AE 13: Logistic regression introduction

Nov 02, 2022

> **!** Important
>
> The AE is due on GitHub by Saturday, November 05 , 11:59pm.

Packages

```
library(tidyverse)
library(tidymodels)
library(knitr)

heart_disease <- read_csv("data/framingham.csv") |>
  select(totChol, TenYearCHD) |>
  drop_na() |>
  mutate(high_risk = as.factor(TenYearCHD)) |>
  select(totChol, high_risk)
```

Linear regression vs. logistic regression

State whether a linear regression model or logistic regression model is more appropriate for each scenario:

1. Use age and education to predict if a randomly selected person will vote in the next election.

Logistic regression.

2. Use budget and run time (in minutes) to predict a movie's total revenue.

Linear regression.

3. Use age and sex to calculate the probability a randomly selected adult will visit Duke Health in the next year.

Logistic regression.

Heart disease

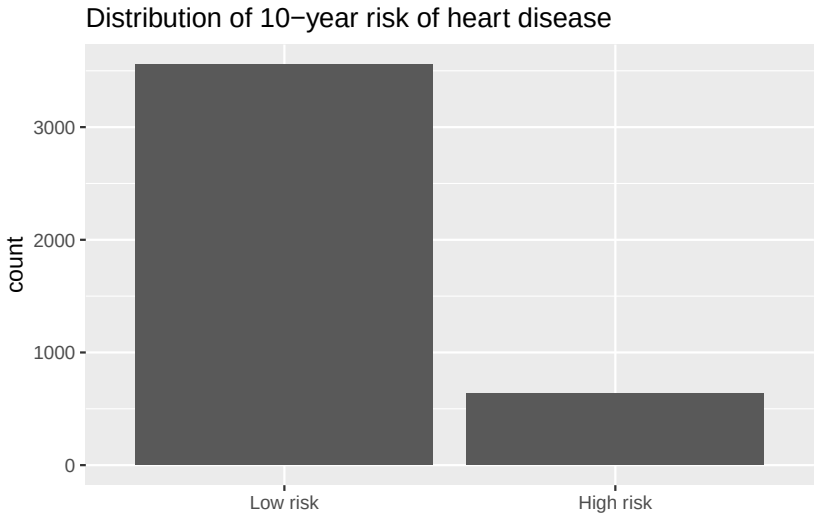
Data: Framingham study

This data set is from an ongoing cardiovascular study on residents of the town of Framingham, Massachusetts. We want to use the total cholesterol to predict if a randomly selected adult is high risk for heart disease in the next 10 years.

- `high_risk`:
  - 1: High risk of having heart disease in next 10 years
  - 0: Not high risk of having heart disease in next 10 years
- `totChol`: total cholesterol (mg/dL)

Outcome: `high_risk`

```
ggplot(data = heart_disease, aes(x = high_risk)) +
  geom_bar() +
  scale_x_discrete(labels = c("1" = "High risk", "0" = "Low risk")) +
  labs(
    title = "Distribution of 10-year risk of heart disease",
    x = NULL)
```




```
heart_disease |>
  count(high_risk)
```

```
# A tibble: 2 x 2
  high_risk     n
  <fct>     <int>
1 0          3555
2 1           635
```

Calculating probability and odds

1. What is the probability a randomly selected person in the study is **not** high risk for heart disease?

P = 0.84845.

2. What are the **odds** a randomly selected person in the study is **not** high risk for heart disease?

O = 5.598482.

Logistic regression model

Fit a logistic regression model to understand the relationship between total cholesterol and risk for heart disease.

Let π be the probability an adult is high risk of heart disease. The statistical model is

$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 TotChol_i$$

```
heart_disease_fit <- logistic_reg() |>
  set_engine("glm") |>
  fit(high_risk ~ totChol, data = heart_disease, family = "binomial")

tidy(heart_disease_fit) |> kable(digits = 3)
```

term	estimate	std.error	statistic	p.value
(Intercept)	-2.894	0.230	-12.607	0
totChol	0.005	0.001	5.268	0

3. Write the regression equation. Round to 3 digits.

$$\log\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = -2.894 + 0.005 \times totChol$$

Calculating log-odds, odds and probabilities

Based on the model, if a randomly selected person has a total cholesterol of 250 mg/dL,

4. What are the log-odds they are high risk for heart disease?

-1.644

5. What are the odds they are high risk for heart disease?

0.19321

6. What is the probability they are high risk for heart disease? *Use the odds to calculate your answer.*

0.16192

Comparing observations

Suppose a person's cholesterol changes from 250 mg/dL to 200 mg/dL.

7. How do you expect the log-odds that this person is high risk for heart disease to change?

They should decrease.

8. How do you expect the odds that this person is high risk for heart disease to change?

They should also decrease, by a lot.

> **!** Important
>
> To submit the AE:
>
> - Render the document to produce the PDF with all of your work from today's class.
> - Push all your work to your `ae-13-` repo on GitHub. (You do not submit AEs on Gradescope).