Exercise Sheet 5: Decidability

Problem 11:

Show the following properties of the computational complexity notions introduced in the lecture:

a. Reflexivity

b. Symmetry

c. Transpose Symmetry

Problem 12:

We consider the abstraction-based supervisory control using the natural observer condition with two plants G_1, G_2 with alphabets Σ_1, Σ_2 and local specification automata C_1, C_2. Also there is a global specification automaton C over the alphabet $\hat{\Sigma} \subset \Sigma = \Sigma_1 \cup \Sigma_2$. We assume that G_i has n_i states, $i = 1, 2$; C_i has m_i states, $i = 1, 2$ and C has m states.

a. What is the computational complexity for the monolithic supervisor computation (without abstraction)?

b. Sketch the architecture for the abstraction-based supervisor computation.

c. What is the complexity for the abstraction-based computation?

Hint: Assume that the state size of the abstractions $\hat{G}_i$ is $\hat{n}_i$, $i = 1, 2$.

Use the computational complexity of synchronous composition, SupCon computation, natural observer extension.

d. Discuss what is the potential advantage of the abstraction-based computation.

Problem 13: [optional]

It is shown in the following paper that finding a minimal alphabet extension for fulfilling the natural observer condition is NP-hard.

L. Feng and W.Wonham, "On the computation of natural observers in discrete-event systems," Discrete Event Dyn. Syst.: Theor. Appl., vol. 20, no. 1, pp. 63–102, Mar. 2010.

Study the proof of this result.