Introduction to Computer Science Theory

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Turing Machines

A Turing machine is a finite-state machine in which each transition prints a symbol on the tape. The tape head can move in either direction. The tape is infinite to the right. A Turing machine is a septuple $T = (Q, \Sigma, \Gamma, \delta, q_0, q_{accept}, q_{reject})$ where:

- Q is a finite set of states.
- Σ is the input alphabet such that $\sqcup \notin \Sigma$.
- Γ is a finite set called the tape alphabet. $\Sigma \cup \{\sqcup\} \subseteq \Gamma$.
- δ is the transition function from $(Q - \{q_{reject}, q_{accept}) \times \Gamma$ to $Q \times \Gamma \times \{R, L\}$.
- $q_0 \in Q$ is the initial state.
- $q_{accept} \in Q$ is the accept state.
- $q_{reject} \in Q$ is the reject state.

Universal Turing Machines

Universal Turing Machines (UTMs) are Turing machines that can simulate any Turing machines. If $M = (Q, \Sigma, \Gamma, \delta, q_0, q_a, q_r)$ is a Turing machines, let $< M >$ be a binary encoding of M. Let $< M, x >$ be a binary encoding of M and input x. U is a universal turing machine if on input $< M, x >$, $U(< M, x >)$ simulates M on x.

What problems are decidable?

By the Church-Turing thesis, any problem for which an algorithm decision process exists is decidable. Turing machine $A = \{< M, x >| \, M$ on input x halts and accepts$\}$.

You can find all my notes at `http://omgimanerd.tech/notes`. If you have any questions, comments, or concerns, please contact me at alvin@omgimanerd.tech