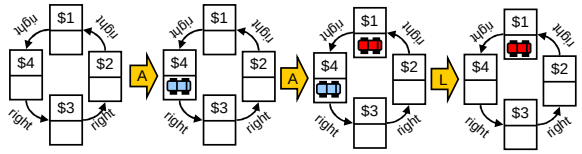
Victoria University of Wellington, New Zealand
Te Whare Wananga o te Upoko o te Ika a Maui Aotearoa

#33 State Machines

James Noble & David J. Pearce & Petra Malik

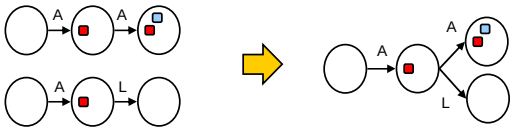
Software Engineering,
Victoria University of Wellington
http://www.mcs.vuw.ac.nz/

Execution Trace for Roundabout



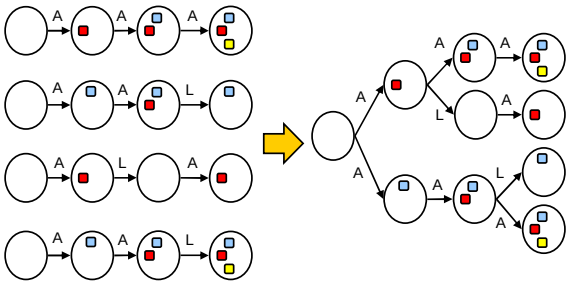
- An **execution trace** for our roundabout:
  - Represents possible sequence of Arrive/Leave events
  - Assumes roundabout empty to begin with (i.e. initial state)
  - May go on **forever**
  - Or, may reach an **end state** (where no event can occur)

Execution Trace Trees

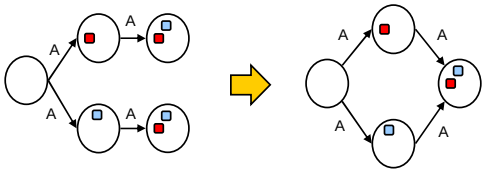


- Consider above two traces (on left)
  - First two states are common
  - So, can combine them together into a **tree**
  - **This simplifies** their presentation
  - One of traces on left **contained in** tree on right

Execution Trace Trees

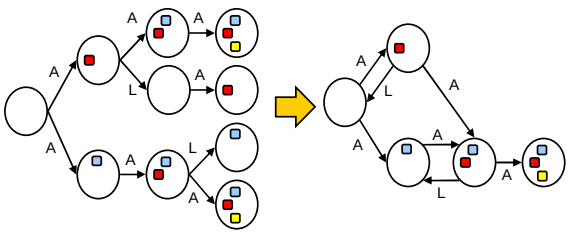


Execution Trace Graph



- Can further simplify trace trees into **graphs**
  - At most **one node per state**
  - Each can potentially be reached by **different transitions**

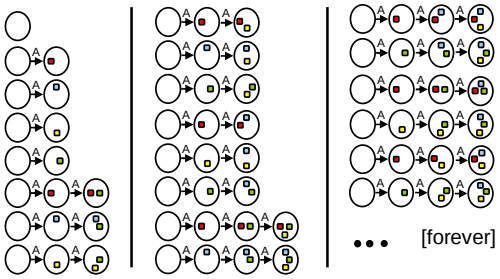
Execution Trace Graph



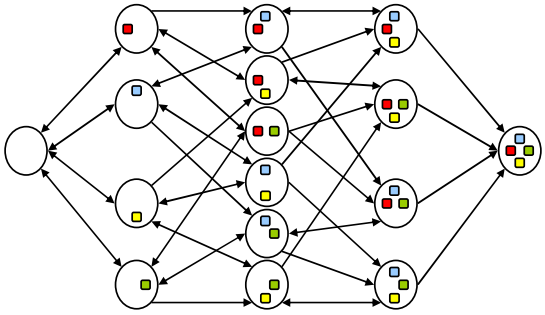
- Graph may **encode more traces** than started with!
  - For example …

All Possible Execution Traces

- Imagine the set of **all possible execution traces** for our roundabout example:



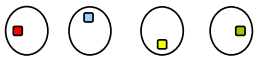
State Machine Representation



- Graph of all possible traces (a.k.a. **state machine)**
  - Should include **transition labels**, but not enough space!

Symmetry Reduction

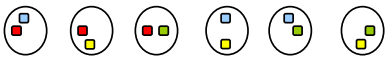
- Consider these four states:



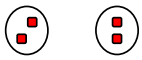
  - Each describes a roundabout with **one car**
  - Each has **four** possible transitions (3A, 1L)
  - In some sense, they are **identical**
  - Let's denote **any roundabout** with one car as:

Symmetry Reduction

- Now, consider these four states:

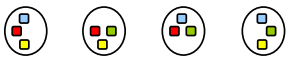


  - Each describes a roundabout with **two cars**
  - But, not all have **same possible** transitions
  - Some have **four** possible transitions (2A, 2L)
  - Some only have **three** possible transitions (2A, 1L)
  - Let's differentiate the two cases like this:



Symmetry Reduction

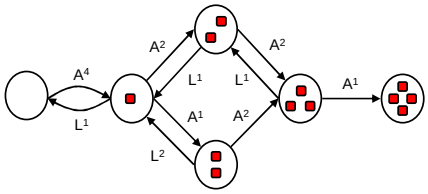
- Now, consider these four states:



  - Each describes a roundabout with **two cars**
  - How many transitions does each have?
  - So, what does this mean?

Simplified graph of all traces

- Applying these **state simplifications** yields:



  - L^x indicates there are **x different cars** which could leave
  - A^x indicates there are **x different cars** which could arrive