Artificial Intelligence for Environmental Compliance

Machine learning and artificial intelligence are becoming part of everyday data science training programs. (Photo Credit: Elisha Gamboa)

OBJECTIVE

The objective of this effort is to demonstrate the capability of artificial intelligence (AI) and machine learning (ML) to predict the risk of an installation experiencing a future Notice of Violation (NOV) or noncompliance event.

PROBLEM STATEMENT

The Department of Defense and Navy have traditionally addressed operational risk and environmental regulatory compliance on a reactive basis. Compliance oversight improved with formation of the Navy Environmental Management System (EMS) Web. However, this database only records historic noncompliance information, with little to no energy focused on how the Navy might anticipate and avoid future accidents or noncompliance situations.

DESCRIPTION

Recent improvements in memory capacity, processing speed, and programming tools have made analytics via AI/ML more accessible and powerful than ever before. This as the growing volume and complexity of data available in repositories is becoming increasingly difficult for analysts and managers to process with simpler techniques. ML models present a way to evaluate this large volume of high-dimensional data to look for patterns, trends, relationships, other associations that can help the Navy to understand and predict the potential for violations.

Several large regulatory databases and repositories will be identified to determine the feasibility of downloading, formatting, and processing the existing big data sources for analytics using AI. At least one of these data sources will be curated and analyzed using an AI/ML approach developed through the project. Candidate ML models will be chosen based on prediction method and data constraints. These models will be used

to extract and simplify spatiotemporal patterns in the data. Regression/classification techniques will be used to estimate the probabilities of certain events. These probabilities can then be represented and stored as a probability network which can be queried. Supervised and unsupervised learning model performance can be quantified using a variety of metrics. These metrics can be used to compare and rank different models and configurations using statistical tests such as analysis of variance (ANOVA) and response surface methods.

This effort will consider differences between federal and industry enforcement findings; however, important knowledge may be gained from including the broadest categories of operational compliance and risk.

RETURN ON INVESTMENT

The current approach to addressing compliance issues is reactive, and issues are often only addressed after an NOV, accident, or safety violation occurs. Between 2018 and 2020, the Navy spent an average $183,782 per year in environmental compliance

NOVs, with serious violations costing installations upwards of $50,000 per day. Successful implementation of an AI/ML tool to effectively predict and alert decision makers about potential compliance concerns would result in significantly reduced noncompliance risk and overall costs to the Navy.

NAVY BENEFITS

Benefits from this effort will potentially impact every Navy installation worldwide and every operational entity afloat. Additionally, the accuracy and effectiveness of an AI/ML algorithm typically improves with time as the system learns more via continued use and feedback.

Results from this project will also help to shape environmental compliance data management. If existing data sources are not currently being compiled in an appropriate format, we will recommend changes to Navy data source management to ensure that more advanced computational analyses will be possible in the future.

TRANSITION DESCRIPTION

Technology integration will include briefing Commander Navy Installations Command and Office of the Chief of Naval Operations (OPNAV) leadership on the project outputs. In addition, a database matrix including potential data sources for future in-depth associative analyses with necessary formatting requirements and challenges will be assembled, and results of the demonstration analysis on at least one database source will be provided to Navy leadership. Future work could involve more in-depth software development using the tools and information from this project.

Beyond the initial technology integration benefits, there are vast future potential benefits in applying AI/ML technology to all aspects of Navy operations, and this project will open the door to these possibilities.

CONTACT

For more specific information about this project, contact the Principal Investigator at 805-982-4839.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by OPNAV N4I Installations Division and managed by the Naval Facilities Engineering Systems Command from the Engineering and Expeditionary Warfare Center in Port Hueneme, CA. The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes and materials and by filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Navy readiness and lethality.

For more information, visit the program's web site at www.navfac.navy.mil/nesdi or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or kenneth.c.kaempffe.civ@us.navy.mil.