Nina Hua (nhua2)
MSDS 622
Final Project

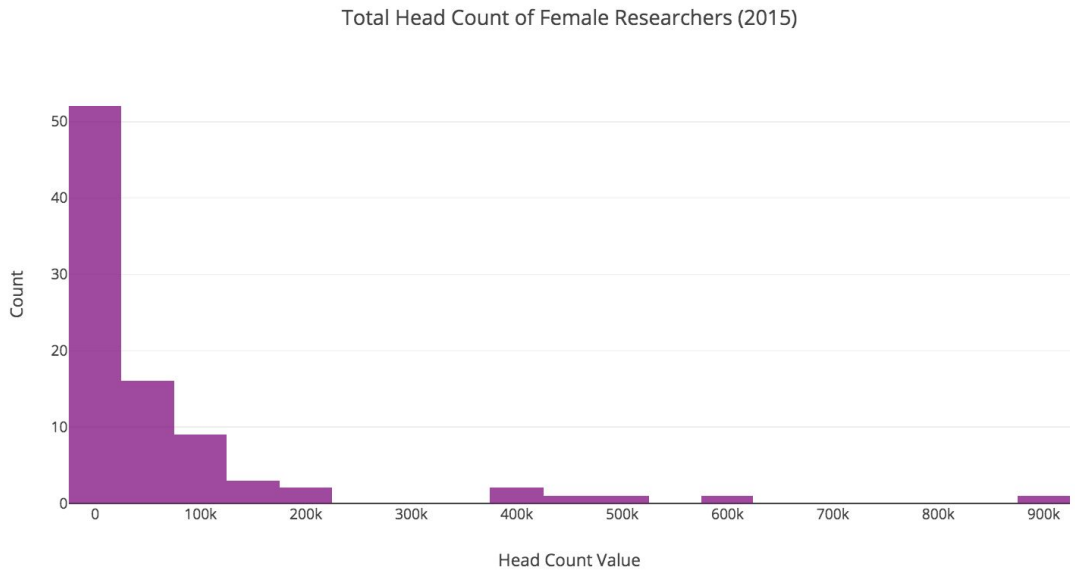
Introduction

For the final project, I wanted to explore the proportion of women who work in STEM fields around the world. Particularly, I wanted to answer if the proportion of women in STEM has increased over the years with the investment of education in girls. This stemmed from the fact that achieving gender equality and empowering women and girls is one of the United Nations' seventeen Sustainability Development Goals. As STEM fields are very male-oriented, I wanted to visualize if the number of women entering STEM fields around the world has changed over the last several years. My main data set consists of women who work in R&D, research, and as technicians from the UNESCO Institute for Statistics.

Summary of Data

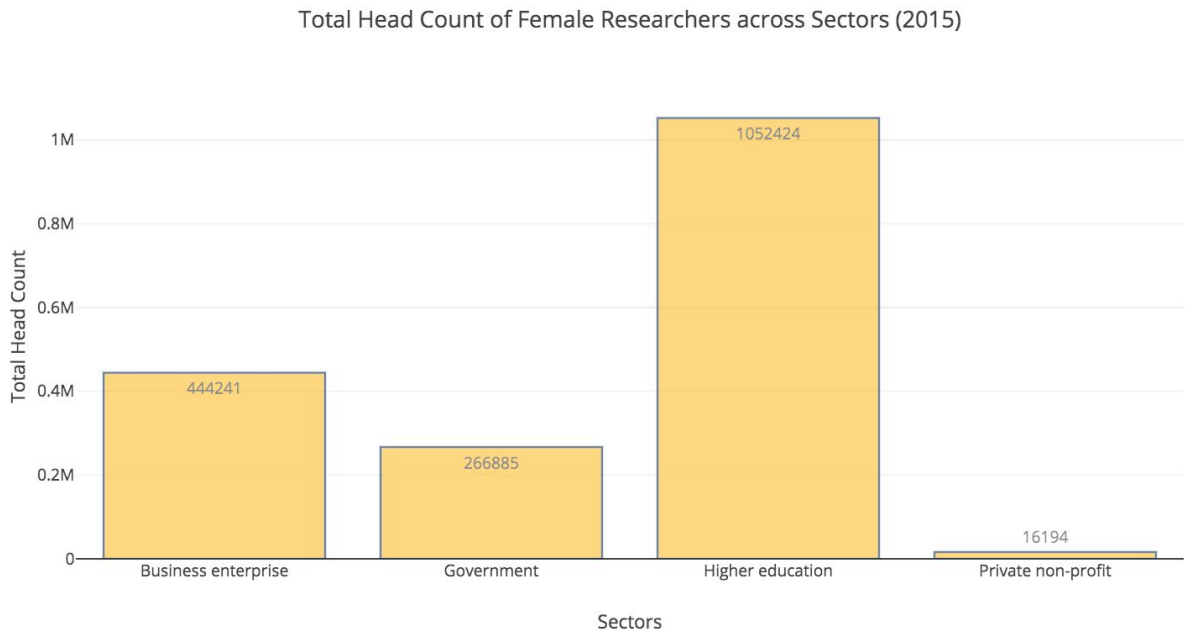
*With the exception of the connection map, bubble map, and treemap, all plots were created using Plotly, which implies that all plots are interactive.

1. What is the distribution of female researchers in 2015?



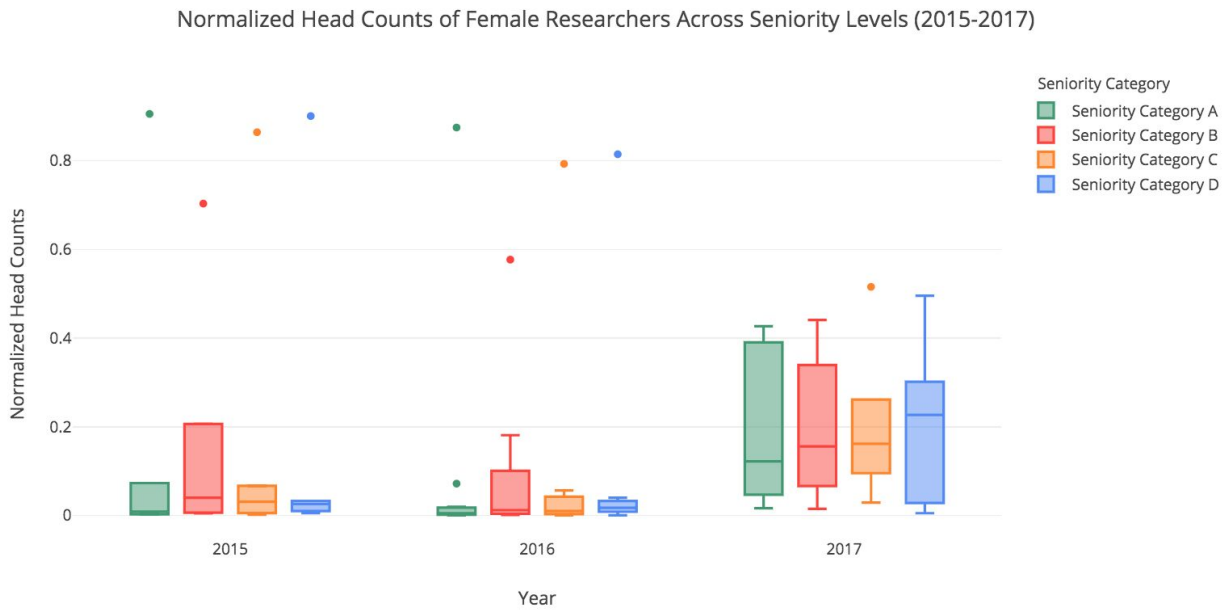
A majority of countries have reported having fewer than 100,000 female researchers (in headcount) in 2015.

2. How many female researchers are there in different sectors as reported by UNESCO?



UNESCO has defined four sectors of research: Business enterprise, Government, Higher Education, and Private non-profit. The headcounts were summed as an aggregate value, which showed that Higher education has the highest number of female researchers in 2015.

3. How many female researchers are there across seniority levels as reported by UNESCO?



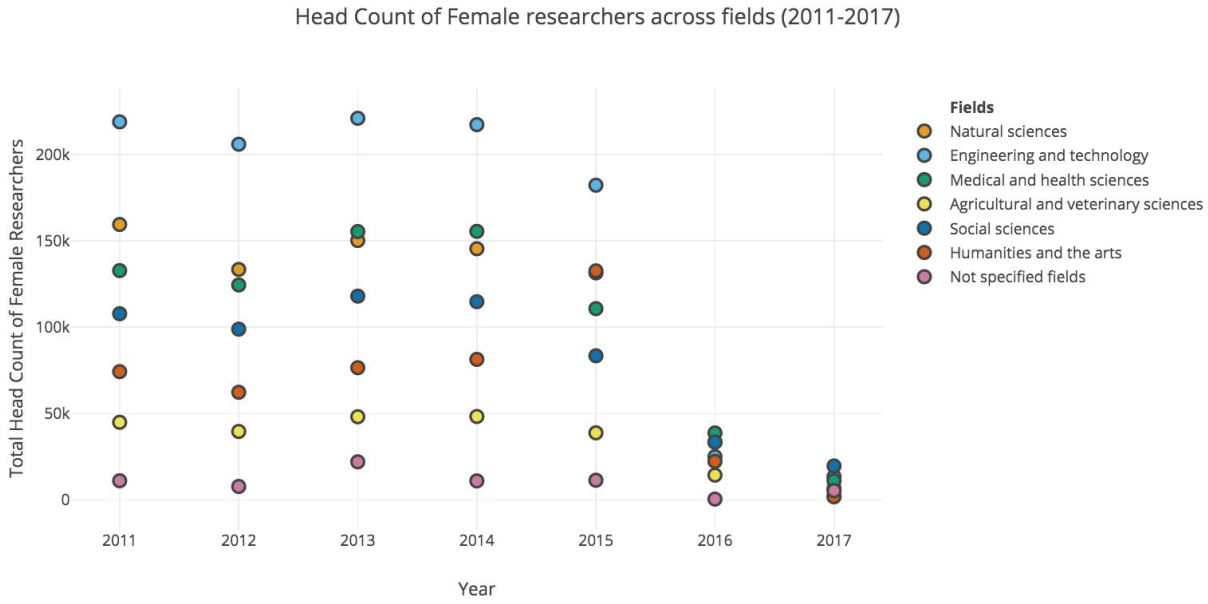
UNESCO has defined four categories of seniority:[1]

- Category A: The single highest grade/post at which research is normally conducted (e.g. Director of research, Full professor)

- Category B: Researchers working in positions not as senior as top position (A) but more senior than newly qualified doctoral graduates (ISCED level 8) (e.g. Senior researcher, Principal investigator, Associate professor)
- Category C: The first grade/post into which a newly qualified doctoral graduate would normally be recruited. (e.g. Researcher, Investigator, Assistant professor, Post-doctoral fellow)
- Category D: Either doctoral students at the ISCED level 8 who are engaged as researchers or researchers working in posts that do not normally require a doctorate degree (e.g. Ph.D. students, junior researchers)

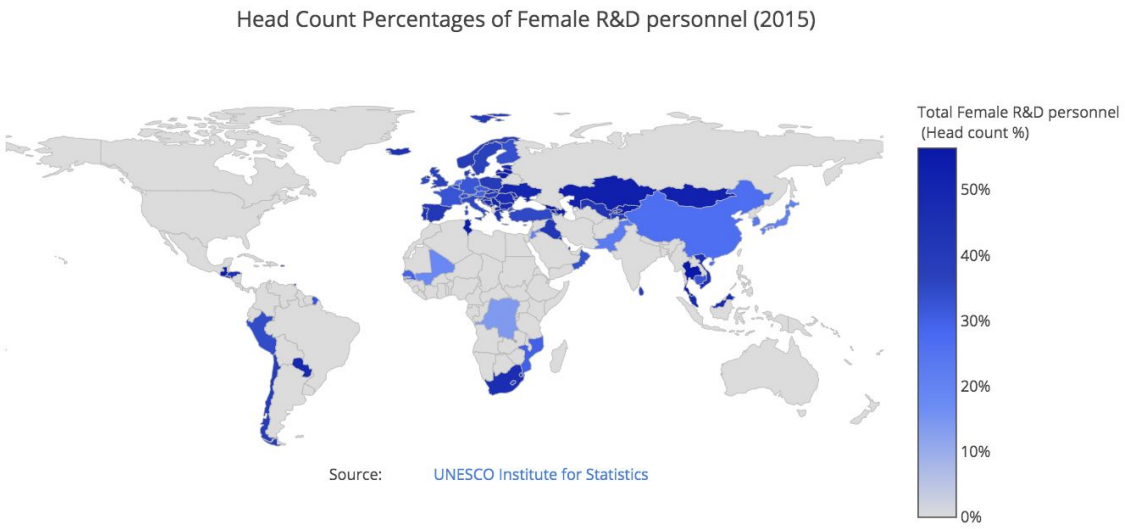
Headcount values were normalized to each category level per year. The highest normalized headcount values of female researchers were found in 2017.

4. What is the distribution of female researchers across different fields between 2011 and 2017?



UNESCO has defined seven fields of research: Natural sciences, Engineering and Technology, Medical and health sciences, Agricultural and veterinary sciences, Social sciences, Humanities and the arts, and unspecified fields. The headcount values were aggregated per year and field. Although the scatter plot shows a suspicious decreasing trend, there were fewer countries that have reported headcount values, so a trend should not be inferred from this visualization.

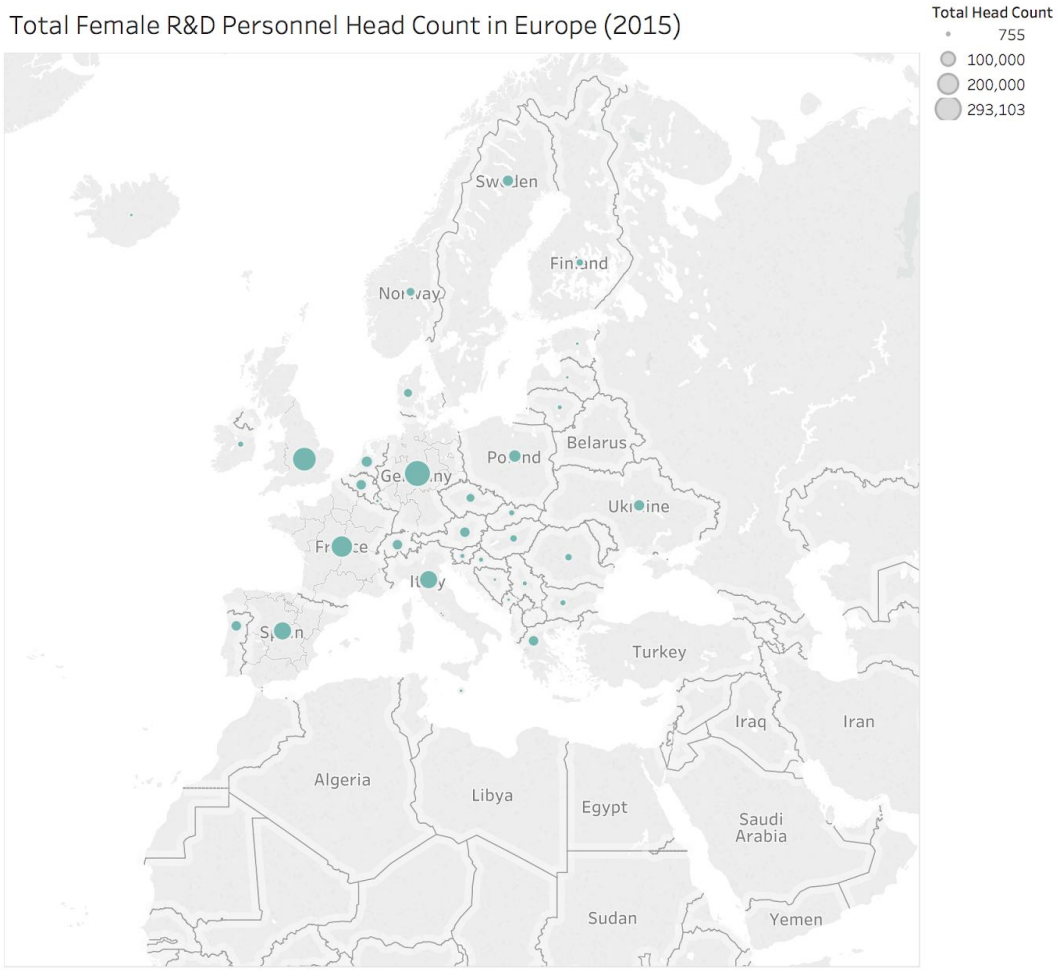
5. What is the global distribution of female Research and Development employees?



The top five countries with the highest headcount percentages of female R&D personnel in 2015 include:

- Thailand
- Tunisia
- Guatemala
- Latvia
- Armenia

6. What is the distribution of female Research and Development employees in Europe?



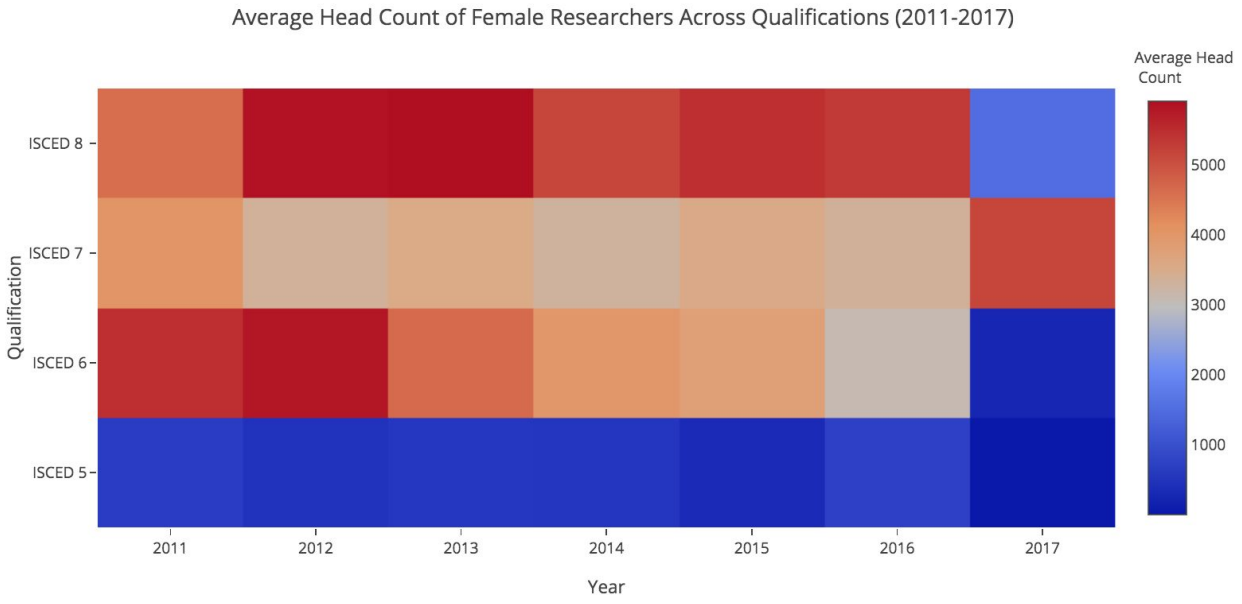
The choropleth map prior showed that European countries contained a great number of countries with female R&D personnel. This bubble map was used to further explore the headcount of personnel in 2015. Five countries with the greatest number of female R&D personnel include:

- Germany
- United Kingdom of Great Britain and Northern Ireland
- France
- Spain
- Italy

7. As ensuring gender equality is a Sustainability Development Goal, where are UN offices located in the world?

In order to create the connected graph above, I created my own data set that held the information centers of the United Nations where people can learn more about the sustainability goals.[2] Since there are fifty-nine offices around the globe, it was difficult to depict the offices as one connected graph. Random offices from five defined regions (Americas, Africa, Arab State, Asia and the Pacific, and Europe) were selected to be featured as connection points.

8. What is the average number of female researchers with certain qualifications?

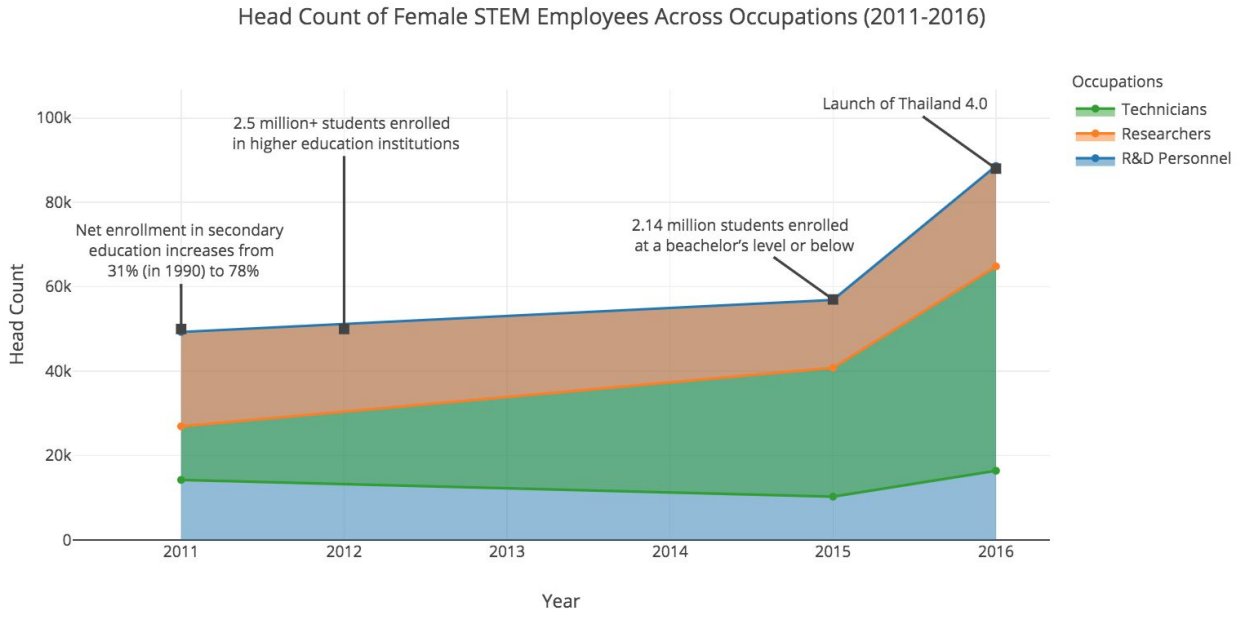


Qualifications are defined as the following:[3]

- ISCED 5: Short-cycle tertiary education
- ISCED 6: Bachelor's or equivalent level
- ISCED 7: Master's or equivalent level
- ISCED 8: Doctoral or equivalent level

The greatest average values of female researchers with a doctorate degree occurred between 2012 and 2013. The greatest average value of female researchers with a master's degree occurred was recorded in 2017. The greatest average value of female researchers with a bachelor degree occurred was recorded in 2012. However, the dataset does not include the same number of countries each year as some countries did not report their headcount values, so the average is not equally representative through time.

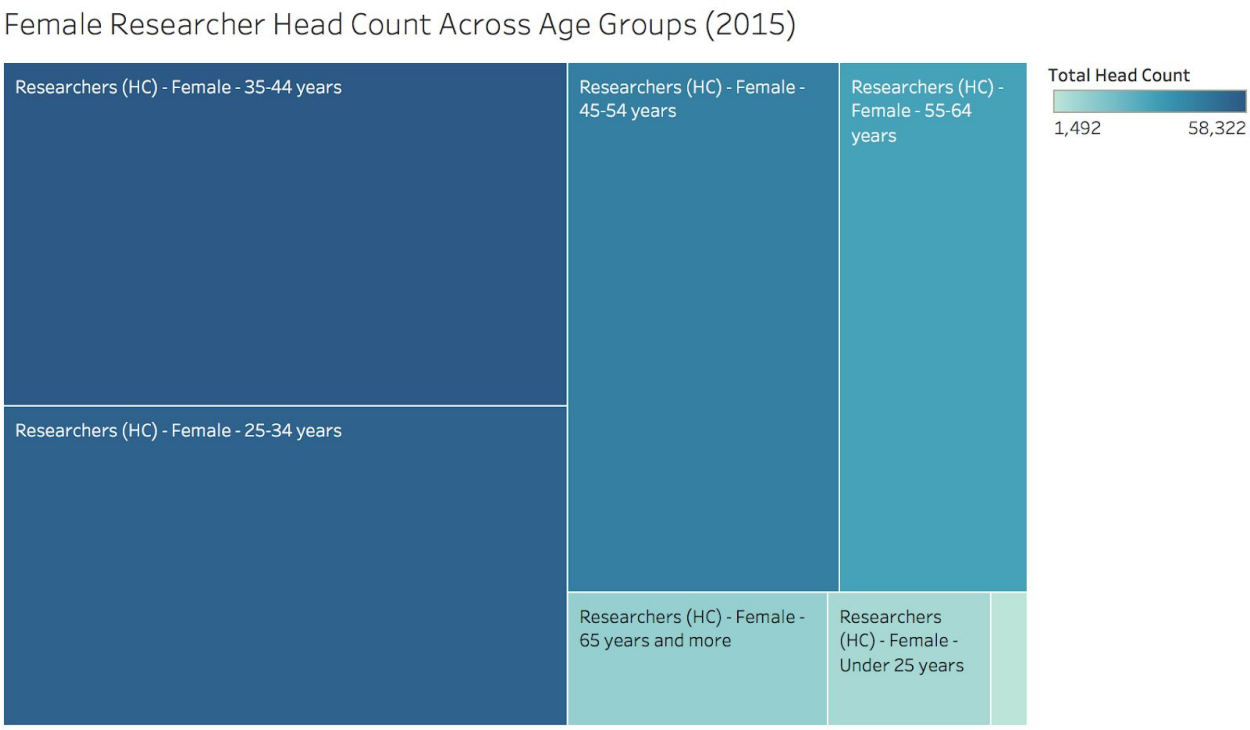
9. Since Thailand consistently shows an equal or greater proportion of women as R&D staff, researchers, and technicians, how do these proportions compare with one another over time?



The headcount values of female researchers and R&D personnel in Thailand increased from 2011 to 2016. However, the headcount values of female technicians decreased from 2011 to 2015 before increasing in 2016. Facts used to support the annotations can be found in the citation.[4,5]

10. What is the distribution of female researchers across age groups?

Nina Hua (nhua2)
MSDS 622
Final Project

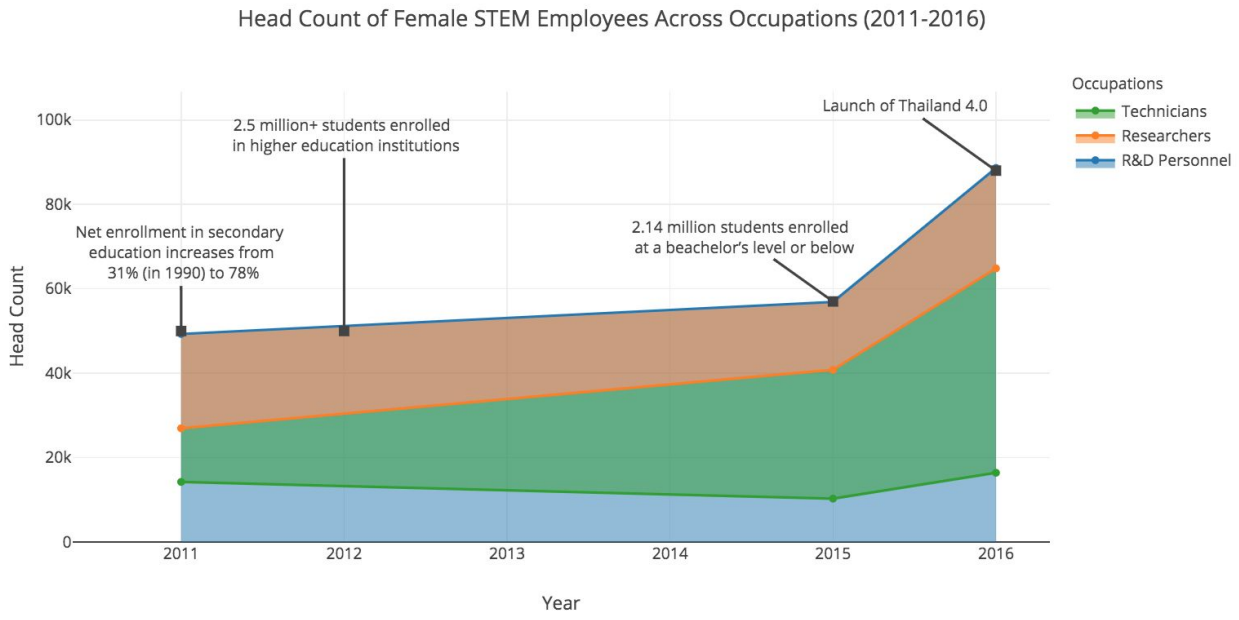


UNESCO has defined the following age groups:

- Not specified
- Under 25 years
- 25 - 34 years
- 35 - 44 years
- 45 - 54 years
- 55 - 64 years
- 65 years and more

This treemap displays the proportion of female researchers across different age groups. The largest proportion of female researchers are between the ages of thirty-five and forty-five years old.

Storyline



Thailand is an upper middle income Southeast Asian country that has shown the rewards of investing in education for all children, especially for girls.[6] In 1999, the National Education Act was enacted in order to ensure that all Thai children received access to education.[7] Through the years, Thailand has been devoted to creating a value-based economy that is driven by innovation, technology, and creativity with the adoption of the initiative Thailand 4.0.[5] Although Thailand boasts near gender equality in STEM fields, they have partnered with UNESCO to promote female STEM education. They are the first country in Asia-Pacific to pilot a policy toolkit under UNESCO's global STEM and Advancement, or SAGA. SAGA aims to analyze the impact of policies on gender disparities in STEM fields.[8] As a country that has evolved from a low-income economy to an upper-middle-income economy in less than a generation, it is worth believing that the continuous investment of educating all individuals is invaluable to a nation's success.[6]

Results/Summary/Conclusion

Overall, the world is seeing a surge of women in STEM, but there are countries and years where the proportion between genders is unequal. With the advent of programs such as SAGA and Girl Up's STEM for Social Good, there is confidence that the gap between the genders will decrease in the future.

Link to your github page with this analysis

https://github.com/nina-hua/data_visualization/tree/master/final

Citations

1. http://uis.unesco.org/node/458458
2. https://unic.un.org/aroundworld/unics/en/whereWeWork/africa/index.asp?regionCode=1
3. http://uis.unesco.org/en/glossary
4. https://wenr.wes.org/2018/02/education-in-thailand-2

5. https://thaiembdc.org/thailand-4-0-2/
6. http://www.worldbank.org/en/country/thailand/overview
7. https://borgenproject.org/facts-about-education-in-thailand/
8. https://thaiembdc.org/2017/09/07/thailand-promoting-female-stem-education-with-unesco/