DECISIONMAKING FOR COMPLEX ADAPTIVE SYSTEMS

PAUL K. DAVIS
RAND AND PARDEE RAND GRADUATE SCHOOL
PRESENTED TO NATIONAL ACADEMY WORKSHOP, NOVEMBER 13, 2019

Tenets

- *Most* policy analysis deals with social systems
- Social systems are *usually* complex adaptive systems
- *Most* social challenges involve *wicked problems* and *deep uncertainty*
- Implications for analysis and management are profound

Topics for Change: Worldview

Topic	Now	CAS-Informed
Context	Simple, complicated, well behaved partial systems	Systems, which are complex, adaptive, and ill-behaved
Problem	Well-posed solvable problems	Ill-defined, not solvable, wicked problems Solutions *may* emerge, or may not
Objectives	Known values, utilities, objectives	Unknown, changing values, objectives, and nonlinear utilities
Knowledge	Reasonable best estimates; some uncertainties. Basis for finding optimal solutions,	Deep uncertainty everywhere; no meaningful best estimate. Models, not just parameters, are suspect. Solutions should be flexible, adaptive,and robust. Optimization is anathema
Decisions	Once-and-for-all decisions	Repeated decisions as reality evolves
Locus	Top-down, confident actions	Top-down, bottom-up, sideways, networked; humble and adaptive

Basis for Reasoning and Inference; analytic style

Topic	Current	Future
Basis for inference	Data, correlation	Causal theory, informed by data
Types of theory	Simple, fragmented mini theories	Integrative, coherent with contextual distinctions but uncertainty-sensitive
Ethic	A statistician's parsimony	Einstein's parsimony
Uncertainty	On margin as add-on	From outset with broad exploration
Option comparison	Cost-effectiveness (CE)	Multicriteria scoreboards, net effectiveness by perspective (normal CE is badly wrong)

Character of Models and Model-Based Analysis

Topic	Current	Future
Type	Statistical	Diverse:causal models, games, ... and empirical methods
Purpose	Explain and predict data in statistical sense (for stable systems)	Describe, explain in causal terms, post-dict, explore, predict when feasible
Ethic	Meaningful correlations (good R2) with old and new data	Causal explanation and rough prediction even as system and circumstances change
Focus of outcomes	Expected valuue	Distributional effects, multiple criteria; balance

Final Observations

- Qualitative models may be sound (right factors), but uncertainty sensitive
- Beware of fake rigor
- See games and ABMs as laboratories to inform system dynamics
- Enhance system dynamics to include decision models
- Design for exploratory analysis under deep uncertainty in both models and parameters.
  - Multi-resolution for synoptic first, then selective zoom
  - Routinely report “parametrically” and by “perspective” (beyond what-if analysis)
  - Use theory-informed exploration to discover phases and tipping points (sharpening “context”)
  - Identify system states that do or do not allow influence with reasonable control
- **Predictions are almost certainly wrong but familiarity with relationships and illustrative dynamics ihelps <u>actual</u> decision making**

References

- Email: pdavis@rand.org or Paul_K_Davis@me.com

  - Davis, McDonald, et al., “Updating …Policy Analysis to … Address Complex Adaptive Social Systems,” Working Paper, RAND (forthcoming) and Proc. of 2010 Meeting of the Computational Social Science Society, forthcoming.

- Davis, O’Mahony, and Pfautz (eds.), **Social-Behavioral Modeling for Complex Systems** (2019), Wiley & Sons,

- Marchau, Walker, and Popper, **Decisionmaking under Deep Uncertainty** (2019), Springer.

- Davis and Popper, “Confronting Model Uncertainty in Policy Analysis for Complex Systems: What Policymakers Should Demand,” *Journal of Policy and Complex Systems,* in press, 2019.