OK			
osx1 - libshogun (offline, plus 48)					
osx2 - python (offline)					
precise - libshogun	OK	OK		OK	OK
rpm1 - libshogun	OK	OK		OK	OK

Outline

Strong vibrations

- Active mailing list
- Populated IRC (come say hello)
- Cool team & backgrounds



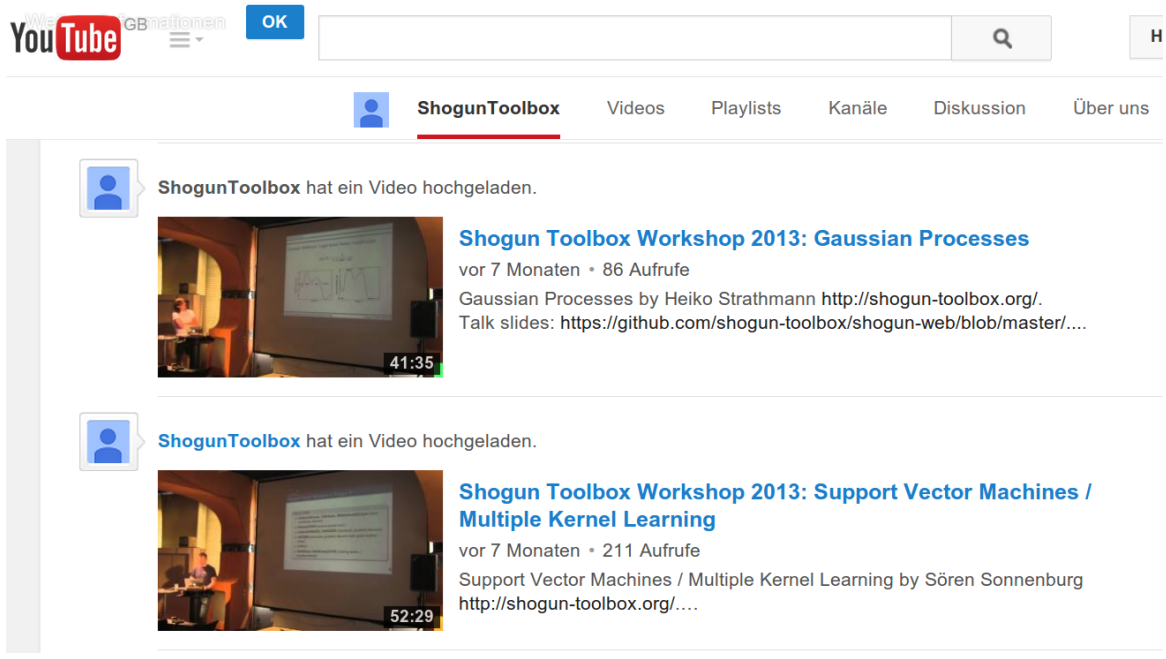
`http://www.shogun-toolbox.org/page/contact/contacts`

Google Summer of Code

- Student works full time during the summer
- Receives $5000 stipend
- Work remains open-source
- At this moment!
- 29 x 3 months (we have lots of impact)

Future Ideas

- We just founded a non-profit association
- Goal: Take donations and hire a full-time developer
- GPL $\rightarrow$ BSD (industry friendly)
- Shogun in education, fundamental ML
- We organise workshops (next July 27, 28, c-base)



Help!

- We don't sleep.
- You could:
  - Use Shogun and give us feedback
  - Fix bugs (see github), help us with framework design
  - Write (Python) examples and notebooks
  - Write documentation and update our website (Django)
  - Implement Super-parametric Massively Parallel Manifold Tree Classification Samplers (tm)
  - Mentor GSoC projects, or join as a student
  - Give us your money (we expose your logo to a large community)
  - **Come to the workshop on Sunday/Monday**

Thanks!

Questions?

http://www.shogun-toolbox.org