Analysing penguin data

…to show what Quarto documents can do

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# 1. Introduction

## 1.1 The data set

As everyone always says, penguins are very cute, so let’s work with penguin data today.

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| Figure 1: Penguin species drawing by Allison Horst |

Note that the palmerpenguins dataset is meant as an alternative to the commonly used iris data and contains data on three species - see [Figure 1](#fig-penguins).

More information on this data set is available on [Allison Horst’s Github page.](https://allisonhorst.github.io/palmerpenguins/)

## 1.2 Data source

Data were collected and made available by Dr. Kristen Gorman and the Palmer Station, Antarctica LTER, a member of the Long Term Ecological Research Network.

This data can also be used via the {palmerpenguins} package ([Horst et al., 2020](#ref-Horst.2020)) and was originally introduced in Gorman et al. ([2014](#ref-Gorman.2014)).

# 2. Descriptive statistics

We’ve removed missing values here, which means that the data has 333 rows[[1]](#footnote-28).

## 2.1 Overall statistics

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| Figure 2: Explaining bill dimensions |

Some descriptive statistics:

The data was collected between 2007 and 2009.

* bill lengths and depths
  + the average bill length is 43.99 mm
  + the average bill depth is 17.16 mm
* body mass
  + the average weight is 4207.06 g

Penguins on the island Torgersen have the smallest average bill length: 39.04 mm (cf. [Table 1](#tbl-billIslands)).

Table 1: Bill lengths (in mm) by island

| island | average bill length |
| --- | --- |
| Torgersen | 39.04 |
| Biscoe | 45.25 |
| Dream | 44.22 |

## 2.2 Separate per species

[Table 2](#tbl-billSpecies) shows bill lengths for each of the three species in the data. We can see that the average bill length for Chinstrap penguins is 10.01 mm longer than that for Adelie penguins.

Table 2: Bill lengths (in mm) by species

| species | average bill length | variance | std. deviation |
| --- | --- | --- | --- |
| Adelie | 38.82 | 7.09 | 2.66 |
| Gentoo | 47.57 | 9.65 | 3.11 |
| Chinstrap | 48.83 | 11.15 | 3.34 |

# 3. Graphs

**Hypotheses:**

1. Flipper length and body mass are *positively* associated.
2. This is true for ***all*** three species in the data.

The following graphs are slightly simplified versions from the [vignette for the {palmerpenguins} package.](https://allisonhorst.github.io/palmerpenguins/articles/examples.html)

## 3.1 Weight and flipper length: Entire data

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| Figure 3: Penguin flipper length and body mass |

Refer to [Figure 2](#fig-bill) for an explanation of the measurements.

## 3.2 Weight and flipper length: Separated by species

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| Figure 4: Penguin flipper length and body mass, separately by species |

[Figure 3](#fig-entire) does not separate the data by species, while [Figure 4](#fig-species) does.

# 4. Regression modeling

## 4.1 Model output

We’ve constructed a mixed-effects model that predicts bill length by bill depth, body mass, and their interaction, with island as a random intercept.

Table 3: Model output - Predicting penguin bill lengths

| term | estimate | standard error | t-value | p-value |
| --- | --- | --- | --- | --- |
| Intercept | -6.3638 | 19.2569 | -0.3305 | 0.7413 |
| Bill depth (in mm) | 1.7408 | 1.1334 | 1.5359 | 0.1255 |
| Body mass (in g) | 0.0121 | 0.0044 | 2.7584 | 0.0061 |
| Bill depth : Body mass | -0.0004 | 0.0003 | -1.6365 | 0.1027 |

The model output is shown in [Table 3](#tbl-penguinsMdl). Only the slope for body mass is significant at p < 0.05 (β = 0.0121, SE = 0.0044).

## 4.2 Model predictions

The model predictions are visualised in [Figure 5](#fig-MdlPred). They show that as body mass increases, so does the predicted bill length.

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| Figure 5: Model predictions for bill lengths for different body masses |

# 5. Bibliography

Gorman, K. B., Williams, T. D., & Fraser, W. R. (2014). Ecological sexual dimorphism and environmental variability within a community of antarctic penguins (genus pygoscelis). *PloS One*, *9*(3), e90081. <https://doi.org/10.1371/journal.pone.0090081>

Horst, A. M., Presmanes Hill, A., & Gorman, K. B. (2020). *Palmerpenguins: Palmer archipelago (antarctica) penguin data. R package version 0.1.0.* Zenodo. <https://doi.org/10.5281/zenodo.3960218>

1. Note that this removes any rows with missing values! [↑](#footnote-ref-28)