



# Jupiter with Jupyter

## Teaching Data Visualization and Statistics in Geosciences



A. R. Azari<sup>1</sup>, M. W. Liemohn<sup>1</sup>, B. M. Swiger<sup>1</sup>  
 1. University of Michigan, azari@umich.edu, liemohn@umich.edu

### Motivation: Beyond the Data

- With the **advent of opportunities within data analytics and sciences**, there is a clear need for students to understand the basics of data science (1).
- **Data visualization is a critical need** within industry with data visualization targeted job postings increasing by 1500% in the past decade (2).
- However, only **18% of undergraduates majoring in computer science were women in 2015**, as compared to ~40% of undergraduates in geosciences (3, 4).
- **Geosciences as a whole has the lowest diversity of all STEM fields** at all levels of higher education (5).
- Embracing growth mindset teaching and beliefs in STEM courses has positive implications for all students, but in particular **decreases racial achievement gaps** (6).

**Developed a unique 400 level undergrad/grad course on data skills & statistics through visualization in geosciences**

### Growth Mindset: Enabling Learning with Jupyter

**A growth mindset is:** “the idea that ability is malleable and can be developed through persistence...” (6)

Jupyter provides novel ways to interact with and see code, visualization, text, and equations

Students can turn in both source code AND output together – for progress focused grades

```
fig = plt.figure(figsize=(10, 5))
fig.suptitle('Temperature Variants From 1880 - 2017 Global Averages', font
size=20)

#----- we edited the following color statement ONLY
plt.bar(temperVarGlobal['Year'], temperVarGlobal['Anomaly'], width = 0.8,
align='edge',
color = temperVarGlobal['Colors2'])

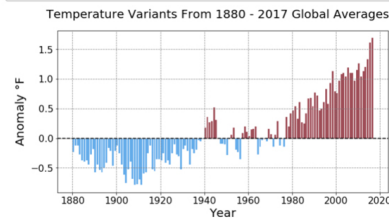
plt.ylabel('Anomaly $^\circ$F', fontsize = 20)
plt.xlabel('Year', fontsize = 20)

plt.xticks(fontsize=16)
plt.yticks(fontsize=16)
plt.axhline(y=0.0, color='k', linestyle='--')

plt.grid(color='gray', linestyle='dashed')

#How to save figures -
#this first command will not save with a white background, the second will
plt.savefig('./Figures/TempVariants_GlobalYearlyAverages_Transparent.png',
transparent=True)
plt.savefig('./Figures/TempVariants_GlobalYearlyAverages.png')

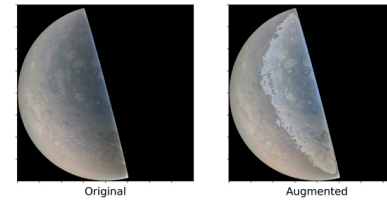
#please go see within your Jupyter folder the .png file
```



How did the methods we learn differ and compare to each other? The for loop vs the boolean index method? Specifically, did you like one more than the other?

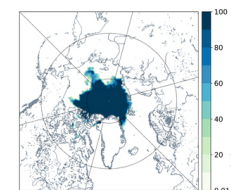
### Focus on Statistics Through Visualizations

Programming & statistics presented through back to back lecture to application in interactive notebooks



Multi-dimensional data structures through images and spacecraft data

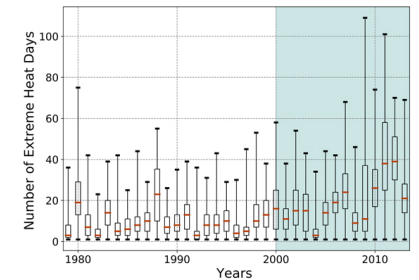
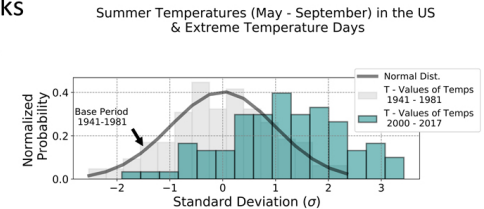
Sea Ice Fractional Content for September - 2010



Geo-located data model comparison and linear regression with sea ice melting rates

### Course labs online!

[github.com/astro-abby/data\\_vis\\_statistics\\_geosciences](https://github.com/astro-abby/data_vis_statistics_geosciences)



Normal distributions and interquartile ranges explored with climate trends

**Visualization and data analytics are not only necessary skillsets for students but an avenue for learning in computation sciences, geosciences, and statistics**

### References:

1. National Academies of Sciences, Engineering, and Medicine. 2018. Data Science for Undergraduates: Opportunities and Options. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25104>.
2. Ryan, L., Silver, B., Laramie, B., & D. Ebert (2019). Teaching Data Visualization as a Skill. IEEE Computer Graphics and Applications (IEEE CG&A), 39. doi:10.1109/MCG.2018.2889526
3. National Science Foundation, National Center for Science and Engineering Statistics. 2019. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019. Special Report NSF 19-304. Alexandria, VA. Available at <https://www.nsf.gov/statistics/wmpd>.
4. American Geosciences Institute (2016). U.S. Female Geoscience Enrollments and Degrees Remain Level in 2015, Geoscience Currents, No. 110. <https://www.americangeosciences.org/sites/default/files/currents/Currents-110-GenderEnrollments2015.pdf>
5. Huntton, J. E., C. Tanenbaum, and J. Hodges (2015). Increasing diversity in the geosciences. Eos, 96, doi:10.1029/2015E0025897. Published on 9 March 2015.
6. E. A. Canning, K. Muenks, D. J. Green, M. C. Murphy, STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. Sci. Adv. 5, eaau4734 (2019).