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Formal Methods in Software Engineering

Introduction to Alloy
Join

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Exercises and Solutions

- The following slides will include several series of exercises and solutions
- The slides occur in pairs
  - The first slide just has the exercise questions
  - The second slides includes the answers as well
- Try to solve the exercises without looking at the answers
- Other slides are included to give some hints and advice not included in the lectures
Join

- Given a relation \( \text{addr} \) of arity four that contains the tuple \( b \rightarrow n \rightarrow a \rightarrow t \) when book \( b \) maps name \( n \) to address \( a \) at time \( t \), and a book \( b \) and a time \( t \):
  - \( \text{addr} = \{(B0,N0,D0,T0),(B0,N0,D1,T1), (B0,N1,D2,T0), (B0,N1,D2,T1), (B1,N2,D3,T0), (B1,N2,D4,T1)\} \)
  - \( t = \{(T1)\} \)
  - \( b = \{(B0)\} \)

The expression \( b.\text{addr}.t \) is the name-address mapping of book \( b \) at time \( t \). What is the value of \( b.\text{addr}.t \) ?

- When \( p \) is a binary relation and \( q \) is a ternary relation, what is the arity of the relation \( p.q \) ?

- Join is not associative, why?
  (i.e. \( (a.b).c \) and \( a.(b.c) \) are not always equivalent)
Join

\[ \text{addr} = \{(B0,N0,D0,T0), (B0,N0,D1,T1), (B0,N1,D2,T0), (B0,N1,D2,T1), (B1,N2,D3,T0), (B1,N2,D4,T1)\} \]
\[ \text{t} = \{(T1)\} \]
\[ \text{b} = \{(B0)\} \]

- What is the value of \( \text{b.addr.t} \)?
  - \( \text{b.addr.t} = \{(N0,D1),(N1,D2)\} \)

- When \( p \) is a binary relation and \( q \) is a ternary relation, what is the arity of the relation \( p.q \)?
  - \( p.q \) is a ternary relation

- Join is not associative, why?
  - (i.e. \((a.b).c\) and \(a.(b.c)\) are not always equivalent)
    - if \( a \) is a ternary relation, and \( b \) and \( c \) are unary relations
    - then \((a.b).c\) is a unary relation, while \(a.(b.c)\) is not defined