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Abstract: Many accounts describe and define human intelligence. Some common abilities include: learning solving problems, creating innovative solutions, remembering details, etc. Artificial intelligence (AI) has fewer descriptions and definitions, including these: performing things normally done by experienced humans, or assisting less experienced persons go perform well. We have learned a great deal in the last 50 years about both human intelligence and artificial intelligence. Researchers now believe there are billions of neurons in the brain and mapping how people use those neurons to react to situations and solve problems is an area of active exploration with many unknowns. Human intelligence has not progressed on a scale or order of magnitude to match the progress in AI. How things will both evolve? Will AI evolve to support humans including the development of human intelligence, or is there a darker path ahead? This article aims to cause focused deliberations going forward.

Keywords: creativity; artificial intelligence; human intelligence; intelligence; problem solving.

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Biographical notes: Jonathan Michael Spector, Professor at the Learning Technologies Department at the University of North Texas, was previously Professor at the University of Georgia, Florida State University, Syracuse University, and the University of Bergen. He earned a PhD from The University of Texas. He is a visiting research professor in China and India. His research focuses on assessing learning in complex domains, developing critical thinking skills, and program evaluation. He is a Past President of the Association for Educational and Communications Technology and has more than 175 academic publications to his credit.

1 Introduction

Years ago, Alan Turing (1950) proposed a test to determine if a machine was intelligent. Basically, if one could not distinguish a human response to a problem from a computer response to that problem with both respondents hidden from view, then one would have to admit that the computer program was intelligence. For a detailed discussion of that

approach see the *Stanford Encyclopedia of Philosophy* entry on the Turing test (https://plato.stanford.edu/entries/turing-test/). While Turing's proposal was clever and somewhat practical at that time, many problems and issues arose. In many cases, the computer response would be much quicker than the human response to the time to respond could easily distinguish the computer from the human. Another issue arises with regard to the kinds of problems presented to each respondent, so the focus shifted to challenging and complex problems not quickly answered by either a human respondent or a computer respondent. And of course, there is the variety of human respondents and those doing the distinguishing to consider as well as multiple computer programs that might be used. In spite of such problems and issues, Turing's proposal helped inspire many innovative developments in AI. Unfortunately, so such large-scale and innovative developments occurred on the human intelligence side. Much progress has since occurred in the area of AI but not much progress in the area of human intelligence. People have evolved from cave dwelling ancestors while AI has evolved from programs running on large, room-size computers to small devices implanted in a human body to monitor various organs and communicate results with medical personnel many miles away. Perhaps we can dive more deeply into these issues in the next few sections.

2 Human intelligence

Let's return to the evolution of human intelligence. When one thinks of one's ancestors, one typically thinks of grand-parents or great grand-parents or perhaps even in terms of a family tree going back hundreds of years. However, a longer view can be informative. Early hominoids several million years ago developed the ability to make weapons and use tools and live in small groups for mutual protection and shared labour. Rudimentary language was developed along with pictograms, pictographs and story-telling. The earliest pictograms are almost a million years old (Robinson, 2007). In this abbreviated history of our ancestry, along came tools and weapons and a need to pass along lessons learned to the next generation. This required language development and story-telling. Sweller (2021) argues that early human history with story-telling as a dominant way to pass along learning and information, had an impact on human cognitive processing as represented in his cognitive load theory which emphasises the relevance of germane load which is what would have been emphasised in early story telling.

Understanding our evolutionary history along with our personal and family history can help us better understand ourselves. While Sweller's idea of how human cognitive processing developed is somewhat speculative, it helps to explain cognitive load theory which does have much research to show that minimising external load and emphasising germane load can improve recall in learners.

One might be inclined to cite the many advances in science to argue that human intelligence has advance significantly over the centuries. For example, Aristotle studied many phenomena and catalogued his finding, including those pertaining to what would called science today (Barnes, 1984). Aristotle's method including observations and then opinions about those observations and how different opinions might be resolved. While some of his specific conclusions in physics have been shown to be wrong, some argue that science originated with Aristotle and others a few thousand years ago and many advances have occurred since then.

However, while science has clearly advanced over millennia, there does seem to be similar progress in human intelligence when one considers people in general rather than focusing on the best and brightest in any particular domain. Consider the teachings passed down to us from Confucius, Socrates and other ancient wise persons. We now have what is often called the golden rule that one can find in Confucius and Hillel and many other ancient scholars (Puka, n.d.). Thinking about the nature of wisdom (which tends to focus on understanding and insight), rather than intelligence (which tends to focus on problem solving), one might conclude that with regard to wisdom, there has not been significant advances or improvements pervasive in humans since the time of Confucius and Socrates thousands of years ago.

To conclude this section on a more positive note, it is noteworthy to see how humans have passed along lessons from those early pictograms and stories by elders. Written language has enabled lessons to be passed along in more detail and to more persons, and that process was accelerated by Gutenberg's printing press in the fifteenth century. Mass production of texts spread lessons and information to many more than was possible by hand crafted documents. In addition, in Europe where the language of the intelligentsia was typically Latin, some started to write and publish in the native language in order to reach beyond a small elite group to many more in the general population. For example, Descartes (1637) first published his *Discourse on Method* that codifies the scientific method that has guided scientists for generations in French. What this bring to mind is one thing that humans might be doing that exceeds what machines do is to originate lessons learned in forms that can be shared and understood widely. Perhaps … we shall see in the years to come.

3 Artificial intelligence (AI)

As suggested earlier, there have been remarkable advances in AI. Recently, a shift to big data and learning analytics has occurred within the AI community. Suppose, one wants to understand trends in what researchers are publishing in a particular area. I have had three doctoral students pursue that issue in the last six years. Each dealt with a large collection of published papers … thousands of paper and millions of words. They had to collect the articles and make them available for analysis using latent semantic analysis. In each case, the process took about a year. While their conclusions were insightful and useful, one can imagine a skilled AI researcher performing a similar task using recently developed AI tools in perhaps a few hours or even less time.

Many AI researchers now argue that the goal is not to mimic the best human reasoning capabilities but to use computing power to solve complex problems much more quickly than humans. One promising area in the domain of bid data is what is called deep learning (Golubev, 2019). One can find so called AI, big data, and learning analytics in many domains include health care, national defence, space exploration, and business applications. To date, there is little evidence of AI, big data, and learning analytics being used to improve instruction and education.

Part of that disparity is an historical to first apply new technologies in domains that a society prioritises. In the USA, corporate interests and the defence industry drive early applications. At one time space exploration received emphasis and interest and made use of early AI applications in planning launches. That interest may be on the rise again as well as interest in global climate change and related environmental concerns. Some might

argue that looking at which new technologies a society embraces and funds reveals a great deal about that society. Will there be a return to the ideas behind Skinner's teaching machine and focus AI innovations and developments on advancing human knowledge and intelligence (Skinner, 1961). That remains to be seen, but one might make a prediction that specific societies and people prefer other areas of emphasis.

4 Conclusion

My bias is probably clear and has been for a number of years. I once made a distinction between weak AI and strong AI. Weak AI were applications that were aimed at enabled less experienced persons to perform on par with more experience persons. Strong AI were applications aimed at replacing what a human had been doing with a machine (Spector, 1993).

One can find both kinds of applications. Medical and legal advising systems, now powered with search engines with access to big data, allow medical and legal professionals to perform at a high level and higher than they would otherwise be able to perform. Those are highly useful weak AI systems. One can also find both weak and strong AI applications in the automobile industry. Many automobiles now come with lane departure warning systems and speed control systems that slow down when approaching another car or barrier. Those are weak AI applications. On the other hand, there are now some self-driving cars, trucks and delivery vehicles. Those are examples of strong AI applications. A GPS (global positioning system) advising drivers about the shortest route from X to Y are accessing large databases and current traffic patterns and accidents to advise drivers enabling those drivers to perform at a high level. That is a case of a weak AI application. A GPS guiding a driver-less delivery vehicle to a destination is an example of a strong AI system.

When one considers a business, perspective focused on long term profits, it might seem reasonable to invest thousands of dollars in developing an AI system to replace a highly paid human expert. There are many strong AI applications already in use that are replacing unskilled workers. What happens to displaced workers and professionals? Will they become AI programmers? Perhaps in a few cases that will happen. When self-driving vehicles replace taxi and truck drivers, a similar concern arises with regard to displaced employees. Strong AI systems seem attractive to many entrepreneurs and to government funding agencies. Perhaps the decision makers in those agencies believe that people will have more free time to explore and pursue personal interests. That seems like an unfounded dream as pursuing personal interests often requires funds and without work, many will be left with adequate funds.

In a sense, what is developing is a widening of the divide between the haves and the have-nots. That divide has historically been associated with wars, and regardless of such a dramatically disastrous outcome, the financial divide could and should be a top social concern. This last remark brings up what might be called a values perspective. What do citizens value? Do we want AI, big data and learning analytics to displace workers? To provide advantages of one group or society over another? Or, would we prefer to see AI and related technologies used to improve living and working and loving and learning for the overwhelming majority of citizens?

In closing, there are a few issues to monitor in the coming years. At present, humans excel at passing along lessons and information to other humans, often with the support of a variety of technologies. Machines have yet to supplant human superiority in that area, but that might change as machines learn how to program other machines and replace humans as conveyers of lessons learned and information to humans. Humans tell jokes … some funny and some not so funny. Humans complain about many things some of which can be improved. Humans have likes and dislikes, preferences, biases, emotions, and other aspects that differentiate people from machines however intelligent the machines might be. At present humans develop AI algorithms and program machines. Will that also change in the years to come.

We do not know how the future will evolve and what strong AI systems might do in the future. Acting on our values and understanding that at present machines have no values and lack all those characteristics of humans just mentioned, it is not the case that humans are superior to machines. Machines have many advantages that humans lack. What is the core issue is what kind of society we would like to see develop in the future? What values do we want to see preserved? Who are we becoming? What is AI becoming? The future is uncertain and undetermined.

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