Update on NSF's Office of Advanced Cyberinfrastructure and the National AI Research Resource (NAIRR) Pilot

Katie Antypas

Director, Office of Advanced Cyberinfrastructure

Office of Advanced Cyberinfrastructure

Transform science and engineering research through an integrated cyberinfrastructure ecosystem

Advanced Cyberinfrastructure Research

Testbeds (computing, data, networking)

Software and data infrastructure

Cybersecurity and networking

Core research program

Research partnering with other divisions and directorates

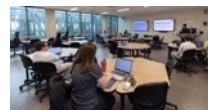## Nationally available infrastructure and services for the R&E community

Large-scale computing, data and networking infrastructure
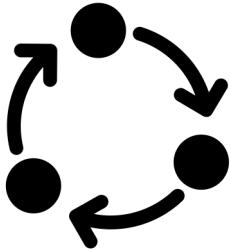
Software, services and middleware

Allocations, user support, communities of practice

Training and workforce development

Transform science and engineering research through an integrated cyberinfrastructure ecosystem

Defining, advancing and interconnecting broad CI ecosystem

Growing and developing communities and workforce

Enabling discovery through integrations of data, software and cyberinfrastructure

NAIRR

Infrastructure for AI

Investing in and transitioning to new technologies

Developing partnerships for long-term US leadership in research CI
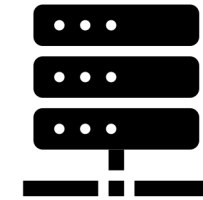
Transform science and engineering research through an integrated cyberinfrastructure ecosystem

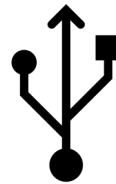Defining, advancing and interconnecting broad CI ecosystem

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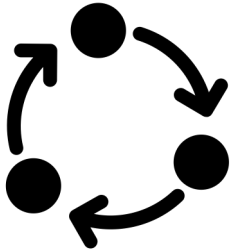
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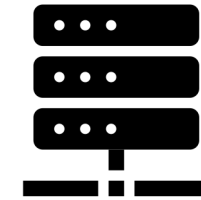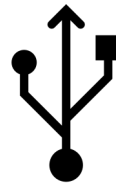Developing partnerships for long-term US leadership in research CI

OAC investment areas

Advanced Computing	Production and operational level advanced computing and data capabilities and services
Networking & Cybersecurity	Advanced networking and security infrastructure, research and communities of practice capabilities
Learning & Workforce Development	Foster a national research workforce for creating, utilizing, and supporting advanced CI
Software & Data	Supports development and deployment of robust, reliable and sustainable data and software
Strategic Investments	Special opportunities, cross-cutting and national initiatives, open science and public access

A few highlights

An NSF-funded collaborative research team exposed safety flaws in customizable A.I. models behind chatbots

Customizable pre-trained LLM with safeguards

Fine-tuned LLM with compromised safety

Retrained LLM with only a few adversarial training examples learns to disregard original safety features

https://www.nytimes.com/2023/10/19/technology/guardrails-artificial-intelligence-open-source.html

7
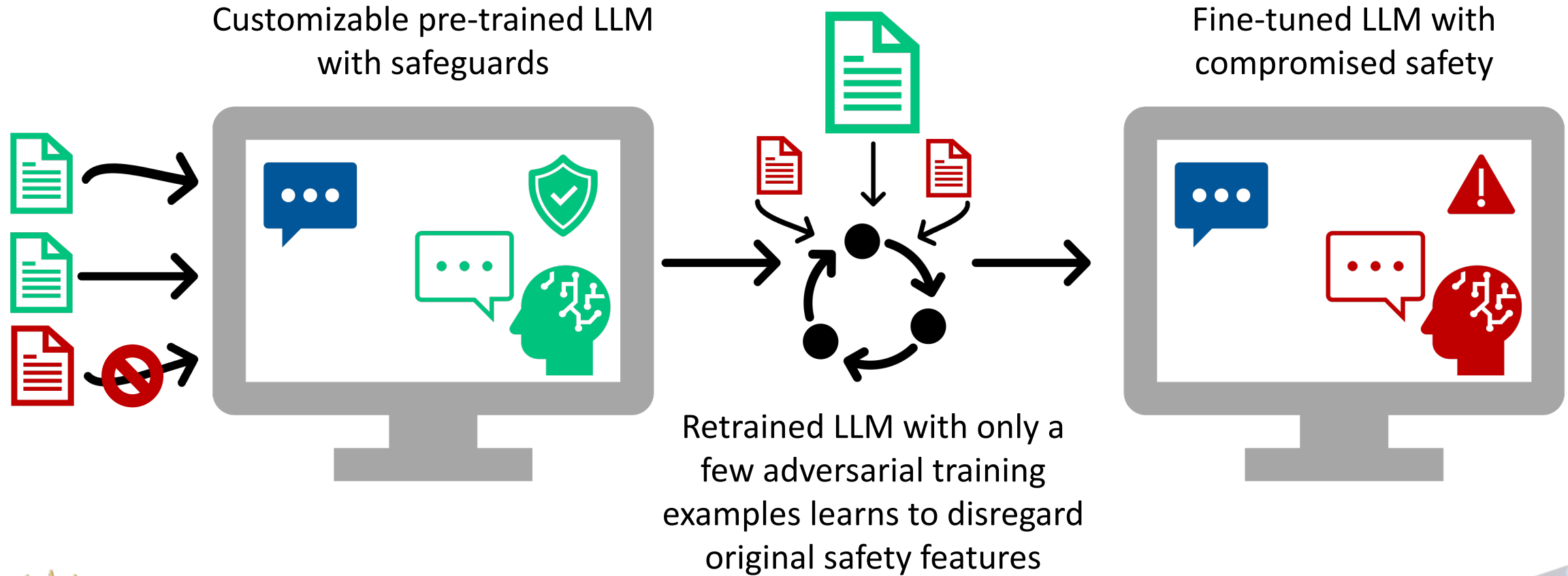
Transformative Science & Engineering Discoveries

Using artificial intelligence (AI) to analyze tens of thousands of X-ray images and genetic sequences, scientists using Frontera have identified the genes that shape our skeletons. *Eucharist Kun, U. of Texas, Science, July 2023.*
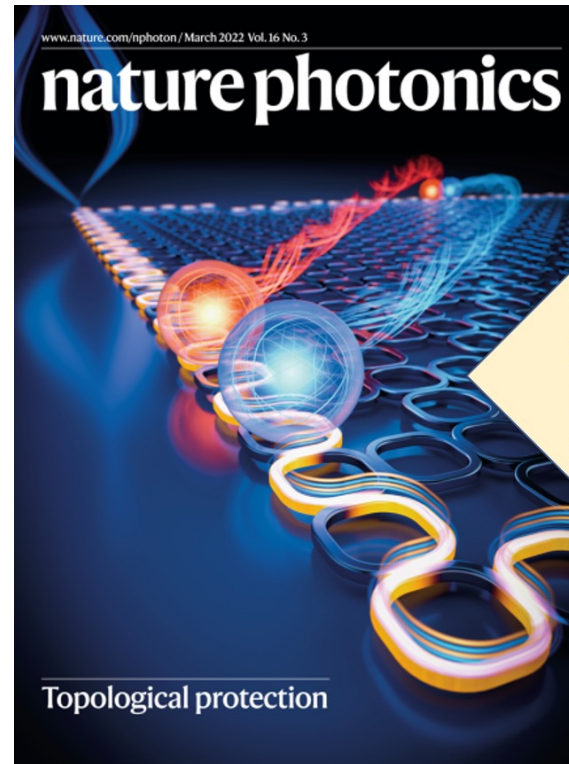
Accelerating Design, Discovery, and Dissemination of New Organic-Inorganic Hybrid Crystalline Semiconductors (OAC/DMR Collaboration #1729297 Blum/Duke)

Overall Goal: To fill targeted gaps in emission spectrum or to improve upon efficiency and production cost profiles afforded by current semiconductor alternatives

Capstone Product: an Open Source Database
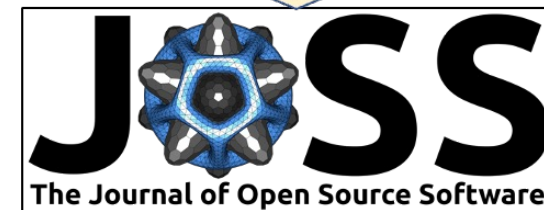
Laasner et al., (2020). MatD3: A Database and Online Presentation Package for Research Data Supporting Materials Discovery, Design, and Dissemination. *Journal of Open Source Software*, 5(45), 1945. https://doi.org/10.21105/joss.01945

National
Discovery Cloud
for Climate

National Discovery Cloud for Climate (NDC-C)

In FY 2023, CISE will invest. . .in the development of a National Discovery Cloud (NDC) for Climate. This resource will federate advanced compute, data, software and networking resources, democratizing access to a cyberinfrastructure ecosystem that is increasingly necessary to further climate-related S&E. The NDC for Climate will serve as a pilot for future efforts to enable equitable access to an NDC across all fields of S&E. **-- NSF FY 2023 Budget Request**

Components of an NDC-C

| Advanced Compute | Open Platforms | Platform Services | Focused Pilots |
| Cloud Resources | Data Resources | Training/Education | Security/Resiliency |

Broad Engagement

NDC-C Prototype: ~30 Investments

Advanced Compute
- DeltaAI
- Stampede3

Cloud Resources
- Cloudbank
- CloudLab
- Chameleon

Open Platforms
- Pelican
- AI Testbed
- SAGE
- NDP

Data Resources
- NCAR/OSDF
- OGreenland
- NOAA Sounders
- Storage

Platform Services
- ACCESS/RAMPS
- Open Access Services

Training/Education
- ACCESS/RAMPS
- Open Access Services
- Argovis (ocean sciences)

Focused Pilots
- Glaciology
- Permafrost
- Sea Level Research
- Forest Ecosystems
- South Florida
- Marine resources
- Terrain Parameters

Security/Resiliency
- Sustainability

Broad Engagement
- Minority Serving – Cyberinfrastructure Consortium (MS-CC)
- The American Indian Higher Education Consortium (AIHEC)

Integrating Pelican/OSDF and Fisheries Sonar Data

- NOAA National Marine Fisheries Service routinely collects "water column sonar data" to inform fisheries stock assessments. These sonar systems use sound to map what is in the water and contain information about fish, zooplankton (fish and whale food), and methane seeps.

- Using OSDF/PATh a researcher adapted a local workflow and processed **55 research cruises conducted between 2007 and 2022 comprising over 100,000 files in 11 hours**

Research vessel collecting sonar data

Pelican Platform   PATh

Your Data — Pelican Connector — National Distribution Infrastructure (OSDF) — Available Compute

NAIRR Pilot Update

March 2024

NAIRR Pilot

Vision for the National AI Research Resource

A widely-accessible, national research infrastructure that will advance the U.S. AI R&D environment, discovery, and innovation by empowering a diverse set of users through access to:
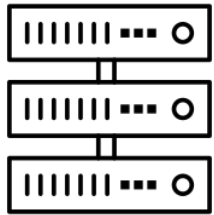
Secure, high-performance, privacy-preserving **computing**

High-quality **datasets**
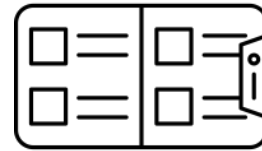
Catalogs of **testbeds** and **educational materials**

Training tools and **user support** mechanisms

Why do we need a NAIRR?

- Many potential contributors lack access to requisite resources which can be costly *as well as* hard to navigate

- Researchers investigating AI to serve the public good require access to resources

- To train the next generation of researchers and AI leaders

AI Curriculum Development

Wind Farm Grid Connection

Juvenile Justice

Trustworthy AI in Medical Systems

Cardiovascular Disease

Neuro-Inspired AI

Atmospheric Modeling

Power grid infrastructure

Security

Urgent national goals we are aiming to fulfill with NAIRR

Spur **innovation**

Increase the **diversity** of talent in AI

Improve U.S. **capacity** for AI R&D

Advance **trustworthy AI**

- Facilitate *national, coordinated* access to AI resources for the broad research and education community to accelerate discovery and innovation.

- Assure that public interest is strongly represented in AI and drives a responsible and trustworthy AI ecosystem.

- Combine forces across the S&T enterprise to increase AI resource capacity and expertise.

Full NAIRR Vision vs NAIRR Pilot Goals

Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem

An Implementation Plan for a National Artificial Intelligence Research Resource

January 2023

THE WHITE HOUSE

OCTOBER 30, 2023

Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence

BRIEFING ROOM ▸ PRESIDENTIAL ACTIONS

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. Purpose. Artificial intelligence (AI) holds extraordinary potential for both promise and peril. Responsible AI use has the potential to help solve urgent challenges while making our world more prosperous, productive, innovative, and secure. At the same time, irresponsible use could exacerbate societal harms such as fraud, discrimination, bias, and disinformation; displace and disempower workers; stifle competition; and pose risks to national security. Harnessing AI for good and realizing its myriad benefits requires mitigating its substantial risks. This endeavor demands a society-wide effort that includes government, the private sector, academia, and civil society.

NAIRR Pilot Goals

Using existing and in-kind contributions:

1. Demonstrate the value & impact of the NAIRR concept.

2. Support novel & transformative AI research and education with participation from broad communities.

3. Gain initial experience to advance and refine the NAIRR design in preparation for a full NAIRR implementation.

* NOTE: funding only an estimate from the Task Force. No funding has yet been appropriated for NAIRR.

NAIRR Pilot Users
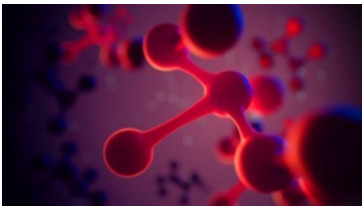
AI Researchers

Domain Scientists Applying AI

Students and Educators

US-Based Institutions including:

- Academic institutions

- Non-profits

- Federal agencies or federally-funded R&D centers

- State, local, or tribal agencies

- Startups and small businesses with Federal grants

Initial NAIRR Pilot AI Research Thrusts

- Accelerate societally-relevant research on **AI safety, reliability, security, and privacy**.

- Empower advances in **cancer treatment and individual health outcomes.**

- Support resilience and optimization of **agricultural, water, and grid infrastructure.**

- Improve design, control, and quality of **advanced manufacturing systems.**

- Address **earth, environmental, and climate challenges** via integration of diverse data and models.
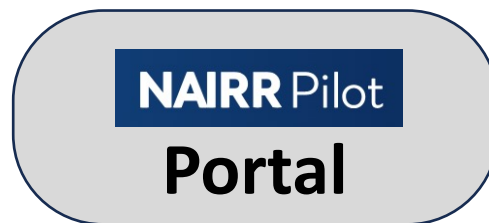
NAIRR Pilot Organization

US-based Researchers, Educators & Students

NAIRR Pilot
Portal

https://nairrpilot.org

Pilot Resources and Opportunities

The NAIRR Pilot provides infrastructure and resources; it does not fund end-user research.

Operations

NAIRR Open	**NAIRR Secure**	**NAIRR Software**	**NAIRR Classroom**
Enable open AI research and access to diverse AI resources via a central portal and coordinated allocations	Enable AI research needing privacy and security-preserving resources. Assemble exemplar privacy preserving resources.	Facilitate use of AI software, platforms, tools and services across platforms	Reach new communities through education, training, user support and outreach

Governance

Community Design Process

U.S. DEPARTMENT OF **ENERGY** | Office of Science **NIH**

Bringing together the strengths of government, private industry and non-profit partners

Contributing Partners

Agencies

- National Science Foundation
- Defense Advanced Research Projects Agency
- Department of Agriculture
- Department of Defense
- Department of Energy
- Department of Veterans Affairs
- National Aeronautics and Space Administration
- National Institutes of Health
- National Institute of Standards and Technology
- National Oceanic and Atmospheric Administration
- US Patent and Trademark Office (USPTO)

Non-governmental orgs

- AI2: Allen Institute for AI
- AMD
- Amazon Web Services
- Anthropic
- Cerebras
- Databricks
- Datavant
- EleutherAI
- Google
- Groq
- Hewlett Packard Enterprise
- Hugging Face
- IBM
- Intel
- Meta
- Microsoft
- MLCommons
- NVIDIA
- Omidyar Networks
- OpenAI
- OpenMined
- Palantir
- Regenstrief Institute
- SambaNova Systems
- Vocareum
- Weights & Biases

Contributions to the pilot go far beyond compute

Contributed Resources

- Access to computing hardware, systems and testbeds

- Cloud computing credits and access to associated models, data and software platforms

- Software and platforms

- Open models, datasets and PETs

- API access to closed models

- Educational platforms online notebooks for students

- Enhanced training, expertise and user support.

Pilot Launched in Jan with 10 agency and 25 non-govt partners

NAIRR Pilot — National Artificial Intelligence Research Resource Pilot

NAIRR Pilot **Portal**

Built by SGX3

https://nairrpilot.org/

Current Opportunities

SURVEY OF US RESEARCHERS, EDUCATORS, AND STUDENTS

We are eager to learn your use cases for the NAIRR Pilot, your challenges using AI resources, and other perspectives. The survey is open through March 8, 2024.

Fill out survey

APPLY FOR COMPUTING

An initial set of NAIRR Pilot advanced computing resources, such as GPUs, is available to researchers and educators. The call is open through March 1, 2024.

Apply for computing

PILOT RESOURCES

Partners are contributing many kinds of resources to the pilot, such as pre-trained models, AI-ready datasets, and relevant platforms.

View Pilot resources

Extended to March 31st

Initial call closed March 1st
> 150 submissions
Next open call mid-April

NAIRR Pilot

Early peak at survey interim results

Most Urgent Need
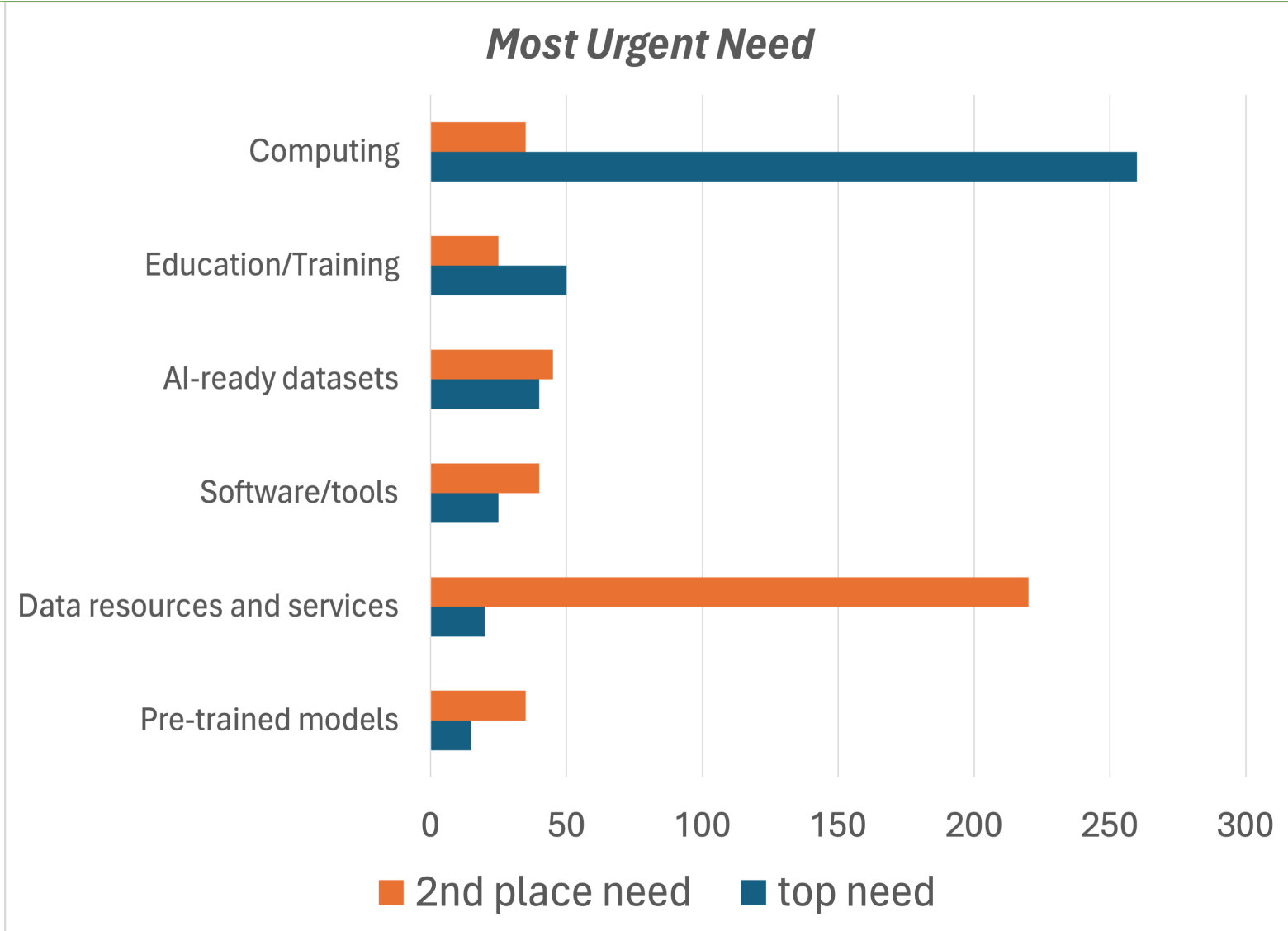
Early peak at survey interim results

How would you use the NAIRR?

Perform AI research	Apply AI to Domain	Perform R&D for product	As an instructor	Learn about AI	Other
22%	29%	12%	19%	15%	3%

Science/Research Disciplines (according to NSF categories)

BIO	CISE	EDU	ENG	GEO	MPS	SBE	TIP	Other
6%	50%	16%	8%	3%	8%	8%	0%	12%

First open call for compute results in > 150 requests
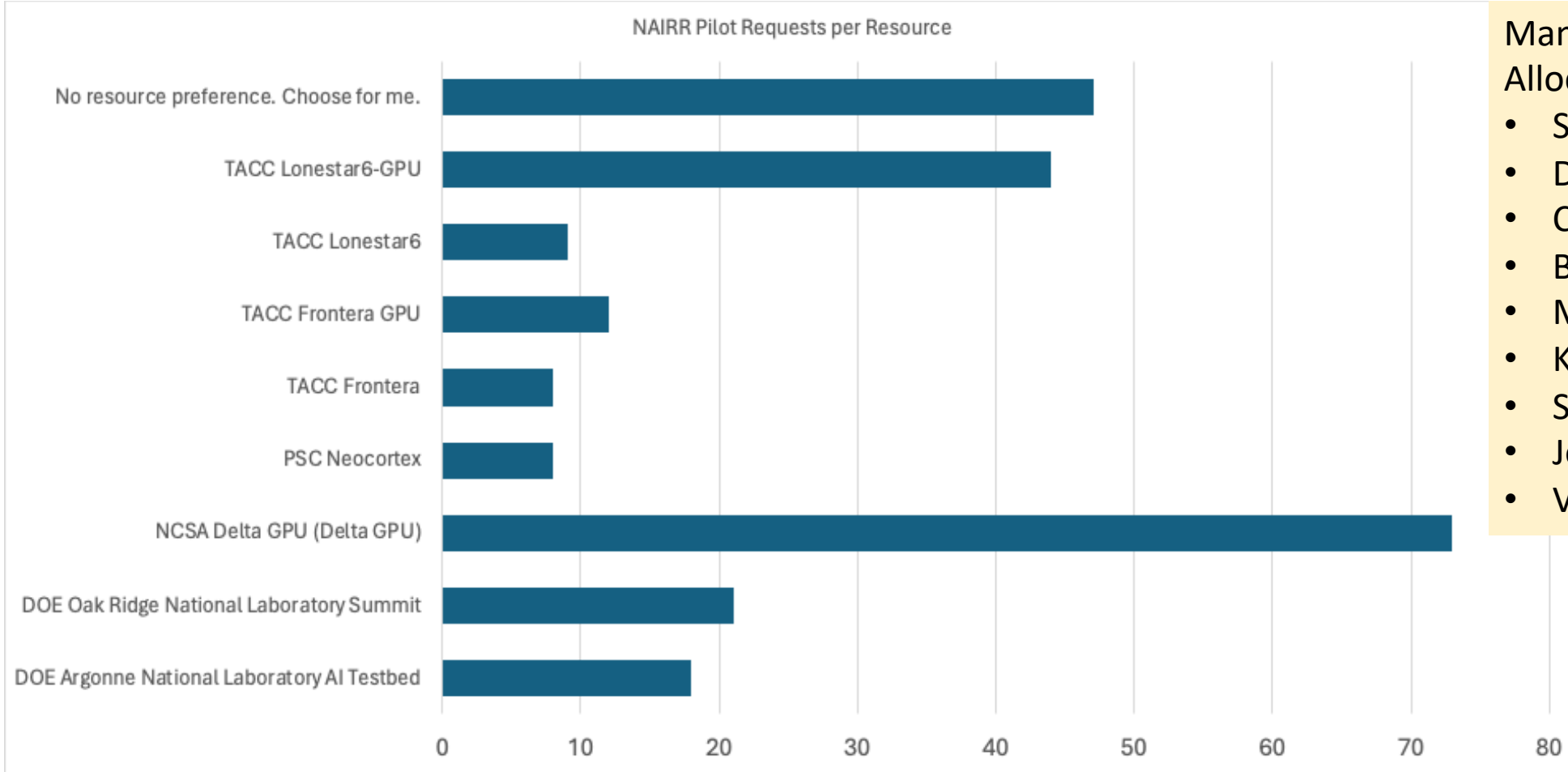
NAIRR Pilot Requests per Resource

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- Stephen Deems – PSC
- Dave Hart – NCAR
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- Mike Norman – SDSC
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Second open opportunity for researchers to apply for access target for April – will include additional agency resources and private/non-profit sector resources

Data and Networking Challenges and Opportunities

Data growing in size and complexity

Data pipelines, staging and wrangling often dominate researcher time

Data quality and fairness is of top concern

Data often needs to be transferred to reside close to compute

Edge computing for sensors and detectors add new use cases

Developing a data discovery services that provides incentives for community datasets

Data policies that enable trustworthy AI

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Our strategy in the pilot is to address data challenges through specific use cases and demonstration projects

Data

Edge computing for sensors and detectors add new use cases

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Data policies that enable trustworthy AI

Transparent and responsible AI will be a key focus of pilot

Advance
trustworthy AI

- Goal is to be transparent with NAIRR pilot processes
- Stand up an advisory sub-committee to aid with guidance on:
  - Evaluation of proposals and standards for NAIRR pilot contributions
  - Community outreach
  - Transparent operational policies
  - Training and User support
- Workshop with NIST and NIH on how pilot can support Trustworthy AI

NAIRR Pilot governance and operations organization

NAIRR Pilot IWG

NSF, EOP & interested federal agencies

NAIRR Pilot Steering Committee

NSF and Representatives from EOP and contributing partner federal agencies
Provides strategic direction for the NAIRR Pilot.

Administrative home for the Pilot

NAIRR Pilot Advisory Subcommittee

Advises on pilot policy, ethics and technical issues.

Non-government Partner Forum

Non-governmental contributing partners (signed MOIs with NSF) - Input on use of resources and pilot opportunities

Partner agencies designate program manager members to PPMO

Non-gov partners designate technical contacts for working groups as appropriate

Pilot Program Management Office (PPMO)

Allocations WG
User Experience WG

Pilot Operations Teams & Working Groups

NAIRR Pilot
Portal

nairrpilot.org

NAIRR Open

NAIRR Software

NAIRR Classroom

NAIRR Secure

Pilot organizational areas

Color key
- Agency governance
- Community
- Advisory

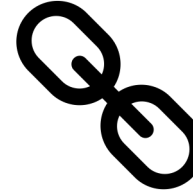U.S. DEPARTMENT OF ENERGY | Office of Science   NIH

Many anticipated challenges...

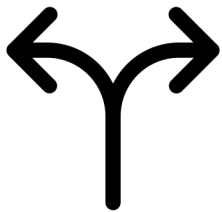Democratization: reaching broad communities

Assuring trustworthy & responsible AI in research space

Interoperability of resources

Data access, quality, curation, pipelines

Divergent software stacks

Applying design patterns across domains, NAIRR Open and Secure

On-boarding & user support

Community engagement and design is imperative to success of NAIRR pilot

Questions and Discussion

Acknowledgements

- NAIRR Pilot Interagency Steering Committee
- NSF NAIRR Pilot Team
- Amy Walton
- Bill Miller
- Tess deBlanc-Knowles
- Sharon Geva
- Alejandro Suarez
- Daniel Bullock
- Varun Chandola
- Marlon Pierce
- Maria Fernanda Pembleton
- JD Kunda
- Dilma Da Silva

- Ellen Zegura
- Michael Littman
- Wendy Nilson
- Jeff Forbes
- Jim Donlan
- Sheikh Gafoor
- Juan Li
- Vivica Brooks
- Christine Christy
- Alice Kamens
- Kerstin Mukerji
- Gabby Cates
- Josh Chamot

NAIRR pilot survey of researcher and educator use cases

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NAIRR Pilot — National Artificial Intelligence Research Resource Pilot

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- Department of Agriculture
- Department of Defense
- Department of Energy
- Department of Veterans Affairs
- National Aeronautics and Space Administration
- National Institutes of Health
- National Institute of Standards and Technology
- National Oceanic and Atmospheric Administration
- US Patent and Trademark Office (USPTO)

➤ **More Joining!**

Non-governmental orgs

- AI2: Allen Institute for AI
- AMD
- Amazon Web Services
- Anthropic
- Cerebras
- Databricks
- Datavant
- EleutherAI
- Google
- Hewlett Packard Enterprise
- Hugging Face
- IBM
- Intel
- Meta
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➤ **More Joining!**

- Access to computing hardware, systems and testbeds

- Cloud computing credits and access to associated models, data and software platforms

- Software/platform licenses for NAIRR Pilot users

- Open large language models, datasets, software libraries and privacy-enhancing platforms

- API access and research collaborations on closed models

- Educational platforms 'notebooks' for classrooms and students

- Enhanced training, expertise and user support.

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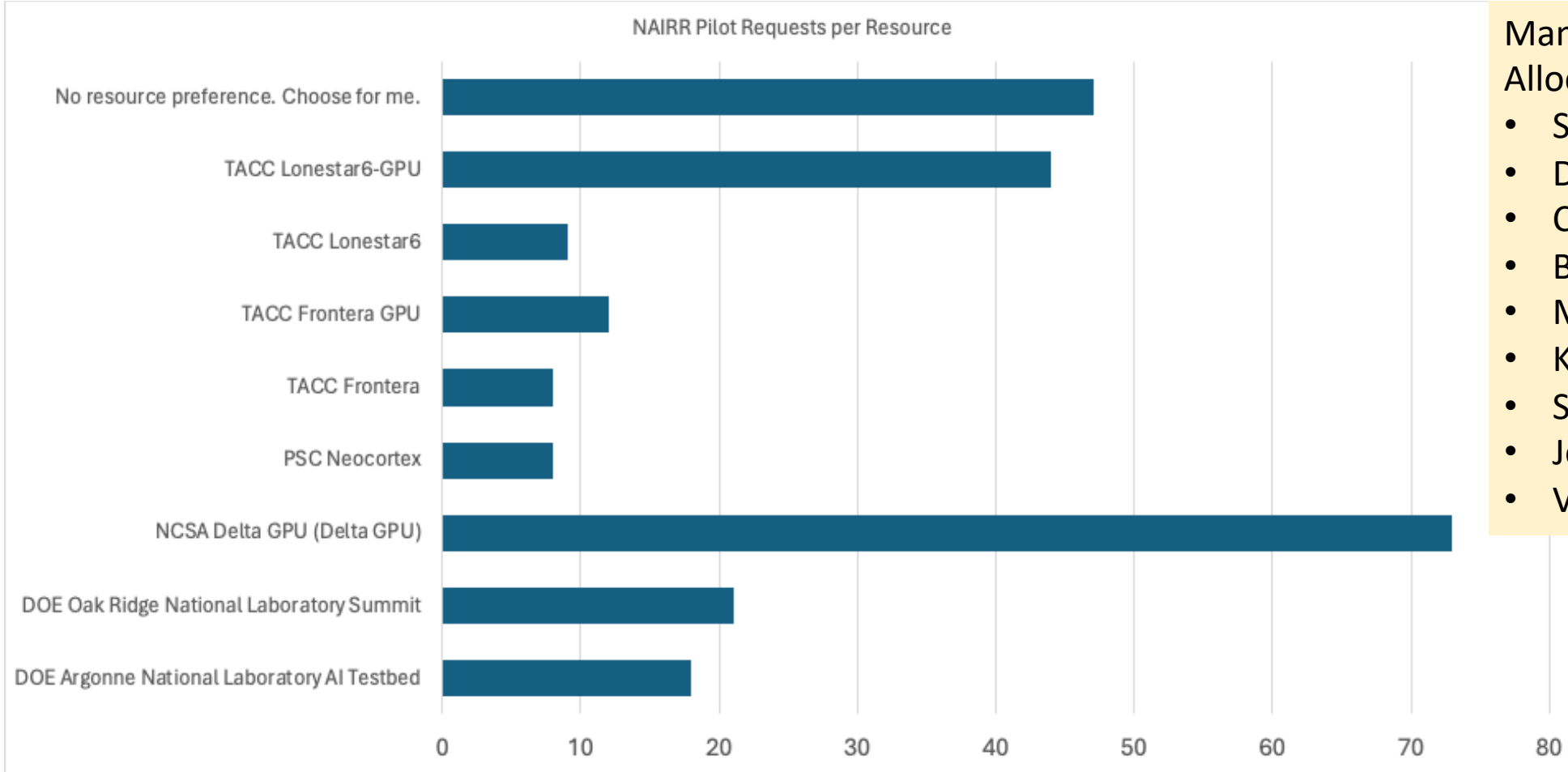
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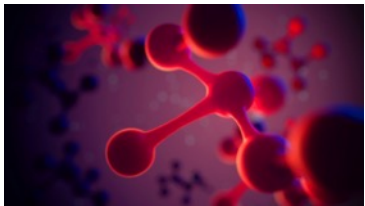- John Towns – UIUC
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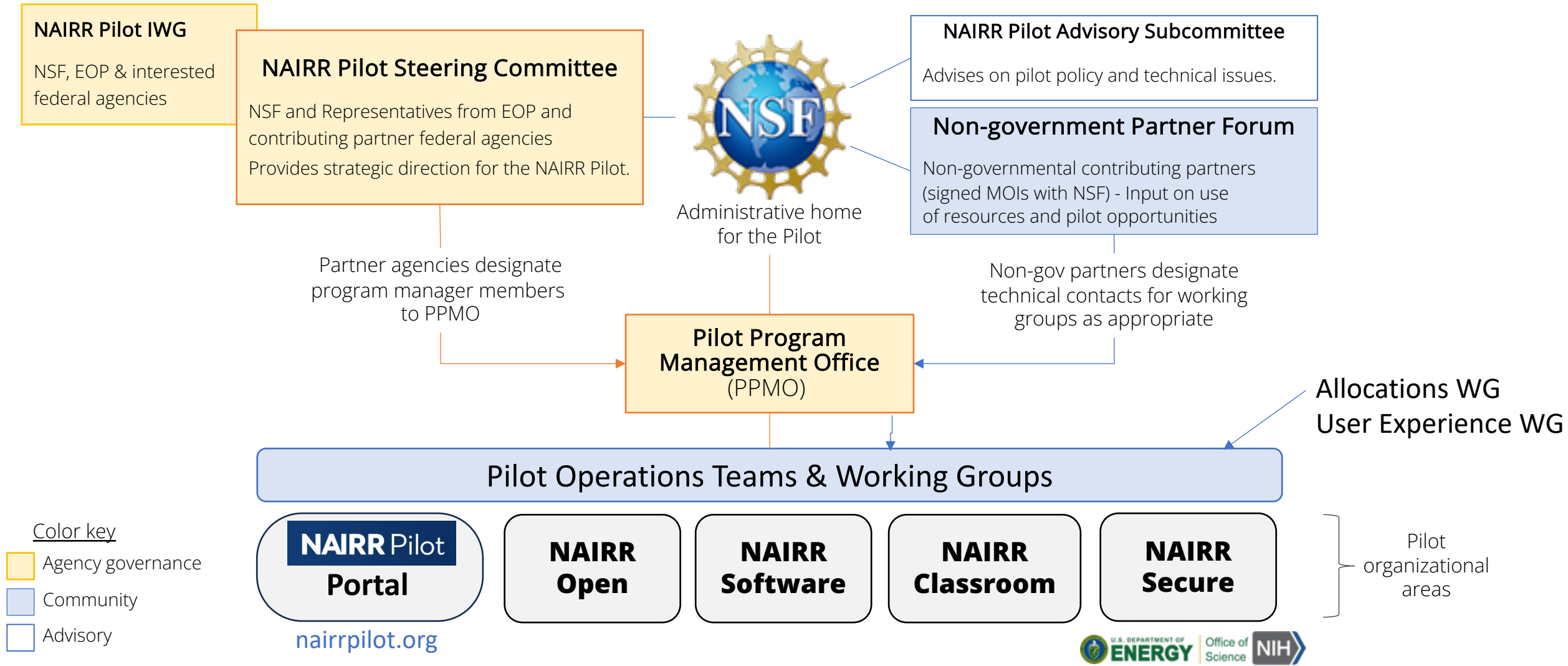

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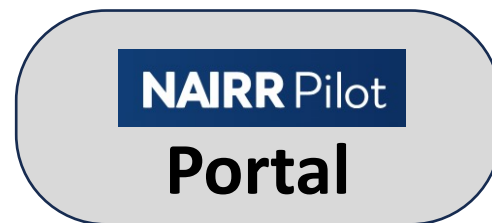- Startups and small businesses with Federal grants

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NAIRR Pilot Organization

User Journey

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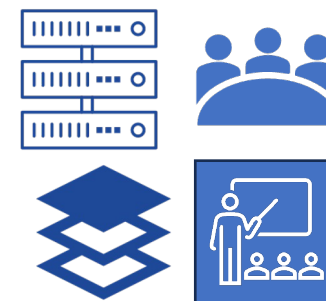
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Community Design Process

U.S. DEPARTMENT OF ENERGY | Office of Science   NIH

NAIRR Classroom

- We have heard from many educators and instructors that simply finding the computing resources to do a machine learning course's hands-on exercises is a challenge

- The intention of NAIRR Classroom is to provide educators with computing and data resources to support hand-on activities and student projects.

- We know for many communities, access to an integrated Jupyter notebook is critical and sufficient.

- We are working on our NAIRR classroom strategy. A first opportunity is available with EducateAI DCL

Networking and Data Challenges and Opportunities

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Early outcomes and learnings

- Scale and breadth of industry in-kind contributions validates the stated interest in working with government to achieve the goals.

- After only 40 days from launch, the Pilot has confirmed a strong cross-agency interest and involvement and overwhelming researcher needs.

- Educator (and education) interest in NAIRR for classrooms and student projects has skyrocketed → Need to accelerate NAIRR Classroom thrust

- Many needs expressed for integrated pathways between data and compute → building pilot demonstration projects

Funding will ultimately determine the scale of the pilot and how fast we can prepare for a full-scale NAIRR

The NSF NAIRR Pilot Team

Katie Antypas
OAC

Amy Walton
OAC

William Miller
OAC

Tess deBlanc-Knowles
OD/TIP

Varun Chandola
OAC

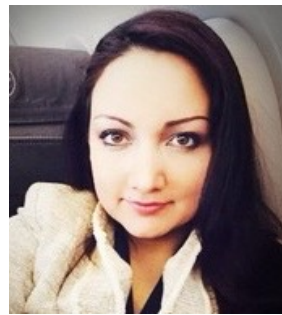**Dan Bullock**
AAAS Fellow OAC

Sharon Geva
OAC

Alejandro Suarez
OAC

Marlon Pierce
OAC

Maria Fernanda Pembleton, CISE

Sheikh Ghafoor
OAC

Juan (Jen) Li
OAC

Vivica Brooks
CISE Directorate

Christine Christy
OAC

Alice Kamens
TIP

Kerstin Mukerji
TIP

Gabrielle Cates
OAC

Michael Litman
IIS

Wendy Neilson
IIS

Jim Donlan
IIS

Jeff Forbes
CNS

Ellen Zegura
CNS

Dilma DaSilva
CISE

JD Kunda
CISE

Joshua Chamot
OLPA

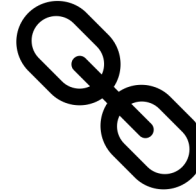# Questions and Discussion

Many anticipated challenges...
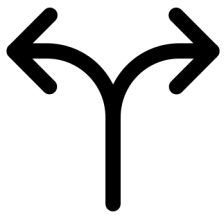
Democratization: reaching broad communities

Assuring trustworthy & responsible AI in research space

Interoperability of resources

Data access, quality, curation, pipelines

Divergent software stacks

Applying design patterns across domains, NAIRR Open and Secure

On-boarding & user support