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Theoretical Aspects of Logistics

Modelling of Processes (Part 1)

Processes are key concepts in logistics (and computer science).

From an intuitive point of view, processes are devices to solve problems, to complete tasks, to perform computations.

Processes consist of steps (representing events and actions), steps are executed one after the other.

There is something to be processed, inputs, outputs, and someting in between. The something may be called states or configurations, it may be of a material nature or consist of data structures.

The informal description leads to the first attempt towards a formal definition of processes.

> A *process* is a construct $proc = (\mathcal{C}, \rightarrow, \mathcal{I}, \mathcal{T})$ where $\mathcal{C}$ is a set of *configurations*, $\rightarrow \subseteq \mathcal{C} \times \mathcal{C}$ is a binary step relation, $\mathcal{I} \subseteq \mathcal{C}$ is a set of *initial configurations*, and $\mathcal{T} \subseteq \mathcal{C}$ is a set of *terminal configurations*.
>
> The step relation is used in infix notation, i.e. $(c, c') \in \rightarrow$ is written as $c \rightarrow c'$. The latter is called a *step* from c to c'.

The step relation can be arbitrarily iterated yielding the reflexive and transitive closure.

> A sequence of steps of the form $c_1 \rightarrow c_2 \rightarrow \ldots \rightarrow c_n$ is called a *run* and denoted by $c \stackrel{n}{\rightarrow} c'$ or $c \stackrel{*}{\rightarrow} c'$ if $c = c_1$ and $c' = c_n$. Moreover, $c \stackrel{0}{\rightarrow} c$ is allowed.

If one starts with an initial configuration, iterates steps, and ends with a terminal configuration, the process represents or computes a binary relation, which is called the *semantic relation* of the process:

$$SEM(proc) = \stackrel{*}{\rightarrow} \cap\, \mathcal{I} \times \mathcal{T} = \{(c, c') \in \mathcal{I} \times \mathcal{T} \mid c \stackrel{*}{\rightarrow} c'\} \subseteq \mathcal{I} \times \mathcal{T} \subseteq \mathcal{C} \times \mathcal{C}.$$

Questions:

1. What about infinite processes as opposed to finite ones (as defined by finite runs)?
2. What about continuous processes as opposed to discrete ones (which are composed of steps)?
3. What about parallel and concurrent processes as opposed to sequential ones (where steps follow each other)?
4. What about determistic processes as opposed to nondetermistic ones (where a configuration may have many next configurations via the step relation)?
5. What about processes the steps of which are actions and events explicitly?
6. What about processes the steps of which are processes again?
7. What about processes that follow a particular strategy rather then to run nondetermistically without any extra control?
8. How should configurations and steps be defined?