

## A2: Analysing behaviour

### Crossing the river – Part 2

David Pereira & José Proença

RAMDE – 2021/2022

#### To do

Produce a report as a PDF document including the answers to the exercises below. Continue to work in your git repository – you will need the 3 files produced in your last assignment: `farmer1.mcrl2`, `farmer2.mcrl2` and `farmer3.mcrl2`.

#### What to submit

The PDF report and a new `vending.mcrl2` file (for Exercise 3), placed in your group's git repository. Recall that **all students should push commits**.

#### Deadline:

TBD

## Verification of the farmer-fox-goose-beans problem

Recall the specifications in the `farmer1`, `farmer2`, and `farmer3` projects from the modelling exercises (<https://cister-labs.github.io/ramde2122/assignments/a2-modelling.pdf>) You will now verify properties of these systems. In `mcrl2ide`, a property can be written using **Tools>Add Property**. There are 2 types of properties: **Equivalence** and **Mu-Calculus**, covered by this assignment.

## LTS Equivalence

**Exercise 1.** Create variations of the Sys processes in `farmer1` and `farmer2` and compare them to the originals as follows.

**1.1.** Create a new process `SysHide` in both `farmer1` and `farmer2` equal to `Sys` but hiding all allowed actions except `win` (using `hide`). **Show the resulting `SysHide` processes for each file.**

**1.2.** Combine both specifications of `farmer1` and `farmer2` in a single specification. Rename `Sys` from `farmer1` to `Sys1` and `SysHide1`, and similarly for `Sys` from `farmer2`. Redefine the function `ok` by setting it to `true`, i.e., define `ok(fm,f,g,b)=true;`.

Visualise the processes `SysHide1` and `SysHide2`. Compare them using strong bisimulation by adding a new **Equivalence** property that compares them. **What can you conclude?**

## Verification of properties

**Exercise 2.** Answer the questions below on the use of mu-calculus for specifying properties in mCRL2.

**2.1.** What does the property “[true\*]<ready>true” mean? Does it hold in any of these 2 LTSs?

**2.2.** Does the property “[true\*.foxr.win]false” holds for **farmer1**? Does the equivalent property “[true\*.fox(right).win]false” holds for **farmer2**? What can you conclude?

**2.3.** Consider now the extended system **farmer3**. In this example there is a an extra process called Counter(n:Nat). **Define the following two properties** over actions of this counter:

1. It is possible to win after exactly 7 moves.
2. It is not possible to win in less than 7 moves.

## Modelling a vending machine

**Exercise 3.** Specify two interacting processes in mCRL2:

- a **vending machine** with 2 products, apples and bananas, costing 1eur and 2eur respectively; and
- a **user** who can insert 1eur or 2eur coins and request for products.

Provide two variations of this system and include them in files **vending1.mcrl2** and **vending2.mcrl2**, respectively, according to the requirements below. Try to keep the specifications simple. **Submit this file in your git repository.**

**3.1.** Specify in **vending1.mcrl2** a system such that the properties below hold.

```
[true*.pay2eur.pay2eur] false
[true*.pay2eur.pay1eur] false
[true*.pay2eur]<(!pay1eur && !pay2eur)*.getApple
<true*.pay2eur.true*.getBanana> true
```

**Show your specification and show a screenshot of its LTS.**

**3.2.** Specify another system in **vending2.mcrl2** such that the properties below hold.

```
<true*.pay2eur.pay2eur> true
<true*.getApple> true
<true*>[true*.getApple] false
```

**Show your specification and show a screenshot of its LTS.**

## Self-peer-evaluation

**Exercise 4.** In a scale from 0-5, where 5 is better than 0, give a mark to you and each of your team groups for each of the following criteria:

- **Effort** (time spent)
- **Quality** (of the work produced)
- **Collaboration** (how easy it was to meet and interact)

**Send this information individually** by e-mail or via private message in Teams to David Pereira and José Proença. No justification is needed – e.g., “*João: Effort 5, Quality 4, Collaboration 5; Maria: ...*”.