HW5

Ruwen Zhou

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Problem 1

Read in the data.

```
homicide_df =
  read_csv("homicide_data/homicide-data.csv") %>%
  mutate(
    city_state = str_c(city, state, sep = "_"),
    resolved = case_when(
      disposition == "Closed without arrest" ~ "unsolved",
      disposition == "Open/No arrest"        ~ "unsolved",
      disposition == "Closed by arrest"      ~ "solved",
    )
  ) %>%
  select(city_state, resolved) %>%
  filter(city_state != "Tulsa_AL")
```

```
## Parsed with column specification:
## cols(
##   uid = col_character(),
##   reported_date = col_double(),
##   victim_last = col_character(),
##   victim_first = col_character(),
##   victim_race = col_character(),
##   victim_age = col_character(),
##   victim_sex = col_character(),
##   city = col_character(),
##   state = col_character(),
##   lat = col_double(),
##   lon = col_double(),
##   disposition = col_character()
## )
```

Let's look at this a bit

```
aggregate_df =
  homicide_df %>%
  group_by(city_state) %>%
  summarize(
    hom_total = n(),
    hom_unsolved = sum(resolved == "unsolved")
  )
```

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

Can I do a prop test for a single city?

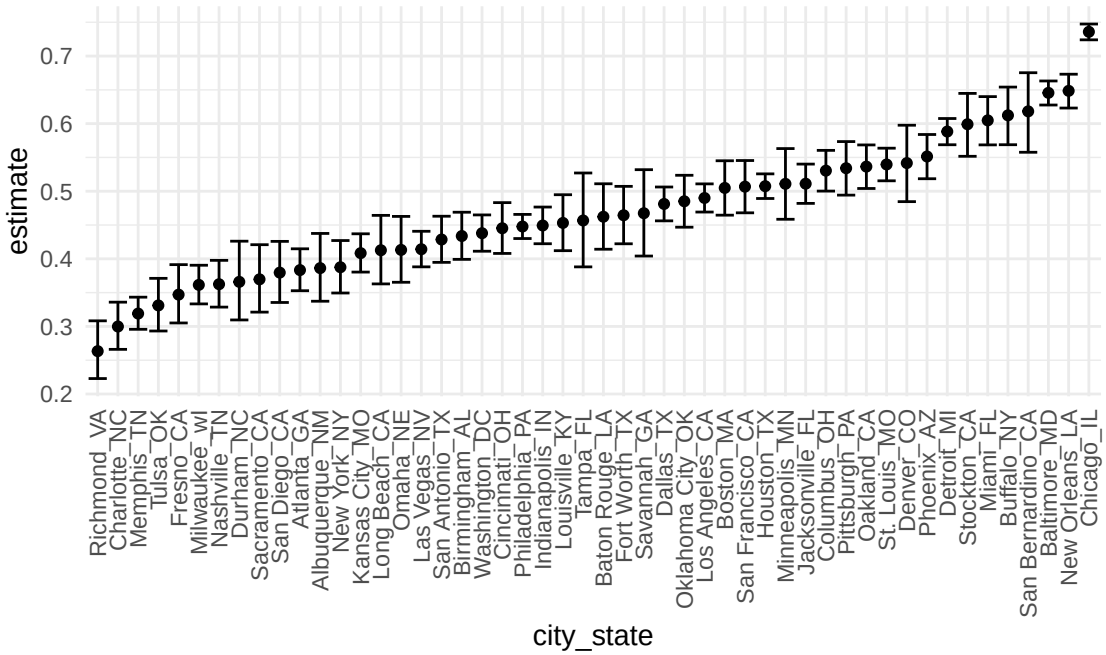
```
prop.test(
  aggregate_df %>% filter(city_state == "Baltimore_MD") %>% pull(hom_unsolved),
  aggregate_df %>% filter(city_state == "Baltimore_MD") %>% pull(hom_total)) %>%
  broom::tidy()
```

```
## # A tibble: 1 x 8
##   estimate statistic  p.value parameter conf.low conf.high method    alternative
##      <dbl>     <dbl>    <dbl>     <int>    <dbl>     <dbl> <chr>     <chr>
## 1    0.646      239. 6.46e-54         1    0.628     0.663 1-sample~ two.sided
```

Try to iterate ……..

```
results_df =
  aggregate_df %>%
  mutate(
    prop_tests = map2(.x = hom_unsolved, .y = hom_total, ~prop.test(x = .x, n = .y)),
    tidy_tests = map(.x = prop_tests, ~broom::tidy(.x))
  ) %>%
  select(-prop_tests) %>%
  unnest(tidy_tests) %>%
  select(city_state, estimate, conf.low, conf.high)
```

```
results_df %>%
  mutate(city_state = fct_reorder(city_state, estimate)) %>%
  ggplot(aes(x = city_state, y = estimate)) +
  geom_point() +
  geom_errorbar(aes(ymin = conf.low, ymax = conf.high)) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust = 1))
```



```
homicide_df =
  read_csv("homicide_data/homicide-data.csv") %>%
  mutate(
    city_state = str_c(city, state, sep = "_"),
    resolved = case_when(
      disposition == "Closed without arrest" ~ "unsolved",
      disposition == "Open/No arrest"        ~ "unsolved",
      disposition == "Closed by arrest"      ~ "solved",
    )
  ) %>%
  select(city_state, resolved) %>%
  filter(city_state != "Tulsa_AL") %>%
  nest(data = resolved)
```

```
## Parsed with column specification:
## cols(
##   uid = col_character(),
##   reported_date = col_double(),
##   victim_last = col_character(),
##   victim_first = col_character(),
##   victim_race = col_character(),
##   victim_age = col_character(),
##   victim_sex = col_character(),
##   city = col_character(),
##   state = col_character(),
##   lat = col_double(),
##   lon = col_double(),
##   disposition = col_character()
## )
```

Problem 2

Create a tidy dataframe containing data from all participants, including the subject ID, arm, and observations over time

```
tidy_df = tibble(
    path = list.files("lda_data"),
  ) %>%
  mutate(
    path = str_c("lda_data/", path),
    data = map(.x = path, ~read_csv(.x)),
    arm_id = str_remove(path, "lda_data/"),
    arm_id = str_remove(arm_id, ".csv")) %>%
  unnest(data) %>%
  select(-path) %>%
  pivot_longer(
    week_1:week_8,
    values_to = "observation_data",
    names_to = "week",
    names_prefix = "week_",
  ) %>%
  separate(arm_id, into = c("arm", "subject_id"), sep = "_")
```

```
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
```

```
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
```

```
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
```

```
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
## Parsed with column specification:
## cols(
##   week_1 = col_double(),
##   week_2 = col_double(),
##   week_3 = col_double(),
##   week_4 = col_double(),
##   week_5 = col_double(),
```

```
##   week_6 = col_double(),
##   week_7 = col_double(),
##   week_8 = col_double()
## )
```

```
tidy_df %>% knitr::kable()
```

arm	subject_id	week	observation_data
con	01	1	0.20
con	01	2	-1.31
con	01	3	0.66
con	01	4	1.96
con	01	5	0.23
con	01	6	1.09
con	01	7	0.05
con	01	8	1.94
con	02	1	1.13
con	02	2	-0.88
con	02	3	1.07
con	02	4	0.17
con	02	5	-0.83
con	02	6	-0.31
con	02	7	1.58
con	02	8	0.44
con	03	1	1.77
con	03	2	3.11
con	03	3	2.22
con	03	4	3.26
con	03	5	3.31
con	03	6	0.89
con	03	7	1.88
con	03	8	1.01
con	04	1	1.04
con	04	2	3.66
con	04	3	1.22
con	04	4	2.33
con	04	5	1.47
con	04	6	2.70
con	04	7	1.87
con	04	8	1.66
con	05	1	0.47
con	05	2	-0.58
con	05	3	-0.09
con	05	4	-1.37
con	05	5	-0.32
con	05	6	-2.17
con	05	7	0.45
con	05	8	0.48
con	06	1	2.37
con	06	2	2.50
con	06	3	1.59
con	06	4	-0.16
con	06	5	2.08

arm	subject_id	week	observation_data
con	06	6	3.07
con	06	7	0.78
con	06	8	2.35
con	07	1	0.03
con	07	2	1.21
con	07	3	1.13
con	07	4	0.64
con	07	5	0.49
con	07	6	-0.12
con	07	7	-0.07
con	07	8	0.46
con	08	1	-0.08
con	08	2	1.42
con	08	3	0.09
con	08	4	0.36
con	08	5	1.18
con	08	6	-1.16
con	08	7	0.33
con	08	8	-0.44
con	09	1	0.08
con	09	2	1.24
con	09	3	1.44
con	09	4	0.41
con	09	5	0.95
con	09	6	2.75
con	09	7	0.30
con	09	8	0.03
con	10	1	2.14
con	10	2	1.15
con	10	3	2.52
con	10	4	3.44
con	10	5	4.26
con	10	6	0.97
con	10	7	2.73
con	10	8	-0.53
exp	01	1	3.05
exp	01	2	3.67
exp	01	3	4.84
exp	01	4	5.80
exp	01	5	6.33
exp	01	6	5.46
exp	01	7	6.38
exp	01	8	5.91
exp	02	1	-0.84
exp	02	2	2.63
exp	02	3	1.64
exp	02	4	2.58
exp	02	5	1.24
exp	02	6	2.32
exp	02	7	3.11
exp	02	8	3.78
exp	03	1	2.15

arm	subject_id	week	observation_data
exp	03	2	2.08
exp	03	3	1.82
exp	03	4	2.84
exp	03	5	3.36
exp	03	6	3.61
exp	03	7	3.37
exp	03	8	3.74
exp	04	1	-0.62
exp	04	2	2.54
exp	04	3	3.78
exp	04	4	2.73
exp	04	5	4.49
exp	04	6	5.82
exp	04	7	6.00
exp	04	8	6.49
exp	05	1	0.70
exp	05	2	3.33
exp	05	3	5.34
exp	05	4	5.57
exp	05	5	6.90
exp	05	6	6.66
exp	05	7	6.24
exp	05	8	6.95
exp	06	1	3.73
exp	06	2	4.08
exp	06	3	5.40
exp	06	4	6.41
exp	06	5	4.87
exp	06	6	6.09
exp	06	7	7.66
exp	06	8	5.83
exp	07	1	1.18
exp	07	2	2.35
exp	07	3	1.23
exp	07	4	1.17
exp	07	5	2.02
exp	07	6	1.61
exp	07	7	3.13
exp	07	8	4.88
exp	08	1	1.37
exp	08	2	1.43
exp	08	3	1.84
exp	08	4	3.60
exp	08	5	3.80
exp	08	6	4.72
exp	08	7	4.68
exp	08	8	5.70
exp	09	1	-0.40
exp	09	2	1.08
exp	09	3	2.66
exp	09	4	2.70
exp	09	5	2.80

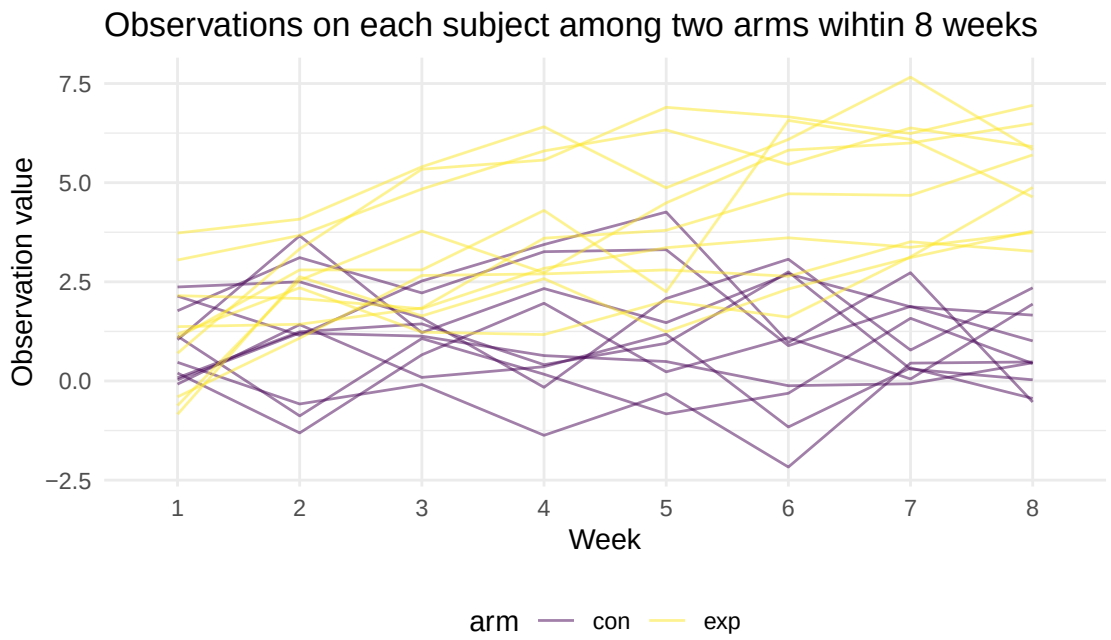
arm	subject_id	week	observation_data
exp	09	6	2.64
exp	09	7	3.51
exp	09	8	3.27
exp	10	1	1.09
exp	10	2	2.80
exp	10	3	2.80
exp	10	4	4.30
exp	10	5	2.25
exp	10	6	6.57
exp	10	7	6.09
exp	10	8	4.64

```
tidy_df
```

```
## # A tibble: 160 x 4
##    arm   subject_id week  observation_data
##    <chr> <chr>      <chr>             <dbl>
##  1 con   01         1                  0.2
##  2 con   01         2                 -1.31
##  3 con   01         3                  0.66
##  4 con   01         4                  1.96
##  5 con   01         5                  0.23
##  6 con   01         6                  1.09
##  7 con   01         7                  0.05
##  8 con   01         8                  1.94
##  9 con   02         1                  1.13
## 10 con   02         2                 -0.88
## # ... with 150 more rows
```

Make a spaghetti plot showing observations on each subject over time, and comment on differences between groups

```
tidy_df %>%
  unite("arm_id", c(arm, subject_id), sep = "_", remove = F) %>%
  ggplot(aes(x = week, y = observation_data)) +
  geom_path(aes(color = arm, group = as.factor(arm_id)),alpha = 0.5) +
  labs(
    x = "Week",
    y = "Observation value",
    title = "Observations on each subject among two arms wihtin 8 weeks"
    )
```



The observation data of experimental arm increases faster than the control arm over time. The measure in control arm is more stable and decreases a little bit after week 6.

Problem 3

T test

```
n = 30
mu = 0
sigma = 5
x = rnorm(n, mean = mu, sd = sigma)
t.test(x, mu = mu, conf.level = 0.95)
```

```
##
##  One Sample t-test
##
## data:  x
## t = -0.70399, df = 29, p-value = 0.4871
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -2.835154  1.383163
## sample estimates:
## mean of x
## -0.725995
```

Generate 5000 datasets from the model

```
sim_data = function(n = 30, mu = 0, sigma = 5) {
     x = rnorm(n, mean = mu, sd = sigma)
```

```
    t_test = t.test(x, conf.int = 0.95) %>% broom::tidy()
    t_test
}
output = vector("list", 5000)
for (i in 1:5000) {
  output[[i]] = sim_data()
}
output %>% head()
```

```
## [[1]]
## # A tibble: 1 x 8
##   estimate statistic p.value parameter conf.low conf.high method     alternative
##      <dbl>     <dbl>   <dbl>     <dbl>    <dbl>     <dbl> <chr>      <chr>
## 1   -0.941     -1.06   0.297        29    -2.76     0.873 One Sampl~ two.sided
##
## [[2]]
## # A tibble: 1 x 8
##   estimate statistic p.value parameter conf.low conf.high method     alternative
##      <dbl>     <dbl>   <dbl>     <dbl>    <dbl>     <dbl> <chr>      <chr>
## 1   -0.810     -1.09   0.284        29    -2.33     0.706 One Sampl~ two.sided
##
## [[3]]
## # A tibble: 1 x 8
##   estimate statistic p.value parameter conf.low conf.high method     alternative
##      <dbl>     <dbl>   <dbl>     <dbl>    <dbl>     <dbl> <chr>      <chr>
## 1  -0.0698   -0.0617   0.951        29    -2.38      2.24 One Sampl~ two.sided
##
## [[4]]
## # A tibble: 1 x 8
##   estimate statistic p.value parameter conf.low conf.high method     alternative
##      <dbl>     <dbl>   <dbl>     <dbl>    <dbl>     <dbl> <chr>      <chr>
## 1    0.352     0.349   0.730        29    -1.71      2.41 One Sampl~ two.sided
##
## [[5]]
## # A tibble: 1 x 8
##   estimate statistic p.value parameter conf.low conf.high method     alternative
##      <dbl>     <dbl>   <dbl>     <dbl>    <dbl>     <dbl> <chr>      <chr>
## 1    0.659     0.765   0.450        29    -1.10      2.42 One Sampl~ two.sided
##
## [[6]]
## # A tibble: 1 x 8
##   estimate statistic p.value parameter conf.low conf.high method     alternative
##      <dbl>     <dbl>   <dbl>     <dbl>    <dbl>     <dbl> <chr>      <chr>
## 1   0.0764    0.0979   0.923        29    -1.52      1.67 One Sampl~ two.sided
```

for mu = {0,1,2,3,4,5,6}

```
set.seed(1000)
combine =
  tibble(mu = c(0, 1, 2, 3, 4, 5, 6)) %>%
  mutate(
```

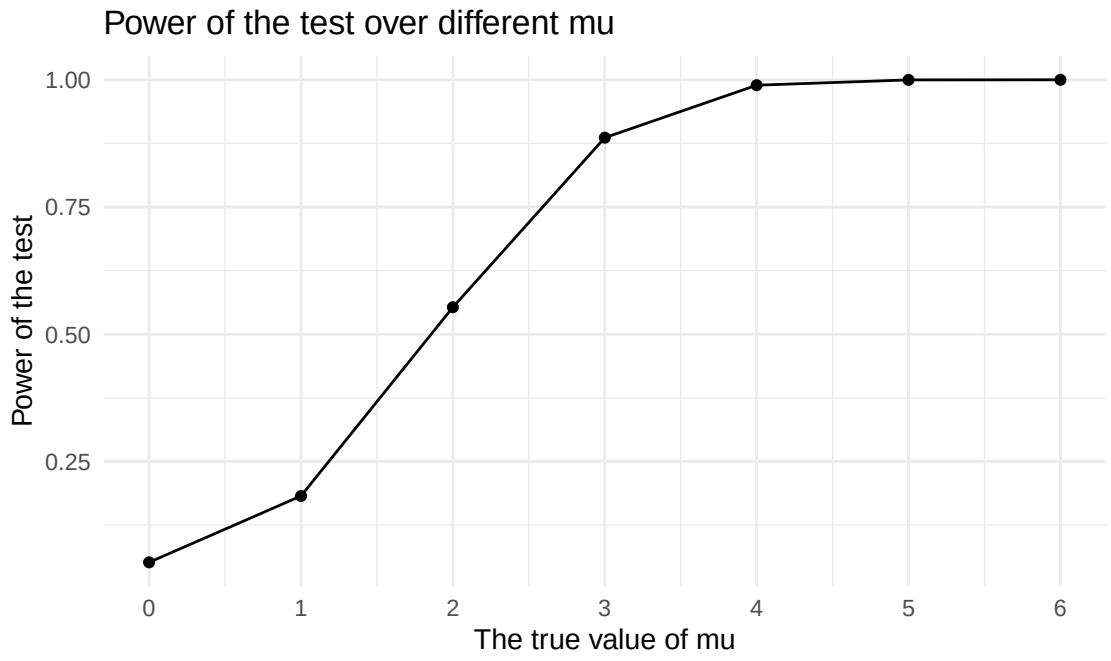
```
    output = map(.x = mu, ~rerun(5000, sim_data(mu = .x))),
    new = map(output, bind_rows)) %>%
  select(-output) %>%
  unnest(new)
combine %>% head()
```

```
## # A tibble: 6 x 9
##      mu estimate statistic p.value parameter conf.low conf.high method
##   <dbl>    <dbl>     <dbl>   <dbl>     <dbl>    <dbl>     <dbl> <chr>
## 1     0   -0.758    -0.850   0.402        29   -2.58       1.06 One S~
## 2     0   -0.593    -0.651   0.520        29   -2.46       1.27 One S~
## 3     0    1.02      1.13    0.267        29   -0.824      2.86 One S~
## 4     0    0.991     1.04    0.306        29   -0.956      2.94 One S~
## 5     0    0.183     0.235   0.816        29   -1.41       1.78 One S~
## 6     0   -0.101    -0.120   0.905        29   -1.82       1.62 One S~
## # ... with 1 more variable: alternative <chr>
```

Make a plot showing the proportion of times the null was rejected (the power of the test) on the y axis and the true value of mu on the x axis.

```
combine %>%
  filter(p.value < 0.05) %>%
  group_by(mu) %>%
  summarize(prop_rej = n()) %>%
  mutate(prop_rej = prop_rej/5000) %>%
  ggplot(aes(x = mu, y = prop_rej), color = mu) +
  geom_point() +
  geom_line() +
  scale_x_continuous(limits = c(0,6), breaks = seq(0,6,1)) +
  labs(
    title = "Power of the test over different mu",
    x = "The true value of mu",
    y = "Power of the test"
  )
```

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



As the number of mu increases, the power of the test also increases. The power converges to 1 when mu = 4.