philosophical/armwaving material

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Philosophy

Modeling is *applied* math; mapping between the real world and mathematical framework. Getting the mapping right is the hardest part. "All models are wrong" (attr. George Box): want an **approximate** solution to the right question, rather than an exact solution to a different question. Platt (1964): "you can catch phenomena in a logical box or in a mathematical box. The logical box is coarse but strong. The mathematical box is fine-grained but flimsy. The mathematical box is a beautiful way of wrapping up a problem, but it will not hold the phenomena unless they have been caught in a logical box to begin with."

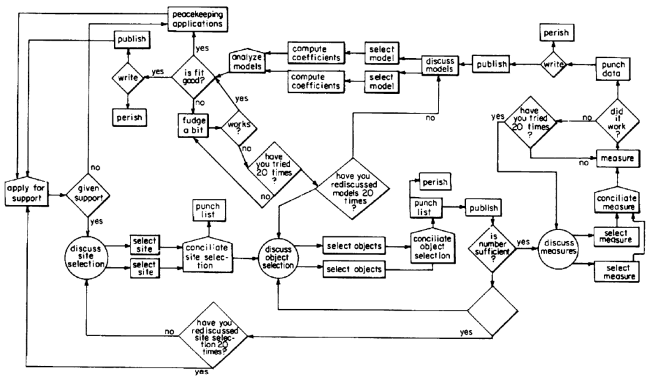

Fig. 2 "Nabian" flowchart of systems analysis

Categories

Scope and approach

abstract	concrete
strategic	tactical
general	specific
theoretical	applied
qualitative	quantitative
descriptive	predictive
mathematical	statistical
mechanistic	phenomenological
pattern	process

Technical

analytical	computational
dynamic	static
continuous	discrete
population-based	individual-based
Eulerian	Lagrangian
deterministic	stochastic

What is a 'simulation'?

Criteria: generality, realism, precision (Levins 1966). "The validation of a model is not that it is 'true' but that it generates good testable hypotheses relevant to important problems" (or sufficiently accurate predictions?) ($\approx$ "useful")?

Limits: data, analytical tractability, computation, human comprehension?

Odenbaugh (2006): "The premature use of numerical methods (especially computer methods) can often confuse numbers with knowledge."

Tools

- Spreadsheets:
  - intuitive, visible, auto-updating
  - hard to reproduce, non-transparent, numerically sloppy, often closed-source
- Programming languages (R, Python, MATLAB/Scilab)
  - free and open (some), flexible, extendable, widely used
  - harder to learn, somewhat limited for big data, no support/arrogant
- Analytical solutions
  - general, rigorous, computationally efficient
  - very hard (*closed-form* solutions sometimes impossible)

modeling choices

- linear / nonlinear
- univariate / multivariate
- discrete / continuous time
- deterministic / stochastic
- *also*: discrete / continuous state, individual- / population-based ...

e.g. LUDD, MUDS, ...

References

Levins, R. 1966. *American Scientist* 54: 421–431.

Odenbaugh, J. 2006. *Biology & Philosophy* 21 (5): 607–621. doi:10.1007/s10539-006-9049-3. http://www.springerlink.com/content/9827k6256542g762/.

Platt, JR. 1964. *Science* 146 (3642). New series (October): 347–353. doi:10.2307/1714268. http://www.jstor.org/stable/1714268.