8. Simulation und Äquivalenz

8.2 Bisimulation
How gain a simulation congruence?

Observation:
A slightly more tight relation
makes simulation equivalence a congruence:

R simulates L with $\rho$ and
L simulates R with $(\rho)^{-1}$.
R simulates L with

L: 
- $l_0 \xrightarrow{a} l'_1 \xrightarrow{a} l_1 \xrightarrow{b} l_2$

R: 
- $r_0 \xrightarrow{a} r_1 \xrightarrow{b} r_2$
L simulates R with

L: $l_0 \rightarrow l_1 \rightarrow b \rightarrow l_2 \rightarrow a \rightarrow l'_1$

R: $r_0 \rightarrow a \rightarrow r_1 \rightarrow b \rightarrow r_2$

is not the reverse of
**Theorem.** Bisimulation is a congruence.

**Def.** $\rho$ is a *bisimulation from $L$ to $R$* iff $R$ simulates $L$ with $\rho$ and $L$ simulates $R$ with $(\rho)^{-1}$.

**Def.** $L$ and $R$ are *bisimilar* iff there exists a bisimulation from $L$ to $R$.

$$\text{sim} = \text{def} \quad \{(l_0, r_0), (l_0, r_2), (l_1, r_1), (l_2, r_1)\}$$ is a bisimulation from $L$ to $R$. 

**mutual simulation by $\rho$ and $(\rho)^{-1}$**
Bisimulation harmonizes with the *Temporal Logic CTL*.

**Theorem.**
Two states are bisimilar iff they share the same *CTL* properties.

**Consequence:**
Specify a system in terms of *CTL*.
This may yield various different implementations.
They all are bisimular.
Variant: L is weakly simulated by R

a) \[ l_0 \xrightarrow{\alpha} l' \]
\[ r_0 \] „ \( r_0 \) simulates \( l_0 \) “

b) If
\[ l \xrightarrow{\alpha} l' \]
\[ r \xrightarrow{\tau^*} \alpha \xrightarrow{\tau^*} r' \] then there exists

Caution!
Weak bisimulation is no congruence
Examples for weak Bisimilarity

P and Q are weakly bisimilar:

R, S and T are pairwise *not* weakly bisimilar:

Caution!
Weak bisimulation is no congruence
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Ende