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

(i) Read the paper by Eppner et al [1] on lessons learned from the Amazon Picking Challenge. 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 $true \ U (\psi_1 \lor \neg \psi_2)$.

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

(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) $G ((XF \text{CS237B}) \Rightarrow \neg \text{CS237B})$
(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