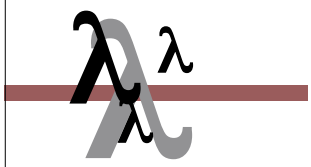


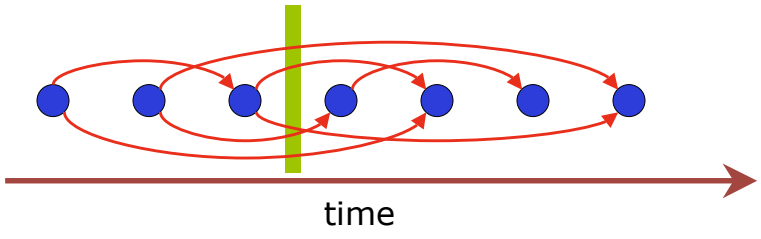
modelling state

looking within

From Formalism to Physicality, Alan Dix, UPC North, 30 April 2008

what is state

that in the present
of that in the past
which affects that of the future



modelling state

- describe state using variables
- types of variables:
  - basic type:
    x: Nat – non-negative integer {0,1,2,...}
  - individual item from set:
    shape: {circle, line, rectangle}
  - subset of bigger set:
    selection: **set** Nat – set of integers
  - function (often finite):
    objects: Nat → shape
  - user defined:
    Point = | x, y: Real – e.g. (1.79,-3.2)

stages

iteratively define:

state	–	what needs to be remembered
invariants	–	what is always true
initial state	–	how it starts
actions	–	what can happen to the state (need to relate this to keys etc.)
display	–	what the user sees (hears etc.)

use scenarios to check they are what you want

four function calculator

- formal description of the state
- define the effect of the following actions:

  type_digit(d) – user presses single digit
  equals – user presses '=' button
  op(p) – user presses '+','–', '*' or '/' button

N.B. will not be right first time ... spot the mistakes

calculator state - first attempt

state

total: Nat – running total (accumulator)
disp: Nat – number currently displayed

no invariants

initial state

total = 0
disp = 0

display

disp – more complex calculator may show formulae

calculator actions - first attempt

type_digit(d)

add d to the end of disp
total unchanged

equals

do last operation "+,-,*," to disp and total
...

what is it!

calculator state - second attempt

state

total: Nat – running total (accumulator)
disp: Nat – number currently displayed
pend_op: {+,–,*,/,none} – pending operation

initial state

total = 0
disp = 0
pend_op = none

calculator actions - second attempt

type_digit(d)
- add d to the end of disp
- total and pend_op unchanged

equals
- do pend_op to disp and total
- put result in both disp and total
- set pend_op to none

op(o)
- do pend_op to disp and total
- put result in both disp and total
- put o into pend_op

calculator - scenario

- user types: 1 + 2 7 = − 3
- start after 1 + 2

action	total	disp	pend_op
	1	2	+
type_digit(7)	1	27	+
equals	28	28	none
op(−)	28	28	−
type_digit(3)	28	283	−

!!!

calculator state - third attempt

state

total: Nat – running total (accumulator)
disp: Nat – number currently displayed
pend_op: {+,–,*,/,none} – pending operation
typing: Bool – true/false flag

- added 'typing' flag
  - user in the middle of typing a number

calculator actions - third attempt

type_digit(d)

if typing then add d to the end of disp
otherwise clear disp and put d in it
also set typing to true
total and pend_op unchanged

equals and op(o):

- as before except both set typing to false

calculator - scenario revisited

- user types: 1 + 2 7 = – 3
- start after 1 + 2

action	total	disp	pend_op	typing
type_digit(7)	1	2	+	yes
equals	1	27	+	yes
op(–)	28	28	none	no
type_digit(3)	28	28	–	no
	28	3	–	yes

defining state

two problems:

- too little state
  - elements missing from specification
  - may be deliberate
    - e.g. dialogue level spec.
- too much state
  - too many states, too complex state
  - may be deliberate
    - redundancy, extensibility

too little state

- forgotten elements

  e.g. 'typing' flag for calculator

- checking:
  - dialogue state

    can you work out current dialogue state?
  - action specification

    do you have enough information?
  - implicit global variables (see also later)

    suggest state missing

too much state

- unreachable states

  too few actions (see later)

  constraints

  states are not orthogonal
- spare variables: constant/functional dependent
- dependent state

  e.g. first point of line, number being typed
- indistinguishable states

  what is observable?

defining actions

- framing problems
  = too little in result state
- unreachable states – insufficient actions
- using 'global' variables
  implicit in operation definition
- beware extreme cases
  (e.g. empty document, cursor at end of line)

internal and external consistency