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Replication and Robust Results

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Science Is Based on a Peculiar Logic

- Experimental method
  - Relationship => hypothesis
  - Hypothesis is true
  - Conclude relationship is true
- Affirming the consequent
  - A => B
  - B is true
  - Conclude A

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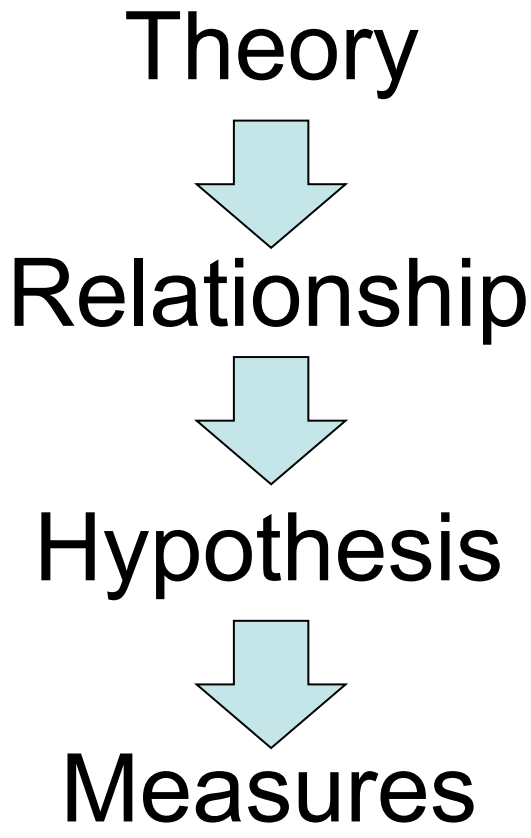
Many-Layered Problem



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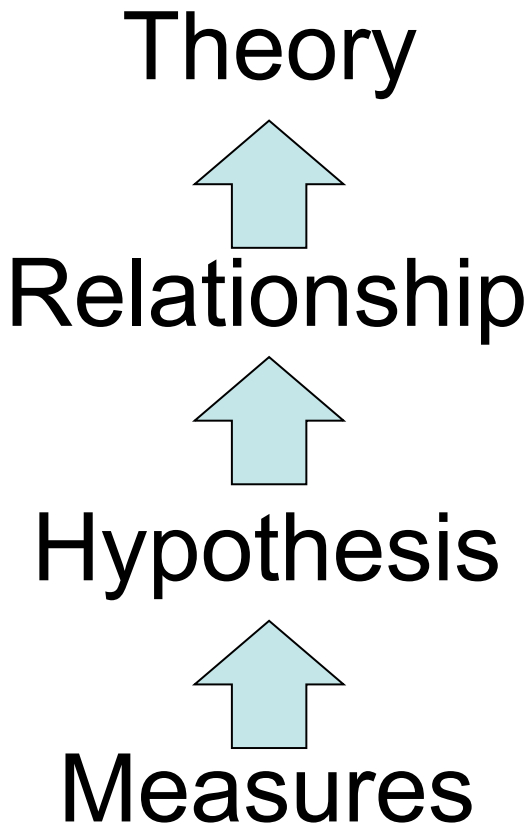
Many-Layered Problem



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Robust Results

- Results consistent as “irrelevant” things vary

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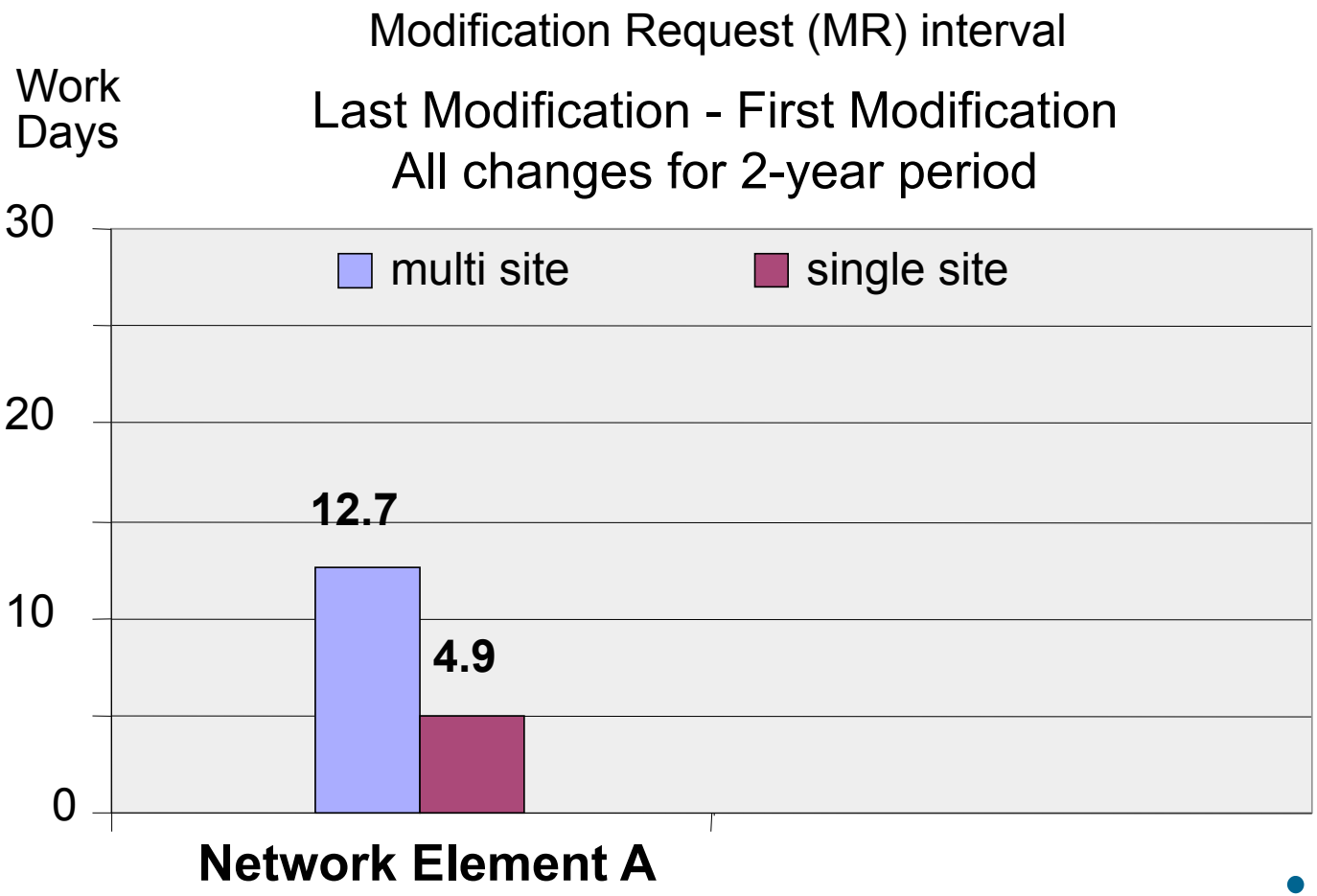
Multi-site Delay



Herbsleb, J.D. & Mockus, A. (2003). An Empirical Study of Speed and Communication in Globally-Distributed Software Development. *IEEE Transactions on Software Engineering*, *29, 3*, pp. 1-14.

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Modeling Interval

Variable	Measure used in models
MR interval	Log of number of days, first delta to last delta
Number of people	Log of number of people
Diffusion	Log of number of modules touched by change
Size	Log of number of delta
Time	Date
Severity	Is high severity
Fix	Is fix
Multi-site	Set of sites of all actors has more than one element

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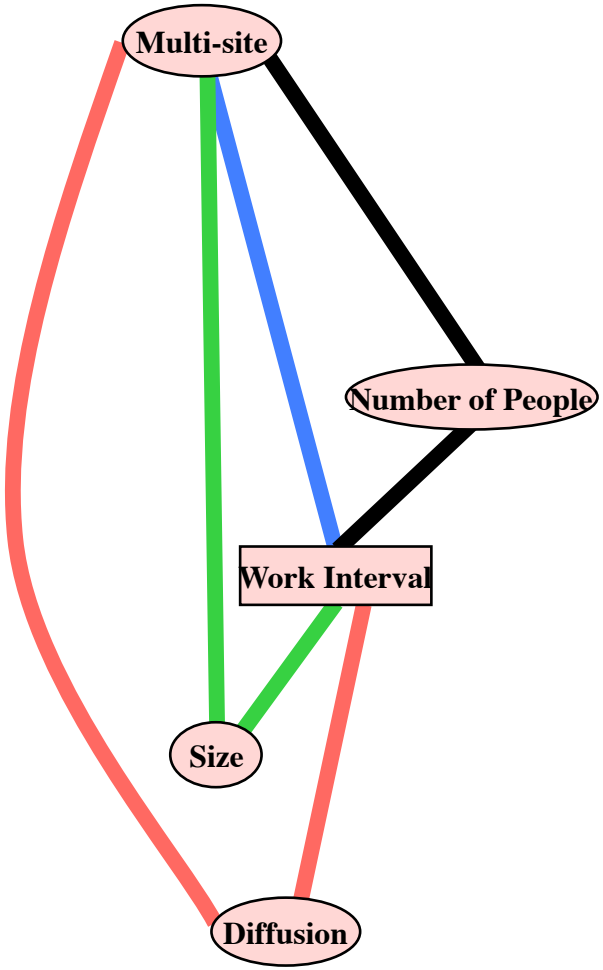

H1 Multi-site work just takes longer

H2 Multi-site MRs are larger, take longer

H3 Multi-site MRs are more diffuse, take longer

H4 Multi-site MRs involve more people, take longer

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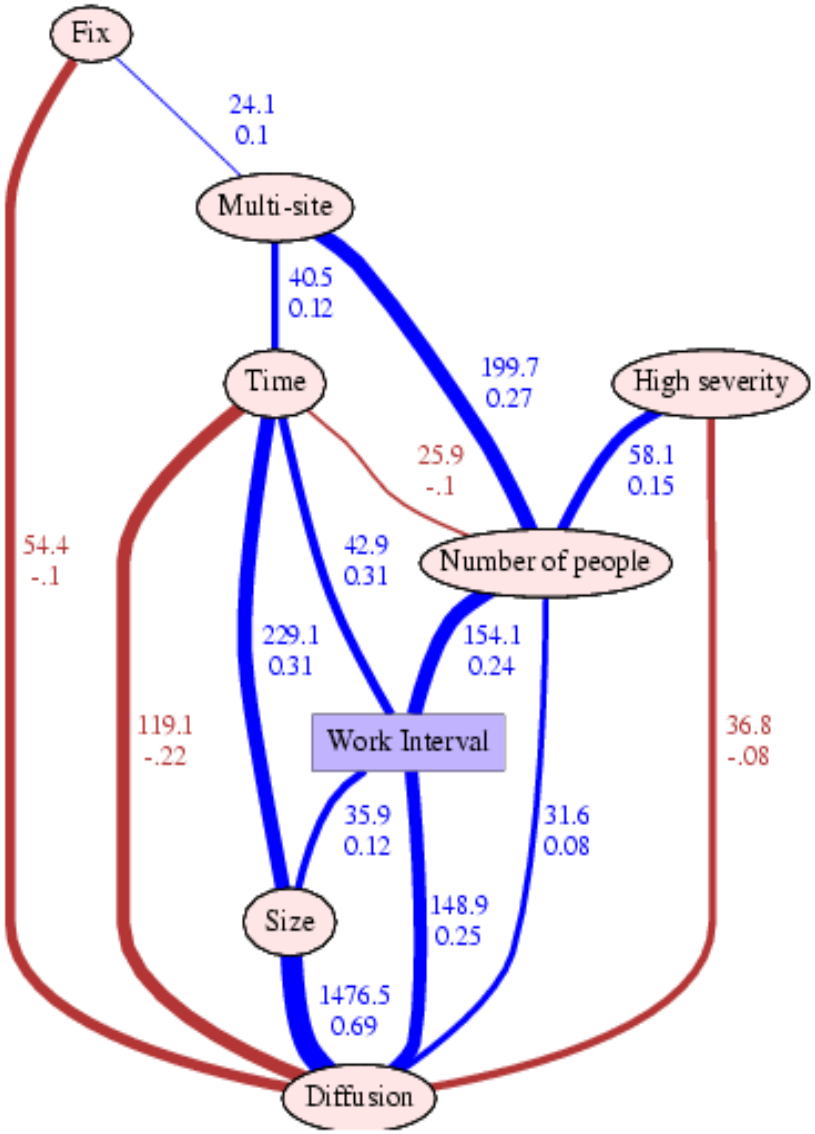
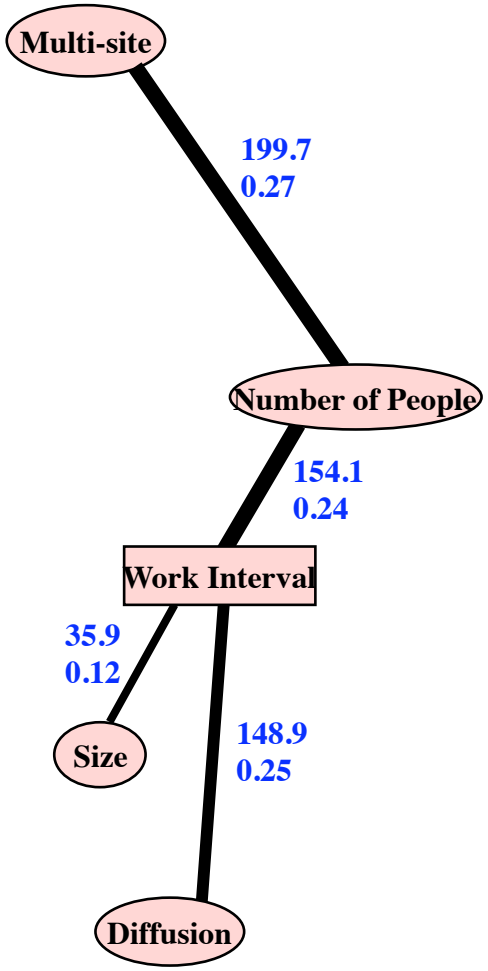


Graphical model of work interval for Network Element A



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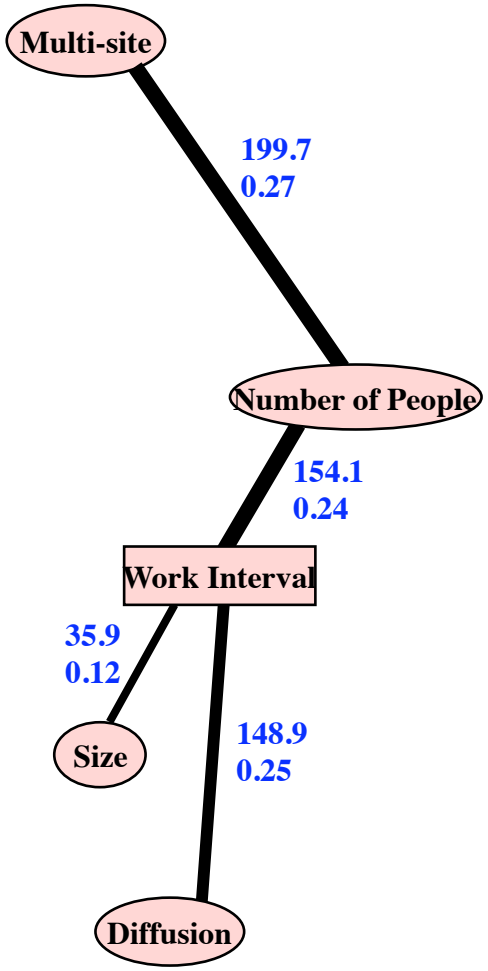

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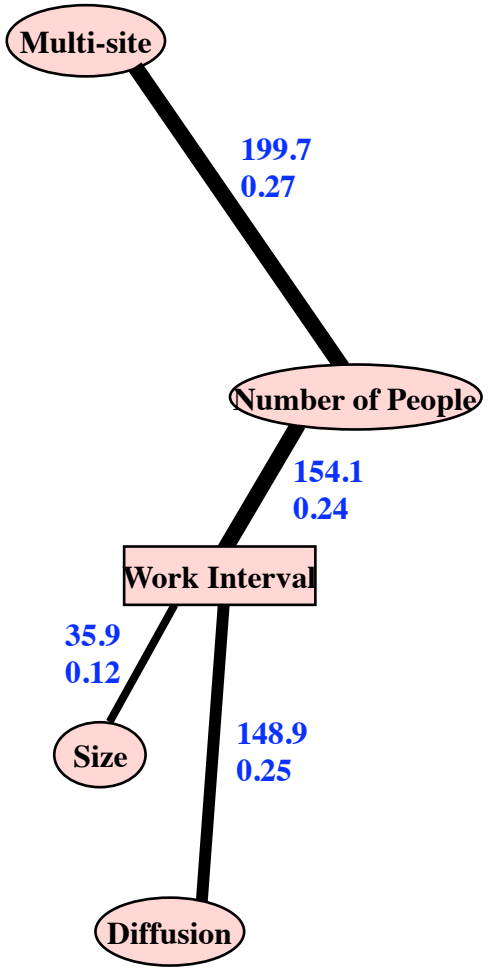

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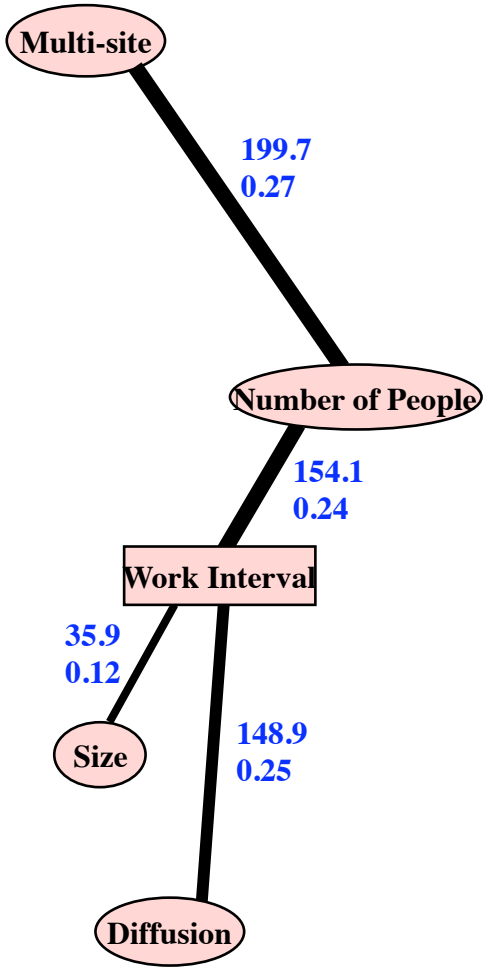

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The Decision . . .

- Published in ICSE
- What next?
  - Declare victory and move on?
  - Replicate with different data?
- What was different?
  - Locations
  - People
  - Product
  - Software type

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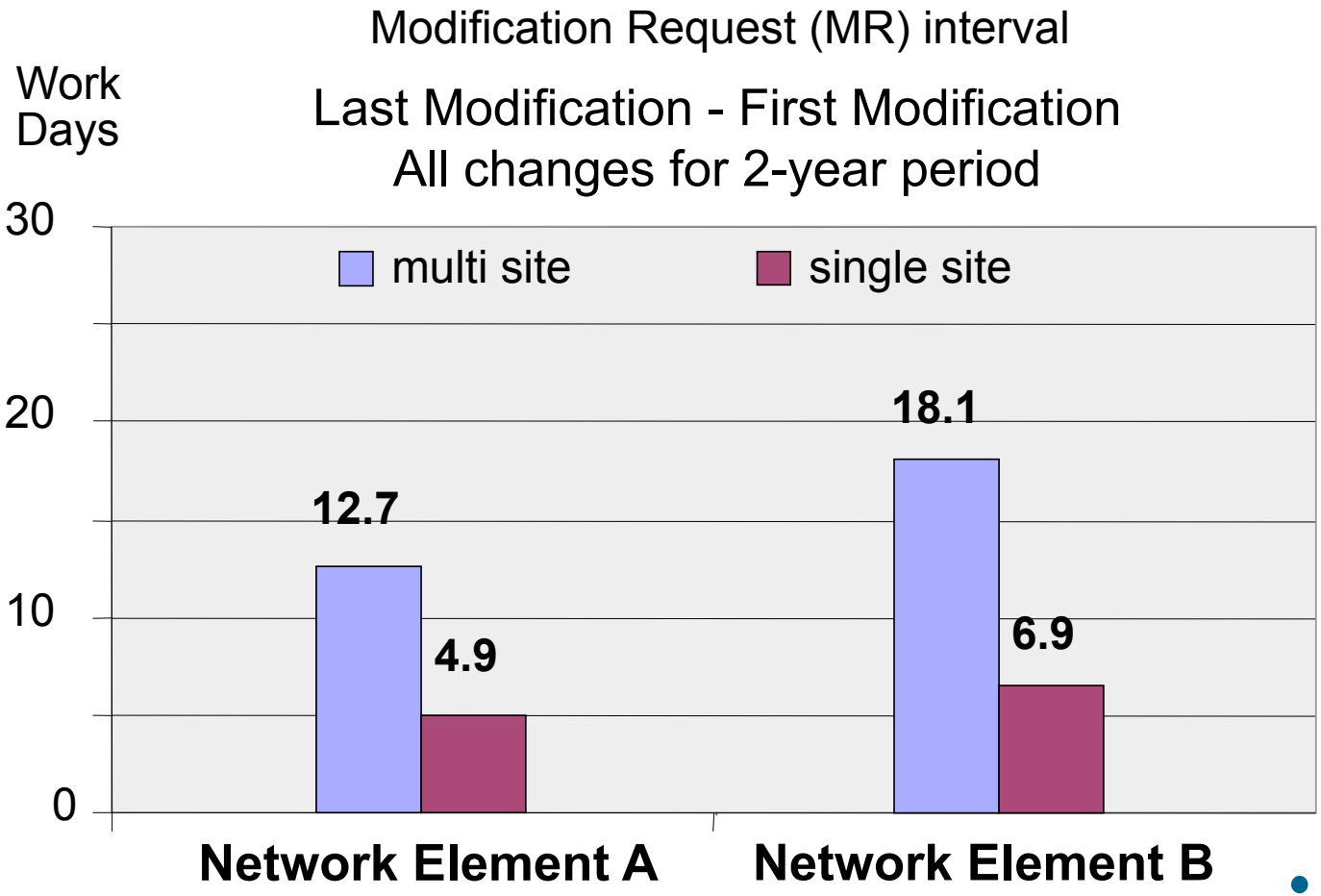
Multi-site Delay



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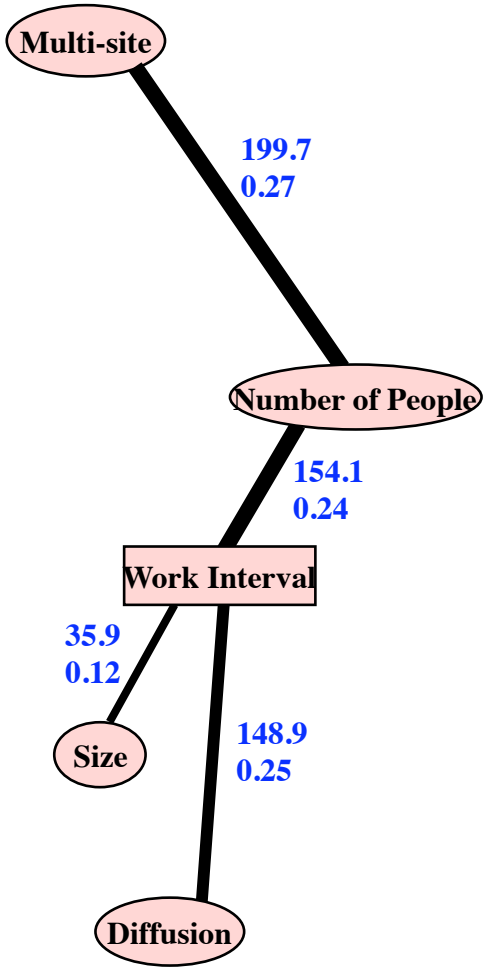
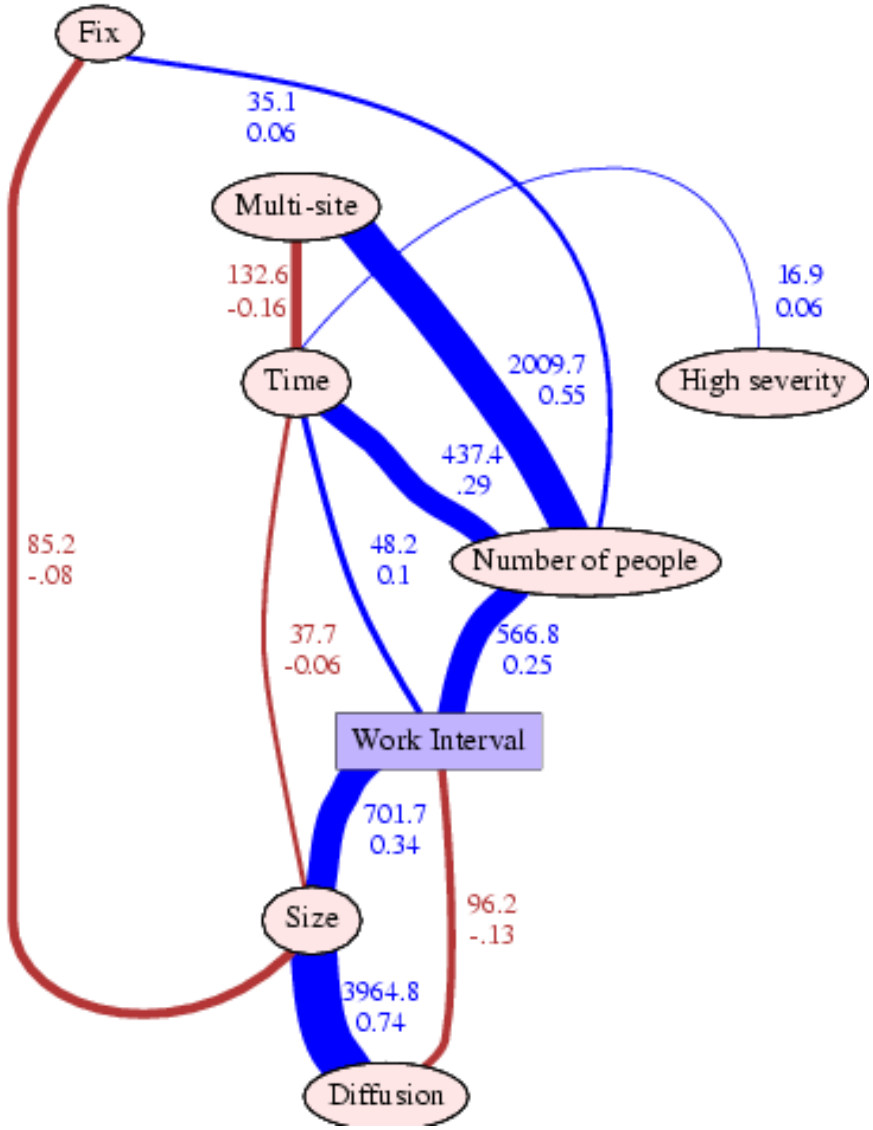
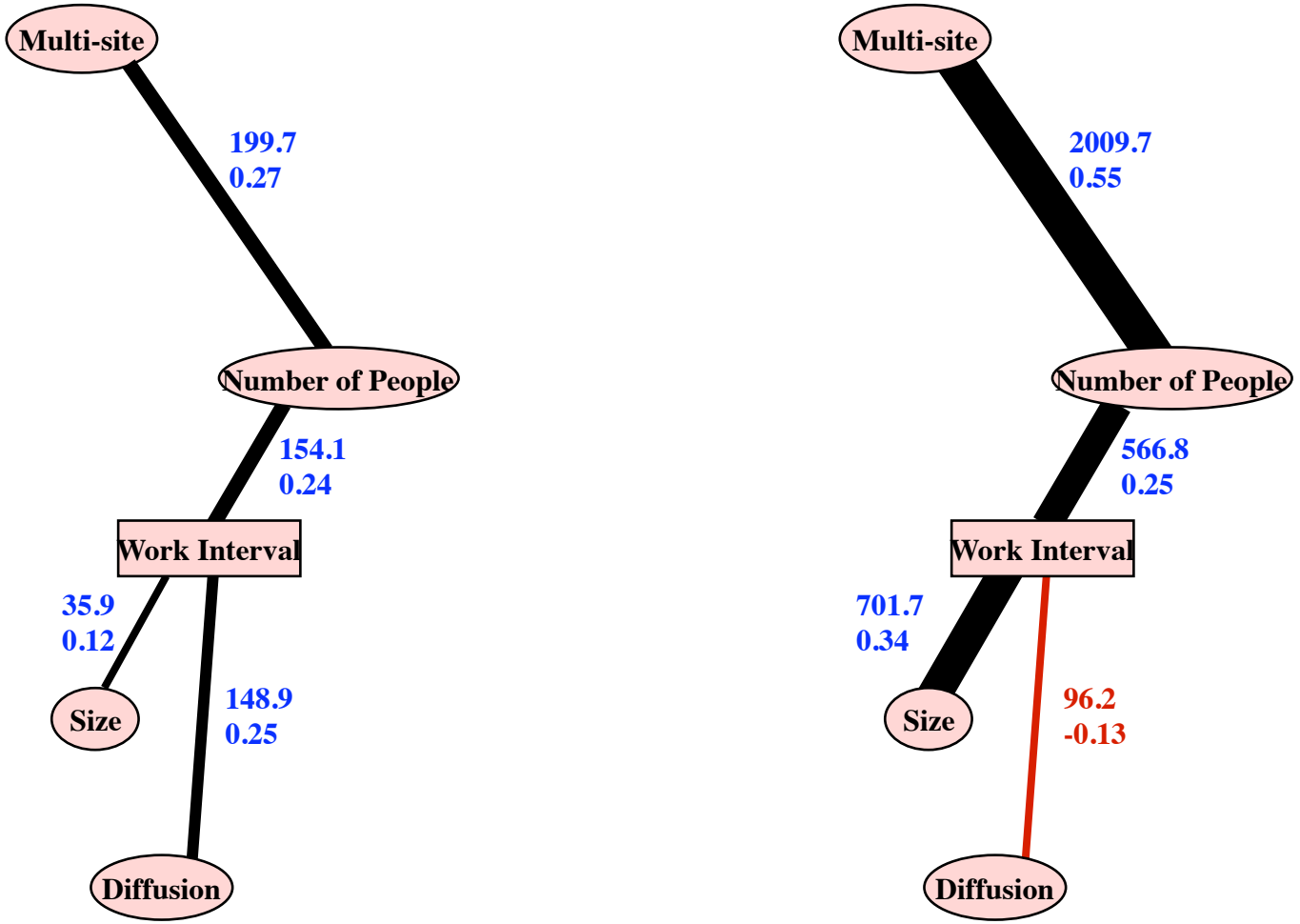




Graphical model of work interval for Network Element A (left) and B (right)



Graphical model of work interval for Network Element A (left) and B (right)

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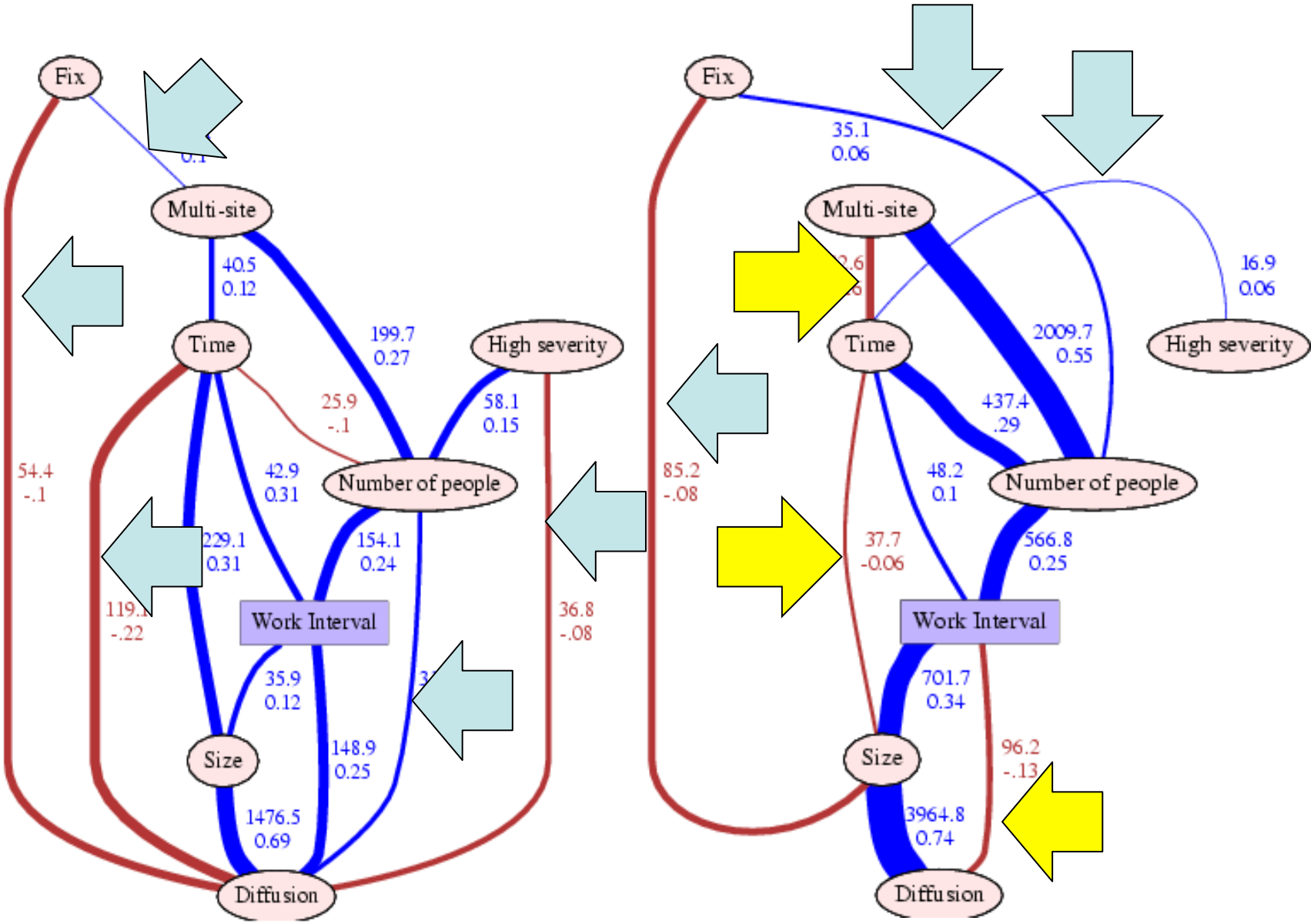
Thoughts on Replication

- Replicating the result was a bit scary
  - What do we do if the results are different?
  - But that's science
- How similar must results be?



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Closer? More Differentiated?

- Would we have learned more from a closer replication?
- From a more differentiated replication?
  - Differentiated how?
  - What would we have learned?

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Replication is Always about Generalization

- Close replication
  - Generalize over concrete instances
- Differentiated replication
  - Generalize over additional variables
- External replication
  - Generalize over experimenters/labs

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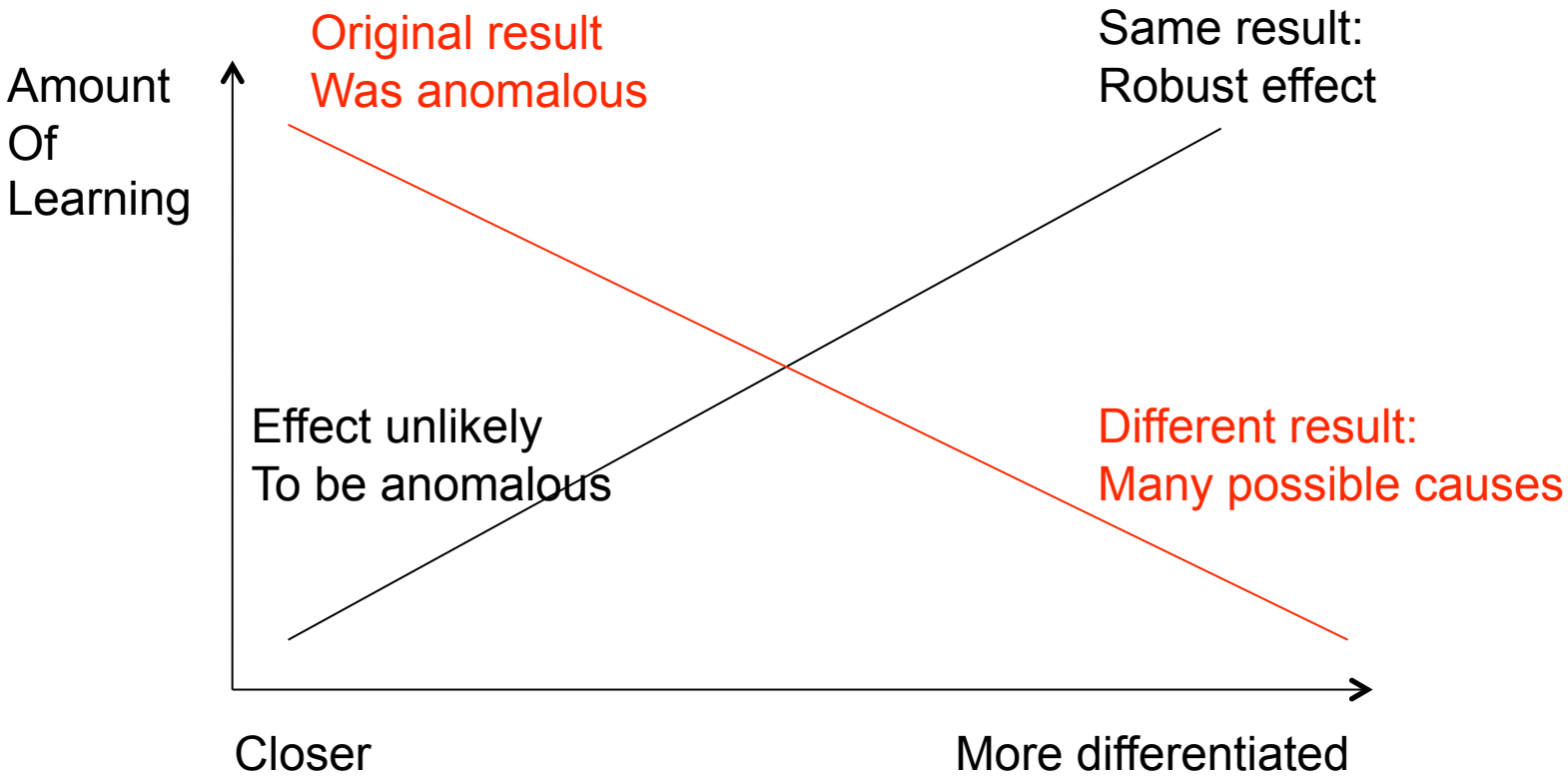
What Do You Learn?



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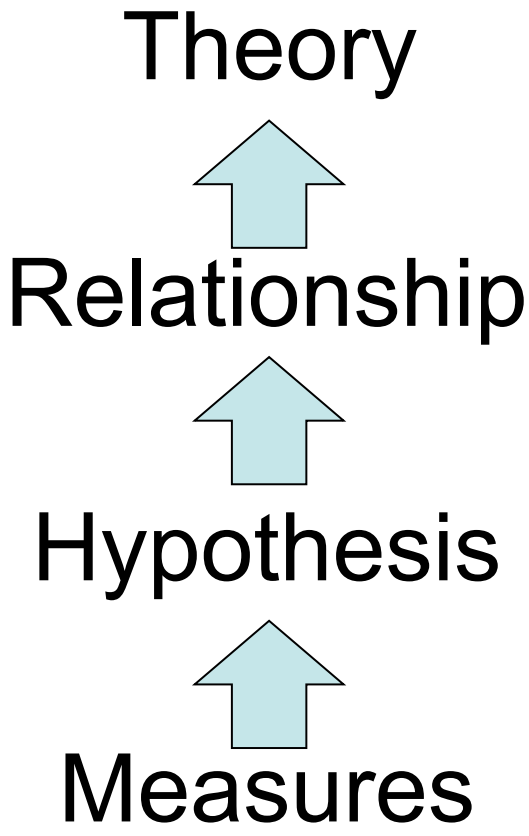
Most of Science is Replication



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