**Master d'Informatique Fondamentale – 2019**
**Semantics and Verification (M1)**

ENS DE LYON

TD de Sémantique et Vérification

# V– Fairness and Regular Properties

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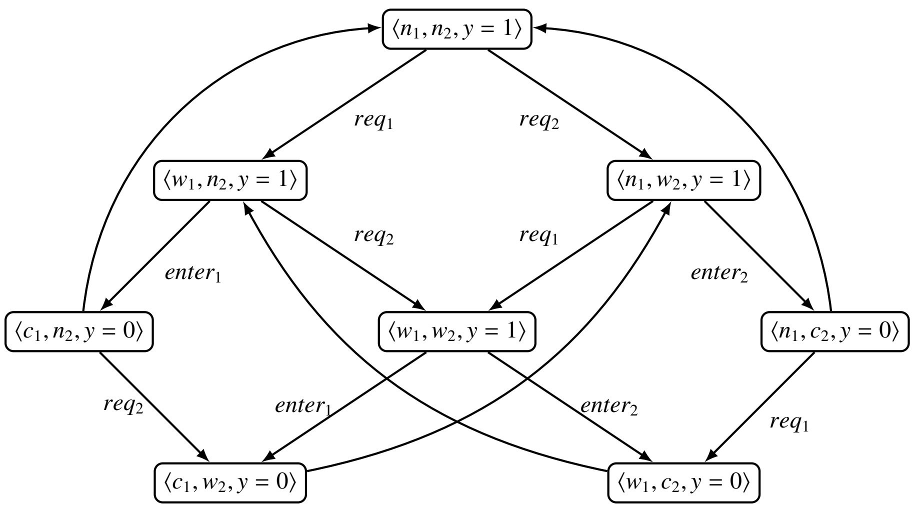
In this set of exercises, we will discuss fairness restrictions, regular safety properties and $\omega$-regular expressions.

**Recommendation**: The exercises are all purely pen and paper exercises. However, it is quite fun to implement notions from the course and the exercises. At the very end, you may obtain this way your very own model checker. This week, you may implement the product construction of transition systems and the automaton construction for bad prefixes Note that your implementation will not be evaluated as part of the course.

**Exercise 1.**

Consider the following LTS representing mutual exclusion by means of a semaphore, in which back arrows are implicitly labelled with *rel* (not drawn on the picture to avoid clutter).

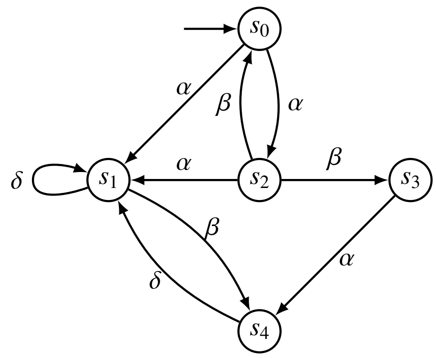



What is a good fairness assumption to ensure that both processes get in the critical section infinitely often in a fair trace?

**Exercise 2.**

Let $TS$ be a LTS. A $\mathcal{F}$ fairness assumption is **realizable** for $TS$ when for each state $s$ of $TS$, there exists a fair path starting from $s$.

Consider the following transition system $TS$ (without atomic propositions):



Decide which of the following fairness assumptions $\mathcal{F}_i$ are realizable for $TS$. Justify your answers!

1. $\mathcal{F}_1 = (\{\{\alpha\}\}, \{\{\delta\}\}, \{\{\alpha, \beta\}\})$
2. $\mathcal{F}_2 = (\{\{\delta, \alpha\}\}, \{\{\alpha, \beta\}\}, \{\{\delta\}\})$
3. $\mathcal{F}_3 = (\{\{\alpha, \delta\}, \{\beta\}\}, \{\{\alpha, \beta\}\}, \{\{\delta\}\})$

**Exercise 3.**

Let $AP = \{a, b, c\}$. Consider the following LT properties:

1. If $a$ becomes valid, afterwards $b$ stays valid *ad infinitum* or until $c$ holds.
2. Between two neighbouring occurrences of $a$, $b$ always holds.
3. Between two neighbouring occurrences of $a$, $b$ occurs more often than $c$.
4. $a \wedge \neg b$ and $b \wedge \neg a$ are valid in alternation or until $c$ becomes valid.

For each of these properties, give an $\omega$-regular expression (if the language is $\omega$-regular), decide if it is a regular safety property (justify your answers) and if so, define an automaton recognising its set of bad prefixes.

*(Hint: You may use propositional formulae over the set AP as transition labels.)*