Artificial Intelligence (AI), the Future of Work, and the Building of a National Talent Ecosystem

Linda Molnar[1], Ranjana K. Mehta[2], and Robby Robson[3](B)

[1] National Science Foundation, 2415 Eisenhower Avenue, Alexandria, VA 22314, USA
[2] Texas A&M University, College Station, TX, USA
[3] Eduworks Corporation, STE 110, Corvallis, OR 97333, USA
robby.robson@eduworks.com

Abstract. This article presents the background and vision of the Skills-based Talent Ecosystem for Upskilling (STEP UP) project. STEP UP is a collaboration among teams participating in the US National Science Foundation (NSF) Convergence Accelerator program, which supports translational use-inspired research. This article details the context for this work, describes the individual projects and the roles of AI in these projects, and explains how these projects are working synergistically towards the ambitious goals of increasing equity and efficiency in the US talent pipeline through skills-based training. The technologies that support this vision range in maturity from laboratory technologies to field-tested prototypes to production software and include applications of Natural Language Understanding andMachine Learning that only become feasible over the past two to three years.

Keywords: Convergence Accelerator · National Science Foundation · AI · Future of Work · SkillSync · Talent Ecosystem · VR · AR · Fairness

1 Introduction

In 2022, science education remains at the forefront of discussions about national priorities in the United States, as is highlighted in the June 25, 2021, Executive Order on Diversity, Equity, Inclusion, and Accessibility (DEIA) in the Federal Workforce [1] and in recent symposia and reports from the National Academies of Sciences, Engineering, and Medicine [2, 3]. Artificial Intelligence (AI) is at the intersection of these needs, including AI as it influences work and how AI can be part of the solution in ways that are fair and equitable. The US National Science Foundation's *Convergence Accelerator* [4] seeks to develop truly convergent areas of use-inspired research where AI is converged with other disciplines – including education and behavioral and cognitive science – to achieve a just and fair workplace.

The NSF Convergence Accelerator Tracks B1 (Artificial Intelligence and Future Jobs) and B2 (National Talent Ecosystem) – together, *Track B* – were created in 2019 with

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the overarching goal of providing accessible and inclusive opportunities for everyone and are rooted in STEM (science, technology, engineering, and mathematics) education. An intentional approach to working towards a fair future of work has been central to their work and aligns well with the priorities cited above and with the Biden-Harris priority of "equipping the American middle class to succeed in a global economy" [5]. All Convergence Accelerator tracks were asked to work towards a shared vision of "Track Integration." This paper describes two of the Track B projects, the roles of AI in these projects, and the shared vision they are pursuing, called *STEP UP*.

2 The SkillSync Project

The SkillSync project, led by the last author, seeks to improve workforce upskilling by addressing the connection between employers and college non-degree programs. These programs are underutilized for upskilling due to many factors, including misalignment with desired skills, lack of communication between colleges and company HR and training departments, and mismatched business processes [6]. As stated in a report on a 2021 MIT Open Learning conference on this theme, "The labor market information chain is broken: Workers don't know what skills they need, educators don't know what skills to educate for, and employers don't know what skills workers have" [7].

To address this, the SkillSync project has developed a set of AI services for extracting knowledge, skills, and abilities (KSAs) from unstructured text (and specifically from job descriptions), for de-biasing and anonymizing job descriptions and associated KSA by replacing "company identifiable information" and biased language with generic and unbiased terminology, and for computing the alignment between a set of courses and a prioritized set of skills. These services apply large pre-trained language models such as BERT [8] and GPT-2 [9]. They then use transfer learning to fine-tune these models to perform specific tasks in specific domains and multiple techniques to reduce gender, racial, ethnic and other biases that have been shown to affect job searches [10]. Ensuring fair, ethical, and equitable treatment of workers is a key guiding principle in the creation of tangible deliverables for Track B.

These AI services support a SkillSync web app that digitizes the connection between companies and colleges, enabling companies to identify and communicate skills needs and enabling colleges to identify and respond with training opportunities that are aligned to these needs. The SkillSync app also incorporates an intelligent virtual agent called *AskJill*, which is being developed by Dr. Ashok Goel's Design & Intelligence Lab at the Georgia Institute of Technology. AskJill serves as a text-based dialog agent that answers user questions about the SkillSync app. Its goal is to provide contextual help and, more importantly, to increase user understanding and trust in the AI. It is based on technology developed for the Jill Watson virtual teaching assistant [11] and uses a two-dimensional hybrid machine learning and semantic processing model.

3 The LEARNER Project

LEARNER (Learning Environments with Augmentation and Robotics for Next-gen Emergency Responders), led by the second author, is engaged in developing an intelligent

training platform for first responders who use new technologies such as augmented reality (AR) and exoskeletons. The platform employs a unique human-centered adaptive training framework that incorporates physiological, neural, and behavioral markers of learning, together with user preference and training history, into real-time exercises that use AR, virtual reality (VR), and force feedback. Two specific emergency response curricula are being developed: Triage and Patient Handling. A core tenet of LEARNER is supporting multiple access levels and modalities, ranging from web-based training delivery to physical live trainings and spanning the spectrum of virtual to physical realities. This is critical for providing access to all first responders and has implications for the design and development of adaptive training algorithms. AI is currently used to analyze pre-training exercises for the purpose of differentiating learners and will be used in algorithms that adapt learning at micro and macro levels.

The LEARNER team is creating adaptation models for each exercise based on the transferability of learning markers across different access levels, explainability of the machine learning models, and associated computation cost for near real-time adaptation. These learning markers are biometric markers that have been correlated with learning speed and effectiveness. In web-based desktop learning, markers are limited to mouse clicks and dwell time, whereas VR and AR-based training modalities at higher access levels can offer rich insights into gaze behavior [12] and can capture markers such as heart rate variability and neural activity through integrated neurophysiological sensors. The LEARNER architecture supports both performance-based and state-based evaluation, which enable macro and micro adaptation to optimize training effectiveness. Performance-based adaptations are guided by heuristics developed with input from subject-matter experts (e.g., trainers). Affect- and behavior-based markers gathered during learning using neurophysiological data will also inform state-based adaptation to ensure effective encoding of information from training materials.

4 Collaborations

The first significant collaboration among Track B projects was the formation of a *National Talent Ecosystem Council* (NTEC). This council is intended to guide, disseminate, and increase the impact of translational research in the AI and Future of Work domain regardless of its origin. It is also intended to serve as a mechanism that helps identify vetted research, which is important as more and more workforce and training applications use AI without identifying its limitations and potential biases and without exposing the underlying techniques they use. This council was formally launched in October 2021 and is intended to be a sustainable council that continues past the end of NSF funding for the Track B projects.

The second planned collaboration among Track B projects is a project that investigates the tradeoffs among various training modalities with different levels of fidelity and sophistication, ranging from non-adaptive desktop training to AI-supported virtual, augmented, and extended reality (VR, AR, XR) environments and adaptive instructional systems. This collaboration will produce guidelines for evaluating the pros and cons of using different approaches and training modalities in research and real world settings and will disseminate these through NTEC.

The third and most significant collaboration – Track Integration – is research and development of the *Skills-based Talent Ecosystem Platform for Upskilling* (STEP UP), envisioned as supporting a complete skills-based talent pipeline ecosystem. STEP UP will (a) allow employers to create job profiles that identify the skills needed for in-demand jobs; (b) enable individuals to create (and validate) skills profiles that identify the skills they have; (c) use AI to match skills profiles to job profiles and to identify skill gaps; (d) enable individuals to find and enroll in training to fill skills gaps; (e) issue skills-based credentials that validate newly acquired skills; and (f) enable individuals to provide existing or potential employers with those credentials. All these functions will be supported by extensions of SkillSync AI services and by freely available infrastructure, including the Credential Engine and the Open Competency Framework Collaborative [13]. These will be used to (a) extract skills profiles from work history and other data provided by workers (subject to human editing and validation), (b) to determine the skills addressed by specific training opportunities, (c) to recommend training pathways, (d) to select training and training modalities in accordance with the guidelines mentioned above, and (e) to match worker skills with employer needs.

5 The Long Term Vision

STEP UP is creating infrastructure to help advance a fair and efficient transition to the future of work. It is envisioned that new workforce technologies and associated skills can be rapidly added to the STEP UP platform with the assistance of AI that mines job postings and other sources; that providing skills-based credentials, training profiles, worker profiles and job profiles will create more opportunities to support different types of learning and career pathways; and that new AI-assisted training technologies and modalities can accelerate the speed and effectiveness with which skills can be acquired. STEP UP is also envisioned as a public good that can support organizations who have similar visions of skills-based talent management and that is integrated into emerging infrastructure such as *Learner and Employment Records* (LERs), currently being piloted in universities, government agencies, and US fortune 50 companies and with efforts such as the US Chamber of Commerce T3 Innovation network, which now includes more than 500 organizations [14]. The contribution of STEP UP lies in the translation of basic AI and learning science research into practice and in the ability to continue to advance this research. This long-term vision can only be achieved by careful integration of multiple disparate fields and by establishing a platform that supports continued integration of future advances in all of them.

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