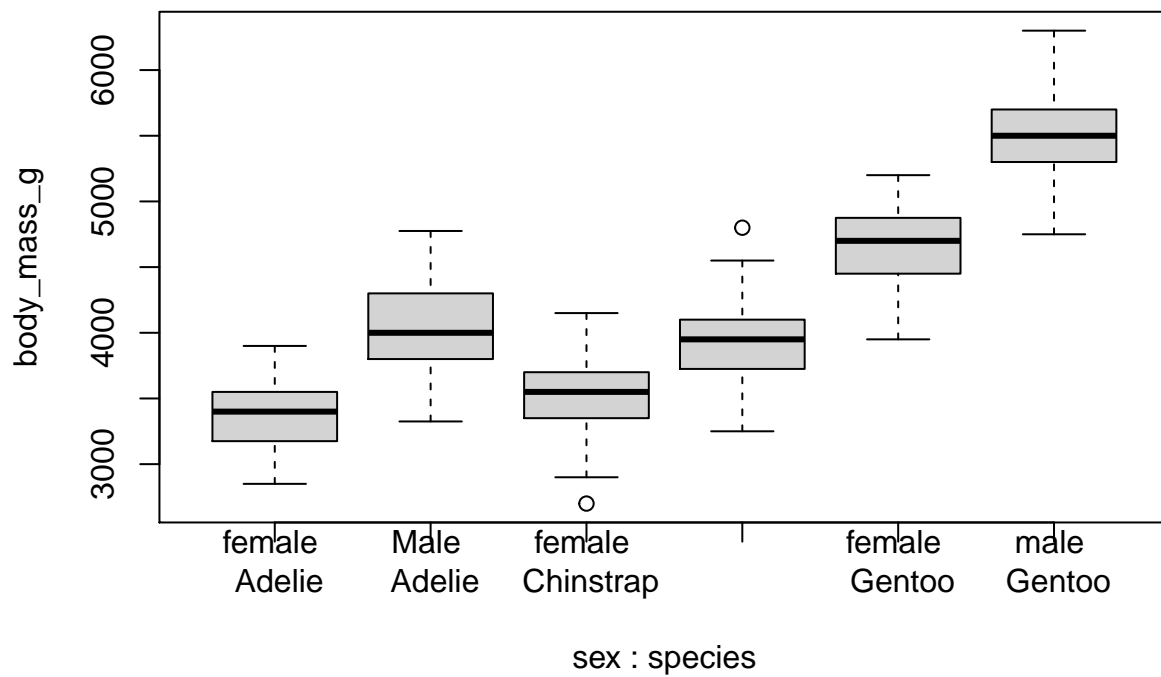# Models 2

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Q1

```
boxplot(body_mass_g ~sex +  species, data = penguins, names = c("female \n Adelie", "Male \n Adelie", ":
```


Q2

From these boxplots, I don't think that male penguins of any species are heavier than female penguins of any species, as the female Gentoo are on average larger than the Male adelie and male Chinstrap penguins. However, it seems like Males are larger than the females of the same species.

Q3

Adding sex to a model that already includes species will increase the model fit. Adding sex removes the added variance to body mass within each species caused by the grouping of male and female penguins together.

Q4

```
fit_both <- lm(body_mass_g ~ sex*species, data = penguins)
```

Q5

```
summary(fit_both)
```

```
##
## Call:
## lm(formula = body_mass_g ~ sex * species, data = penguins)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -827.21 -213.97   11.03  206.51  861.03
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)               3368.84      36.21  93.030  < 2e-16 ***
## sexmale                    674.66      51.21  13.174  < 2e-16 ***
## speciesChinstrap           158.37      64.24   2.465  0.01420 *
## speciesGentoo             1310.91      54.42  24.088  < 2e-16 ***
## sexmale:speciesChinstrap  -262.89      90.85  -2.894  0.00406 **
## sexmale:speciesGentoo      130.44      76.44   1.706  0.08886 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 309.4 on 327 degrees of freedom
##   (11 observations deleted due to missingness)
## Multiple R-squared:  0.8546, Adjusted R-squared:  0.8524
## F-statistic: 384.3 on 5 and 327 DF,  p-value: < 2.2e-16
```

The base case is a female adelie penguin.

Q6

To calculate the mass of female chinstrap penguins you need the coefficients for the intercept and speciesChinstrap.

Q7

```r
#intercept + speciesChinstrap
3368.84 + 158.37
```

```
## [1] 3527.21
```

The predicted average mass of female chinstrap penguins is 3527.21g.

Q8

```r
penguins %>%
  group_by(species, sex) %>%
  summarize (mean(body_mass_g), .groups = "keep")
```

```
## # A tibble: 8 x 3
## # Groups:   species, sex [8]
##   species   sex    'mean(body_mass_g)'
##   <fct>     <fct>                <dbl>
## 1 Adelie    female               3369.
## 2 Adelie    male                 4043.
## 3 Adelie    <NA>                   NA
## 4 Chinstrap female               3527.
## 5 Chinstrap male                 3939.
## 6 Gentoo    female               4680.
## 7 Gentoo    male                 5485.
## 8 Gentoo    <NA>                   NA
```

The observed average mass of female chinstrap penguins is 3527.206g.