Solutions

Overview

This script makes some plots from Q10, which is about what solutions participants would find most useful.

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

```
data <- load_qualtrics_data("deidentified_no_qual.tsv")
solutions <- load_qualtrics_data("clean_data/solutions_Q10.tsv")
other_quant <- load_qualtrics_data("clean_data/other_quant.tsv")
```

Wrangle data

First, remove empty rows, i.e. rows from respondents who didn't receive this question. As with many questions in this survey, we can cut some corners in the code because the question was mandatory. For example, no need to worry about incomplete answers.

```r
nrow(solutions)
```

```
[1] 332
```

```r
solutions <- exclude_empty_rows(solutions) # from scripts/utils.R
nrow(solutions)
```

```
[1] 233
```

Let's reshape the data from wide to long format for easier plotting later.

```r
long_data <- solutions %>%
  pivot_longer(
    cols = everything(),
    names_to = "solution",
    values_to = "utility"
  )

long_data <- long_data %>%
  mutate(
    utility_score = recode(
      utility,
      "Non-applicable" = 0L,
      "Not very useful" = 0L,
      "Useful" = 1L,
      "Very useful" = 2L
    )
  )
# Using interger literals 0L, 1L, etc., ensures that
# the new column will be integers, not doubles.

long_data
```

```
# A tibble: 2,796 x 3
   solution               utility     utility_score
   <chr>                  <chr>               <int>
 1 Computing environments Very useful             2
 2 Publicity              Very useful             2
 3 Containerization       Very useful             2
 4 Documentation help     Very useful             2
```

```
 5 A learning community   Very useful             2
 6 Event planning         Very useful             2
 7 Mentoring programs     Very useful             2
 8 Education              Very useful             2
 9 Legal support          Very useful             2
10 Industry partnerships  Very useful             2
# i 2,786 more rows
```

Descriptive statistics

Next, let's calculate some simple descriptive statistics. I will choose:

- The total "score", that is, the total number of "points" a solution received (see scoring scheme in previous code chunk)
- The mean (which might be misleading if 0s drag it down, and also, who's to say what a 1.5 really means? Are the distances between the Likert points equal? We don't know.)
- The mode
- The standard deviation

```r
# Helper to compute the (numeric) mode
get_mode <- function(x) {
  ux <- unique(x)
  ux[which.max(tabulate(match(x, ux)))]
}

summary_df <- long_data %>%
  group_by(solution) %>%
  summarise(
    total  = sum(utility_score),
    mean   = mean(utility_score, na.rm = TRUE),
    mode   = get_mode(utility_score),
    st_dev = sd(utility_score, na.rm = TRUE)
  ) %>%
  ungroup()

# Order by highest total "score"
summary_df <- summary_df %>%
    arrange(desc(total))

summary_df
```

```
# A tibble: 12 x 5
   solution               total  mean  mode st_dev
   <chr>                  <int> <dbl> <int>  <dbl>
 1 Sustainability grants    353 1.52      2  0.732
 2 Help finding funding     316 1.36      2  0.764
 3 Computing environments   301 1.29      2  0.783
 4 A learning community     251 1.08      1  0.733
 5 Documentation help       248 1.06      1  0.788
 6 Legal support            242 1.04      1  0.762
 7 Education                236 1.01      1  0.801
 8 Industry partnerships    232 0.996     0  0.838
 9 Publicity                232 0.996     1  0.817
10 Mentoring programs       216 0.927     1  0.776
11 Containerization         203 0.871     0  0.820
12 Event planning           190 0.815     0  0.807
```

Cool. It looks like sustainability grants are by far the most popular, with assistance identifying funding sources and free computing environments in second and third place. These were the only three solutions that had a mode of 2.

Out of curiosity, how does it look when we order by variability?

```
summary_df %>%
  arrange(desc(st_dev))
```

```
# A tibble: 12 x 5
   solution               total  mean  mode st_dev
   <chr>                  <int> <dbl> <int>  <dbl>
 1 Industry partnerships    232 0.996     0  0.838
 2 Containerization         203 0.871     0  0.820
 3 Publicity                232 0.996     1  0.817
 4 Event planning           190 0.815     0  0.807
 5 Education                236 1.01      1  0.801
 6 Documentation help       248 1.06      1  0.788
 7 Computing environments   301 1.29      2  0.783
 8 Mentoring programs       216 0.927     1  0.776
 9 Help finding funding     316 1.36      2  0.764
10 Legal support            242 1.04      1  0.762
11 A learning community     251 1.08      1  0.733
12 Sustainability grants    353 1.52      2  0.732
```

This analysis doesn't seem as interesting as it was for the challenges. Industy partnerships, Containerization, and Publicity all show high variance/stdev. These were also somewhat less popular.

Out of curiosity, how many people said they would all be very useful?

```
nrow(
  solutions %>%
    filter(if_all(.cols = everything(), ~ . == "Very useful"))
)
```

```
[1] 14
```

Ah, ok. Not that many.

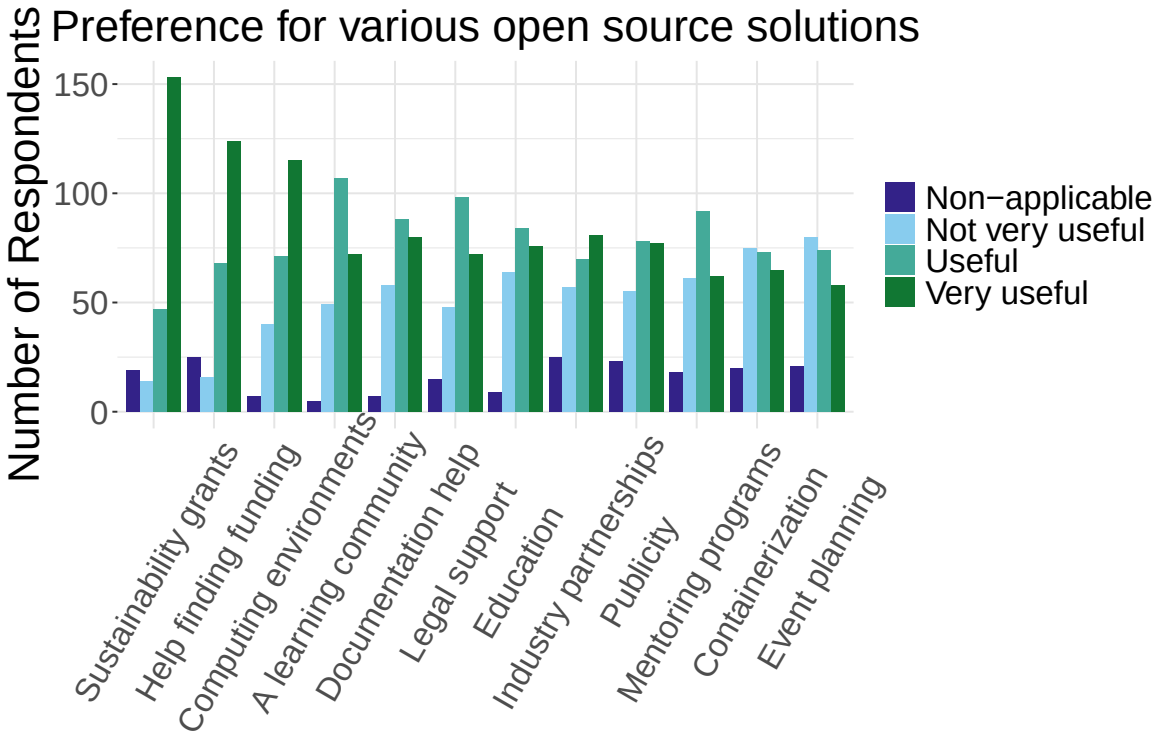
Plot the distributions

Prepare data for plotting.

```
ordered_levels <- (summary_df %>%
    arrange(desc(total)))$solution

long_data$solution <- factor(long_data$solution, levels = ordered_levels)
```

Grouped bar chart showing the distributions of answers.

```
grouped_plot <- grouped_bar_chart(
  df = long_data,
  x_var = "solution",
  fill_var = "utility",
  title = "Preference for various open source solutions"
)

grouped_plot
```



Save the plot if you wish.

```
save_plot("fave_solutions.tiff", 10, 6, p=grouped_plot)
```

Simple bar plot

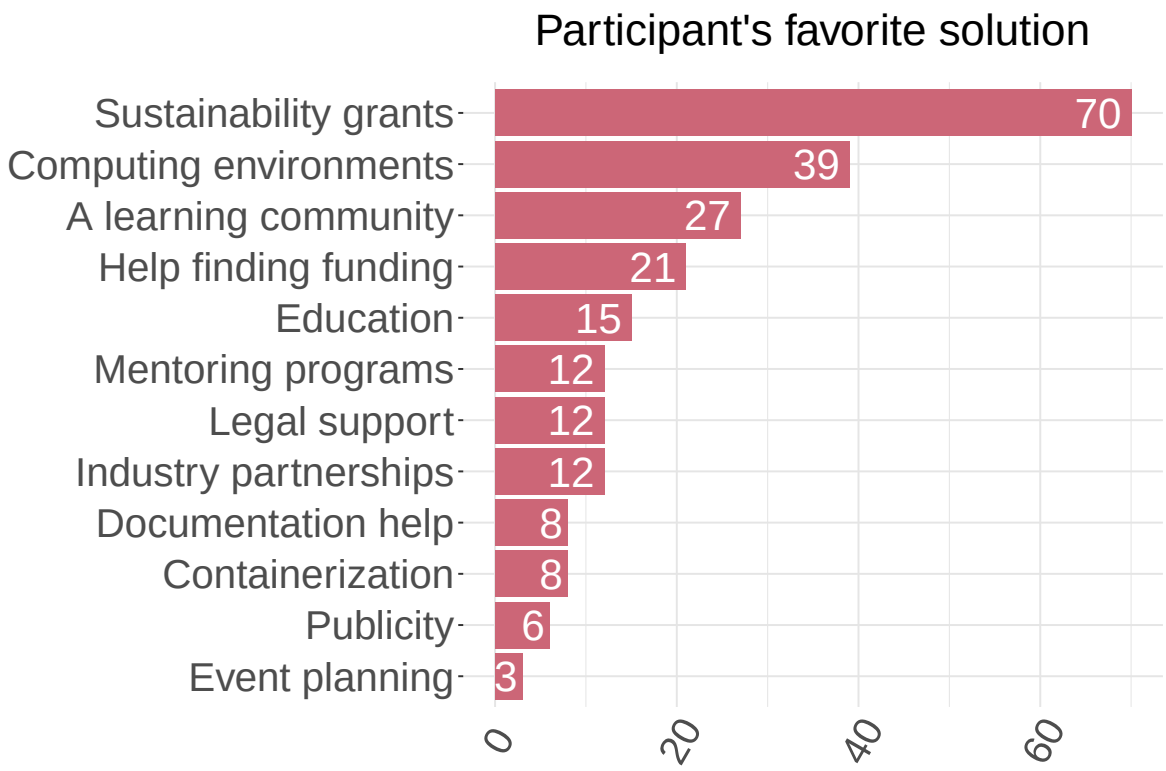
Now let's make a simpler bar plot from the next question, which asked participants to choose their favorite solution.

```
favorites <- data.frame(other_quant$favorite_solution)
favorites <- exclude_empty_rows(favorites) # from scripts/utils.R

fav_to_plot <- data.frame(table(favorites[, 1]))
# from scripts/utils.R
fav_to_plot <- reorder_factor_by_column(
  df = fav_to_plot,
  factor_col = Var1,
  value_col = Freq,
```

```
  descending = FALSE
)
head(fav_to_plot)
```

```
                    Var1 Freq
1   A learning community   27
2 Computing environments   39
3       Containerization    8
4     Documentation help    8
5              Education   15
6         Event planning    3
```

```
faves_plot <- basic_bar_chart(
  df = fav_to_plot,
  x_var = "Var1",
  y_var = "Freq",
  title = "Participant's favorite solution",
  show_axis_title_y = FALSE,
  ylabel = "Number of Respondents",
  show_bar_labels = TRUE,
  color_index = 7,
  horizontal = TRUE
)

faves_plot
```



The top solutions are not exactly the same in this question compared to tallying up the totals from the previous one, though they are close.

Save the plot if you wish.

```
save_plot("fave_solutions_simple.tiff", 10, 6, p=faves_plot)
```

Incorporating demographics

Plots

Who are these people who want access to computing environments? Don't all the UCs already offer this?

Let's focus on job category.

```
campus_job_fave <- other_quant %>%
  select(campus, job_category, favorite_solution)
campus_job_fave <- exclude_empty_rows(campus_job_fave, strict = TRUE)
```

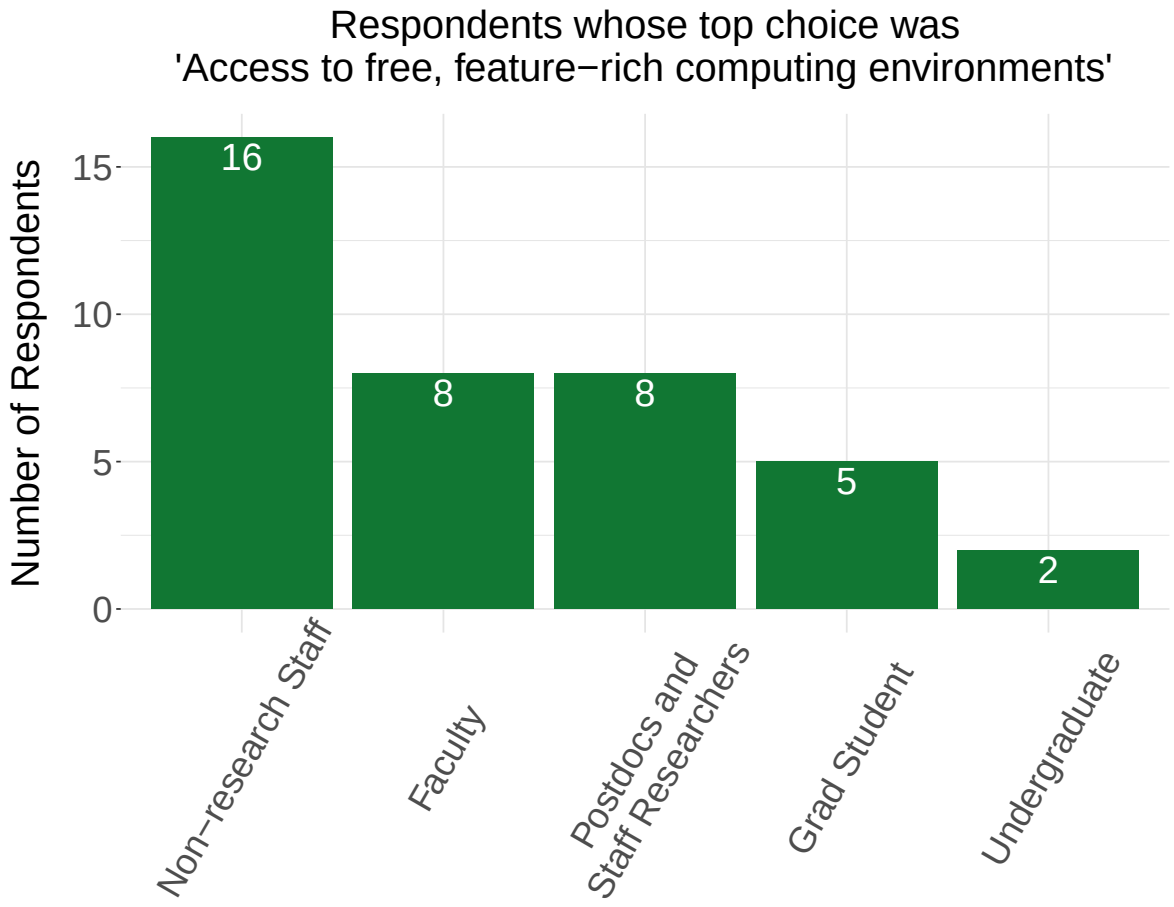
```
# For visual clarity, let's combine postdocs and other staff researchers.
campus_job_fave <- campus_job_fave %>%
  mutate(
    job_category = recode(
      job_category,
      "Post-Doc" = "Postdocs and\nStaff Researchers",
      "Other research staff" = "Postdocs and\nStaff Researchers"
    )
  )

head(campus_job_fave)
```

```
            campus                     job_category      favorite_solution
1 UC Santa Barbara                          Faculty  Sustainability grants
2 UC Santa Barbara Postdocs and\nStaff Researchers       Containerization
3 UC Santa Barbara Postdocs and\nStaff Researchers Computing environments
4 UC Santa Barbara                          Faculty  Sustainability grants
5 UC Santa Barbara                          Faculty     Documentation help
7 UC Santa Barbara                          Faculty          Legal support
```

Of the people who selected "Computing environments", what is the distribution of job categories?

```
compute <- campus_job_fave %>%
  filter(favorite_solution == "Computing environments")
compute_counts <- data.frame(table(compute$job_category))

compute_counts <- compute_counts %>% rename(job_category = Var1, compute = Freq)

compute_counts <- reorder_factor_by_column(
  df = compute_counts,
  factor_col = job_category,
  value_col = compute
)

compute_bar <- basic_bar_chart(
  df = compute_counts,
  x_var = "job_category",
  y_var = "compute",
  title = "Respondents whose top choice was\n'Access to free, feature-rich computing environ
  color_index = 4,
```

```
  show_bar_labels = TRUE
)
compute_bar
```



Save the plot if you wish.

```
save_plot("compute_job.tiff", 10, 10, p=compute_bar)
```

So those are the absolute numbers, but they don't normalize for the sample sizes of the different job categories. The number of non-research staff who voted for computing environments might be high because there are simply a lot of non-research staff in our survey.

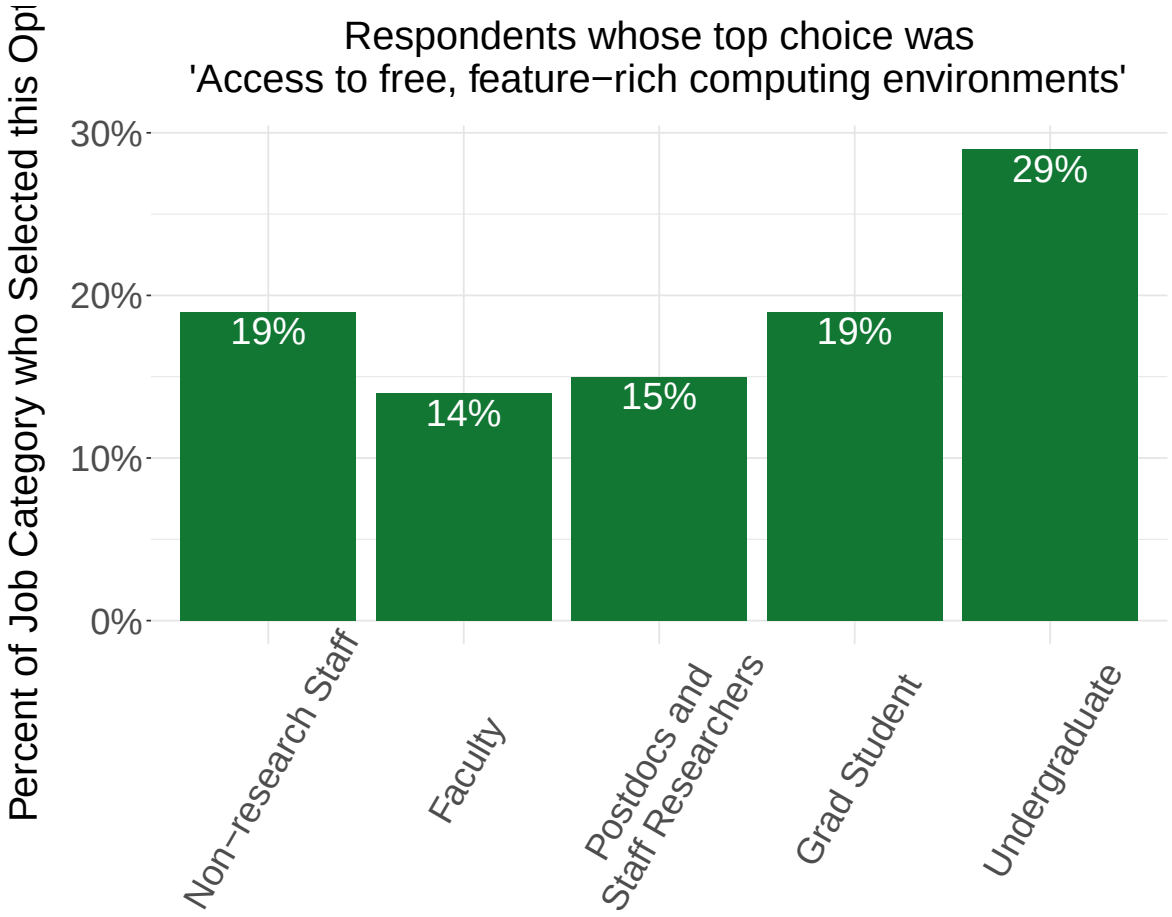
```
total_counts <- data.frame(table(campus_job_fave$job_category))
```

```r
total_counts <- total_counts %>% rename(job_category = Var1, total = Freq)

proportion_df <- compute_counts %>%
  left_join(total_counts, by = "job_category") %>%
  mutate(proportion = round(compute / total, 2))

proportion_df
```

```
                    job_category compute total proportion
1                        Faculty       8    59       0.14
2                    Grad Student       5    26       0.19
3              Non-research Staff      16    86       0.19
4 Postdocs and\nStaff Researchers       8    55       0.15
5                    Undergraduate       2     7       0.29
```

The previous plot suggested the demand was mostly coming from non-research staff, but that was deceiving, because we do indeed have a lot of non-research staff in our sample. Let's make a plot that is, I think, more informative. This plot shows the percent of people in that job category who selected computing environments as their favorite solution.

```r
compute_bar_prop <- basic_bar_chart(
  df = proportion_df,
  x_var = "job_category",
  y_var = "proportion",
  ylabel = "Percent of Job Category who Selected this Option",
  title = "Respondents whose top choice was\n'Access to free, feature-rich computing environm
  color_index = 4,
  show_bar_labels = TRUE,
  percent = TRUE
)
compute_bar_prop
```



Save the plot if you wish.

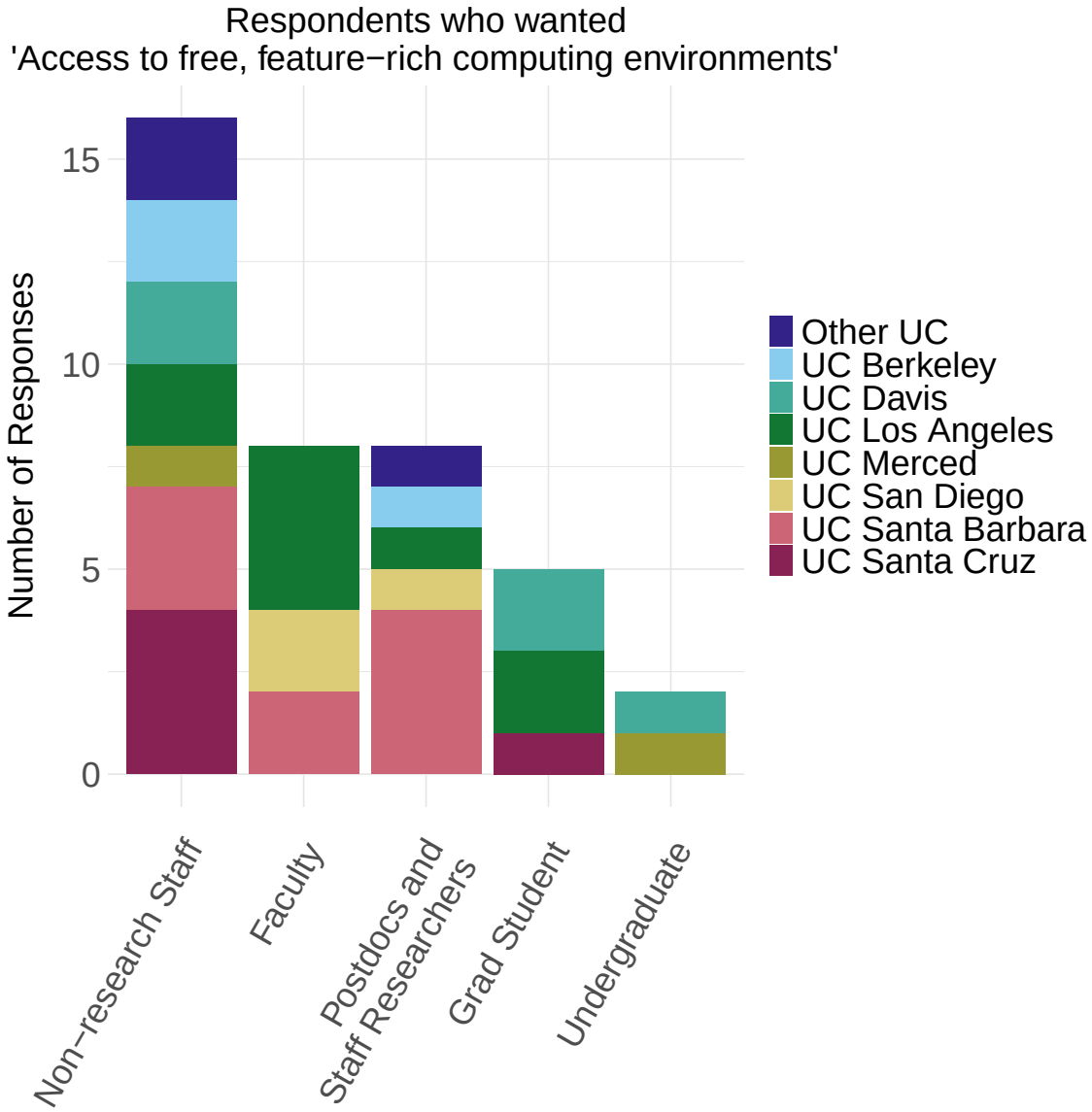
```
save_plot("compute_job_prop.tiff", 10, 10, p=compute_bar_prop)
```

Let's make the same plot, but this time with campus info.

```
compute_counts2 <- compute %>%
  select(-favorite_solution) %>%
  count(
    campus,
    job_category,
    name = "count"
  )

compute_counts2$job_category <- factor(
```

```
  compute_counts2$job_category,
  levels = levels(compute_counts$job_category)
)
```

```
compute_campus_bar <- stacked_bar_chart(
  df = compute_counts2,
  x_var = "job_category",
  y_var = "count",
  fill = "campus",
  title = "Respondents who wanted\n'Access to free, feature-rich computing environments'",
  ylabel = NULL,
  proportional = FALSE
)

compute_campus_bar
```



This one is a bit harder to interpret, because it's a busy plot and the sample sizes are small. Anyway, save the plot if you wish.

```
save_plot("compute_job_campus.tiff", 14, 14, p=compute_campus_bar)
```

Response rates by campus, for "Compute environments"

I'm wondering if there's one or two campuses in particular where compute environments are lacking.

```
compute_counts_campus <- campus_job_fave %>%
  filter(favorite_solution == "Computing environments") %>%
  count(campus, name = "compute_n")

# a scalar
total_compute_votes <- nrow(campus_job_fave %>%
  filter(favorite_solution == "Computing environments"))
```

```
campus_totals <- campus_job_fave %>%
  count(campus, name = "campus_total")

campus_totals <- left_join(campus_totals, compute_counts_campus, by="campus")
campus_totals <- exclude_empty_rows(campus_totals, strict=TRUE)

campus_totals %>% mutate( compute_perc = 100*compute_n / campus_total)
```

```
             campus campus_total compute_n compute_perc
1          Other UC           19         3     15.78947
2       UC Berkeley           26         3     11.53846
3          UC Davis           29         5     17.24138
5    UC Los Angeles           40         9     22.50000
6         UC Merced            8         2     25.00000
7      UC San Diego            9         3     33.33333
9  UC Santa Barbara           61         9     14.75410
10    UC Santa Cruz           32         5     15.62500
```

So, anywhere from 12% to 33% of respondents selected this as their favorite solution, when we break it down by campus. The numbers from UCSD (33%) and UC Merced (25%) should probably be taken with a grain of salt, since those campuses had really low participation rates.

For each job category, what are the top 3 favorite solutions?

```r
job_fave <- campus_job_fave %>% select(-campus)
#Reorder factor levels for plotting
job_fave$job_category <- factor(job_fave$job_category, levels = c(
  "Faculty",
  "Postdocs and\nStaff Researchers",
  "Grad Student",
  "Undergraduate",
  "Non-research Staff"
))

job_fave_counts <- job_fave %>%
  count(
    job_category,
    favorite_solution,
    name = "count"
  )

# 2) For each job_category, keep only the top 3 solutions by count
top3_solutions <- job_fave_counts %>%
  group_by(job_category) %>%
  # slice_max() picks the rows with the highest `count`
  slice_max(order_by = count, n = 3, with_ties = TRUE) %>%
  ungroup()

top3_solutions
```

```
# A tibble: 15 x 3
   job_category                    favorite_solution      count
   <fct>                           <chr>                  <int>
 1 "Faculty"                       Sustainability grants     24
 2 "Faculty"                       Computing environments     8
 3 "Faculty"                       Help finding funding       6
 4 "Postdocs and\nStaff Researchers" Sustainability grants    16
 5 "Postdocs and\nStaff Researchers" Help finding funding      9
 6 "Postdocs and\nStaff Researchers" Computing environments    8
 7 "Grad Student"                  Sustainability grants     13
 8 "Grad Student"                  Computing environments     5
 9 "Grad Student"                  Mentoring programs         3
10 "Undergraduate"                 Computing environments     2
11 "Undergraduate"                 Industry partnerships      2
12 "Undergraduate"                 Mentoring programs         2
13 "Non-research Staff"            A learning community      20
```

```
14 "Non-research Staff"              Sustainability grants     17
15 "Non-research Staff"              Computing environments    16
```

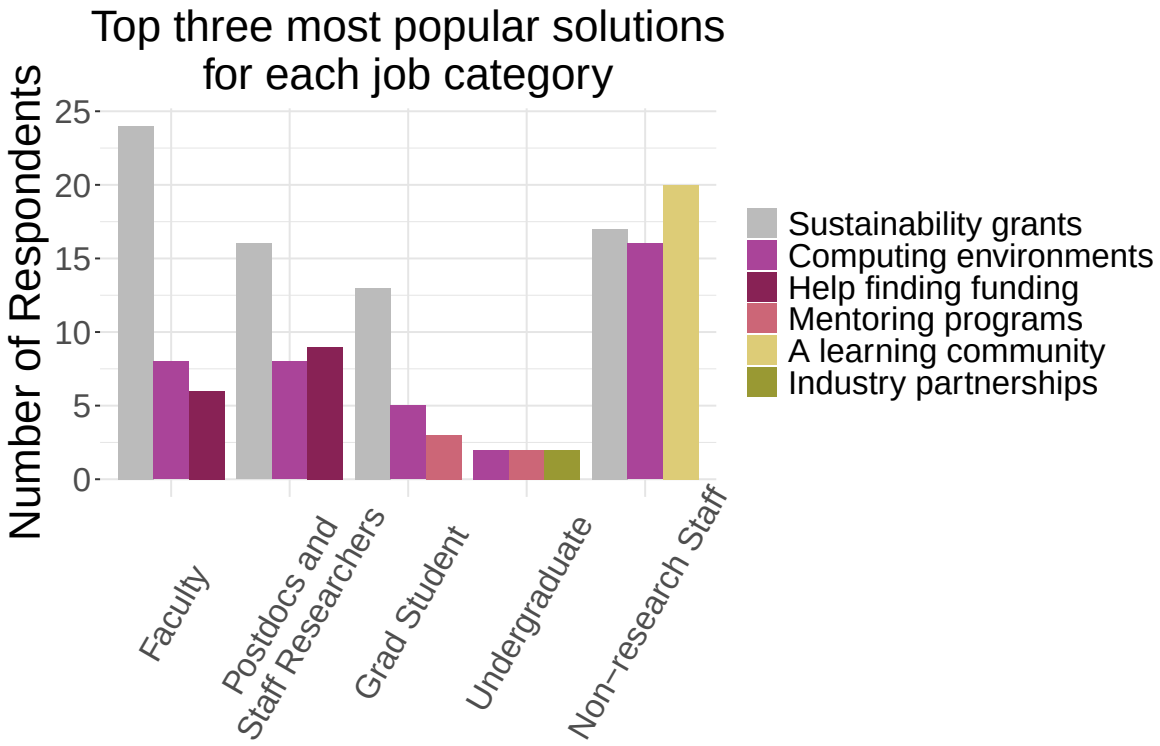
This looks like it's worth plotting. Let's go back to the big data frame, since my grouped_bar_chart function doesn't want counts (it will count rows itself); drop all job/solution combinations except those that appear in the top3_solutions data frame.

```
job_fave_top3 <- job_fave %>%
  semi_join(
    top3_solutions,
    by = c("job_category", "favorite_solution")
  )

head(job_fave_top3)
```

```
                    job_category      favorite_solution
1                         Faculty  Sustainability grants
2 Postdocs and\nStaff Researchers Computing environments
3                         Faculty  Sustainability grants
4 Postdocs and\nStaff Researchers Computing environments
5                         Faculty Computing environments
6 Postdocs and\nStaff Researchers  Sustainability grants
```

```
# Reorder factor levels so legend items are in order of appearance
job_fave_top3 <- job_fave_top3 %>%
  mutate(favorite_solution = fct_inorder(favorite_solution))
```

```
top3_plot <- grouped_bar_chart(
  df = job_fave_top3,
  x_var = "job_category",
  fill_var = "favorite_solution",
  title = "Top three most popular solutions\nfor each job category",
  color_palette = rev(COLORS) #from utils.R
)
top3_plot
```




```
save_plot("top3_solutions_by_job.tiff", 12, 10, p=top3_plot)
```

So, I think these are the takeaways:

- Dedicated grants for OS project sustainability is the most popular solution. This solution was in the top3 for all but undergrads.
- The other top solutions depend on how you look at the data. For non-research staff, the most popular solution is a learning community, though grants and access to free, feature-rich computing environments are close behind.
- I was surprised that access to computing environments was in second place. Upon inspection, this seems to be because this choice is popular among non-research staff, and we had a lot of non-research staff in our participant pool. About 12-33% of respondents said this was their top choice, depending on the campus.
- Undergraduates were the only group in which nobody selected grants as their top choice.
- Grad students and undergraduates were the only groups for whom a mentoring program was in their top 3.
- Researchers and non-research staff have very distinct needs.

Session Info

```
sessionInfo()
```

```
R version 4.4.2 (2024-10-31)
Platform: aarch64-apple-darwin20
Running under: macOS Sequoia 15.4.1

Matrix products: default
BLAS:   /Library/Frameworks/R.framework/Versions/4.4-arm64/Resources/lib/libRblas.0.dylib
LAPACK: /Library/Frameworks/R.framework/Versions/4.4-arm64/Resources/lib/libRlapack.dylib;  L

locale:
[1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8

time zone: America/Los_Angeles
tzcode source: internal

attached base packages:
[1] tools     stats     graphics  grDevices datasets  utils     methods
[8] base

other attached packages:
 [1] treemap_2.4-4         tidyr_1.3.1           stringr_1.5.1
 [4] scales_1.4.0          readr_2.1.5           pwr_1.3-0
 [7] patchwork_1.3.0       mvabund_4.2.1         languageserver_0.3.16
[10] here_1.0.1            gtools_3.9.5          fpc_2.2-13
[13] forcats_1.0.0         factoextra_1.0.7      ggplot2_3.5.2
[16] dplyr_1.1.4           corrplot_0.95         cluster_2.1.8.1

loaded via a namespace (and not attached):
 [1] gtable_0.3.6        xfun_0.52           ggrepel_0.9.6
 [4] processx_3.8.6      lattice_0.22-6      callr_3.7.6
 [7] tzdb_0.5.0          vctrs_0.6.5         ps_1.9.1
[10] generics_0.1.4      stats4_4.4.2        parallel_4.4.2
[13] flexmix_2.3-20      tibble_3.2.1        DEoptimR_1.1-3-1
[16] pkgconfig_2.0.3     data.table_1.17.6   RColorBrewer_1.1-3
[19] lifecycle_1.0.4     compiler_4.4.2      farver_2.1.2
[22] statmod_1.5.0       httpuv_1.6.16       htmltools_0.5.8.1
[25] class_7.3-22        yaml_2.3.10         later_1.4.2
[28] pillar_1.10.2       prabclus_2.3-4      MASS_7.3-61
```

```
[31] diptest_0.77-1      mclust_6.1.1        mime_0.13
[34] robustbase_0.99-4-1 tidyselect_1.2.1    digest_0.6.37
[37] stringi_1.8.7       purrr_1.0.4         kernlab_0.9-33
[40] labeling_0.4.3      rprojroot_2.0.4     fastmap_1.2.0
[43] grid_4.4.2          colorspace_2.1-1    cli_3.6.5
[46] magrittr_2.0.3      utf8_1.2.5          withr_3.0.2
[49] promises_1.3.3      tweedie_2.3.5       rmarkdown_2.29
[52] igraph_2.1.4        nnet_7.3-19         modeltools_0.2-24
[55] hms_1.1.3           shiny_1.11.0        evaluate_1.0.3
[58] knitr_1.50          rlang_1.1.6         Rcpp_1.0.14
[61] xtable_1.8-4        gridBase_0.4-7      glue_1.8.0
[64] xml2_1.3.8          renv_1.1.4          jsonlite_2.0.0
[67] R6_2.6.1
```