Week 10: *Data Visualization*

EMSE 4571: Intro to Programming for Analytics

John Paul Helveston

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Week 10: *Data Visualization*

1. Plotting with Base R

2. Plotting with ggplot2: Part 1

BREAK

3. Plotting with ggplot2: Part 2

4. Tweaking your ggplot

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Today's data:

Bear attacks in North America

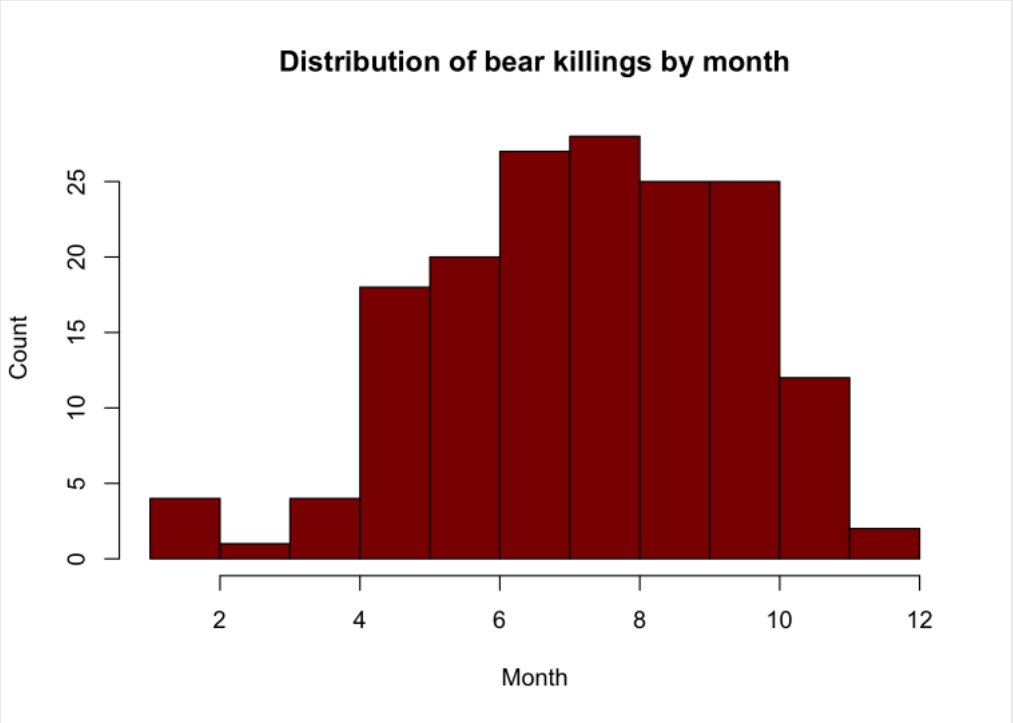
Explore the `bears` data frame:

```
glimpse(bears)
head(bears)
```

Two basic plots in R

Scatterplots

Histograms



Scatterplots with `plot()`

Plot relationship between two variables

General syntax:

```
plot(x = x_vector, y = y_vector)
```

Scatterplots with `plot()`

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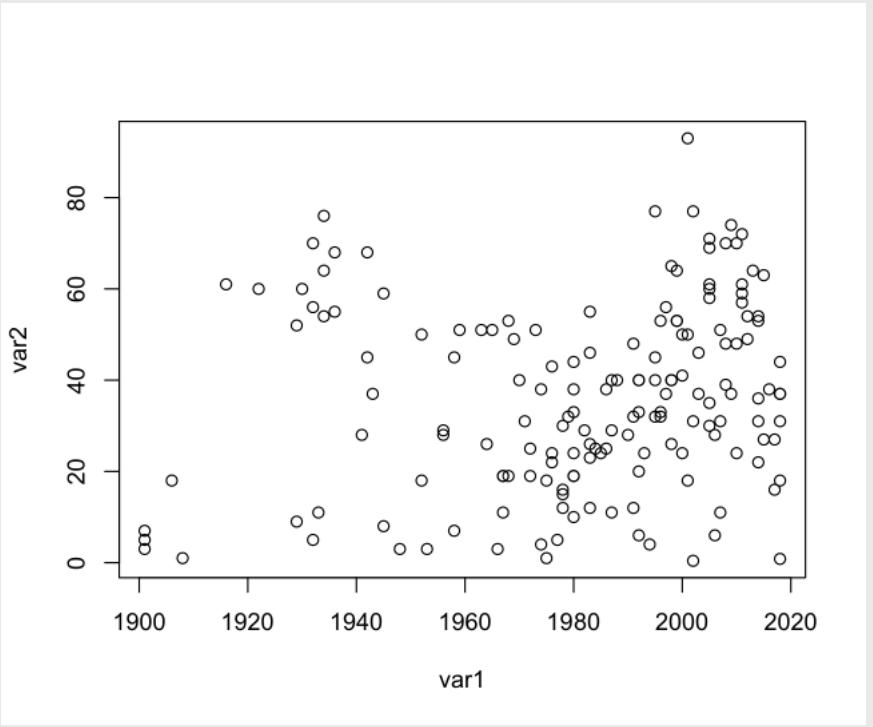
General syntax:

```
plot(x = x_vector, y = y_vector)
```

Example:

```
var1 <- bears$year
var2 <- bears$age
plot(x = var1, y = var2)
```



Scatterplots with `plot()`

`x` and `y` must have the same length!

```
var2 <- var2[-1]
```

```
length(var1) == length(var2)
```

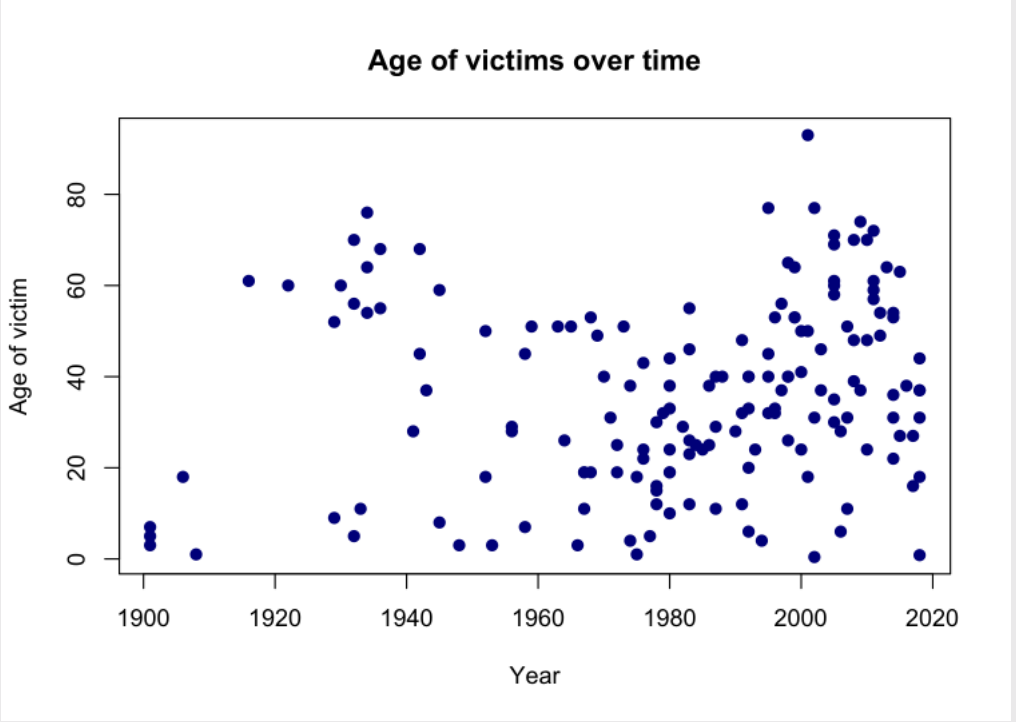
```
#> [1] FALSE
```

```
plot(x = var1, y = var2)
```

```
#> Error in xy.coords(x, y, xlabel, ylabel, log): 'x' and 'y' lengths differ
```

Making `plot()` pretty

```
plot(
  x    = bears$year,
  y    = bears$age,
  col  = 'darkblue', # Point color
  pch  = 19, # Point shape
  main = "Age of victims over time",
  xlab = "Year",
  ylab = "Age of victim"
)
```



Your turn: `plot()`

10:00

Does the annual number of bird impacts appear to be changing over time?

Make a plot using the `birds` data frame to justify your answer.

Hint: You may need to create a *summary* data frame to answer this question!

Bonus: Make your plot pretty!

Histograms with `hist()`

Plot the *distribution* of a single variable

General syntax:

```
hist(x = x_vector)
```

Histograms with `hist()`

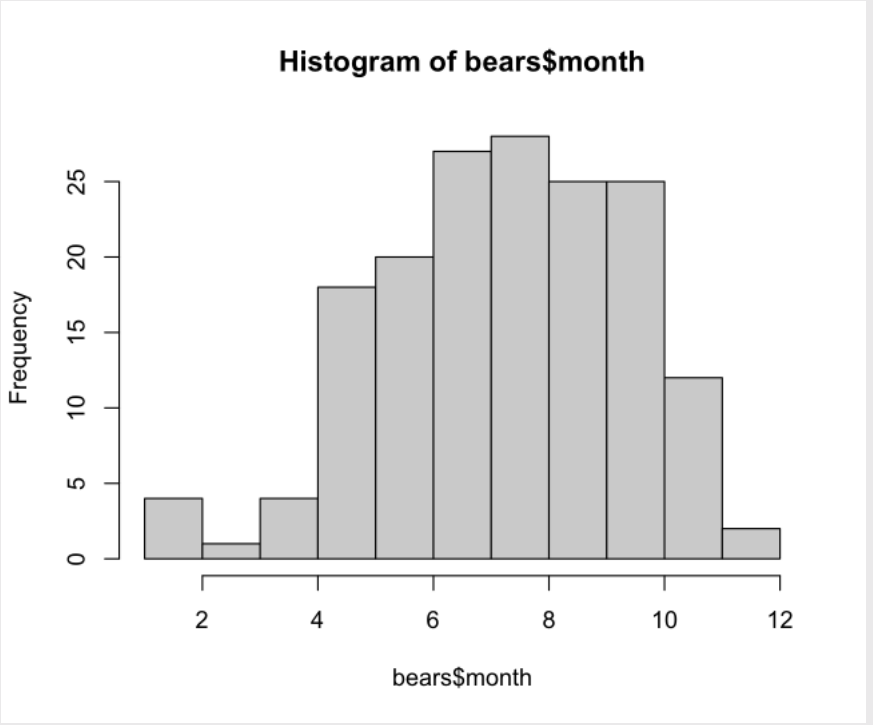
Plot the *distribution* of a single variable

General syntax:

```
hist(x = x_vector)
```

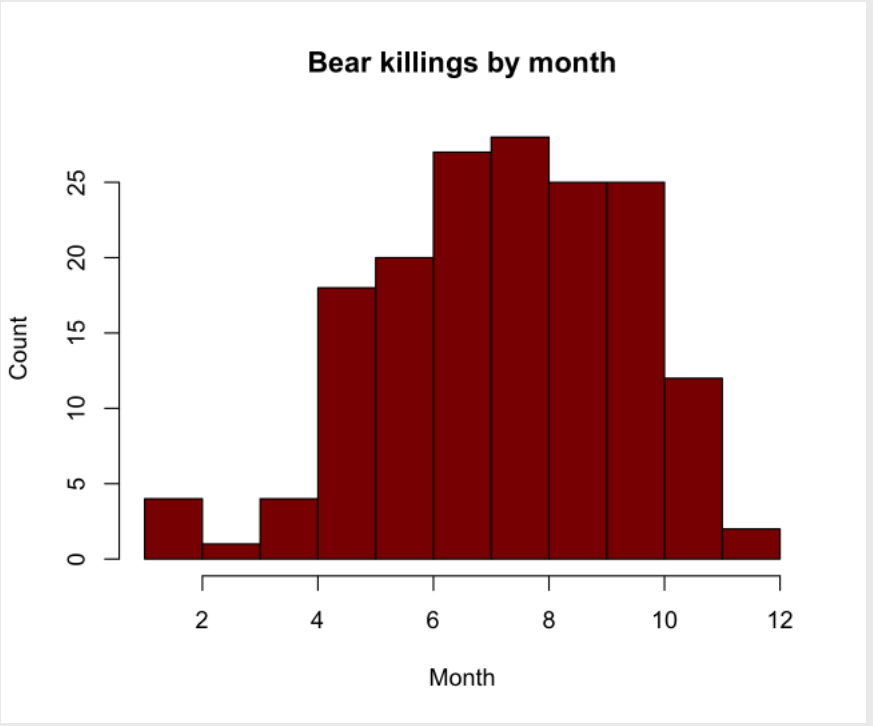
Example:

```
hist(bears$month)
```



Making `hist()` pretty

```
hist(
  x      = bears$month,
  breaks = 12,
  col    = 'darkred',
  main   = "Bear killings by month",
  xlab   = "Month",
  ylab   = "Count"
)
```



Your turn: `hist()`

10:00

Make plots using the `birds` data frame to answer these questions

1. Which months have the highest and lowest number of bird impacts in the dataset?
2. Which aircrafts experience more impacts: 2-engine, 3-engine, or 4-engine?
3. At what height do most impacts occur?

Bonus: Make your plots pretty!

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BREAK

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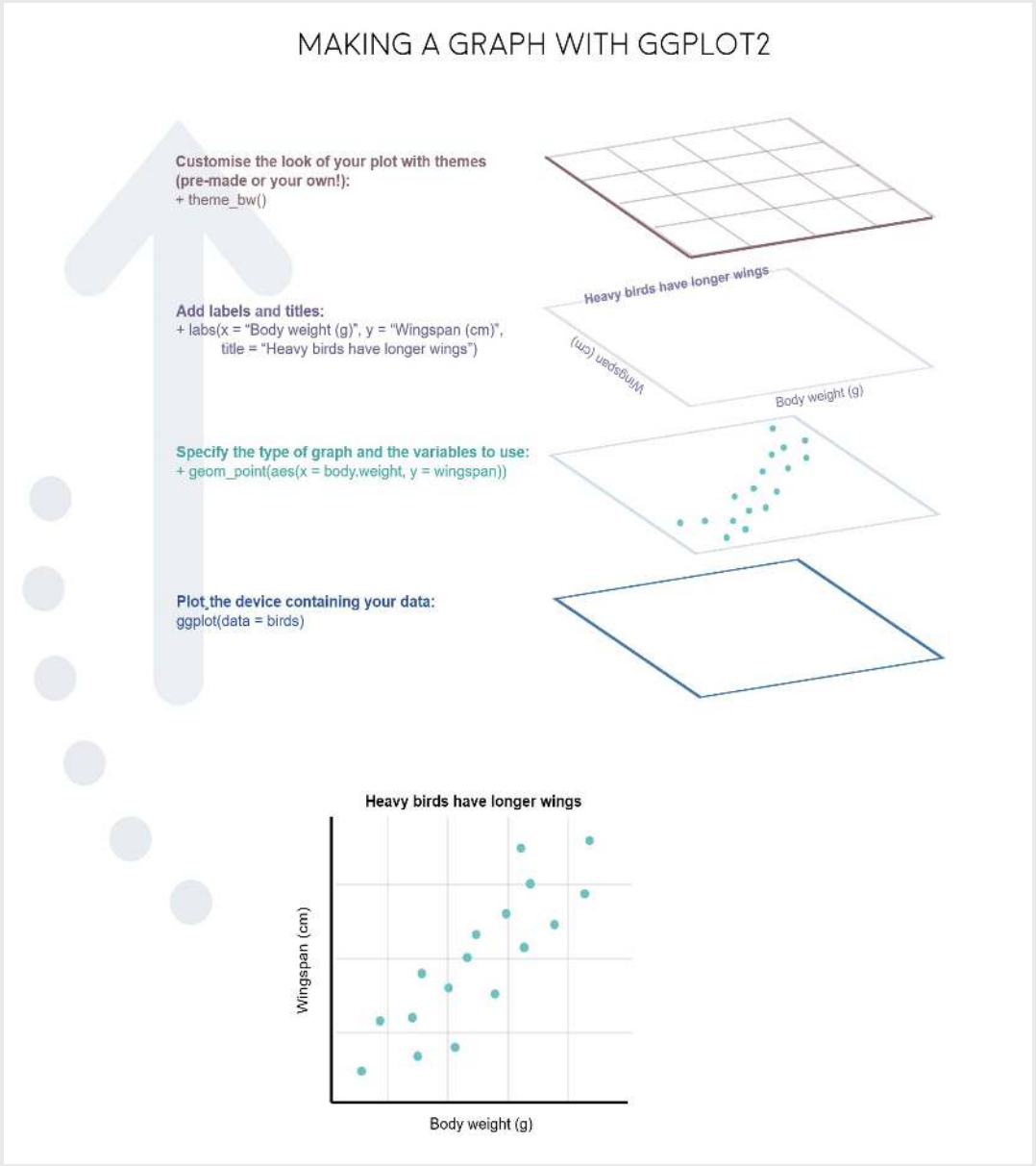
Better figures with `ggplot2`

Art by Allison Horst



"Grammar of Graphics"

Concept developed by Leland Wilkinson (1999)

ggplot2 package developed by Hadley Wickham (2005)

Making plot layers with ggplot2

1. The data (we'll use `bears`)

2. The aesthetic mapping (what goes on the axes?)

3. The geometries (points? bars? etc.)

Layer 1: The data

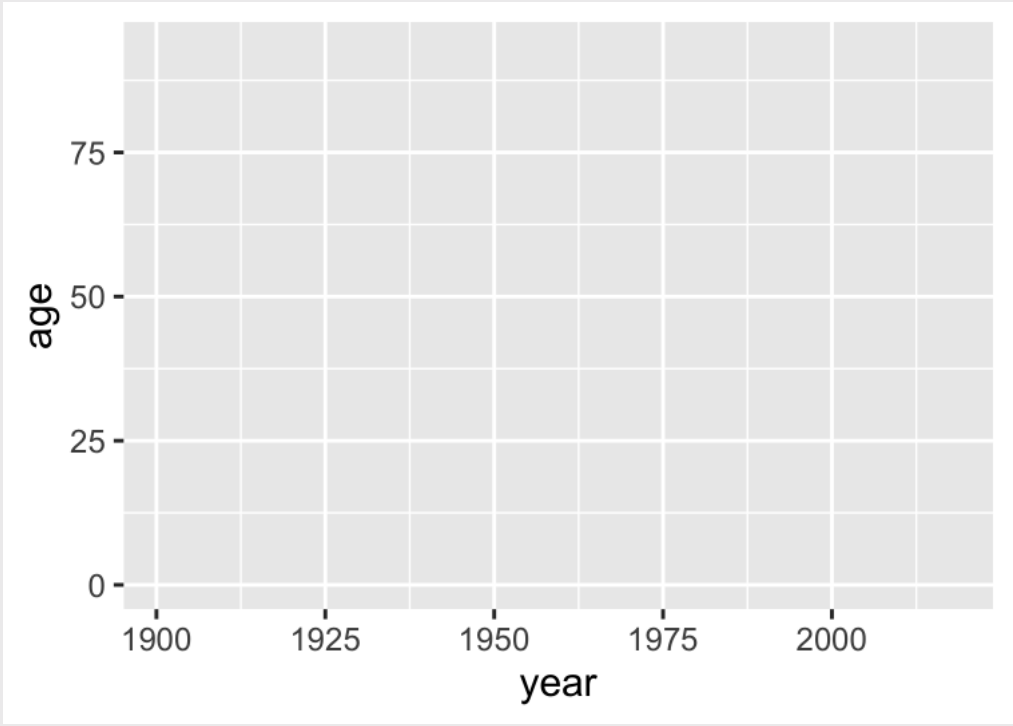
The `ggplot()` function initializes the plot with whatever data you're using

```
ggplot(data = bears)
```

Layer 2: The aesthetic mapping

The `aes()` function determines which variables will be *mapped* to the geometries (e.g. the axes)

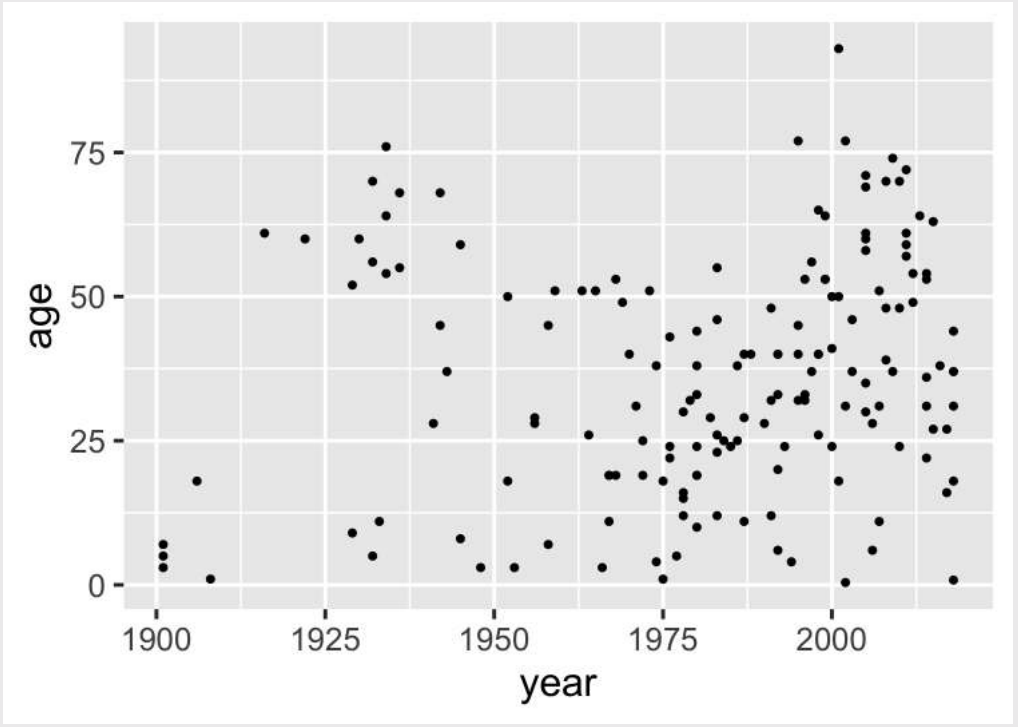
```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age))
```



Layer 3: The geometries

Use + to add geometries (e.g. points)

```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point()
```



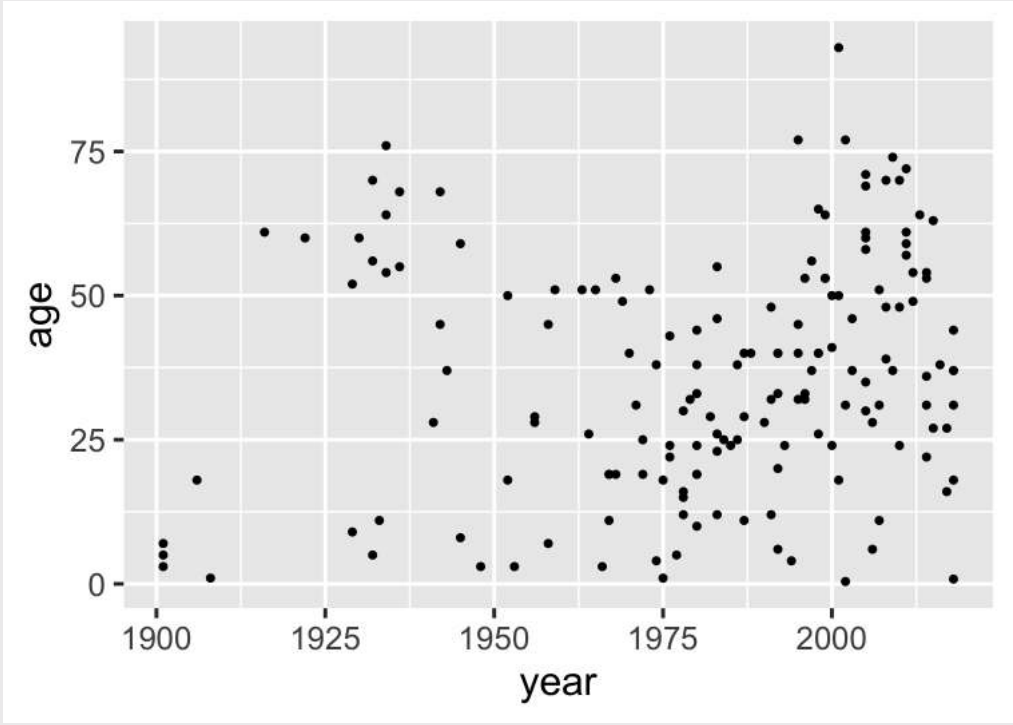
Other common geometries

- `geom_point()`: scatter plots
- `geom_line()`: lines connecting data points
- `geom_col()`: bar charts
- `geom_boxplot()`: boxes for boxplots

Scatterplots with `geom_point()`

Add points:

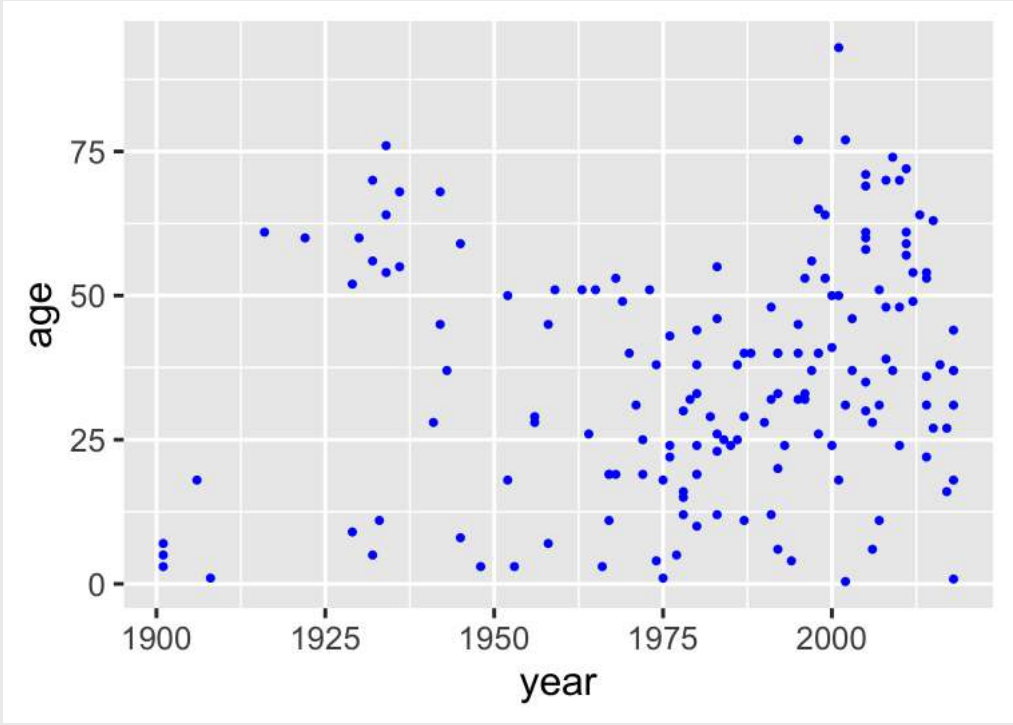
```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point()
```



Scatterplots with `geom_point()`

Change the color of all points:

```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point(color = 'blue')
```

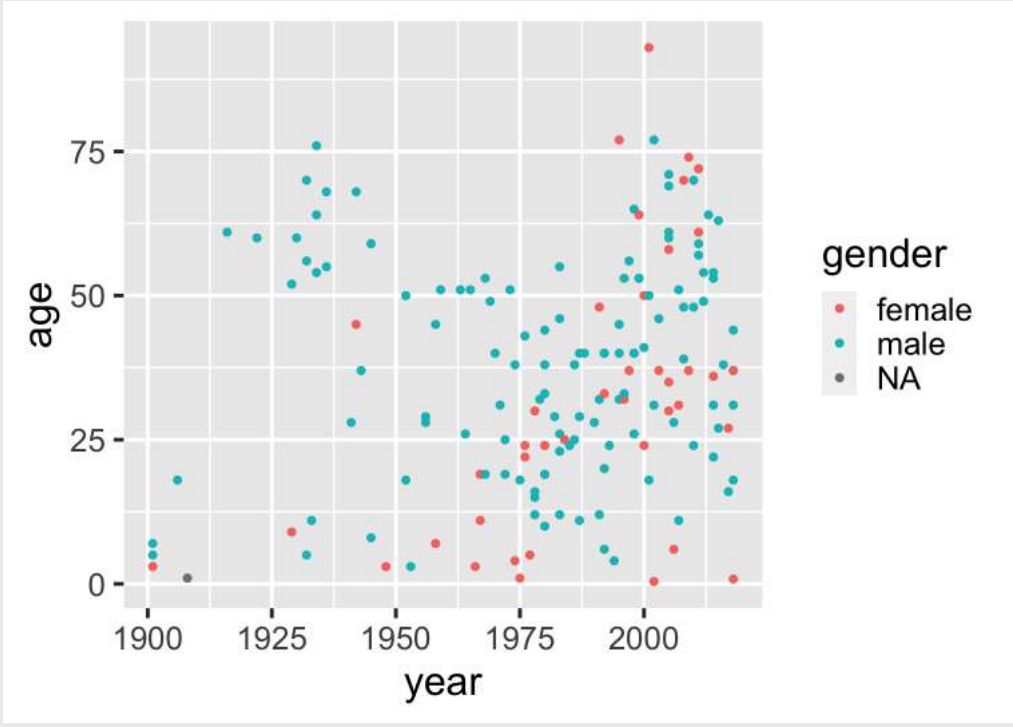


Scatterplots with `geom_point()`

Map the point color to a **variable**:

```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point(aes(color = gender))
```

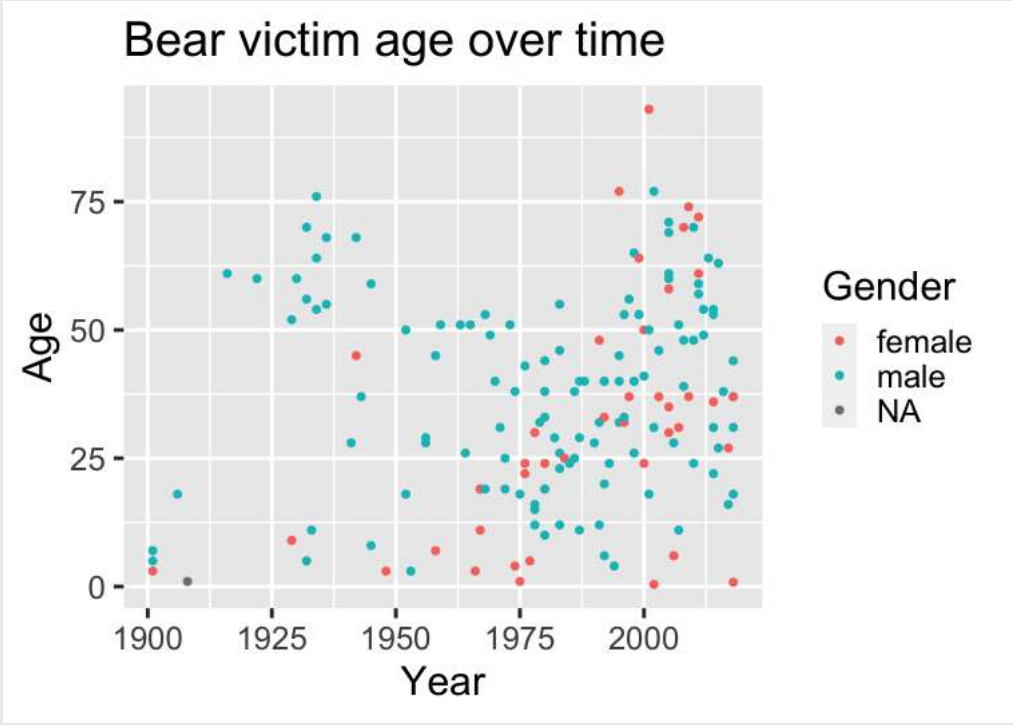
Note that `color = gender` is *inside* `aes()`



Scatterplots with `geom_point()`

Adjust labels with `labs()` layer:

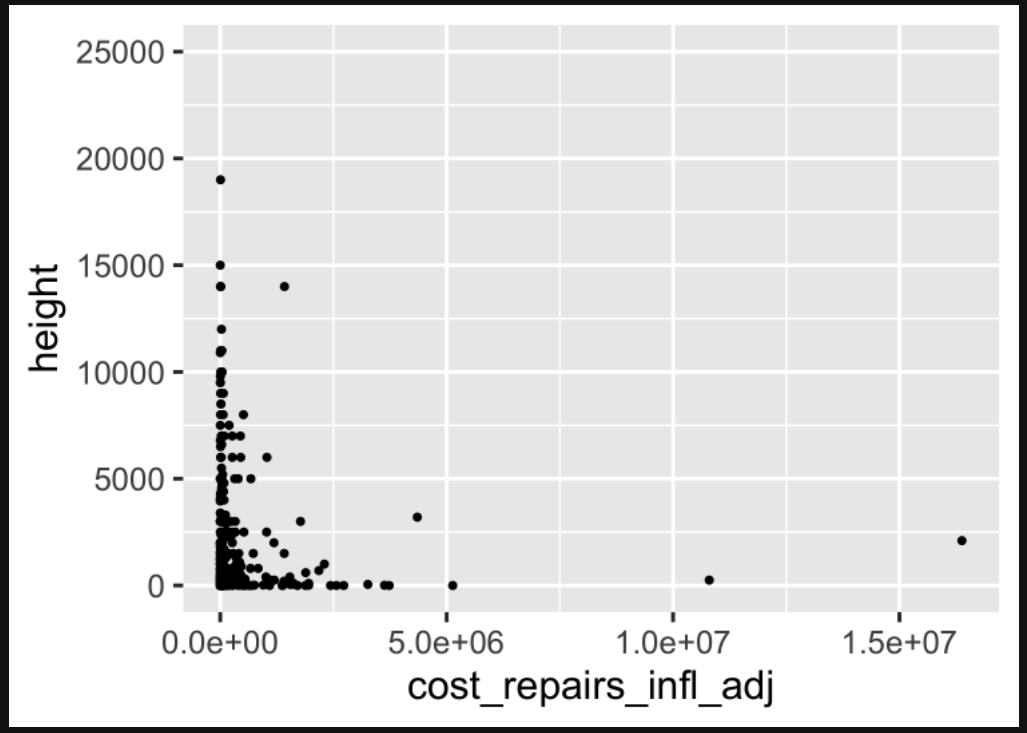
```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point(aes(color = gender)) +
  labs(
    x = "Year",
    y = "Age",
    title = "Bear victim age over time",
    color = "Gender")
```

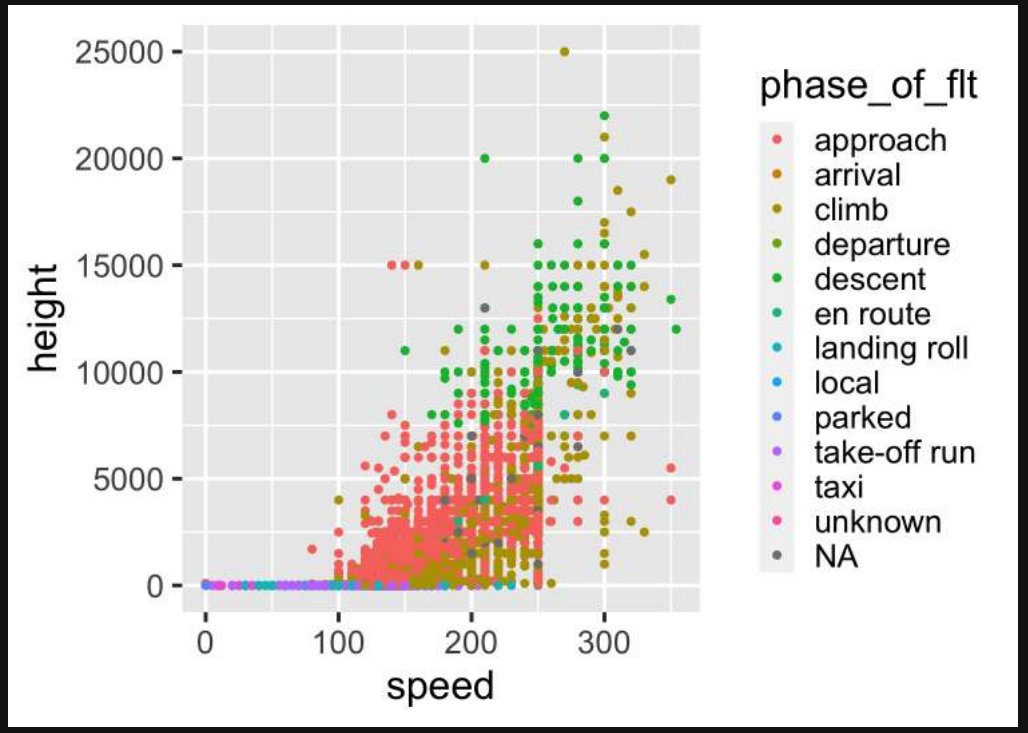


Your turn: `geom_point()`

10:00

Use the `birds` data frame to create the following plots





Break

05:00

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1. Plotting with Base R

2. Plotting with ggplot2: Part 1

BREAK

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4. Tweaking your ggplot

Make bar charts with `geom_col()`

With bar charts, you'll often need to create summary variables to plot

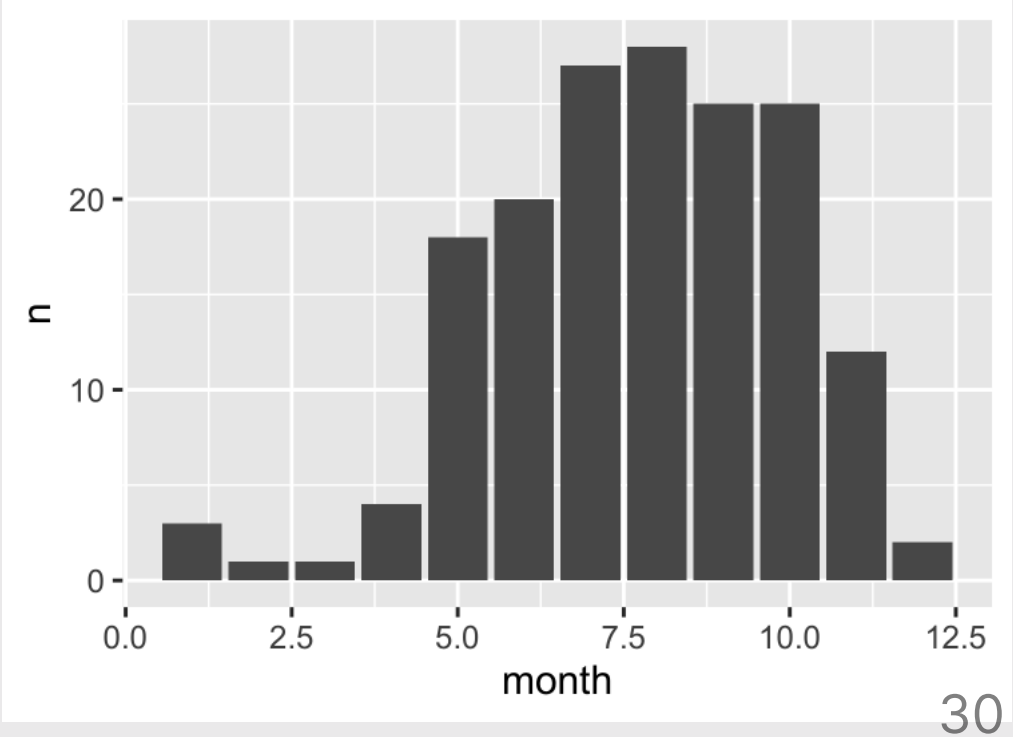
Step 1: Summarize the data

```
bear_months <- bears %>%
  count(month)
```

Step 2: Make the plot

```
ggplot(data = bear_months) +
  geom_col(aes(x = month, y = n))
```

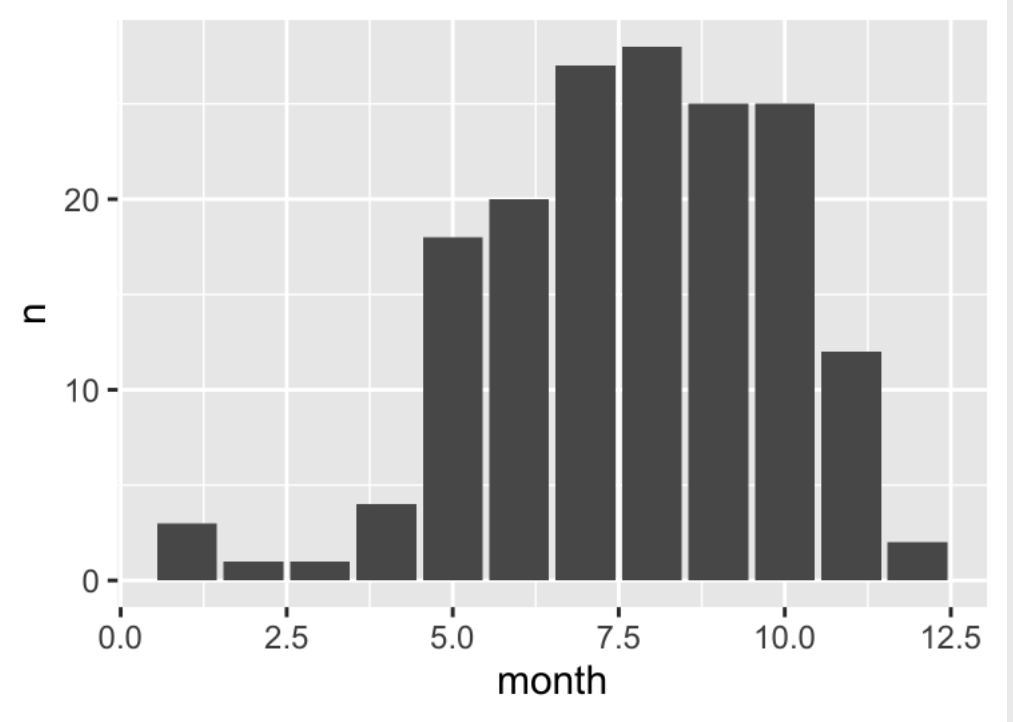
Example: count of attacks by month



Make bar charts with `geom_col()`

Alternative approach: piping directly into ggplot

```
bears %>%
  count(month) %>%  # Pipe into ggplot
  ggplot() +
  geom_col(aes(x = month, y = n))
```

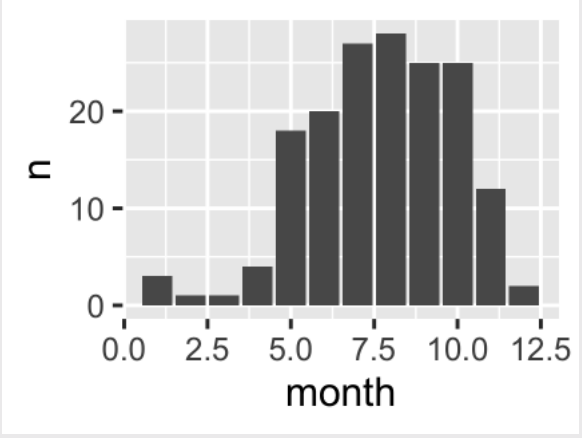


Be careful with `geom_col()` vs. `geom_bar()`

`geom_col()`

Map both `x` and `y`

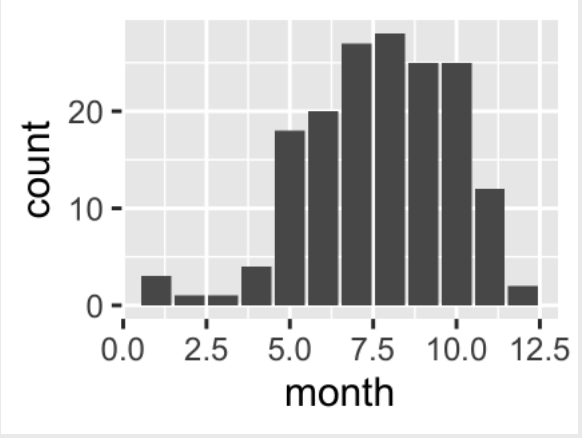
```
bears %>%
  count(month) %>%
  ggplot() +
  geom_col(aes(x = month, y = n))
```



`geom_bar()`

Only map `x` (`y` is computed)

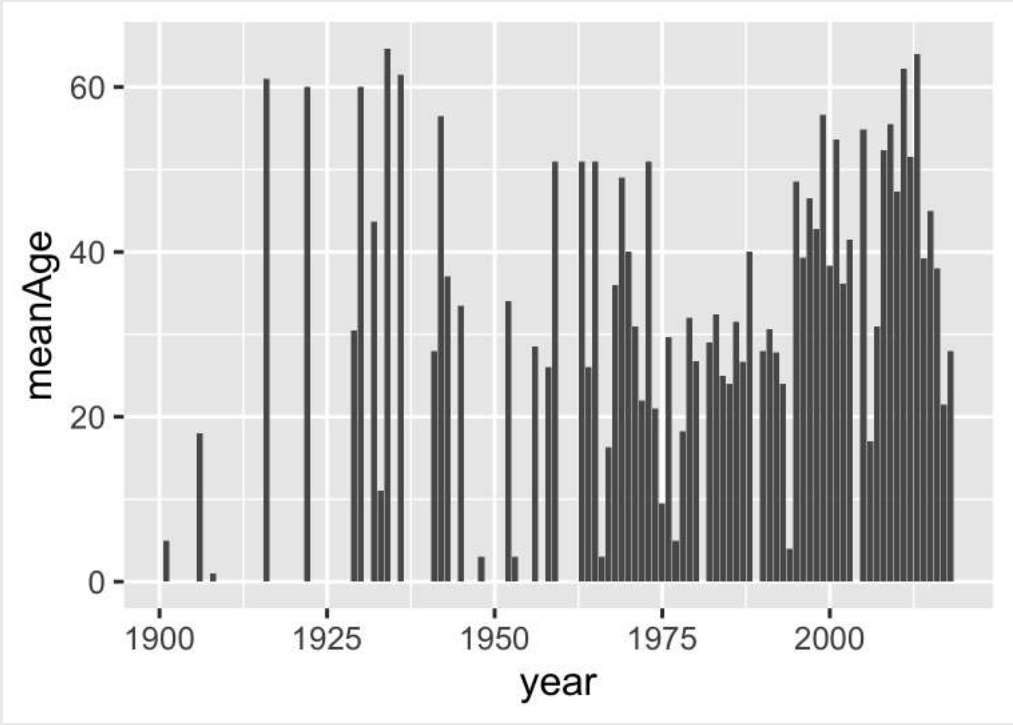
```
bears %>%
  ggplot() +
  geom_bar(aes(x = month))
```



Make bar charts with `geom_col()`

Another example:
Mean age of victim in each year

```
bears %>%
  filter(!is.na(age)) %>%
  group_by(year) %>%
  summarise(meanAge = mean(age)) %>%
  ggplot() +
  geom_col(aes(x = year, y = meanAge))
```

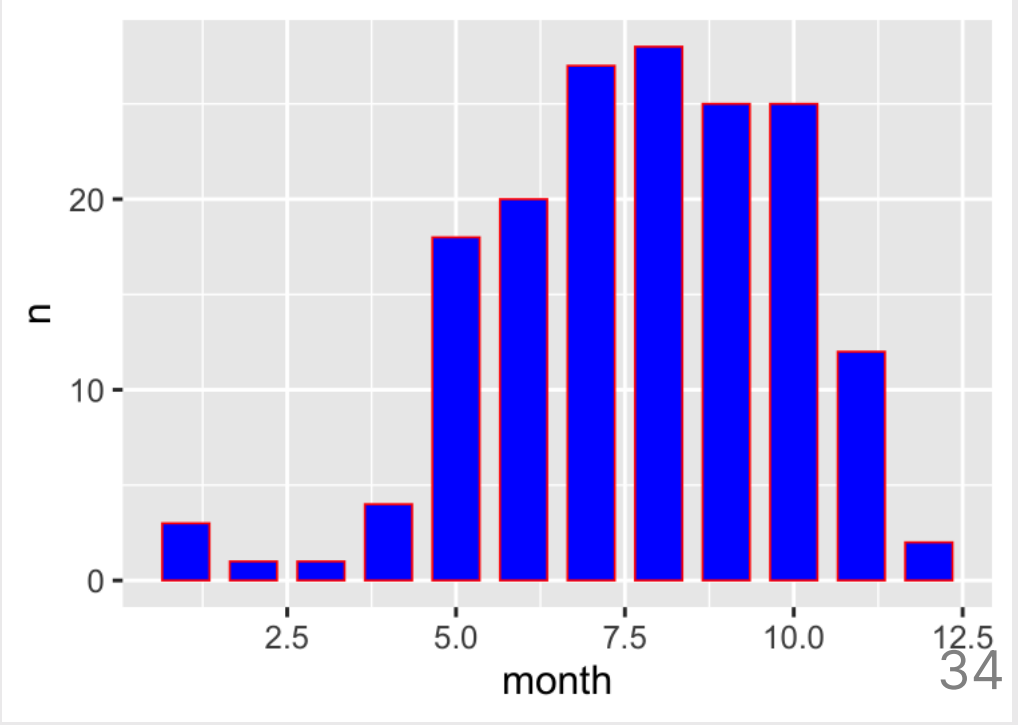


Change bar width: `width`

Change bar color: `fill`

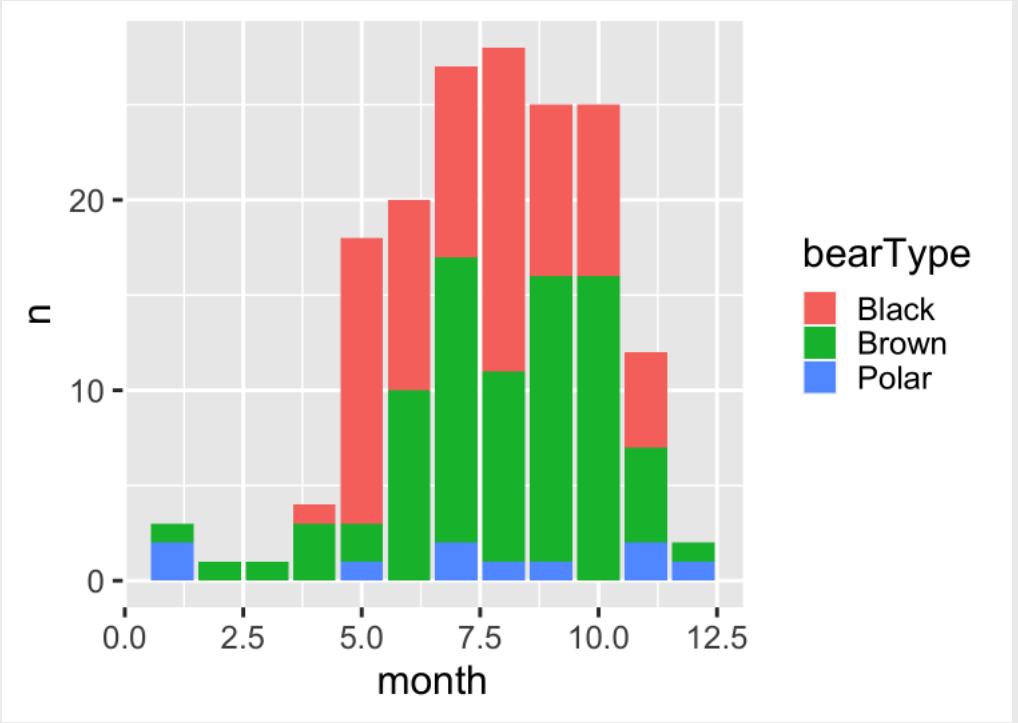
Change bar outline: `color`

```
bears %>%
  count(month) %>%
  ggplot() +
  geom_col(
    mapping = aes(x = month, y = n),
    width = 0.7,
    fill = "blue",
    color = "red"
  )
```



Map the `fill` to `bearType`

```
bears %>%
  count(month, bearType) %>%
  ggplot() +
  geom_col(
    mapping = aes(
      x = month, y = n, fill = bearType)
  )
```



Note that I had to summarize the count by both `month` and `bearType`

```
bears %>%
  count(month, bearType)
```

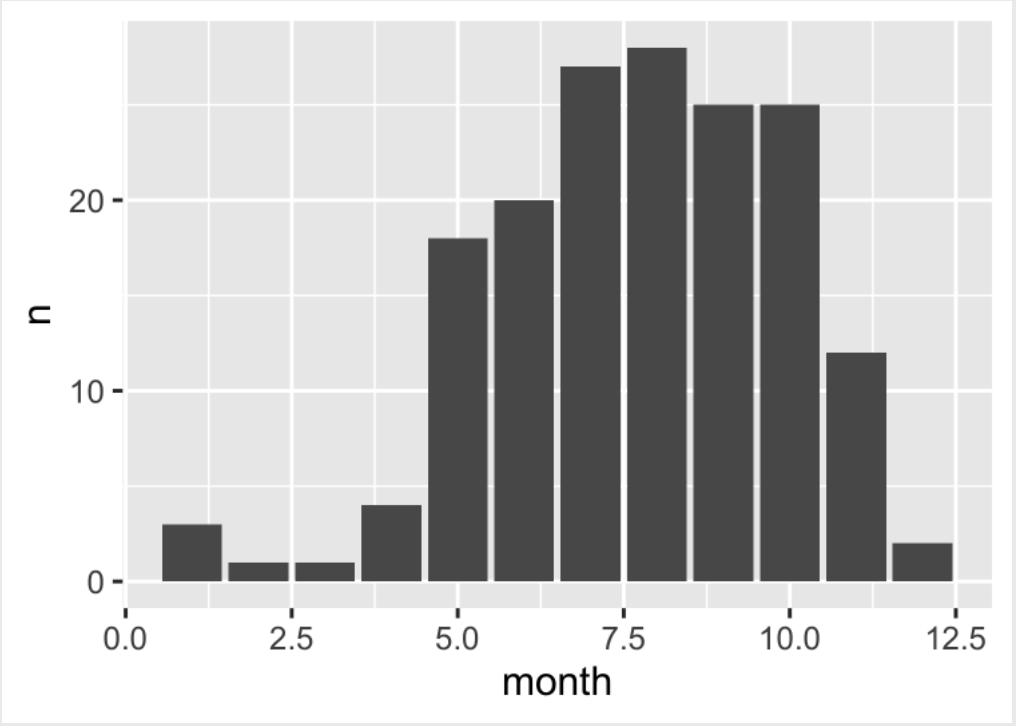
```
#> # A tibble: 27 × 3
#>    month bearType     n
#>    <dbl> <chr>    <int>
#>  1     1 Brown        1
#>  2     1 Polar        2
#>  3     2 Brown        1
#>  4     3 Brown        1
#>  5     4 Black        1
#>  6     4 Brown        3
```

"Factors" = Categorical variables

By default, R makes numeric variables *continuous*

```
bears %>%
  count(month) %>%
  ggplot() +
  geom_col(aes(x = month, y = n))
```

The variable `month` is a *number*

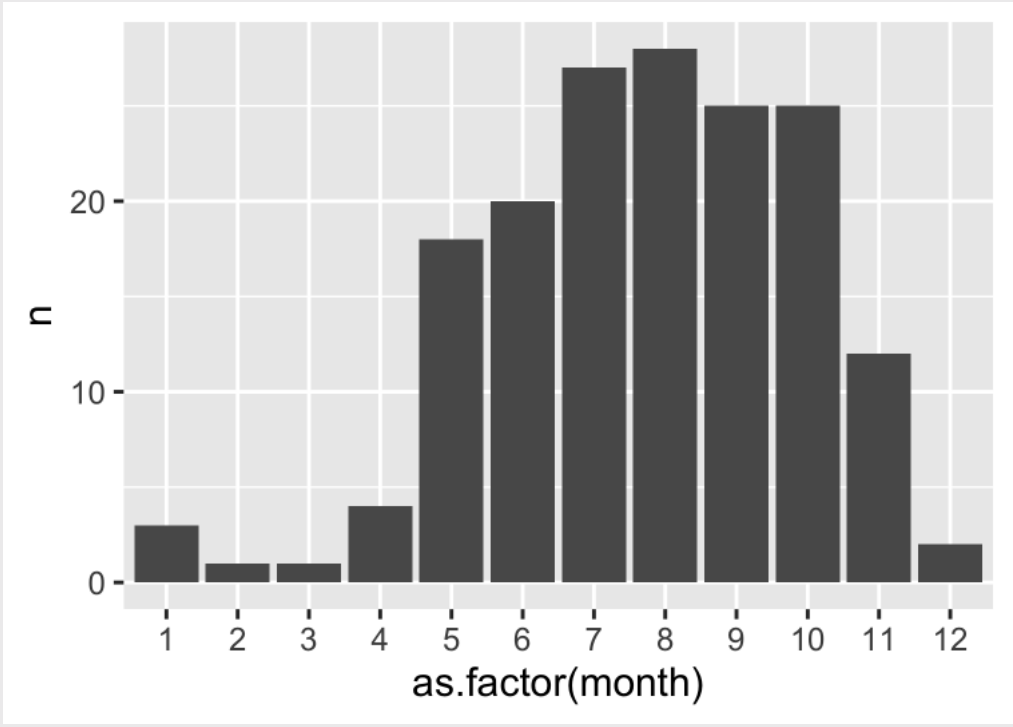


"Factors" = Categorical variables

You can make a continuous variable *categorical* using `as.factor()`

```
bears %>%
  count(month) %>%
  ggplot() +
  geom_col(
    mapping = aes(
      x = as.factor(month),
      y = n)
  )
```

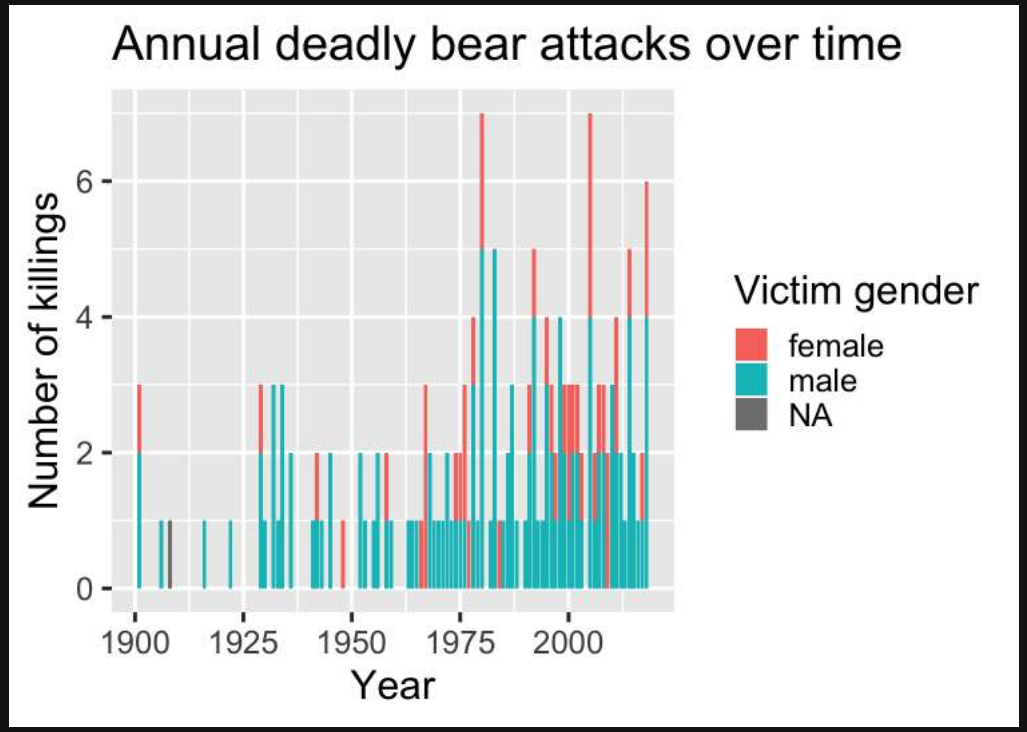
The variable `month` is a *factor*

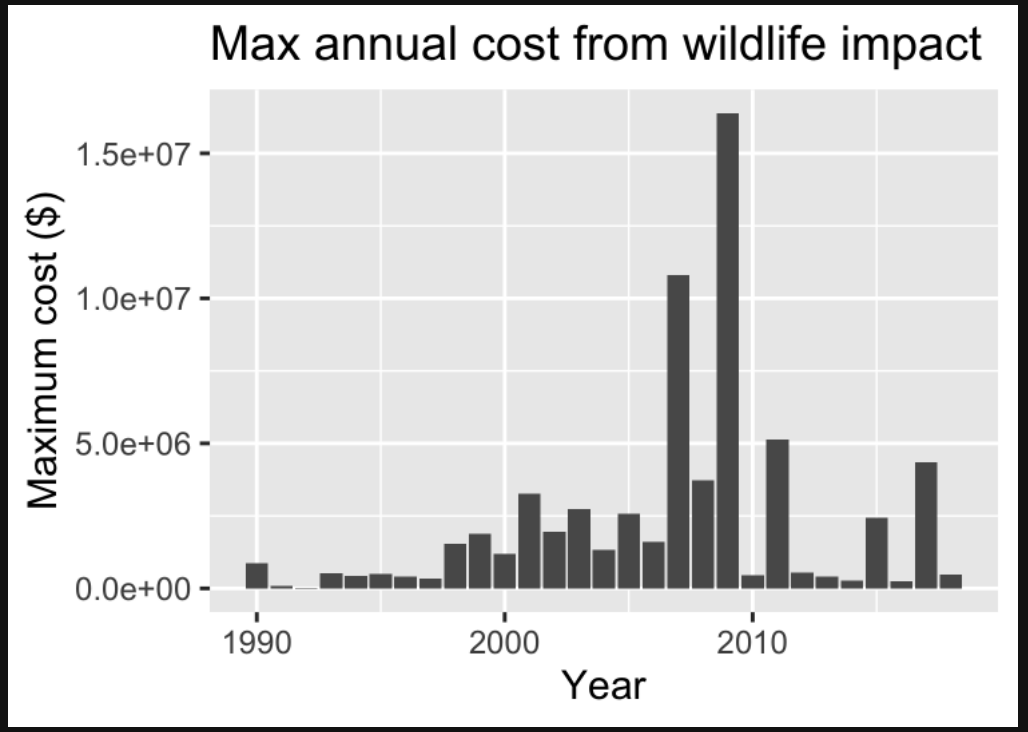


Your turn: `geom_col()`

15:00

Use the `bears` and `birds` data frame to create the following plots





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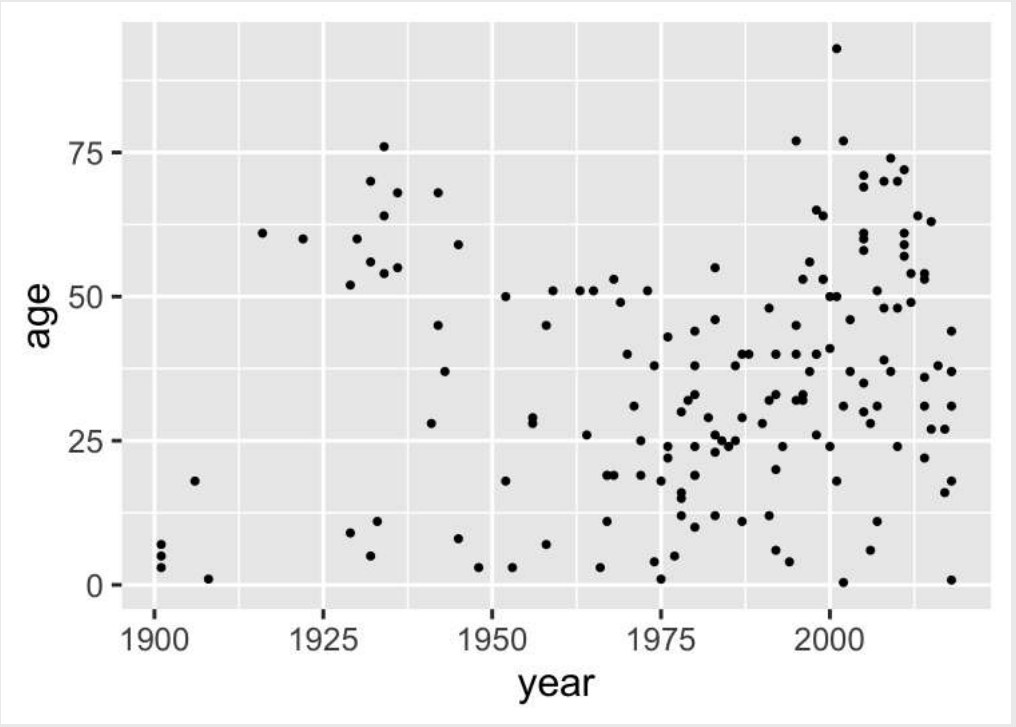
Working with themes

Themes change *global* features of your plot, like the background color, grid lines, etc.

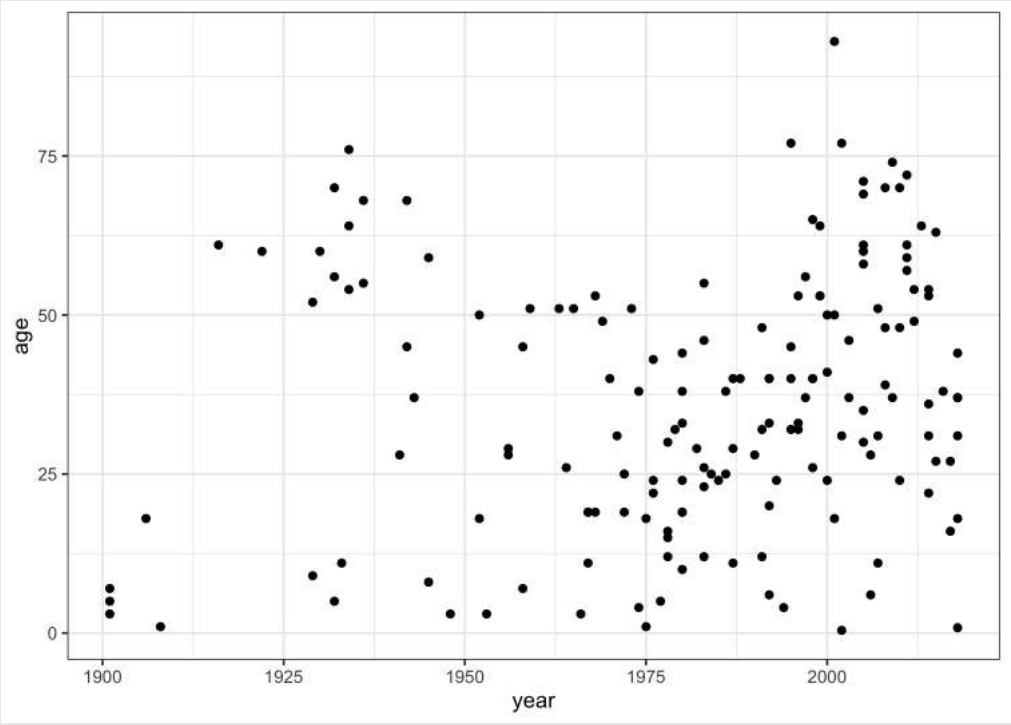
```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point()
```



Working with themes

Themes change *global* features of your plot, like the background color, grid lines, etc.

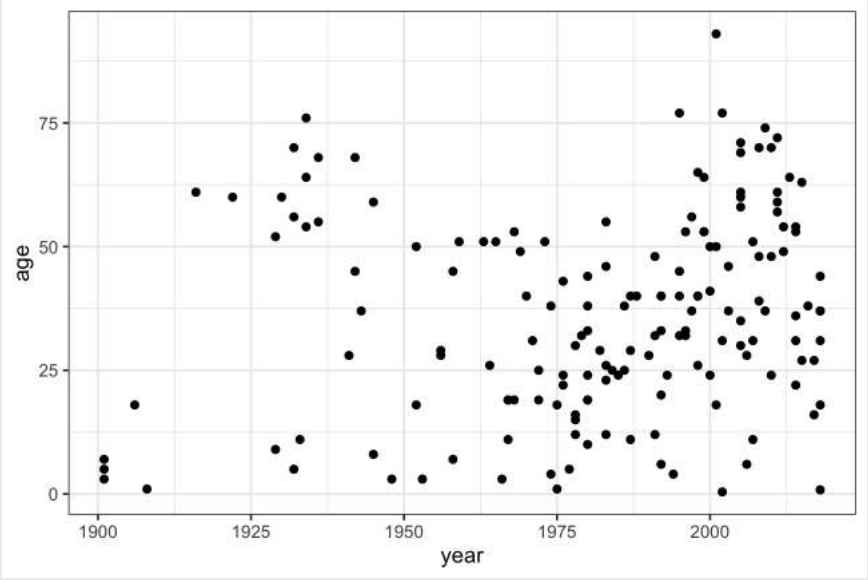
```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_bw()
```



Common themes

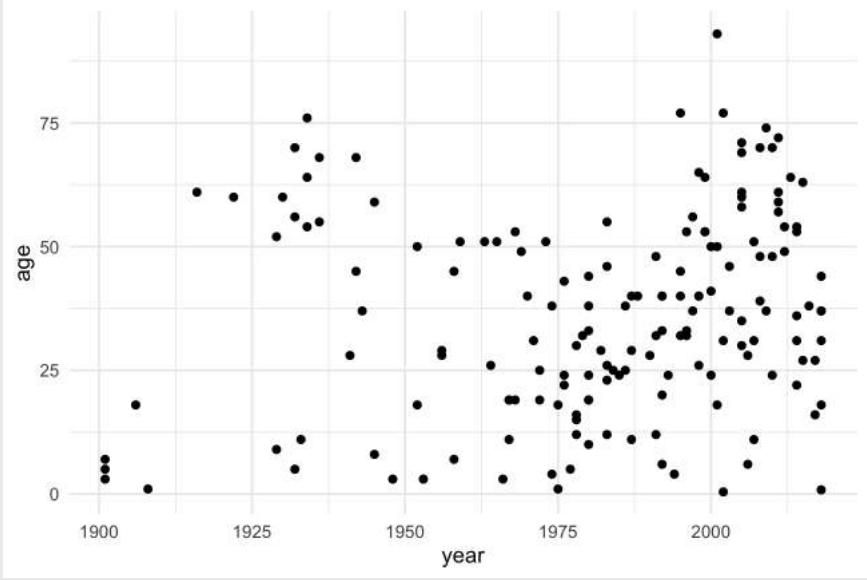
`theme_bw()`

```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_bw()
```



`theme_minimal()`

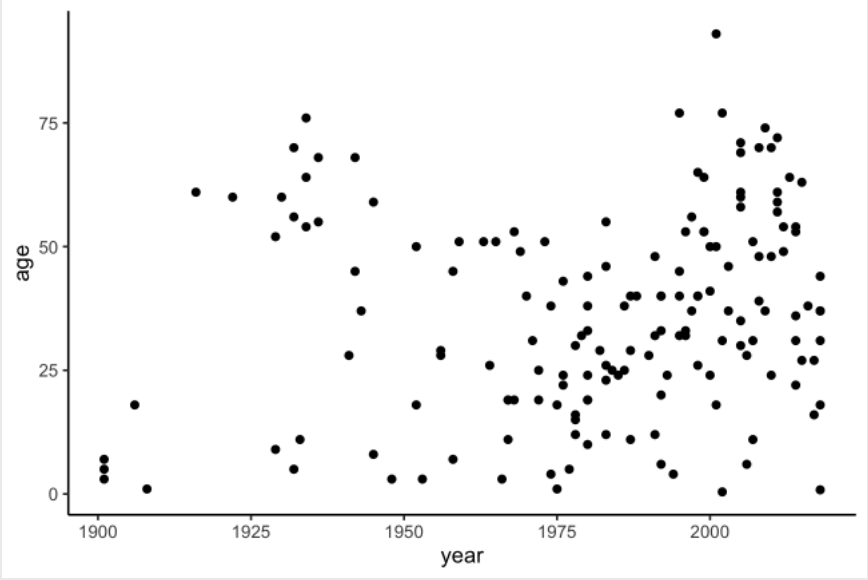
```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_minimal()
```



Common themes

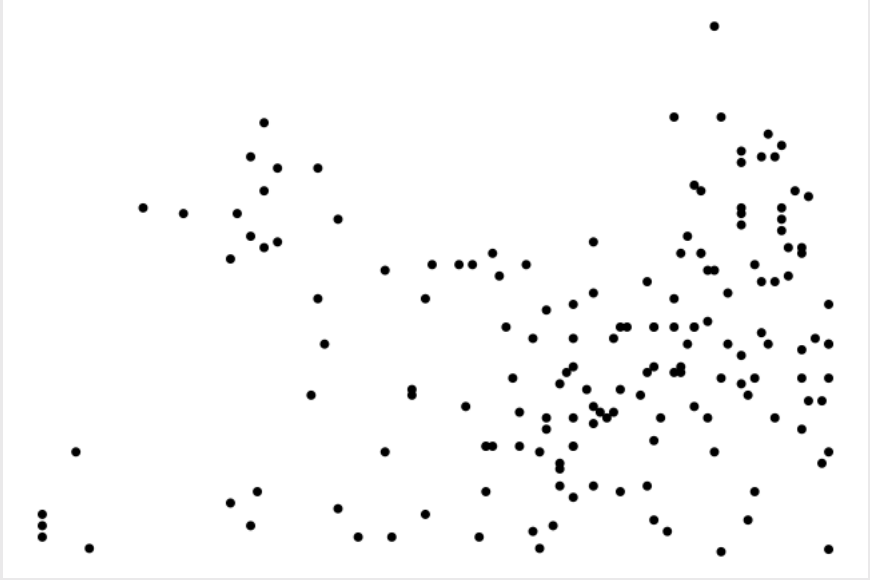
`theme_classic()`

```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_classic()
```



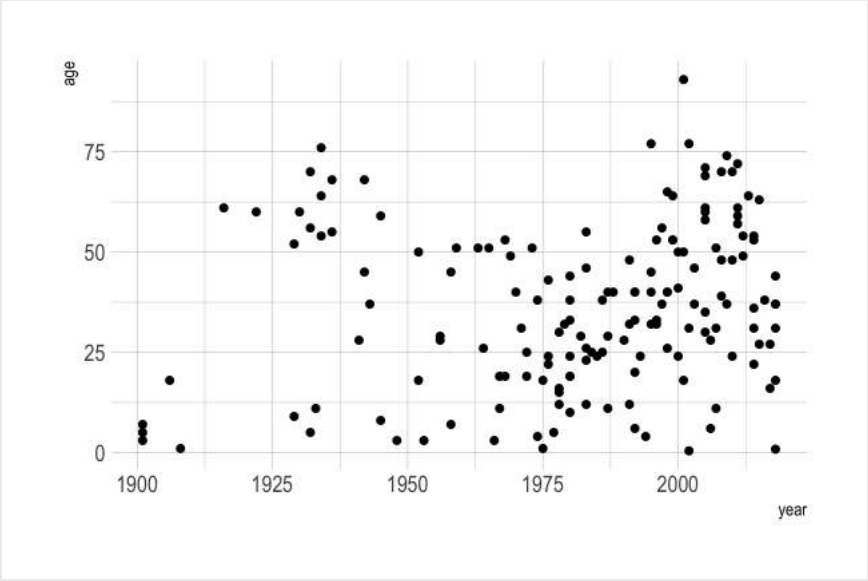
`theme_void()`

```
ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_void()
```

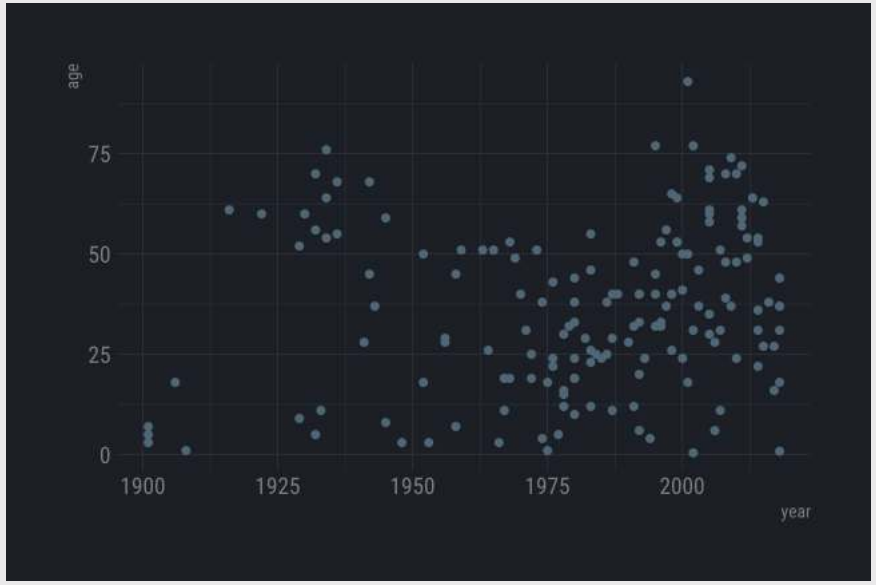


Other themes: hrbrthemes

```
library(hrbrthemes)

ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_ipsum()
```

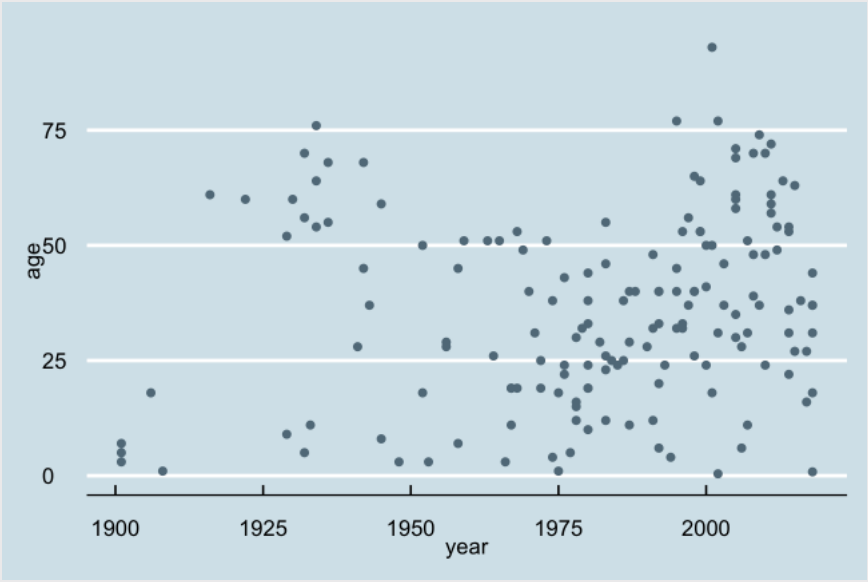



```
library(hrbrthemes)

ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_ft_rc()
```

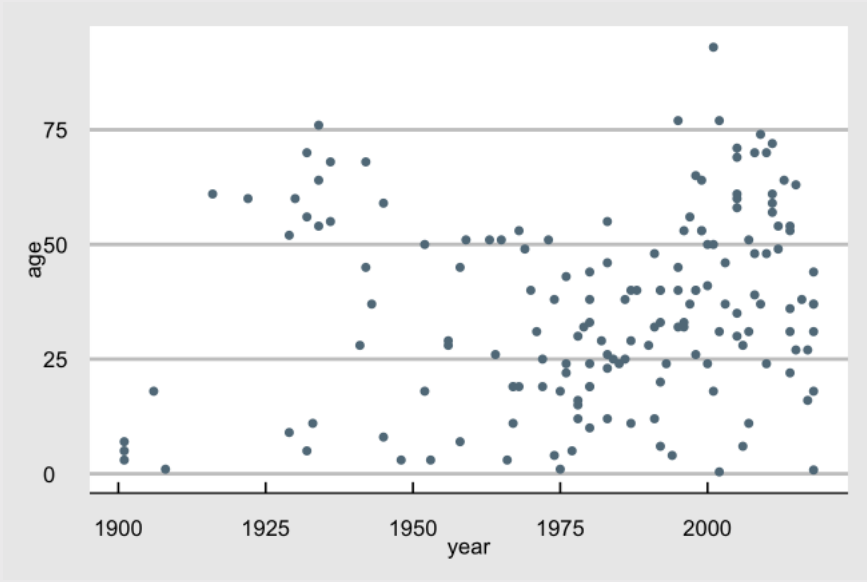


Other themes: **ggthemes**

```
library(ggthemes)

ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_economist()
```




```
library(ggthemes)

ggplot(
  data = bears,
  mapping = aes(x = year, y = age)) +
  geom_point() +
  theme_economist_white()
```



Save figures with `ggsave()`

First, assign the plot to an object name:

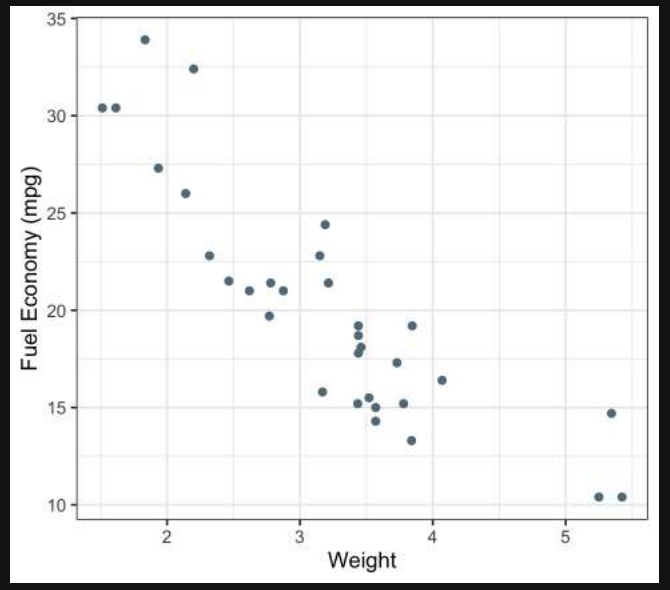
```
scatterPlot <- ggplot(data = bears) +
    geom_point(aes(x = year, y = age))
```

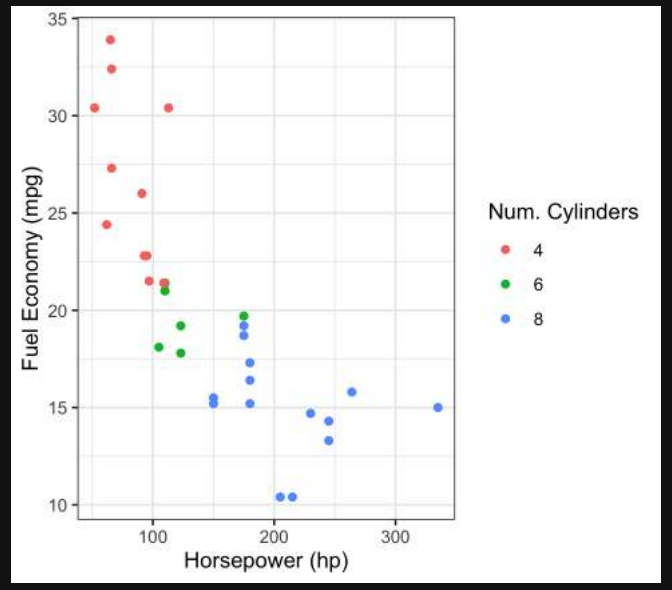
Then use `ggsave()` to save the plot:

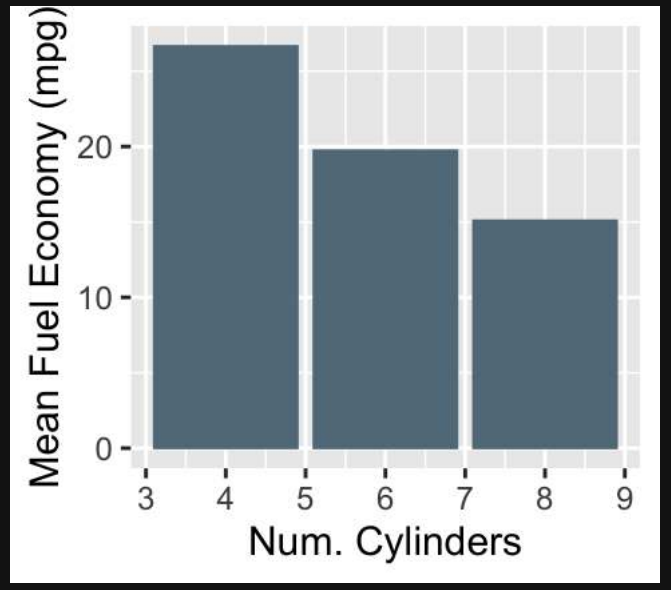
```
ggsave(
    filename = here('plots', 'scatterPlot.png'),
    plot   = scatterPlot,
    width  = 6, # inches
    height = 4)
```

Extra practice 1

Use the `mtcars` data frame to create the following plots







Extra practice 2

Use the `mpg` data frame to create the following plot