CONNECTIVISM – A BREAKTHROUGH FROM THE TRADITIONAL LEARNING THEORIES

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Connectivism is a theory of learning developed by George Siemens and Stephen Downes described as learning theory for the digital age. It describes network learning and is a marked departure from earlier theories including behaviorism, cognitivism and constructivism. Connectivism represents the modern learning environment in which the Internet plays an important role. This calls for a redefinition of the learning paradigm. The present paper discusses some of the basic knowledge-related processes from the network model and tries to show how the principles of connectivism apply. The paper also argues for introducing metalearning skills as a part of regular curriculum.

Keywords: Learning theory, Network model, Connectivism, Curriculum

INTRODUCTION

Connectivism is a theory of learning developed by George Siemens and Stephen Downes. Siemens describes it as a learning theory for the digital age (Siemens, 2004). A major difference between connectivism and earlier theories like behaviorism, cognitivism and constructivism is that while these theories solely dealt with learning by individuals, connectivism includes within the purview of learning, the learning by individuals, machines, groups, organizations as well as other systems (Siemens, 2006). In the present-day society, widespread use of technology has precipitated an explosive growth of knowledge. The rate at which knowledge gets obsolete is very rapid. Thus as described by Gonzalez (2004) the half-life of learning is becoming shorter and shorter.

According to Siemens, connectivism as a learning theory has emerged through the integration of principles explored by Chaos, Network, Complexity and Self-organization theories. Learning has been defined as a change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth (Gagne, 1985, p. 2). Thus learning can be identified with actionable knowledge. This knowledge can not only reside in the minds of people, but also outside in the form of databases, organizational knowledge, intelligent machines, system functioning, as well as in other formats. According to Siemens (2004) connectivism is driven by the understanding that decisions are based on rapidly altering foundations as new information is continually being acquired. The need of the day is to distinguish between the important and the unimportant so as to cope with and meaningfully contribute to the new technological society. "Know-how" and "know-what" are being supplemented today with "know-where" (an understanding of where to find the knowledge that is required in the given situation). Furthermore, metalearning (learning how to learn) is becoming just as important as learning itself (Connectivism in Wikipedia, 2010).

Siemens views connectivism as a learning theory. A learning theory basically describes how learning takes place. But I find connectivism as more of defining a new learning paradigm. It is required to be expressed in a manner useful for applications. As a descriptor of the characteristics of modern technology-based society, connectivism is quite relevant and should be explored further. Today the process of learning is being transferred more and more to machines as they are getting smarter, and more and more knowledge is residing in soft format within the computer networks accessed by the Internet. Knowledge today lies distributed in the form of databases within machines or in the form of collective knowledge within organizations, which is able to fulfill its tasks although no single component has complete or even sufficient idea of the know-how. These phenomena of collective learning and machine learning have remained unaddressed in the earlier learning theories because they were created before the era of widespread networking of knowledge (Mohamed, 2008). One of the aims of the present paper is to describe the ideas inherent within connectivism in more concrete terms in relation to basic network concepts.

PRINCIPLES OF CONNECTIVISM

According to Siemens (2004), the principles of connectivism are the following.

— Learning and knowledge rests in the diversity of opinions.

— Learning is a process of connecting specialized nodes or information sources.

— Learning may reside in non-human appliances.

— Capacity to know is more critical than what is currently known.

— Nurturing and maintaining connections is needed to facilitate continual learning.

— Ability to see connections between fields, ideas and concepts is a core skill.

— Currency (accurate up-to-date knowledge) is the intent of all connectivist learning activities.

— Decision-making is in itself a learning process.

These principles are stated here in their original form. I will try to elaborate some of these ideas and explain them with reference to the context. These points have to be understood in the context that connectivism is a learning theory for the networked environment. Connectivism includes internal learning (learning by persons) and external learning (databases, organizational knowledge, intelligent machines and larger systems). To be able to describe learning at this scale, it is necessary to define it in a broader sense.

Learning extended to machines and systems

The definition of learning given above by Gagne, as well as most others, deal exclusively with human learning. In the present context we need a definition that would apply to individual human beings, machines and for collective behavior as well. Learning has been defined in various ways. "Learning is acquiring new knowledge, behaviors, skills, values, preferences or understanding, and may involve synthesizing different types of information. The ability to learn is possessed by humans, animals and some machines" (Learning in Wikipedia, 2010). Learning has also been defined in more general terms as "a process of adaptation by which a set of adjustable parameters is automatically modified so that some objective is more readily achieved". In complex systems these parameters can be both tangible and intangible. Learning essentially involves steps that a human being or a machine or a system takes for adapting to new situations, needs and goals.

Connectivism accepts the growth and redefinition of knowledge in the present-day scenario and talks about strategies for coping with it. The growth of human knowledge is taking place in a non-linear and uncontrolled fashion. Every new fact has to be integrated with the already available knowledge in a meaningful way. Sometimes the rate at which new information is being generated exceeds the rate of assimilation. Strategies for coping with the situation have to be developed. For instance it is not always possible to learn everything that you require. But you should know where to look for the required information or knowledge and how to assimilate it for your own purpose with a reasonable amount of effort. Models for describing different information processing activities that can be used for human as well as machine learning are also needed and are a pre-requisite to proper understanding of the connectivism paradigm.

A common knowledge metaformat

If learning is to be considered as a cross-platform activity including humans and machines or systems, then a common knowledge-format (or metaformat which can be translated into different system-specific formats) is a necessary requirement.

Implicit in connectivism is the assumption that knowledge can be usefully represented as a network. The network representation has been used effectively for linguistic research (Briggs, 1985). The use of Semantic nets in education in the form of concept charts has been gaining popularity of late because of the convenience and concreteness it provides to the knowledge (Novak, 1990).

Knowledge representation in a network

The network model is a very flexible and versatile model which is almost universally accepted as a good representation for knowledge of various types. Knowledge representation in the mind (Matlyn, 1995) is quite complex, nevertheless one can model it in terms of networked entities. For working with knowledge-bases on the computer a network representation can be quite convenient (Russell & Norwig, 2003). By representation I mean a convention for expressing a given body of information and defined by a set of rules. The concept charts as described by Novak and others (Kharatmal & Nagarjuna, 2009; Novak, 1990; Sowa, 2006) also use network model which is, incidentally, becoming increasingly popular as a versatile educational tool. The network representation appears to be the basis of natural communication languages also. For instance, Briggs (1985) has shown Sanskrit to be a semantic net based representation for knowledge. Due to its flexibility and versatility a network representation can be considered as a good representation of knowledge common for humans as well as within machines. It is versatile enough to be useful for larger systems also. A brief description of the essential network model is given below.

Network model in brief

A is any physical or mathematical entity with an internal relational structure. It consists of two basic types of elements: a node and a link. A node is a representation for an object or entity of any form and a link represents a relation between two nodes. A network is a set of nodes interconnected by links. In the network model considered by Siemens, the links can have various characteristics and can vary in strength (Siemens, 2005). Strong associations are represented by strong links and weak associations by weak links. Networks that describe mental images or situations should also contain besides entities and relations, attributes that qualify or describe entities or relations.

For extracting specific information from a network one can use various filters or masks. The usage of filters or masks will be described in a section below. Thus we can describe a network as a structure having following elements: (1) node entities, (2) relations, (3) attributes. Mathematically attributes are not essential to a network but they are useful in language descriptions. A set of linked entities can be described to form a layer within the network. A knowledge base can consist of one or more networked layers. Figure 1 gives a schematic representation of network elements. It shows a pair of entities (nodes) interconnected by a relation (link). The entities as well as the relation are shown with attribute specifiers. Figure 2 shows schematically a network layer as consisting of several nodes interconnected by links. To avoid cluttering the attribute, specifiers are not shown in this figure.

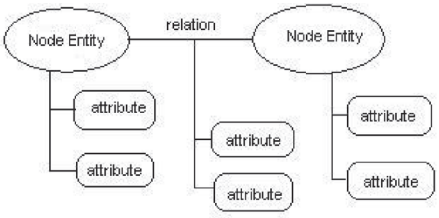

Figure 1: Network elements

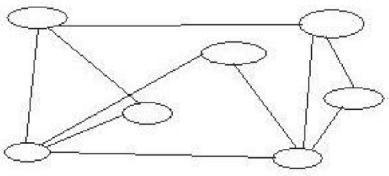

Figure 2: A network layer showing nodes and links

Network application in language

As an example let us see how network model applies to grammatical structure. (I have deliberately simplified the structure to show only the essential elements. More complete representations can be found in textbooks such as Russell and Norvig, 2003). The network model forms the basis of language descriptions. Remarkable work has been done in the past in the form of the grammar of Sanskrit which has been shown by a number of language scientists to have a very well formed semantic net structure (Briggs, 1985). A sentence is a unit consisting of a relatively simple interconnection of network elements. For instance in the sentence "That boy ate a ripe mango yesterday" the words "boy" and "mango" can be considered as node entities, "ate" is a relation, "That" is an attribute qualifier for "boy", "a" and "ripe" are attribute qualifiers for "mango" and "yesterday" is a qualifier for "ate". Grammatically, nouns and pronouns consist of node entities, verbs are relations, and adjectives and adverbs can be considered as attribute qualifiers. This is a simplified network description of any grammar in its bare form. Sentences can be put together in a serial form to construct passages that describe a given topic. A passage can be constructed to represent more complex networks.

Communication of knowledge through language

Some of the basic aspects of what is communicated in any interaction through language have been described in Patanjali's Yoga Darshan. Let us first see what the primary object of communication is. There is a fleeting stream of mental images forming and continuously changing in every one's mind. These mental images can be broadly classified into two types: Images based on factual information (leading to knowledge) and images that do not have any factual basis. (fragments of imagination leading nowhere). Patanjali has mentioned five types which can be put into either of these two categories.

Communication is the process of sharing knowledge representing mental images carried out by one mind with another. Now, strictly speaking, mental images are personal in nature and cannot be shared. Then how is communication carried out? In communication process, a copy of the mental image of one person is transmitted to another person through the use of a language, either verbal or written (Narayan, 2009). This is possible only if it is first converted into a semantic net representation and then transmitting the elements of that representation serially. It is received by the receiving person. The received network elements are recompiled at the other end for reconstruction of the mental image as an approximate copy.

Knowledge is not always just mental images. Often it consists of correlated information extracted or generalized from mental images. Such knowledge is more complex but this can also be expressed in terms of semantic nets and communicated through language. The encoding is done in terms of language through the processes of abstraction and generalization. Language elements (words, sentences, passages, etc.) are semantic network elements which act as descriptors of mental image. codes are constructed so as to conform to the of our sense organs, i.e. through sound pattern (voice) or visual pattern (writing & reading) or spatial touch pattern (e.g. Braille and Stephen Hawking's computer), etc. The limitation of sense organs forces one to represent a network in symbolic format as an array of network elements. These are transmitted through a linear sequence either orally, or in written form (text) or in any other electronic form. (An exception is the transmission of pictures). Thus, according to Siemens (2006) language forms a conduit for communication of mental images, representing concepts between different minds.

Filtering useful parts of knowledge

Various operations can be done on knowledge networks for different information retrieving processes. For example, knowledge in the mind exists as a jumble of entities and relations in various strengths. Some relations exist in form of

strong links while most exist in the form of weak links. Learning consists to a great extent, of filtering the useful from trash. This filtration process can be represented in the following manner (Figure 3).

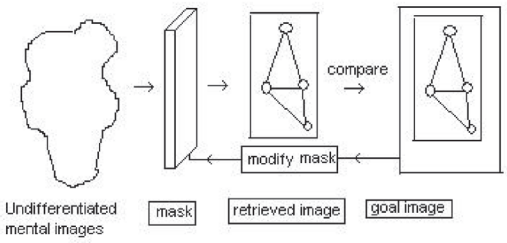

Figure 3: Filtering and retrieving desired information

Figure 3 illustrates the process of information from a database or an undifferentiated mental image. We start with an undifferentiated mental image and apply a mask to it. This mask contains a representation of the kind of information we are looking for (goal image). Once we apply a mask and get a partial match, we check with the goal image whether it is this that we were looking for. If it is not, we readjust the mask specifications and again apply the mask. This process of refining the mask and checking whether the obtained match is satisfactory or not is iteratively repeated until a satisfactory match is retrieved. Each time a successful match is found the corresponding links are reinforced. This ultimately results in a well-defined network representation of the mental image.

Connectivism from Viewpoint of Network Representation of Knowledge

Let us now examine the principles stated by Siemens in the light of the above network model.

(i) Learning and knowledge rest in the diversity of opinions. The process of cognition and learning consists of starting with a relatively fuzzy mental map and successively refining it until the desired sub-map is recognized. This process has been illustrated in Figure 3. When there is a large diversity of opinion, it means that there is a large variety of undifferentiated data to be processed. In general, this will imply that the probability of getting a "hit" or an answer to our specification is better. So the scope of learning and acquiring knowledge of the right kind improves.

(ii) Learning is a process of connecting specialized nodes or information sources. Learning consists of acquiring knowledge that causes change in responses in a relatively permanent way. Human learning will change human response while machine learning will change the response of machines. This change of response takes place when new response patterns which are better options than earlier ones are recognized through analysis. This process is escalated by the discovery of new information sources and recognition of new options for solution of the problem. So whenever one feels need to learn new patterns of response one looks for new sources of information.

(iii) Learning may reside in non-human appliances. When knowledge and learning are not limited to the individual minds, then physical information storing devices together with suitable search schemes and search engines become extensions of the human mind. Machine intelligence is not a far-fetched concept today. Thus not just knowledge, but the capacity to learn can also reside outside the human body boundary.

(iv) Capacity to know is more critical than what is currently known. In the present age of rapid change in technology much of knowledge acquired by a person gets obsolete and to stay abreast with current changes the person has to continually acquire newer knowledge. A person with better capacity for learning as well as unlearning has better staying capacity in the modern world. Many employers today do not much care about what their prospective employees have learned. They are more concerned about whether they have sufficient adaptability for newer knowledge. Thus meta cognitive skills and meta learning has become as important as learning itself. This implies that learning how to learn should become a necessary theme in education. Connectivism demands more efficient ways of sifting through and mining for required knowledge.

(v) Nurturing and maintaining connections is needed to facilitate continual learning. In the present era of tremendous information and knowledge explosion it requires special technologies and effort for maintaining knowledge bases and making knowledge practically accessible so that one may not have to spend illogically large amount of effort and time in locating and deciphering desired knowledge. Available knowledge bases have to be nurtured continuously, by adding, editing, updating and removing obsolete parts.

(vi) Ability to see connections between fields, ideas and concepts is a core skill. Filtering out useful knowledge from a knowledge base available in the form of books, papers, web pages, or in other forms is a meta learning skill that has to be learned and practiced. Such skill becomes especially important in today's information age.

(vii) Currency (accurate up-to-date knowledge) is the intent of all connectivist learning activities. A person who is not up to date in knowledge is likely to be left out in the age of rapidly changing technology. So in the connectivist paradigm special effort has to be made to keep up-to date in knowledge. This is made possible because of the availability of better technology related to information and knowledge maintenance and retrieval.

(viii) Decision-making is in itself a learning process. Decision making is based on acquiring the right information and making right choices. Every such instance empowers the person or group for making better decisions in future. So decision-making is a learning process.

Connectivism Versus Other Learning Theories

Let us see where connectivism stands in terms of other principal learning theories.

Aspect	Behaviorism	Cognitivism	Constructivism	Connectivism
Learning process	Focuses on observable outcomes	Focuses on internal mechanism modeled similar to computer	Concept formation as construction in mind from given inputs	Recognition of useful patterns in a distributed network
Factors influencing learning	Stimuli, Rewards & Punishments	Previous experience, pattern of sensory inputs	Participation, Previous experience	Diversity of network, strength of ties
Approach	Black box approach: No attempt to understand mechanism	Modeling of human cognitive process on basis of observed behavior pattern	Learner centered, s reconstruction of situations from available input	Based on network representation of knowledge, adaptive learning
Where does learning reside	Individual's mind	Individual's mind	Individual's mind	Individual as well as in network
Types of learning explained by the model	Task-based learning	Reasoning, problem solving, concept formation	Spontaneous learning, Creativity	Adaptability to new situations, complex learning, concept formation

Table 1: Principal learning theories

Metacognitive Skills for Connectivism

Connectivism as a learning paradigm is closest description of the present day digital information environment. There is an explosive growth in easy availability of information through the internet. The nature of available information and its utility value is also changing rapidly. With the assurance that you can retrieve whatever information you need at any desired time, it is not even necessary to learn everything. You must know how and where to obtain relevant information. Some metacognitive skills such as internet browsing have been introduced in the curriculum formally as well as informally. In my opinion, this is not enough. Some other skills should also form a part of regular curriculum. Concept maps (Novak, 1990) are network based representation of learning material which are useful in teaching as well as learning. They help in consolidating your knowledge. Use of concept maps should be encouraged. Rather, the students should be well versed in use of concept maps. Framing the right question is another skill that needs to be practiced. You can save a lot of searching time if you have framed the right questions. Keyword recognition, summing up a situation, search and match are some other metacognitive skills that can greatly enhance the effectiveness of learning. It is not a common practice nowadays to teach how to learn, but there are a number of very useful metacognitive skills and if they are introduced in the regular curriculum, I believe there will be a visible change in their proficiency.

Criticisms

There have been several criticisms of connectivism. Verhagen (2006) has argued that connectivism is not a learning theory but merely a pedagogical view. Another criticism has come from Kerr (2007) who has argued that the earlier theories are altogether sufficient for describing learning process. Siemens has given a detailed answer to Verhagen's comments in his paper (Siemens, 2006).

Conclusion

In this short discussion I have attempted to show the following points. (1) Connectivism is a theory that reflects a shift in paradigm in tune with the new technology-based society. (2) Connectivism can be better appreciated through basic knowledge about network theory of knowledge representation and (3) Navigation through a networked world can be made more effective if certain important metacognitive skills (learning how to learn in the connected world of knowledge) are taught as part of the regular curriculum.

Connectivism has been called a new learning theory for the digital age. That the idea of connectivism has been criticized and ridiculed is understandable. Connectivism is a new theory that expands the domain of learning to cover machines, groups and larger systems. Its elements are not new but the present digital era has made them more relevant. It is in tune with the expanding horizons of the new technological society. In this paper I have attempted to discuss some of the concepts incorporated in cognitivism in terms of network theory of knowledge representation and have shown that the theory makes sense. Since it is a relatively new theory a lot of points need to be resolved before it is brought into a seamlessly usable form. The dynamics of knowledge in a distributed set up needs to be understood better. It is rather interesting that technological advances have practically forced us to adopt its

ways even while debates, arguments and counterarguments are being pursued. This shows the solidarity of this theory and although I am doubtful whether to call it a learning theory or a learning paradigm, like most people of the present generation, I am using the modern tools of learning and being benefited by it. In my opinion time, is ripe for this change in paradigm and further study along this line should be seriously undertaken.

What is its relevance to India? India is on the path of growth and we are fast adapting to the new digital age. Our school education system is undergoing a number of changes related to teaching methods, curriculum, examination patterns and so on. The National Curriculum Framework, NCERT (2005) is based on the constructivist approach. But we need to go ahead. I feel that in the not so far future we will need to integrate in our system of education a connectivist learning paradigm. But before that, a lot of ground work needs to be done.

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