Use of Machine Learning and Artificial Intelligence In Earth Science

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***Abstract*- We know more about the surface of the moon that surface of the ocean. Ocean and marine life are far from being explored. The new technological advancement in the field of AI and ML have been helpful in the field of earth science. ML algorithms have proven to be a powerful tool for analyzing oceanographic, seismology and meteorology and climate data with high accuracy in efficient way. Marine science has its own unique challenges and uncertainties whether in collecting data over vast spatiotemporal scales development of new algorithm helps in dimensionality reduction. The main application of machine learning in this field is prediction of ocean weather and climate, habitat modelling and distribution, species identification and classification of new marine biomes and, coastal water monitoring, marine resources management, detection of oil spill and pollution and wave modelling for Wave power (Generating electricity from ocean waves). This survey paper explains in simple way the realistic uses and applications of major ML and AI algorithms. The main contribution of this paper is to help classify and predict anomalies in future for sustainable environment.**

Keywords: Oceans, Marine life, Habitat modelling, Classification, Image recognition

I. INTRODUCTION

Ocean Science is a part of the geoscience which is emerging lately. As of now, only 5% of oceans have been studied. Oceans have large resources; electricity, transportation, marine life studies are in great demand lately. Problems like Global-Warming, change in monsoon currents, weather unpredictability has knocked the doors. Tackling both sides is the challenge of today's world.

As artificial intelligence is being genie of mankind, we can peek into "Digital Ocean" for answers.
Artificial Intelligence can help from top to toe. Collecting information using IOT devices, nurturing it in big data, analyzing it using machine learning, inferencing using deep learning can accomplish us to a far end.

Systems like these can help in many ways, IOT devices could be sent in deep oceans with temperature sensors, pressure sensors, cameras, microphones for better understanding of ocean beds, ocean currents, marine life, atmosphere etc. Manmade activities could be monitored like garbage proportion, transportation, tourism, natural resources, and other activities that can be heavily monitored.

This field has vast applications of Machine learning like predicting storms, next big earthquakes by monitoring seismic activities and all other fields of geology and earth science.

Machine Learning focuses on prediction, classification, decision making, anomaly detection etc. which could give more inferences for studies in oceanology, geology. For example, data collected by IOT devices can predict the ocean currents which can help in transportation, a general trend in fish migrations, etc.

II. RELATED WORKS

Various researches and students have published related work In national and international research papers, thesis to Understand the objective, types of algorithm they have used And various techniques for processing.

Anuj Karpatne, Imme Ebert-Uphoff, Sai Ravela, Hassan Ali Babaie, and Vipin Kumar
Paper on 'Machine Learning for the Geosciences: Challenges and Opportunities' [1]
Talks on various algorithms and challenges which are faced in this field. This introduces researchers in the machine learning (ML) community to these challenges offered by geoscience problems and the opportunities that exist for advancing both machine learning and geosciences.

'Artificial Intelligence in Geoscience and Remote Sensing'
In book: Geoscience and Remote Sensing New Achievements [9]
By David John Lary, He talks about Machine learning which has recently found many applications in the geosciences and remote sensing. As a broad subfield of artificial intelligence, machine learning is concerned with algorithms and techniques that allow computers to "learn".

Estimating the Daily Pollen Concentration in the Atmosphere Using Machine Learning and NEXRAD Weather Radar Data
By Monit Assess, Gebreab Zewdie, David John, LaryDaji Wu, and Estelle Levetin.[10]
The impact of pollen allergies is on the rise due to increased pollen levels caused by global warming and the spread of highly invasive weeds. This model can be used/ based on weather prediction model.

Using Neural Nets to Derive Sensor-Independent Climate Quality Vegetation Data based on AVHRR, SPOT.[5],[10]
David John Lary, Hamse Y Mussa, Molly Elizabeth Brown.
They have talked about use of neural networks to study vegetation data based on Advanced Very-High-Resolution Radiometer. It shows the impact of atmospheric contamination, such as clouds, smoke, pollution and other aerosols, variations in soil color and exposure through vegetation, and land cover type has a differential effect on AVHRR data as compared to MODIS data.
An assessment of the impact of climate change effects on forest land cover based on satellite data
Maria A. Zoran Adrian I. Dida [15]
This paper gives us a brief idea about impact of climate change with help of image classification which is obtained from satellite data.
A Deep Neural Networks Approach to Automatic Recognition Systems for Volcano-Seismic Events [16]
Manuel Titos, Angel Bueno, Luz Garcia, Carmen Benítez
It talks about deep neural networks (DNNs) could help to identify the internal sources of volcano-seismic events. Its shows that DNNs can efficiently capture complex relationships of volcano-seismic data and achieve better classification performance with faster convergence when compared to classical models.

Detecting earthquakes over a seismic network using single-station similarity measures [8]
In this work, they have shown network detection with single-station blind, waveform-similarity-based detectors in the context of FAST, first introduced in Yoon et al. (2015). FAST detects earthquakes by performing a blind search for similar waveforms in a single-channel of continuous data.
Machine learning for data-driven discovery in solid Earth geoscience.
Karianne J. Bergen, Paul A. Johnson, Maarten V. de Hoop, Gregory C. Beroza,[4]
Solid Earth geoscience is a field that has very large set of observations, which are ideal for analysis with machine-learning methods. Bergen et al. review how these methods can be applied to solid Earth datasets.

III. GEOSCIENCE CHALLENGES

There are several characteristics of Earth science applications that limit the usefulness of traditional machine learning algorithms for knowledge discovery. Firstly, data is hard to collect by natural causes and environment. Many man hours and costly equipment's are needed.
The data follow non-linear relationships, rare events. Apart from these challenges of geoscience processes, the procedures used for collecting geoscience observations introduce more challenges for machine learning and artificial indigence. This includes the presence of data at multiple resolutions of space and time, with varying degrees of noise and uncertainties.

IV. SOURCES OF GEOSCIENCE DATA

The Earth and its major interacting components (air, surface, and water) are complex dynamic systems in which the states of the system keep changing in space and time. The elements of the Earth system (e.g., layers in oceans, ions in air, minerals and grains in rock, and land covers on the ground) interact with each other through complex and dynamic geoscience processes. Data about these Earth system components and geoscience processes can generally be obtained from two broad categories of data sources: (a) observational data collected via sensors in space, in the sea, or on the land, and (b) simulation data from physics-based models of the Earth system

V. USE OF ML AND AI IN GEOSCIENCE

Big data and data visualization to raise awareness about the scope of the problem:

According to a recent report from the World Economic Forum and PwC, the rapid development of key technologies involving big data and machine learning is opening up new possibilities for measuring and tracking Earth's resources. It also allows for better coordination between researchers to share and analyze key data on pollution.

- Future predictions**:**

While data science can be of great help with analyzing the current impact of plastic waste and predicting its future development, one of the biggest problems is what we don't know. Properly documenting data about plastic pollution can be challenging, given the rate at which it's growing and how little we know about its long-term effects, but with increased computing power and AI algorithms, scientists can better understand natural systems and ocean pollution patterns to optimize interventions.

- New trends:

Satellite observation, image detection of ocean plastics and marine life
Satellite imaging and machine learning to help clean up and capture the 5 trillion pieces of plastic trash they have observed in the world's "ocean garbage patches." They estimate that within 5 years they could collect 50% of the ocean waste.

- Block chain

A grassroots organization, The Plastic Bank, offers Block chain secured digital tokens for the exchange of recycled plastics. They aim to stop the flow of plastic into our oceans by rewarding those who recycle. Thereby reducing trash and helping fight poverty. Working with partners at Cognition Foundry and IBM to implement their scheme, The Plastic Bank aims to scale its block chain solutions to meet growing demands and secure the transactions that run on it.
And the UNFCCC recently launched a Climate Chain Coalition with over 80 organizations committed to using block chain technologies for climate change efforts.

- Reinforcement learning for Earth sciences breakthroughs

7 science, materials science, biology, and other areas – which can be codified to apply reinforcement learning for scientific progress and discovery is vital. For example, DeepMind co-founder, Demis Hassabis, has suggested that in materials science, a descendant of Alpha Go Zero could be

used to search for a room temperature superconductor – a hypothetical substance that allows for incredibly efficient energy systems.

CONCLUSION

Earth is never ending story of challenges, illusions, and unimaginable. How much progress we make in any field it will be no match for the forces of nature. Our only goal is to help mankind, animals to make a world sustainable environment and a better place for the future generations.

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