Understanding the Usage Model of Scientific Data Analysis Tools

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Motivation & Goal

Goal:

Understand users' mental models and workflows of data analysis

Motivation:

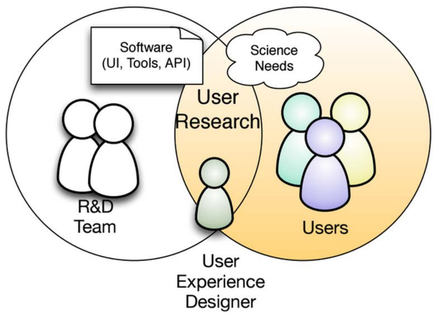
- Exascale poses new challenges such as increasing data movement costs and growing data sizes
- Important to build tools with data models that support next-generation data analysis
- First step is to understand users' mental models and workflows of data analysis

Usable Data Abstraction

Enable large-scale data analysis workflows on exascale systems using user research and ethnographic methods to

- Design and address data abstractions for next-generation exascale workflows
- Combine usability with performance, resilience and energy considerations of next-generation hardware

User Research



- User research fills in the missing link between the R&D team and their users
- Some common user research methods are user interview, participant observation, and contextual inquiry
- User research differs from requirement gathering in its holistic approach to understanding users' needs

Research Approach

- Interview and observe scientists who currently use data analysis tools on HPC to perform large-scale data analysis
- Focus on users of three data analysis tools (UV-CDAT, SPARK and R), and consider custom scripts

Tool Name	Domain	Functionality	HPC Support
UV-CDAT	Climate Science	Primarily Data Visualization	Edison, Hopper
SPARK	General-Purpose	Big Data Processing	Edison
R	General-Purpose	Statistical Computer & Graphics	Edison, Hopper

Workflow:

Extract users' data analysis workflows with focus on tasks, tools used, computing platforms, science goals, data lineage, transformation, and size.

- Interview users and talk through their workflows
- Observe users performing data analysis

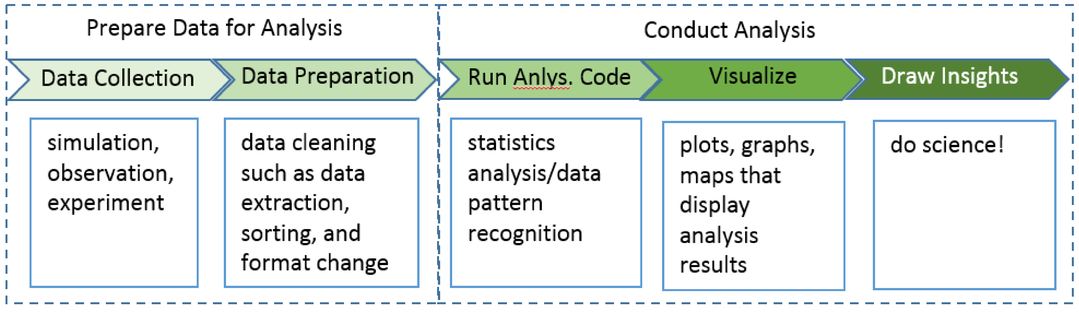
Mental Model:

Construct users' data analysis mental model by studying their experiences using existing data analysis tools on HPC.

- Reasons for switching from the previous tools
- Improvements in the workflows compared to previous tools
- Types of analysis that the current tools perform well
- Initial learning hurdles
- Adaptations made for the analysis to fit the tool
- Inefficiency in analysis workflows
- Types of analysis that are especially challenging to perform on current tools
- Recommendations for improvement

Scientific Data Analysis Workflow

An exemplar analysis workflow based on early findings:



Key Observations:

- Keeping analysis scripts organized is challenging
- Memory is analysis bottleneck
- Data management between steps is difficult
- HPC system updates cause significant productivity losses

Future Work

- The highly customized nature of scientists' data analysis requires customized interview approaches
- Continue filling out the data analysis workflow and mental model landscape
- Improve data abstraction based on user research findings
- Conduct usability evaluation on prototypes to validate proposed improvements

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