Case Study for Hypothesis Testing Applications Solutions

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Exercises

1. Side effects of Avandia

Rosiglitazone is the active ingredient in the controversial type~2 diabetes medicine Avandia and has been linked to an increased risk of serious cardiovascular problems such as stroke, heart failure, and death. A common alternative treatment is pioglitazone, the active ingredient in a diabetes medicine called Actos. In a nationwide retrospective observational study of 227,571 Medicare beneficiaries aged 65 years or older, it was found that 2,593 of the 67,593 patients using rosiglitazone and 5,386 of the 159,978 using pioglitazone had serious cardiovascular problems. These data are summarized in the contingency table below.

		Cardiovascular problems		
		Yes	No	Total
Treatment	Rosiglitazone	2,593	65,000	67,593
	Pioglitazone	5,386	154,592	159,978
	Total	7,979	219,592	227,571

Determine if each of the following statements is true or false. If false, explain why. *Be careful:* The reasoning may be wrong even if the statement's conclusion is correct. In such cases, the statement should be considered false.

   a. Since more patients on pioglitazone had cardiovascular problems (5,386 vs. 2,593), we can conclude that the rate of cardiovascular problems for those on a pioglitazone treatment is higher.

False. Instead of comparing counts, we should compare percentages.

   b. The data suggest that diabetic patients who are taking rosiglitazone are more likely to have cardiovascular problems since the rate of incidence was (2,593 / 67,593 = 0.038) 3.8% for patients on this treatment, while it was only (5,386 / 159,978 = 0.034) 3.4% for patients on pioglitazone.

True.

   c. The fact that the rate of incidence is higher for the rosiglitazone group proves that rosiglitazone causes serious cardiovascular problems.

False. We cannot infer a causal relationship from an association in an observational study. However, we can say the drug a person is on affects his risk in this case, as he chose that drug and his choice may be associated with other variables, which is why part (b) is true. The difference in these statements is subtle but important.

   d. Based on the information provided so far, we cannot tell if the difference between the rates of incidences is due to a relationship between the two variables or due to chance.

True.

2. Heart transplants

The Stanford University Heart Transplant Study was conducted to determine whether an experimental heart transplant program increased lifespan. Each patient entering the program was designated an official heart transplant candidate, meaning that he was gravely ill and would most likely benefit from a new heart. Some patients got a transplant and some did not. The variable `group` indicates which group the patients were in; patients in the treatment group got a transplant and those in the control group did not. Another variable called `outcome` was used to indicate whether or not the patient was alive at the end of the study.

In the study, of the 34 patients in the control group, 4 were alive at the end of the study. Of the 69 patients in the treatment group, 24 were alive. The contingency table below summarizes these results.

		Group		
		Control	Treatment	Total
Outcome	Alive	4	24	28
	Dead	30	45	75
	Total	34	69	103

The data is in a file called **Stanford_heart_study.csv**. Read the data in and answer the following questions.

```
heart<-read_csv("data/Stanford_heart_study.csv")
```

```
## Parsed with column specification:
## cols(
##   outcome = col_character(),
##   group = col_character()
## )
```

    a. What proportion of patients in the treatment group and what proportion of patients in the control group died?

```
inspect(heart)
```

```
##
## categorical variables:
##       name      class levels   n missing
## 1 outcome  character      2 103       0
## 2   group  character      2 103       0
##                               distribution
## 1 Dead (72.8%), Alive (27.2%)
## 2 Treatment (67%), Control (33%)
```

```
tally(~outcome+group,data=heart,margins = TRUE)
```

```
##          group
## outcome Control Treatment Total
##   Alive       4        24    28
##   Dead       30        45    75
##   Total      34        69   103
```

```
tally(outcome~group,data=heart,margins = TRUE,format="percent")
```

```
##          group
## outcome   Control Treatment
##    Alive  11.76471  34.78261
##    Dead   88.23529  65.21739
##    Total 100.00000 100.00000
```

So 88.2% of patients in control group died and 65.2% in the treatment group.

One approach for investigating whether or not the treatment is effective is to use a randomization technique.

    b. What are the claims being tested? Use the same null and alternative hypothesis notation used in the lesson notes.

H_0: **Independence model.** The variables *group* and *outcome* are independent. They have no relationship, and the difference in survival rates between the control and treatment groups was due to chance. In other words, heart transplant is not effective.

H_A: **Alternative hypothesis.** The variables *group* and *outcome* are *not* independent. The difference in survival rates between the control and treatment groups was not due to chance and the heart transplant is effective.

    c. The paragraph below describes the set up for such approach, if we were to do it without using statistical software. Fill in the blanks with a number or phrase, whichever is appropriate.

We write *alive* on **28** cards representing patients who were alive at the end of the study, and *dead* on **75** cards representing patients who were not. Then, we shuffle these cards and split them into two groups: one group of size **69** representing treatment, and another group of size **34** representing control. We calculate the difference between the proportion of *dead* cards in the control and treatment groups (control - treatment), this is just so we have positive observed value, and record this value. We repeat this many times to build a distribution centered at **zero**. Lastly, we calculate the fraction of simulations where the simulated differences in proportions are **0.23**. If this fraction of simulations, the empirical p-value, is low, we conclude that it is unlikely to have observed such an outcome by chance and that the null hypothesis should be rejected in favor of the alternative.

Next we will perform the simulation and use results to decide the effectiveness of the transplant program.

    d. Find observed value.
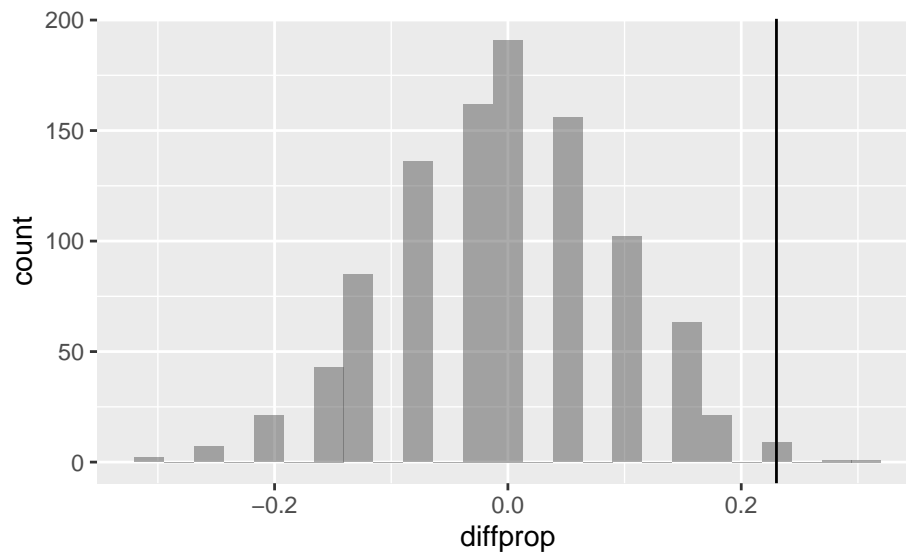
```
obs<-diffprop(outcome~group,data=heart)
obs
```

```
## diffprop
## 0.230179
```

    e. Simulate 1000 values by using `shuffle` on group.

```
set.seed(1213)
results <- do(1000)*diffprop(outcome~shuffle(group),data=heart)
```

    f. Plot distribution of results.

```
results %>%
  gf_histogram(~diffprop) %>%
  gf_vline(xintercept =obs )
```


g. Find p-value.

```
results %>%
  summarise(p_value = mean(diffprop>=obs))
```

```
##   p_value
## 1   0.011
```

h. Decide if the treatment is effective.

Under the independence model, only 11 out of 1000 times (1.1%) did we get a difference of 0.23 or higher between the proportions of patients that died in the control and treatment groups. Since this is a low probability, we can reject the claim of independence in favor of the alternate model. There is convincing evidence to suggest that the transplant program is defective.

File Creation Information

- File creation date: 2020-07-09
- Windows version: Windows 10 x64 (build 17763)
- R version 3.6.3 (2020-02-29)
- `mosaic` package version: 1.6.0
- `tidyverse` package version: 1.3.0
- `fastR2` package version: 1.2.1