You will submit your homework to Gradescope. Your submission will consist of a single pdf with your answers for written questions (denoted by the ✍ symbol).

**Important:** Remember, your written part must be typeset (e.g., \LaTeX or Word).
Problem 1: Do elephants play chess?

(i) Read the paper by Brooks [1] on why elephants don’t play chess! Review the paper by providing
  • a summary of the main points in your own words,
  • a discussion of the advantages and disadvantages of the overall approach from the viewpoint of designing system architectures!
Problem 2: Specifications and Model Checking

(i) Explain if the linear temporal logic specification $F (\psi_1 \Rightarrow \psi_2)$ is equivalent to $\text{true} \; U \; (\psi_1 \lor \neg \psi_2)$.

(ii) For each specification below, explain if it formalizes the following statement or not: “One might enter Stanford Stadium in the next state only if they have a game ticket or they are a Stanford student in the current state.”

   **Note:** The predicate “GameTicket” indicates having a game ticket, “StanfordStudent” indicates being a Stanford student, and “StanfordStadium” indicates entering the Stadium (not eligibility to enter the stadium).

   (a) $\text{G} \; ((\text{GameTicket} \lor \text{StanfordStudent}) \; U \; \text{StanfordStadium})$
   (b) $\text{G} \; ((\text{GameTicket} \lor \text{StanfordStudent}) \Rightarrow \text{X} \; \text{StanfordStadium})$
   (c) $\text{G} \; ((\neg \text{X} \; \text{StanfordStadium}) \Rightarrow \neg (\text{GameTicket} \lor \text{StanfordStudent}))$
   (d) $\text{G} \; ((\neg \text{GameTicket} \land \neg \text{StanfordStudent}) \Rightarrow \text{X} \; \neg \text{StanfordStadium})$
   (e) $\text{G} \; (\text{StanfordStadium} \Rightarrow (\text{GameTicket} \lor \text{StanfordStudent}))$
   (f) $\text{G} \; ((\text{X} \; \text{StanfordStadium}) \Rightarrow (\text{GameTicket} \lor \text{StanfordStudent}))$

(iii) For each specification below, explain if it formalizes the following statement: “One can take CS237B at most once.”

   **Note:** The predicate “CS237B” indicates taking CS237B (not eligibility to take it!).

   (a) $(F \; \text{CS237B}) \; U \; (G \; \neg \text{CS237B})$
   (b) $G \; ((F \; \text{CS237B}) \Rightarrow \neg \text{CS237B})$
   (c) $G \; ((X \; \text{CS237B}) \Rightarrow \neg \text{CS237B})$
   (d) $\text{CS237B} \land XG \; \neg \text{CS237B}$
   (e) $\text{CS237B} \; U \; (G \; \neg \text{CS237B})$
   (f) $(F \; \text{CS237B}) \land (FG \; \neg \text{CS237B})$

(iv) Consider a state machine $M$ whose transitions are:

   
   $s_t = \begin{cases} 
   0 & \text{if } a_t \leq b_t, \\
   1 & \text{otherwise.}
   \end{cases}$

   $a_{t+1} = \begin{cases} 
   a_t + 1 \mod 10 & \text{if } s_t = 0, \\
   a_t & \text{otherwise.}
   \end{cases}$

   $b_{t+1} = \begin{cases} 
   b_t + 1 \mod 10 & \text{if } s_t = 1, \\
   b_t & \text{otherwise.}
   \end{cases}$

   for time index $t \geq 0$ with $a_0 = b_0 = 0$. Explain if the following specifications are true or not:

   (a) $FG \; (s = 0)$
   (b) $GF \; (s = 1)$
References