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Turing and Super-Turing Computation: From Theory to Reality

All current computers are based on the Turing Machine mathematical model, invented by one of the greatest minds of the last century: English mathematician and computer scientist, Alan Turing (1912-1954). And while many biological systems or aspects of systems are appropriately described in this manner, Turing computation can only compute what it has been programmed for; it lacks the ability to learn or adapt while it executes. This is the case with all AI and ML systems as well – they are coded and trained prior to being fielded (during their “training phase”), yet it is in contrast to biological systems. We introduce the Super-Turing computational model - capable of describing adaptation and computation found in living organisms. We explain the relationship between the two models, where Super-Turing computation can be thought of as an adaptive program calling non-adaptive Turing sub-routines. Turing himself predicted a superior computational system that would mimic natural systems and make possible more intelligent, human-like computation; Super-Turing computation may be the answer Turing sought. DARPA is actively interested in pursuing new ideas such as super-Turing computation and bringing it to reality but as well as ideas that enable lifelong continual learning.