UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

THINKING SKILLS **9694/43**

Paper 4 Applied Reasoning **October/November 2012**

1 hour 30 minutes

Additional Materials: Answer Booklet/Paper

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READ THESE INSTRUCTIONS FIRST

If you have been given an Answer Booklet, follow the instructions on the front cover of the booklet.
Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE ON ANY BARCODES.

Answer **all** the questions.
Start each question on a new answer sheet.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question.

This document consists of **7** printed pages and **1** blank page.

1 *Study the passage below and answer the question that follows.*

> In 2012, the Batran local government commissioned an analysis of the cost of providing services in the 8 Leisure Learning Centres in the region, in order to determine which one of them should be closed. The analysis revealed that, in 2012, the Centre at the historic town of Sinar was ranked highest in terms of total expenditure, second-highest in spending on resources, and highest in terms of number of staff employed per local population head. Furthermore, library records from June 2012 showed that Sinar had the lowest rate of book-borrowing per local population head of all of the 8 Centres. On the basis of this information, the local government decided that Sinar's Leisure Learning Centre should be closed.

Do you think that the local government's decision to close Sinar's Leisure Learning Centre can be justified on the basis of the statistics and information provided? Justify your answer. [5]

Questions 2, 3 and 4 refer to Documents 1 to 5.

2 Briefly analyse the argument in Document 1: *Electronic Brain*, by identifying its main conclusion and main reasons, as well as any intermediate conclusions and counter-arguments. [6]

3 Critically evaluate Tan's argument in Document 1: *Electronic Brain*, by identifying and explaining strengths, weaknesses, implicit assumptions and flaws. [9]

4 'A computer brain will be as good as, if not better than, a human brain.'

Construct a well-reasoned argument either for **or** against this statement, commenting critically on some or all of Documents 1 to 5, and introducing ideas of your own. [30]

DOCUMENT 1

Electronic brain

There is no great popular support as yet for building an artificial brain. Some think it is not possible, but such people must be driven above all by fear of being challenged by a greater intelligence. In actual fact, it would be worthwhile and beneficial for the human race to create artificial intelligence (AI).

What we have developed in the area of computers is still not as interesting, powerful, and creative as the human brain. However, recent studies show computers are rapidly learning to match the capabilities of humans, be it language processing, visual processing, problem-solving, or whatever. And when, in a few years, we learn to combine these different technologies, we will have, for lack of a better term, a synthetic brain or AI. Moore's law* predicts that by 2013 we might have developed a supercomputer far surpassing the human brain. By 2049, a $1000 computer will reach speeds surpassing the entire human species. So, really, there is nothing we can do to stop computers evolving into superstructures, except to stop making them. This is why it is inevitable that AI will come into being.

Computers with artificial intelligence will have minds very similar to those of humans, with feelings, creativity and imagination. They will be able to recognise faces and voices, and react to stimuli. But the additional advantage is they are artificial, not human, so they will not have our negative human qualities such as greed, selfishness and competitiveness that make us walk all over our fellow humans and exploit them. A world where robots interact with human beings will be a more peaceful world.

An AI computer brain will be para-human, as it will work on a similar frame of creative capabilities as human brains. I cannot think of any human feat which would be beyond the capabilities of AI. Because of capability for voice and face recognition, AI will be able to respond to human beings of all cultures, hence breaking through cultural barriers. Of course, human brains can run out of ideas, and so will the computer brain. It will have its limitations, being programmed to work within a certain set of parameters, beyond which it cannot know the way ahead.

But is AI, with all its amazing capabilities, only as good as the human brain? There will be many ways in which a computer brain can outperform the human brain. Human strength is finite and can get fatigued and worn down physically, but a computer can perform functions, thousands of times, better and more quickly before it is (if ever) exhausted. No human can achieve such a feat. It has been pointed out that there are certain dimensions of human experience that may not be accessible to a computer brain, such as emotional experiences in social contexts. But this is more than compensated for by the consistency, efficiency, accuracy and methodical rigour with which an electronic brain can perform every task necessary to survive in the modern world. All things considered then, such a computer brain is far superior to the human brain and therefore will enhance human lives.

Tan Kuan Yew

*See Document 3 for more details about Moore's Law.

DOCUMENT 2

Human brain vs computer

The human brain is highly evolved and an amazingly complex 'machine' that is often compared to the most complex of man-made machines, digital computers. But brains and computers differ fundamentally. The brain is an evolved biological entity made from materials such as small organic molecules, proteins, lipids, carbohydrates, a few trace elements and quite a lot of salty water. A modern computer is built with electronic components and switches made with silicon, metal and plastic.

Does it matter what a machine is made of? For computers the answer is 'no'. Computer operations depend on components made from any suitable material. Cogs and hydraulics, or optical devices could replace the electronics of a modern computer without affecting the machine's ability to compute. It seems extraordinarily unlikely either that the brain is simply performing computational algorithms, or that thinking could equally well be achieved with cogs and levers as with nerve cells. Perhaps we cannot expect computers to perform like brains, unless we find a way to build them in a biological medium.

Computer scientists' interest in neurosciences is quite understandable. After all, some aspects of what the brain does can be thought of as 'computational', and the digital computer is a compelling metaphor for the brain. But we must be careful not to see the brain as being like a computer, in the same way as the heart is like a pump. The heart is not just like a pump, it is a pump. It is possible to know everything about how the heart works, by understanding how it functions as a pump. We cannot speak of the brain in a similar way. If our model of how the brain works is dominated by reference to the way computers work, we will ultimately fail to understand the brain, because the most interesting thing it does – 'thinking' – is fundamentally not a computational process.

Michael O'Shea

Source: *The Brain: A Very Short Introduction*, Oxford University Press, 2005

DOCUMENT 3

Robotic future

You have probably heard about Moore's Law. It says that CPU (Central Processing Unit) power doubles every 18 to 24 months or so. History shows Moore's Law very clearly.

Taking Moore's Law literally, you would expect processor power to increase by a factor of 1000 every 15 or 20 years. Between 1981 and 2001, that was definitely the case. Clockspeed* improved by a factor of over 300 during that time, and the number of transistors per chip increased by a factor of 1400. A processor in 2002 was 10 000 times faster than a processor in 1982 was. This trend has been in place for decades, and there is nothing to indicate that it will slow down any time soon. Scientists and engineers always get around the limitations that threaten Moore's Law by developing new technologies.

The same thing happens with RAM chips and hard disk space. A 10 megabyte hard disk cost about $1000 in 1982. Today you can buy a 250 gigabyte drive that is twice as fast for $350. Today's drive is 25 000 times bigger and costs one third the price of the 1982 model because of Moore's Law. In the same time period (1982 to 2002) the standard RAM available in a personal computer has gone from 64 kilobytes to 128 megabytes – it improved by a factor of 2000.

What if we simply extrapolate out, taking the idea that every 20 years things improve by a factor of 1000 or 10 000? What we get is a machine in 2020 that has a processor running at something like 10 trillion operations per second. It has a terabyte of RAM and one or two petabytes of storage space. A machine with this kind of power is nearly incomprehensible. In 2020, every kid will be running their video games on a $500 machine that has that kind of power.

What if we extrapolate another 20 years after that, to 2040? Human brains are thought to be able to process at a rate of approximately one quadrillion operations per second. A CPU in 2040 could have the processing power of a human brain, and it will cost only $1000. It will have a petabyte of RAM. It will have one exabyte of storage space. An exabyte is 1000 petabytes. That's what Moore's Law predicts.

	1981	*2001*	*2021*	*2041*
Processor	330 thousand ops/sec	1 billion ops/sec	10 trillion ops/sec	10 quadrillion ops/sec
Disk space	10 megabytes	250 gigabytes	1 petabyte	1 exabyte
Memory (RAM)	64 kilobytes	256 megabytes	1 terabyte	1 petabyte

A typical home computer in 2050 will have processing power and memory capacity that exceeds that of a human brain.

The point is simple. In 2050, robots will displace millions of employees, leaving them unable to find work and therefore destitute. I believe that it is time to start rethinking our economy and understanding how we will allow people to live their lives in a robotic nation.

Marshall Brain

*clockspeed – the operating speed of a computer.

DOCUMENT 4

Brain–Mind

A lot of research has been able to show us which parts of the brain are active during certain activities, but not how those parts actually function. Probably the most comprehensive idea we came up with was to use computers to imitate the brain, to see if this would help us to understand it better.

It is possible, in my opinion, that however our brain was made (whether it be by evolution or God), it was formed deliberately so that we should never understand how it works. If we did know everything about the brain, then we would also be able to manipulate it in many ways. This may be seen as a good thing or a bad thing, depending on how you look at it.

Exploring the mind could have serious moral implications, as we could reach a stage where people's private thoughts were no longer private, where thoughts could be manipulated, memories could be erased; the possibilities are endless. Maybe humans should stop being so arrogant that they think they can do anything.

We know that if you give a computer a command that it has never encountered before and is not programmed to understand, it will not do it. In the same way, if a human brain encounters something unknown, like words spoken in a foreign language, it will not understand.

There is a discrepancy in this, however. That is that if you continue to give this computer the same command over and over, you will not make any progress. On the other hand, if foreign language is encountered enough by the human brain, it will eventually pick it up and learn what it has heard. This is because there are other factors involved. The human brain can recognise facial expressions, gestures and even perceive emotion. In this way, it will eventually learn what is being said, even though the initial words have remained the same.

That brings me to the question: do we also have the added advantage over the computer of using our minds, which are apart from our physical brains? But can there really be something called the 'mind' which is non-physical, or is everything including our mind just a bounded set of physical objects?

Then the other interesting question arises: if mind is not matter, and therefore non-bounded and non-physical, how can it control the brain which consists of matter? In our model of today's laws, only physical entities can cause a change in a physical object. But if we accept the concept of mind, then the brain can be influenced by non-matter, which is obviously not bounded in space. If the brain can be influenced by non-matter, what is there to stop my mind from influencing your brain too?

Tony

DOCUMENT 5

Some blogger views

Computers are fast but dumb. As a software engineer I know, all too well, how much effort and persistence is needed to make the computer do what I want. My three-year-old daughter amazes me more than all the computers I have worked with in the last 20 years.

Since the conception of the computer, people have dreamed about computers thinking like humans (like HAL in the film 2001: A Space Odyssey). But 2001 has passed without a trace of them. Whenever I read now about people pursuing artificial intelligence I know they are either scientists who seek funding for their pet projects or futurists who need promotion for their book. Only people with lots of money or time to dream take them seriously.

We're capable of art, and love, and they are not.

More proof? Ok.
Boot your machine, start your browser, and watch as the internet hacks your PC within minutes. Easy.
Smart machines? No.
Stupid software.
Brains are really safe for quite some time into the future.

Why bother building an artificial brain you ask?
Who wouldn't want a conversation with the most intelligent entity in the world?

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