

# Mapping for MT Project 1

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2/15/2022

## 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_top = routes_BH[c(1:50),]
routes_BH_inv_top = routes_BH_inv[c(1:50),]
routes_Storey_top = routes_Storey[c(1:50),]
routes_Storey_inv_top = routes_Storey_inv[c(1:50),]

```

```

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_top,
             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_top,
            aes(x=long.x, y=lat.x),
            colour="red",
            size=0.2) +
geom_point(data=routes_BH_top,
            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="#8b0000",
    size=1.7,
    curvature=0.2) +
  geom_point(data=routes_BH_top,
    aes(x=long.x, y=lat.x),
    colour="red",
    size=1.7) +
  geom_point(data=routes_BH_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

```

```

BHinvmap <- 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_top,
    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_top,
    aes(x=long.x, y=lat.x),
    colour="red",
    size=0.2) +
  geom_point(data=routes_BH_inv_top,
    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="#8b0000",
             size=1.7,
             curvature=0.2) +
  geom_point(data=routes_BH_inv_top,
             aes(x=long.x, y=lat.x),
             colour="red",
             size=1.7) +
  geom_point(data=routes_BH_inv_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
#BHinvtopmap

```

```

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_top,
             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_top,
  aes(x=long.x, y=lat.x),
  colour="red",
  size=0.2) +
geom_point(data=routes_Storey_top,
  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 BH 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_point(data=routes_Storey_top,
    aes(x=long.x, y=lat.x),
    colour="red",
    size=1.7) +
  geom_point(data=routes_Storey_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 BH 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_top,
    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_top,
    aes(x=long.x, y=lat.x),
    colour="red",
    size=0.2) +
  geom_point(data=routes_Storey_inv_top,
    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 BH 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="#8b0000",
    size=1.7,
    curvature=0.2) +
  geom_point(data=routes_Storey_inv_top,
    aes(x=long.x, y=lat.x),
    colour="red",
    size=1.7) +
  geom_point(data=routes_Storey_inv_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 BH Inverse Procedure 50 Most Significant Routes")

```

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

```

#Storeyinumap
#Storeyinvtopmap

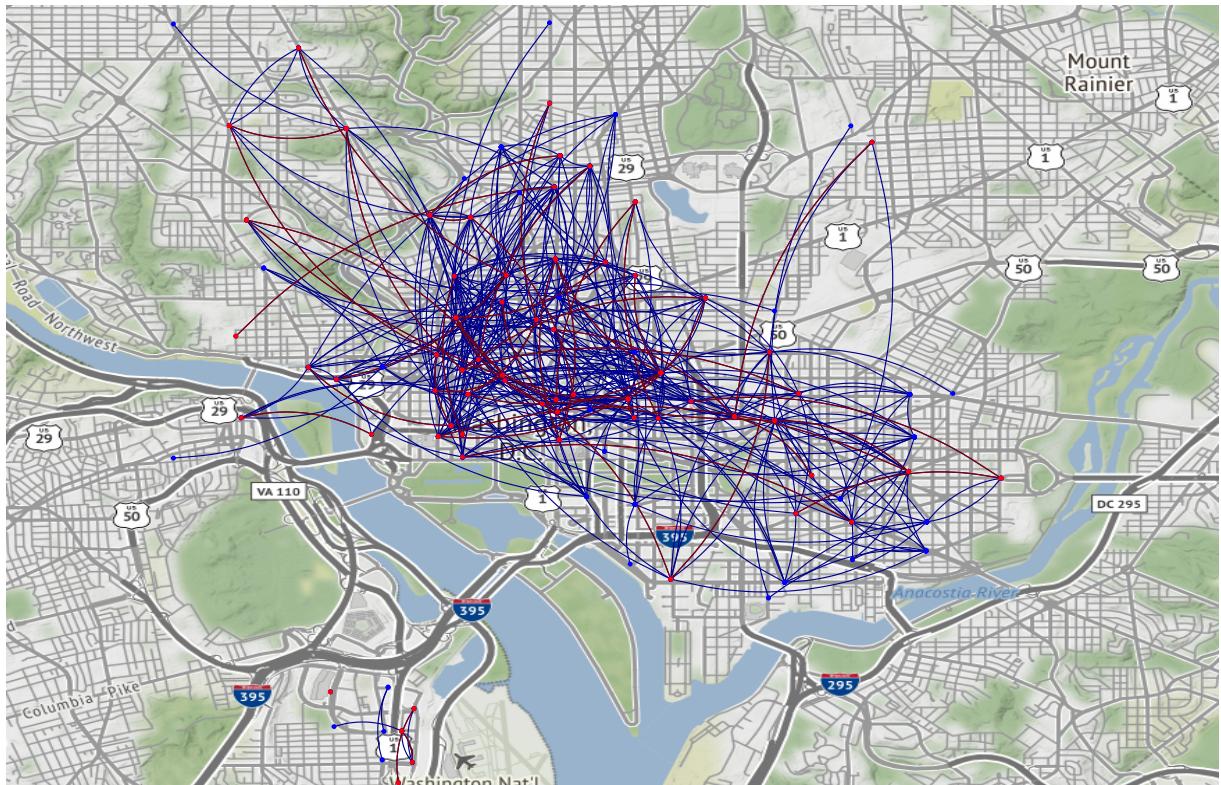
```

```

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

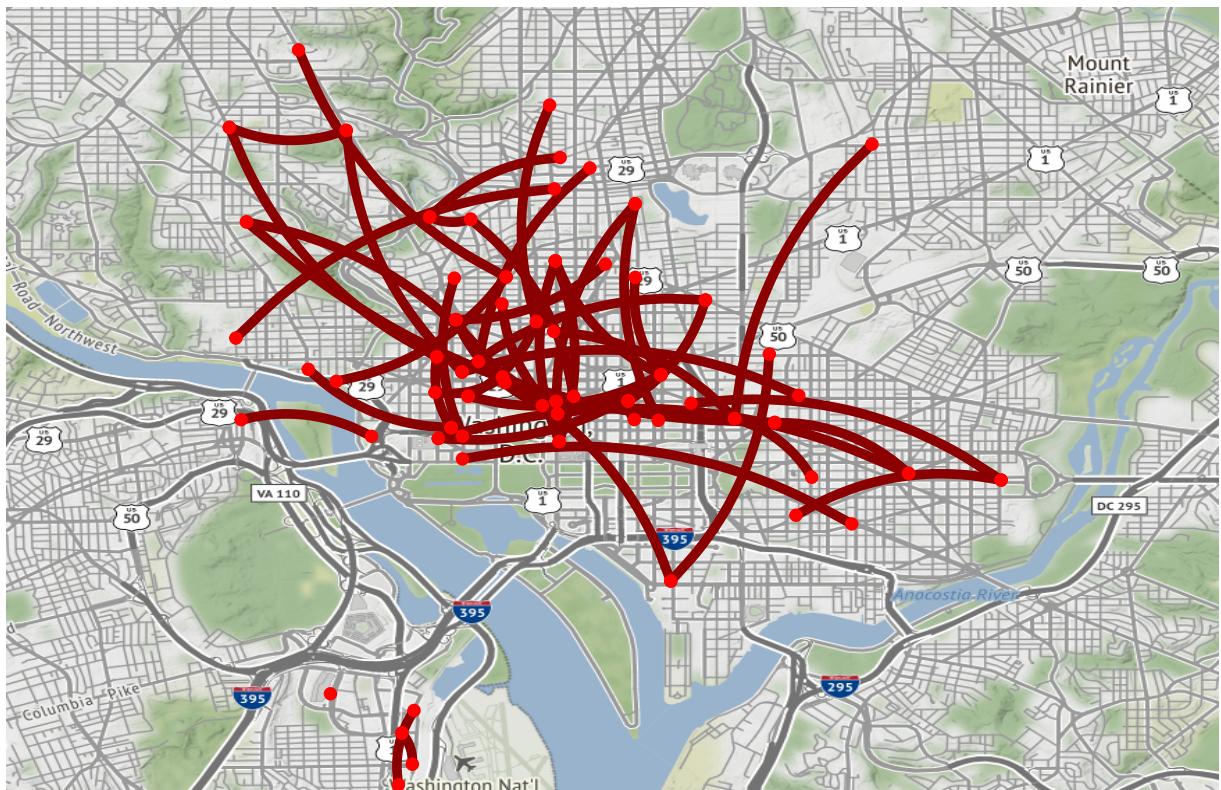
```

BH Procedure Significant Routes



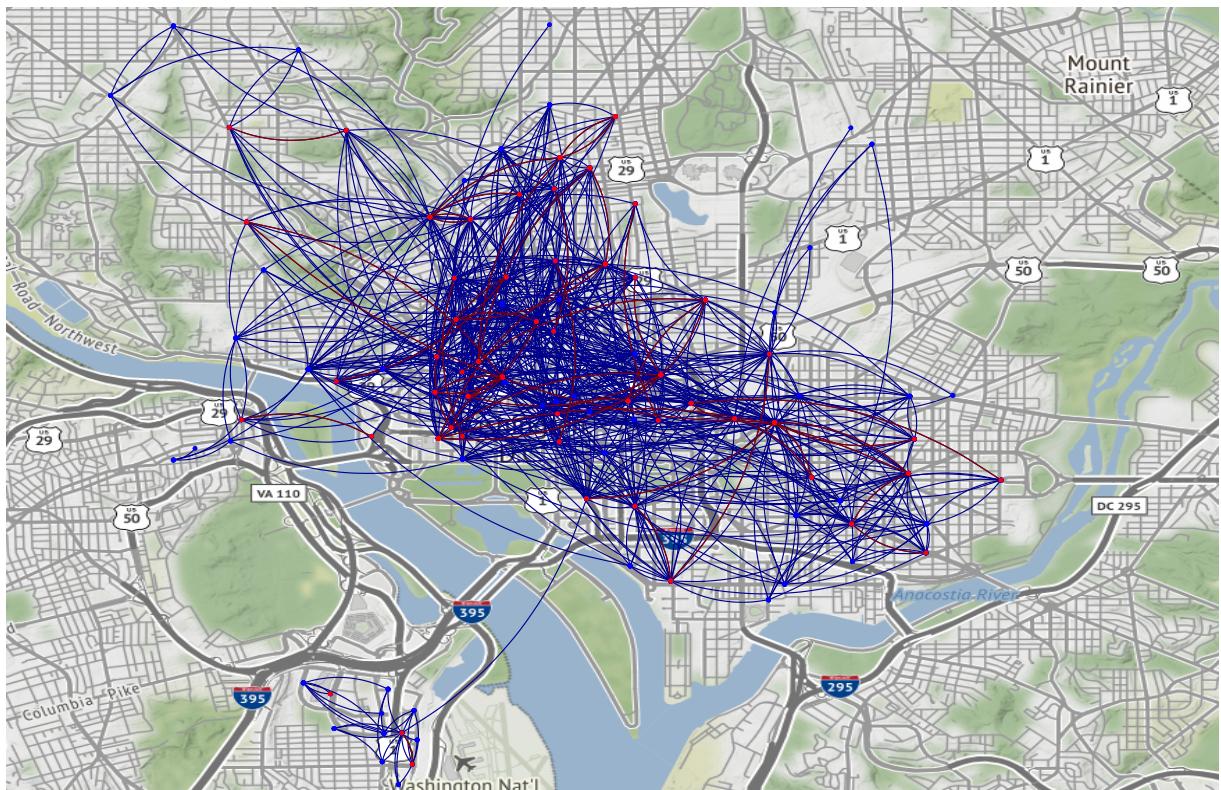
```
BHtopmap
```

## BH Procedure 50 Most Significant Routes



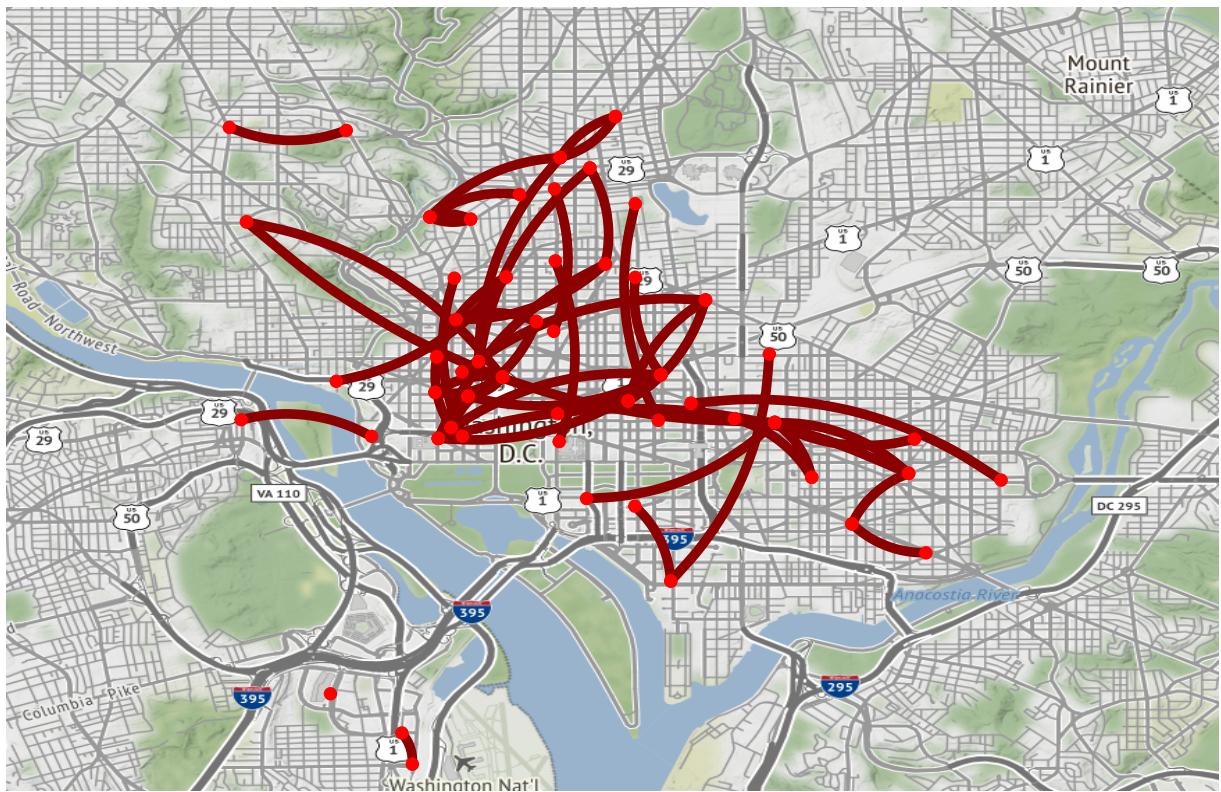
BHinvmap

## BH Inverse Procedure Significant Routes



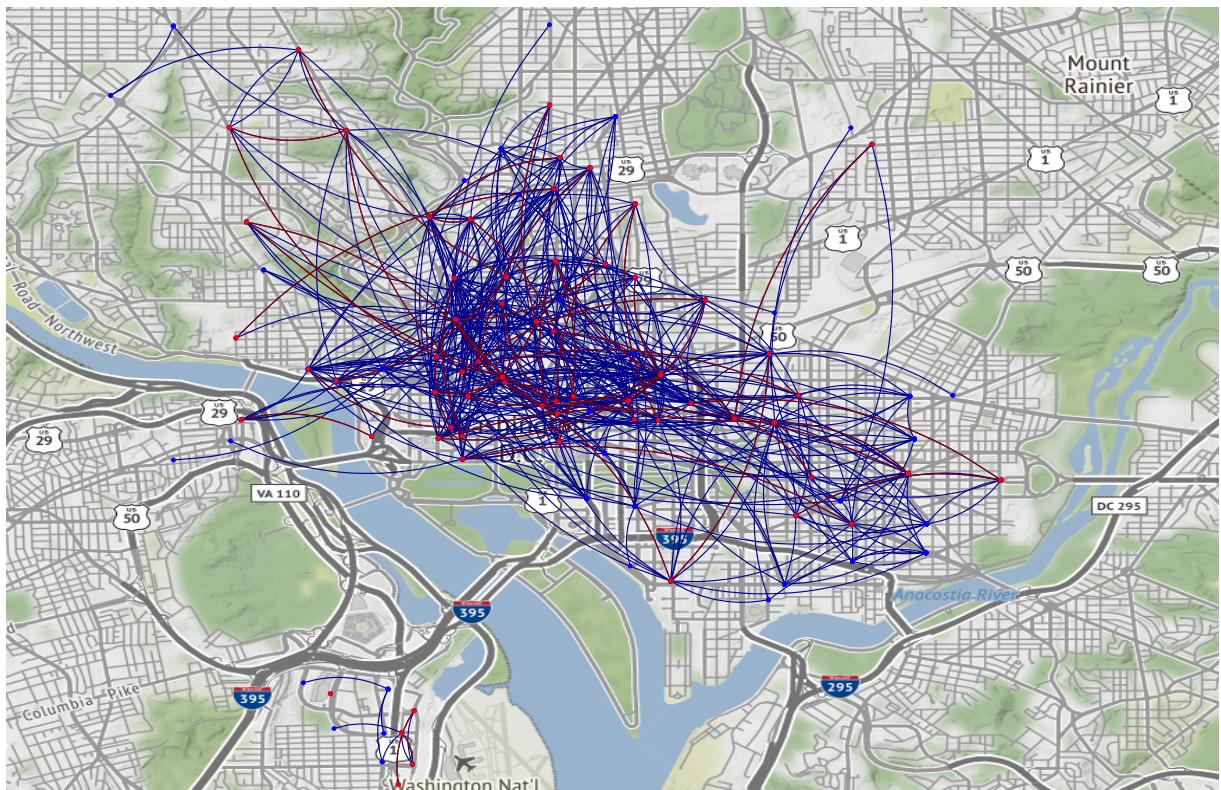
BHinvtopmap

## BH Inverse Procedure 50 Most Significant Routes



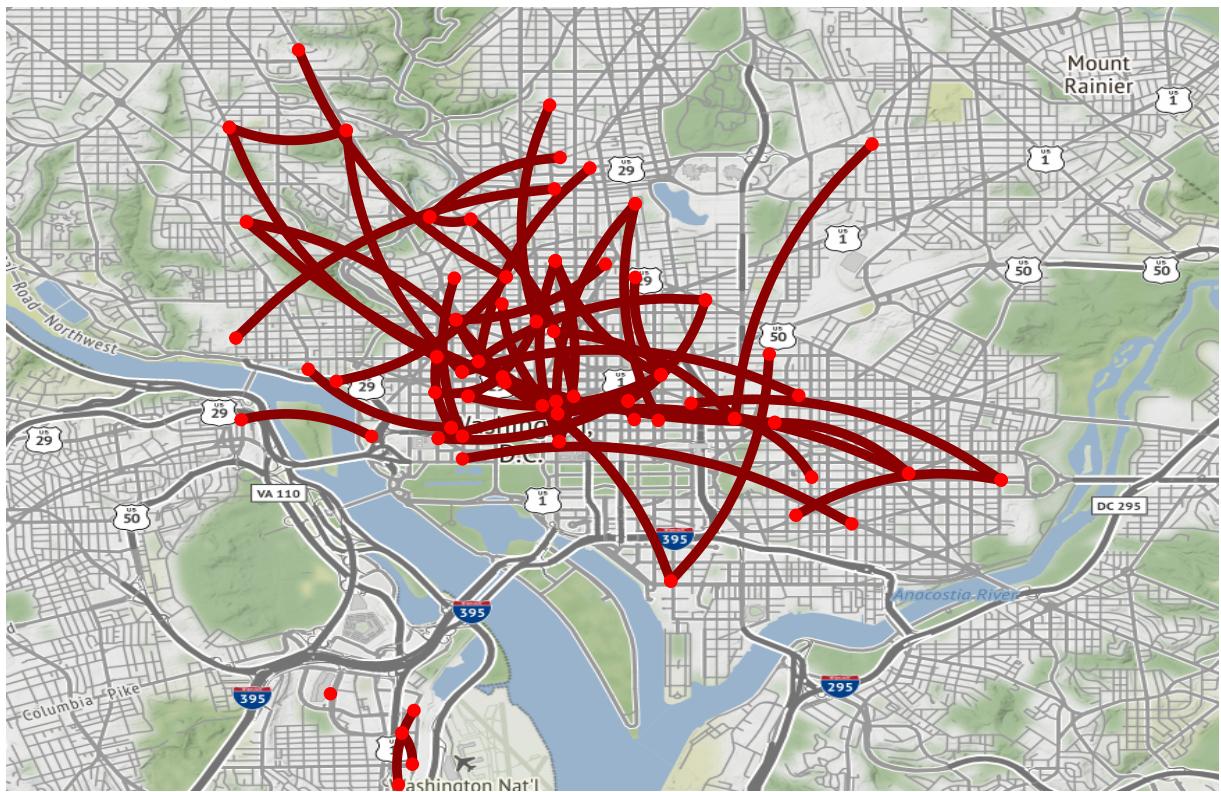
StoreyMap

## Storey BH Procedure Significant Routes



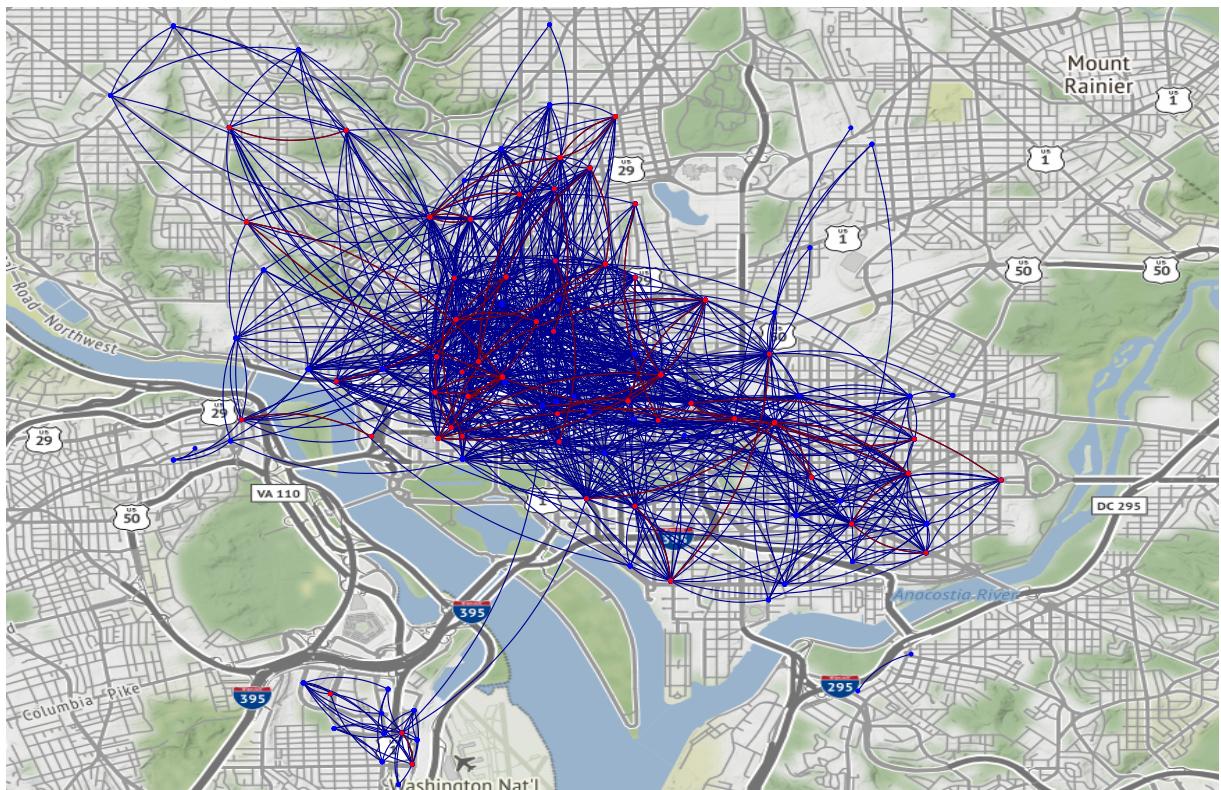
Storeytopmap

## Storey BH Procedure 50 Most Significant Routes



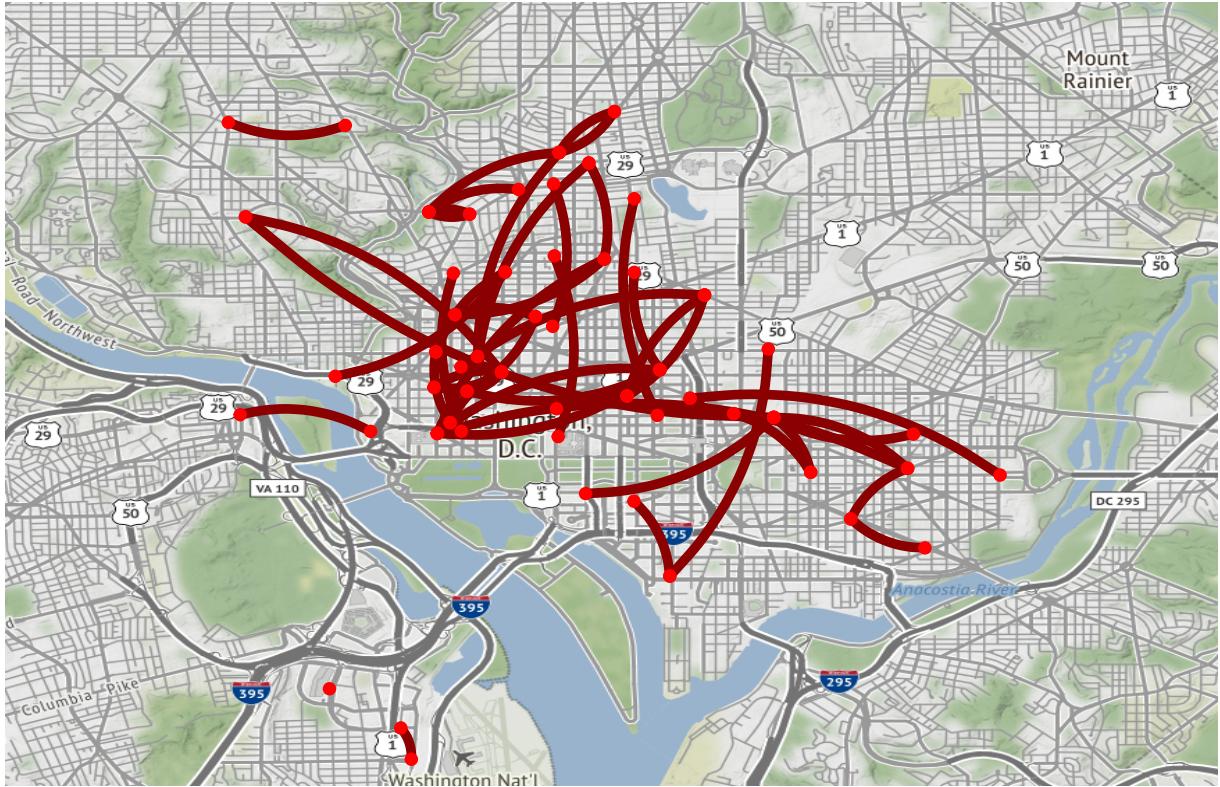
Storeyinvmap

## Storey BH Inverse Procedure Significant Routes



Storeyinvtopmap

## Storey BH 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

```

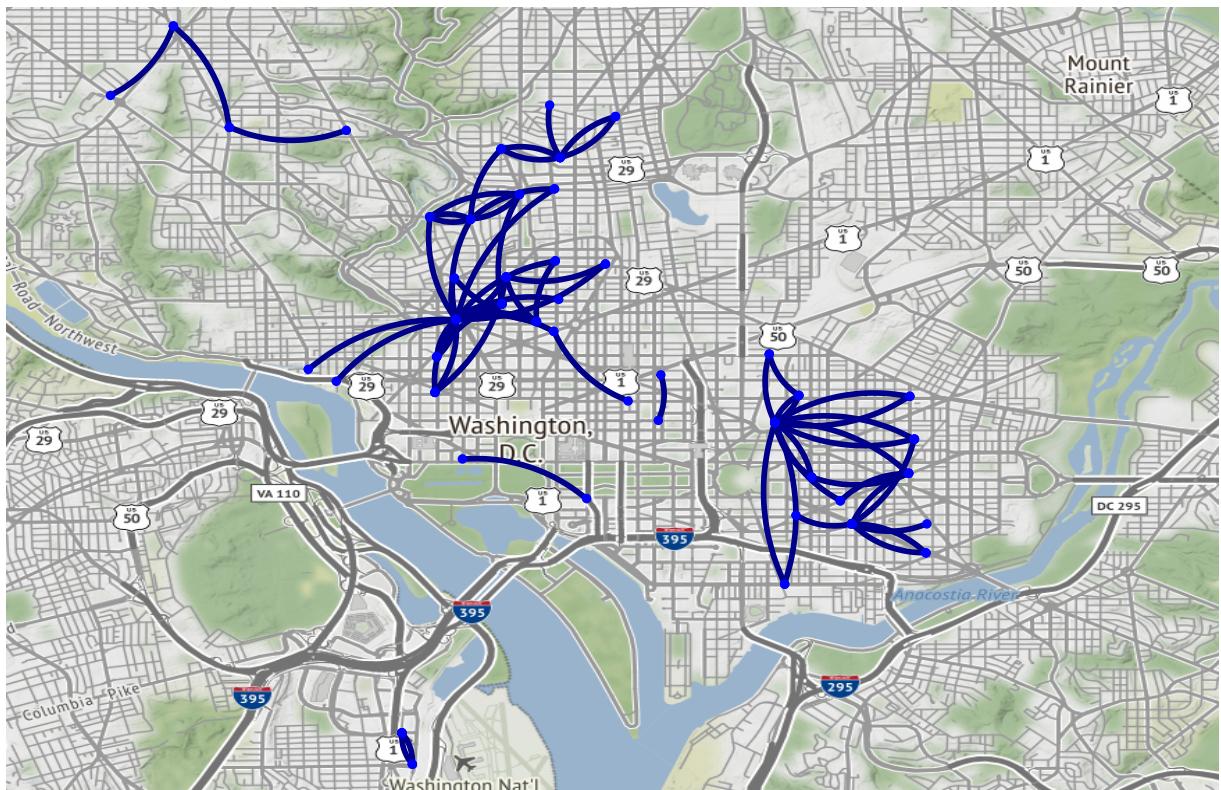
Storeypermmap <- ggmap(get_stamenmap(bbox, zoom = 13)) +
geom_curve(data=routes_perm_Storey,
           aes(x=long.x, y=lat.x, xend=long.y, yend=lat.y),
           col="#00008b",
           size=1.0,
           curvature=0.2) +
geom_point(data=routes_perm_Storey,
           aes(x=long.x, y=lat.x),
 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

