

Alan Turing, Google's doodle and the Diamond Age

ALAN TURING YEAR



Turing's memorial statue in Manchester

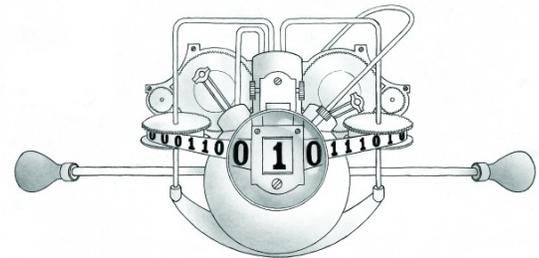
The year 2012 has been declared the *Turing year* because Alan Turing was born in 1912 in London. He died in 1954 at the age of 41 in Wilmslow (UK) by cyanide poisoning. It was allegedly a suicide as a consequence of prosecution for his homosexuality.

Turing got a mathematics degree in 1935 at Cambridge and got later in 1937 a PhD in Princeton. During World War II he became a key figure in breaking the code settings of the German Enigma machine. The *bombe* was an electromechanical device that he designed to find the rotor settings in the Enigma machine and hence decrypt the military German messages for that setting.

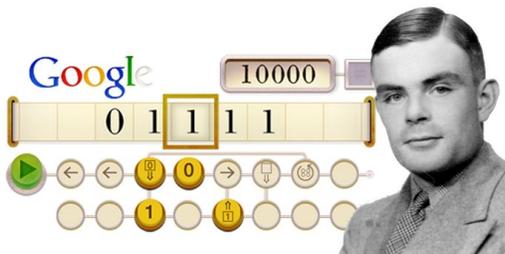
After the war he was involved in the development of the *Manchester Computers*, a project that has led to the development of modern electronic computers as it was later conceived by *John von Neumann*. The hypothetical device is currently known as a *Universal Turing machine*. Turing's involvement was a consequence of him being intrigued by the *Entscheidungsproblem* formulated by *Hilbert* in 1928: can an algorithm, starting from a set of axioms, decide whether a first-order logic statement is universally true or not? *Alonzo Church* and Turing both proved independently that it is impossible in 1936-37. Clearly, this is very closely related to

Gödel's completeness theorem, which had been proved in 1929 already.

Church approached the problem by inventing λ -calculus, which he used to define functions. Computability corresponds to the fact that the function is representable in some 'normal form'. Turing approached the problem in a more algorithmic way and proposed an 'a-machine' (which is now known as a Turing machine). He also proved that the class of functions defined by λ -calculus and computable by his a-machine coincide. On the other hand, every algorithm is in fact a recursive function.



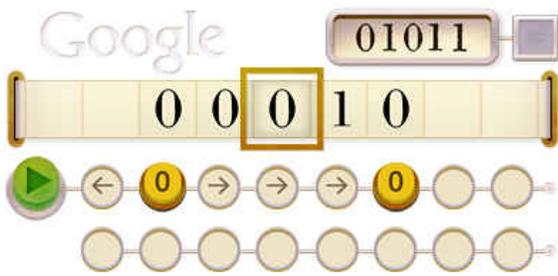
Alan Turing Google Doodle - 23th June 2012



The Turing machine is a device that reads symbols (for example 0 and 1) one by one from an infinite strip. Then, following certain rules, possibly replaces the symbol by another symbol and then moves to the previous, the next, or remains at the same position to read the next symbol. The rules are described in a table and depend on the *state* of the machine. It is supposed that there is only a finite number of states. The transition depends on the state of the machine and the symbol that is read

and prescribes what will be the next state, what symbol to write back on the tape and in which direction to move the reading head. A *Universal Turing machine* (UTM) is itself a Turing machine that can simulate any other Turing machine, given the description of the machine it has to simulate and its input.

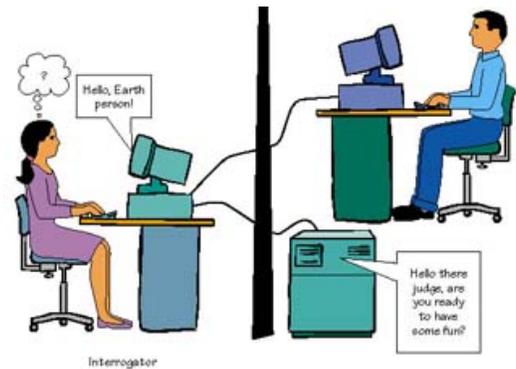
Simple as this machine may be, anything a real computer can compute, a Turing machine can also compute. The difference is of course that Turing machines can manipulate an infinite amount of data (the tape is infinite) and if you have the patience of waiting an infinite time while real machines have only a finite memory and are supposed to produce a result in a finite amount of time.



On Turing's birthday, 23 June, Google devoted a doodle to this event. It is a kind of Turing machine and at the same time a puzzle. The purpose is to generate the successive letters of 'Google'. If you want to play with it yourself, see www.google.com/doodles/alan-turings-100th-birthday. It's a challenge! An animation of the solution can be found on Youtube.

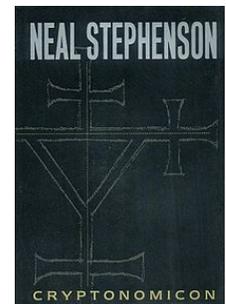
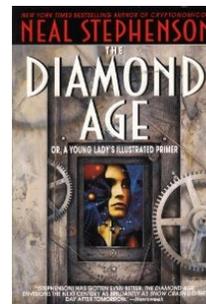
What is going on in the puzzle? Initially it is just counting binary. You start after pushing the green button. On the top right is a target that you should reach. (See the starting configuration above.) This target represents a letter of Google, thus the first is '01011' which represents the letter 'G'. The starting tape shows '00010' which should be transformed into the target. The reader head is represented by the frame. The transition rule can be set by the line below which indicates that it consists in moving 1 place to the left, then write a 0 or a 1 (which you can choose), then move three places to a right and write again a 0 or a 1 (which you can choose). The defaults are to write 0 in both cases. Thus if you do nothing and push the green button, then the result will be '00010' which is not the target. If however you choose both symbols to be written as '1', then the target is obtained, and you can move on to the next letter. There are many such possible variations that you should now be able to find out.

Turing can also be considered to be the father of Artificial Intelligence (AI). The *Turing test* involves a human who has to interrogate an opponent through a computer screen and he should decide on the basis of the answers received whether the opponent is a computer or a human being. In other words, the problem is: can a computer think? Is a computer intelligent? Nowadays different *chat-boxes* are available that are computer programs that interact (sometimes) in a sensible way in conversation with a human. Early programs like ELIZA (mid 1960's), PARRY (early 1970's) and RACTOR (early 1980's) were very popular.



The proceedings of a symposium on Turing's test held on 4-5 June 2012 in Birmingham, are available at www.pt-ai.org/turing-test/.

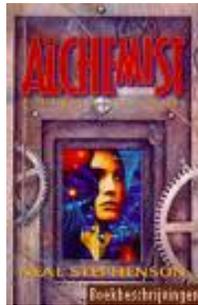
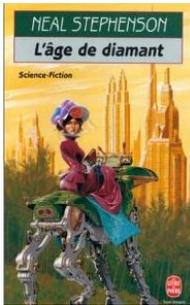
Most of the readers of this Newsletter of course do know Alan Turing and the bits of information I gave in the previous paragraphs. I believe on the other hand, not many may know what the *Diamond Age* refers to. I take this occasion to write more about one of my favorite cyberpunk authors: *Neal Stephenson*. I gave a review of his novel *Anathem* in issue 86 of this Newsletter (January 2012) and there was Paul Levrie's review of *Quicksilver*, one of his Baroque cycle books in issue 54 (September 2005).



The Diamond Age or *A Young Lady's Illustrated Primer* (1995) is one of his earlier novels that he wrote before *Cryptonomicon* (1999). The latter has two intertwining plots: one plays during World War II and evolves around the Allied code breakers of the German Enigma at Bletchley Park where Turing was working; the other plot is set at the end of the 1990's where descendants of the characters in the former plot are setting up a data haven for an anonymous internet banking system but that should also serve as a channel to help to prevent a future holocaust. This would have been a good connection with Turing, however there is somewhat less mathematics involved. So I prefer to point to *The Diamond Age*.¹

¹There are many editions and translations published. In French it is entitled *L'âge de diamant, ou le manuel illustré d'éducation à l'usage de filles* and in Dutch *De Alchemist of Het Geïllustreerde Eerste Leesboek voor Jongedames*.

It is a futuristic novel put in a Dickens-like Victorian style. The Diamond Age refers to an era like the Stone Age or the Bronze Age, etc. Just a few words about the story. In a world where nanotechnology governs society, there is no material shortage, since all the basic necessities can be produced very cheaply by matter compilers rearranging molecules and energy to produce whatever is needed. The society is divided into *phyles* (castes) with *Victorians* on top (controlling the feed of compilers) while a *thete* is basically casteless and at the bottom of society.

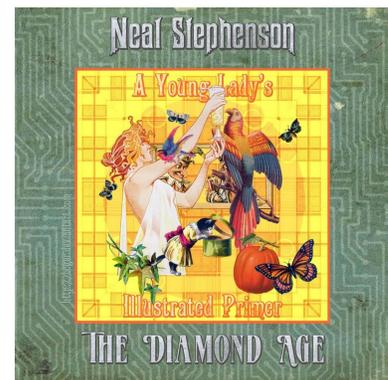


Entertainment is not by looking at a stage show or a movie, like we know it, which are *passives*, but instead *ractives* are much more common. That is something like a video game where the consumer may or may not play an active role and where the other characters may be purely computer generated, or one or more could be steered by professional actors.

A brilliant nanotech engineer Hackworth develops the code for a book that is in fact an interactive multimedia device that is supposed to educate young girls. He produces it for a rich lord, but he keeps a copy for his own daughter. However he is robbed and the copy is stolen so that he has to produce a third one. The stolen copy falls into possession of Nell, a four-year old thete-girl. Being neglected by her marginal parents she leaves home and is hence educated by the Primer. She enters the Victorian phyle and leaves her older brother behind.

While reading, Nell lives through many fairy-tale like adventures, and is taught by her toy friends, who come to life in these interactive plays. At some point, she, being Princess Nell, has to find 12 keys to rescue her brother. These are kept in as many castles. The eleventh is hidden in castle Turing. She is imprisoned but Duke Turing (who is in fact a prisoner in his own castle, only being able to execute the program he is fed with) communicates with her using chains.

Here Stephenson does indeed describe quite precisely a Turing machine. The original paper tape is replaced by a chain. The chains are 'infinitely long' *The chain containing the Duke's program dangled on either side into these holes. Nell tried throwing stones into the holes and never heard them hit bottom; the chain must be unfathomably long.* The symbols and transition rule are essential elements of a Turing machine: *The lock only had a few parts that she could observe: the crank, the bolt, and a pair of brass drums set into the top with digits from 0 to 9 engraved in them (...). The number on the top changed with every link that went into the machine, and it seemed to determine, in a limited way, what the machine would do next (...)* So when Nell finds out about how the Turing machine works, she uses it to solve other puzzles like reprogramming an organ playing sad music *(...) plunging the place into a profound depression so that no one worked or even got out of bed (...) it could just as well be reduced to an unfathomably long and complicated Turing machine program.* Nell also learns from a report by the Duke that adding more reading heads and more chains may slow down the computation, but it does not increase the possibilities because there is always *'a way to simulate their behavior by putting a sufficiently long chain into one of the traditional Turing machines (...)* they didn't really do anything different'.



source:

www.deviantart.com/

Why should not the Primer be a Turing machine itself, or was there a human behind it after all? So Nell knew about the *Turing test* as well. She believes that there is some human behind and indeed King Coyote in the 12th castle is and so is Miranda, who has been a surrogate mother for Nell from the beginning. Eventually Nell becomes the leader of a new phyle of orphans that all have been educated by purely computer operated Primers.

Adhemar Bultheel