

Simulating an NTM by a DTM

On input w , a DTM traverses the computation tree of the NTM on w .

Breadth-first search - level by level traversal.

N be a 1-tape NTM.

δ_N : its transition function.

Assume: two or zero transitions from each configuration.

Order the two transitions as the first and the second.

On input w , a 3-tape DTM D simulates N as described below.

Tape 1 of D : the input w .

Tape 2 of D : contents of N 's tape .

Tape 3 of D : a bit string that describes a path of N 's computation tree.

1. Tape 3 $\leftarrow \epsilon$;
2. Set ToNextLevel to FALSE;
3. Tape 2 \leftarrow Tape 1 ; Tape 3 \leftarrow next string; Let the length of the string on Tape 3 be k .
4. Simulate N on w for k steps guided by the bit string on Tape 3:
 (If current Tape 3 bit is 0 (1), use the first (second) immediate successor of the current transition.)
 Current move results in an accepting state : HALT and ACCEPT;
 No move possible or current move results in a rejecting state: go to step 5;
 Current move results in a non-halting state: ToNextLevel \leftarrow TRUE; go to step 5;
5. IF (this is the last path of length k) Tape 3 contains all 1's THEN
 IF ToNextLevel is TRUE THEN go to step 2;
 ELSE HALT and REJECT;
6. ELSE go to step 3;

Nondeterministic Turing Machines

Theorem: A language L is recognizable iff there is an NTM M such that $L = L(M)$.

A decider NTM halts on all branches of computations on all inputs.

Theorem: A language L is decidable iff there is a decider NTM M such that $L = L(M)$.

Simulating an NTM by a Guess-Verify NTM

N be a 1-tape NTM.

δ_N : its transition function.

Assume:

Two or zero transitions from each configuration.

Every computation path has same length t .

Order the two transitions as the first and the second.

On input w , an NTM V simulates N as described below.

1. GUESS a bit vector of length t and write on Tape 2.
2. Simulate N on w for t steps guided by the bit string on Tape 2:
(If current Tape 2 bit is 0 (1), use the first (second) immediate successor of the current transition.)
Current move results in an accepting state : HALT and ACCEPT;
No move possible or current move results in a non-accepting state: HALT and REJECT.