

Take-Home Exam

Foundations of CS

Given: 9 am, 1388-11-8

Due: 10 pm, 1388-11-10

1. Consider the following models along with their corresponding classes of languages. Define each class precisely and compare these models and the corresponding classes of languages in detail. (present your proofs along with all the details.)
 - A DFA (this is the online constant space model!).
 - A tree tape Turing machine (with input, work and output tapes) that uses only a constant amount of the work-tape for any input.
 - A deterministic Turing machine with just one readonly tape.
 - A nondeterministic Turing machine with just one readonly tape.
 - A deterministic binary Turing machine that only uses $|w|$ clocks to compute a given input w .
 - A deterministic binary Turing machine that only uses $|w|$ clocks to compute a given input w .
2. Explain the details of your discussions on the error of the proof by diagonalization given during the last session of our class for the fact that the class of CS languages is **not** closed under complementation.
3. Try to develop an algebraic theory for the model PDA and the CF languages. (Write down all your speculations.)
4. Is the class of languages that are characterized by the model DPDA the same as the class of CF languages that are inherently unambiguous? Why? (explain in details.)
5. Does there exist two r.e. sets A and B such that $A \not\leq_m B$ and $B \not\leq_m A$? Why? (explain in details.)
6. Let A be an r.e. set such that every subset of A is recursive (i.e. decidable). What can you say about A ? (explain in details.)
7. Does there exist a set A with the following properties? why? (explain in detail.)
 - The set A is recursively enumerable (r.e.).
 - Its complement A^c is infinite.
 - Its complement A^c does not contain infinite r.e. subsets.

8. Try to develop a theory of parallel computations based on a model of computation that uses a couple or more Turing machines working simultaneously. Add your discussions on the usefulness of your model and prove a number of basic results in that regard.