

# CCS and equivalences

José Proença & Renato Neves  
pro@isep.ipp.pt & nevrenato@di.uminho.pt

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TPC-1

## To do

Solve the exercises and produce a PDF with your answers.

## How to submit via email

Please send it by email (pro@isep.ipp.pt) with the name "cpc2223-N.pdf", where "N" is your student number. The subject of the email should be "cpc2223 N TPC-1".

## Valorization questions

Questions marked with **[Hard]** are valorization questions. These have very small marks when compared with the other questions and are meant to be more difficult.

## Deadline

7 April 2023 @ 23:59 (Friday)

## CCS analysis

**Exercise 1.** For each of the CCS processes below, **draw** its transition system.

1.1.  $A = a.b.0$

1.2.  $B = A + a.0$

1.3.  $C = (B || c.d.A) \setminus \{d\}$

**Exercise 2.** Recall  $A$  and  $B$  processes from Ex. 1.

2.1. **Prove** that  $A \lesssim B$  or **explain** why not.

2.2. **Prove** that  $B \lesssim A$  or **explain** why not.

2.3. **Prove** that  $A \sim B$  or **explain** why not.

**Exercise 3. [Hard]** Prove that, for all CCS processes  $P$  and  $Q$ :

$$P + Q \sim Q + P$$

## CCS modelling

**Exercise 4.** Consider the 5 components below.

- **T**: A temperature sensor that periodically sends a temperature value;
- **H**: A humidity sensor that periodically sends a humidity value;
- **C**: A clock that sends a timestamp with the current time;
- **O**: An orchestrator that receives a temperature value, followed by a humidity value and by a timestamp, and in the end sends this data package;
- **D**: A display that receives data from the orchestrator and displays the content.

Consider each underlined word above to be an action of our CSS processes.

**4.1. Specify** each of these 5 components in CCS and **draw** their transition system.

**4.2. Specify** a new component **S** of this system, which composes the 5 components above in parallel, imposing synchronisation of all actions except display.

**4.3. Propose** a variation of a similar system **S2** in CCS with no orchestrator. In this variation:

1. the humidity sensor informs the temperature sensor, then
2. the temperature sensor informs the timestamp, then
3. the timestamp sends the whole data to the display; and finally
4. the display prompts the humidity sensor to restart the process.

**4.4. [Hard]** Experiment with the tool mCRL2 (<https://mcr12.org>). Use it to **validate** your **S** and **S2** definitions above.