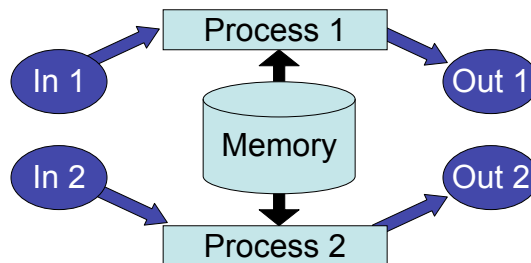


Making Meaningful Memory Structure Comparisons Using Bootstrap Analysis of Pathfinder Networks

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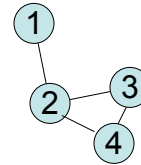
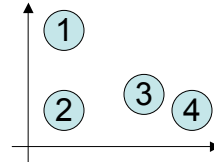
Memory Structures

- Comparing memory structures can help...
 - Contrast experts and non-experts
 - Suggest a common basis for many differences in cognitive behaviors



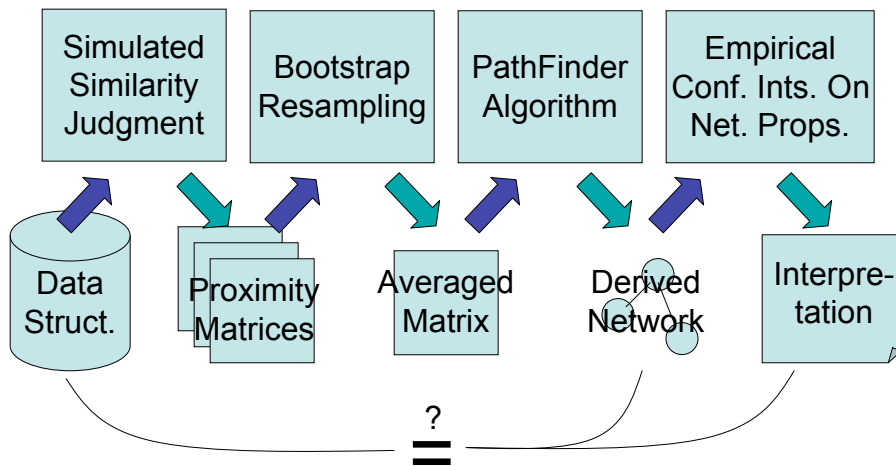
Eliciting Memory Structures

- Most common is Multidimensional Scaling
- But, metric assumptions not met
- Instead of a spatial metaphor, Pathfinder networks assume a network metaphor -- matching high-level models of memory
- Questions
 - Can the resulting network be meaningfully interpreted?
 - How can you differentiate signal and noise when comparing populations?



Goal: detect differences in how differentiated trait knowledge is

Task: judge similarities between different animals' personalities

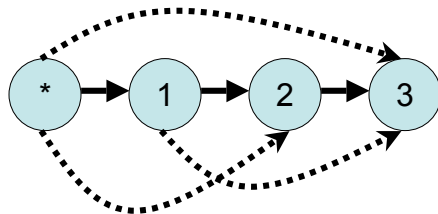


Simulating Similarity

- Domain: animal personalities
butterfly, cat, deer, dog, fox, lion, rat, snake, tiger, wolf
- Animal traits taken from the Lex-Ecologist
– afflatus.ucd.ie/lexeco/lexeco.jsp
- Relationships between traits derived semi-automatically using WordNet
- Similarity determined using ratio rule from Tversky (1977), determining features to use based on simulated spread of activation

Memory Structure Differences

- Compare original trait knowledge network with one including “shortcuts” to nodes reachable within 3 steps



- Muddles subtle trait distinctions

Properties Compared

- Network Density
 - %age of possible connections that are there
 - In memory, higher means less differentiation
- Average Node Degree
 - Average number of connections per node
 - Higher means broader spread of activation
- Average Path Length
 - Average shortest path between nodes
 - Smaller means network is more compact

Comparison Standard

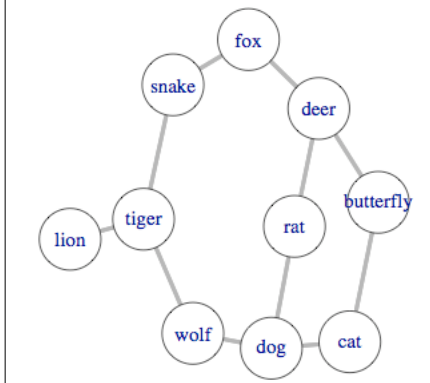
Simulation without Randomness

- Data generated from a *more dense* memory network result in a *less dense* PF network
 - Due to the fact that similarity becomes more stereotyped, and more consistent across pairs
 - Could be different for other elicitation tasks
- Parameterizing PFNET (for those already familiar with it...)
 - Will use $r = \infty$, $q = 3$: ordinal interpretation, no strict triangle inequality violations
 - Higher values of q wash out differences for $r = \infty$, since many more intransitivities will result

Comparison Standard

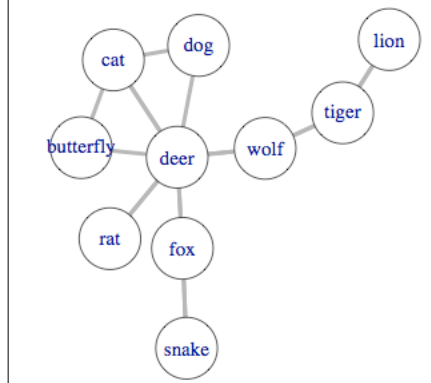
at $r = \infty, q = 3$

More Differentiated



Density = .49, Mean Degree = 4.4,
Mean Path Len = 2.3

Less Differentiated



Density = .4, Mean Degree = 3.6,
Mean Path Len = 2.3

Simulated Experiment

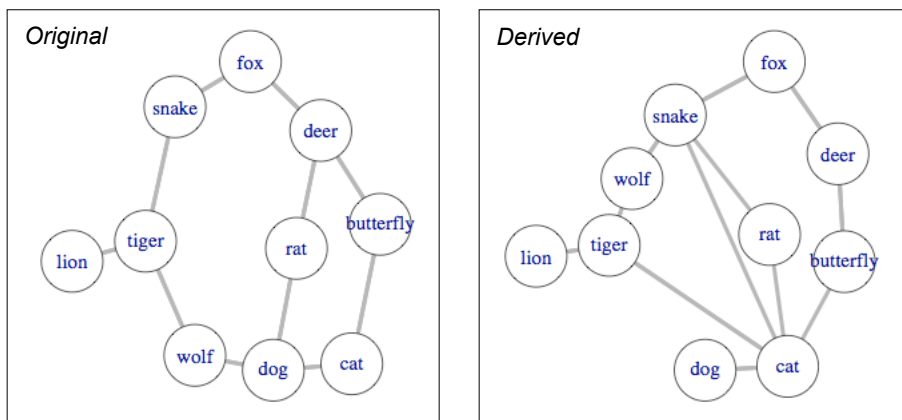
- Simulate multiple participants (25/cell)
- Initial activations from animal to traits is probabilistic
- Comparison approaches
 - Statistical: run PFNET for each participant, compare summary statistics parametrically
 - Bootstrap: average matrices across bootstrap resampling of participants, use for PFNET, compare summary statistics empirically

Comparing Comparisons

- Statistical (t-test)
 - Density
.44 v. .41, $p < .01$
 - Mean Degree
3.9 v. 3.7, $p < .01$
 - Path Length
1.9 v. 2.0, $p < .05$
- All differences significant, in the right direction
- Bootstrap (95% CI)
 - Density
(.42, .51) v. (.4, .4)
 - Mean Degree
(3.8, 4.6) v. (3.6, 3.6)
 - Path Length
(1.4, 2.3) v. (2.4, 2.8)
- All differences significant, in the right direction

Comparing Graphs

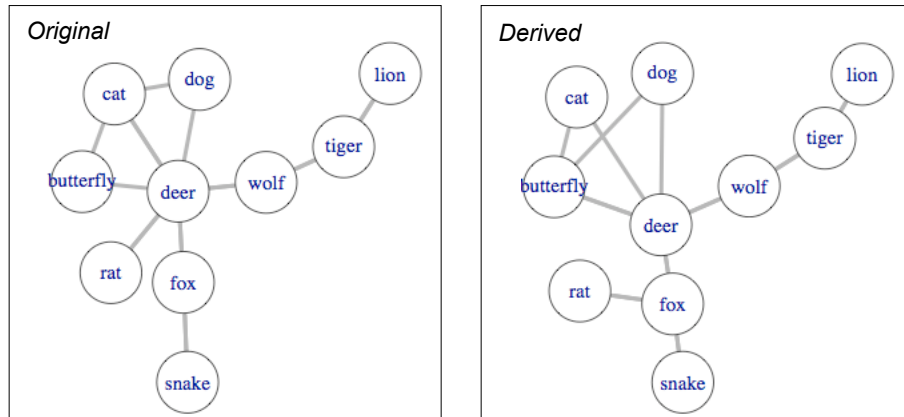
More Differentiated



shared connections: 7; missing in derived: 5; new in derived: 4

Comparing Graphs

Less Differentiated



shared connections: 9; missing in derived: 2; new in derived: 2

Conclusions

- Interpretation of derived network
 - Depends on the kinds of proximity data
 - Might not match intuitions about original network
- Both statistical and bootstrap comparisons can work if all pairwise proximity judgments available from each participant
- Pathfinder's network metaphor is intuitive but deceiving
 - Does not match the actual generating process
 - Not clear how to interpret connections
 - Unclear which parts are robust and which are not

Thank You

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