Concept Analysis in Programming Language Research
Done Well It Is All Right

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What are the appropriate research approaches in PL research?

- human-factors empirical research
- technical empirical research
- mathematical
- maybe others?
- my claim: philosophical concept analysis
Philosophical concept analysis

- bringing clarity to unclear concepts
- proposing a definition, with an argument in support
- showing that a concept is really multiple concepts, or no concept
- debating analyses (definitions)
Concepts
Some concepts

- effectively calculable function
- object-oriented programming
- type (in a particular PL or more generally)
Concepts are

important

- thinking tools
- communication tools
- often value-laden

often confusing

- people use the same language but do not understand each other

often disregarded

- stipulated definitions
Three views on concepts

- realism / Platonism
  - natural kinds, universals
- formalism / naturalism
  - metaphors, thinking aids, language elements
- (social) constructionism
  - concepts constructed by humans interacting
- can be mixed & matched
- a systematic formalist probably finds this talk nonsensical
Choice of methodology
Empiricism vs rationalism

Empiricism

We can (only) learn about the reality by sense experience.

Rationalism

We can learn about the reality by reasoning from the first principles.
Empiricism won. With good reason.  
So why am I advocating a non-empirical research approach?

If you are a realist:
Because concepts cannot be observed.

If you are a formalist:
You probably think this is all nonsense; fair enough.

If you are a (social) constructionist:
Because empirical work can only answer what is, not what ought to be.
Conceptual questions
Philosophical not mathematical

Concepts

philosophy  →  axioms  →  mathematics

unclear  stipulated  clear
Concept analysis
Two main species of concept analysis

Classical analysis

A (well known) vague concept is really this precise concept (that I propose).

Carnapian explication

A (well known) vague concept should be replaced (in scientific usage) by this precise concept (that I propose).
Some notable analyses in computing

- Turing: effective calculability $\rightarrow$ Turing machine computability
- Church: effective calculability $\rightarrow$ $\lambda$ normalization
- Cook et al.: inheritance is not subtyping
- Kell (Onward 2014): type *to*
  1. named interpretations
  2. storage contracts
  3. operational well-definedness over storage
  4. semantic well-formedness
- Kell (today): systems code $\rightarrow$ communicative code
Concept analysis requires an argument

- reasons $\rightarrow$ conclusion
- can be deductive, but that does not help much
  - your *modus ponens* is my *modus tollens*
- the reasons are the key, but...
Concept analysis requires counter-arguments

- your *modus ponens* is my *modus tollens*
- without first principles anything can be criticized
- goal must be community agreement
  ➞ social construction
- we should develop a culture of conversation in the literature
What is a good concept analysis?

- clear argument – precise but not too precise
- consider Carnap’s criteria
- not expected to convince everybody
1. The explicatum is to be similar to the explicandum [...]; however, close similarity is not required, and considerable differences are permitted.

2. The characterization of the explicatum, that is, the rules of its use [...], is to be given in an exact form [...]

3. The explicatum is to be a fruitful concept, that is, useful for the formulation of many [...] empirical laws [or] logical theorems[...].

4. The explicatum should be as simple as possible; this means as simple as the more important requirements (1), (2), and (3) permit.
Conclusion
Philosophical concept analysis

- proposing a sharp definition
- arguing for it
- discussing the issue
- (maybe) reaching a community agreement