

Check whether the following model satisfies the STL formulas

- $AG(Start \rightarrow AF\ Heat)$

• $AG(Start \rightarrow AF\ Heat)$

Using SAT(Φ) function

$$\begin{aligned}
 & SAT(AG(Start \rightarrow AF\ Heat)) \\
 &= SAT(\neg EF \neg (Start \rightarrow AF\ Heat)) \\
 &= S \setminus SAT(EF \neg (Start \rightarrow AF\ Heat)) \\
 &= S \setminus SAT(ETU \neg (Start \rightarrow AF\ Heat)) \\
 &= S \setminus SAT_{EU}(T, \neg (Start \rightarrow AF\ Heat)) \\
 & SAT(T) = S \\
 & SAT(\neg (Start \rightarrow AF\ Heat)) = S \setminus SAT(Start \rightarrow AF\ Heat) \\
 &= S \setminus SAT(\neg Start \vee AF\ Heat) \\
 &= S \setminus (SAT(\neg Start) \cup SAT(AF\ Heat)) \\
 &= S \setminus ((S \setminus SAT(Start)) \cup SAT_{AF}(Heat)) \\
 &= S \setminus ((S \setminus \{2, 5, 6, 7\}) \cup SAT_{AF}(Heat)) \\
 &= S \setminus (\{1, 3, 4\} \cup SAT_{AF}(Heat)) \\
 &= S \setminus (\{1, 3, 4\} \cup \{4, 7\} \cup \{1, 2, 3, 4, 5, 6, 7\}) \\
 &= S \setminus \{\cancel{1, 2, 3, 4}, \cancel{7}\} \setminus \{1, 3, 4, 7\} \\
 &= \cancel{\{2, 5, 6\}} \\
 &\Rightarrow SAT_{EU}(T, \neg (Start \rightarrow AF\ Heat)) = \emptyset \\
 &\Rightarrow SAT(AG(Start \rightarrow AF\ Heat)) = S \setminus \emptyset = S \\
 &SO\ AG(Start \rightarrow AF\ Heat) \text{ satisfies CTL formula.}
 \end{aligned}$$

not

- $AG(A[\neg Error \cup (AF\ Close)])$



$$AG(A[\neg Error \cup (AF Close)])$$

using SAT(Φ) function:

$$\begin{aligned} & SAT(AG(A[\neg Error \cup (AF Close)])) \\ &= SAT(\neg EF \neg (A[\neg Error \cup (AF Close)])) \\ &= S \setminus SAT(EF \neg (A[\neg Error \cup (AF Close)])) \\ &= S \setminus SAT(E[T \cup \neg (A[\neg Error \cup (AF Close)])]) \\ &= S \setminus SAT_{EU}(T, \neg (A[\neg Error \cup (AF Close)])) \end{aligned}$$

$$SAT(T) = S$$

$$\begin{aligned} & SAT(\neg (A[\neg Error \cup (AF Close)])) \\ &= S \setminus SAT(A[\neg Error \cup (AF Close)]) \\ &= S \setminus SAT(\neg (E[\neg \neg Error \cup (\neg \neg Error \wedge \neg AF Close)] \vee EG \neg (AF Close))) \\ &= S \setminus SAT(\neg (E[Error \cup (Error \wedge \neg (AF Close))] \vee EG \neg (AF Close))) \\ &= SAT(E[Error \cup (Error \wedge \neg (AF Close))] \vee EG \neg (AF Close)) \\ &= SAT(E[Error \cup (Error \wedge \neg (AF Close))]) \cup SAT(EG \neg (AF Close)) \\ &= SAT_{EU}(Error, Error \wedge \neg (AF Close)) \cup SAT(\neg AF(AF Close)) \\ &= SAT_{EU}(Error, Error \wedge \neg (AF Close)) \cup (S \setminus SAT_{AF}(AF Close)) \\ &= SAT_{EU}(Error, Error \wedge \neg (AF Close)) \cup (S \setminus SAT_{AF}(AF Close)) \end{aligned}$$

$$\begin{cases} SAT(Error) = \{2, 5\} \end{cases}$$

$$\begin{aligned} SAT(Error \wedge \neg (AF Close)) &= SAT(Error) \cap SAT(\neg (AF Close)) \\ &= \{2, 5\} \cap (S \setminus SAT_{AF}(AF Close)) \\ &= \{2, 5\} \cap (S \setminus SAT_{AF}(Close)) \\ &= \{2, 5\} \cap (S \setminus \{1, 2, 3, 4, 5, 6, 7\}) \\ &= \{2, 5\} \cap \emptyset = \emptyset \end{aligned}$$

$$\Rightarrow SAT_{EU}(Error, Error \wedge \neg (AF Close)) = \{2, 5\}$$

$$SAT_{AF}(Close) = \{1, 2, 3, 4, 5, 6, 7\}$$

$$SAT_{AF}(AF Close) = \{1, 2, 3, 4, 5, 6, 7\} \Rightarrow S \setminus SAT_{AF}(AF Close) = S \setminus \{1, 2, 3, 4, 5, 6, 7\} = \emptyset$$

$$\Rightarrow SAT(\neg (A[\neg Error \cup (AF Close)]))$$

$$= \emptyset \cup \emptyset = \emptyset$$

$$\Rightarrow SAT(AG(A[\neg Error \cup (AF Close)]))$$

$$= S \setminus \emptyset = S$$

so $AG(A[\neg Error \cup (AF Close)])$ satisfies CTL formula