SOEN 331 - S and U: Introduction to Formal Methods for Software Engineering

Assignment 4 on Temporal Logic

Dr. Constantinos Constantinides, P.Eng.

constantinos.constantinides@concordia.ca

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1 General information

Date posted: Monday 5 April, 2020.

Date due: Monday 19 April, 2020, by 23:59.

Weight: 25% of the overall mark.

2 Introduction

This is a team assignment. Each team should designate a leader who will submit the assignment electronically. There are 2 problems in this assignment, with a total of 50 points. You must prepare all your solutions in LaTeX and produce a single `pdf` file. Please make sure you include all names and id's of all contributing team members as the authors. Name the file after your team, e.g. `team1.pdf`.

3 Ground rules

This is an assessment exercise. You may not seek any assistance while expecting to receive credit. **You must work strictly within your team and seek no assistance for this project (from the instructor, the teaching assistants, fellow classmates and other teams or external help)**. Please note that you should **not** discuss the assignment during tutorials. Failure to do so will result in penalties or no credit.

All team members are expected to work relatively equally on each aspect of the problem. The team leader has the responsibility to ensure that the team does not violate this rule. Failure to do so will result in penalties. In your submission, you must include only the names of those people who contributed to the assignment. Accommodating someone who did not contribute will result in penalties.

If there is any problem in the team (such as lack of contribution, etc.), the team leader must contact the instructor as soon as the problem appears.

Problem 1 (18 pts): Analyzing program behavior

The behavior of a program is expressed by the following temporal formula:

$$\Box \left[\begin{array}{c} \textbf{start} \rightarrow \neg a \vee \neg b \\ \textbf{start} \rightarrow c \oplus d \\ b \vee d \rightarrow \bigcirc (x \ \mathcal{R} \ y) \\ (a \wedge d \wedge \bigcirc y) \rightarrow \bigcirc^4 x \\ (x \wedge y) \rightarrow \bigcirc (w \oplus z) \\ (a \wedge c) \rightarrow (e \ \mathcal{W} \ g)) \\ c \rightarrow \bigcirc^4 g \\ (x \wedge y \wedge \bigcirc z) \rightarrow \bigcirc n \\ x \wedge \bigcirc (z \wedge n) \rightarrow \bigcirc^2 (b \wedge d) \end{array} \right]$$

1. (12 pts) Visualize all models of behavior.
2. (6 pts) Specify conditions (model of behavior), if any exist, under which the program can terminate. If none exist, please indicate so.

Problem 2 (32 pts) : Visualizing temporal expressions

Provide a description and a visualization of each of the following expressions:

1. $\Box\phi \rightarrow \Diamond\psi$
2. $\Box\phi \rightarrow \bigcirc\Box\Diamond\psi$
3. $(\phi \wedge \bigcirc\psi) \rightarrow \Diamond\Box\tau$
4. $((\psi \wedge \bigcirc\chi) \rightarrow \bigcirc\tau)$
5. $(\chi \wedge \bigcirc\omega) \rightarrow \bigcirc^2(\phi \,\mathcal{U}\, \psi)$
6. $(\phi \oplus \psi) \rightarrow \Box\omega$
7. $\chi \wedge \bigcirc(\chi \wedge \psi) \rightarrow \Diamond\omega$
8. $$\begin{bmatrix} (\chi \wedge \bigcirc^2\psi) \rightarrow \bigcirc^2(\tau \,\mathcal{W}\, \omega) \\ \\ \mu \rightarrow \bigcirc^5\omega \end{bmatrix}$$

4 What to submit

You must use LaTeX to produce a **pdf** file named after the id of the person to submit, e.g. `123456.pdf`.

Please submit your `pdf` file at the Electronic Assignment Submission portal

(`https://fis.encs.concordia.ca/eas`)

under **Theory Assignment 4**.

END OF ASSIGNMENT.
