Statistics for Toastmasters

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… with extra penguins!

Figure 1: Gentoo penguins

Source

What we'll be doing

- Have a dataset on three different species of penguins (Adelie, Chinstrap, Gentoo)
- Contains species, measurements on bills and flippers
- Want to learn something about the data
- For example, how the penguins compare
- Or, can we tell the species apart from the measurements we have?
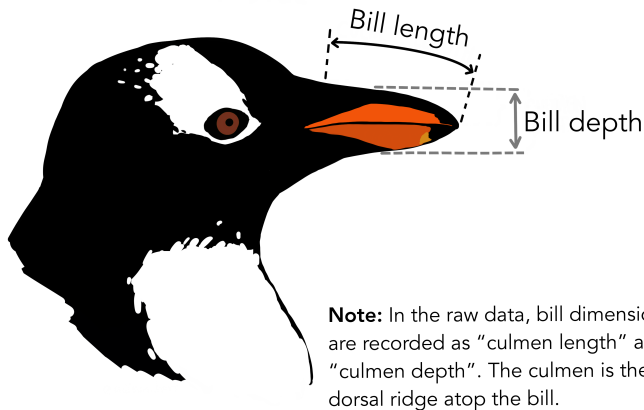
The bill of a penguin

Bill length

Bill depth

Note: In the raw data, bill dimensions are recorded as "culmen length" and "culmen depth". The culmen is the dorsal ridge atop the bill.

Figure 2: Bill or culmen depth

Source. Penguins also have flippers, but you know about those, right?

Some of our data

species	bill_length_mm	bill_depth_mm	flipper_length_mm
Gentoo	48.4	16.3	220
Adelie	40.1	18.9	188
Adelie	36.7	18.8	187
Adelie	39.3	20.6	190
Gentoo	41.7	14.7	210
Adelie	41.6	18.0	192
Adelie	34.4	18.4	184
Adelie	37.6	19.3	181
Adelie	38.7	19.0	195
Gentoo	45.1	14.4	210
Adelie	37.8	18.3	174
Adelie	46.0	21.5	194

There are 344 penguins altogether.

The species

- a so-called "categorical variable" or "grouping variable" (classified)
- could count how many of each:

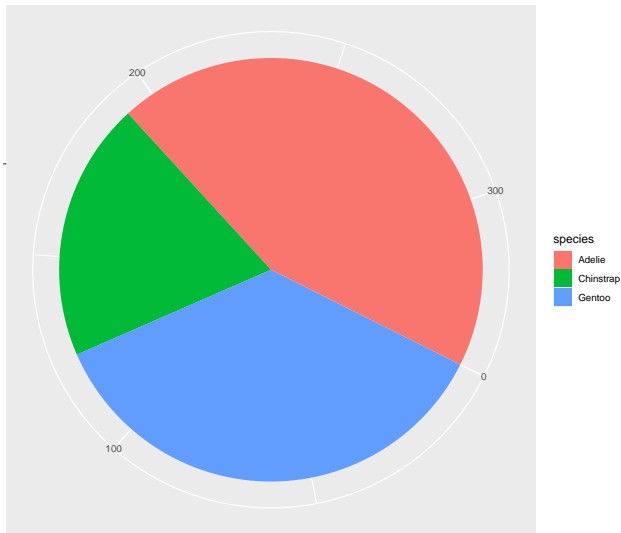| species	n
Adelie	152
Chinstrap	68
Gentoo	124

Or make a graph.

Bar chart

Best chart for a categorical variable is a bar chart:
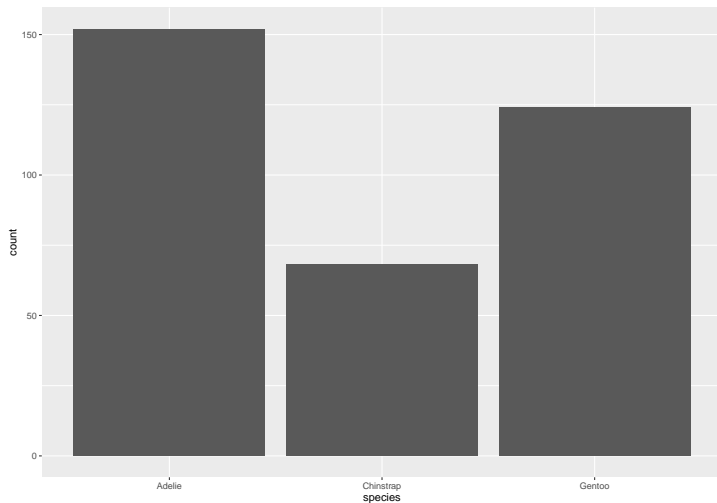
Pie chart, if you must

# Why bar charts are better than pie charts

- The human eye is better at judging heights (of bars) than angles (of pie slices)
  - on pie chart, it is work to see that red slice is bigger that blue slice
  - but on bar chart, clear that Adelie bar taller than Gentoo bar
- Only time pie chart is better is for judging *fractions of whole*
  - eg a bit less than a quarter of all the penguins are Chinstrap, and about a third are Gentoo.

Flipper length

... is measured, not categorized ("quantitative"):

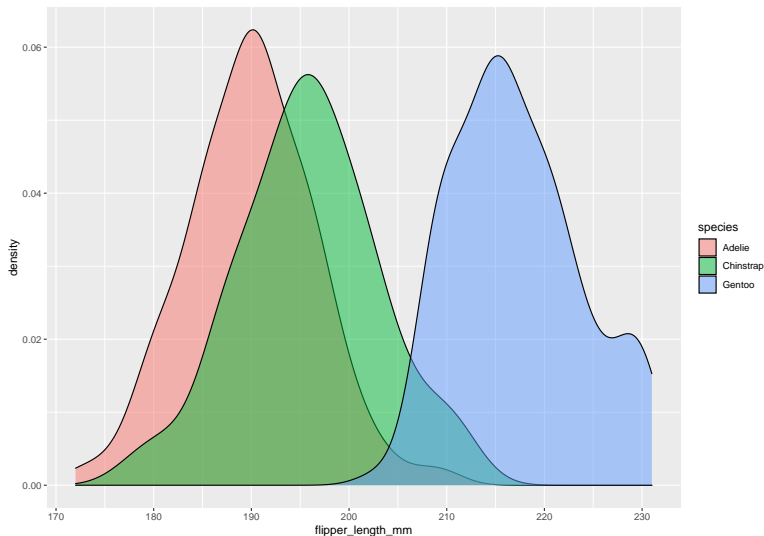| flipper_length_mm |
| --- |
| 181 |
| 192 |
| 191 |
| 228 |
| 192 |
| 191 |
| 195 |
| 190 |

Density plot: Gentoo flipper length
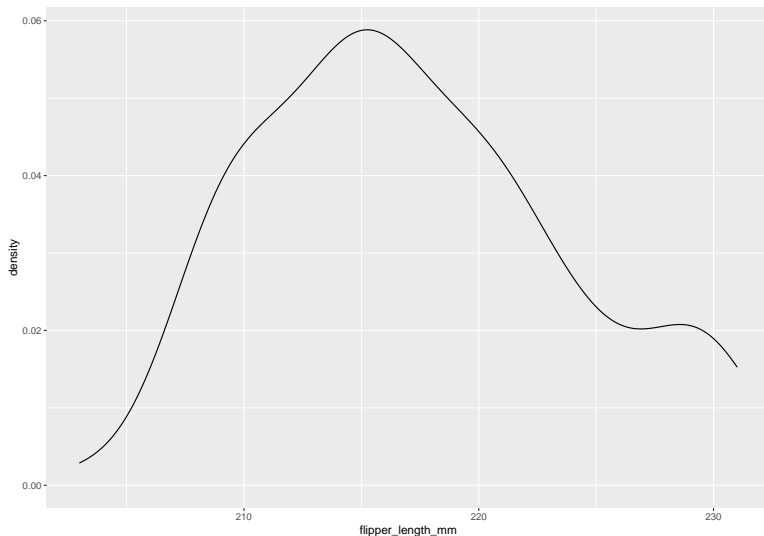
Comments

- most of the Gentoo penguins have flipper length near 215 mm

- there is variability: the flipper lengths vary between about 200 and 230 mm

- how do the other species compare?

- idea: do *overlaid* density plots (in different colours).

# Density plot for all three species

Comments

- Gentoo penguins have longer flippers than others
- Chinstrap slightly longer than Adelie, but a lot of overlap
- if all you knew was flipper length, you would do reasonably well at distinguishing Gentoo from others.
- but even then, would not be perfect (eg. what if flipper length was 205 mm?)

Two measured variables: scatterplot

Bill length vs depth for Gentoo:
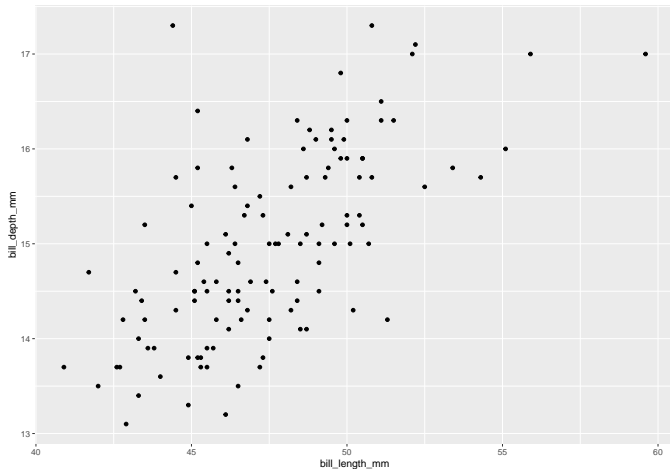
Comments

- Each dot is one (Gentoo) penguin
- for example, at the bottom left is a penguin with bill length 41 mm and bill depth 13.7 mm
- and at top left, bill length 44 and bill depth 17.3
- usually, a Gentoo penguin with greater bill length also has greater bill depth, but not always

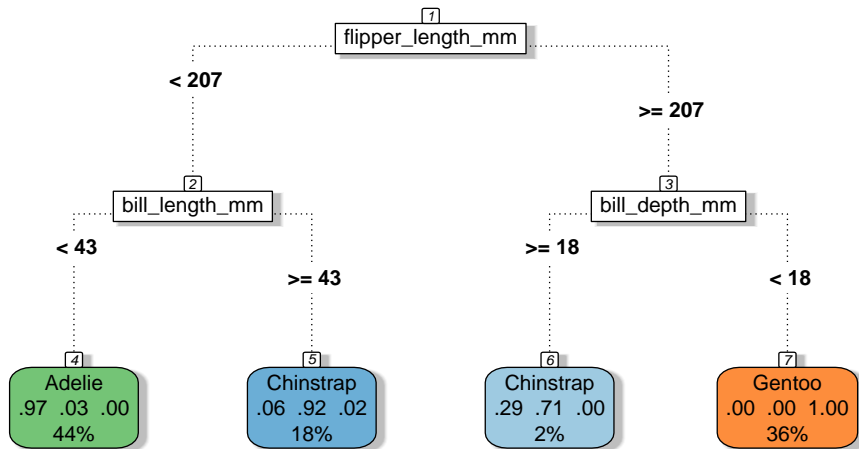# Bill length vs. depth for all the penguins: a big mess!
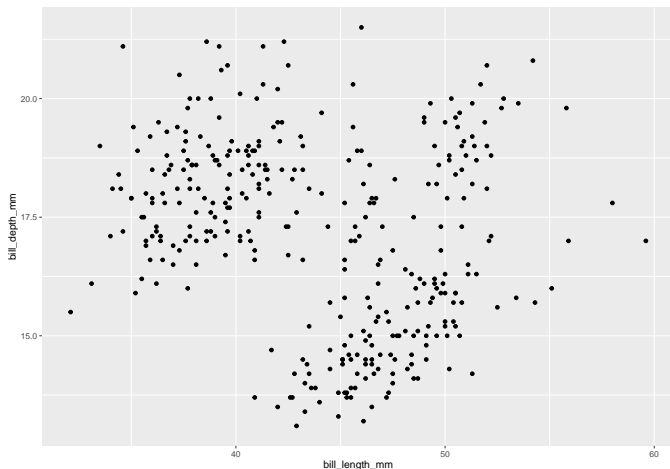
Bill length vs. depth with species shown

comments
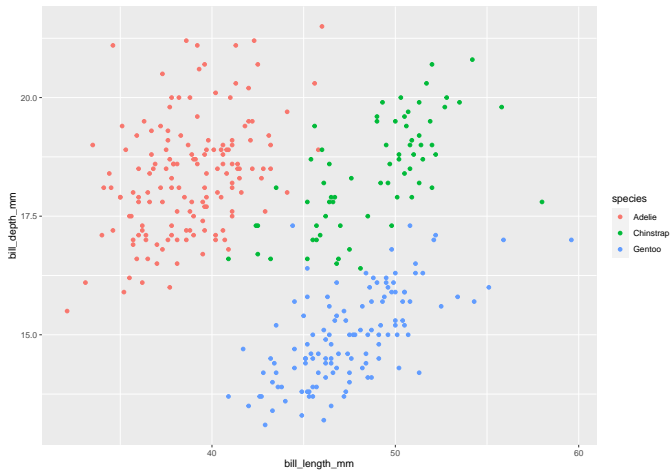
- the species are fairly distinct, eg Adelie have small bill length and large bill depth
- we know that Gentoo have large flipper length, so that plus a small bill depth identifies them
- can we do better? I ran a "classification tree".

Classification tree

Examples:

penguin	bill_length_mm	bill_depth_mm	flipper_length_mm
50	42.3	21.2	191
202	45.2	15.8	215

- Penguin 50:
  - compare flipper length with 207. Less.
  - so compare bill length with 43. Less again.
  - so it's Adelie.
- Penguin 202:
  - compare flipper length with 207. Greater.
  - compare bill depth with 18. Less.
  - so it's Gentoo.

Were we right?

| penguin	species
50	Adelie
202	Gentoo

we were!

to summarize

- variables
  - categorical: something you classify
  - quantitative: something you measure
- graphs
  - bar chart (*not* pie chart) for 1 categorical
  - density plot for 1 quantitative
  - density plots layered to compare such by groups
  - scatterplot for 2 quantitative
  - scatterplot with colours to include groups
- classification tree to understand how groups differ on quantitative variables

these also work for things other than penguins!

Extra 1: Flipper length vs bill depth
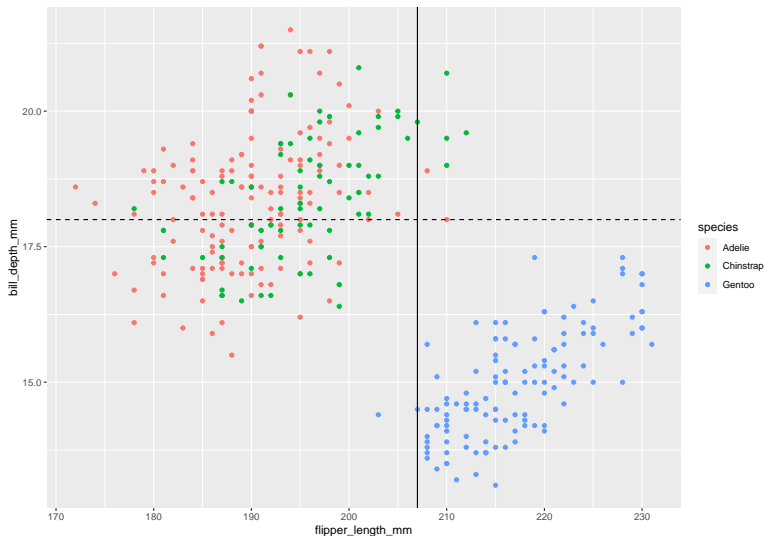
Comments

- Look to right of solid line.
- There are a few Chinstraps with long flippers (top right).
- These are distinguished from Gentoos by bill depth: above dashed line is Chinstrap, below is Gentoo.
- A few Adelie (red) will be guessed wrong.

Extra 2: Flipper length vs. bill length

Comments

- Look to left of solid line.
- The Adelie and Chinstrap have short flippers (left of solid line).
- To tell them apart, look at bill length: Chinstrap longer, Adelie shorter.
- A few Adelie and Chinstrap will get mistaken for each other.

more pictures

see https://oceanwide-expeditions.com/blog/meet-all-6-antarctic-penguin-species