

# Model Checking Homework 5

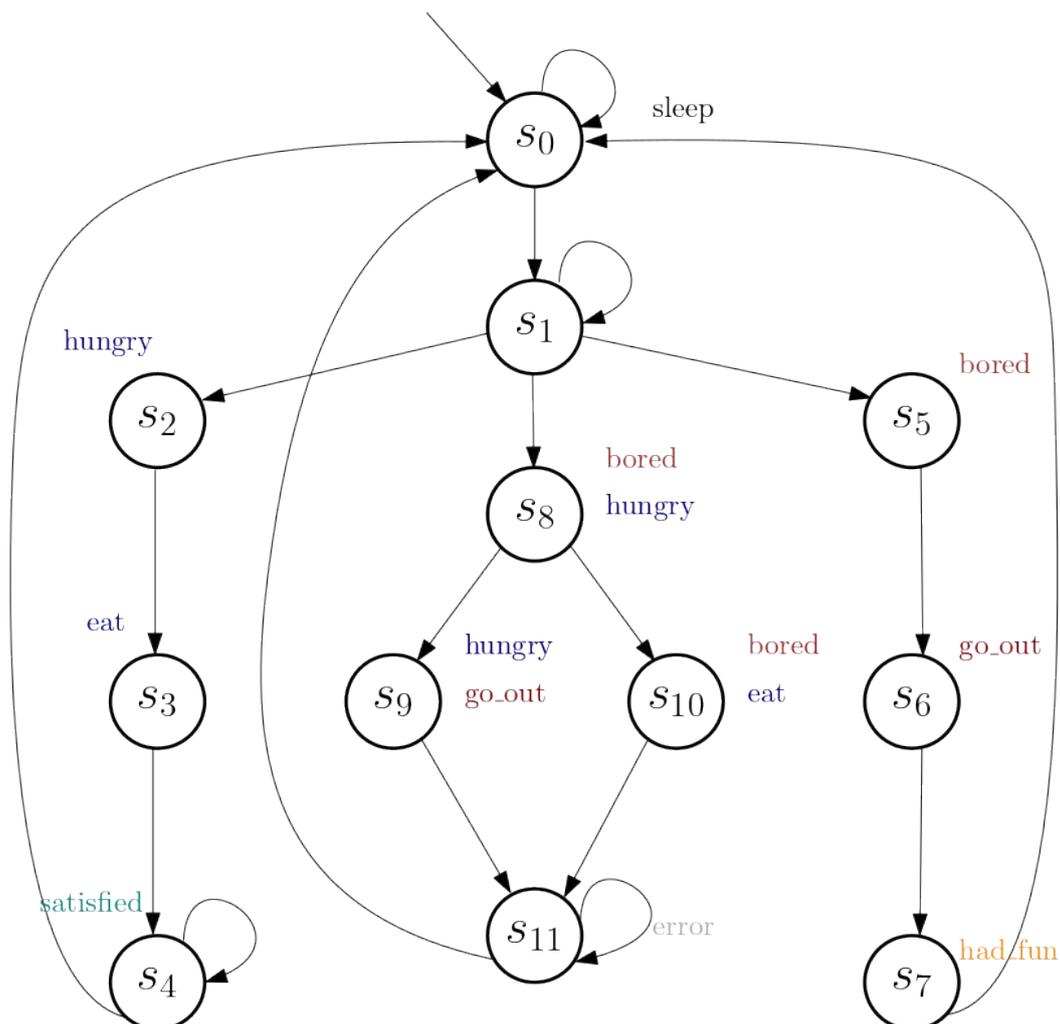
**Deadline: 14 April 2022 4:00pm**

**Send solution to:** [modelchecking@iaik.tugraz.at](mailto:modelchecking@iaik.tugraz.at)

Tempesta is a cheerful and simple dog. She is so simple that her behaviour can be represented by a Kripke structure with just 12 states (see figure). Every hour Tempesta undergoes a transition available from whatever state she is in. The atomic propositions  $AP = \{\text{sleep, hungry, bored, eat, go\_out, satisfied, had\_fun, error}\}$  indicate her activity.

This is a description of her behaviour:

Tempesta starts the day asleep ( $s_0$ ). At each hour, she might wake up ( $s_1$ ), and in the next hour might be hungry ( $s_2$ ), bored ( $s_5$ ) or both ( $s_8$ ). If she is only hungry, she will eat ( $s_3$ ), be satisfied ( $s_4$ ) and remain satisfied until she sleeps again ( $s_0$ ). If she is only bored, she will go out ( $s_6$ ), have fun ( $s_7$ ) and be so tired that she directly goes to sleep ( $s_0$ ). If she is bored and hungry at the same time, she will either try to go out while hungry ( $s_9$ ) or eat while bored ( $s_{10}$ ), but she will not manage and thus will enter into an error state ( $s_{11}$ ), in which she will remain until she goes to sleep ( $s_0$ ).



**Task 4a [8 points \*].** Translate these sentences to CTL\* formulas. Indicate for each formula whether it is in CTL, LTL, both or neither. Indicate also if the Kripke structure in the figure satisfies your sentence, and give an informal explanation of why.

1. From any state, Tempesta will eventually be hungry, and once she is hungry, she will eventually be satisfied in the future.
2. When Tempesta is hungry and not bored, she will sleep before reaching an error.
3. It is possible that Tempesta never wakes up from her sleep.
4. It is possible that Tempesta never stops eating.
5. Before Tempesta goes to sleep forever, which will eventually happen, she will have eaten.
6. It can be the case that Tempesta is asleep, and continues asleep for two hours more.
7. In any case, after Tempesta eats she is satisfied
8. When Tempesta wakes up, she requires at least 2 hours to sleep again
9. It is possible that Tempesta is infinitely often hungry and finitely often bored.

(\*) Each sentence is worth 1 point, there are 9 sentences, so you are allowed one mistake.

**Task 4b [2 points].** Tempesta wants to improve herself to enter her error state less often. When she is hungry and bored, if she decides to eat, she will (1) suppress the boredom while eating, (2) go out later and then (3) be satisfied and tired, (4) go to sleep. Write a modified Kripke structure that implements this new behaviour. From the previous sentences, is there any that the previous model of Tempesta did not satisfy and this new model satisfies? If so, which one?