

Tests for UnitEvents Package

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1 Installation and initialization of the package

To install UnitEvents, you need to download the archive package and to install the package as a usual package. For example, using the command line

Code chunk 1: <<install>>

```
install.packages('UnitEvents_0.0.1.tar.gz')
```

The neuro-stat code is downloaded and compiled during the installation process. *git*, *CMake* and a C++ compiler are required. The compilation of neuro-stat on Mac OS should finish despite several warnings.

To initialize the package, do as usual

Code chunk 2: <<init>>

```
library('UnitEvents')
```

2 Time windows

2.1 Creation of time windows

The time windows of reference examples in papers [1] and [3] are defined by the *compute_windows* function for Neurons 13 and 40 as follows

Code chunk 3: <<lepton/testTW.R>>(part 2)

```
TW = compute_time_windows(a=0.001, b=1.997, height=0.1, spacing=0.001)
print('TW is a list with fields')
print(names(TW))
print('First 10 columns of TW$A')
print(TW$A[,1:10])
print('Length of TW')
print(TW$len)
```

Code chunk 4: <<Run>>

```
source('lepton/testTW.R')
```

Interpret with R

```
[1] "TW is a list with fields"
[1] "A" "L" "len"
[1] "First 10 columns of TW$A"
  [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,] 0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.01
[2,] 0.101 0.102 0.103 0.104 0.105 0.106 0.107 0.108 0.109 0.11
[1] "Length of TW"
[1] 1996
```

compute_time_windows function is the main function to create time windows.

Code chunk 5: <<lepton/testUE2.R>>

```
TW1 = compute_time_windows(0, 2, 0.1, 0.05)
print('First 10 columns of TW1$A')
print(TW1$A[,1:10])
print('Length of TW1')
print(TW1$len)
```

Code chunk 6: <<Run>>(part 2)

```
source('lepton/testUE2.R')
```

Interpret with R

```
[1] "First 10 columns of TW1$A"
  [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,] 0.0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45
[2,] 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55
[1] "Length of TW1"
[1] 40
```

2.2 Representation of time windows

draw_windows function allows to represent time windows.

Code chunk 7: <<lepton/testdraw.R>>

```
graphics.off()
pdf(file='lepton/dw.pdf')
draw_windows(TW1, yrange=c(-0.5,0))
dev.off()
```

Code chunk 8: <<Run>>(part 3)

```
source('lepton/testdraw.R')
```

Interpret with R

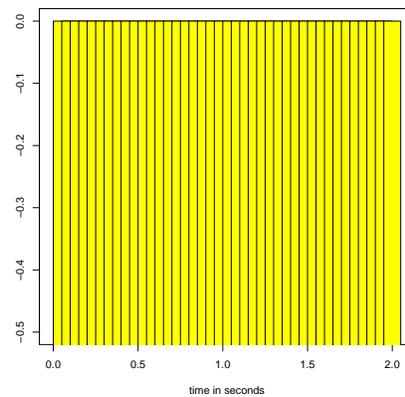


Figure 1: Time windows for interval $[0, 2]$ from *compute_time_windows* function

3 MTGAUE tests

Some results are presented here for MTGAUE (Multiple Tests based on a Gaussian Approximation of the Unitary Events method with delayed coincidence count) (see [3]).

3.1 MTGAUE tests with neuro-stat code

3.1.1 Neuron 13

Result for $\simeq 40$ time windows

Code chunk 9: <<lepton/MTGAUE-nw=40-ns.R>>

```
TW = compute_time_windows(0, 2, height=0.1, spacing=0.05)
xns = UnitEvents(delay=0.02, TW=TW, export=TRUE,
  neurostatpath="..", DataNeur=DNeur("Neur1_c13.txt", "Neur2_c13.txt"))
```

Code chunk 10: <<Run>>(part 4)

```
source('lepton/MTGAUE-nw=40-ns.R')
system('mv Neur_c13-MTGAUE-nw=40-neuro-stat-all.png lepton/')
save(xns, file='lepton/MTGAUE-nw=40-ns.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c13.txt"
[1] "The second file is Neur2_c13.txt"
[1] "Figure title is Neur_c13-MTGAUE-nw=40-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "Both upper and lower tests"
```

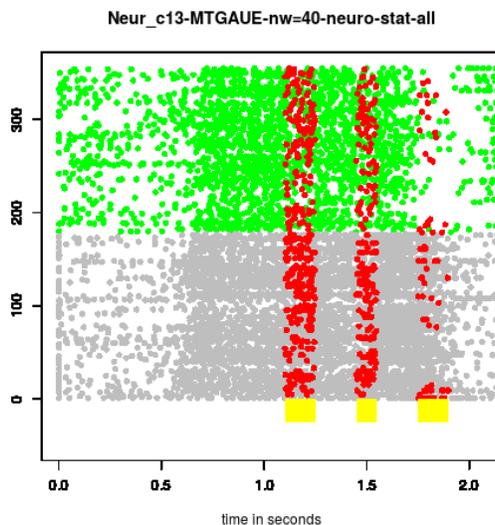


Figure 2: MTGAUE test for neuro-stat code. Neuron 13 - 40 time windows, $\delta = 0.02$

Result for $\simeq 2000$ time windows

Code chunk 11: <<lepton/MTGAUE-nw=2000-ns.R>>

```
TW = compute_time_windows(a=0.001, b=1.973, height=0.1, spacing=0.001)
xns_nw2000 = UnitEvents(delay=0.02, export=TRUE, neurostatpath="..",
                        TW=TW, DataNeur=DNeur("Neur1_c13.txt", "Neur2_c13.txt"))
```

Code chunk 12: <<Run>>(part 5)

```
source('lepton/MTGAUE-nw=2000-ns.R')
system('mv Neur_c13-MTGAUE-nw=1972-neuro-stat-all.png lepton/')
save(xns_nw2000, file='lepton/MTGAUE-nw=2000-ns.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c13.txt"
[1] "The second file is Neur2_c13.txt"
[1] "Figure title is Neur_c13-MTGAUE-nw=1972-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 1972 time windows"
[1] "Both upper
```

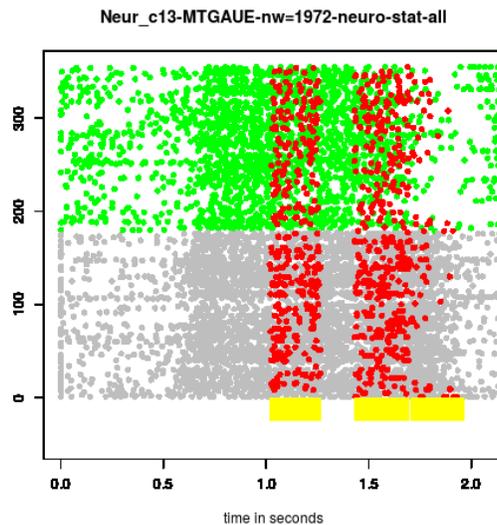


Figure 3: MTGAUE test for neuro-stat code. Neuron 13 - $\simeq 2000$ time windows, $\delta = 0.02$

3.1.2 Neuron 40

Result for 40 time windows and upper test only

Code chunk 13: <<lepton/MTGAUE-nw=40-ns-up_40.R>>

```
TW = compute_time_windows(0, 2, 0.1, 0.05)
xns_nw40_up = UnitEvents(delay=0.02, TW=TW, export=TRUE, neurostatpath="..",
                          Rtest="upper", DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"))
```

Code chunk 14: <<Run>> (part 6)

```
source('lepton/MTGAUE-nw=40-ns-up_40.R')
system('mv Neur_c40-MTGAUE-nw=40-neuro-stat-upper.png lepton/')
save(xns_nw40_up, file='lepton/MTGAUE-nw=40-ns-up_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-MTGAUE-nw=40-neuro-stat-upper"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "upper test with neuro-stat code"
```

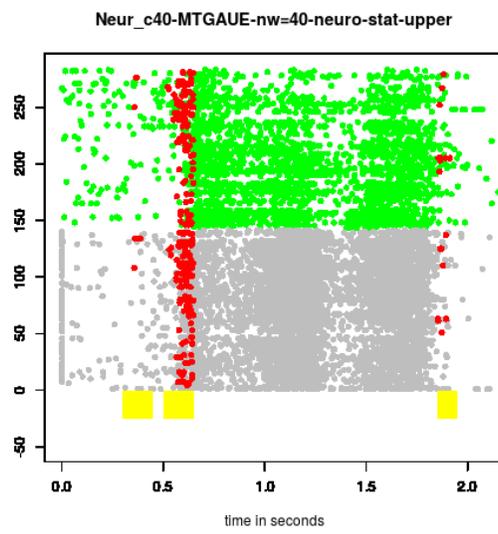


Figure 4: MTGAUE test for neuro-stat code. Neuron 40 - 40 time windows, upper test, $\delta = 0.02$

Result for 40 time windows and lower test only

Code chunk 15: <<lepton/MTGAUE-nw=40-ns-lo_40.R>>

```
TW = compute_time_windows(0, 2, 0.1, 0.05)
xns_nw40_lo = UnitEvents(delay=0.02, TW=TW, export=TRUE, neurostatpath="..",
                          Rtest="lower", DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"))
```

Code chunk 16: <<Run>>(part 7)

```
source('lepton/MTGAUE-nw=40-ns-lo_40.R')
system('mv Neur_c40-MTGAUE-nw=40-neuro-stat-lower.png lepton/')
save(xns_nw40_lo, file='lepton/MTGAUE-nw=40-ns-lo_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-MTGAUE-nw=40-neuro-stat-lower"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "lower test"
```

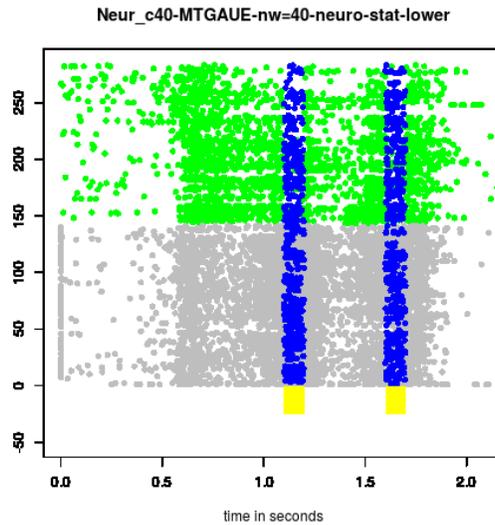


Figure 5: MTGAUE test for neuro-stat code. Neuron 40 - 40 time windows, lower test, $\delta = 0.02$

Result for 40 time windows both upper and lower test

Code chunk 17: <<lepton/MTGAUE-nw=40-ns_40.R>>

```
TW = compute_time_windows(0, 2, 0.1, 0.05)
xns_nw40_40 = UnitEvents(delay=0.02, TW=TW, export=TRUE, neurostatpath="..",
                          DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"))
```

Code chunk 18: <<Run>>(part 8)

```
source('lepton/MTGAUE-nw=40-ns_40.R')
system('mv Neur_c40-MTGAUE-nw=40-neuro-stat-all.png lepton')
save(xns_nw40_40, file='lepton/MTGAUE-nw=40-ns_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-MTGAUE-nw=40-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "Both upper
```

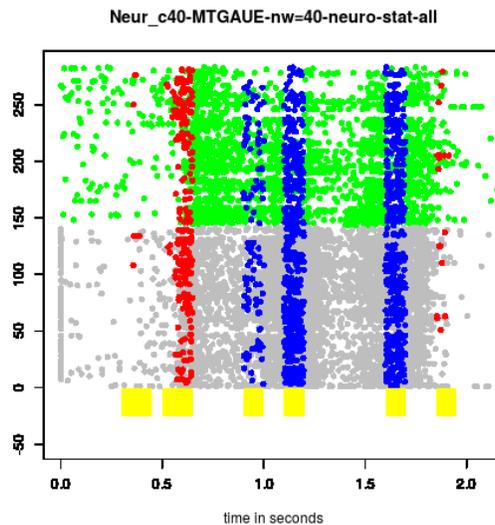


Figure 6: MTGAUE test for neuro-stat code. Neuron 40 - 40 time windows, $\delta = 0.02$

Result for $\simeq 2000$ time windows, upper test

Code chunk 19: <<lepton/MTGAUE-nw=2000-ns-up_40.R>>

```
TW = compute_time_windows(a=0.001, b=1.997, height=0.1, spacing=0.001)
xns_nw2000_40_up = UnitEvents(delay=0.02, TW=TW, export=TRUE, neurostatpath="..",
                             Rtest="upper", DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"))
```

Code chunk 20: <<Run>>(part 9)

```
source('lepton/MTGAUE-nw=2000-ns-up_40.R')
system('mv Neur_c40-MTGAUE-nw=1996-neuro-stat-upper.png lepton/')
save(xns_nw2000_40_up, file='lepton/MTGAUE-nw=2000-ns-up_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-MTGAUE-nw=1996-neuro-stat-upper"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 1996 time windows"
[1] "upper test"
```

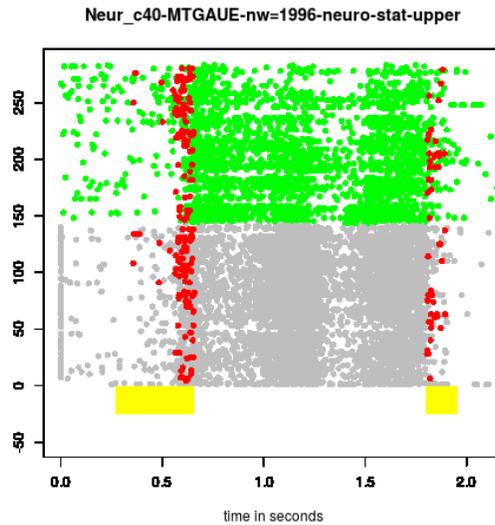


Figure 7: MTGAUE test for neuro-stat code. Neuron 40 - $\simeq 2000$ time windows, upper test, $\delta = 0.02$

Result for $\simeq 2000$ time windows, lower test

Code chunk 21: <<lepton/MTGAUE-nw=2000-ns-lo_40.R>>

```
TW = compute_time_windows(a=0.001, b=1.997, height=0.1, spacing=0.001)
xns_nw2000_40_lo = UnitEvents(delay=0.02, TW=TW, export=TRUE, neurostatpath="..",
                             Rtest="lower", DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"))
```

Code chunk 22: <<Run>>(part 10)

```
source('lepton/MTGAUE-nw=2000-ns-lo_40.R')
system('mv Neur_c40-MTGAUE-nw=1996-neuro-stat-lower.png lepton/')
save(xns_nw2000_40_lo, file='lepton/MTGAUE-nw=2000-ns-lo_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-MTGAUE-nw=1996-neuro-stat-lower"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 1996 time windows"
[1] "lower test with neuro-stat code"
[1] "k==0"
```

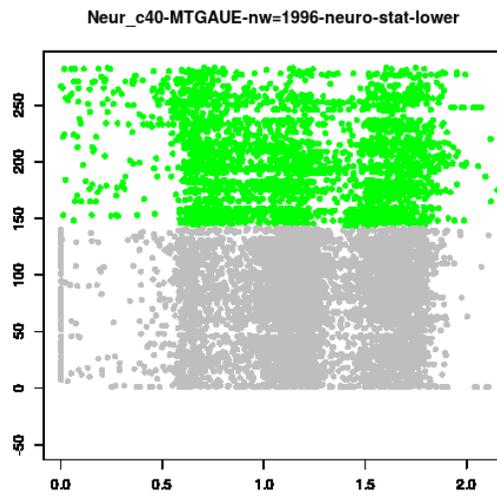


Figure 8: MTGAUE test for neuro-stat code. Neuron 40 - \simeq 2000 time windows, lower test, $\delta = 0.02$

Result for $\simeq 2000$ time windows, both upper and lower test

Code chunk 23: <<lepton/MTGAUE-nw=2000-ns_40.R>>

```
TW = compute_time_windows(a=0.001, b=1.997, height=0.1, spacing=0.001)
xns_nw2000_40 = UnitEvents(delay=0.02, export=TRUE, neurostatpath="..",
                          TW=TW, DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"))
```

Code chunk 24: <<Run>>(part 11)

```
source('lepton/MTGAUE-nw=2000-ns_40.R')
system('mv Neur_c40-MTGAUE-nw=1996-neuro-stat-all.png lepton/')
save(xns_nw2000_40, file='lepton/MTGAUE-nw=2000-ns_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-MTGAUE-nw=1996-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 1996 time windows"
[1] "Both upper
```

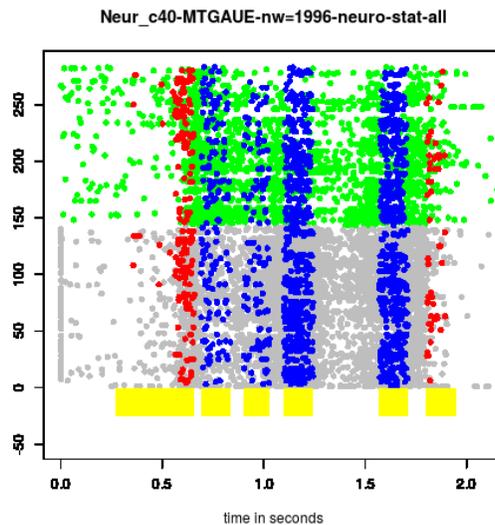


Figure 9: MTGAUE test for neuro-stat code. Neuron 40 - $\simeq 2000$ time windows, $\delta = 0.02$

4 Tests with permutation method

4.1 Permutation with neuro-stat code

4.1.1 Neuron 13

Result for 40 time windows

Code chunk 25: <<lepton/Perm-nw=40-ns.R>>

```
ti = proc.time()
TW = compute_time_windows(0, 2, 0.1, 0.05)
xns_perm_nw40 = UnitEvents(delay=0.02, neurostatpath="..", iperm=TRUE, TW=TW,
                           DataNeur=DNeur("Neur1_c13.txt", "Neur2_c13.txt"), export=TRUE)
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 26: <<Run>>(part 12)

```
source('lepton/Perm-nw=40-ns.R')
system('mv Neur_c13-Perm-nw=40-neuro-stat-all.png lepton/')
save(xns_perm_nw40, file='lepton/Perm-nw=40-ns.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c13.txt"
[1] "The second file is Neur2_c13.txt"
[1] "Figure title is Neur_c13-Perm-nw=40-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "Both upper and lower tests"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 177 | max_tops=  91
      WINK: Neuron 2 | #trials= 177 | max_tops=  44
      WINK: #intervals  = 40
      WINK: #bootstraps = 10000
      WINK: <SERIAL CODE>
[1] "Computation time 2.7"
```

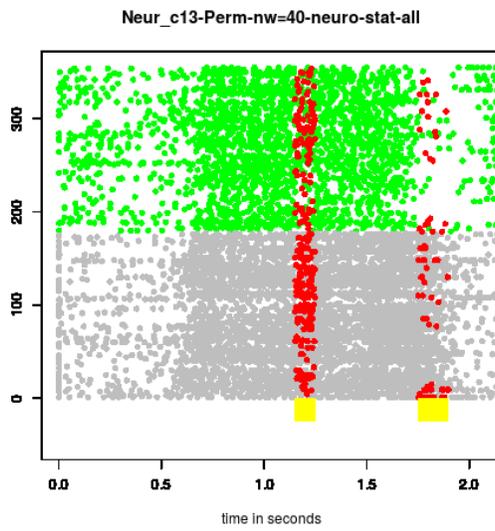


Figure 10: Permutation for neuro-stat code. Neuron 13 - 40 time windows, $\delta = 0.02$

Result for $\simeq 2000$ time windows

Code chunk 27: <<lepton/Perm-nw=2000-ns.R>>

```
ti = proc.time()
TW = compute_time_windows(a=0.001, b=1.973, height=0.1, spacing=0.001)
xns_perm = UnitEvents(delay=0.02, TW=TW, iperm=TRUE, export=TRUE,
                      DataNeur=DNeur("Neur1_c13.txt", "Neur2_c13.txt"),
                      neurostatpath="..")
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 28: <<Run>>(part 13)

```
source('lepton/Perm-nw=2000-ns.R')
system('mv Neur_c13-Perm-nw=1972-neuro-stat-all.png lepton/')
save(xns_perm, file='lepton/Perm-nw=2000-ns.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c13.txt"
[1] "The second file is Neur2_c13.txt"
[1] "Figure title is Neur_c13-Perm-nw=1972-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4/wink.so"
[1] ""
[1] "There are 1972 time windows"
[1] "Both upper and lower tests"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 177 | max_tops=   91
      WINK: Neuron 2 | #trials= 177 | max_tops=   44
      WINK: #intervals   = 1972
      WINK: #bootstraps  = 10000
      WINK: <SERIAL CODE>
[1] "Computation time 121.29"
```

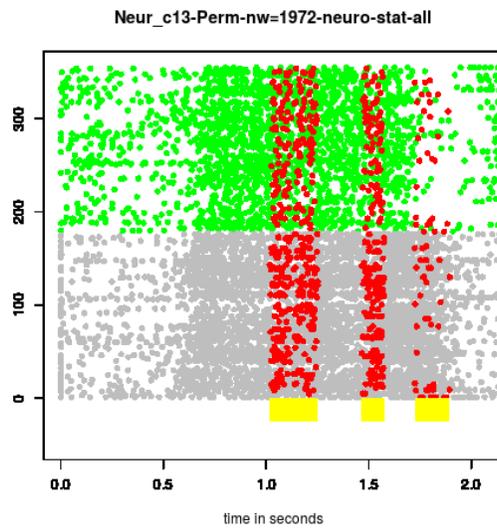


Figure 11: Permutation for neuro-stat code. Neuron 13 - \simeq 2000 time windows, $\delta = 0.02$

4.1.2 Neuron 40

Result for 40 time windows and upper test only

Code chunk 29: <<lepton/Perm-nw=40-ns_40_up.R>>

```
ti = proc.time()
xns_perm_nw40_40_up = UnitEvents(delay=0.02, TW=compute_time_windows(0, 2, 0.1, 0.05), export=TRUE, neurostatpat
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 30: <<Run>>(part 14)

```
source('lepton/Perm-nw=40-ns_40_up.R')
system('mv Neur_c40-Perm-nw=40-neuro-stat-upper.png lepton/')
save(xns_perm_nw40_40_up, file='lepton/Perm-nw=40-ns_40_up.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-Perm-nw=40-neuro-stat-upper"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "upper test with neuro-stat code"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 141 | max_tops= 112
      WINK: Neuron 2 | #trials= 141 | max_tops= 51
      WINK: #intervals = 40
      WINK: #bootstraps = 10000
      WINK: <SERIAL CODE>
[1] "Computation time 2.40099999999998"
```

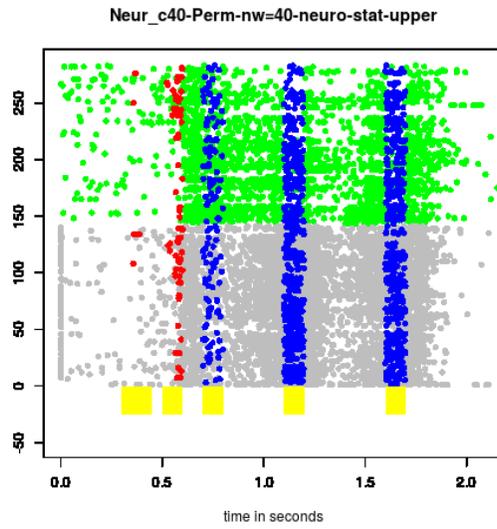


Figure 12: Permutation for neuro-stat code. Neuron 40 - 40 time windows, upper test, $\delta = 0.02$

Result for 40 time windows and lower test only

Code chunk 31: <<lepton/Perm-nw=40-ns-lo_40.R>>

```
ti = proc.time()
xns_perm_nw40_40_lo = UnitEvents(delay=0.02, TW=compute_time_windows(0, 2, 0.1, 0.05), export=TRUE, neurostatpat
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 32: <<Run>>(part 15)

```
source('lepton/Perm-nw=40-ns-lo_40.R')
system('mv Neur_c40-Perm-nw=40-neuro-stat-lower.png lepton/')
save(xns_perm_nw40_40_lo, file='lepton/Perm-nw=40-ns-lo_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-Perm-nw=40-neuro-stat-lower"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "lower test with neuro-stat code"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 141 | max_tops= 112
      WINK: Neuron 2 | #trials= 141 | max_tops= 51
      WINK: #intervals = 40
      WINK: #bootstraps = 10000
      WINK: <SERIAL CODE>
[1] "Computation time 2.523"
```

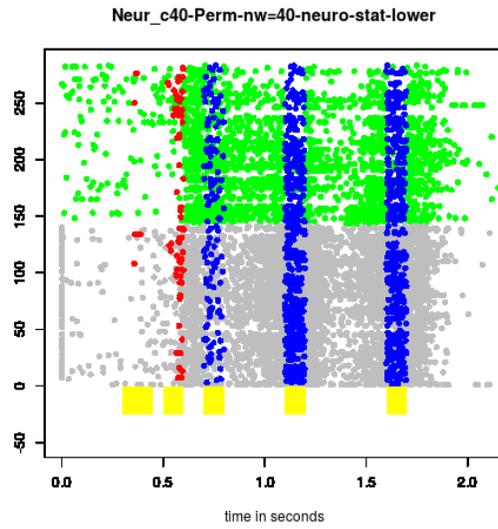


Figure 13: Permutation for neuro-stat code. Neuron 40 - 40 time windows, lower test, $\delta = 0.02$

Result for 40 time windows both upper and lower test

Code chunk 33: <<lepton/Perm-nw=40-ns_40.R>>

```
ti = proc.time()
xns_perm_nw40_40 = UnitEvents(delay=0.02, TW=compute_time_windows(0, 2, 0.1, 0.05), export=TRUE, neurostatpath="
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 34: <<Run>>(part 16)

```
source('lepton/Perm-nw=40-ns_40.R')
system('mv Neur_c40-Perm-nw=40-neuro-stat-all.png lepton/')
save(xns_perm_nw40_40, file='lepton/Perm-nw=40-ns_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-Perm-nw=40-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 40 time windows"
[1] "Both upper and lower tests"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 141 | max_tops=  112
      WINK: Neuron 2 | #trials= 141 | max_tops=   51
      WINK: #intervals  = 40
      WINK: #bootstraps = 10000
      WINK: <SERIAL CODE>
[1] "Computation time 2.31300000000002"
```

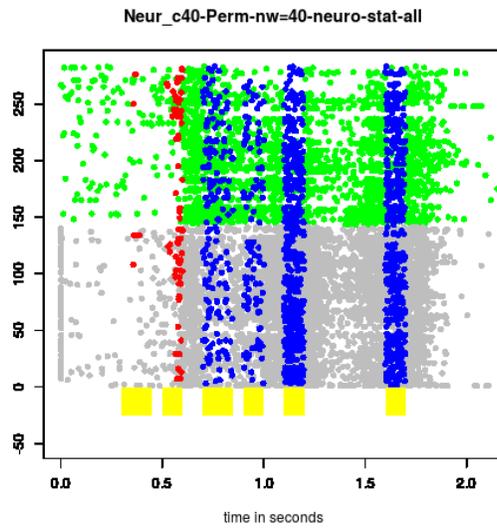


Figure 14: Permutation for neuro-stat code. Neuron 40 - 40 time windows, $\delta = 0.02$

Result for $\simeq 2000$ time windows, upper test

Code chunk 35: <<lepton/Perm-nw=2000-ns_40_up.R>>

```
ti = proc.time()
TW = compute_time_windows(a=0.001, b=1.997, height=0.1, spacing=0.001)
xns_perm_nw2000_40_up = UnitEvents(delay=0.02, export=TRUE, TW=TW, iperm=TRUE,
neurostatpath="..", DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"), Rtest="upper")
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 36: <<Run>>(part 17)

```
source('lepton/Perm-nw=2000-ns_40_up.R')
system('mv Neur_c40-Perm-nw=1996-neuro-stat-upper.png lepton/')
save(xns_perm_nw2000_40_up, file='lepton/Perm-nw=2000-ns_40_up.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-Perm-nw=1996-neuro-stat-upper"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 1996 time windows"
[1] "upper test with neuro-stat code"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 141 | max_tops= 112
      WINK: Neuron 2 | #trials= 141 | max_tops= 51
      WINK: #intervals = 1996
      WINK: #bootstraps = 10000
      WINK: <SERIAL CODE>
[1] "k==0"
[1] "Computation time 83.117"
```

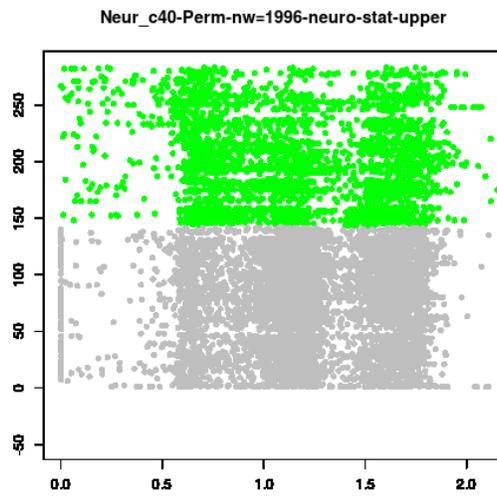


Figure 15: Permutation for neuro-stat code. Neuron 40 - \simeq 2000 time windows, upper test, $\delta = 0.02$

Result for $\simeq 2000$ time windows, lower test

Code chunk 37: <<lepton/Perm-nw=2000-ns_40_lo.R>>

```
ti = proc.time()
TW = compute_time_windows(a=0.001, b=1.997, height=0.1, spacing=0.001)
xns_perm_nw2000_40_lo = UnitEvents(delay=0.02, export=TRUE, TW=TW, iperm=TRUE,
neurostatpath="..", DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"), Rtest="lower")
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 38: <<Run>>(part 18)

```
source('lepton/Perm-nw=2000-ns_40_lo.R')
system('mv Neur_c40-Perm-nw=1996-neuro-stat-lower.png lepton/')
save(xns_perm_nw2000_40_lo, file='lepton/Perm-nw=2000-ns_40_lo.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-Perm-nw=1996-neuro-stat-lower"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 1996 time windows"
[1] "lower test with neuro-stat code"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 141 | max_tops= 112
      WINK: Neuron 2 | #trials= 141 | max_tops=  51
      WINK: #intervals  = 1996
      WINK: #bootstraps = 10000
      WINK: <SERIAL CODE>
[1] "k==0"
[1] "Computation time 93.348"
```

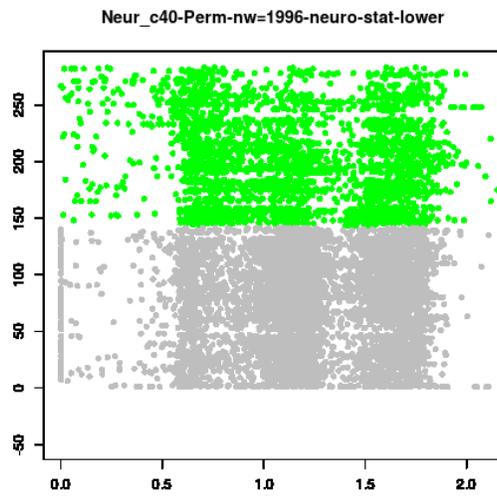


Figure 16: Permutation for neuro-stat code. Neuron 40 - \simeq 2000 time windows, $\delta = 0.02$, lower test

Result for $\simeq 2000$ time windows

Code chunk 39: <<lepton/Perm-nw=2000-ns_40.R>>

```
ti = proc.time()
TW = compute_time_windows(a=0.001, b=1.997, height=0.1, spacing=0.001)
xns_perm_nw2000_40 = UnitEvents(delay=0.02, export=TRUE, TW=TW, iperm=TRUE,
neurostatpath="..", DataNeur=DNeur("Neur1_c40.txt", "Neur2_c40.txt"))
tf = (proc.time()-ti)[3]; print(paste('Computation time', as.character(tf)))
```

Code chunk 40: <<Run>>(part 19)

```
source('lepton/Perm-nw=2000-ns_40.R')
system('mv Neur_c40-Perm-nw=1996-neuro-stat-all.png lepton/')
save(xns_perm_nw2000_40, file='lepton/Perm-nw=2000-ns_40.RData')
```

Interpret with R

```
[1] ""
[1] "The file for the first neuron is Neur1_c40.txt"
[1] "The second file is Neur2_c40.txt"
[1] "Figure title is Neur_c40-Perm-nw=1996-neuro-stat-all"
[1] ""
[1] "The value of delay for coincidences (denoted by delta in MTGAUE paper) is 0.02"
[1] "The level value in Benjamini-Hochberg procedure is 0.05"
[1] ""
[1] "Exporting figures to png format ..."
[1] ""
[1] "The value of neurostatpath seems to be uncorrect. No neuro-stat existing directory"
[1] "neuro-stat code is under ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat"
[1] "WINK: Loading ~/R/x86_64-pc-linux-gnu-library/3.2/UnitEvents/neuro-stat/v3/src/wink_mam4//wink.so"
[1] ""
[1] "There are 1996 time windows"
[1] "Both upper and lower tests"
      WINK: Permutation[1 thread ]
      WINK: Neuron 1 | #trials= 141 | max_tops=  112
      WINK: Neuron 2 | #trials= 141 | max_tops=   51
      WINK: #intervals  = 1996
      WINK: #bootstraps = 10000
      WINK: <SERIAL CODE>
[1] "k==0"
[1] "Computation time 90.453"
```

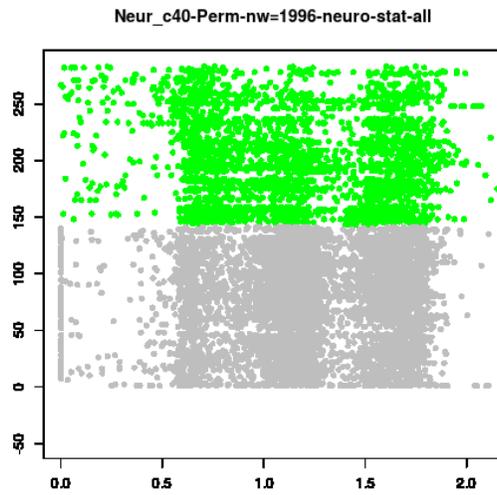
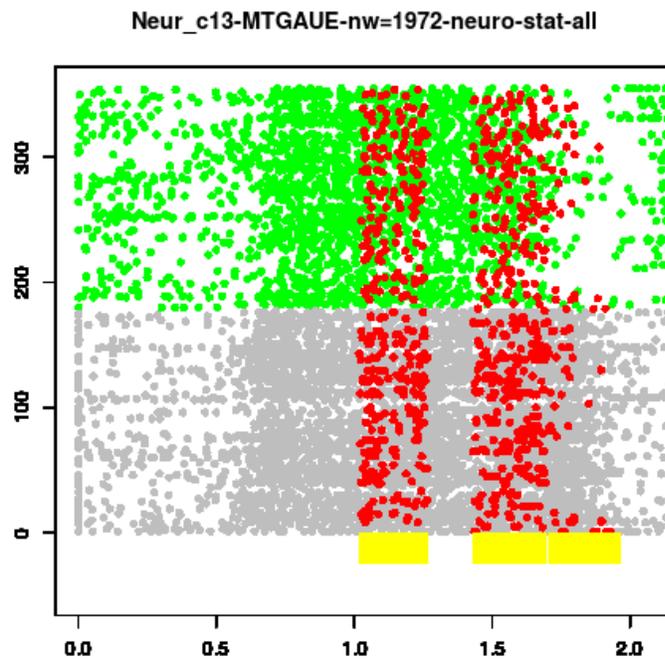
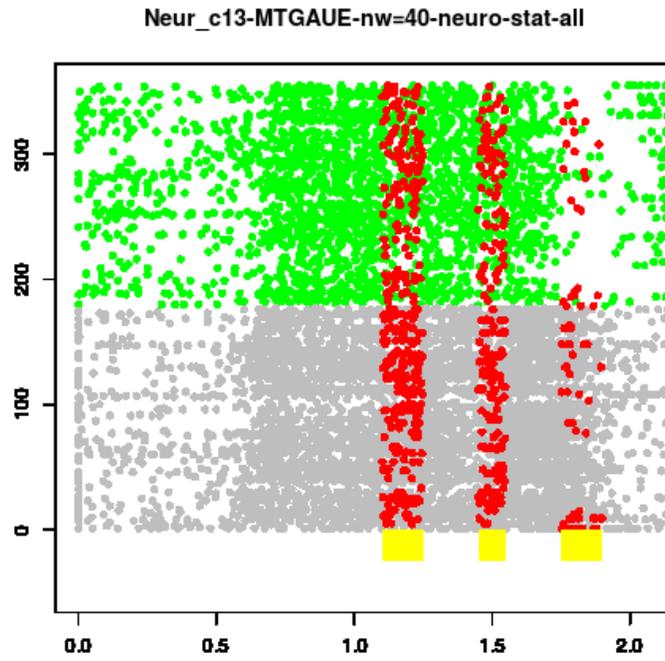


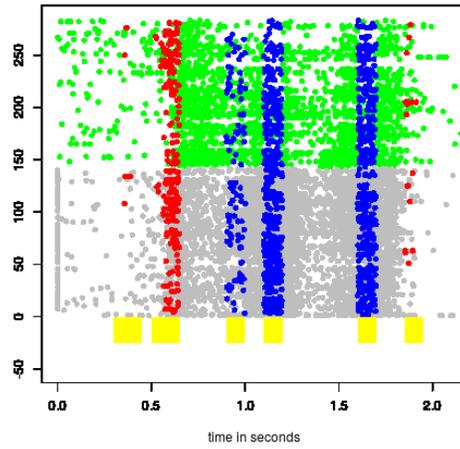
Figure 17: Permutation for neuro-stat code. Neuron 40 - \simeq 2000 time windows, $\delta = 0.02$

5 Reference figures

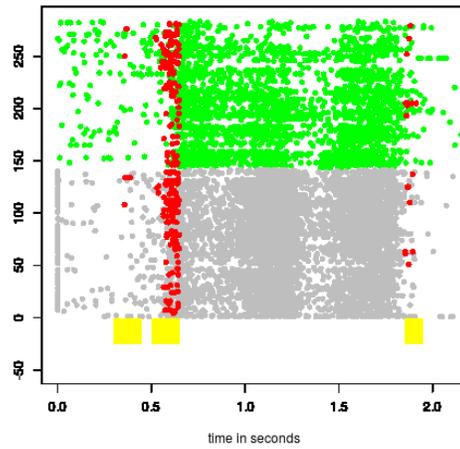


time in seconds

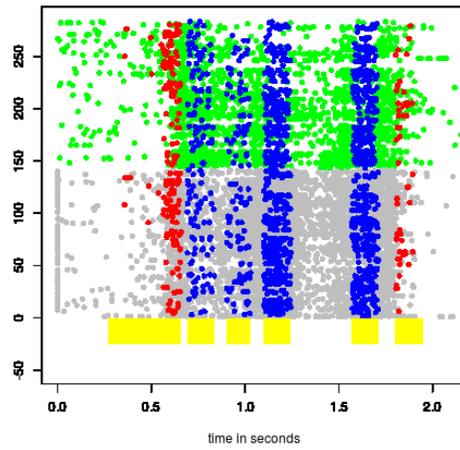
Neur_c40-MTGAUE-nw=40-neuro-stat-all



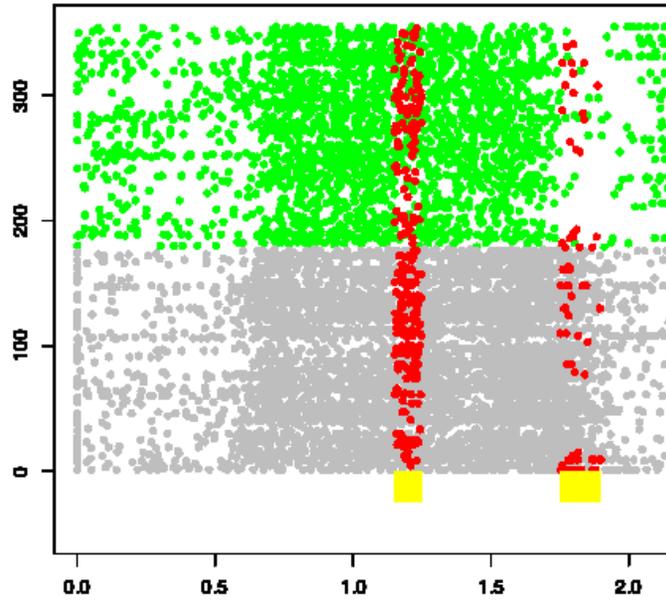
Neur_c40-MTGAUE-nw=40-neuro-stat-upper



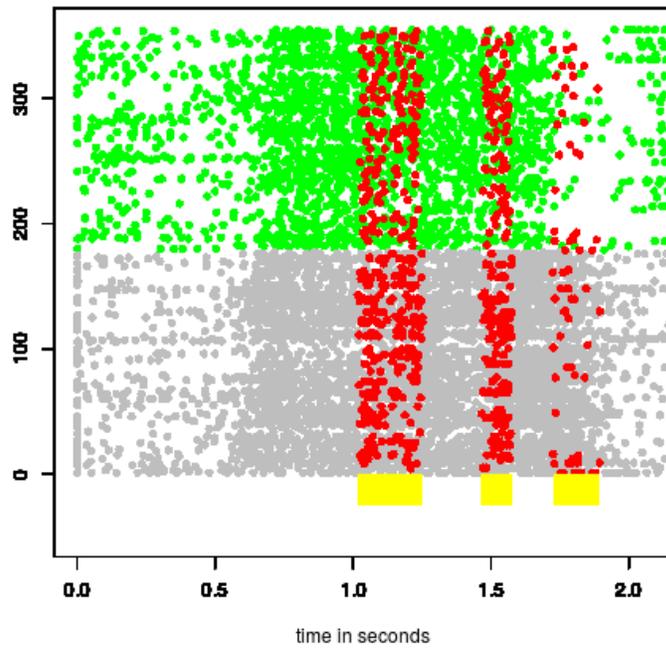
Neur_c40-MTGAUE-nw=1996-neuro-stat-all



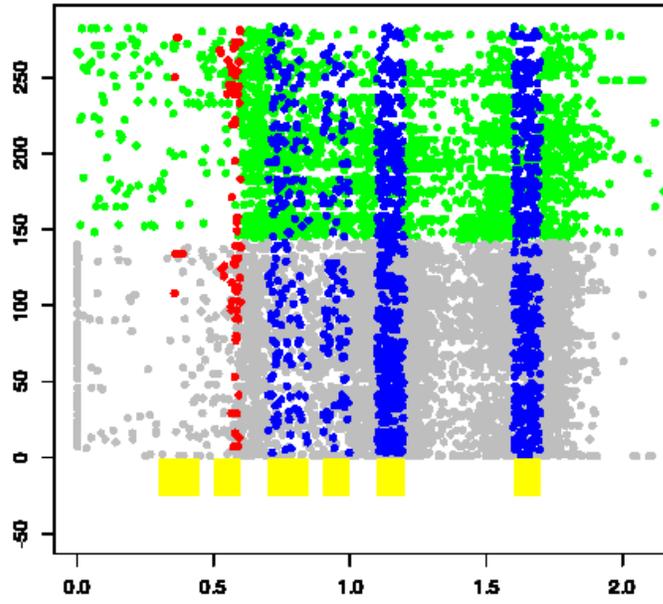
Neur_c13-Perm-nw=40-neuro-stat-all



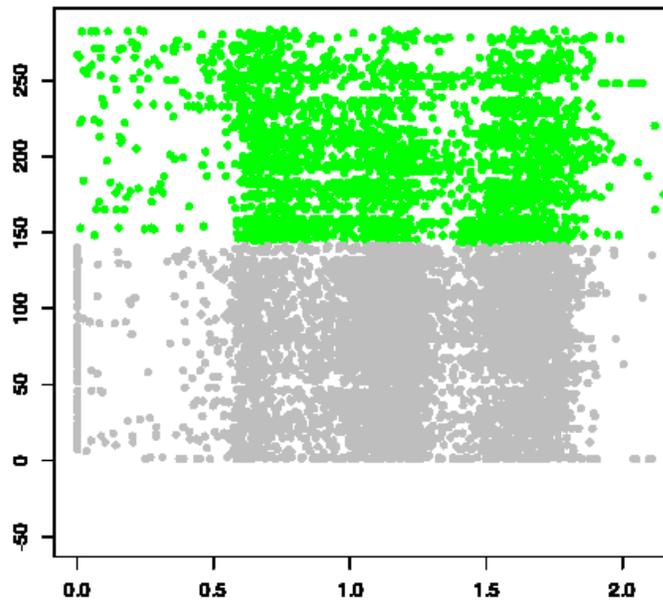
Neur_c13-Perm-nw=1972-neuro-stat-all



Neur_c40-Perm-nw=40-neuro-stat-all



Neur_c40-Perm-nw=1996-neuro-stat-all



6 Discussion - TO DO

- Understand the difference between R and neuro-stat for an MTGAUE example
- Comparison of the performance

References

- [1] Mélisande Albert, Yann Bouret, Magalie Fromont, and Patricia Reynaud-Bouret. Surrogate Data Methods Based on a Shuffling of the Trials for Synchrony Detection: The Centering Issue. *Neural Computation*, 28(11):2352–2392, 2016.
- [2] Yoav Benjamini and Yosef Hochberg. Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society. Series B (Methodological)*, 57(1):289–300, 1995.
- [3] Christine Tuleau-Malot, Amel Rouis, Franck Grammont, and Patricia Reynaud-Bouret. Multiple Tests based on a Gaussian Approximation of the Unitary Events method with delayed coincidence count. *Neural Computation*, 26(7):1408–1454, July 2014.