THE UNIVERSITY OF ARIZONA
COLLEGE OF ENGINEERING
Systems & Industrial Engineering

Roots for Resilience Fellowship Presentation

Advancing Sustainable Research: My Journey with Roots for Resilience (R4R) Fellowship

Sunday Usman
Department of Systems and Industrial Engineering
sundayusman@arizona.edu

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Discussion Outline

- Fellowship Details
  - ✓ Program Overview
  - ✓ Program Structure
  - ✓ Program Goals
  - ✓ Program Requirements & Timeline
  - ✓ How to Participate
  - ✓ R4R Lectures
- My Research Focus
- Benefits of R4R
- Conclusion

Program Overview

- Led by Arizona Institute for Resilience (AIR), CyVerse, and Data Science Institute (DSI)
- Focused on environmental resilience research
- Trains graduate students on open science and computational tools

Fig. 1: Data as the foundation for environmental resilience research

Image Source: Freepik (www.freepik.com)

Program Structure

- Weekly schedules and sessions
- Tuesdays (in-person): Meeting with CyVerse, DSI, and/or AIR members
- Thursday (virtual): Foundational Open Science Skills (FOSS) training on data science tools

Program Goals

- Accelerate research for fellows and departments
- Enhance data science skills across departments
- Foster professional networks for resilience research

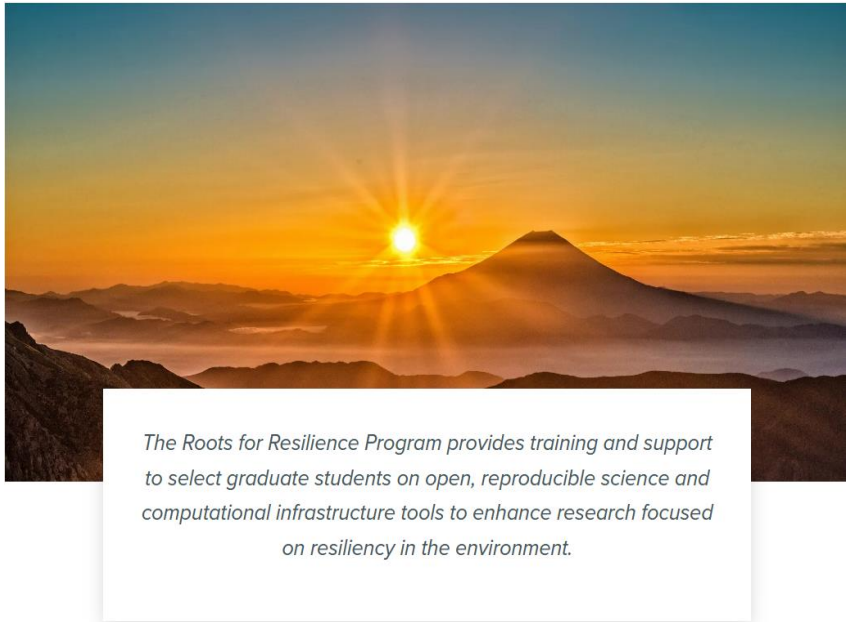


Fig. 2: Focus of R4R Program

Image Source: Roots for Resilience (https://datascience.arizona.edu/r4r)

Requirements and Timeline

- Attend weekly meetings for a semester
- Complete two presentation with capstone projects
- Receive a stipend

How to Participate

- Ph.D. student who has completed qualifying exams or an exceptional master's student
- Show interest by talking with your advisor
- Department nominates one graduate student
- Department heads select/submit the nomination

Open Science

- Open Science is transparent and accessible knowledge that is shared and developed through collaborative networks
- Increase impact
- Encourages collaborations
- Supports reproducibility

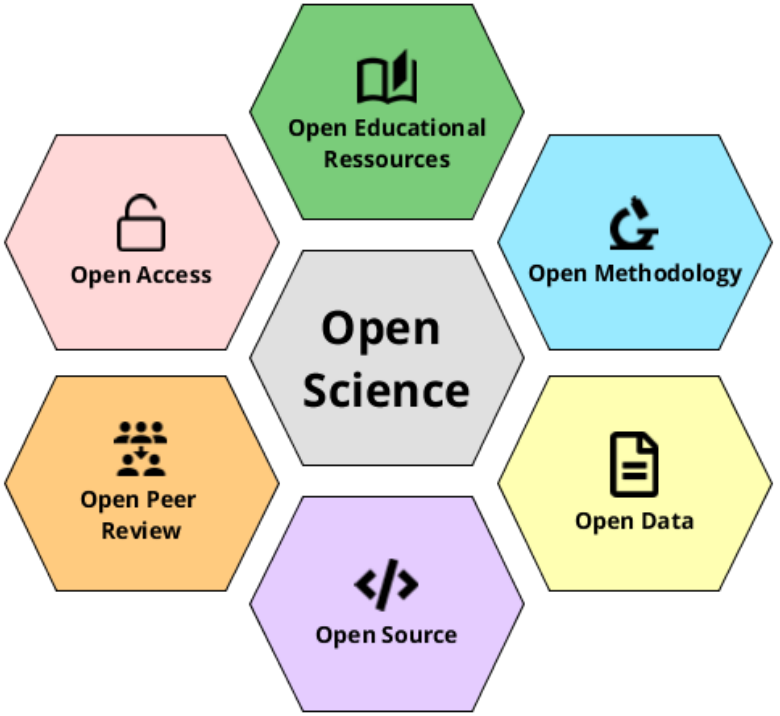


Fig. 3: Six Pillars of Open Science

Image Source: University of Lucerne (https://www.unilu.ch)

Vicente-Saez, R., Martinez-Fuentes, C., (2018). Journal of Business Research 88, 428–436

Data Management

- Data is the foundation for open science
- Benefits:
  - Eases collaboration and reuse
  - Supports scientific integrity and reproducibility
  - Complies with funders' and journals' requirements (e.g., NSF)

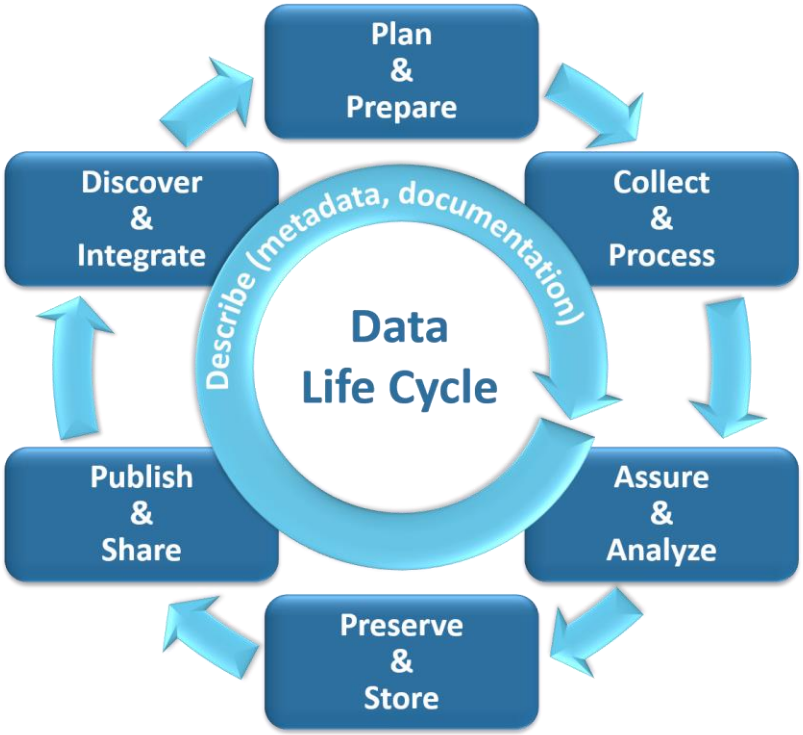


Fig. 4: Data Life Cycle Model

Image Source: California Water Boards (https://www.waterboards.ca.gov)

Project Documentation

Documenting your work is essential for sharing knowledge beyond publications

Tips for Great Documentation:

Clarity: Easy to understand, no ambiguity	Completeness: Cover all critical details	Accuracy: Keep information up-to-date	Organization: Logical structure for easy navigation	Relevance: Focus on what's important for the audience

Public Repositories for Documentation:

GitHub Readme, Wiki, Pages, MkDocs, Material MkDocs, JupyterBook, etc.

Talking to Computers

Command Line Interface (CLI)

What is CLI?

- A more direct and powerful way to interact with computers
- CLI is found in operating systems like Windows, MacOS, and Linux

Why Learn CLI?

- Efficiency: Perform tasks quickly with direct commands
- Powerful: Automate repetitive tasks with scripts

Using Github for CLI

- Access a Linux shell via Github Codespaces for direct computing

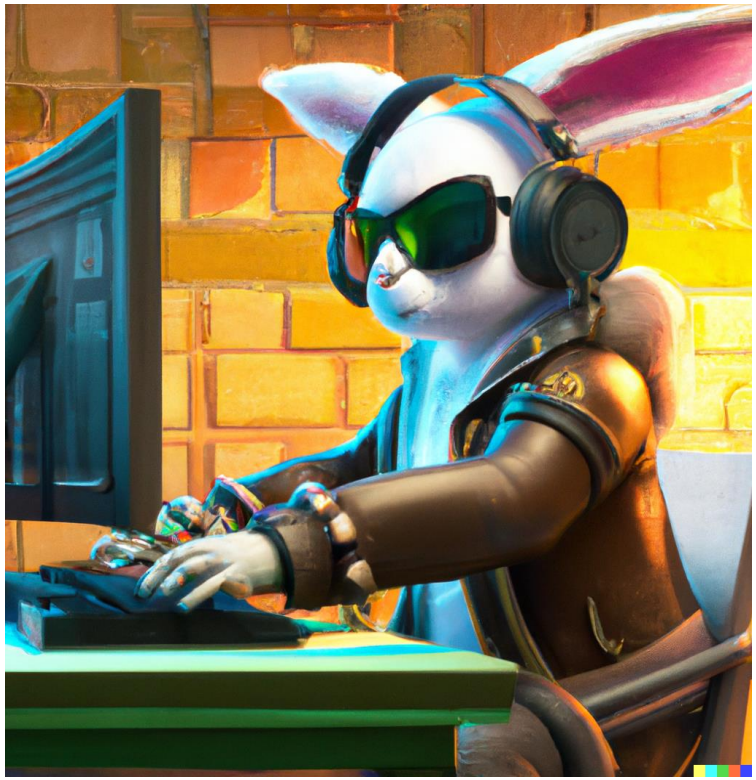


Fig. 5: How to talk to Computers

Image Source: Medium (https://towardsdatascience.com/)

Version Control

Version Control: Tracking changes to files over time (e.g., Git, Google Docs, Microsoft Word)

Git vs. GitHub:

Git: Local version control tool

GitHub: Online platform for hosting repositories and collaborations

Git Basics:

Key Commands: git clone, git pull, git commit, git push, git branch

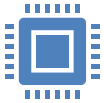
Branching & Merging: Enables parallel development and integration

Image Source: California Water Boards (https://www.waterboards.ca.gov)

Reproducibility: Software Environments

Reproducibility: Same software, same data, same results

Challenges: Ensuring code works across environments.



Software Environments: Hardware, software, and network resources for computation

Environment Managers:

Conda: Isolated environments for reproducibility.

Renv: Similar tool for R

Rougier et al., (2013). PeerJ Comput. Sci. 3, e142

Reproducibility: Build & Run Containers

Containers package code and its dependencies into a single, portable unit that ensures consistent execution across different systems

Container Benefits:

- Easily share and replicate software environments
- Run applications on any machine without reinstallation

Popular Tools:

- Docker: A platform to create and run containers
- Singularity: A container engine for high-performance computing

Remote Computing: CyVerse

CyVerse is a cloud computing system for the academic and research communities

CyVerse is an excellent platform to make your research open and reproducible

Cyverse is completely Free for University of Arizona students, staff, and faculty

CyVerse Data Store: Secure cloud storage (up to 3TB for Pro users)

Store, share, and analyze data with powerful computing resources

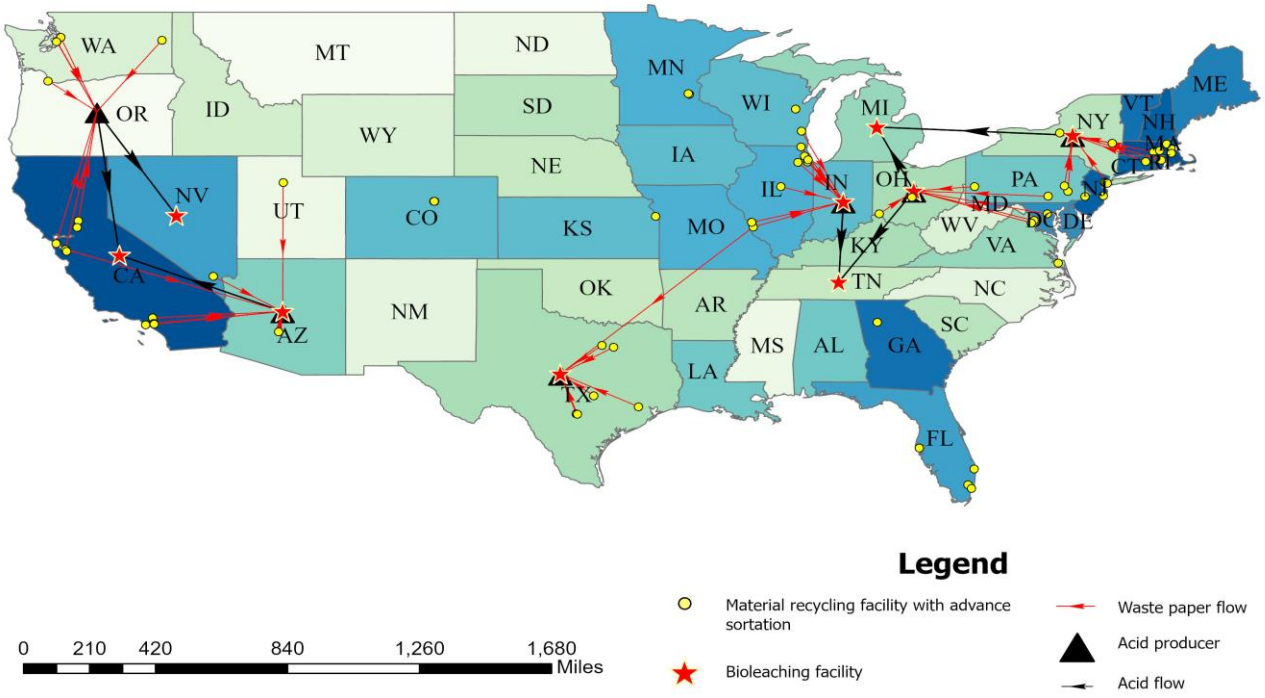
Includes pre-installed apps for analysis (e.g., Jupyter, RStudio, QGIS)

My Research Focus

- Utilization of the following methods in recovering critical minerals and rare earth elements:
  - Lifecycle Assessment
  - Technoeconomic Analysis
  - Geographic Information System (GIS)
- Waste identification, characterization and conversion

Recycling

Designing profitable supply chains for lithium-ion battery recycling in the United States



Alipanah, M., et al., (2024). Clean Technologies and Recycling, 4, 22–42.

Benefits of R4R

- Building a website using GitHub repository (Website)
- Integrating a website interactive map for waste conversion facilities
- Worked with GitHub Repository
- Interacted with experts in different fields

Conclusion

Participating in the Roots for Resilience fellowship has been a transformative experience, equipping me with advanced data science tools and open science principles to enhance sustainability research.

This journey has not only expanded my technical expertise but has also deepened understanding of critical global challenges.

As I continue my research on lifecycle assessment for critical minerals and rare earth elements recovery, I am positioned to apply these skills to drive meaningful change, collaborate across fields, and contribute to a more sustainable and resilient future.

THANK YOU!!!