

Mapping for MT Project 1

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Maps

```
load("data/rejections.RData")
load("data/bikedata.RData")

# find source for geographical data (lat & long) regarding stations
locData <- read.csv("https://gist.githubusercontent.com/since1968/e51c0f3d95e67bf49f74/raw/37a6c381df111
colnames(stations) <- c("terminalName", "locations")

#take those with matching terminalName
newStations<-merge(x=stations, y=locData, by="terminalName", all.x=TRUE)
newStations<-newStations[, c("terminalName", "locations", "lat", "long")]
```

After the merge, some of the locations do not match (excluding those wherein the order of the street names were simply switched such as “Pentagon City Metro / 12th & S Hayes St” vs “12th & Hayes St / Pentagon City Metro”). For these pairs of locations that do not match at all, we resorted to verifying the latitude and longitude for the location listed in `stations`, a data object provided from the Group Project 1 instructions. Latitude and longitude for these locations were gathered from inputting location names into Google Maps.

The 5 terminals with different locations are: 31000, 31500, 31302, 31609, 31239

```
newStations[1,3] <- 38.85979; newStations[1,4] <- -77.05357
newStations[78,3] <- 38.90567; newStations[78,4] <- -77.04120
newStations[89,3] <- 38.93465; newStations[89,4] <- 77.07246
newStations[98,3] <- 38.91930; newStations[98,4] <- -77.00056
newStations[114,3] <- 38.87863; newStations[114,4] <- -77.02283
```

```
#routes = cbind(routes, route_rejects_standard, route_rejects_standard_inverse, route_rejects_storey, route_
sig_BH = sig_BH[(sig_BH$station_start != sig_BH$station_end),]
sig_BH_inverse = sig_BH_inverse[(sig_BH_inverse$station_start != sig_BH_inverse$station_end),]
sig_storeyBH = sig_storeyBH[(sig_storeyBH$station_start != sig_storeyBH$station_end),]
sig_storeyBH_inverse = sig_storeyBH_inverse[(sig_storeyBH_inverse$station_start != sig_storeyBH_inverse$station_end),]
library(dplyr)

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##      filter, lag
```

```

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union

startStations = newStations
startStations$station_start = as.numeric(startStations$terminalName)
endStations = newStations
endStations$station_end = as.numeric(endStations$terminalName)
routes_BH_start = left_join(sig_BH,startStations,by = "station_start")
routes_BH_end = left_join(routes_BH_start,endStations,by = "station_end")
routes_BH = routes_BH_end[c(3,4,5,8,9,12,13)]
routes_BH_inv_start = left_join(sig_BH_inverse,startStations,by = "station_start")
routes_BH_inv_end = left_join(routes_BH_inv_start,endStations,by = "station_end")
routes_BH_inv = routes_BH_inv_end[c(3,4,5,8,9,12,13)]
routes_Storey_start = left_join(sig_storeyBH,startStations,by = "station_start")
routes_Storey_end = left_join(routes_Storey_start,endStations,by = "station_end")
routes_Storey = routes_Storey_end[c(3,4,5,8,9,12,13)]
routes_Storey_inv_start = left_join(sig_storeyBH_inverse,startStations,by = "station_start")
routes_Storey_inv_end = left_join(routes_Storey_inv_start,endStations,by = "station_end")
routes_Storey_inv = routes_Storey_inv_end[c(3,4,5,8,9,12,13)]

routes_BH_pos = routes_BH[(routes_BH$Beta_hat > 0),]
routes_BH_top = routes_BH[c(1:50),]
routes_BH_pos_top = routes_BH_top[(routes_BH_top$Beta_hat > 0),]
routes_BH_inv_pos = routes_BH_inv[(routes_BH_inv$Beta_hat < 0),]
routes_BH_inv_top = routes_BH_inv[c(1:50),]
routes_BH_inv_pos_top = routes_BH_inv_top[(routes_BH_inv_top$Beta_hat < 0),]
routes_Storey_pos = routes_Storey[(routes_Storey$Beta_hat > 0),]
routes_Storey_top = routes_Storey[c(1:50),]
routes_Storey_pos_top = routes_Storey_top[(routes_Storey_top$Beta_hat > 0),]
routes_Storey_inv_pos = routes_Storey_inv[(routes_Storey_inv$Beta_hat < 0),]
routes_Storey_inv_top = routes_Storey_inv[c(1:50),]
routes_Storey_inv_pos_top = routes_Storey_inv_top[(routes_Storey_inv_top$Beta_hat < 0),]

```

```

library(ggplot2)
library(ggmap)

```

```

## Google's Terms of Service: https://cloud.google.com/maps-platform/terms/.

```

```

## Please cite ggmap if you use it! See citation("ggmap") for details.

```

```

bbox <- c(left = -77.1, bottom = 38.85, right = -76.95, top = 38.95)
BHmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_BH,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#00008b",
             size=.2,
             curvature=0.2) +
  geom_curve(data=routes_BH_pos,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#8b0000",
             size=.2,

```

```

        curvature=0.2) +
geom_point(data=routes_BH,
            aes(x=long.x, y=lat.x),
            colour="blue",
            size=0.2) +
geom_point(data=routes_BH,
            aes(x=long.y, y=lat.y),
            colour="blue", size=0.2) +
geom_point(data=routes_BH_pos,
            aes(x=long.x, y=lat.x),
            colour="red",
            size=0.2) +
geom_point(data=routes_BH_pos,
            aes(x=long.y, y=lat.y),
            colour="red", size=0.2) +
theme(axis.line=element_blank(),
      axis.text.x=element_blank(),
      axis.text.y=element_blank(),
      axis.title.x=element_blank(),
      axis.title.y=element_blank(),
      axis.ticks=element_blank(),
      plot.title=element_text(hjust=0.5, size=12)) +
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
ggtitle("BH Procedure Significant Routes")

```

```

## Source : http://tile.stamen.com/terrain/13/2341/3132.png

## Source : http://tile.stamen.com/terrain/13/2342/3132.png

## Source : http://tile.stamen.com/terrain/13/2343/3132.png

## Source : http://tile.stamen.com/terrain/13/2344/3132.png

## Source : http://tile.stamen.com/terrain/13/2341/3133.png

## Source : http://tile.stamen.com/terrain/13/2342/3133.png

## Source : http://tile.stamen.com/terrain/13/2343/3133.png

## Source : http://tile.stamen.com/terrain/13/2344/3133.png

## Source : http://tile.stamen.com/terrain/13/2341/3134.png

## Source : http://tile.stamen.com/terrain/13/2342/3134.png

## Source : http://tile.stamen.com/terrain/13/2343/3134.png

## Source : http://tile.stamen.com/terrain/13/2344/3134.png

## Source : http://tile.stamen.com/terrain/13/2341/3135.png

```

```

## Source : http://tile.stamen.com/terrain/13/2342/3135.png

## Source : http://tile.stamen.com/terrain/13/2343/3135.png

## Source : http://tile.stamen.com/terrain/13/2344/3135.png

## Coordinate system already present. Adding new coordinate system, which will replace the existing one

BHtopmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_BH_top,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#00008b",
             size=1.7,
             curvature=0.2) +
  geom_curve(data=routes_BH_pos_top,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#8b0000",
             size=1.7,
             curvature=0.2) +
  geom_point(data=routes_BH_top,
             aes(x=long.x, y=lat.x),
             colour="blue",
             size=1.7) +
  geom_point(data=routes_BH_top,
             aes(x=long.y, y=lat.y),
             colour="blue", size=1.7) +
  geom_point(data=routes_BH_pos_top,
             aes(x=long.x, y=lat.x),
             colour="red",
             size=1.7) +
  geom_point(data=routes_BH_pos_top,
             aes(x=long.y, y=lat.y),
             colour="red", size=1.7) +
  theme(axis.line=element_blank(),
        axis.text.x=element_blank(),
        axis.text.y=element_blank(),
        axis.title.x=element_blank(),
        axis.title.y=element_blank(),
        axis.ticks=element_blank(),
        plot.title=element_text(hjust=0.5, size=12)) +
  coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
  ggtitle("BH Procedure 50 Most Significant Routes")

```

```

## Coordinate system already present. Adding new coordinate system, which will replace the existing one

#BHmap
#BHtopmap

```

```

BHiinvmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_BH_inv,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#00008b",

```

```

        size=.2,
        curvature=0.2) +
geom_curve(data=routes_BH_inv_pos,
            aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
            col="#8b0000",
            size=.2,
            curvature=0.2) +
geom_point(data=routes_BH_inv,
            aes(x=long.x, y=lat.x),
            colour="blue",
            size=0.2) +
geom_point(data=routes_BH_inv,
            aes(x=long.y, y=lat.y),
            colour="blue", size=0.2) +
geom_point(data=routes_BH_inv_pos,
            aes(x=long.x, y=lat.x),
            colour="red",
            size=0.2) +
geom_point(data=routes_BH_inv_pos,
            aes(x=long.y, y=lat.y),
            colour="red", size=0.2) +
theme(axis.line=element_blank(),
      axis.text.x=element_blank(),
      axis.text.y=element_blank(),
      axis.title.x=element_blank(),
      axis.title.y=element_blank(),
      axis.ticks=element_blank(),
      plot.title=element_text(hjust=0.5, size=12)) +
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
ggtitle("BH Inverse Procedure Significant Routes")

```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

```

BHinvtopmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_BH_inv_top,
            aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
            col="#00008b",
            size=1.7,
            curvature=0.2) +
  geom_curve(data=routes_BH_inv_pos_top,
            aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
            col="#8b0000",
            size=1.7,
            curvature=0.2) +
  geom_point(data=routes_BH_inv_top,
            aes(x=long.x, y=lat.x),
            colour="blue",
            size=1.7) +
  geom_point(data=routes_BH_inv_top,
            aes(x=long.y, y=lat.y),
            colour="blue", size=1.7) +
  geom_point(data=routes_BH_inv_pos_top,
            aes(x=long.x, y=lat.x),
            colour="blue",
            size=1.7)

```

```

        colour="red",
        size=1.7) +
geom_point(data=routes_BH_inv_pos_top,
            aes(x=long.y, y=lat.y),
            colour="red", size=1.7) +
theme(axis.line=element_blank(),
      axis.text.x=element_blank(),
      axis.text.y=element_blank(),
      axis.title.x=element_blank(),
      axis.title.y=element_blank(),
      axis.ticks=element_blank(),
      plot.title=element_text(hjust=0.5, size=12)) +
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
ggtitle("BH Inverse Procedure 50 Most Significant Routes")

```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

```

#BHinumap
#BHinutopmap

```

```

Storeymap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_Storey,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#00008b",
             size=.2,
             curvature=0.2) +
  geom_curve(data=routes_Storey_pos,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#8b0000",
             size=.2,
             curvature=0.2) +
  geom_point(data=routes_Storey,
             aes(x=long.x, y=lat.x),
             colour="blue",
             size=0.2) +
  geom_point(data=routes_Storey,
             aes(x=long.y, y=lat.y),
             colour="blue", size=0.2) +
  geom_point(data=routes_Storey_pos,
             aes(x=long.x, y=lat.x),
             colour="red",
             size=0.2) +
  geom_point(data=routes_Storey_pos,
             aes(x=long.y, y=lat.y),
             colour="red", size=0.2) +
  theme(axis.line=element_blank(),
        axis.text.x=element_blank(),
        axis.text.y=element_blank(),
        axis.title.x=element_blank(),
        axis.title.y=element_blank(),
        axis.ticks=element_blank(),
        plot.title=element_text(hjust=0.5, size=12)) +

```

```
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
  ggtitle("Storey Procedure Significant Routes")
```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

```
Storeytopmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_Storey_top,
    aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
    col="#8b0000",
    size=1.7,
    curvature=0.2) +
  geom_curve(data=routes_Storey_pos_top,
    aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
    col="#00008b",
    size=1.7,
    curvature=0.2) +
  geom_point(data=routes_Storey_top,
    aes(x=long.x, y=lat.x),
    colour="blue",
    size=1.7) +
  geom_point(data=routes_Storey_top,
    aes(x=long.y, y=lat.y),
    colour="blue", size=1.7) +
  geom_point(data=routes_Storey_pos_top,
    aes(x=long.x, y=lat.x),
    colour="red",
    size=1.7) +
  geom_point(data=routes_Storey_pos_top,
    aes(x=long.y, y=lat.y),
    colour="red", size=1.7) +
  theme(axis.line=element_blank(),
    axis.text.x=element_blank(),
    axis.text.y=element_blank(),
    axis.title.x=element_blank(),
    axis.title.y=element_blank(),
    axis.ticks=element_blank(),
    plot.title=element_text(hjust=0.5, size=12)) +
  coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
  ggtitle("Storey Procedure 50 Most Significant Routes")
```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

```
#Storeymap
#Storeytopmap
```

```
Storeyinvmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_Storey_inv,
    aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
    col="#00008b",
    size=.2,
    curvature=0.2) +
  geom_curve(data=routes_Storey_inv_pos,
```

```

aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
  col="#8b0000",
  size=.2,
  curvature=0.2) +
geom_point(data=routes_Storey_inv,
  aes(x=long.x, y=lat.x),
  colour="blue",
  size=0.2) +
geom_point(data=routes_Storey_inv,
  aes(x=long.y, y=lat.y),
  colour="blue", size=0.2) +
geom_point(data=routes_Storey_inv_pos,
  aes(x=long.x, y=lat.x),
  colour="red",
  size=0.2) +
geom_point(data=routes_Storey_inv_pos,
  aes(x=long.y, y=lat.y),
  colour="red", size=0.2) +
theme(axis.line=element_blank(),
  axis.text.x=element_blank(),
  axis.text.y=element_blank(),
  axis.title.x=element_blank(),
  axis.title.y=element_blank(),
  axis.ticks=element_blank(),
  plot.title=element_text(hjust=0.5, size=12)) +
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
ggttitle("Storey Inverse Procedure Significant Routes")

```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

```

Storeyinvtopmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_Storey_inv_top,
    aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
    col="#00008b",
    size=1.7,
    curvature=0.2) +
  geom_curve(data=routes_Storey_inv_pos_top,
    aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
    col="#8b0000",
    size=1.7,
    curvature=0.2) +
  geom_point(data=routes_Storey_inv_top,
    aes(x=long.x, y=lat.x),
    colour="blue",
    size=1.7) +
  geom_point(data=routes_Storey_inv_top,
    aes(x=long.y, y=lat.y),
    colour="blue", size=1.7) +
  geom_point(data=routes_Storey_inv_pos_top,
    aes(x=long.x, y=lat.x),
    colour="red",
    size=1.7) +
  geom_point(data=routes_Storey_inv_pos_top,

```

```

aes(x=long.y, y=lat.y),
  colour="red", size=1.7) +
theme(axis.line=element_blank(),
  axis.text.x=element_blank(),
  axis.text.y=element_blank(),
  axis.title.x=element_blank(),
  axis.title.y=element_blank(),
  axis.ticks=element_blank(),
  plot.title=element_text(hjust=0.5, size=12)) +
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
ggtitle("Storey Inverse Procedure 50 Most Significant Routes")

```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

```

#Storeyinumap
#Storeyinvtopmap

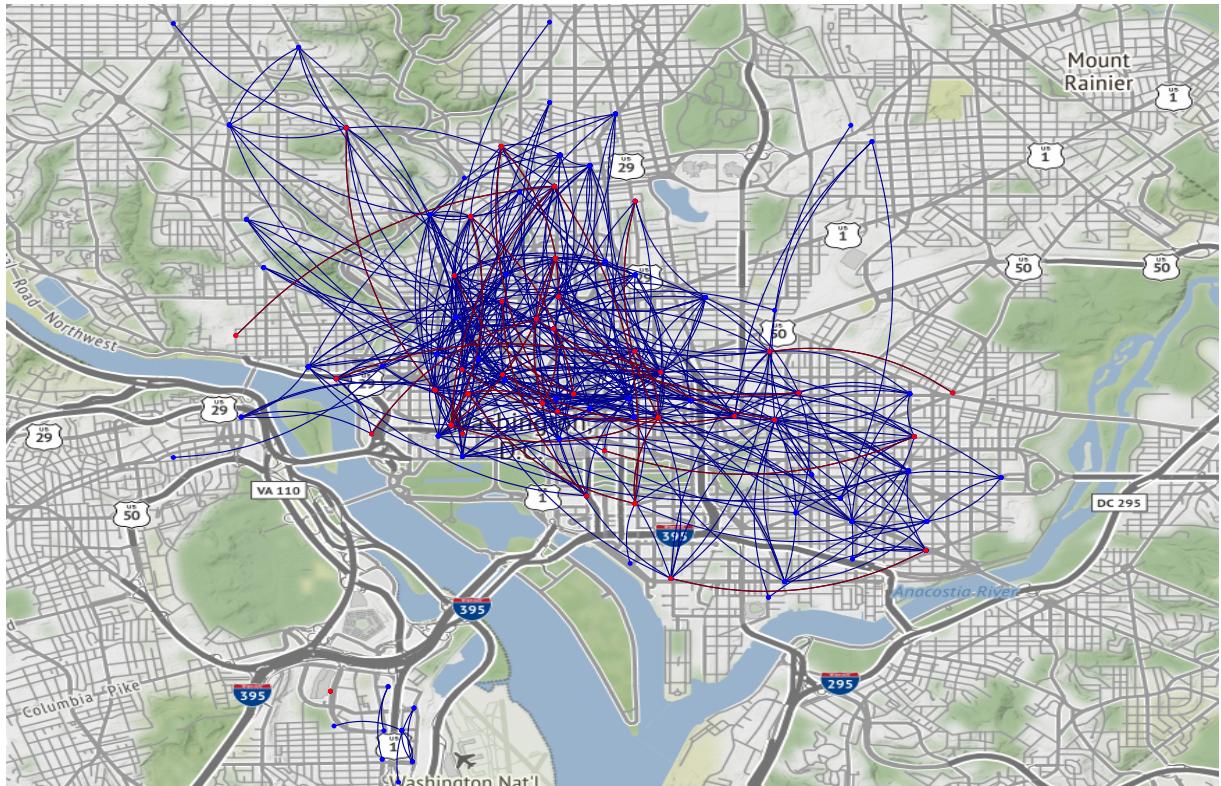
```

```

par(mfrow=c(4,2))
BHmap

```

BH Procedure Significant Routes

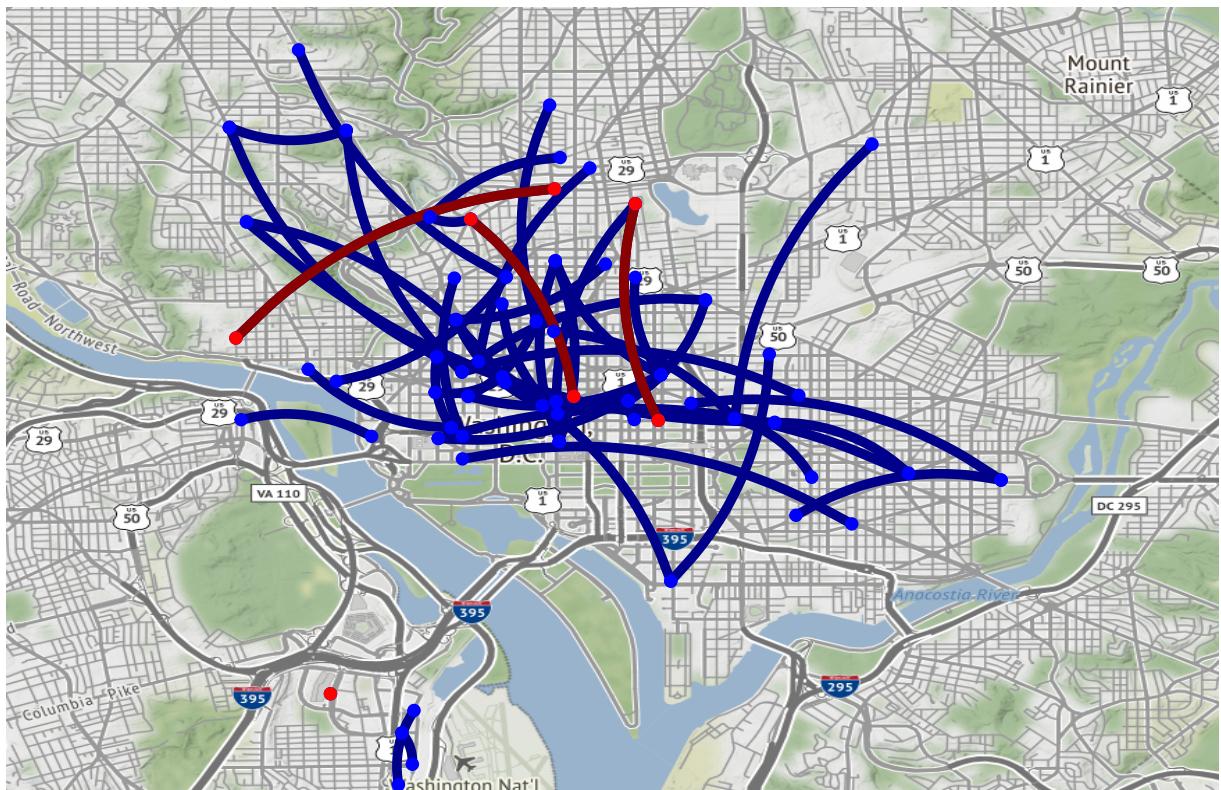


```

BHtopmap

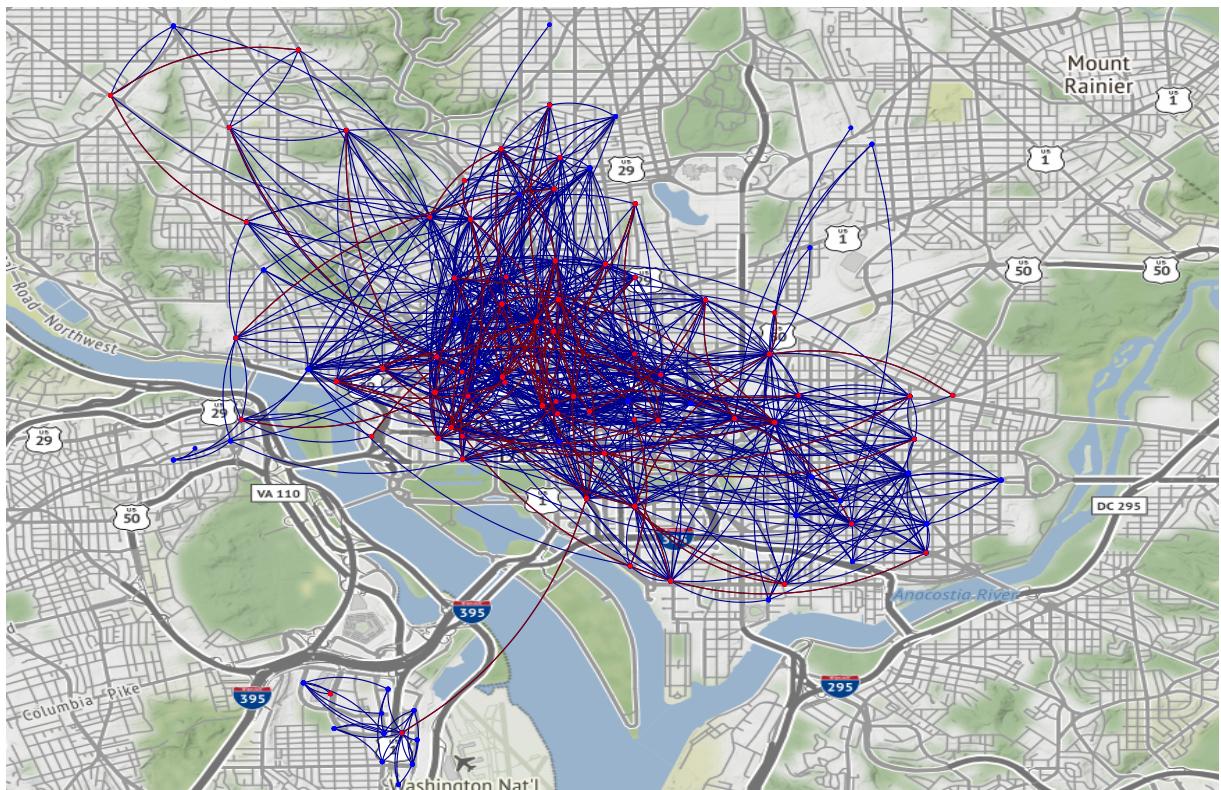
```

BH Procedure 50 Most Significant Routes



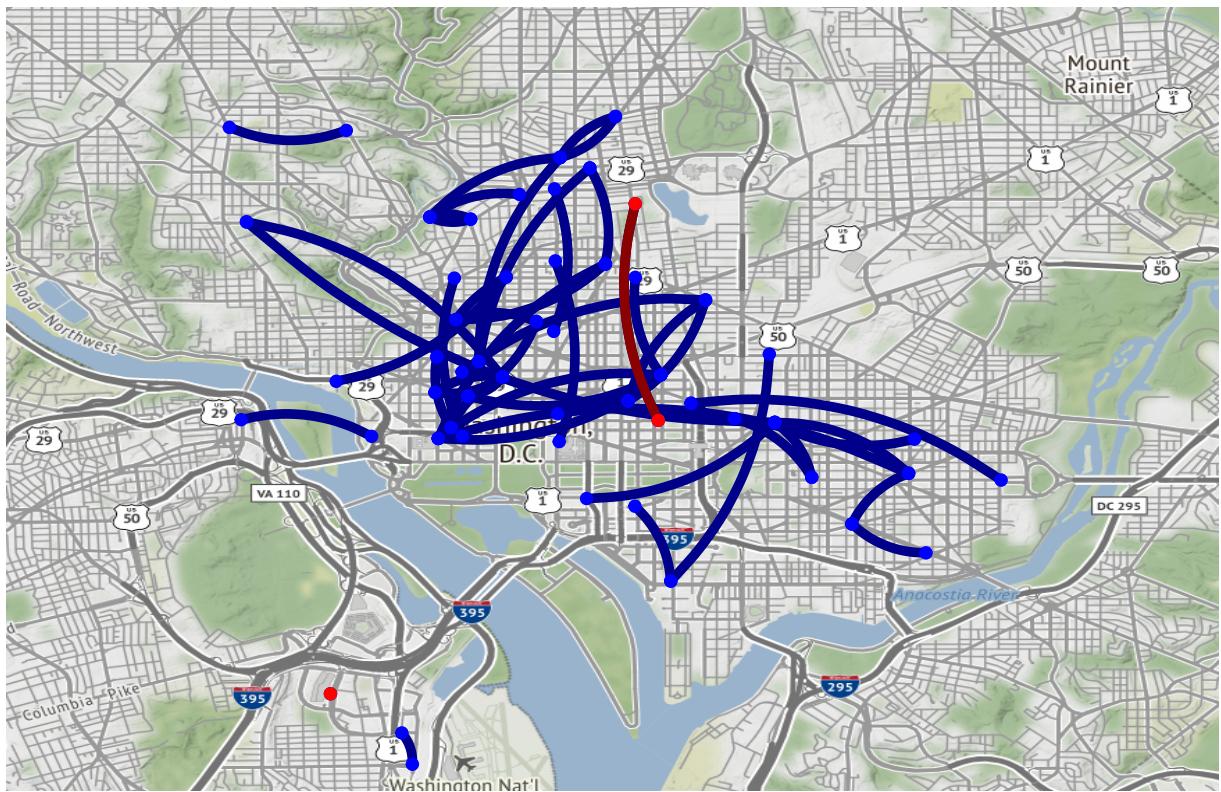
BHinvmap

BH Inverse Procedure Significant Routes



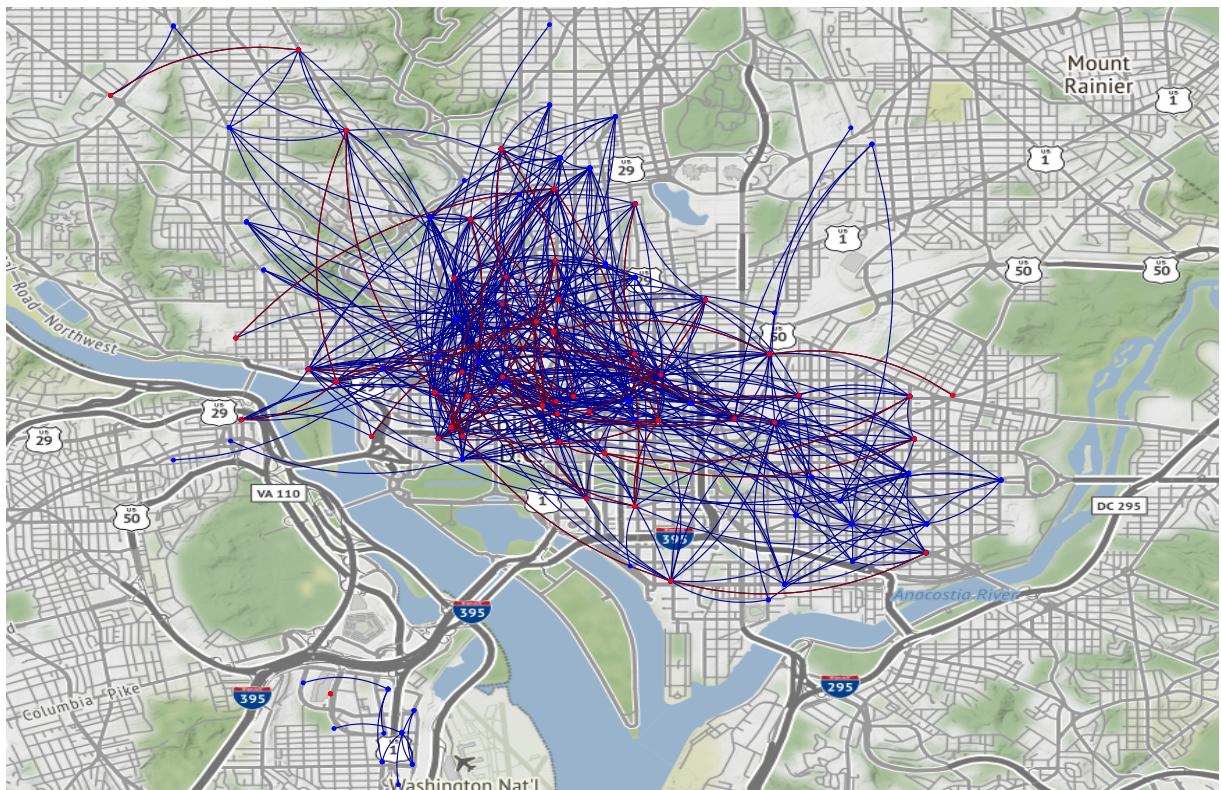
BHinvtopmap

BH Inverse Procedure 50 Most Significant Routes



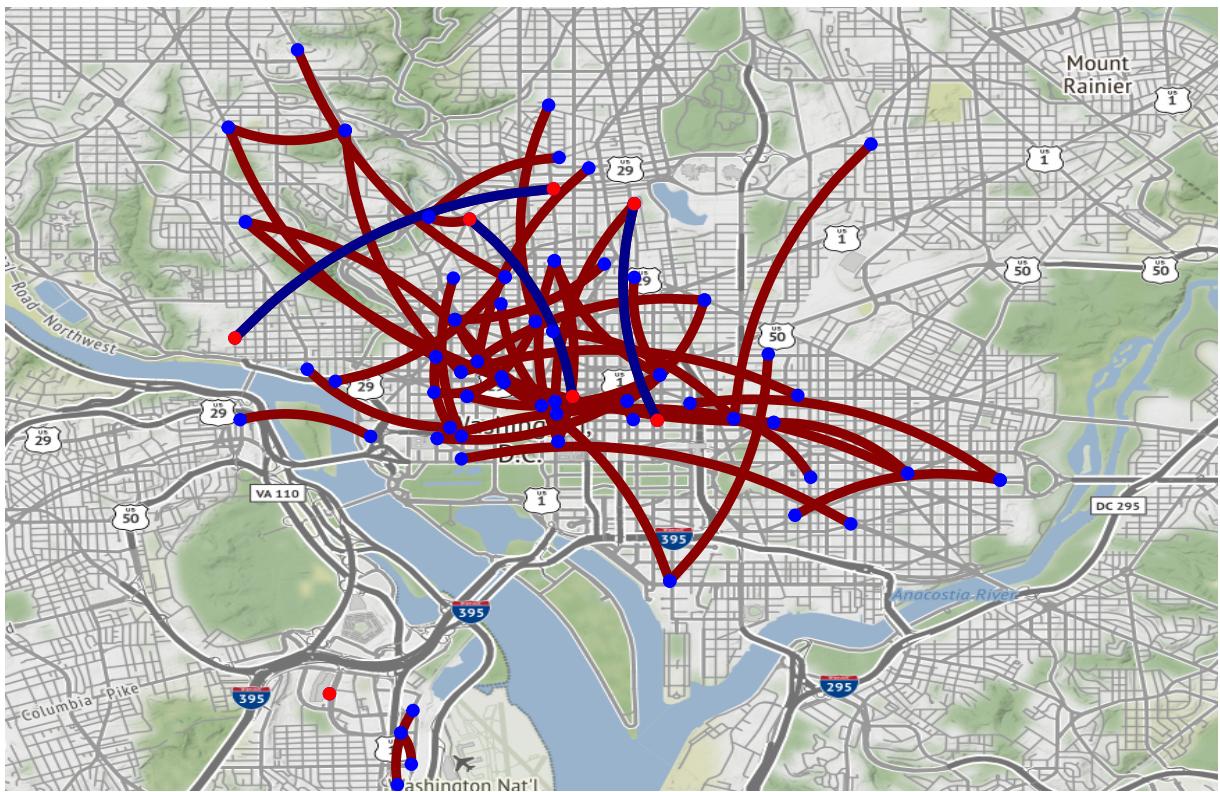
StoreyMap

Storey Procedure Significant Routes



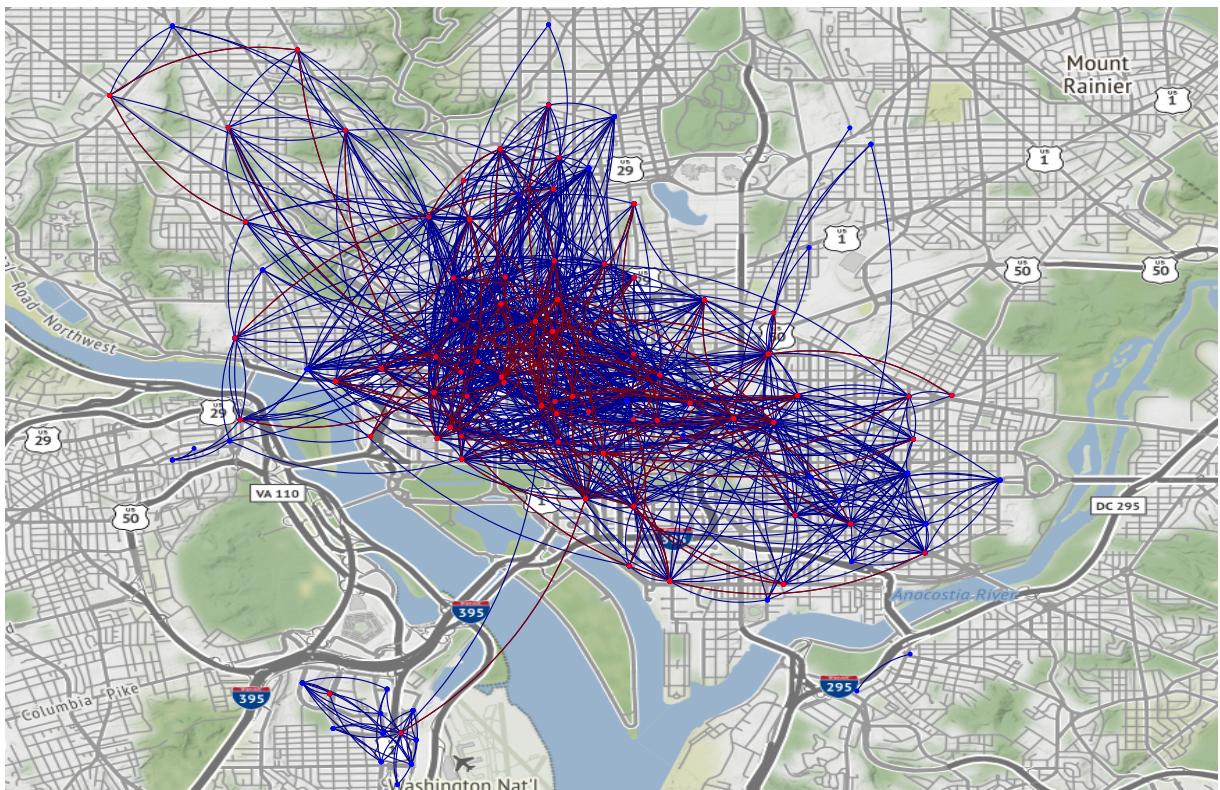
Storeytopmap

Storey Procedure 50 Most Significant Routes



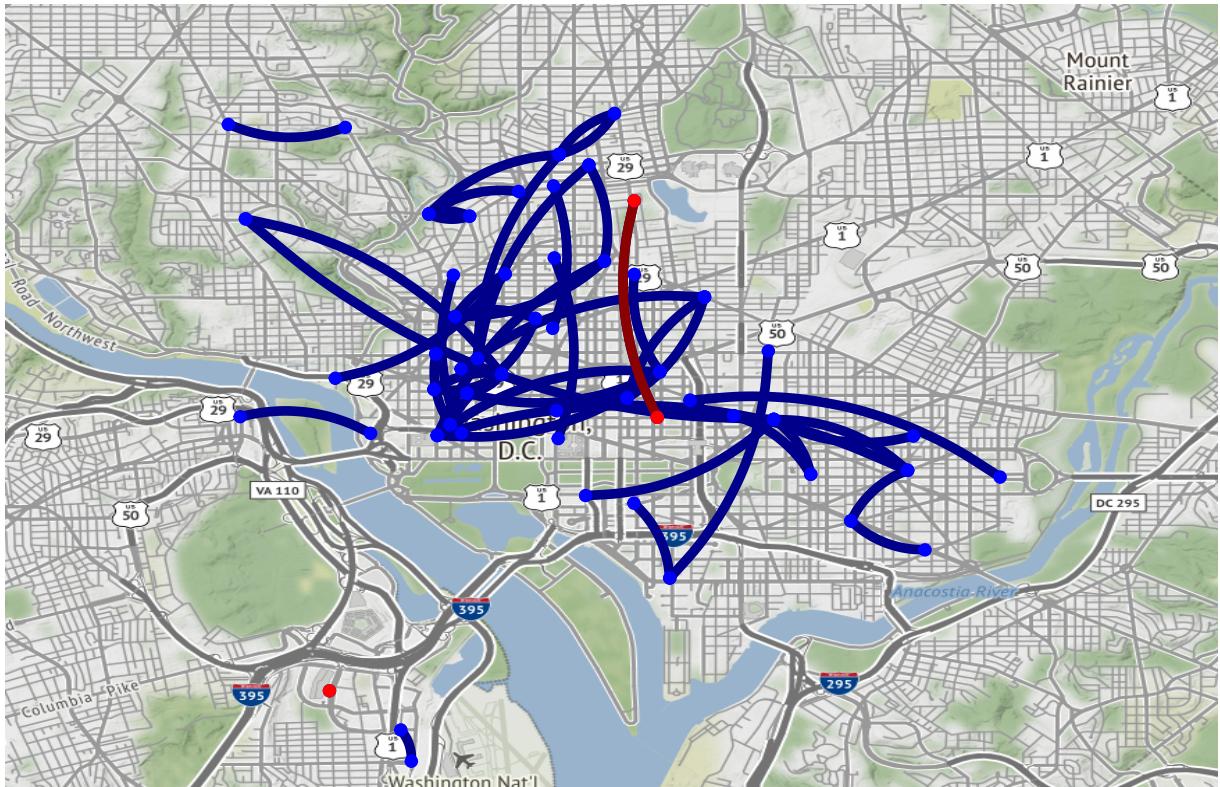
Storeyinvmap

Storey Inverse Procedure Significant Routes



Storeyinvtopmap

Storey Inverse Procedure 50 Most Significant Routes



```

load("data/perm_rejections.RData")
load("data/perm_rejections_150.RData")
routes_perm_tests_standard = routes_perm_tests_standard[(routes_perm_tests_standard$station_start != routes_perm_tests_storey$station_start) & (routes_perm_tests_standard$perm_rejects_standard == 1),]
routes_perm_BH_start = left_join(routes_perm_tests_standard,startStations,by = "station_start")
routes_perm_BH_end = left_join(routes_perm_BH_start,endStations,by = "station_end")
routes_perm_BH = routes_perm_BH[,c(3,4,7,8,11,12)]
routes_perm_BH = routes_perm_BH[(routes_perm_BH$perm_rejects_standard == 1),]
routes_perm_tests_Storey = routes_perm_tests_Storey[(routes_perm_tests_Storey$station_start != routes_perm_tests_Storey$station_end) & (routes_perm_tests_Storey$perm_rejects_standard == 1),]
routes_perm_Storey_start = left_join(routes_perm_tests_Storey,startStations,by = "station_start")
routes_perm_Storey_end = left_join(routes_perm_Storey_start,endStations,by = "station_end")
routes_perm_Storey = routes_perm_Storey[,c(3,4,7,8,11,12)]
routes_perm_Storey = routes_perm_Storey[(routes_perm_BH$perm_rejects_standard == 1),]

```

```

BHpermmmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
  geom_curve(data=routes_perm_BH,
             aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
             col="#00008b",
             size=1.0,
             curvature=0.2) +
  geom_point(data=routes_perm_BH,
             aes(x=long.x, y=lat.x),
             colour="blue",
             size=1.0) +
  geom_point(data=routes_perm_BH,
             aes(x=long.y, y=lat.y),

```

```

        colour="blue", size=1.0) +
theme(axis.line=element_blank(),
      axis.text.x=element_blank(),
      axis.text.y=element_blank(),
      axis.title.x=element_blank(),
      axis.title.y=element_blank(),
      axis.ticks=element_blank(),
      plot.title=element_text(hjust=0.5, size=12)) +
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
ggtitle("BH Permutation Test Procedure Significant Routes")

```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

```

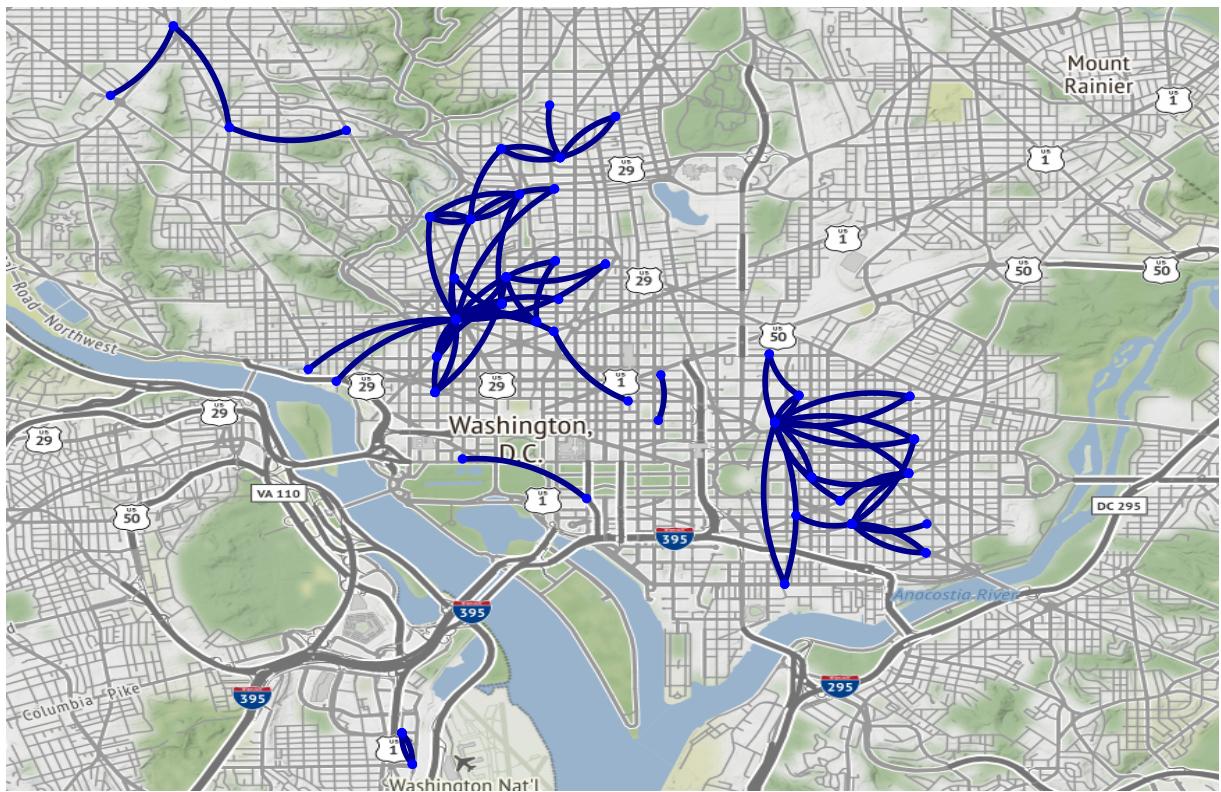
Storeypermmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
geom_curve(data=routes_perm_Storey,
           aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
           col="#00008b",
           size=1.0,
           curvature=0.2) +
geom_point(data=routes_perm_Storey,
           aes(x=long.x, y=lat.x),
           colour="blue",
           size=1.0) +
geom_point(data=routes_perm_Storey,
           aes(x=long.y, y=lat.y),
           colour="blue", size=1.0) +
theme(axis.line=element_blank(),
      axis.text.x=element_blank(),
      axis.text.y=element_blank(),
      axis.title.x=element_blank(),
      axis.title.y=element_blank(),
      axis.ticks=element_blank(),
      plot.title=element_text(hjust=0.5, size=12)) +
coord_cartesian(ylim=c(38.85, 38.95), xlim=c(-77.1, -76.95)) +
ggtitle("Storey Permutation Test Procedure Significant Routes")

```

Coordinate system already present. Adding new coordinate system, which will replace the existing one

BHpermmap

BH Permutation Test Procedure Significant Routes



Storeypermmap

Storey Permutation Test Procedure Significant Routes

