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Machine Learning: A Way to Smart Environment

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Abstract:- Smart cities attempt to create a management system of expanding metropolitan center to enhance the economy, energy consumption and upgrade the living conditions of residents in an effort to attain sustainability goals. Information and Communication Technology (ICT) now plays a significant role in decision making, policy development and the application of new approaches for smart environment. The main goal of this book paper is to highlight the importance of machine learning in the development of smart green environment in a way to achieving smart green economy. This paper gives a summary on the aspect of green smart environment (smart cities), Machine learning and AI in the development and sustenance of smart environment and the role it plays for smart green economy and infrastructure which are pre-requisite requirement for smart environment. In the insight of this work, we offer an explanation about AI and machine learning in smart environment as well as the potential application of Machine Learning in the same.

I. INTRODUCTION

The capacity to learn from experience, or intelligent thinking, is one of the most important aspects of human intelligence. The question then becomes whether machines can be programmed to think intelligently in the same way that humans do. If that's the case, what are the fundamentals of Machine Learning, what can it do in the construction of a green smart environment, and how can urban planners/designers, architects, engineers, economists, and others go about doing so?

The increasing accessibility of robust sensors and actuators, as well as the convergence of technology in machine learning and pervasive computing, has sparked interest in the development of smart environments. Researchers are also realizing that smart settings can help with important functions like remote health monitoring and intervention. The aging of the population, the high cost of formal health care, and the significance that people have on being independent in their own homes all point to the need for such technologies (Parisa et al., 2011).

Because ubiquitous computing is so different, it is difficult for software designers to come up with a single model that can fulfill all of their needs. Smart cities" is a concept that has acquired popularity across industries and has infiltrated the domains of sustainability, urban planning, engineering, and computer science, resulting in a plethora of definitions (Albino et al. 2015). Cities that were regarded "pioneers in embedding digital infrastructure and systems into their urban fabric" were referred to as "wired cities," "digital cities," and "intelligent cities" in previous incarnations (Kitchin 2014). Despite the fact that the word "smart city" has many variations, experts have found it beneficial to define two broad but related meanings for the term [1].

The first, is the broad integration of Information and Communication Technologies (ICTs) and Internet of Things (IoT) tools into the urban environment to better monitor, assess, and manage municipal assets and services (Bibri & Krogstie 2017b). The vast amounts of data obtained through these methods undoubtedly provide a better understanding of the city as an ecosystem, and can be used for analysis, modeling, and prediction (Kitchin 2014).

The second definition of "smartness" focuses on people, with ICTs serving as tools for citizen involvement and mobilization, as well as participatory governance (Mller et al. 2018). It has been proposed that a city cannot be genuinely smart until it effectively harnesses the potential of social capital, entrepreneurship, and innovation, often known as the information economy (Kourtit et al. 2012).

Smart Environment is a complex system, which need a mix of transparency and context awareness. Such systems' architectures must adapt to demand space and have a modular and flexible design capable of producing suitable services at the correct moment. Contributions from leading researchers describe techniques and issues related to developing and living in intelligent environments. The latest research in smart environment preset the philosophical and computational architecture considerations, network protocols for smart environments, intelligent sensor networks and power line control of devices, and action prediction and identification are among the topics covered, reflecting the multidisciplinary nature in the design of smart environment.

The characteristics of smart environments are presented in this paper based on the requirements established for them and the features accomplished in prototype solutions for various application domains. These summaries aid in comprehending the importance of machine learning in intelligent settings. Many of our cities are adopting digital technologies. These smart environments use data and digital technology to enhance efficiency and inhabitants' quality of life, from self-driving cars to smart grids to intelligent traffic lights.

The natural capital that cities rely on, however, it is at a risk of being left behind by the digital revolution. Smart technologies are already being used in environmental and resource management, with increasing technological capabilities and recent calls to action for environmental technology investments. Indeed, green infrastructure and natural asset management are barely mentioned in smart environment funding mechanisms and policy initiatives. The majority of European nations and associated partner funding for smart-city projects has been limited to energy, transit and mobility, and ICTs. However, in India's "Smart City mission" aims to create hundred smart cities by implementing "smart solutions" in the areas of e-governance, waste management, water and energy management, and urban mobility. These methods, on the other hand, leave out urban green space and forest management. As a result, the purpose of this paper was to highlight the importance of machine learning in attaining a smart green environment in the digital era.

II. MACHINE LEARNING

Despite the fact that there are numerous definitions of Machine Learning, I prefer a straightforward one. For example, machine learning (ML) can be defined as a collection of techniques that can be used to build a model from data in order to make predictions or take actions to improve a system. Machine learning is an area of AI that deals with the design and development of algorithms for recognizing and making decisions about complicated patterns based on experimental data. Machine-based learning models can be analytical in nature, predicting outcomes, or descriptive in nature, gaining information from data. The original purpose of machine learning techniques was to automate the creation of data for integration into knowledge structures [2]. AI algorithms is of high interest to smart environment builders, the so-called evolutionary computing, has drawn inspiration from biological evolution. These algorithms perform a different type of AI learning enabling machines to make autonomous decisions, adapt to a changing environment and find non-obvious solutions to complex and 'wicked' problems[3]. Machine learning is divided into two categories based on the training resources: supervised and unsupervised learning.

- *Supervised Learning:*

The AI network is trained to map output data using a mapping function using a set of inputs and targets. The existence of a "teacher" and the input-output data for the instruction are the most important aspects of supervised learning. It is further divided into two categories: regression and classification. Supervised learning includes techniques such as support vector machines, random forecasting, and linear regression[4]–[12].

- *Unsupervised Learning:*

In unsupervised learning, no direction is provided; instead, an unclassified and unlabeled input dataset is provided for the AI network to train on in order to identify hidden patterns, responses, and distributions. Unsupervised learning challenges include clustering and association, among others. Unsupervised learning techniques such as auto-encoders and k-means are common examples[13].

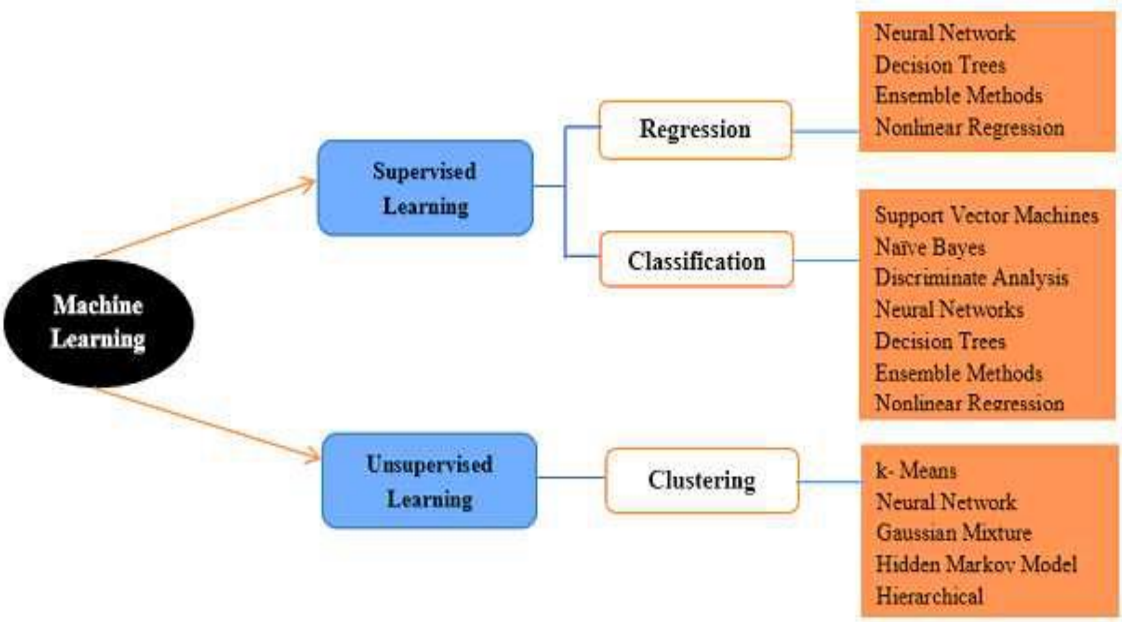

Fig 1:- Types of machine learning with adopted algorithms.

- *Big Data*

Because of the expansion of mobile phones, the Internet of Things (IoT), and satellite earth observation technology, to mention a few sources, the rate at which we generate incredibly huge datasets every day (in terms of volume, variety, and velocity or the "3 Vs of big data") is amazing. That indicates that by 2020, the entire amount of data will have surpassed 44 zettabytes (or 1021 bytes), or 40 times the number of stars in the observable universe.

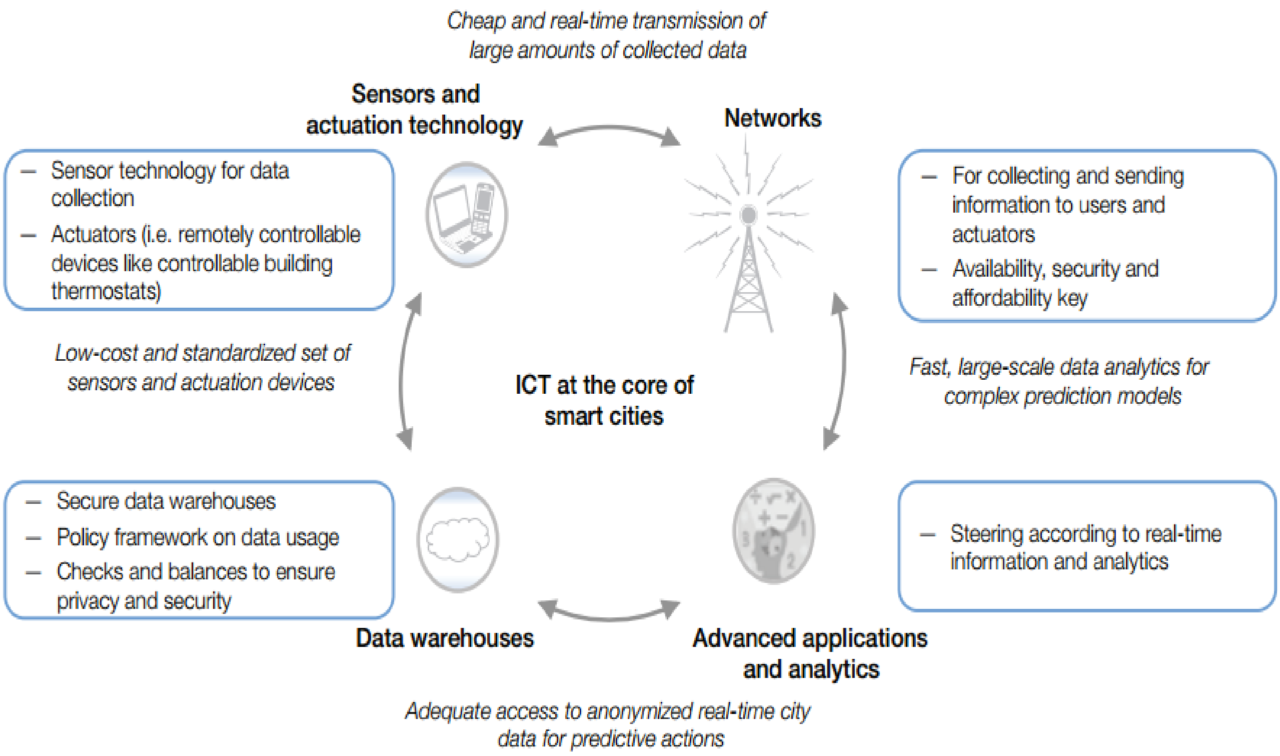

Fig 3: City data synchronization, collection and real-time transmission

III. MACHINE LEARNING AND SMART ENVIRONMENT

AI and machine learning have the potential to transform the way smart environment or cities work in a variety of ways. However, for an AI and ML-based smart city, developing and integrating software and hardware platforms, smart frameworks and algorithms, theoretical planning, and mathematical computing models of ICT infrastructure is critical. This special issue encourages academicians and researchers to share their work that uses AI and machine learning to aid in the creation of smart environment. The availability of intelligent devices via Artificial Intelligence (AI) and Machine Learning (ML) has been critical in the advancement of the smart city idea. You can now create a cyber-physical space with traffic sensors, video cameras, environmental sensors, smart meters, and other devices by combining sharp computing programs with human intelligence.

When numerous people live in the same house, multi-class categorization is required, which is a tough and time-consuming operation due to the nature of the data. Furthermore, sensor data is constantly noisy and sensitive to a variety of unknown circumstances, such as missing data and defective sensors. To achieve high accuracy classification, it is necessary to identify and understand spatio-temporal correlations between sensor readings[14].

Intelligent green and smart environment (e.g., smart home, smart factory, smart city, smart building, smart parking, smart agriculture, intelligent traffic systems, smart car, etc.) that use pervasive computing, machine learning, artificial intelligence, cognitive sensor systems, wireless and sensor networking to realize cyber and physical components for sensing, reasoning, and controlling the environment are referred to as smart environments. Autonomous agents can play an essential mediating function between human users and the environment in a smart environment. This is especially true when high-level cognitive skills and computational intelligence are utilized to cope with the uncertainties of the complex environment, allowing agents to respond appropriately in a range of situations. System integration, system maintenance, geographical and functional extensibility, social networking, mobile computing, context-aware applications and services, human-in-the-loop modeling and simulation, big data analysis, cloud and edge-based IoT frameworks and environments, field experiments and test beds are all issues that must be addressed in the creation of a smart environment. The primary objective of this Special Issue is to present and debate recent developments in the field of sensor systems, particularly in terms of technologies, architectures, algorithms, and protocols for smart environments, with a focus on real-world applications. Topics that are appropriate include, but are not limited to: Wireless sensor networks (WSN) in smart cities, smart city sewage, water and electricity management, Smart city healthcare service monitoring, smart city education, training and social services, smart transportation system planning, evaluation, and technologies, smart home, smart building and social community networks/infrastructures, big data analytics and machine learning cloud computing for Internet of things, machine learning etc.

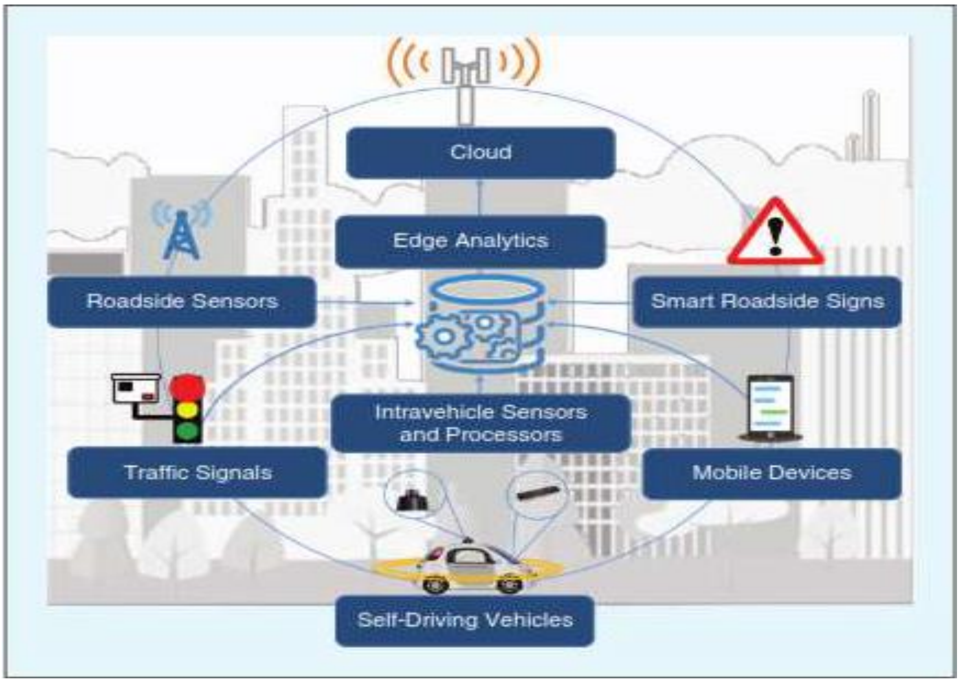

Fig 1: Architecture and components

IV. POTENTIAL USES OF MACHINE LEARNING IN SMART ENVIRONMENT

➢ *Smart Green Economy and Infrastructure*

The depletion of conventional energy resources, city congestion, increased chemical, physical, and biological pollution, as well as global warming, are the most serious challenges of the twenty-first century, with all of their effects for quality of life. Large settlements, which are characterized by high densities of population and buildings, would be the most affected in this regard; as a result, planners will have to rethink their form and functions in order to meet the needs for a sustainable urban living [15]. Intelligent green growth offers a chance to rethink our economic and smart environment development models as a new paradigm that supports economic development while decreasing environmental degradation and protecting natural resources. The conventional efficiency paradigm is giving way to a broader concept of societal development, one that includes efficiency, fairness, and environmental sustainability[16], [17], [25]–[27], [18]–[24], [24]. Growth Economic efficiency has long been viewed as a distinct goal from equality and environmental goals. In light of the massive social and environmental changes occurring on a global scale, an increasing number of cities have shifted their development strategies to smart policies aimed at sustainable mobility, building energy upgrades, increasing energy production from renewable sources, improving waste management, and implementing ICT infrastructures. The objective is to transform Smart Cities into Smart Communities that can improve the quality of life of its residents by providing a long-term opportunity for cultural, economic, and social progress in a healthy, safe, exciting, and dynamic environment. The primary message of an early copy of an online release on the issue of a green economy' (2011) is that urban development must be substantially modified to enable the transition to a green economy through the aid of modern techniques like artificial intelligence and machine learning. According to the research, metropolitan regions will soon be home to 50% of the world's population, but they will also account for 60-80% of energy consumption and 75% of carbon emissions[28]. Every city has a unique chance to take a step toward greening the global economy. There are also real possibilities for national and local authorities to decrease carbon emissions and pollution, improve ecosystems, and reduce environmental hazards. It is feasible to promote compact, somewhat densely inhabited cities with a mixed-use urban shape that are more resource-efficient than any other settlement pattern with comparable levels of economic production by taking advantage of the opportunity. Integrated urban and regional planning and design strategies using technology are also available to improve urban transportation, building construction, and the development of urban energy, water, and getting energy from urban waste systems in such a way that they reduce reliance on natural resources and energy consumption in the process of long-term planning[29]–[33].

➢ *How Green IT can Resolve the Issue of Sustainability*

To develop a sustainable smart city, it is necessary to employ sustainable technologies. The demand for green IT is heightened by the issue of sustainability. Green IT allows for the development of hardware and software applications that use fewer resources. Green IT's product lifetime idea can help to tackle the problem of rising demand for computer devices. Manufacturing a new computer, for example, will require far more resources than manufacturing new RAM for an existing computer. The generation of hazardous elements such as lead and mercury will be reduced if computer equipment is recycled rather than discarded. Urban regions are responsible for 80% of CO_2 emissions. Cities are attempting to reduce CO_2 and other greenhouse gas emissions, preserve resources, and provide the foundation for new economic activity by utilizing ICTs and optimization approaches. Despite the fact

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that this goal encompasses a variety of sectors, transportation in metropolitan areas is responsible for the majority of CO_2 emissions. Better urban design and changes in human habits, both of which are generated and facilitated by new technologies, are seen as potential solutions to this problem [34]. Recycling will minimize the demand for new gadgets and, as a result, energy and resource consumption will be reduced. The usage of a decentralized system can help to minimize CO_2 emissions. A decentralized system is an inter-connected information system that can provide search results without sending the request to servers around the world.

Cloud computing has established itself as a technology that enables a variety of IT services. As the number of cloud-based IT services and apps grows, data centers with thousands of web servers, storage, and network devices must be built. Cloud data centers (CDC) offer a variety of services to end users, ranging from high-performance computing to large-scale data analytics. Because of the massive scale of cloud data centers, which are set up in multiple geographical locations to serve distributed users, they account for 25% of total IT electricity consumption[35].

Cloud Computing provides a variety of computing services that are accessible over the Internet and provide high availability, increased security, and reduced total cost of ownership. Infrastructure as a service, Platform as a service, Software as a service, Network as a Service, Storage as a Service, Sensor as a Service, and other cloud computing services exist, depending on the type of resources given via them [34]. The Internet of Things (IoT) can improve efficiency, performance, and through put when smart devices migrate outside of the cloud infrastructure environment. Smart cities are residential areas that make systematic efforts to observe for themselves where records and communication technologies are being kept, to accomplish environmental sustainability, urban system authority, better health, knowledge development, and network-driven advancement. Cloud computing can help with energy and resource usage concerns. Large and small organizations alike may migrate their on-premise applications to cloud computing, halving their energy usage and carbon emissions. The world is fast transforming into a smart city. People have gained comfort because to information technology and smart cities, but they have also released dangerous gases that contribute to global warming. Existing and developing technology must be adapted in a way that has the least possible environmental effect. The objective must be to achieve balanced growth from both a social and an environmental standpoint. With the aid of green IT, this aim may be realized. Universities are taking steps to educate students, as well as create and maintain systems that are less harmful to the environment. More applications for employing green IT in all areas of company may be created with more educated and skilled students.

V. CONCLUSION

The world is on its way to becoming a supremely computerized environment, with current era technologies like IoT, machine learning, and artificial intelligence guiding the way. As previously stated, we have discussed how these technologies can be used to plan a smart green environment that is both relaxing and comfortable to live in. Collaboration with digital transformation experts and software testing providers is essential for the successful implementation of new technologies and IoT devices. It is predicted that the knowledge of such specialists would be utilized to the remodeling of various cities throughout the world in the near future. Complex systems characterize smart environments, which necessitate a balance of transparency and context awareness. Such systems' architectures must respond to demand space and incorporate a modular and flexible design capable of producing appropriate services at the right time.

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