Designing a Synergistic Relationship Between Undergraduate Data Science Education and Usability of Biodiversity Databases

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Outline

1. Motivation

2. Project set-up

2. Results of the project

3. End questions

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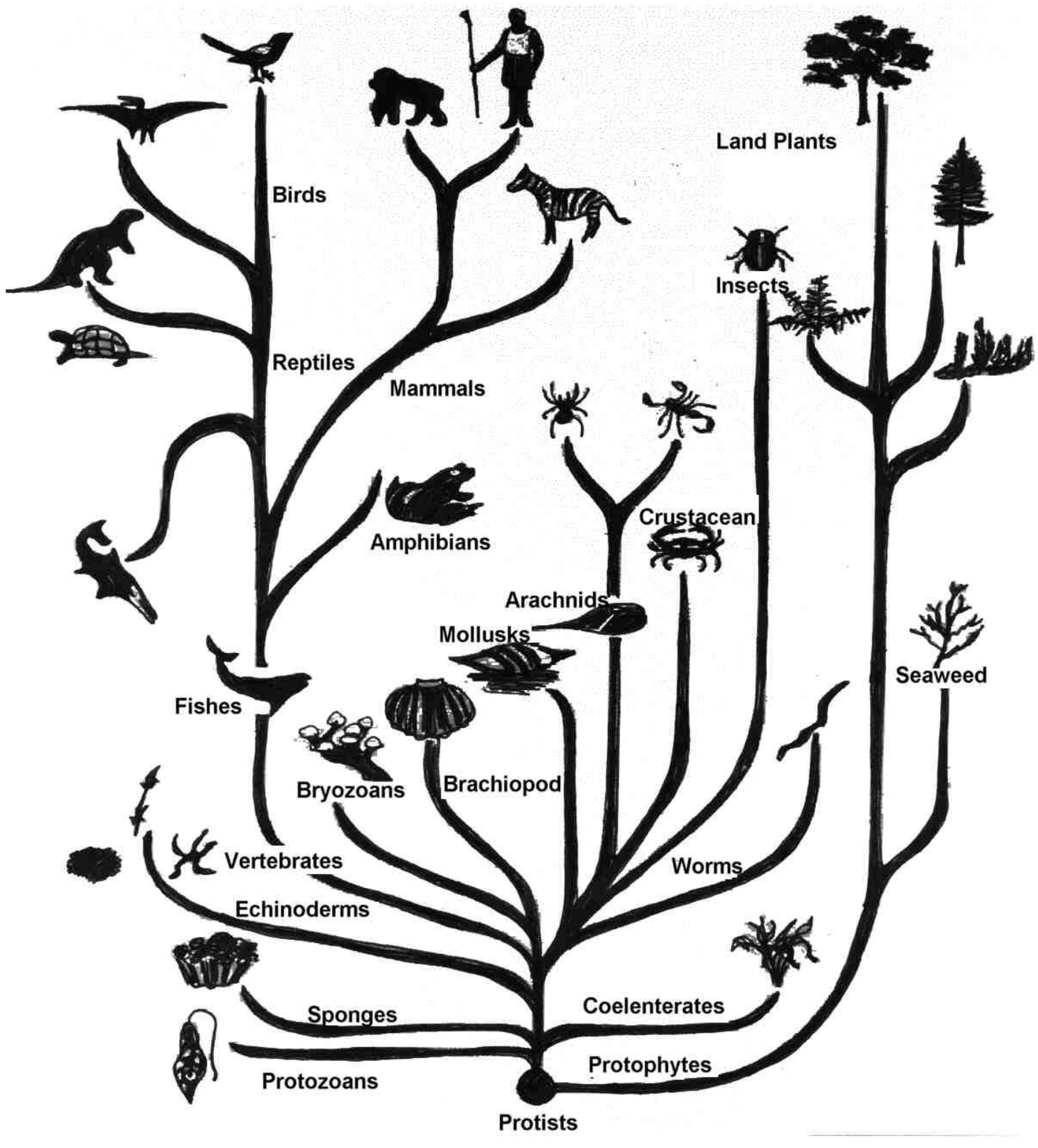
Motivation

How do organisms get their shape?

Evolution!



Motivation

Learning to perform computational research is hard

- Attempting to gain the correct skills is frustrating
- They don’t teach the skills you need in classes
- PIs don’t teach these skills to their students

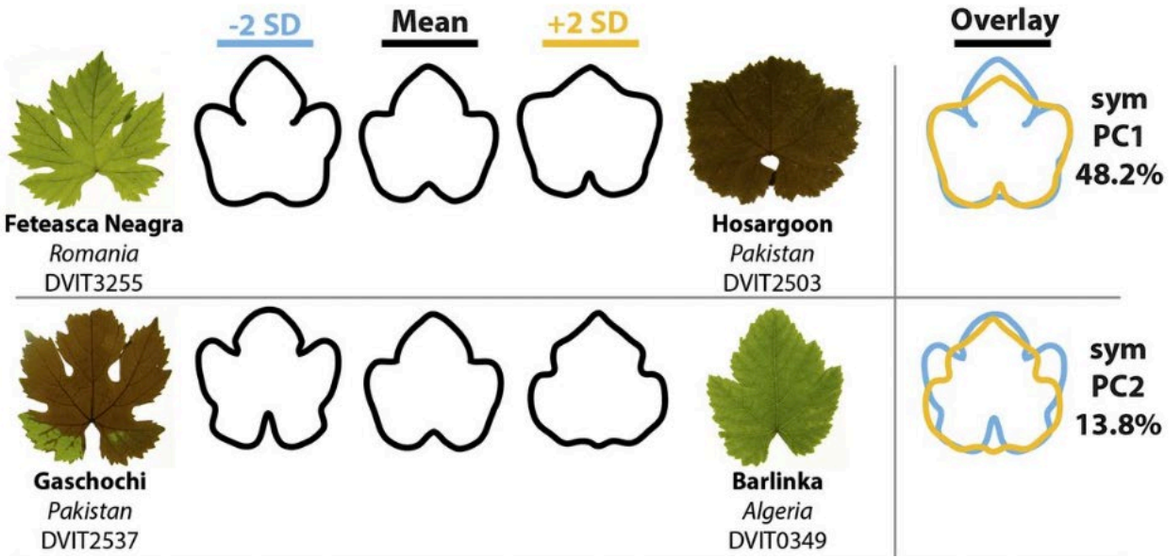
How I learned

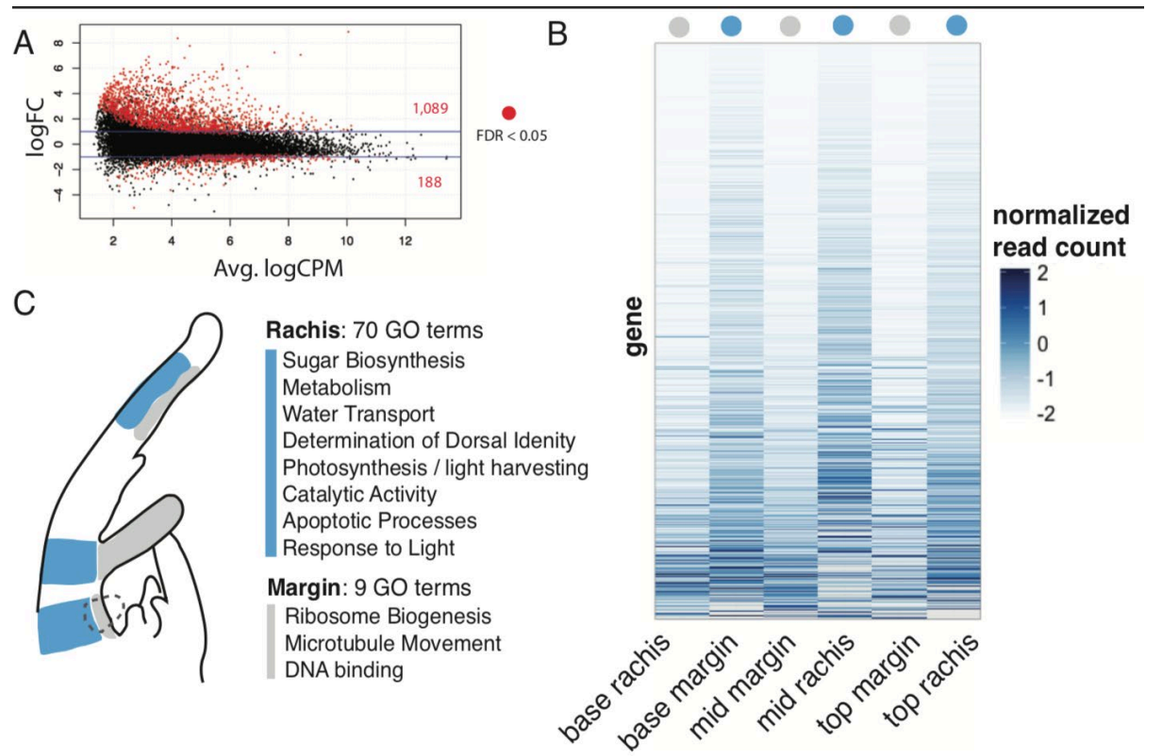
- Using online tutorials and documentation
- Talking with peers, largely online
- Teaching others

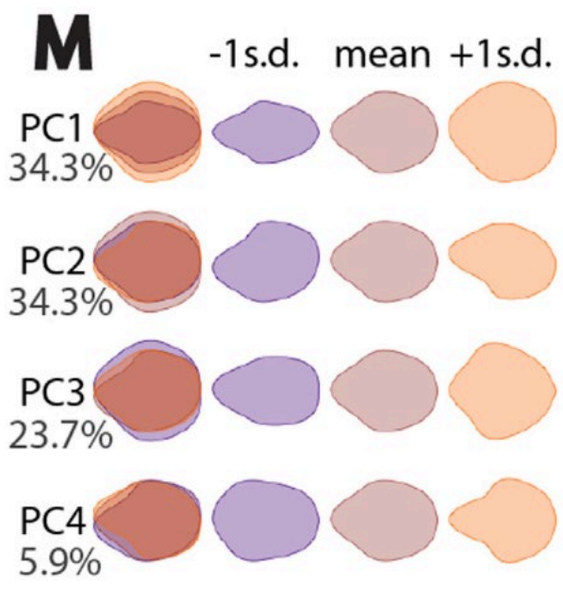
Now committed to programming education

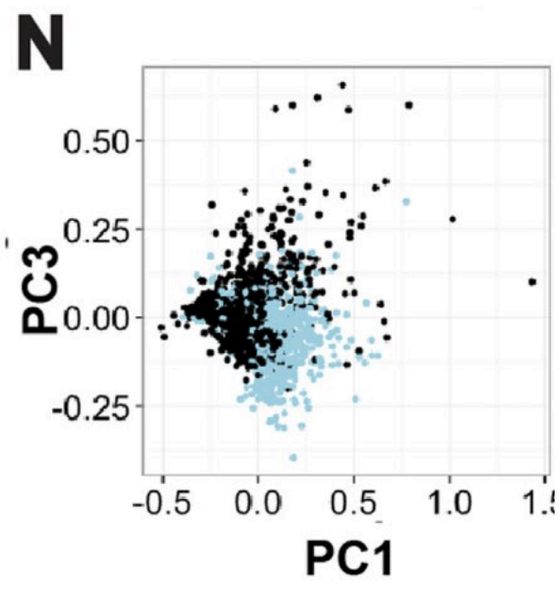
Motivation

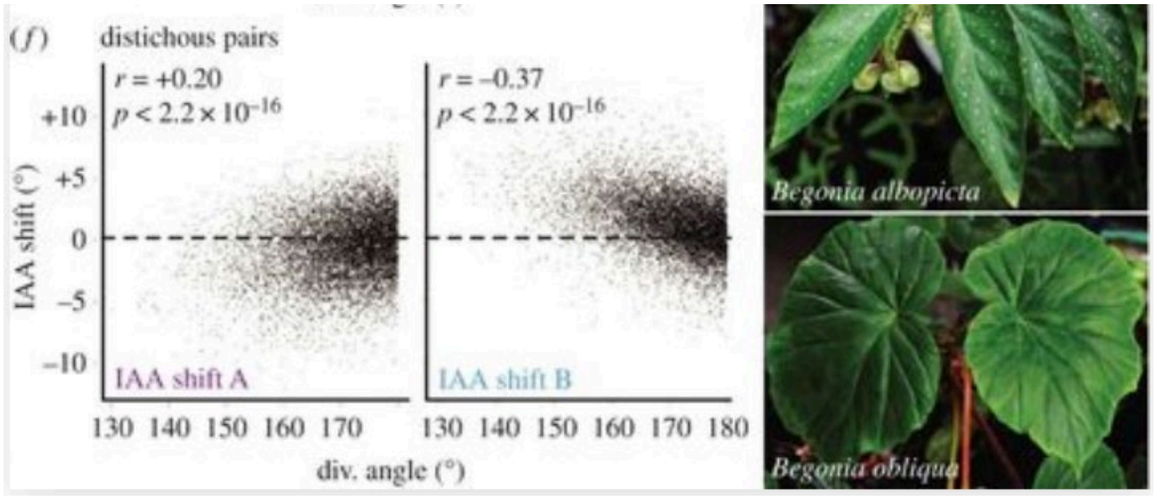
Utilizing data made my research faster and better











Chitwood et al, 2014, Martinez et al, 2019, Martinez et al, 2016a, Martinez et al., 2016b,

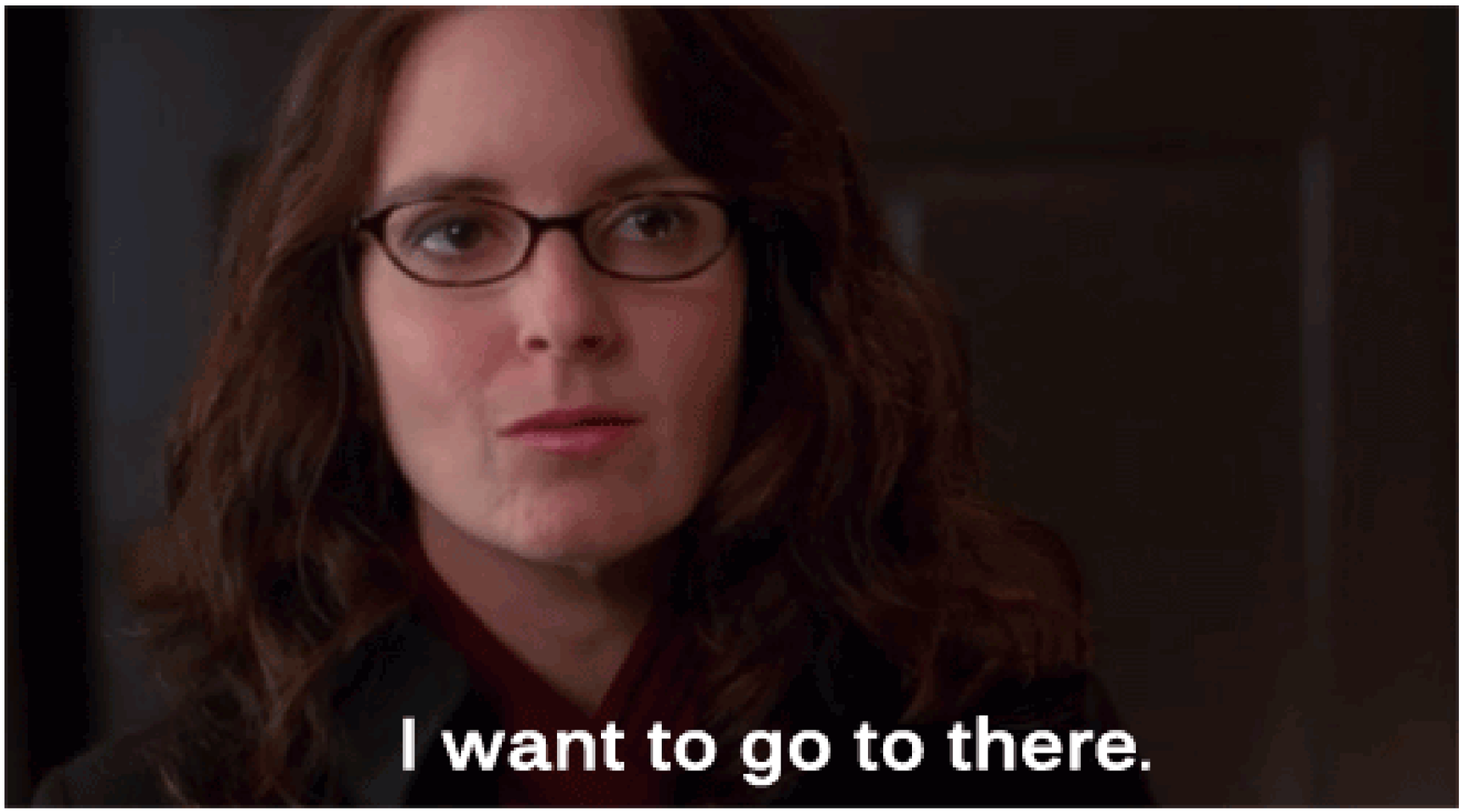
Motivation

fieldmuseum.org

Motivation

ag.com/smithsonian-institution/story-behind-those-jaw-dropping-photos-collections-natur

Motivation



Motivation

Yay!

So much cool data!

Ect

Motivation

Yay!

So much cool data!

Nay! It's hard to:

Navigate these databases

Access data within these databases

Understand what is in these databases

Ect

Motivation

Data Science Education + **Using Biodiversity data To answer research questions** =

Curiosity Data Project

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Project set-up

Curiosity Data Project

To use biodiversity databases and inquiry based learning to teach data literacy skills to undergraduate and graduate students.

Project Overview

Guided by mentors, students are given free rein to explore a database of their choosing with the end goal of creating a tutorial outlining their process.

Project set-up

Synergistic Relationship

- give feedback
- use data
- recruite lifelong advocates
- create tools
- create guide to use the database and handle data

- provide approachable open data
- provide a point of contact for questions

Project set-up

1.Got team together

- Recruited eight undergraduates from pool of 30
- Some programming knowledge (R or Python)
- Majors: CS, Stats, Biology
- Recruited mentor help: 1 PhD student and 1 industry data scientist

Project set-up

2. The students were asked to pick one database and document how they access, clean, and analyze the data from that database

Project set-up

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List of prompt questions to begin exploration

- What features you find most useful?
- What kind of questions can we ask when using this database?
- What tools are available to use this database?
- What skills are required to use this database?
- How do you access the data?
- What tutorials help you access the database?
- What are the challenges to using this data?
- What are the rules for using this database?

Project set-up

3. Student end project goal is a tutorial that will be posted *online*

Reasoning

- We are giving back to the community by teaching others
- They get over their fears of posting their code online
- Expose them to open science philosophy and computational reproducibility
- Focus on code readability
- Allow them to learn how to present a story
- Teaches them computational research notebook management
- Regularly use Git and Github
- Start online presence and portfolio

Project set-up

4. We met for 20 min individually each week to discuss what they worked on, challenges, and plan next weeks work. (~3 hours a week)

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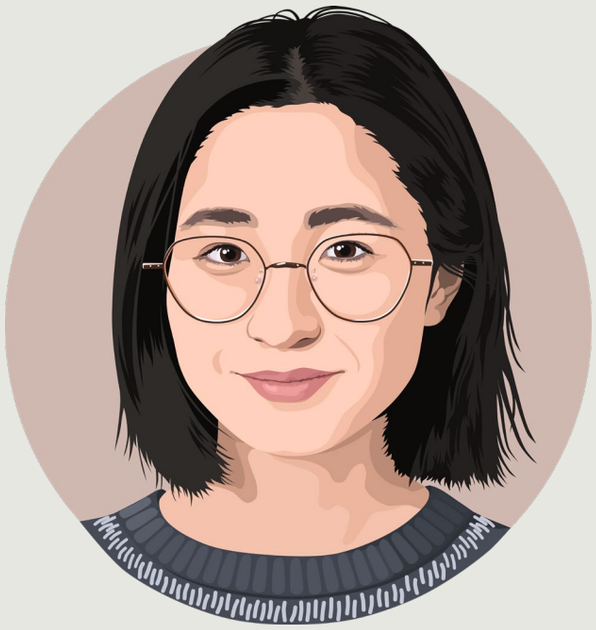
Results of the project

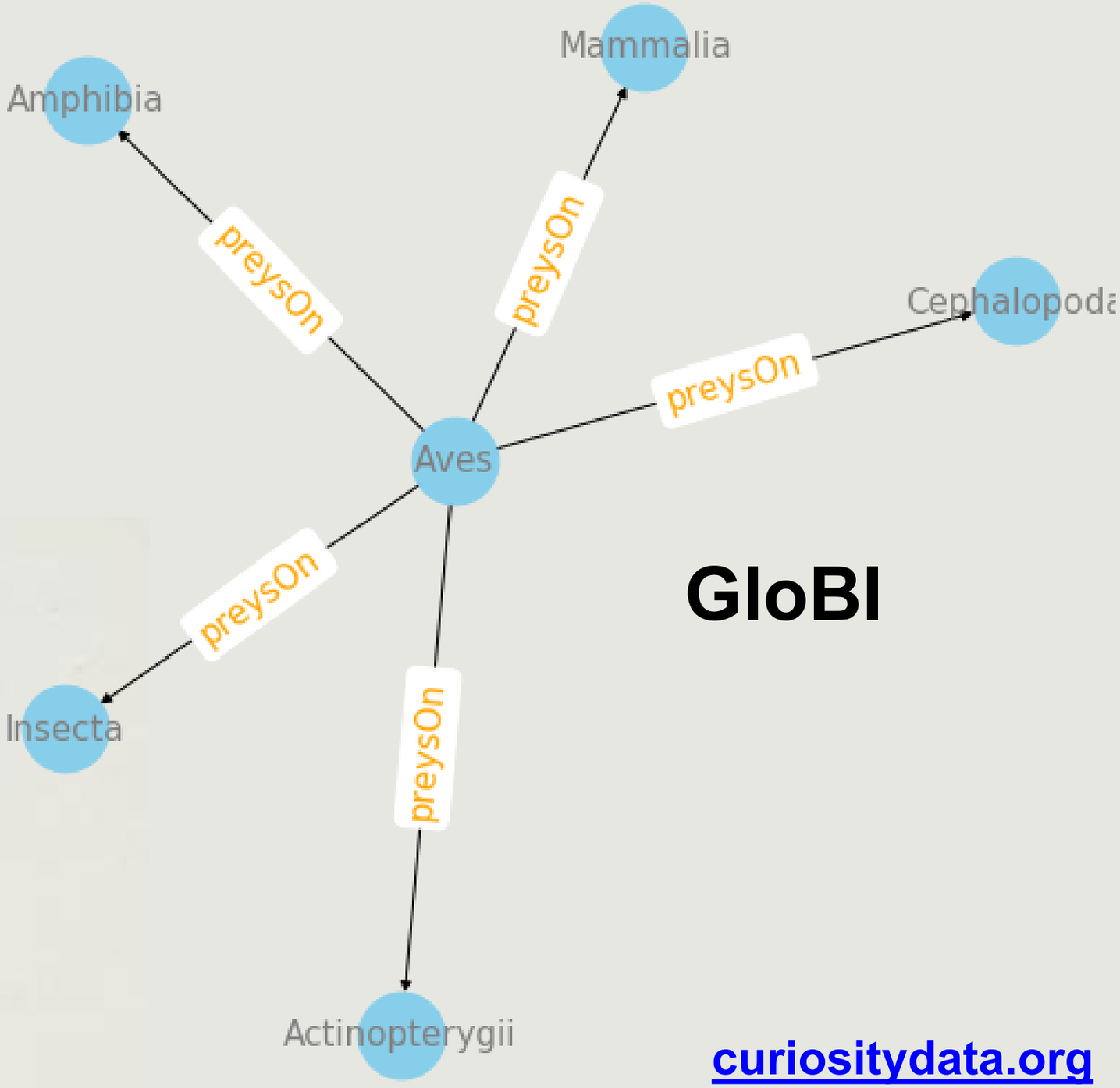
I am so impressed with their work!

Results of the project

Ask how animals interact with network graph visualization



Yikang Li



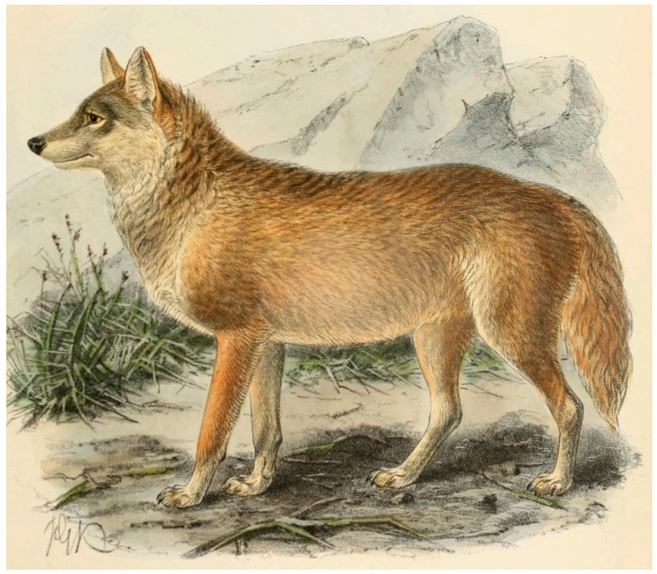
GloBI

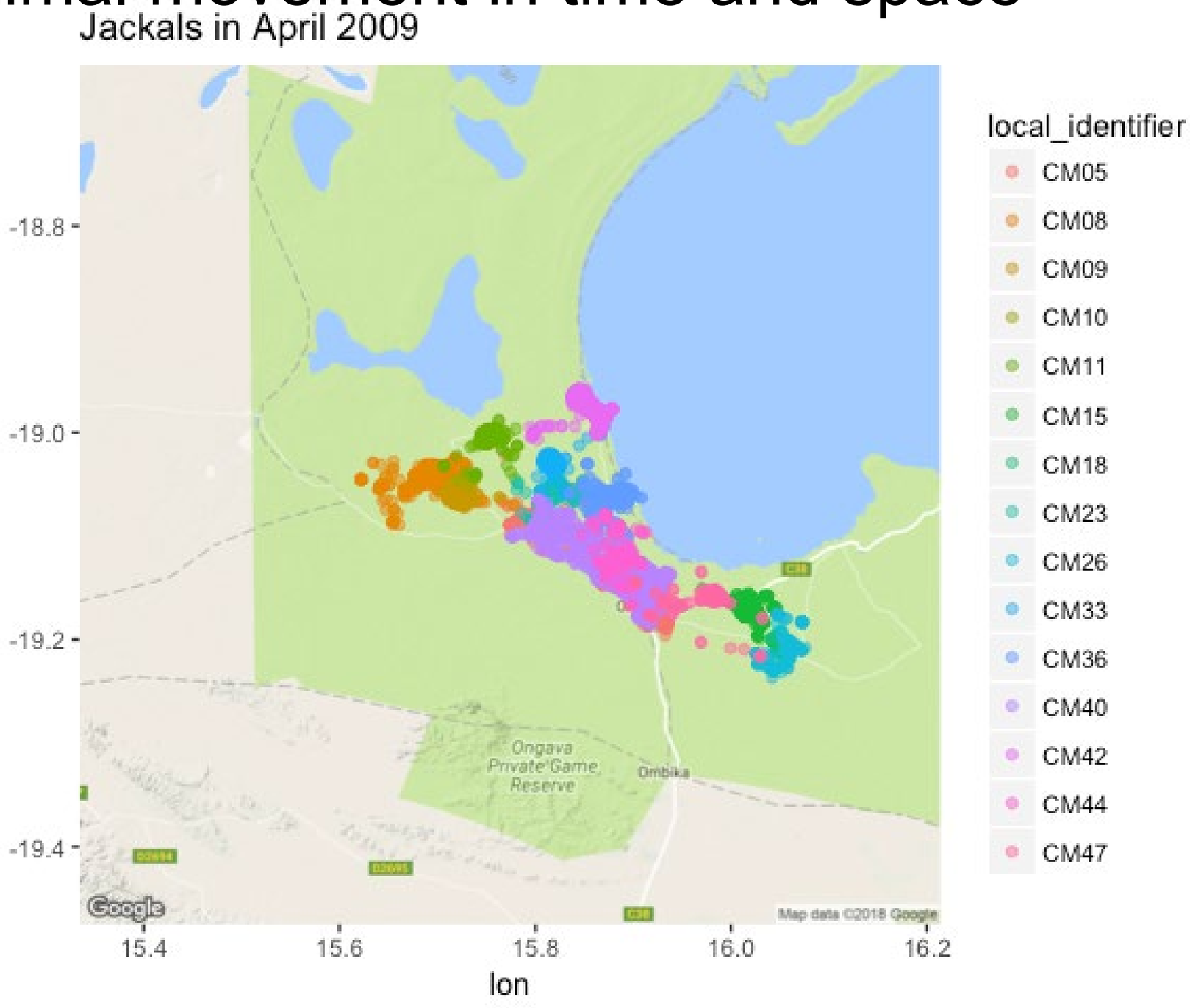
curiositydata.org

Results of the project

Tracking animal movement in time and space

Caryn





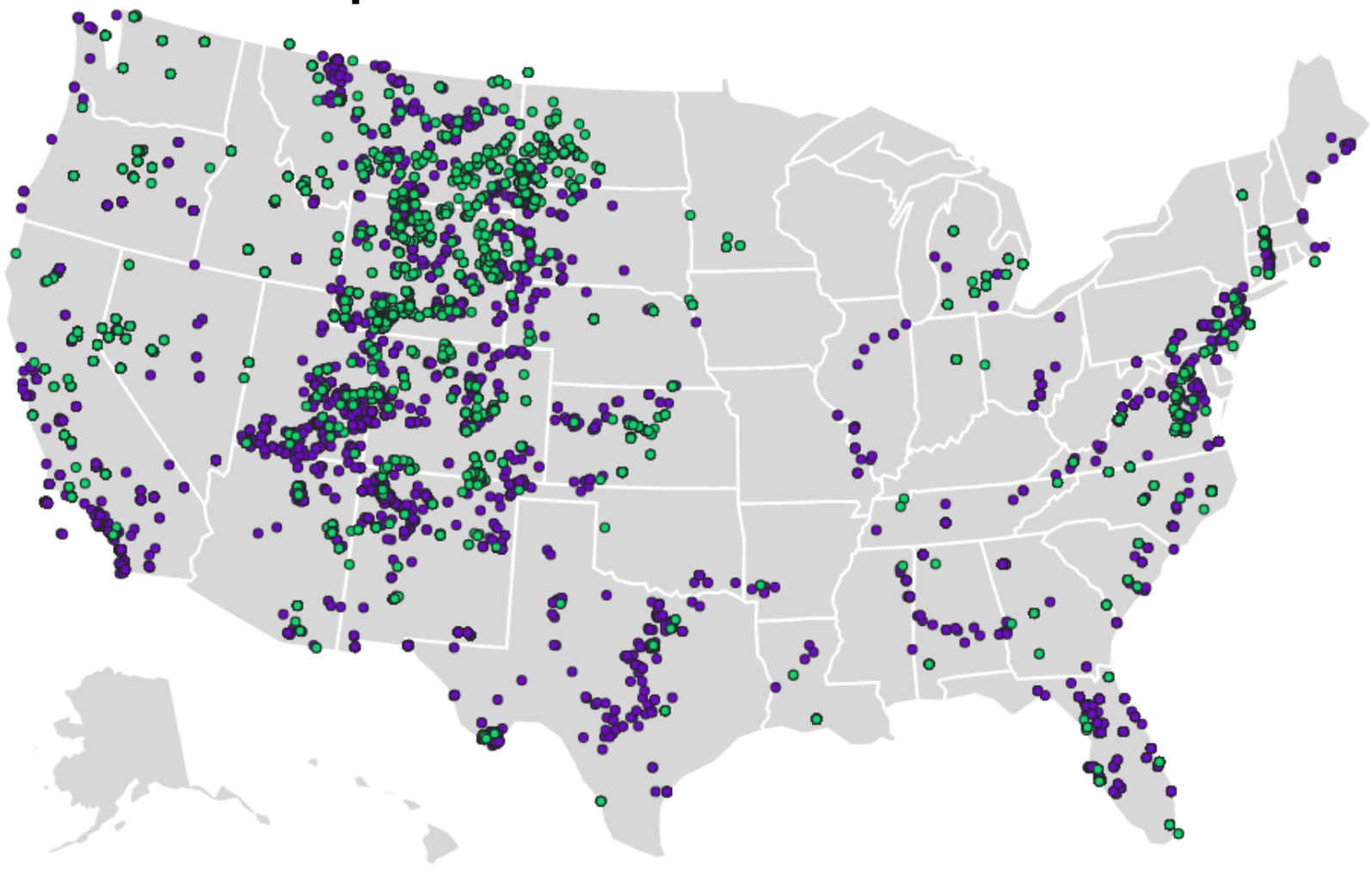
MoveBank

curiositydata.org

Results of the project

Mapping dinosaur and plant fossil data in time and space

Zoe



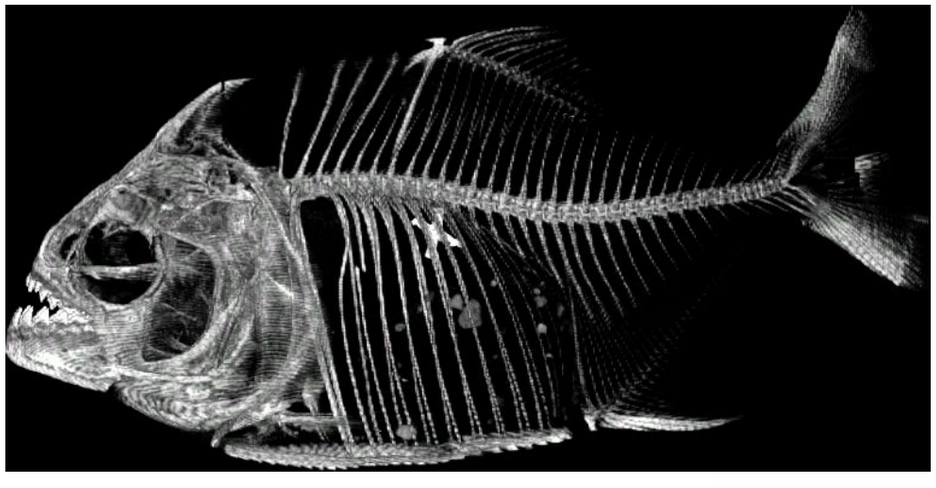
Paleobiology Database (PBDB)

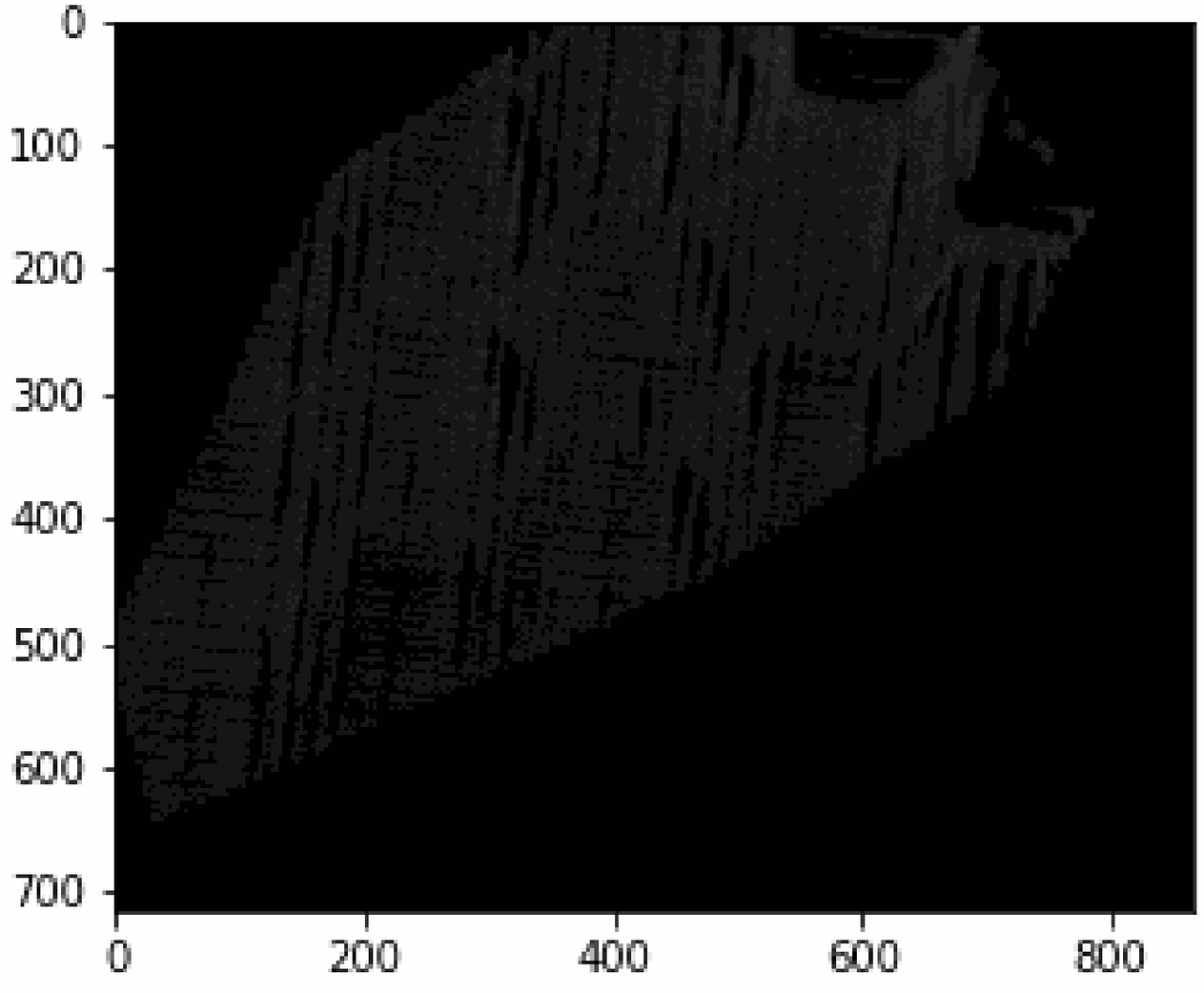
curiositydata.org

Results of the project

Coming Soon: Explore 3D CT Scans using open source tools

Samantha





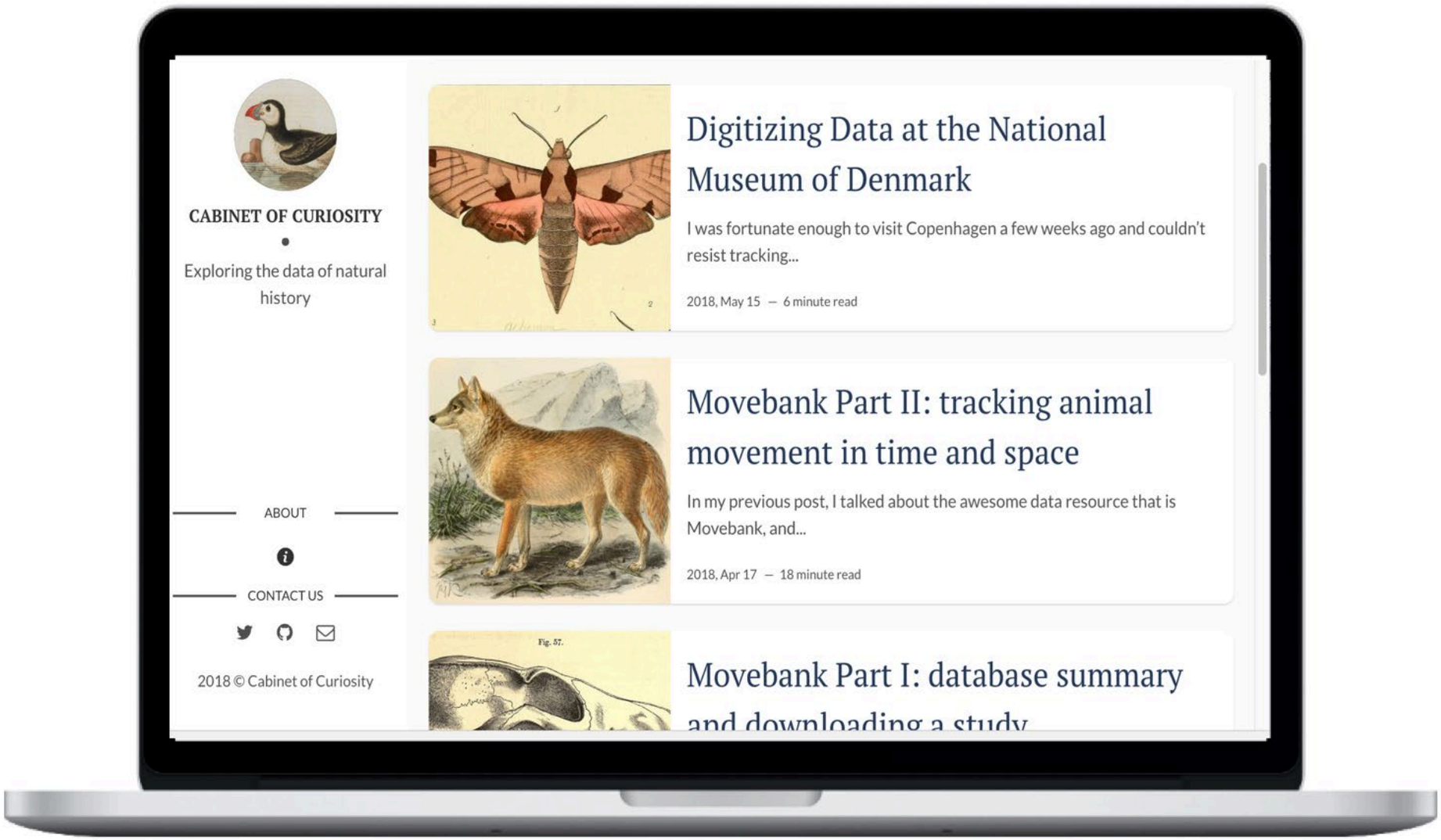
Morphosource

curiositydata.org

Results of the project

curiositydata.org

Exploring the data of natural history



Results of the project

What worked?
What didn’t work?
What did the students like about the project?
What did the students dislike about the project?

Results of the project

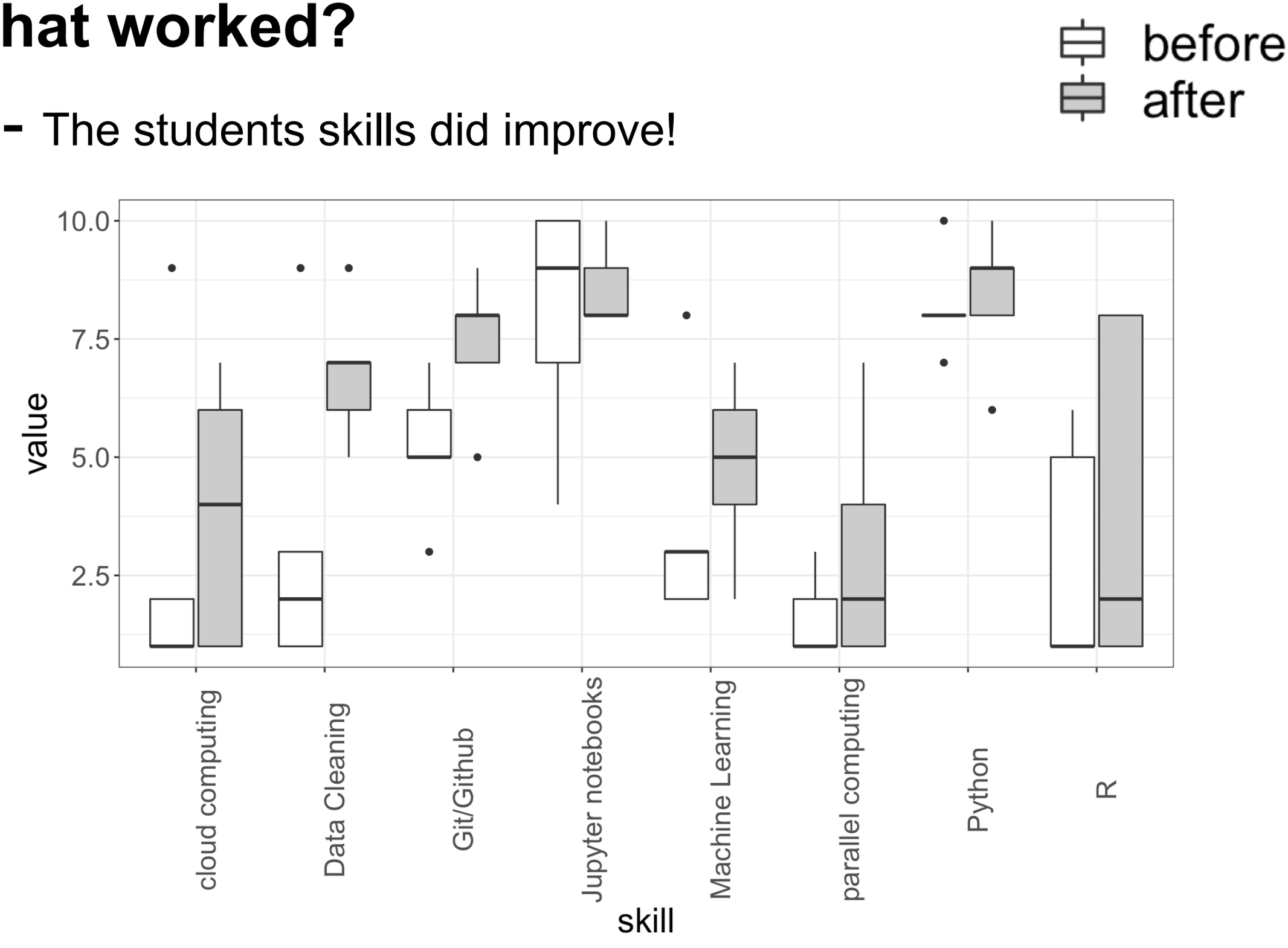
What worked?

- They all thrived in self directed inquiry
- These tutorials can be coopted for workshops AND be remixed for lesson modules
- Feedback works if directly in contact with developer
- They all enjoyed it and stuck with it, I didn't lose one student
- Students became extremely interested in the data

Results of the project

What worked?

- The students skills did improve!



Results of the project

What didn’t work?

- They sometimes floundered with so much freedom
- It was hard to assess how much work they did each week
- They could not create tools like I originally planned
- The limiting factor is me, hard to scale.
  - Reviewing the code
  - Dealing with notebook to website
  - Individual meetings

Results of the project

What did they like about the project?

- “**Ability to take the project in whatever direction I wanted**”
- “I love manipulating data programmatically and making plots with the data.”
- “I enjoyed learning new skills outside of the classroom and actually being able to create a tutorial using data that I was really interested in!”
- “Exploring different data visualization methods and tailor them to fit the data set”

Results of the project

What did they dislike about the project?

- “Debugging code and figuring out how to make an interesting…story out of the data”
- “Downloading data using API and storing big data.”
- "Lack of structure”
- “Trying to figure out how to solve the problems like dealing with missing and "bad" data”
- “That some visualization methods/packages are difficult to install and use “

Results of the project

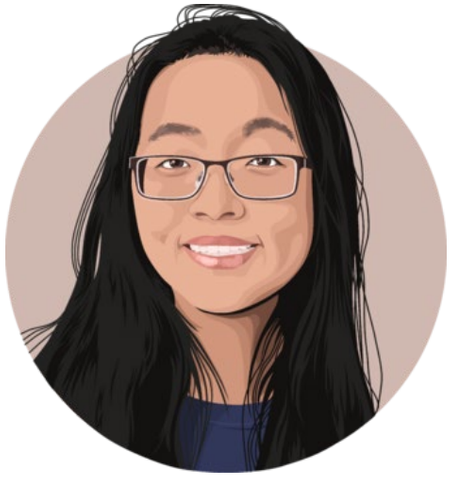
What did they dislike about the project?

- “Debugging code and figuring out how to make an interesting…story out of the data”
- “Downloading data using API and storing big data.”
- "Lack of structure”
- “Trying to figure out how to solve the problems like dealing with missing and "bad" data”
- “That some visualization methods/packages are difficult to install and use “

But everything they listed is normal frustrations about working with code, so they learned what is common frustrations with the code

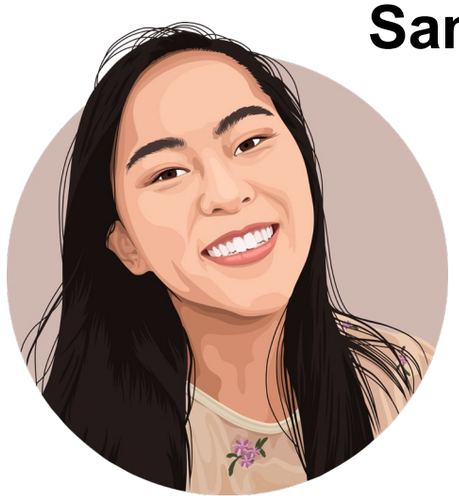
CURIOSITY DATA TEAM

Samantha



Zoe

Shirley



Winifred

Sara

Ciera

Lynn

Yikang

Ollie

Caryn

*Not pictured Yihui

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End questions

- Is there something here with gender and this data? Why? How do we leverage for bridging gender gap in STEM?
- Can this scale as an academic course?
- Can this scale in the online community?
- Do you need to know how to program to run a similar project?
- Will people use these tutorials?
- Where is an appropriate place to house these tutorials?

Thank You!

Neotoma, PBDB, GloBI, Movebank, Google Earth, iDigBio, BHL, Morphosource

All the museums, collections, and universities that hosted me to visit, and provided insightful discussion and critical feedback

Berkeley Museum of Vertebrate and Zoology, New York Botanical Garden, National Museum of Denmark, Kew Gardens, Natural History Museum of Utah, American Museum of Natural History, Cooper-Hewitt Design Museum, UT Austin Vertebrate Paleontology Laboratory Collection, Digimorph Facility, UT Austin Ichthyology Collection, Lewis and Clark College, Natural History Museum (London)

Special Thanks: Deb Paul

moz://a

BIDS
BERKELEY INSTITUTE FOR DATA SCIENCE

Learning Objectives

Link to exact document

- identify assumptions about data
- formulate research questions
- tell a story with data
- visualize data
- build data science portfolio
- write collaborative code
- employ version control
- apply data / file management
- think with reproducibility in mind
- handle and merge data
- clean messy data

Overlapping Data Literacy Skills

Minimum

1. Manipulation of data frames
    - subset
    - merge
    - transform long vs wide
    - apply formulas to values
2. Map points onto a geographic map, understand assumptions
3. Clean taxonomic names, understand assumptions
    1. Species concept
    2. Spelling errors
    3. Species synonyms
    4. Hierarchical classification
    5. Species databases available and differences between them

4. Time stamp data formats
    1. Time collected vs time measured
    2. Time formats
    3. Visualization techniques for time and space
5. Look into biology for sanity checks
6. Understand the value of plotting data and which visualization is important