Hypothesis tests

Advanced Statistics

2020-10-23

LAB 3

- Deadline: November, 6
- To: adv.statistics.2020@gmail.com.
- Subject: LAB 3
- Report file name: LAB3_LastName1_LastName2

For this lab:

- You'll solve all the exercises from "Part C2-Applications".
- You'll solve the exercises from these slides.

Guidelines: We expect a self-contained report with answers, figures and results. You can use RMarkdown, it is not mandatory. Additionally, you will send the code (.R) or the file that builds the report (.Rmd), we only want to look at it if there is a mistake on the report. If you are not comfortable writing equations in LaTeX you can add a hand-written appendix with the exercises that need a derivation with formulas.

Hypothesis testing

Ingredients:

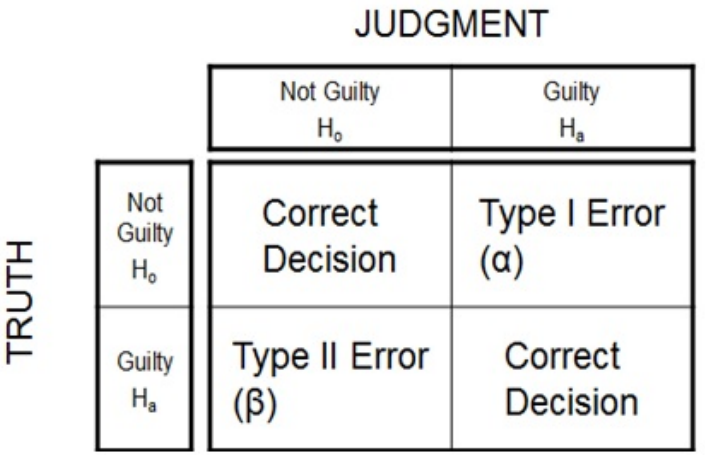
- Data
- two hypotheses H0 vs H1

Idea:

- Assuming H0 true, compute P(what we see)
- If this value is small then H0 is not likely. Then, H0 rejected.
- Else, there is no evidence to conclude.

Hypothesis testing: Errors

2 types of errors, trial example:



Type I is fixed (alpha)

Type II is minimized

Example 1

Flights from NY, duration

```
bos_sfo <- flights %>%
  na.omit() %>%
  filter(dest %in% c("BOS", "SFO")) %>%
  group_by(dest) %>%
  sample_n(100)

bos_sfo_summary <- bos_sfo %>%
  group_by(dest) %>%
  summarize(mean_time = mean(air_time),
            sd_time = sd(air_time))
```

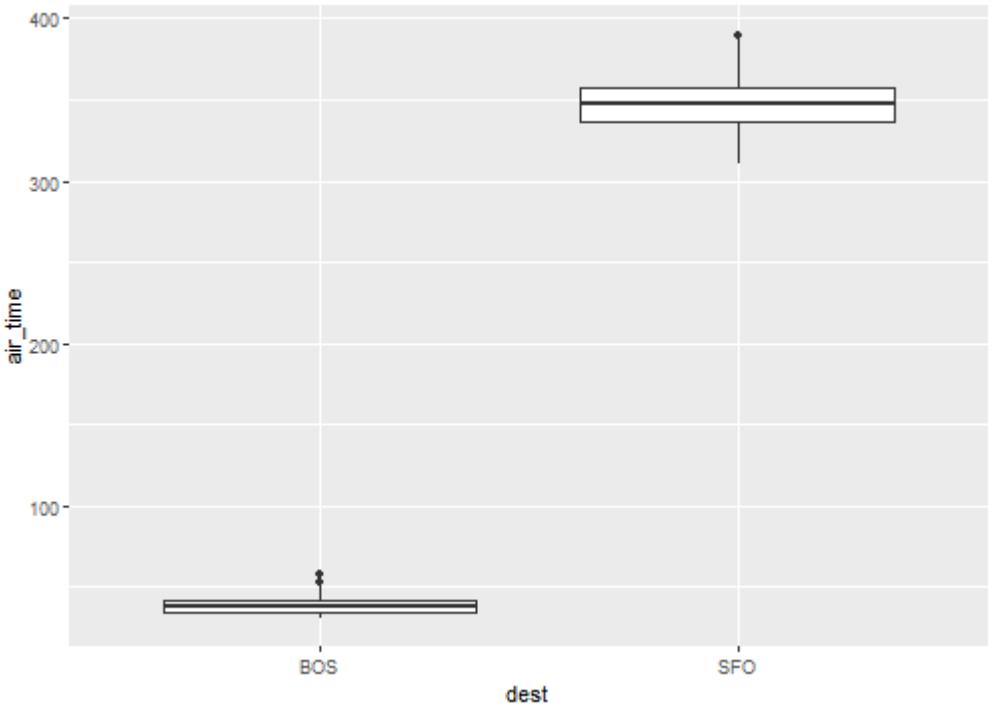
```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
bos_sfo_summary
```

```
## # A tibble: 2 x 3
##   dest  mean_time sd_time
##   <chr>     <dbl>   <dbl>
## 1 BOS        39.1    4.87
## 2 SFO       348.    16.7
```

Example 1

```
ggplot(data = bos_sfo, mapping = aes(x = dest, y = air_time)) +
  geom_boxplot()
```



Example 2

Movies rating

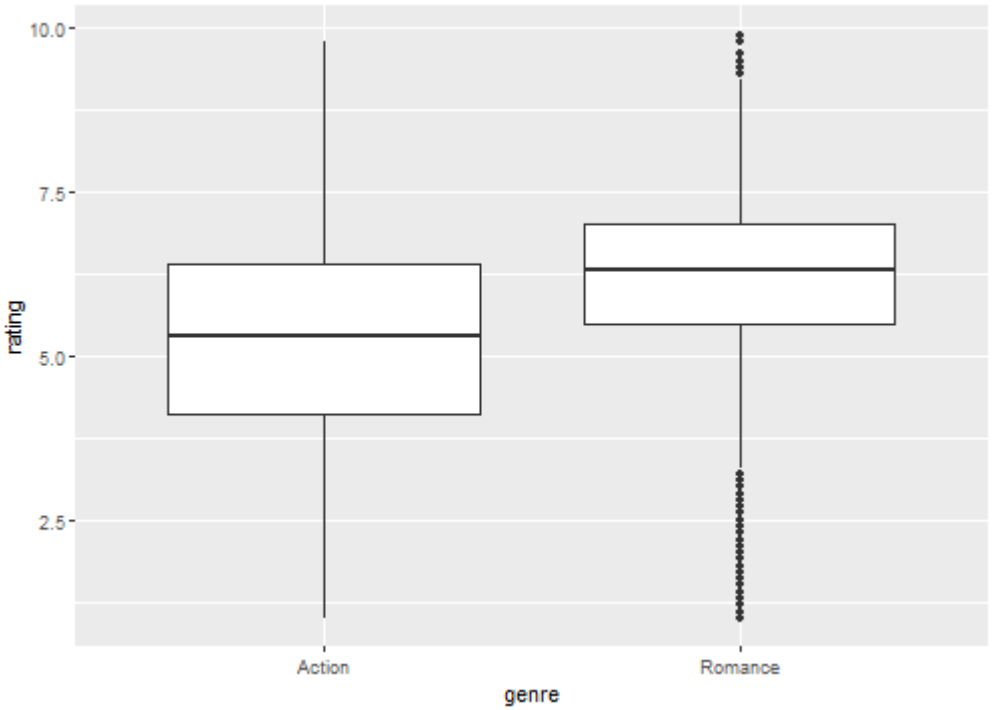
```
movies[1:3, ]
```

```
## # A tibble: 3 x 24
##   title  year length budget rating votes    r1    r2    r3    r4    r5
##   <chr> <int>  <int>  <int>  <dbl> <int> <dbl> <dbl> <dbl> <dbl> <dbl> <db
## 1 $      1971    121     NA    6.4   348   4.5   4.5   4.5   4.5  14.5  24
## 2 $100~  1939     71     NA    6      20   0    14.5   4.5  24.5  14.5  14
## 3 $21 ~  1941      7     NA    8.2     5   0     0     0     0     0    24
## # ... with 12 more variables: r7 <dbl>, r8 <dbl>, r9 <dbl>, r10 <dbl>,
## #   mpaa <chr>, Action <int>, Animation <int>, Comedy <int>, Drama <int>,
## #   Documentary <int>, Romance <int>, Short <int>
```

```
movies_trimmed <- movies %>%
  select(title, year, rating, Action, Romance) %>%
  filter(!(Action == 1 & Romance == 1)) %>%
  mutate(genre = case_when(Action == 1 ~ "Action",
                           Romance == 1 ~ "Romance",
                           TRUE ~ "Neither")) %>%
  filter(genre != "Neither") %>%
  select(-Action, -Romance)
```

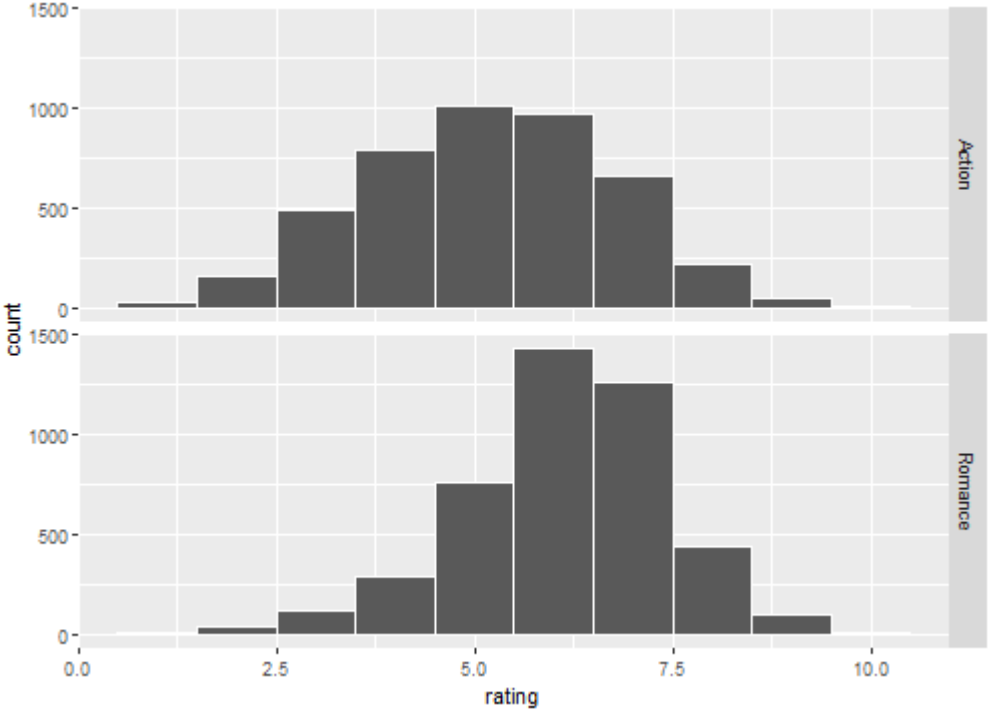
Example 2

```
ggplot(data = movies_trimmed, aes(x = genre, y = rating)) +
  geom_boxplot()
```



Example 2

```
ggplot(data = movies_trimmed, mapping = aes(x = rating)) +
  geom_histogram(binwidth = 1, color = "white") +
  facet_grid(genre ~ .)
```



Procedure

You'll:

- statistically model the data based on the type of involved variables
- determine the hypotheses to test
- use the specific function for that test, e.g. binom.test, t.test
- reject or not the null hypotesis based on the p-value

EX 1:

Simulations on Hypothesis testing:

- Simulate coin tosses with a fixed p (probability of getting head)
- Derive an asymptotic test with level α to check if the coin is biased
- Empirically verify the asymptotic level of the test

EX 2: Rock-paper-scissors (from OpenIntro book)

Rock-paper-scissors is a hand game played by two or more people where players choose to sign either rock, paper, or scissors with their hands. For your statistics class project, you want to evaluate whether players choose between these three options randomly, or if certain options are favored above others. You ask two friends to play rock-paper-scissors and count the times each option is played. The following table summarizes the data:

Rock: 43

Paper: 21

Scissors: 35

Use these data to evaluate whether players choose between these three options randomly, or if certain options are favored above others.