SMPoster

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Well-structured transition systems [FS01]

Labeled WSTS $\mathcal{W} = (S, \leqslant, T, I, F)$ over Σ with
- $(S, \leqslant)$ well-quasi ordered states,
- $T \subseteq S \times \Sigma \times S$ transitions, (strongly) compatible with $\leqslant$,
- $I \subseteq S$ initial states,
- $F \subseteq S$ final states, upward closed.

Coverability language:

$$\mathcal{L}(\mathcal{W}) = \{w \in \Sigma^* \mid s_I \xrightarrow{w} s_F \text{ for some } s_I \in I, s_F \in F\}$$

Examples: Petri nets and extensions (transfer nets, reset nets, ...) with covering a marking as acceptance condition.

Finite branching

$\mathcal{W}$ finitely branching if I and $\text{Post}_\Sigma(s)$ finite for all $s \in S$.
$\mathcal{W}$ deterministic if I and $\text{Post}_a(s)$ unique for all $s \in S, a \in \Sigma$.
$\mathcal{W}$ ω^2-WSTS if $(S, \leqslant)$ does not embed the Rado order.

Theorem: *The following inclusions of language classes hold:*

$$\text{lang. of } \omega^2\text{-WSTS} \subsetneq \text{lang. of deterministic WSTS},$$
$$\text{lang. of fin.-branching WSTS} \subsetneq \text{lang. of deterministic WSTS}.$$

The result & its consequences

Theorem: *If two WSTS languages, one of them finitely branching, are disjoint, then they are regularly separable.*

Corollary: *If a language and its complement are languages of finitely-branching WSTS, then they are necessarily regular.*

Corollary: *No subclass of the class of languages of finitely-branching WSTS beyond* REG *is closed under complement.*

Proof approach:
1. Show that finitely-represented inductive **invariants** can be turned into regular separators.
2. Show that such invariants always exist using **ideals**.

Ideals [KP92] [FG12, BFM14]

Let $\widehat{\mathcal{W}}$ be the ideal completion of $\mathcal{W}$. Note: $\mathcal{L}(\mathcal{W}) = \mathcal{L}(\widehat{\mathcal{W}})$.

Proposition: *If X is an invariant for $\mathcal{W}$, then its ideal decomposition* $\textsc{Id-Dec}(X)\Downarrow$ *is a finitely-represented invariant for $\widehat{\mathcal{W}}$.*