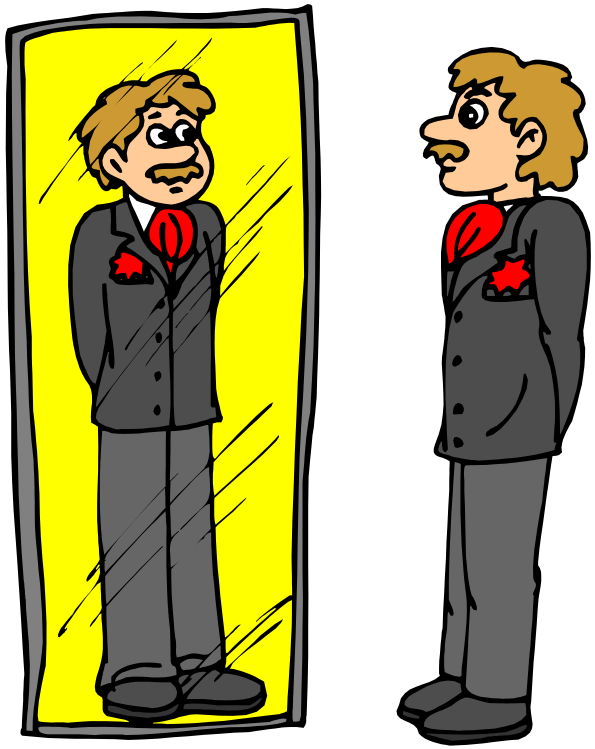
Equivalence

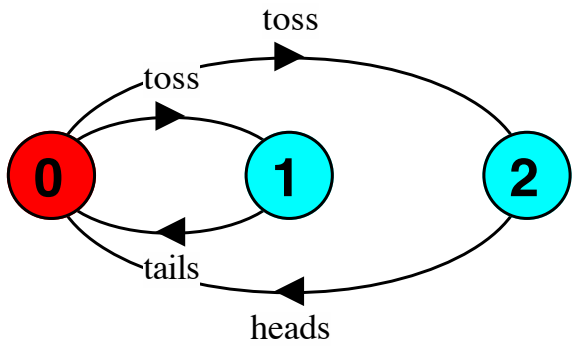


Semantics of LTS

Semantics: Noun. (1) The branch of linguistics and logic concerned with meaning. (2) The meaning of a language, word, phrase, or sentence.

- Consider **COIN**,
  - what does it mean?
  - what information does it convey?
  - what process does it accurately model?

COIN



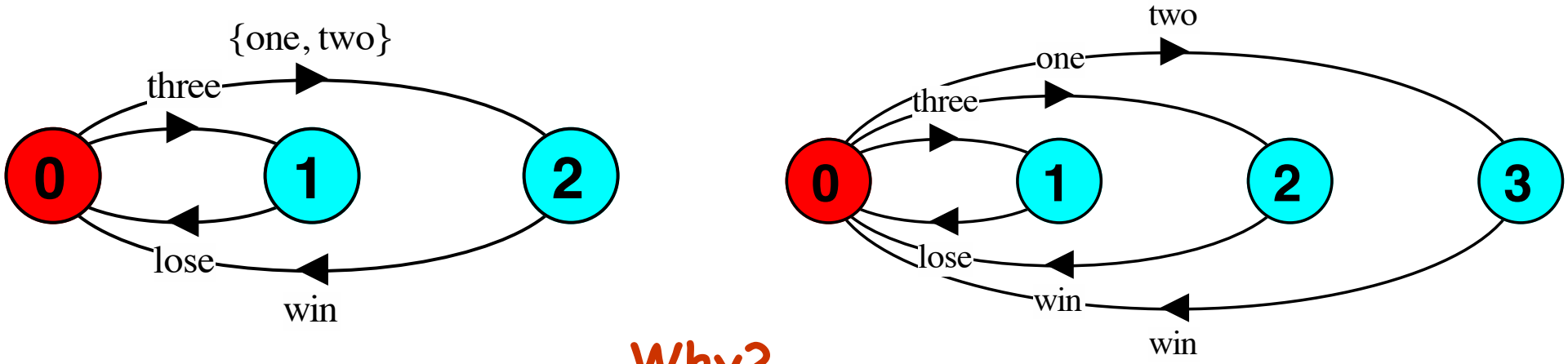
- Understanding the semantics of our models is crucial. Otherwise, how do we know if our model accurately describes our intended solution?

Exploring Equivalence (1)

Defining an equivalence relation between elements of a language is one way of gaining an understanding of its semantics

Two LTS should be equivalent if they mean the same....

... should the following LTS be considered equivalent?



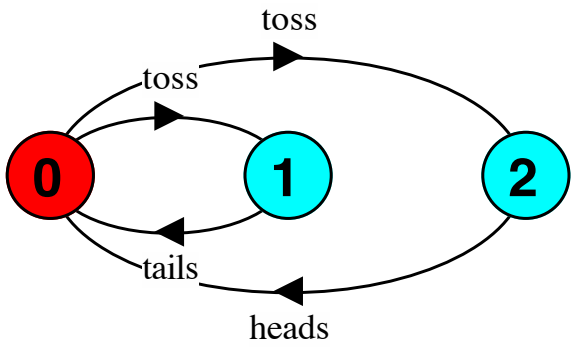
Why?

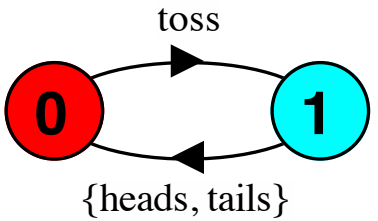
(This can be transformed using LTSA minimisation)

Exploring Equivalence (2)

Two LTS should be equivalent if they mean the same....

... should the following LTS be considered equivalent?



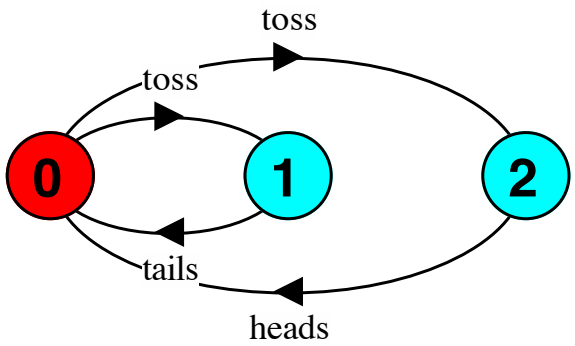


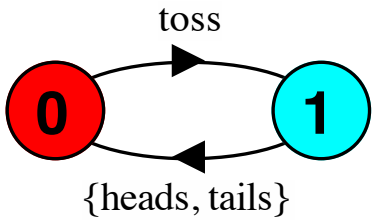
Why?

They are trace equivalent but offer different choices!

An experimental approach to equivalence

As we are modelling observable process behaviour,
two LTS should be considered **equivalent** if we **cannot** devise
an experiment that will allow us to observe different behaviour





Assuming we can observe the actions that a process can engage in,
what experiment distinguishes these LTS?

Equivalence Relation for LTS

How can we define an equivalence for LTS in a precise way?

> A relation ~ is an **equivalence** relation if and only if it is
> reflexive (for all LTS P, P~P),
> transitive (P ~ Q and Q ~ R implies P ~ R), and
> symmetric (P ~ Q implies Q ~ P).

In addition, the equivalence relation should be...

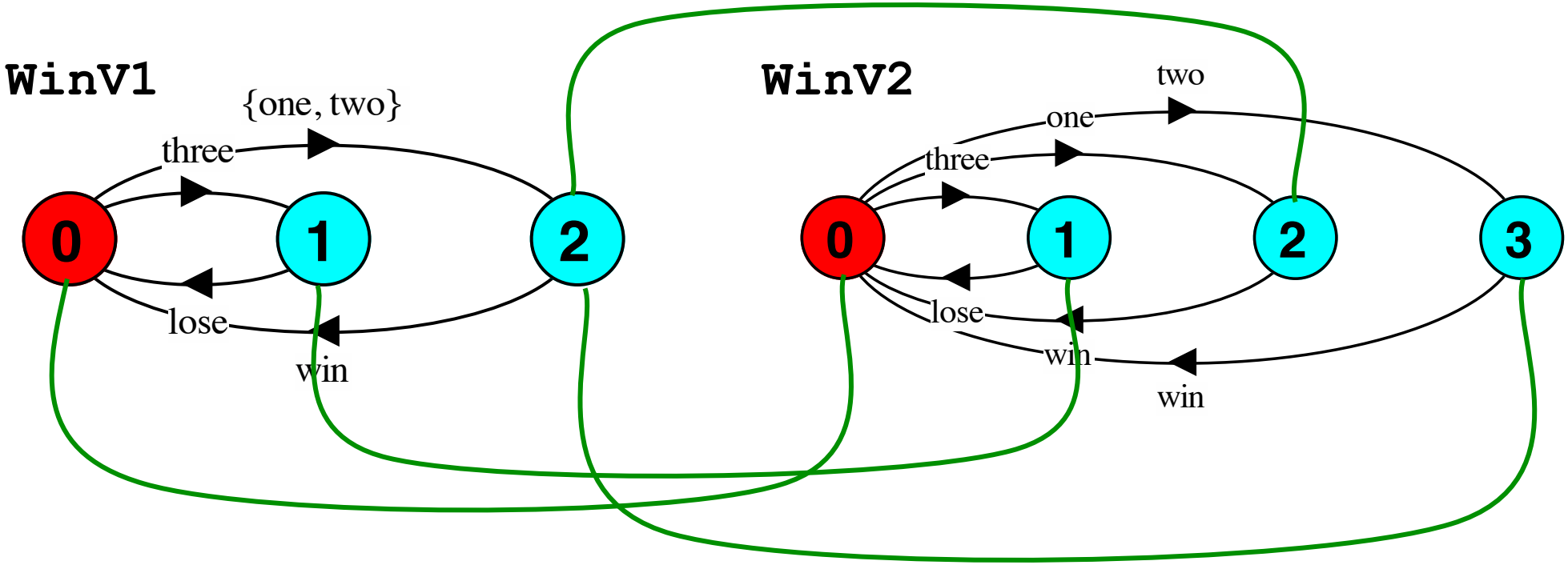
- Abstract with respect to structure...
- Stronger than trace equivalent

What other requirements must LTS equivalence fulfil?

> P and Q are **bisimilar** (noted P ~ Q) if and only if
> there exists a bisimulation between their states

Exploring Equivalence (1) - Revisited

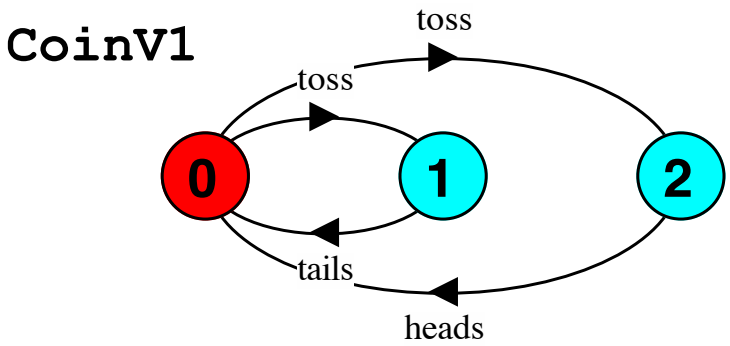
Intuitively, bisimlation is a relation as follows …

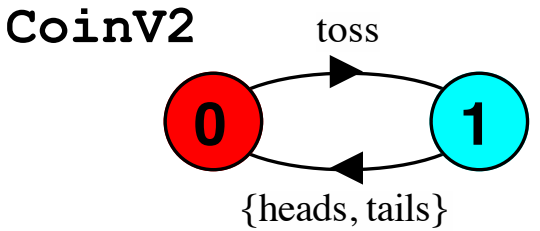


There is a bisimulation between the states of `WinV1` and `WinV2`
Consequently, `WinV1 ~ WinV2`

Exploring Equivalence (2) - Revisited

Can you find a bisimulation for `CoinV1` and `CoinV2` ?





Proving non-equivalence is harder (i.e. non-existence of a bisimulation)

Summary

- Concepts
  - semantics - an interpretation of elements in a language into the problem domain being described.
  - equivalence - an mechanism for understanding the semantics of a language.
- Models
  - Weak Bisimulation as the semantics for LTS
  - Verification as an equivalence problem