

# onsetsynch

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This is a simple package meant to facilitate the analysis of onset data extracted from audio. I've made this in the context of Interpersonal Entrainment Music Performance (IEMP, an AHRC-funded research project, Principal Investigator Martin Clayton), partially to create structures for analyses of materials from different sources, partially to see whether I can do a simple R extension myself. This extension is available at <https://github.com/tuomaseerola/onsetsynch>.

## Example

We will first read in data which consists of extracted onsets (done with MIR toolbox for Matlab) and hand annotated labelling of beats and structures. This is a Cuban song, recorded by Adrian Poole (more details [here](#)).

### Read data

```
asere <- read.csv(url('https://raw.githubusercontent.com/tuomaseerola/onsetsynch/master/data/Asere_OU_2
head(asere)
```

```
##      Piece N Label.SD Beat.pos SD.pos SD Clave_ Section Virtual.SD
## 1 Song_2 7      01:01         1      1 1         Y      Son    5.037333
## 2 Song_2 7      01:02         1      2 2         N      Son    5.260063
## 3 Song_2 7      01:03         1      3 3         N      Son    5.482792
## 4 Song_2 7      01:04         1      4 4         Y      Son    5.705521
## 5 Song_2 7      01:05         2      1 5         N      Son    5.928250
## 6 Song_2 7      01:06         2      2 6         N      Son    6.150979
##      Tactus      Tempo Clave      Bass      Guitar      Tres      Bongo Bell
## 1 0.8909167 67.34637      NA      NA      NA      NA      NA      NA
## 2 0.8909167 67.34637      NA      NA 5.281932      NA      NA      NA
## 3 0.8909167 67.34637      NA      NA 5.480643      NA 5.477695      NA
## 4 0.8909167 67.34637      NA 5.714555 5.707537 5.730943 5.718635      NA
## 5 0.8909167 67.34637      NA 5.927078 5.939071 5.917083 5.926234      NA
## 6 0.8909167 67.34637      NA      NA 6.153243 6.144901 6.155149      NA
##      Cl_Dens Bs_Dens Gt_Dens Tr_Dens Bn_Dens Bl_Dens
## 1      NA      NA      NA      NA      NA      NA
## 2      NA      NA      NA      NA      NA      NA
## 3      NA      NA      NA      NA      2.0      NA
## 4      NA      NA      NA      NA      2.0      NA
## 5      NA      NA      NA      NA      2.5      NA
## 6      NA      NA      NA      NA      2.5      NA
```

There is quite a bit of extra data here, which we won't need. I also want to handle the data in `tidyverse` fashion and give few diagnostics about the data.

```
library(dplyr)
library(ggplot2)
library(reshape2)
```

```
asere <- as_tibble(asere)
asere <- select(asere,SD,Section,Tempo,SD,Virtual.SD,Clave,Bass,Guitar,Tres,Bongo,Bell) # keep only key
print(dim(asere))
```

```
## [1] 1585    10
```

```
round(colSums(!is.na(asere[,which(colnames(asere)=="Clave"):which(colnames(asere)=="Bell")])),na.rm = T)
```

```
## Clave    Bass Guitar    Tres    Bongo    Bell
##   0.31    0.31    0.89    0.58    0.40    0.25
```

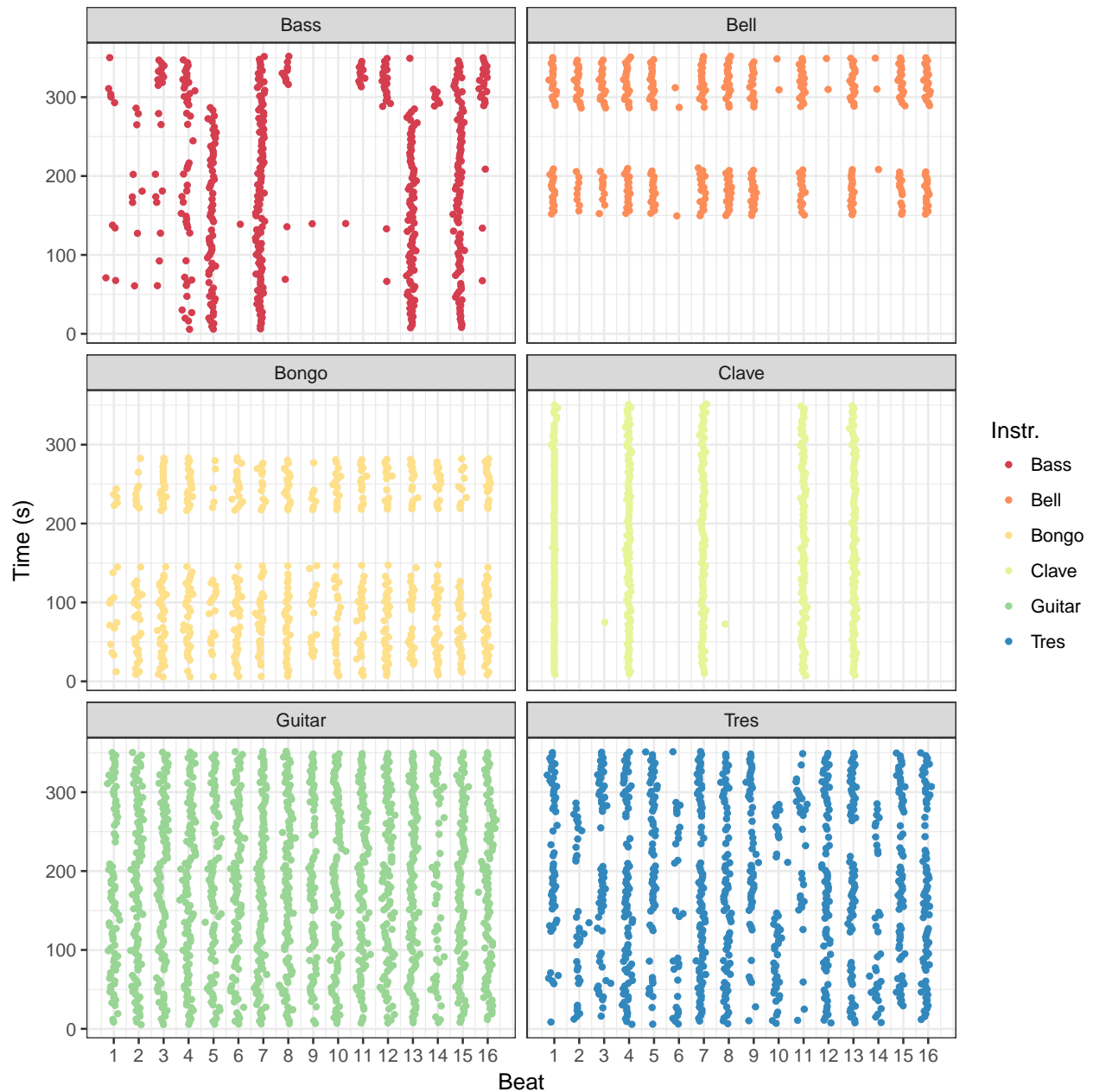
## Load onsetsynch library

OK. Load up the library and visualise the relative asynchrony to equal division for each instrument.

```
devtools::install_github("tuomaseerola/onsetsynch") # install the developmental package synchrony
```

```
## Skipping install of 'onsetsynch' from a github remote, the SHA1 (46043bb3) has not changed since last
## Use `force = TRUE` to force installation
```

```
library(onsetsynch)
p <- onsetsynch_by_beat_plot(asere,
  c('Bass','Clave','Guitar','Tres','Bongo','Bell'),'SD','Virtual.SD',pcols=2)
print(p)
```



### Calculate the synchrony between the instruments

How well are the pairs of instruments synced? Since the instrument play different amounts of onset, and these are bound to at different beats, the mutual amount of onsets for each pair varies. In order to keep the mean and standard deviations comparable, we will randomly sample the joint onsets for both instruments.

```
set.seed(1201) # set random seed before doing any sampling in order replicate results
N <- 100 # Let's select 100 onsets
d1 <- onsetsynch_sample_paired(asere, 'Clave', 'Bass', N, 1, 'SD', TRUE) # Determine the instrument pair

## [1] "onsets in common: 241"

print(paste('Asynchrony mean=', round(mean(d1$asynch*1000), 4),
           'ms & sd. dev=', round(sd(d1$asynch*1000), 3)))
```

```
## [1] "Asynchrony mean= 18.0883 ms & sd. dev= 21.525"
```

The first example might still be inaccurate since we now know that there are at least 241 shared onset times between the Clave and the Bass. Let's redo the random sampling 10 times so we get more observations whilst still always sampling 100 joint onsets.

```
d10 <- onsetsynch_sample_paired(asere, 'Clave', 'Bass', N, 10, 'SD', TRUE) # New parameter 10 for 10 times
```

```
## [1] "onsets in common: 241"
```

```
print(paste('Asynchrony mean=', round(mean(d10$asynch*1000), 4),  
           'ms & sd. dev=', round(sd(d10$asynch*1000), 3)))
```

```
## [1] "Asynchrony mean= 16.9891 ms & sd. dev= 19.692"
```

Carry this out for all possible pairings of the instruments and visualise the results.

```
inst<-c('Clave', 'Bass', 'Guitar', 'Tres', 'Bongo', 'Bell') # Define instruments  
dn <- onsetsynch_execute_pairs(asere, inst, N, 10, 'SD') # Carry out pairwise comparisons
```

```
## [1] "onsets in common: 241"  
## [1] "onsets in common: 462"  
## [1] "onsets in common: 312"  
## [1] "onsets in common: 189"  
## [1] "onsets in common: 173"  
## [1] "onsets in common: 469"  
## [1] "onsets in common: 354"  
## [1] "onsets in common: 166"  
## [1] "onsets in common: 173"  
## [1] "onsets in common: 858"  
## [1] "onsets in common: 575"  
## [1] "onsets in common: 397"  
## [1] "onsets in common: 344"  
## [1] "onsets in common: 348"  
## [1] "onsets in common: 0"
```

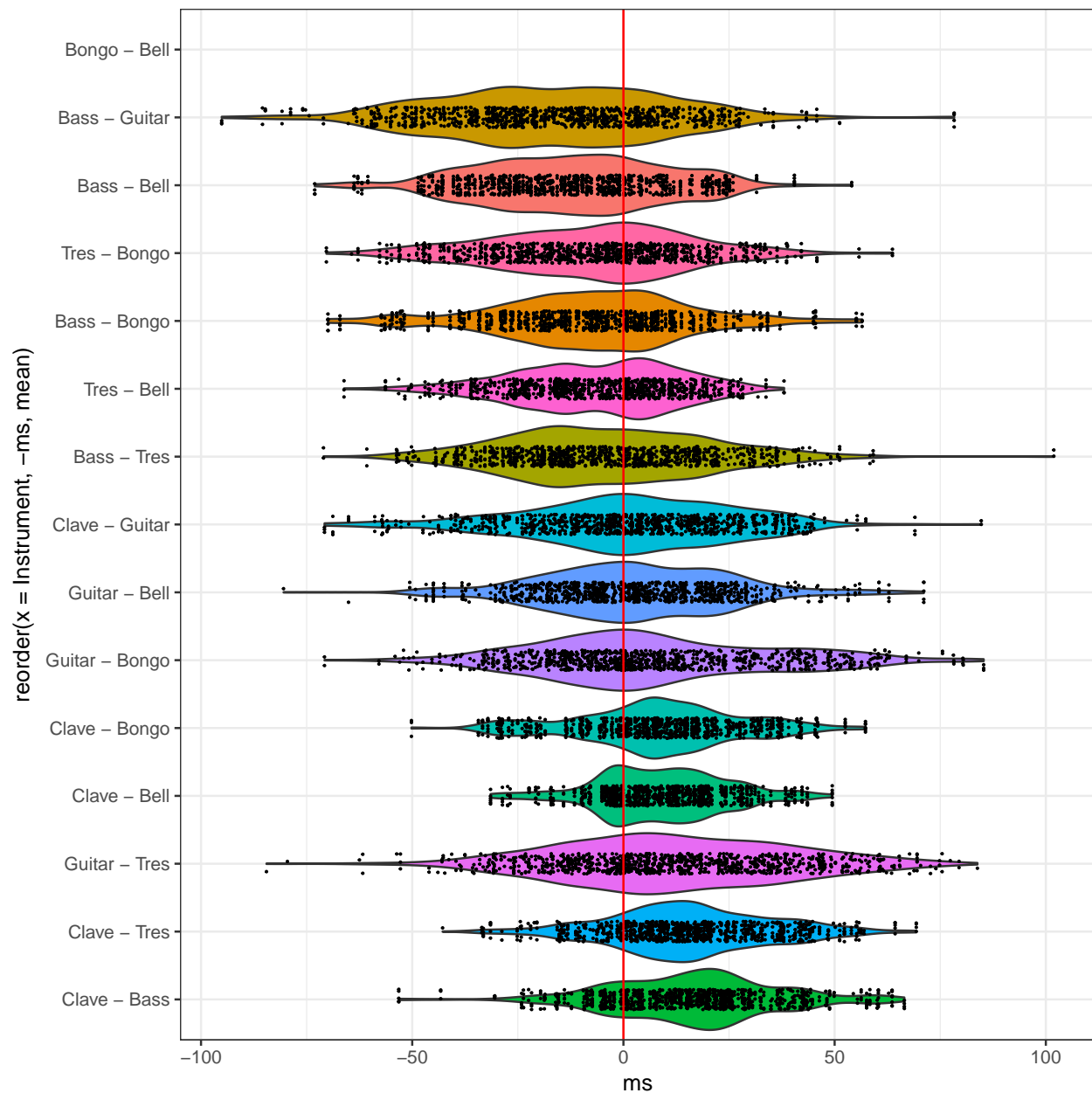
```
dim(dn$asynch)
```

```
## [1] 1000 15
```

```
p2 <- onsetsynch_by_pair_plot(dn) # plot
```

```
## No id variables; using all as measure variables
```

```
print(p2)
```



```
# Compare only three interesting instruments in terms of the synchrony across the beats
inst<-c('Bass','Guitar','Tres') # Define instrument for exhaustive pairwise comparison
dn <- onsetsynch_execute_pairs(asere,inst,N,10,'SD')
```

```
## [1] "onsets in common: 469"
## [1] "onsets in common: 354"
## [1] "onsets in common: 858"
```

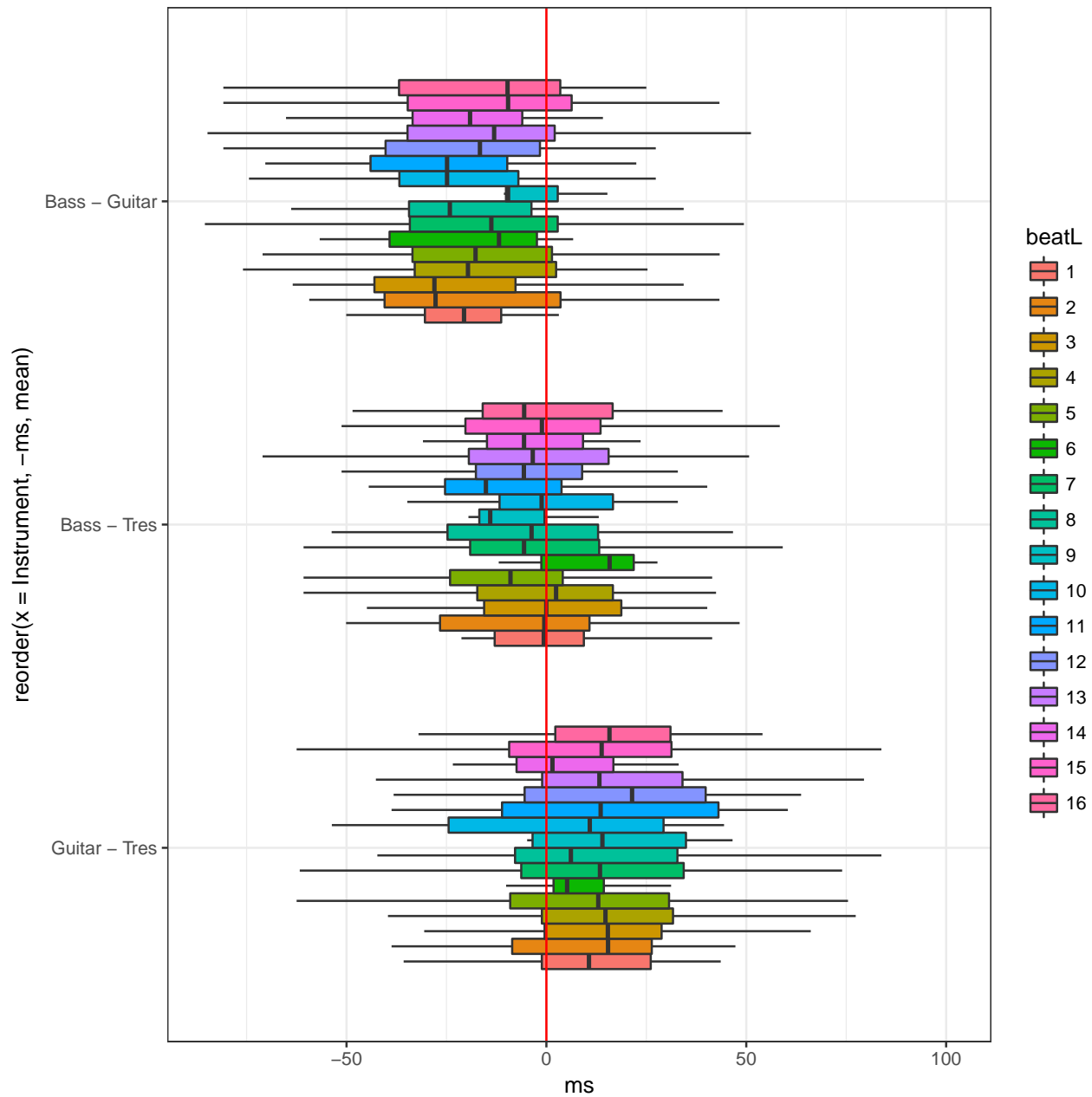
```
p3 <- onsetsynch_by_pair_plot(dn,bybeat=TRUE) # plot by beats
```

```
## No id variables; using all as measure variables
## No id variables; using all as measure variables
```

```
## 'data.frame': 3000 obs. of 3 variables:
## $ Instrument: Factor w/ 3 levels "Bass - Guitar",...: 1 1 1 1 1 1 1 1 1 ...
## $ ms : num -51.7 -40.2 -75.3 -27.7 -18.4 ...
```

```
## $ beatL      : int  13 14 7 2 15 5 4 13 7 7 ...
```

```
print(p3)
```



Calculate simple t-statistics for the instrument pairs.

```
T <- data.frame(onsetsynch_by_pair_stats(dn))
```

```
## No id variables; using all as measure variables
```

```
print(T)
```

```
##          tval          pval
## 1 -20.236730 1.394008e-76
## 2  -4.494225 7.798707e-06
## 3  14.534338 1.467087e-43
```

## Other visualisations

Visualise asynchronies against another variable, for instance, tempo.

```
d1 <- onsetsynch_sample_paired(asere, 'Clave', 'Bass', 200, 1, 'Tempo')
g1 <- onsetsynch_by_X_plot(d1, meta = 'Clave-Bass', xlab='Tempo (BPM)')
print(g1)
```

