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# Request for Information (RFI) on an Implementation Plan for a National Artificial Intelligence Research Resource: Responses

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# 1 Introduction

In an effort to democratize the infrastructure to fuel artificial intelligence (AI) research and development (R&D), Congress established the National Artificial Intelligence Research Resource (NAIRR) Task Force (Task Force). The Task Force has been mandated by Sec 5106 of the National Artificial Intelligence Initiative Act of 2020 to “develop a coordinated roadmap and implementation plan for creating and sustaining a National Artificial Intelligence Research Resource.” The NAIRR would establish a shared infrastructure that, per the RFI, “would provide Artificial Intelligence (AI) researchers and students across scientific disciplines with access to computational resources, high-quality data, educational tools, and user support.” To support this initiative, Amazon Web Services, Inc. (AWS) is responding to the RFI to offer our perspective as a leading cloud and AI provider with years of experience building AI solutions for government, nonprofit, and educational organizations around the world.

## AWS and CloudBank

AWS supports groundbreaking research by working with higher education institutions and national and international research agencies to advance research and promote collaboration using the AWS Cloud. Over the past decade, we have supported key initiatives, such as the NSF-funded [CloudBank](#), for data and compute-intensive research and education efforts using the cloud.

AI and related technologies, including machine learning (ML) and deep learning, enable government agencies to transform how they operate and improve citizen services. We know this from our experience helping the federal government and research institutions create impactful AI solutions faster. As a leading cloud service provider, AWS’s compute, storage, AI/ML, and data analytics services can form the backbone of NAIRR’s shared research infrastructure, helping the Task Force meet the requirements in the [National Artificial Intelligence Initiative Act of 2020](#) and as directed by Congress.

AWS seeks to continue supporting research and education efforts and bridging the digital divide through initiatives like the NAIRR. Our AI services offer capabilities to support the Task Force in developing a roadmap for “expanding access to critical resources and educational tools that will spur AI innovation and economic prosperity nationwide,” as stated in The White House Office of Science and Technology Planning (OSTP) press release, *The Biden Administration Launches the National Artificial Intelligence Research Resource Task Force*. Additionally, our suite of AI services enables the Task Force to carry out the activities described in the OSTP press release and in the National Artificial Intelligence Initiative Act.

**Section 2** includes our responses to the RFI questions and our recommendations for the Task Force to consider during development of the NAIRR roadmap and implementation plan.

## 2 Responses to the RFI Questions

Our responses to the RFI questions provide our recommendations for establishing and sustaining the NAIRR and meeting its objectives as a shared research infrastructure.

## 2.1 Question 1: Implementation Roadmap Elements

As outlined in Section 5106(b) of Public Law 116-283, the implementation roadmap developed by the Task Force should include the following elements discussed in the subsections below.

### 2.1.1 Roadmap Element A: Goals and Success Metrics for Establishing and Sustaining the NAIRR

To further the National AI Initiative and create a NAIRR that is sustainable for the future, the NAIRR should establish goals and associated metrics that clearly demonstrate the efficacy of the program. Good metrics will enable data-driven decision making related to future funding and the efficacy of public and private sector investment in the NAIRR. While there are many goals the Task Force can consider, we recommend emphasizing goals that increase the benefits of AI technology to underrepresented and underserved communities and that strengthen our national AI workforce (such as the suggested goals and metrics below). As AI technology is introduced more widely to the U.S. population through the NAIRR and other initiatives, the demand for AI education and a developed workforce will continue to grow.

**Suggested Goal 1: Increase the extent to which AI technology benefits underrepresented and underserved communities.** AI technology has the potential to improve myriad critical products and services for all segments of society (e.g., legal, healthcare, financial services, etc.). The NAIRR can track the use cases and communities served by the technologies developed with its resources and adjust the allocation of its resources over time to ensure that underrepresented and underserved communities benefit from the technologies developed. The NAIRR will need input from diverse stakeholders to identify the communities and use cases that it should prioritize and to decide what qualitative or quantitative measures of “benefit” make the most sense. For example, for a small number of specific demographic and healthcare use cases each year, the NAIRR could (a) inventory the publicly available AI applications that address the use case, (b) assess the size of the gap between what a National Institutes of Health (NIH) research panel suggests is possible and the inventory, (c) prioritize allocating computing resources to classwork and research that closes the gap, and (d) measure the closure of the gap.

**Suggested Goal 2: Increase the size and skills of the national AI workforce.** To take full advantage of the opportunities that AI presents, we need to increase the number of people qualified to fill the new technical and non-technical jobs being created by the AI boom. While there are already programs to increase the number of STEM graduates, within AI, STEM roles constitute only a portion of the new jobs that will become available. For example, there will be new AI-related jobs in product design, dataset construction, policy analysis, and business leadership. All of these jobs will require a solid understanding of AI principles and some familiarity with how real systems work. The NAIRR can (a) review the availability of AI curricula and research programs across secondary and post-secondary schools in the United States, (b) estimate the production rate of skilled technical and non-technical workers from existing programs, (c) sponsor the development of new curricula and research programs that use NAIRR compute, storage, and other resources to accelerate skill development, (d) help schools without existing programs or with underdeveloped programs expand their enrollment of students via the adoption of the new NAIRR curricula, and (e) track the resulting improvement in the national AI workforce.

## 2.1.2 Roadmap Element B: NAIRR Ownership and Administration

NSF, or NSF-led National AI Research Institutes, may be best suited to operate the NAIRR's infrastructure. NSF has existing data computing and shared infrastructure through partnerships with cloud service providers. This infrastructure can support the NAIRR's implementation, deployment, and administration. NSF can leverage this existing infrastructure to provide the NAIRR as a resource to universities and colleges, nonprofits, and other educational or research institutions focused on AI. This collaboration can help allocate resources and knowledge to support the NAIRR's ownership and administration of its objectives—whether through infrastructure, training services, or programs—and evaluation of responsible AI research. Recommendations for the NAIRR's governance structure are described in **Section 2.1.3**.

## 2.1.3 Roadmap Element C: Governance and Oversight Strategy Model

NSF, with its own oversight and administration, is well equipped to support programmatic decisions and allocate resources to researchers and students. Supplementary to NSF, we recommend creating an advisory board composed of advocates for underrepresented and underserved communities, professional organizations dedicated to economic development, and AI experts from the private sector and federal agencies. The purpose of this board is to gather individuals who have experience with critical technology initiatives and making AI more accessible, enhancing online adult learning programs to upskill the workforce, and supporting underrepresented students in elementary through post-secondary education. This advisory board can help set goals for the NAIRR, track progress against those goals, and allocate resources to achieve those goals.

We recommend an iterative approach to the governance and oversight strategy. Programmatic decisions should initially be focused on tangible outcomes and agile iteration of minimum viable products (MVPs), such as a rapid prototype of an AI model or a pilot education program. Data produced from these MVPs can inform how to improve a prototype or pilot before scaling it to be an official component of the NAIRR. By starting with small-scale, agile iteration of the NAIRR's critical components rather than larger-scale investments, the NAIRR could achieve early success and accelerate buy-in from the government, research institutions, and the private sector.

## 2.1.4 Roadmap Element D: Creating and Maintaining Shared Computing Infrastructure

Research institutions like NSF have decades of experience creating and maintaining shared computing infrastructure. Together with modern infrastructure providers, including large-scale cloud service providers, the NAIRR can leverage the expertise of research institutions with previous experience establishing and maintaining the infrastructure. The core capabilities and resources of the NAIRR should include processes to communicate the NAIRR's mission to students and researchers, enroll students and researchers in the NAIRR programs, grant access to the NAIRR resources,

### Using AWS to simplify access to cloud resources for researchers

Using AWS, researchers have created the largest high-performance cluster in the cloud to study natural language processing by using over 1.1 million virtual CPUs running in a single AWS Region, demonstrating the scalability and elasticity of the infrastructure.

track usage and results of using the NAIRR, and contract with vendors to provide underlying software systems.

AWS offers several capabilities to support creating and maintaining a secure shared computing infrastructure like the NAIRR and to give researchers access to advanced computing resources,

training, and curated datasets. For example, the [AWS Global Cloud Infrastructure](#) enables the NAIRR to deploy application workloads across the globe in a single click or build and deploy specific applications closer to end users with single-digit millisecond latency so that researchers can quickly analyze massive data pipelines, store petabytes of data, and advance research using transformative technologies like AI/ML. Additionally, in support of initiatives like the NAIRR, AWS provides curated public datasets available to researchers through programs like the [Registry of Open Data on AWS](#).

### **2.1.5 Roadmap Element E: Assessment of and Solutions to Use of Government Datasets**

Access to data is crucial for research in AI, including access to high-quality, publicly available data and proprietary datasets. The NAIRR therefore must make it easy to find, subscribe to, and use valuable government datasets in the cloud. Currently, use of government datasets can be a complex issue since it is often difficult to make government datasets easily available and accessible to researchers because of concerns about data protection and privacy or because agencies have voluminous data stored within siloed and disparate data sources.

To help address these challenges, the NAIRR should support continued research and enable piloting of innovative data sharing mechanisms that could help reduce obstacles to the use of government datasets. For example, the [Global Partnership on AI](#) is pursuing comprehensive research on data trusts, or a legal framework for managing shared data, as part of its mandate; the Task Force should consider a partnership to further support this work.

Additionally, solutions to the challenges of using government datasets should include the ability to quickly find datasets in a shared repository, securely access datasets from the cloud, and easily characterize datasets. For example, the NAIRR can use research and technical computing resources like the [AWS Data Exchange](#), [Registry of Open Data on AWS](#), [Amazon Sustainability Data Initiative \(ASDI\)](#), and [AWS Open Data Sponsorship Program](#) to support the computational demands of training and collecting, storing, and sharing data at scale.

### **2.1.6 Roadmap Element F: Assessment of Security Requirements**

The key security requirements for the NAIRR are (1) securing the datasets, models, and other work products of NAIRR users, (2) controlling access to the computing resources within the shared infrastructure (e.g., ensuring each user consumes only the resources allocated to them), and (3) limiting access to data within the NAIRR's administrative systems, which may overlay or interact with the shared infrastructure (e.g., ensuring shared resources are, in fact, shared and not exploited by subgroups of users).

Additionally, the NAIRR should consider trade-offs between ease of public access to data and users' willingness to share data. For example, to avoid restrictive policies for sensitive datasets,

the NAIRR could consider only hosting datasets that are publicly available, which may encourage dataset owners to make their data more broadly available. These public datasets would help reduce barriers to accessing proprietary data that would otherwise not be shared with the NAIRR's users. Requiring publicly available data will increase the number of people who can access the data, but the NAIRR should be mindful that this requirement may decrease the amount of data available to users.

### 2.1.7 Roadmap Element G: Assessment of Privacy and Civil Rights and Liberties Requirements

Developing responsible AI solutions is a process involving inputs and discussions with key stakeholders during all stages of the ML lifecycle, including AI developers and engineers, AI-focused policy experts, and end users and communities. The use of AI and ML technology, such as facial recognition, must comply with all laws, including laws that protect civil rights. There should be no ambiguity that existing laws (e.g., the Civil Rights Act of 1964 and the Fourth Amendment to the U.S. Constitution) apply to and may restrict the use of AI/ML technology in some circumstances.

Standards that establish clear benchmarks and testing methodologies are a proven way to address design issues in software, including fairness in AI. AWS supports current initiatives to develop independent standards for AI/ML with the International Organization for Standardization (ISO) and National Institute of Standards and Technology (NIST). The Task Force should adopt and support the development of such standards and guidelines while driving responsible research behavior and improvement of research outcomes.

AWS has engaged with NSF, NIST, and other stakeholders to offer direct assistance to this effort. NSF and AWS, for example, are partnering to support computational research on fairness in AI (see [NSF Program on Fairness in Artificial Intelligence in Collaboration with Amazon](#)). We also support efforts by members of the academic community to establish independent and trusted criteria, benchmarks, and evaluation protocols around AI/ML services (e.g., AWS Machine Learning Research grants invite researchers to apply for funding in various research areas, including ML topics such as fairness, privacy, and explainability in AI).

### 2.1.8 Roadmap Element H: Plan for Sustaining the NAIRR through Federal Funding and Private Partnerships

The U.S. government plays a significant role in funding long-term, critical research initiatives. The current administration is working on an AI policy will provide for continued investment in AI research to sustain U.S. technological leadership. Federal investments in AI R&D are imperative. For example, the [American Jobs Plan](#) proposes a \$180 billion investment to advance U.S. leadership in critical technologies, upgrade research infrastructure, and remove inequities in research and

**Partnering with educational institutions to increase access to computer science education for children and young adults**

[Amazon Future Engineer](#) is a comprehensive childhood-to-career program aimed at increasing access to computer science education for children and young adults from underserved and underrepresented communities.

careers in emerging technologies. Additionally, Division E of the 2020 National Defense

Authorization Act allotted significant funding to position the U.S. as a global leader in AI. As the NAIRR supports many of the objectives of these plans, funding for the NAIRR should be included in any current significant AI funding initiatives. Ultimately, the NAIRR should request long-term funding to reflect the government's investment in sustaining long-term AI/ML goals domestically and internationally.

Collaborations with the private sector, post-secondary institutions, and non-governmental organizations can also help sustain the NAIRR through access to talent, new ideas, and innovative approaches. AWS, for example, offers technical resources, mentorship, and networking opportunities to help build a future of technology that is inclusive, diverse, and accessible. With programs such as [We Power Tech](#), [AWS Educate](#), and [Amazon Future Engineer](#), AWS increases the number of underrepresented technologists participating in the innovation economy through educational content, partnerships, and programs. The NAIRR can use these AWS examples and similar programs to connect with a national network of future AI students and leaders.

### Resources for researchers and institutions to work remotely

The rapidly changing and dynamic global health situation has impacted the lives of many people, including researchers at universities and institutions worldwide. Many academic institutions are migrating to remote operations. Researchers are processing data, collaborating online, and maintaining labs remotely. Amazon and AWS are responding to these events in support of our communities and deploying resources and technology to enable remote learning and working from home. Visit our [AWS Public Sector Blog](#) for more information.

## 2.1.9 Roadmap Element I: Parameters for Establishing and Sustaining the NAIRR and Agency Roles and Responsibilities

Parameters for establishing and sustaining the NAIRR should primarily follow standards and best practices already in place for public sector AI initiatives. For example, NSF and NSF-led AI Research Institutes and NIST have technical standards that promote innovation and public trust in systems that use AI, including standards for AI data, performance, and governance. For additional industry recommendations about agency roles and responsibilities, refer to the considerations in the preceding roadmap elements.

## 2.2 Question 2: Capabilities and Services Prioritization

The Task Force should prioritize capabilities and services that focus on investing in and managing IT, AI/ML programs, and research projects aligned with the NAIRR's goals and objectives. Priorities should include facilitating access to advanced cloud computing resources and curated datasets and delivering educational tools and programs to advance U.S. leadership in critical technologies.

### Simplifying Access to Cloud Computing Resources for Research and Education Efforts

Having the right computing resources is necessary to sustain the NAIRR. The AWS Cloud and other public clouds enable researchers to quickly and affordably access the latest versions of

many resources that may otherwise be difficult to obtain. This level of availability promotes deployment of new ideas or services that otherwise could have taken months or years to achieve.

Further, AWS pre-trained AI services can provide ready-made intelligence for the NAIRR's applications and workflows.

AI services easily integrate with applications to address common use cases such as extracting text from unstructured documents, automating document and image analysis, adding natural language search capabilities, and building accurate forecasting models.

### **Bridging the Digital Divide**

Training and education are fundamental to the NAIRR's effort to democratize access to AI/ML technology. This should include teaching researchers and students how to approach and process complex workloads by providing scalable and secure compute, storage, and database capabilities to accelerate time to science.

There are many commercially available training and education programs available to the NAIRR and NAIRR users. [AWS Training and Certification](#) has curated a list of no-cost, on-demand online courses tailored to researchers' needs. These online courses are available at any time to help users learn new cloud skills. For example, [Research Learning](#)

[Pathway: Foundational Services](#) is a no-cost online AWS

training pathway for researchers and research professionals who want to become more proficient in optimizing research on AWS. AWS also has low- or no-cost training and education resources for learners. Cloud-based educational programs like [AWS Academy](#), [AWS Educate](#), and [AWS re/Start](#) are designed to reach diverse communities and individuals, including underserved and underrepresented populations.

#### **Reaching diverse communities and individuals with varying skill levels**

AWS Academy and AWS Educate partnered with the Los Angeles Community College District to offer Cloud Computing Certificate training at 19 Los Angeles County community colleges and their sister high schools.

## **2.3 Question 3: Ethical and Responsible Research Development**

With the increased use of AI in everyday life, creating fairness in AI systems is critical. Amazon collaborates with NSF and other research institutions to award research grants in areas such as ensuring fairness in AI algorithms (and the systems that incorporate them), using AI to promote equity in society, and developing principles for human interaction with AI-based systems. The agency administering the NAIRR and its components can promote principles of responsible AI R&D by implementing the following recommendations.

**Recommendation 1: Promote diversity and inclusion within NAIRR staff, within NAIRR student, educator, and researcher populations, and within the AI development process.** The NAIRR can improve the outcomes of using AI technology by including a variety of perspectives (representing different backgrounds, skillsets, beliefs, and life experiences) in the design, development, and operation of its policies and practices; in the student, educator, and research populations that it supports; and in the design and testing of AI applications built using NAIRR resources. For example, the NAIRR will need to set policies that determine how much compute

and storage to allocate to each student, class, educational institution, and research team. These policies will have downstream impacts on the economy and so should be influenced by a broad spectrum of stakeholders (e.g., end users, technologists, academics, industry experts, lawyers, parents). As another example, the NAIRR can incorporate mechanisms to help researchers engage with diverse groups of citizens and other end users during the design and assessment of AI technologies.

**Recommendation 2: Fund the datasets, research, and education needed to improve AI fairness, explainability, privacy, and transparency.** First, since the lack of high-quality training and test datasets often impedes AI research, the NAIRR should fund the creation and acquisition of datasets that represent all demographics (for fairness research), that capture complex causal relationships between data attributes (for explainability research), and that otherwise enable privacy and transparency research. Second, the NAIRR should sponsor research, possibly funded in partnership with other public and private sector organizations, focused on the following areas: technical solutions for fairness, explainability, privacy, and transparency; best practices for educating a national AI workforce; and best practices in building and using AI applications. These research programs should be executed using NAIRR compute, storage, and datasets. Finally, the NAIRR should fund educational programs to help the public better understand the nature and capabilities of AI systems and increase the influence of the public on the design and use of AI applications. These educational programs should cover important concepts like the predictive nature of ML, confidence indicators and thresholds, the importance of human involvement and human review, capabilities and limitations of AI, recommended or prohibited uses, and best practices.

## 2.4 Question 4: Building Blocks for the NAIRR

By working with research institutes and cloud service providers, the NAIRR gains access to existing programs and services that can be used as building blocks to customize engagement across the public sector. The agency administering the NAIRR can use these building blocks “out of the box” to move with increased speed. For example, in addition to providing cloud infrastructure services (**Section 2.2**), we also invest in successful public-private partnerships across government and academia, which are detailed in **Section 2.5**. The NAIRR can incorporate these partnerships to upskill a community of AI users in the future.

## 2.5 Question 5: Public-Private Partnerships

Public-private partnerships between education, industry, and policymakers should play a critical role in the NAIRR because they can speed up access to educational resources and stackable credentials mapped to in-demand tech jobs. AWS has implemented public-private partnerships that have successfully trained workforces, brought emerging technology to under-resourced communities, and provided educators with cloud-focused curricula. Our programs can inform a future model for the NAIRR to align public programs of study with access to cloud technology.

We have teamed with educational institutions across the U.S. to offer cloud skills education as part of matriculating and non-matriculating degree programs at scale. We also support the workforce and economic development efforts of state and local governments through cloud-focused

programs that upskill people with varying educational backgrounds. Our programs, a few of which we detail below, offer instructional resources, curriculum alignment to industry demand, faculty development, career support services, certifications, academic services, and connections to employers looking to hire cloud-skilled talent.

### **Connecting Academia and AWS**

AWS has public-private partnerships with NSF, researchers, and institutions to advance emerging technology initiatives like the NAIRR. Through [AWS Academy](#), we provide higher education institutions with a free, ready-to-teach cloud computing curriculum that prepares university students to pursue industry-recognized certifications and in-demand cloud jobs. This curriculum includes AWS Academy Machine Learning Foundations, which can help certify educators to teach AI/ML concepts.

### **NOVA and AWS Announce Cloud Computing Degree**

Through a public-private partnership, AWS Educate, AWS Academy, and Northern Virginia Community College (NOVA) launched a [cloud computing specialization](#) as part of NOVA's Information Systems Technology Associate of Applied Science degree in Fall 2018, making NOVA one of the first community colleges to offer a cloud computing degree.

### **Free Hands-on Training for Any Individual**

As part of our efforts to make the cloud accessible to all, [AWS Educate](#) provides an online suite of free hands-on labs and personal study resources for any individual interested in learning about cloud fundamentals on AWS, including a Machine Learning Pathway. This pathway can help individuals discover how to use the AWS AI suite to solve real-world problems. By the end of the course, individuals gain the prerequisite skills and competencies necessary to be successful as an ML scientist.

### **Accelerating Research through Collaboration**

AWS collaborated with NSF and the NIH to create the [AWS Research Initiatives \(ARI\)](#) program, which supports groundbreaking research in the fields of computer science, biomedical engineering, and information science. ARI provides support to public sector organizations through access to AWS scientists, research workshops led jointly by AWS and NSF/NIH, AWS research credits that can be applied to AWS Cloud service usage, and awards consisting of federal funds and AWS resources.

## **2.6 Question 6: Limitations to Democratizing Access to AI/ML**

Limitations to the democratization of AI R&D are multifaceted, often driven by technical, socioeconomic, or educational factors. For example, underserved communities or smaller organizations may experience challenges accessing AI/ML because of large upfront costs. However, cloud-based solutions are helping to break down barriers to entry by bringing computational capabilities within reach of more public sector citizens, regardless of prior technology expertise, funding, or geographic location. Based on our own efforts to democratize AI/ML, we provide detail below on the limitations we foresee for the NAIRR in addition to our recommendations for overcoming these limitations.

## Privacy and Security Limitations

As with any technological advancement, expanded access may lead to expanded opportunities for risk, such as bad actors that would be a threat to cybersecurity. As the NAIRR expands access to AI resources, the privacy and security controls associated with AI services must scale alongside usage. The NAIRR should leverage a robust underlying infrastructure with built-in privacy and security components—such as commercial cloud—to proactively protect users from cybersecurity attacks.

## Educational Limitations

Lack of instructor expertise is a primary challenge that public and higher education institutions face when enabling AI democratization through education. These institutions need time, resources, and tools to upskill their faculty and keep their programs current with rapidly evolving AI technology. To address knowledge gaps as structured degrees and a standardized, national curriculum are more widely adopted for this technology, AWS provides U.S. educators with free professional development sessions, access to free self-paced learning resources, and free instructor certification exams. The NAIRR can promote resources like AWS Academy to help educators and students gain access to cloud skills.

## Financial Limitations

Financial constraints may present obstacles to the democratization of AI/ML technology. To overcome them, we recommend the agency administering the NAIRR engage with industry to explore possible funding models that would enable private industries to contribute service credits or additional funds to initiatives related to AI/ML research and accessible education. Additionally, the agency administering the NAIRR should seek government seed funding to substantiate the government's investment in the outcomes of the NAIRR.

## Capacity Limitations

AI R&D requires tremendous data storage and high-speed, high-volume connectivity to enable the accessibility of development, training, and use of AI technology. Further, fiber-optic broadband connections—and the skilled technical workforce needed to construct, maintain, upgrade, and secure them—are essential to providing access to the NAIRR. The cloud provides the compute power and virtually unlimited scalability required to sustain AI R&D and access to the NAIRR. For example, AWS uses 100 Gbps network bandwidth to provide high-speed access to those in rural communities so that they have more opportunities to expand their tech skills and career development.

## 3 Conclusion

As the need for advancement in AI grows, AWS stands as an industry leader with a robust, reliable, and scalable cloud infrastructure. We are dedicated to supporting the federal government in its AI initiatives to advance AI R&D. We are also committed to building a diverse and highly skilled workforce that can close the AI talent gap. To discuss our response to the RFI or the NAIRR initiative in general, please feel free to reach out for more information. We look forward to discussing this initiative with OSTP and NSF in more detail.