



Math for the people, by the people.

universal Turing machine

Canonical name	UniversalTuringMachine
Date of creation	2013-03-22 13:43:46
Last modified on	2013-03-22 13:43:46
Owner	tromp (1913)
Last modified by	tromp (1913)
Numerical id	7
Author	tromp (1913)
Entry type	Definition
Classification	msc 68Q05
Related topic	ArtificialInteglligence
Related topic	StrongAIThesis

A universal Turing machine U is a Turing machine with a single binary one-way read-only input tape, on which it expects to find the encoding of an arbitrary Turing machine M . The set of all Turing machine encodings must be prefix-free, so that no special end-marker or ‘blank’ is needed to recognize a code’s end. Having transferred the description of M onto its worktape, U then proceeds to simulate the behaviour of M on the remaining contents of the input tape. If M halts, then U cleans up its worktape, leaving it with just the output of M , and halts too.

If we denote by $M()$ the partial function computed by machine M , and by $\langle M \rangle$ the encoding of machine M as a binary string, then we have $U(\langle M \rangle x) = M(x)$.

There are two kinds of universal Turing machine, depending on whether the input tape alphabet of the simulated machine is $\{0, 1, \#\}$ or just $\{0, 1\}$. The first kind is a *plain* Universal Turing machine; while the second is a *prefix* Universal Turing machine, which has the nice property that the set of inputs on which it halts is prefix free.

The letter U is commonly used to denote a fixed universal machine, whose type is either mentioned explicitly or assumed clear from context.