

```
In [1]: library(tidyverse)
library(sf)
library(mapview)
library(rvest)
library(httr)
library(ggplot2)
library(ggmap)
library(maps)
library(ggsn)
library(geosphere)
library(dplyr)
library(RColorBrewer)
library(readxl)
library(leaflet)
library(leaflet.extras)
library(plot3D)
library(av)
library(rayshader)
library(lattice)
library(latticeExtra)
```

```

— Attaching core tidyverse packages — tidyverse
2.0.0 —
✓ dplyr      1.1.2      ✓ readr      2.1.4
✓ forcats    1.0.0      ✓ stringr    1.5.0
✓ ggplot2    3.4.2      ✓ tibble     3.2.1
✓ lubridate  1.9.2      ✓ tidyr      1.3.0
✓ purrr      1.0.1

```

```

— Conflicts — tidyverse_conflic
ts() —

```

```

✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()      masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force al
l conflicts to become errors
Linking to GEOS 3.11.0, GDAL 3.5.3, PROJ 9.1.0; sf_use_s2() is TRUE

```

The legacy packages maptools, rgdal, and rgeos, underpinning this package will retire shortly. Please refer to R-spatial evolution reports on <https://r-spatial.org/r/2023/05/15/evolution4.html> (<https://r-spatial.org/r/2023/05/15/evolution4.html>) for details.
This package is now running under evolution status 0

Attaching package: 'rvest'

The following object is masked from 'package:readr':

guess_encoding

```

i Google's Terms of Service: <https://mapsplatform.google.com>
i Please cite ggmap if you use it! Use `citation("ggmap")` for details.

```

Attaching package: 'maps'

The following object is masked from 'package:purrr':

map

Loading required package: grid

```

Warning message:
"multiple methods tables found for 'elide'"

```

Attaching package: 'latticeExtra'

The following object is masked from 'package:ggplot2':

layer

```
In [2]: Bluephone_location <- read_csv("data/Bluephone Locations My Map Downloaded
head(Bluephone_location)
```

Rows: 89 Columns: 4

Column specification

Delimiter: ", "

chr (2): Formal_Name_and_Room, Street_Address

dbl (2): Latitude, Longitude

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.

A tibble: 6 × 4

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>
Blue Phone 01 ANSOC @ Northwest Marine Drive	6303 N W MARINE DR at ANSOC Building	49.26973	-123.2572
Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	Main Mall & Crescent Road	49.26894	-123.2566
Blue Phone 04 Wyman Plaza @ Main Mall & Memorial Road	Main Mall & Memorial Road	49.26777	-123.2550
Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	2008 LOWER MALL Ponderosa Annex F	49.26497	-123.2575
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	2011 WEST MALL Ponderosa Annex A	49.26534	-123.2562
Blue Phone 07 Hennings @ East Mall & Agricultural Road	6224 AGRICULTURAL RD/EAST MALL Hennings Bldg	49.26697	-123.2518

```
In [3]: Bluephone_location <- Bluephone_location |>
mutate(across(Longitude, as.double))
```

```
In [4]: head(Bluephone_location)
```

A tibble: 6 × 4

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>
Blue Phone 01 ANSOC @ Northwest Marine Drive	6303 N W MARINE DR at ANSOC Building	49.26973	-123.2572
Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	Main Mall & Crescent Road	49.26894	-123.2566
Blue Phone 04 Wyman Plaza @ Main Mall & Memorial Road	Main Mall & Memorial Road	49.26777	-123.2550
Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	2008 LOWER MALL Ponderosa Annex F	49.26497	-123.2575
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	2011 WEST MALL Ponderosa Annex A	49.26534	-123.2562
Blue Phone 07 Hennings @ East Mall & Agricultural Road	6224 AGRICULTURAL RD/EAST MALL Hennings Bldg	49.26697	-123.2518

```
In [5]: base_map <- leaflet() %>%
  addTiles() %>%
  fitBounds(-123.22,49.263,-123.28,49.27)

#base_map
```

```
In [6]: # save the map view
mapshot(base_map, file = "Map Image Save/base map.png")
```



```
In [7]: bluephone_map <- leaflet(data = Bluephone_location) %>%
  addTiles() %>%
  fitBounds(-123.22,49.263,-123.28,49.27) %>%
  addMarkers(lng = ~Longitude,
             lat = ~Latitude,
             popup = ~Street_Address, label = ~Formal_Name_and_Room)

#bluephone_map
```

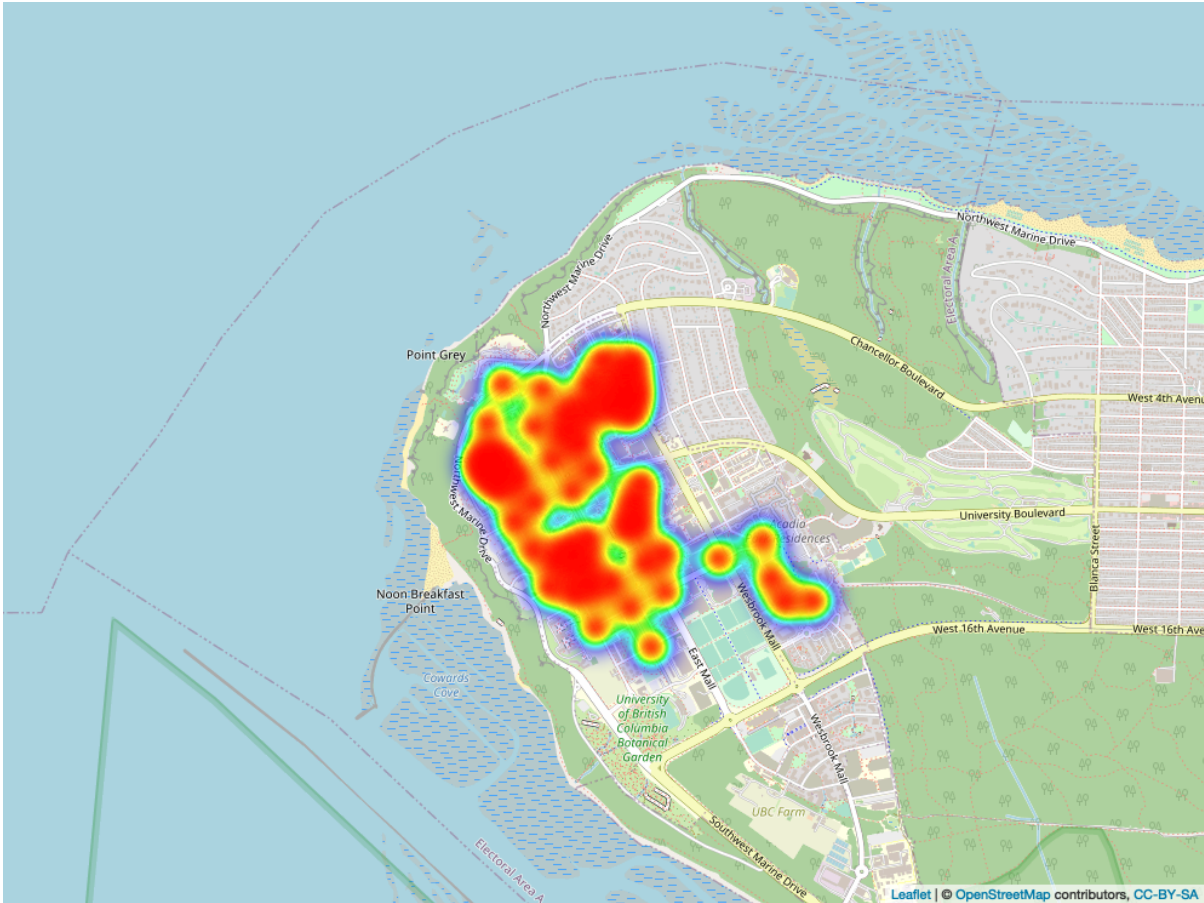
```
In [8]: # save the map view
mapshot(bluephone_map, file = "Map Image Save/bluephone map.png")
```



```
In [9]: # heatmap of bluephone density
bluephone_heatmap <- addHeatmap(base_map, lng = ~Longitude, lat = ~Latitude,
  layerId = NULL, group = NULL, minOpacity = 0.05, max = 0.05,
  radius = 20, blur = 25, gradient = NULL, cellSize = 10,
  data = Bluephone_location)

#bluephone_heatmap
```

```
In [10]: # save the map view
mapshot(bluephone_heatmap, file = "Map Image Save/bluephone heatmap.png")
```



```
In [11]: head(Bluephone_location)
```

A tibble: 6 × 4

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>
Blue Phone 01 ANSOC @ Northwest Marine Drive	6303 N W MARINE DR at ANSOC Building	49.26973	-123.2572
Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	Main Mall & Crescent Road	49.26894	-123.2566
Blue Phone 04 Wyman Plaza @ Main Mall & Memorial Road	Main Mall & Memorial Road	49.26777	-123.2550
Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	2008 LOWER MALL Ponderosa Annex F	49.26497	-123.2575
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	2011 WEST MALL Ponderosa Annex A	49.26534	-123.2562
Blue Phone 07 Hennings @ East Mall & Agricultural Road	6224 AGRICULTURAL RD/EAST MALL Hennings Bldg	49.26697	-123.2518

```
In [12]: bluephone_lon_lat <- Bluephone_location |>
  select(Longitude, Latitude)
```



```
In [13]: first_bluephone <- Bluephone_location[89, ]
first_bluephone
first_bluephone_lon_lat <- select(first_bluephone, Longitude, Latitude)
first_bluephone_lon_lat
rest_bluephone <- Bluephone_location |>
  filter(Latitude != pull(first_bluephone, Latitude))

Bluephone_distance <- rest_bluephone |>
  group_by(Formal_Name_and_Room, Latitude, Longitude) |>
  summarize(distance = distGeo(first_bluephone_lon_lat, c(Longitude,
  arrange(distance) |>
  head(1) |>
  mutate(Bluephone_origin = pull(first_bluephone, Formal_Name_and_Room),
    origin_Lat = pull(first_bluephone, Latitude),
    origin_Lon = pull(first_bluephone, Longitude)) |>
  select(Bluephone_origin, origin_Lat, origin_Lon, Formal_Name_and_Room)

colnames(Bluephone_distance) <- c("Bluephone_origin", "origin_Lat", "origin_Lon", "distance")
Bluephone_distance
```

A tibble: 1 × 4

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>
Blue Phone 89	Saltwater Octopus House	49.27075	-123.248

A tibble: 1 × 2

Longitude	Latitude
<dbl>	<dbl>
-123.248	49.27075

`summarise()` has grouped output by 'Formal_Name_and_Room', 'Latitude'. You can override using the `.groups` argument.

A grouped_df: 1 × 7

Bluephone_origin	origin_Lat	origin_Lon	closest_Bluephone	closest_lat	closest_lon	distance
<chr>	<dbl>	<dbl>	<chr>	<dbl>	<dbl>	<dbl>
Blue Phone 89	49.27075	-123.248	Blue Phone 88	49.27007	-123.2484	80.77666

```
In [14]: bluephone_closest_distance <- as_tibble(filter(Bluephone_distance, Bluephone_origin == "Blue Phone 89"))
bluephone_closest_distance
```

A tibble: 0 × 7

Bluephone_origin	origin_Lat	origin_Lon	closest_Bluephone	closest_lat	closest_lon	distance
<chr>	<dbl>	<dbl>	<chr>	<dbl>	<dbl>	<dbl>


```

In [15]: bluephone_closest_distance <- filter(Bluephone_distance, Bluephone_origin =
options(dplyr.summarise.inform = FALSE) #disable dplyr messages in code

for (i in 1:89){
  first_bluephone <- Bluephone_location[i, ]
  first_bluephone_lon_lat <- select(first_bluephone, Longitude, Latitude)
  rest_bluephone <- Bluephone_location |>
    filter(Latitude != pull(first_bluephone, Latitude))

  Bluephone_distance <- rest_bluephone |>
    group_by(Formal_Name_and_Room, Latitude, Longitude) |>
    summarize(distance = distGeo(first_bluephone_lon_lat, c(Longitude,
    arrange(distance) |>
    head(1) |>
    mutate(Bluephone_origin = pull(first_bluephone, Formal_Name_and_Room),
           origin_Lat = pull(first_bluephone, Latitude),
           origin_Lon = pull(first_bluephone, Longitude)) |>
    select(Bluephone_origin, origin_Lat, origin_Lon, Formal_Name_and_Room)

  colnames(Bluephone_distance) <- c("Bluephone_origin", "origin_Lat", "origin_Lon",
    "closest_Bluephone", "closest_lat", "closest_lon")

  bluephone_closest_distance <- bind_rows(bluephone_closest_distance, Bluephone_distance)
}

head(bluephone_closest_distance)

```

A grouped_df: 6 × 7

Bluephone_origin	origin_Lat	origin_Lon	closest_Bluephone	closest_lat	closest_lon	distance
<chr>	<dbl>	<dbl>	<chr>	<dbl>	<dbl>	<dbl>
Blue Phone 01 ANSOC @ Northwest Marine Drive	49.26973	-123.2572	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	55.42414
Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	49.26894	-123.2566	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	56.72429
Blue Phone 04 Wyman Plaza @ Main Mall & Memorial Road	49.26777	-123.2550	Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	49.26894	-123.2566	171.26136
Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	49.26497	-123.2575	Blue Phone 48 Fraser River Parkade South West Level 1	49.26568	-123.2583	94.76914
Blue Phone 06 Ponderosa A @ West Mall & Agricultural Road	49.26534	-123.2562	Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	49.26497	-123.2575	103.17813
Blue Phone 07 Hennings @ East Mall & Agricultural Road	49.26697	-123.2518	Blue Phone 41 Thunderbird Park pedestrian pathway near Soccer Centre	49.26753	-123.2527	87.78280

```
In [16]: write_csv(bluephone_closest_distance, file = "data/Each Bluephone Distance
```

```
In [17]: #rename from the formal name to index
bluephone_closest_distance_renamed <- bluephone_closest_distance |>
  mutate(Bluephone_No = substr(Bluephone_origin, 11, 13)) |>
  mutate(across(Bluephone_No, as.integer)) |>
  select(Bluephone_No, origin_Lat, origin_Lon, closest_Bluephone, closest
head(bluephone_closest_distance_renamed)
```

A grouped_df: 6 × 7

Bluephone_No	origin_Lat	origin_Lon	closest_Bluephone	closest_lat	closest_lon	distance
<int>	<dbl>	<dbl>	<chr>	<dbl>	<dbl>	<dbl>
1	49.26973	-123.2572	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	55.42414
3	49.26894	-123.2566	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	56.72429
4	49.26777	-123.2550	Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	49.26894	-123.2566	171.26136
5	49.26497	-123.2575	Blue Phone 48 Fraser River Parkade South West Level 1	49.26568	-123.2583	94.76914
6	49.26534	-123.2562	Blue Phone 05 Ponderosa F @ Lower Mall & Pedestrian Path	49.26497	-123.2575	103.17813
7	49.26697	-123.2518	Blue Phone 41 Thunderbird Park pedestrian pathway near Soccer Centre	49.26753	-123.2527	87.78280

```
In [18]: arranged_bluephone_closest_distance <- bluephone_closest_distance_renamed |
         arrange(desc(distance))
         head(arranged_bluephone_closest_distance, n = 15)
```

A grouped_df: 15 × 7

Bluephone_No	origin_Lat	origin_Lon	closest_Bluephone	closest_lat	closest_lon	distance
<int>	<dbl>	<dbl>	<chr>	<dbl>	<dbl>	<dbl>
17	49.25758	-123.2467	Blue Phone 16 Old Barn Community Centre @ Main Mall & Thunderbird Blvd	49.25932	-123.2481	220.0795
30	49.25846	-123.2507	Blue Phone 16 Old Barn Community Centre @ Main Mall & Thunderbird Blvd	49.25932	-123.2481	206.8730
77	49.26246	-123.2388	Blue Phone 78 Osoyoos Crescent & Oyama Court	49.26072	-123.2382	198.3806
31	49.26008	-123.2456	Blue Phone 33 Pulp & Paper @ East Mall & Agronomy Road	49.26143	-123.2471	185.6423
4	49.26777	-123.2550	Blue Phone 03 Flagpole Plaza @ Main Mall & Crescent Road	49.26894	-123.2566	171.2614
16	49.25932	-123.2481	Blue Phone 14 MacMillan @ Main Mall & Agronomy Rd	49.26053	-123.2495	168.3631
21	49.26616	-123.2537	Blue Phone 07 Hennings @ East Mall & Agricultural Road	49.26697	-123.2518	164.4280
22	49.26948	-123.2544	Blue Phone 62 Rose Garden Parkade Elevator Level 5	49.26945	-123.2566	156.5045
10	49.26471	-123.2523	Blue Phone 20 Chemistry Physics @ East Mall & University Blvd.	49.26575	-123.2508	155.5971
80	49.25967	-123.2352	Blue Phone 79 Point Grey Apartments	49.25961	-123.2373	149.3701
2	49.26789	-123.2583	Blue Phone 23 Fraser River Parkade @ Memorial Rd at Fraser River Parkade	49.26658	-123.2578	149.3273
20	49.26575	-123.2508	Blue Phone 81 University Blvd Lot Stairs 1	49.26659	-123.2493	148.7244
26	49.26421	-123.2549	Blue Phone 25 St. John's @ Lower Mall & University Blvd.	49.26331	-123.2563	143.3557
78	49.26072	-123.2382	Blue Phone 79 Point Grey Apartments	49.25961	-123.2373	140.7909
79	49.25961	-123.2373	Blue Phone 78 Osoyoos Crescent & Oyama Court	49.26072	-123.2382	140.7909

```
In [19]: # calculate the mean of the distance
distance_mean <- bluephone_closest_distance_renamed |>
  pull(distance) |>
  mean()

cat("The distance between each bluephone and its closet bluephone is", dist
```

The distance between each bluephone and its closet bluephone is 88.23234 m.

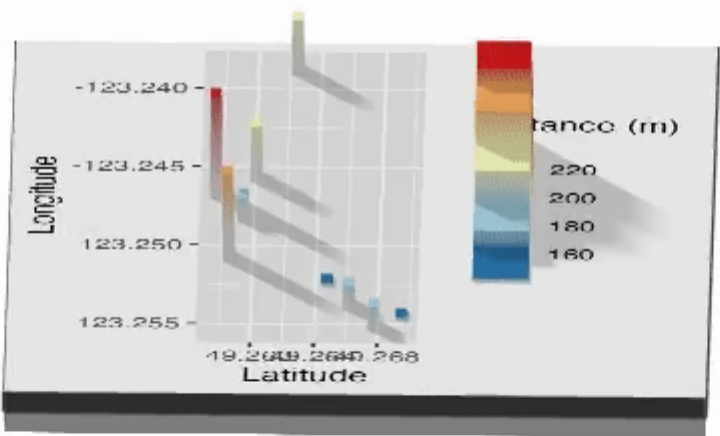
```
In [20]: # 3d bar plot in the exact coordinates locations
arranged_bluephone_closest_distance_9 <- head(arranged_bluephone_closest_di

Barplot_3d <- arranged_bluephone_closest_distance_9 |>
  ggplot(aes(origin_Lat, origin_Lon, fill = distance)) +
  geom_tile() +
  scale_fill_fermenter(type = "div", palette = "RdYlBu") +
  xlab("Latitude") +
  ylab("Longitude") +
  labs(fill = "Distance (m)")

suppressWarnings(plot_gg(Barplot_3d))
```

```
In [21]: suppressWarnings(render_movie(filename = "plot.gif"))
```

'/Users/chengxiansheng/Desktop/Jupyter Notebook/VANT
149/VANT149_Group9_Project/plot.gif.mp4'



```

In [22]: #3d bar plot according to the relative location base on coordinates
df.distance <- data.frame(matrix(NA, nrow=9, ncol=4))
names(df.distance) <- c("x", "y", "z", "z.rank")

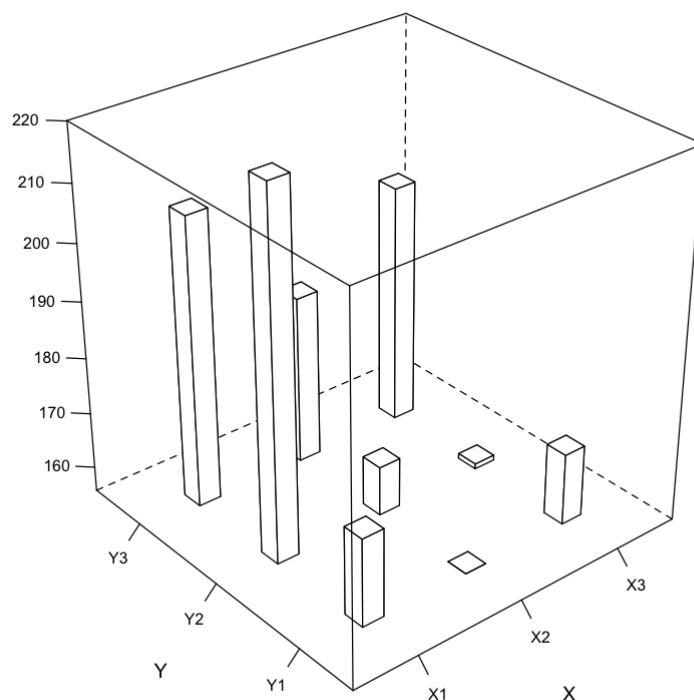
df.distance$x <- factor(rep(c("X1", "X2", "X3"), times=3), levels=c("X1", "
df.distance$y <- factor(rep( paste0("Y", 1:3), each=3), levels=c("Y1", "Y2"
df.distance$z <- pull(arrange(arranged_bluephone_closest_distance_9, Blueph

df.distance$z.rank <- as.numeric(rank(df.distance$z))

p1. <- cloud(z~x+y, data=df.distance, panel.3d.cloud=panel.3dbars,
  ylab="Y", xlab="X", zlab="Z",
  xbase=0.2, ybase=0.2, scales=list(arrows=FALSE, col="black", di
  par.settings = list(axis.line = list(col = "transparent")),
  #screen = list(z = 35, x = -35, y=0),
  alpha.facet = 1.00, border = "transparent",
  zoom=1.00);

print(p1.)

```



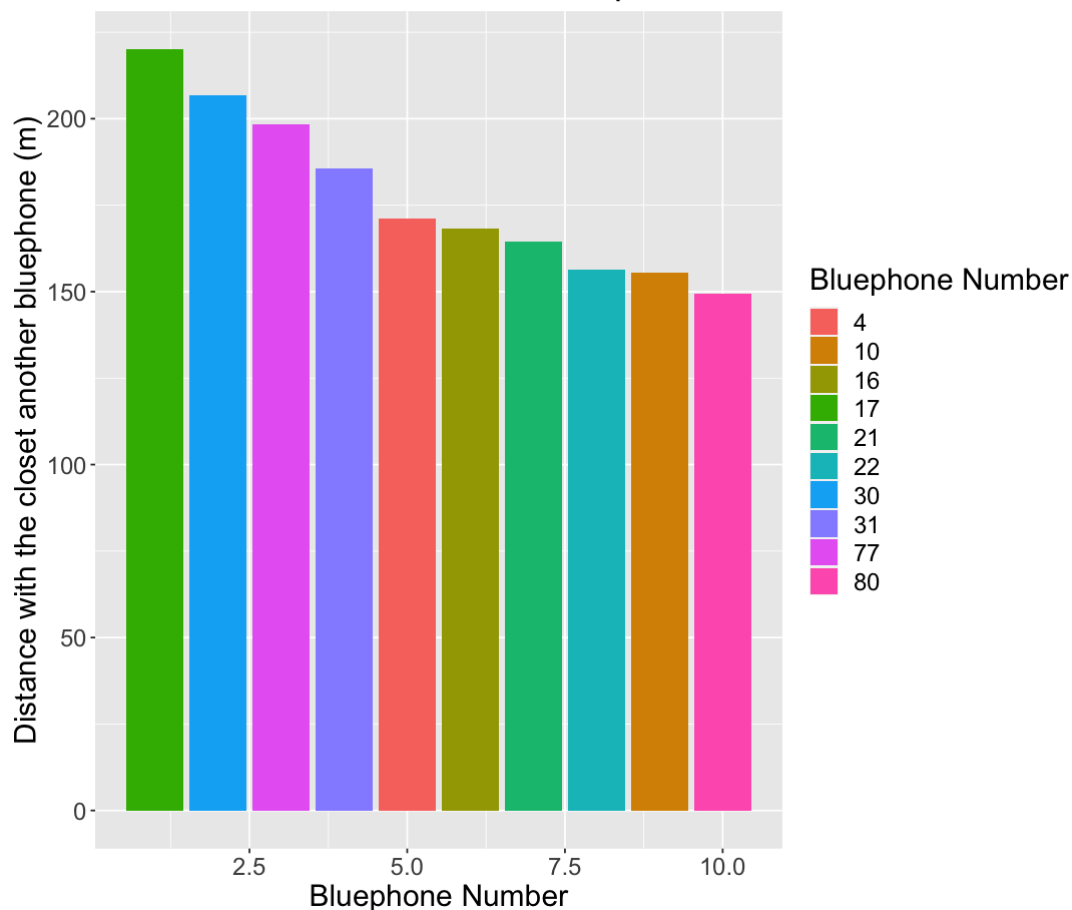

```
In [23]: #plot the distance between the current bluephone and its closet one in 2D
options(repr.plot.height = 8, repr.plot.width = 9)

bluephone_closest_distance_plot <- head(arranged_bluephone_closest_distance
  ggplot(aes(x = c(1:10), y = distance, fill = as_factor(Bluephone_No)))
  geom_bar(stat = "identity", bins = 10) +
  labs(x = "Bluephone Number",
       y = "Distance with the closet another bluephone (m)",
       fill = "Bluephone Number") +
  ggtitle("The distance between each bluephone and its closet one") +
  theme(text = element_text(size = 18))

bluephone_closest_distance_plot
```

Warning message in `geom_bar(stat = "identity", bins = 10)`:
 "Ignoring unknown parameters: `bins`"

The distance between each bluephone and its closet one



```
In [24]: #find the location of the bluephone such that has the maximum distance with
bluephone_distance_max <- bluephone_closest_distance |>
  arrange(desc(distance)) |>
  head(1)

bluephone_distance_max
```

A grouped_df: 1 × 7

Bluephone_origin	origin_Lat	origin_Lon	closest_Bluephone	closest_lat	closest_lon	distance
<chr>	<dbl>	<dbl>	<chr>	<dbl>	<dbl>	<dbl>
Blue Phone 17 Rhododendron Wood @ Main Mall & Eagles Drive	49.25758	-123.2467	Blue Phone 16 Old Barn Community Centre @ Main Mall & Thunderbird Blvd	49.25932	-123.2481	220.0795

```
In [25]: bluephone_distance_max_location <- Bluephone_location |>
  filter(
    Formal_Name_and_Room %in% c(
      "Blue Phone 17 Rhododendron Wood @ M",
      "Blue Phone 16 Old Barn Community Ce",
      "Blue Phone 30 Totem Park @ West Mal",
      "Blue Phone 31 Tennis Centre @ Thund"
    )
  )

bluephone_distance_max_location
```

A tibble: 4 × 4

Formal_Name_and_Room	Street_Address	Latitude	Longitude
<chr>	<chr>	<dbl>	<dbl>
Blue Phone 16 Old Barn Community Centre @ Main Mall & Thunderbird Blvd	6308 THUNDERBIRD Blvd Old Barn Community Ctr	49.25932	-123.2481
Blue Phone 17 Rhododendron Wood @ Main Mall & Eagles Drive	Main Mall	49.25758	-123.2467
Blue Phone 30 Totem Park @ West Mall & Thunderbird Blvd	2525 WEST MALL & THUNDERBIRD Blvd	49.25846	-123.2507
Blue Phone 31 Tennis Centre @ Thunderbird & East Mall	6160 THUNDERBIRD BLVD & EAST MALL	49.26008	-123.2456

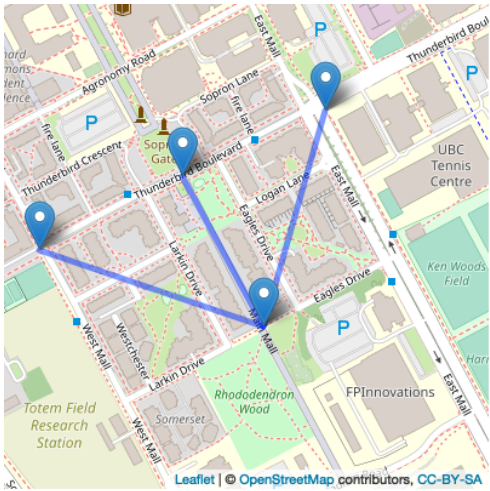
In [26]: *#plot the location on the map*

```
bluephone_map_max_distance <- leaflet(data = bluephone_distance_max_location)
  addTiles() |>
  fitBounds(-123.246, 49.257, -123.248, 49.26) |>
  addMarkers(lng = ~Longitude,
             lat = ~Latitude,
             popup = ~Street_Address,
             label = ~Formal_Name_and_Room) |>
  addMarkers(data = bluephone_distance_max_location,
             lng = ~Longitude,
             lat = ~Latitude,
             popup = ~Street_Address,
             label = ~Formal_Name_and_Room) |>
  addPolylines(data = bluephone_distance_max_location[1:2,], lng = ~Longitude, lat = ~Latitude) |>
  addPolylines(data = bind_rows(bluephone_distance_max_location[2, ],
                                bluephone_distance_max_location[3, ]),
               lng = ~Longitude, lat = ~Latitude) |>
  addPolylines(data = bind_rows(bluephone_distance_max_location[2, ],
                                bluephone_distance_max_location[4, ]),
               lng = ~Longitude, lat = ~Latitude) |>
  addScaleBar()

#bluephone_map_max_distance
```

In [27]: *# mapview image save*

```
mapshot(bluephone_map_max_distance, file = "Map Image Save/Longest_Bluephone_Map.png")
```



In []: