मोतीलालनेहरूराष्ट्रीयप्रौद्योगिकीसंस्थानइलाहाबाद प्रयागराज–211004 (भारत)

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Unit: V – Numerical Assignment

1. Let φ = E[p U (q ∧ EX r)]. Show how this formula can be broken down using fixed point expressions. Explain how nested fixed points can be evaluated in model checking.
2. Assume you have a finite Kripke structure with 5 states and transitions forming a DAG (no cycles). Design an algorithm to compute EF φ using fixpoint iteration. Now suppose φ holds in exactly one sink state. How many iterations would it take (in the worst case) for the fixpoint to converge? Justify.
3. Prove using the fixed point formulation that: E[p U q] ≡ q ∨ (p ∧ EX E[p U q])
   Clearly define the fixpoint function involved. Demonstrate how the recursive formulation corresponds to a least fixpoint computation.
4. Consider a CTL formula EG p. Let the following transition system be defined:
   - States: s0, s1, s2
   - Transitions: s0 → s1, s1 → s2, s2 → s0
   - Labeling: All states satisfy p

   Using the greatest fixpoint characterization of EG p, show how the fixpoint is computed iteratively. Does EG p hold in s0? Justify each step.
5. Given the following Kripke structure with atomic propositions {p, q}:

   States and transitions:

   - S0 → S1, S0 → S2
   - S1 → S1
   - S2 → S3
   - S3 → S3

   Labeling:
   - L(S0) = {p}, L(S1) = {p}, L(S2) = {q}, L(S3) = {q}

   Apply the CTL model checking algorithm to determine whether the formula E[p U q] holds in state S0. Explain each step of the fixpoint iteration and show the evolution of the set of states satisfying the formula.

*Note: Also complete the theory questions given in the lecture slides of 5^{th} unit.

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