

Homework 3

EE 290n - Advanced Topics in Systems Theory

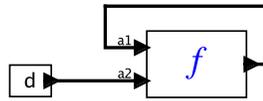
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1. This problem studies a determinate PN actor with behavior similar in some ways to the non-determinate merge. Suppose D is a set of data values and $f: (D^{**})^2 \rightarrow D^{**}$ is a function defined by

$$f(s_1, s_2) = \underbrace{(e, e, \dots, e)}_{N \text{ times}}$$

for all $s_1, s_2 \in D^{**}$, for some $e \in D$, and where $N = |s_1| + |s_2|$, the sum of the lengths of the sequences s_1 and s_2 . If either input sequence is infinite, then the length of the output is infinite.

- (a) Suppose this function is used in the following PN model:

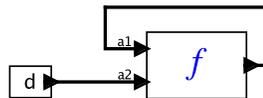


where $d \in D^{**}$ is a finite sequence of length 5 produced by the left actor. What is the output of f ?

- (b) Is this function monotonic? Continuous?
 (c) Is this function sequential?
2. Suppose D is a set of data values and $A = \{\perp, \varepsilon\} \cup D$ is a flat CPO with \perp at the bottom. Consider a function $f: A^2 \rightarrow A$ given by, for all $a_1, a_2 \in A$,

$$f(a_1, a_2) = \begin{cases} \perp & \text{if } a_1 = a_2 = \perp \\ a_1 & \text{if } a_1 \in D \\ a_2 & \text{otherwise} \end{cases}$$

- (a) Is this function strict?
 (b) Suppose this function is used in the following SR model:



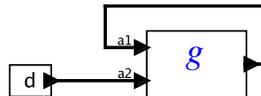
where $d \in D$ is produced on every tick by the left actor. What is the output of f on each tick? What if d is replaced with ε ?

- (c) Show that this function is not monotonic.
3. Suppose D is a set of data values and $A = \{\perp, \varepsilon\} \cup D$ is a flat CPO with \perp at the bottom. Consider a function $g: A^2 \rightarrow A$ given by, for all $a_1, a_2 \in A$,

$$g(a_1, a_2) = \begin{cases} \perp & \text{if } a_1 = a_2 = \perp \\ d & \text{if } a_1 \in D \text{ or } a_2 \in D \\ \varepsilon & \text{otherwise} \end{cases}$$

for some $d \in D$.

- (a) Is this function strict?
- (b) Is this monotonic? continuous?
- (c) Is this function sequential?
- (d) Suppose this function is used in the following SR model:



where $d \in D$ is produced on every tick by the left actor. What is the output of f on each tick? What if d is replaced with ϵ ?

4. This problem explores construction of various sequential control logic systems using the Ptolemy II SR director and basic SR actors. The basic SR actors are Default, When, Pre, NonstrictDelay, and EnabledComposite. You may also use other basic actors not specific to SR, such as Const, Sequence, Ramp, and any arithmetic or logic functions.

- (a) Use Sequence and When to construct an SR model that generates a sequence of values *true* interspersed with *absent* (ϵ). For example, produce the sequence

$$(true, \epsilon, \epsilon, true, \epsilon, true, true, true, \epsilon) .$$

- (b) Create a composite actor IsAbsent that given any input sequence, produces an output *true* at every tick when the input is ϵ , and otherwise produces the output ϵ .
- (c) Create a model that can recognize the difference between single and double mouse clicks. That is, given a sequence like those generated by your model in part (a), produce an output *true* on an output port named *singleClick* if there are N or more ϵ following an input *true* on an input port named *click*. Otherwise, upon occurrence of a second *true* within N ticks, it outputs a *true* on a port named *doubleClick*. How does your model behave if given three values *true* within N ticks on input port *click*? To be concrete, you may implement this for the fixed $N = 3$, although a better design would have this as a parameter.
- (d) **Extra credit:** Redo (a)-(c) by writing a custom a Java actor for each of the three functions above. How does this design compare with the design implemented using primitive SR actors? Is it more or less understandable? complex?