COMP424/524-06A Topics in Software Engineering

Part I – *Finite State Machines*

4. Supervisory Control

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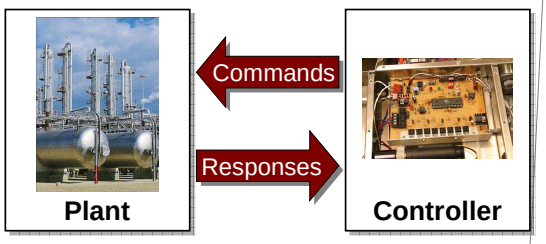
Modelling Reactive Systems

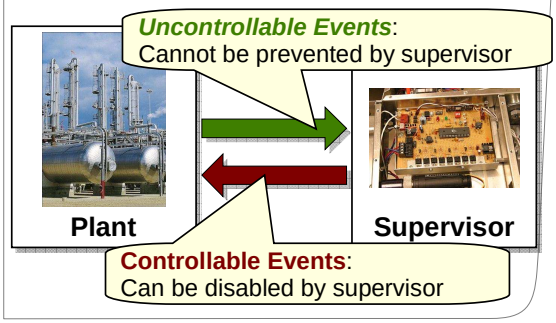
Plant Model
- Model of the system to be controlled
- Possible behaviour

Specification
- Model of the control program
- Desired behaviour

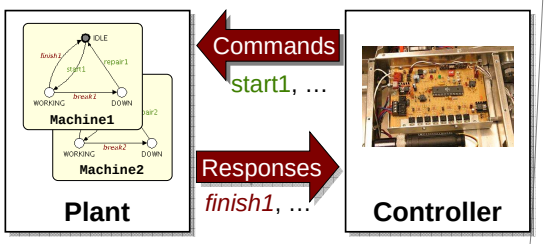
Controlling Reactive Systems



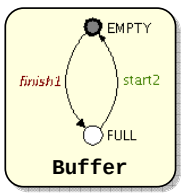
Supervisory Control



Controlling Small Factory



Desired Behaviour



We want small factory together with its controller to behave exactly like the **`Buffer`** automaton.

Is this possible?

Controllability

Plant Spec

Definition

Let P and S be two automata.

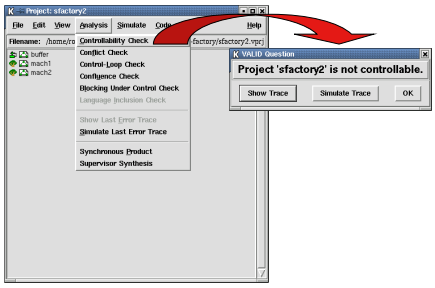
S is called **controllable** with respect to P if, for every state (q_P, q_S) reachable in $P \parallel S$, every uncontrollable event which is enabled in q_P also is enabled in q_S.

Controllability Check Algorithm

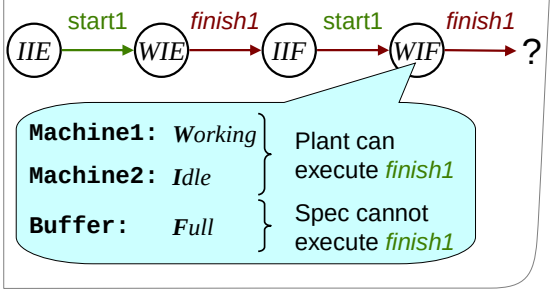
To check whether plants $P_1,\ldots,P_n$ are controllable with respect to specifications $S_1,\ldots,S_m$:

Add initial state $q_0 = (q_{01}^P,\ldots,q_{0n}^P,q_{01}^S,\ldots,q_{0m}^S)$ to state set Q
While there are unvisited states $q \in Q$ **do**
  For each event e enabled by all plants P_i in state q **do**
    If e is uncontrollable and there exists a specification S_j that cannot execute e in state q **then**
      return "*The system is not controllable.*"
    If e can be executed by all specifications **then**
      Compute successor state r such that $q \xrightarrow{e} r$
      Add r to state set Q if not yet present

Checking for Controllability



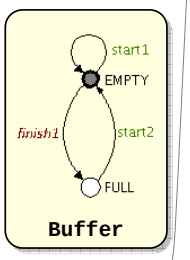
Small Factory is Not Controllable



Making Small Factory Controllable

Observations

- We cannot disable the uncontrollable event *finish1*.
- If the system ever enters state *WIF*, we have a problem.
- We can avoid entering this state by disabling the controllable event start1 in state *IIF*.



Reading

Texts on Supervisory Control

- C. G. Cassandras and S. Lafortune, *Introduction to discrete event systems.* Kluwer, 1999.
- W. M. Wonham, *Notes on control of discrete event systems.* Available on our course home page `http://www.cs.waikato.ac.nz/Teaching/COMP424A/`