

Concept Analysis in Programming Language Research

Done Well It Is All Right

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Concept
Analysis in
Program-
ming Lan-
guage Re-
search

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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

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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)

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Some concepts

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

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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

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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

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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.

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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*.

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Conceptual questions

Philosophical not mathematical



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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).

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Some notable analyses in computing

- ▶ Turing: effective calculability \rightarrow Turing machine computability
- ▶ Church: effective calculability \rightarrow λ 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

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Concept analysis requires an argument

- ▶ reasons → conclusion
- ▶ can be deductive, but that does not help much
 - ▶ your *modus ponens* is my *modus tollens*
- ▶ the reasons are the key, but. . .

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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

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What is a good concept analysis?

- ▶ clear argument – precise but not too precise
- ▶ consider Carnap's criteria
- ▶ not expected to convince everybody

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Carnap's criteria

Quoted from [10], p. 7.

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.

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Philosophical concept analysis

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

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