Models

1 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. Cow & bull (Perry, 1997). 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 if 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."

Categories of models:

Scope and approach

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

Technical details

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

Sophistication

simple	complex
crude	sophisticated

What is a 'simulation'?

Criteria: generality, realism, precision (Levins, 1966) [Google scholar for `Levins 'strategy of model building'` to see many responses to this classic paper]; '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."

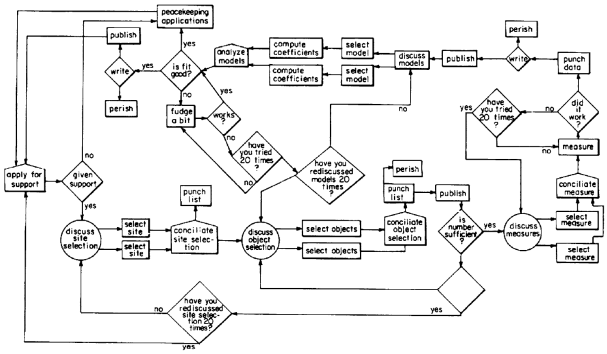

Fig. 2 "Nabian" flowchart of systems analysis

Tools

- Spreadsheets:
  - *pro*: intuitive, visible, auto-updating
  - *con*: lack of reproducibility, invisible properties of cells, numerical sloppiness, bad graphical defaults, fixed geometry, often closed-source
- R:
  - *pro*: free, open, flexible, extendable, lingua franca (huge package collection), interfaces
  - *con*: hard to learn, somewhat limited for big data, no support/arrogant
- Analytical solutions:
  - *pro*: far more general solution, efficient, fewer/different bugs
  - *con*: hard, sometimes impossible

References

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