Modelling and Verification 2008
Take-Home Celebratory Exam

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This exam is meant of a celebration of the learning outcomes and skills you have mastered over the last six weeks. In addition, it will give you an opportunity to learn something new and to improve on your understanding of the main notions we studied during our course sessions.

The exercises in this exam set should be completed by the project and exercise-session groups of students following the course. Each group should return *one* solution to the lecturer in the form of a PDF file by

Friday, 21 November 2008, at 16:00.

The take-home exam will account for 40% of your final mark for the overall course. Each group member will receive the same grade for the exam.

Please ensure that your solutions are *readable and clear*. Justify your answers carefully. This does *not* mean that your answers should be lengthy, but that they should be convincing. When you write an answer to a question, ask yourself 'Would I be convinced by this argument myself if somebody else were to explain this to me?' If the answer is negative, then make an effort to clarify your argument.

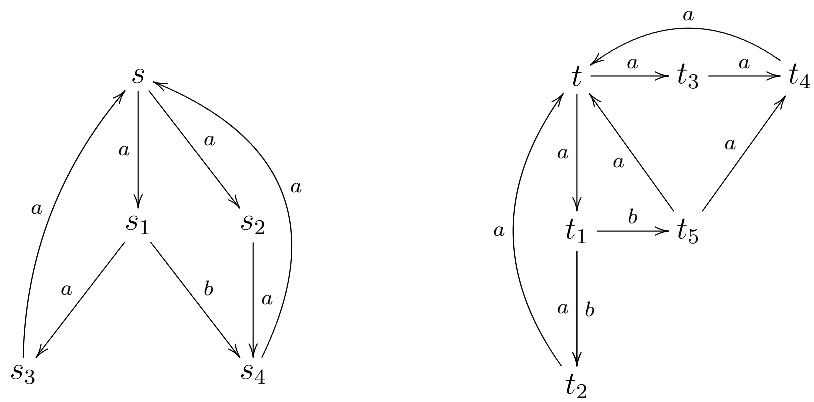
Acknowledge all sources, including others in the class from whom you obtained ideas. Note, however, that the solutions should be your own and that no form of plagiarism will be condoned. Failure to respect this policy will be considered a violation of the Code of Academic Integrity and will result in the group's grade being reduced by at least 40%.

If you are unsure about anything, please ask.

Good luck!

Exercise 1 (6 points)

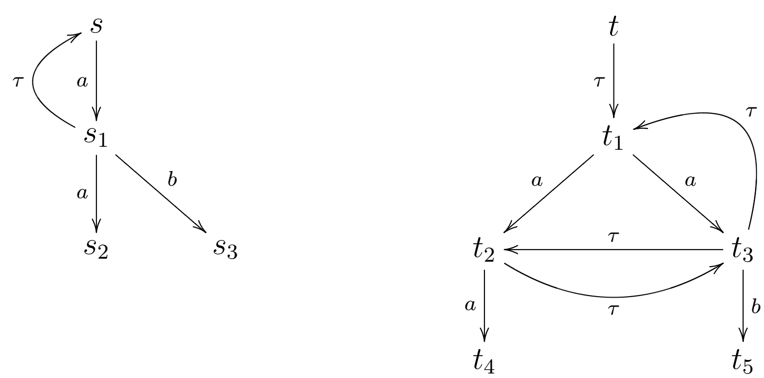
Consider the following labelled transition system.



1. Show that $s \not\sim t$ by giving a winning strategy for the attacker in the strong bisimulation game.
2. Find a formula in Hennessy-Milner logic that is satisfied by t, but not by s.

Exercise 2 (4 points)

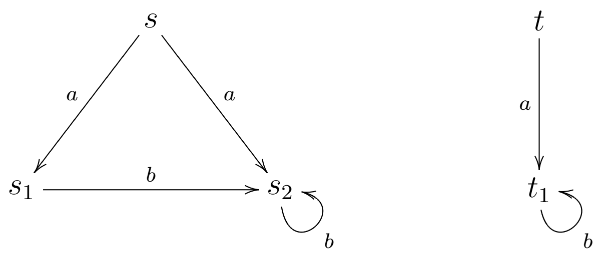
Consider the following transition system.



Show that s and t are weakly bisimilar by constructing a weak bisimulation that relates those two states.

Exercise 3 (6 points)

Consider the following labelled transition system.



1. (3 points) Compute the set of processes in the labelled transition system above that satisfy the property
$$Y \stackrel{\min}{=} \langle b \rangle tt \vee \langle \{a, b\} \rangle Y \ .$$

2. (3 points) Compute the set of processes in the labelled transition system above that satisfy the property
$$X \stackrel{\max}{=} \langle b \rangle tt \wedge [\{a, b\}] X \ .$$

Exercise 4 (9 points)

In Hyman's algorithm for mutual exclusion, there are two processes P_1 and P_2, two boolean variables b_1 and b_2 and an integer variable k that may take the values 1 and 2. The boolean variables b_1 and b_2 have initial value false, whereas the initial value of the variable k can be arbitrary.

Each process P_i ($i \in \{1, 2\}$) executes the algorithm in Figure 1, where we use j to denote the index of the other process.

while true do
begin
  'noncritical section';
  $b_i :=$ **true**;
  while $k \neq i$ **do begin**
        while b_j **do skip**;
        k:=i
      end;
  'critical section';
  $b_i :=$ **false**;
end

Figure 1: The pseudocode for Hyman's algorithm

Read Chapter 7 in the textbook up to Section 7.2 included. Make a model of Hyman's mutual exclusion algorithm using the version of the CWB you prefer to use, and argue that the algorithm does *not* preserve mutual exclusion.

Exercise 5 (8 points)

The icing on the cake for those aiming at top marks!

Solve Exercise 3.18 in the textbook. The solutions to questions 1–3 are worth two points each and so is an answer to the last question.