Project sizes: exploratory plots

Overview

This notebook explores Q5: "How frequently have you contributed to projects of the following size?".

Import packages and utilities

```
project_root <- here::here() # requires that you be somewhere in the
# project directory (not above it)
# packages
suppressMessages(source(file.path(project_root, "scripts/packages.R")))
# functions and objects used across scripts
suppressMessages(source(file.path(project_root, "scripts/utils.R")))
```

Load data

```
sizes_raw <- load_qualtrics_data("clean_data/project_size_Q5.tsv")
other_quant <- load_qualtrics_data("clean_data/other_quant.tsv")
```

Wrangle data

Drop rows with no data

```r
sizes <- exclude_empty_rows(sizes_raw)
nrow(sizes)
```

```
[1] 233
```

Let's create a long-format version for plotting.

```r
sizes_long <- sizes %>%
  pivot_longer(
    cols = everything(),
    names_to  = "size",
    values_to = "frequency"
  )

sizes_long
```

```
# A tibble: 699 x 2
   size   frequency
   <chr>  <chr>
 1 Small  Relatively frequently
 2 Medium Occasionally
 3 Large  Relatively infrequently
 4 Small  Occasionally
 5 Medium Relatively infrequently
 6 Large  Never
 7 Small  Occasionally
 8 Medium Relatively infrequently
 9 Large  Never
10 Small  Relatively frequently
# i 689 more rows
```

Inspect data

Let's look at the counts.

```r
sizes_counts <- sizes_long %>%
  count(size, frequency, name = "n")

sizes_counts[
```

```
  order(
    sizes_counts$n,
    decreasing = TRUE
  ),
]
```

```
# A tibble: 12 x 3
   size   frequency                 n
   <chr>  <chr>                 <int>
 1 Small  Relatively frequently   109
 2 Large  Never                    82
 3 Large  Relatively infrequently  74
 4 Medium Relatively infrequently  69
 5 Medium Occasionally             68
 6 Small  Occasionally             67
 7 Medium Relatively frequently    53
 8 Medium Never                    43
 9 Small  Relatively infrequently  41
10 Large  Occasionally             39
11 Large  Relatively frequently    38
12 Small  Never                    16
```

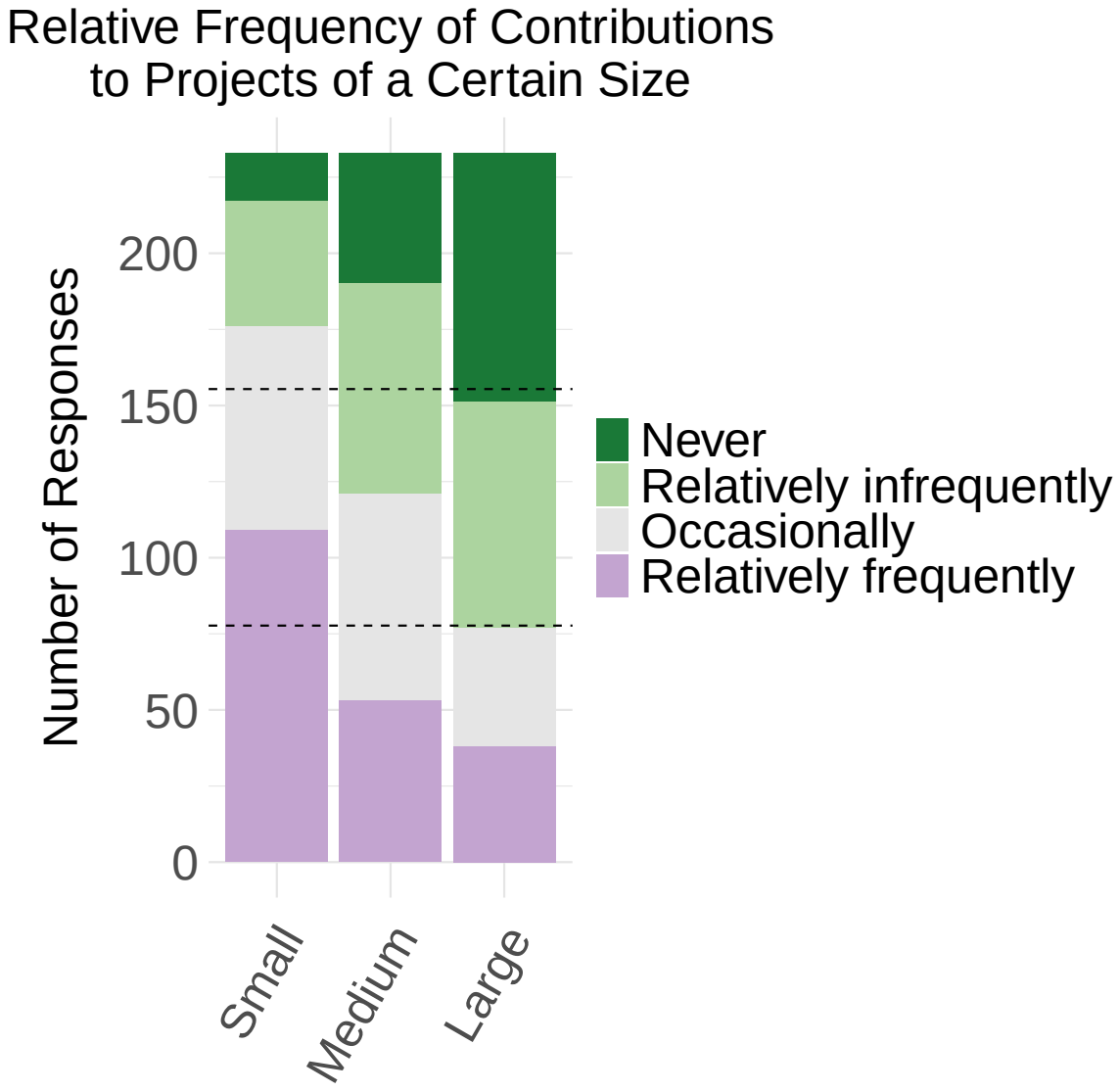
Reorder factor levels

```
ordered_freqs <- c(
  "Never",
  "Relatively infrequently",
  "Occasionally",
  "Relatively frequently"
)

sizes_counts$frequency <- factor(
  sizes_counts$frequency,
  levels = ordered_freqs
)

ordered_sizes <- c(
  "Small",
  "Medium",
  "Large"
)
```

```r
sizes_counts$size <- factor(
  sizes_counts$size,
  levels = ordered_sizes
)
```

Stacked bar chart

```r
stacked_bar <- stacked_bar_chart(
  sizes_counts,
  x_var = "size",
  y_var = "n",
  fill = "frequency",
  title = "Relative Frequency of Contributions\nto Projects of a Certain Size",
  cpalette = c(
    "#1a7937", # dark green
    "#acd49f", # light green
    "#e5e5e5", # light gray
    "#c3a4d0", # light purple
    "#752a82" # dark purple
  )
)
stacked_bar <- stacked_bar +
  geom_hline(yintercept = 155.4, linetype = "dashed", color = "black") +
  geom_hline(yintercept = 77.7, linetype = "dashed", color = "black")
stacked_bar
```



The dashed lines indicate 1/3 and 2/3 of the total number of responses.

Save the plot

```
save_plot("proj_sizes_bar.tiff", 8, 6, p=stacked_bar)
```

Incorporate job category

```
sizes_job <- cbind(sizes_raw, other_quant$job_category)
# Rename column
names(sizes_job)[ncol(sizes_job)] <- "job_category"
# Filter out people who didn't answer either question
sizes_job <- exclude_empty_rows(sizes_job, strict = TRUE)
```

```
sizes_job_long <- sizes_job %>%
  pivot_longer(
    cols = -job_category,
    names_to = "size",
    values_to = "frequency"
  )
```

```
# three way cross tabs (xtabs) and flatten the table
# code from: https://ladal.edu.au/tutorials/regression/regression.html
ftable(xtabs(~ job_category + size + frequency, data = sizes_job_long))
```

```
                          frequency Never Occasionally Relatively frequently Relatively in
job_category         size
Faculty              Large               26           6                     8
                     Medium              13          17                    10
                     Small                6          17                    28
Grad Student         Large               11           7                     1
                     Medium               8          10                     2
                     Small                0           7                    14
Non-research Staff   Large               15          17                    20
                     Medium              11          28                    22
                     Small               10          25                    33
Other research staff Large               17           5                     8
                     Medium               6           8                    14
                     Small                0          11                    22
Post-Doc             Large                8           3                     1
                     Medium               1           4                     4
                     Small                0           6                     8
Undergraduate        Large                5           1                     0
                     Medium               4           1                     1
                     Small                0           1                     4
```

Maybe these data are more suited to line plots than to bar plots. Also, maybe we should fold in the smaller job categories, like we did with the regressions.

Panel of line plots

```
combined <- sizes_job_long %>%
  mutate(
    job_category = recode(
      job_category,
      "Post-Doc" = "Postdocs and Staff Researchers",
      "Other research staff" = "Postdocs and Staff Researchers"
    )
  )

combined <- combined %>%
  mutate(
    job_category = recode(
      job_category,
      "Grad Student" = "Students",
      "Undergraduate" = "Students"
    )
  )
```

Reorder factor levels

```
ordered_jobs <- c(
  "Students",
  "Postdocs and Staff Researchers",
  "Faculty",
  "Non-research Staff"
)

combined$size <- factor(combined$size, levels = ordered_sizes)
combined$frequency <- factor(combined$frequency, levels = ordered_freqs)
combined$job_category <- factor(combined$job_category, levels = ordered_jobs)
```

Recode frequency from categorical to a numeric score

```r
combined_coded_all <- combined %>%
  mutate(
    frequency_score = recode(
      frequency,
      "Never" = 0L,
      "Relatively infrequently" = 1L,
      "Occasionally" = 2L,
      "Relatively frequently" = 3L
    )
  ) %>%
    select(-frequency)

combined_coded_all
```

```
# A tibble: 699 x 3
   job_category                    size   frequency_score
   <fct>                           <fct>            <int>
 1 Faculty                         Small                3
 2 Faculty                         Medium               2
 3 Faculty                         Large                1
 4 Postdocs and Staff Researchers  Small                2
 5 Postdocs and Staff Researchers  Medium               1
 6 Postdocs and Staff Researchers  Large                0
 7 Postdocs and Staff Researchers  Small                2
 8 Postdocs and Staff Researchers  Medium               1
 9 Postdocs and Staff Researchers  Large                0
10 Faculty                         Small                3
# i 689 more rows
```

Sum up frequency scores

```r
combined_scores <- combined_coded_all %>%
  count(job_category, size, wt = frequency_score, name = "total_score")

# Reorder factor levels
combined_scores$size <- factor(combined_scores$size, levels = ordered_sizes)

combined_scores
```

```
# A tibble: 12 x 3
   job_category                    size   total_score
```

```
   <fct>                          <fct>        <int>
 1 Students                       Small           77
 2 Students                       Medium          38
 3 Students                       Large           27
 4 Postdocs and Staff Researchers Small          132
 5 Postdocs and Staff Researchers Medium          96
 6 Postdocs and Staff Researchers Large           56
 7 Faculty                        Small          126
 8 Faculty                        Medium          83
 9 Faculty                        Large           55
10 Non-research Staff             Small          167
11 Non-research Staff             Medium         147
12 Non-research Staff             Large          128
```

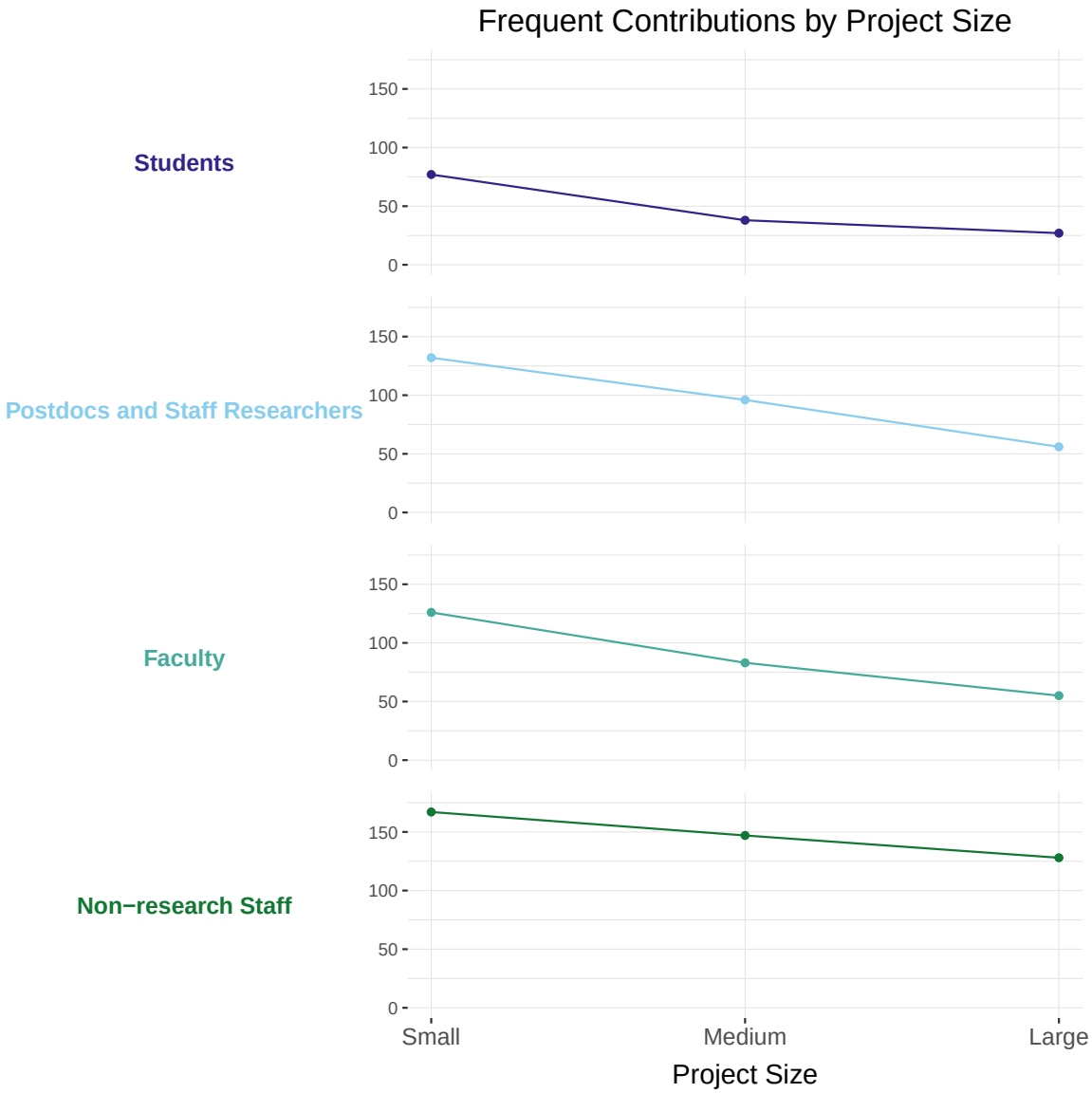
Recycling some old code to create a stack of line plots.

```
labeled_colors <- setNames(as.list(COLORS), ordered_jobs)

lineplot <- function(df, current_job_cat) {
  x <- ggplot(
    subset(df, job_category == current_job_cat),
    aes(x = size, y = total_score, group = job_category, color = job_category)
  ) +
    geom_line() +
    geom_point() +
    ylim(0, 175) +
    scale_x_discrete(expand = c(0.025, 0.025)) +
    ylab(current_job_cat) +
    xlab("Project Size") +
    ggtitle("Frequent Contributions by Project Size") +
    scale_color_manual(values = c(labeled_colors[[current_job_cat]])) +
    # Use different theme options depending on whether this is
    # the first plot, a middle plot, or the last plot in the stack
    # I know this code is painfully "wet" as opposed to "d.r.y" but it gets the job done
    {
      if (current_job_cat == ordered_jobs[[1]]) {
        theme(
          axis.title.y = element_text(
            angle = 0,
            vjust = 0.5,
            color = labeled_colors[[current_job_cat]],
            size = 12,
```

```
          face = "bold"
        ),
        axis.title.x = element_blank(),
        axis.text.x = element_blank(),
        axis.ticks.x = element_blank(),
        panel.background = element_blank(),
        panel.grid.major = element_line(linewidth = 0.25, linetype = "solid", color = "gray
        panel.grid.minor = element_line(linewidth = 0.25, linetype = "solid", color = "gray
        plot.margin = unit(c(0.3, 0.5, 0, 0), "cm"),
        plot.title = element_text(hjust = 0.5, size = 16),
        legend.position = "none"
      )
    }
  } +
  {
    if (
      current_job_cat != ordered_jobs[[length(ordered_jobs)]] &
        current_job_cat != ordered_jobs[[1]]) {
      theme(
        axis.title.y = element_text(
          angle = 0,
          vjust = 0.5,
          color = labeled_colors[[current_job_cat]],
          size = 12,
          face = "bold"
        ),
        axis.title.x = element_blank(),
        axis.text.x = element_blank(),
        axis.ticks.x = element_blank(),
        panel.background = element_blank(),
        panel.grid.major = element_line(linewidth = 0.25, linetype = "solid", color = "gray
        panel.grid.minor = element_line(linewidth = 0.25, linetype = "solid", color = "gray
        plot.margin = unit(c(0.3, 0.5, 0, 0), "cm"),
        plot.title = element_blank(),
        legend.position = "none"
      )
    }
  } +
  {
    if (current_job_cat == ordered_jobs[[length(ordered_jobs)]]) {
      theme(
        axis.title.y = element_text(
```

```
            angle = 0,
            vjust = 0.5,
            color = labeled_colors[[current_job_cat]],
            size = 12,
            face = "bold"
          ),
          axis.title.x = element_text(size = 14, vjust = -0.5),
          axis.text.x = element_text(size = 12),
          panel.background = element_blank(),
          panel.grid.major = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          panel.grid.minor = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          plot.margin = unit(c(0.3, 0.5, 0.3, 0), "cm"),
          plot.title = element_blank(),
          legend.position = "none"
        )
      }
    }
}
```

```
plotlist <- lapply(
  ordered_jobs,
  function(x) lineplot(combined_scores, x)
)

patchwork::wrap_plots(plotlist, nrow = 4, ncol = 1)
```

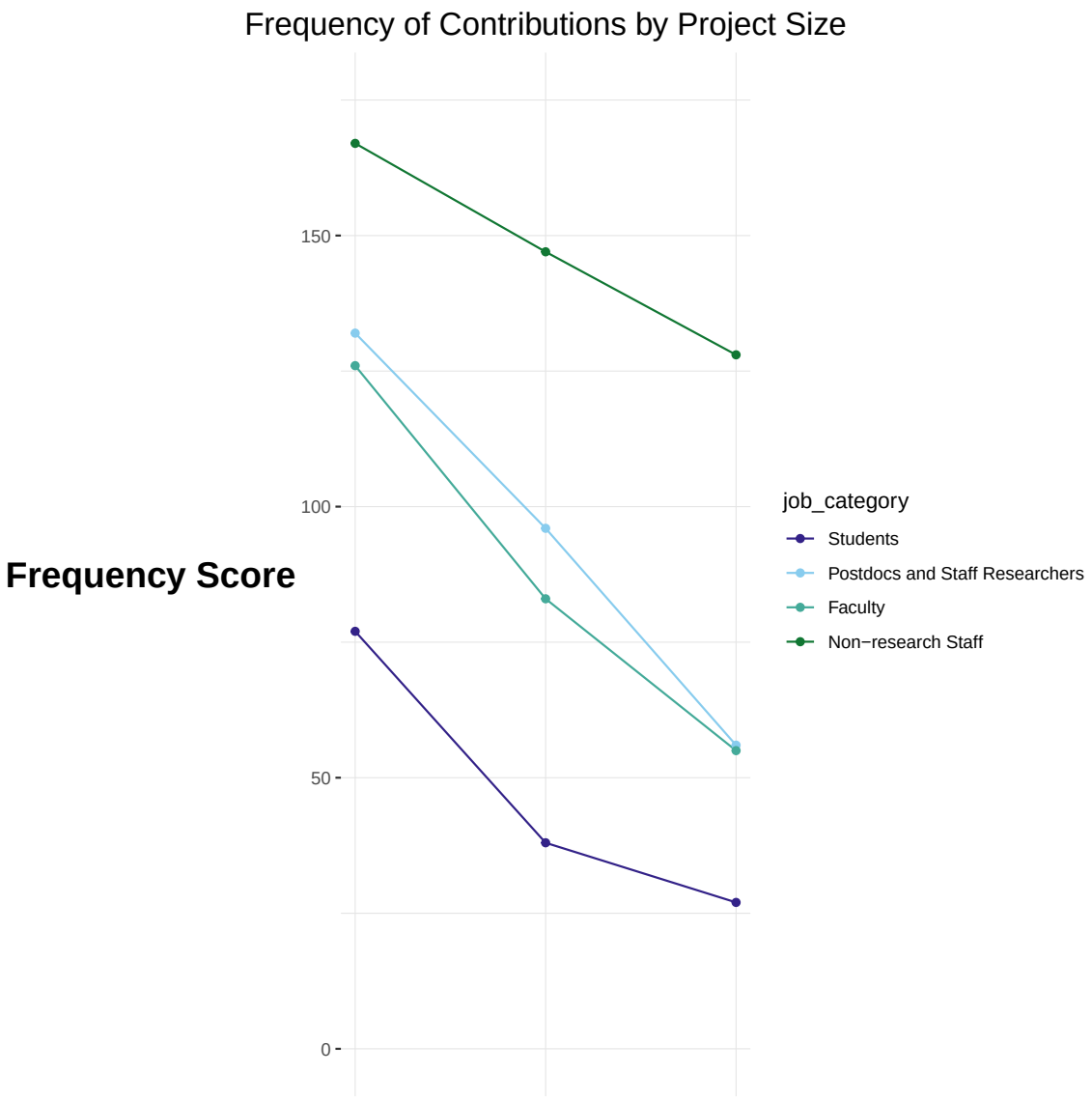


Eh, I think they would look better if they were all on the same plot.

Normal line plot

```
ggplot(
    combined_scores,
    aes(x = size, y = total_score, group = job_category, color = job_category)
```

```
  ) +
    geom_line() +
    geom_point() +
    ylim(0, 175) +
    scale_x_discrete(expand = c(0.025, 0.025)) +
    ylab("Frequency Score") +
    xlab("Project Size") +
    ggtitle("Frequency of Contributions by Project Size") +
    scale_color_manual(values = COLORS) +

    theme(
          axis.title.y = element_text(
            angle = 0,
            vjust = 0.5,
            size = 18,
            face = "bold"
          ),
          axis.title.x = element_blank(),
          axis.text.x = element_blank(),
          axis.ticks.x = element_blank(),
          panel.background = element_blank(),
          panel.grid.major = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          panel.grid.minor = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          plot.margin = unit(c(0.5, 0.5, 0.5, 0.5), "cm"),
          plot.title = element_text(hjust = 0.5, size = 16),
        )
```



Nah, still needs work. How about we just plot the trend for large projects?

Large projects

```
large <- subset(combined, size == "Large")
large_counts <- large %>%
  count(job_category, frequency, name = "n")
```

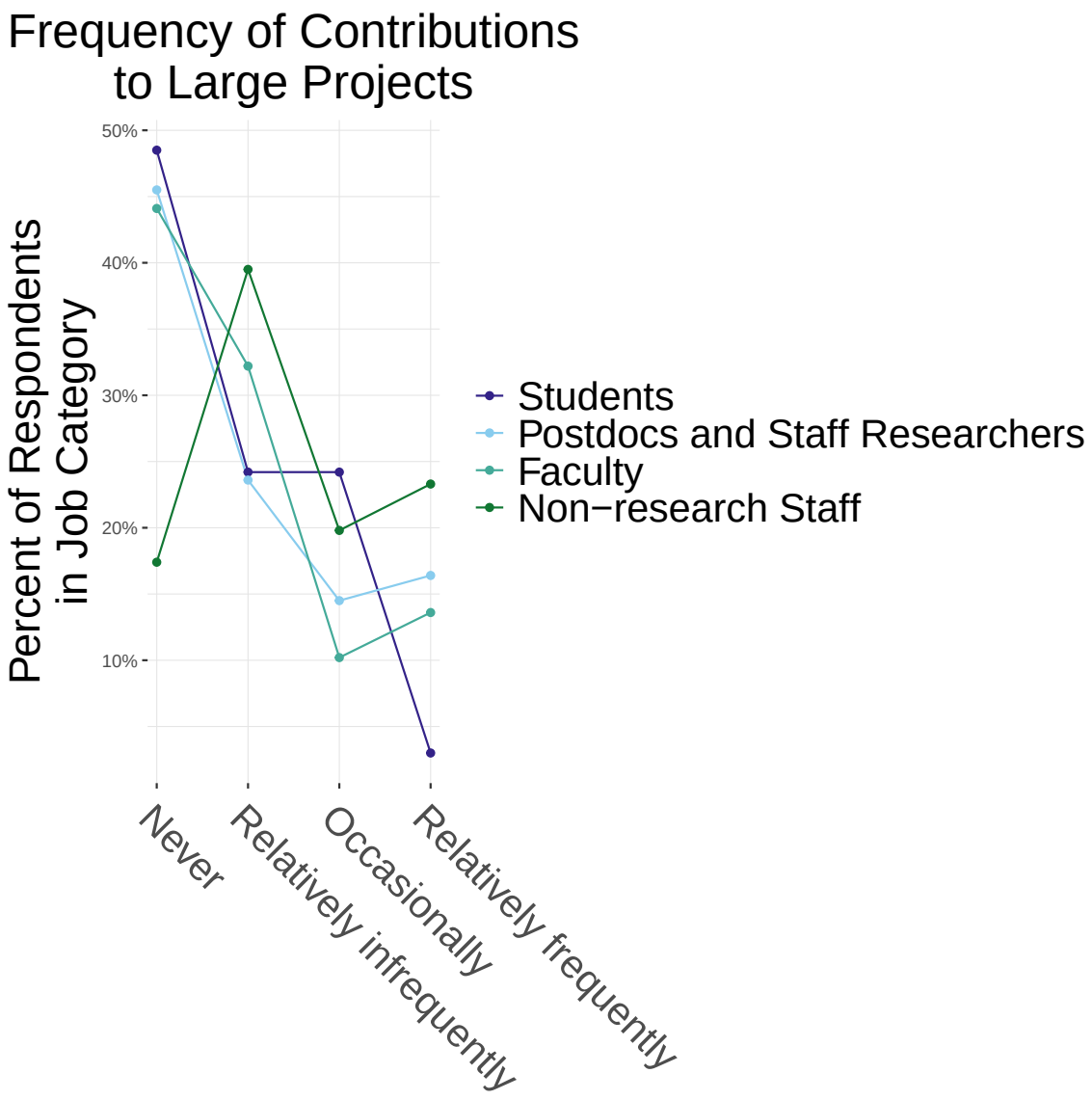
```r
large_counts <- large_counts %>%
  group_by(job_category) %>%
  mutate(perc_total = round(100 * n / sum(n), 1)) %>%
  ungroup()
```

```r
large_line <- ggplot(
    large_counts,
    aes(x = frequency, y = perc_total, group = job_category, color = job_category)
  ) +
    geom_line() +
    geom_point() +
    ylim(0, 50) +

    scale_x_discrete(expand = c(0.025, 0.025)) +
    scale_y_continuous(labels = scales::percent_format(accuracy = 1, scale = 1)) +
    scale_color_manual(values = COLORS) +

    ylab("Percent of Respondents\nin Job Category") +
    xlab("Project Size") +
    ggtitle("Frequency of Contributions\nto Large Projects") +


    theme(
          axis.title.y = element_text(
            size = 22,
            #face = "bold"
          ),
          axis.title.x = element_blank(),
          axis.text.x = element_text(
            angle = -45,
            hjust = 0,
            vjust = 1,
            size = 20,
            margin = margin(t = 6)),
          #axis.ticks.x = element_blank(),
          legend.text = element_text(size = 20),
          legend.title = element_blank(),
          panel.background = element_blank(),
          panel.grid.major = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          panel.grid.minor = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          plot.margin = unit(c(0.5, 0.5, 0.5, 0.5), "cm"),
```

```
          plot.title = element_text(hjust = 0.5, size = 24),
        )
```

```
Scale for y is already present.
Adding another scale for y, which will replace the existing scale.
```

```
large_line
```



Hard to discern a clear trend. Let's save the plot anyway.

Save the plot

```
save_plot("proj_sizes_large_line.tiff", 10, 6, p=large_line)
```

Medium projects

What about Medium projects? Do the same trends hold?

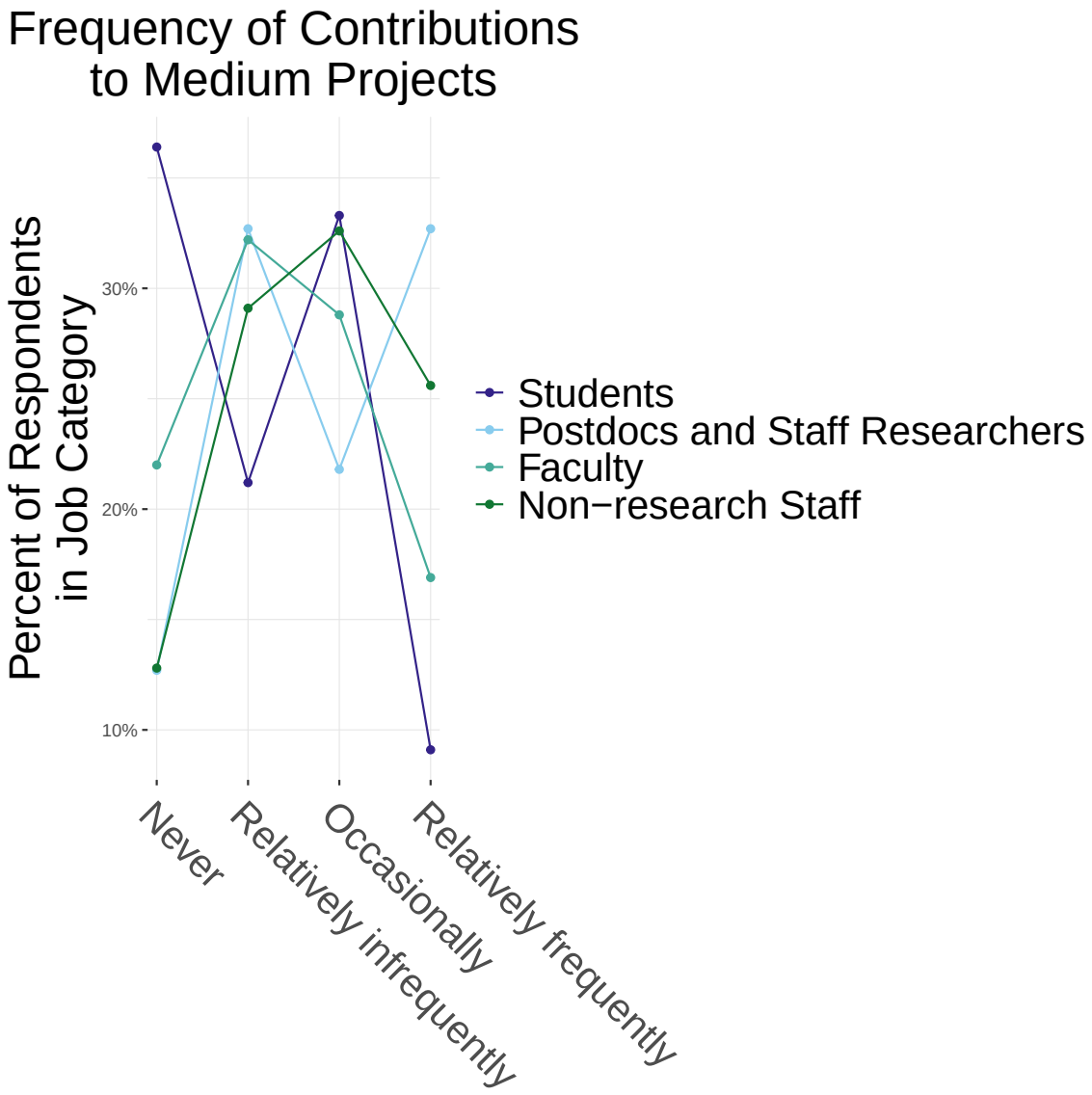
```
med <- subset(combined, size == "Medium")
med_counts <- med %>%
  count(job_category, frequency, name = "n")

med_counts <- med_counts %>%
  group_by(job_category) %>%
  mutate(perc_total = round(100 * n / sum(n), 1)) %>%
  ungroup()
```

```
med_line <- ggplot(
    med_counts,
    aes(x = frequency, y = perc_total, group = job_category, color = job_category)
  ) +
    geom_line() +
    geom_point() +
    ylim(0, 50) +

    scale_x_discrete(expand = c(0.025, 0.025)) +
    scale_y_continuous(labels = scales::percent_format(accuracy = 1, scale = 1)) +
    scale_color_manual(values = COLORS) +

    ylab("Percent of Respondents\nin Job Category") +
    xlab("Project Size") +
    ggtitle("Frequency of Contributions\nto Medium Projects") +


    theme(
          axis.title.y = element_text(
            size = 22,
            #face = "bold"
          ),
```

```
          axis.title.x = element_blank(),
          axis.text.x = element_text(
            angle = -45,
            hjust = 0,
            vjust = 1,
            size = 20,
            margin = margin(t = 6)),
          #axis.ticks.x = element_blank(),
          legend.text = element_text(size = 20),
          legend.title = element_blank(),
          panel.background = element_blank(),
          panel.grid.major = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          panel.grid.minor = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          plot.margin = unit(c(0.5, 0.5, 0.5, 0.5), "cm"),
          plot.title = element_text(hjust = 0.5, size = 24),
        )
```

```
Scale for y is already present.
Adding another scale for y, which will replace the existing scale.
```

```
med_line
```



Save the plot

```
save_plot("proj_sizes_med_line.tiff", 10, 6, p=med_line)
```

Small projects

We've made it this far. We might as well look at small projects, too.

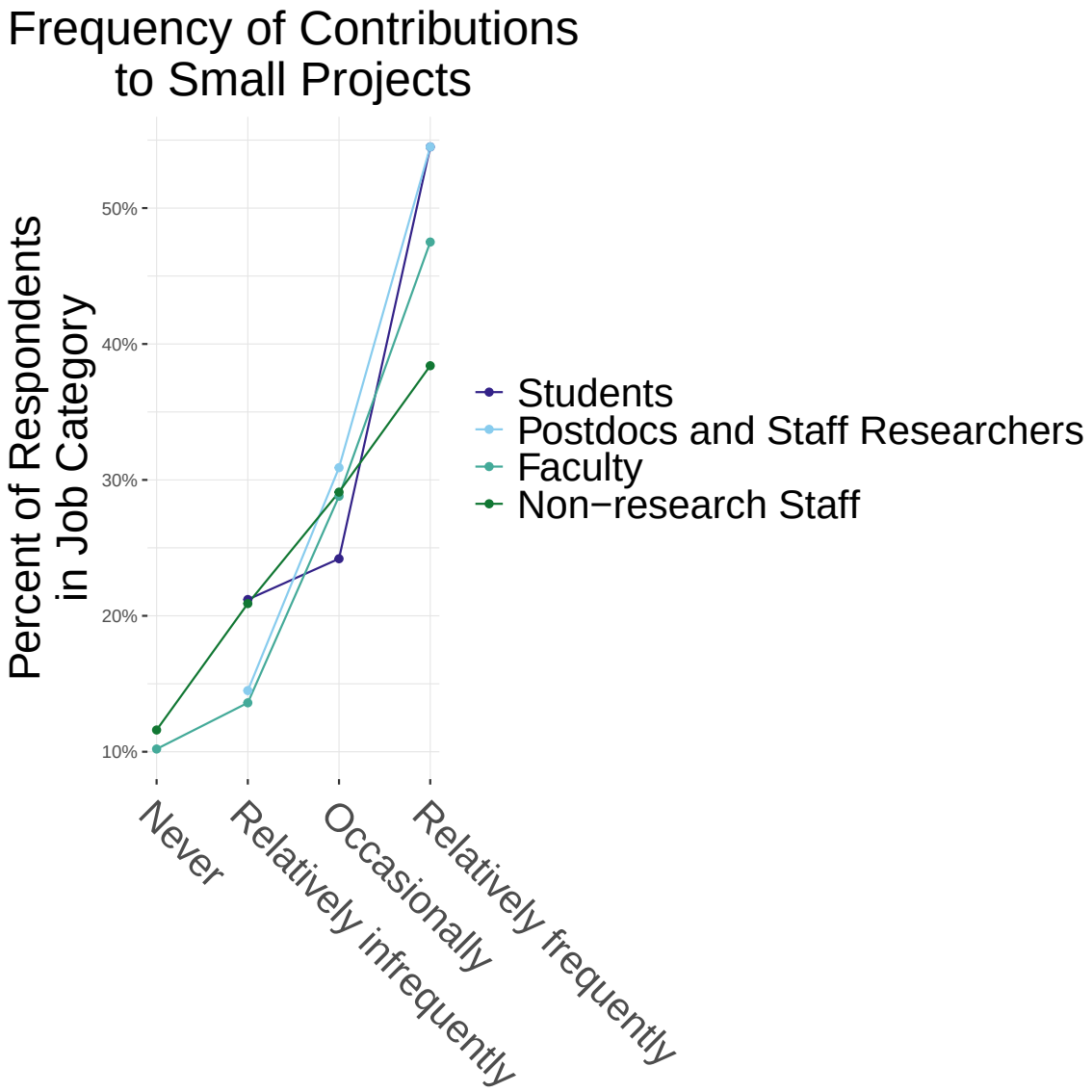
```r
small <- subset(combined, size == "Small")
small_counts <- small %>%
  count(job_category, frequency, name = "n")

small_counts <- small_counts %>%
  group_by(job_category) %>%
  mutate(perc_total = round(100 * n / sum(n), 1)) %>%
  ungroup()
```

```r
small_line <- ggplot(
    small_counts,
    aes(x = frequency, y = perc_total, group = job_category, color = job_category)
  ) +
    geom_line() +
    geom_point() +
    ylim(0, 50) +

    scale_x_discrete(expand = c(0.025, 0.025)) +
    scale_y_continuous(labels = scales::percent_format(accuracy = 1, scale = 1)) +
    scale_color_manual(values = COLORS) +

    ylab("Percent of Respondents\nin Job Category") +
    xlab("Project Size") +
    ggtitle("Frequency of Contributions\nto Small Projects") +


    theme(
          axis.title.y = element_text(
            size = 22,
            #face = "bold"
          ),
          axis.title.x = element_blank(),
          axis.text.x = element_text(
            angle = -45,
            hjust = 0,
            vjust = 1,
            size = 20,
            margin = margin(t = 6)),
          #axis.ticks.x = element_blank(),
          legend.text = element_text(size = 20),
          legend.title = element_blank(),
          panel.background = element_blank(),
```

```
          panel.grid.major = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          panel.grid.minor = element_line(linewidth = 0.25, linetype = "solid", color = "gray
          plot.margin = unit(c(0.5, 0.5, 0.5, 0.5), "cm"),
          plot.title = element_text(hjust = 0.5, size = 24),
        )
```

```
Scale for y is already present.
Adding another scale for y, which will replace the existing scale.
```

```
small_line
```



Wow, that's much prettier.

Save the plot

```
save_plot("proj_sizes_small_line.tiff", 10, 6, p=small_line)
```

I'd like to know whether the proportion of academics who contribute to large projects with some frequency is significantly lower than the proportion of non-research staff who contribute to large projects with some frequency.

```r
combined_counts <- combined %>%
  count(job_category, size, frequency, name = "n")

res <- combined_counts %>%
  filter(size == "Large") %>%
  mutate(
    group = if_else(job_category == "Non-research Staff",
                    "Non-research Staff", "Academics"),
    freq2 = if_else(frequency == "Never", "Never", "Other")
  ) %>%
  group_by(group, freq2) %>%
  summarise(n = sum(n), .groups = "drop_last") %>%
  mutate(prop = n / sum(n)) %>%
  ungroup()

# 2×2 table: proportions for each group
res_wide <- res %>%
  select(group, freq2, prop) %>%
  pivot_wider(names_from = freq2, values_from = prop) %>%
  arrange(match(group, c("Non-research Staff", "Academics")))

res_wide
```

```
# A tibble: 2 x 3
  group              Never Other
  <chr>              <dbl> <dbl>
1 Non-research Staff 0.174 0.826
2 Academics          0.456 0.544
```

Hmm. Seems promising. We should probably do a regression…