Machine Learning and Its Usage in Community Colleges

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Introduction

Artificial Intelligence (AI) has many subsets, including Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Super Intelligence (ASI). Subsets of AI include Machine Learning (ML), Deep Learning (DL), and Neural Networks (NNs). This field is "broadly defined as the capability of a machine to imitate intelligent human behavior" (Brown, 2021). At my work, I am specifically under a not-for-credit department that is focused on providing training for those in the workforce. AI in general will have a large impact on those we are serving and the overall Community College. This paper explores the concept and types of machine learning, focusing on its applications in community colleges.

What is ML

ML is more than just a subsect of AI but rather it's a multidisciplinary field, "it draws on results from artificial intelligence, probability and statistics, computational complexity theory, control theory, information theory, philosophy, psychology, neurobiology, and other fields" (Mitchell, 1997). Learning in terms of ML can be understood as any computer program that improves performance through experience, which is like the human learning style.

While many believe that ML and artificial intelligence are new, they aren't as recent as the public thinks; in fact, it started in 1943 when Walter Pitts and Warren McCulloch developed the mathematical model of a neural network. From their paper, "many years ago one of us ... was led to conceive of the response of any neuron as factually equivalent to a proposition which proposed its adequate stimulus. He therefore attempted to record the behavior of complicated nets in the notation of the symbolic logic of propositions" (McCulloch & Pitts, 1943). They worked to notate how they understood the human brain and its neural activity into a mathematical equation.

Only recently has computational power advanced enough to calculate these large algorithms since the 1940s. In the 2010s and 2020s, ML grew and gathered public attention. As early as 2012, AlexNet winning the ImageNet challenge, "marked the beginning of the deep learning era and demonstrated the power of deep neural networks in computer vision" (Kumar, 2024). Since then, there have been many more breakthroughs in ML algorithms and computational power leading to the development of many tools, some include Google's BERT and OpenAI's GPT-2 in 2018, and more advanced models since, including: OpenAI's GPT-4.5 and o4 models, Google's Gemini, and many others for generative text models, as well as models for image generation from DALL-E to Midjourney and the others in between.

Types of ML

In general, there are a few ways for ML models to learn, such as supervised learning, semi-supervised learning, unsupervised learning, and reinforcement learning. Each of these approaches has their pros and cons, as well as some sub-learning methods. For example, in supervised learning, there are classification, regression, and forecasting. While under unsupervised learning, there is clustering and dimension reduction. Determining which algorithm to use for the task can be difficult to determine but is dependent on various factors, "including: the size, quality, and nature of data, the available computational time, the urgency of the task, what you want to do with the data" (Li, 2020). Supervised learning and semi-supervised learning have human intervention, while unsupervised learning has no human interaction during the training process. What does it mean to have human intervention? For example, we are training a model to detect certain shapes in an image, the human would tag the sample data, saying that this image has a cat, while this other image has a dog, until all sample data is tagged appropriately. The ML model would then be trained on this training data that has appropriate tags.

How can ML be used in Community Colleges?

Supervised learning could be utilized to predict student success in programs based on historical performance data, enabling targeted interventions for at-risk students. Unsupervised learning, such as clustering, might identify patterns among learners' strengths and weaknesses, enabling customized content delivery. Tailored learning experiences for the student are one of the most promising aspects of AI in education. “AI tools can tailor learning paths, provide instant feedback, and assist in career guidance, making training more efficient and adaptable to individual needs” (Oschinski, Crawford, & Wu, 2024). These new advantages will help students gain the upper hand on the skills they need to finish a program, resulting in them improving their knowledge and supporting their future careers.

While a tailored learning experience can greatly improve students' ability to succeed, there are additional ways to have an impact on the students’ success and integrate ML into an institution. ML models can provide insights allowing for early intervention in a student’s educational pathway to enhance retention rates through tutoring and advising. “Based on the findings of this study, students at the risk of dropping out of the school can be identified based on influential factors and different agents of education can refer to this information for early intervention in the uncontrolled behavior that can lead to the risk of dropping out and taking proactive precautionary measures before the issue arise” (Liao, Nziyumva, Murwanashyaka, Nshimyumukiza, & Niyogisubizo, 2021).

Another approach would be with Natural Language Processing (NLP) and helping with labor market alignment. NLPs can be implemented to analyze the job market and “community colleges can form collaborations with businesses and industry partners to develop economic and workforce development aligned practices, programs, structures, and systems” (Vo & Rios-

Aguilar, 2024). Moreover, utilizing ML and NLP to compare student skills with those required in job postings will help with aligning curricula with labor market requirements. ML "algorithms can provide more personalized and accurate insights into the suitable path … helping individuals anticipate future demand for specific skills and industries" (Cul, 2024). Taking it further, ML algorithms analyze student interest and aptitudes, using the ML model to recommend tailored career paths and stackable credentials, in turn, enhancing job placement success. "By providing personalized and accurate career recommendations, the SFOwML framework enables individuals to make choices that align with their interests, values, and aspirations, ultimately leading to greater satisfaction and success in their chosen career path" (Cul, 2024).

Ethical Considerations

Many concerns can arise when thinking about integrating ML algorithms into decision-making processes at community colleges. Can a machine truly understand the complexity of a student's journey? Should an algorithm decide who is "at risk" or advise on what path to pursue? These are just a few of the ethical dilemmas facing higher education as they implement ML models. In addition to privacy concerns to bias in predictions, these tools must be approached with critical awareness and deep responsibility.

Misuse, unauthorized access, or breaches are other concerns that may arise. Community colleges handle large volumes of sensitive data, from academic records to socioeconomic status, and applying ML increases these risks. "As difficulties relating to student data security become more complicated, educational institutions, government, and AI actors must work together to create an efficient data protection framework" (Huang, 2023). Moreover, there can be bias embedded in datasets, which can lead to discriminatory outcomes. These outcomes could look like disproportionately flagging minority students as at-risk, or career track recommendations

being stereotypical. “Bias in AI refers to systematic and unfair favoritism or prejudice in AI systems, which can lead to discriminatory outcomes” (Hanna, et al., 2025).

Discoveries and Conclusion

I had some context from previous educational and professional experiences; however, through this research process, there was still a lot that I learned. I have learned that community colleges and workforce training programs are well-positioned to benefit from predictive models that support retention, program alignment, and student success. The ethical concerns can be addressed, and do not nullify the need for the integration of AI and ML into community colleges.

In summary, ML offers promising opportunities for community colleges to elevate themselves through enhanced student outcomes, improved retention, and aligning programs with labor market needs. ML’s ability to uncover patterns in large datasets and make informed predictions can support more personalized and proactive student services. However, the technology is powerful, it’s not without risk. Ethical concerns must be prioritized to ensure that ML serves as a tool for inclusion rather than exclusion. Community colleges have a unique opportunity to lead in responsible ML adoption, given their diverse student populations and strong connections to workforce development. It is crucial to harness these tools for student success and the success of the community college, while also developing and deploying them in ways that reflect the values of access, equity, and accountability in education.

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