WaveForm DataBase Toolbox for MATLAB and Octave

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Outline

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Origins of MATLAB and Octave

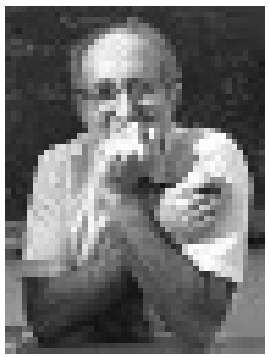
MATLAB

- MATrix LABoratory (MATLAB).
- Developed by Cleve Moler in the 1970s.
- Purpose: teach matrix theory at University of New Mexico.

Origins of MATLAB and Octave

Octave

- Octave is an open source (GPL) project that is similar to MATLAB
- Developed by John W. Eaton in 1988 for chemical reactor design course
- Named after his professor, Octave Levenspiel



What is MATLAB/Octave ?

Characteristics of the language

- Scripting language (not strongly typed), biased towards high precision numerical computations:

  x=1 (defaults to 64 bit double)

- Integrated development environment with debugger & compiler
- Heavy use of linear algebra libraries

Outline

What are the advantages of using MATLAB/Octave ?

Outline

- Language syntax and libraries suitable for applying signal processing and linear algebra techniques
- Graphics
- Highly portable and very well documented
- Strong user community

What are the advantages of using MATLAB/Octave ?

Language syntax and libraries

- Very concise and intuitive syntax for developing linear algebra and signal processing algorithms:

  $y = Ax$

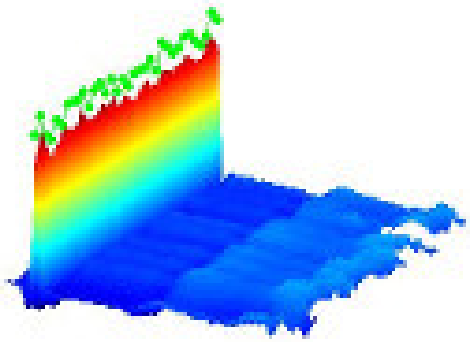
  $x = A \backslash y$

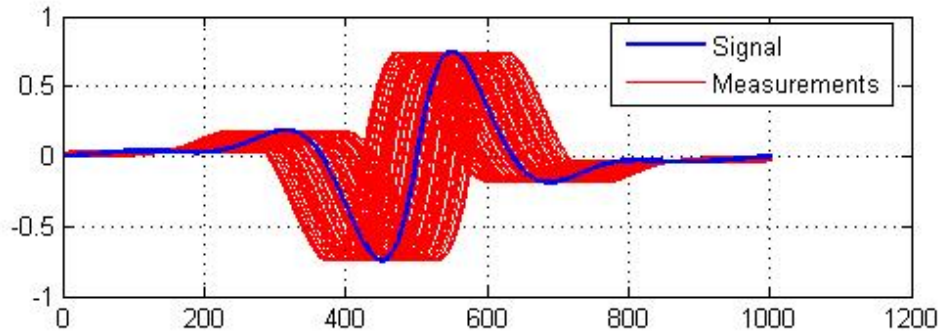
- Libraries for filter design, wavelets, control systems, neural networks, image processing, statistics ... etc
- Ideal for quickly developing, testing, and cross validating

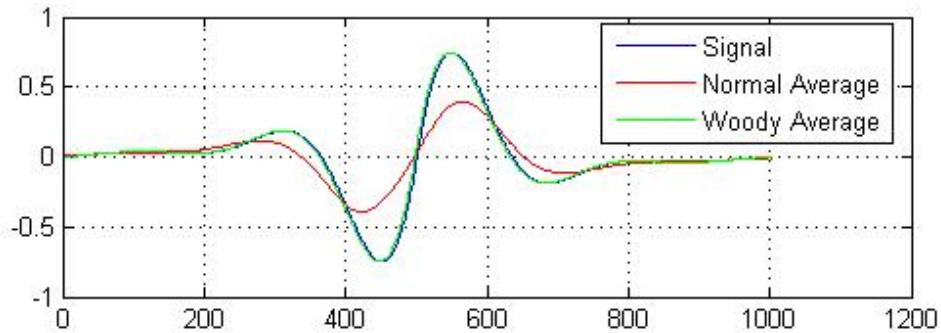
What are the advantages of using MATLAB/Octave ?

Graphics

- Easy to use and well documented graphics library







Outline

MATLAB/Octave User Community

- Used by students, researchers, government, and industry
- Academic textbooks (Over 5k books in Amazon)
- Active forum, magazine, developer blogs, and code repository (MATLAB Central)
- Ranked 14th most popular programming language (tiobe.com)

MATLAB/Octave User Community

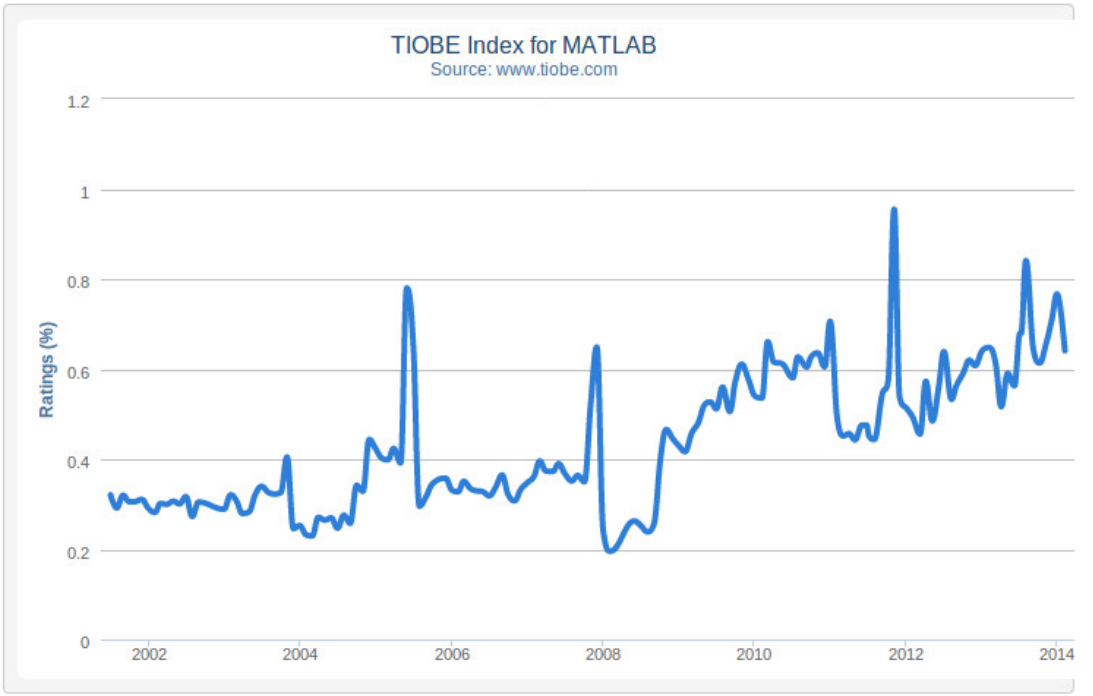
TIOBE Index : Ranked 14th

- Increasing trend in user base
- Ahead of: PL/SQL, Scala, Lisp, and R

Some information about MATLAB:

Highest Position (since 1993): #14 in Feb 2014

Lowest Position (since 1993): #29 in Aug 2011

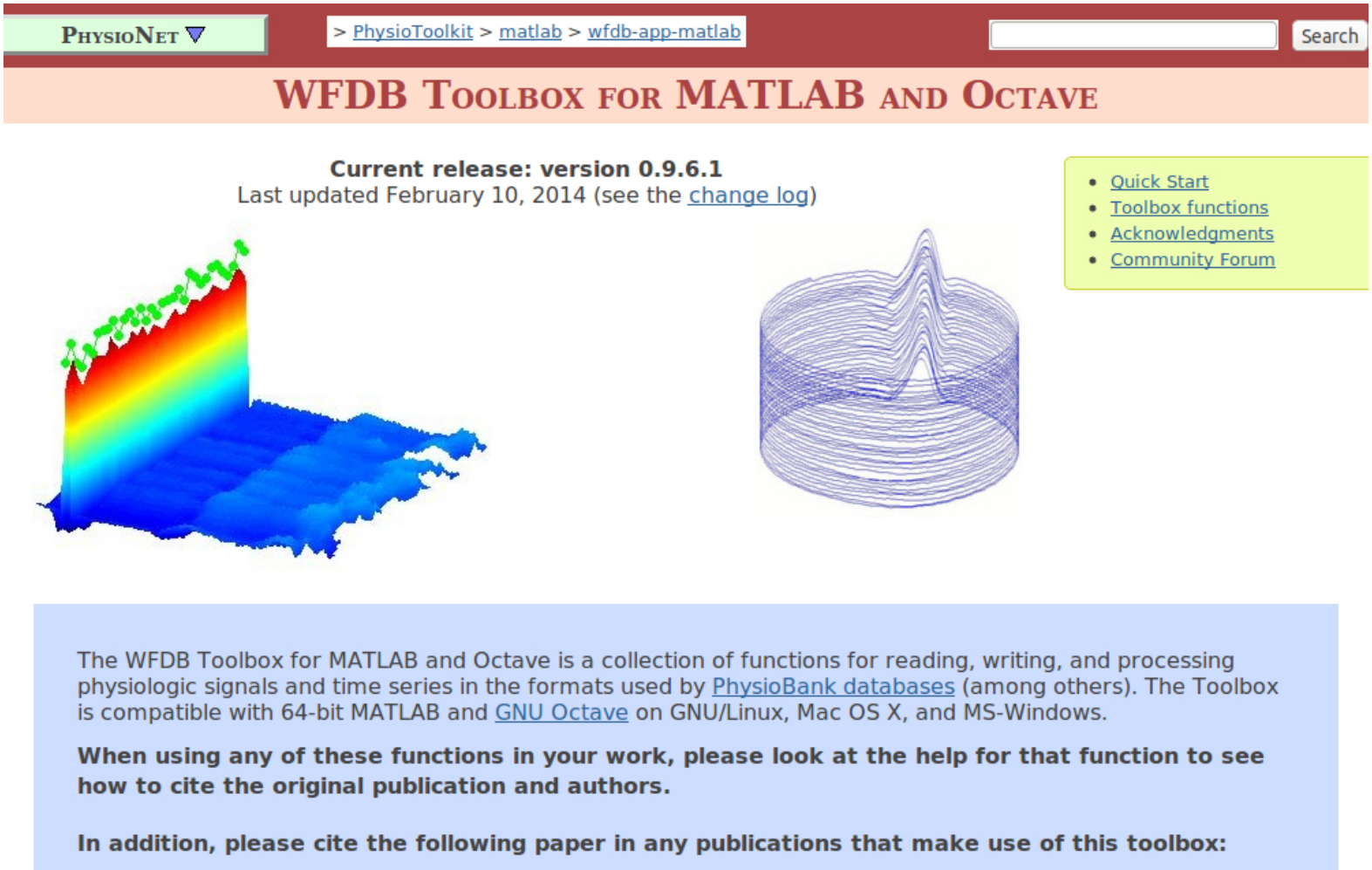


Outline

WFDB Toolbox for MATLAB/Octave Described

Description

- MATLAB/Octave/Java functions for accessing and processing physiologic signals in the formats used by PhysioBank databases



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www.against-the-grain.com

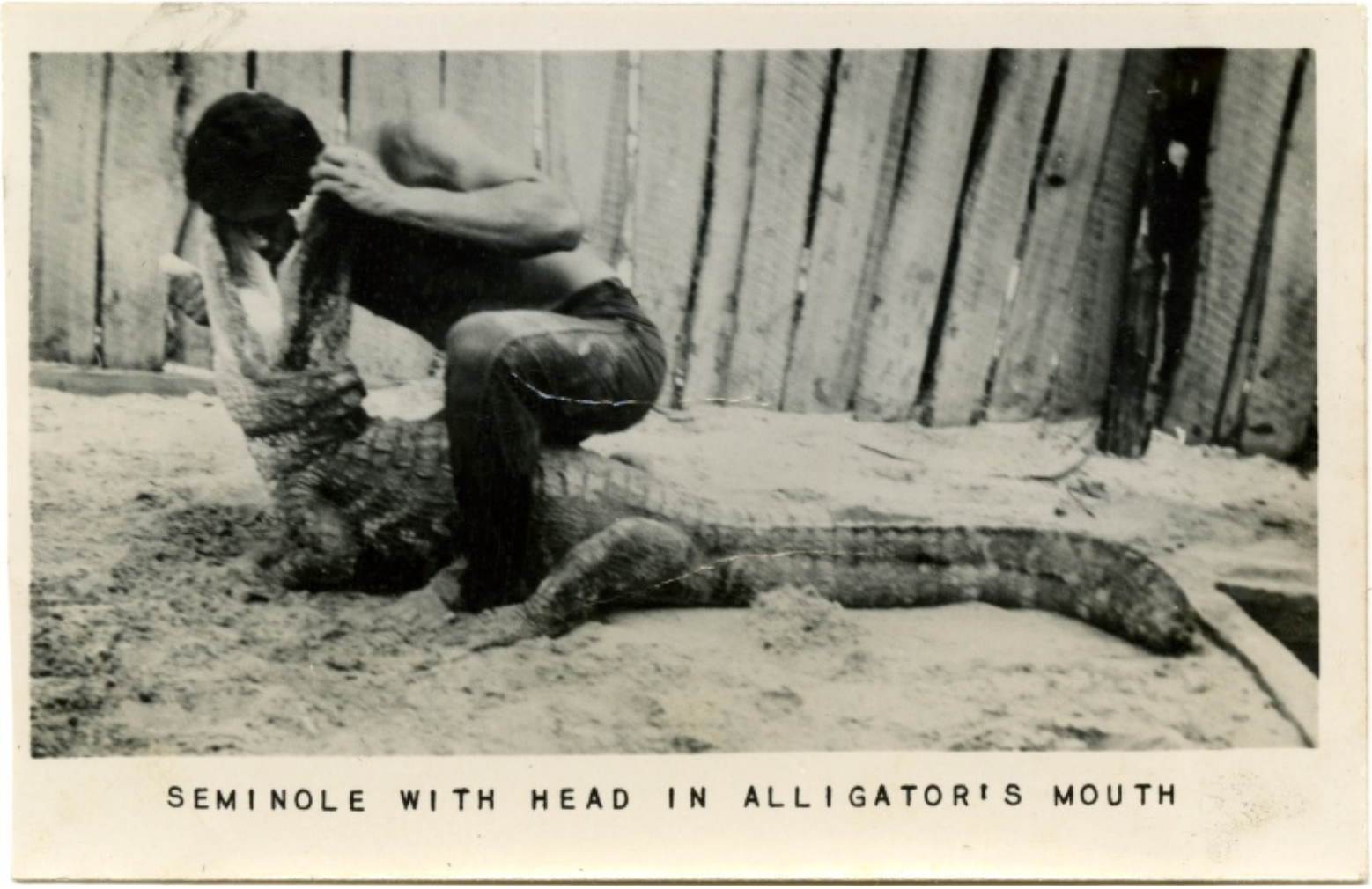
WFDB Toolbox for MATLAB/Octave Described

General Information

- Beta release 0.9.6.1 (February 10, 2014)
- 31 M-functions
- Provides access to over 3 TB of physiological signals
- Interface to LightWave (annotation visualization tool)
- Multicore processing at JVM level (alpha)
- Unit tested on 64-bit Windows, Mac, and Linux

How is the WFDB Toolbox is built?

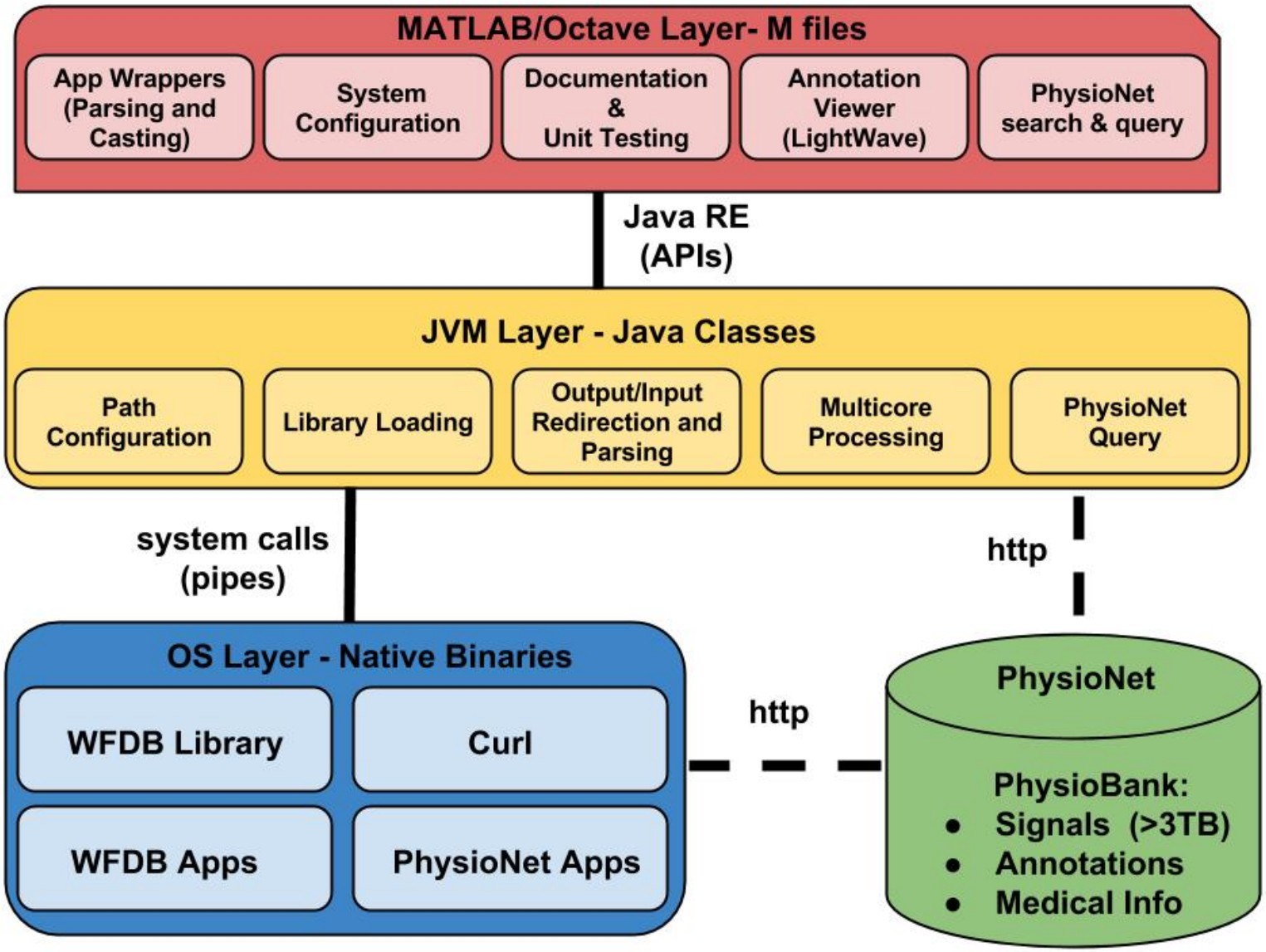
Let's take a look inside



www.vintageprintable.com

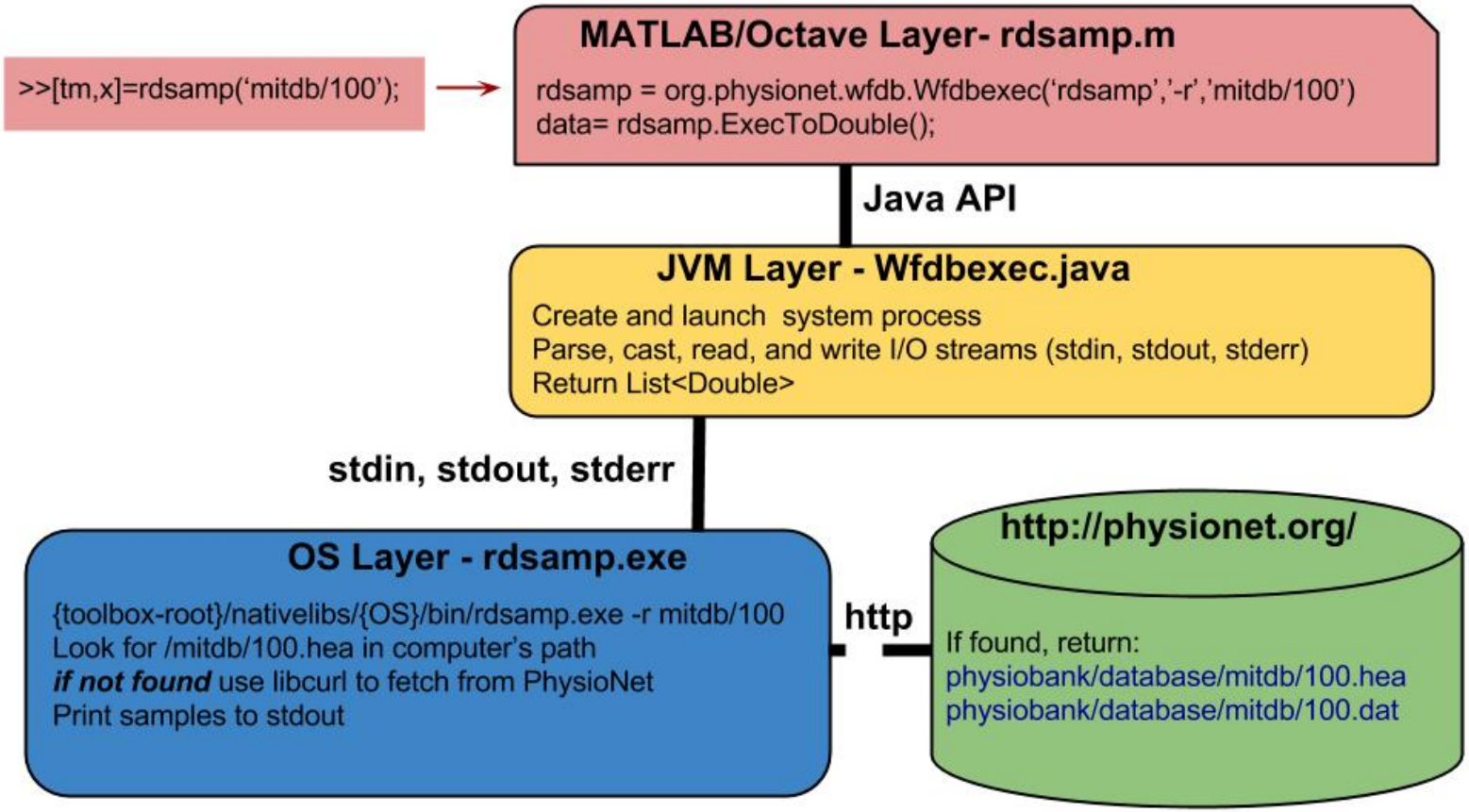
How is the WFDB Toolbox is built?

Structure of the WFDB Toolbox



How is the WFDB Toolbox is built?

Example

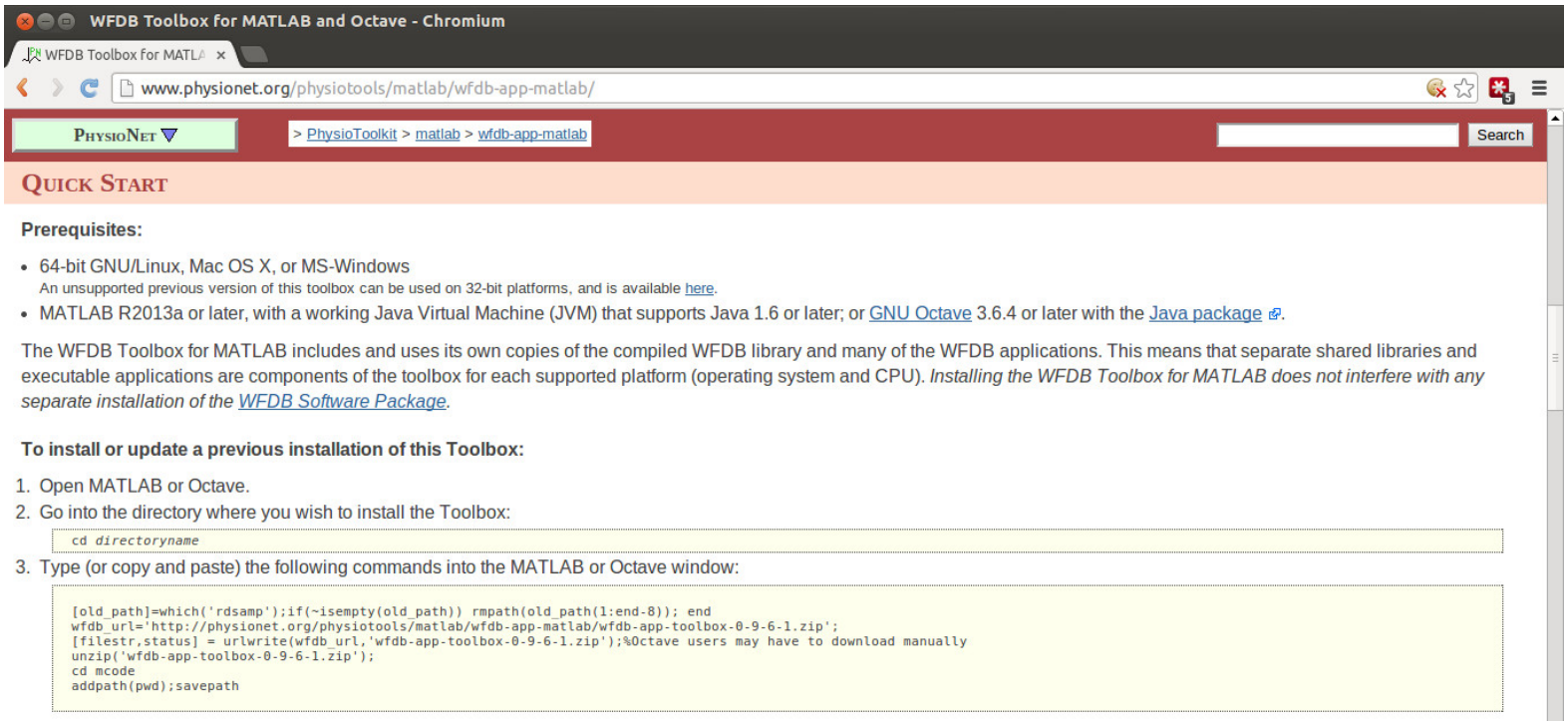


Outline

Installation

Web install

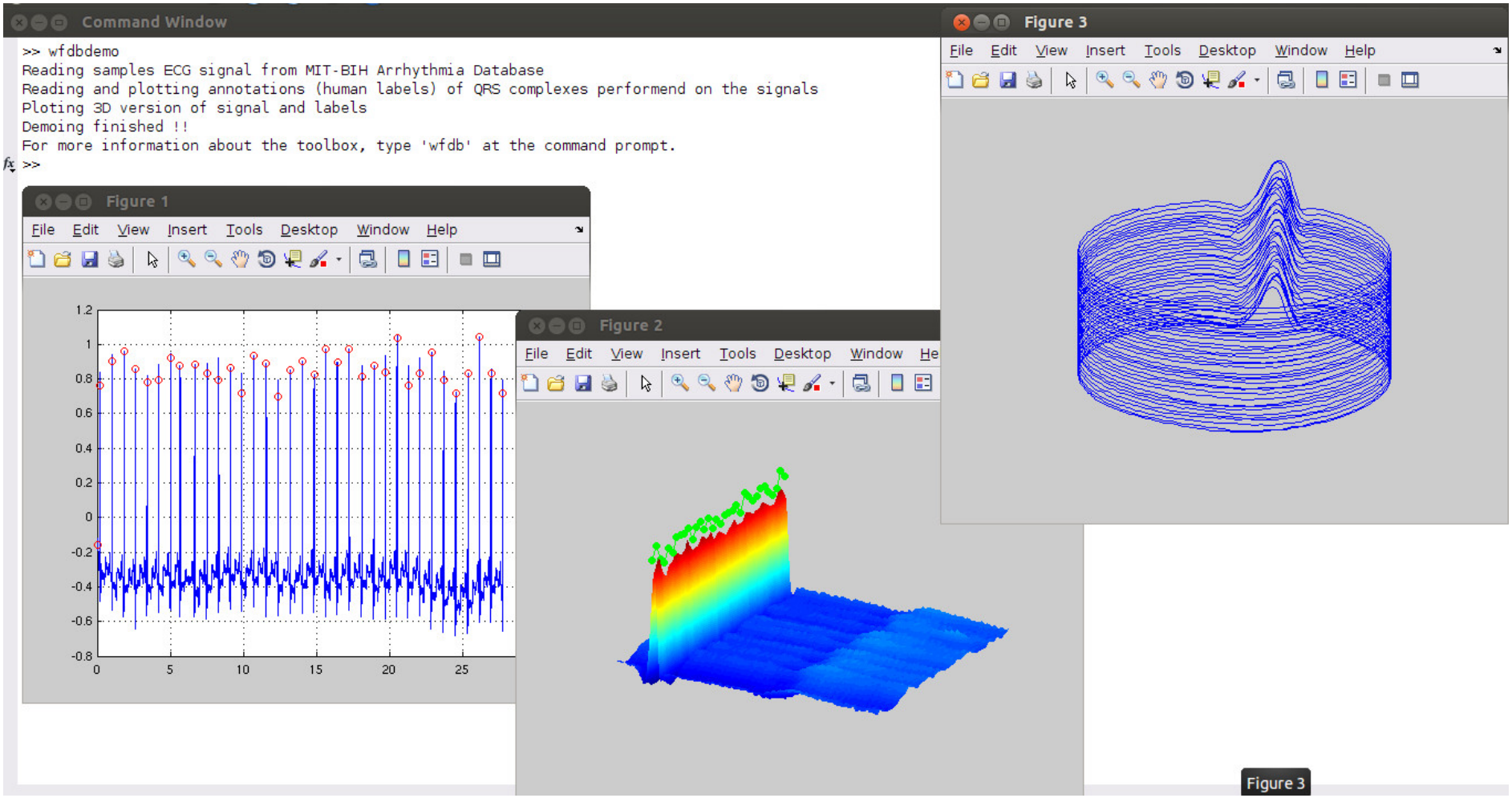
www.physionet.org/physiotools/matlab/wfdb-app-matlab/



Outline

Exploring the toolbox

Demo



Exploring the toolbox

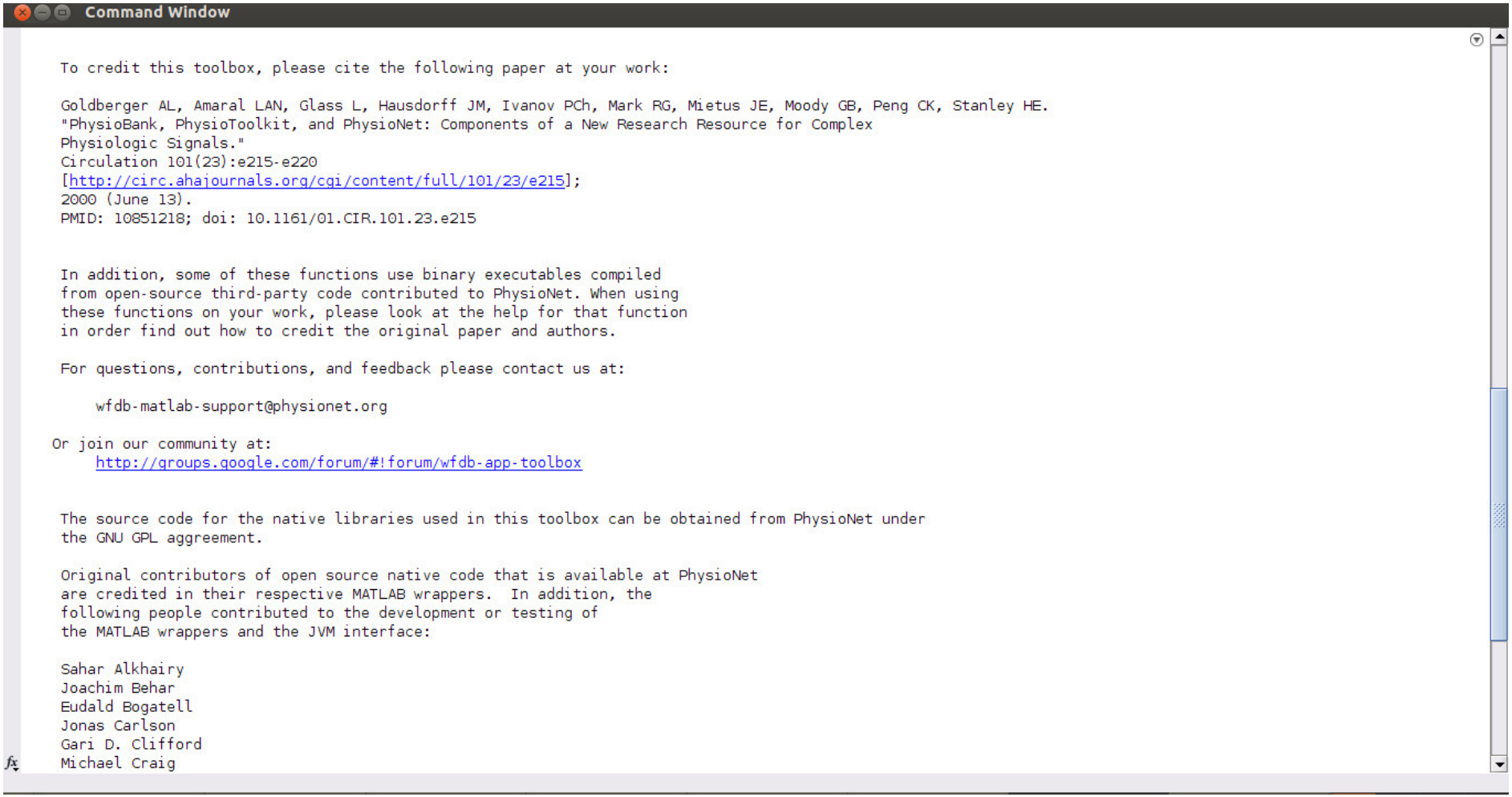
Table of Contents

Command Window

```
>> wfdb
   WaveForm DataBase (WFDB) Toolbox
   Version 0.9.6.1

   Last Updated February 10, 2014


This is a set of MATLAB functions and wrappers for reading, writing, and processing
files in the formats used by PhysioBank databases (among others).
The WFDB Toolbox has support for reading public PhysioNet databases directly from
web. This feature allows your code to analyze a wide range of physiological
signals available from PhysioBank without the need to download entire
records and to store them locally. This toolbox is distributed under the LGPL
license (see LICENSE.txt file in this directory). For more informationa about the
toolbox please go to: http://www.physionet.org


  Table of Contents (TOC)
 ------------------------
   ann2rr          - Extract a list of intervals from an annotation file
   bxb             - ANSI/AAMI-standard beat-by-beat annotation comparator
   edr             - Derives a respiration signal from an ECG signal
   ecgpuwave       - Estimation of QRS and P waves from ECG signals
   gqrs            - Estimation of QRS from ECG signals
   lomb            - Estimates power spectrum using the Lomb periodogram method
   mat2wfdb        - Writes a MATLAB variable into a WDFB record file
   maprecord       - Performs multithreaded concurent annotation or processing of WFDB records
   mrgann          - Merge annotation files
   msentropy       - Multi scale entropy estimation
   physionetdb     - Get information about all of PhysioNet's available databases and signals
   rdann           - Read annotation files for WFDB records
   rdmimic2wave    - Searches MIMIC II matched waveform records within a clinical time range
   rdsamp          - Read signal files of WFDB records
   score2013       - Scores entries to the PhysioNet 2013 Fetal ECG challenge
   sortann         - Rearrange annotations in canonical order
   sqrs            - Finds the QRS complexes of a WFDB ECG record signal
```

Exploring the toolbox

Table of Contents

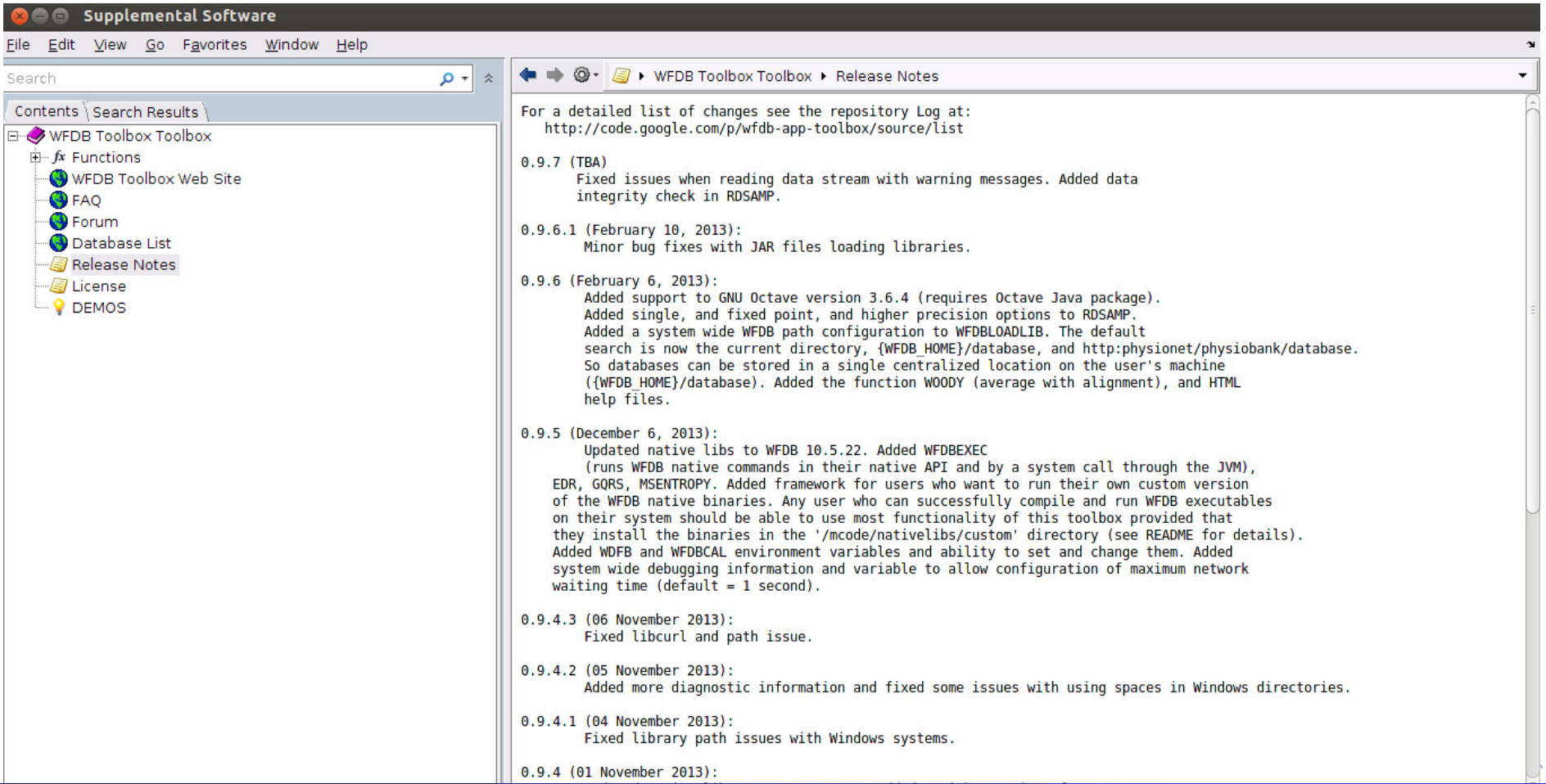


Outline

MATLAB Doc

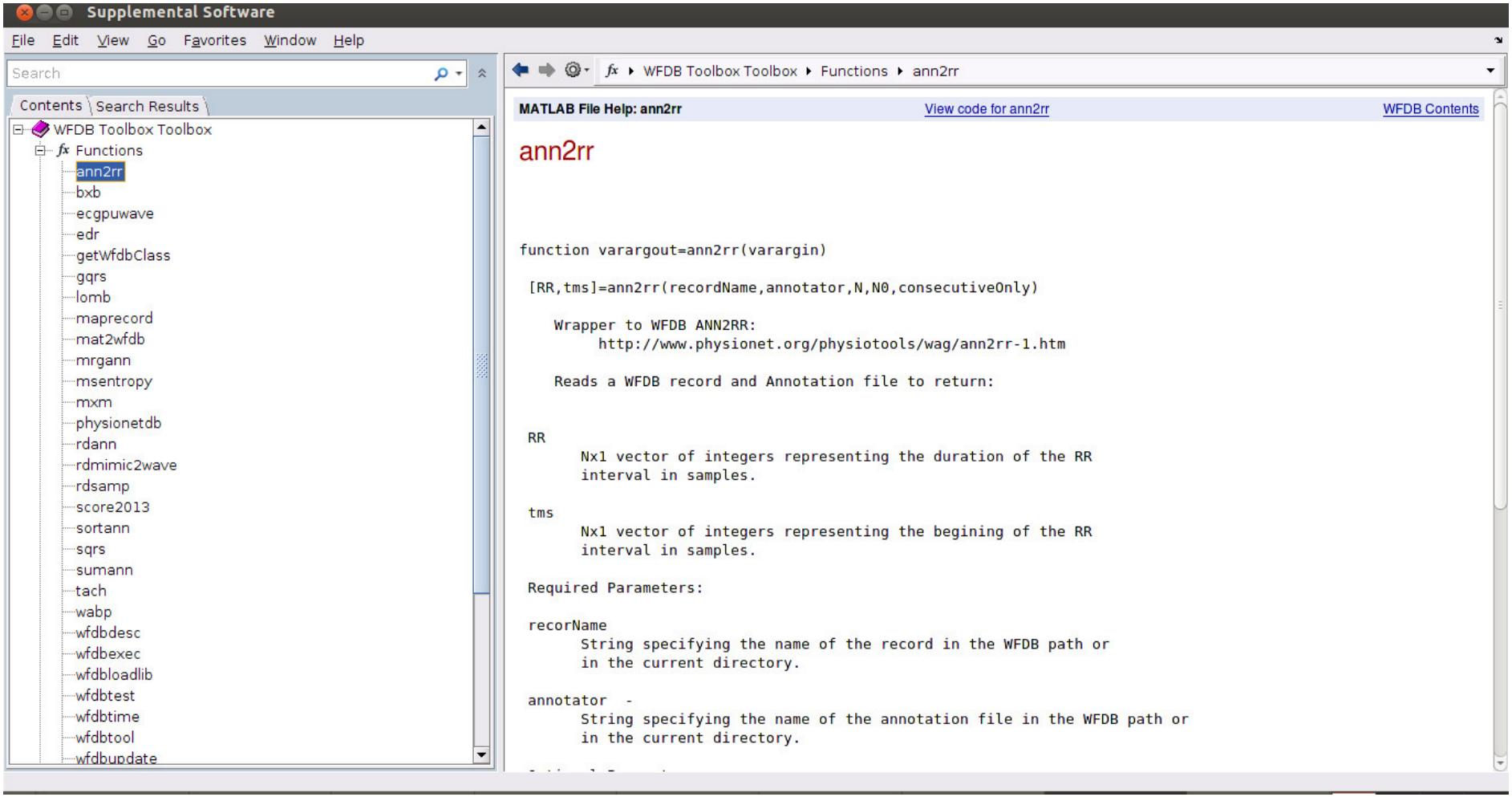
General Toolbox Info

```
>>doc
%Browse to -> Supplemental Software
```



MATLAB Doc

Function list help



Outline

Exploring data bases

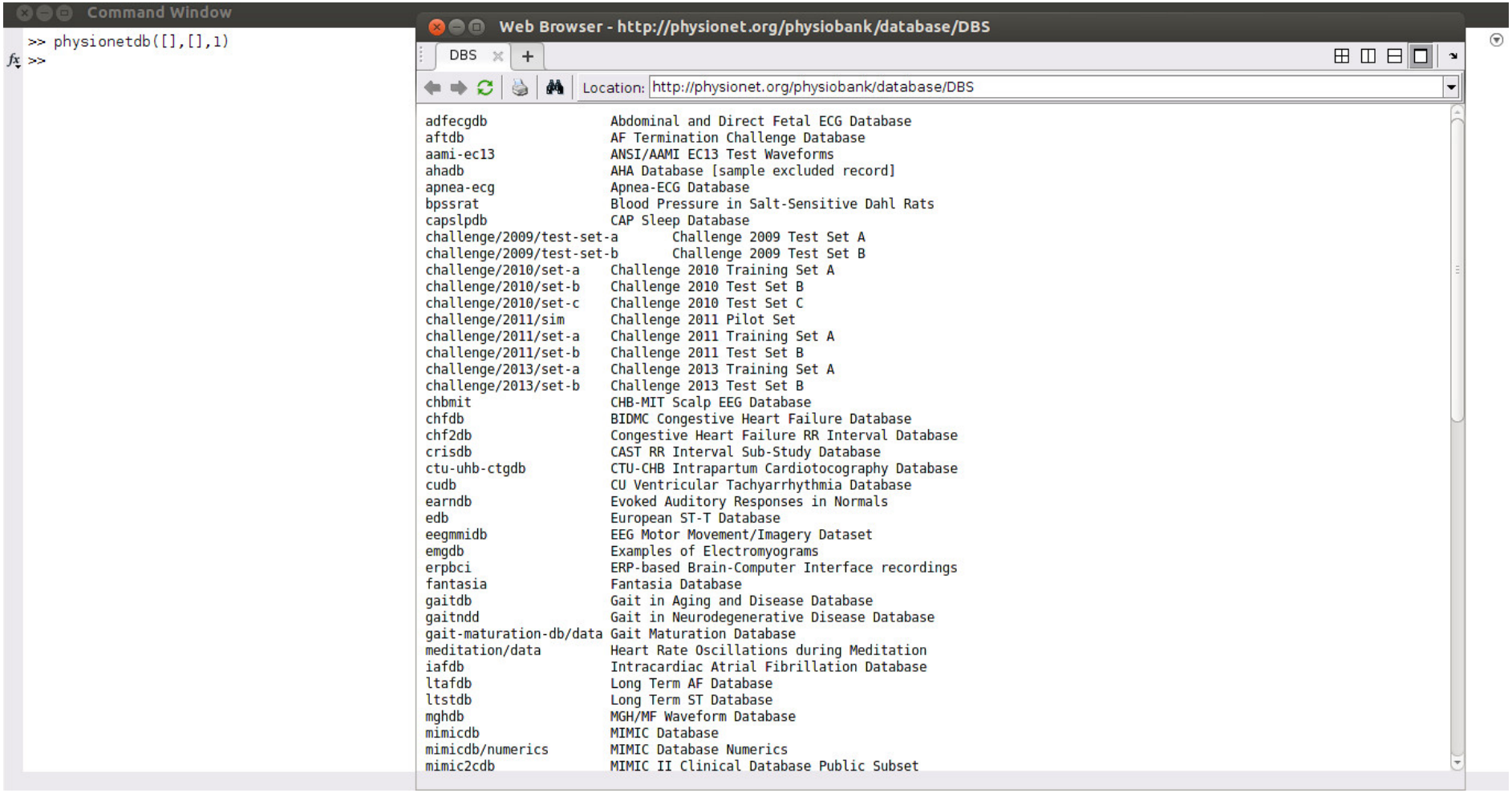
Printing database list

Command Window

```
>> physionetdb
adfecgdb
        Description: Abdominal and Direct Fetal ECG Database
        URL: http://physionet.org/physiobank/database/pbi/adfecgdb
aftdb
        Description: AF Termination Challenge Database
        URL: http://physionet.org/physiobank/database/pbi/aftdb
aami-ec13
        Description: ANSI/AAMI EC13 Test Waveforms
        URL: http://physionet.org/physiobank/database/pbi/aami-ec13
ahadb
        Description: AHA Database [sample excluded record]
        URL: http://physionet.org/physiobank/database/pbi/ahadb
apnea-ecg
        Description: Apnea-ECG Database
        URL: http://physionet.org/physiobank/database/pbi/apnea-ecg
bpssrat
        Description: Blood Pressure in Salt-Sensitive Dahl Rats
        URL: http://physionet.org/physiobank/database/pbi/bpssrat
capslpdb
        Description: CAP Sleep Database
        URL: http://physionet.org/physiobank/database/pbi/capslpdb
challenge/2009/test-set-a
        Description: Challenge 2009 Test Set A
        URL: http://physionet.org/physiobank/database/pbi/challenge_2009_test-set-a
challenge/2009/test-set-b
        Description: Challenge 2009 Test Set B
        URL: http://physionet.org/physiobank/database/pbi/challenge_2009_test-set-b
challenge/2010/set-a
        Description: Challenge 2010 Training Set A
        URL: http://physionet.org/physiobank/database/pbi/challenge_2010_set-a
challenge/2010/set-b
        Description: Challenge 2010 Test Set B
        URL: http://physionet.org/physiobank/database/pbi/challenge_2010_set-b
challenge/2010/set-c
        Description: Challenge 2010 Test Set C
        URL: http://physionet.org/physiobank/database/pbi/challenge_2010_set-c
challenge/2011/sim
        Description: Challenge 2011 Pilot Set
```

Exploring data bases

Database list webview



Exploring data bases

Printing & Downloading signals

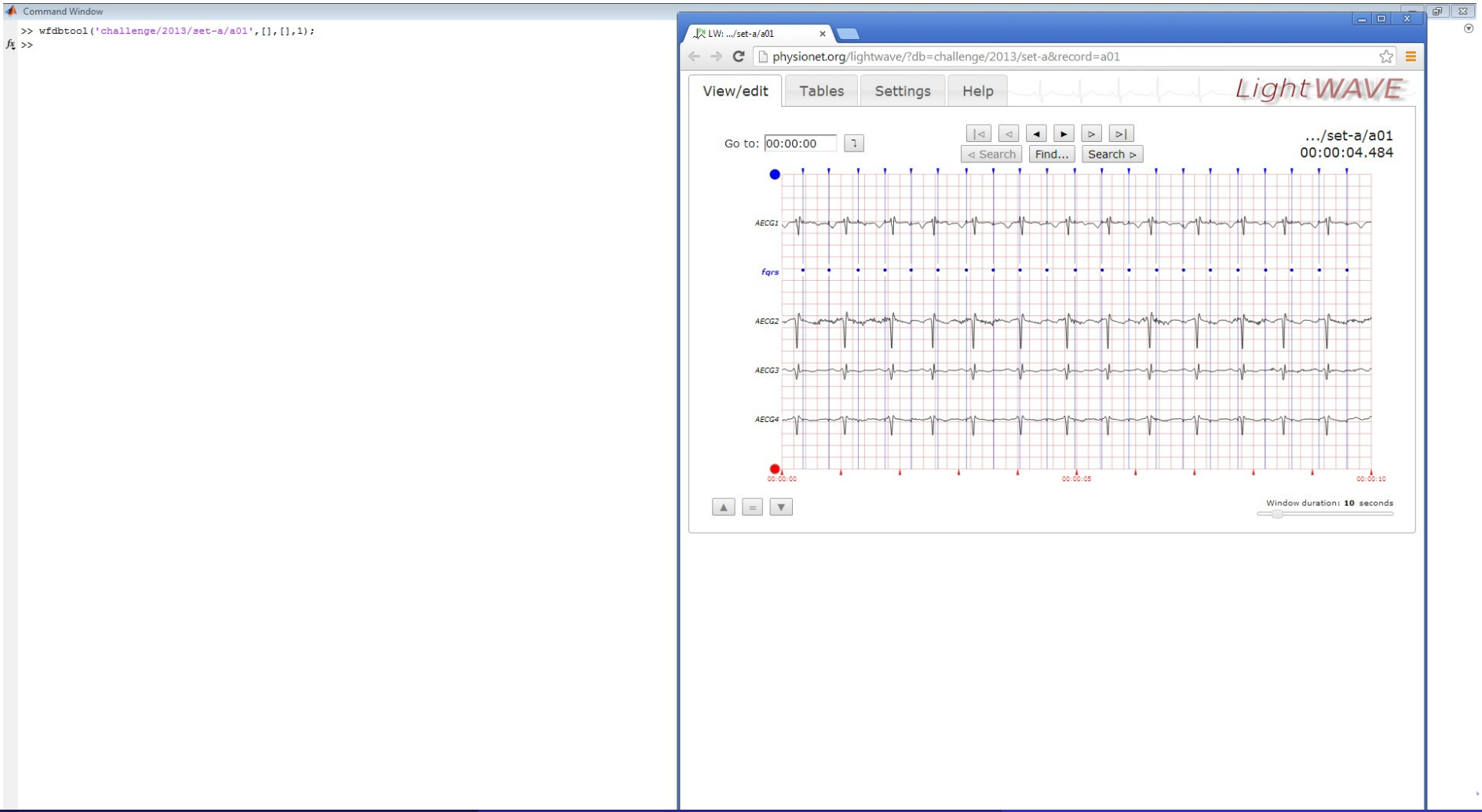
Command Window

```
>> record_list=physionetdb('mitdb');record_list(1:10)' %Get record list from database 'mitdb'

ans =

    'mitdb/101'
    'mitdb/101'
    'mitdb/102'
    'mitdb/102'
    'mitdb/103'
    'mitdb/103'
    'mitdb/104'
    'mitdb/104'
    'mitdb/105'
    'mitdb/105'

>> [tm,signal]=rdsamp(record_list{1}); signal(1:10,1)%Read first record from the database

ans =

   -0.3450
   -0.3450
   -0.3450
   -0.3450
   -0.3450
   -0.3450
   -0.3450
   -0.3450
   -0.3300
   -0.3200

>> physionetdb('mitdb',1);%Download entire database
```

Calling LightWave

Displaying data in LightWave (Alpha!)

```
>>wfdbtool('challenge/2013/set-a/a01',[],[],1);
```



Future Work

Near Horizon

- Adding unit testing, documentation, tutorial
- Improving JVM performance and memory efficiency
- Testing on MATLAB 2014a, Octave 3.8, WFDB 10.5.23, and Java 1.8
- Dropping support to MATLAB 2013a and Java 1.6

Future Work

Long term development

- Read/write user annotation from LightWave
- Upload & download data from PhysioNetWorks
- Have a parallel and distributed computing framework using Hadoop
- Document and release Java API
- Suggestions ?

In conclusion

Ways to get involved

- Use the toolbox and submit open-source code to PhysioNet
- Join the community:
  www.physionet.org/physiotools/matlab/wfdb-app-matlab/
- Report any bugs, fixes, and enhancement requests:
  wfdb-matlab-support@physionet.org