Model Based Testing

Dr Michael Foster
Based on material from Professor Rob Hierons

Outline

- Formal models of systems (FSMs)

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- Testing from finite state machines

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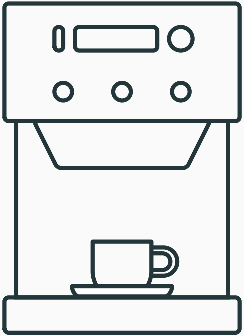
    - Unique I/O sequences
    - The W method

Motivating Example - Simple Drinks Machine



- Select a drink

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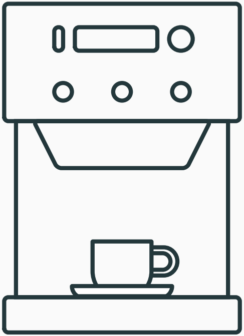

- Select a drink
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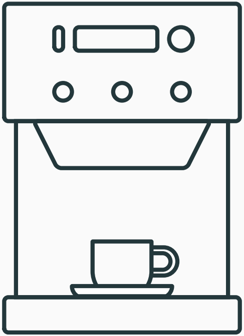

- Select a drink
- Insert coins
- Press “vend” to dispense drink

How do we test this system?

Unit testing

- Generate tests according to code components

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Formal Models of Systems

There are lots of different modelling notations (Z, B, state machines)

We will introduce MBT with state machines

An FSM (Mealy machine) is a six tuple $(S, s_0, X, Y, \delta, \lambda)$ where

- S is a finite set of states

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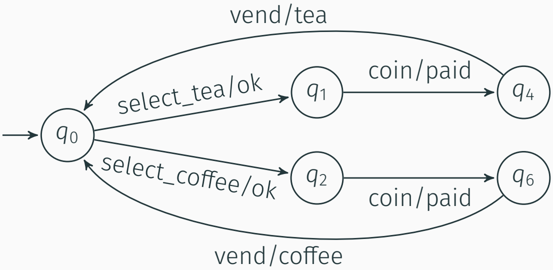

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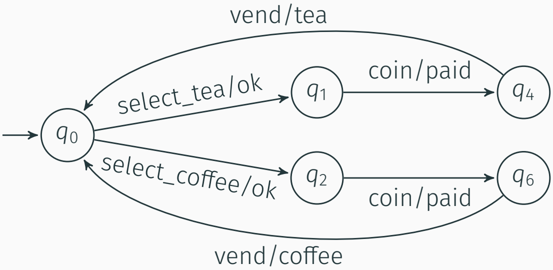

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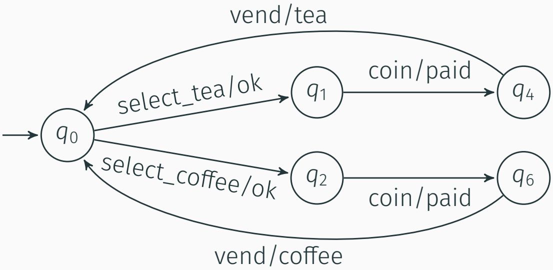

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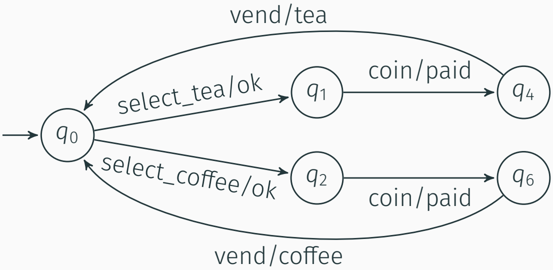

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  - inputs *select_tea, coin, vend*, gives us outputs *ok, paid, tea*
  - Machine follows path $q_0 \rightarrow q_1 \rightarrow q_4 \rightarrow q_0$

Terminology (sorry!)

We will focus on FSM testing with *deterministic*, *minimal*, and *completely specified* models

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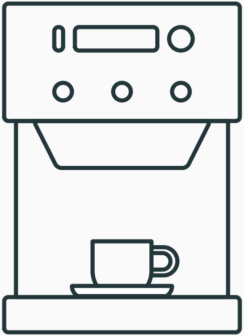
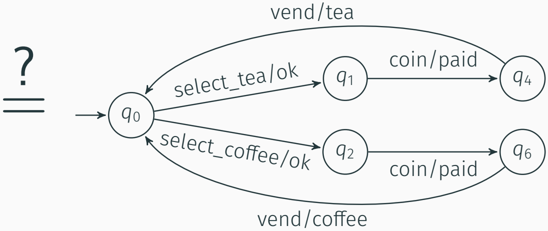
- An FSM is *minimal* if there is no trace equivalent FSM with fewer states
    - We can minimise any FSM by following the algorithm

Testing from an FSM





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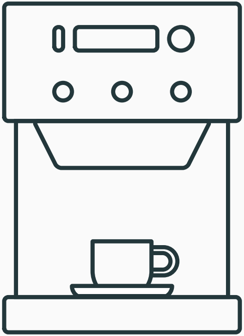

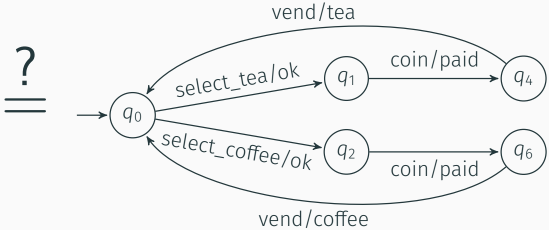

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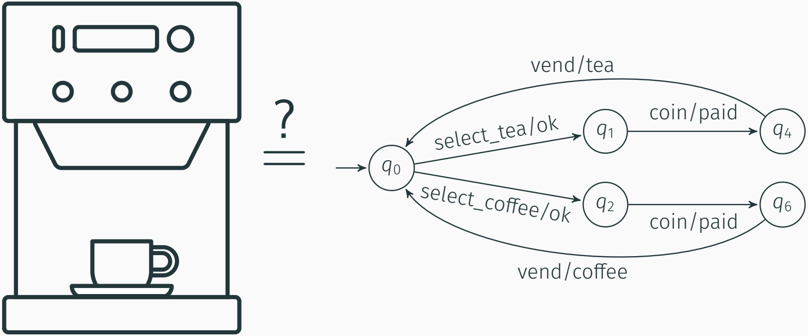

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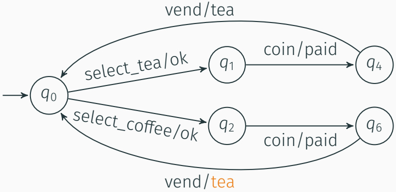
- Submit inputs to the FSM and software in parallel
- Observe and compare the outputs

Faults

Output faults: A transition produces the wrong output



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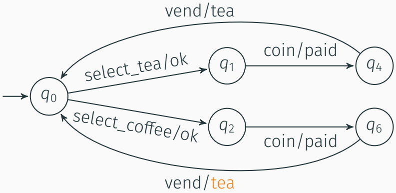
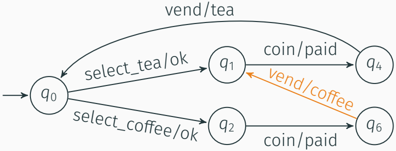
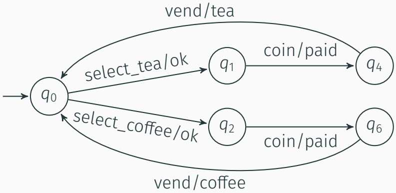


State transfer faults: A transition goes to the wrong state



Transition Tour

Assume no state transfer faults, then we can test by just executing every transition



The input sequence *select_tea, coin, vend, select_coffee, coin, vend* will do that for us

We validate that the output sequence is *ok, paid, tea, ok, paid, coffee*

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- We want to explicitly check for state transfer faults

Identifying States

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Challenges

Controllability: How do we get the FSM to q_i?

Observability: How do we know the FSM is in q_j?

Solutions

Controllability

Find a sequence that gets the *specification* to the desired state.

Observability

Characterise states in terms of the I/O actions they can perform:

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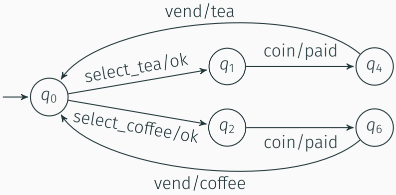
- Characterising set

Distinguishing Sequences

A distinguishing sequence is an input sequence that produces a different output for **each state**.

Not every FSM has a distinguishing sequence! Does the drinks machine have a distinguishing sequence?



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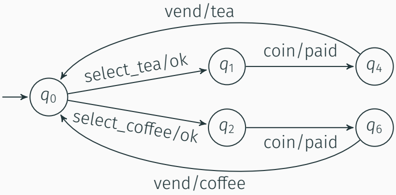

Yes! (assuming we know when an input has been refused)

select_tea, coin, vend

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- Not all FSMs have these either!

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- There are polynomial time algorithms to generate W sets
- We can minimise every FSM

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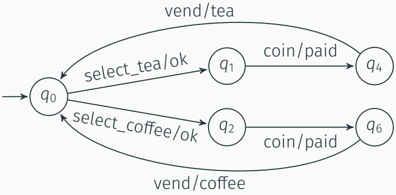
- *W* is a characterising set
- *V* is a *state cover*

A *state cover V* is a set of input sequences such that each state of an FSM *M* is reached from s_0 by a sequence from *V*, and *V* also contains the empty input sequence.

The W Method for Drinks



$$W = \{[select\_tea, coin, vend]\}$$

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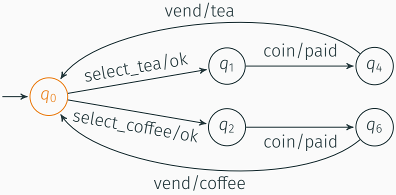

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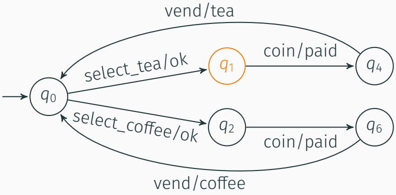

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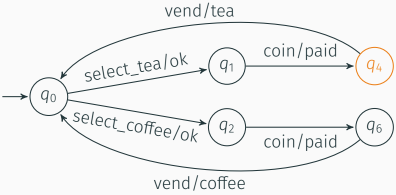

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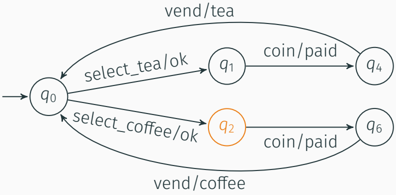

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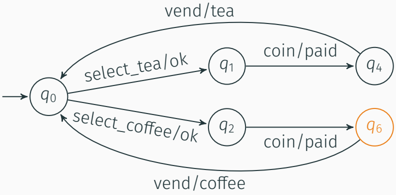

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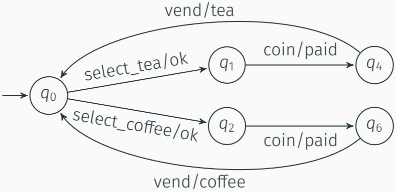
Make sure you reset before each sequence!

Applying the W Method to Drinks



$$V = \{\epsilon, [select\_tea], [select\_tea, coin], [select\_coffee], [select\_coffee, coin]\}$$

$$X = \{[select\_tea], [select\_coffee], [coin], [vend]\}$$

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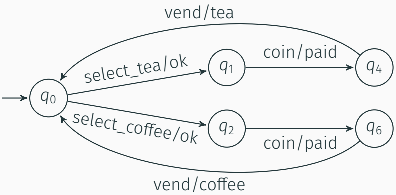

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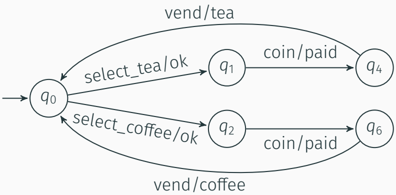

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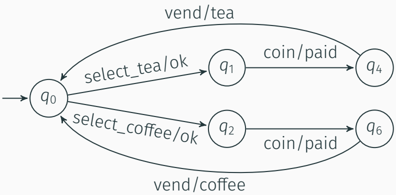

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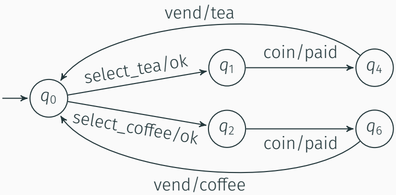

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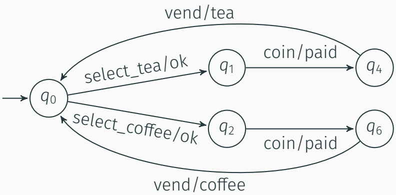

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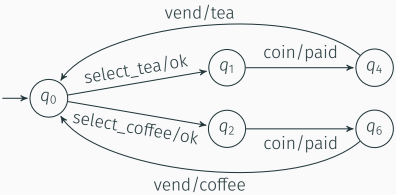

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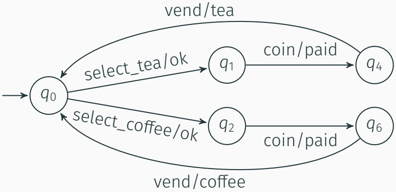

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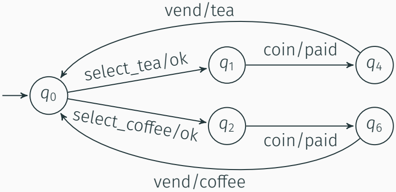

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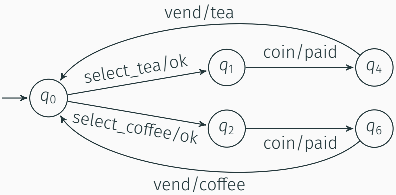

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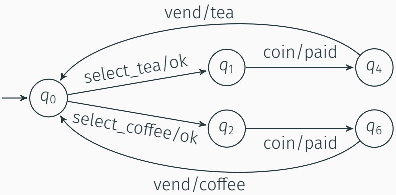

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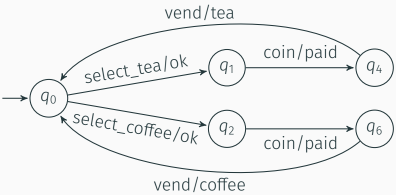

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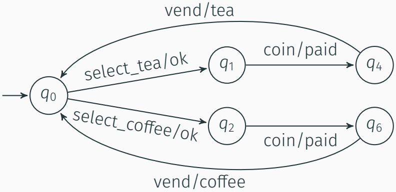

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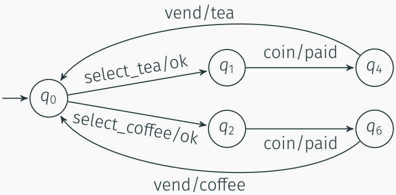

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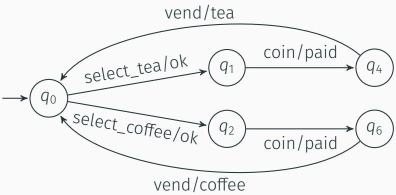

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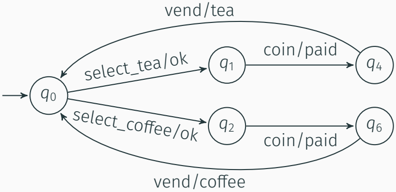

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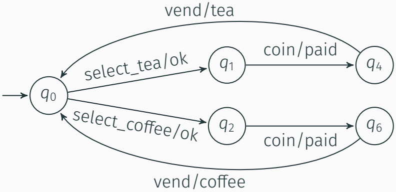

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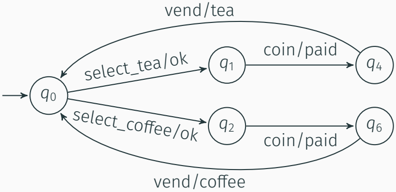

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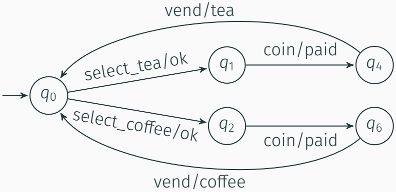

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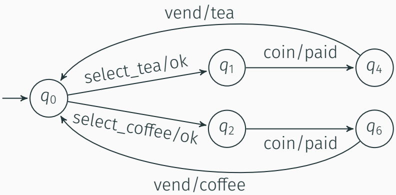

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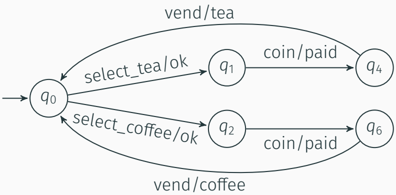

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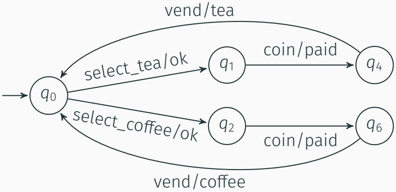

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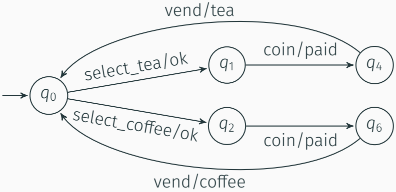

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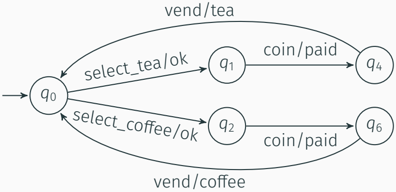

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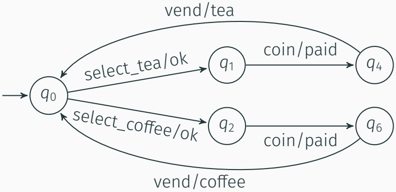

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