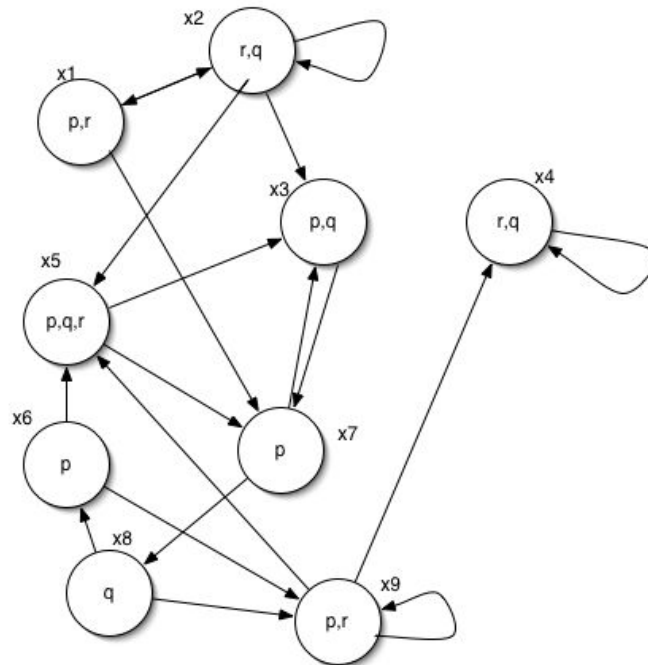


# Final Exam Sample Problems: Part I

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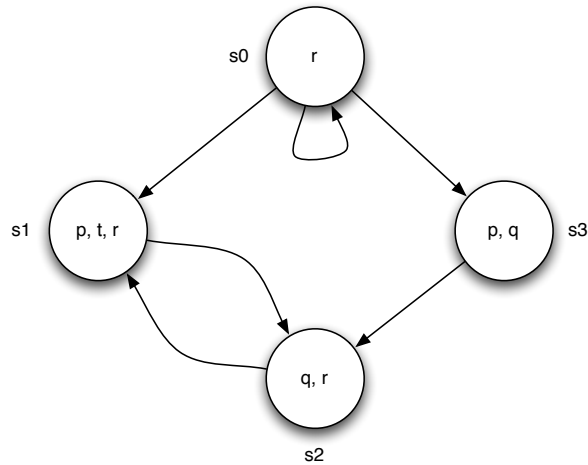
## 1 Propositional Modal Logic



1. Find all worlds satisfying:
  - (a)  $x \Vdash \Diamond(p \wedge q)$ ;
  - (b)  $x \Vdash \Box(p \vee r)$ ;
2. Does  $x_1 \Vdash \Diamond\Box q$ ? Show why or why not.
3. Does  $x_7 \Vdash \Box\Box\Diamond p$ ? Show why or why not.
4. Does  $x_9 \Vdash \Diamond(r \vee \Diamond p)$ ? Show why or why not.
5. Decide whether the following formulas are valid in the model:
  - (a)  $\Diamond p \vee \Diamond q$
  - (b)  $\Box(r \wedge \Diamond p)$

## 2 Linear Temporal Logic

Consider the system  $M$ , shown below:



Determine whether  $M, s_0 \models \phi$  and  $M, s_2 \models \phi$  hold and justify your answer where  $\phi$  is the LTL formula:

- (a)  $\neg p \rightarrow r$
- (b)  $Ft$
- (c)  $G(r \vee q)$
- (d)  $X(F(t \vee q))$

### 3 Computation Tree Logic

The following questions use computational tree logic. For your convenience, we have given you what each of the operators mean:

**A:** along all paths

**E:** along at least one path

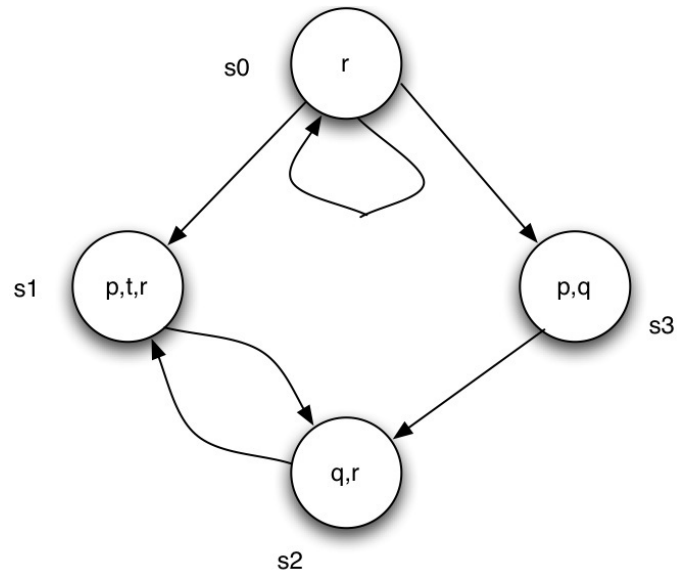
**X:** next state

**F:** some future state

**G:** all future states including the current state

**U:** until

Use the following model to answer the questions below:



1. Does  $s0 \models AFt$ ? Show why or why not.
2. Does  $s0 \models \neg EGr$ ? Show why or why not.
3. Does  $s0 \models E(tUq)$ ? Show why or why not.
4. Does  $s0 \models AG(r \vee q)$ ? Show why or why not.
5. Decide whether the following formula is valid in the model:  $AFq$