DEEP LEARNING IN TOURISM

(Encyclopedia of Tourism Management and Marketing)

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Definition of deep learning

Deep learning (DL) is a class of techniques that analyze data through successive layers which are increasingly deep. The first steps of the analysis are superficial, and allow the identification of simple observable characteristics in the data. These results are then used as inputs for the next layer. The pattern continues until the system achieves a complete interpretation of the object or situation. Each of the layers is generally composed of a series of very simple mathematical models. In this way, DL mimics the way that the human brain works, as a series of layers of neurons in the cerebral cortex (Sejnowski, 2020). DL is a technique that comes very close to the way that humans learn which enables the technology to process raw data in natural form directly (LeCun et al., 2015).

For example, in video processing the initial layer may be involved in identifying the edges of the objects in each frame. This is called the visible layer, since it is based on characteristics that are observable in the input (Goodfellow et al., 2016). The intermediate levels will then try to identify the objects and their movement in each frame. Last, the final levels will attempt to understand what is going on in the video clip. The intermediate and final layers are called hidden layers (Goodfellow et al., 2016).

DL is a type of machine learning method. DL works best under two conditions: first, having access to very fast and powerful machines, that is, computational power; and second, having access to massive amounts of data. Attempting to computationally imitate the human brain is not new. The idea of artificial neural networks, or simply neural networks, has been around since the 1940s. However, it is the current combination of computing capabilities and data that have allowed DL to progress significantly in recent years. DL can be useful for many challenging tasks, including automated translation, autonomous driving, and robots walking on irregular surfaces. DL has also been around for decades –since the 1980s– but the lack of massive data and computational capabilities significantly limited its effectiveness at that time.

There are several areas in which DL can be applied and in which DL has achieved great advances (LeCun et al., 2015). These include vision, text analysis, speech recognition, language processing, and pharmaceuticals, among many others.

Use of Deep Learning in tourism management and marketing

DL can be used in tourism management and marketing in areas in which large amounts of data must be analyzed. For example, in image and video processing to recognize patterns in order to improve recommendation algorithms (Zhang et al., 2019; Sertkan et al., 2020), for forecasting tasks (Law et al., 2019), to automate real-time translation processes, and to prevent fraud in payments while traveling, among many others.

More specifically, DL can aid in management tasks such as processing comments made in eWOM in natural language. It is quite common to find hotels with large number of online comments, in some cases approaching 10,000 reviews. Machines are well-suited for the tasks of reading and extracting valuable insights from these comments.

Additionally, DL can improve destination management. Currently available and future sources of data will allow each destination to collect large datasets containing all of the activity taking place at the destination: behavior of tourists, traffic, water and energy consumption, activities taking place, etc. DL can help Destination Management Organizations (DMOs) to analyze these massive data sets.

Critical aspects, challenges, and opportunities of Deep Learning

There are four aspects related to the critical aspects and challenges of DL that are worth mentioning. First, as the definition suggests, DL requires significant amounts of quality data to work properly. Good quality data is what allows DL algorithms to learn and to improve. When these types of data are not available, experience shows that DL algorithms do not learn properly and tend to fail and make bulge errors.

Second, a challenge. Currently, DL is not aware and does not understand the context in which the learning takes place. In fact, the word “deep” references how the technology works, with multiple layers, more than to the fact that the system develops a deep understanding of what is going on. Thus, DL systems are not flexible. They are not able to adapt to even slight environmental changes. DL models are very good at providing solutions to very specific problems. But currently every time there is a slight change in the input conditions, the system needs to be retrained, which requires a great amount of computing power.

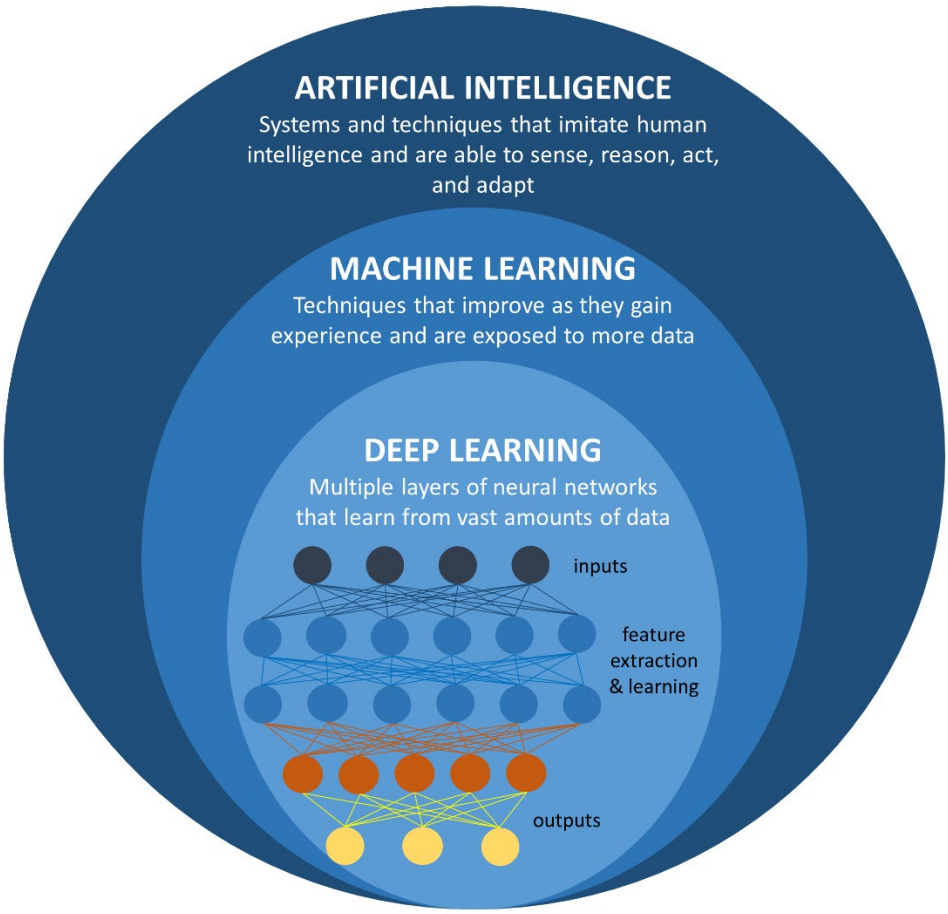
Third is another challenge. This one refers to transparency or explainability requirements. As DL neural networks start from bigger sets of data and include more and more layers, the possibility for humans to understand what is really going on inside the “black box” becomes more difficult every time. It is almost impossible to understand how a DL system arrives at a certain conclusion.

Finally, as with all AI systems, DL systems are subject to biases that must be carefully addressed. In fact, DL systems start with data which has usually been categorized by humans. Thus, biases in categorization will likely be present, and those biases will then be amplified by the DL system. Connected to the third challenge mentioned above, if the DL system is not transparent and explainable it will be extremely difficult to detect these biases.

Future developments

DL has many promising uses. It is expected to be able to do everything required from technology (Geoff Hinton, cited in Hao, 2020), especially as new conceptual advances emerge. Current systems are still 1,000 times smaller than the human brain, which means there is still a long path ahead. Presently, DL is trained through supervised learning. However, it is expected that unsupervised learning –the way in which humans and animals learn– will become more important in the future, thereby allowing systems to understand the environment by themselves (LeCun et al., 2015). Thus, it is expected that DL will be able to help systems develop common sense and support the complex social interactions of machines (Sejnowski, 2020). It might also contribute to the development of general AI. Another area of expected future development of DL is related to its general availability to everyone. It will likely be integrated into all types of devices.

Summary figure



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