modelling state

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http://www.hcibook.com/alan/topics/formal/

model based methods

- describe state using variables
- types of variables:
  - basic type: \( x : \text{Nat} \) - non-negative integer \( \{0,1,2,...\} \)
  - individual item from set:
    - shape: \{circle, line, rectangle\}
  - subset of bigger set:
    - selection: \text{set Nat} - set of integers
  - function (often finite):
    - objects: \text{Nat} \rightarrow \text{Shape Type}

define your own types

\[
\text{Shape Type} =
\begin{align*}
\text{shape} : & \{\text{circle, line, rectangle}\} \\
\text{x, y} : & \text{Nat} \quad \text{position of centre} \\
\text{wid} : & \text{Nat} \\
\text{ht} : & \text{Nat} \quad \text{size of shape}
\end{align*}
\]

use them to define state

\[
\begin{align*}
\text{objects} : & \text{Nat} \rightarrow \text{Shape Type} \\
\text{selection} : & \text{set Nat} \quad \text{selected objects}
\end{align*}
\]

invariants and initial state

invariants - conditions that are always be true
- must be preserved by every operation

\[
\begin{array}{l}
\text{selection} \subseteq \text{dom objects} \\
\text{selection must consist of valid objects}
\end{array}
\]

initial state - how the system starts!

\[
\begin{align*}
\text{objects} = & \{\} \quad \text{no objects} \\
\text{selection} = & \{\} \quad \text{selection is empty}
\end{align*}
\]

finally define operations

delete:

\[
\begin{align*}
\text{dom objects}' = & \text{dom objects} - \text{selection} \\
\forall id \in \text{dom objects}' \\
\text{objects}'(id) = & \text{objects}(id) \\
\text{selection}' = & \{\} \quad \text{new selection is empty}
\end{align*}
\]

* note use of primed variables for ‘new’ state
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)