

## Concurrency Theory

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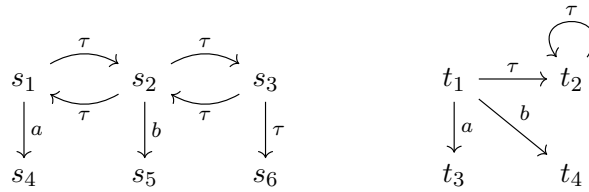
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### Sheet 3

Due: Monday, 2025-11-17

#### Exercise 3.1

Consider the two LTS below:



Show that  $s_1 \approx t_1$  by constructing a weak bisimulation.

#### Exercise 3.2

Prove or disprove the statements below:

$$a.\tau.nil \sim \tau.a.nil$$

$$a.\tau.nil \approx \tau.a.nil$$

#### Exercise 3.3

Prove that  $P + \tau.P \approx \tau.P$  for all CCS processes  $P$ .

#### Exercise 3.4

In the weak bisimulation game the attacker is only allowed to use  $\xrightarrow{a}$  moves, but the defender is allowed to use  $\xRightarrow{a}$  moves. Give an argument why letting the attacker use  $\xRightarrow{a}$  moves would not make the attacker more powerful.

#### Exercise 3.5

Define two CCS processes  $A$  and  $B$  such that

- $LTS(A)$  has an infinite number of states,
- $LTS(B)$  has a finite number of states
- $A \sim B$  is false (no proof needed)
- $A \approx B$  is true (no proof needed)

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If you have questions, please post a message in the dedicated [chat](#).

Bonus: prove that  $A \approx B$  is true, but  $A \sim B$  is false.

**Exercise 3.6** (Bonus)

We want to model a simple communication protocol between a sender and a receiver. The sender accepts data and the receiver delivers the data. We want to implement this specification via a medium that transmits the data between sender and receiver.

Consider the following CCS definition for the specification and implementation of this communication protocol:

$\text{ProtocolSpec} \doteq \text{acc}.\overline{\text{del}}.\text{ProtocolSpec}$

$\text{Protocol} \doteq (\text{Send} \parallel \text{Med} \parallel \text{Rec}) \setminus \{\text{send}, \text{err}, \text{trans}, \text{ack}\}$

$\text{Send} \doteq \text{acc}.\text{Sending}$

$\text{Med} \doteq \text{send}.\text{Trans}$

$\text{Rec} \doteq \text{trans}.\text{Del}$

$\text{Sending} \doteq \overline{\text{send}}.\text{Wait}$

$\text{Trans} \doteq \tau.\text{Err} + \overline{\text{trans}}.\text{Med}$

$\text{Del} \doteq \overline{\text{del}}.\text{Ack}$

$\text{Wait} \doteq \text{ack}.\text{Send} + \text{err}.\text{Sending}$

$\text{Err} \doteq \overline{\text{err}}.\text{Med}$

$\text{Ack} \doteq \overline{\text{ack}}.\text{Rec}$

Show that  $\text{Protocol}$  is an implementation of  $\text{ProtocolSpec}$  by showing that  $\text{Protocol} \approx \text{ProtocolSpec}$  is true.