Assignment Final

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Quarto

Quarto enables you to weave together content and executable code into a finished document. To learn more about Quarto see https://quarto.org.

Data: Birds observed at feeding stations in USA

Data Sets: PFW_count_site_data_public_2021 (Site description data) and PFW_2021_public (Observation data)

Data Wrangling activities done using Tidyverse packages such as Dplyr and tidyr

```
1 + 1
```

```
[1] 2
```

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.4     v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to beco
```

Call data sets

```
Dataset_1 <- read.csv("PFW_2021_Public.csv")
```

```
Dataset_2 <- read.csv("PFW_count_site_data_public_2021.csv")
```

Check the structure of data sets

```
str(Dataset_1)
```

```
'data.frame':   100000 obs. of  22 variables:
 $ loc_id            : chr  "L981010" "L3161698" "L13210778" "L13258348" ...
 $ latitude          : num  52.1 43.8 39.7 42.2 32.7 ...
 $ longitude         : num  -122.1 -123.1 -75.9 -83.7 -79.9 ...
 $ subnational1_code : chr  "CA-BC" "US-OR" "US-MD" "US-MI" ...
 $ entry_technique   : chr  "POSTCODE LAT/LONG LOOKUP" "/GOOGLE_MAP/ZOOM:18" "/GOOGLE_MAP/ZO
 $ sub_id            : chr  "S83206450" "S78031190" "S81318993" "S79251313" ...
 $ obs_id            : chr  "OBS1092604618" "OBS1036509564" "OBS1073386105" "OBS1051702542"
 $ Month             : int  3 12 2 1 1 3 1 4 11 1 ...
 $ Day               : int  4 19 13 13 11 13 23 23 28 2 ...
 $ Year              : int  2021 2020 2021 2021 2021 2021 2021 2021 2020 2021 ...
 $ PROJ_PERIOD_ID    : chr  "PFW_2021" "PFW_2021" "PFW_2021" "PFW_2021" ...
 $ species_code      : chr  "amegfi" "moudov" "tuftit" "houspa" ...
 $ how_many          : int  20 11 2 2 10 2 5 2 6 9 ...
 $ valid             : int  1 1 1 1 1 1 1 0 1 1 ...
 $ reviewed          : int  0 0 0 0 0 0 0 0 0 0 ...
 $ day1_am           : int  1 1 1 1 1 1 1 1 1 1 ...
 $ day1_pm           : int  0 1 1 1 1 1 1 1 1 1 ...
 $ day2_am           : int  1 1 1 1 1 1 1 1 1 1 ...
 $ day2_pm           : int  0 1 1 1 1 1 1 1 1 1 ...
 $ effort_hrs_atleast: num  1 1 8 4 1 ...
 $ snow_dep_atleast  : num  5 0 5 0 0 ...
 $ Data_Entry_Method : chr  "PFW Web 4.1.4" "PFW Web 4.1.4" "PFW Web 4.1.4" "PFW Web 4.1.4"
```

```
str(Dataset_2)
```

```
'data.frame':   254355 obs. of  62 variables:
 $ loc_id                      : chr  "L100016" "L100016" "L100016" "L100016" ...
 $ proj_period_id              : chr  "PFW_2002" "PFW_2003" "PFW_2004" "PFW_2005" ...
 $ yard_type_pavement          : int  0 0 0 0 0 0 0 0 0 0 ...
 $ yard_type_garden            : int  0 0 0 0 0 0 0 0 0 0 ...
 $ yard_type_landsca           : int  1 1 1 1 1 1 0 0 0 0 ...
 $ yard_type_woods             : int  0 0 0 0 0 0 1 1 1 1 ...
 $ yard_type_desert            : int  0 0 0 0 0 0 0 0 0 0 ...
 $ hab_dcid_woods              : int  1 1 1 1 1 1 1 1 1 1 ...
 $ hab_evgr_woods              : int  NA NA NA NA 0 0 NA NA NA NA ...
 $ hab_mixed_woods             : int  1 1 1 1 1 1 NA NA NA NA ...
 $ hab_orchard                 : int  NA NA NA NA 0 0 NA NA NA NA ...
 $ hab_park                    : int  NA NA NA NA 0 0 NA NA NA NA ...
 $ hab_water_fresh             : int  1 1 1 1 1 1 1 1 1 1 ...
 $ hab_water_salt              : int  NA NA NA NA 0 0 NA NA NA NA ...
 $ hab_residential             : int  1 1 1 1 1 1 NA NA NA NA ...
 $ hab_industrial              : int  NA NA NA NA 0 0 NA NA NA NA ...
```

```
$ hab_agricultural            : int  1 1 1 1 1 1 NA NA NA NA ...
$ hab_desert_scrub            : int  NA NA NA NA 0 0 NA NA NA NA ...
$ hab_young_woods             : int  NA NA NA NA 0 0 NA NA NA NA ...
$ hab_swamp                   : int  NA NA NA NA 0 0 NA NA NA NA ...
$ hab_marsh                   : int  1 1 1 1 1 1 NA NA NA NA ...
$ evgr_trees_atleast          : int  11 11 11 11 11 11 0 0 0 4 ...
$ evgr_shrbs_atleast          : int  4 4 4 4 1 1 1 1 1 1 ...
$ dcid_trees_atleast          : int  11 11 11 11 1 1 11 11 11 11 ...
$ dcid_shrbs_atleast          : int  4 4 4 4 4 4 11 11 11 11 ...
$ fru_trees_atleast           : int  4 4 4 4 1 1 1 1 1 1 ...
$ cacti_atleast               : int  0 0 0 0 0 0 0 0 0 0 ...
$ brsh_piles_atleast          : int  0 0 0 0 0 0 1 1 1 1 ...
$ water_srcs_atleast          : int  1 1 1 1 1 1 0 0 0 0 ...
$ bird_baths_atleast          : int  0 0 0 0 0 0 1 1 1 1 ...
$ nearby_feeders              : int  0 1 1 1 0 0 1 0 1 1 ...
$ squirrels                   : int  0 0 0 0 0 0 1 1 1 1 ...
$ cats                        : int  0 1 1 1 1 1 1 0 0 0 ...
$ dogs                        : int  0 0 0 0 0 0 0 1 0 0 0 ...
$ humans                      : int  0 0 0 0 0 0 1 1 1 0 1 ...
$ housing_density             : int  2 2 2 2 2 2 2 1 1 1 1 ...
$ fed_yr_round                : int  0 0 0 0 NA NA 1 1 1 1 ...
$ fed_in_jan                  : int  1 1 1 1 1 1 1 1 1 1 ...
$ fed_in_feb                  : int  1 1 1 1 1 1 1 1 1 1 ...
$ fed_in_mar                  : int  1 1 1 1 1 1 1 1 1 1 ...
$ fed_in_apr                  : int  1 1 1 1 1 0 1 1 1 1 ...
$ fed_in_may                  : int  0 0 0 0 0 0 0 1 1 1 1 ...
$ fed_in_jun                  : int  0 0 0 0 0 0 0 1 1 1 1 ...
$ fed_in_jul                  : int  0 0 0 0 0 0 0 1 1 1 1 ...
$ fed_in_aug                  : int  0 0 0 0 0 0 0 1 1 1 1 ...
$ fed_in_sep                  : int  0 0 0 0 0 0 0 1 1 1 1 ...
$ fed_in_oct                  : int  0 0 0 0 0 0 0 1 1 1 1 ...
$ fed_in_nov                  : int  1 1 1 1 1 1 1 1 1 1 1 ...
$ fed_in_dec                  : int  1 1 1 1 1 1 1 1 1 1 1 ...
$ numfeeders_suet             : int  1 1 1 1 1 1 3 3 3 3 ...
$ numfeeders_ground           : int  NA 0 0 0 NA NA 1 1 1 1 ...
$ numfeeders_hanging          : int  1 1 1 3 NA NA 2 2 2 2 ...
$ numfeeders_platfrm          : int  1 1 1 0 NA NA 1 1 1 2 ...
$ numfeeders_humming          : int  NA 0 0 0 NA NA 1 1 1 1 ...
$ numfeeders_water            : int  1 1 1 1 NA NA 2 2 2 2 ...
$ numfeeders_thistle          : int  NA 0 0 0 NA NA 1 1 1 2 ...
$ numfeeders_fruit            : int  NA 0 0 0 NA NA 1 1 1 1 ...
$ numfeeders_hopper           : int  NA NA NA NA 1 1 NA NA NA NA ...
$ numfeeders_tube             : int  NA NA NA NA 1 1 NA NA NA NA ...
$ numfeeders_other            : int  NA NA NA NA NA NA NA NA NA NA ...
$ population_atleast          : int  1 1 1 1 1 1 1 1 1 1 ...
$ count_area_size_sq_m_atleast: num  1.01 1.01 1.01 1.01 1.01 ...
```

Description of data sets

Looks like both are long data sets

Entered by many data sources with varying levels of credibility hence high chances of error or bias

However, the data set has validation data which if done thoroughly has potential to reduce error

Data manipulations

Pivot Wider data with selected columns Check vaiables names to select for analysis

```
names(Dataset_1)
```

```
 [1] "loc_id"             "latitude"           "longitude"
 [4] "subnational1_code"  "entry_technique"    "sub_id"
 [7] "obs_id"             "Month"              "Day"
[10] "Year"               "PROJ_PERIOD_ID"     "species_code"
[13] "how_many"           "valid"              "reviewed"
[16] "day1_am"            "day1_pm"            "day2_am"
[19] "day2_pm"            "effort_hrs_atleast" "snow_dep_atleast"
[22] "Data_Entry_Method"
```

Run pivot wider for Dataset1 but only For loc_id,obs_id and how_many

```
wider_Data_1 <- Dataset_1 %>%
select(loc_id,obs_id, how_many) %>%
  pivot_wider(names_from = loc_id,
              values_from = how_many)
```

An overview of the created wider data set

```
head(wider_Data_1)
```

```
# A tibble: 6 x 15,291
  obs_id   L981010 L3161698 L13210778 L13258348 L149639 L10140349 L74629 L162342
  <chr>      <int>    <int>     <int>     <int>   <int>     <int>  <int>   <int>
1 OBS1092~      20       NA        NA        NA      NA        NA     NA      NA
2 OBS1036~      NA       11        NA        NA      NA        NA     NA      NA
3 OBS1073~      NA       NA         2        NA      NA        NA     NA      NA
4 OBS1051~      NA       NA        NA         2      NA        NA     NA      NA
5 OBS1050~      NA       NA        NA        NA      10        NA     NA      NA
6 OBS1095~      NA       NA        NA        NA      NA         2     NA      NA
# i 15,282 more variables: L189158 <int>, L19251 <int>, L28977 <int>,
```

```
#   L12797578 <int>, L12711146 <int>, L162530 <int>, L272593 <int>,
#   L10162485 <int>, L10227242 <int>, L1319717 <int>, L1793922 <int>,
#   L12730203 <int>, L12755092 <int>, L5147006 <int>, L12740683 <int>,
#   L10768239 <int>, L8193205 <int>, L78156 <int>, L8927802 <int>,
#   L13831719 <int>, L12815327 <int>, L77181 <int>, L281817 <int>,
#   L12629725 <int>, L664025 <int>, L2409840 <int>, L13477384 <int>, ...
```

Not very useful- a lot of empty cells!

Data wrangling continued- Selecting a few variables(loc_id, subnational1_code, obs_id, Month, Year, species_code, how_many) to work with from Dataset1 and call it Subset_1

```
Subset_1 <- Dataset_1 %>%
  select(loc_id, subnational1_code, obs_id, Month, Year, species_code, how_many)
```

Combined subnational codes of Subset_1 by prefixes

```
combined_natnlcodes2 <- Subset_1 %>%
  mutate(prefix = str_extract(subnational1_code, "^[A-Z]{2}")) %>%
  group_by(prefix)
```

Rename some variables

```
combined_natnlcodes2 <- combined_natnlcodes2 %>% rename(Country = prefix, Counts = how_many)
```

Visualisations, Draw 3/4 Graphs and a combination plot

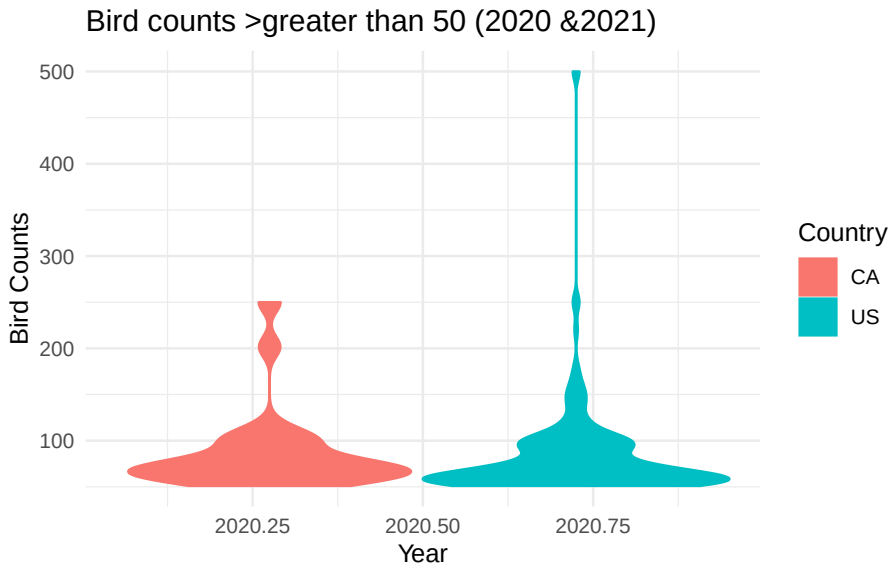
Data set too big for distinct figures- Filter for analysis (Subset_2)

```
Subset_2 <- combined_natnlcodes2 %>%
 select(loc_id, Country, obs_id, Month, Year, species_code, Counts) %>%
  filter(Counts >50)
```

Create a violin plot (plot1)

```
plot1 <- ggplot(Subset_2, aes(x = Year, y = Counts, color = Country)) +
  geom_violin(aes(fill = Country)) +
  labs(title = "Bird counts >greater than 50 (2020 &2021)",
       x = "Year",
       y = "Bird Counts",
       fill = "Country") +
```

```
  theme_minimal()
print(plot1)
```



Create a figure showing the proportion representation of top species per country of sighting counts

Filter out the N/A from the country data

```
combined_natnlcodes2 <- combined_natnlcodes2 %>% filter(!is.na(Country))
```

Then aggregate the data

```
 agg_data <- combined_natnlcodes2 %>%
  group_by(Country, species_code) %>%
  summarise(total_counts = sum(Counts)) %>%
  ungroup()
```

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

Calculate proportion of each species for each country

```
proptn1 <- agg_data %>%
  group_by(Country) %>%
  mutate(proportion = total_counts / sum(total_counts)) %>%
  ungroup()
```

Now filter out the highest proportion- top species per country + rename the species

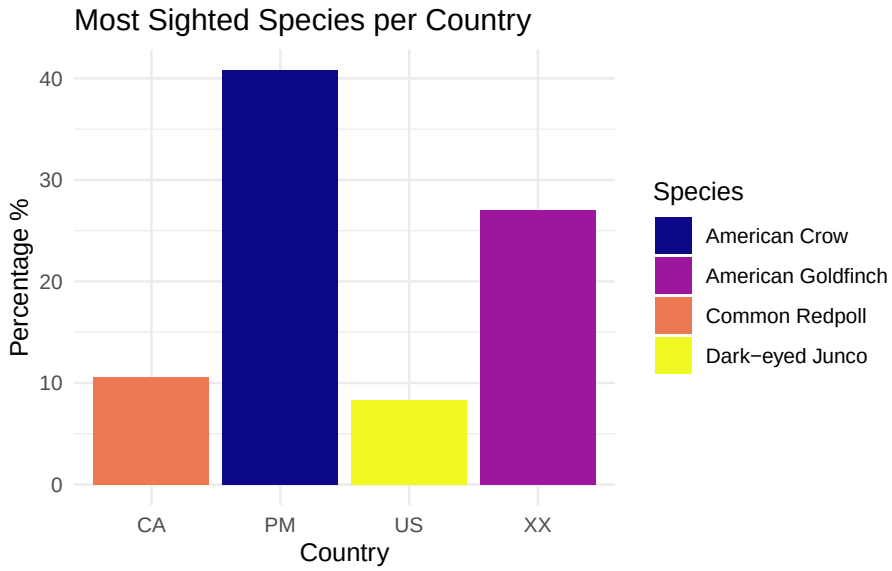
```
Top_species <- proptn1 %>%
  group_by(Country) %>%
  filter(proportion == max(proportion)) %>%
  ungroup() %>%
   mutate(species_code = case_when(
    species_code == "amecro" ~ "American Crow",
    species_code == "amegfi" ~ "American Goldfinch",
    species_code == "comred" ~ "Common Redpoll",
    species_code == "daejun" ~ "Dark-eyed Junco",
    TRUE ~ species_code
  ))
```

Convert proportions to percentage (preference)

```
Top_species <- Top_species %>%
  mutate(percentage = proportion* 100)
```

Now plot the graph with colorblind consideration

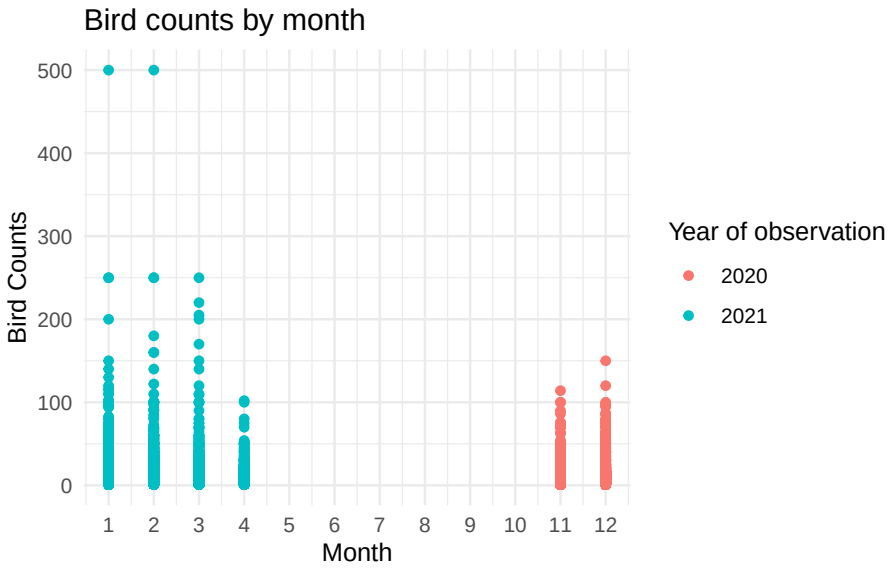
```
plot2 <- ggplot(Top_species, aes(x = Country, y = percentage, fill = species_code)) +
  geom_bar(stat = "identity") +
  labs(title = "Most Sighted Species per Country",
       x = "Country",
       y = "Percentage %",
       fill = "Species") +
  scale_fill_viridis_d(option = "plasma") +
  theme_minimal()
print(plot2)
```



*Country PM: Palau- Western Pacific Ocean

Scatter plot

```
plot3 <- ggplot(
  data = combined_natnlcodes2,
  mapping = aes(x = Month, y = Counts)
) +
  geom_point(aes(color = factor(Year))) +
  scale_x_continuous(breaks = seq(min(combined_natnlcodes2$Month), max(combined_natnlcodes2$
  labs(
    title = "Bird counts by month",
    x = "Month",
    y = "Bird Counts",
    color = "Year of observation"
  ) +
  theme_minimal()
print(plot3)
```

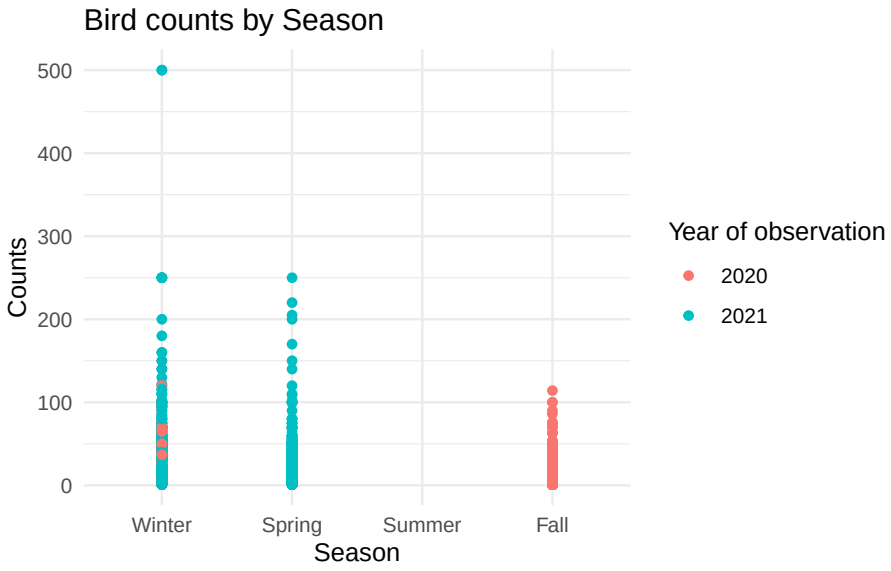


Change months to seasons in America

```
combined_natnlcodes2S <- combined_natnlcodes2 %>%
  mutate(Season = case_when(
    Month %in% c(12, 1, 2) ~ "Winter",
    Month %in% c(3, 4, 5) ~ "Spring",
    Month %in% c(6, 7, 8) ~ "Summer",
    Month %in% c(9, 10, 11) ~ "Fall"
  ))
```

Plot the new figure

```
plot3b <- ggplot(
  data = combined_natnlcodes2S,
  mapping = aes(x = Season, y = Counts)
) +
  geom_point(aes(color = factor(Year))) +
  scale_x_discrete(limits = c("Winter", "Spring", "Summer", "Fall")) +
  labs(title = "Bird counts by Season", x = "Season", y = "Counts", color = "Year of observa
  theme_minimal()
print(plot3b)
```



Missing package-Install cowplot

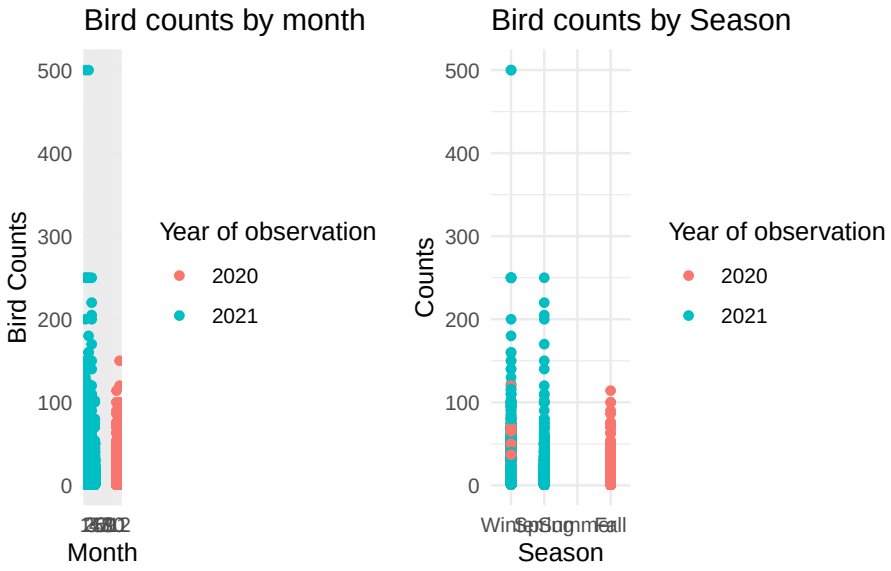
```
#install.packages("cowplot")
library(cowplot)
```

```
Attaching package: 'cowplot'
```

```
The following object is masked from 'package:lubridate':

    stamp
```

Arrange the two related plots in one figure

```
plot3F <- plot_grid(plot3, plot3b, ncol = 2, rel_widths = c(2.0, 2.5))
print(plot3F)
```




```
Dataset_2NA<- Dataset_2 %>% filter(!is.na(nearby_feeders))
```

```
summary(Dataset_2NA)
```

```
   loc_id          proj_period_id     yard_type_pavement yard_type_garden
Length:224869      Length:224869      Min.   :0          Min.   :0.00
Class :character   Class :character   1st Qu.:0          1st Qu.:0.00
Mode  :character   Mode  :character   Median :0          Median :0.00
                                      Mean   :0          Mean   :0.04
                                      3rd Qu.:0          3rd Qu.:0.00
                                      Max.   :1          Max.   :1.00
                                      NA's   :48324      NA's   :48095
yard_type_landsca yard_type_woods yard_type_desert hab_dcid_woods
Min.   :0.00      Min.   :0.00    Min.   :0.00     Min.   :0.00
1st Qu.:1.00      1st Qu.:0.00    1st Qu.:0.00     1st Qu.:0.00
Median :1.00      Median :1.00    Median :0.00     Median :0.00
Mean   :0.82      Mean   :0.61    Mean   :0.01     Mean   :0.49
3rd Qu.:1.00      3rd Qu.:1.00    3rd Qu.:0.00     3rd Qu.:1.00
Max.   :1.00      Max.   :1.00    Max.   :1.00     Max.   :1.00
NA's   :46014     NA's   :48048   NA's   :48303    NA's   :32080
hab_evgr_woods  hab_mixed_woods  hab_orchard      hab_park
Min.   :0.00    Min.   :0.000   Min.   :0.00    Min.   :0.00
1st Qu.:0.00    1st Qu.:0.000   1st Qu.:0.00    1st Qu.:0.00
Median :0.00    Median :1.000   Median :0.00    Median :0.00
Mean   :0.22    Mean   :0.648   Mean   :0.09    Mean   :0.44
3rd Qu.:0.00    3rd Qu.:1.000   3rd Qu.:0.00    3rd Qu.:1.00
Max.   :1.00    Max.   :1.000   Max.   :1.00    Max.   :1.00
```

```
NA's   :40766   NA's   :28185   NA's   :57772   NA's   :96514
hab_water_fresh hab_water_salt  hab_residential hab_industrial
Min.   :0.0     Min.   :0.00    Min.   :0.000   Min.   :0.00
1st Qu.:0.0     1st Qu.:0.00    1st Qu.:1.000   1st Qu.:0.00
Median :1.0     Median :0.00    Median :1.000   Median :0.00
Mean   :0.6     Mean   :0.05    Mean   :0.868   Mean   :0.22
3rd Qu.:1.0     3rd Qu.:0.00    3rd Qu.:1.000   3rd Qu.:0.00
Max.   :1.0     Max.   :1.00    Max.   :1.000   Max.   :1.00
NA's   :32117   NA's   :54458   NA's   :24812   NA's   :40328
hab_agricultural hab_desert_scrub hab_young_woods   hab_swamp
Min.   :0.0      Min.   :0.00     Min.   :0.00    Min.   :0.00
1st Qu.:0.0      1st Qu.:0.00     1st Qu.:0.00    1st Qu.:0.00
Median :0.0      Median :0.00     Median :0.00    Median :0.00
Mean   :0.4      Mean   :0.09     Mean   :0.34    Mean   :0.28
3rd Qu.:1.0      3rd Qu.:0.00     3rd Qu.:1.00    3rd Qu.:1.00
Max.   :1.0      Max.   :1.00     Max.   :1.00    Max.   :1.00
NA's   :61402    NA's   :54385    NA's   :63335   NA's   :94232
  hab_marsh     evgr_trees_atleast evgr_shrbs_atleast dcid_trees_atleast
Min.   :0.00    Min.   : 0         Min.   : 0.000     Min.   : 0.000
1st Qu.:0.00    1st Qu.: 1         1st Qu.: 1.000     1st Qu.: 3.000
Median :0.00    Median : 3         Median : 3.000     Median : 4.000
Mean   :0.17    Mean   : 4         Mean   : 3.632     Mean   : 5.612
3rd Qu.:0.00    3rd Qu.: 4         3rd Qu.: 4.000     3rd Qu.:11.000
Max.   :1.00    Max.   :11         Max.   :11.000     Max.   :11.000
NA's   :69250   NA's   :18667      NA's   :21370      NA's   :17372
dcid_shrbs_atleast fru_trees_atleast cacti_atleast   brsh_piles_atleast
Min.   : 0.000     Min.   : 0.00     Min.   : 0.0    Min.   : 0.00
1st Qu.: 1.000     1st Qu.: 1.00     1st Qu.: 0.0    1st Qu.: 0.00
Median : 4.000     Median : 1.00     Median : 0.0    Median : 1.00
Mean   : 4.971     Mean   : 2.37     Mean   : 0.2    Mean   : 1.03
3rd Qu.:11.000     3rd Qu.: 4.00     3rd Qu.: 0.0    3rd Qu.: 1.00
Max.   :11.000     Max.   :11.00     Max.   :11.0    Max.   :11.00
NA's   :20327      NA's   :43356     NA's   :38855   NA's   :35094
water_srcs_atleast bird_baths_atleast nearby_feeders     squirrels
Min.   : 0.00      Min.   : 0.00      Min.   :0.0000   Min.   :0.0000
1st Qu.: 0.00      1st Qu.: 0.00      1st Qu.:0.0000   1st Qu.:1.0000
Median : 0.00      Median : 1.00      Median :0.0000   Median :1.0000
Mean   : 0.39      Mean   : 0.88      Mean   :0.4364   Mean   :0.7982
3rd Qu.: 1.00      3rd Qu.: 1.00      3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :11.00      Max.   :11.00      Max.   :1.0000   Max.   :1.0000
NA's   :50422      NA's   :46041                       NA's   :2538
     cats            dogs           humans      housing_density
Min.   :0.000   Min.   :0.000   Min.   :0.000   Min.   :1.000
1st Qu.:0.000   1st Qu.:0.000   1st Qu.:1.000   1st Qu.:1.000
Median :1.000   Median :1.000   Median :1.000   Median :2.000
Mean   :0.538   Mean   :0.532   Mean   :0.809   Mean   :2.189
```

```
3rd Qu.:1.000   3rd Qu.:1.000   3rd Qu.:1.000   3rd Qu.:3.000
Max.   :1.000   Max.   :1.000   Max.   :1.000   Max.   :4.000
NA's   :14319   NA's   :15814   NA's   :8813    NA's   :15347
 fed_yr_round      fed_in_jan      fed_in_feb      fed_in_mar
Min.   :0.00     Min.   :0.00    Min.   :0.00    Min.   :0.00
1st Qu.:1.00     1st Qu.:1.00    1st Qu.:1.00    1st Qu.:1.00
Median :1.00     Median :1.00    Median :1.00    Median :1.00
Mean   :0.78     Mean   :0.93    Mean   :0.93    Mean   :0.92
3rd Qu.:1.00     3rd Qu.:1.00    3rd Qu.:1.00    3rd Qu.:1.00
Max.   :1.00     Max.   :1.00    Max.   :1.00    Max.   :1.00
NA's   :144834   NA's   :40682   NA's   :40757   NA's   :40808
  fed_in_apr      fed_in_may      fed_in_jun      fed_in_jul
Min.   :0.00    Min.   :0.00    Min.   :0.0     Min.   :0.00
1st Qu.:1.00    1st Qu.:1.00    1st Qu.:0.0     1st Qu.:0.00
Median :1.00    Median :1.00    Median :1.0     Median :1.00
Mean   :0.89    Mean   :0.76    Mean   :0.7     Mean   :0.67
3rd Qu.:1.00    3rd Qu.:1.00    3rd Qu.:1.0     3rd Qu.:1.00
Max.   :1.00    Max.   :1.00    Max.   :1.0     Max.   :1.00
NA's   :41511   NA's   :43339   NA's   :44340   NA's   :44711
  fed_in_aug      fed_in_sep      fed_in_oct      fed_in_nov
Min.   :0.00    Min.   :0.00    Min.   :0.00    Min.   :0.00
1st Qu.:0.00    1st Qu.:0.00    1st Qu.:1.00    1st Qu.:1.00
Median :1.00    Median :1.00    Median :1.00    Median :1.00
Mean   :0.67    Mean   :0.74    Mean   :0.84    Mean   :0.93
3rd Qu.:1.00    3rd Qu.:1.00    3rd Qu.:1.00    3rd Qu.:1.00
Max.   :1.00    Max.   :1.00    Max.   :1.00    Max.   :1.00
NA's   :44632   NA's   :43616   NA's   :41998   NA's   :40313
  fed_in_dec    numfeeders_suet     numfeeders_ground numfeeders_hanging
Min.   :0.00    Min.   :    0.000   Min.   : 0.000    Min.   : 0.00
1st Qu.:1.00    1st Qu.:    1.000   1st Qu.: 0.000    1st Qu.: 1.00
Median :1.00    Median :    1.000   Median : 1.000    Median : 2.00
Mean   :0.93    Mean   :    1.672   Mean   : 1.254    Mean   : 2.71
3rd Qu.:1.00    3rd Qu.:    2.000   3rd Qu.: 2.000    3rd Qu.: 4.00
Max.   :1.00    Max.   :14850.000   Max.   :76.000    Max.   :55.00
NA's   :40541   NA's   :9523        NA's   :26590     NA's   :127794
numfeeders_platfrm numfeeders_humming numfeeders_water numfeeders_thistle
Min.   :  0.00     Min.   : 0.0       Min.   : 0.00    Min.   : 0.00
1st Qu.:  0.00     1st Qu.: 0.0       1st Qu.: 0.00    1st Qu.: 0.00
Median :  1.00     Median : 0.0       Median : 1.00    Median : 1.00
Mean   :  1.02     Mean   : 0.5       Mean   : 0.79    Mean   : 1.01
3rd Qu.:  1.00     3rd Qu.: 1.0       3rd Qu.: 1.00    3rd Qu.: 1.00
Max.   :111.00     Max.   :40.0       Max.   :20.00    Max.   :50.00
NA's   :29797      NA's   :42330      NA's   :132607   NA's   :157084
numfeeders_fruit numfeeders_hopper numfeeders_tube  numfeeders_other
Min.   :  0.00   Min.   :  0.00    Min.   :  0.00   Min.   : 0.00
1st Qu.:  0.00   1st Qu.:  0.00    1st Qu.:  1.00   1st Qu.: 0.00
```

```
 Median :  0.00   Median :  1.00    Median :  2.00   Median : 0.00
 Mean   :  0.14   Mean   :  1.35    Mean   :  2.14   Mean   : 0.58
 3rd Qu.:  0.00   3rd Qu.:  2.00    3rd Qu.:  3.00   3rd Qu.: 1.00
 Max.   :112.00   Max.   :211.00    Max.   :104.00   Max.   :99.00
 NA's   :77543    NA's   :114942    NA's   :105008   NA's   :135761
 population_atleast count_area_size_sq_m_atleast
 Min.   :     1     Min.   :  0.01
 1st Qu.:     1     1st Qu.:  1.01
 Median :  5001     Median :100.01
 Mean   : 25300     Mean   :126.02
 3rd Qu.: 25001     3rd Qu.:100.01
 Max.   :100001     Max.   :375.01
 NA's   :19870      NA's   :17983
```

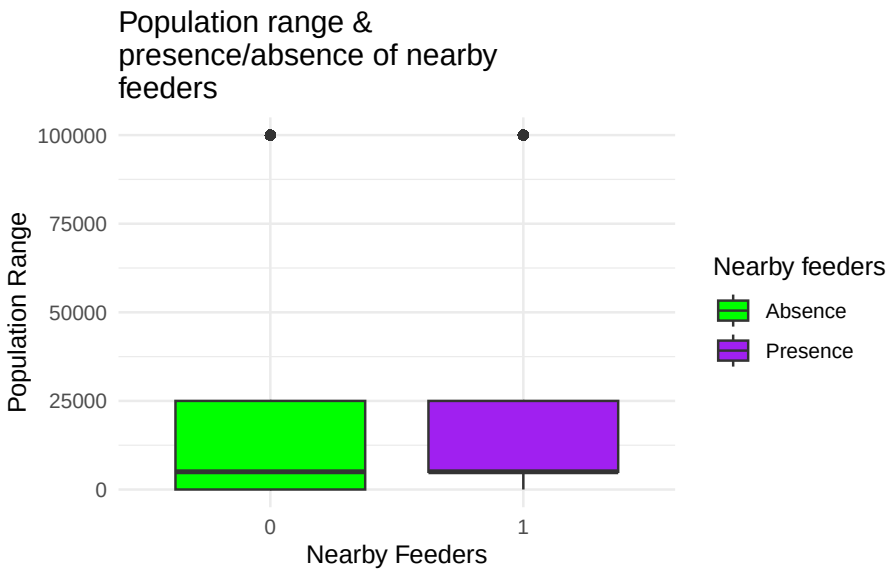
Remove all non finite entries

```
Dataset_2NAF <- Dataset_2NA %>%
  filter(is.finite(population_atleast) & is.finite(nearby_feeders))
```

Wrap the title

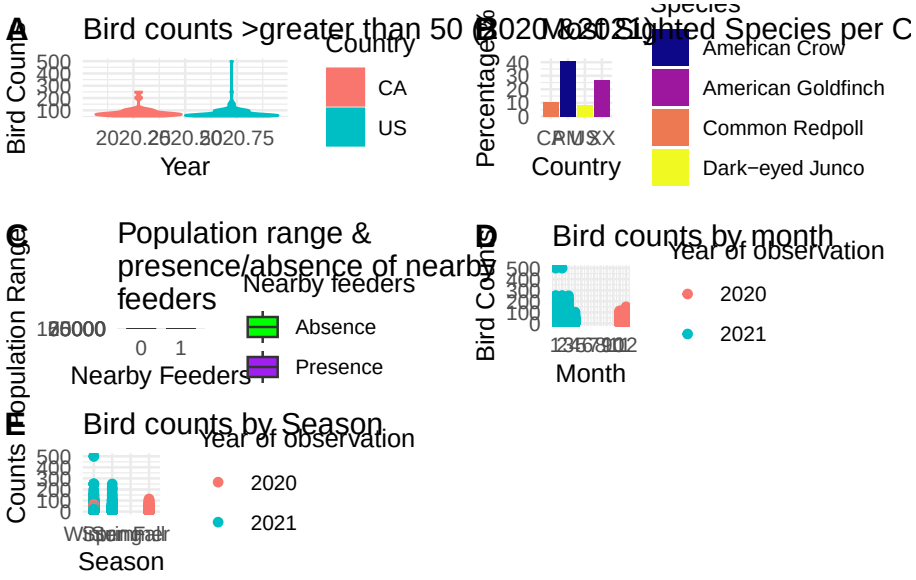
```
wrapped_title <- str_wrap("Population range & presence/absence of nearby feeders", width = 3
```

```
plot4 <- ggplot(
  data = Dataset_2NAF,
  aes(x = factor(nearby_feeders), y = population_atleast, fill = factor(nearby_feeders))
) +
  geom_boxplot() +
  scale_fill_manual(values = c("0" = "green", "1" = "purple"), labels = c("0" = "Absence", "
  labs(
    title = wrapped_title,
    x = "Nearby Feeders",
    y = "Population Range",
    fill = "Nearby feeders"
  ) +
  theme_minimal()

print(plot4)
```



Combine the plots

```
Combined_plot <- plot_grid(
  plot1, NULL, plot2,
  NULL, NULL, NULL,
  plot4, NULL, plot3,
  plot3b,
  ncol = 3, nrow = 4,
  rel_widths = c(2, 0.1, 2),
  rel_heights = c(1, 0.1, 1),
  labels = c("A", "", "B", "", "", "", "C", "", "D", "E")
)

print(Combined_plot)
```



Creating a map in R

```
library (sf)
```

```
Linking to GEOS 3.12.2, GDAL 3.9.3, PROJ 9.4.1; sf_use_s2() is TRUE
```

```
Dataset_1 <- read.csv("PFW_2021_Public.csv")
```

```
library(tidyverse)
```

```
library(sf)
library("ggspatial")
```

merge nat codes by prefix

```
merge_natnlcodes <- Dataset_1 %>%
  mutate(prefix = str_extract(subnational1_code, "^[A-Z]{2}")) %>%
  group_by(prefix)
```

rename some columns

```
merge_natnlcodes2 <- merge_natnlcodes %>% rename(Country = prefix, Counts = how_many)
```

Remove missing values of coordinates

```
merge_natnlcodes2 <- merge_natnlcodes2[!is.na(merge_natnlcodes2$latitude) & !is.na(merge_nat
```

Convert to sf object

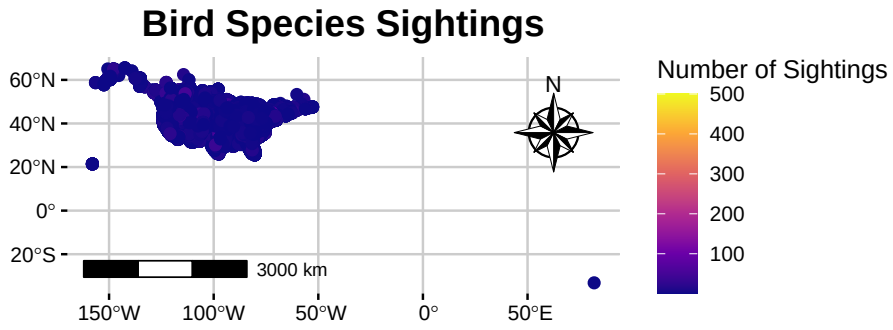
```
sf_mapdata<- st_as_sf(merge_natnlcodes2, coords = c("longitude", "latitude"), crs = 4326)
```

Draw the map

and add North arrow, scale and grid lines

```
ggplot(data = sf_mapdata) +
geom_sf(aes(geometry = geometry, color = Counts), size = 2) +
  scale_color_viridis_c(option = "plasma", name = "Number of Sightings") +
  theme_minimal() +
  theme(
    plot.title = element_text(hjust = 0.5, size = 16, face = "bold"),
    axis.title = element_blank(),
    axis.text = element_text(color = "black"),
    axis.ticks = element_line(color = "black"),
    panel.grid.major = element_line(color = "grey80"),
    panel.grid.minor = element_line(color = "grey90")
  ) +
  labs(title = "Bird Species Sightings", color = "Sightings") +
  annotation_north_arrow(location = "tr", which_north = "true",
                         style = north_arrow_nautical()) +
  annotation_scale(location = "bl", width_hint = 0.30) +
  coord_sf()
```

```
Scale on map varies by more than 10%, scale bar may be inaccurate
```



##Trying alternative packages for additional layering

Load and install Other packages

```
library(rnaturalearth)
library(ggthemes)
```

```
Attaching package: 'ggthemes'
```

```
The following object is masked from 'package:cowplot':

    theme_map
```

Remove country XX with location in the sea etc

```
sf_mapdata2 <- sf_mapdata %>%
  filter(Country != "XX")
```

```
WorldM <- ne_countries(scale = "medium", returnclass = "sf" )
```

Recreate map to add Country boarders

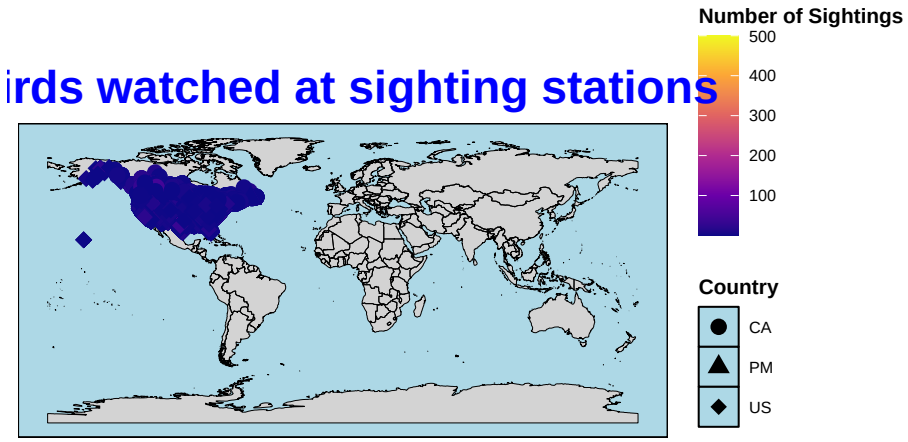
with color deficiency consideration

```
sf_mapdata2 %>%
  ggplot() +
  geom_sf(data = WorldM, fill = NA, color = "black") +
  geom_sf(aes(geometry = geometry, color = Counts), size = 3) +
  scale_color_viridis_c(option = "cividis", name = "Number of Sightings") +
  labs(title = "Birds watched at sighting stations") +
  ggthemes::theme_map() +
  theme(
    legend.position = "right",
    axis.title = element_blank(),
    axis.text = element_text(color = "black"),
    axis.ticks = element_line(color = "black"),
    panel.grid.major = element_line(color = "grey80"),
    panel.grid.minor = element_line(color = "grey90"),
    legend.title = element_text(face = "bold"),
    plot.title = element_text(size = 20, hjust = 0.5, face = "bold", color = "blue")
  )
```

Add background colour around countries for "ocean effect"

and shapes to denote countries

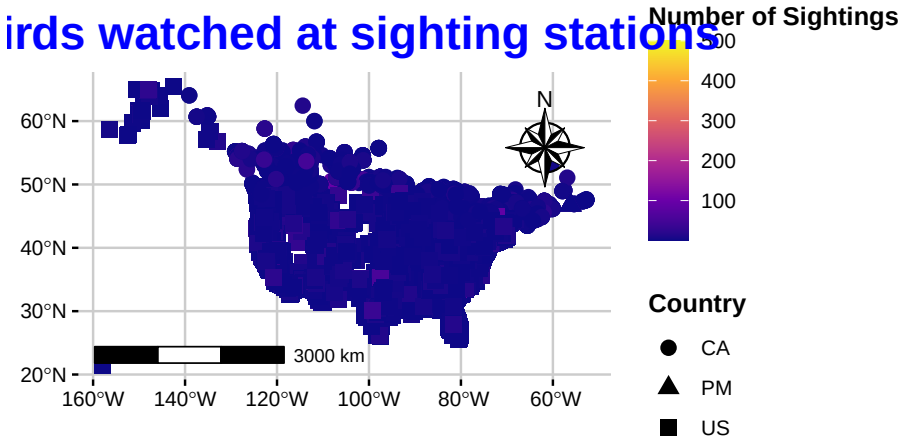
```
sf_mapdata2 %>%
  ggplot() +
  geom_sf(data = WorldM, fill = "lightgray", color = NA) +
  geom_sf(data = WorldM, fill = NA, color = "black") +
  geom_sf(aes(geometry = geometry, color = Counts, shape = Country), size = 3) +
  scale_color_viridis_c(option = "plasma", name = "Number of Sightings") +
  scale_shape_manual(values = c(16, 17, 18, 19)) +  # Assign different shapes to countries
  labs(title = "Birds watched at sighting stations") +
  ggthemes::theme_map()+
  theme(
    legend.position = "right",
    axis.title = element_blank(),
    axis.text = element_text(color = "black"),
    legend.title = element_text(face = "bold"),
    plot.title = element_text(size = 20, hjust = 0.5, face = "bold", color = "blue"),
    panel.background = element_rect(fill = "lightblue")  # Add background color to the panel
  )
```



Zooming In

```
theme_map <- theme_minimal()
sf_mapdata2 %>%
  ggplot(aes(color = Counts)) +
  geom_sf(aes(geometry = geometry, color = Counts, shape = Country), size = 3) +
  scale_color_viridis_c(option = "plasma", name = "Number of Sightings") +
  labs(title = "Birds watched at sighting stations") +
  theme_map +
  theme(
    legend.position = "right",
    legend.title = element_text(face = "bold"),
    plot.title = element_text(size = 20, hjust = 0.5, face = "bold", color = "blue"),
    axis.title = element_blank(),
    axis.text = element_text(color = "black"),
    axis.ticks = element_line(color = "black"),
    panel.grid.major = element_line(color = "grey80"),
    panel.grid.minor = element_line(color = "grey90")
  ) +
  annotation_north_arrow(location = "tr", which_north = "true",
                         style = north_arrow_nautical()) +
  annotation_scale(location = "bl", width_hint = 0.40)
```

```
Scale on map varies by more than 10%, scale bar may be inaccurate
```



Challenges

Unknown data set- Had to understand it, learn its genesis, study the meta data before i could clean and synthesize the data The many filters and data groups i created got me a little confused and lost with which data I was supposed to be working with Course facilitators and lecturers helped sort the saving and rendering challenges that plagued my initial work- All is good now

Lessons learnt and future prospects

Moved from being an R, Quarto novice to all i know now…learnt so much!! from practically not having an idea what a pipe was to being able to do relatively complex illustrations in R or at least understanding the process to them Also learnt lots of problem solving techniques that i will find extremely useful in future. Also the constant restarts i did due to failure to save initially gave me an opportunity to keep practicing and provided an additional learning platform. I need more practice with QGIS and map generation in general