Revealed Causal Mapping

Deb Armstrong
Division of Accounting and Information Systems
School of Business, The University of Kansas

darmstrong@ukans.edu

History of Causal Mapping

- Understanding Cognition
- Cognitive Mapping
  - Tolman (1948)
- Causal Mapping
  - Axelrod (1976)

Causal Mapping

- Six Distinct Approaches
  - Eden (1992)
  - Boland et al. (1994)
  - Zmud et al. (1993)
  - Bougon et al. (1977)
  - Ford & Hegarty (1984)
  - Narayanan & Fahey (1990)

Sample Research Domains

- Political Science
  - Axelrod (1976)
- Organizations
  - Bougon et al. (1977)
- Strategy
  - Narayanan & Fahey (1990)
- Information Systems
  - Nelson, Nadkarni, Narayanan & Ghods (2000)

Evaluation of Methodology

	Confirmatory	Evocative
Choice of Source	Wide choice – observation, archival, interview	Access relevant experts
Sampling Criteria	Determined by inference procedure	Arriving at representation of domain specific theory is key
Categories & Linkages	Specified a priori	Concepts emerge from the experts
Unit of Analysis	Correspond with sampling criteria invoked	Correspond with sampling criteria invoked
Inference Procedures	Statistical inference	Valid theoretical representation of domain specific phenomena
Validity of Findings	Agreement with existing theory	Applicability of general theoretical framework invoked Do the experts find the representation of their theories accurate?

Revealed Causal Mapping

1. Select data source and gather narratives
2. Identify causal statements
3. Construct ‘raw’ causal maps
4. Develop coding scheme
5. Recast ‘raw’ maps into revealed causal maps
6. Derive measures for maps

Revealed Causal Mapping

- Step 1: Select data source and gather narratives
  - Availability of experts is key
  - Narratives can be gathered through interview, text, case analysis
  - Capture narratives in the language of the experts
  - Gather data to the point of redundancy

Revealed Causal Mapping

- Step 2: Identify causal statements
  - Causal statements imply cause-effect relationship
  - Identify using key words “if-then”, “because”, “so”
  - Watch for conversational usage (ie: so)

Identify Causal Statements

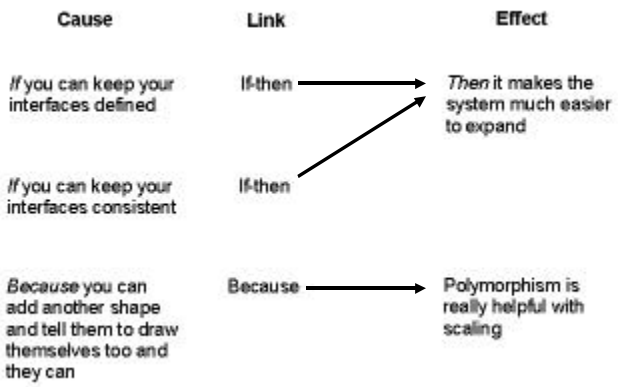
Examples of Causal Statements:

1. If you can keep your interfaces defined and consistent then it makes the system much easier to expand.
2. Polymorphism is really helpful with scaling because you can add another shape and tell them to draw themselves too and they can.

Revealed Causal Mapping

- Step 3: Construct "raw" causal maps
  - Causal statements broken down into causes and effects
  - Inter-rater reliability

Construct Raw Causal Maps



Revealed Causal Mapping

- Step 4: Develop coding scheme
  - Identify conceptual categories from texts
  - New categories emerge from texts
  - Place statements in appropriate categories

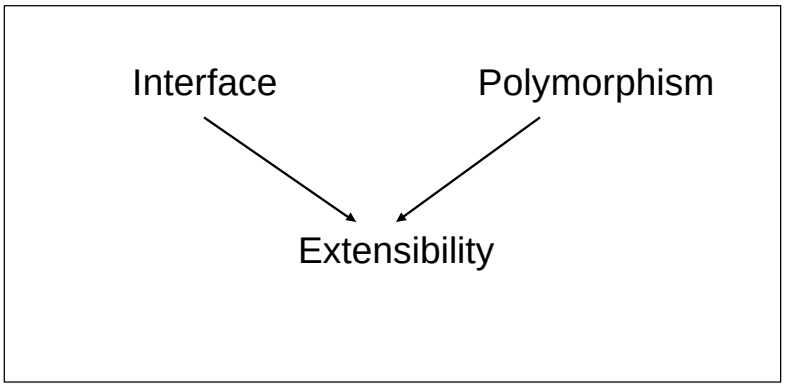
Coding Scheme

Raw Phase	Coded Concept
Keep interfaces defined	Interface
Keep interfaces consistent	Interface
Makes the system much easier to expand	Extensibility
Polymorphism is really helpful with scaling	Extensibility
you can add another shape and tell them to draw themselves too and they can.	Polymorphism

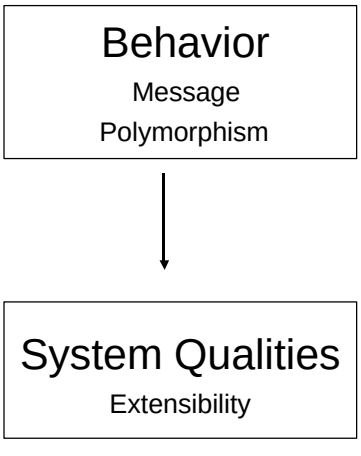
Revealed Causal Mapping

- Step 5: Recast 'raw' maps into revealed causal maps
  - Cause and effect statements recast into concept level maps
  - Member check performed
  - Prepare aggregated map (Bougon et al, 1977)

Recast Concept Level Map



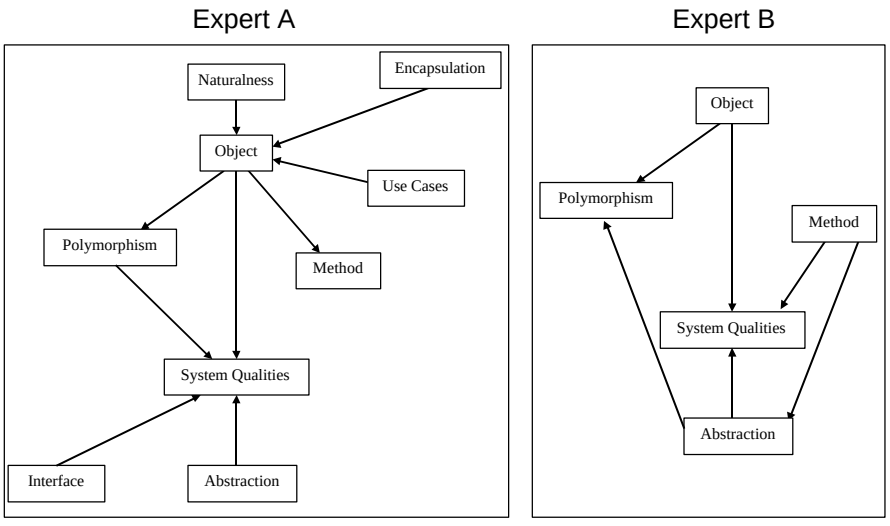
Construct Level Map



Revealed Causal Mapping

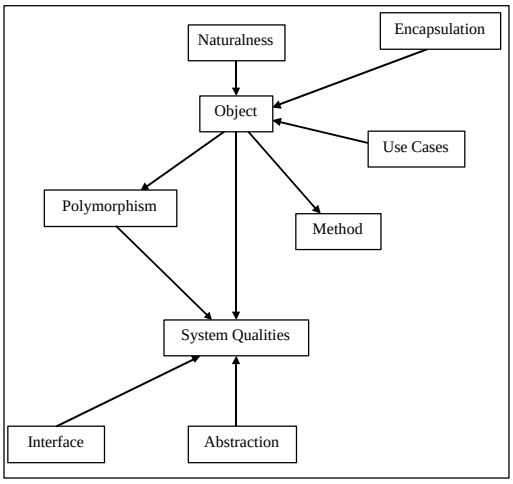
- Step 6: Derive measures for maps
  - Comprehensiveness
  - Density
  - Adjacency Matrix
  - Reachability Matrix

Comprehensiveness



Density

Expert A

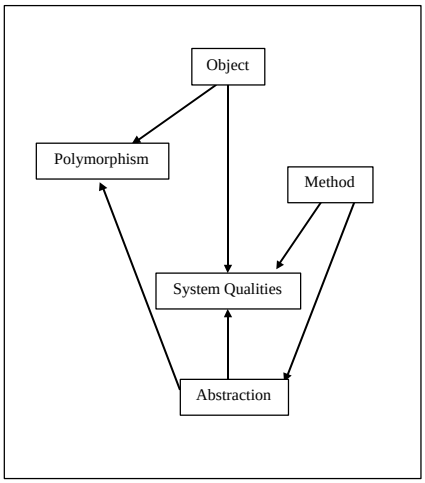


$$\text{Density} = \frac{\text{number of ties}}{\text{number of all possible ties}}$$

$$\text{Density} = \frac{9}{72} = .125$$

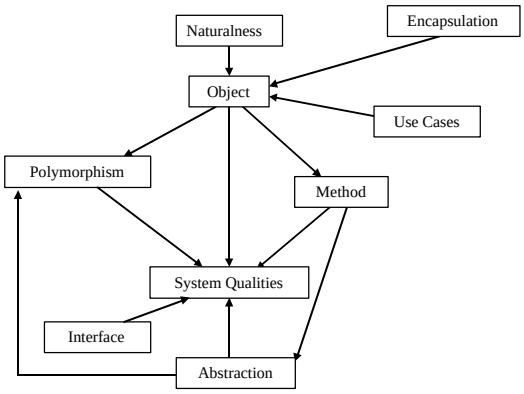
Density

Expert B



$$\text{Density} = \frac{6}{20} = .300$$

Adjacency Matrix

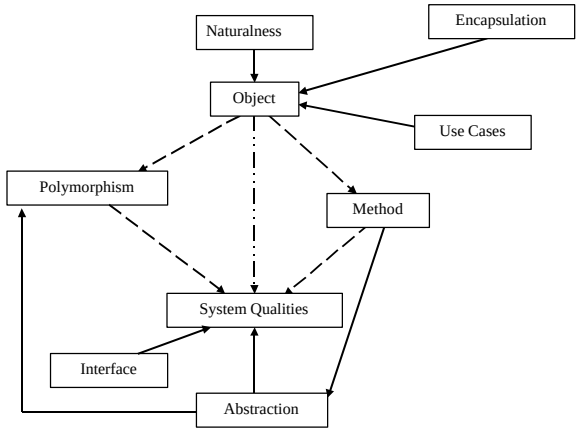


Adjacency Matrix

Construct	A	B	C	D	E	F	G	H	I	Outdegree
A. Naturalness	0	0	**1**	0	0	0	0	0	0	1
B. Encapsulation	0	0	**2**	0	0	0	0	0	0	2
C. Object	0	0	0	0	0	**5**	**1**	0	**2**	8
D. Use Cases	0	0	**3**	0	0	0	0	0	0	3
E. Polymorphism	0	0	0	0	0	0	**4**	0	0	4
F. Method	0	0	0	0	0	0	**1**	0	**9**	10
G. System Qualities	0	0	0	0	0	0	0	0	0	0
H. Interface	0	0	0	0	0	0	**1**	0	0	1
I. Abstraction	0	0	0	0	**1**	0	**7**	0	0	8
Indegree	0	0	6	0	1	5	14	0	11	37

Construct	A	B	C	D	E	F	G	H	I
A. Naturalness	-	-	0.027	-	-	-	-	-	-
B. Encapsulation	-	-	0.054		-	-	-	-	-
C. Object	-	-	-	-	-	0.135	0.027	-	0.054
D. Use Cases	-	-	0.081	-	-	-	-	-	-
E. Polymorphism	-	-	-	-	-	-	0.108	-	-
F. Method	-	-	-	-	-	-	0.027	-	0.243
G. System Qualities	-	-	-	-	-	-	-	-	-
H. Interface	-	-	-	-	-	-	0.027	-	-
I. Abstraction	-	-	-	-	0.027	-	0.189	-	-

Reachability Matrix



Reachability Matrix

Construct	A	B	C	D	E	F	G	H	I
A. Naturalness	0.000	0.000	**0.027**	0.000	0.000	**0.004**	**0.001**	0.000	**0.002**
B. Encapsulation	0.000	0.000	**0.054**	0.000	0.000	**0.007**	**0.003**	0.000	**0.005**
C. Object	0.000	0.000	0.000	0.000	**0.002**	**0.135**	**0.047**	0.000	**0.087**
D. Use Cases	0.000	0.000	**0.081**	0.000	0.000	**0.011**	**0.004**	0.000	**0.007**
E. Polymorphism	0.000	0.000	0.000	0.000	0.000	0.000	**0.108**	0.000	0.000
F. Method	0.000	0.000	0.000	0.000	**0.007**	0.000	**0.074**	0.000	**0.243**
G. System Qualities	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
H. Interface	0.000	0.000	0.000	0.000	0.000	0.000	**0.027**	0.000	0.000
I. Abstraction	0.000	0.000	0.000	0.000	**0.027**	0.000	**0.192**	0.000	0.000

Conclusion

- Applications of revealed causal mapping to IS research:
  - Explore cognition
  - Develop mid-range theories
  - Develop maps that can be the basis for confirmatory empirical testing

References

- **Axelrod, R**. *Structure of decision: The Cognitive Maps of Political Elites*. Princeton, NJ: Princeton University Press, 1976.
- **Boland, R.J., Tenkasi, R., and Te'eni, D**. Designing information technology to support distributed cognition. *Organization Science*, 5(30), August 1994, 456-475.
- **Bougon, M., Weick, K., and Binkhorst, D.** Cognition in organizations: An analysis of the Utrecht jazz orchestra. *Administrative Science Quarterly*, 22 (1977), 606-639.
- **Eden. C.** On the nature of cognitive maps. *Journal of Management Studies,* 29, (1992), 261-265.

References

- **Ford, J.D. and Hegarty, W.** Decision maker's beliefs about the causes and effects of structure: An exploratory study. *Academy of Management Journal,* 27(2), (1984), 271-291.
- **Huff, A.** *Mapping Strategic Thought.* New York: John Wiley and Sons, 1990.
- **Knoke, D., and Kuklinski. J.H**. *Network Analysis*, Newbury Park, CA: Sage Publications, 1982.
- **Narayanan, V.K. and Fayhey, L**. Evolution of revealed causal maps during decline: A case study of Admiral. In A. Huff (Ed.) *Mapping Strategic Thought*. London: John Wiley and Sons, 1990, pp. 109-133.

References

- **Nelson, K.M., Nadkarni, S., Narayanan, V.K. and Ghods, M**. Understanding software operations support expertise: A causal mapping approach. *MIS Quarterly,* 24(3), (2000), 475-507.
- **Tolman, E.C**. Cognitive maps in rats and men. *Psychological Review*, 55, (1948), 189-208.
- **Zmud, R.W., Anthony,m W.P. and Stair, R.M**. The use of mental imagery to facilitate information identification in requirements analysis. *Journal of Management Information Systems*, 9(4), (1993), 175-192.