

Formal Specification from an Observation-oriented Perspective

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1. Formal specification of algorithms:
- an experiential perspective

Key question:

*In what sense does a formal specification have
an experiential counterpart?*

- can't *experience* the formal specification directly: contrast an animation of heapsort
- algorithm execution has many instances identifying any one instance of heapsorting with a formal specification of heapsort involves a process of extrapolation
- implementation vs. embodiment not *just* concerned with implementations of heapsort on a conventional computer
- requires the representation of state 'as experienced' vs. closed world state heapsort has specific intermediate states
- needs abstract states and transitions *states* as referenced by invariants *transitions* from state to state as automatic, subject to user control, in response to input

2. What - in experiential terms - is an instance of heapsort?

Our answer ...

a phenomenon in which - as it is *construed* by the human interpreter - state-changes are effected by a reliable stimulus-response mechanism

[such as a conventional computer executing heapsort, or a human sorting physical items by following the heapsort recipe faithfully]

where

this mechanism is 'programmed' to react to specified stimuli in a specified way
[as dictated by the guarded commands in the formal specification]

Interpretation wrt the formal specification ...

a phenomenon is heapsort if it reliably exhibits a particular pattern of abstract states and state-changing processes that is prescribed by the variants and invariants in the specification

? represent/communicate how we construe

3. Useful analogy from experimental science

Express explanatory insights into phenomena wrt to interaction with physical models

['construal' borrowed from David Gooding]
Construals are a means of interpreting unfamiliar experience and communicating one's trial interpretations. Construals are practical, situational and often concrete. They belong to the pre-verbal context of ostensive practices.

Central idea of Empirical Modelling

construe phenomena in terms of observables, dependencies and agency (NB nec. informal)

create (computer-based) models based on familiar and accessible observables

use interaction with these models to represent invisible interactions between hypothetical agents construed to account for a phenomenon

Examples

- water model of electrical potential & current
- circuit diagrams
- magnetic fields

4. Empirical Modelling applied to heapsort

Heapsort is framed with reference to data structures and agency operating upon them

... typically invisible agents and data structures involved in a heapsort mediated via experience in which the human interpreter participates

Principle: embody in an *interactive computer model* the observables, dependency and agency that are representative of heapsort

NB **openness**: scope for experiment to verify construals - not just passive observation and preconceived interaction (e.g. to disclose hidden rogue violation of integrity such as $10 > 47$)

situatedness: semantics for model established through direct reference to its context, and with reference to possible modeller interaction

6. Ways of using the model

invariants/variants as abstract observables
teaching/learning the heap concept
formulating/debugging the heap condition
automatic execution of heapsort
agent-based event-driven implementation
pigeon heapsort: cf. look-up heapsort

Exploratory development

identity issues (outside the formal framework)
cf. substitute for elements during the process

cf. multiply every element by a factor

using the formal method to supply meta-control

fault-tolerance

5. Status of the construal of heapsort

In many respects, how perceptual mediation to the user is achieved not significant

... size of the model, colour/display conventions to depict ordering relations & heap conditions

cf. standard conventions for data structures

Crucial issues ...

framework of observables, dependency and agency is canonically established by the formal specification of heapsort

conventions must respect characteristic rels between observables, dependencies and agency.