Data Cleaning: Redwood Lab

January 29, 2025

Today’s plan

1. Review: Git/GitHub + Reproducible Environments

2. Hands-on practice: Redwood data cleaning

Review: Git/GitHub + Reproducible Environments

Setting up git, GitHub, and a reproducible environment

Details at: https://tiffanymtang.github.io/dsip-s25/

- We set up two repositories:
  - `dsip-s25`: for me to distribute course materials (lecture slides, **code**, etc) to you
    - You should only *pull* to retrieve information
  - `dsip`: **your** repository to do all your work in
- We introduced **`renv`** and **`conda`** to create reproducible environments

Overview of renv and conda

Details at: https://tiffanymtang.github.io/dsip-s25/

	renv	conda
1. Create environment:	Create .Rproj and open it `renv::init()`	`conda create --name env_name`
2. Activate:	`renv::activate("pkg_name")` # not necessary if you're working in an .Rproj # (automatically activated if in .Rproj)	`conda activate env_name`
3. Add packages:	`renv::install("pkg_name")`	`conda install pkg_name`

4. Create/update lock file:	`renv::snapshot()`	`conda env export --from-history > environment.yml`
		`conda lock`
		# to run `conda lock`, need to have installed
		# conda-lock package beforehand

Why bother with reproducible environments?

- Exact reproduction of the packages, software versions, etc.
- Different projects might use/require different package versions
  - E.g., older projects might use older package versions
- Ease of portability to different computers and operating systems:

renv

1. Clone GitHub repository
2. Open R project
3. Install renv:
   ```
   install.packages("renv")
   ```
4. Restore environment:
   ```
   renv::restore()
   ```

conda

1. Clone GitHub repository
2. Navigate to directory with lock file
3. Install conda-lock (and conda if not already available)
   ```
   conda install conda-lock
   ```
4. Restore environment:
   ```
   conda-lock install --name "new_env_name"
   ```

A couple extra bells and whistles from last time...

- How do you choose a particular conda environment in VS Code?
  - Open command palette (Ctrl+Shift+P or Cmd+Shift+P)
  - Search for "Python: Select Interpreter"
- What is quarto and how do you use quarto in VS Code?
  - Details: https://tiffanymtang.github.io/dsip-s25/#using-quarto
  - Note: to do this, usually need to install jupyterlab and ipykernel in your conda environment:

    ```
    conda install ipykernel
    conda install jupyterlab
    ```

Pushing changes to GitHub

We've completed our basic setup – A great time to pause and take a snapshot of our project.

But before doing so, if you check your git status,

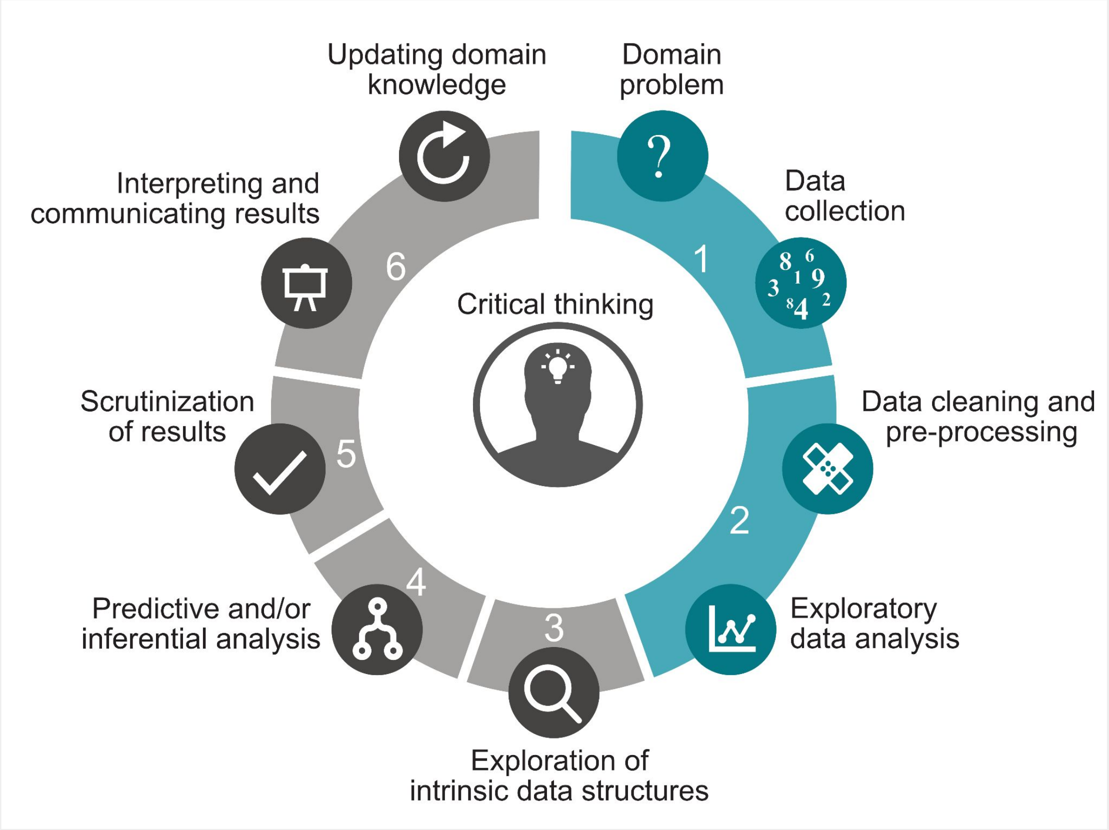
- You might notice a lot of "junk" files that aren't worth tracking (e.g., they are useless to collaborators and/or they change too frequently)
- Add these files to your .gitignore, e.g.,

```
*.DS_Store
*/data/*
*__pycache__*
*.ipynb_checkpoints*
```

Details: https://tiffanymtang.github.io/dsip-s25/#pushing-your-changes-to-github

Getting started with the Redwood Lab

Lab 1: A Macroscope in the Redwoods [Tolle et al. (2005)]


Updating domain knowledge
Domain problem
Data collection
Interpreting and communicating results
Critical thinking
1
6
8 6 3 1 9 8 4 2
Scrutinization of results
Data cleaning and pre-processing
5
2
4
Predictive and/or inferential analysis
3
Exploratory data analysis
Exploration of intrinsic data structures

Lab 1: A Macroscope in the Redwoods [Tolle et al. (2005)]

- **Coastal redwood trees:**
  very tall, very old
- 44-day study in Sonoma, California
  (April 27, 2004 5:10pm - June 10, 2004 2pm)

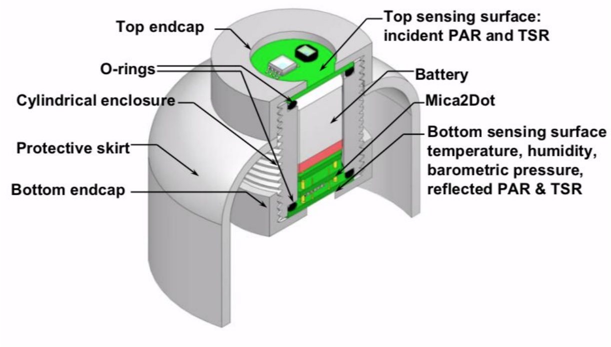

Top endcap
Top sensing surface: incident PAR and TSR
O-rings
Battery
Cylindrical enclosure
Mica2Dot
Protective skirt
Bottom sensing surface temperature, humidity, barometric pressure, reflected PAR & TSR
Bottom endcap

Figure 2: Sensor node and packaging

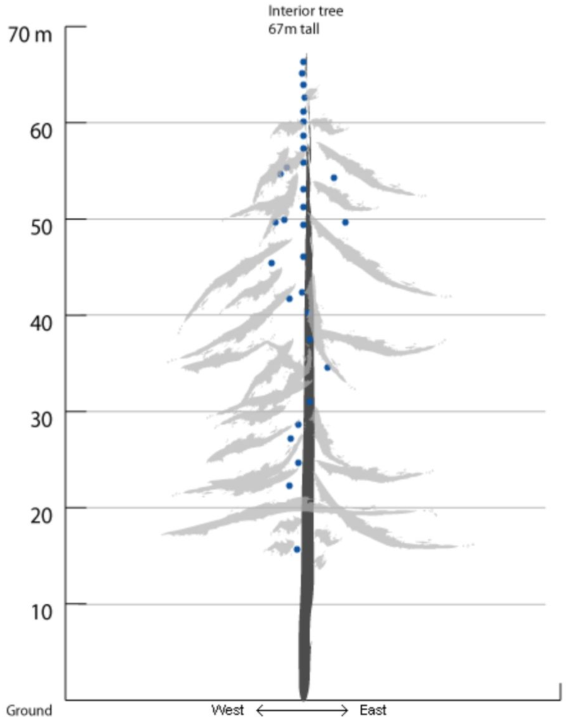
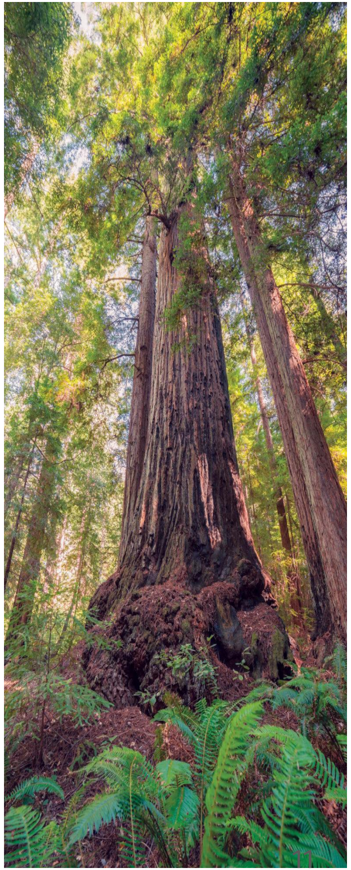


Figure 1: The placement of nodes within the tree



Getting started with the redwood lab

Available templates on the course repository (`dsip-s25`)

- For your **reproducible report**: you can find R Markdown (R only) and quarto templates (R, Python) in `notebooks/`
  - This report should only contain your "filtered" code, not everything you ever did and or looked at in this lab.
- Some **loading** and **cleaning** functions have already been populated in `R/` and `python/` folders
  - Some functions have scaffolding but not yet filled in; this is your to-do

For today's class, you can use **notebooks/exploration_R.qmd** (or _python.qmd)

Your tasks for today

1. **Load in the data**
   a. Epoch/dates and redwood datasets have already been filled out for you.
   b. You need to fill out the `load_mote_location_data()` in the load.R/load.py file.

2. Look and "play" around with the data in order to:
   a. Try to **identify as many issues or oddities** with the data as you can. *Hint:* there are many!!
   b. Also **think** about how you might address these issues and clean the data. Jot down these ideas, but no need to take the time to implement it *yet*.
      - *Time permitting*: you can start implementing your ideas, but prioritize identifying the issues over fixing them.

Redwood Data Issues

- Two trees
- Outliers in voltage
- Missing values in humidity, hamatop/bot, temperature
- Log versus network data
  - Duplicated observations
- Humidity/temperature log data (mean = 16.4 in paper)
  - Lots of -4’s, -9000, -5000 in humidity
  - Lots of -138 in temperature

Redwood Data Issues

- Unknown/missing mote location data
- NAs in humidity, temperature, and PAR measurements
- Reported dates/times were weird
- Two(?) trees
- Erroneous humidity, temperature, PAR measurements or other outliers
- Failed sensors/missing observations
- Inverse relationship between voltage from network and log datasets
- >1 observation within 5 minutes; some exact duplicates; some aren't
- Issues with network data versus local logging system
- So many others…

Your tasks for today

3. ***Start*** data cleaning:
    a. Remove duplicate rows/observations
    b. Remove missing data
    c. Merge redwood log and network data
    d. Merge redwood data with epoch/dates data and mote location data
    e. *Time permitting:* other data cleaning steps that you think are appropriate

A Macroscope in the Redwoods [Tolle et al. (2005)]

Data Collection

- 44-day study in Sonoma California (April 27, 2004 5:10pm - June 10, 2004 2pm)
- Total of 33 motes
- *Timing:* measurements taken every 5 minutes
- *Vertical distance:* placed between 15m - 70m about 2m apart
- *Angular location:* mostly west side since it has a thicker canopy to buffer against direct environmental effects
- *Radial distance:* 0.1-1m from the trunk to capture trends that affect the tree directly and not the broader climate

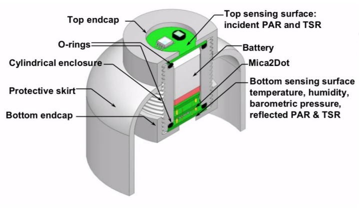

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Figure 2: Sensor node and packaging

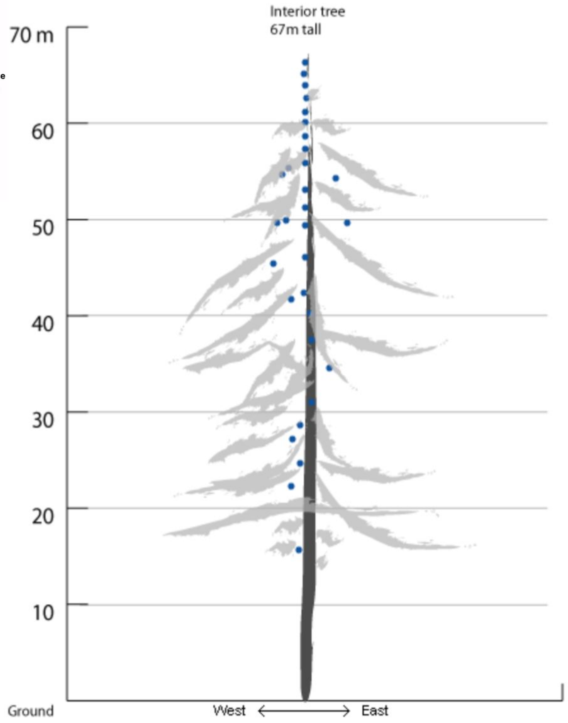
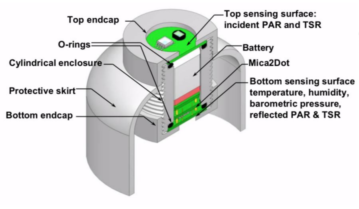


Figure 1: The placement of nodes within the tree

A Macroscope in the Redwoods [Tolle et al. (2005)]

Data Collection (continued)

- Measured variables
  - **Temperature**
  - **Humidity**
  - Light levels: PAR (photosynthetically active radiation)
    - **Incident (direct) PAR**: provide information about energy available for photosynthesis
    - **Reflected (ambient) PAR**: related to measurements of land surface reflectance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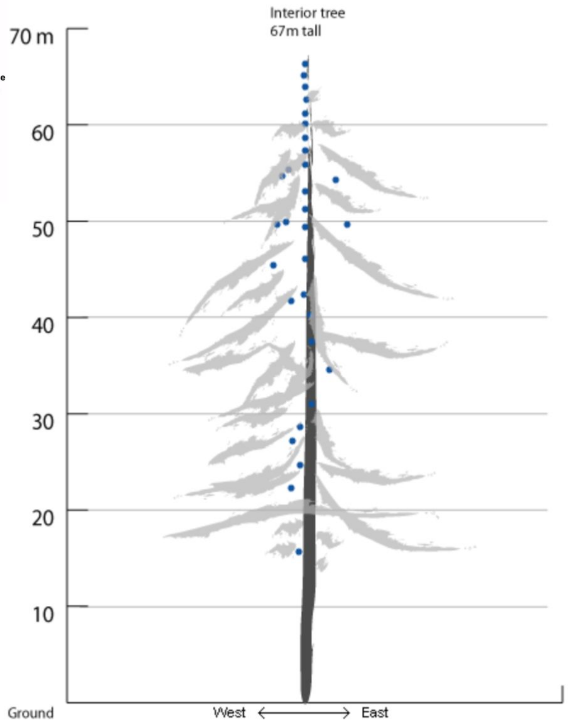

Figure 1: The placement of nodes within the tree

Recap + Next Time

Recap

- **Data cleaning** is a highly iterative process.
- My two cents:
  - Don’t be afraid to ask lots of questions. Better to ask than to assume (more likely than not, incorrectly)
  - Read all documentation

Next Time

- More hands-on practice with exploratory data analysis
  [chapters 4 and 5 from VDS textbook]