Week 11: Activity

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Data Visualization

```
library(tidyverse)
```

```
── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
✔ dplyr     1.1.4     ✔ readr     2.1.5
✔ forcats   1.0.0     ✔ stringr   1.5.1
✔ ggplot2   3.5.1     ✔ tibble    3.2.1
✔ lubridate 1.9.3     ✔ tidyr     1.3.1
✔ purrr     1.0.2
── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()
ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to b
```

```
library(Stat2Data)
library(maps)
```

```
Attaching package: 'maps'

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

    map
```

```
library(sf)
```

```
Linking to GEOS 3.11.0, GDAL 3.5.3, PROJ 9.1.0; sf_use_s2() is TRUE
```

```
library(RColorBrewer)
library(stringr)
library(dplyr)
```

Graph 1:

Read the file

```
wind <- read_csv("wind-turbine.csv")
```

```
Rows: 6698 Columns: 15
── Column specification ────────────────────────────────────────────────────────
Delimiter: ","
chr (8): province_territory, project_name, turbine_identifier, turbine_numbe...
dbl (7): objectid, total_project_capacity_mw, turbine_rated_capacity_k_w, ro...

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.
```

```
wind
```

objectid	province_territory	project_name
<dbl>	<chr>	<chr>
1	Alberta	Optimist Wind Energy
2	Alberta	Castle River Wind Farm
3	Alberta	Waterton Wind Turbines
4	Alberta	Waterton Wind Turbines
5	Alberta	Waterton Wind Turbines
6	Alberta	Waterton Wind Turbines
7	Alberta	Cowley North
8	Alberta	Cowley North
9	Alberta	Cowley North
10	Alberta	Cowley North

1-10 of 6,698 rows | 1-3 of 15 columns Previous 1 2 3 4 5 6 ... 670 Next

See the territories

```
unique(wind$province_territory)
```

```
 [1] "Alberta"                   "British Columbia"
 [3] "Manitoba"                  "New Brunswick"
 [5] "Newfoundland and Labrador" "Northwest Territories"
 [7] "Nova Scotia"               "Ontario"
 [9] "Prince Edward Island"      "Quebec"
[11] "Saskatchewan"              "Yukon"
```

My first figure is going to be a map of Canada that shows the amount of wind turbines in each province.

First, we need to get the data for the number of wind turbines in each province.

```
wind |>
  group_by(province_territory) |>
  summarise(NumOfTurbines = n()) -> wind.sum
wind.sum
```

province_territory	NumOfTurbines
<chr>	<int>
Alberta	900
British Columbia	292
Manitoba	133
New Brunswick	119
Newfoundland and Labrador	27
Northwest Territories	4
Nova Scotia	310
Ontario	2663
Prince Edward Island	104
Quebec	1991

1-10 of 12 rows Previous 1 2 Next

I am going to use geo-package to do this...

```
canada <- st_layers("gadm41_CAN.gpkg")
canada
```

	name	geomtype	driver	features	fields	crs
	<chr>	<list>	<chr>	<dbl>	<dbl>	<list>
1	ADM_ADM_0	<chr [1]>	GPKG	1	2	<S3: crs>
2	ADM_ADM_1	<chr [1]>	NA	13	11	<S3: crs>
3	ADM_ADM_2	<chr [1]>	NA	293	13	<S3: crs>
4	ADM_ADM_3	<chr [1]>	NA	5581	16	<S3: crs>

4 rows

```
canada <- st_read("gadm41_CAN.gpkg", layer = "ADM_ADM_1")
```

```
Reading layer `ADM_ADM_1' from data source
  `/Users/mitchlevy/Marist/Fall 2024/Data Visualization/gadm41_CAN.gpkg'
  using driver `GPKG'
Simple feature collection with 13 features and 11 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: -141.0069 ymin: 41.67693 xmax: -52.61889 ymax: 83.11042
Geodetic CRS:  WGS 84
```

```
canada
```

GID_1	GID_0	COUNTRY	NAME_1
<chr>	<chr>	<chr>	<chr>
CAN.1_1	CAN	Canada	Alberta
CAN.2_1	CAN	Canada	British Columbia
CAN.3_1	CAN	Canada	Manitoba
CAN.4_1	CAN	Canada	New Brunswick
CAN.5_1	CAN	Canada	Newfoundland and Labrador
CAN.6_1	CAN	Canada	Northwest Territories
CAN.7_1	CAN	Canada	Nova Scotia
CAN.8_1	CAN	Canada	Nunavut
CAN.9_1	CAN	Canada	Ontario
CAN.10_1	CAN	Canada	Prince Edward Island

1-10 of 13 rows | 1-4 of 12 columns Previous 1 2 Next

Rename the col

```
wind.sum |>
  rename(NAME_1 = province_territory) -> wind.name
wind.name
```

NAME_1	NumOfTurbines
<chr>	<int>
Alberta	900
British Columbia	292
Manitoba	133
New Brunswick	119
Newfoundland and Labrador	27
Northwest Territories	4
Nova Scotia	310
Ontario	2663
Prince Edward Island	104
Quebec	1991

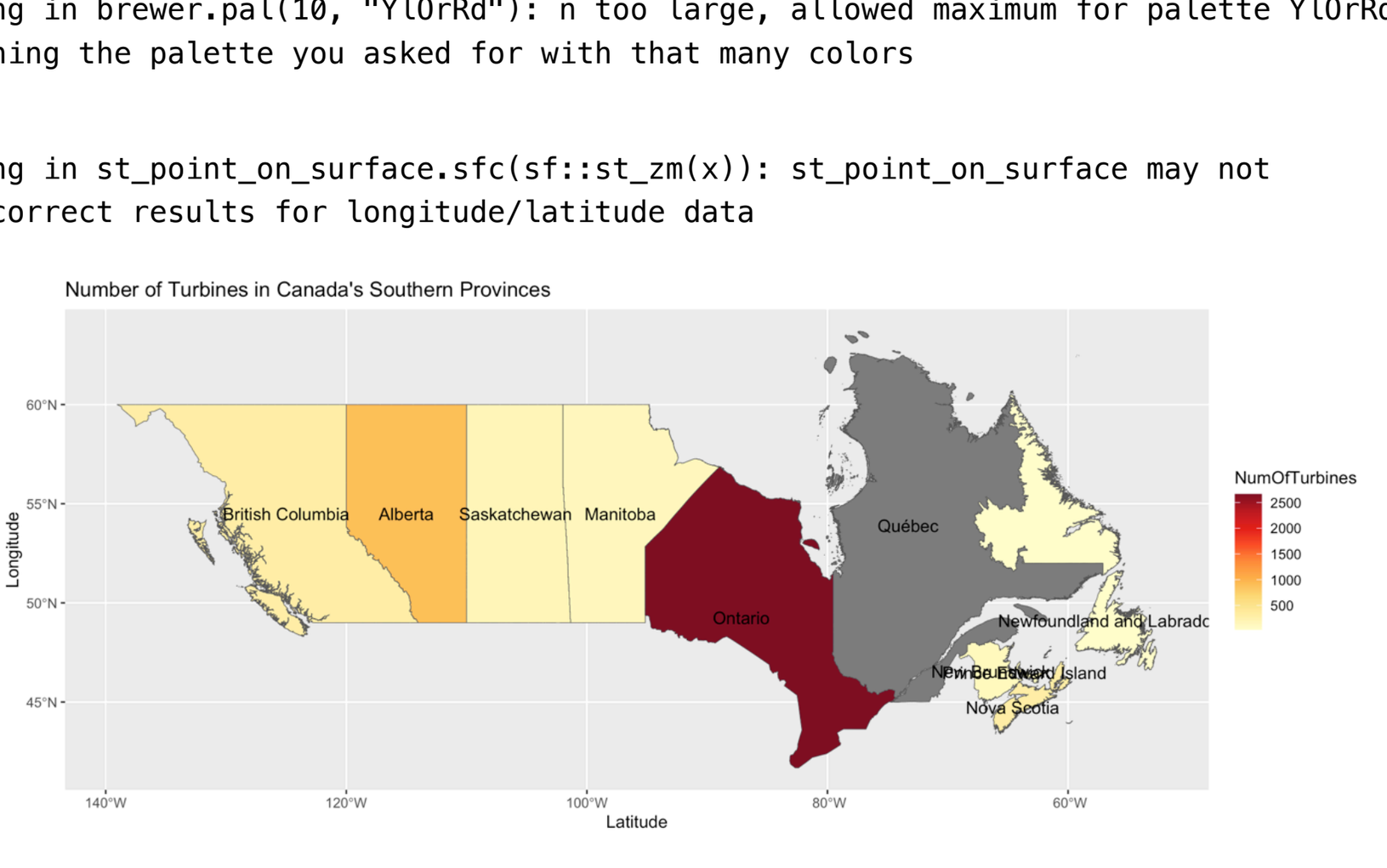
1-10 of 12 rows Previous 1 2 Next

Graph it...

```
Joining with `by = join_by(NAME_1)`

Warning in brewer.pal(10, "YlOrRd"): n too large, allowed maximum for palette YlOrRd is 9
Returning the palette you asked for with that many colors


Warning in st_point_on_surface.sfc(sf::st_zm(x)): st_point_on_surface may not
give correct results for longitude/latitude data
```



Note: I could not figure out why Onatrio is grey. I also don't really like this graph, but I have spent 2 and a half hours working on it, so it is what it is. I hate maps.

Graph 2:

I am going to try to graph just one of Canada's provinces and plot the turbines on top of the map.

Filter and rename col

```
wind |>
  filter(province_territory == "Prince Edward Island") |>
  rename(subregion = province_territory) -> wind.prince
wind.prince
```

objectid	subregion
<dbl>	<chr>
4449	Prince Edward Island
4450	Prince Edward Island
4451	Prince Edward Island
4452	Prince Edward Island
4453	Prince Edward Island
4454	Prince Edward Island
4455	Prince Edward Island
4456	Prince Edward Island
4457	Prince Edward Island
4458	Prince Edward Island

1-10 of 104 rows | 1-2 of 15 columns Previous 1 2 3 4 5 6 ... 11 Next

Get Canada map data

```
map_data("world", region = c("Canada")) -> prince
prince
```

	long	lat	group	order	region	subregion
	<dbl>	<dbl>	<dbl>	<int>	<chr>	<chr>
1	-59.78760	43.93960	1	1	Canada	Sable Island
2	-59.92227	43.90391	1	2	Canada	Sable Island
3	-60.03775	43.90664	1	3	Canada	Sable Island
4	-60.11426	43.93911	1	4	Canada	Sable Island
5	-60.11748	43.95337	1	5	Canada	Sable Island
6	-59.93604	43.93960	1	6	Canada	Sable Island
7	-59.86636	43.94717	1	7	Canada	Sable Island
8	-59.72715	44.00283	1	8	Canada	Sable Island
9	-59.78760	43.93960	1	9	Canada	Sable Island
11	-66.27377	44.29229	2	11	Canada	5

1-10 of 10,000 rows Previous 1 2 3 4 5 6 ... 1000Next

```
unique(prince$subregion)
```

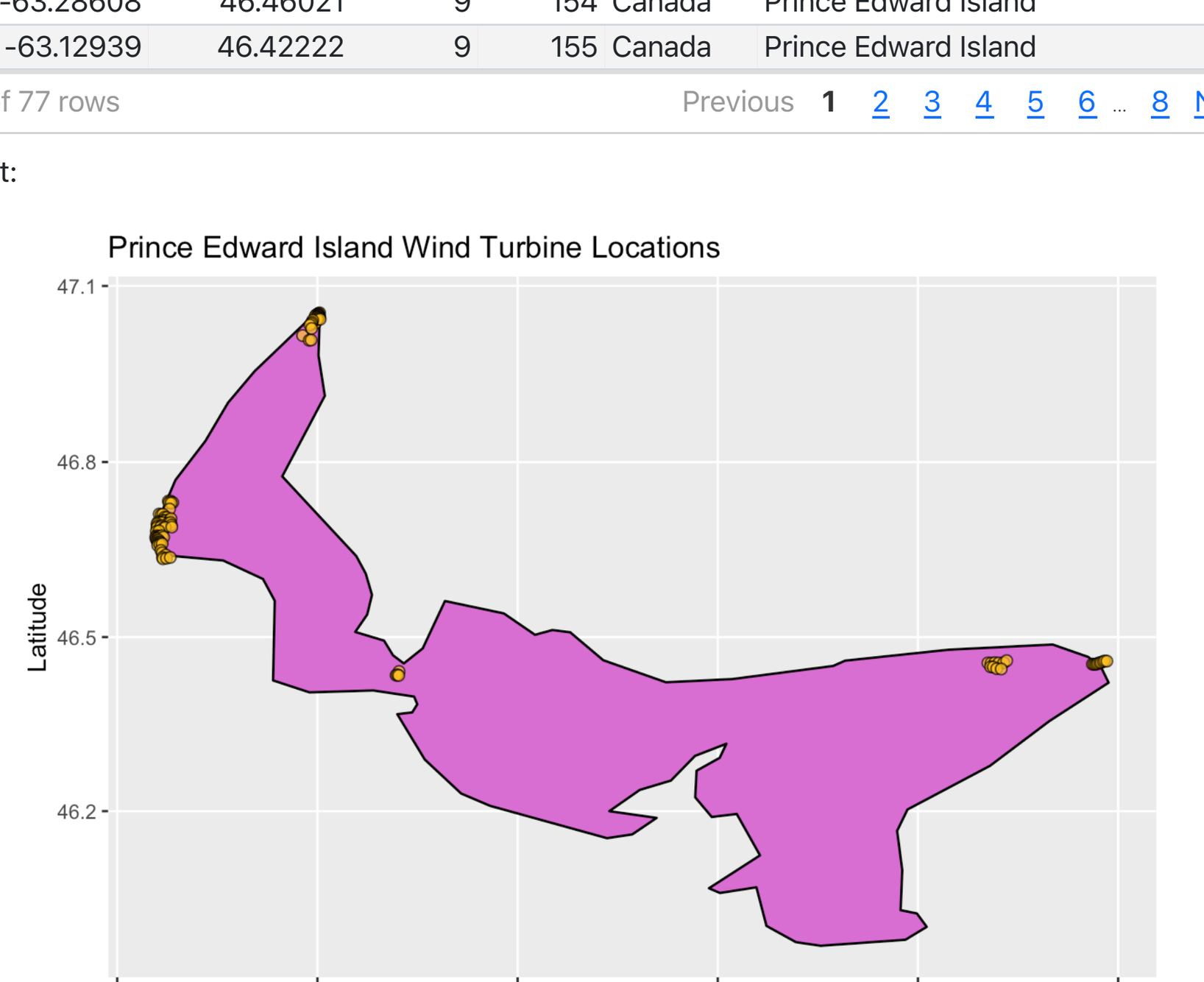
```
  [1] "Sable Island"                "5"
  [3] "Grand Manan Island"          "9"
  [5] "10"                          "11"
  [7] "15"                          "Cape Breton Island"
  [9] "Prince Edward Island"        "Ile du Cap aux Meule"
 [11] "Merasheen Island"            "Ile Lameque"
 [13] "22"                          "Saltspring Island"
 [15] "Galiano Island"              "27"
 [17] "Flores Island"               "New World Island"
 [19] "Fogo Island"                 "Texada Island"
 [21] "Nootka Island"               "Anticosti Island"
 [23] "Redonda Island"              "Quadra Island"
 [25] "Bell Island"                 "Vancouver Island"
 [27] "Newfoundland"                "Calvert Island"
 [29] "40"                          "Charlton Island"
 [31] "42"                          "43"
 [33] "Aristazabal Island"          "45"
 [35] "46"                          "Moresby Island"
 [37] "Princess Royal Island"       "49"
 [39] "50"                          "BC"
 [41] "Porcher Island"              "Graham Island"
 [43] "54"                          "55"
 [45] "56"                          "Tukarak Island"
 [47] "58"                          "Belcher Island"
 [49] "60"                          "61"
 [51] "62"                          "63"
 [53] "64"                          "65"
 [55] "66"                          "67"
 [57] "Akpatok Island"              "Smith Island"
 [59] "Resolution Island"           "71"
 [61] "Edgell Island"               "Mansel Island"
 [63] "Loks Land Island"            "Charles Island"
 [65] "Big Island"                  "Coats Island"
 [67] "Nottingham Island"           "Salisbury Island"
 [69] "Mill Island"                 "Southampton Island"
 [71] "White Island"                "Vansittart Island"
 [73] "Winter Island"               "85"
 [75] "86"                          "87"
 [77] "Chapman Lewes Island"        "Air Force Island"
 [79] "90"                          "Wales Island"
 [81] "Prince Charles Island"       "93"
 [83] "Melbourne Island"            "Foley Island"
 [85] "Jenny Lind Island"           "Royal Geographical Society Island"
 [87] "99"                          "100"
 [89] "Harrison Island"             "Bray Island"
 [91] "103"                         "Matty Island"
 [93] "Herschel Island"             "106"
 [95] "Koch Island"                 "Jens Munk Island"
 [97] "King William Island"         "110"
 [99] "Gateshead Island"            NA
[101] "Prescott Island"             "Victoria Island"
[103] "Stefansson Island"           "Bylot Island"
[105] "Baffin Island"               "Prince of Wales Island"
[107] "Russell Island"              "Somerset Island"
[109] "Banks Island"                "122"
[111] "123"                         "Byam Martin Island"
[113] "Cornwallis Island"           "126"
[115] "127"                         "128"
[117] "Eglinton Island"             "Coburg Island"
[119] "131"                         "Cameron Island"
[121] "Bathurst Island"             "Helena Island"
[123] "Melville Island"             "North Kent Island"
[125] "Emerald Isle"                "Devon Island"
[127] "Prince Patrick Island"       "140"
[129] "Lougheed Island"             "Cornwall Island"
[131] "King Christian Island"       "Brock Island"
[133] "Mackenzie King Island"       "146"
[135] "Borden Island"               "Amund Ringnes Island"
[137] "Ellef Ringnes Island"        "Meighen Island"
[139] "Axel Heiberg Island"         "Ellesmere Island"
```

```
prince |>
  filter(subregion == "Prince Edward Island") -> prince.map
prince.map
```

long	lat	group	order	region	subregion
<dbl>	<dbl>	<dbl>	<int>	<chr>	<chr>
-63.81128	46.46870	9	146	Canada	Prince Edward Island
-63.78423	46.45464	9	147	Canada	Prince Edward Island
-63.73701	46.48052	9	148	Canada	Prince Edward Island
-63.68145	46.56192	9	149	Canada	Prince Edward Island
-63.53437	46.54063	9	150	Canada	Prince Edward Island
-63.45649	46.50391	9	151	Canada	Prince Edward Island
-63.41314	46.51201	9	152	Canada	Prince Edward Island
-63.36865	46.50826	9	153	Canada	Prince Edward Island
-63.28608	46.46021	9	154	Canada	Prince Edward Island
-63.12939	46.42222	9	155	Canada	Prince Edward Island

1-10 of 77 rows Previous 1 2 3 4 5 6 ... 8 Next

Graph it:



Interstingly enough, most of the turbines are clustered in tight groups, they are not spread out at all.

Graph 3:

I am not going to use a map this time, (thank god!) and I will look at the data and search for trends.

```
wind
```

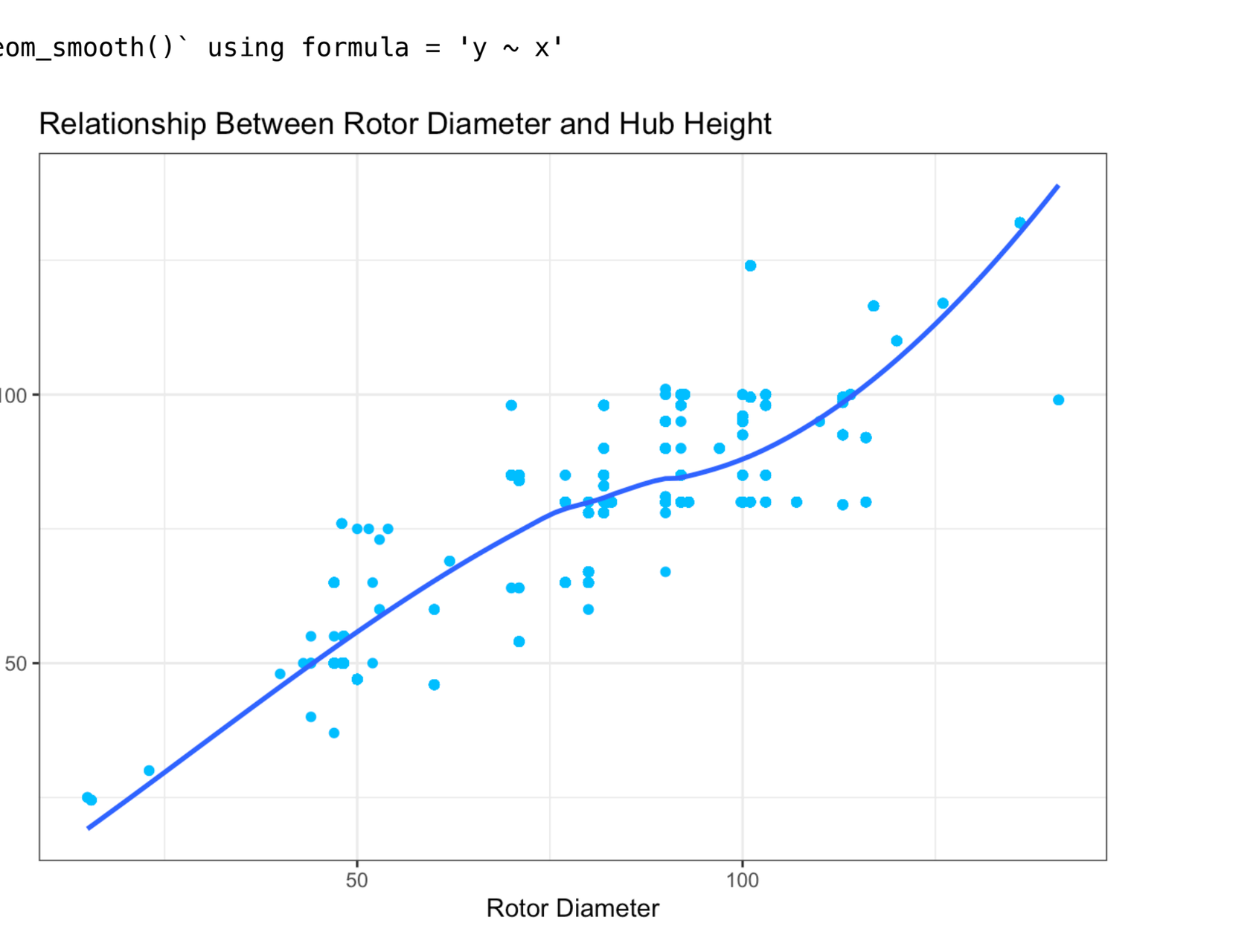
objectid	province_territory	project_name
<dbl>	<chr>	<chr>
1	Alberta	Optimist Wind Energy
2	Alberta	Castle River Wind Farm
3	Alberta	Waterton Wind Turbines
4	Alberta	Waterton Wind Turbines
5	Alberta	Waterton Wind Turbines
6	Alberta	Waterton Wind Turbines
7	Alberta	Cowley North
8	Alberta	Cowley North
9	Alberta	Cowley North
10	Alberta	Cowley North

1-10 of 6,698 rows | 1-3 of 15 columns Previous 1 2 3 4 5 6 ... 670 Next

Alright, I think that the relationship between rotor diameter and hub height could be intersting, so I am going to make a scatter plot and look for relationships there!

```
wind |>
  ggplot(aes(rotor_diameter_m, hub_height_m)) +
  geom_point(color = "deepskyblue") +
  geom_smooth(method = "loess", se = FALSE) +
  theme_bw() +
  labs(x = "Rotor Diameter", y = "Hub Height") +
  ggtitle("Relationship Between Rotor Diameter and Hub Height")
```

```
`geom_smooth()` using formula = 'y ~ x'
```



From this graph you can clearly see that there is a strong, positive correlation between the rotor diameter and the hub height.