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Navigating the Future: Integrating AI into Maritime Education

Qi Chen [1, *], Amanda Pang [2] and Daniel Pang [3]

[1] *Massachusetts Maritime Academy, USA*
[2] *Northeastern University, Boston, USA*
[3] *New York University, New York, USA*
[*] *Corresponding author: qchen@maritime.edu; Tel.:* +001-508-830-5423.

Abstract: Nowadays, new technology like artificial intelligence (AI) has been applied extensively to the maritime industry. The AI adoption results in a huge increase of the efficiency and productivity of maritime companies. To keep pace with these developments, it has become crucial for maritime institutions all over the world to integrate AI into the conventional maritime education and training. Hopefully, graduating cadets will obtain the proficient knowledge and specialized skills to navigate through a new era of AI-powered technology. The paper examines what the maritime institutions should do to meet challenges imposed upon them at the new AI age. The paper also explains how to integrate the current maritime education with the emerging technological breakthrough like AI so that the graduating cadets will be highly qualified and well-trained when they enter the workforce.

Keywords: Artificial Intelligence; maritime education; shipping industry.

1. Introduction

In recent years, there has been an exponential growing in the adoption of artificial intelligence (AI) in the maritime industry. According to the report of Ship Technology: "The maritime industry is forecast to spend $931 million USD on AI solutions in 2022. That figure is forecast to more than double in the next five years to $2.7 billion USD by 2027, a compound annual growth rate of 23%". AI-powered technologies are rapidly expanding across the shipping industry, including autonomous ships, route optimization, green energy, and logistics chain management, all of which are spearheading a massive increase in productivity and efficiency of maritime companies.

While stakeholders applaud the positive impact AI brings upon the shipping industry, they are also acutely aware of the high level of expertise required to effectively apply advanced algorithms and data analysis to achieve optimization objectives. As a result, it has been paramount that we support a call for maritime universities to enhance their AI Maritime Education and Training (MET), so that cadets may obtain proficient knowledge and specialized skills to navigate through this new era of artificially intelligent machines.

This paper intends to examine the important role maritime institutions play in the assimilation of AI-powered technologies to the established MET. Using Massachusetts Maritime Academy (MMA) as an illustrative example, this paper examines the challenges and barriers that have hindered the extensive integration of AI learning into the existing MET curricula of maritime institutions. The paper further explores strategies for maritime institutions to effectively leverage available resources in order to address the complexities posed by technological advancements and the application of AI in the maritime sector.

This paper is structured as follows: Introduction describes the research purpose and contextual background information; Section 2 highlights insufficiencies in integrating computer science with existing maritime curriculums; Section 3 reviews the effective methodologies and results to incentivize maritime universities to implement trainings that promote computational informatics skills and technical literacy for their cadets; Section 4 offers discussion and concluding remarks on maritime preparation for the future of automation.

2. Integration of Conventional Maritime Education with AI Elements

The technological advancements in AI and its various applications in the maritime industry offer a wealth of opportunities for optimized efficiency. However, an increasingly noticeable fact is the widening disconnect

between the rapid distribution of AI innovations being implemented in professional practice, versus AI Computer Science (CS) courses being built into the MET curriculums at maritime institutions. In this section, we will discuss current MET methods and reasons for the ongoing discrepancy between MET reality.

2.1 The insufficient AI presence in curriculums of maritime institutes

Despite the buzzing excitement regarding the untapped potential of the AI revolution, in maritime industry, we are unfortunately experiencing limited integration of AI, machine learning (ML), and fundamental CS courses offered in maritime institutions. Computationally capable cadets interested in developing AI tools should have access to courses such as: big dataset collection and statistical analysis; ML predictive forecasting using validated training datasets; and programming computational models with a maritime interface, to the same degree of availability as traditional MET courses for maritime institutions. Additionally, robust funding and expertise is required to maintain high powered local servers, well-equipped CS research laboratories, and the necessary hardware and software to properly support resource-intensive AI-based MET.

This paper uses MMA as our in vivo example. Looking at the current term (Fall 2023), only one in-depth AI course is offered by the academy: AI Programming for Engineering Applications. This course applies computer programming to solve common engineering problems, including: engineering modeling and simulation; motion animations; image processing; network communications. A limited number of ancillary courses do combine AI elements with established curriculums, such as the "Business Data Analysis" class. Additionally, several engineering classes now utilize software applications as an integral part of course requirements. Software examples include computer-aided design (CAD) and Geographic Information System (GIS). Expert command of industry specific software raises the ceiling for cadets who choose to hone these skills, expands their potential job horizons, and benefits maritime optimization.

2.2 Accounting for the Disconnect between industry demand and supply of maritime institutions

It is clear that gearing MET towards AI-oriented framework requires the collaboration of administrators, faculties, and cadets of maritime colleges. While the maritime industry benefits hugely from the application and commercialization of new AI technologies, maritime institutions are not feeling a strong sense of urgency to transit from convectional MET to AI-oriented setups. This is partially due to the fact that graduating cadets are typically well-trained with necessary skills, and already in demand for employment from maritime companies. Using MMA as an example: senior cadets normally receive multiple job offers upon graduation, and procure such competitive entry level salaries amongst all college graduates across the USA, it becomes challenging to justify a dramatic change to basic educational frameworks and curriculums. Furthermore, the implementation of AI courses requires substantial funding from tight school budgets, adding financial complexity to the transition process.

Faculty members also play a significant role in successful progression and integration of AI into MET for maritime institutions. A general shortage of specialized AI knowledge and formal AI training amongst faculty members remains a critical issue. AI is a relatively new field, and its complex nature demands a particular set of skills that may not be readily available among the professors of maritime colleges. At MMA, for instance, zero of the approximately 100 faculty members hold a doctorate in Computer Science. Professors whom offer AI/ML classes, such as computer programming, data analysis, and quantitative analysis, have solid backgrounds in science, math, and engineering that facilitate transference to CS. It is certainly an undeniable fact that the lack of AI expertise among faculty members remains a considerable hurdle for maritime institutions to efficiently revise their METs and incorporate maritime CS and AI training to keep abreast of global demand.

Instating mandatory AI classes, like Computer Programming and Quantitative Methods, may increase the burden on cadets who are already heavily loaded. As a result, an AI overhaul would require significant changes to the curriculums to ensure compatibility between traditional courses and AI elements, which may be arduous for maritime institutes.

Inadequate financial support for AI education can pose an obstacle for maritime colleges as well. The resource-intensive nature of AI classes would require that colleges allocate special funds to guarantee access and ongoing support to maintain the necessary hardware, software, and infrastructure required for effective AI education and training.

3. How maritime institutions should prepare for AI education

As we meet the AI revolution, maritime colleges must confront the crucial challenges of how to offer students AI fundamentals, such as machine learning, data analysis, computer vision, language processing, and

robotics. The seamless integration of AI into maritime education holds the potential to revolutionize industry logistics, offering companies the opportunity to harness the unparalleled power of computer optimization. By doing so, they can enhance their operational efficiency and competitiveness in an increasingly data-driven and automated world. This not only equips them with the cutting-edge skills demanded by the industry but also positions them as valuable contributors to the ongoing transformation of the maritime sector.

The primary objective of higher educational institutions is to empower graduates with the essential skills and qualifications required to ensure success in their future careers within the maritime industry. In the following section, we will delve into strategies and approaches that maritime institutions can adopt to best prepare cadets for acquiring AI knowledge within their MET programs.

3.1 Identifying the most relevant AI trends and integrate them in MET curricula

The realm of artificial intelligence is expansive and intricate, defined by the amalgamation of technologies that blur the boundaries between the physical, digital, and biological realms. Even within the maritime sector, AI applications are influenced by various distinct trends, such as clean energy, maritime robotics, maritime internet of things (IOT), big data & analysis, etc. Therefore, maritime institutions have to determine which trends bear significance for their industry and the feasibility to effectively infuse the trends into their MET.

Here, we will employ MMA as a case study to demonstrate how the academy places emphasis on a key AI trend - big data analysis- and diligently integrates it into its curriculum. MMA authorities, faculties and cadets acknowledge that big data analysis stands as the predominant AI trend pervading the maritime industry. Big data analysis supports various applications in diverse sectors such as supply chain optimization, port management, security and safety, weather routing, vessel routing monitoring, and numerous other critical facets of the shipping industry. Subsequently, in May 2022, department of Maritime Business proposed, for the first time, an AI-powered algorithms class called Data Science and Machine Learning Using R. at MMA.

Data Science and Machine Learning Using R. is a fully explored AI course, designed for business major seniors, using in-depth approach to big data analysis. “The class starts with an introduction to the popular statistical software and programming language, R, and then delves into machine learning algorithms such as classification, nonlinear regressions, generalized additive models, etc” (MMA Registrar Records, 2022). While this class is currently in the midst of formulating proposals and conducting evaluations, several other classes have efficiently incorporated AI components, including R programming and various machine learning techniques, into their curriculum requirements. Courses, such as Business Computation, Data Analysis, and Quantitative Analysis, have made R programming an integral part of their syllabi, with the intention of acquainting students with this statistical computing and graphics language. The MMA experience shows that the progressive integration of AI elements, however gradual, in addition to a fully explored AI course, are evidently proving successful at the MMA campus, altering the classroom environment and standard curriculums.

3.2 To mobilize all resources to maximize the outcome

The 2019 “Global Maritime Professional Body of Knowledge (GMP BoK)” report highlights the top three imperative skills for future mariners and maritime professionals: technical awareness, computing and informatics expertise, and technical competency. In order to empower maritime cadets with these essential proficiencies, maritime institutions must leverage their resources, mainly administrators, faculties and cadets, to seamlessly integrate AI into the established MET framework. Administrators must demonstrate vision and commitment to drive the change, faculties master the required knowledge to keep up with the trends, and cadets exhibit their determination to acquire new skill sets and be ready for the more testing workforce.

Understanding the significance of the AI revolution and its applications in the shipping industry is crucial for leaders of maritime institutions. This knowledge empowers them to make informed decisions regarding the integration of AI into both their operational processes and educational curricula. The leaders of maritime institutions should encourage their universities develop a practical curriculum that seamlessly blends existing coursework with AI education. Given the demanding academic workload typically found in most maritime programs, crafting a well-rounded curriculum that covers all essential aspects of maritime education, including AI learning, can be a formidable task. Furthermore, these leaders should allocate financial resources for the establishment of AI laboratories, procurement of necessary software, recruitment of new computer science faculty members, and the facilitation of curriculum adjustments to embrace this emerging trend.

Maritime faculties should play a critical role in the transition and change. However, many faculties, particularly those who were trained conventionally, struggle to keep up with the latest technological

advancements. To overcome this, faculty members should keep themselves informed of the latest developments in AI and related technologies. Faculties should be engaged in continued scholarship, such as attending conferences, reading research papers, and keeping in touch with industry experts. To stay on the top of trend, faculties can gradually incorporate AI into their coursework by developing AI-related assignments and projects, and assigning relevant case studies and collecting real-life examples into their lectures.

There are several measures maritime cadets can take to prepare themselves for successful career developments at the new AI era. First of all, they must take AI-based courses, such as machine learning and data analysis. Cadets should be familiar with commonly used computer programs like R, Java, Python, etc. This will help them develop the skills to tackle the problems like route optimization, which requires sophisticated AI-powered algorithms to figure out the efficient shipping routes, using the data on weather patterns, sea currents, shipping traffic, and port availability. Secondly, they should gain hands-on experience by participating in research projects related to AI technologies. One good example is that one statistical course project gained big popularity among students when they were required to finish the assignment with three key requirements: a linear regression modal, a randomly generated dataset and the R programming language. Thirdly, cadets should collaborate with industry partners through internships to stay current with the latest developments. As we move into the AI age, maritime colleges are confronted with a critical challenge of offering students AI fundamentals, such as machine learning, data analysis, computer vision, natural language processing, and robotics. The ultimate goal is to equip graduates with essential skills and qualifications to make sure of their successes in the future careers. How much the objective can be achieved depends very much on the collective efforts of school leaders, faculty, and students of maritime institutions.

4. Discussion

The aim of this research is to understand that, while AI-powered algorithm technology can lead to significant industry-wide improvements in shipping efficiency and increasing profitability, they also impose huge tasks on maritime institutions to make compatible changes. Maritime colleges feel the urge to scrutinize the sustainability of ME. This would enable the future maritime workforce to possess the necessary skills, expertise, and requisite knowledge to embrace the challenges brought about by a new horizon of AI-powered technology. To achieve the goal, it is instrumental for administrators, faculties and cadets of maritime institutions to make the continued efforts to incorporate the new technology into established MET.

The AI-powered algorithms are unquestionably effective tools that provide substantial benefits to the shipping industry, and as a result, maritime institutions are eager to incorporate more AI and machine learning into their curriculums. Nevertheless, it is equally essential to instill ethical and social awareness among students regarding the consequences and obligations of employing AI in maritime settings and even in daily life. For instance, some educational institutions have expressed concerns about the potential for new technologies like ChatGPT to enable plagiarism. Given the recent introduction of this technology, it is helpful to have a comprehensive discourse regarding the advantages and disadvantages of adopting AI-powered algorithms and AI technology more generally.

It is certainly exciting to live at the age of this huge AI revolution, which bring about amazing changes constantly, such as higher productivity, and faster growth. At the same time, we do feel the responsibility of thinking through the possible issues associated with the implementation of AI-powered technology and impose proper rules to regulate their applications. We hope to elegantly optimize the advantages of machine learning developments, while foreseeing and proactively mitigating disadvantages.

References

[1] International Association of Maritime Universities (IAMU). (2019). Global Maritime Professional Body of Knowledge. Tokyo: International Association of Maritime Universities (IAMU). https://iamu-edu.org/wp-content/uploads/2019/09/IAMU_GMP-Body-of-Knowledge.pdf

[2] Munim Z, Dushenko M, Jimenez V, Shakil M & Imset M (2020) Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions Maritime Policy and Management Volume 47, 2020 issue 5 https://www.tandfonline.com/doi/full/10.1080/03088839.2020.1788731

[3] Ship Technology, North America is seeing a hiring boom in ship industry machine learning roles, March 7 2022, https://www.ship-technology.com/analysis/north-america-is-seeing-a-hiring-boom-in-ship-industry-machine-learning-roles-2/?cf-view