Assignment 6: Branching-Time Properties
15-414/15-424 Bug Catching: Automated Program Verification

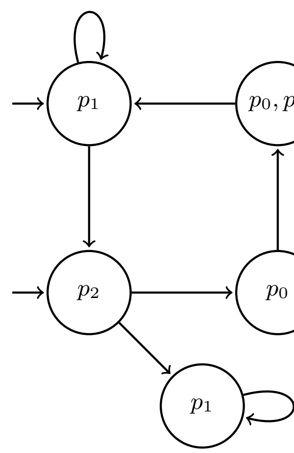
Due: **11:59pm**, Friday 12/1/17
Total Points: 50

1. **Unfinished business (5 points).** Complete the proof of Theorem 3 from Lecture 22 by proving that $[\![\mathbf{EF}P]\!]$ is the least fixpoint of $[\![P]\!] \cup \tau_{\mathbf{EX}}([\![\mathbf{EF}P]\!])$.

2. **Computation tree semantics (5 points).** Consider the computation structure K below, and the CTL formula:

$$\mathbf{A}(p_0 \mathbf{U} p_1) \vee \mathbf{EX}(\mathbf{AG}p_1)$$

For each state in the computation structure, write down the subformulas of the above CTL satisfied by the state. Then, say whether the structure satisfies the formula, i.e. $K \models \mathbf{A}(p_0 \mathbf{U} p_1) \vee \mathbf{EX}(\mathbf{AG}p_1)$. To make sure that you understand the CTL model checking algorithm from Lecture 22, you are encouraged to apply the Tarski-Knaster fixpoint theorem to arrive at your answers.



3. **Both P and $\neg P$ (5 points).** Recall that a computation structure $K = (W, \curvearrowright, v)$ with initial states $W_0 \subseteq W$ satisfies a CTL formula P if and only if each initial state $s \in W_0$ satisfies P:

$$K \models P \text{ if and only if } \forall s_0 \in W. s_0 \models P$$

This definition has a strange property, where it is possible that a given structure K there exists a formula P where $K \not\models P$ and $K \not\models \neg P$. Find a CTL formula and (simple) transition system for which this is the case.