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Artificial Intelligence (AI) - A New Technological Horizon for Sustainable Environment

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Abstract

The manifold roles of Artificial Intelligence(AI) towards transition to (1) AI-guided autonomous and connected electric vehicles, (2) Distributed energy grids, (3) Smart agriculture and food system through automated data collection, decision making and corrective actions via robotics to allow early detection of crop diseases, providing timed nutrition to livestock, (4) Next generation weather and climate prediction (5) Smart disaster response (6) AI designed intelligent, connected and livable cities (7) Transperant digital Earth, can not be denied at the moment. The revolutionary advances in AI have unlocked the ability to rapidly process a variety of signals, identify risks and provide real-time alerts to the conservations. The resilience of the Earth system like climate change, loss of biosphere integrity, land system change and altered cycles in the globe's Chemistry have crossed the boundary levels due to human activity. The six issues like climate change, Biodiversity and conservation, Healthy oceans, Water Security, clean air, Weather and disaster resilience, Pose an urgent global challenge today. As the world's current population of around 7 billion grows to 9.8 billion by 2050, it will increase the demand of food materials, transport and energy thus further increasing the risk of environmental degradation, and affecting human health, livelihoods and security. AI promises to enable human to develop intelligence not yet reached, opening the doors to new discoveries.

Keywords: Biodiversity, Industrial Revolution, Ecosystem, Big Data, Climate Modeling, Machine Learning.

Introduction

Scientist and environmentalist across the globe agree that the health of our mother earth is declining. Deforestation, climate change, melting polar cap and more have wreaked havoc on Earth's ecosystems. Consequently, we are experiencing a catastrophic loss of biodiversity. Our planet is going to lose about two-thirds of wild animal species by 2020.

This huge loss of biodiversity will have devastating impacts on the ecosystems that humans rely on. We receive valuable services such as clean air and water, medicine, food, and environmental protection from a healthy ecosystem. But protecting these natural resources is the biggest challenge for us today.

Even though industrialization has led to many of the current environmental problems such as air pollution, toxins in rivers and soils, overflowing level of waste, it has a silver lining. With the fourth industrial revolution at helm, technology is taking the front seat. We are becoming more connected with the digital world. As technology becomes more pervasive, the difference between digital and biological world is getting blurred. New technologies such as 'Big Data', 'Artificial Intelligence (AI)', 'Sensor network', and 'Internet of Things (IoT)' are presenting us with opportunities to solve some of the pressing issues we are facing. Not only these technological advancements have a positive impact on overall economy and standard of living but also show direction to address environmental problems at scale. We must harness the power of digital technologies to address ecological and biodiversity related issues to better manage our shared natural capital. However, not to forget that any wrong steps can exacerbate existing threats to biodiversity or

create entirely new risks. Hence, we need clear governance frameworks and policy protocols in place involving all stakeholders.

Objective of the Study

The objective of the study is to utilize the opportunity to look at how the matters like addressing climate change, delivering food and water security, building of sustainable cities, protection of biodiversity etc. can be done with the help of AI. This humble endeavour offers insights into the emerging opportunities and risks and highlights the roles of digital technologies like AI which can play to tackle ecological and biodiversity problems. It is not intended to be conclusive, but rather to stimulate a discussion between diverse stakeholders to provide a foundation for further collaborative work.

The age of Big Data, AI, Machine & Deep learning

Big Data

The term "big data" is relatively new, the act of gathering and storing large quantities of information for eventual analysis is not something new. The 3-V's of big data are:

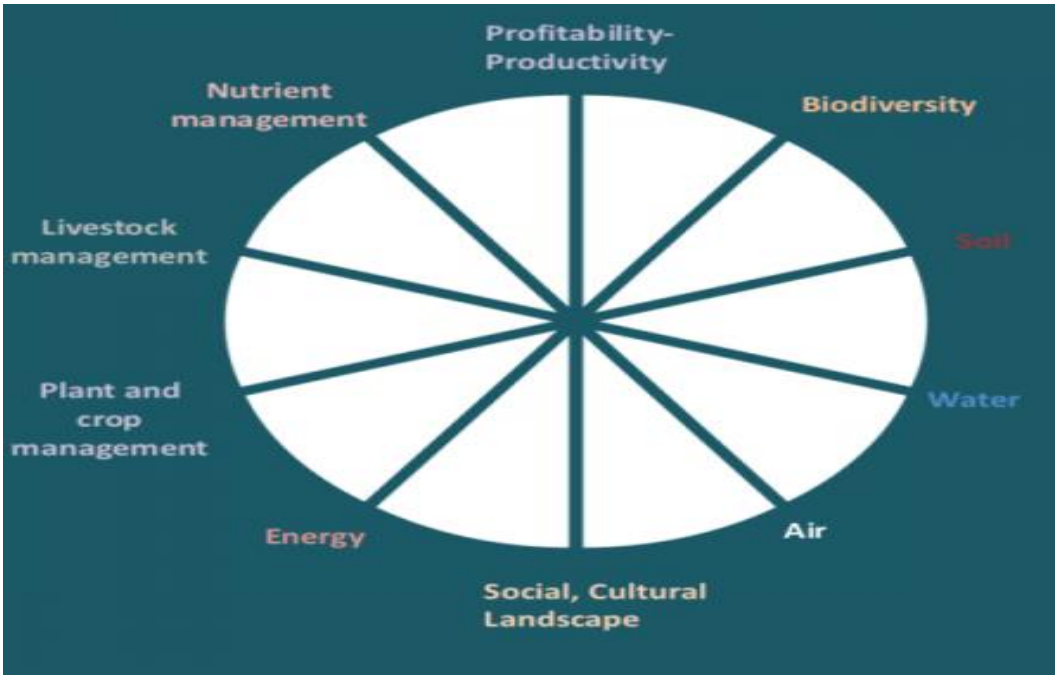
Volume: We collect data from a variety of sources including social media data information from sensor or machine-to-machine data. To get a sense of volume we have 6 billion mobile phones, 1+ billion Facebook users, 500+ million tweets per day.

Velocity

It indicates data streams at an unprecedented speed, whereas, Variety indicates that data come in all text documents with different structured and unstructured formats.

Big data are so large, complex, and/or variable that the tools required to understand them must first be invented. Next, we are going to discuss about some of those tools. The real importance of big data lies not with how much data you possess rather what you do with that. We can collect data from various sources, aggregate the same and then run high powered analytics to glean information from it. There is a rush to extract golden nuggets of insight from mountains of data. Big Data analytics has attracted significant attention in the context of large-scale data computation and processing. One of the ways to run analytics at scale on big data is by using Artificial Intelligence (AI) techniques. We will learn about it in the next section.

Fig 1:- Indicates Manifold Areas under The Focus of AI



Artificial Intelligence (AI)

Artificial Intelligence is a branch in computer science where machines or computers have cognitive abilities like the human mind and can solve problems by learning. AI was founded as an academic discipline in 1956. But it came into prominence as a major field of research only recently, with the advent of the fourth industrial revolution. Today big data, analytics, and machine learning are not mere buzzwords but represent huge changes in much of the technology we deal with in our daily lives.

In medical science also diseases are diagnosed and clinical pathways are developed by AI. It is also being used to identify environmental and land pattern changes. In the manufacturing industry, machines that communicate with each other, inform each other about defects in the production process, identify and re-order scarce material inventories, are creating a revolution.

Industrial robots work in synchronization with the humans handling more delicate tasks. Even the machines can tell humans when the machines need to be fixed before they even break. However, as AI becomes more autonomous and broader in its use, AI safety will become even more important. Commonly discussed risks include bias, poor decision-making, low transparency, job losses and malevolent use of AI (e.g. autonomous weaponry).

Scientists need to stress on creating "human-friendly" AI. No doubt - it is a tall task to achieve. The economic growth and human health can be affected negatively from a deteriorating natural environment. Hence, it is becoming increasingly important to extend the rapidly growing field of AI safety to incorporate "Environment-friendly" AI. As the technology evolves, its direct and indirect applications for the environment will need to be better understood in order to harness the opportunities, while assessing the potential risks and developing approaches for mitigating them. According to a recent report from World Economic Forum (WEF, 2018), AI could be developed to support the creation of distributed, "off-grid" water and energy resources; to improve climate modeling, or to improve natural disaster resilience planning. They envision AI as the electricity for the Fourth Industrial Revolution and suggest that harnessing its full potential could help to create sustainable, beneficial outcomes for humanity and the planet we inhabit. Earth is significant. The AI is projected to become smarter and more pervasive with each passing year – not only more productive but developing intelligence that humans don't yet have, accelerating human learning and innovation. It is an exciting time to talk about the power of AI and put the same in practice to address some of the world's biggest problems. In fact, it's time to put AI to work for our planet.

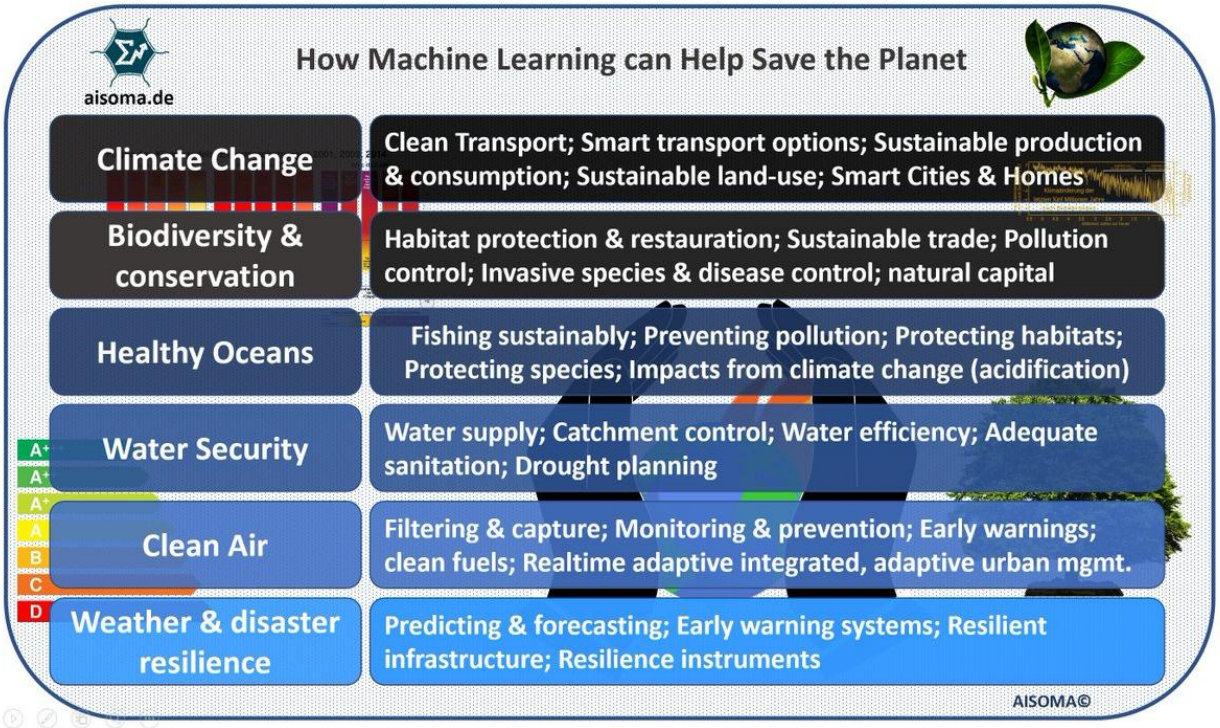
Machinelearning (ML) and Deep learning (DL)

ML and DL are a subset of AI and rely heavily on computational statistics. The phrase machine learning dates back to 1950s when IBM researcher Arthur Samuel was running experiments to teach machines/computers how to play checkers. The basic idea is to ingest machines with data and a machine must process it in order to learn.

Over the years, several scientists and mathematicians came up with numerous algorithms designed to let machines deal with data in the same way as humans do. They borrowed concepts from the field of statistics, employing techniques such as linear regression to assign probabilities to various outcomes, therefore enabling predictions to be made. The main goal is to predict the future by learning from the past event or data.

However, in recent years development in the area of artificial neural network has taken research to a whole new level. Scientists are able to create computer models that can function similar to human brain. Artificial neural networks, like real brains, are formed from connected neurons, all capable of carrying out a data-related task. Each neuron is capable of passing on the results of its work to a neighboring neuron, which can then process it further. Because the network is capable of changing and adapting based on the data that passes through it, so as to more efficiently deal with the next bit of data it comes across, it can be thought of as "learning", in much the same way as our brains do. Deep learning is simply machine learning which is derived from such "deep" neural nets.

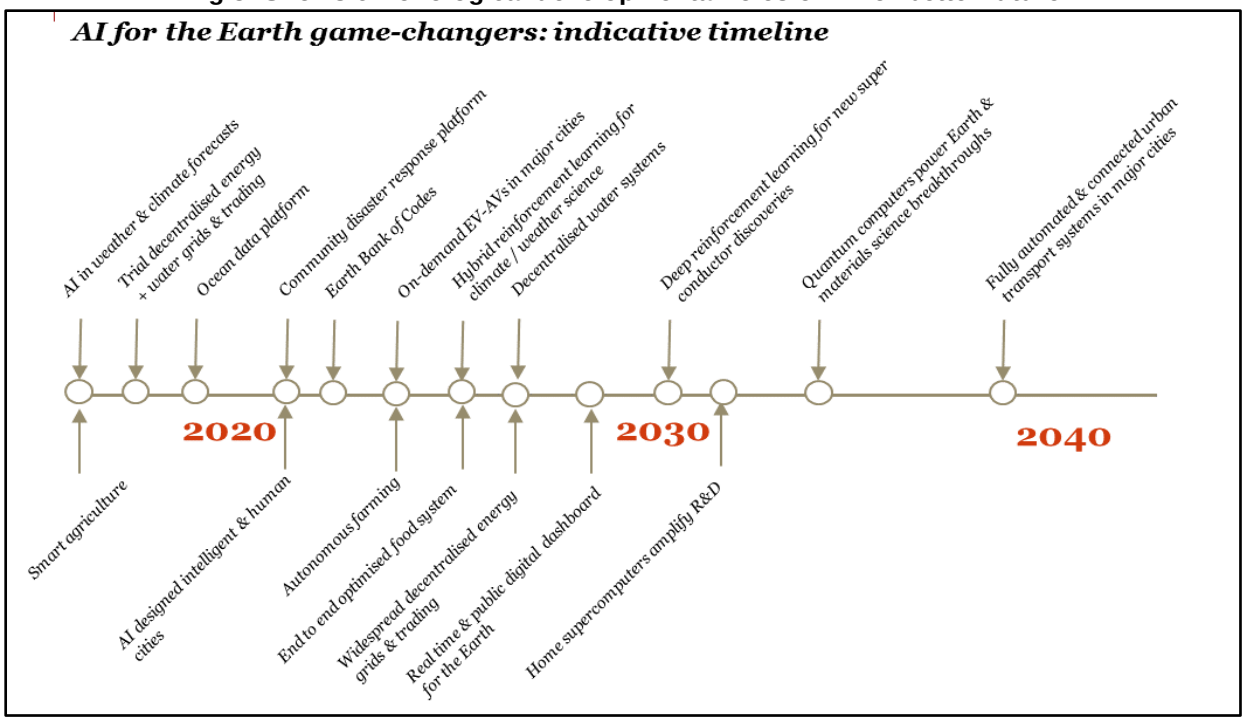
Fig 2:-Indicates various positive roles of Machine learning



ML & DL has widespread applications in the areas of robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing. In our day-to-day lives, machine learning now powers Google's search and image algorithms, to more accurately match us with the information we need in our search.

In general, machine learning algorithms can be divided into two main categories supervised- and unsupervised-learning. Within the supervised- and unsupervised-learning categories, there are several different varieties of machine learning algorithms, including neural networks, decision trees, decisionrules, and Bayesian networks. Researchers are increasingly using such machine learning techniques to solve global problems such as global climate change,food security, biodiversity, and human migration. S. Willcock et al. (2018) haveargued in their seminal work, how machine learning can be used for ecosystem services. They used a Data-Driven Modeling (DDM) by harnessing the power of ML to come-up with biodiversity value in Sicily, an island in the Italy. The research emphasized how DDM can be made more accessible to decision-makers, who show both capacity and willingness to engage with uncertainty information such as biodiversity score.

Fig.3: Shows chronological developmental roles of AI for better future



AI for Biodiversity

The most important consideration in the development of AI is, arguably, to ensure that they benefit humanity, which includes being both "human-friendly" and "planet-friendly". Our AI solution must be value-aligned – that its idea of a good future is aligned with humanity's values, promising safe application of the technology for humankind.

With the use of AI, we should be able to easily mine through troves of data and determine where the most vulnerable species live, where and how humanity changes the planet, and how this drives extinctions. We can assess key statistics about species, their distribution, and their status. Progress on assessing biodiversity will emerge from the continued expansion of the many recently created online databases, combining them with new global data sources on changing land and ocean use. However, we should not look at biodiversity as a standalone problem faced by humanity. It is pretty much intermingled with other issues such as climate change, ocean health, and air pollution. We will discuss next how advanced AI can help to tackle such menace.

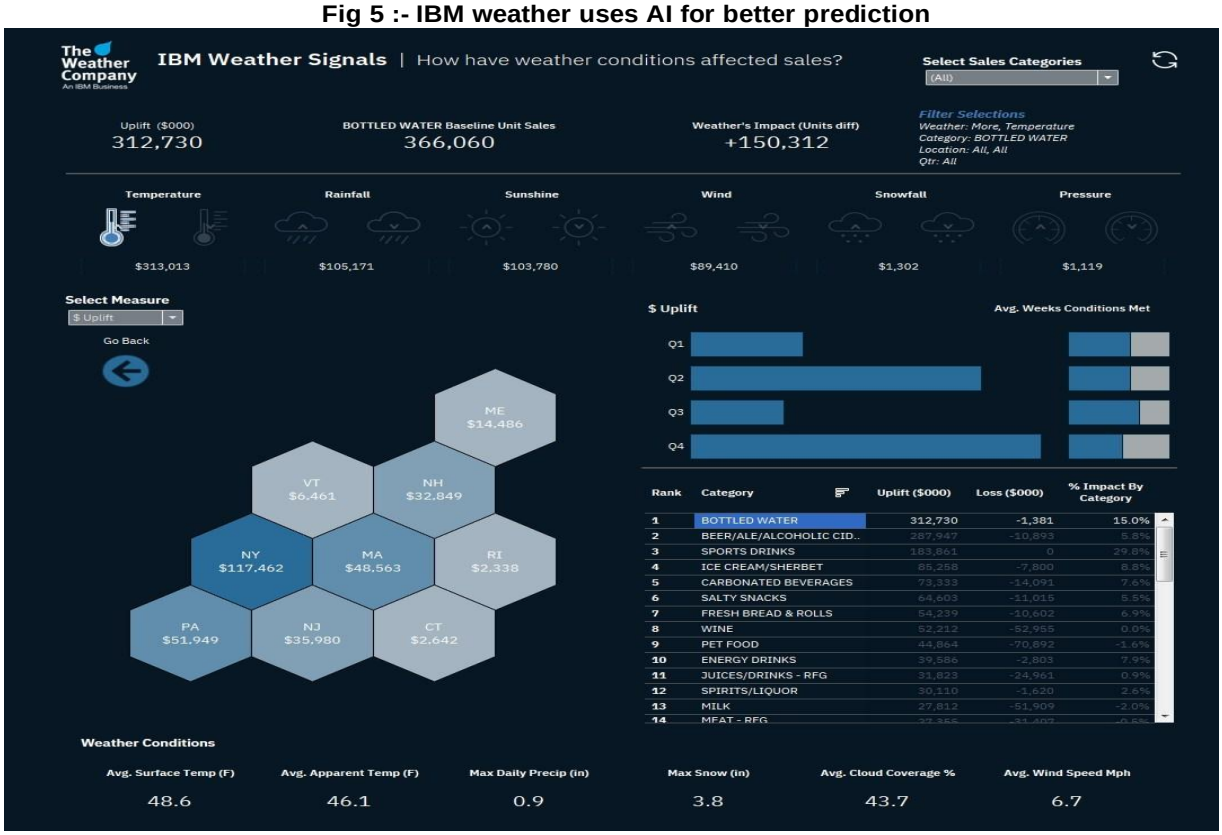
Fig 4 :- AI for Sustainable Planet

Source (siliconupdates.blogspot.com)

Weather Forecasting and Climate Modeling

Climate Informatics has emerged as a new scientific field where the use of AI has changed the way weather forecasting is done. We are getting better at predicting extreme weather conditions such as cyclones, hurricanes or extreme heatwaves. We already have a large volume of climate-related data from the past. Scientists areapplying Machine and Deep learning algorithms to predict future weather conditions. Hence, we are able to enhance the performance of existing climate models and create new ones, usable for decision-making.

Fig 5 :- IBM weather uses AI for better prediction

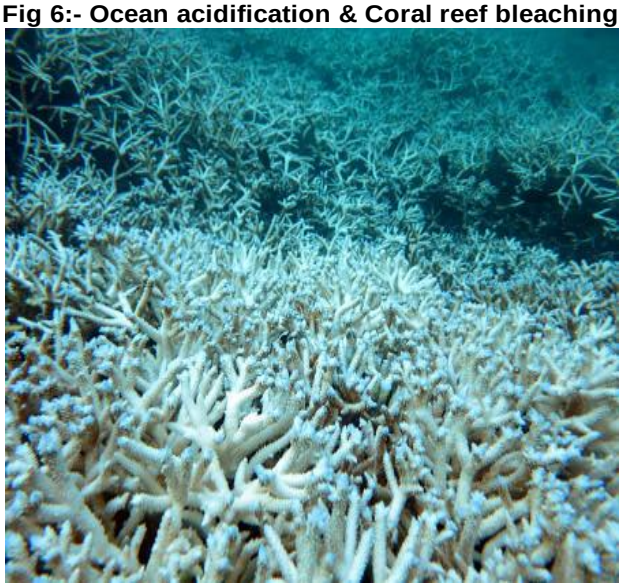


(Source: newsroom.ibm.com)

Both public & private agencies such as IBM and Microsoft, are using AI and machine learning to enhance the performance and efficiency of weather and climate models. These models require expensive, energy-intensive computing, but deep-learning networks can emulate some aspects of these climate simulations, allowing computers to run much faster and incorporate more complexity of the 'real-world' system into the calculations. Hence, we get a much better prediction with improved computational efficiency.

Saving our Oceans with Data Analytics

Fig 6:- Ocean acidification & Coral reef bleaching



(Source: theinertia.com)

AI is also used in monitoring location and quantities of ocean species and predicting the spread of any invasive species. Nordic countries are using drones and AI to analyze whale health. Australia has put in place coral reef mapping and coral reef habitat assessment program to keep a check on coral reef bleaching. Another example is the Ocean Data Alliance, which has started to work together to develop and implement open-source solutions to provide the data needed for comprehensive monitoring of ocean resources, from satellites to data from ocean exploration technologies. This approach could allow us to use machine learning to monitor, predict and respond to changing conditions such as illegal fishing, a disease outbreak or a coral-bleaching event.

Precision Agriculture to Save Ecosystem

One major reason for habitat loss for wild animals is unlawful encroachment and deforestation by human beings. The acquired land is later used either for agriculture or for cattle grazing. Improvement in Agri-process and overall crop yield can help stem this problem. Precision agriculture uses old farm data to determine the optimal use of the plant, pesticides, and fertilizer in the farmlands. Smart farming using AI can detect crop diseases and issues at an early stage, which helps to provide timed nutrition to livestock. Sensors measuring conditions such as crop moisture, temperature, and soil composition will give AI the data needed to automatically optimize production and trigger important actions such as adding moisture. Drones are increasingly being used to monitor conditions and communicate with the sensors and AI-enabled systems.

A major share of habitat loss in happening due to the warming of ocean water, illegal fishing, and coral bleaching. Real-time monitoring of ocean species and resources are very crucial to stop further extinction. AI can help in this regard by employing real-time monitoring of the following:

1. Ocean temperature and pH.
2. Ocean currents.
3. Coral reef ecosystem.
4. Ocean pollution level and litter.
5. Oil spill.
6. Marine dead zone.

Fig 7:- Gulf Oil spill

(Source: latimes.com)

The goal is to optimize agricultural inputs and returns with limited land resources. This promises to increase the resource efficiency of the agriculture industry, lowering the use of water, fertilizers, and pesticides. Consequently, the harmful runoff from Agri-lands, that currently finds its way into rivers, oceans causing damage to important ecosystems, also reduces.

Biodiversity Monitoring & Conservation

Effective wildlife monitoring techniques are a major work of any biodiversity conservation program. However, counting organisms is not easy task.

There are a lot of external factors such as excess rainfall, storms, droughts, and diseases which can impact a biological survey. Consequently, most monitoring programs fail to provide a rigorous measure with enough statistical power. A comprehensive monitoring program can be very expensive and difficult to maintain over time. Hence, we need a cost-effective and sustainable conservation monitoring method to improve inference and drivethe adaptive management of conservation projects. Next, we will discuss how Big data, IoT, AI, machine- and deep- learning can help us in this regard.

As per the work by Klein et al. (2015), the standard approach to biodiversity monitoring involves periodically sending observers to a pre-determined set of survey sites or habitats to collect data over relatively short survey windows. However, the report also points out that logistics cost and time constraints make it difficult to scale such projects. Additionally, frequent human intervention to these sensitive habitats can lead to a host of negative ecological impacts. Thus, typical monitoring efforts suffer not only from severeunder-sampling of space and time but also from the variable skills and biases of different field workers. That's why many conservation monitoring efforts provide inconclusive results which are of no practical use.

Digital technologies can be of help in this regard. Klein et al. (2015), suggestleveraging the power of AI, IoT, and host of other cutting-edge technologies to improve the quality of conservation monitoring and to scale monitoring programs to meet the global need. Researchers can use sensors, drones, and other IoT tools to survey much larger numbers of sites nearly continuously. We can accumulate data using a variety of sensors including microphones, cameras (visual, thermal, and hyperspectral), etc. Then raw data can be collected in different formats (audio, video, and heatmap) and transmitted back to a central database. This rich source of data can be used in conjunction with machine- and deep- learning algorithm to analyze further and glean important information. Such an approach will help to address the sampling bias and any variability issues. As technology is used in the entire process, we will be able to reduce frequent field trip cost and any negative impact on habitat under study.

Technological advancement in the fourth industrial revolution has enabled scientists and researchers to conduct biodiversity study more effectively. For example, advances in, global positioning systems (GPS), and network technology have revolutionized wildlife telemetry and added a wealth of information about animal movements at continental scales. Visual sensor networks and images collected by satellites, airplanes, and drones have made it easier to track changes at the landscape scale. However, this has created a new issue in the form of data glut. We need data mining tools like ML and DL algorithms to extract intelligence out of this big data. Using Deep learning techniques, we can train computational models to detect and classify events of interest and reduce the amount of wildlife data reviewed by human analysts.

Habitat protection and restoration is also an important aspect to preserve biodiversity. It can be achieved by precision monitoring of ecosystems, habitat loss detection and monitoring, and optimized breeding of plants. Microdrones can be used for plant pollination. Bird habitat and migration pattern prediction is another important area which need our attention. When researchers collect audio recordings of birds, they are usually listening to the animals' calls. In a article published in Nature (2019), author outlines Travers work where he uses artificial intelligence (AI) to identify noise which marks bird collision with power lines. They found number of such cases is alarmingly high for two specific species of birds and worked with the local utility company to save them.For underfunded conservation scientists, AI provides an attractive alternative to manually processing huge troves of data.

Conclusion

We live in exciting times when it is now possible to tackle some of the World's biggest problems with emerging technologies like AI. It's time to put AI to work for the planet. Today, everybody is beginning to see the business value of AI which is being added to more and more things every year and even into everyday lives like navigation of cities, shares riding, networks of energy to online world. It is getting smarter and smarter. AI also accelerates human innovation.

However, the unsolved issue of AI is paramount, although its broader use, power and autonomy is unquestionable. Making of poor decisions, biasness, low transparency, losses of jobs, malevolent uses are some of the risk factors of AI that are to be kept in mind. The cheeks and balances developed to ensure that evolving AI system remains friendly must incorporate the health of the natural environment as a fundamental dimension.

The situation demands that proactive collaboration among the policymakers, environmentalists, Scientists, civil society, technocrats and investors, is required at present,
which will lead to achieve a sustainable environment in future.

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