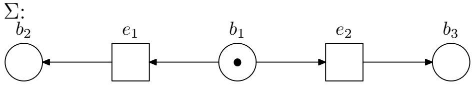
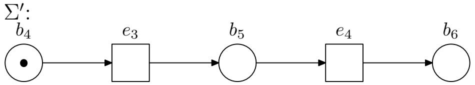
4.1 The following C/E-systems satisfy the requirements:

Σ:



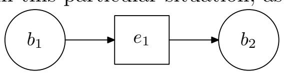
Σ':



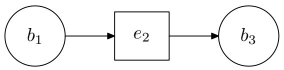
The nonequivalence is easily proved by constructing the case graphs of the systems. That the systems are contact free is also trivially seen from the systems.

The possibilities for the bijection ε are fairly limited, with only two events. One possibility is $\varepsilon(e_1) = e_3, \varepsilon(e_2) = e_4$. Now all that remains is to compute the synchronic distances $\sigma(e_1, e_2)$ and $\sigma(e_3, e_4)$ and verify that they are equivalent. We start by constructing all the processes of both systems. This task is doable in this particular situation, as the systems are trivial.

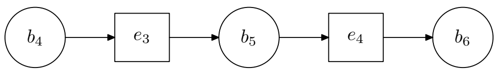
p_{Σ_1}



p_{Σ_2}



$p_{\Sigma'}$



From these processes we get for Σ: $\mu_1(e_1, b_1, b_2) = 1$, $\mu_1(e_2, b_1, b_2) = 0$, $\mu_2(e_1, b_1, b_3) = 0$ and $\mu_2(e_2, b_1, b_3) = 1$. The subscripts denote the processes. For Σ' we get $\mu(e_3, b_4, b_5) = 1$, $\mu(e_3, b_5, b_6) = 0$, $\mu(e_4, b_4, b_5) = 0$ and $\mu(e_4, b_5, b_6) = 1$. Now the variances for processes of Σ are $\nu(p_{\Sigma_1}, e_1, e_2) = 1$ and $\nu(p_{\Sigma_2}, e_1, e_2) = 1$. The variance for the process of Σ' is $\nu(p_{\Sigma'}, e_3, e_4) = 1$.

From the variances we get $\sigma(e_1, e_2) = 1$ and $\sigma(e_3, e_4) = 1$, proving that our choice of the bijection was correct.

4.2 Intuitively, if the synchronic distance is ω, there is a cycle in the C/E-system such that more of E_1's events are present in the cycle than those of E_2. Also, it must be possible for the cycle to occur unbounded number of times.

"$\Rightarrow$" As the C/E-system is cyclic, every case can be reached again after some number of steps. Thus, there exists a non-empty process for which $p(^\circ K) = p(K^\circ)$(K° and $^\circ K$ are defined in 3.1 (i)). This means that the minimal elements of the underlying occurrence net K represent the same case as the maximal elements, and thus we can create a process $p' = p \circ p \circ \cdots \circ p$, where p is repeated n times. As $\sigma(E_1, E_2) = \omega$, the variance $\nu'(p', E_1, E_2) \geq n$. This happens only when the variance $\nu'(p, E_1, E_2) > 0$.

"$\Leftarrow$" If there is a non-empty process p, for which $p(^\circ K) = p(K^\circ)$, we can compose a process $p' = p \circ p \circ \cdots \circ p$, where p is repeated n times. Furthermore, if the variance $\nu'(p, E_1, E_2) > 0$, then the variance of $\nu'(p', E_1, E_2) \geq n$, yielding $\sigma(E_1, E_2) = \omega$.

4.3 b) The unweighted synchronic distance is ω. As the events e_1 and e_3 are in always in conflict when enabled, a process p exists where there are two occurrences of events in E_1 and only one occurrence of event in E_2.

We can assign weights of 2 to events e_3 and e_6. Then $\sigma(E_1, E_2) = 2$. The computation was performed with the unrealiable method presented in 4.1(h), utilizing the Maria reachability analyzer.

4.4 In both cases, the main task is to transform the formulae into one of the forms presented in 4.5(d).

a) First, write the fact in propositional logic and then transform the formula until in correct form:

$$\begin{aligned} & (\neg \mathrm{sum} \land \neg \mathrm{win}) \rightarrow (\mathrm{spr} \lor \mathrm{aut}) \\ \Leftrightarrow\ & \neg(\neg \mathrm{sum} \land \neg \mathrm{win}) \lor (\mathrm{spr} \lor \mathrm{aut}) \\ \Leftrightarrow\ & \neg\neg(\mathrm{sum} \lor \mathrm{win}) \lor (\mathrm{spr} \lor \mathrm{aut}) \\ \Leftrightarrow\ & \mathrm{sum} \lor \mathrm{win} \lor \mathrm{spr} \lor \mathrm{aut} \end{aligned}$$

The last formula corresponds to a fact which is represented as an event with no preconditions and all conditions of the system as postconditions.

b)

$$\begin{aligned} & \mathrm{sum} \rightarrow (\neg \mathrm{win} \land \neg \mathrm{aut}) \\ \Leftrightarrow\ & \neg \mathrm{sum} \lor (\neg \mathrm{win} \land \neg \mathrm{aut}) \\ \Leftrightarrow\ & (\neg \mathrm{sum} \lor \neg \mathrm{win}) \land (\neg \mathrm{sum} \lor \neg \mathrm{aut}) \\ \Leftrightarrow\ & \neg(\mathrm{sum} \land \mathrm{win}) \land \neg(\mathrm{sum} \land \mathrm{aut}) \end{aligned}$$

The formula on the last line can be represented with two events. First has summer and winter as preconditions, and the second has summer and autumn as preconditions. Neither has postconditions.