cppEDM pyEDM rEDM

Package Testing and Installation

Table of Contents

Building cppEDM

To build cppEDM

```
cd cppEDM/src
make
```

Testing cppEDM

1) Basic numerical checks are done in cppEDM/tests by the programs:
CCMTest.cc DateTimeTest.cc MultiviewTest.cc SimplexTest.cc TestCommon.cc SMapTest.cc

Tests can be built and run with the ./run script. PASS/FAIL is reported on the console:

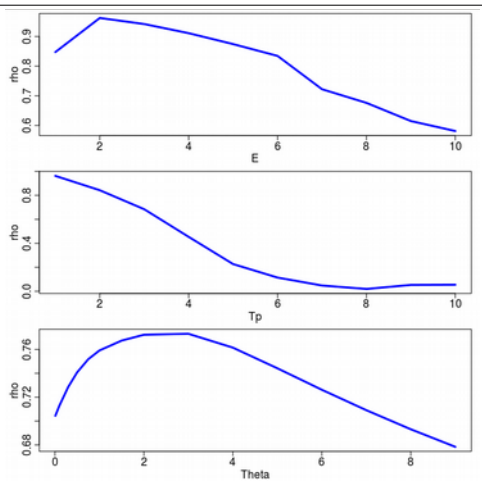
```
tests> ./run


g++ TestCommon.cc -c -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack
g++ SimplexTest.cc -o SimplexTest -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack TestCommon.o
g++ TestCommonTest.cc -o TestCommonTest -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack TestCommon.o
g++ SMapTest.cc -o SMapTest -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack TestCommon.o
g++ CCMTest.cc -o CCMTest -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack TestCommon.o
g++ MultiviewTest.cc -o MultiviewTest -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack TestCommon.o
g++ DateTimeTest.cc -c -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack
g++ DateTimeTest.cc -o DateTimeTest -std=c++11 -D
PRINT_DIFFERENCE_IN_RESULTS -lstdc++ -L../lib/
-I../src/ -lEDM -lpthread -llapack TestCommon.o
```

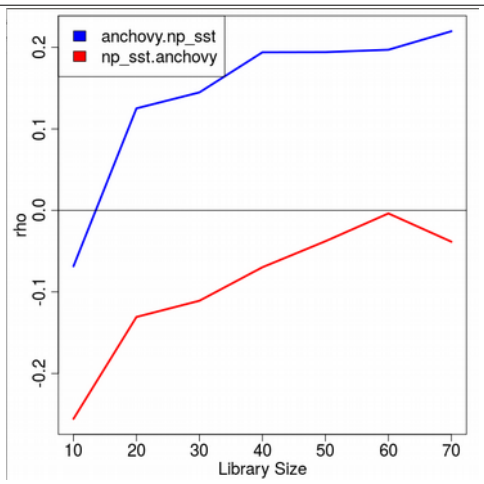
```
-------------------------------------------------
Test: block_3sp.csv embedded data test
-------------------------------------------------
        TEST PASSED. All rows same.
-------------------------------------------------
Test: block_3sp.csv dynamic embedding test
-------------------------------------------------
        TEST PASSED. All rows same.
-------------------------------------------------
Test: S12CD-S333 ISO datetime
-------------------------------------------------
        TEST PASSED. All rows same.
Multiview() Set view sample size to 9
-------------------------------------------------
Test: Multiview combos test
-------------------------------------------------
        TEST PASSED. All rows same.
-------------------------------------------------
Test: Multiview prediction test
-------------------------------------------------
        TEST PASSED. All rows same.
-------------------------------------------------
Test: circle.csv test
-------------------------------------------------
        TEST PASSED. All rows same.
-------------------------------------------------
Test: block_3sp test
-------------------------------------------------
        TEST PASSED. All rows same.
-------------------------------------------------
Test: CCM sardine_anchovy_sst test
-------------------------------------------------
        TEST PASSED. All rows same.
```

2) A series of graphical tests are run by the cppEDM/etc/Test.cc program, and rendered with the R application PlotTest.R. Carefully check that the graphical output matches the images shown below. The CCM test will not match exactly, but the relative behavior should be the same as shown.

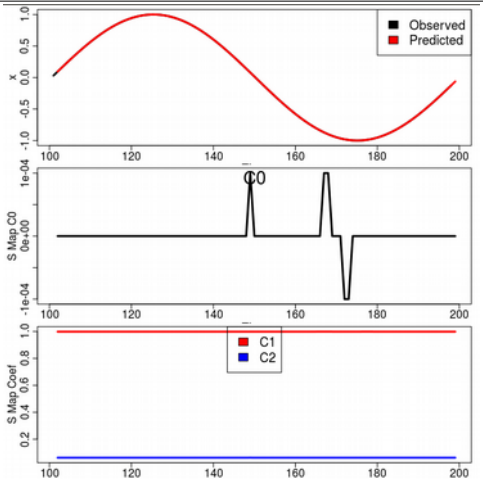
```
cd cppEDM/etc
g++ Test.cc -o Test -std=c++11 -I../src -L../lib -lstdc++ -lEDM -lpthread -llapack -O3
./Test
R
> source('PlotTest.R')
> Run()
> Clean()
```



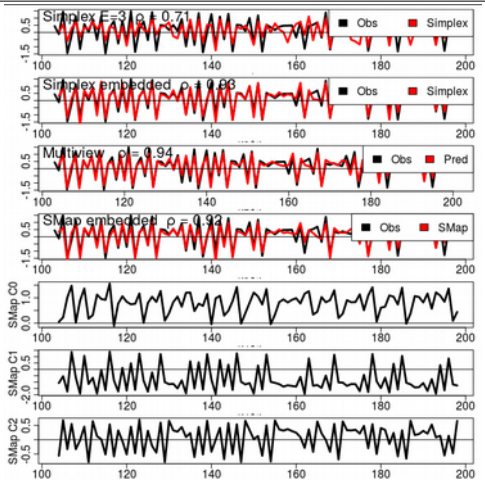
Embed Dimension Predict Interval Predict Nonlinear



CCM



SMap



Simplex SMap Multiview

Building cppEDM on Windows

This has been found to work on Windows 10 with MSVC 2019 build tools and mingw.

Build cppEDM/src:

```
nmake /f makefile.windows
```

Compile cppEDM/etc/Test.cc into Test.obj:

```
cl /c Test.cc /EHsc /MD /I../src
```

Download .lib and .dll from Windows for LAPACKE:
https://icl.cs.utk.edu/lapack-for-windows/lapack/#lapacke
Copy .dll and .lib from LAPACKE_examples.zip into ../../lapacke

Link Test.obj into Test.exe:

```
link /OUT:Test.exe /LIBPATH:../lib /LIBPATH:../../lapacke EDM.lib
liblapack.lib Test.obj
```

Get missing libraries for LAPACK legacy:
Downloaded libgfortran-3.dll into ../../lapacke
https://www.opendll.com/index.php?file-download=libgfortran-3.dll&arch=32bit

Downloaded libwinpthread-1.dll into ../../lapacke
https://wikidll.com/mingw-w64/libwinpthread-1-dll

Set PATH to find the lapacke and mingw dll's:

```
PATH=../../lapacke;C:\MINGW\BIN;%PATH%
```

Run Test.exe

Building pyEDM

pyEDM can be built locally in two steps:

1) Build the cppEDM libEDM.a in pyEDM/cppEDM/src
2) Build and install the pyEDM package with python pip

1) From pyEDM/

```
cd cppEDM/src
make
```

2) From pyEDM/cppEDM/src

```
cd ../..
python -m pip install . --user
```

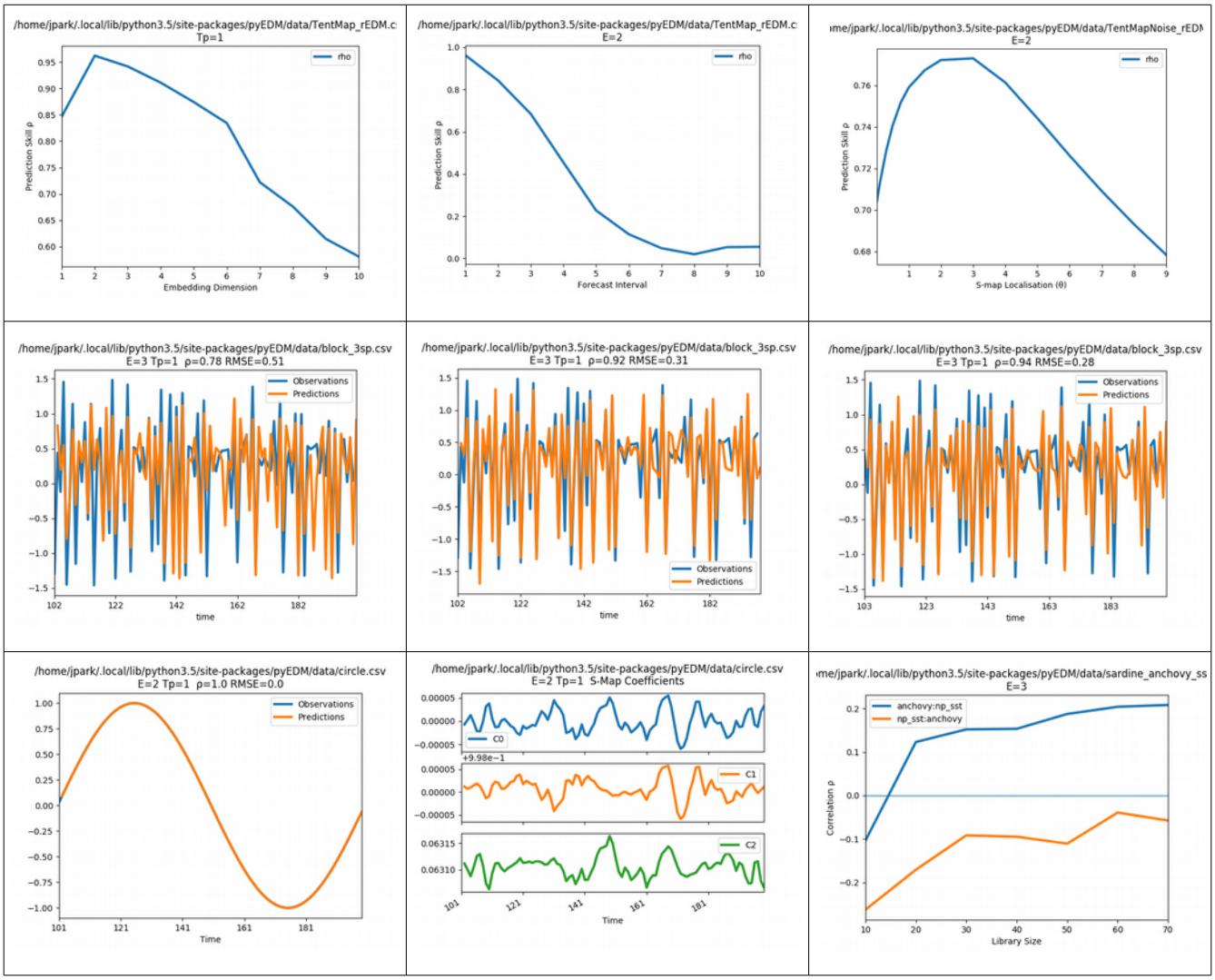
```
Processing pyEDM
Requirement already satisfied: pybind11>=2.3 in /usr/local/lib/python3.5/dist-packages (from pyEDM===-
version-.-.-1.2.1.1-) (2.3.0)
Requirement already satisfied: pandas>=0.20.3 in /usr/local/lib/python3.5/dist-packages (from pyEDM===-
version-.-.-1.2.1.1-) (0.24.2)
Requirement already satisfied: matplotlib>=2.2 in /usr/local/lib/python3.5/dist-packages (from
pyEDM===-version-.-.-1.2.1.1-) (2.2.2)
Requirement already satisfied: numpy>=1.12.0 in /usr/local/lib/python3.5/dist-packages (from
pandas>=0.20.3->pyEDM===-version-.-.-1.2.1.1-) (1.14.5)
Requirement already satisfied: python-dateutil>=2.5.0 in /usr/local/lib/python3.5/dist-packages (from
pandas>=0.20.3->pyEDM===-version-.-.-1.2.1.1-) (2.7.3)
Requirement already satisfied: pytz>=2011k in /usr/local/lib/python3.5/dist-packages (from
pandas>=0.20.3->pyEDM===-version-.-.-1.2.1.1-) (2018.4)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in
/usr/local/lib/python3.5/dist-packages (from matplotlib>=2.2->pyEDM===-version-.-.-1.2.1.1-) (2.2.0)
Requirement already satisfied: six>=1.10 in /usr/local/lib/python3.5/dist-packages (from
matplotlib>=2.2->pyEDM===-version-.-.-1.2.1.1-) (1.11.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.5/dist-packages (from
matplotlib>=2.2->pyEDM===-version-.-.-1.2.1.1-) (1.0.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.5/dist-packages (from
matplotlib>=2.2->pyEDM===-version-.-.-1.2.1.1-) (0.10.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.5/dist-packages (from
kiwisolver>=1.0.1->matplotlib>=2.2->pyEDM===-version-.-.-1.2.1.1-) (39.2.0)

Building wheels for collected packages: pyEDM
  Building wheel for pyEDM (setup.py) ... done
  Stored in directory: /tmp/pip-ephem-wheel-cache-
0npne1yv/wheels/93/f6/91/fe8aef2eef3cef101cf85c751f4d8e3251ed009723a855b6af
Successfully built pyEDM
Installing collected packages: pyEDM
  Found existing installation: pyEDM -version-.-.-1.2.1.1-
    Uninstalling pyEDM--version-.-.-1.2.1.1-:
      Successfully uninstalled pyEDM--version-.-.-1.2.1.1-
Successfully installed pyEDM--version-.-.-1.2.1.1-
```

Testing pyEDM

The pyEDM/pyEDM/tests/examples.py program runs a series of tests for the python wrapper and interface. The CCM test will not be numerically equivalent, but must have the same behavior.

```
cd pyEDM/tests/
./examples.py
```



PyEDM python unittests are run from pyEDM/tests/ with:

```
python -m unittest discover
```

```
       --- CCM ---
       Parameters::Validate(): Set knn = 4 (E+1) for Simplex.
       cppEDM Version 1.2.1 2020-02-05
       CrossMap(): Simplex cross mapping from anchovy to np_sst  E=3  knn=4  Library range: [10 75 5]
       10 15 20 25 30 35 40 45 50 55 60 65 70 75

       cppEDM Version 1.2.1 2020-02-05
       CrossMap(): Simplex cross mapping from np_sst to anchovy  E=3  knn=4  Library range: [10 75 5]
       10 15 20 25 30 35 40 45 50 55 60 65 70 75

       cppEDM Version 1.2.1 2020-02-05
       .--- Multiview ---
       Multiview() Set view sample size to 9
       .--- Simplex embedded = False ---
       .--- Simplex embedded = True ---
       .--- S-map circle embedded = True ---
       .--- S-map block_3sp embedded = True ---
       .
       ----------------------------------------------------------------------
       Ran 6 tests in 0.170s

       OK
```

```
tests> rm -rf __pycache__/
```

Building rEDM

rEDM can be locally built with R CMD in rEDM/.

First, you may wish to cleanup a previous build:

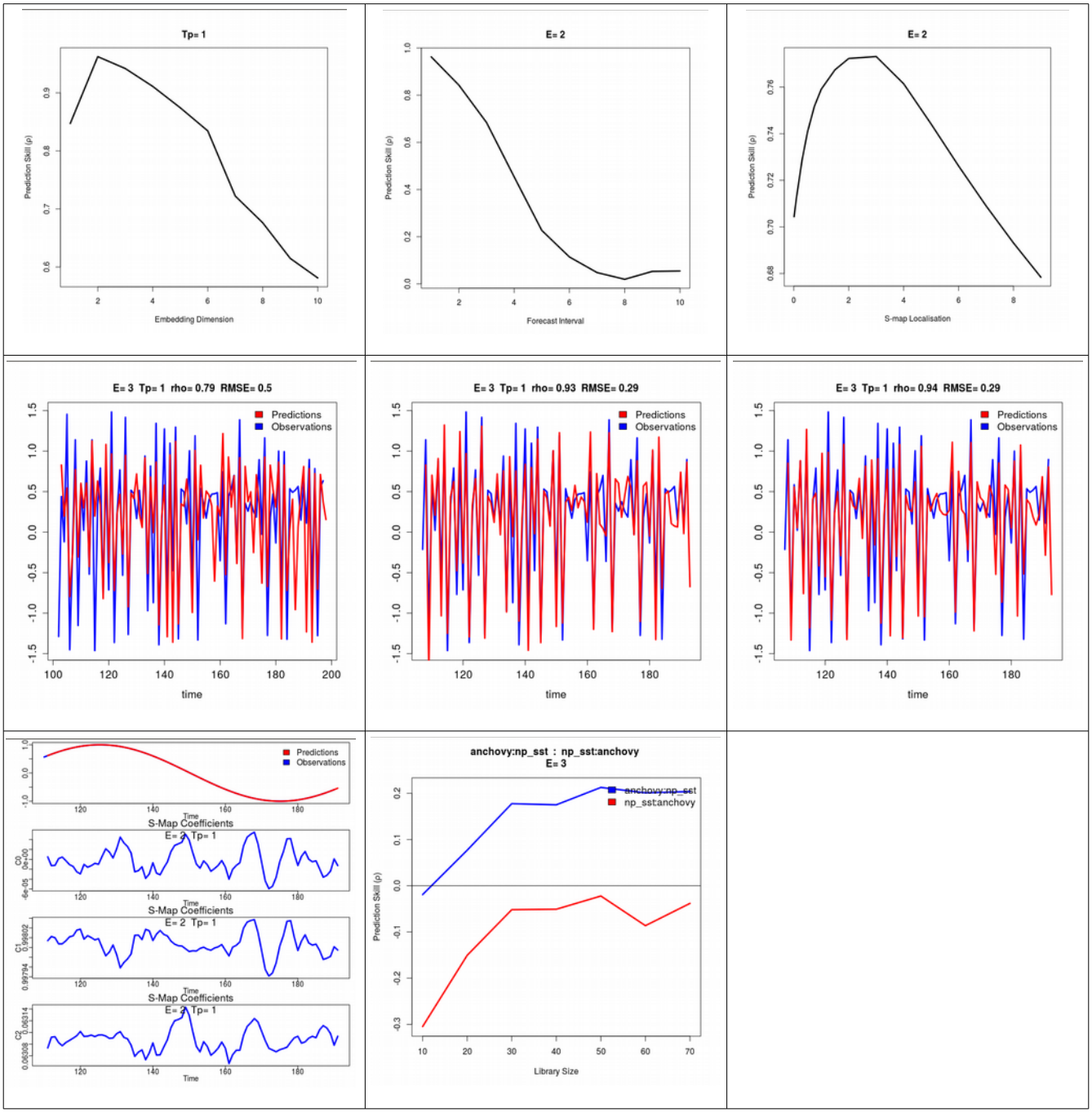
```
cd rEDM
rm -rf src/*.o src/rEDM.so src/cppEDM/lib/libEDM.a
```

```
R CMD INSTALL .
* installing to library ‘/usr/local/lib/R/site-library’
* installing *source* package ‘rEDM’ ...
** libs
g++ -std=gnu++11 -I/usr/share/R/include -DNDEBUG -I ./cppEDM/src/ -I"/usr/local/lib/R/site-
library/Rcpp/include" -I"/usr/local/lib/R/site-library/RcppThread/include"    -fpic  -g -O2
-fstack-protector-strong -Wformat -Werror=format-security -Wdate-time -D_FORTIFY_SOURCE=2 -g -c
CCM.cpp -o CCM.o
...
(cd ./cppEDM/src/; make; make clean)
make[1]: Entering directory 'rEDM/src/cppEDM/src'
g++ -c Common.cc -std=c++11 -DCCM_THREADED -DMULTIVIEW_VALUES_OVERLOAD -O3 -fPIC
g++ -c AuxFunc.cc -std=c++11 -DCCM_THREADED -DMULTIVIEW_VALUES_OVERLOAD -O3 -fPIC
...
ar -rcs libEDM.a Common.o AuxFunc.o DateTimeUtil.o Parameter.o Embed.o Interface.o Neighbors.o
Simplex.o Eval.o CCM.o Multiview.o SMap.o
cp libEDM.a ../lib/
make[1]: Leaving directory 'rEDM/src/cppEDM/src'
make[1]: Entering directory 'rEDM/src/cppEDM/src'
rm -f Common.o AuxFunc.o DateTimeUtil.o Parameter.o Embed.o Interface.o Neighbors.o Simplex.o
Eval.o CCM.o Multiview.o SMap.o  libEDM.a
make[1]: Leaving directory 'rEDM/src/cppEDM/src'
g++ -std=gnu++11 -shared -L/usr/lib/R/lib -Wl,-Bsymbolic-functions -Wl,-z,relro -o rEDM.so CCM.o
ComputeError.o DataFrame.o Embed.o EmbedDim.o Multiview.o PredictInterval.o PredictNL.o
RcppEDMCommon.o RcppExports.o SMap.o Simplex.o -L ./cppEDM/lib/ -lEDM -llapack -L/usr/lib/R/lib
-lR
installing to /usr/local/lib/R/site-library/rEDM/libs
** R
** data
*** moving datasets to lazyload DB
** inst
** preparing package for lazy loading
** help
*** installing help indices
*** copying figures
** building package indices
** installing vignettes
   ‘rEDM-tutorial.Rmd’ using ‘UTF-8’
** testing if installed package can be loaded
* DONE (rEDM)
```

Testing rEDM

The rEDM/R/Examples.R program executes Rcpp wrapper graphical tests. The CCM test will not be numerically equivalent, but must have the same behavior.

```
cd R/
R
> source("Examples.R")
> Examples()
```



rEDM unittest can be run from rEDM/tests

```
cd tests
R
> source('testthat.R')

[1] "Error: ColumnsInDataFrame(): dataFrame is not valid."
[1] "Error: ColumnsInDataFrame(): Target  not found."
[1] "Error: ColumnsInDataFrame(): Target None not found."
[1] "Error: ColumnsInDataFrame(): dataFrame is not valid."
[1] "Error: ColumnsInDataFrame(): Target None not found."
[1] "Error: ColumnsInDataFrame(): dataFrame is not valid."
[1] "Error: ColumnsInDataFrame(): Target  not found."
Multiview() Set view sample size to 9
[1] "Error: ColumnsInDataFrame(): dataFrame is not valid."
[1] "Error: ColumnsInDataFrame(): Target None not found."
[1] "Error: ColumnsInDataFrame(): dataFrame is not valid."
[1] "Error: ColumnsInDataFrame(): Target None not found."
[1] "Error: ColumnsInDataFrame(): dataFrame is not valid."
[1] "Error: ColumnsInDataFrame(): dataFrame is not valid."
== testthat results  ===========================================================
[ OK: 64 | SKIPPED: 0 | WARNINGS: 0 | FAILED: 0 ]
```

rEDM CRAN

To test and prepare rEDM for CRAN, use the `devtools` package.

1) CRAN build check on local system

```
R
> devtools::check()

── Building ──────────────────────────────────────────────────────────── rEDM ──
Setting env vars:
● CFLAGS    : -Wall -pedantic -fdiagnostics-color=always
● CXXFLAGS  : -Wall -pedantic -fdiagnostics-color=always
● CXX11FLAGS: -Wall -pedantic -fdiagnostics-color=always
──────────────────────────────────────────────────────────────────────────────
✔  checking for file ‘rEDM.build/DESCRIPTION’ ...
─  preparing ‘rEDM’:
✔  checking DESCRIPTION meta-information ...
─  cleaning src
─  installing the package to build vignettes
✔  creating vignettes (1m 16.9s)
─  building ‘rEDM_1.2.2.tar.gz’

── Checking ──────────────────────────────────────────────────────────── rEDM ──
Setting env vars:
● _R_CHECK_CRAN_INCOMING_USE_ASPELL_: TRUE
● _R_CHECK_CRAN_INCOMING_REMOTE_    : FALSE
● _R_CHECK_CRAN_INCOMING_           : FALSE
● _R_CHECK_FORCE_SUGGESTS_          : FALSE
── R CMD check ───────────────────────────────────────────────────────────────
─  using R version 3.4.4 (2018-03-15)
─  using platform: x86_64-pc-linux-gnu (64-bit)
─  using session charset: UTF-8
─  using options ‘--no-manual --as-cran’
✔  checking for file ‘rEDM/DESCRIPTION’
─  checking extension type ... Package
─  this is package ‘rEDM’ version ‘1.2.2’
✔  checking package namespace information
✔  checking package dependencies (2.3s)
✔  checking dependencies in R code ...
✔  checking compilation flags in Makevars ...
✔  checking compiled code ...
✔  checking sizes of PDF files under ‘inst/doc’ (849ms)
✔  checking installed files from ‘inst/doc’ ...
✔  checking files in ‘vignettes’
✔  checking examples (1.1s)
✔  checking for unstated dependencies in vignettes ...
✔  checking package vignettes in ‘inst/doc’ ...
✔  checking re-building of vignette outputs (13.6s)
   See
     ‘/tmp/RtmpgTq4pn/rEDM.Rcheck/00check.log’
   for details.

── R CMD check results ──────────────────────────────────── rEDM 1.2.2 ────
Duration: 1m 32.4s

❯ checking installed package size ... NOTE
    installed size is  8.7Mb
    sub-directories of 1Mb or more:
      libs   7.7Mb

0 errors ✔ | 0 warnings ✔ | 1 note ✖
```

2) CRAN build check on Windows

Using cloud servers. This will email build results to the package maintainer address.

```
R
> devtools::check_win_release()

Building windows version of rEDM (1.2.2) for R-release with win-builder.r-project.org.
Email results to JosephPark@IEEE.org?
1: I forget
2: Of course
3: No way

Selection: 2
✔  checking for file ‘rEDM.build/DESCRIPTION’ ...
─  preparing ‘rEDM’:
✔  checking DESCRIPTION meta-information ...
─  cleaning src
─  installing the package to build vignettes
✔  creating vignettes (1m 20.6s)
─  building ‘rEDM_1.2.2.tar.gz’

[02:55 PM (2020-02-18)] Check JosephPark@IEEE.org for a link to the built package in 15-30 mins.

win-builder.r-project.org - /PYKlZmqsszt1/
18.02.2020    16:10         4500 00check.log
18.02.2020    16:10        14129 00install.out
18.02.2020    16:10        <dir> examples_and_tests
18.02.2020    16:10      2067513 rEDM_1.2.2.zip

* installing *source* package 'rEDM' ...
** using staged installation
** libs

*** arch - i386
d:/Compiler/gcc-4.9.3/mingw_32/bin/g++  -std=gnu++11 -I"D:/RCompile/recent/R-3.6.2/include" -DNDEBUG
-I./cppEDM/src -I../ -I"d:/RCompile/CRANpkg/lib/3.6/Rcpp/include"
-I"d:/RCompile/CRANpkg/lib/3.6/RcppThread/include"   -I"d:/Compiler/gcc-4.9.3/local330/include"     -O2
-Wall  -mtune=core2 -c CCM.cpp -o CCM.o
...
installing to d:/RCompile/CRANguest/R-release/lib/00LOCK-rEDM/00new/rEDM/libs/i386

*** arch - x64
d:/Compiler/gcc-4.9.3/mingw_64/bin/g++ -m64 -std=gnu++11 -I"D:/RCompile/recent/R-3.6.2/include"
-DNDEBUG -I./cppEDM/src -I../ -I"d:/RCompile/CRANpkg/lib/3.6/Rcpp/include"
-I"d:/RCompile/CRANpkg/lib/3.6/RcppThread/include"   -I"d:/Compiler/gcc-4.9.3/local330/include"     -O2
-Wall  -mtune=core2 -c CCM.cpp -o CCM.o
d:/Compiler/gcc-4.9.3/mingw_64/bin/g++ -m64 -shared -s -static-libgcc -o rEDM.dll tmp.def CCM.o
ComputeError.o DataFrame.o Embed.o EmbedDim.o Multiview.o PredictInterval.o PredictNL.o RcppEDMCommon.o
RcppExports.o SMap.o Simplex.o -L./cppEDM/src/ -lEDM -LD:/RCompile/recent/R-3.6.2/bin/x64 -lRlapack
-Ld:/Compiler/gcc-4.9.3/local330/lib/x64 -Ld:/Compiler/gcc-4.9.3/local330/lib -LD:/RCompile/recent/R-
3.6.2/bin/x64 -lR
installing to d:/RCompile/CRANguest/R-release/lib/00LOCK-rEDM/00new/rEDM/libs/x64
** R
** data
*** moving datasets to lazyload DB
** byte-compile and prepare package for lazy loading
** help
** installing vignettes
** testing if installed package can be loaded from temporary location
*** arch - i386
*** arch - x64
** testing if installed package can be loaded from final location
*** arch - i386
*** arch - x64
** testing if installed package keeps a record of temporary installation path
* MD5 sums
packaged installation of 'rEDM' as rEDM_1.2.2.zip
* DONE (rEDM)
```

3) CRAN build check on docker platforms

```
> devtools::check_rhub()
```

4) Build CRAN release file to upload to CRAN

```
> devtools::build()
```

rEDM Documentation Utilities

Useful commands and rmarkdown package commands to build and convert documentation.

```
rmarkdown::render("rEDM-tutorial.Rmd","pdf_document")
rmarkdown::render("rEDM-tutorial.Rmd","html_document")

R CMD Rd2pdf rEDM
R CMD Rdconv -t html ./rEDM/man/rEDM.Rd > rEDM.html
```

pyEDM PyPI

Microsoft Azure pipeline builds are automatically run when new versions are pushed to the pyEDM github respository as defined in pyEDM/azure-pipelines.yml. The dashboard is here: https://dev.azure.com/cos0080412/pyEDM

The pyEDM package is distributed on the PyPI archives: https://pypi.org/project/pyEDM/

To upload to PyPI, the version string must be different from the previously published one.

Increment the 4th element of `__version__ = "1.2.1.1" in pyEDM/pyEDM/__init__.py`

Optional: Build a single-platform wheels on local machine:

```
python setup.py bdist_wheel
```

Download the Azure wheels (Artificats) from the Azure pipeline.

Upload to PyPI using twine:

```
twine upload [wheel output location]
```

Note: `manylinux` is the only Linux wheel that can be uploaded to PyPI.