Explanatory Data Analysis

Import the weather data

```
weather_df =
  rnoaa::meteo_pull_monitors(
    c("USW00094728", "USW00022534", "USS0023B17S"),
    var = c("PRCP", "TMIN", "TMAX"),
    date_min = "2021-01-01",
    date_max = "2022-12-31") |>
  mutate(
    name = case_match(
      id,
      "USW00094728" ~ "CentralPark_NY",
      "USW00022534" ~ "Molokai_HI",
      "USS0023B17S" ~ "Waterhole_WA"),
    tmin = tmin / 10,
    tmax = tmax / 10,
    month = floor_date(date, unit = "month")) |>
  select(name, id, everything())
```

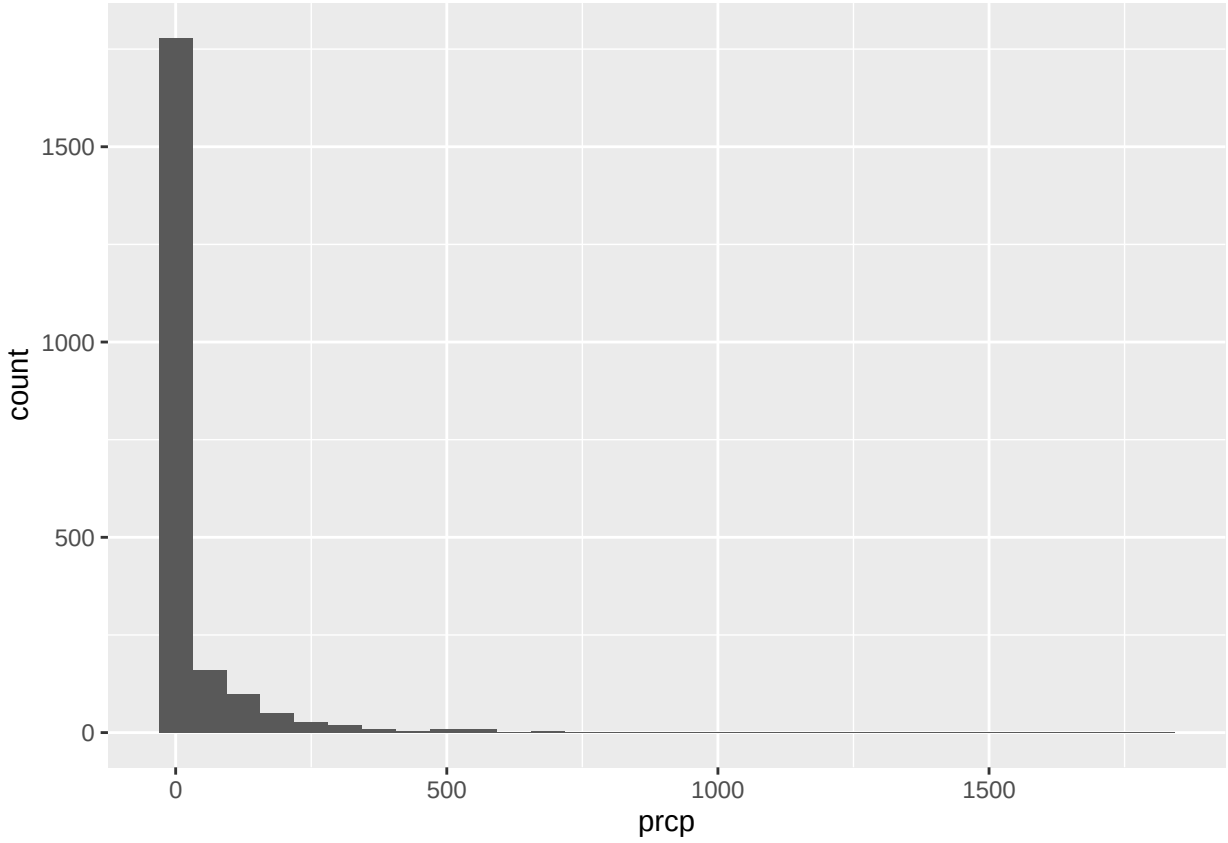
```
## using cached file: /Users/soomin.you/Library/Caches/org.R-project.R/R/rnoaa/noaa_ghcnd/USW00094728.d

## date created (size, mb): 2024-09-03 14:09:15.067935 (8.636)

## file min/max dates: 1869-01-01 / 2024-09-30

## using cached file: /Users/soomin.you/Library/Caches/org.R-project.R/R/rnoaa/noaa_ghcnd/USW00022534.d

## date created (size, mb): 2024-09-03 14:09:24.583853 (3.913)

## file min/max dates: 1949-10-01 / 2024-09-30

## using cached file: /Users/soomin.you/Library/Caches/org.R-project.R/R/rnoaa/noaa_ghcnd/USS0023B17S.d

## date created (size, mb): 2024-09-03 14:09:27.654133 (1.036)

## file min/max dates: 1999-09-01 / 2024-08-31
```

Let's make some plots

```
weather_df |>
  ggplot(aes(x = prcp)) +
  geom_histogram()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

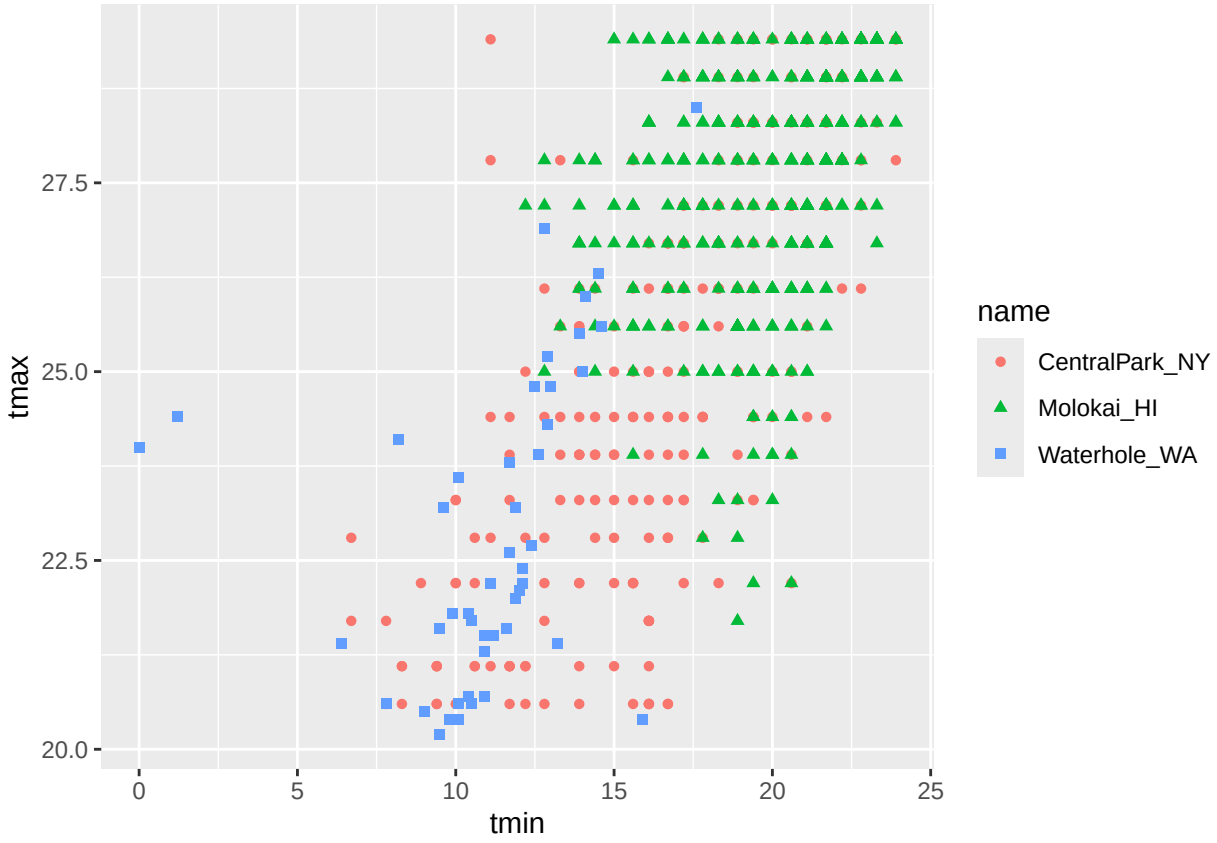
```
## Warning: Removed 15 rows containing non-finite outside the scale range
## (`stat_bin()`).
```




```
weather_df |>
  filter(prcp >= 1000)
```

```
## # A tibble: 3 x 7
##   name           id          date        prcp  tmax  tmin month
##   <chr>          <chr>       <date>     <dbl> <dbl> <dbl> <date>
## 1 CentralPark_NY USW00094728 2021-08-21  1130  27.8  22.8 2021-08-01
## 2 CentralPark_NY USW00094728 2021-09-01  1811  25.6  17.2 2021-09-01
## 3 Molokai_HI     USW00022534 2022-12-18  1120  23.3  18.9 2022-12-01
```

```
weather_df |>
  filter(tmax > 20, tmax < 30) |>
  ggplot(aes(x = tmin, y = tmax, color = name, shape = name)) +
  geom_point()
```



##group_by()

```
weather_df |>
  group_by(name)
```

```
## # A tibble: 2,190 x 7
## # Groups:   name [3]
##    name           id          date        prcp  tmax  tmin month
##    <chr>          <chr>       <date>     <dbl> <dbl> <dbl> <date>
##  1 CentralPark_NY USW00094728 2021-01-01   157   4.4   0.6 2021-01-01
##  2 CentralPark_NY USW00094728 2021-01-02    13  10.6   2.2 2021-01-01
##  3 CentralPark_NY USW00094728 2021-01-03    56   3.3   1.1 2021-01-01
##  4 CentralPark_NY USW00094728 2021-01-04     5   6.1   1.7 2021-01-01
##  5 CentralPark_NY USW00094728 2021-01-05     0   5.6   2.2 2021-01-01
##  6 CentralPark_NY USW00094728 2021-01-06     0   5     1.1 2021-01-01
##  7 CentralPark_NY USW00094728 2021-01-07     0   5    -1   2021-01-01
##  8 CentralPark_NY USW00094728 2021-01-08     0   2.8  -2.7 2021-01-01
##  9 CentralPark_NY USW00094728 2021-01-09     0   2.8  -4.3 2021-01-01
## 10 CentralPark_NY USW00094728 2021-01-10     0   5    -1.6 2021-01-01
## # i 2,180 more rows
```

counting stuff

```
weather_df |>
  group_by(name, month) |>
```

```
  summarize(
    n_obs = n())
```

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

```
## # A tibble: 72 x 3
## # Groups:   name [3]
##    name           month      n_obs
##    <chr>          <date>     <int>
##  1 CentralPark_NY 2021-01-01    31
##  2 CentralPark_NY 2021-02-01    28
##  3 CentralPark_NY 2021-03-01    31
##  4 CentralPark_NY 2021-04-01    30
##  5 CentralPark_NY 2021-05-01    31
##  6 CentralPark_NY 2021-06-01    30
##  7 CentralPark_NY 2021-07-01    31
##  8 CentralPark_NY 2021-08-01    31
##  9 CentralPark_NY 2021-09-01    30
## 10 CentralPark_NY 2021-10-01    31
## # i 62 more rows
```

```
weather_df |>
  count(name)
```

```
## # A tibble: 3 x 2
##   name                n
##   <chr>           <int>
## 1 CentralPark_NY    730
## 2 Molokai_HI        730
## 3 Waterhole_WA      730
```

2x2

```
weather_df |>
  drop_na(tmax) |>
  filter(name != "Molokai_HI") |>
  mutate(
    cold = case_when(
      tmax < 5 ~"cold",
      tmax >= 5 ~ "not_cold"
    )
  ) |>
  group_by(name, cold) |>
  summarize(count = n())
```

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

```
## # A tibble: 4 x 3
## # Groups:   name [2]
##   name           cold     count
##   <chr>          <chr>    <int>
## 1 CentralPark_NY cold        96
## 2 CentralPark_NY not_cold   634
## 3 Waterhole_WA   cold       319
## 4 Waterhole_WA   not_cold   395
```

```
weather_df |>
  drop_na(tmax) |>
  filter(name != "Molokai_HI") |>
  mutate(
    cold = case_when(
      tmax < 5 ~"cold",
      tmax >= 5 ~ "not_cold"
    )
  ) |>
  janitor::tabyl(name, cold)
```

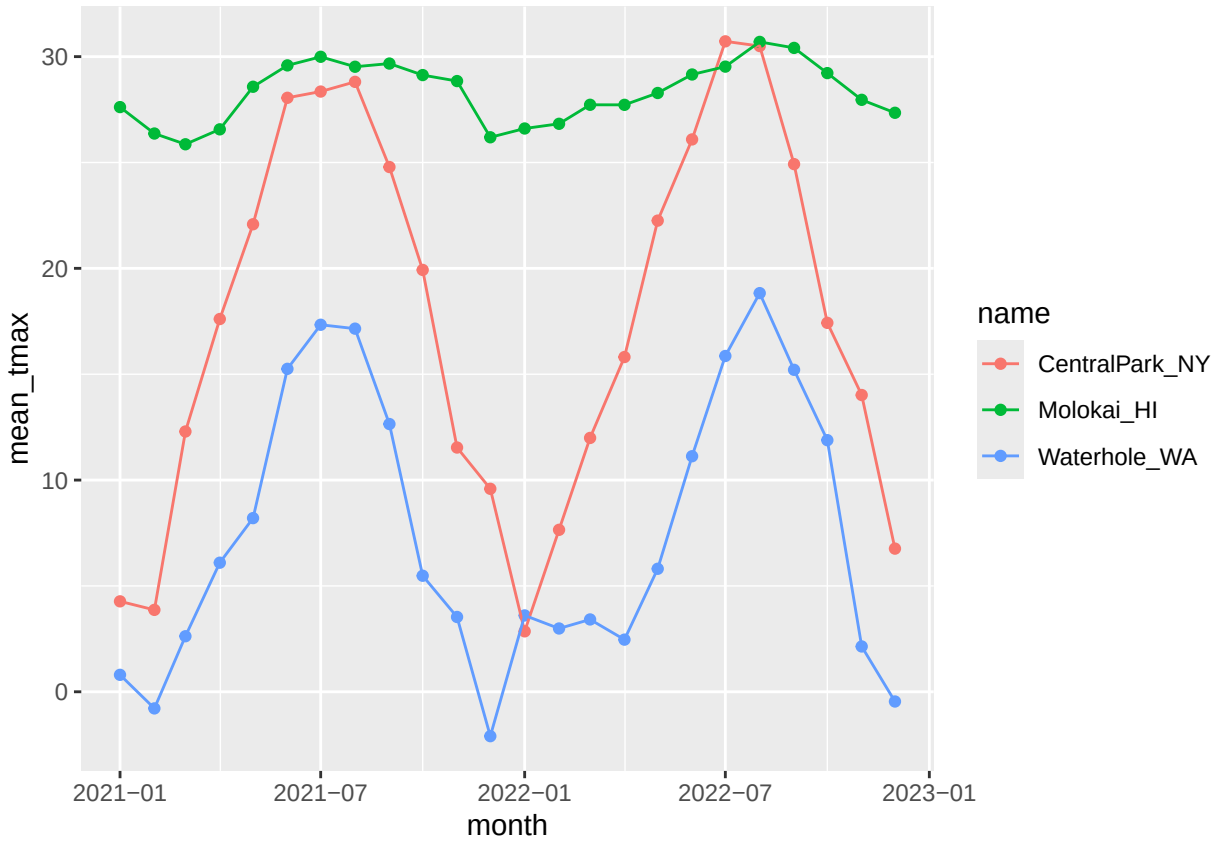
```
##            name cold not_cold
##  CentralPark_NY   96      634
##    Waterhole_WA  319      395
```

general numeric summaries

let's try some other useful summaries.

```
weather_df |>
  group_by(name, month) |>
  summarize(
    mean_tmax = mean(tmax, na.rm = TRUE),
    median_tmin = median(tmin, na.rm = TRUE),
    sd_prcp = sd(prcp, na.rm = TRUE)
  ) |>
  ggplot(aes(x = month, y = mean_tmax, color = name)) +
  geom_point() +
  geom_line()
```

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



format for readers

```
weather_df |>
  group_by(name, month) |>
  summarize(
    mean_tmax = mean(tmax, na.rm = TRUE)
  ) |>
  pivot_wider(
    names_from = name,
    values_from = mean_tmax
  ) |>
  knitr::kable(
    digits = 3,
    col.names = c("Month", "Central Park", "Molokai", "Waterhole"))
```

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

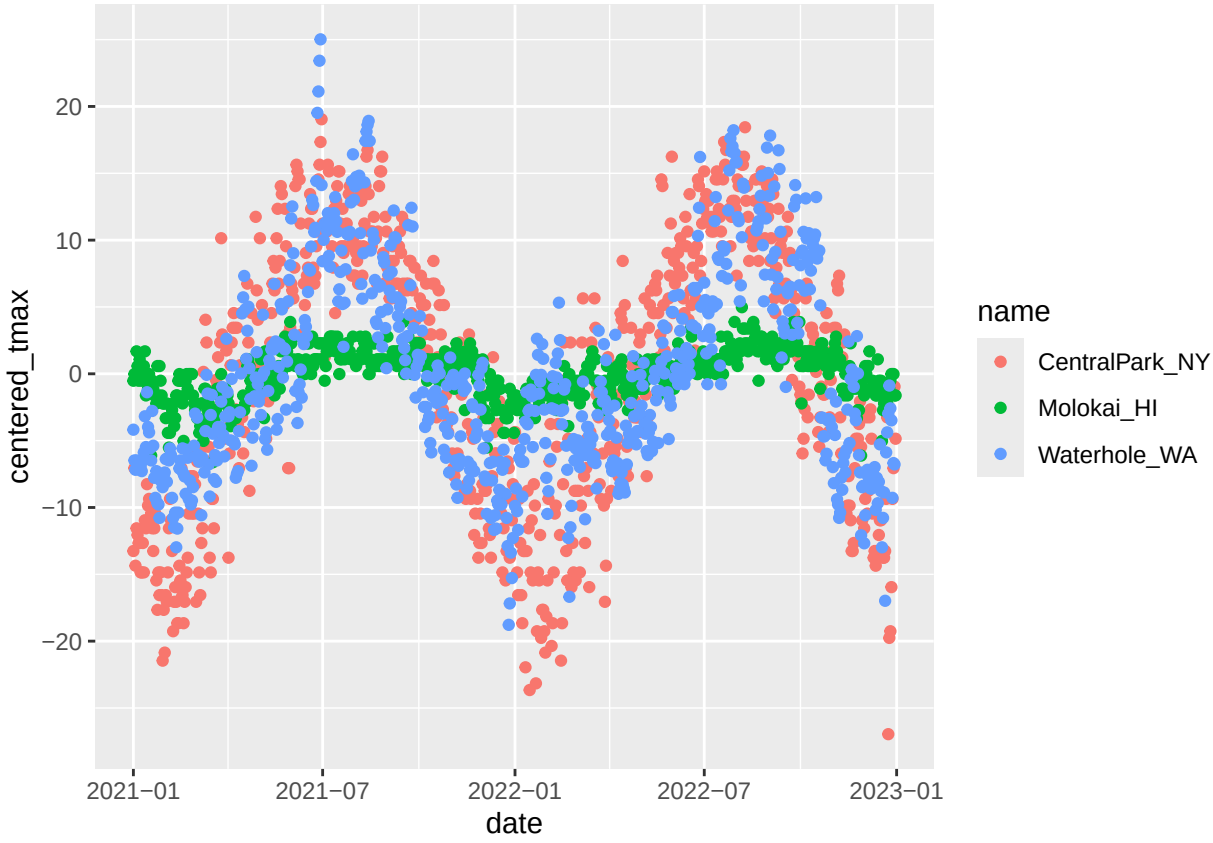
Month	Central Park	Molokai	Waterhole
2021-01-01	4.271	27.616	0.800
2021-02-01	3.868	26.368	-0.786
2021-03-01	12.294	25.861	2.623
2021-04-01	17.607	26.567	6.097
2021-05-01	22.084	28.577	8.203

Month	Central Park	Molokai	Waterhole
2021-06-01	28.057	29.587	15.253
2021-07-01	28.352	29.994	17.335
2021-08-01	28.810	29.523	17.152
2021-09-01	24.787	29.673	12.647
2021-10-01	19.926	29.129	5.481
2021-11-01	11.537	28.847	3.533
2021-12-01	9.587	26.190	-2.097
2022-01-01	2.855	26.606	3.606
2022-02-01	7.650	26.829	2.989
2022-03-01	11.990	27.726	3.416
2022-04-01	15.810	27.723	2.463
2022-05-01	22.255	28.283	5.810
2022-06-01	26.090	29.157	11.127
2022-07-01	30.723	29.529	15.861
2022-08-01	30.500	30.697	18.830
2022-09-01	24.923	30.413	15.207
2022-10-01	17.426	29.223	11.884
2022-11-01	14.017	27.960	2.140
2022-12-01	6.761	27.348	-0.460

grouped mutates

```
weather_df |>
  group_by(name) |>
  mutate(
    mean_tmax = mean(tmax, na.rm = TRUE),
    centered_tmax = tmax - mean_tmax) |>
  ggplot(aes(x = date, y = centered_tmax, color = name)) +
  geom_point()
```

```
## Warning: Removed 17 rows containing missing values or values outside the scale range
## (`geom_point()`).
```




```
weather_df |>
  mutate(
    temp_rank = min_rank(tmax)
  ) |>
  filter(temp_rank < 10)
```

```
## # A tibble: 10 x 8
##    name           id          date        prcp  tmax  tmin month      temp_rank
##    <chr>          <chr>       <date>     <dbl> <dbl> <dbl> <date>         <int>
##  1 CentralPark_NY USW00094728 2022-01-15     0  -6   -12.1 2022-01-01         7
##  2 CentralPark_NY USW00094728 2022-12-24     0  -9.3 -13.8 2022-12-01         4
##  3 Waterhole_WA   USS0023B17S 2021-02-11    51  -5.6 -10.9 2021-02-01         9
##  4 Waterhole_WA   USS0023B17S 2021-12-26   102 -11.4 -18.3 2021-12-01         1
##  5 Waterhole_WA   USS0023B17S 2021-12-27    25  -9.8 -19.6 2021-12-01         2
##  6 Waterhole_WA   USS0023B17S 2021-12-28     0  -6   -11.4 2021-12-01         7
##  7 Waterhole_WA   USS0023B17S 2021-12-29   102  -7.9 -15.4 2021-12-01         6
##  8 Waterhole_WA   USS0023B17S 2022-02-22   102  -9.3 -16.6 2022-02-01         4
##  9 Waterhole_WA   USS0023B17S 2022-12-18     0  -5.6 -11.3 2022-12-01         9
## 10 Waterhole_WA   USS0023B17S 2022-12-21     0  -9.6 -18.4 2022-12-01         3
```

```
weather_df |>
  group_by(name) |>
  mutate(
    temp_rank = min_rank(desc(tmax))
```

```
  ) |>
  filter(temp_rank < 4)
```

```
## # A tibble: 16 x 8
## # Groups:   name [3]
##    name           id          date        prcp  tmax  tmin month      temp_rank
##    <chr>          <chr>       <date>     <dbl> <dbl> <dbl> <date>         <int>
##  1 CentralPark_NY USW00094728 2021-06-29     0  35    25.6 2021-06-01         3
##  2 CentralPark_NY USW00094728 2021-06-30   165  36.7  22.8 2021-06-01         1
##  3 CentralPark_NY USW00094728 2022-07-20     0  35    25.6 2022-07-01         3
##  4 CentralPark_NY USW00094728 2022-07-23     0  35    25.6 2022-07-01         3
##  5 CentralPark_NY USW00094728 2022-07-24     0  35    26.1 2022-07-01         3
##  6 CentralPark_NY USW00094728 2022-08-09     8  36.1  25.6 2022-08-01         2
##  7 Molokai_HI     USW00022534 2021-05-31     0  32.2  17.2 2021-05-01         2
##  8 Molokai_HI     USW00022534 2021-09-16     0  32.2  21.1 2021-09-01         2
##  9 Molokai_HI     USW00022534 2022-07-30     0  32.2  22.2 2022-07-01         2
## 10 Molokai_HI     USW00022534 2022-08-06     0  33.3  20.6 2022-08-01         1
## 11 Molokai_HI     USW00022534 2022-08-17     0  32.2  21.1 2022-08-01         2
## 12 Molokai_HI     USW00022534 2022-09-24     0  32.2  22.2 2022-09-01         2
## 13 Molokai_HI     USW00022534 2022-09-30     0  32.2  20   2022-09-01         2
## 14 Waterhole_WA   USS0023B17S 2021-06-27     0  28.5  17.6 2021-06-01         3
## 15 Waterhole_WA   USS0023B17S 2021-06-28     0  30.8  20.7 2021-06-01         2
## 16 Waterhole_WA   USS0023B17S 2021-06-29     0  32.4  17.6 2021-06-01         1
```

```
weather_df |>
  group_by(name) |>
  filter(min_rank(tmax) < 4) |>
  arrange(tmax)
```

```
## # A tibble: 9 x 7
## # Groups:   name [3]
##   name           id          date        prcp  tmax  tmin month
##   <chr>          <chr>       <date>     <dbl> <dbl> <dbl> <date>
## 1 Waterhole_WA   USS0023B17S 2021-12-26   102 -11.4 -18.3 2021-12-01
## 2 Waterhole_WA   USS0023B17S 2021-12-27    25  -9.8 -19.6 2021-12-01
## 3 Waterhole_WA   USS0023B17S 2022-12-21     0  -9.6 -18.4 2022-12-01
## 4 CentralPark_NY USW00094728 2022-12-24     0  -9.3 -13.8 2022-12-01
## 5 CentralPark_NY USW00094728 2022-01-15     0  -6   -12.1 2022-01-01
## 6 CentralPark_NY USW00094728 2022-01-21     0  -5.5  -9.9 2022-01-01
## 7 Molokai_HI     USW00022534 2021-03-18   142  21.7  18.9 2021-03-01
## 8 Molokai_HI     USW00022534 2021-01-18   234  22.2  19.4 2021-01-01
## 9 Molokai_HI     USW00022534 2022-11-28    56  22.2  20.6 2022-11-01
```

```
weather_df |>
  group_by(name) |>
  mutate(
    lagged_tmax = lag(tmax),
    temp_change = tmax - lagged_tmax,
  ) |>
  filter(min_rank(temp_change) < 3)
```

```
## # A tibble: 6 x 9
```

```
## # Groups:   name [3]
##   name     id    date        prcp  tmax  tmin month      lagged_tmax temp_change
##   <chr>    <chr> <date>     <dbl> <dbl> <dbl> <date>           <dbl>       <dbl>
## 1 Central~ USW0~ 2022-02-24     0   1.7  -1.6 2022-02-01        20         -18.3
## 2 Central~ USW0~ 2022-12-24     0  -9.3 -13.8 2022-12-01        14.4       -23.7
## 3 Molokai~ USW0~ 2021-01-18   234  22.2  19.4 2021-01-01        27.8        -5.6
## 4 Molokai~ USW0~ 2022-11-28    56  22.2  20.6 2022-11-01        27.2        -5
## 5 Waterho~ USS0~ 2021-06-30     0  21.5  10.9 2021-06-01        32.4       -10.9
## 6 Waterho~ USS0~ 2022-06-28     0  12.4   5.7 2022-06-01        23.6       -11.2
```

```
weather_df |>
  group_by(name) |>
  mutate(
    lagged_tmax = lag(tmax),
    temp_change = tmax - lagged_tmax,
  ) |>
  summarize(
    sd_tmax_change = sd(temp_change, na.rm = TRUE)
  )
```

```
## # A tibble: 3 x 2
##   name           sd_tmax_change
##   <chr>                   <dbl>
## 1 CentralPark_NY           4.43
## 2 Molokai_HI               1.24
## 3 Waterhole_WA             3.04
```

learning assessment

```
pulse_df =
  read_sas("./data/public_pulse_data.sas7bdat") |>
  janitor::clean_names() |>
  pivot_longer(
    cols = (bdi_score_bl:bdi_score_12m),
    names_to = "visit",
    values_to = "bdi_score",
    names_prefix = "bdi_score_") |>
  mutate(visit = ifelse(visit == "bl", "00m", visit))


pulse_df |>
  group_by(visit) |>
  summarize(
    mean_bdi = mean(bdi_score, na.rm = TRUE)
  ) |>
  knitr::kable(digits = 1)
```

visit	mean_bdi
00m	8.0
01m	6.0

visit	mean_bdi
06m	5.7
12m	6.1

FAS

```
litters_df =
  read_csv("./data/FAS_litters.csv", na=c("NA", ",", "")) |>
  janitor::clean_names() |>
  separate(
    group, into = c("dose", "tx_day"), sep = 3
  )
```

```
## Rows: 49 Columns: 8
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (4): Group, Litter Number, GD0 weight, GD18 weight
## dbl (4): GD of Birth, Pups born alive, Pups dead @ birth, Pups survive
##
## 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.
```

```
pups_df =
  read_csv("./data/FAS_pups.csv", na=c("NA", ",", "")) |>
  janitor::clean_names()
```

```
## Rows: 313 Columns: 6
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (2): Litter Number, PD ears
## dbl (4): Sex, PD eyes, PD pivot, PD walk
##
## 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.
```

```
fas_df =
  left_join(pups_df, litters_df, by = "litter_number")
```

Compute a table that we care about.

```
fas_df |>
  drop_na(dose) |>
  group_by(dose, tx_day) |>
  summarize(mean_pivot = mean(pd_pivot, na.rm = TRUE)) |>
  pivot_wider(
    names_from = tx_day,
    values_from = mean_pivot
  ) |>
  knitr::kable(digits = 2)
```

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

dose	7	8
Con	7.00	6.24
Low	7.94	7.72
Mod	6.98	7.04