Behavior models and verification

Lab 1: LTS and CCS

http://d3s.mff.cuni.cz

Jan Kofroň
LTS and equivalences

1. Draw two LTSs being trace equivalent but different
2. Draw two LTSs being simulation equivalent but different
3. Draw two LTSs being bisimilar but different
LTS and equivalences
Bisimilar LTSs

- They have to be “locally equal”
  - at each state they have to provide the same set of transitions w.r.t. labels
  - the only difference may be number of transitions labeled with a particular label, e.g.:

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Process algebras: CCS

- CCS stands for Calculus of Communicating Systems
- Equations describing particular actions
  - . for sequencing
  - + for alternative
  - | for parallel composition
  - \ for restriction
  - [] for relabeling
CCS formally

\[ P ::= 0 \]
\[ a.P_1 \]
\[ A \]
\[ P_1 + P_2 \]
\[ P_1 \parallel P_2 \]
\[ P_1[b/a] \]
\[ P_1\backslash a \]
CCS semantics

\[
\begin{align*}
\text{Act} & : \frac{\alpha.E \xrightarrow{\alpha} E}{\alpha.E \xrightarrow{\alpha} E} \\
\text{Com}_1 & : \frac{E \xrightarrow{\alpha} E'}{E|F \xrightarrow{\alpha} E'|F} \\
\text{Com}_2 & : \frac{F \xrightarrow{\alpha} F'}{E|F \xrightarrow{\alpha} E|F'} \\
\text{COM}_3 & : \frac{E \xrightarrow{\ell} E'}{E|F \xrightarrow{\tau} E'|F'} \\
\text{Res} & : \frac{E \xrightarrow{\alpha} E'}{E\backslash L \xrightarrow{\alpha} E'\backslash L} \quad (\alpha, \overline{\alpha} \not\in L) \\
\text{Rel} & : \frac{E \xrightarrow{\alpha} E'}{E[f] \overset{f(\alpha)}{\rightarrow} E'[f]} \\
\text{Con} & : \frac{P \xrightarrow{\alpha} P'}{A \xrightarrow{\alpha} P'} \quad (A \overset{\text{def}}{=} P)
\end{align*}
\]
CCS example – Coffee machine

\[ CM = \text{coin.}(\text{coffee.CM} + \text{tea.CM}) \]
Modeling example: Alternating Bit Protocol

- A sender and a receiver
- Data accompanied with a bit alternating between 0 and 1

- Model them in CCS