System Properties

Causal: $x_1(t) = x_2(t)\ \forall t \leq \tau \implies S\{x_1(t)\} = S\{x_2(t)\}\ \forall t \leq \tau$

Strictly Causal: $x_1(t) = x_2(t)\ \forall t < \tau \implies S\{x_1(t)\} = S\{x_2(t)\}\ \forall t \leq \tau$

Memoryless: $S\{x(t)\} = f(x(t))$

Linearity $S\{\alpha x_1(t) + \beta x_2(t)\} = \alpha S\{x_1(t)\} + \beta S\{x_2(t)\}$

Time Invariance: $\forall \tau \in \mathbb{R},\ S\{x_1(t-\tau)\} = S\{x(t)\}(t-\tau)$

Stability $\exists A < \infty$ such that $|x(t)| \leq A\ \forall t \implies \exists B < \infty$ such that $|S\{x(t)\}| \leq B\ \forall t$

Discrete Dynamics

Discrete Signal: A signal e is discrete if $\exists f : T \to \mathbb{N}$ which is order-preserving. In other words, we can count the number of times e is present

State Machines

States:: Finite set (S)

Inputs:: Finite set of inputs (I)

Outputs:: Finite set of outputs (O)

update:: $S \times I \to S \times O$

$$(s(n+1), y(n)) = update(s(n), x(n))$$

(If the machine is non-deterministic, then $update : S \times I \to 2^{S \times O}$)

Initial State: The beginning state of the state machine

Behavior: An assignment of a signal such that the output signals are the output produced for the given inputs

Observable Trace: $((x_0, y_0), (x_1, y_1), (x_2, y_2), \dots)$ where x_i are inputs and y_i are outputs

Execution Trace: $((x_0, s_0, y_0), (x_1, s_1, y_1), \dots)$ where x_i are inputs, s_0 is the state the machine is leaving, and y_i are outputs

Components

Self-Transition: A transition starting and ending at the same state

Stuttering Transition: A transition where all inputs and outputs are absent and the machine does not change state

Default Transition: A transition enabled if no non-default transition is enabled and if the guard evaluates to true.

Set Action: Specifies assignment to a variable after the guard is evaluted and the output is produced.

State Space: All possible settings of modes + variables. $|States| = np^m$ where n is the number of modes, and there are m variables taking on p values each.

Pre-emptive Transition: The guard of a pre-emptive transition is evaluted before the refinement, and if it is true, the refinement does not act

Reset Transition: The destination refinement of the transition is set to its initial state

History Transition: The destination refinement of the transition resumes in the state where it was last.

Composition

Synchronous Composition: Two or more state machines react simultaneously.

Asynchronous Composition: When two or more state machines react independently of each other.

Side by Side Synchronous Composition: One react of the overall machine is the simultaneous react of the sub-machines

Side by Side Asynchronous Composition with Interleaving Semantics: A react of the overall state machine is the react of one of the sub-machines where the choise is non-deterministic.

Cascade Composition: When the output port of state machine A feeds into the input of state machine B. The reactions are simultaneous and instantaneous but A reacts first to produce the input to B (if any).