CS 512 Formal Methods, Spring 2018	Instructor: Assaf Kfoury
CTL Examples	
February 15, 2018	Shreya Ramesh

(These lecture notes are **not** proofread and proof-checked by the instructor.)

1 Detailed solution for Assignment 3, Problem 1, Part e

Part e formula: $\varphi \triangleq (\bigcirc(a \wedge b) \wedge \diamond(\neg a \wedge \neg b))$

Here, $AP = \{a, b\}$.

1.1 Part i

We can split up the formula into subformulas as follows:

- $a \wedge b$ evaluates to q_4.
- $\bigcirc q_4$ evaluates to q_3. Therefore the left side of the formula evaluates to the ω-regular expression $(q_3q_4)^+q_3$.
- $\neg a \wedge \neg b$ evaluates to q_1.
- $\diamond q_1$ evaluates to $(q_3q_4)^*q_3q_1q_2^\omega$.
- Now, because of the $\wedge$ we need to find the common terms between the left and right paths. This ends up being $(q_3q_4)^+q_3q_1q_2^\omega$.

1.2 Part ii

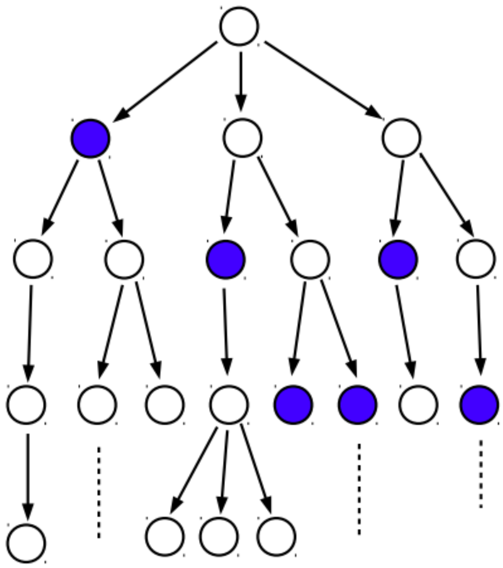
- No, because the path $q_3q_2^\omega$ is missing.

2 Example of visualization of behavior of temporal connectives (Based on Handout 11)

Consider the example where $AP = p, q$.

- An empty node can be denoted as $\bar{p}\bar{q}$.
- A blue node can be denoted as $p\bar{q}$.
- A red node can be denoted as $\bar{p}q$.

Below is another way of visualizing the constraint $\forall \diamond p$, which can be translated as "for all eventually". The cross section in the image below denotes the point where p is eventually entered in the path.



3 Algorithm for CTL Model Checking (Handout 13)

A useful technique for reducing/simplifying transition systems is to pre-process. For example, consider all the sub-WFFs of Φ. Consider sub-WFF φ_0. By deleting all the states where φ_0 = false, we can potentially greatly reduce the space of our transition system, and make the problem simpler.

4 Dining Philosophers Problem represented in CTL

Assume $AP = \{e_1, f_1, e_2, f_2, ...e_5, f_5\}$ where e_i means philospher i is eating and f_1 means philosopher i is finished eating.

- Better way of writing Property 2 on Handout 12, page 4: $\forall((\neg e_1 \wedge \neg e_3 \wedge \neg e_4 \wedge \neg e_5) \Cup e_2)$
- Property 4 on Handout 12, page 4 is an example of the liveness property.