

Chapter 5 Exercises Solutions

Question	Answer
5.1	It is possible to rule out the invalid transition scenario through meta-modeling. By defining the relationship between states and transitions within a Machine object, the meta-model enforces a structure that disallows transitions crossing machine boundaries.
5.3	<p>First-Order Formula for the Meta-Model in Figure 5.1</p> <p>1. Parent Constraint: $\forall x(\text{Person}(x) \rightarrow \text{count}(\{y: \text{Parent}(y, x)\}) \leq 2$</p> <p>Verification of the Two Rightmost Instances in Figure 5.2</p> <ul style="list-style-type: none"> The provided instances: <ul style="list-style-type: none"> Alice, Bob, and E cycle: Each has no more than two parents. D and C mutual parent-child relationship: Each has no more than two parents. <p>Both instances adhere to the constraints specified in the first-order formula.</p>
5.4	$\forall x, y, s(\text{Transition}(s, x) \wedge \text{Transition}(s, y) \wedge x \neq y \rightarrow \exists l1, l2(\text{InputLabel}(x, l1) \wedge \text{InputLabel}(y, l2) \wedge l1 \neq l2))$
5.5	<p>Base Case (Path Length 1):</p> <ul style="list-style-type: none"> If $s1 = sn$, the equation trivially holds (direct successor). <p>Inductive Case (Path Length $k+1$):</p> <ul style="list-style-type: none"> Assume the equation holds for k-length paths. If $\text{successor}^*(s1, sn)$, there exists a path with intermediate state $s2$: <ul style="list-style-type: none"> $\text{successor}(s1, s2)$ $\text{successor}^*(s2, sn)$ (path length k) By induction hypothesis, the equation holds for the sub-path $(s2, sn)$: $(s2 = sn) \vee \exists s3. \text{successor}(s2, s3) \wedge \text{successor}^*(s3, sn)$ Combining: We get the original equation for the $k+1$ path length. <p>By induction, $\text{successor}^*(s1, sn) \equiv \text{true}$ implies the equation for all path lengths, proving it satisfies the definition of the transitive closure.</p>
5.16.a	<p><code>inv[Person] { _.getChild.size <= 2 }</code></p> <ul style="list-style-type: none"> Ecore Feature to Use: Upper Bound of a Reference <ul style="list-style-type: none"> Reference: children Type: Person Containment: True Multiplicity: 0..2 (meaning 0 to 2 children are allowed)
5.16.b	<p>invariant: <code>self.name.notEmpty()</code>.</p> <ul style="list-style-type: none"> Ecore Feature to Use: EAttribute Properties <ul style="list-style-type: none"> Attribute: name Type: EString Additional Specification: Use an OCL invariant in the model: <code>name.notEmpty()</code>

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