ARTIFICIAL INTELLIGENCE/MACHINE



Strengthening and Democratizing Artificial Intelligence Research and Development

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This article summarizes the vision, roadmap, and implementation plan for a National Artificial Intelligence Research Resource that aims to provide a widely accessible cyberinfrastructure for artificial intelligence R&D, with the overarching goal of bridging the resource–access divide. rtificial intelligence (AI) has become an essential engine of innovation that is driving scientific discovery and economic growth. It is increasingly becoming

nomic growth. It is increasingly becoming an integral component of solutions that stand to impact everything from routine daily tasks to societal-level challenges. At the same time, there are also concerns that AI could have negative social, environmental, and even economic consequences. To realize the positive and transformative potential of AI, it is imperative to advance the field in a way that protects privacy, civil rights, and civil liberties, while also promoting principles of fairness, accountability, transparency, and equity.

INTRODUCTION

Progress at the current frontiers of AI is often tied to access to large amounts of computational power and data. Such access today is too often limited to those in well-resourced organizations. This large and growing resource divide has the potential to limit and adversely skew our AI

Digital Object Identifier 10.1109/MC.2023.3284568 Date of current version: 18 October 2023 research and innovation ecosystem. This imbalance can lead to AI models and applications that are biased and lack fairness and can threaten our ability to cultivate an AI research community and workforce that reflect the Nation's rich diversity and ability to harness AI to advance the public good.

A widely accessible cyberinfrastructure for AI R&D that brings together computational resources, data, testbeds, algorithms, software, services, networks, user training and support, and expertise, as described in this article, is critical to democratizing the AI R&D landscape and sustaining U.S. competitiveness in the longer term. Such a federated research resource would create pathways to broaden the range of researchers involved in AI and to grow and diversify approaches to, and applications of, AI. This cyberinfrastructure would also open up new opportunities for progress across all scientific fields and disciplines, including in critical areas such as AI auditing, testing and evaluation, trustworthy AI, bias mitigation, and AI safety. Increased access and a diversity of perspectives would, in turn, lead to new ideas that would not otherwise materialize and set the conditions for developing AI systems that are inclusive by design and world leading.

This article summarizes the vision, roadmap, and implementation plan for establishing a National AI Research Resource (NAIRR) as outlined in the Final Report of the NAIRR Task Force,¹ a federal advisory committee that ran from June 2021 through April 2023, with the overarching goal of strengthening and democratizing the United States AI innovation ecosystem in a way that protects privacy, civil rights, and civil liberties (see "The National AI Research Resource Task Force").

NAIRR VISION AND GOALS

The NAIRR is envisioned as a widely accessible, national cyberinfrastructure that will advance and accelerate the U.S. AI R&D environment and fuel AI discovery and innovation in the United States by empowering a diverse set of users across a range of fields through access to computational, data, software, and training resources, along with testbeds. Created by leveraging, linking, and augmenting the Nation's existing cyberinfrastructure resources, the NAIRR would support cutting-edge explorations in AI R&D and improve the ease of collaboration across disciplines. If realized, it would create opportunities to train the future AI workforce, support and advance

THE NATIONAL AI RESEARCH RESOURCE TASK FORCE

n the National Al Initiative Act of 2020, Congress directed the National Science Foundation, in consultation with the White House Office of Science and Technology Policy (OSTP), to establish a task force to create a roadmap for a NAIRR–a shared research infrastructure that would provide Al researchers and students with significantly expanded access to computational resources, high-quality data, educational tools, and user support. Per its legislative mandate, it comprised 12 technical experts in total, with four from government, four from institutions of higher education, and four from private organizations. Task Force members were appointed to represent these sectors, not the specific organizations with which they are affiliated. The Final Report summarized in this article is the culmination of the Task Force's effort. Additional information about the Task Force and its work can be found at https://ai.gov/nairtf. trustworthy and responsible AI, and catalyze the development of ideas that can be practically deployed for societal and economic benefits.

As illustrated in Figure 1, the NAIRR would accelerate these outcomes by enabling U.S.-based researchers to access the digital resources that enable AI R&D. These resources would be made available through an integrated user portal with key functionalities such as single sign-on access to resources, collaboration tools, search tools for resource discovery, detailed resource specifications and user guides, an interface for computational job submission, and consolidated accounting of resource use. User support services and interactive training modules would support users new to the field, which, along with clearly defined policies and standards of practice, would promulgate best practices for trustworthy AI model development and responsible data use by design. A publicly accessible NAIRR user portal would provide curated catalogs that list commonly used AI datasets, testbeds, educational resources, and relevant metadata, serving as a clearinghouse for the AI R&D community. Through a tiered-access model, vetted researchers would be able to conduct research on sensitive or restricted data in secure enclaves.

The NAIRR Task Force recommended that the NAIRR be established with four measurable goals in mind: 1) spur innovation, 2) increase diversity of talent, 3) improve capacity, and 4) advance trustworthy AI. The NAIRR would meet these goals by supporting the needs of researchers and students from diverse backgrounds who are pursuing foundational, use-inspired, and translational AI research, with the overarching goal of lowering barriers to participation in the AI research ecosystem and increasing the diversity of AI researchers. These users would be U.S.-based or affiliated with U.S. organizations, to include academic institutions, nonprofit organizations, and startups or small businesses.

ADMINISTRATION AND GOVERNANCE

The Task Force considered many different models of implementation for the administration and governance of the NAIRR. In the end, the Task Force came to the consensus that a cooperative stewardship model, where a single agency serving as the administrative home for the NAIRR paired with an interagency steering committee, would offer the strongest path forward for ensuring effective administration of NAIRR operations and that agencies across the federal government with equities in AI R&D would play active roles in decision-making.

As illustrated in Figure 2, the organizational structure for NAIRR management and governance was designed to incorporate the interests and perspectives of the many federal agencies involved in AIR&D, take advantage of the distributed nature of existing and future cyberinfrastructure, and facilitate input from the various constituents and communities involved in and affected by AI research. Specifically, the Task Force recommended that the day-to-day NAIRR operations be conducted by an external, nongovernmental operating entity funded and overseen by a dedicated NAIRR Program Management Office within a single administrative agency, the National Science Foundation. This single point of management for core operations would be paired with a steering committee comprising other federal agencies with equities in AI R&D. The steering committee would set the strategic direction for the NAIRR and drive

decisions about which resources would be brought into the NAIRR. The agencies serving on the steering committee would also fund the resources made available through the NAIRR.

Given the NAIRR's many operational requirements, the Task Force determined that expert advice would be needed on issues spanning from technical resource design to user experience to legal and regulatory compliance to education and training. The Task Force recommended an initial four advisory boards be established as follows:

 A Science Advisory Board to provide advice about the rapidly changing needs across multiple scientific domains so that the NAIRR can rapidly adapt to support innovation.



FIGURE 1. Schematic overview of the NAIRR vision.¹

- A Technology Advisory Board to advise the operating entity about cutting-edge technological solutions in the provisioning and use of computational and data infrastructures, workforce training, and privacy- and security-related technologies.
- An Ethics Advisory Board to advise the operating entity on issues of ethics, fairness, bias, and accessibility, as well as risks and blind spots.
- A User Committee to provide the user perspective on the NAIRR and identify new directions for the NAIRR to create value and serve the community.

ARCHITECTURE AND COMPOSITION

The NAIRR is envisioned as a shared national cyberinfrastructure—a broadly accessible federated mix of computational and data resources, testbeds, software, and testing tools. These resources would be made available through an integrated portal, with available training tools and user support services to facilitate their use. Computational resources would include conventional servers,

computing clusters, high-performance computing, and cloud computing, and would support access to edge computing resources and testbeds for AI R&D. Open and protected data would be made available under tiered-access protocols and colocated with computational resources, and an "AI commons" where data resources could be contributed by NAIRR users or stakeholders would be explored. When fully implemented, the NAIRR would address both the capacity (ability to support a large number of users) and capability (ability to train resource-intensive AI models) needs of the AI research community.

The NAIRR would establish multiple allocation processes based on the nature, size, and scope of the requests, agency-driven allocations, peer-reviewed research allocations, and expedited startup allocations. Users would be able to discover and address resources through an integrated NAIRR portal. For more advanced users, opportunities to access resources directly from providers would also be made available.

To protect the resources made available through the NAIRR, the NAIRR



FIGURE 2. Proposed NAIRR governance structure.¹

would implement system safeguards using government-applicable security guidelines, particularly those established by the National Institute of Standards and Technology (NIST). Furthermore, drawing from expectations in the Blueprint for an AI Bill of Rights that OSTP published in October 2022 as well as the best practices in the AI Risk Management Framework developed by NIST in January 2023, the NAIRR operating entity would develop resource acceptance criteria and controls for datasets, as well as privacy, civil rights, and civil liberties research review criteria. NAIRR users would also be required to complete ethics training.

OUTREACH AND INTERNATIONAL COLLABORATION

The NAIRR Task Force further recommended that, once the NAIRR has reached full operations, the steering committee and operating entity should explore ways to leverage the NAIRR to advance AI research through international cooperation with similar resource infrastructure efforts around the world. In doing so, the operating entity should follow the guidelines for international collaboration set by OSTP and U.S. Government research funding agencies and comply with relevant export controls. The operating entity must also avoid activities with or assigning access to its infrastructure to any embargoed or sanctioned countries, institutions, organizations, or persons. Otherwise, the operating entity should work to establish collaboration and the sharing of information between U.S. and non-U.S. research entities. As it matures, the NAIRR should leverage existing international forums such as the International Science Council's Committee on Data and the Global Partnership on AI to support ongoing international collaborations and foster new opportunities.

IMPLEMENTATION ROADMAP

As illustrated in Figure 3, the NAIRR implementation would occur in a phased



manner with a gradual ramp-up of resources over time. Phasing can help ease the process of integration across the federated NAIRR system, provide opportunities for users to transition as older resources age out and new resources come online, provide value to users more quickly, and allow the NAIRR operating entity to receive user feedback expeditiously. Specifically, the NAIRR implementation plan is divided into four phases. The NAIRR Task Force recommended that the NAIRR achieve initial operational capability—that is, availability of the core user portal and a basic complement of computational and data resources for users—no later than 21 months from the U.S. Government launch of the program. The NAIRR Task Force further noted that steady-state operations, during which the NAIRR has met target capacity and capabilities for all components, should be established by the fourth year, with the understanding that the system would evolve and grow on an ongoing basis (see Figure 3).

STATUS AND NEXT STEPS

The NAIRR Task Force submitted its final report to the President and Congress on 24 January 2023, and then continued its efforts for 90 days following the release of the report, during which time it helped socialize and communicate the recommendations made in the implementation plan. Action to take forward the plan rests with

NAIRR PILOT OPTION

To expedite the availability of Al research resources to the Al R&D community, the NAIRR Task Force recommended that the NAIRR Program Management Office consider providing pilot-scale access to existing computational resources, software, datasets, services, and user portals across the current national cyberinfrastructure ecosystem, by providing supplemental funds to support additional use by the beginning of year 1 and issuing broad calls to the AI R&D community to apply for this access. Setting up such a pilot would require rapid establishment of interim management and governance mechanisms. The pilot would operate until the NAIRR is fully operational in year 2, at which point it would ramp down.

the executive and legislative branches. In the meantime, a U.S. Government effort involving multiple agencies is exploring the implementation of the NAIRR pilot option outlined in the report (see "NAIRR Pilot Option").

his article has summarized the key elements of the NAIRR and Final Report of the NAIRR Task Force. The NAIRR is designed to meet the national need for increased access by a broad and diverse user base to the state-of-the-art resources that fuel AI innovation. The roadmap for achieving this vision builds on existing federal investments; includes protections for privacy, civil rights, and civil liberties; and promotes diversity and equitable access. If successful, the NAIRR would transform the U.S. national AI research and innovation ecosystem, facilitate the ability to address societal-level problems by strengthening and democratizing participation in foundational, use-inspired, and translational AI R&D in the United States, and ensure the Nation remains in the vanguard of competitiveness in this critically important technology for decades to come.

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SUBMIT

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