1 LTL

1. The LTL formulas f and g are equivalent, denoted $f \equiv g$, if for all transition systems TS,

$$TS \models f \text{ iff } TS \models g.$$

   (a) $\Diamond(f \wedge g) \equiv \Diamond f \wedge \Diamond g$?

   (b) $\Diamond \bigcirc f \equiv \bigcirc \Diamond f$?

2. Safety properties are characterized by "nothing bad ever happens." For example, "a red light is immediately preceded by amber" is a safety property. How can we express this property in LTL?

3. Liveness properties are characterized by "something good eventually happens." For example, "the light is infinitely often red" is a liveness property. How can we express this property in LTL?

2 CTL

1. How to express "Each red light is preceded by an amber light" in CTL?

2. How to express "The light is infinitely often green" in CTL?

3. Recall that

$$\exists \Diamond f = \exists(\text{true } \mathsf{U}\ f).$$

How is

$$s \models \exists \Diamond f$$

defined?

4. Recall that

$$\forall \Diamond f = \forall(\text{true } \mathsf{U}\ f).$$

How is

$$s \models \forall \Diamond f$$

defined?

5. Recall that

$$\exists \Box f = \neg \forall(\text{true } \mathsf{U}\ \neg f).$$

How is

$$s \models \exists \Box f$$

defined?

6. Recall that

$$\forall \Box f = \neg \exists(\text{true } \mathsf{U}\ \neg f).$$

How is

$$s \models \exists \Box f$$

defined?