"Will It Be Possible to Build a Computer That Can Think?"

Peter Dey, 15 May 2003

The Information Technology revolution is occurring at an extraordinary pace. What started 40 years ago with a computer the size of a room which could perform simple arithmetic from punch-card inputs, has now evolved into an essential business and entertainment tool. At this rate of evolution the question has to be asked: Will it be possible for computers to think?

There are many definitions of the verb 'to think'. With these definitions come many questions and implications, such as "Does thinking imply emotions?" Primitive animals can essentially only perform one task at a time, and their set of possible tasks is usually quite limited, for example, hunting and gathering. Given tens of thousands of years of evolution, modern society is the end result. If computers were given this time, would they evolve to become what society would consider to be sentient? Even at this point in time, computers match, or even in some areas exceed, the benchmarks or tests which have been created to assess the ability to 'think'.

A definition of 'think' from the Merriam-Webster dictionary[1] is *"to subject to the processes of logical thought"*. Every time an operation is performed on a computer, it is run through the computer's internal processes (hence the "brain" of the computer being labelled as its *processor*). All programs rely on logic to function – this is the sole purpose of a computer. If one were to ask a computer what the answer to 1+1 was, and a result of '3' were obtained, the computer would not be of any use. Society values computers in society because of their ability to maintain logic in all situations.

However, does the ability to think imply the ability to evolve? Primitive humans and many animals essentially have the ability to perform one task at a time. They are also limited to a small set of tasks; for example, hunting and gathering. In this way, they are "limited to their programming". Instincts are to mammals as programs are to computers; they're simply a starting place. In mammals, these instincts were allowed to develop, and modern society was born after tens of thousands of years. Computers are only 40 years into their evolution. Computers' ability to adapt was limited by their programmers' short-sightedness until the mid-1990's.

Until the mid 70's, computer programmers couldn't grasp the idea of a recursive subroutine (a section of a program which calls itself). Until this point in time, subroutines were used simply as aides to the main program. It wasn't until Politzer Rozsa published "Recursive Functions in Computer Theory"[2] that programmers realised the potential they had previously been neglecting.

---

[1] Merriam-Webster Online Dictionary, "think" – definition #9 (http://www.m-w.com/) 18/05/03

[2] Rozsa Peter: Founder of Recursive Function Theory (http://www.sdsc.edu/ScienceWomen/peter.html) 18/05/03 5:28 PM

In the mid 90's, David B. Fogel began the development of a radically new computer program – one that learned[3]. Dubbed 'Blondie24', the program was given basic information: the size of a checkers board and legal moves; but not which moves were good, or even how to win. Blondie had to deduce this information on its own. Fogel played hundreds games with Blondie. With each 'generation', Blondie became more intelligent as to which moves were good and which moves weren't. Blondie24 is now in the top 500 of checkers players in the world[4]. This suggests that, with the right frame-of-mind a programmer could write a program that could learn and adapt in any situation.

With the ability to learn and adapt would naturally come the ability to make decisions[5]. If a computer program were taught what was 'wrong' and 'right' in a given situation, would it be able to move this information to another similar situation? Does the ability to think imply the ability to make a judgement? Blondie24 will put together pieces of moves it knows to be "good" (i.e. have a heavier weighting) to counter a tactic it's never seen before. In a similar way, programs may soon be able to make judgements on a larger scale.

In the 1980's, Hans Moravec estimated that it would take 10,000 Cray-2 supercomputers (the world's most powerful supercomputer at the time) to emulate the entire human brain[6]. A single Cray-2 is capable of 2 Giga-FLOPS (Floating Point Operations Per Second). By this logic, 10,000 Cray-2's would yield 10 Tera-FLOPS. In 1998, IBM's "Pacific Blue" was capable of 3.2 Tera-FLOPS[7]. The US-Backed ASC Initiative aims to build a 100 Tera-FLOPS supercomputer by the year 2004. Given a mastermind such as David Fogel, the emulation of the entire human brain could well become a reality.

While hosting a discussion panel, an individual suggested that the ability to think implied the ability to be bored (from lack of material to think about). The example was given:

> *"If you lock a human in a room for 48 hours, the human will get bored and irritated. If you leave a computer unattended, it still responds to your commands after 48 hours."*

Currently, when a computer's resources are unused, it executes an 'idle loop' program. This 'idle loop' means that the computer's processor is running at 100%, all the time[8]. Essentially, a computer doesn't have the time

---

[3] Blondie24, Playing at the Edge of AI (http://www.comp.hkbu.edu.hk/~cib/2002/cib_iss1f.pdf), 16/05/03 3:24 PM
[4] Evolving Solutions that are Competitive with Humans, David B. Fogel, pg. 3 (http://www.isd.mel.nist.gov/research_areas/research_engineering/Performance_Metrics/PerMIS_2002_Proceedings/Fogel.pdf) 18/05/03 3:27 PM
[5] Asimov's Laws of Robotics, Roger Clarke (http://www.anu.edu.au/people/Roger.Clarke/SOS/Asimov.html) 18/05/03 6:07 PM
[6] Taking Sides: Clashing Views on Controversial Issues in Science, Technology & Society, 5th Ed, pg 252, Thomas A Easton, McGraw-Hill
[7] Computer History (http://home.earthlink.net/~mrob/pub/ch-machines.html) 18/05/03 3:57 PM
[8] Microsoft Windows 2000 SP3 5.00.2195, Task Manager, 'Processes' tab, 18/05/03

to get bored. If this idle loop did not exist, the operating system may go haphazard, in a similar way to bored human teenagers.

Silicon technology has its limits. Chips can only go so fast, and can only get so small – you can only get down to the size of an electron. The next stage for computing is biological, or neuron processors[9]. Neurons are the brain's "circuitry". They have many things in common with silicon chips – both transmit electrical signals. Seymour Cray himself, founder of Cray Computer and creator of the Cray Supercomputer, said that the next step for computing was to use DNA and proteins, "just as Nature does"[10].

However, there are problems with using neurons to transmit signals: while silicon chips perform predictably, neurons can behave chaotically. Perhaps this inherent chaos in the human brain is what allows us to be creative and think outside the square. Soon, using neuron technology, even computers may have this ability.

Computers currently have many abilities that are regarded as thinking; by the general public and many dictionary definitions of the word. However, some still say that computers will never fully be able to emulate a human's intelligence. With the advances that have been made over the last 40 years of the evolution of computers, it is not safe to assume so. Advances such as 'Blondie24', a program that learns, and now the move into quantum and biological computing, indicate that the ability of a computer that can think is in the not-to-distant future.

[9] "A New Breed of Thinking Computer?", BusinessWeek Online (http://www.businessweek.com/1999/99_25/b3634137.htm) 18/05/03, 4:09 PM
[10] Supercomputers, Don Calle (http://ei.cs.vt.edu/~history/SUPERCOM.Calle.HTML) 18/05/03