# S670 Final Project Report

## STEM Graduate Students

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## Research question

**How does the academic experience of STEM graduate students affect their choice of staying back in the United States after graduation?**

## Why should we care?

**As STEM graduate students ourselves, we believe it would be very interesting to know if our academic experience in the United States has any effect whatsoever on the likelihood of us staying back after the completion of our graduation.**

## About the data

- **The dataset is a part of the International STEM Graduate Student Survey (2015) that was funded by the National Science Foundation**

- **Pertains to 787 graduate students (Master's and PhD) in STEM disciplines from 10 prestigious US universities**

**Demographic variables**

- Gender
- Degree
- Discipline
- Home country

```
##     gender            degree                       discipline   country
##  Female:292   Master's:251   Computer science :134   China:235
##  Male  :482   PhD     :536   Engineering      :262   India:202
##  NA's  : 13                  Life sciences    :141   Other:350
##                              Mathematics      : 75
##                              Other            : 60
##                              Physical sciences:115
```

**Relevant survey questions**

- How do you feel you are treated by your colleagues and professors in the US in comparison with those in your home country? (Scaled response on a scale from 1 to 5 with 1 being "Much worse" and 5 being "Much better")
- How do you feel you would be treated by your colleagues and professors in your home country if you returned? (Scaled response on a scale from 1 to 5 with 1 being "Much worse" and 5 being "Much better")
- How successfully do you feel you have adjusted to American educational culture? (Scaled response on a scale from 1 to 5 with 1 being "Did not adjust well" and 5 being "Adjusted well")
- Please select any challenges you may have encountered while adjusting (Cultural, Social, Racial, Academic,
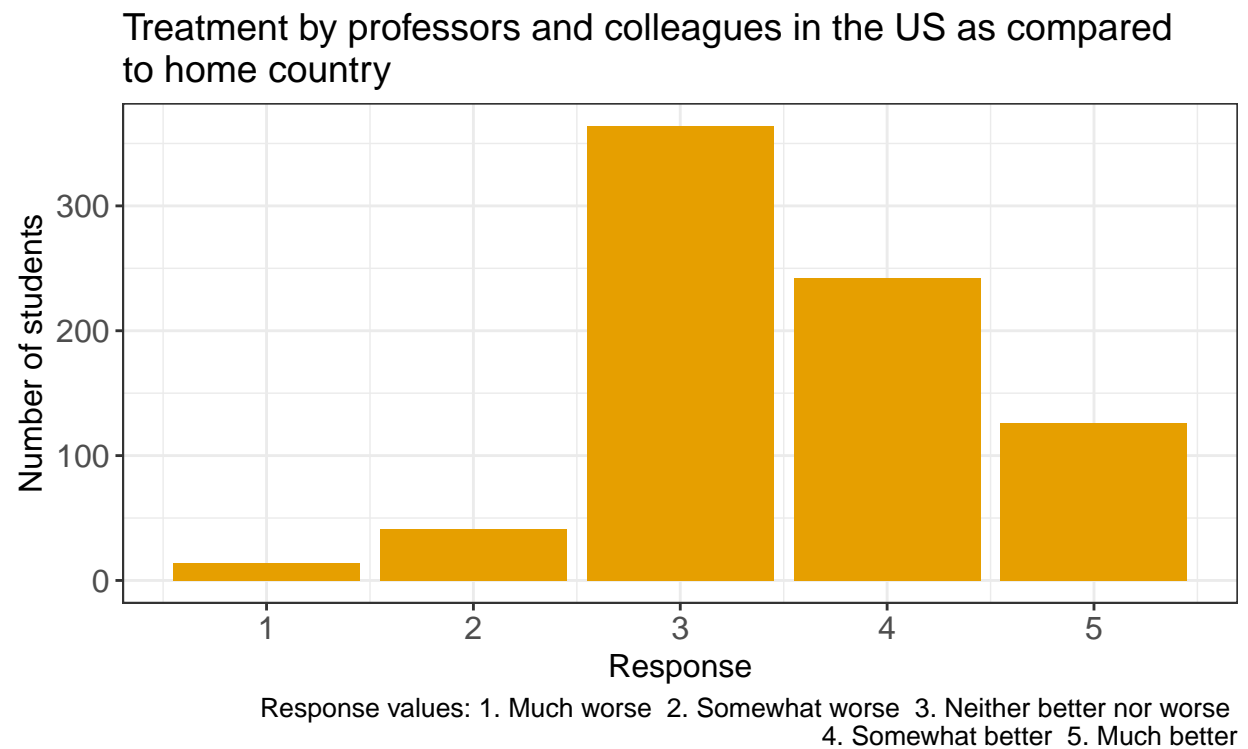
1

Financial, and Other challenges)*
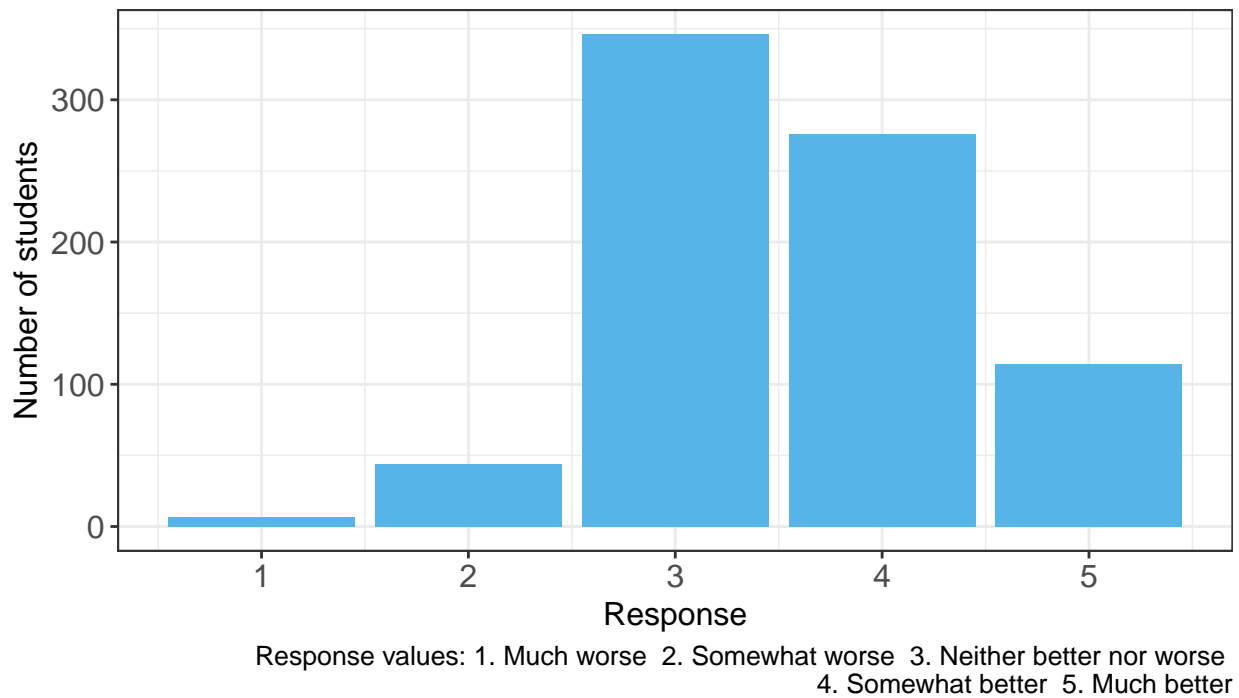
- Do you hope to remain in the US after graduation?

*This was a multiple choice multi-answer question. Hence, in order to come up with meaningful charts, we have categorized the responses to this question into three categories:

- Faced no challenges
- Faced some challenges (Strictly less than 3 challenges)
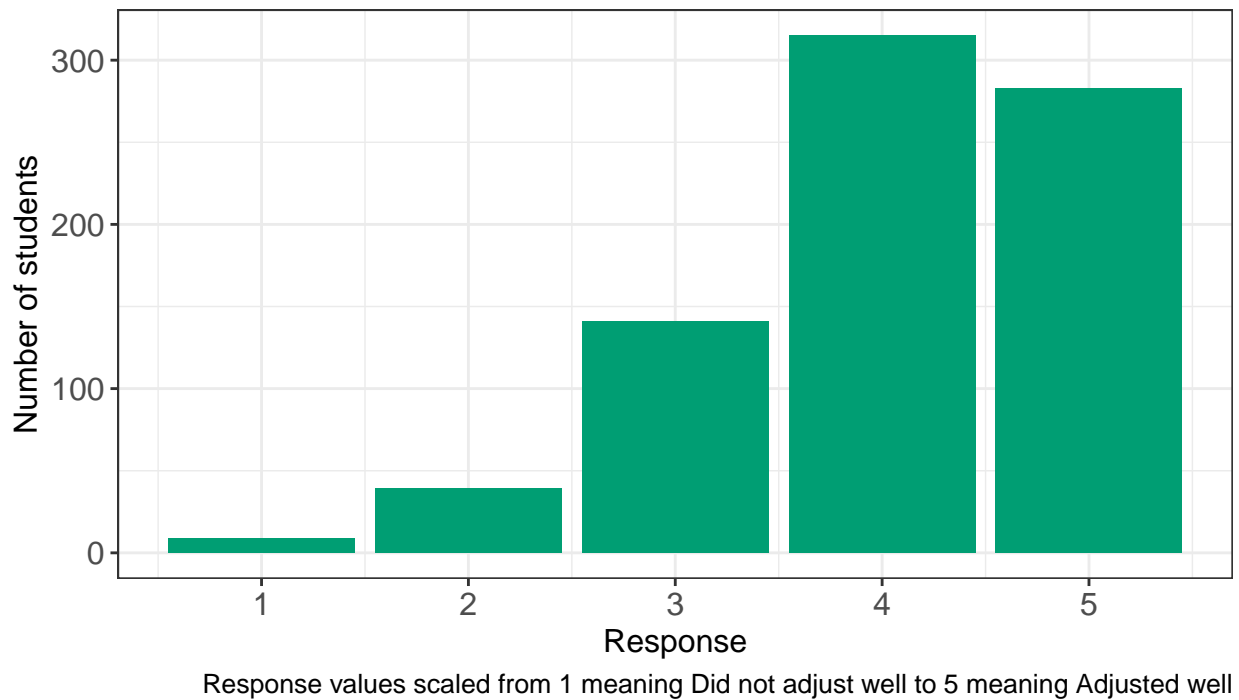- Faced a lot of challenges (More than or equal to 3 challenges)

**Responses to survey questions**

Treatment by professors and colleagues in the US as compared to home country

Response values: 1. Much worse  2. Somewhat worse  3. Neither better nor worse
4. Somewhat better  5. Much better

## Expected treatment in home country on return



Response values: 1. Much worse  2. Somewhat worse  3. Neither better nor worse
4. Somewhat better  5. Much better

## Adjustment to American culture



Response values scaled from 1 meaning Did not adjust well to 5 meaning Adjusted well

The charts corresponding to the three response variables depicted above have a lot of 4s and 5s suggesting that the academic experience of international graduate students does not seem to be bad at all. However, the chart below paints a very different picture:

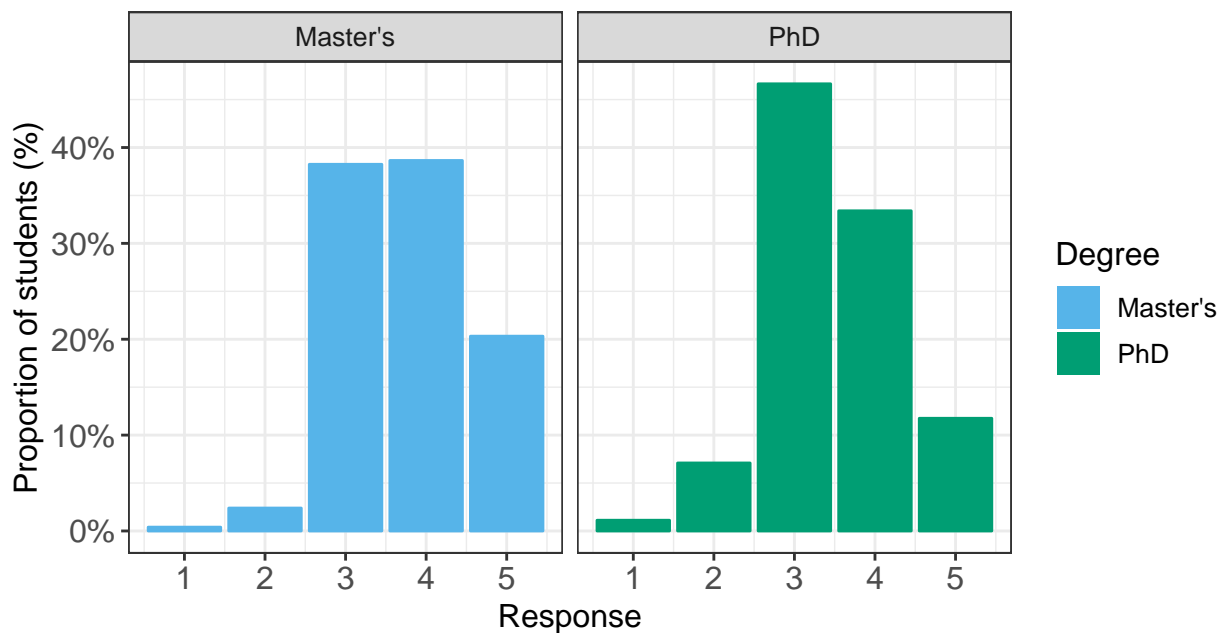## Challenges encountered in the US
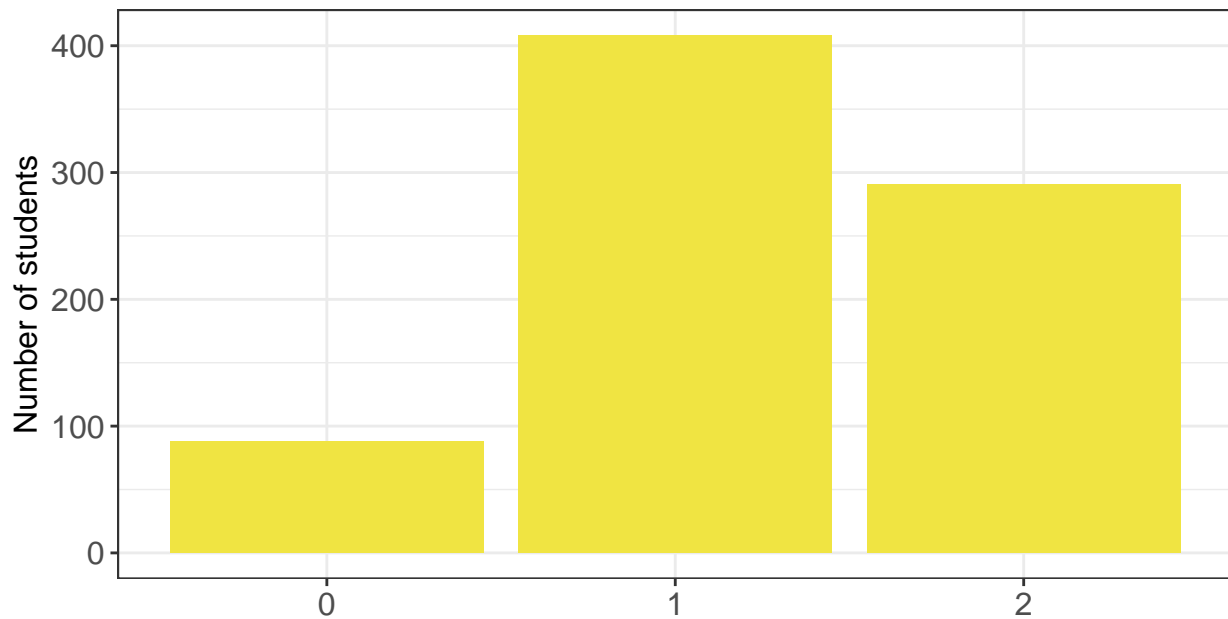


Some: Less than 3 challenges   Lots: More than or equal to 3 challenges

We see that fewer than 100 students faced no challenges, while more than 50% of the participating students faced one or two challenges during their stay in the United States. Approximately 300 students faced a lot of challenges.

## Bivariate plots

### Expected treatment in home country on return, split by degree



Response values: 1. Much worse  2. Somewhat worse  3. Neither better nor worse
4. Somewhat better  5. Much better

As compared to PhD students, Master's students are more confident that they would be treated better in their home country if they were to return.
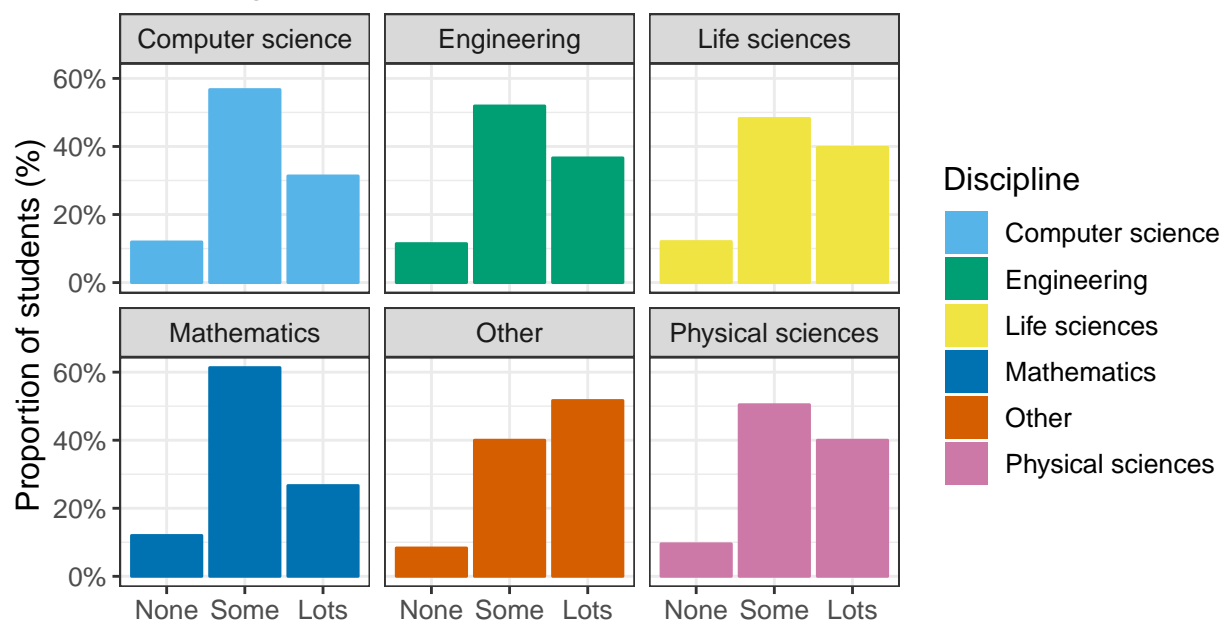
## Challenges encountered in the US, by gender
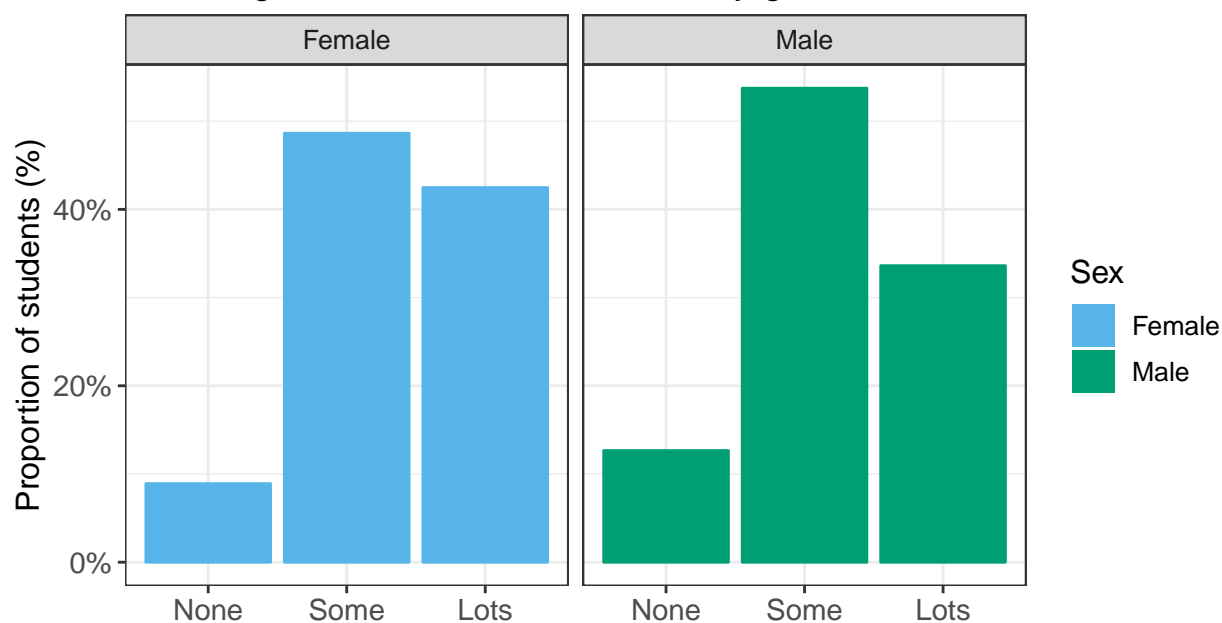


Some: Less than 3 challenges    Lots: More than or equal to 3 challenges

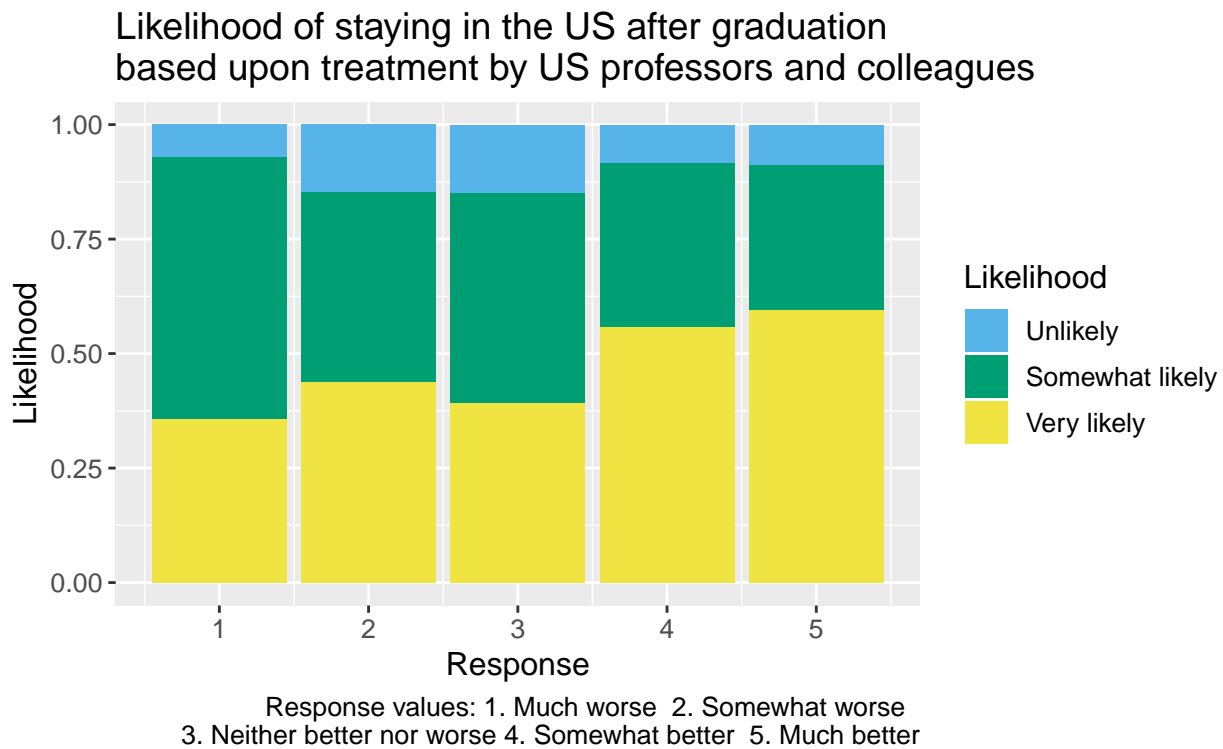Female students face more challenges than their male counterparts.

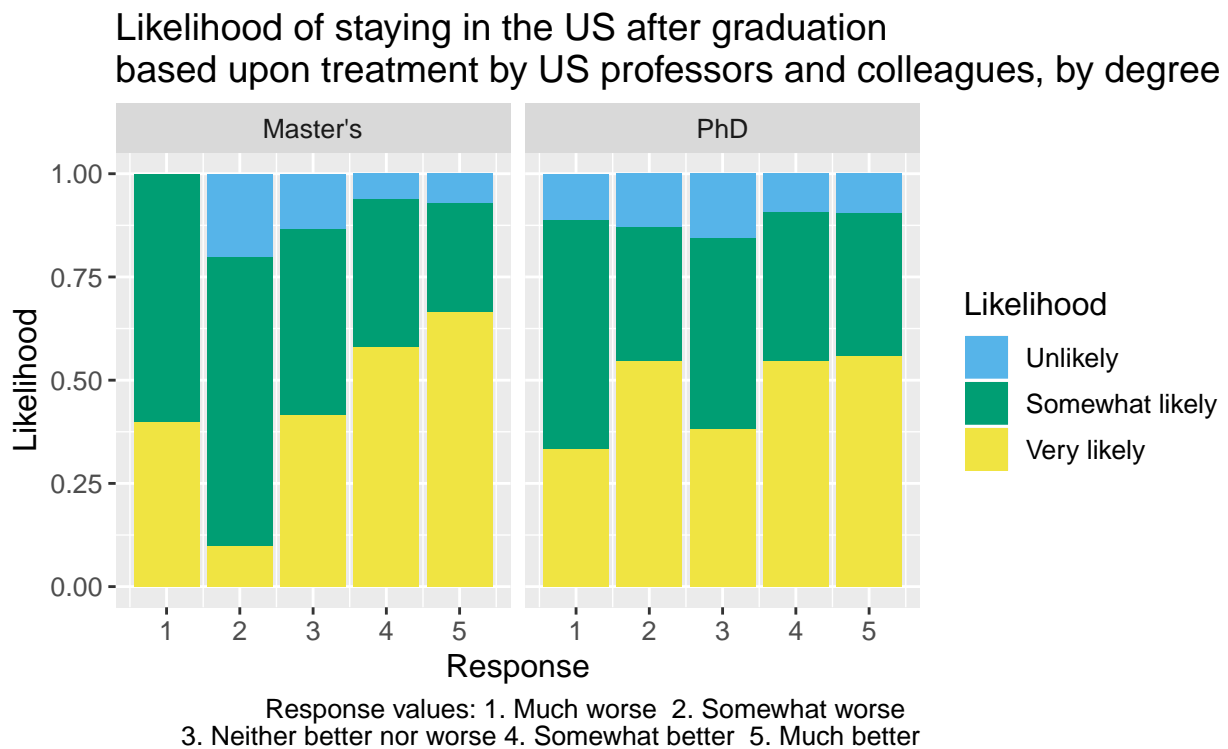## Challenges encountered in the US, by discipline



Some: Less than 3 challenges    Lots: More than or equal to 3 challenges

Students in other disciplines faced more challenges as compared to those in the "mainstream" subject areas.

**Behavior on the response variable**

## Likelihood of staying in the US after graduation based upon treatment by US professors and colleagues



Response values: 1. Much worse  2. Somewhat worse
3. Neither better nor worse 4. Somewhat better  5. Much better
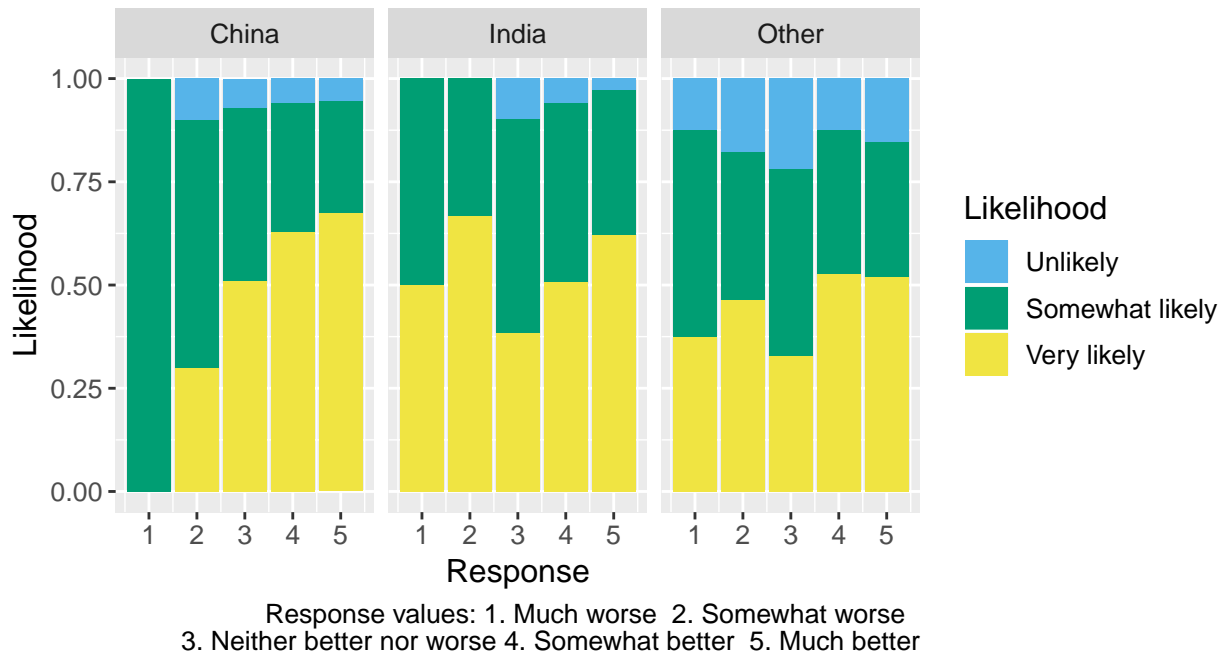
We can observe some trend in the "Very likely" cohort of responses as per which the likelihood of staying back in the US increases with better treatment by US professors and colleagues.

## Likelihood of staying in the US after graduation based upon treatment by US professors and colleagues, by degree



Response values: 1. Much worse  2. Somewhat worse
3. Neither better nor worse 4. Somewhat better  5. Much better

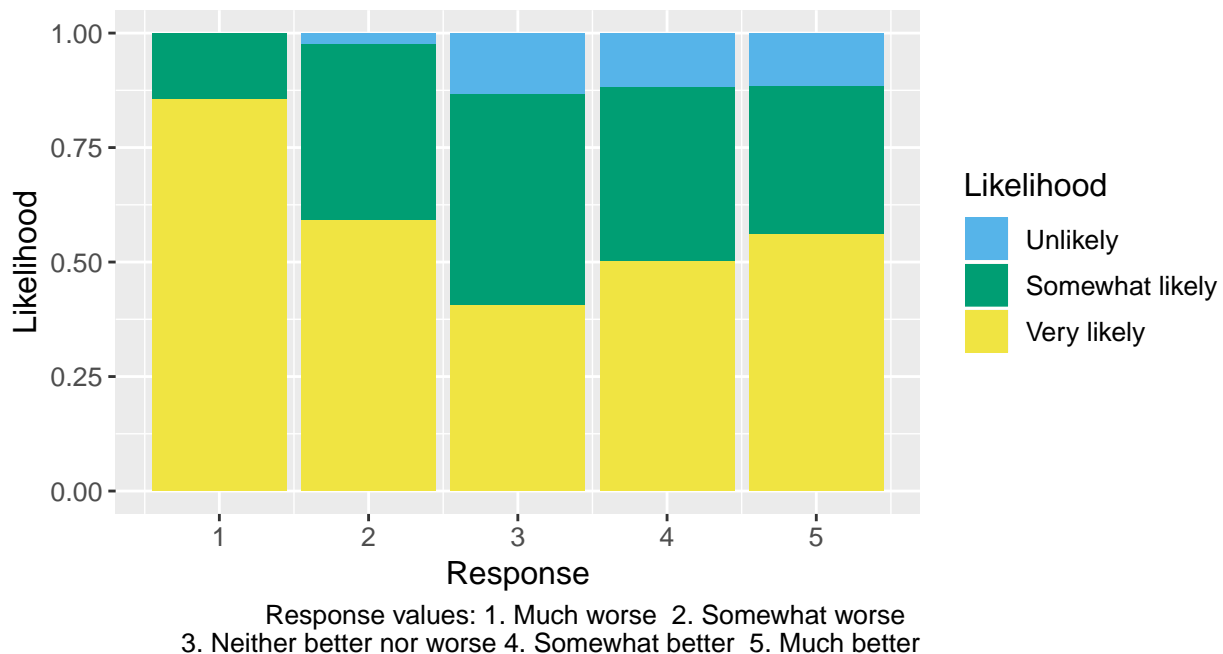Faceting the same variable by degree, we see a clear trend in the "Very likely" cohort of responses of the

Master's students.

## Likelihood of staying in the US after graduation
## based upon treatment by US professors and colleagues, by country



Response values: 1. Much worse  2. Somewhat worse
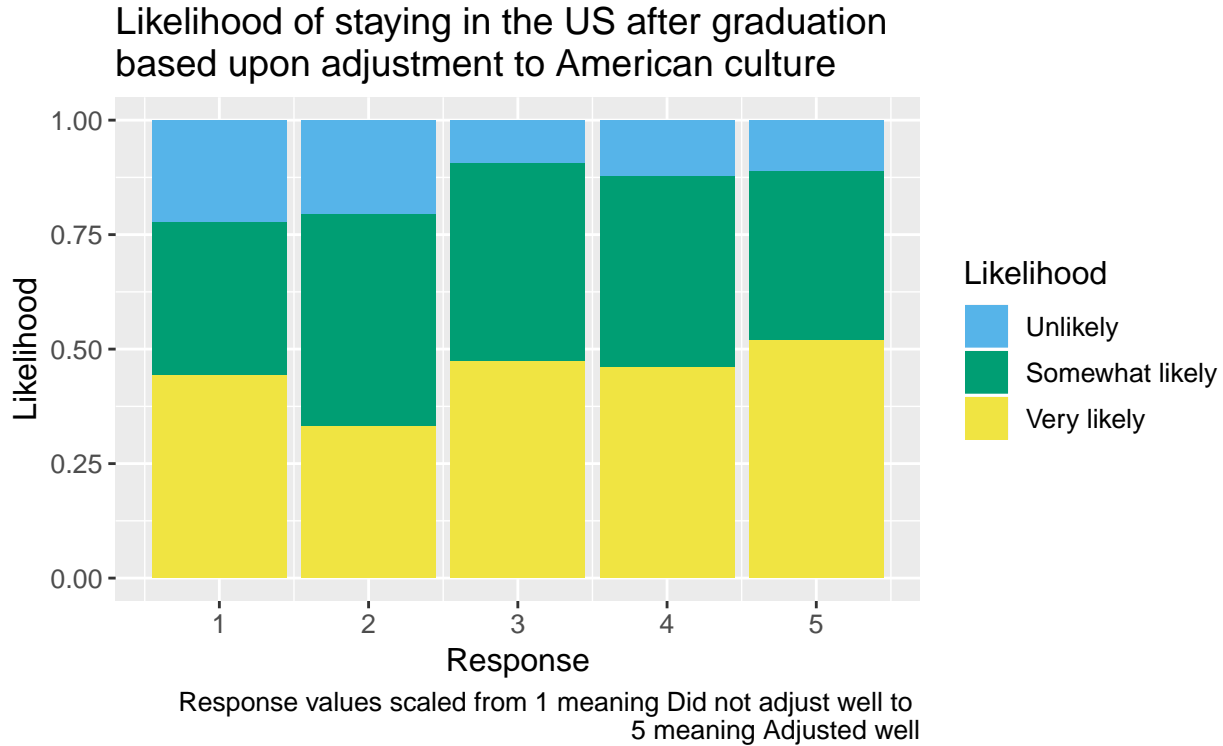3. Neither better nor worse 4. Somewhat better  5. Much better

Faceting the likelihoods by home country, we see a similar trend being observed for the Chinese students suggesting an interaction.

## Likelihood of staying in the US after graduation
## based upon expected treatment in home country on return



Response values: 1. Much worse  2. Somewhat worse
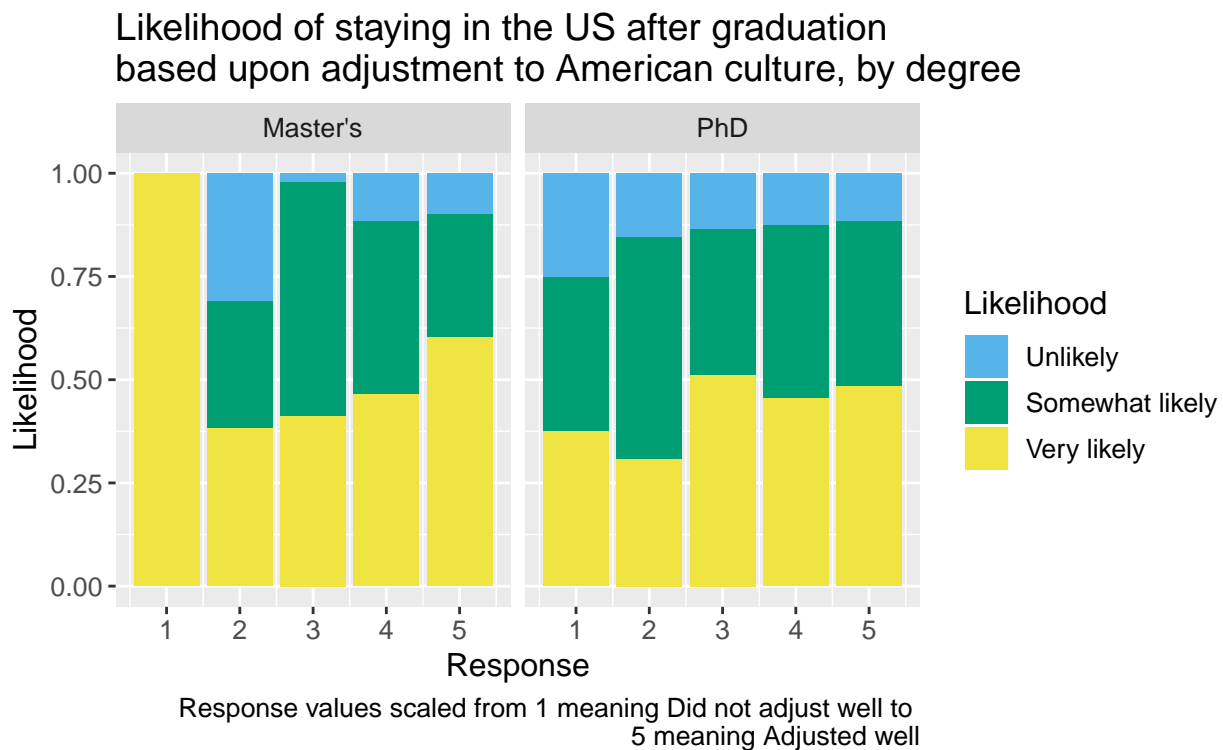3. Neither better nor worse 4. Somewhat better  5. Much better

The above chart is counter-intuitive as we move from response 1 to 3, but makes sense for responses 3 to 5. This might be the case because, as we saw in the previous plots, a very small number of students responded
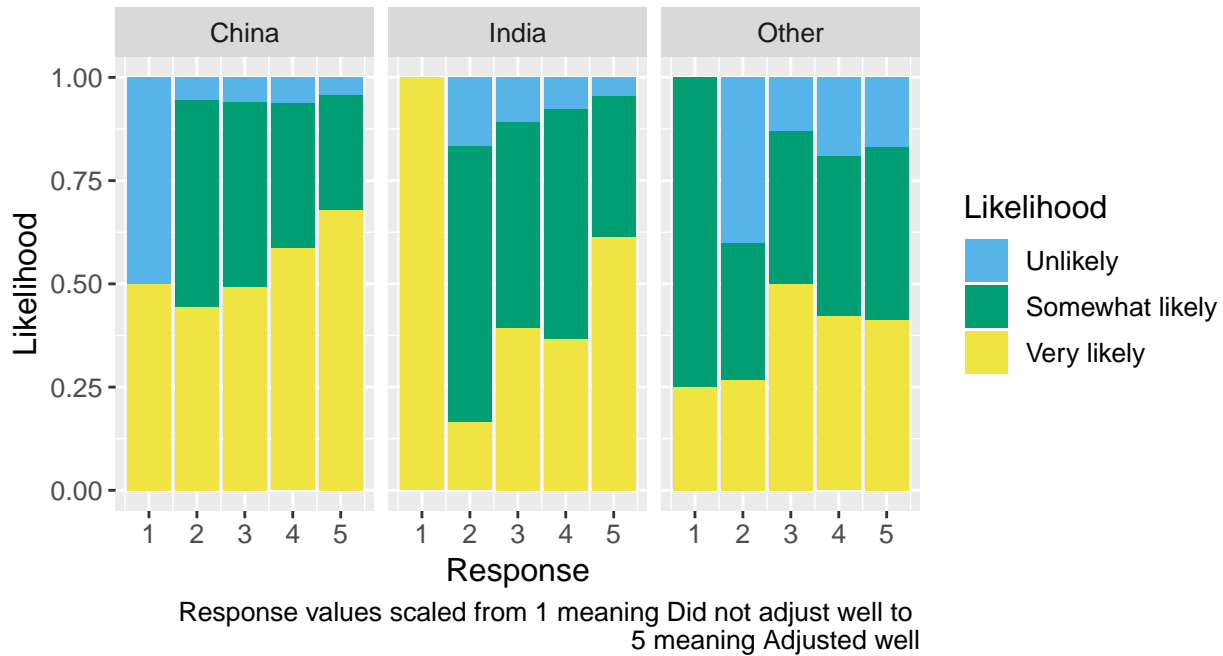
with 1s and 2s. This suggests that we might fare better by combining the responses 1 and 2 into a single cohort.

### Likelihood of staying in the US after graduation based upon adjustment to American culture



Response values scaled from 1 meaning Did not adjust well to 5 meaning Adjusted well

Again, we see some trend in the "Very likely" cohort with the likelihood of staying back increasing with better adjustment to American culture, which makes some intuitive sense.

### Likelihood of staying in the US after graduation based upon adjustment to American culture, by degree



Response values scaled from 1 meaning Did not adjust well to 5 meaning Adjusted well

Likelihood of staying in the US after graduation based upon adjustment to American culture, by country

Response values scaled from 1 meaning Did not adjust well to 5 meaning Adjusted well

Yet again, a clear trend is observed for the Master's and Chinese students suggesting an interaction between the predictors.



Likelihood of staying in the US after graduation based upon adjustment to American culture, by country
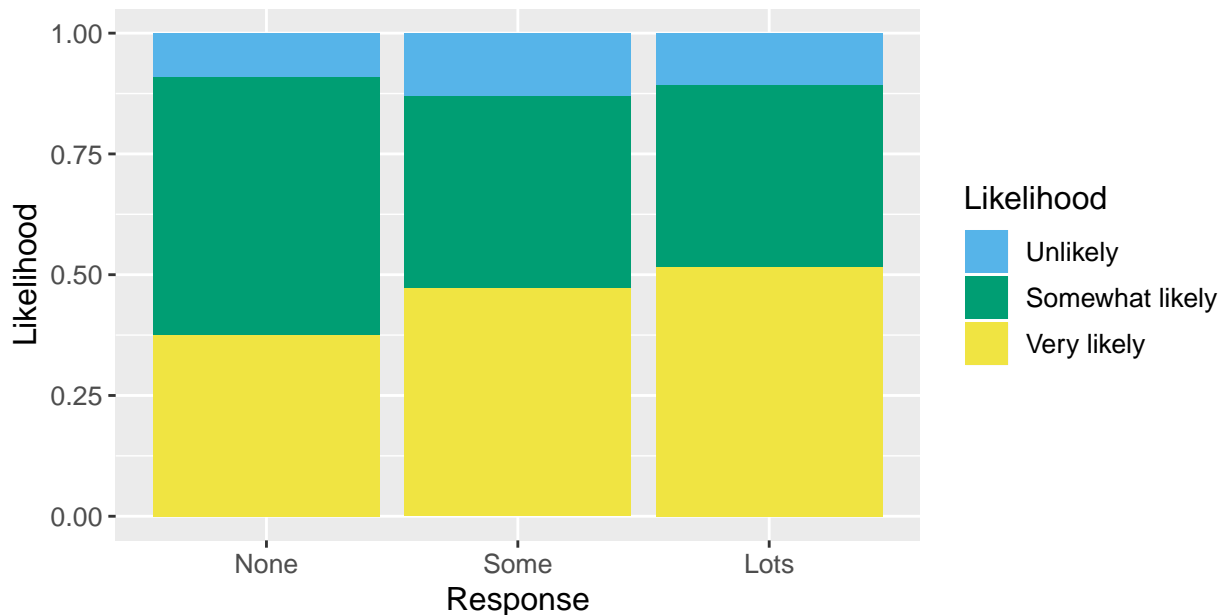
Some: Less than 3 challenges    Lots: More than or equal to 3 challenges

The above chart is pretty counter-intuitive across all cohorts of likelihoods as it suggests a higher likelihood of staying back in the US with higher number of challenges faced. Furthermore, since the variation across the responses is very minimal, we might fare better if we exclude this predictor while fitting the model.

Note here that we fitted many more similar plots to check for any relevant interactions for our model, but did not find any relevant ones. All these plots can be seen in the Appendix section of the report.

## Model fitting

```
## polr(formula = likelihood ~ 1, data = inter.small)
##                               coef.est coef.se
## Unlikely|Somewhat likely     -2.02      0.11
## Somewhat likely|Very likely   0.09      0.07
## ---
## n = 787, k = 2 (including 2 intercepts)
## residual deviance = 1526.5, null deviance is not computed by polr
```

We fit a Proportional Odds Logistic Regression(POLR) model to predict the likelihood of staying back in the US. We see that the model above, which has not predictors, has a residual deviance of 1526.5, which corresponds to the null deviance in our case.

We can now refit the POLR with the relevant predictors (after combining the 1 and 2 level responses for "Treatment in US" and "Expected treatment in home country") and their interactions that we had observed in the previous sections.

```
##
## Re-fitting to get Hessian
## polr(formula = likelihood ~ Q40_adj + Q41_adj + Q42 + Q40_adj:degree +
##     Q40_adj:country + Q42:degree + Q42:country, data = inter.small)
##                               coef.est coef.se
## Q40_adj                        0.45      0.16
## Q41_adj                        0.09      0.09
## Q42                            0.18      0.15
## Q40_adj:degreePhD             -0.16      0.15
## Q40_adj:countryIndia          -0.19      0.18
## Q40_adj:countryOther           0.07      0.16
## Q42:degreePhD                  0.13      0.13
## Q42:countryIndia               0.04      0.16
## Q42:countryOther              -0.26      0.15
## Unlikely|Somewhat likely       0.04      0.51
## Somewhat likely|Very likely    2.25      0.51
## ---
## n = 787, k = 11 (including 2 intercepts)
## residual deviance = 1478.6, null deviance is not computed by polr
```

In the summary of the model above:
- Q40_adj is the response variable for treatment by US professors and colleagues
- Q41_adj is the response variable for expected treatment in home country on return
- Q42 is the response variable for adjustment to American culture

We see that the residual deviance has come down by $(1526.5 - 1478.6 =)$ 47.9 points, thereby explaining ~3.3% of the variance in the likelihood. This suggests that the academic experience of an international student is not the **only** criterion based on which we can explain the likelihood of the student staying in the US after his/her graduation.

Looking at the table above, we observe that treatment by US professors and colleagues has a much higher coefficient than the other predictors suggesting that, relatively, it plays a much bigger role in predicting the likelihood of staying in the US.

Since we are not interested in making any predictions from our model, we have refrained from making any probabilistic predictions here.

**Conclusion**

As mentioned above, while the academic experience of international students does explain some variance in the likelihood of staying in the US after their graduation, it definitely is not sufficient to explain ~96% variance in our response variable. However, we do observe that the way students are treated by the US professors and colleagues during their stay, and their adjustment to the American culture do play some role in their decision-making process. We believe that including some additional relevant variables can a long way in improving our model, such as:

- Does the student have a family business back in their home country?
- Has the student taken an education loan for their higher studies in the US?
- Marital status of the student
- Is the student the only child in the family?
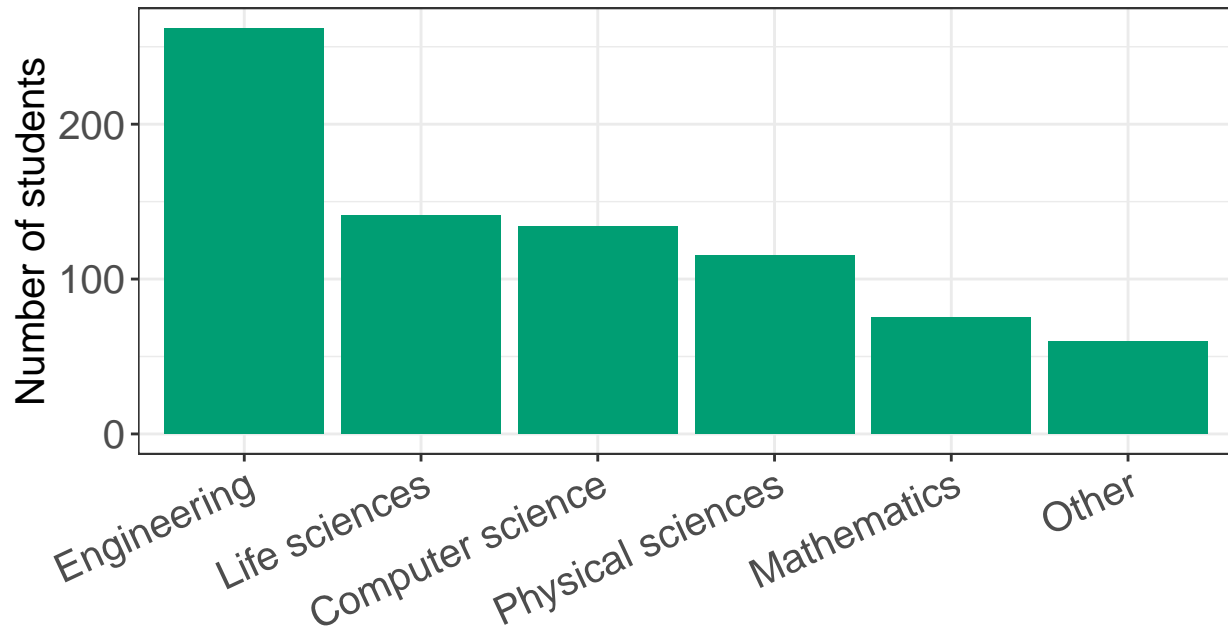- How welcoming do you find the US immigration culture?

# Distribution of respondents by gender
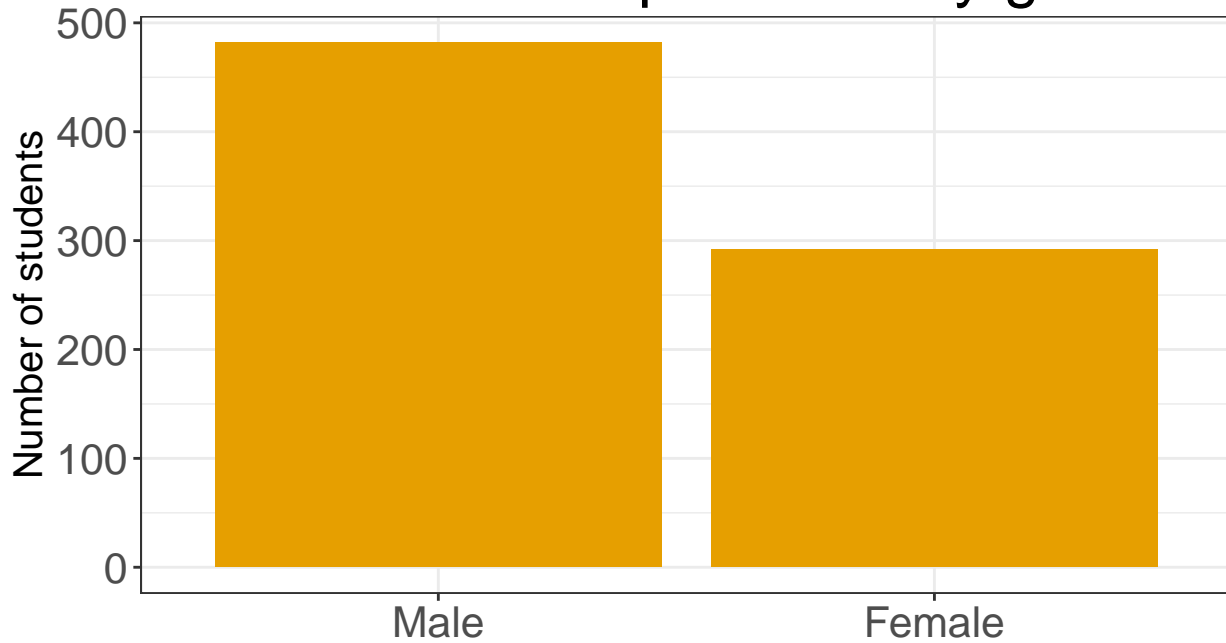


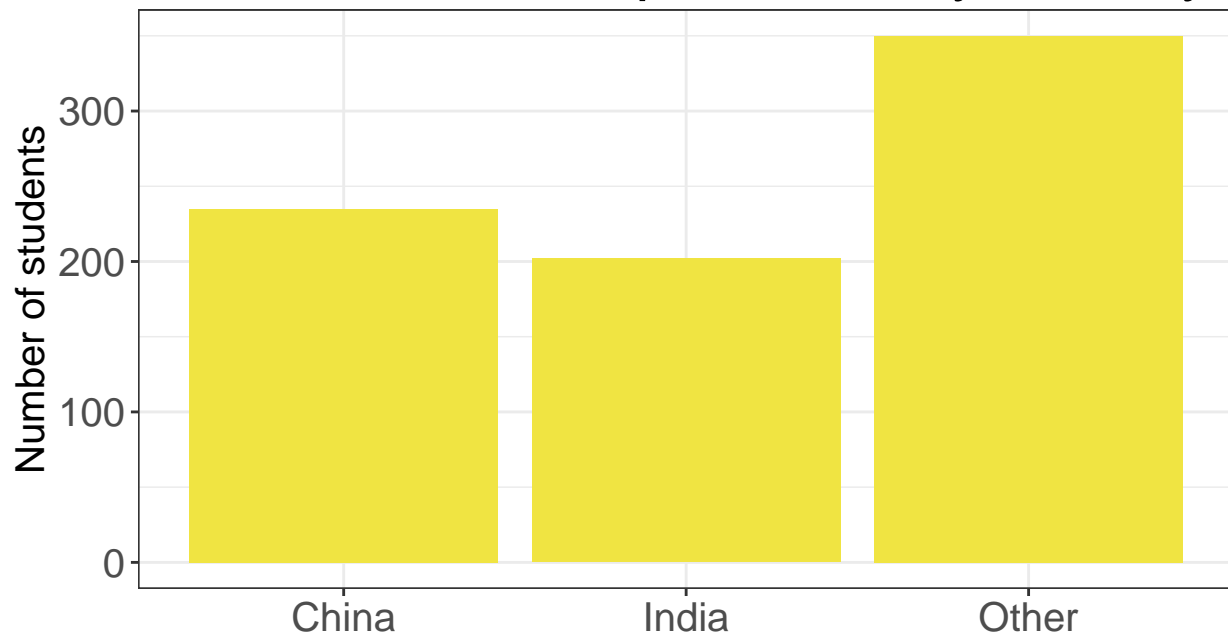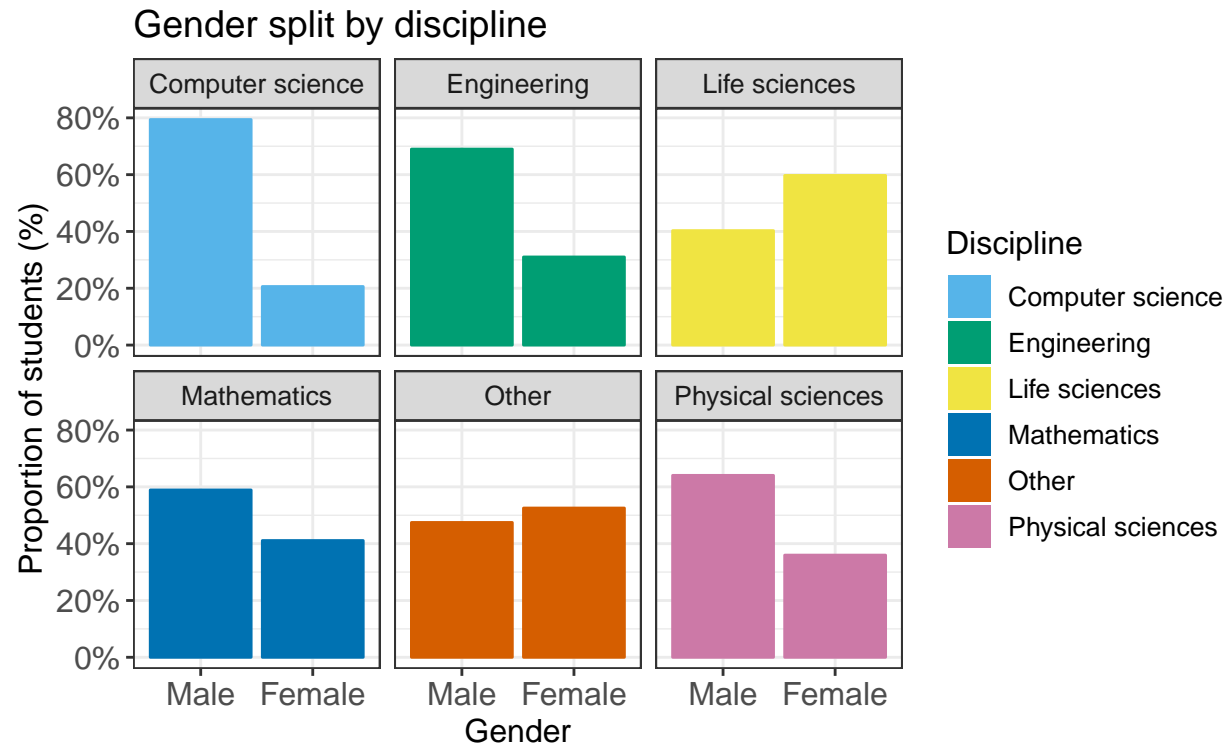# Distribution of respondents by degree
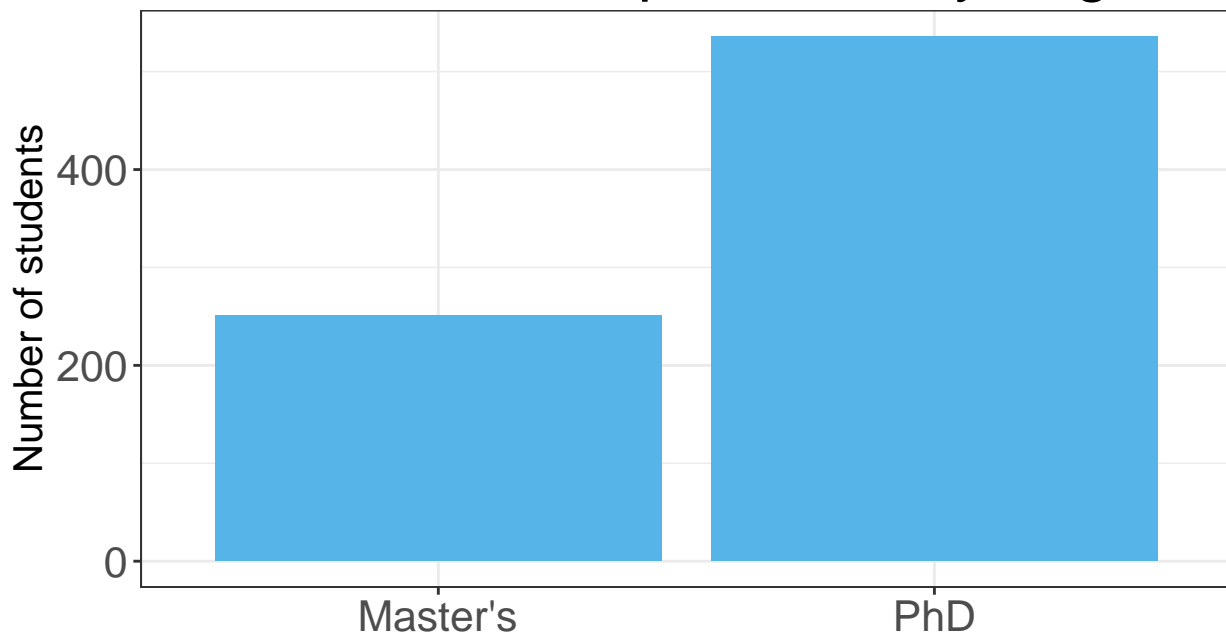
# Distribution of respondents by discipline
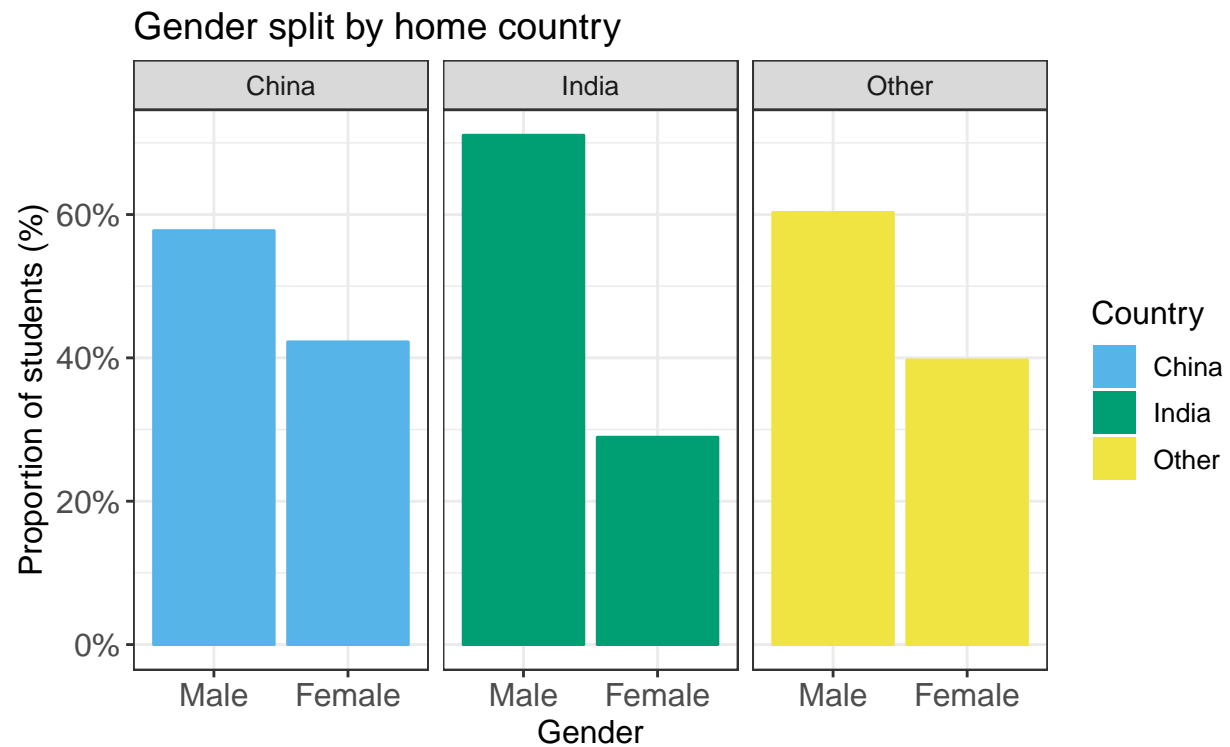


# Distribution of respondents by country

## Gender split by discipline
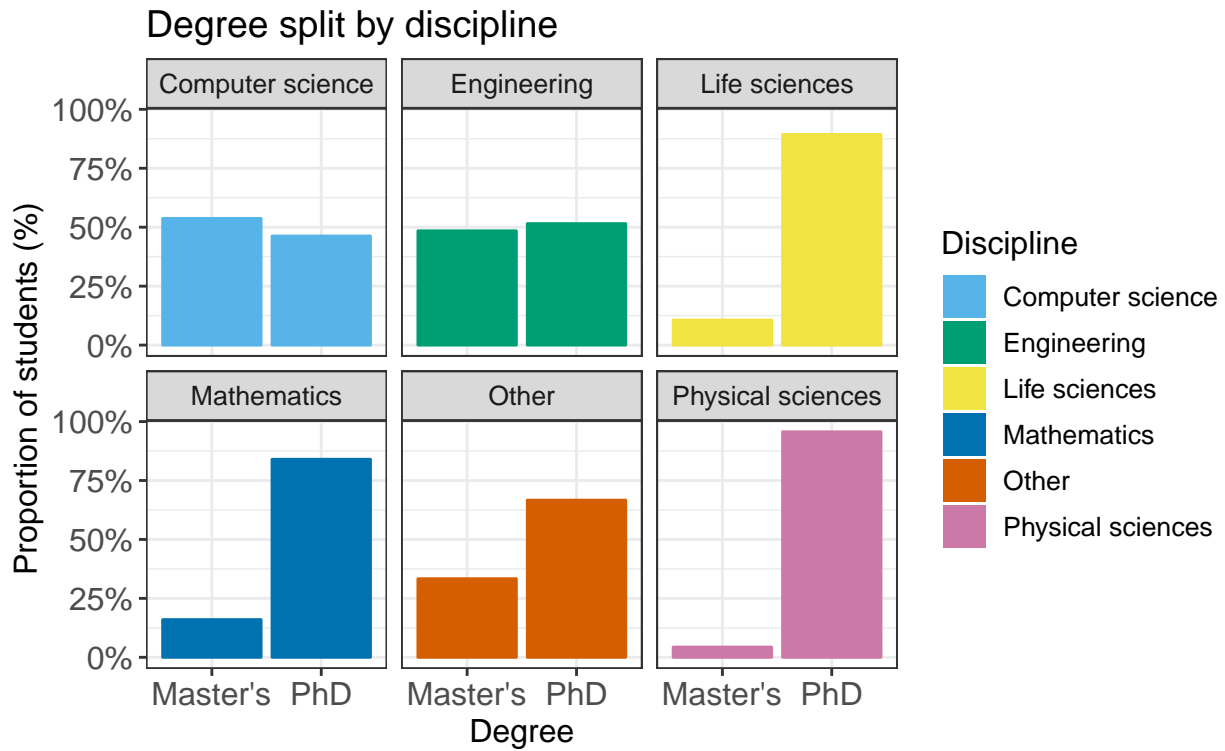


Share of females is much higher in Life sciences as compared to Computer science and Engineering disciplines where males dominate the proportion.

## Gender split by home country



India has much higher share of male students than female students as compared to any other country.

## Degree split by discipline



There are much more PhD students than Master's students in Physical sciences, Life sciences and Mathematics disciplines as compared to Computer science and Engineering disciplines.

## Degree split by home country
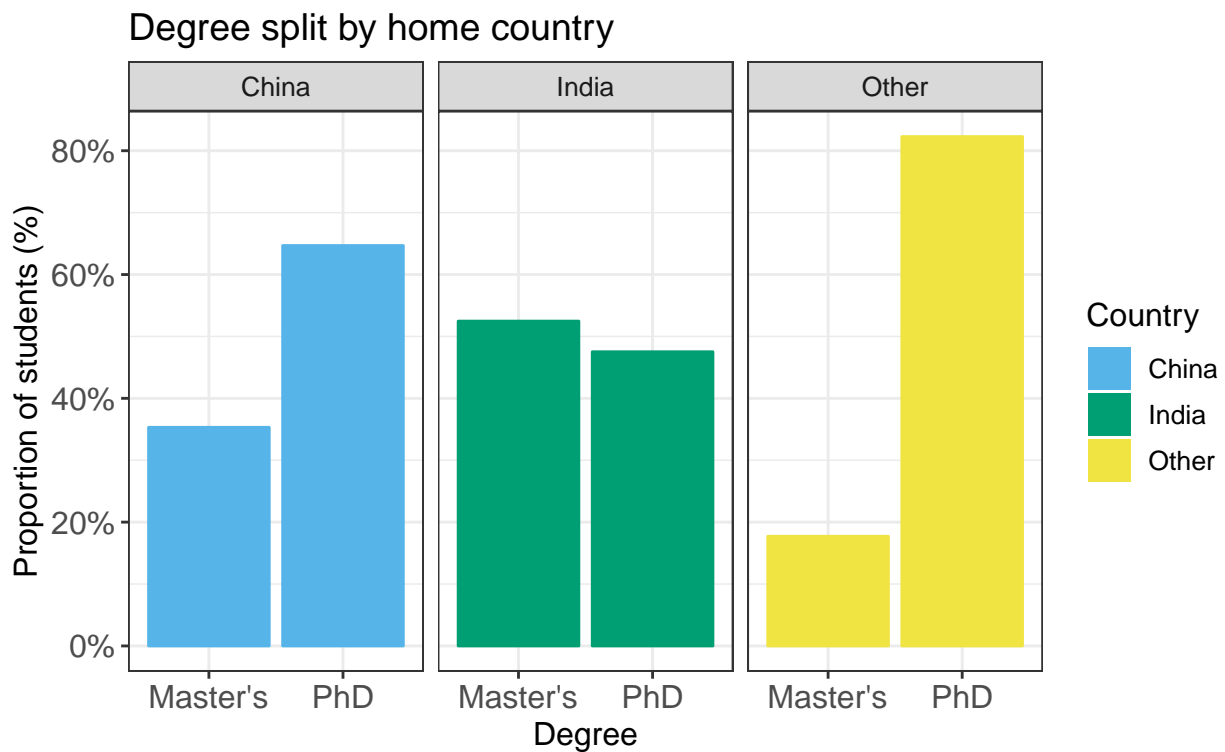


With the exception of India, the share of PhD students dominate over that of Master's students across all countries.

Home country split by discipline
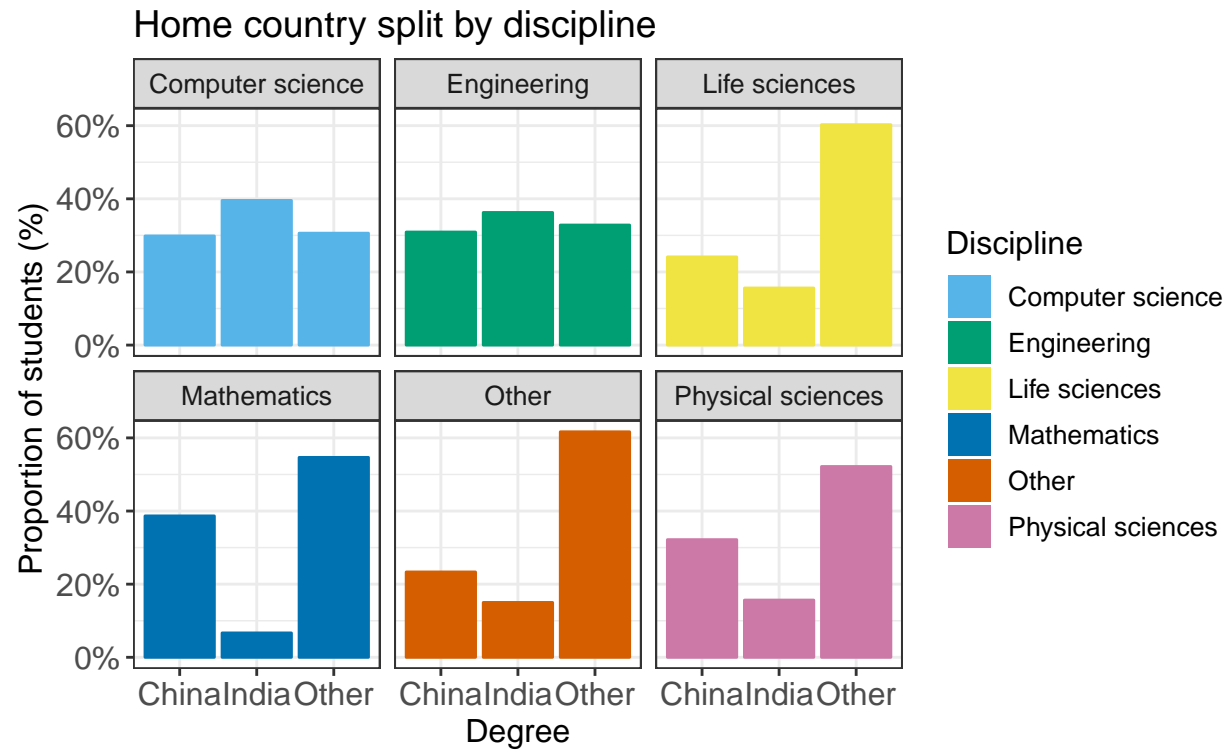
Indian students have the highest share among all countries in the Computer Science and Engineering disciplines.