U.S. DEPARTMENT OF ENERGY
Office of Science

The Journey to STRUDEL:
How We Came to Embrace User Experience in Scientific Ecosystems

February 21, 2024

https://strudel.science

https://ux.lbl.gov

Lavanya Ramakrishnan

Lawrence Berkeley National Lab
LRamakrishnan@lbl.gov

Funded by Sloan Foundation, Liz Vu & Josh Greenberg Program Officers, Grants #10074 & #10572

ALFRED P. SLOAN FOUNDATION

UX.lbl.gov SciData

Scientific Data Division

BERKELEY LAB
Bringing Science Solutions to the World

Team

Lavanya Ramakrishnan
lramakrishnan@lbl.gov

Dan Gunter
dkgunter@lbl.gov

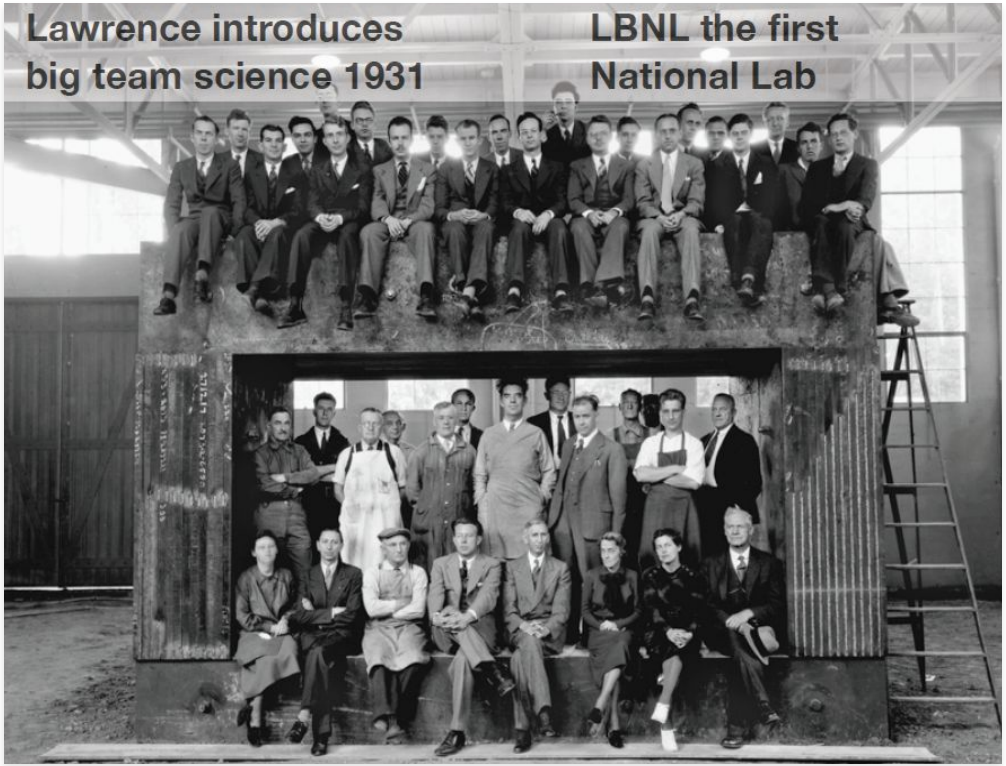
Sarah Poon
sspoon@lbl.gov

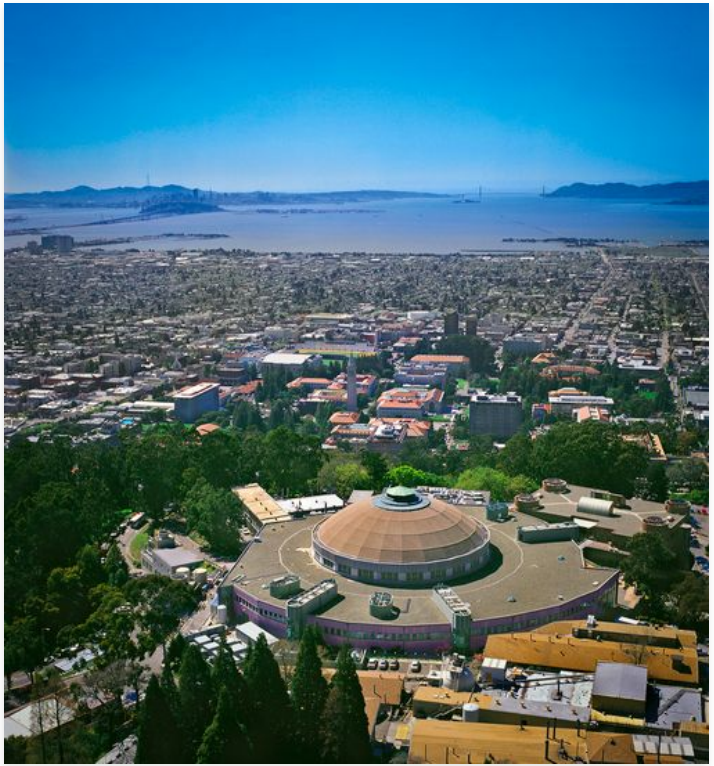
Rajshree Deshmukh
rajshreed@lbl.gov

Cody O'Donnell
ctodonnell@lbl.gov

Drew Paine
pained@lbl.gov

Team science is at the core of what we do at Berkeley Lab





from LBNL image archive

Workflows: How do we enable researchers to effectively and efficiently manage their computation and data?

ESnet

Molecular Foundry

ALS

JGI
JOINT GENOME INSTITUTE

NERSC

ESS-DIVE
Deep Insight for Earth Science Data

AmeriFlux Network

nmdc
National Microbiome Data Collaborative

NMDC

KBase

KBase

Workflow management

- data abstractions
- HPC and distributed
- resource management
- autonomous pipelines
- reproducibility

Data management

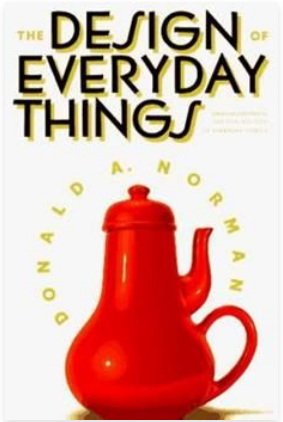
- search through AI-driven metadata extraction
- data change
- provenance

Why user experience (UX) matters for scientific software

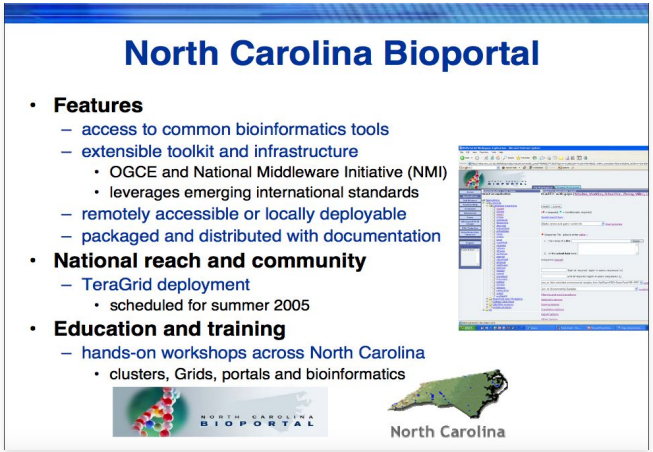
How our team views UX for scientific software development

How these experiences lead to STRUDEL as a way to provide open source tools to help teams build more usable scientific software

How did I get here …



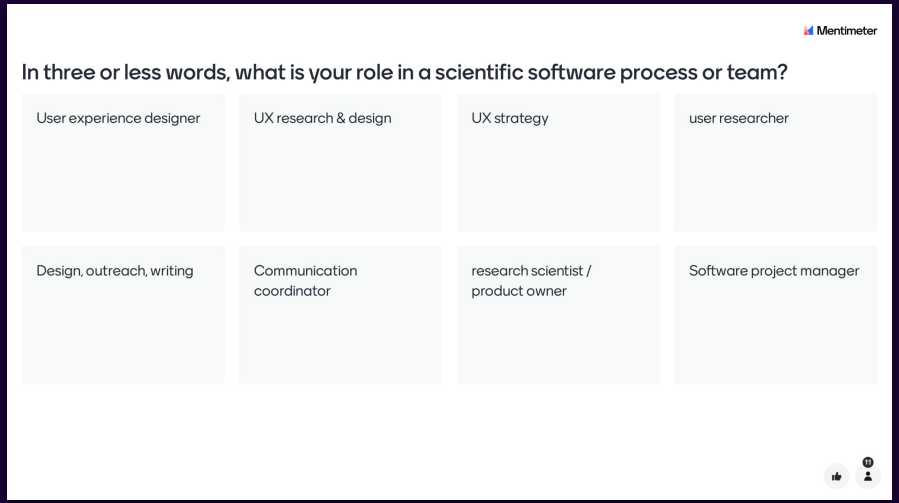
~2001

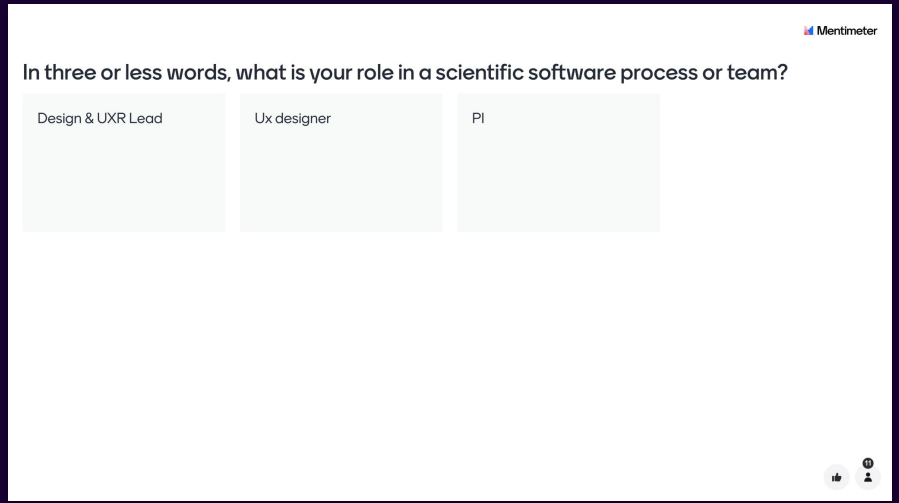


~2005

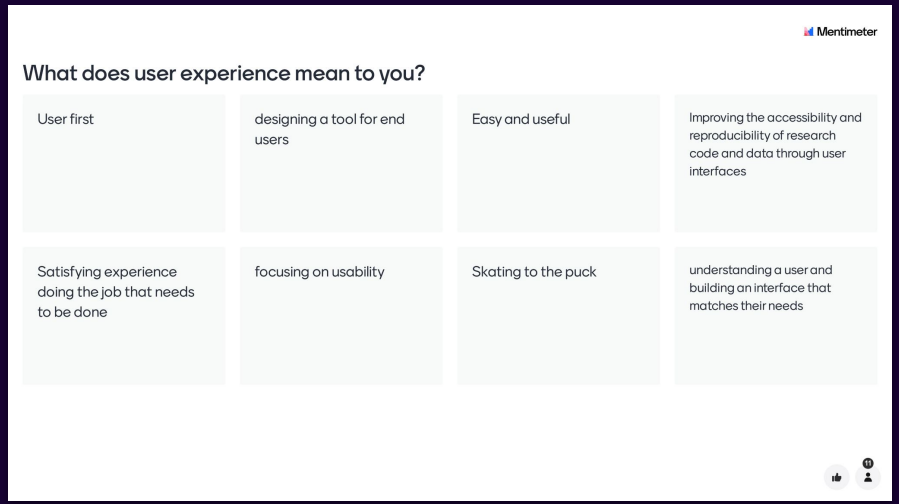
2012

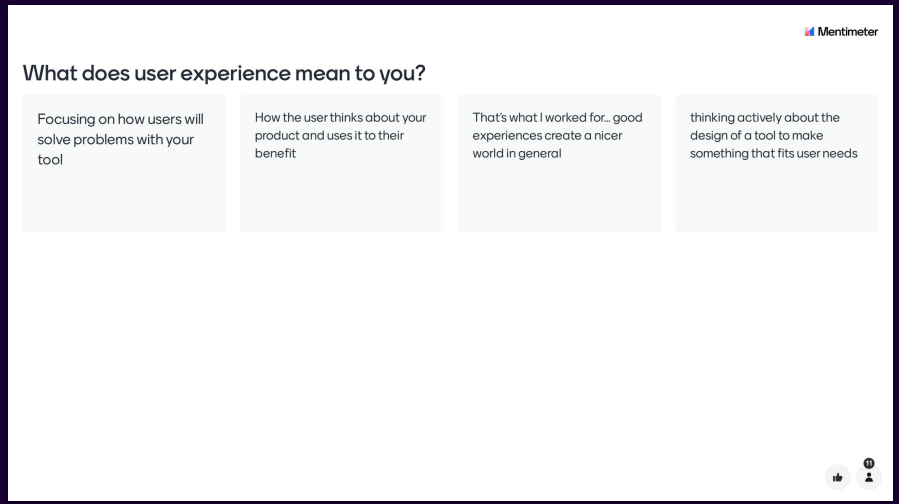
Menti poll — Question 1





Menti poll — Question 2

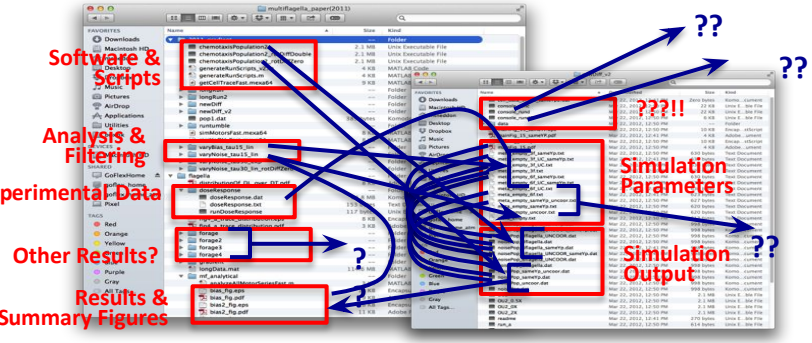




Why is building usable scientific software challenging?

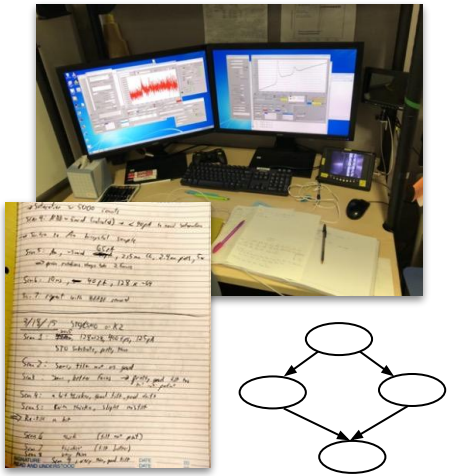
Realities of scientific work

Don’t fit into nice graphs



Courtesy: Paramvir Dehal, KBase team

Supporting artifacts and context are not captured



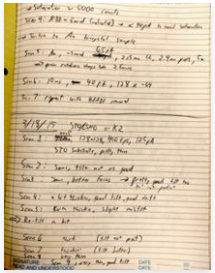
Courtesy: DESI project

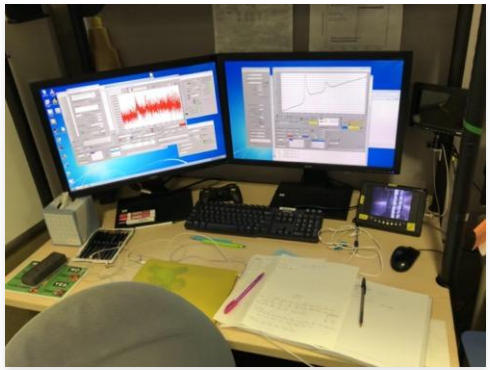
Collaborations have complex software stacks

Source: Ameriflux project

New work practices that don’t fit into current work process will likely not get adopted.

How we see UX in scientific software development



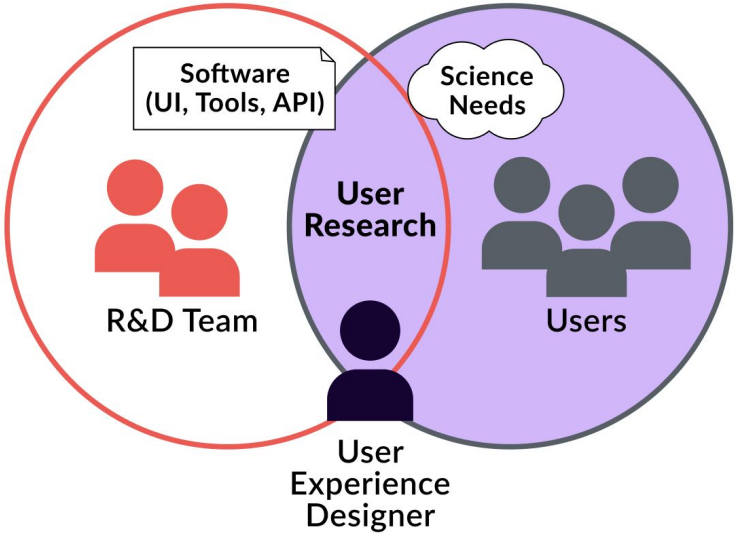


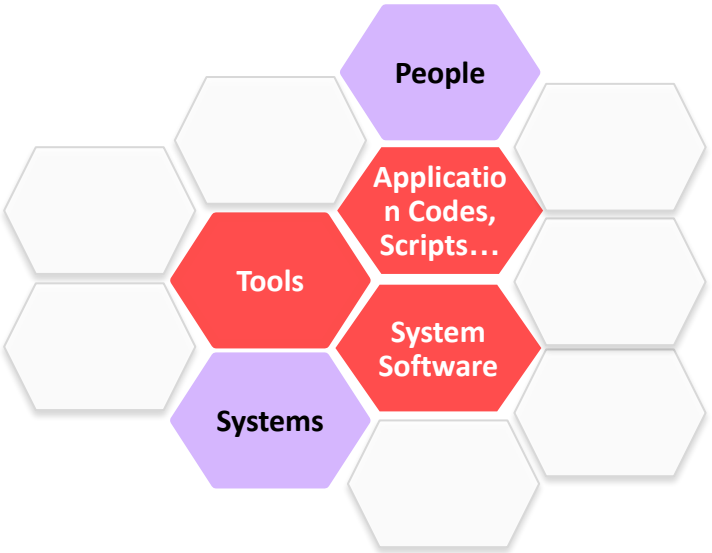
Scientific software project involve art as much as science

Just like pastry making... such as strudel

STRUDEL enables teams to create user-centered software for scientific communities. Plan, design, and build better scientific software projects using STRUDEL Planning Framework and Design System.

Our UX approach to addressing challenges in scientific workflows





User research gives you a **process to verify/validate your "intuition about what the user needs" (hypothesis) and convert into action**

User research processes can significantly improve the research and software outcomes

Discover Explore
- Interviews
- Contextual Inquiry, observations
- Competitive Analysis

Synthesis
- Journey Maps
- Scenarios
- Design Constraints or Considerations

Design
- Wireframes
- Detailed Mockups
- Prototypes

Usability Tests
- Interfaces, APIs

- Increased Productivity For End Users
- Decreased Development Costs and Time
- Increased Adoption
- Better and/or Lesser Documentation and Training
- Fewer Errors/Bugs, Lower Costs

How do we define User Experience (UX)?

User experience (UX) is the **practice** of developing services & products that provide ***consistent, relevant, productive, & joyful*** experiences for users.

Misconception: UX is purely focused on graphical user interfaces.

Best Practice: UX practices are employed to shape *everything* from internal organizational processes to all varieties of user interfaces (UIs) & interactions among systems & users.

Ten Principles for Creating Usable Scientific Systems

1. Solve the right problem first
2. Understand user motivations
3. Understand the context of use
4. Validate and verify what you have heard
5. Test before building; test after building
6. Clean interfaces can't make up for bad design
7. Build for the right user (i.e., computer engineers vs scientists)
8. Understand the user's metrics (usually not performance)
9. Cost/benefit for the science team is different from the development team
10. Be willing to iterate (early and often)

#1 Source: Dula Parkinson

#2 Source: Ameriflux project

[More details at https://berkeleydata.github.io/tenprinciples/ - Ten Principles for Creating Usable Scientific Systems, Paper at eScience 2017]

Planning, design & stewardship of scientific software often *tumultuous, even chaotic*

Individuals often fulfill roles that are varied, multifaceted

Never enough resources (time, $$ people)

Management & planning can be ad hoc responding to emerging scientific demands and needs

UX often an afterthought at best

Uncommon is an industry-like *Product Management* role who stewards vision, user engagement, etc.

STRUDEL builds on our experiences incorporating UX in many scientific projects

Providing UX as consultants, typically design or some usability research

Incorporating UX as key part of our R&D Projects

Deduce

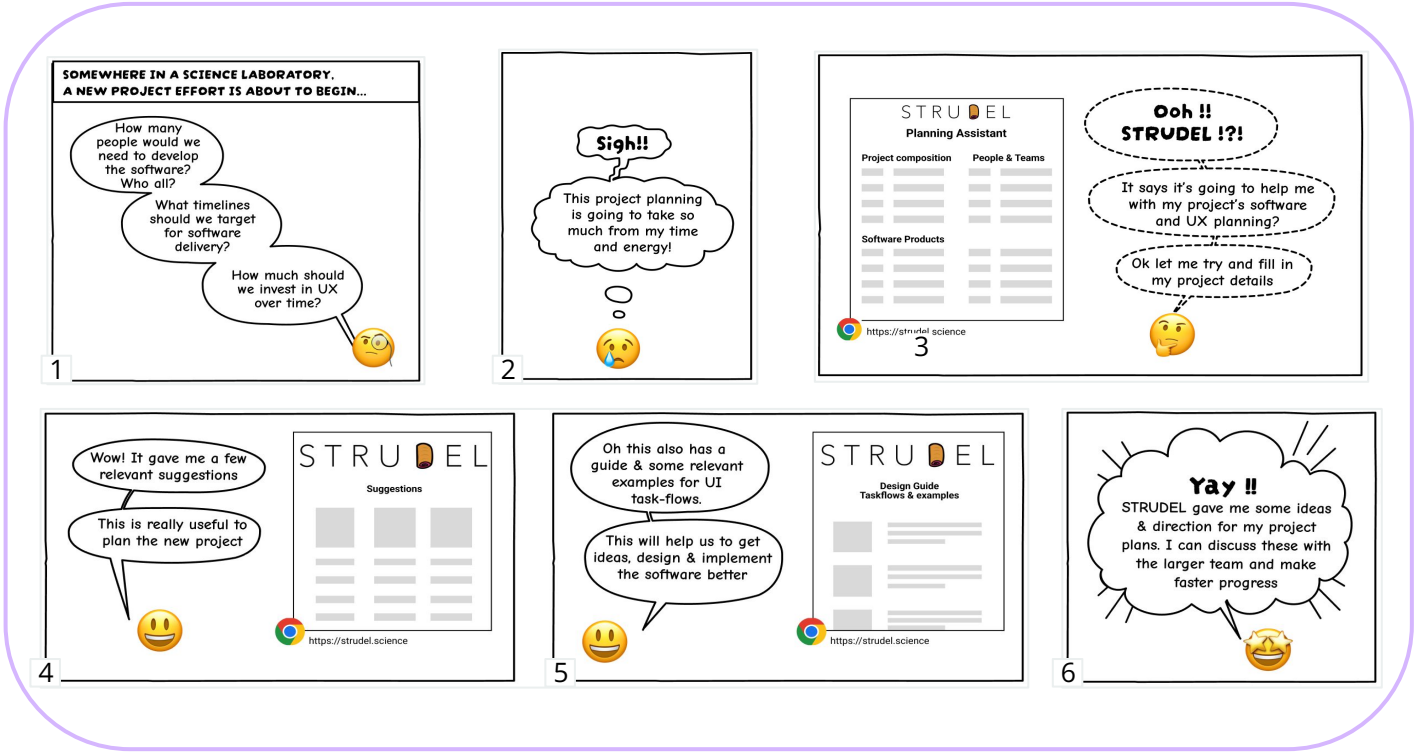
SCIRA

Systematically expanding & abstracting insights from this repeated work

STRUDEL

The long-term STRUDEL vision

Our aim is to develop products that help scientific software teams simplify adoption of UX approaches to enable more usable, sustainable software.



Our Experiences

HPC user’s perception of computing time
Challenges adapting Jupyter to HPC environments
Leveraging UX research to improve R&D process

Time is a key factor in our optimization strategy …

Machine Time
[Optimize Perf]

Allocation

Human time
[Optimize Productivity]

Compile / Move data

Preparation

Get code running /
Manage data / Submit jobs

Jobs wait in queue

Submit to Queue

Wait for jobs

Schedule and run jobs

Execution

Wait for jobs and debug results

Move data

Post Processing

Manual data management

Considering Time in Designing Large-Scale Systems for Scientific Computing, CSCW 2016
https://dl.acm.org/doi/10.1145/2818048.2819988

UX research highlighted how incorporating open source software in HPC environments requires strategic adaptations

Qualitative UX research in 2019-2020 investigated experiences with Jupyter on NERSC HPC systems

UXR surfaced *joyful* and *frustrating* user experiences, showed challenges & opportunities HPC environments face incorporating common open source tools

😀Streamlined JupyterLab setup makes accessing HPC resources easier & users happier

🤩Adaptations facility provided for pre-configured Jupyter kernels & python environments made for productive experience

🗃️Customized JupyterLab file system browser was small but significant improvement for users

😡Facility maintenance windows induce frustration

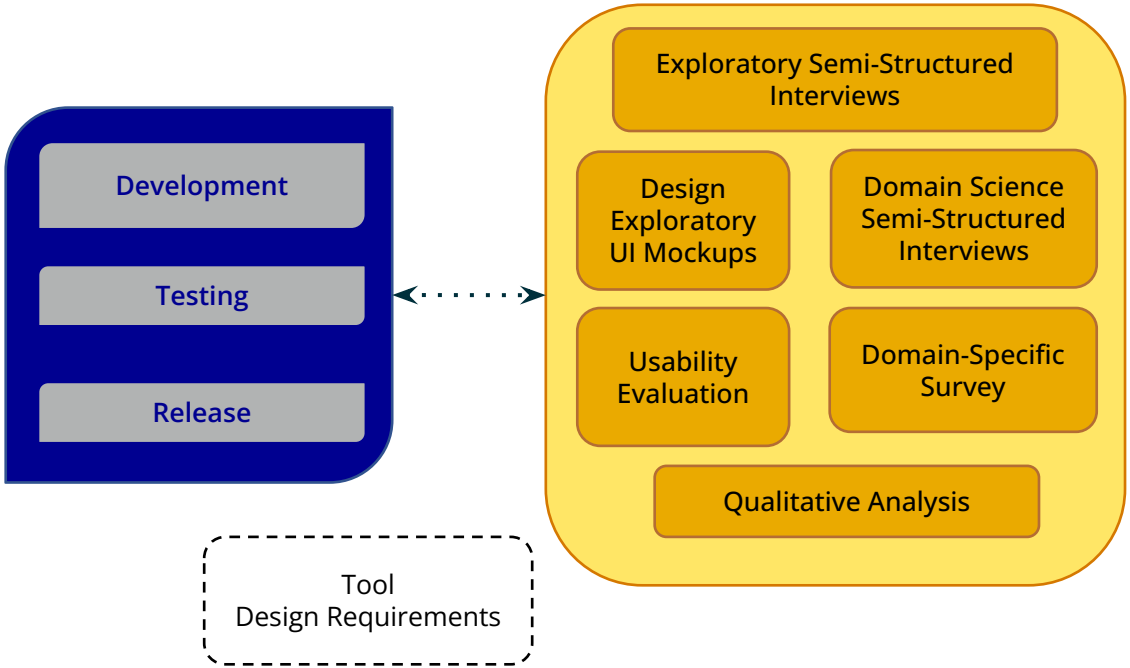
😠Customization of a shared Jupyter instance is tricky

😩Real time collaboration not simple or easy to accomplish

Follow on R&D work tackled these challenge!

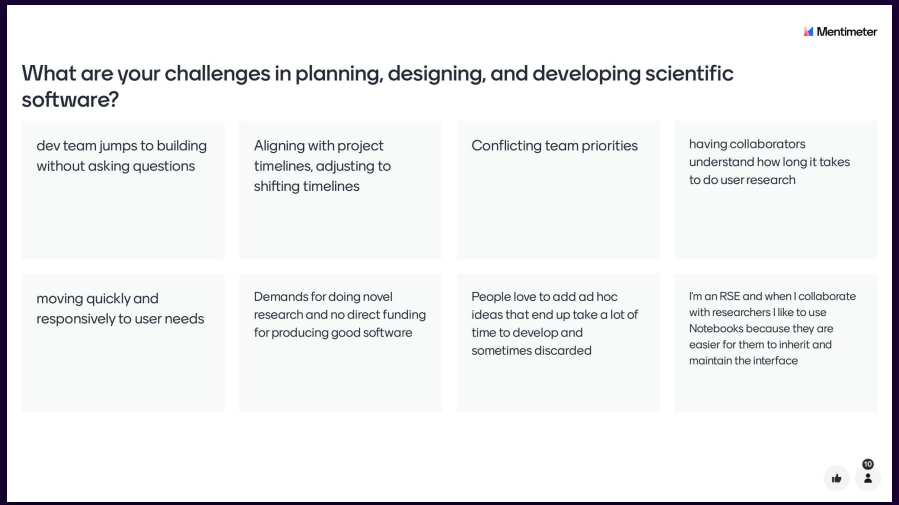
Drew Paine, Lavanya Ramakrishnan, "Understanding Interactive and Reproducible Computing With Jupyter Tools at Facilities", LBNL Technical Report, October 31, 2020. LBNL-2001355. https://escholarship.org/uc/item/9n11k2zm

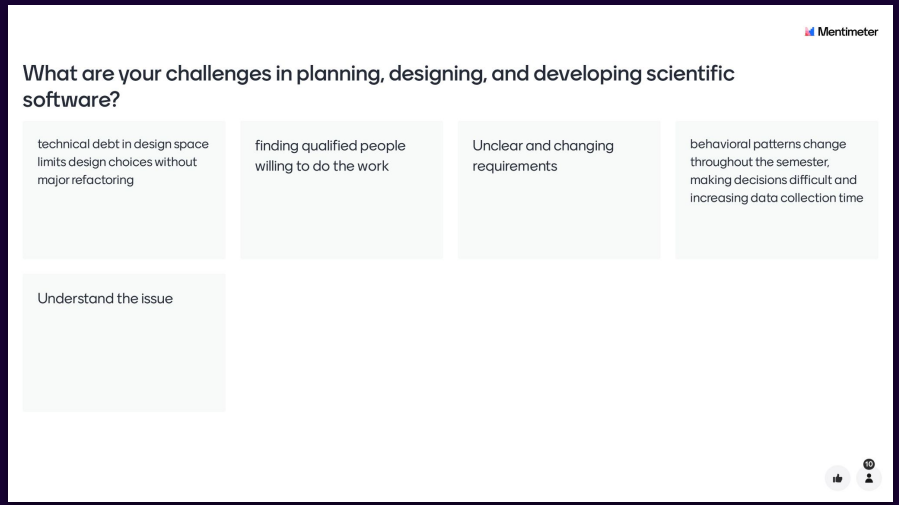
User research methods can weave closely with the R&D process to produce better results for the project and users.



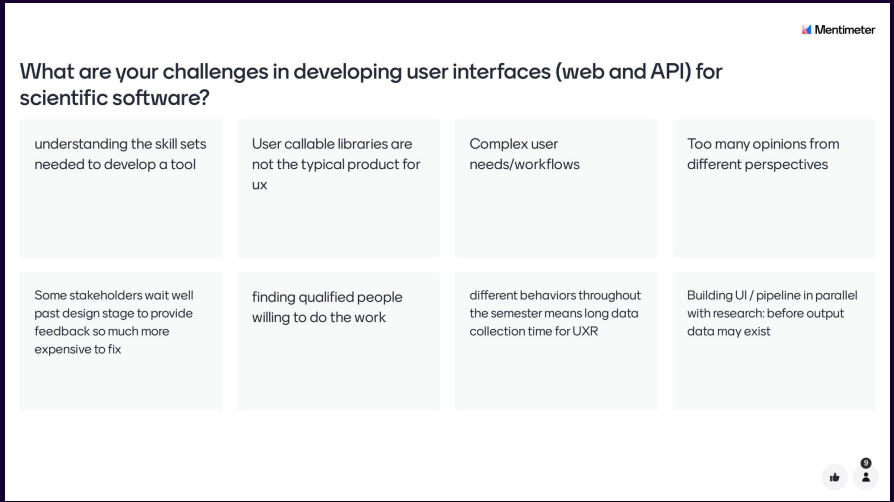
Paine, D., Ghoshal, D., & Ramakrishnan, L. (2020). Experiences with a Flexible User Research Process to Build Data Change Tools. Journal of Open Research Software, 8(1), 18. DOI: http://doi.org/10.5334/jors.284

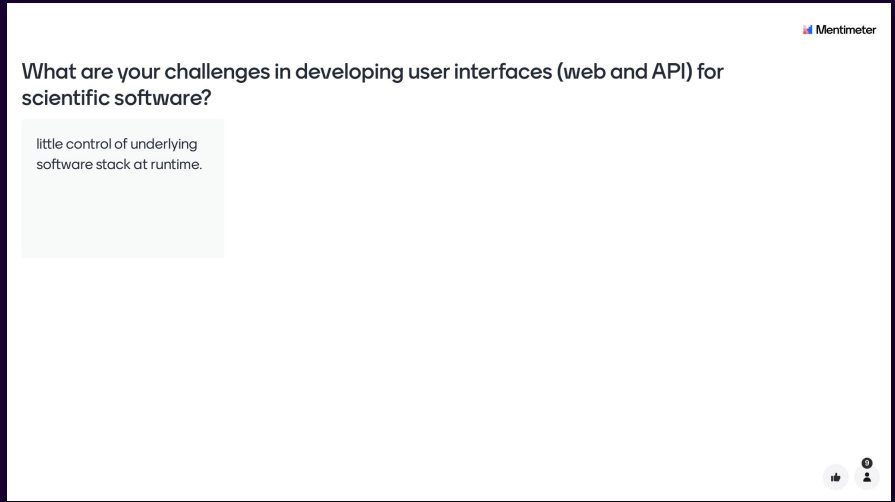
Menti poll — Question 3





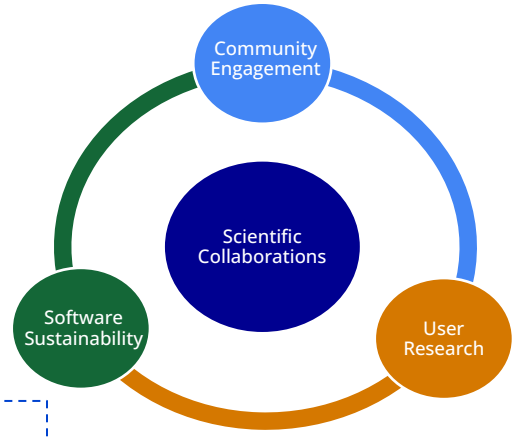
Menti poll — Question 4

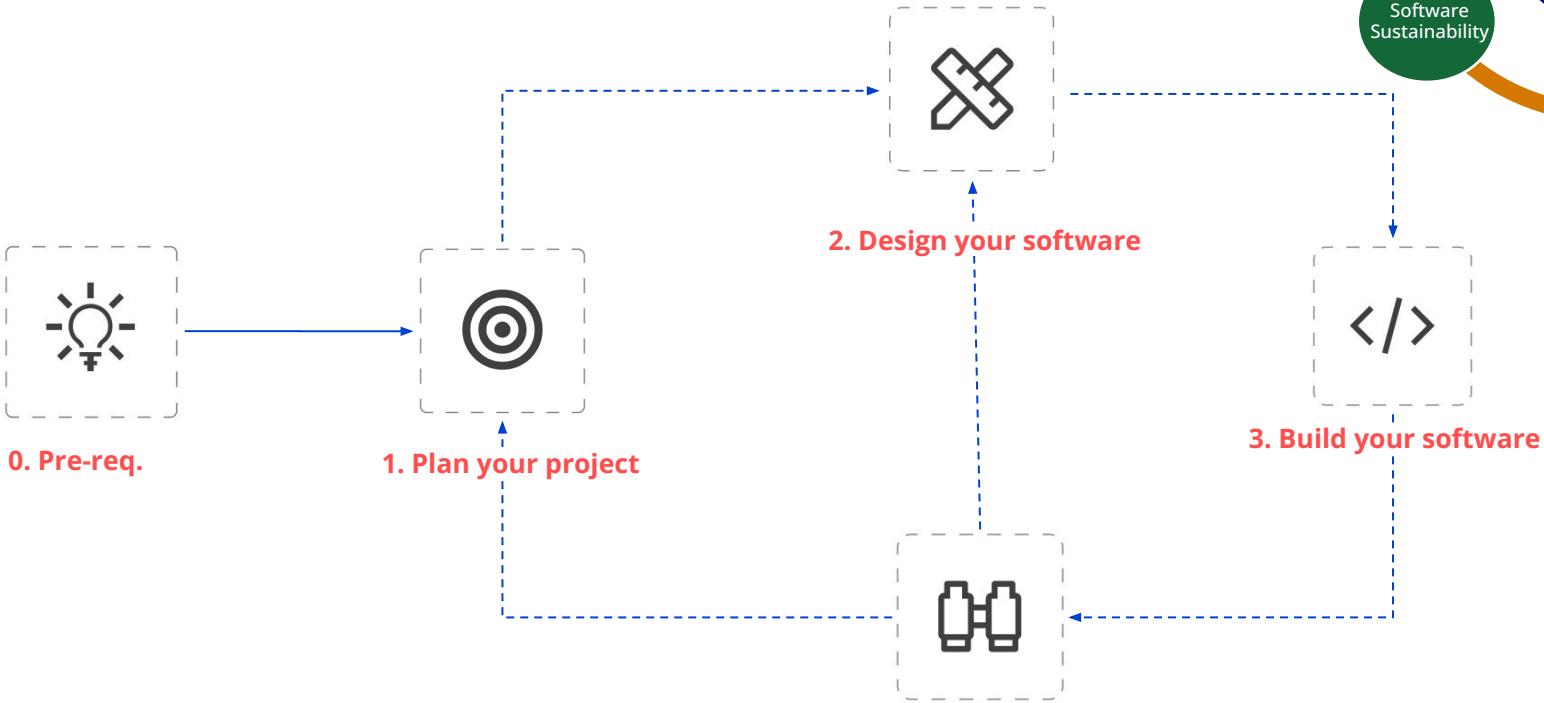




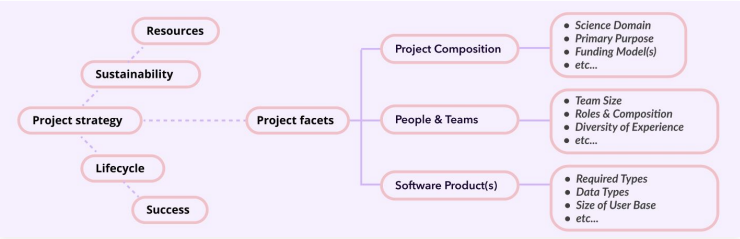
STRU  EL

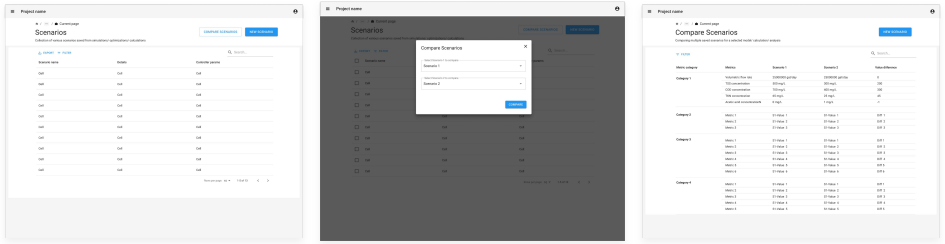
Scientific software design life cycle





STRUDEL: Open source project with two key products





Typology of Scientific Software

informing a strategic

Planning Framework

Design System

with

Task Flows

Supporting the scientific software development life cycle

0. Pre-reqs.

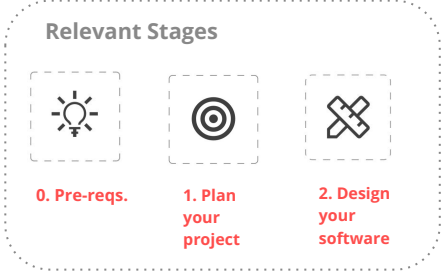
1. Plan your project

2. Design your software

3. Build your software

4. Test and evaluate software

Categorizing Patterns in Scientific (Software) Work

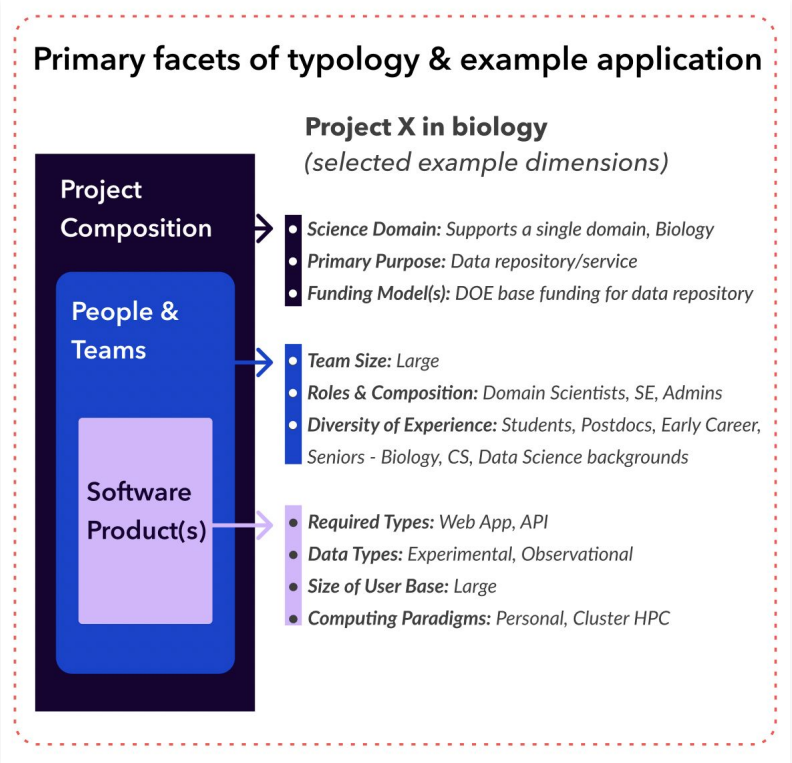


Today

Tomorrow

Typology is a first attempt to categorize questions & concerns we have seen repeatedly across projects, environments, etc.

Crafting a strategic **Planning Framework** from this categorization & resources to enable better project planning & software design



Design system

A design system is a set of reusable components and patterns for designing and building UIs as well as guidelines on when and how to use them.

What is unique about the STRUDEL design system?

Designed specifically for scientific UIs.

Enables building UIs applicable across different scientific domains

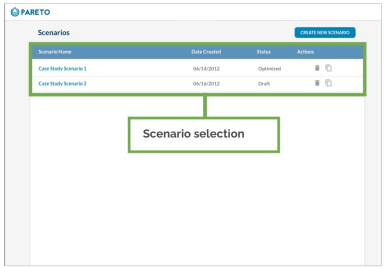
Focuses on the larger flow & function of UI

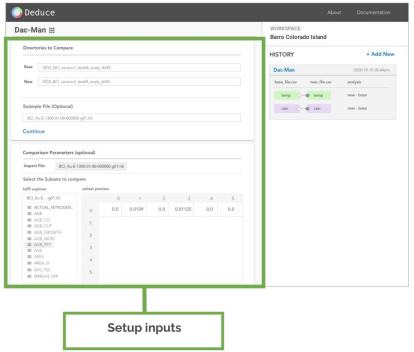
Gives you a jump start to think about entire UI flow rather than starting from scratch

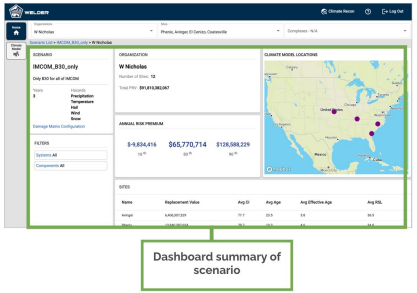
Designed by experts for experts.

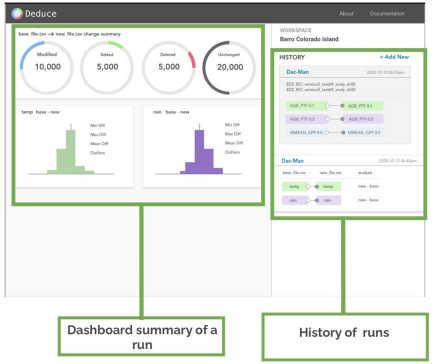
Informed by over a decade of collective UX experience in the sciences and democratizes good UX practices

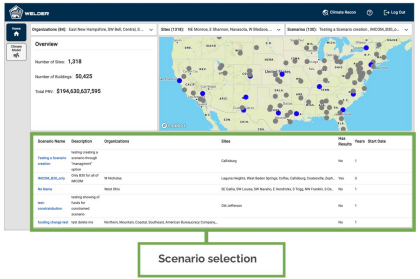
Identifying Task Flows From Common UI Needs

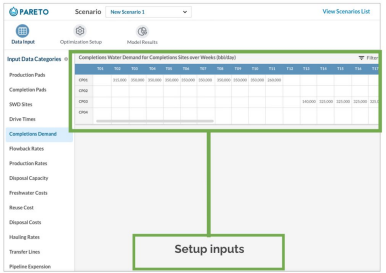


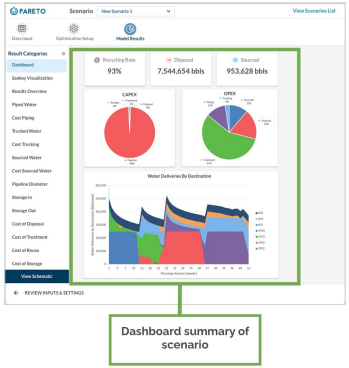


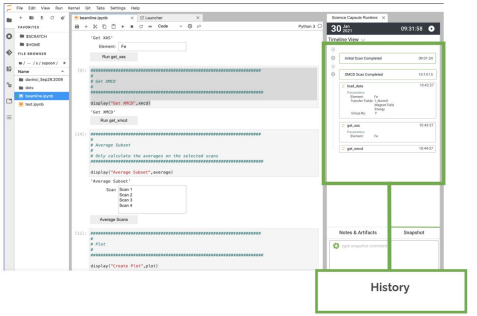












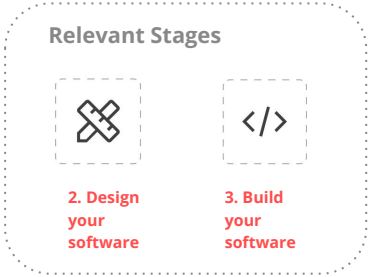
Scenario Selection

Select Inputs

Dashboard summary of results

History

Task Flows



Task Flow: series of steps represented by screens which helps user to accomplish particular task in the scientific software's user interface

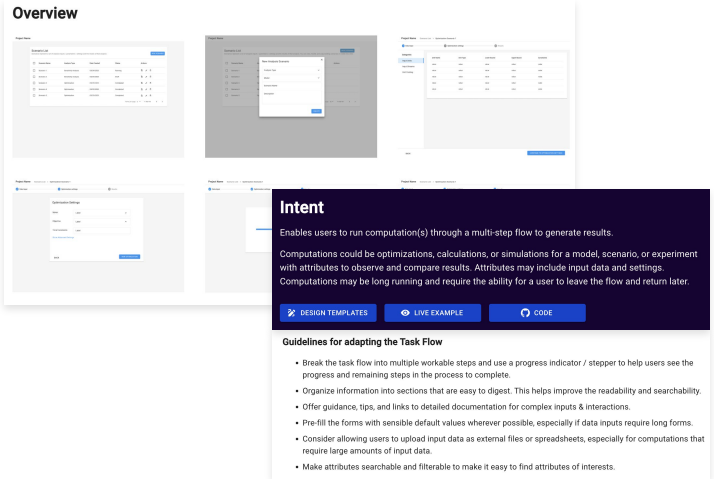
Similar Task Flows exist across various types of scientific software.

Analysis	Data	Exploration	Community Contributions
Run Computation	Explore Data	Monitor Activity	
Run Interactive Computation	Explore Data Repositories	Track State	
Compare Data	Contribute Data	Manage Account	

Task Flow Resources

Design templates & guidelines for the series of steps involved in the Task Flow.

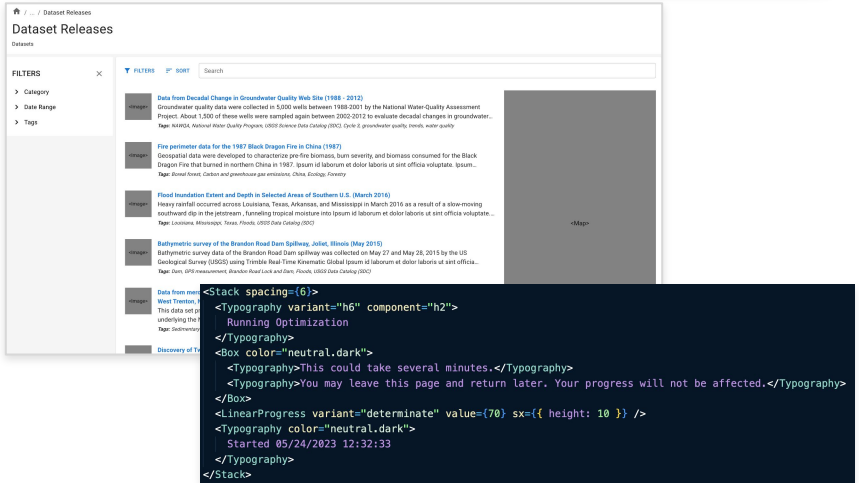
These templates are available as images and as design files on **Figma community** for customizing designs.



strudel-kit

Web interactive templates and coded UI library for high level components & task flows from our design system.

Uses **React javascript framework** and is built on top of the popular Material UI (MUI) components library



Using STRUDEL Design System example

Relevant Stages

2. Design your software

Science need: **A UI to run optimations on models**

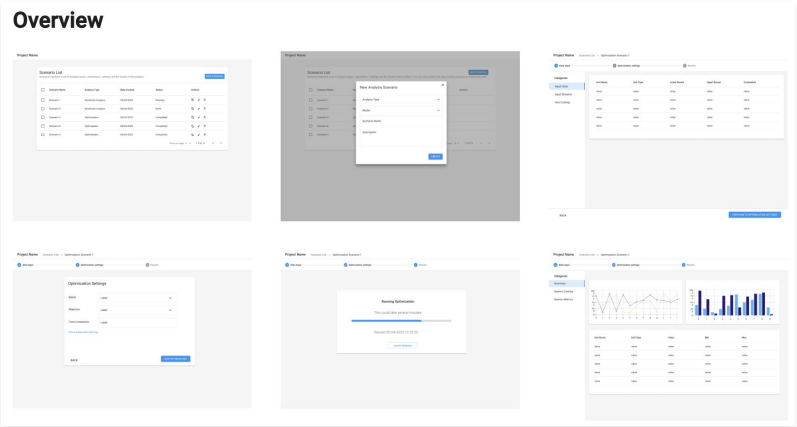
1. Select relevant Task Flow from STRUDEL:

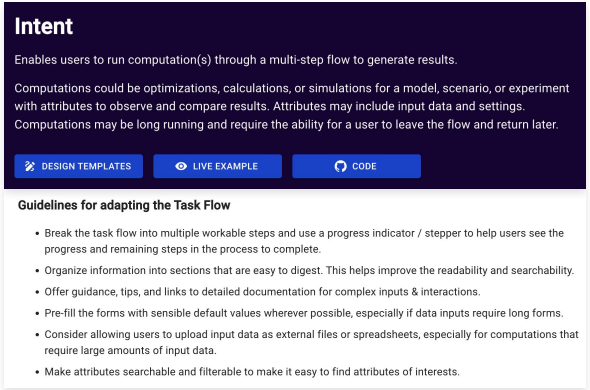
Run Computation

Enables users to run computation(s) through a multi-step flow to generate results.

execution | scenario | job | simulation | optimization | stepper | wizard

2. See details:





Using STRUDEL Design System example

Relevant Stages

2. Design your software

3. Understand selected Task Flow, map to requirements and plan customizations

'Run Computation' *Task Flow template screens:*

Task Flow Step 1: *Initiate new computation from list view of scenarios/ models*

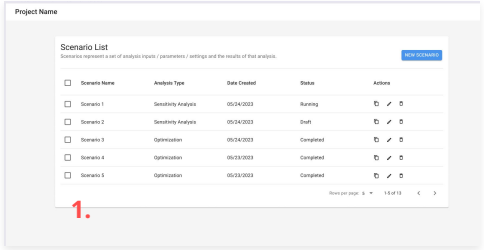
Task Flow Step 2: *New optimization/ analysis meta data input form*

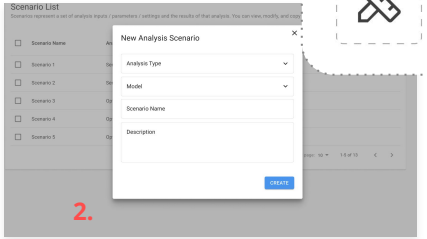
Task Flow Step 3: *Input optimization parameters*

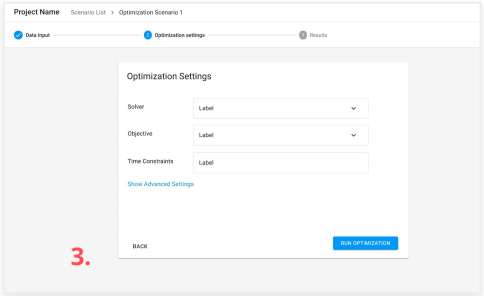
Task Flow Step 4: *Select optimization settings*

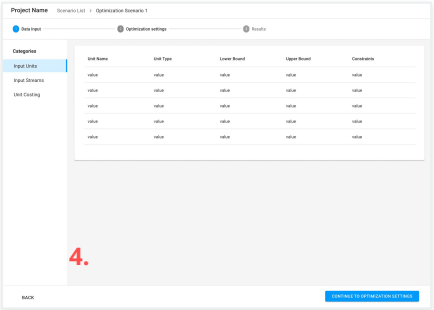
Task Flow Step 5: *Progress view for long process optimization*

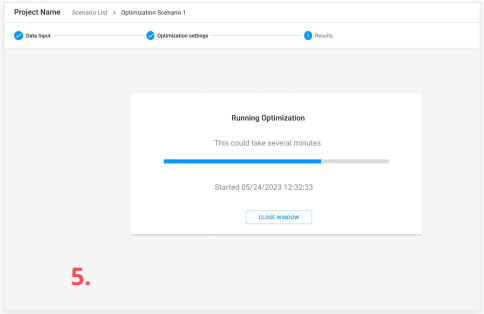
Task Flow Step 6: *Optimization results view*

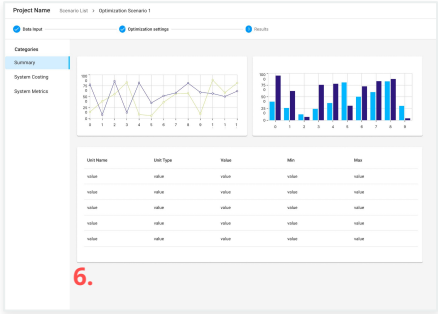










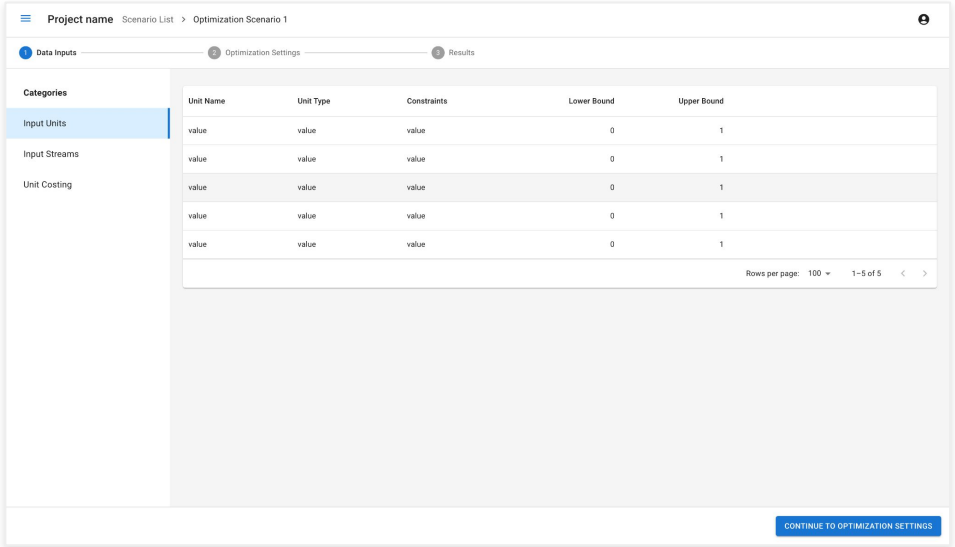


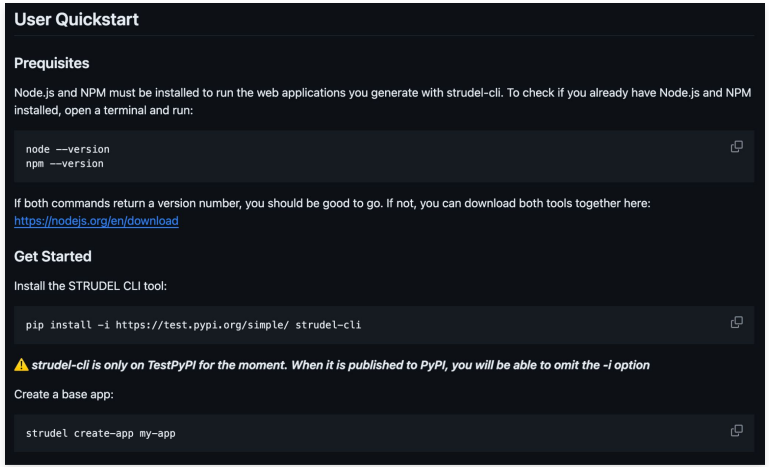
Using STRUDEL Design System example

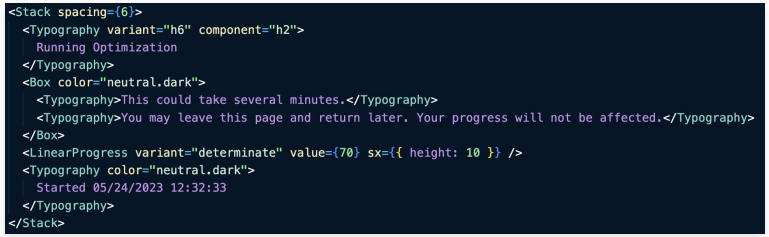
Relevant Stages

3. Build your software

4. Browse prototype & code implementation guide from STRUDEL-kit UI Library







5. Create base app and start integrating your customizations, data and APIs

Get Involved!
Join the STRUDEL Community

Next events in the STRUDEL series

- **Getting Started with the STRUDEL Design System**
  - Virtual webinar on Zoom
  - Friday March 8th, 11am Pacific

- **STRUDEL Design System Hackathon**
  - In person @ Berkeley Lab
  - Tuesday March 19, All Day
  - *Space is limited!*

Visit our website to learn more & use our products!

https://strudel.science

Have comments?
Start a conversation on our GitHub
https://go.lbl.gov/strudel-discussion

Join the US-RSE User Experience working group to connect with the larger community of practice!

#wg-ux on the **US-RSE Slack**
https://go.lbl.gov/usrse-uxwg

Join our mailing list to keep up to date & contribute to the community!

strudel-community+subscribe@lbl.gov

Thank you!