1997 Paper 3 Question 9

Computation Theory

Explain the action of a Turing machine, and show how the progress of a computation may be tracked by maintaining a record of the configuration at each time t. Prove that a computation which enters the same configuration twice will not terminate.

[8 marks]

Suppose you are given a Turing machine T having r states and k symbols. It is known that in a particular computation the head moves on the tape so that it is never more than l squares from its starting point. Calculate a bound on the number of configurations that the machine may enter during the computation.   [4 marks]

State a precise form of the unsolvability of the HALTing problem for Turing machines. Assuming this result, show that it is not possible to compute a bound on the distance of the head from its starting position during HALTing Turing machine computations.   [8 marks]

[You may assume that a Turing machine computation may be characterised by codes q and d that specify the quintuplet description and initial tape contents uniquely.]