Complete FBR example

Sebastiaan Remmers

2017-06-20

The basic

An example of the use and addition of this package. Imagine, we have fMRI data and we want to study an advanced method based on beta-series (for example brain connectivity). This package can read nifti files, thanks to the package arf3DS4 with function readData, and uses the FBR method based on beta-series.

First, we set the working directory (not shown) and read the data. Note that this example is based on pre-processed data and is based on the directory of FSL.

Read the data

```
library(FBRbeta)
```

```
## Loading required package: arf3DS4
```

```
## Loading required package: tcltk
```

```
## Loading required package: corpcor
```

```
##
## Attaching package: 'arf3DS4'
```

```
## The following object is masked from 'package:stats':
##
##     BIC
```

```
## Loading required package: MASS
```

```
## Loading required package: Matrix
```

```
dat = readData("filtered_func_data.nii")
```

We also need the timings. These timings are obtained in the same *.feat file, as the data. For this study, we used a custum three-column file, but only the first column is of interest (the second represents the duration). The study consisted of two conditions, but we will elaborate on one condition

```
time = read.table(file = "custom_timing_files/ev1.txt")
time
```

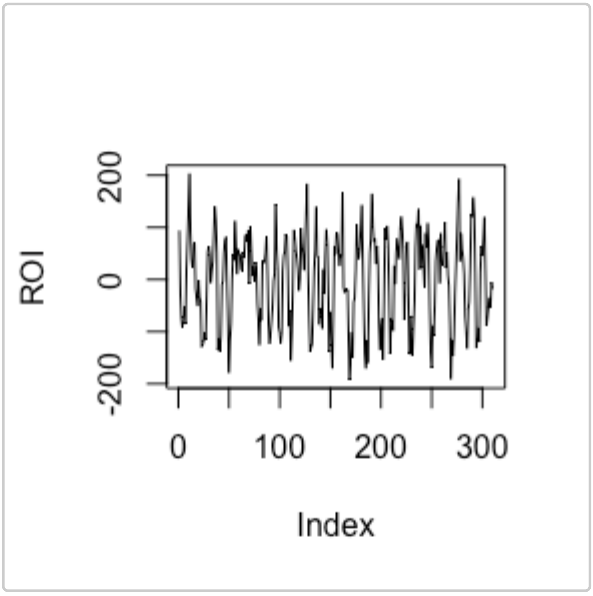
```
##      V1 V2 V3
## 1    22  8  1
## 2    62  8  1
## 3    82  8  1
## 4   112  8  1
## 5   132  8  1
## 6   162  8  1
## 7   202  8  1
## 8   222  8  1
## 9   242  8  1
## 10 262  8  1
## 11 312  8  1
## 12 352  8  1
## 13 372  8  1
## 14 402  8  1
## 15 432  8  1
## 16 462  8  1
## 17 482  8  1
## 18 512  8  1
## 19 542  8  1
## 20 572  8  1
```

Based on the brain activation, it is possible to select several voxels. These voxels represent region of interest (ROI). For the most accurate estimates, we demeaned the BOLD. Voxels can be extracted with . For example, a voxel in voxel-space x, y, z, can be extraced in the code dat[x, y, z,].

The following 4 voxels lead to the ROI, which is presented as follows.

```
ROI = ((dat[50, 32, 15,] - mean(dat[50, 32, 15, ]) + dat[51, 32, 15,] -
      mean(dat[51, 32, 15,]) + dat[52, 32, 15,] - mean(dat[52, 32, 15,]) +
      dat[53, 32, 15,] - mean(dat[53, 32, 15,])) /4)

plot(ROI, type = "l")
```



We know that the inter-trial time (the time between 2 successive trials) is 20 seconds, and the TR is equal to 2. To fill 20 seconds, we use 5 boxes, of length 4. Other options are also a possibility, for example, 20 boxes of length 1.

With this data, we can have the following datamatrix, which shall be called boxtimings. For the first timing, we will have the following designmatrix.

```
boxtimings <- designmatrix(ROI = ROI, timings = time[, 1], nbox = 5, lenbox = 4, TR
= 2)
boxtimings$timing1
```

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
##  [1,]    0    0    0    0    0    0    0    0    0     0
##  [2,]    0    0    0    0    0    0    0    0    0     0
##  [3,]    0    0    0    0    0    0    0    0    0     0
##  [4,]    0    0    0    0    0    0    0    0    0     0
##  [5,]    0    0    0    0    0    0    0    0    0     0
##  [6,]    0    0    0    0    0    0    0    0    0     0
##  [7,]    0    0    0    0    0    0    0    0    0     0
##  [8,]    0    0    0    0    0    0    0    0    0     0
##  [9,]    0    0    0    0    0    0    0    0    0     0
## [10,]    0    0    0    0    0    0    0    0    0     0
## [11,]    1    0    0    0    0    0    0    0    0     0
## [12,]    1    0    0    0    0    0    0    0    0     0
## [13,]    0    1    0    0    0    0    0    0    0     0
## [14,]    0    1    0    0    0    0    0    0    0     0
## [15,]    0    0    1    0    0    0    0    0    0     0
## [16,]    0    0    1    0    0    0    0    0    0     0
## [17,]    0    0    0    1    0    0    0    0    0     0
## [18,]    0    0    0    1    0    0    0    0    0     0
## [19,]    0    0    0    0    1    0    0    0    0     0
## [20,]    0    0    0    0    1    0    0    0    0     0
## [21,]    0    0    0    0    0    0    0    0    0     0
## [22,]    0    0    0    0    0    0    0    0    0     0
## [23,]    0    0    0    0    0    0    0    0    0     0
##  [24,]    0    0    0    0    0    0    0    0    0     0
##  [25,]    0    0    0    0    0    0    0    0    0     0
##  [26,]    0    0    0    0    0    0    0    0    0     0
##  [27,]    0    0    0    0    0    0    0    0    0     0
##  [28,]    0    0    0    0    0    0    0    0    0     0
##  [29,]    0    0    0    0    0    0    0    0    0     0
##  [30,]    0    0    0    0    0    0    0    0    0     0
##  [31,]    0    0    0    0    0    1    0    0    0     0
##  [32,]    0    0    0    0    0    1    0    0    0     0
##  [33,]    0    0    0    0    0    0    1    0    0     0
##  [34,]    0    0    0    0    0    0    1    0    0     0
##  [35,]    0    0    0    0    0    0    0    1    0     0
##  [36,]    0    0    0    0    0    0    0    1    0     0
##  [37,]    0    0    0    0    0    0    0    0    1     0
##  [38,]    0    0    0    0    0    0    0    0    1     0
##  [39,]    0    0    0    0    0    0    0    0    0     1
##  [40,]    0    0    0    0    0    0    0    0    0     1
##  [41,]    0    0    0    0    0    1    0    0    0     0
##  [42,]    0    0    0    0    0    1    0    0    0     0
##  [43,]    0    0    0    0    0    0    1    0    0     0
##  [44,]    0    0    0    0    0    0    1    0    0     0
##  [45,]    0    0    0    0    0    0    0    1    0     0
##  [46,]    0    0    0    0    0    0    0    1    0     0
##  [47,]    0    0    0    0    0    0    0    0    1     0
##  [48,]    0    0    0    0    0    0    0    0    1     0
##  [49,]    0    0    0    0    0    0    0    0    0     1
##  [50,]    0    0    0    0    0    0    0    0    0     1
##  [51,]    0    0    0    0    0    0    0    0    0     0
##  [52,]    0    0    0    0    0    0    0    0    0     0
##  [53,]    0    0    0    0    0    0    0    0    0     0
##  [54,]    0    0    0    0    0    0    0    0    0     0
##  [55,]    0    0    0    0    0    0    0    0    0     0
##  [56,]    0    0    0    0    0    1    0    0    0     0
##  [57,]    0    0    0    0    0    1    0    0    0     0
##  [58,]    0    0    0    0    0    0    1    0    0     0
##  [59,]    0    0    0    0    0    0    1    0    0     0
##  [60,]    0    0    0    0    0    0    0    1    0     0
##  [61,]    0    0    0    0    0    0    0    1    0     0
##  [62,]    0    0    0    0    0    0    0    0    1     0
##  [63,]    0    0    0    0    0    0    0    0    1     0
##  [64,]    0    0    0    0    0    0    0    0    0     1
##  [65,]    0    0    0    0    0    0    0    0    0     1
##  [66,]    0    0    0    0    0    1    0    0    0     0
##  [67,]    0    0    0    0    0    1    0    0    0     0
##  [68,]    0    0    0    0    0    0    1    0    0     0
##  [69,]    0    0    0    0    0    0    1    0    0     0
##  [70,]    0    0    0    0    0    0    0    1    0     0
##  [71,]    0    0    0    0    0    0    0    1    0     0
##  [72,]    0    0    0    0    0    0    0    0    1     0
##  [73,]    0    0    0    0    0    0    0    0    1     0
##  [74,]    0    0    0    0    0    0    0    0    0     1
##  [75,]    0    0    0    0    0    0    0    0    0     1
##  [76,]    0    0    0    0    0    0    0    0    0     0
##  [77,]    0    0    0    0    0    0    0    0    0     0
##  [78,]    0    0    0    0    0    0    0    0    0     0
##  [79,]    0    0    0    0    0    0    0    0    0     0
##  [80,]    0    0    0    0    0    0    0    0    0     0
##  [81,]    0    0    0    0    0    1    0    0    0     0
##  [82,]    0    0    0    0    0    1    0    0    0     0
##  [83,]    0    0    0    0    0    0    1    0    0     0
##  [84,]    0    0    0    0    0    0    1    0    0     0
##  [85,]    0    0    0    0    0    0    0    1    0     0
##  [86,]    0    0    0    0    0    0    0    1    0     0
##  [87,]    0    0    0    0    0    0    0    0    1     0
##  [88,]    0    0    0    0    0    0    0    0    1     0
##  [89,]    0    0    0    0    0    0    0    0    0     1
##  [90,]    0    0    0    0    0    0    0    0    0     1
##  [91,]    0    0    0    0    0    0    0    0    0     0
##  [92,]    0    0    0    0    0    0    0    0    0     0
##  [93,]    0    0    0    0    0    0    0    0    0     0
##  [94,]    0    0    0    0    0    0    0    0    0     0
##  [95,]    0    0    0    0    0    0    0    0    0     0
##  [96,]    0    0    0    0    0    0    0    0    0     0
##  [97,]    0    0    0    0    0    0    0    0    0     0
##  [98,]    0    0    0    0    0    0    0    0    0     0
##  [99,]    0    0    0    0    0    0    0    0    0     0
## [100,]    0    0    0    0    0    0    0    0    0     0
## [101,]    0    0    0    0    0    1    0    0    0     0
## [102,]    0    0    0    0    0    1    0    0    0     0
## [103,]    0    0    0    0    0    0    1    0    0     0
## [104,]    0    0    0    0    0    0    1    0    0     0
## [105,]    0    0    0    0    0    0    0    1    0     0
## [106,]    0    0    0    0    0    0    0    1    0     0
## [107,]    0    0    0    0    0    0    0    0    1     0
## [108,]    0    0    0    0    0    0    0    0    1     0
## [109,]    0    0    0    0    0    0    0    0    0     1
## [110,]    0    0    0    0    0    0    0    0    0     1
## [111,]    0    0    0    0    0    1    0    0    0     0
## [112,]    0    0    0    0    0    1    0    0    0     0
## [113,]    0    0    0    0    0    0    1    0    0     0
## [114,]    0    0    0    0    0    0    1    0    0     0
## [115,]    0    0    0    0    0    0    0    1    0     0
## [116,]    0    0    0    0    0    0    0    1    0     0
## [117,]    0    0    0    0    0    0    0    0    1     0
## [118,]    0    0    0    0    0    0    0    0    1     0
## [119,]    0    0    0    0    0    0    0    0    0     1
## [120,]    0    0    0    0    0    0    0    0    0     1
## [121,]    0    0    0    0    0    1    0    0    0     0
## [122,]    0    0    0    0    0    1    0    0    0     0
## [123,]    0    0    0    0    0    0    1    0    0     0
## [124,]    0    0    0    0    0    0    1    0    0     0
## [125,]    0    0    0    0    0    0    0    1    0     0
## [126,]    0    0    0    0    0    0    0    1    0     0
## [127,]    0    0    0    0    0    0    0    0    1     0
## [128,]    0    0    0    0    0    0    0    0    1     0
## [129,]    0    0    0    0    0    0    0    0    0     1
## [130,]    0    0    0    0    0    0    0    0    0     1
## [131,]    0    0    0    0    0    1    0    0    0     0
## [132,]    0    0    0    0    0    1    0    0    0     0
## [133,]    0    0    0    0    0    0    1    0    0     0
## [134,]    0    0    0    0    0    0    1    0    0     0
## [135,]    0    0    0    0    0    0    0    1    0     0
## [136,]    0    0    0    0    0    0    0    1    0     0
## [137,]    0    0    0    0    0    0    0    0    1     0
## [138,]    0    0    0    0    0    0    0    0    1     0
## [139,]    0    0    0    0    0    0    0    0    0     1
## [140,]    0    0    0    0    0    0    0    0    0     1
## [141,]    0    0    0    0    0    0    0    0    0     0
## [142,]    0    0    0    0    0    0    0    0    0     0
## [143,]    0    0    0    0    0    0    0    0    0     0
## [144,]    0    0    0    0    0    0    0    0    0     0
## [145,]    0    0    0    0    0    0    0    0    0     0
## [146,]    0    0    0    0    0    0    0    0    0     0
## [147,]    0    0    0    0    0    0    0    0    0     0
## [148,]    0    0    0    0    0    0    0    0    0     0
## [149,]    0    0    0    0    0    0    0    0    0     0
## [150,]    0    0    0    0    0    0    0    0    0     0
## [151,]    0    0    0    0    0    0    0    0    0     0
## [152,]    0    0    0    0    0    0    0    0    0     0
## [153,]    0    0    0    0    0    0    0    0    0     0
## [154,]    0    0    0    0    0    0    0    0    0     0
## [155,]    0    0    0    0    0    0    0    0    0     0
## [156,]    0    0    0    0    0    1    0    0    0     0
## [157,]    0    0    0    0    0    1    0    0    0     0
## [158,]    0    0    0    0    0    0    1    0    0     0
## [159,]    0    0    0    0    0    0    1    0    0     0
## [160,]    0    0    0    0    0    0    0    1    0     0
## [161,]    0    0    0    0    0    0    0    1    0     0
## [162,]    0    0    0    0    0    0    0    0    1     0
## [163,]    0    0    0    0    0    0    0    0    1     0
## [164,]    0    0    0    0    0    0    0    0    0     1
## [165,]    0    0    0    0    0    0    0    0    0     1
## [166,]    0    0    0    0    0    0    0    0    0     0
## [167,]    0    0    0    0    0    0    0    0    0     0
## [168,]    0    0    0    0    0    0    0    0    0     0
## [169,]    0    0    0    0    0    0    0    0    0     0
## [170,]    0    0    0    0    0    0    0    0    0     0
## [171,]    0    0    0    0    0    0    0    0    0     0
## [172,]    0    0    0    0    0    0    0    0    0     0
## [173,]    0    0    0    0    0    0    0    0    0     0
## [174,]    0    0    0    0    0    0    0    0    0     0
## [175,]    0    0    0    0    0    0    0    0    0     0
## [176,]    0    0    0    0    0    1    0    0    0     0
## [177,]    0    0    0    0    0    1    0    0    0     0
## [178,]    0    0    0    0    0    0    1    0    0     0
## [179,]    0    0    0    0    0    0    1    0    0     0
## [180,]    0    0    0    0    0    0    0    1    0     0
## [181,]    0    0    0    0    0    0    0    1    0     0
## [182,]    0    0    0    0    0    0    0    0    1     0
## [183,]    0    0    0    0    0    0    0    0    1     0
## [184,]    0    0    0    0    0    0    0    0    0     1
## [185,]    0    0    0    0    0    0    0    0    0     1
## [186,]    0    0    0    0    0    1    0    0    0     0
## [187,]    0    0    0    0    0    1    0    0    0     0
## [188,]    0    0    0    0    0    0    1    0    0     0
## [189,]    0    0    0    0    0    0    1    0    0     0
## [190,]    0    0    0    0    0    0    0    1    0     0
## [191,]    0    0    0    0    0    0    0    1    0     0
## [192,]    0    0    0    0    0    0    0    0    1     0
## [193,]    0    0    0    0    0    0    0    0    1     0
## [194,]    0    0    0    0    0    0    0    0    0     1
## [195,]    0    0    0    0    0    0    0    0    0     1
## [196,]    0    0    0    0    0    0    0    0    0     0
## [197,]    0    0    0    0    0    0    0    0    0     0
## [198,]    0    0    0    0    0    0    0    0    0     0
## [199,]    0    0    0    0    0    0    0    0    0     0
## [200,]    0    0    0    0    0    0    0    0    0     0
## [201,]    0    0    0    0    0    1    0    0    0     0
## [202,]    0    0    0    0    0    1    0    0    0     0
## [203,]    0    0    0    0    0    0    1    0    0     0
## [204,]    0    0    0    0    0    0    1    0    0     0
## [205,]    0    0    0    0    0    0    0    1    0     0
## [206,]    0    0    0    0    0    0    0    1    0     0
## [207,]    0    0    0    0    0    0    0    0    1     0
## [208,]    0    0    0    0    0    0    0    0    1     0
## [209,]    0    0    0    0    0    0    0    0    0     1
## [210,]    0    0    0    0    0    0    0    0    0     1
## [211,]    0    0    0    0    0    0    0    0    0     0
## [212,]    0    0    0    0    0    0    0    0    0     0
## [213,]    0    0    0    0    0    0    0    0    0     0
## [214,]    0    0    0    0    0    0    0    0    0     0
## [215,]    0    0    0    0    0    0    0    0    0     0
## [216,]    0    0    0    0    0    1    0    0    0     0
## [217,]    0    0    0    0    0    1    0    0    0     0
## [218,]    0    0    0    0    0    0    1    0    0     0
## [219,]    0    0    0    0    0    0    1    0    0     0
## [220,]    0    0    0    0    0    0    0    1    0     0
## [221,]    0    0    0    0    0    0    0    1    0     0
## [222,]    0    0    0    0    0    0    0    0    1     0
## [223,]    0    0    0    0    0    0    0    0    1     0
## [224,]    0    0    0    0    0    0    0    0    0     1
## [225,]    0    0    0    0    0    0    0    0    0     1
## [226,]    0    0    0    0    0    0    0    0    0     0
## [227,]    0    0    0    0    0    0    0    0    0     0
## [228,]    0    0    0    0    0    0    0    0    0     0
## [229,]    0    0    0    0    0    0    0    0    0     0
## [230,]    0    0    0    0    0    0    0    0    0     0
## [231,]    0    0    0    0    0    1    0    0    0     0
## [232,]    0    0    0    0    0    1    0    0    0     0
## [233,]    0    0    0    0    0    0    1    0    0     0
## [234,]    0    0    0    0    0    0    1    0    0     0
## [235,]    0    0    0    0    0    0    0    1    0     0
## [236,]    0    0    0    0    0    0    0    1    0     0
## [237,]    0    0    0    0    0    0    0    0    1     0
## [238,]    0    0    0    0    0    0    0    0    1     0
## [239,]    0    0    0    0    0    0    0    0    0     1
## [240,]    0    0    0    0    0    0    0    0    0     1
## [241,]    0    0    0    0    0    1    0    0    0     0
## [242,]    0    0    0    0    0    1    0    0    0     0
## [243,]    0    0    0    0    0    0    1    0    0     0
## [244,]    0    0    0    0    0    0    1    0    0     0
## [245,]    0    0    0    0    0    0    0    1    0     0
## [246,]    0    0    0    0    0    0    0    1    0     0
## [247,]    0    0    0    0    0    0    0    0    1     0
## [248,]    0    0    0    0    0    0    0    0    1     0
## [249,]    0    0    0    0    0    0    0    0    0     1
## [250,]    0    0    0    0    0    0    0    0    0     1
## [251,]    0    0    0    0    0    0    0    0    0     0
## [252,]    0    0    0    0    0    0    0    0    0     0
## [253,]    0    0    0    0    0    0    0    0    0     0
## [254,]    0    0    0    0    0    0    0    0    0     0
## [255,]    0    0    0    0    0    0    0    0    0     0
## [256,]    0    0    0    0    0    1    0    0    0     0
## [257,]    0    0    0    0    0    1    0    0    0     0
## [258,]    0    0    0    0    0    0    1    0    0     0
## [259,]    0    0    0    0    0    0    1    0    0     0
## [260,]    0    0    0    0    0    0    0    1    0     0
## [261,]    0    0    0    0    0    0    0    1    0     0
## [262,]    0    0    0    0    0    0    0    0    1     0
## [263,]    0    0    0    0    0    0    0    0    1     0
## [264,]    0    0    0    0    0    0    0    0    0     1
## [265,]    0    0    0    0    0    0    0    0    0     1
## [266,]    0    0    0    0    0    0    0    0    0     0
## [267,]    0    0    0    0    0    0    0    0    0     0
## [268,]    0    0    0    0    0    0    0    0    0     0
## [269,]    0    0    0    0    0    0    0    0    0     0
## [270,]    0    0    0    0    0    0    0    0    0     0
## [271,]    0    0    0    0    0    1    0    0    0     0
## [272,]    0    0    0    0    0    1    0    0    0     0
## [273,]    0    0    0    0    0    0    1    0    0     0
## [274,]    0    0    0    0    0    0    1    0    0     0
## [275,]    0    0    0    0    0    0    0    1    0     0
## [276,]    0    0    0    0    0    0    0    1    0     0
## [277,]    0    0    0    0    0    0    0    0    1     0
## [278,]    0    0    0    0    0    0    0    0    1     0
## [279,]    0    0    0    0    0    0    0    0    0     1
## [280,]    0    0    0    0    0    0    0    0    0     1
## [281,]    0    0    0    0    0    0    0    0    0     0
## [282,]    0    0    0    0    0    0    0    0    0     0
## [283,]    0    0    0    0    0    0    0    0    0     0
## [284,]    0    0    0    0    0    0    0    0    0     0
## [285,]    0    0    0    0    0    0    0    0    0     0
## [286,]    0    0    0    0    0    1    0    0    0     0
## [287,]    0    0    0    0    0    1    0    0    0     0
## [288,]    0    0    0    0    0    0    1    0    0     0
## [289,]    0    0    0    0    0    0    1    0    0     0
## [290,]    0    0    0    0    0    0    0    1    0     0
## [291,]    0    0    0    0    0    0    0    1    0     0
## [292,]    0    0    0    0    0    0    0    0    1     0
## [293,]    0    0    0    0    0    0    0    0    1     0
## [294,]    0    0    0    0    0    0    0    0    0     1
## [295,]    0    0    0    0    0    0    0    0    0     1
## [296,]    0    0    0    0    0    0    0    0    0     0
## [297,]    0    0    0    0    0    0    0    0    0     0
## [298,]    0    0    0    0    0    0    0    0    0     0
## [299,]    0    0    0    0    0    0    0    0    0     0
## [300,]    0    0    0    0    0    0    0    0    0     0
## [301,]    0    0    0    0    0    0    0    0    0     0
## [302,]    0    0    0    0    0    0    0    0    0     0
## [303,]    0    0    0    0    0    0    0    0    0     0
## [304,]    0    0    0    0    0    0    0    0    0     0
## [305,]    0    0    0    0    0    0    0    0    0     0
## [306,]    0    0    0    0    0    0    0    0    0     0
## [307,]    0    0    0    0    0    0    0    0    0     0
## [308,]    0    0    0    0    0    0    0    0    0     0
## [309,]    0    0    0    0    0    0    0    0    0     0
## [310,]    0    0    0    0    0    0    0    0    0     0
```

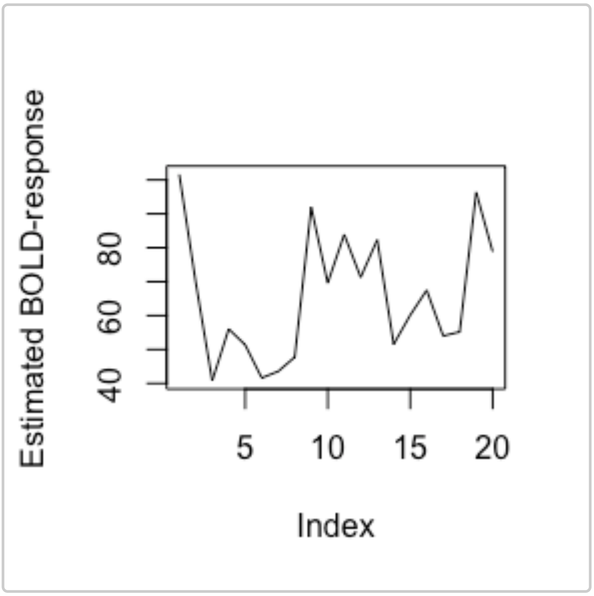
Finally, we want to use those boxtimings to calculate the maximum beta-value of every HRF.

```
nbox = 5
lenbox = 4
fbrbetafunc(dat, boxtimings, ROI, timings = time[, 1], nbox, lenbox, TR = 2,
maximum = T )
```

```
##              [,1]
##  [1,] 146.75464
##  [2,] 113.48340
##  [3,]  62.60718
##  [4,]  86.01172
##  [5,]  84.99573
##  [6,]  46.04004
##  [7,]  70.33166
##  [8,]  66.46326
##  [9,] 100.19324
## [10,]  97.90906
## [11,]  88.33496
## [12,] 116.97913
## [13,] 121.57288
## [14,]  90.30762
## [15,] 108.10266
## [16,] 104.85059
## [17,]  85.01379
## [18,]  86.12671
## [19,] 115.74524
## [20,] 139.31470
```

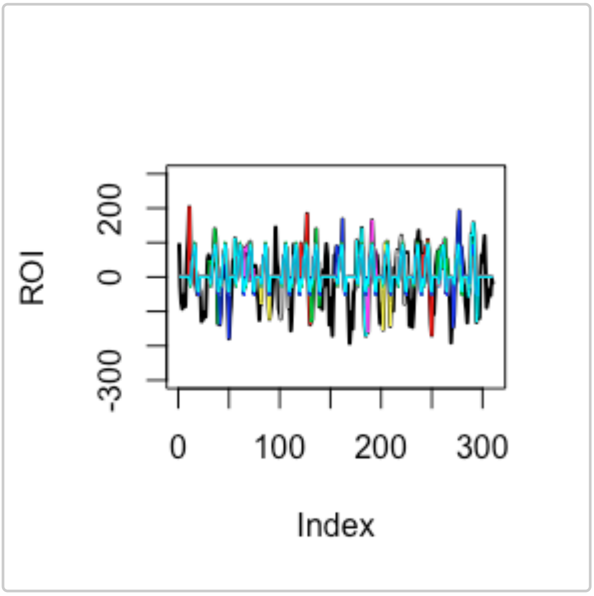
It is also possible to estimate the BOLD with the FBR. For a more accurate estimation, we will use 20 boxes, with length 1. So, we need a total of 20 designmatrix (for every timing one).

```
nbox = 20
lenbox = 1
boxtimings <- designmatrix(ROI = ROI, timings = time[, 1], nbox = nbox, lenbox =
lenbox, TR = 2)
plot(main.interest(boxtimings, ROI = ROI, maximum = T, nbox = nbox), type = "l",
ylab = "Estimated BOLD-response")
```



To fully understand the model, it is possible to show every maximum beta-value for every designmatrix.

```
plot(ROI, type = "l", lwd = 2, ylim = c(-300, 300))
for (i in 1:length(boxtimings)) {
  lines(boxtimings[[i]] %*% betafunc(boxtimings[[i]], ROI),col=(i + 1))
}
```



Advanced: Connectivity

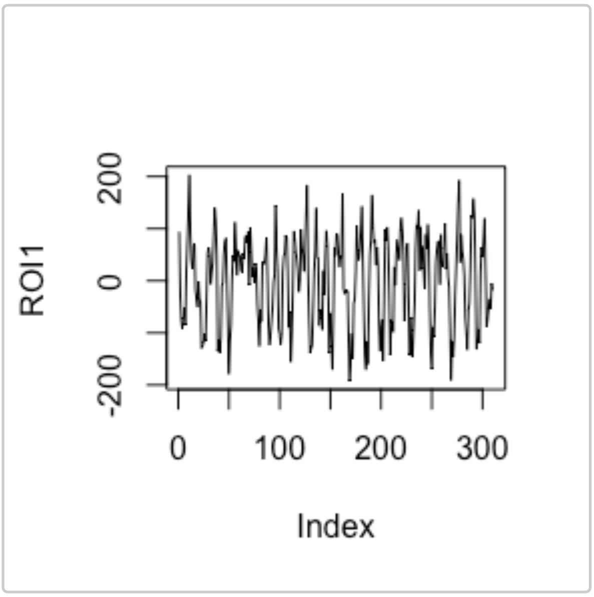
Functional connectivity is a measurement of how two brain areas/regions correlated with each other. This package can also be used to do this. To do a connectivity analysis, we need to correlate the beta-series of two region.

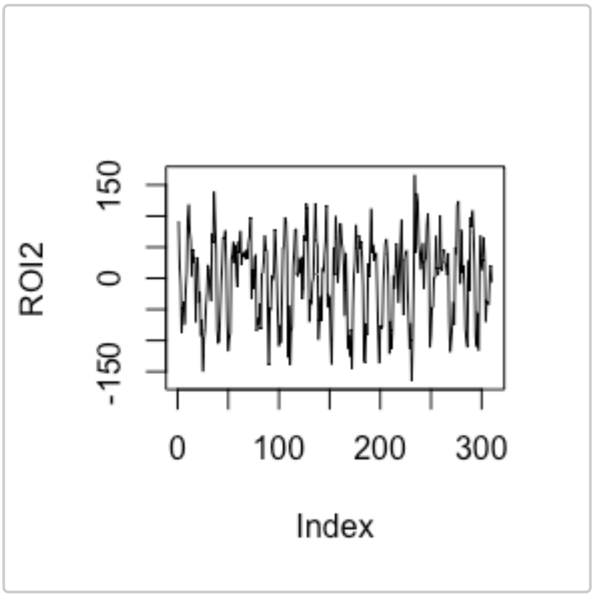
For example, We have the following demeaned temporal areas,

```
ROI1 = ((dat[50, 32, 15, ] - mean(dat[50, 32, 15, ]) + dat[51, 32, 15, ] -
       mean(dat[51, 32, 15,]) + dat[52, 32, 15,] - mean(dat[52, 32, 15,]) +
       dat[53, 32, 15,] - mean(dat[53,32,15,])) / 4)
ROI2 = ((dat[17, 32, 14, ] - mean(dat[17, 32, 14, ]) + dat[17, 33, 14, ] -
       mean(dat[17, 33, 14, ]) + dat[17, 34, 14, ] - mean(dat[17, 34, 14, ]) +
       dat[17, 35, 14, ] - mean(dat[17, 35, 14, ])+ dat[17, 32, 13, ] -
       mean(dat[17, 32, 13, ]) + dat[17, 33, 13, ]- mean(dat[17, 33, 13, ]) +
       dat[17, 34, 13, ] - mean(dat[17, 34, 13, ]) + dat[17, 35, 13, ] -
       mean(dat[17, 35, 13, ])) / 8)
```

which is visually presented as,

```
plot(ROI1, type = "l")
plot(ROI2, type = "l")
```





Since the FBR is a flexible method, we chose to have 2 boxes, of length 10. The data (the “filtered_func_data.nii”-file) and the timings are the same, so no adaptation is required.

```
nbox = 2
lenbox = 10

boxtimings1 <- designmatrix(ROI = ROI1, timings = time[, 1], nbox = nbox,
                            lenbox = lenbox, TR = 2)
boxtimings2 <- designmatrix(ROI = ROI2, timings = time[, 1], nbox = nbox,
                            lenbox = lenbox, TR = 2)

cor(main.interest(boxtimings1, ROI = ROI1, maximum = T, nbox = nbox),
    main.interest(boxtimings2, ROI = ROI2, maximum = T, nbox = nbox))
```

```
##            [,1]
## [1,] 0.8776699
```

So, we have a correlation of .88 between these 2 regions.

The general function

In previous 2 sections, we analysed the data step by step. However, this package includes a general function, which is the combination of the previous steps. We will elaborate on this general function with one argument per line.

```
region1 <- fbrbetafunc(dat = readData("filtered_func_data.nii"),
            ROI = ((dat[50, 32, 15, ] - mean(dat[50, 32, 15, ]) + dat[51, 32, 15, ]
                  - mean(dat[51, 32, 15, ]) + dat[52, 32, 15, ] -
                  mean(dat[52, 32, 15, ]) + dat[53, 32, 15,] -
                  mean(dat[53, 32, 15, ])) / 4),
            boxtimings = designmatrix(ROI = ROI1, timings = time[, 1], nbox = 5,
                         lenbox = 4, TR = 2),
            timings = time[, 1],
            nbox = 5,
            lenbox = 4,
            TR = 2,
            maximum = T)
beta1 <- main.interest(region1, ROI = ROI,  maximum  = T, nbox = nbox)

region2 <- fbrbetafunc(dat = readData("filtered_func_data.nii"),
             ROI = ((dat[17, 32, 14, ] - mean(dat[17, 32, 14, ]) + dat[17, 33, 14,
]
                   - mean(dat[17, 33, 14,  ]) + dat[17, 34, 14, ] -
                   mean(dat[17, 34, 14, ]) +dat[17, 35, 14, ] -
                   mean(dat[17, 35, 14,  ]) + dat[17, 32, 13, ] -
                   mean(dat[17, 32, 13, ]) + dat[17, 33, 13, ] -
                   mean(dat[17, 33, 13, ]) + dat[17, 34, 13, ] -
                   mean(dat[17, 34, 13, ]) + dat[17, 35, 13, ] -
                   mean(dat[17, 35, 13, ])) / 8),
             boxtimings = designmatrix(ROI = ROI2, timings = time[, 1], nbox = 5,
                          lenbox = 4, TR = 2),
             timings = time[, 1],
             nbox = 5,
             lenbox = 4,
             TR = 2,
             maximum = T)
beta2 <- main.interest(region2, ROI = ROI2,  maximum  = T, nbox = nbox)

cor(beta1, beta2)


##           [,1]
## [1,] 0.6709698
```