Folks,

The assignment is to rewrite or reinterpret the article written by J.C.R. Licklider on “Man-Computer Symbiosis”, which was published 68 years ago. With his amazing foresight, he suggested five areas which would enable a symbiotic relationship to be established between man and the computer, where each side could benefit from the behavior of the other. In essence, he recognized the unique characteristics of the human and the machine, and specifically noted five particular areas.

These were:

1. The speed mismatch between man and the computers
2. The hardware requirements
3. Memory organization requirements
4. The language problem (communication)
5. Devices for input and output

Note that Licklider’s prescient predictions are still valuable today, even though the environments have changed radically in more than six decades. For your background information, Licklider was also head of DARPA, and sponsored projects such as the creation of the Internet, the beginning of computer graphics at MIT’s Lincoln Labs with Ivan Sutherland, the fundamentals of digital television, etc.

To set the stage for the assignment, one first has to acknowledge the continued exponential growth over the past half century or more of integrated circuits, following Moore’s Law. Thus the exponential gain in processing capability has seen a doubling in short time periods (between one and three years) throughout this long time period. As a rough estimate we have 1000x more processing power every fifteen years, which roughly translates to a several hundred million times increase since Licklider’s article was first published.

But in addition to the processing power, we will also have witnessed significant increases in bandwidth, memory, storage, machine architectures, and radical changes in the input and output devices. At the time of the original article, the Internet did not exist, television was analog, Xerox was a noun, no one knew of Google or Wikipedia, cameras used film, and there were no mobile phones. Today, with the popularity of social media and the connectivity and ubiquity of digital environments, there has been a complete change in communication. The enormous increase in data storage has resulted in cloud computing, search engines, and an immense amount of structured and unstructured information.

The above changes have resulted in capabilities where we can execute very complex simulations in relatively short time frames, and accurately model many types of physical simulations such as the behavior of light, heat, fluid flow, etc., and in many disciplines such as physics, chemistry, astronomy, and biology, to name a few. As the capabilities of the digital environments continue to improve exponentially, we have also addressed problems of increasing complexity such as climate and weather modelling, the documentation of the earth’s topography, astronomical observations, evolution, and brain science. In a sense we have put the entire knowledge base of humankind at the fingertips of everyone, anywhere, at any time.

What may be just as important as the explosive growth in what I have mentioned above is the fact that there is a convergence of many disciplines with different and important salient characteristics, such that by combining different types of data, algorithms, and thought processes, it creates a “whole which is greater than the sum of its parts.” This has led to two types of disparate approaches to improve our

knowledge base. These are the physical simulations, which historically have not been easily obtained without long computation times, and now with the availability of the "big data", statistical and probabilistic results which complete the physical simulations. The combination has led to great advances in the machine being able to predict at significantly greater accuracy then can be obtained with human input or diagnosis alone. This is leading to huge changes in medical practice, interpretations of previously unrecognized phenomena, computer vision, as well as new subjects for computer science, such as artificial intelligence, neural networks, and machine learning.

With all of the above, certainly the symbiotic relationship between man and machine, as described by Licklider, must change. At least several of the constraints in communication between man and the machine have changed so radically that although communication is still an issue, we now have radically new input and output technologies which depend on computer graphics, high resolution display devices, time-of-flight sensors which allow gesture understanding, the ability to have touch, haptic and sound communication, digital speech synthesis, and subjects like natural language processing, all at our disposal.

How can we use these capabilities now? It is no longer conjecture, as witnessed by earlier examples such as Jeopardy and Watson, but more awesome examples such as medical diagnosis and surgical training, genomics, drug design, and autonomous driving vehicles. What will happen fifteen years from now, when we have 1000x more compute power than currently exists, and how should we be addressing the elimination of existing constraints in 2018, particularly the dialogue between man and the machine? These are the important questions for the future, the ones which I hoped the class should at least partially address. It is a thought-provoking question and it certainly has not been answered to-date, although there are interesting, stimulating ideas which have been presented in science fiction, literature, and the entertainment industry.

Requirements

Your rewritten article should assume a fifteen year time period from roughly 2018-2033. You must submit this in paper form in no less than four, or no more than five printed papers in addition to an electronic copy.

Specifically, you should note your assumptions, including the rates of change of the dominant characteristics of the future digital environments and how we can take advantage of the machines capabilities. One must also consider the best means of communication between man and the machine. Papers will also be judged not only on your technical assumptions, but on the creativity and imagination of the authors in identifying new methods for future dialogue between man and the machine. Noting the performance trajectories of different modalities, what new disruptive situations will occur?

Each submission is to be authored by a group of three students and brought to my office at 580 Rhodes Hall by 3pm on Friday afternoon, March 2nd. Please note that in addition to the paper we will need confidential evaluations of the percentage of effort for each individual. These group evaluations will remain confidential, but each evaluation will not be anonymous. Specific details will be given at a later date.

I will be leaving the Ithaca campus within a few days of completion of this short five-week course and will need to take a hard copy of each of the submissions. I will grade the articles while I am at Cornell

New York Tech, so they may be returned to you within a few weeks and can be picked up at the registrar's office.

Personal Comments

On a personal note, as I am nearing the end of my academic career I am particularly interested in "design", and would love to teach a studio which incorporated the current capabilities of the machine, combining the physically-accurate simulation capabilities and its correlation with the statistical and probabilistic observations based on evaluation of "big data", so that all of this could be used at the earlier phases of design, when decisions have the greatest impact. As you now know well, I am also fascinated with improving the channel of information through the human visual system, utilizing VR and AR.

Maybe it is too much to try and teach a course or subject which has this broad a mission in a short five week time period? I also recognize that in a shortened, one year Master's program, there is not sufficient time to dedicate to a short elective course. However, I do hope that I have made you consider the impact of the exponential growth in our current digital environments, and at least influenced a change in your thought processes with respect to more traditional approaches and how this huge change in capabilities can influence the creation of new disruptive technologies.

Lastly, I wish you all well, and hope that our paths may cross in the future.

Best wishes,
Uncle Don