

An Overview of Deep Learning in Smart Grids

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Introduction

In recent years, with the growth of the computational methods particularly in case of data management and analysis several machine learning (ML) approaches has been implemented in various industries. According to the current situation most of the researchers have concentrated their studies on deep learning (DL) because deep learning has been treated as one of the emerging areas for feature extraction and handling huge amount of data where machine learning methods fail. Altogether, artificial intelligence encloses with numerous subfields, counting as machine learning, deep learning, computer vision, neural network and natural language processing etc. Deep learning utilizes massive neural networks with a lot of layers of processing units, for advances in computing power and enhanced training techniques to learn versatile patterns from huge quantity of data. Common applications include image and speech recognition. Deep learning is implemented through neural network. The motivation behind neural network is the biological neuron. Generally, deep learning is a sub-branch of machine learning and machine learning is also another sub-branch of artificial intelligence as given in the figure1.

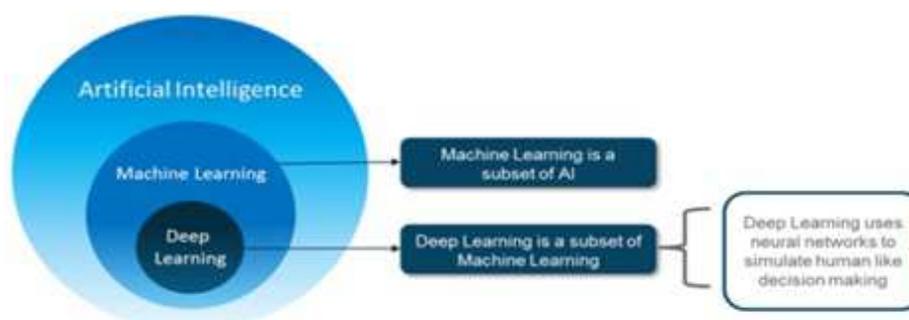


Figure 1: Depiction of AI, ML, DL

The biggest advantages of deep learning are:

- Deep learning gives better performance on dissimilar troubles that significantly outperforms other solutions in diverse domains. This take in speech recognition, language, computer vision, playing games etc.
- Deep learning overcomes the limitation of machine learning methods in case of feature extraction that means it takes less time.
- For adopting new type of problems in upcoming days deep learning architecture performs well.
- Robustness to natural variations in the data is automatically learned.

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Importance of deep learning over machine learning

- Machine learning is not enough capable for managing high dimensional data wherever input & output is relatively large.
- Deep learning has sufficient power for managing the high dimensional data as well as to focus on the exact features by themselves. This procedure is known as feature mining.
- Deep learning can do better than traditional methods. For example, in image classification, deep learning algorithms gave 41percent more correct result than machine learning algorithm and gave 27 percent more accurate in facial recognition and lastly 25 percent in case of voice recognition.

Deep learning works in smart grids

For electricity data analysis industries were adopted novel methods like machine learning, fuzzy logic, data mining, artificial neural network (ANN),support vector machine (SVM) and genetic algorithm etc. to get better outcomes for estimating the exact electricity demand and also used these methods to forecast both energy production and consumption. Among all methods deep learning plays a vital role in smart grids applications.

Smart Grids (SG)

According to digital technology “grid” is recognized as the electric grid and it is bi-directional communication line of network between consumers and utility. Now a days electricity disturbance is common problems which cause a series of failures such as in banking sector, communications, traffic, and security etc. For this purpose smart grid technology is implemented based on varieties of artificial intelligence approach. This scheme gives permission for supervising, investigate, organize and communication within the supply chain to assist progress effectiveness, shrink energy utilization and cost, and make best use of the transparency and reliability of the energy supply chain. The smart grid system overcomes the drawbacks of traditional electrical grids where smart net meters concept has been implemented in earlier days. The concept of smart grid approach not only concentrates on utilities and technologies but also focuses on the consumer choices regarding their consumption of electricity energy.

The layout of smart grids is as follows in figure 2.

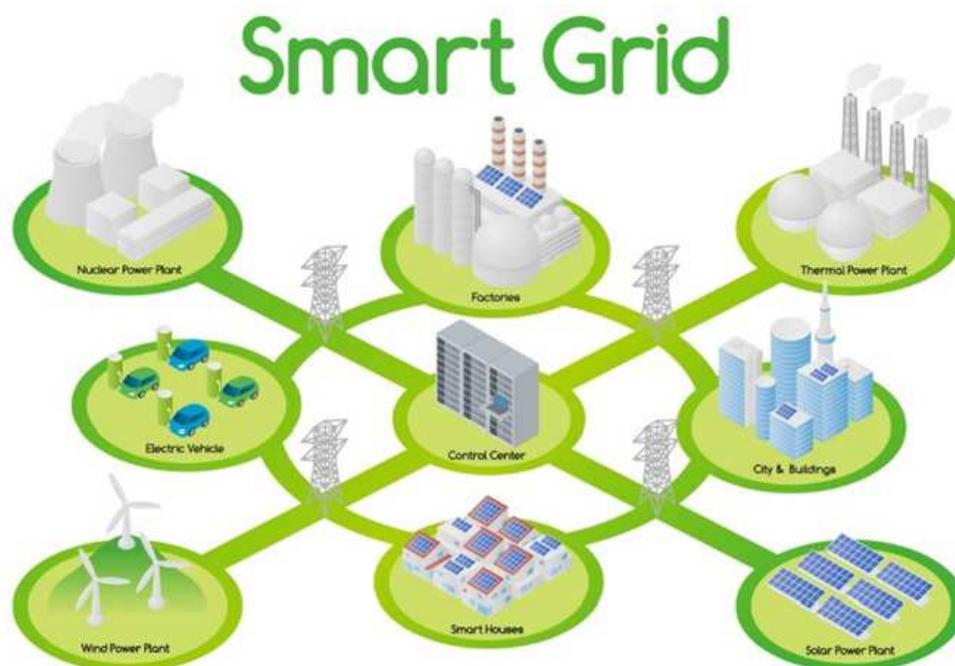


Figure 2: Powers ahead with smart grids

Smart grid is totally a new concept for all researchers in comparison with traditional electricity grids. The smart grid is the renovation of the electricity flow system. So this theme takes a significant role in the research society. Smart grid is the mixture of information and all digital communication approaches by means of power grid systems to facilitate two way communication and power flow that can boost safety, reliability, and effectiveness of the power scheme. In addition we can say that smart grid is the arrangement of tools, systems and procedure to manufacture power grid intelligent and computerized. Due to huge amount of data collection in each and every moment from different sources, it is necessary for all power companies to take responsibilities of all collected data and find out the clear knowledge about electricity consumption behaviors which is shown in block diagram 3 below. So deep learning algorithm is required for feature extraction and data analysis. Most of the studies were done on smart meter data for instance load outline, customer classification, load predicting and anomaly detection. For doing improved understanding of electricity utilization, flexible demand management and useful energy control smart meter data analysis are essential.

According with the advancement of smart grids the United States Department of Energy recommend four types of technology such as:

- Technologies regarding measurement and intelligent.
- Another approach is automated flow of communication among constituent of the electric grid and their Integrations.
- Computerized controls for division and repairs.
- Enhanced organization management dashboards and decision support software

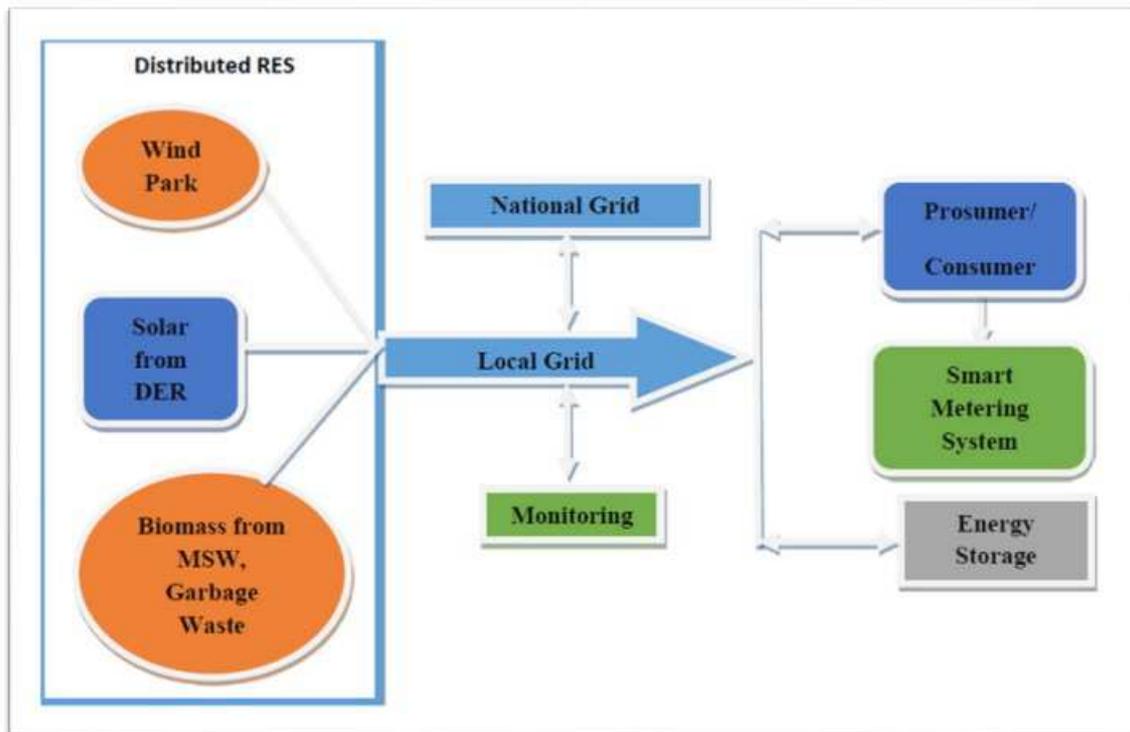


Figure3: Block diagram of smart grids

RES, DER and MSW stand for renewable energy source, distributed energy resource and municipal solid waste respectively in figure 3.

The important benefits related with the smart grid include:

- Electricity flows of transmission are much more proficient.
- When power disturbances of electricity arise smart grids approach gives quicker resolution.
- Smart grid approach provides minimum power and operation cost for consumers.
- Reduced peak demand, which will also help lower electricity rates.
- Improved bonding of customer-owner power generation systems, counting renewable energy systems
- Enhanced the security feature.

Challenges of smart grids

Although smart grid has numerous profits still there are lots of challenges in its achievement. Smart grids occupy a lot of stakeholders who are in charge of dissimilarity aspect of the energy system and sorry to say, the synchronization and rate of adoption of the novel tools happens at diverse paces. The vast investments required for together the infrastructure and new devices are also a hurdle to adoption. Lastly, regulatory obstacle and jurisdictional topic issues present important challenges that must be overcome.

Conclusion

From literature studies, it is revealed that most of the researchers concentrated their experiment on smart grids using artificial learning and machine learning methods. Still it is a challenging factor for all. Therefore a novel enhanced model has been adopted based on deep learning to solve more complex problems of smart grids which have not been yet solved by machine learning methods. By increasing the number of layers in the well-known artificial neural networks, nowadays we are referring to deep neural networks as the principal direction in deep learning. This algorithm has immense application potential in case of smart grids but researchers are still struggling on their studies on deep learning techniques due to many hidden layers are included in this algorithm. Numerous problems required to be studied in deepness, for example, for a specific use case which structure of deep learning is preferable and how many layers are appropriate for the particular problem and also concentrate on security of power system.

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Education is the passport to the future, for tomorrow belongs to those who prepare for it today. – Malcolm X

The roots of education are bitter, but the fruit is sweet. – Aristotle

Education is what remains after one has forgotten what one has learned in school. – Albert Einstein