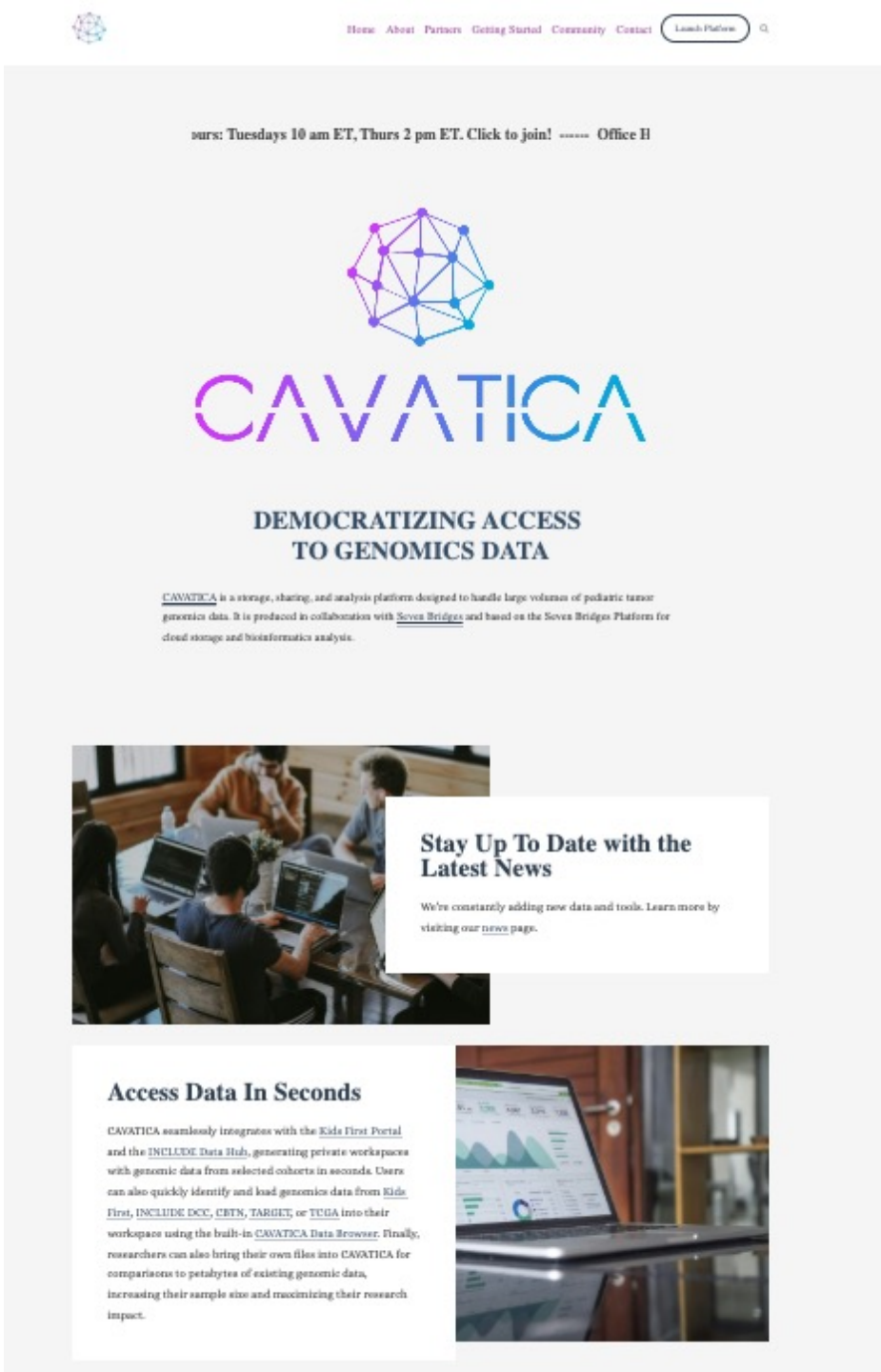
Introduction to Cloud Computing.

CAVATICA and Velsera

But First: Log On To CAVATICA

https://www.cavatica.org/



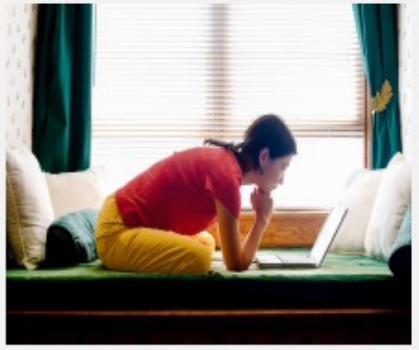
Join Our
Office Hours

Questions? Need help?

We hold sessions twice a week:
Tuesdays at 10 AM ET and
Thursdays at 2 PM ET

Come chat with us about your research!









Scan the QR Code or
Follow The Link

https://meet.google.com/kbs-ojnj-dcg

Introduction to Cloud Computing with CAVATICA.

Adding Concepts and Competencies to your Toolbelt

What is Cloud Computing?

- **The cloud** - (kind of) just means “the internet”
- **Cloud computing** - connecting to computers (located elsewhere) over the internet to use their processing power and storage.
- **Cloud providers** - the people who own those computers. Amazon, Google, and Microsoft, plus others.

Explosion of ‘omics data with ease of sequencing

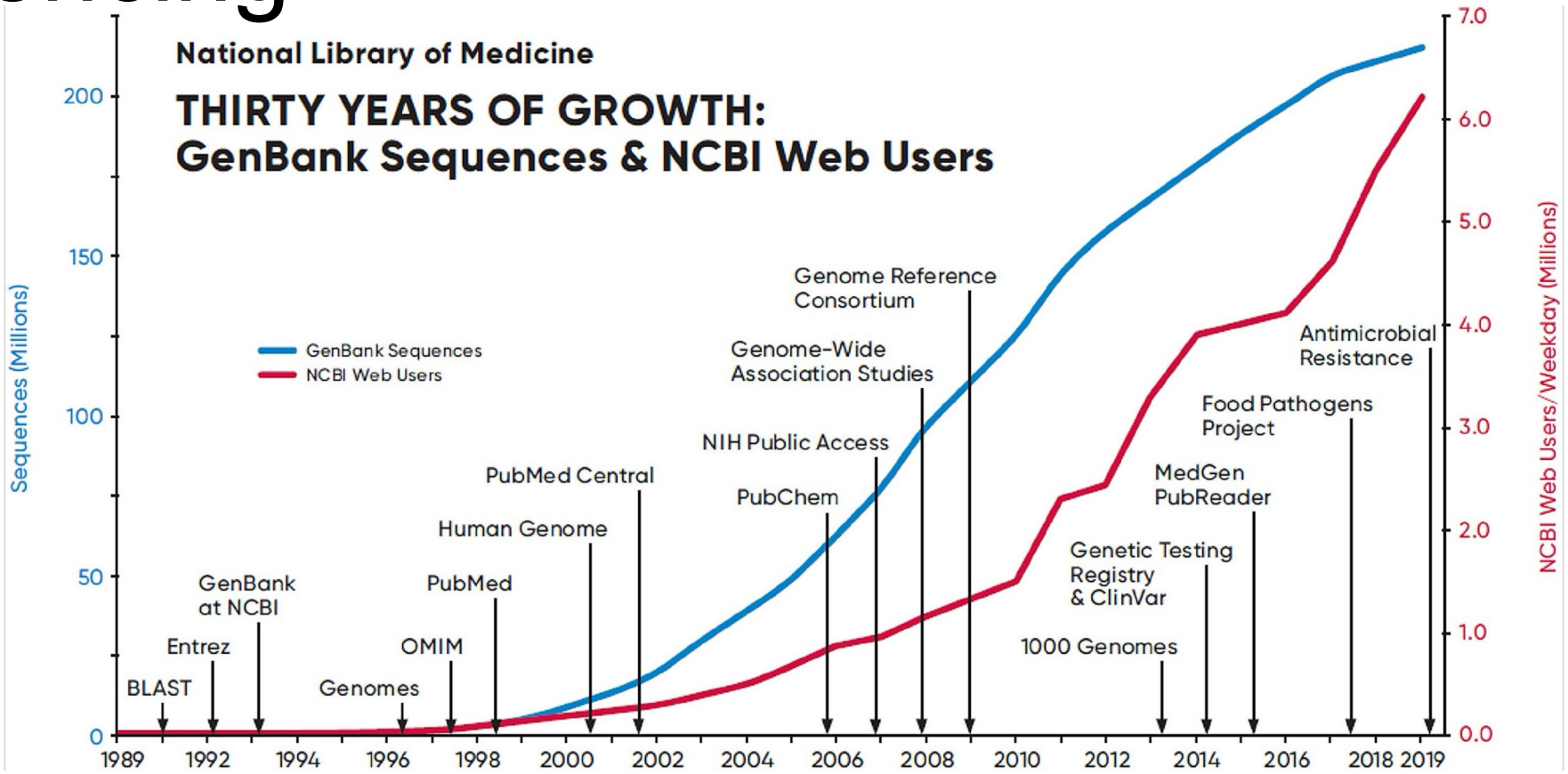
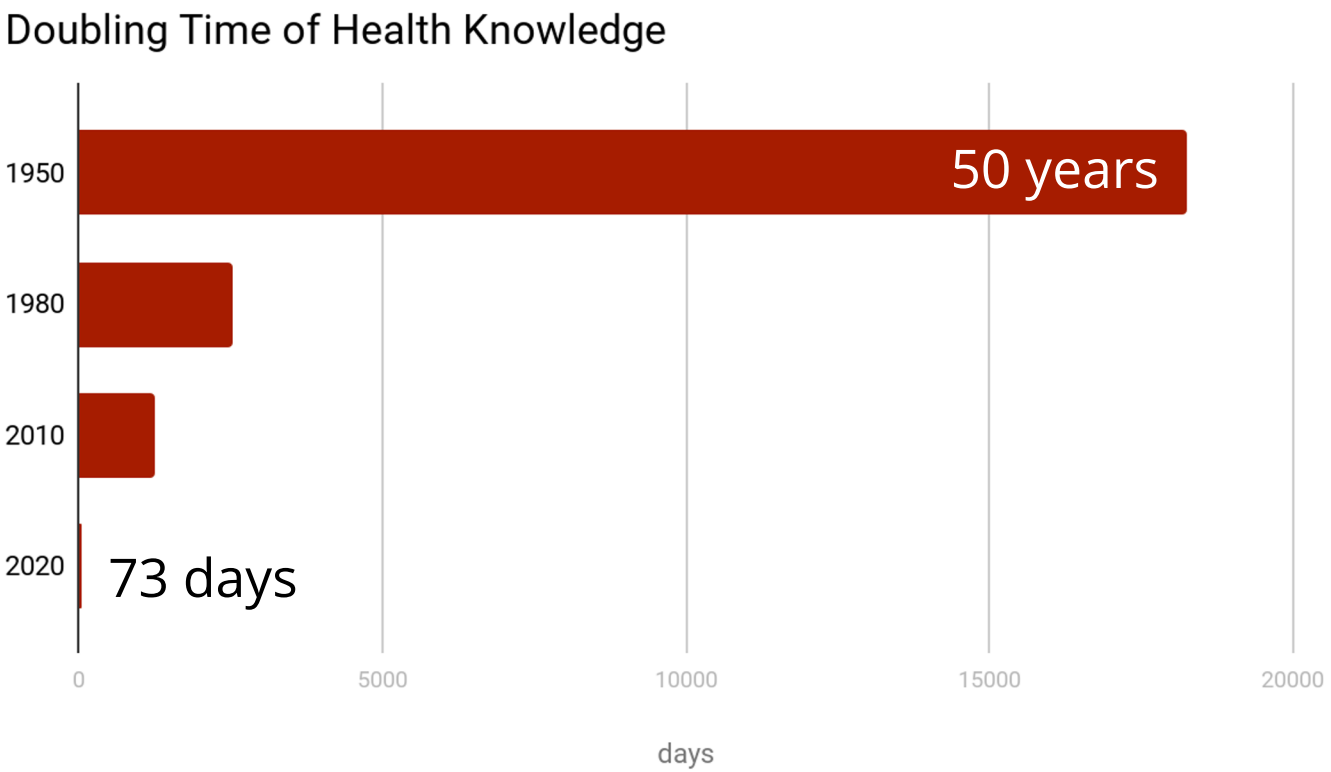


Fig. 1. **Growth of GenBank sequences and NCBI web users through 2019.** Figure from the Department of Health and Human Services National Institutes of Health. Jim Gaffney, et. al. Open access to genetic sequence data maximizes value to scientists, farmers, and society, Global Food Security, Volume 26, 2020.

The rate of data generation is accelerating rapidly



- More biomedical data will be generated this year than all previous years **combined**
- More different **kinds** of data – gene and genome sequencing, imaging, sensors (i.e. fitbit), cellular measurement data, and more

Why do Cloud Computing?

Why *should I* do Cloud Computing?

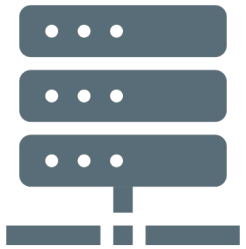
“Cloud is about how you do computing, not where you do computing.”

Important Concepts in Cloud Research.

- Cloud provider costs
- FAIR Data Principles
- Scalability, portability, and reproducibility
- Security and Compliance

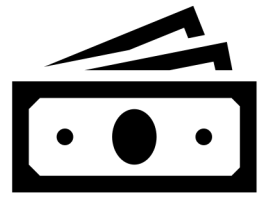
Cloud Provider Costs...

Compute Costs



File Storage Costs

Data Transfer Costs



… and Cloud Credit Support

- For Down Syndrome research

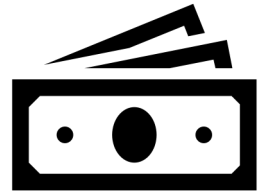
- $100 INCLUDE Pilot Credits
- Up to $1,000 Limited Credits
- Up to $20,000 Extended Credits

For every user - Email Support@Velsera.com

One page description of intended use

Budget and description

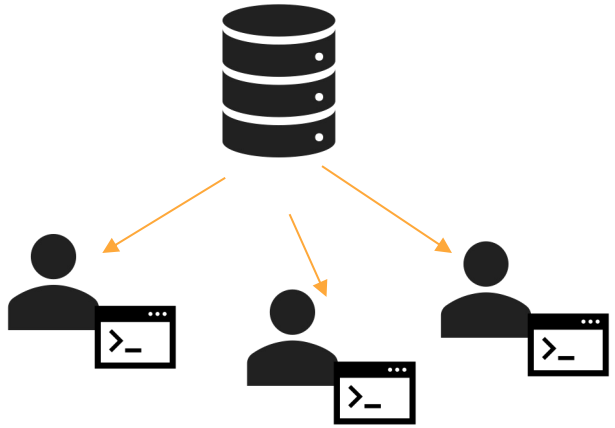
Other sources of support may be available depending on the research proposed – see https://docs.cavatica.org/docs/cloud-credits-on-cavatica for details



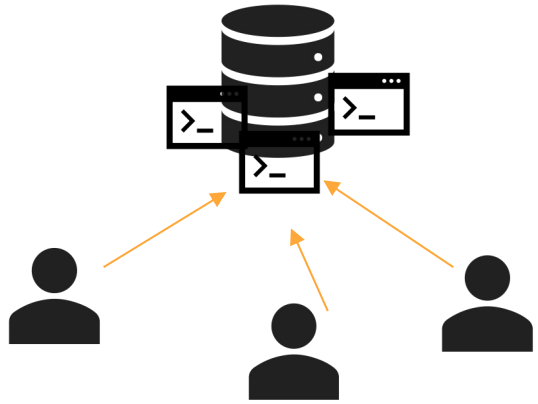
Using the Cloud to Store and Analyze Growing Health Data

- Immediate scaling. (“Rent” vs “Buy”)
- Levels the playing field
    - Researchers at institutions that lack high performance computation systems can access data and resources
- Many researchers can access the data without needing to make duplicate copies
- Data and analysis methods kept in the same repository

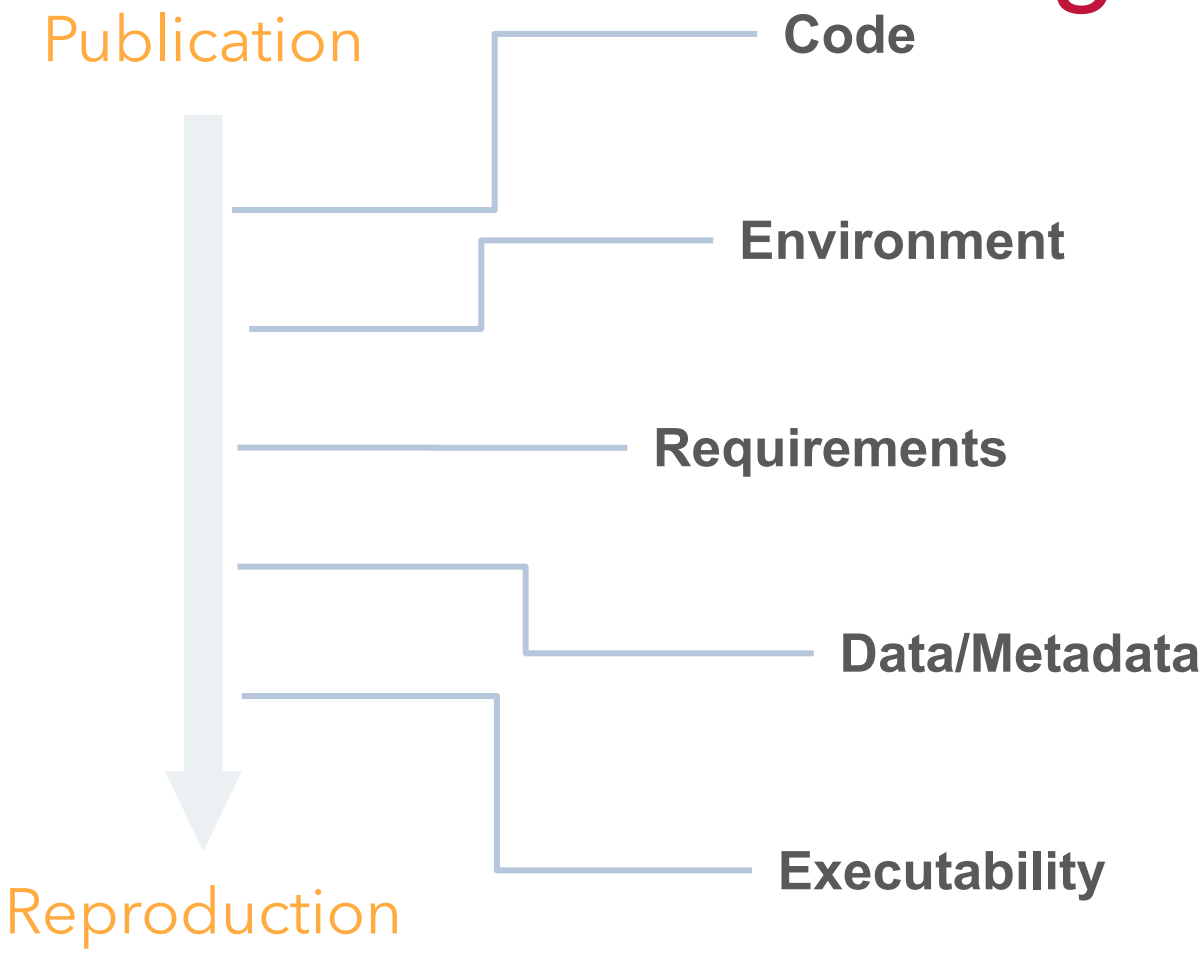
Old model: Data-to-Analysis



New model: Analysis-to-Data



Portability via containerization and workflow language



GitHub

docker

COMMON WORKFLOW LANGUAGE

nextflow

INCLUDE Data Coordinating Center

What is FAIR?

Findable, Accessible, Interoperable, Reusable

"The FAIR Guiding Principles for scientific data management and stewardship"

- Wilkinson *et al.* (2016) *Scientific Data* 3, 160018. doi: 10.1038/sdata.2016.18

- Findable: Registered in a searchable resource; the data is described with rich **metadata**; both humans and machines can *find the data they want if it exists*.
- Accessible: Retrievable using standard protocols; includes **authorization** (is the requester allowed to have this data?) and **authentication** (is this the data that the requester means to get?)
- Interoperable: Uses standard, agreed-upon terminology; humans and machines can reliably understand what to do with the data.
- Reusable: Give rich and thorough detail about the data so that a researcher can reuse it in a new analysis; it is very clear where the data come from and how it was created (**provenance**).

Velsera Security & Compliance

GDPR

HIPAA

AICPA SOC 2 — Formerly SAS 70 Reports

AICPA SOC 3 — Formerly SAS 70 Reports

21 CFR PART 11 FDA COMPLIANCE

FedRAMP

ISO 27001 — International Organization for Standardization

ISO 27017 — International Organization for Standardization

ISO 27018 — International Organization for Standardization

ISO 27701 — International Organization for Standardization

ISO 9001 — International Organization for Standardization

dbGaP — GENOTYPES and PHENOTYPES

Privacy Shield Framework

FISMA — FEDERAL INFORMATION SECURITY MANAGEMENT ACT

GSA Section508.gov — GSA Government-wide IT Accessibility Program

INCLUDE Data Coordinating Center

NIH Genomic Data Sharing Guidelines 2025

Starting **January 26, 2025**, two major changes will affect how authorized users can download and analyze this data:

- Repositories storing genomic data must meet stricter security guidelines, like NIST SP 800-53 Moderate or equivalent standards (e.g., FedRAMP or FISMA Moderate).
- Approved users must confirm that their IT systems or third-party cloud services comply with NIST SP 800-171, covering all computers used to work with this data.
- This applies to all computers that are used to **download and analyze controlled-access data**.

CAVATICA already meets and exceeds these guidelines

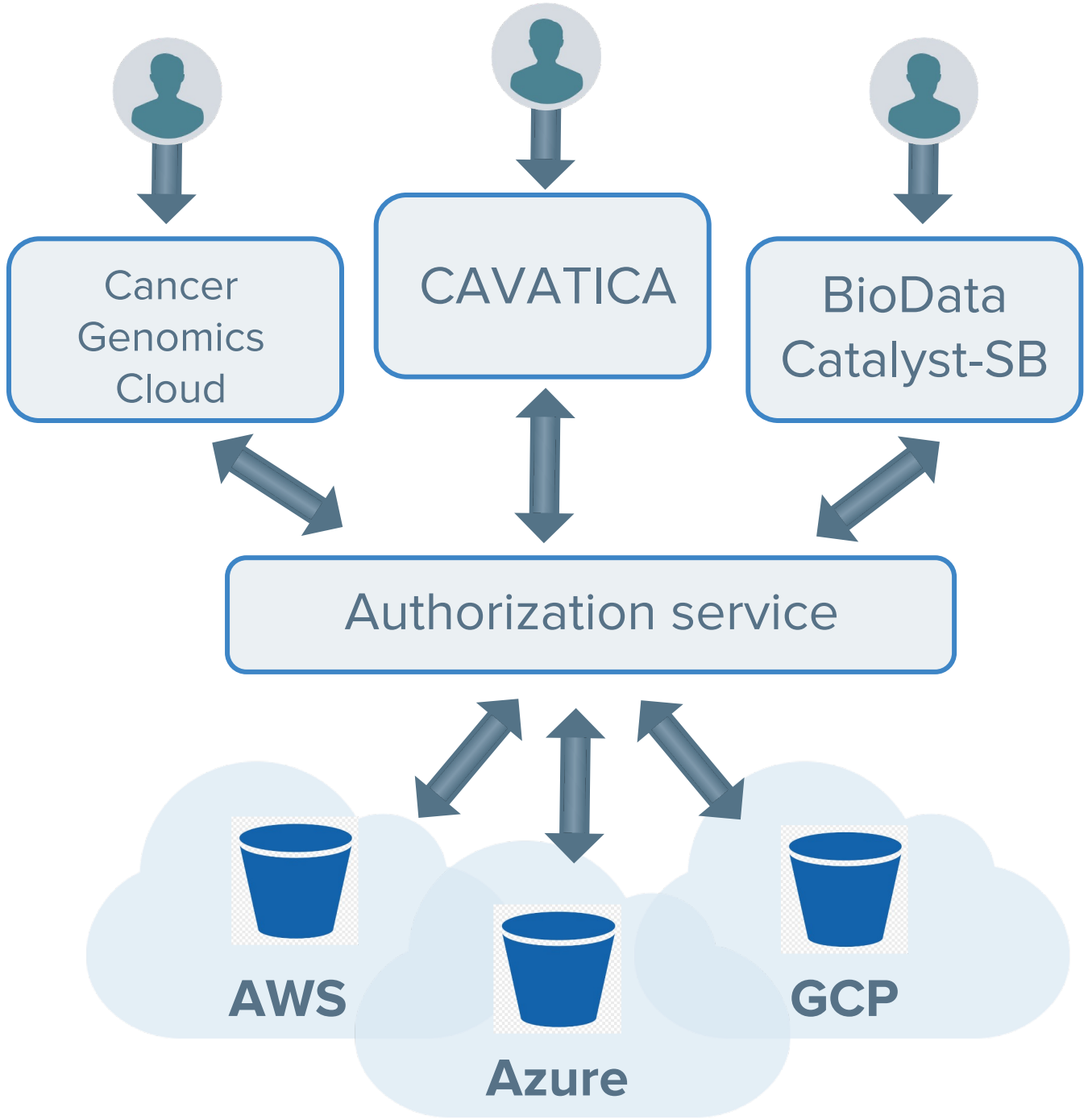
https://velsera.com/nih-genomic-data-sharing-policy-updates/

Access hosted data

Stored in cloud buckets

Available on all Velsera academic platforms

Access controlled programmatically by authorization service. User permissions are read from dbGaP using iTrust and eRA Commons login

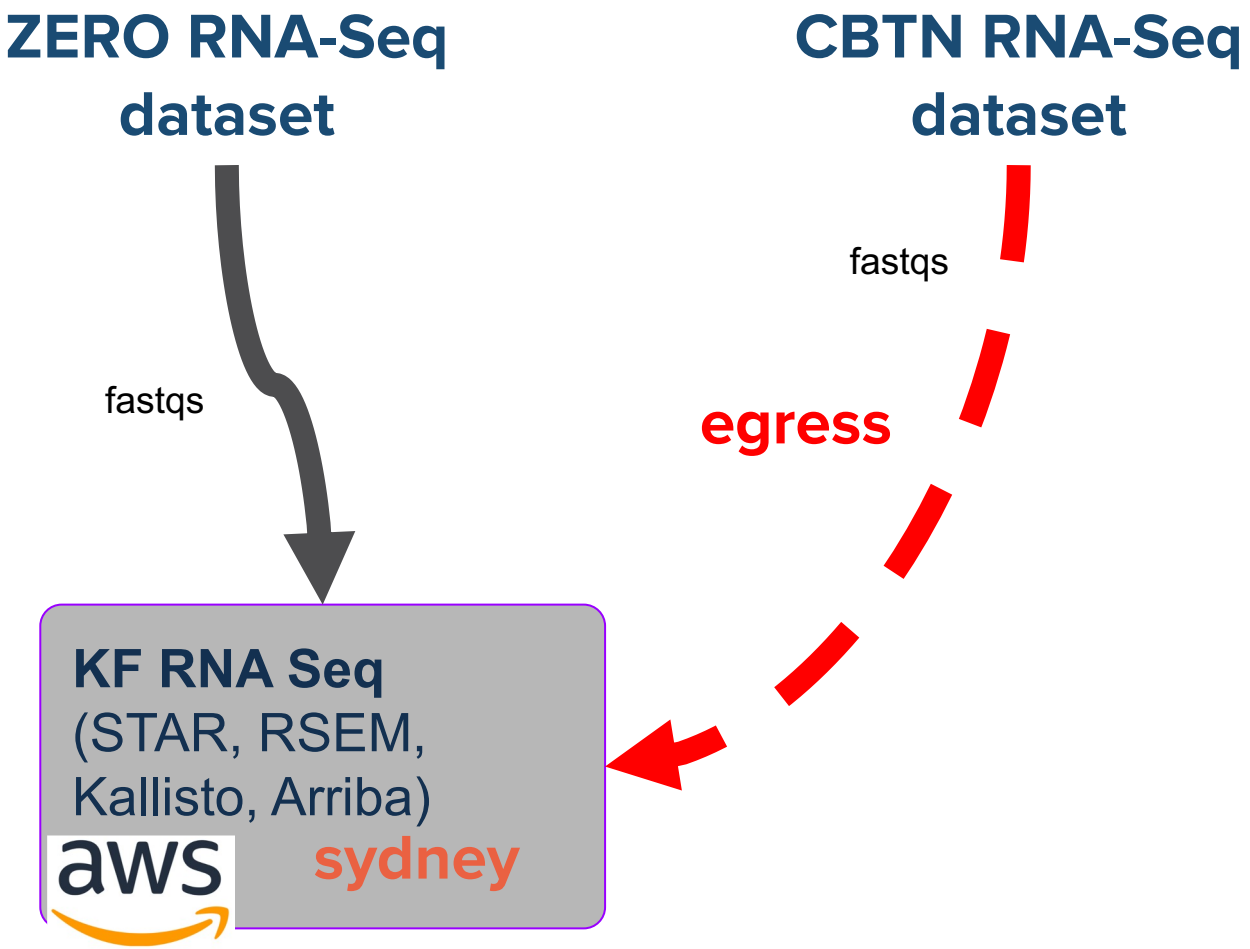


Example: Data portability and data location depends on cost, policy, & other factors

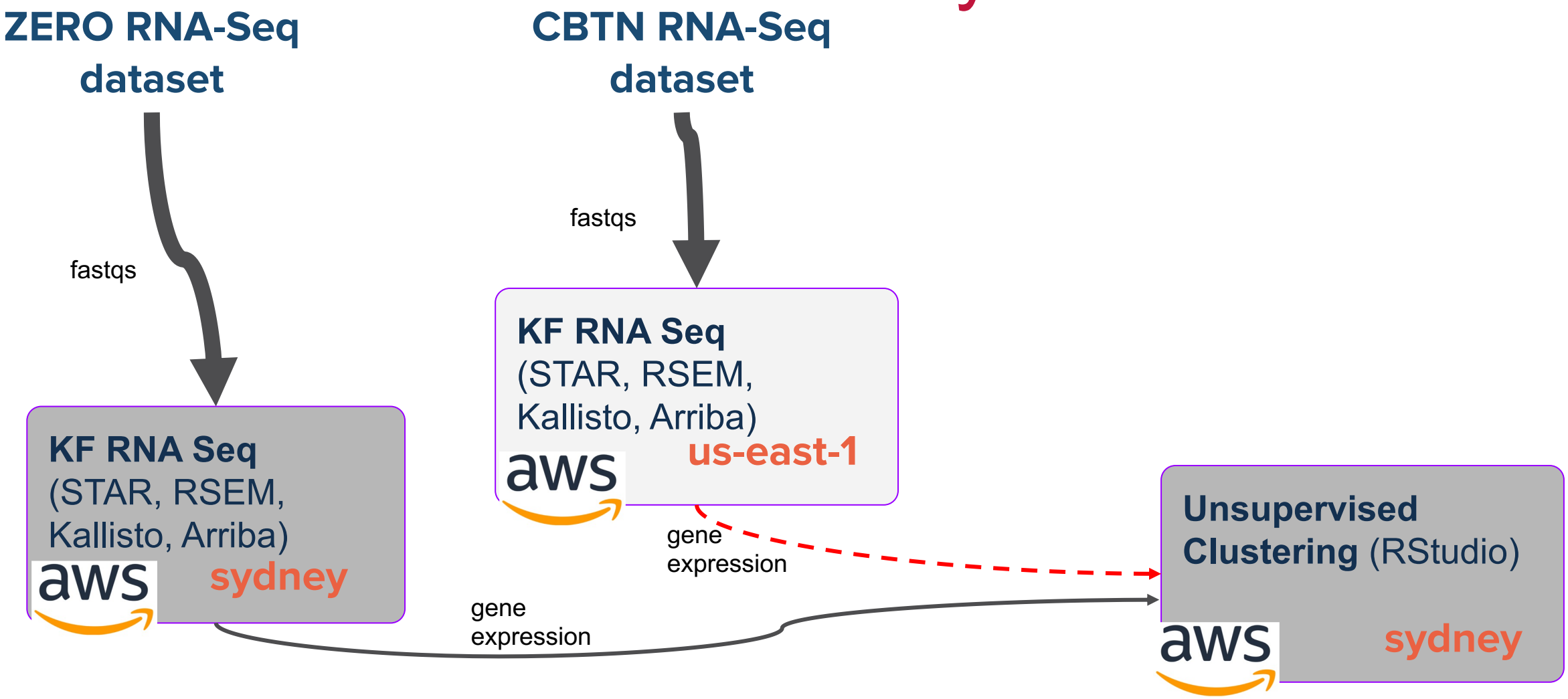
RNA-Seq & WGS (n ~ 9k) samples uniformly processed on CAVATICA with the Kids First RNA-Seq pipelines

RNA-Seq & WGS (n = 112) samples available in National Compute Infrastructure Australia (traditional HPC)

Moving or copying data can be expensive



Design your analysis to leverage the cloud efficiently



Institutional level: Design Data for Cloud

The INCLUDE Data is Cloud Native

- INCLUDE data processing is done on CAVATICA
- FAIR data by design:
  - Stored on a Data Repository Service (DRS) server
  - Researcher Auth Service (RAS) built in
  - Easy to access (as you will see!)

Introduction to CAVATICA

A cloud computing platform for biomedical researchers

CAVATICA

Who are the CAVATICA Users?

CAVATICA is designed to serve a wide range of scientists and users with varying skill sets

ADMINISTRATORS

- Manage and Control Users
- Monitor and Control Institutional Assets
- Manage and Monitor Projects
- Monitor and Control Costs
- Create Reports

BIOINFORMATICIANS

- Store, Manage, and Share Data
- Access Public and Proprietary Datasets
- Query, Build, and Investigate Cohorts of Interest
- Access Optimized Tools and Workflows
- Create, Optimize, Maintain, and Distribute New Tools and Workflows
- Create Push-button Automation Solutions
- Analyze Data at Scale with Tools and Workflows
- Conduct Interactive Exploratory Analyses
- Explore/Visualize Results and Gather Insights
- Easily Collaborate with Other Stakeholders
- Integrate with External Systems

BENCH SCIENTISTS

- Store, Manage, and Share Data
- Run Optimized Tools/ Workflows at Scale
- Conduct Defined Analyses via Push-button Solutions
- Investigate/Visualize Results
- Easily Collaborate with Other Stakeholders

CLINICIANS

- Conduct Validated Analyses via Push-button Solutions
- Query, Build, and Investigate Cohorts of Interest
- Create Reports
- Investigate/Visualize Results
- Easily Collaborate with Other Stakeholders

DEVELOPERS

- Create, Optimize, and Maintain New Tools and Workflows
- Create Push-button Automation Solutions
- Create Custom Interfaces for Specific Use Cases
- Distribute Proprietary Tools/ Workflows
- Integrate with Upstream/ Downstream Systems

What is it and what can it do?

User friendly portal

Access petabytes of publicly available data, and analyze it alongside private data.

Unprecedented Collaboration Features

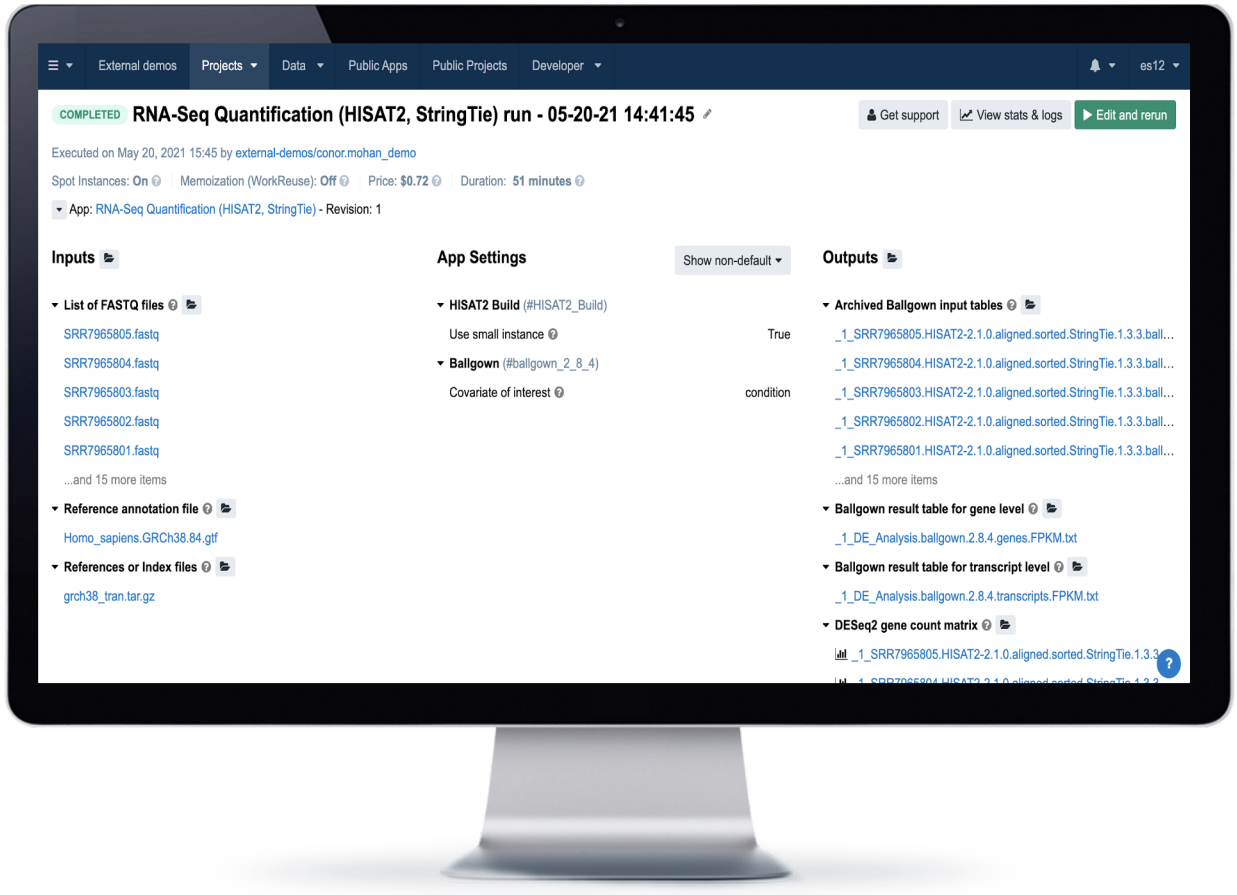
Collaborate within and across organizations while keeping control of your assets with precise permission levels.

Industry Standard Tools: Reproducibility

Execute, build, and customize analysis pipelines using popular tools such as CWL, WDL, Nextflow, Docker, RESTful APIs, and CLI.

Connected Cloud

Keep data in your own buckets with storage support for AWS, and Google Cloud Platform.



Connect to the data & use it wisely

Federated Public Data Sets

We partner with a wide range of public organizations to facilitate access to large federated public data sets.

Trusted Partner

Only commercial "**NIH Trusted Partner**," and NIH Researcher Authentication Service partner; allowing our users with access rights to leverage large NIH datasets.

National Institutes of Health

TCGA

TARGET

PCAWG PanCancer Analysis OF WHOLE GENOMES

CPTAC

Pacific Pediatric Neuro-Oncology Consortium

CANCER IMAGING ARCHIVE

CBTTC Children's Brain Tumor Tissue Consortium

CCLE Cancer Cell Line Encyclopedia

Gabriella Miller Kids First PEDIATRIC RESEARCH PROGRAM

ICGC

ALLIANCE of GENOME RESOURCES

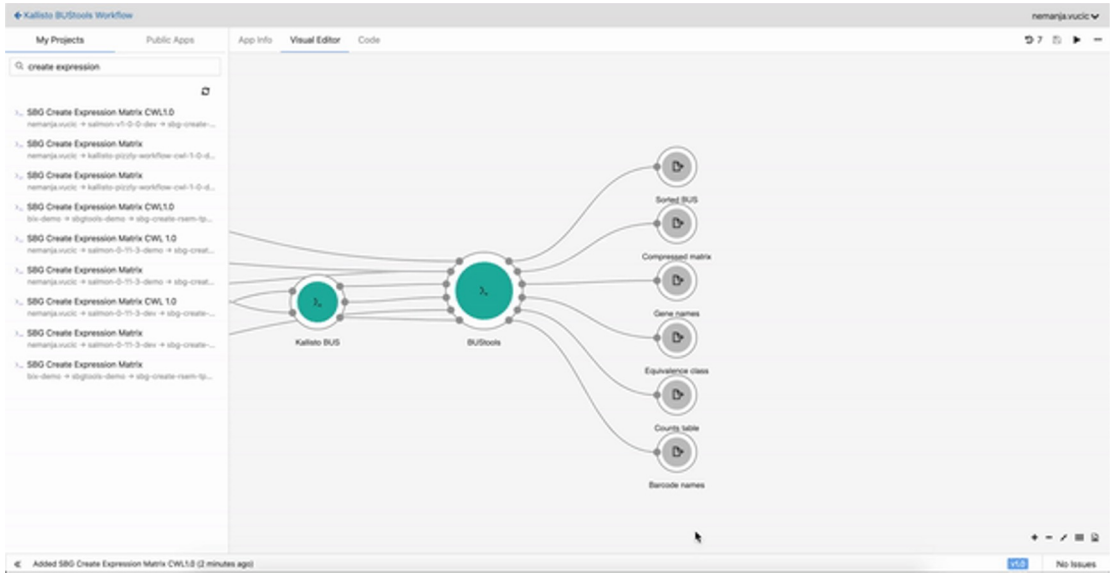
SIMONS FOUNDATION

Personal Genome Project

INCLUDE DATA COORDINATING CENTER

Use or Create Reproducible Workflows

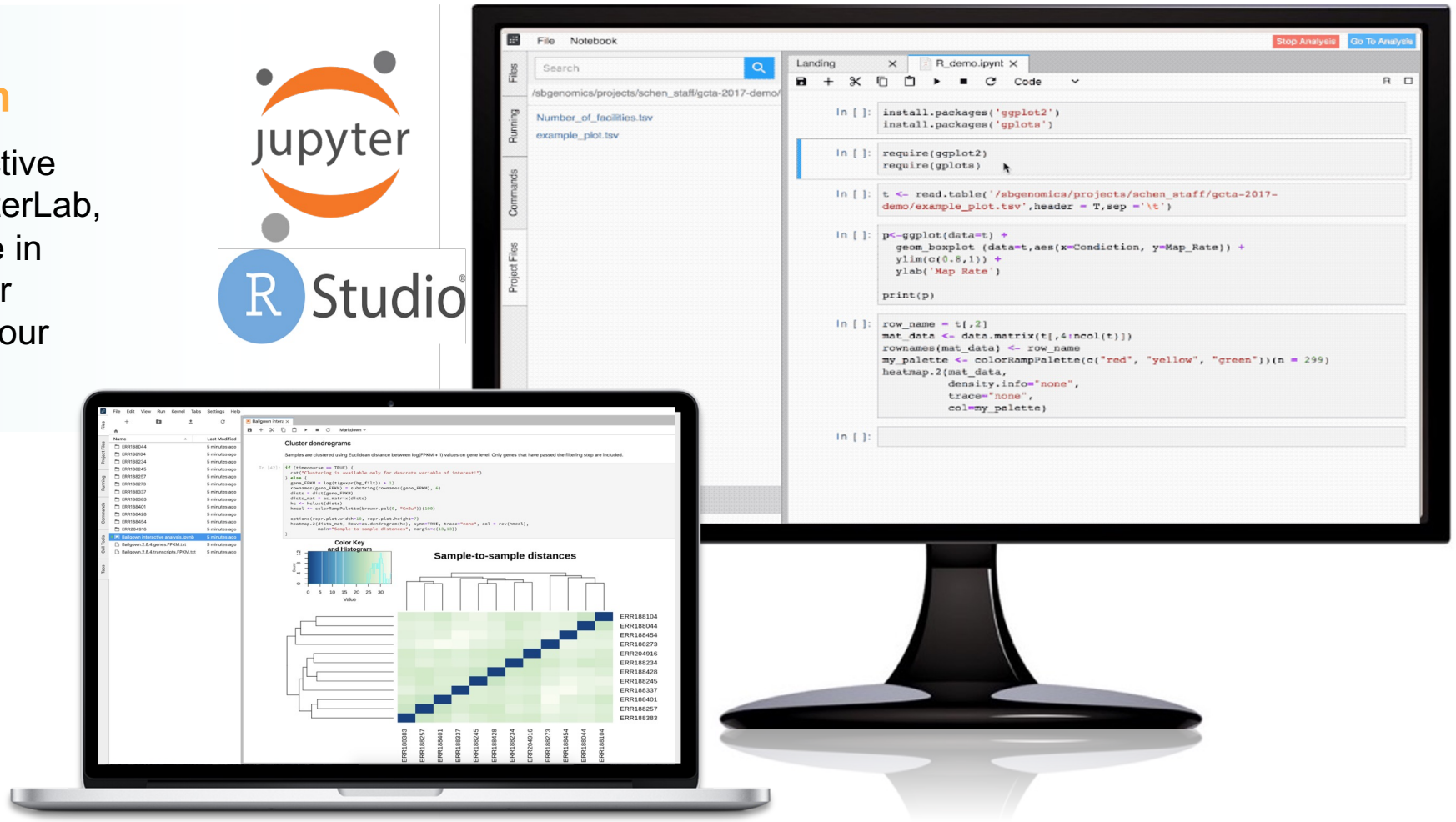
- Common Workflow Language enables **portability**; **reproducibility**; & **scalability**.
- Use or combine **800+ optimized tools** and workflows to construct your analysis.
- Seamlessly **import workflows** from external public repos (e.g. Dockstore).
- **Create your own apps** with our diagrammatic Web Composer.



Integrated Interactive Analysis Tools

Data Science Workbench

Derive new insights using interactive analysis environments with JupyterLab, and RStudio environments. Code in Python and R, and create Jupyter Notebooks to record and share your analyses.



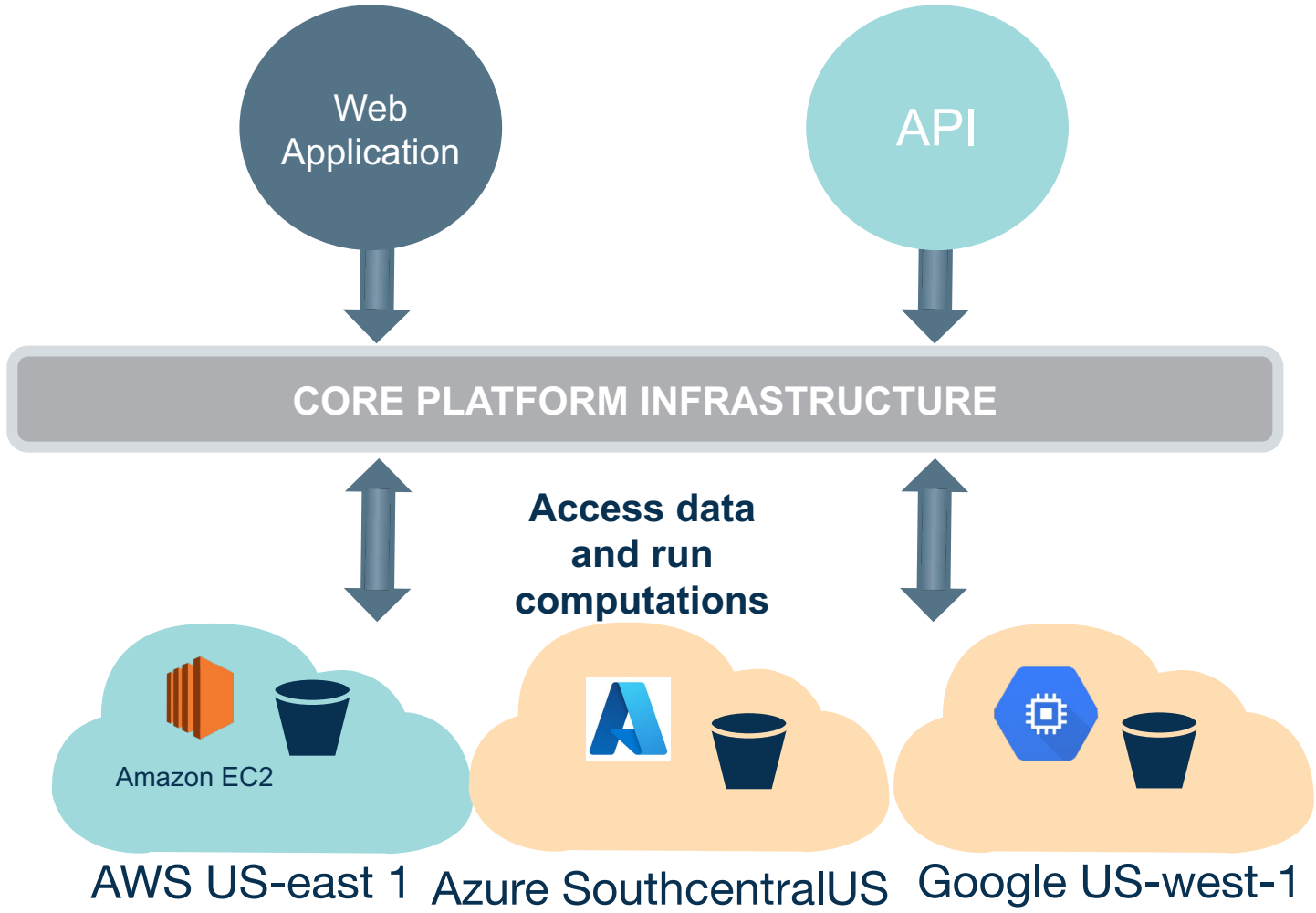
Compute on AWS, Google Cloud, or Azure, based on where data lives

Access and compute on data stored on distributed cloud locations from one user interface or API

Avoid egress costs

Current cloud location options:

- AWS US N. Virginia (us-east-1)
- Google US Oregon (us-west-1)
- Azure *coming soon* (southcentralus)



INCLUDE Data Coordinating Center

Data Type-Agnostic Flexible Analysis Ecosystem

Hundreds of tools for different research questions

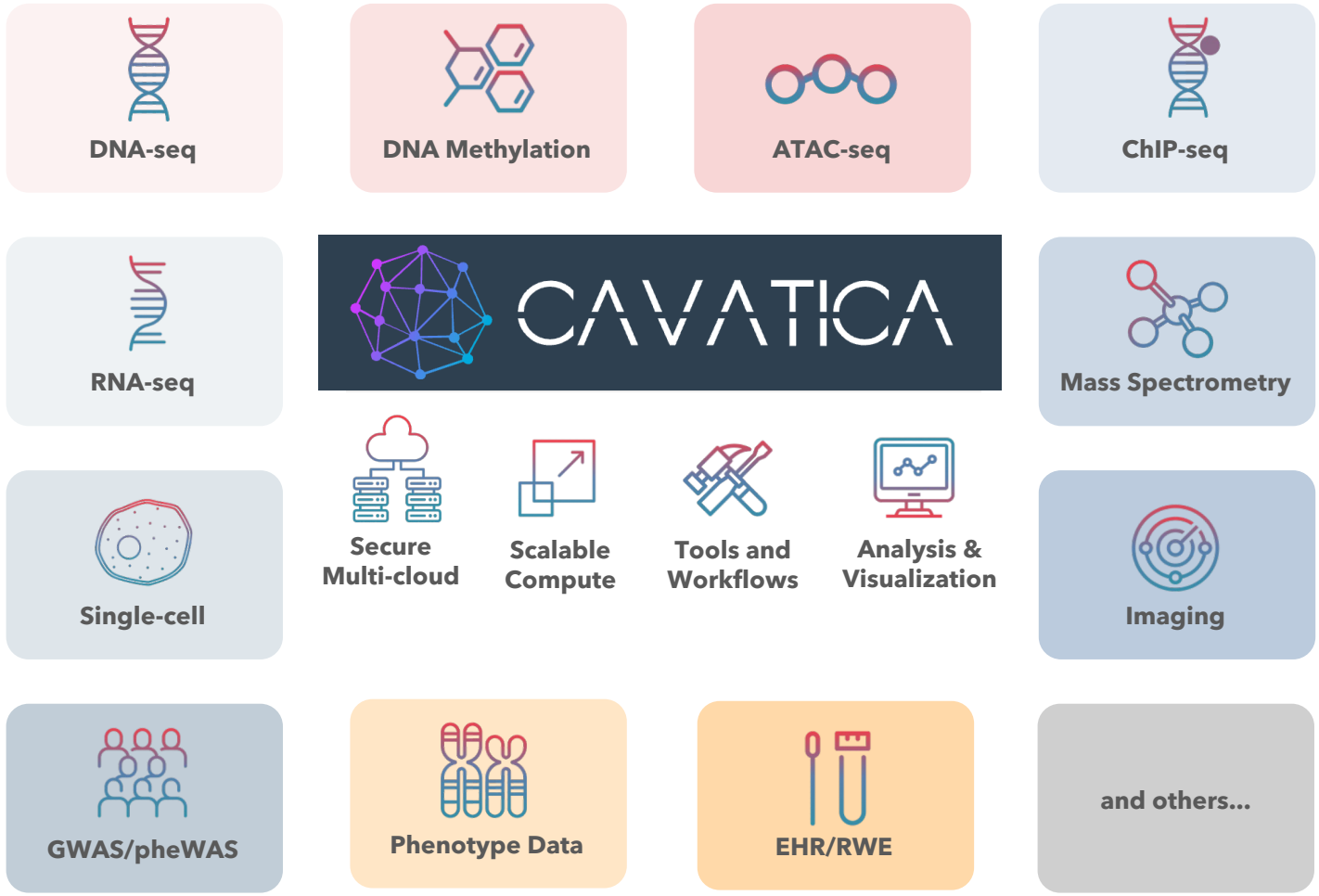
Easy to share with collaborators

Reproducible analysis

Flexible to match your analysis needs

Add your own tools

Contact us at any time with questions!



INCLUDE Data Coordinating Center

Success stories using CAVATICA

Neoplasia
Volume 35, January 2023, 100846

The children's brain tumor network (CBTN) - Accelerating research in pediatric central nervous system tumors through collaboration and open science

Jena V. Lilly [a 1], Jo Lynne Rokita [a 1], Jennifer L. Mason [a], Tatiana Patton [a], Stephanie Stefankiewiz [a], David Higgins [a], Gerri Trooskin [a], Carina A. Larouci [a], Kamnaa Arya [a], Elizabeth Appert [a], Allison P. Heath [a], Yuankun Zhu [a], Miguel A. Brown [a], Bo Zhang [a], Bailey K. Farrow [a], Shannon Robins [a], Allison M. Morgan [a], Thinh Q. Nguyen [a], Elizabeth Frenkel [a], Kaitlin Lehmann [a] ...Angela J. Waanders [p]

Open access Protocol

BMJ Open

Protocol for a comprehensive prospective cohort study of trio-based whole-genome sequencing for underlying cancer predisposition in paediatric and adolescent patients newly diagnosed with cancer: the PREDICT study

Noemi Auxiliadora Fuentes Bolanos [1,2] Bhavna Padhye,[3,4] Macabe Daley,[2] Jacqueline Hunter,[5,6] Kate Hetherington,[6,7] Meera Warby,[2,8] Eliza Courtney,[1,2] Judy Kirk,[9,10] Sarah Josephi-Taylor,[11,12] Yuyan Chen,[4] Frank Alvaro,[13] Kristine Barlow-Stewart,[2,5] Marie Wong-Erasmus,[2,6] Paulette Barahona,[2,6] Pamela Ajuyah,[2,6] Ann-Kristin Altekoester,[2,6] Vanessa J Tyrrell,[2] Loretta M S Lau,[1,2] Claire Wakefield,[5,6] Dianne Sylvester,[4] Katherine Tucker,[1,8] Mark Pinese,[2,6] Luciano Dalla Pozza,[3] Tracey A O'Brien[1]

To cite: Fuentes Bolanos NA, Padhye B, Daley M, *et al.* Protocol for a comprehensive

POSTER PRESENTATIONS - PROFFERED ABSTRACTS | APRIL 04 2023

Abstract 6576: Gabriella Miller Kids First Data Resource Center (KFDRC): Empowering discovery across germline and somatic variation in pediatric cancer FREE

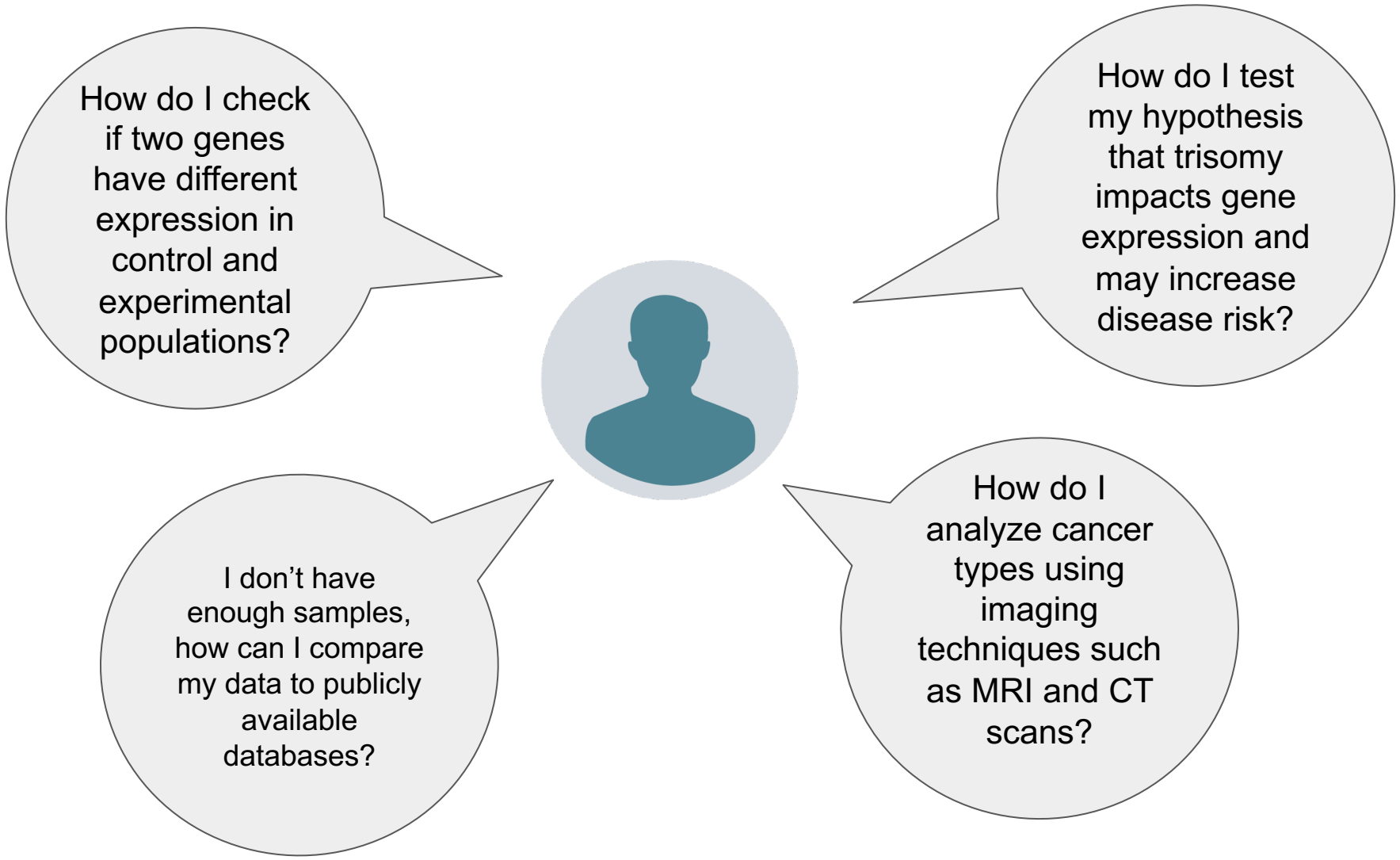
David Higgins; Jean-Philippe Thibert; Michele Mattioni; Jack DiGiovanna; Robert L. Grossman; Bailey K. Farrow; Eric Wenger; Samuel Volchenboum; Robert J. Carroll; Melissa A. Haendel; Deanne M. Taylor; Yuankun Zhu; Vincent Ferretti; Adam C. Resnick; Allison P. Heath

+ Author & Article Information

Cancer Res (2023) 83 (7_Supplement): 6576.

https://doi.org/10.1158/1538-7445.AM2023-6576

What's the research question you want to answer?



INCLUDE Data Coordinating Center

Prototypical User Flow

Organizational unit within platform

Many ways to find and bring in data:

- Data Browser
- Desktop uploader
- Command line uploader
- Volumes

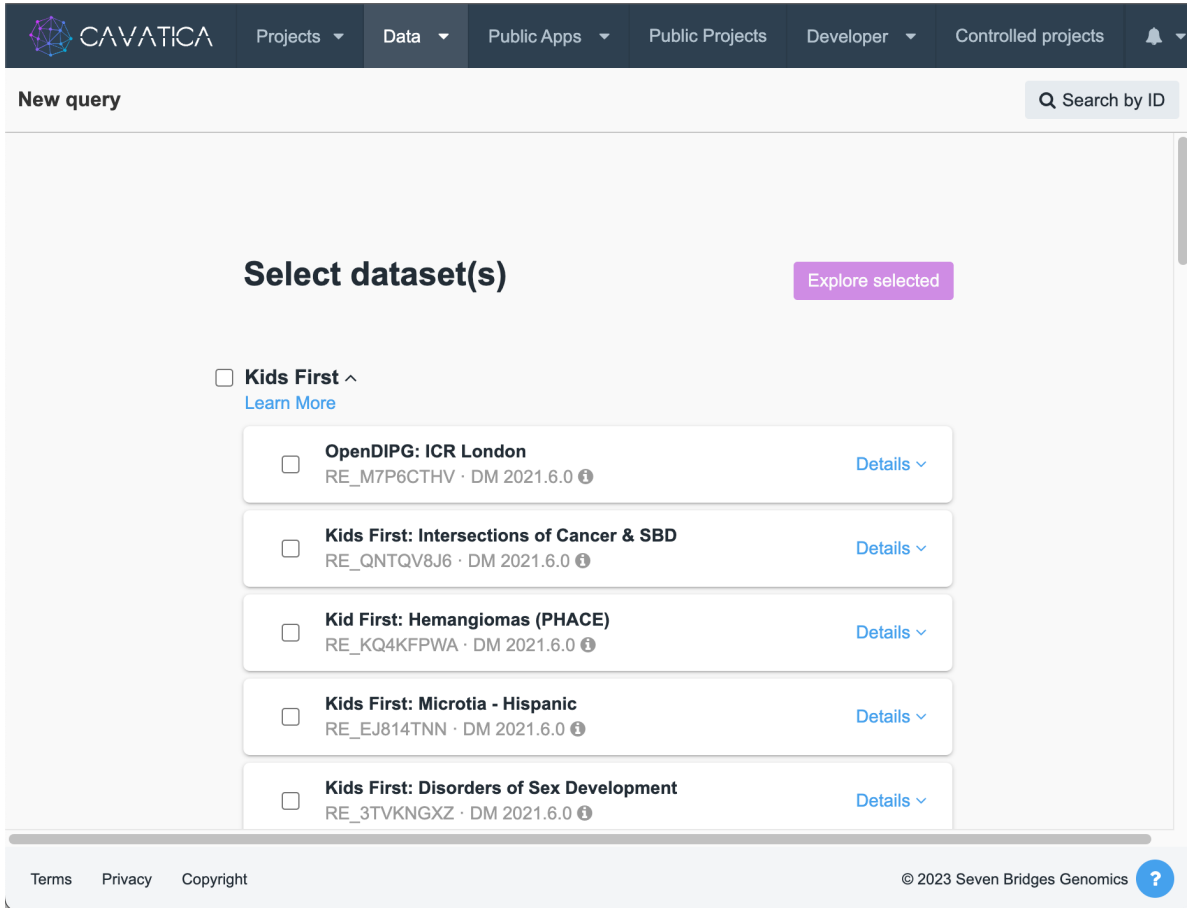
Tools, workflows, and software packages

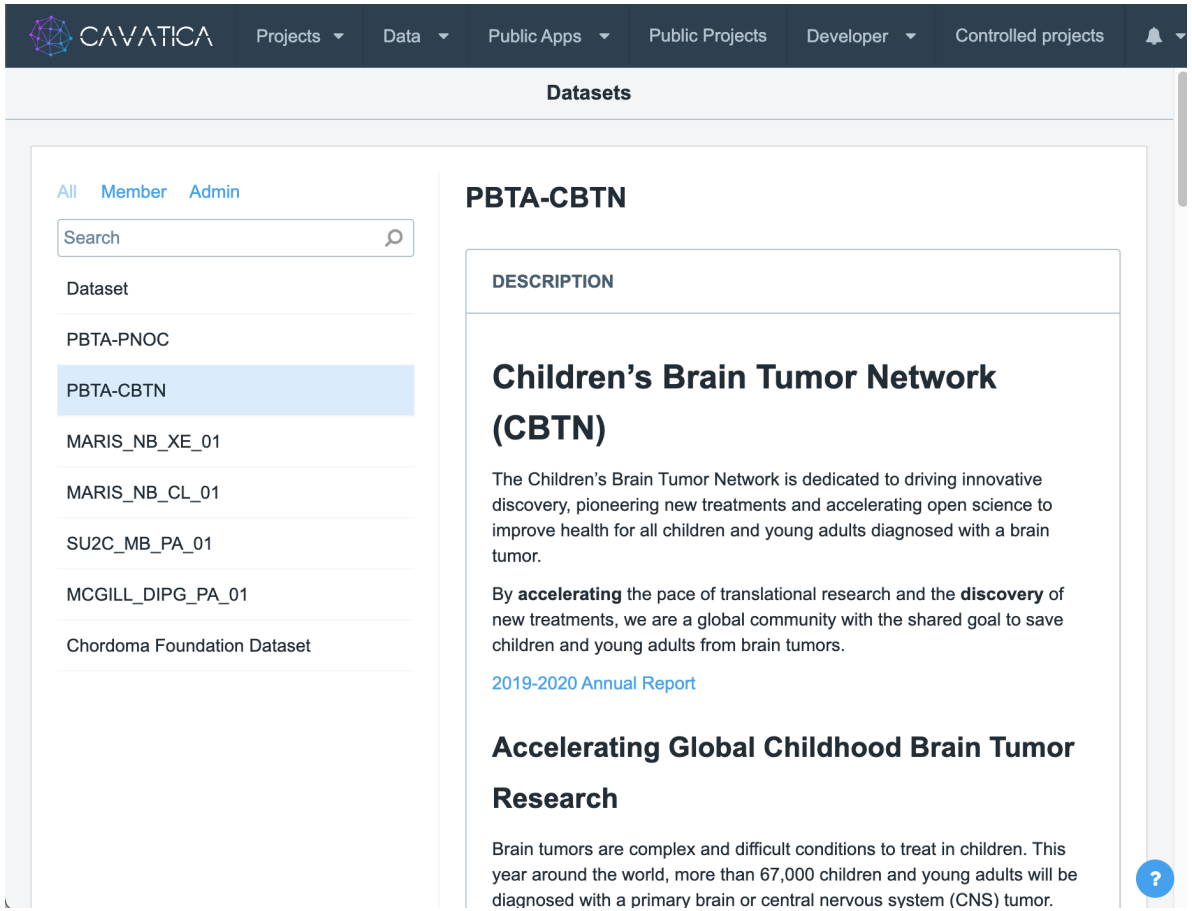
- Public Apps Gallery
- Tools or workflows wrapped in CWL
- R packages
- Python libraries

Specify how an analysis will be run

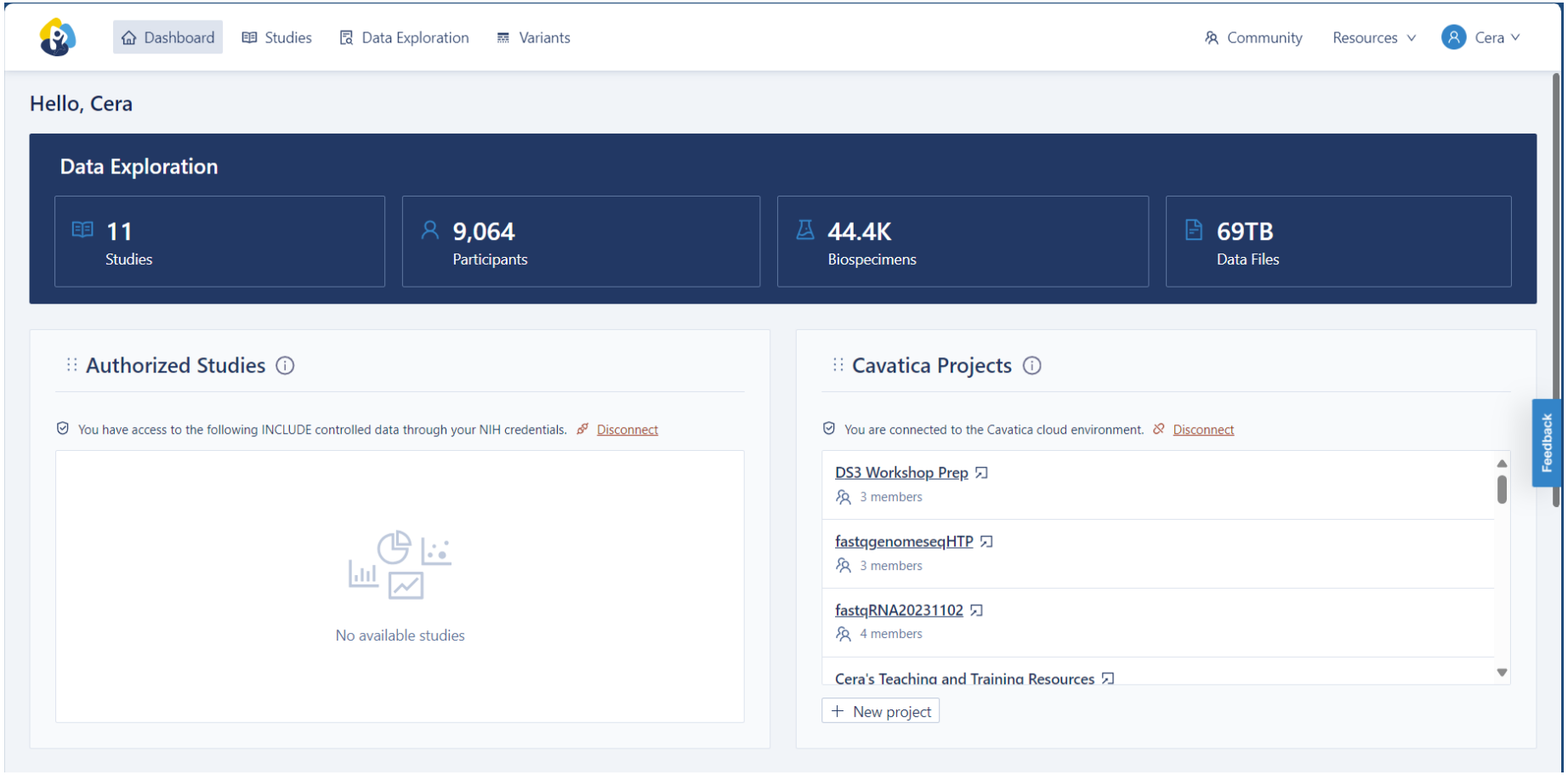
- Task page
- Notebooks in RStudio or JupyterLab

Access and search petabytes public datasets on CAVATICA



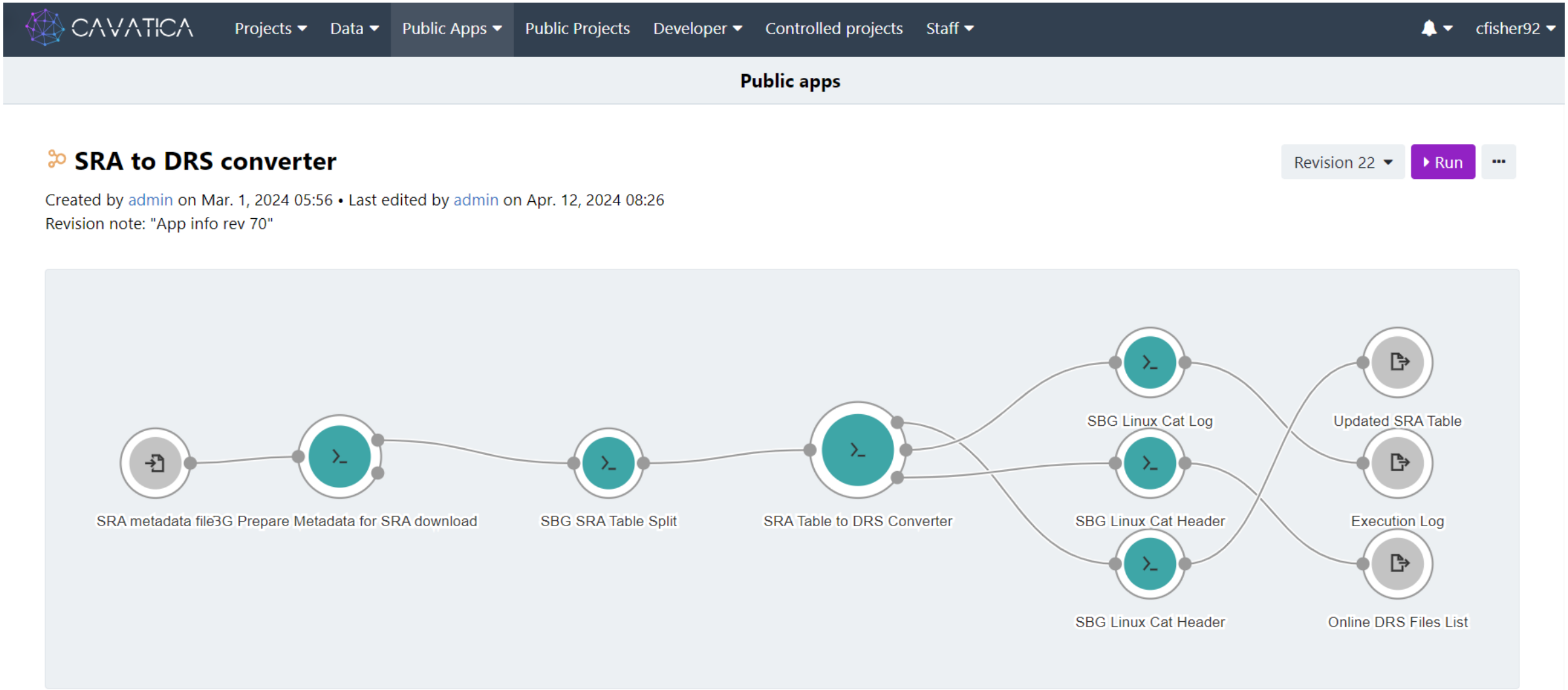


Connected data portals provide an easy way to find data

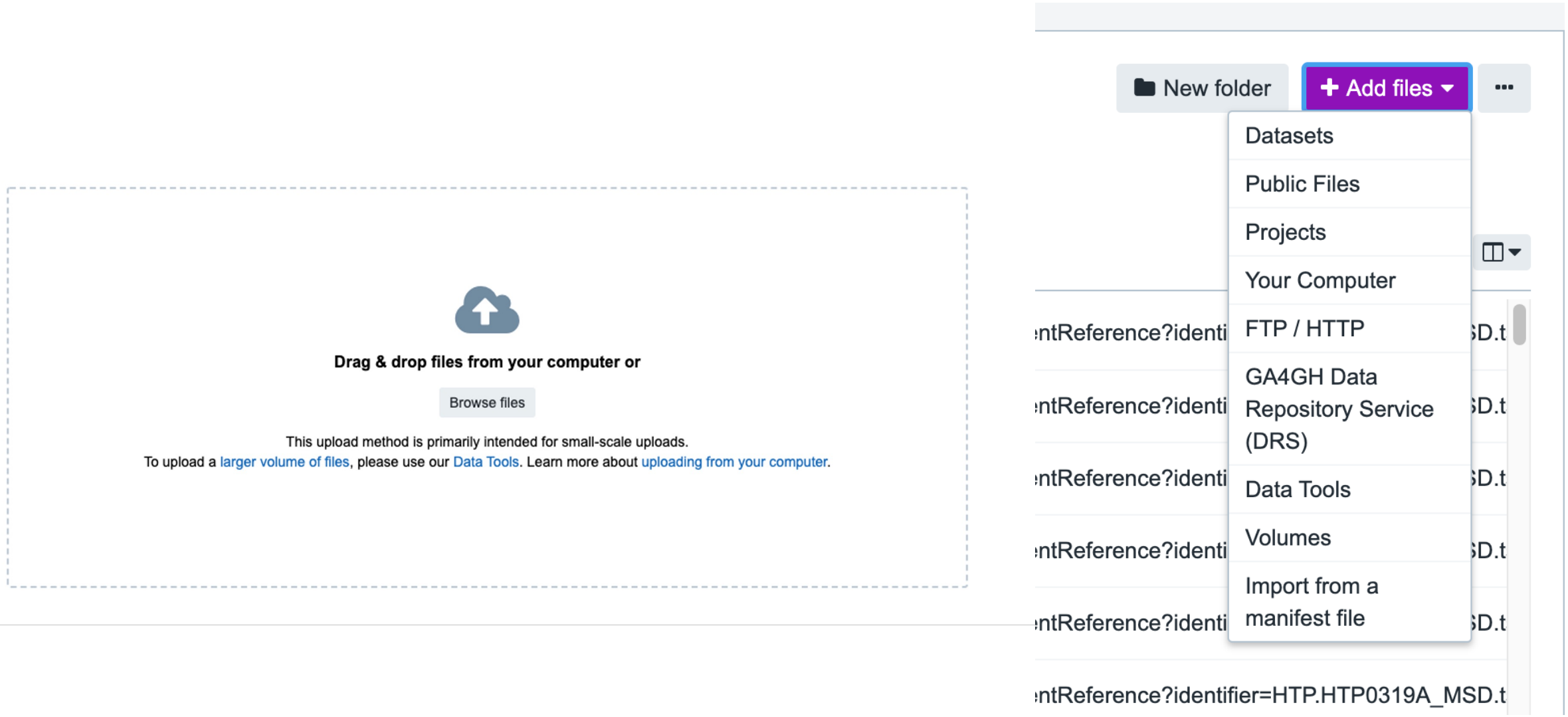


https://portal.includedcc.org/

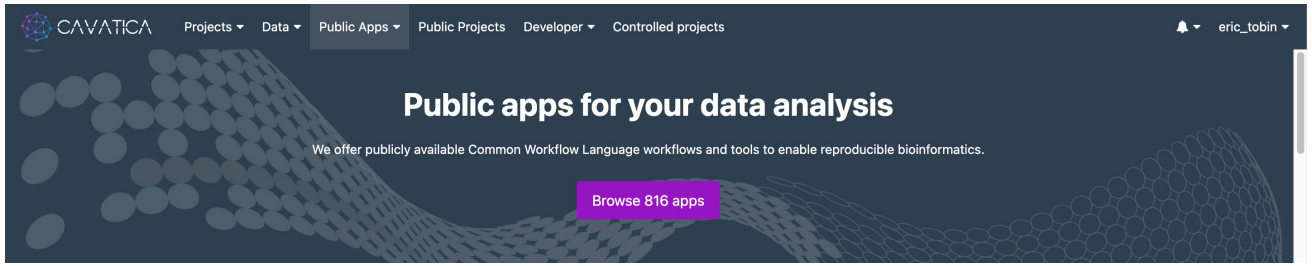
Connect directly to 30+ petabytes of data in the SRA



Conveniently bring in your own data



Public Applications Gallery – tools and workflows for analysis



Platform Tool/Workflow Repository

800+

Curated tools & workflows

Secure

High quality apps & documentation

Optimized to run on cloud

Updated regularly

Customized user tools/workflows

COMMON WORKFLOW LANGUAGE

Founded in 2014 by
Seven Bridges and partners

An open standard adopted by 40+ organizations worldwide including Institut Pasteur, Wellcome Sanger Institute, CERN, UCSC, Harvard T.H. Chan School of Public Health, and many more

An ecosystem of tools and workflows

Reproducible and portable

Complete tooling and low-entry barrier for new users

Dockstore
Create, Share, Use

CWL
project

INCLUDE
Data Coordinating Center

Why (*should I)* do Cloud Computing for Down Syndrome Research?

- Because, to do great science and help people, we have to be able to work together.

“Be positive – be curious. There are a lot of good people in the world doing amazing things. We have so much more useful information than we’ve ever had, and we can harness it to help the world. It’s only going to get better with all the amazing tools we have at our disposal. There is a lot of positivity in the world, and we should contribute as best we can. “

– Vaidhy Mahaganapathy

Dr. Vaidhyanathan Mahaganapathy

Thank you!