Connectivism theory | an analysis

The connectionist models of cognitive science are a part of the movement that focuses on explaining the abilities of the human intellect using artificial neural networks, also known as the neural nets (Garson 1997). These nets are models of the brain, simplified and composed of numerous analog units (in place of neurons) coupled with certain weights (in place of synapses) that are used to measure the strength of connections between the units. Experimentation using models of this kind has led to a revolution in the field of cognitive science encouraging attempts to provide viable alternatives for the classical theory of the mind (Feldman 1982). The model follows neuro-anatomy very closely making it extremely useful in understanding the cognitive functioning of human beings (Harre 2002).

While the classical theory of the mind firmly holds that the human mind resembles a digital computer with its own processing language that it uses to process data (Garson 1997), connectionism claims that " cognition is a high-level, emergent phenomena deriving from the interaction of a large number of smaller, individual components" (Blaylock 2008). There have been widespread debates over the relative efficacy of the schools of thought, and both the models have their advantages and drawbacks. The advantage connectionism has over the classical theory or the language of thought(LOT) is its close relevance to neurology, which makes it easier to understand the human mind (Gardenfors 1996). But, at the same time, Green (1998) points out that the connectionist model is not as structured as the language of thoughts model and has a number of short-comings.

Advantage – Connectionist model of Cognitive Science

Connectionism is promising to provide a better understanding of the cognitive behaviour than the classical theory because of its association to neuro-science and ‘ how’ and ‘ how much’ change will be brought about has been a matter of great debate in the neuro-scientific circles (Garson 1997).

The experiments on the connectionist models of cognitive science have demonstrated ability to pick-up things and learn skills such as reading, structure of simple grammar in language, and face recognition (Garson 1997). These experiments have been possible due to the close proximity of the models to neurology, unlike the language of thought, which concentrates of theoretical interpretation of ideas.

The model uses a large number of units representing neurons connected together by weights representing the synapses to connect the neurons together. The weights can successfully link one unit to another like neurons. This significant similarity to the actual brain gives cognitive models an edge over other traditional theories. The use of connectionist models over the classic theory has many relative advantages and deals with issues like stability, sequence problems and sensitivity (Feldman 1982).

Due to the close relevance to neurology, the information processed by this type of model for the cognitive functioning turns out to be much more reliable and much more fundamental. It is a huge advantage as the theory of conceptual spaces can highlight the philosophical implications of neuro-scientific research in this particular area. The classical theory thoroughly focuses on the understanding of a different processing language of a mind that takes care of all the cognitive functions.

The relevance of the connectionist model to neurology has been widely discussed. Scien and Cottrel (1996) have claimed that connectionist models definitely have a neurological appeal. Cangelosi (2006) has described how the connectionist models consist of the neural networks, which are capable of acquiring categorical perception representations during learning tasks. These representations are further used to ground the meaning of discrete symbols, and performing tasks related to symbol manipulation (Cangelosi 2006).

Rumelhart and McClelland (1986) cited in Garson (1997) have affirmed that philosophers and constructivists are interested in the neural network or the connectionist model as these may lead to a better understanding of the mind and its relation to the brain.

Neurology or neurological sciences are inevitable means of understanding the human brain biologically and psychologically and the connectionist model seems perfectly matched to it (Garson 1997). The brain actually resembles a connectionist model of a neural net where instead of numerous units and weights, neurons and synapses form an intricate network. The functioning of the connectionist models has been found to be similar to that of the network of the brain and there is a possibility that these models may give the actual picture of cognitive processing (Garson 1997). At the same time, the LOT is hypotheses about the nature of thought process rather than its structure; therefore, it may not be accurate and appropriate to other aspects of the brain apart from thinking (Ayedede 1998).

LOT has not been able to explain the nature of some cognitive phenomena such as “ experience, qualia, sensory processes, mental images, visual and auditory imagination, sensory memory, perceptual pattern-recognition capacities, dreaming, hallucinating, etc” (Ayedede 1998). A random generalization made by the theorists supporting LOT is that if LOT doesn’t explain the process of cognition, something similar will (Ayedede 1998). Neural Net on the other hand is more appropriate, although it may not be totally accurate at times. Neural networks are known to be very flexible and robust in facing challenges but there is evidence that the models face problems in artificial intelligence. Although connectionist models can also use the existing knowledge base from AI systems, and can handle clinical problems safely, there are certain drawbacks (Tuhrim et al., 1994). Connectionists argue that neural networks provide a much more natural mechanism for dealing with such problems (Garson 1997).

Disadvantage of connectionist models of cognitive science-

The connectionist models have a lot of potential for the research into the cognitive panorama but there are certain drawbacks, which can be debated in relevance of the classical theory. The systematicity debate over the LOT and the Connectionist models of cognitive science has been around for more than a decade now. With the evolution of this debate, Fodor and Pylushyn’s challenge has become the benchmark for the two theories/models (Garson 1997). And, it has come as a surprise that no one has been able to meet the challenge of providing neural network, which is capable of learning complex processing that can be further generalized to a full range of novel inputs (Garson 1997).

The arguments put forth in LOT are very convincing as they are accompanied by systematicity. In a connectionist model, the weight and the internal patterns create a restriction in the power of the net even with superposition (Harre 2002). The net has to be trained again and again for every subsequent output. Moreover, amending the weighs during retraining can possibly diminish or destroy the power of the net in order to make the original correlations that it was originally instructed to perform (Harre 2002). On the other hand, a brain keeps on learning and storing. “ The brain is a cumulative learning machine” (Harre 2002).

Ultsch (1998) stated that connectionist models were sub-symbolic knowledge representations and the main criterion for such a representation is that no single element has a meaning by itself. So, omission of one unit doesn’t disqualify or shutdown the whole unit, but rather it shuts down very gradually, which may seem improbable from the point of view of computer science. Moreover, whether connectionism can provide an appropriate and new ways of understanding the human mind has also been a controversial point of debate (Garson 1997). This has forced the claim that the connectionist models are only good at processing associations. Like Greene (1998) stated that connectionism is only true as an implementation theory, otherwise it is “ empirically false as a theory of cognitive architecture.”

One of the main problems recognized with connectionism is that the information received is too rich and simple (Gardenfors 1996). This information is highly unstructured and there is a need for a transformation of organisation of the input data to a form that can be processed at a linguistic level. The ability to transform the data as and when needed gives connectionist networks the flexibility. Green (1998) has enthused that this flexibility may be a little too much to call it a good theory. Embarking on Fodor and Pylushyn's criticism, (Green 1998) has stated, " They either fail to explain the law-like cognitive regularities like systematicity and productivity in an adequate way or the connectionist models are nothing but mere implementation models of classical architectures; hence, they fail to provide a radically new paradigm as connectionists claim." Garson (1997) has further claimed that systematicity may exist in connectionist architecture, only as a lucky accident and that the classic solution is better as pervasive systemacticity comes naturally with the classical theories.

Johnson (2004) cited in Garson (1997) has stated an argument that the debate of systematicity is misguiding and that any attempt at defining the systematicity of language or cognitive processes would give us falsehoods. Johnson has suggested the development of neural nets that can process a language with ' recursive syntax', which would react instantaneously on the introduction of a new item into the lexicon.

Fodor and Pylyshyn (1988) cited in Aydede (1998) have stated that cognition has properties of systematicity and inferential coherence and that it can only be represented in a linguistically structured system. Garson (1997) has argued that some can argue against the connectionist models stating that the model is inadequate or that it is not able to explain what it must. Hereby, the LOT is the only model of cognition that is computation and thereby, appropriate. Fodor and McLaughlin (1990) cited in Aydede (1998) have argued that connectionist models are not systematic but can be trained to be systematic. Since there is no guarantee for systematicity, systematicity in the human cognition can't be measured either. And at the same time systematicity is a part of the classical models, which are well structured and coherent.

Garson (1997) has argued that the nets can be made to do anything one wants, including recognise systematicity, but it cannot be done without implementing the classical symbolic processing. So, the connectionist models can account for higher cognition; they cannot do it without the implementation of the classicist's symbolic processing tool. Ayedede (1998) has supported the statement by asserting that connectionism supported by classical theoretical processing tools will always succeed, rather than just an individual connectionist model of cognitive science. " Implementational connectionism may succeed, but radical connectionists will never be able to account for the mind" (Garson 1997).

Conclusion

The connectionist and classical symbolic models may seem to differ on more than a number of factors, but both the approaches work unilaterally to achieve a synthesis of the two apparently different paradigms (Sun 2002). Analysis at a very extensive level studies and analyses of the connectionist models reveal relationship to classic symbolic models (Smolensky 1988). Although there can be a deviation in the performance due to the fact that the result can only be achieved by satisfying soft rules and not the hard rules, the two apparently different models of cognitive science can combine to bring out a clear understanding of cognition (Smolensky 1988).

More and more researchers (Ultsch 1998; Lange et al., 1987) are of the view that connectionist and symbolic methods should be combined to achieve significant advances in understanding human cognition (Sun 2002). Such integration of the two may be referred to as a hybrid approach that takes representation and techniques from both the models to solve problems efficiently (Sun 2002.). Cangelosi (2006) have also supported the statement by stating that hybrid models are ideal for solving the symbol grounding problem. Spratling (1999) explained that humans have the tendency to make use of deliberative behaviour, and therefore, it should be easily perceived that human behaviour is a concoction of external stimuli and internal cognitions.

Both the approaches have their advantages and disadvantages. An effective hybrid or synergy of the two approaches would be recommended so that the conversion of knowledge from sub-symbolic to symbolic and vice-versa can be achieved, which in turn would be better than any other individual model of cognitive science.