Higher Level Intelligence in Machines

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Abstract

There has been a large number of studies in neurological sciences on how human brain works, especially in reading and parallel information processing. So I think this statement is really sweeping. Perhaps it is better to knowledge the abilities of human brains and to comment on the limitations of the human brain. The book "Adapt" by Tim Hartford advocates micro-step changes. An important aspect in this area is to understand the processes involved behind the scenes so that it gives us a better formulation of the creativity algorithms involved. I will try to put in some pointers on the depths to which higher level intelligence has been simulated by AI in the past years. Some of the higher level intelligence mechanisms such as creativity, dreams and logical thinking have been implemented in machines in certain ways. However, they are still not implemented in the way humans do the same. The exact mechanism in which these intelligence mechanisms are used by human brains is still way ahead of that done by computers. However, we now look at other aspects in them as well as other functions which might be explored in the years ahead in AI.

There has been a large number of studies in neurological sciences on how human brain works, especially in reading and parallel information processing. So I think this statement is really sweeping. Perhaps it is better to knowledge the abilities of human brains and to comment on the limitations of the human brain. The book "Adapt" by Tim Hartford [22] advocates micro-step changes. An important aspect in this area is to understand the processes involved behind the scenes so that it gives us a better formulation of the creativity algorithms involved. I will try to put in some pointers on the depths to which higher level intelligence has been simulated by AI in the past years. Some of the higher level intelligence mechanisms such as creativity, dreams and logical thinking have been implemented in machines in certain ways. However, they are still not implemented in the way humans do the same. The exact mechanism in which these intelligence mechanisms are used by human brains is still way ahead of that done by computers. However, we now look at other aspects in them as well as other functions which might be explored in the years ahead in AI.

Before I start putting my pointers, please note the predictions by AI eminent experts such as Rodney Brooks and Ray Kurzweil that computers will become more and more integrated with humans in almost all walks of life. Does that imply that they will have the kind of thinking in their "brains" which we can refer to as human-like? Perhaps the real question is – what is human? Can you consider a swarm of bees constructing Does that imply that they will have the kind o Does that imply that they will have the kind of thinking in their "brains" which we can refer to as human-like thinking in their "brains" which we can refer to as human-like temperature controlled bee hive under the glare of afternoon sun as being creative? But certainly we do not expect a bee to have enough intelligence to buy food. Is it possible to have a robot like Bumblebee from the Transformers movie? Can we have a robot that can reflect and express sentience in a similar fashion? The word "Watson" gives two meanings in today's world – Prof. James Watson and the other being the IBM Supercomputer.

I will devote a substantial paragraph to review the latest research in this area. So the question is: "How can we define creativity in terms of mathematics and logic?" Well, creativity may be defined as the ability of the brain (and/or the organism) to display novel behavior. It is the tendency of the organism to behave, think or generate novel ways of interaction with the environment. In a fascinating development, IBM researchers have created a computer with a brain. Wouldn't it be nice if they could behave just like humans?

Creativity in machines has been explored by many experts over the past few years. Again, I will review some of the latest work in this. We have algorithms that can help us define creativity mathematically to an extent. The algorithm mentioned below might give you a simple idea of creativity. The concept of creativity has been studied in machines for a long time now. Boden [13] defined creativity in terms of changes in representation of the scenarios in the mind (or the owner of the scenario at the system level description). She also categorized creativity [11] as P-Creativity (novelty with respect to the user only) and H-Creativity (novelty with respect to others as well. This can be considered novel in the outside world too). Ritchie [14] has summarized the factors that affect creativity with great detail. Can we consider a chess playing software to be creative since it can interact novelly with the players? It is an example of P-Creativity but not H-Creativity.

The efforts towards the practical implementation of creativity have also been quite noteworthy. In 1970's, the AARON computer program produced fascinating drawings that resembled and utilized the human mode of creativity. The JAPE program tried to implement humour generating model using AI [15] in machines. Again in 2008, the STANDUP program (which was based on the JAPE program in order to improve language skills development) was developed in UK for generating computational humour was made available for free by Ritchie and his team. Also, the work on automated melody generation [16] using AI was quite interesting as it used Case-based reasoning (CBR) and transformation operators to change the generated idea. Other interesting implementations of creativity included the poetry generator [17] and the automated concept formation [18]. Another interesting application was of story-telling [19] developed at IBM in 2008. Many of the methods for creativity is rule-based and utilizes a lot of AI for serving their purposes. The mathematical explanation of creativity by Ritchie [14] was indeed a stepping stone for AI in language understanding. Thus, provision of a complex object like the human brain to the computers will involve a generalization of the thinking functions to the level of infinity. These examples are just some of the huge number of applications which seem to improve decision-making and automated creation of novelty in modern AI based applications. These developments have opened new avenues in AI, language understanding, artificial general intelligence and robotics.

Let us take a simple algorithm to highlight the basic form of creativity:

1. Take thought Th1.
2. Search for Th2. Find another point Th3 that resembles Th2 in structure.
3. If yes, then proceed to 4), else goto end.
4. In this step:
   a. Loop through all the point objects in space(scope of vision)
   b. Match each object with the main point 4). Again, check in memory if this object already exists.
   c. Try to establish a network connection between the points.
   d. After the network has been created, check if it already present.
   e. Measure the quality of the network in terms of point d and connectivity.
   f. Retain all the details and send it to memory for storage.
5. Display the output to the user.

The above algorithm can be a simple trimmed down version of the P-creativity (psychological creativity) . However, if we add one more step before step 5 in the above, it will become H-Creativity (historical creativity). We can define this as:

6. Share and validate the details of the connection with the other entities (stakeholders)
7. If the solution is accepted and validated by the other stakeholders as true, then display the results to the user. Else, reject the same.

Please note that the above steps make up the H-creativity in the simplest form. They seem to be validating them with the other stakeholders and then sending the user the correct details only. Here, we refer to the results as being creative only as correct. However, do note that this is not a simple process. Consideration of the stakeholders and connections along with the validation of creative values is indeed a complex process. A simple way would be to compare the existing value with the available values of each stakeholder. If they are different, then this is a good candidate for creativity. However, there is another point to be noted here regarding the use of stakeholders and entities. There is no mention of entities that do not exist or which lie outside the scope or interest of the owner (of the scenario). These maybe existent or non-existent when the scenario is being considered. However, they maybe influencing the scenario in some mode. This is where the concept of unknown entities comes into picture. One very simple and common way is to make a forward estimation of these conditions by putting aside probabilistic values of entities (let us call them shadow entities) and then give some value based on the risk factor that the scenario can handle. This will help in not only in handling the code but also to reduce the risk in the application's ability to handle unexpected events.

Another point to remember in creativity for software is the depth-based or breadth based implementation of the validation step. In the former, we perform a more direct and deep (nesting based approach) to find the subsets in the given connection or entity and perform validation against them. This approach is very common and used widely for cases where the entity is small and not much is known. However, when the entity or connection is large and breakable into smaller sets, then we use a breadth based approach. Here, we tend to just move along from one direction to another from one part to another instead of cutting deeper into the entity or connection. Note that this line is sync with the approach used in getting creative ideas by many people. Some just investigate deeper into the existing entity or an object (such as biologists go deep into the cell in a microscope) and find new observations of the same (which have not yet been known till date). Again, others may just widen into something other than (like an if-else condition) to create a bigger or a wider representation of the entity or the connection (e.g. a painter creating a fictional painting).

Creativity and Software have an interesting relationship these days. In earlier times, software and creativity were in an inverse relationship. Software used to lack the innovation and always focused on transaction-based systems. Thus, creativity was very low. However, as times have passed and AI has improved, the manner of implementing the human function of creativity is also done in software systems. Cougar [20] has shown in five stages of how creativity can be embedded in to any information system. This includes problem delineation, information collection, ideation, evaluation, and implementation planning. The Genex model [21] is also similar to the above except for the donate phase which requires the code and the functionality to be shared with other users or systems.

Creativity is more of an extension of this basic thinking mechanism. The concept of creativity requires the permutations and combinations of the existing entities into new connections [4]. Thus, a combination involving 'NOT', 'AND','XOR','OR', etc. gets in very useful. The existing connections or entities may be given one or multiple of the above connections to create new connections (which ultimately lead to creative thoughts) .It is also possible the existing connections might be removed or modified to attain creativity in the above case. Thagard had argued on similar lines on creativity with a special emphasis on the [9]. Boden [10] also considered creativity into combination of novel representations of the existing scenarios. Thaggard and Steward also mentioned the presence of creativity in social and molecular mechanisms. This is interesting because creativity was considered within the scope of neural and psychological representations.

However, there is need to consider creativity in terms of non-existent entities. All the above theories seem to indicate the need of prior experience and the combination of them to create alternative scenarios that we can call as creativity. There is a need to consider non-existent entities as well in the context of creativity. We propose that in any scenario, there are 3 types of entities [4]:

1. Known entities
2. Unknown entities
3. Hidden entities.

The Hidden Markov Model (HMM) seems to be sufficient in handling hidden entities and known entities. However, they do not throw any light on those entities which are not known or which do not exist in the scenario. However, they do affect the scenario indirectly. Though they stay outside the scope of the representation, they do tend to exert influence on the possible representations of the scenario (A scenario is another name for representation of the entities). We need to consider those entities which we do not know about and which may exist and maybe influencing our representations, but they do not seem to be visible (known) or present (hidden) in the given representation. Such aspects might be the reason why intuition is still not achieved practically in machines though we know the concept in detail. Such aspects might be the next areas of research that we need to focus in the field of creativity in AI.

Let us also look at the issues of learning, cheating and evolution in machines. Just like self-assembly is the basis for cell development, there are complex thought processes in the human brain that are involved in thought development. Creativity is the function that is developed due to the interconnections between the usual, unusual and unexplored information. Such information is stored in the memory like scattered pieces. The work of the brain is to perform permutations and combinations that lead to distinct or unique information. In short, the brain customizes and processes existing data to produce new knowledge or new chains of existing knowledge. So, if we assume that the computers will think and be creative like us, will they replicate our actions with learning and evolution. However, these issues seem to be far distant but important to note. The reason is that we need to be careful about the possible implications of our own creations. There need to be some protocols that will help define the right from the wrong.

Creativity in machines can be of several advantages to us. Machines will become more powerful and capable of performing their work just like us. Is there a line to be drawn here in this aspect? Well, anything in excess is bad and when such capabilities are used with bad purposes, they can become self-destructive. It is like human cloning, cigarettes and alcohol. You know all these are harmful but still, no one can make them extinct!

It is still possible that you might oppose the idea that computers are at present (or in future) capable of having creative thought like humans. Well, let us look at some evidence in this direction? Holland [1] had mentioned long time back that it is possible to use genetic algorithms that simulate human genetic behavior. The manner in which genes replicate or change (such as crossover, recombination, etc.) can be simulated in software systems. For e.g. two strings can combine in different combinations to produce child strings. These strings will contain traits of the parent strings in different ways. The point is that we have had a lot of research done in this direction to produce "offsprings" in software systems. Minsky [6] had suggested the organization of the concept of thinking as "free agents" that work in sync to generate results. This concept is in line with the existing connectionist approach [9] that involves the interaction of entities to produce a stream to transfer information. Neural networks [10] seem to be the best and the most widely accepted concept for this approach. They seem

The systems today are not being developed to manage transactions only. Some of them assist doctors in surgery, while some control satellites. Some computers are working in hospitals in UK, while some act as agents to detect terrorists in remote places. Context Machines [5] have the ability to create art without the creative input from the human artist himself. The interesting point here is the manner in which they find the connection between itself and the surrounding environment. Computers have moved transaction-based processing to analytical processing. The rate at which they are being able to imitate humans in many ways, it will not be surprising to see them self-evolve and take decisions on their own too. Such a step would ensure that higher-level intelligence in machines is of the same level as humans.

It is not entirely surprising for us to have thoughts of a "friendly robots" living in your neighborhood, especially since these fantasies have been invigorating movies for decades. Consider the "Transformers" movie sequels or the "AI". Each of these movies is depicting machines which display sentience just like humans. There is only one issue, the safety of providing such unusual powers to machines. It will be very important to treat robots with respect. One may think of this as too far-fledged, but the fact is the that we are moving slowly step on, accepting the truth step by step. We now seem to think that there is no doubt that creative thought is the essential marker of sentience. Thus, if machines are to become sentient and creative, we must alter our morality as it pertains to them.

I end this article expecting that machines and humans will live in a symbiotic relationship with each other, or maybe as a part of each other. A day will come when man and machine will have to define things that help in mutual existence. There will be machines who will display and perform normal activities or shall I say 'do our things better than us?'. Will there be a competitive feeling between man and machine too? These issues will one day become the centre of research into high level intelligence. The sooner we accept this fact and work on it, the better for all of us!

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