Data Visualization using ggplot

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Learning objectives

- Produce boxplots, scatter plots and smoothed plots using ggplot.
- Describe what faceting is and apply faceting in ggplot.
- Modify the aesthetics of an existing ggplot plot (including axis labels and color).
- Build complex and customized plots from data in a data frame.

Building your plots iteratively

- Building plots with ggplot2 is typically an iterative process.
- We start by defining the dataset we'll use, lay out the axes, and choose a geom:
- Then, we start modifying this plot to extract more information from it.
- For instance, we can add transparency (alpha) to avoid overplotting:
- We can also add colors for all the points:
- Or to color each species in the plot differently, you could use a vector as an input to the argument color.
- ggplot2 will provide a different color corresponding to different values in the vector. Here is an example where we color with species_id:
- Load required package

```
library(tidyverse)
```

- Set the directory

```
setwd("~")
```

- Load the data

```
bw_df <- read.csv("Data/birthweight2.csv")
names(bw_df)
```

```
##  [1] "id"       "matage"  "ht"       "gestwks" "sex"
##  [6] "bweight" "ethnic"  "lbw"      "agegrp"  "lbw2"
## [11] "agegrp1"
```

Boxplot - for a categorical and continuous variable

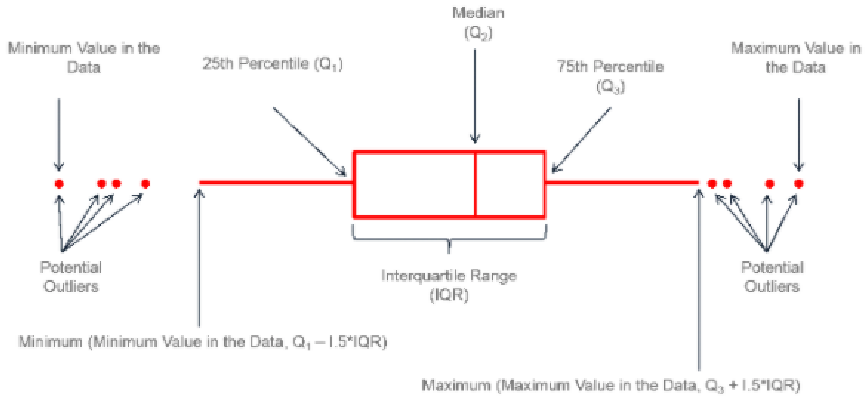
- We will use boxplots to visualize the distribution of birth weight by gender:

- Boxplots provides a standardized way of displaying the distribution of data

- It attempts to provide a visual shape of the data distribution.

- This is based on some summary measures: min, \(1^{st}\) quartile, median, \(3^{rd}\) quartile, max

- Range, IQR, Outliers - 3 \(\times\) IQR above \(3^{rd}\) or below \(1^{st}\) quartiles.


Median (Q_2)
Minimum Value in the Data
25th Percentile (Q_1)
75th Percentile (Q_3)
Maximum Value in the Data
Potential Outliers
Interquartile Range (IQR)
Potential Outliers
Minimum (Minimum Value in the Data, $Q_1 - 1.5*IQR$)
Maximum (Maximum Value in the Data, $Q_3 + 1.5*IQR$)

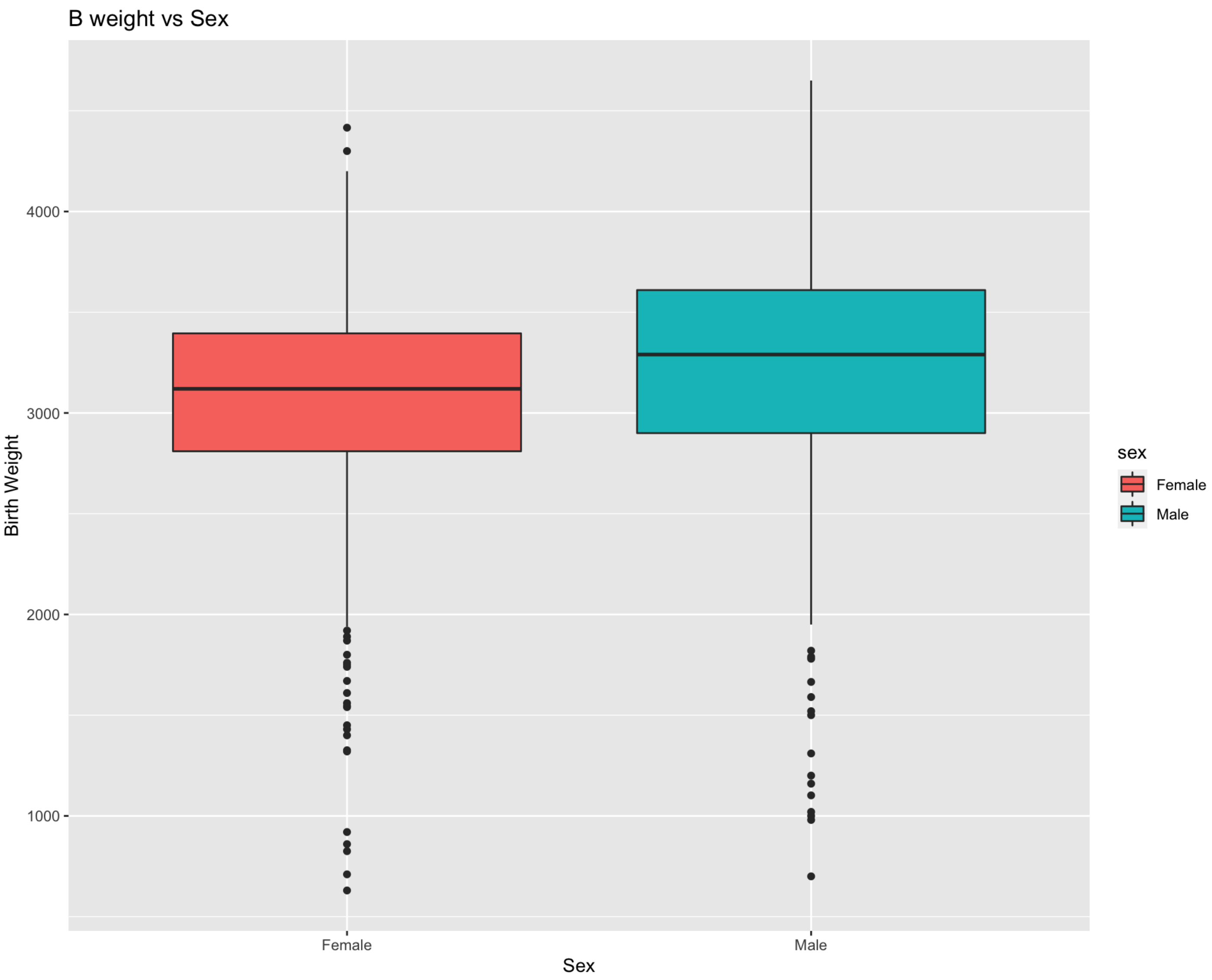
Lets do a Box plot?

- A box plot of bweight vs sex

```
ggplot(data = bw_df)
```

Adding aesthetics and labels

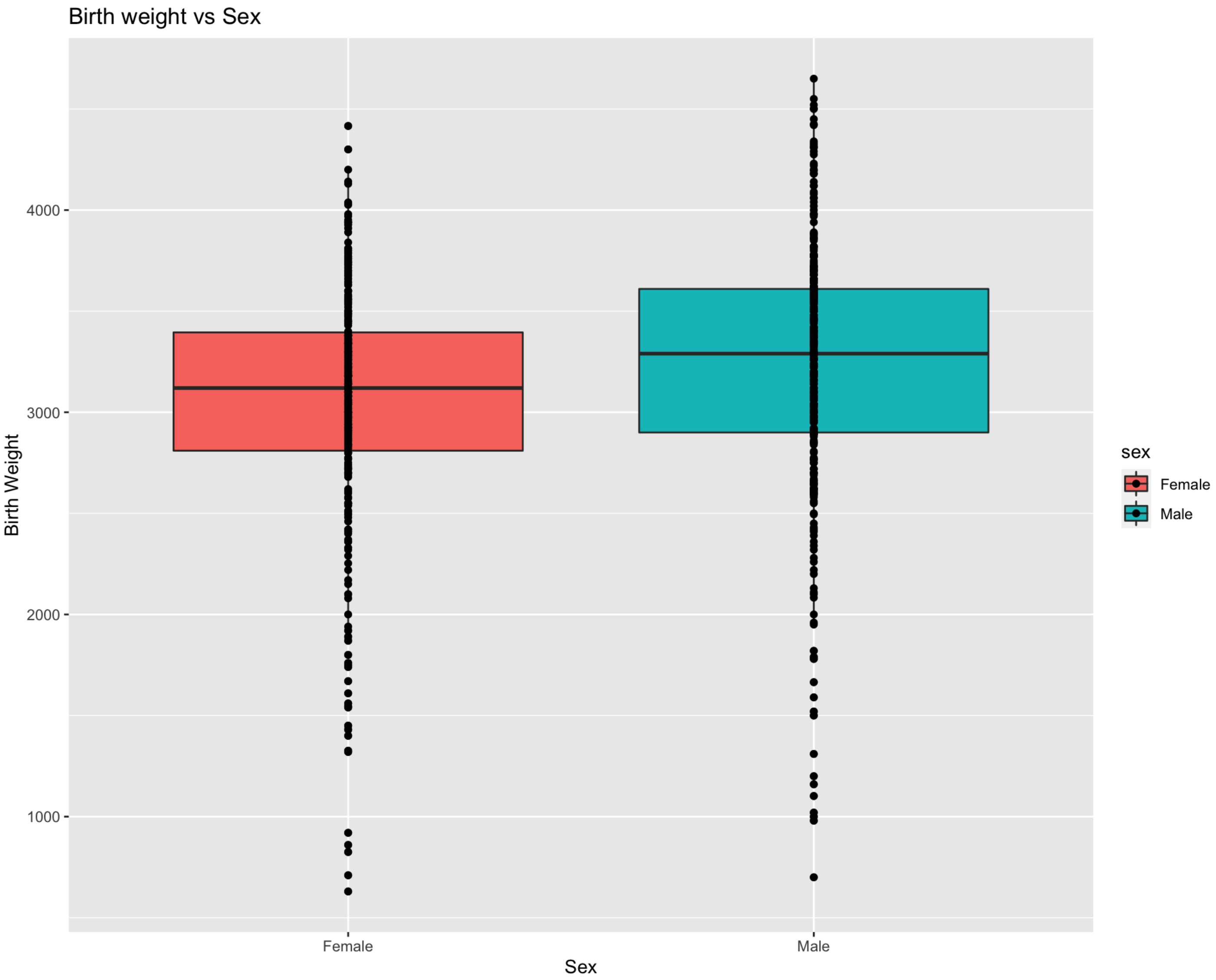
```
ggplot(data = bw_df) + geom_boxplot(aes(y = bweight, x = sex,
    fill = sex)) + ylab("Birth Weight") + xlab("Sex") + ggtitle("B weight vs Sex")
```



Box plot and add scatter

- By adding points to the boxplot, we can have a better idea of the number of measurements and of their distribution:

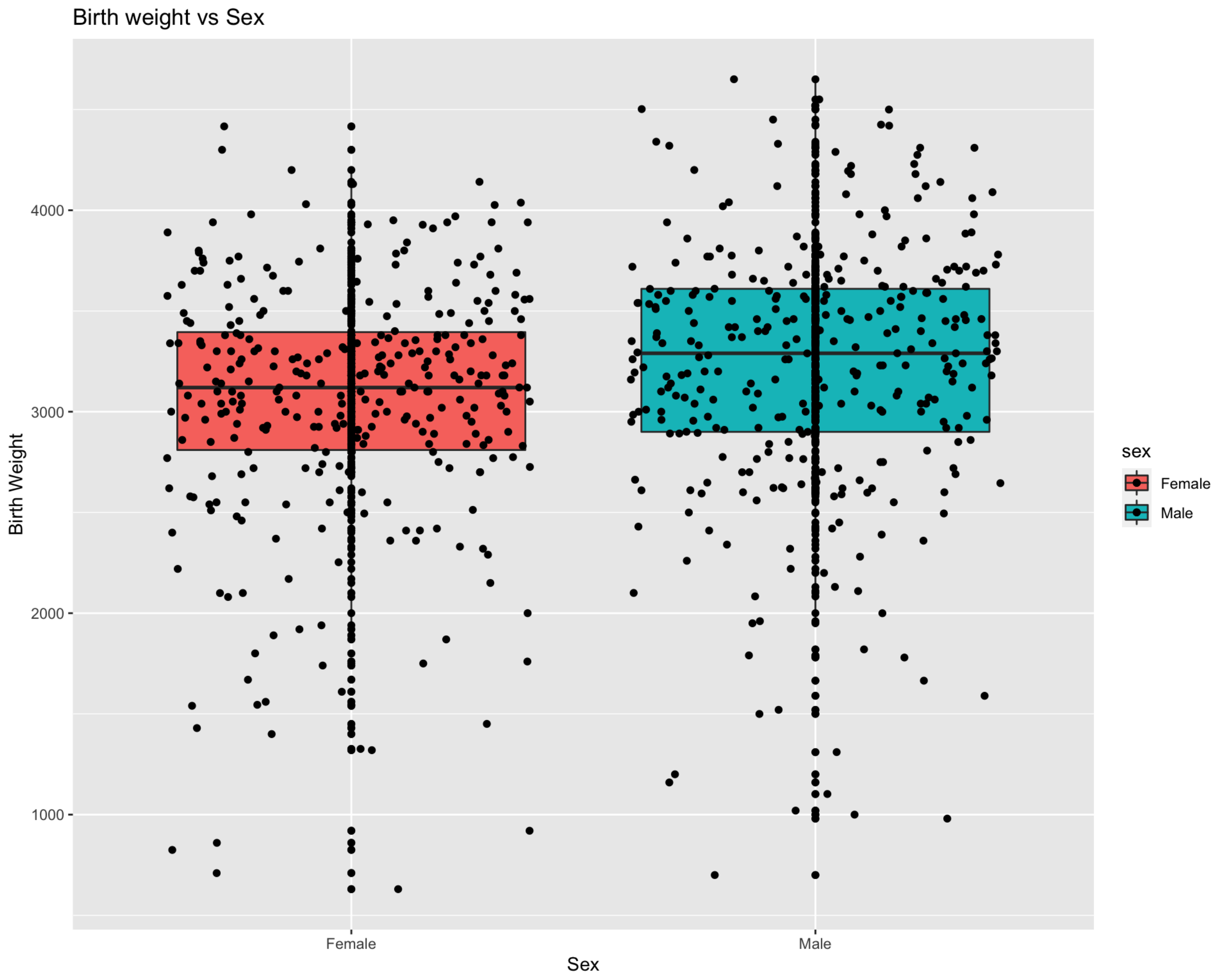
```
ggplot(data = bw_df, mapping = aes(y = bweight, x = sex, fill = sex)) +
    geom_boxplot() + geom_point() + ylab("Birth Weight") + xlab("Sex") +
    ggtitle("Birth weight vs Sex")
```



Box plot and add scatter points that are jittered

- We will jitter points to reduce overplotting
- Notice how the boxplot layer is behind the jitter layer?
- What do you need to change in the code to put the boxplot in front of the points such that it’s not hidden?

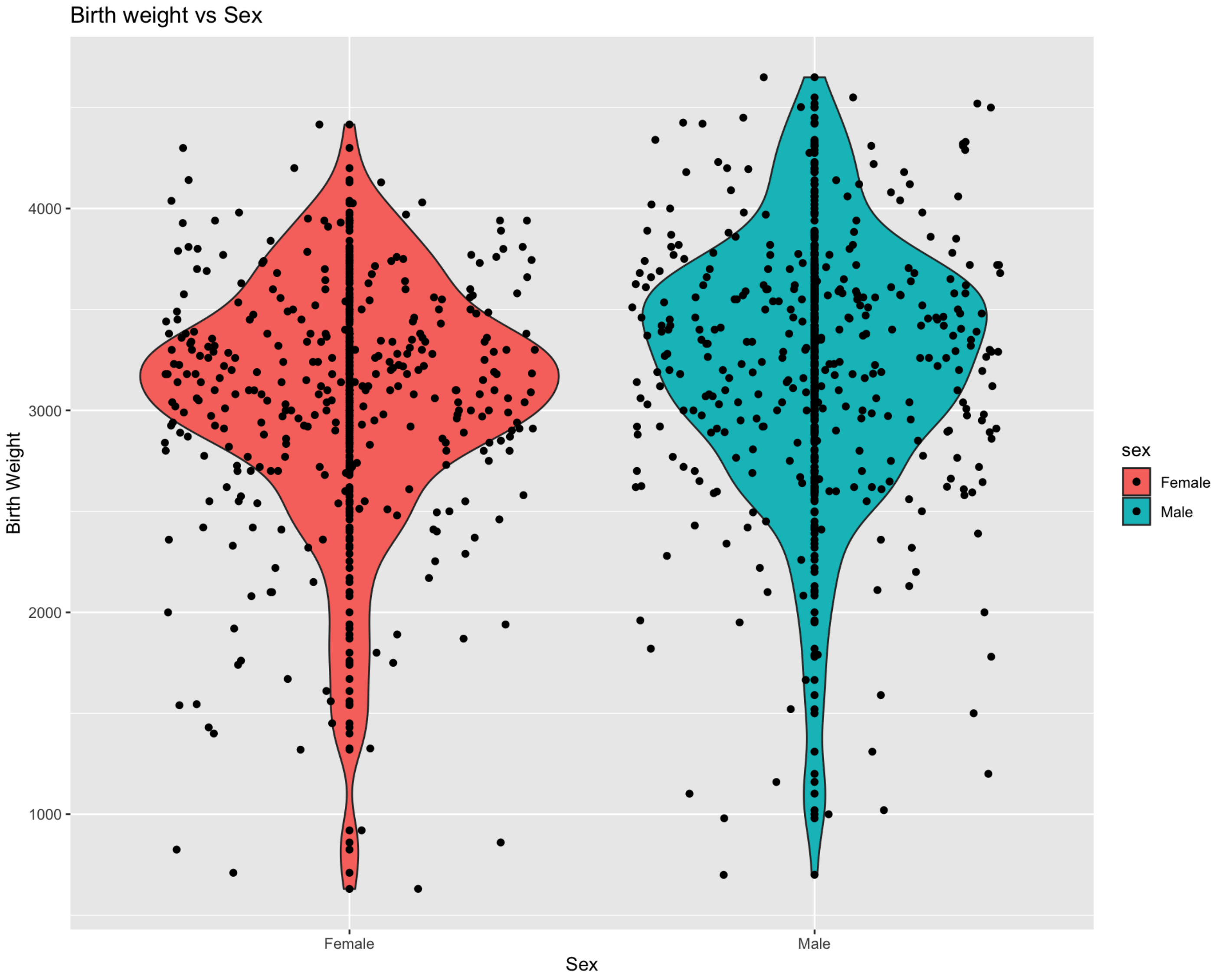
```
ggplot(data = bw_df, mapping = aes(y = bweight, x = sex, fill = sex)) +
    geom_boxplot() + geom_point() + geom_jitter() + ylab("Birth Weight") +
    xlab("Sex") + ggtitle("Birth weight vs Sex")
```



- Boxplots are useful summaries, but hide the shape of the distribution.
- For example, if there is a bimodal distribution, it would not be observed with a boxplot.
- An alternative to the boxplot is the violin plot (sometimes known as a beanplot), where the shape (of the density of points) is drawn.
- Replace the box plot with a violin plot; see geom_violin().

Violin plot

```
ggplot(data = bw_df, mapping = aes(y = bweight, x = sex, fill = sex)) +
    geom_violin() + geom_point() + geom_jitter() + ylab("Birth Weight") +
    xlab("Sex") + ggtitle("Birth weight vs Sex")
```

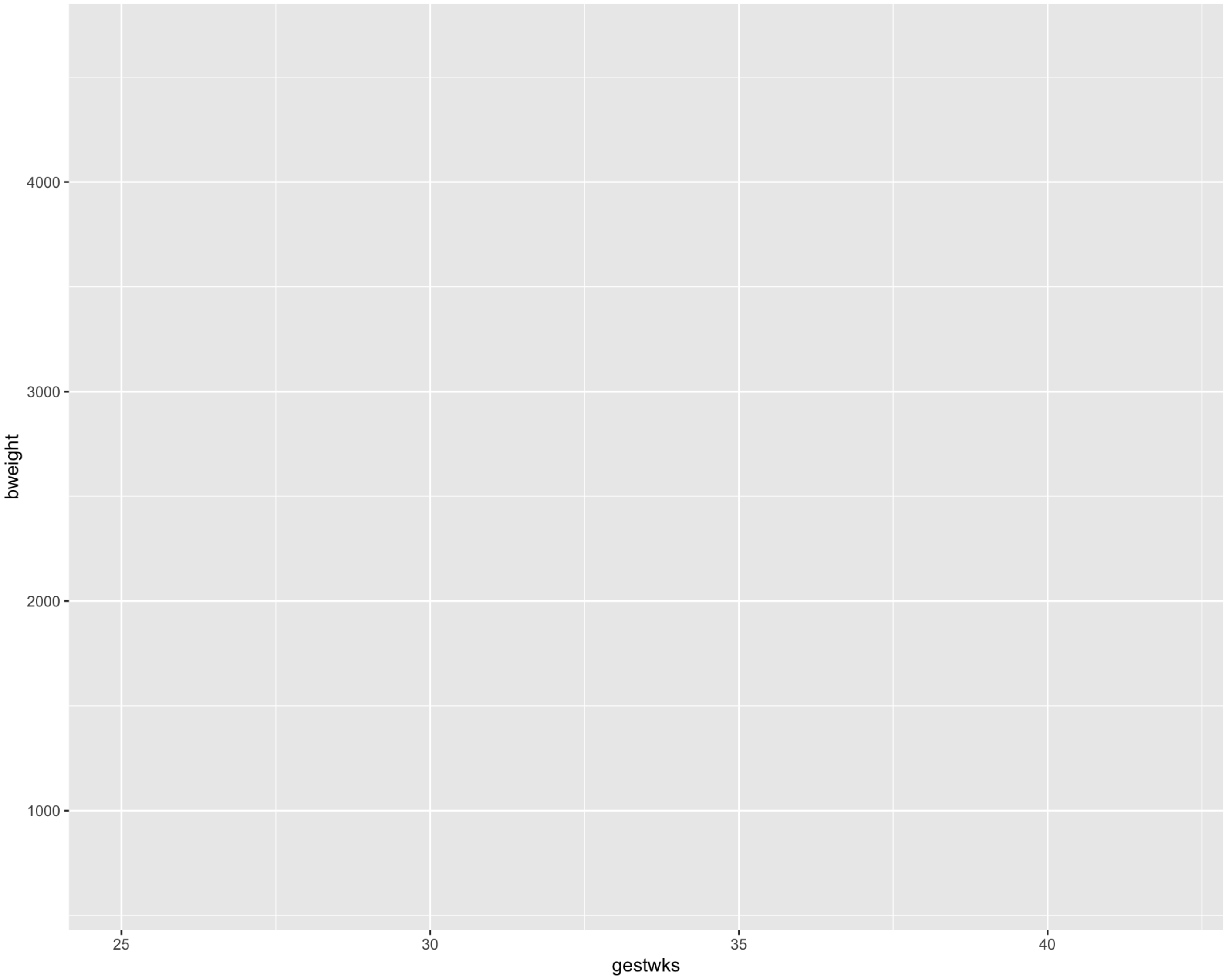


Scatter plot with ggplot2 - for two continuous variables

- We can build a plot sequentially to see how each grammatical layer changes the appearance

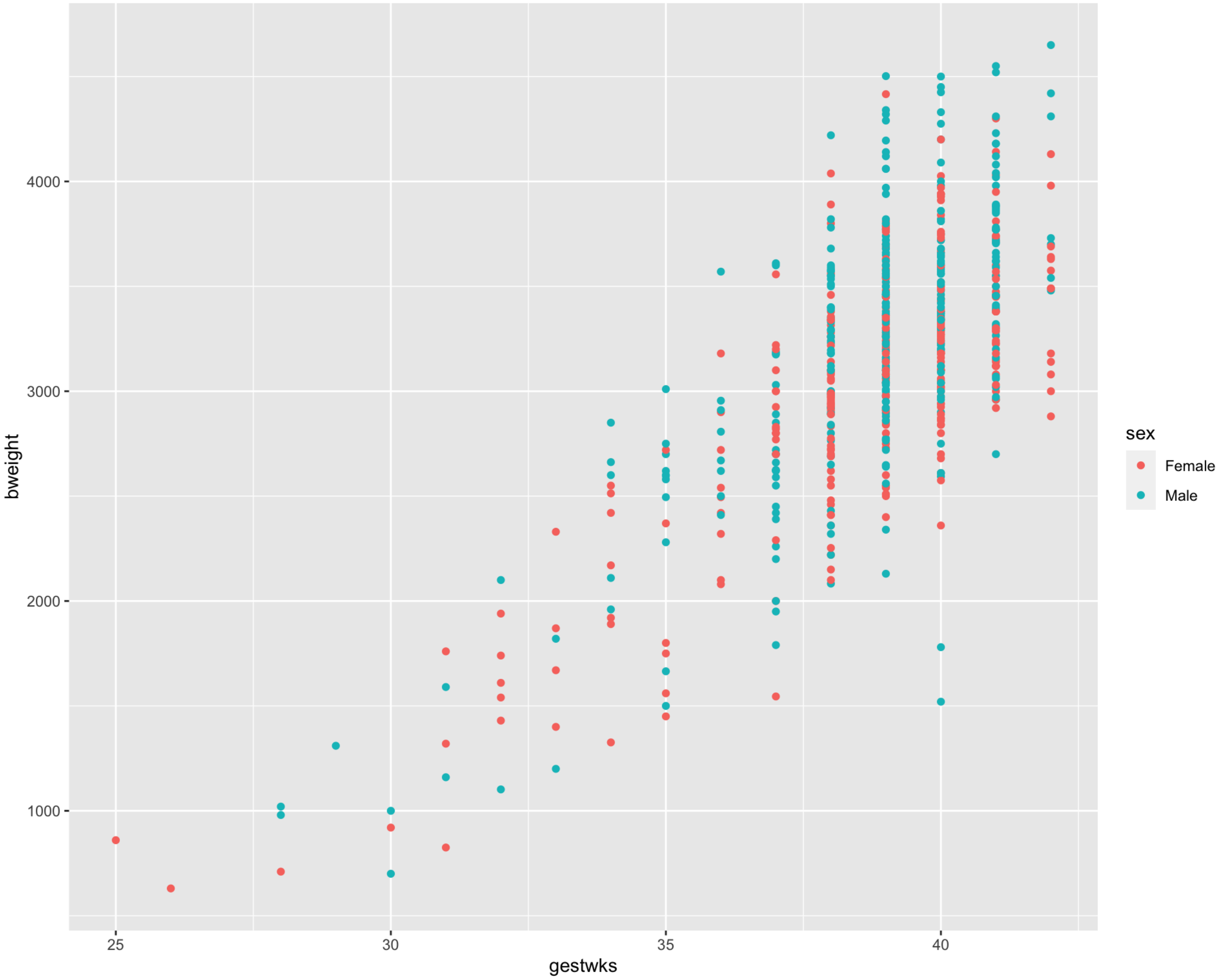
- Start with data and aesthetics

```r
# Start with data and aesthetics
ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex))
```



Add a point geom

```
# Start with data and aesthetics
ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex)) + # Add a point geom
geom_point()
```

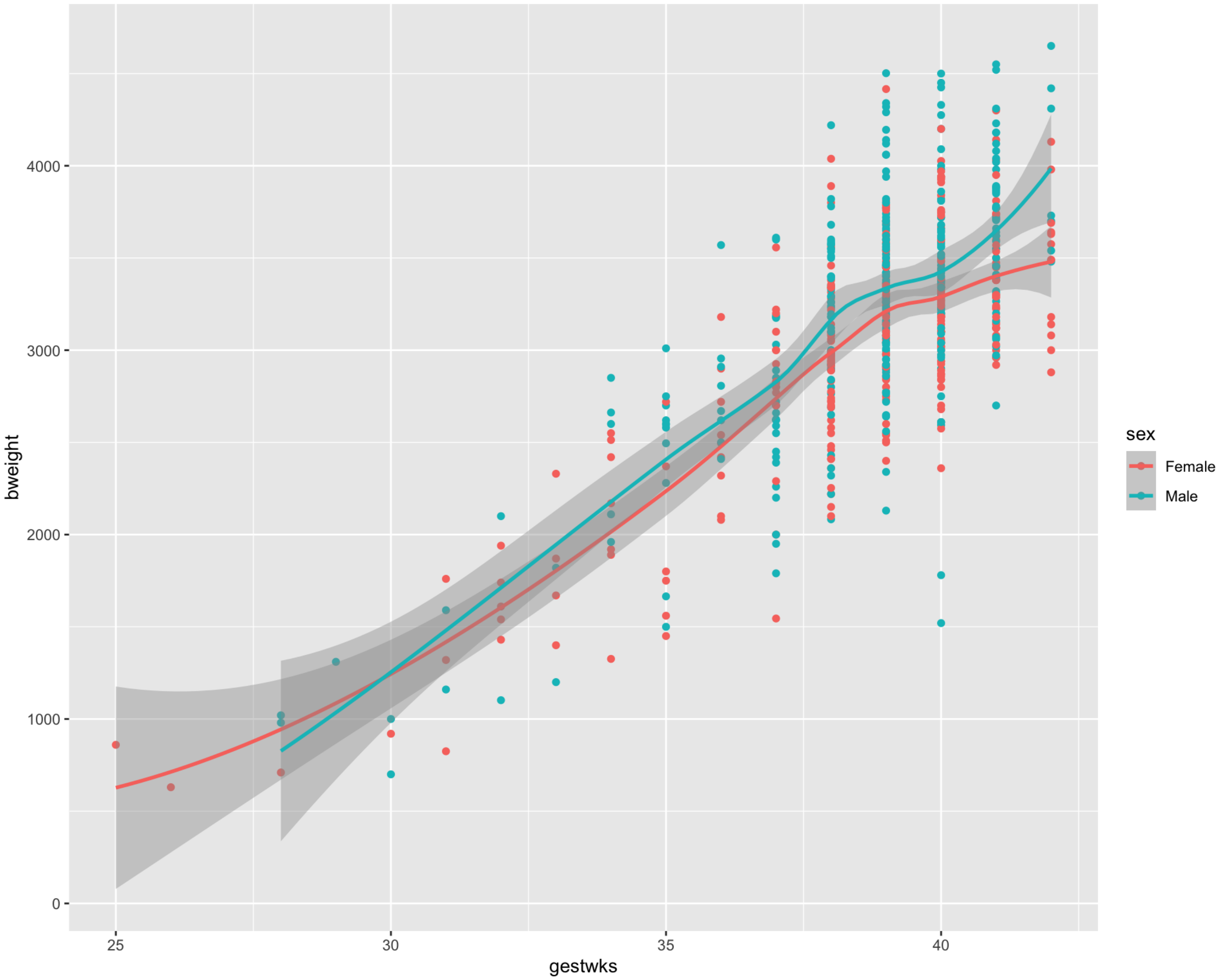


Add a smooth geom

- To add a regression line on a scatter plot, use the function geom_smooth()

```
# Start with data and aesthetics
ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex)) + # Add a point geom
geom_point() + ## Add a smooth geom
geom_smooth()
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

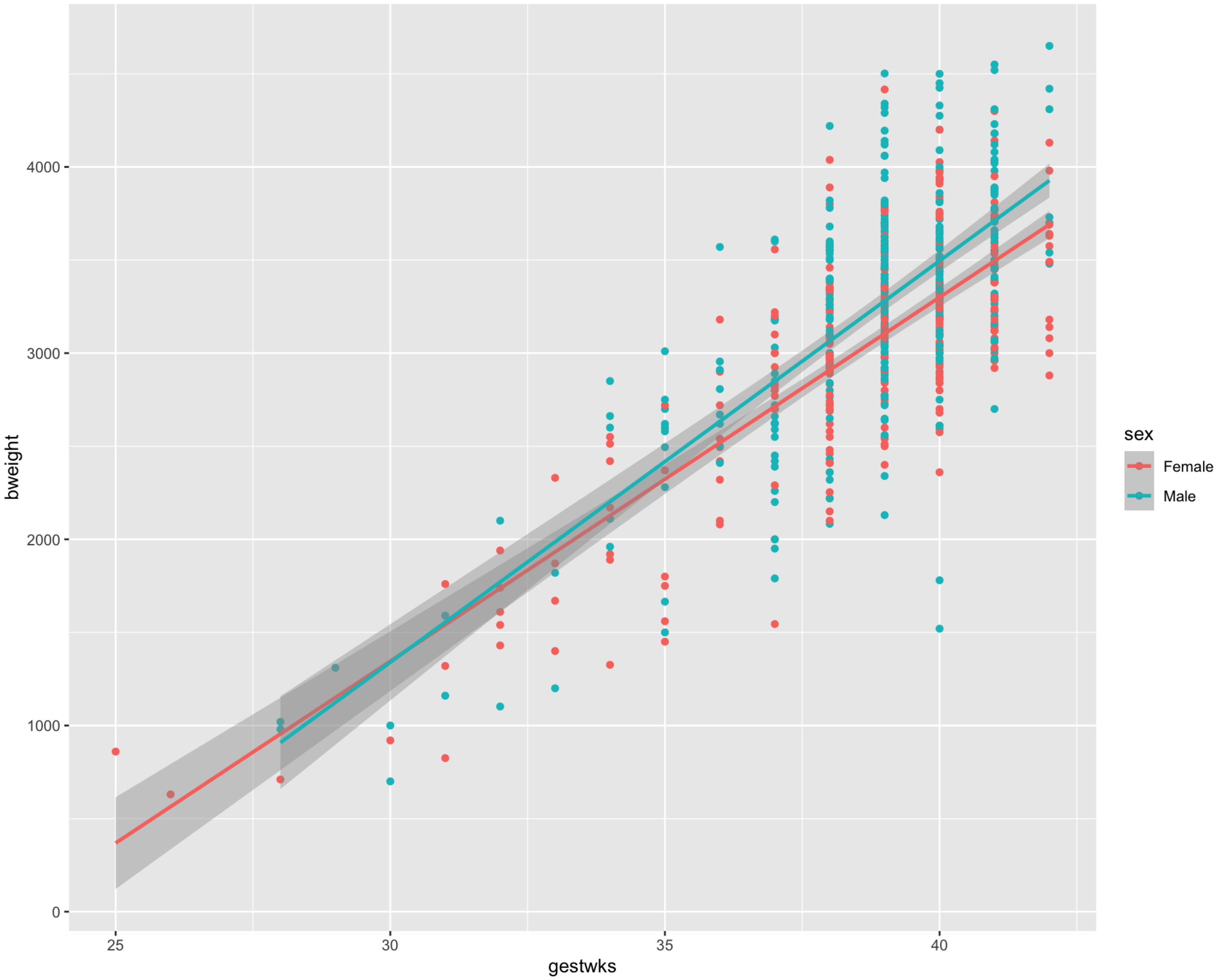


Make the smooth geom straight

- geom_smooth() is used in combination with the argument method = lm. lm stands for linear model.

```
# Start with data and aesthetics
ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex)) + # Add a point geom
geom_point() + ## Add a smooth geom geom_smooth() + Make it straight
geom_smooth(method = "lm")
```

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



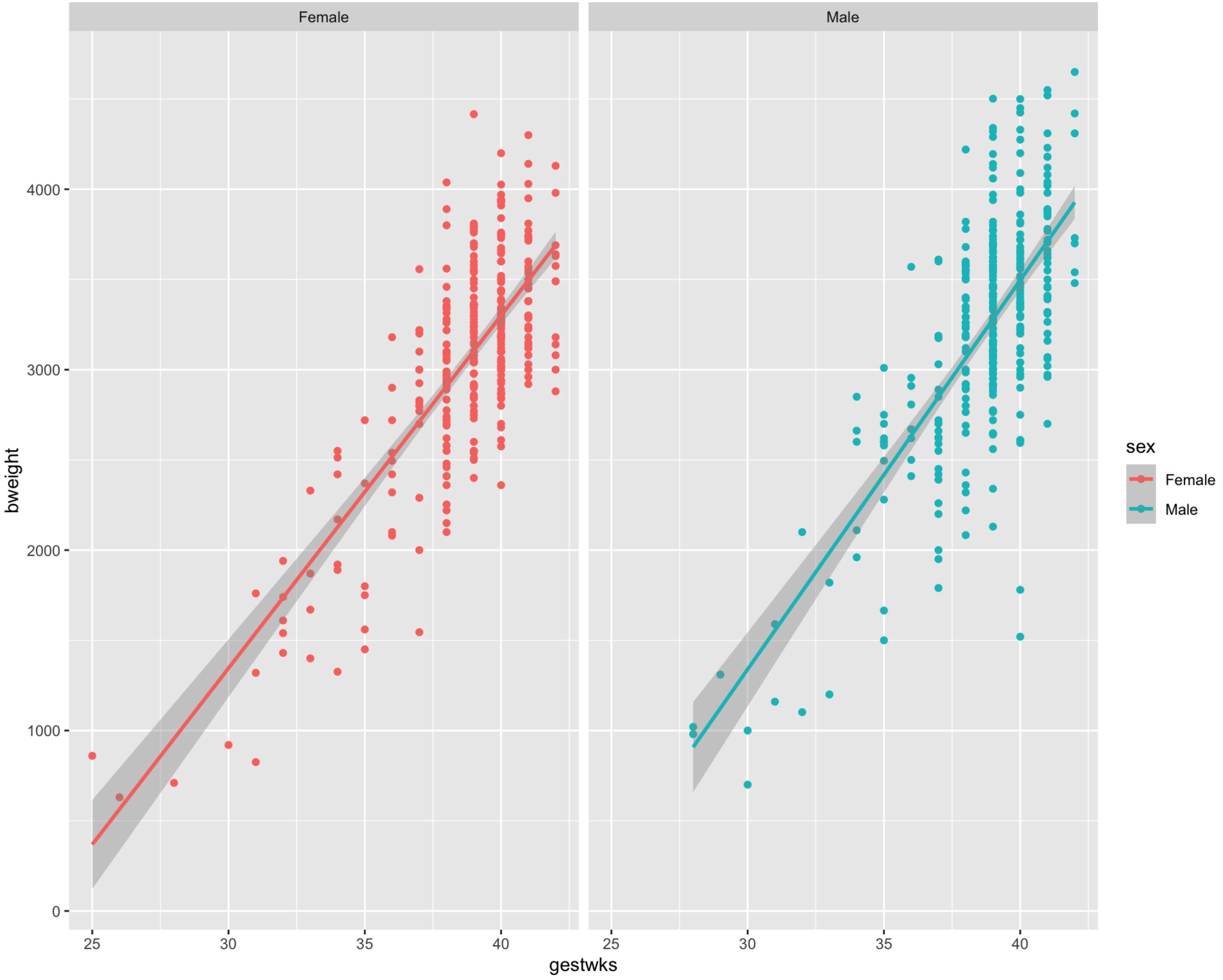
Faceting

- ggplot has a special technique called faceting that allows the user to split one plot into multiple plots based on a factor included in the dataset.
- We will use it to make a scatter plot of birth weight vs gestwks stratified by gender:
- Now we would like to split each plot by the sex of each individual measured.
- You can also organise the panels only by columns (or only by rows):

Facet by sex

```
# Start with data and aesthetics
ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex)) + # Add a point geom
geom_point() + ## Add a smooth geom geom_smooth() + Make it straight
geom_smooth(method = "lm") + # Facet by sex
facet_wrap(vars(sex), ncol = 2)
```

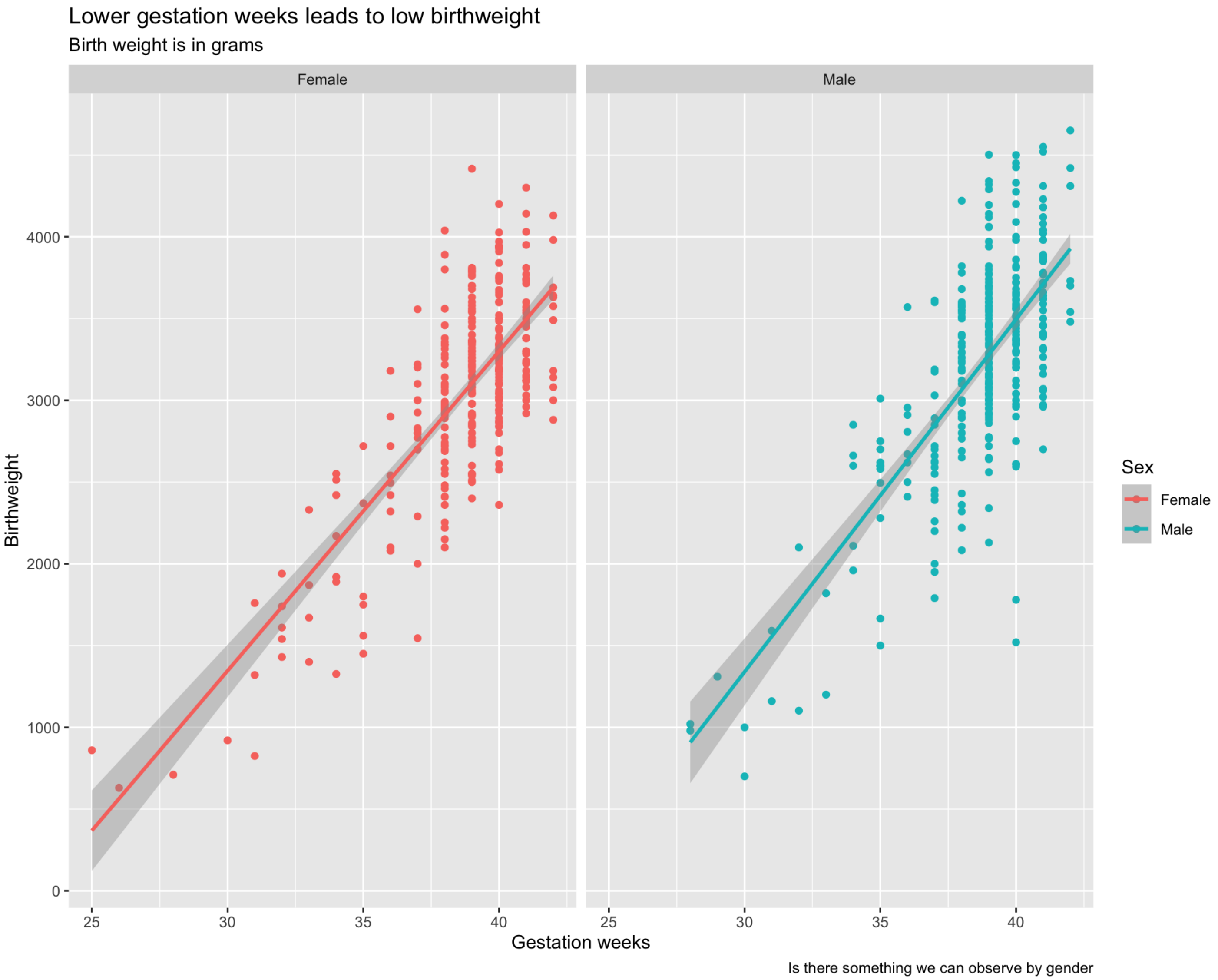
```
## `geom_smooth()` using formula 'y ~ x'
```



add labels

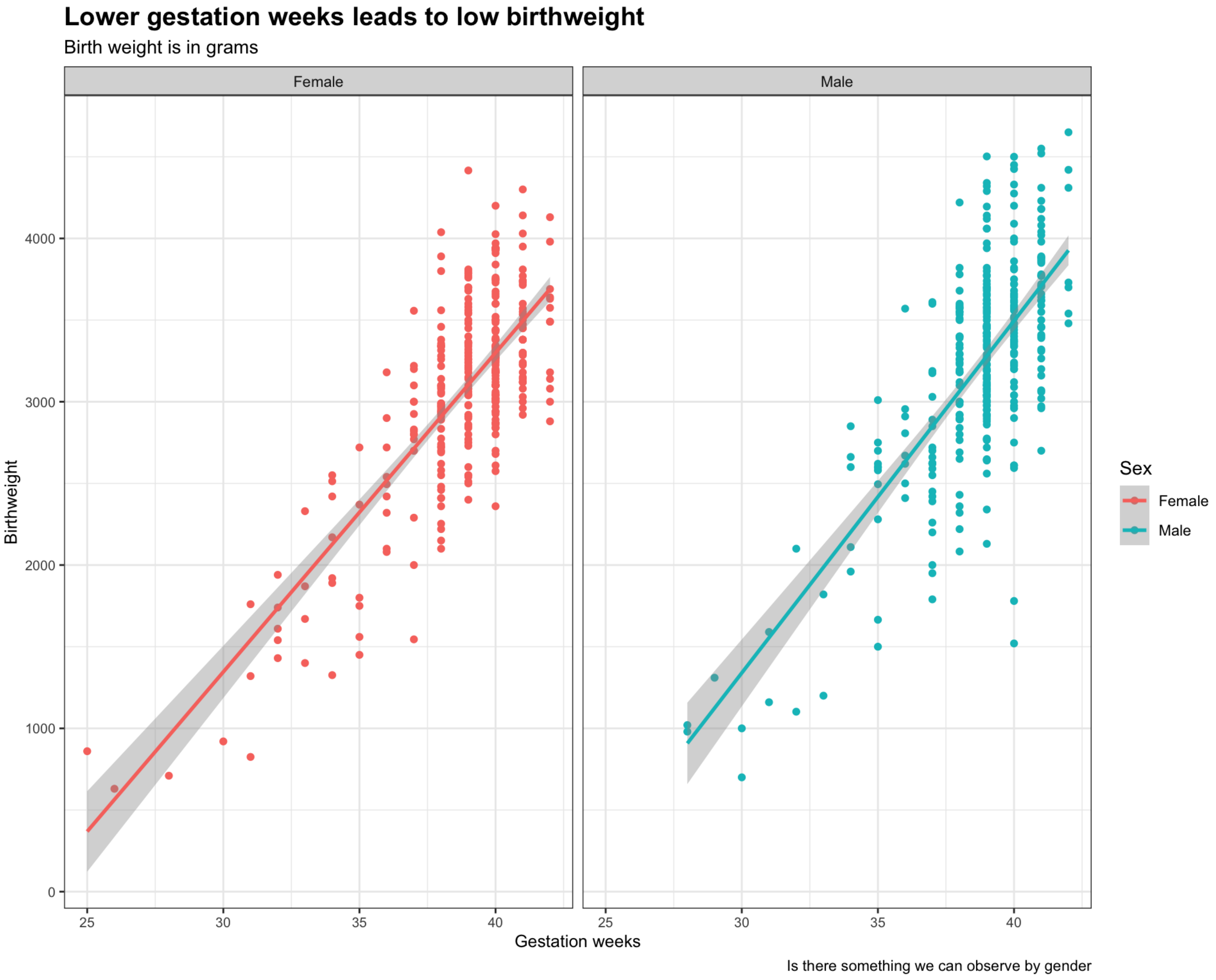
```
# Start with data and aesthetics
ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex)) + # Add a point geom
geom_point() + ## Add a smooth geom geom_smooth() + Make it straight
geom_smooth(method = "lm") + # Facet by sex
facet_wrap(vars(sex), ncol = 2) + ## add labels
labs(x = "Gestation weeks", y = "Birthweight", color = "Sex",
    title = "Lower gestation weeks leads to low birthweight",
    subtitle = "Birth weight is in grams", caption = "Is there something we can observe by gender")
```

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



adding ggplot2 themes

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



Lower gestation weeks leads to low birthweight

Birth weight is in grams

Is there something we can observe by gender

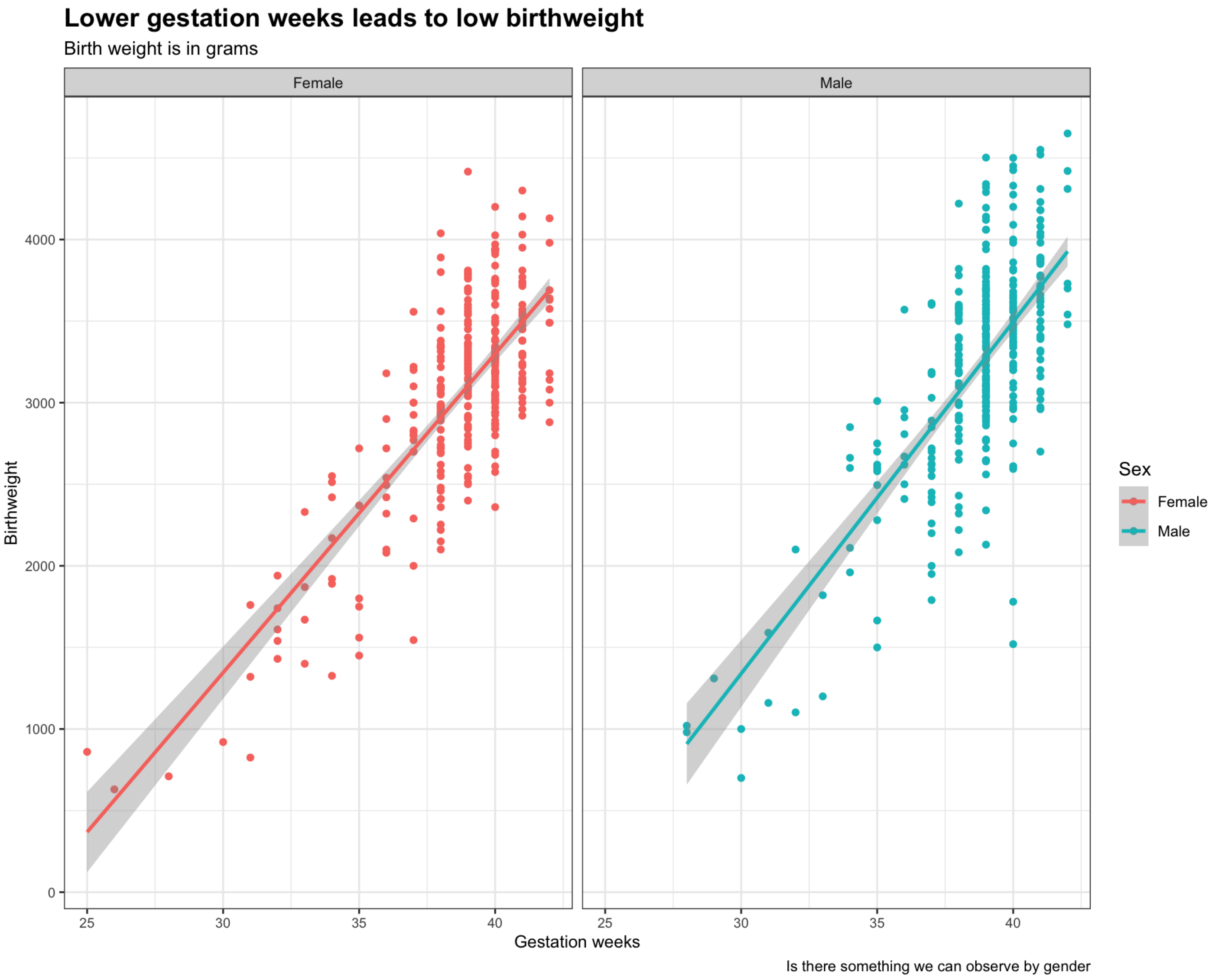
Exporting plots

```
my_plot2 <- ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex)) + geom_point() + geom_smooth(method = "lm") +
    facet_wrap(vars(sex), ncol = 2) + labs(x = "Gestation weeks",
    y = "Birthweight", color = "Sex", title = "Lower gestation weeks leads to low birthweight",
    subtitle = "Birth weight is in grams", caption = "Is there something we can observe by gender") +
    theme_bw() + theme(plot.title = element_text(size = 15, face = "bold"),
    axis.text.x = element_text(size = 8), axis.text.y = element_text(size = 8),
    axis.title.x = element_text(size = 10), axis.title.y = element_text(size = 10)) +
    scale_color_discrete(name = "Sex")
ggsave("Output/Bweight.pdf", my_plot2, width = 15, height = 10)
```

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

```
my_plot2
```

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



Useful link and resource with examples and code

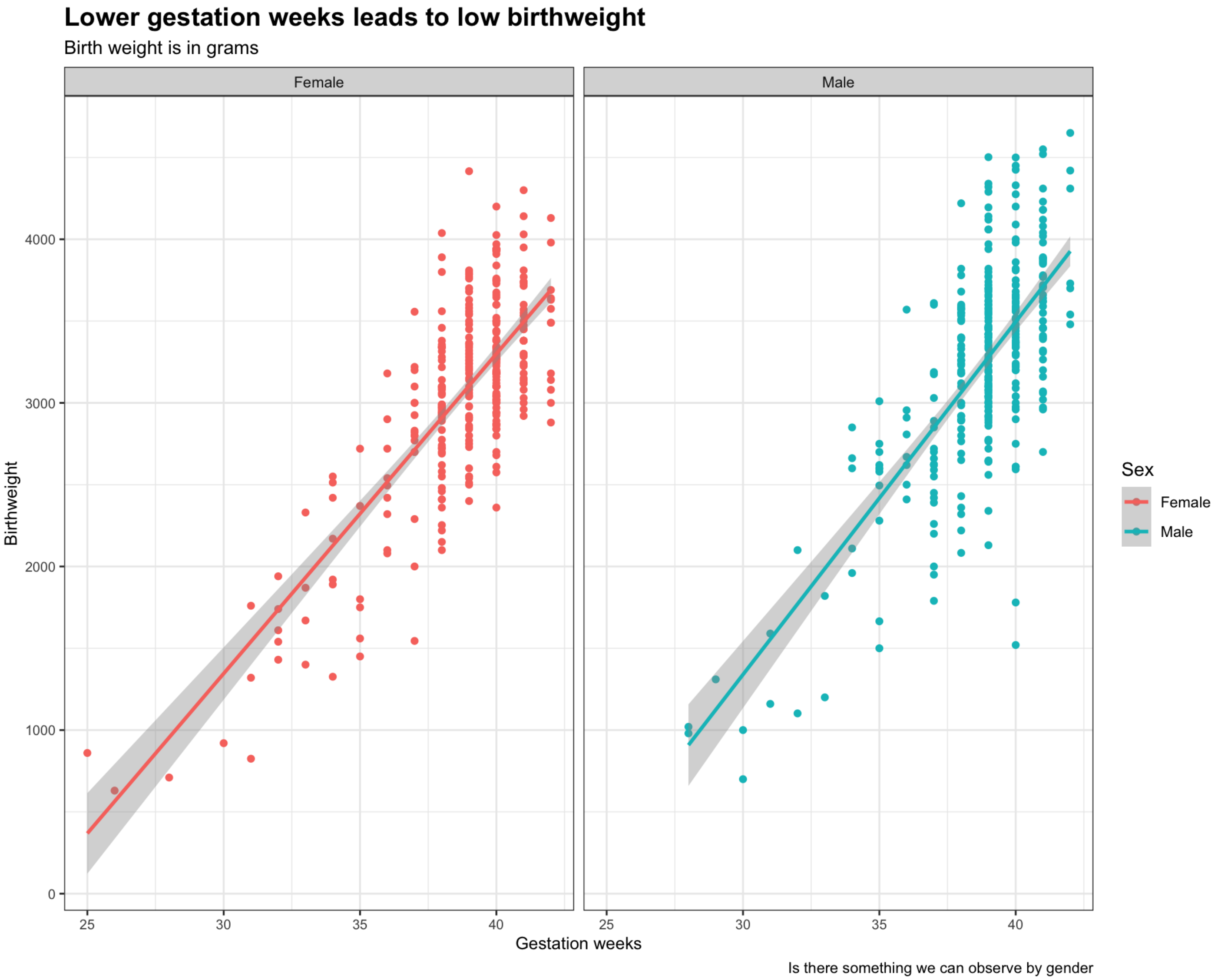
https://www.data-to-viz.com/

Break out session - Exercises

- Replicate the plot below and save

```
ggplot(data = bw_df, mapping = aes(x = gestwks, y = bweight,
    color = sex)) + geom_point() + geom_smooth(method = "lm") +
    facet_wrap(vars(sex), ncol = 2) + labs(x = "Gestation weeks",
    y = "Birthweight", color = "Sex", title = "Lower gestation weeks leads to low birthweight",
    subtitle = "Birth weight is in grams", caption = "Is there something we can observe by gender") +
    theme_bw() + theme(plot.title = element_text(size = 15, face = "bold"),
    axis.text.x = element_text(size = 8), axis.text.y = element_text(size = 8),
    axis.title.x = element_text(size = 10), axis.title.y = element_text(size = 10)) +
    scale_color_discrete(name = "Sex")
```

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



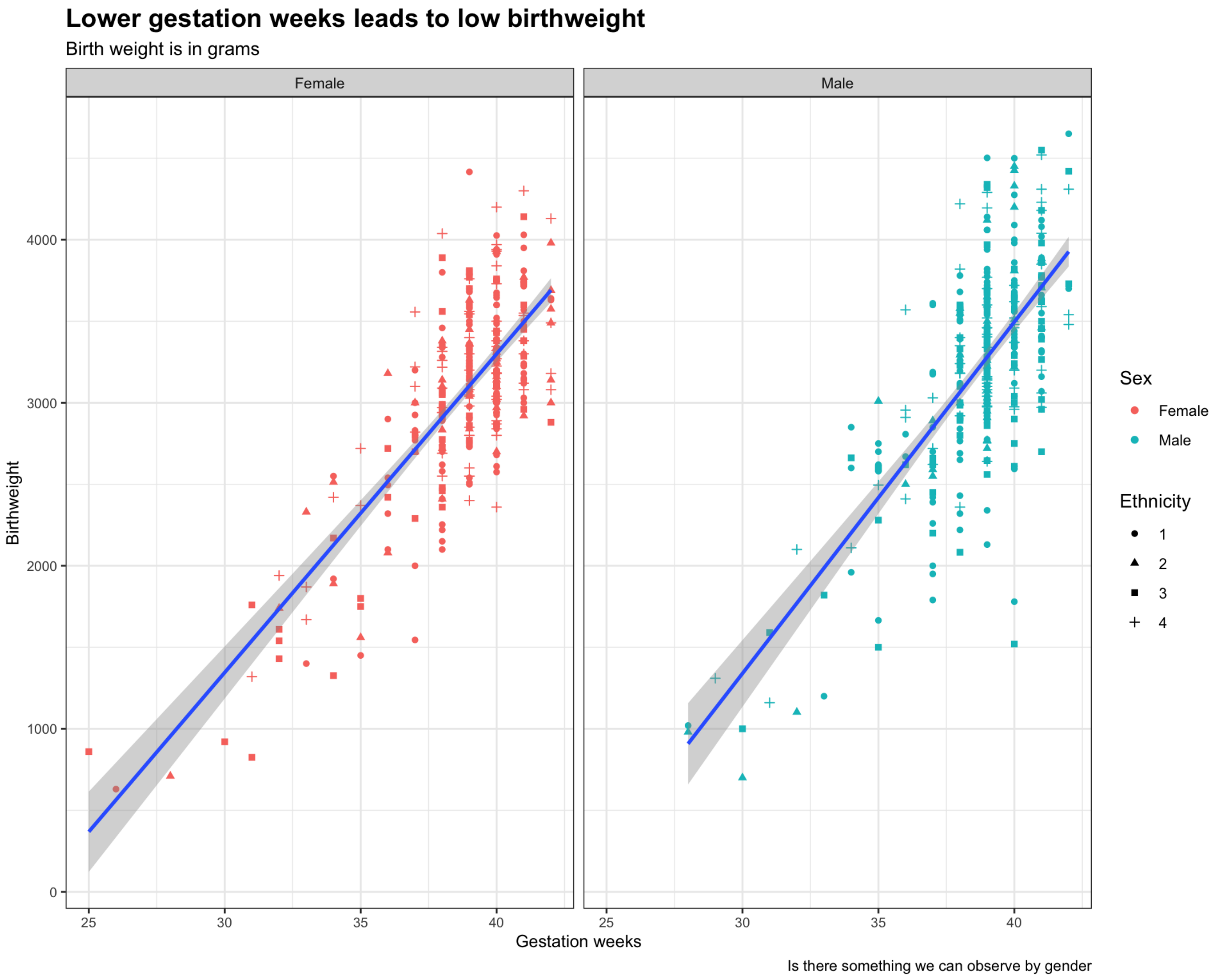
- Can you make the shape of the points in the scatter plot to vary with ethnicity?

- add a scale shape attribute. Hint use: scale_shape_discrete(name="legend title")

- Instead of having multiple smoothing lines for each ethnic group, integrate them all under one line.

Solution

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



Lower gestation weeks leads to low birthweight

Birth weight is in grams

Is there something we can observe by gender