24july2020

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7/24/2020

1. progress summary

This week, as we discussed from last meeting, I have: - 1. selected the 1st complete sin curve of every node and align them to register at the origin. - 2. Scale the the time frame of each node to [-1,1] while time=0 remain unchanged. I also make sure that each node have the same number of rows so that fPCA will be able to apply. - 3. Apply fPCA to the new dataset of curves (1st cycle of each node), and the result is that the first two Principle Component functions covers 91.5% of total variance. - 4. repeat the process above for 2nd cycle of each node, and first two Principle component functions covered in total 93.7% of total variance.

2. read data and attach packages

3. Defined fourier smoothing functions

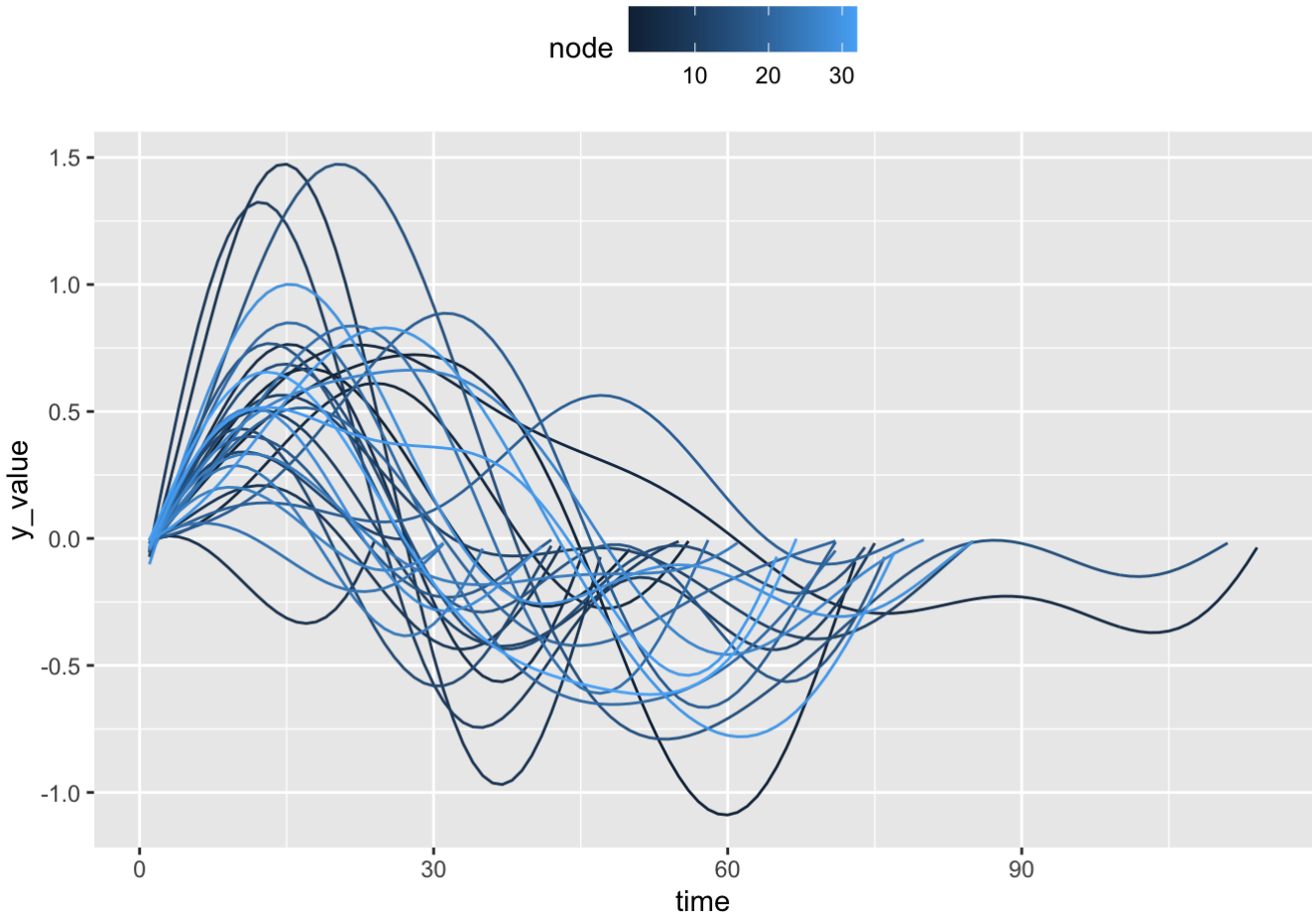
To study a single brain node response, specify the node number in the *node_subset* list.

```
f_fourier_smooth <- function(time_subset, data_mat, node_subset, k){
  basis <- create.fourier.basis(c(time_subset[1],time_subset[length(time_subset)]), k)
  fd_obj <- smooth.basis(time_subset, data_mat[time_subset,node_subset], basis)
  smoothfd <- fd_obj$fd
  #plot(smoothfd)
  #title(main=paste("Fourier Basis Smoothing of node:", node_subset, ", Basis_number:",k
))
  return(fd_obj)
}
```

4. define the function to extract periodic cycle of a single node response

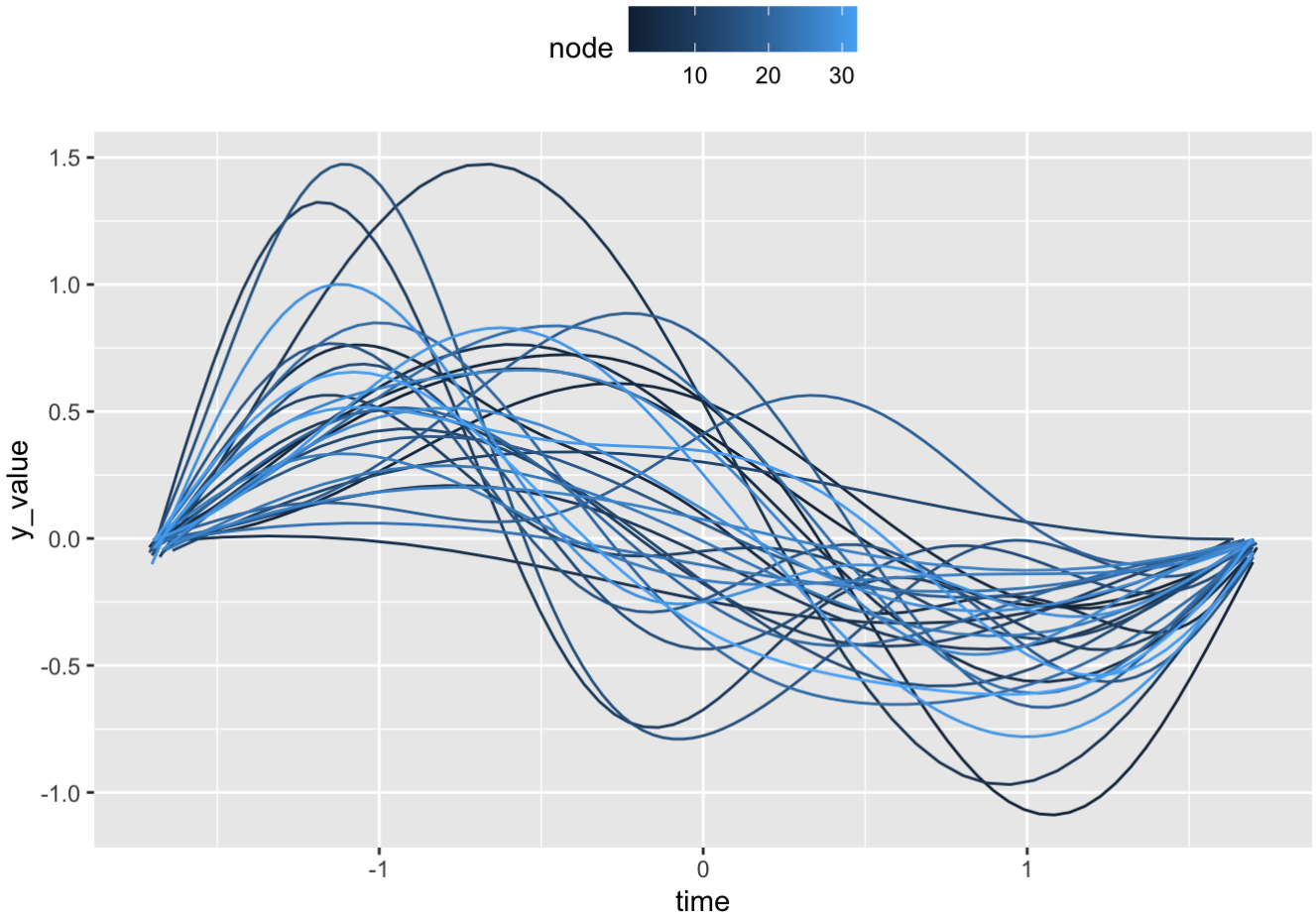
5.1 *1st* cycle across different node

```
df = data.frame(node=integer(),cycle=integer(), time=integer(), y_value=integer())
for(i in 1:32){
  result_obj <- f_fourier_smooth(time_subset=c(1:600), data_mat, node_subset=c(i), k=32)
  smoothed_curve = eval.fd(c(1:600),result_obj$fd)
  transformed_node = transform.Cycle(smoothed_curve, register=1)
  tmp = subset(transformed_node, cycle==1)
  tmp$node=i
  df=rbind(df,tmp)
}
ggplot(df, aes(time, y_value,group=node, colour=node)) + geom_line() + theme(legend.posi
tion="top")
```



5.2 Scale the timeframe of each node

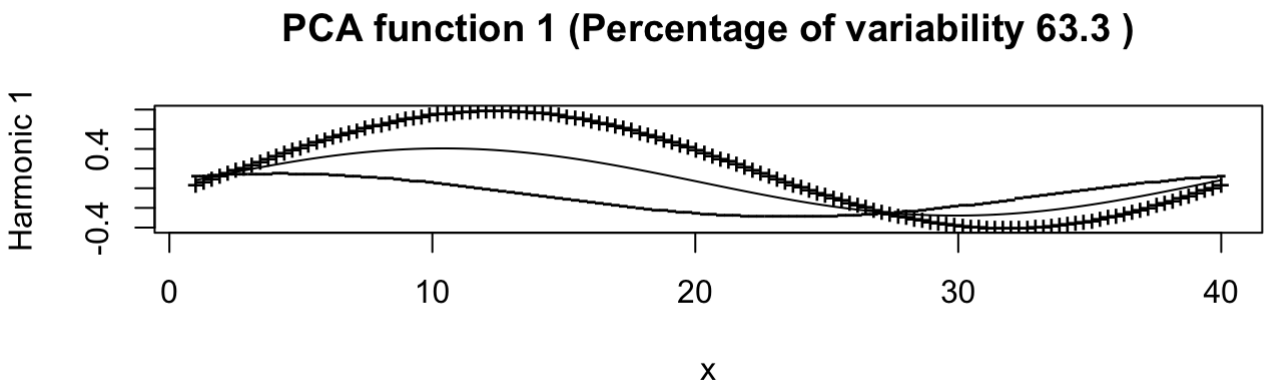
```
df_tmp = data.frame(node=integer(),cycle=integer(), time=integer(), y_value=integer())
for(i in 1:32){
  tmp=subset(df, node==i)
  tmp$time=scale(tmp$time)
  df_tmp=rbind(df_tmp,tmp)
}
ggplot(df_tmp, aes(time, y_value,group=node, colour=node)) + geom_line() + theme(legend.
position="top")
```

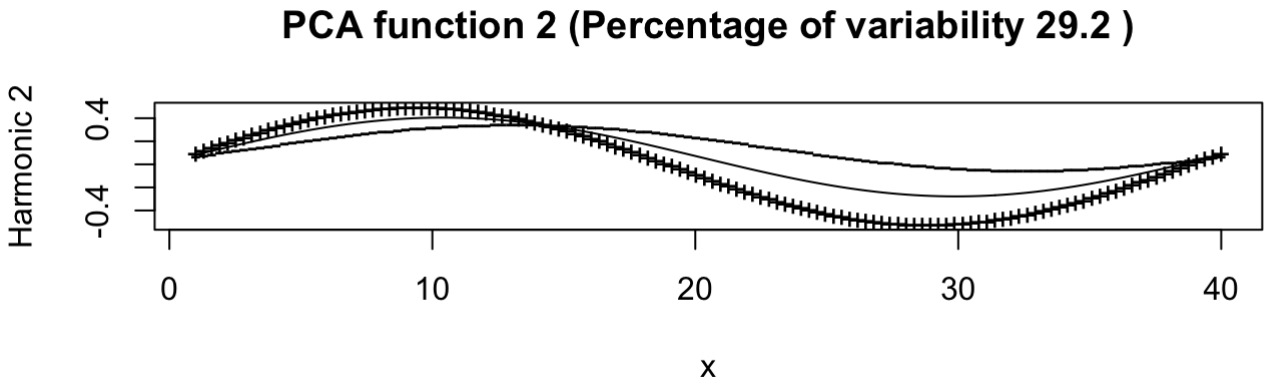


5.3 pivot the new dataframe

5.4 fPCA on new dataframe

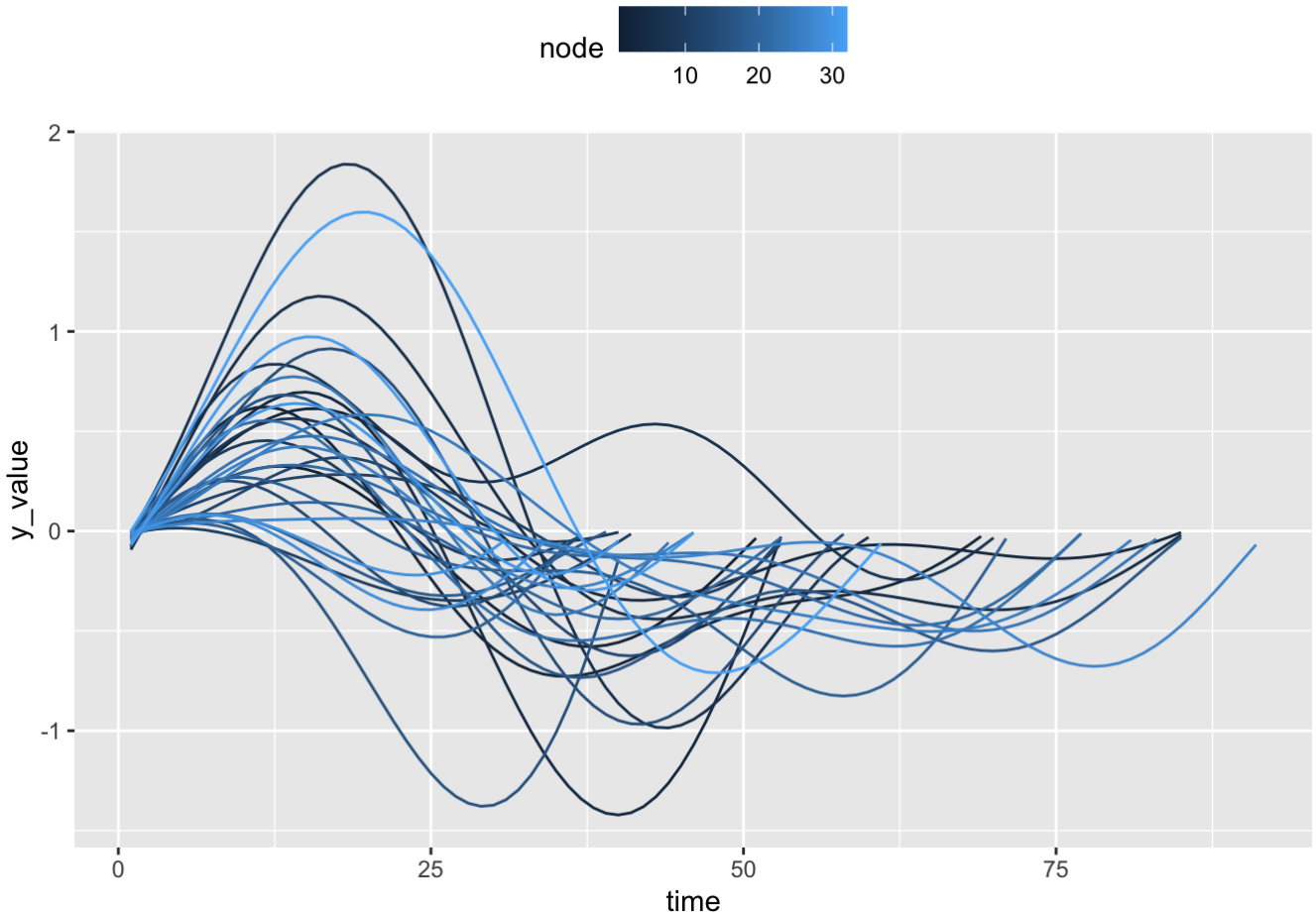
```
fPCA_subset <- function(time_subset, data_mat, node_subset, k, nharm){
basis <- create.fourier.basis(c(time_subset[1],time_subset[length(time_subset)]), k)
smoothfd <- smooth.basis(time_subset, data_mat[time_subset,node_subset], basis)$fd
#plot(smoothfd)
#title(main="smoothed curves")
pcalist = pca.fd(smoothfd, nharm, harmfdPar=fdPar(smoothfd))
rotpcalist = varmx.pca.fd(pcalist)
par(mfrow=c(nharm,1))
plot.pca.fd(rotpcalist)
return(rotpcalist)
}
df_new <- as.matrix(df_new)
rotpcalist = fPCA_subset(time_subset=c(1:40), df_new, node_subset = c(1:32)
                         , k=3, nharm=2)
```





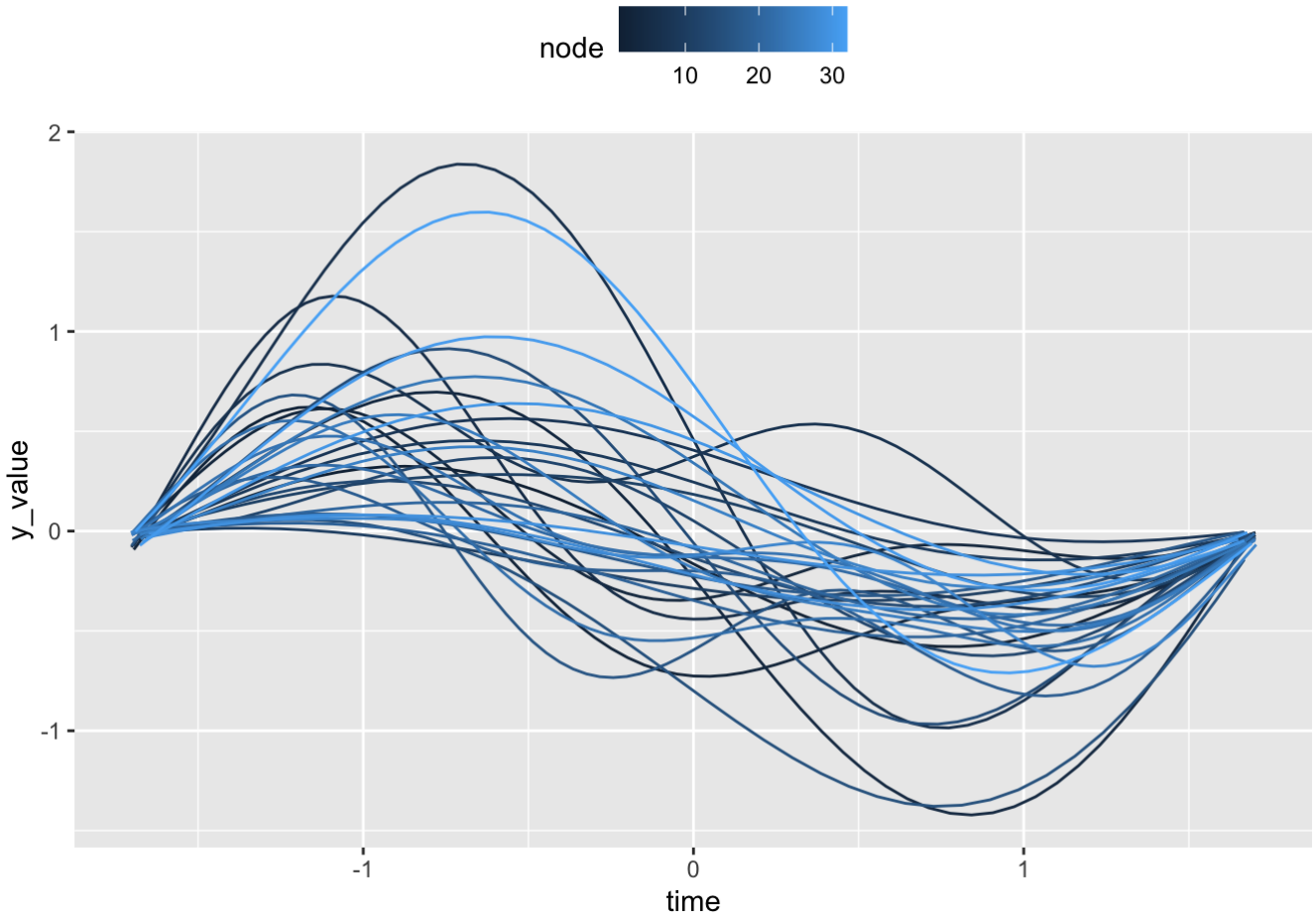
6.1 *2nd* cycle across different node

```
df = data.frame(node=integer(),cycle=integer(), time=integer(), y_value=integer())
for(i in 1:32){
  result_obj <- f_fourier_smooth(time_subset=c(1:600), data_mat, node_subset=c(i), k=32)
  smoothed_curve = eval.fd(c(1:600),result_obj$fd)
  transformed_node = transform.Cycle(smoothed_curve, register=1)
  tmp = subset(transformed_node, cycle==2)
  tmp$node=i
  df=rbind(df,tmp)
}
ggplot(df, aes(time, y_value,group=node, colour=node)) + geom_line() + theme(legend.posi
tion="top")
```



6.2 Scale the timeframe of each node

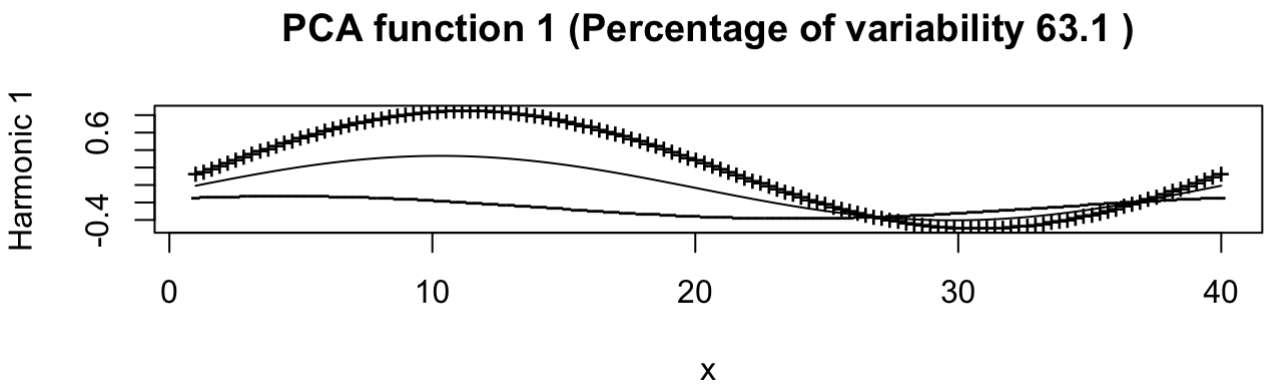
```
df_tmp = data.frame(node=integer(),cycle=integer(), time=integer(), y_value=integer())
for(i in 1:32){
  tmp=subset(df, node==i)
  tmp$time=scale(tmp$time)
  df_tmp=rbind(df_tmp,tmp)
}
ggplot(df_tmp, aes(time, y_value,group=node, colour=node)) + geom_line() + theme(legend.
position="top")
```

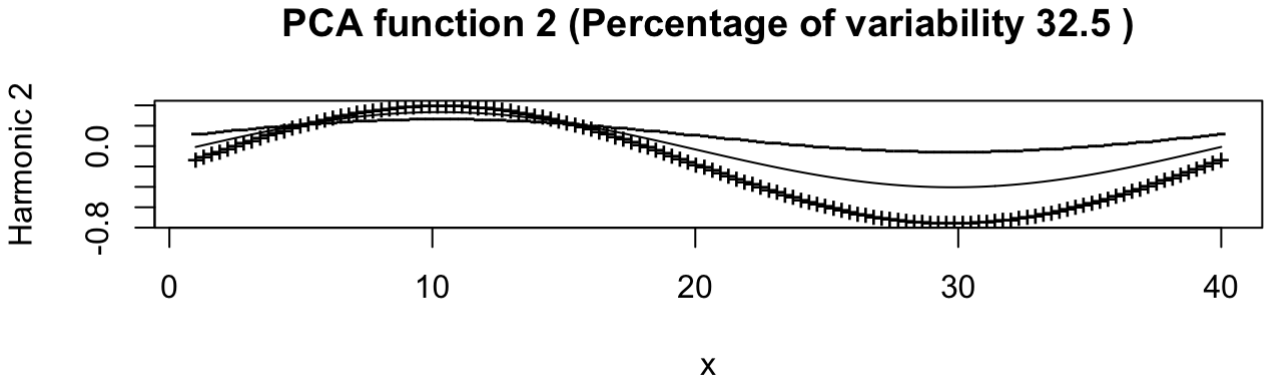


6.3 pivot the new dataframe

6.4 fPCA on new dataframe

```
fPCA_subset <- function(time_subset, data_mat, node_subset, k, nharm){
basis <- create.fourier.basis(c(time_subset[1],time_subset[length(time_subset)]), k)
smoothfd <- smooth.basis(time_subset, data_mat[time_subset,node_subset], basis)$fd
#plot(smoothfd)
#title(main="smoothed curves")
pcalist = pca.fd(smoothfd, nharm, harmfdPar=fdPar(smoothfd))
rotpcalist = varmx.pca.fd(pcalist)
par(mfrow=c(nharm,1))
plot.pca.fd(rotpcalist)
return(rotpcalist)
}
df_new <- as.matrix(df_new)
rotpcalist = fPCA_subset(time_subset=c(1:40), df_new, node_subset = c(1:32)
                         , k=3, nharm=2)
```


PCA function 1 (Percentage of variability 63.1)
Harmonic 1
-0.4
0.6
0
10
20
30
40
x


PCA function 2 (Percentage of variability 32.5)
Harmonic 2
-0.8
0.0
0
10
20
30
40
x