



Council Engagement Session: Shaping a Research Agenda on Artificial Intelligence and Machine Learning

Attendees discussed challenges that must be addressed to advance Artificial Intelligence and Machine Learning (AI/ML) research and education. Using XLeap, a collaborative web-based tool, attendees identified and prioritized these challenges. At the end of the session, attendees engaged in a brief activity to identify potential collaboration opportunities to address these identified and prioritized challenges.

Attendee comments are listed verbatim, with responses to original comments indented. Green and purple dots indicate attendee prioritization as either a short-term (●) or a long-term (●) strategy. The number in parentheses indicates the strength of the agreement; a larger number means higher agreement. Comments without dots can be considered low priority challenges.

Challenges in Research

Using the National Science Foundation’s definition of Convergence Research – “The integration of knowledge, methods, and expertise from different disciplines to form novel frameworks that catalyze scientific discovery and innovation” – what are the key challenges that must be addressed to advance AI/ML research?

Advanced R&D and Resiliency

- (4) ●(1) As we collect very large data sets on a particular domain, we need better tools for organizing and formatting the data for creating training sets and for analysis. Also, need to get the AI/ML engines closer to these very large data sets. Lastly, develop better AI/ML engines/models that allow for additive learning.
- (3) How do we systematically engage multiple stakeholders in the AI development process?
 - ●(1) What requirements documents/tools do we need to gather business requirements for AI systems?
 - This is a difficult thing to accomplish because you want to engage not just diverse individuals but also individuals who represent diverse skillsets, roles, and capabilities.
- (2) Engaging corporate partners into AI engineering research
- (2) ●(1) for some traditional areas of R&D, it may not be obvious how to incorporate AI other than through simulations, etc. This means workforce development all through the system.



- ●(2) Need for novel explainable and interpretable AI methods specifically designed for security, resiliency, and autonomous decision making in smart grids/smart infrastructure. It seems applying known ML/AI techniques is not enough.
- ●(1) ●(2) Meeting infrastructure needs at universities
- ●(1) ●(1) AI/ML depends on high-speed Ethernet, 5G, ubiquitous cloud computing and storage, Internet of Things (IoT) enabled devices. Research must continue to develop these areas long with AI methods.
- ●(1) ●(1) As we move toward complex, converged, AI-mediated infrastructures (e.g., smart cities), we will need to understand what data AI will need to manage these infrastructures, where that data will be managed, and the overall management model, including responsibility for the security of AI and these infrastructures. If everything is interconnected, who is responsible?
- ●(1) A question that arose today: How can we improve cybersecurity of supply chains? For example, if we use cybersecurity tools in our enterprise, how do we know that those tools, now part of our supply chain, are not part of a supply chain attack? We need research to build a secure eco-system.
 - And there is some early research here in federated systems.
- It seems that all areas of research must now incorporate AI to be successful in proposal submissions to NSF and other funding agencies.
- Funding for AI is substantive in other domains, but has not "caught on" in the education domain. How do we get that funding to be where the issues are?

Skilled Workforce Needs

- ●(6) ●(1) How do we engage a more diverse body of students?
 - ●(1) How do we support the diversity - especially in areas such as confidence in being able to do it, ability to overcome the adversity that comes with being diverse?
- ●(4) Much of the expertise in AI/ML is NOT in the education domain. How do we meld together that workforce with the skilled education/teaching workforce?
- ●(1) Provide more internships in AI
 - ●(2) Mentorships, internships and fellowships
- How can we encourage tech firms to build AI labs within the US?
- Can we encourage NSF and other agencies to embed programs targeted at continued development of AI/ML collaborations with and embedded research programs at HBCU and HSI institutions ?



Ethical, Legal, and Societal Implications

- ●(6) ●(3) How do we create a framework for engaging social scientists and humanists in the continued development of ethical principles for AI/ML?
- ●(3) ●(1) AI will be used by the military. How do we employ it morally and with due regard for our ethical values while not losing military advantage to AI-enabled competitors?
 - And how do we convince society that even though it may be used by the military, that societal use is not militarized (much like the separation of nuclear power from nuclear weapons...)
- ●(3) ●(1) Data security and protection are extremely important concepts to be addressed
- ●(3) Community/grassroots collaborations with academics on research projects
- ●(3) How do we engage society to accept decisions made by AI - even decisions whose framework are debated/determined by human social scientists in advance?
- ●(1) ●(3) How do we encourage the private sector to use AI/ML ethically?
- ●(2) ●(2) How do we help researchers see AI bias as a technical challenge that involves a systems approach of looking at the environment where AI is used and the stakeholders involved.
- ●(2) ●(1) Are we capturing sufficient data about diversity communities beyond some very basic demographics?
 - This is an extremely important but difficult topic to address while protecting the privacy of individuals. Often, data have to be aggregated across categories to ensure sufficient blinding but this limits are ability to quantify differences between groups
- ●(2) How should AI be governed inside organizations to ensure that the interests of all organizational stakeholders are taken into account?
- ●(2) Access to individual-student level data is hard to access, especially at scale, due to privacy constraints and limitations in combining data together (especially for K-12). How do we make this data more accessible for AI/ML studies while also maintaining student data privacy?
 - Can we find methods to apply aggregate level data successfully to individual student outcomes?
 - Aggregation at school district level and de-identification comes to mind.
- ●(1) The need for new policies that capture all aspects of AI/ML
- ●(1) Should the community develop overarching self-regulatory principles around AI/ML research to ensure that we are out in front of the normal government regulatory processes?
- ●(1) How do we ensure appropriate ethical standards exist and are followed by third party vendors for data they collect and analyze?
- ●(1) Increased government oversight due to foreign influence concerns. These are warranted, but adds burden to the research enterprise.



- For non-military contexts, how do we address concerns about the loss of jobs due to automation? Is this likely to hinder public support for widespread adoption of AI?

Other

- ●(7) Smaller institutions and MSIs want to participate but are often not considered in team building for initiatives or centers. They often lack some key large scale resources. Yet these institutions are sources of diverse students and engaged faculty. How do they get included.
 - Need for adequate infrastructure HBCUs/MSIs/ HSIs / Tribal Institutions
- ●(3) Data is hard to find but how do we reduce the barriers to collecting necessary data for research efforts so that the same data isn't over used thereby potentially skewing results
- ●(2) Diverse and inclusive conclaves are a must. There has to be consistent engagement around broader spectrum of ideas, people, etc., to drive better research initiatives and outcomes.
 - Integrity and confidence in research.
- ●(1) ●(2) How do we foster stakeholder trust in AI/ML, especially for people from traditionally disenfranchised groups?
- ●(1) Cultural differences between different disciplines complicates collaborative approaches to solving problems.
 - This is a definite obstacle - we need a bridge to connect different research paradigms.
- ●(1) How easy it is to use collaborative environments in research



Challenges in Education

Using the National Science Foundation’s definition of Convergence Research – “The integration of knowledge, methods, and expertise from different disciplines to form novel frameworks that catalyze scientific discovery and innovation” – what are the key challenges that must be addressed to advance AI/ML education?

Advanced R&D and Resiliency

- ●(3) ●(2) Making the topic more understandable and accessible to the public
- ●(3) ●(1) Incorporate AI projects in all classes to educate on what it is, as well as how to use and develop it.
- ●(1) resources to expand IT support
- ●(1) Be proactive in breaking the barriers to research regulations.

Skilled Workforce Needs

- ●(6) Need of curricula at the intersection of involved disciplines and AI/ML
- ●(4) ●(1) Effective strategies for training our teachers to use new AI tools
- ●(4) ●(1) Much of the expertise in AI/ML is NOT in the education domain. How do we meld together that workforce with the skilled education/teaching workforce?
 - ●(2) YES! This must be a joint endeavor. Neither the education field nor the AI/ML field can accomplish this alone. A collaborative approach between educators and researchers is needed.
- ●(2) ●(1) Developing multi-level training materials from general knowledge of AI to how to develop AI needs to plant the seeds of interest in students at an early age. How do we do that?
 - ●(1) Help those who use AI technologies in support of teaching understand what it can/cannot do so that they don't under- or over-rely on it
 - Assisting educators in other disciplines to understand what AI is and how it can be useful/applicable to their disciplines
 - Multi-stakeholder AI education - different viewpoint of AI based on role in AI (developer, funder, user, researcher)
- ●(1) ●(1) Smaller universities have very diverse student populations, how do these institutions engage in this work to help their students in this area.
- ●(1) Interested in need for faculty and PhDs while more broadly students in workforce are placed at bachelor's level. Understanding how we can encourage students to go to PhD level given high salaries in the field of AI, will be important.



- (1) Florida A&M U (FAMU) is just starting a data science program. We are using computer resources at U. of Florida (HiPerGator) and exploring educational opportunities. We already have research in AI through Lawrence Livermore. I have a student in quantum computing at LLNL and she is exploring Quantum AI on a circuit quantum computer.

Ethical, Legal, and Societal Implications

- (3) (1) How can we ensure that bias is not incorporated into the AI that we are using in classrooms?
 - Yes - and part of this goes back to not having enough data that spans the full spectrum of students who are using those tools. AI cannot learn in a "fair" way if the training set is not representative of the student population at large.
- (2) (1) Need to recruit and retain more diverse (defined broadly) faculty in AI/ML
- (1) (1) Retaining faculty - industry pays much better
 - Retaining students in undergraduate and graduate settings - especially graduate students who do one year of a program and then leave for high paying industry jobs.
- (1) Develop Certificate programs in AI

Other

- (6) How do we engage individuals who are interested, but lack the skill sets
 - (1) How to introduce creative ways of funding certificates etc that take pressure off underrepresented communities while tapping into resource reservoirs (ideally) to increase diversity in education and workforce
 - (1) What are best practices for incorporating background technical training into new or existing ML/AI education?
- (3) (1) how do we ensure real world opportunities for those who want to grow their skills and may not be ready for a job in the field
- (1) (3) Level the playing field from K-12 to post secondary education by investing across the board in diverse and inclusive areas.
- (2) (1) There is a need to look at related/supportive technologies...such as access to high speed internet...needed to support the expansion of AI/ML education that are often barriers for students in inner-city and rural communities
- (1) (1) Curriculum to equip K-12 educators.
- (1) How do we develop curricula where the problems appeal to a broad set of individuals - across the spectrum of possible AI use
- (1) As well as training in that curriculum.



- ● (1) Access (to electricity, high-speed internet, computers, etc), as well as opportunities for training.

Collaboration Opportunities

Do you or your institution have opportunities, interesting references, or general information you would like to share with your colleagues in this meeting?

Advanced R&D and Resiliency

- (1) This is a challenge and probably the wrong place to post: learning how to communicate with different disciplines takes time.
 - Which potentially impacts such things as ROI
 - Having some good examples of success stories would be valuable
 - Yes - and there isn't much funding (or hasn't been historically) for combining together other fields with the education domain (or domains around social issues). How do we change that to bring in more funding for work with AI/ML in the education domain?
- ORAU has "Data Science and Analytics" as a key investment area for ODRD. Although FY21 is full, we will continue this investment area in FY22 and are looking forward to building new partnerships.
 - I observed that the FY21 was heavily emphasized on NLP and Multi-media/Image analytics. Will the FY22 consider statistical learning for non text and non multimedia data (for example real time systems) ? Also should the research be tied to an application domain?
 - There are many systems that work on the structured data problems such as predictive analytics.
- MITRE and ORAU are starting to work together on the application of AI to teaching/learning. It may be possible to collaborate on the use of AI for cybersecurity generally, and possibly for Zero Trust Architecture.

Skilled Workforce Needs

- Available resources.
 - Regionality and accessibility.



Ethical, Legal, and Societal Implications

- ● (1) We're proposing work in social determiners of education as well as looking at AI bias in online learning systems.
 - ● (1) Would like to connect. Working on AI governance and AI ethics issues.

Other

- ● (1) ORAU is working across the research continuum to align the research priorities of our health, social and life sciences clients, to our engagement with our university partners, to include, the MSIs- HBCUs, Tribal Colleges and Hispanic Universities.
- ● (1) How do I start a research relationship with ORAU as a university? Is it always through the Directed Research and Development Grants? Are there are other ways to connect, to have more insight on the actual needs of the solicitation/organization?
- It might be useful to consider conducting a series of webinars to provide more indepth discussions on these topics.