

## Basic Structural Models (BSM)

Abstract concepts that carry no empirical or substantive information.

Properties known, methods permit extensive manipulation, structural insights

**Mathematicians** with necessary mathematical knowledge in logic, matrix theory, theory of graphs)

## Interpretive Structural Models (ISM)

Developed to organize/understand empirical, substantive knowledge about complex systems/issues

Properties not necessarily known

**Domain experts** engaged in day-to-day interactions with complexity

“in proper  
correspondence”

Use computer for “logistical tyranny” associated with extensive manipulation of ideas [Warfield, 1974]

## Structural Integration Modeling (SIM)

Pair appropriate organizing relationship with specific sets of mathematical relations, and their properties and attributes.

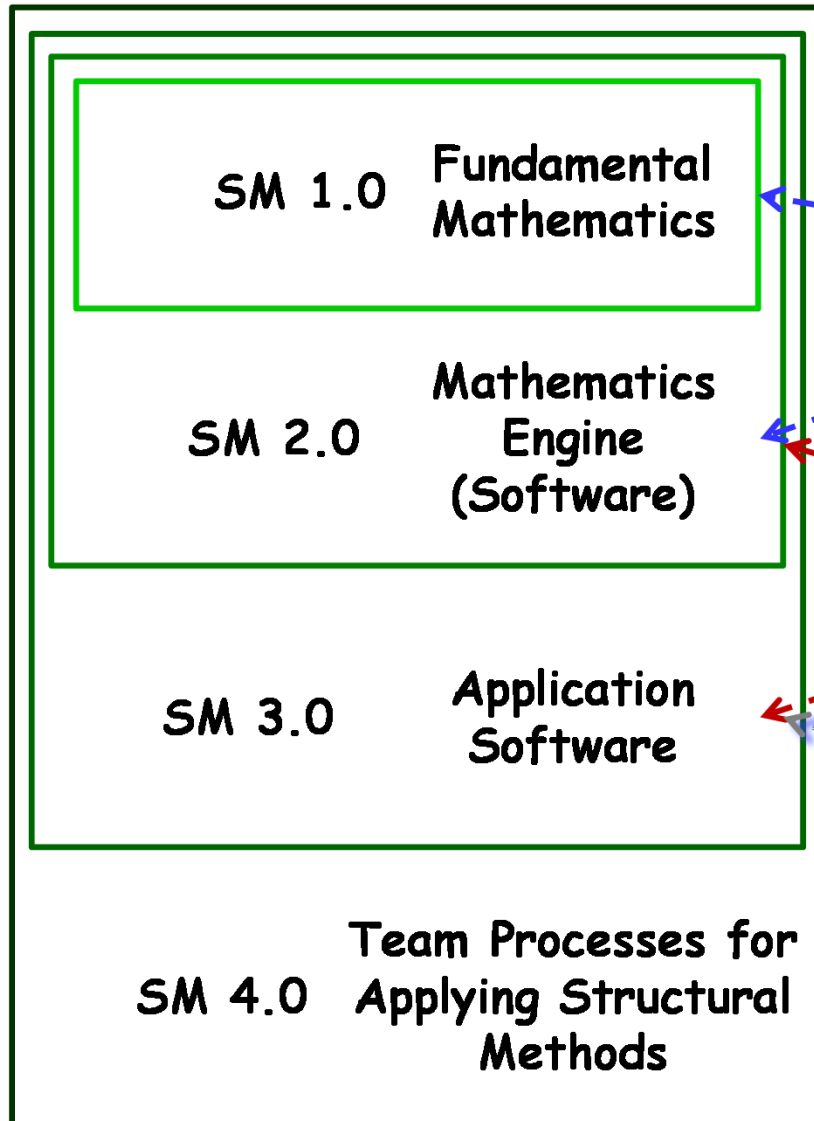
Work systematically to establish relations among many elements in the form of an interpretive structural model.

Use abstract relation type (ART) forms (prose descriptions, graphic representations, executable computer codes) to encode and communicate information

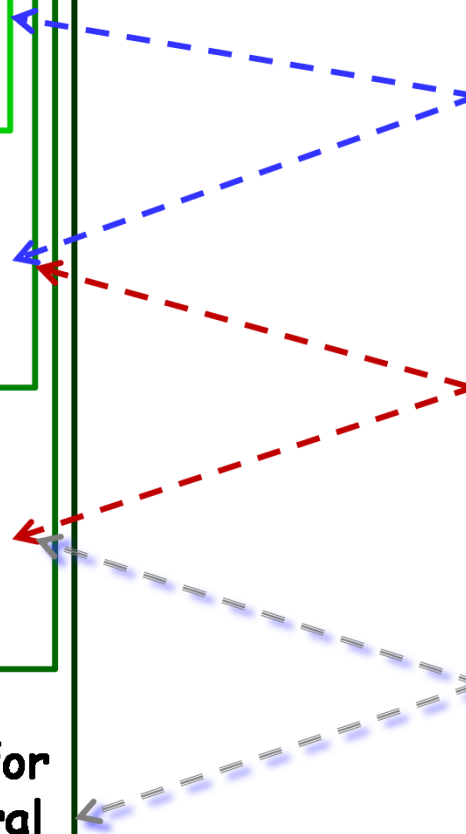
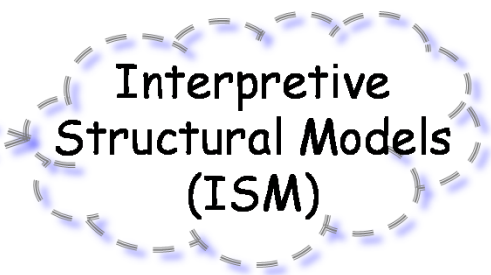
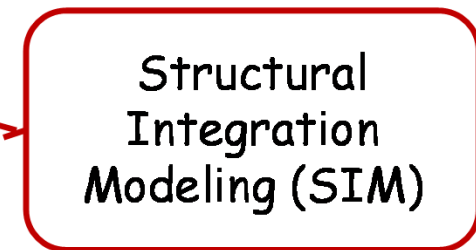
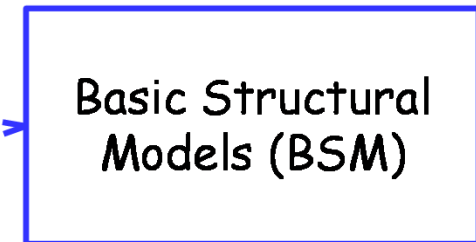
**Systems scientist / systems engineer** develop and test

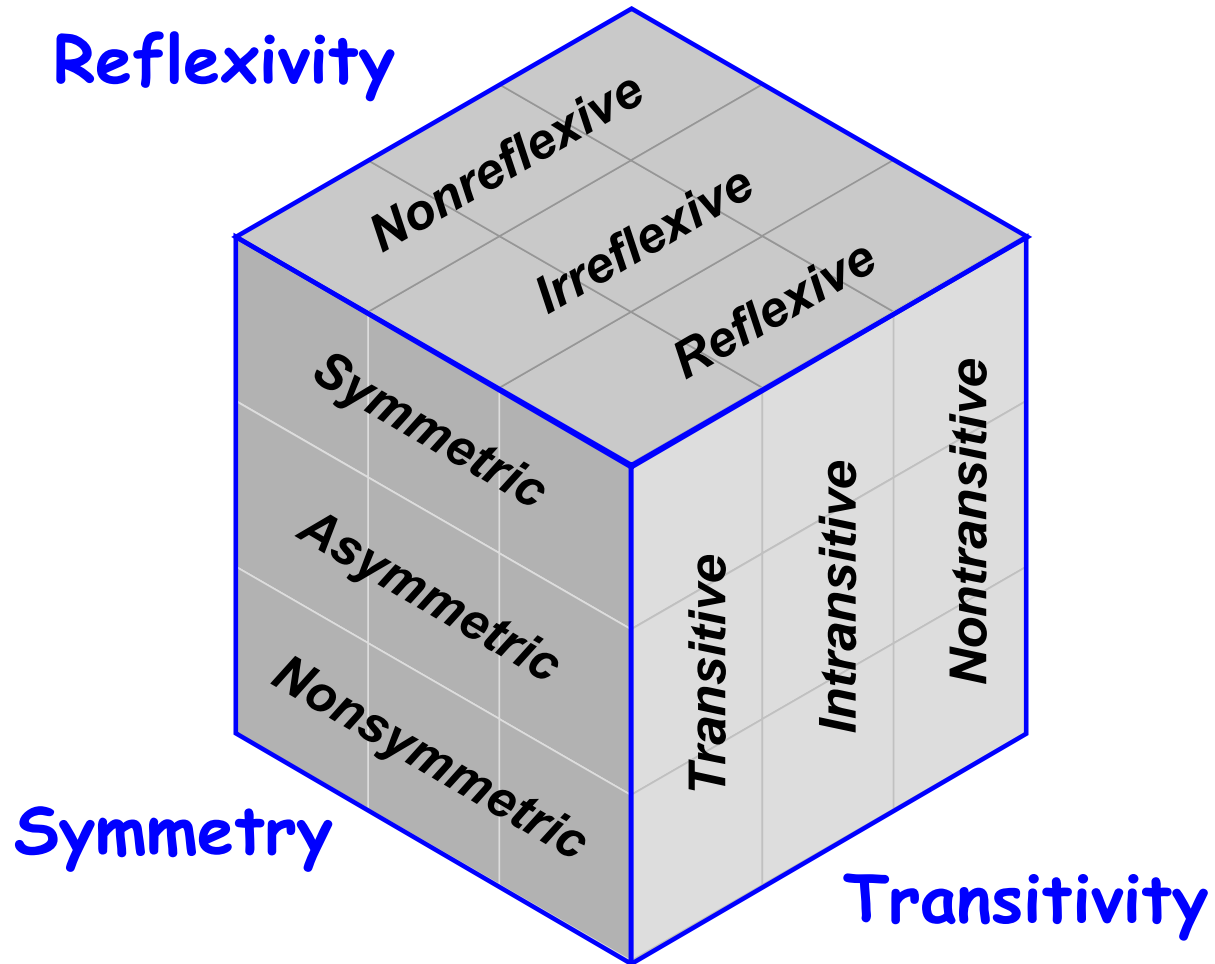
# Structural Modeling

## *SM Implementation Components*



## *SM Activity Areas*

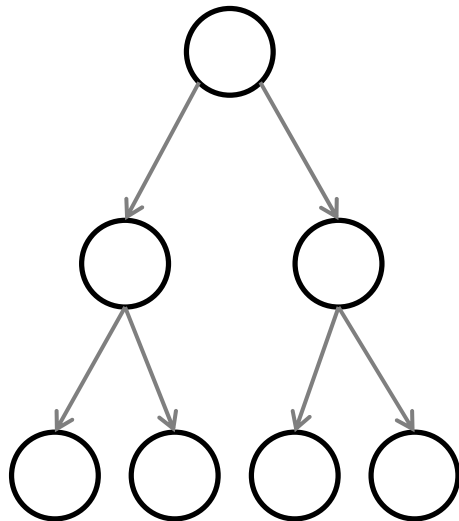




# Organizing Properties of Symmetry

Asymmetric

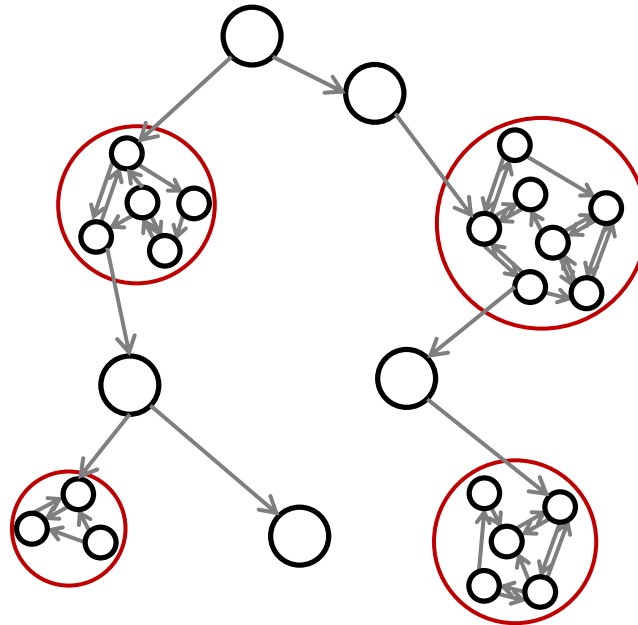
**Hierarchy**



- Use logic rules to discover structure in an efficient manner
- Analyze structure

Nonsymmetric

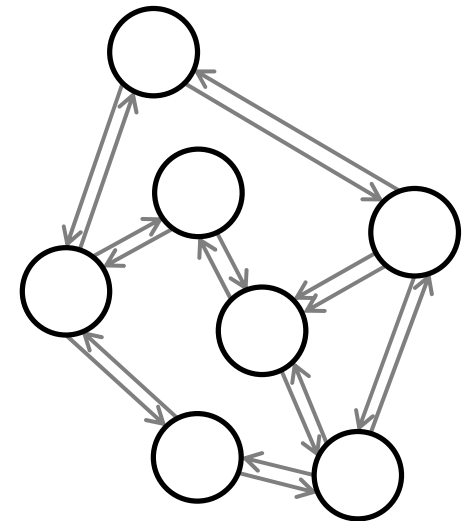
**Combined Hierarchy & Network**



- Apply lattice and set partitioning rules to identify components
- Apply other techniques as needed

Symmetric

**Network**



- Analyze for highest value configuration
- Filter out controlling structure
- Analyze structure

# Hi-Level Logical Characteristics of Three Dyadic Relations

## Reflexivity

### Reflexive

A relation,  $R$ , is reflexive iff any individual that enters into the relation bears  $R$  to itself.

**\*Identical with; Divisible by**

### Irreflexive

A relation,  $R$ , is irreflexive iff no individual bears  $R$  to itself.

**\*Stand next to; Father of**

### Nonreflexive

A relation which is neither reflexive nor irreflexive is nonreflexive.

**\*Respecting; Killing**

**\*Examples**

## Symmetry

### Symmetric

If any individual bears the relation to a second individual, then the second bears it to the first.

**\*Touching**

### Asymmetric

A relation,  $R$ , is asymmetrical iff, if any individual bears  $R$  to a second, then the second does not bear  $R$  to the first.

**\*North of; Heavier than; Child of**

### Nonsymmetric

A relation which is neither symmetrical nor asymmetrical is nonsymmetric.

**\*Likes; Seeing**

## Transitivity

### Transitive

If any individual bears this relation to a second and the second bears it to a third, then the first bears it to the third.

**\*Greater than; North of; Included in**

### Intransitive

A relation,  $R$ , is intransitive iff, if any individual bears  $R$  to a second and the second bears  $R$  to a third, then the first does not bear  $R$  to the third.

**\*Father of; 2" taller than**

### Nontransitive

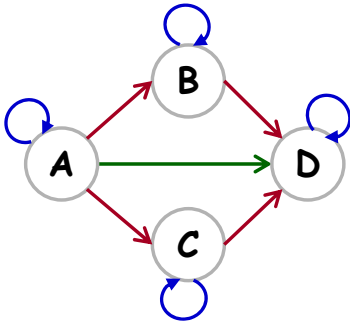
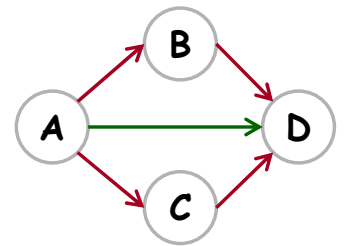
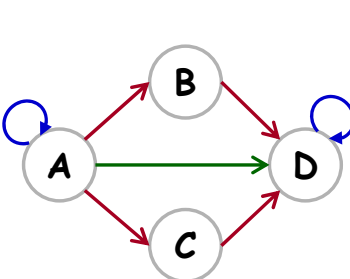
A relation which is neither transitive nor intransitive is nontransitive.

**\*Admiring; Fearing**

**Permutations of Relation Properties, with Unique Identifiers**

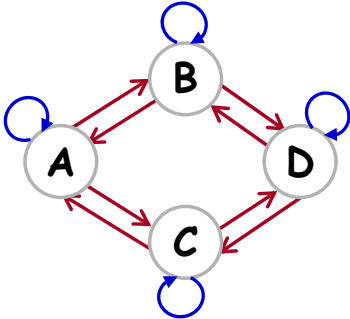
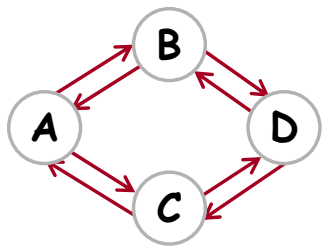
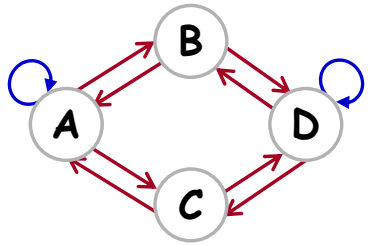
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RAT-[1,2,1]	<b>Reflexive, Asymmetric, Transitive</b>	RAI-[1,2,2]	<b>Reflexive, Asymmetric, Intransitive</b>	RAN-[1,2,3]	<b>Reflexive, Asymmetric, Nontransitive</b>
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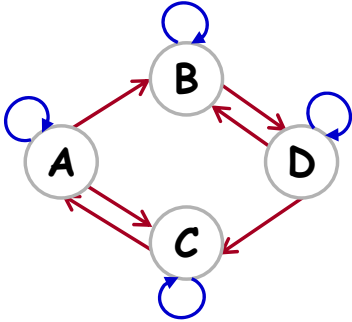
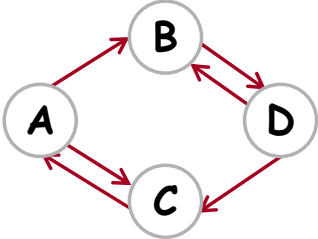
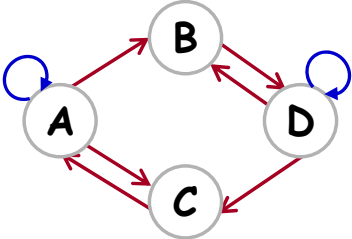
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## Example - Augmented Model-Exchange Isomorphism

Prose	Directed Graph	Matrix	Context	Notes																									
<p>Relation 'North of'</p> <ul style="list-style-type: none"> <li>• Irreflexive</li> <li>• Asymmetric</li> <li>• Transitive</li> </ul> <p>IAT-[2,2,1]</p>	<p>[Absence of self-referential edges]</p>	<table border="1"> <tr> <td></td> <td>A</td> <td>B</td> <td>C</td> <td>D</td> </tr> <tr> <td>A</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>B</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>C</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>D</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> </table>		A	B	C	D	A	0	1	1	1	B	0	0	0	1	C	0	0	0	1	D	0	0	0	0	<p>1. Need to determine if more than one object allowed at same latitude</p>	<p>More information available:  <a href="https://www.researchgate.net/publication/266138960_Structural_Modeling">https://www.researchgate.net/publication/266138960_Structural_Modeling</a>  <a href="http://www.systemsconcept.org/">http://www.systemsconcept.org/</a></p>
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ID	Properties	Natural Language Relationship	Context	Notes
IAT-[2,2,1]	Irreflexive, Asymmetric, Transitive	'North of'	- Need to determine if more than one object allowed at same latitude	<p>More information available:</p> <ul style="list-style-type: none"> <li>- Research Gate  <a href="https://www.researchgate.net/publication/266138960_Structural_Modeling">https://www.researchgate.net/publication/266138960_Structural_Modeling</a></li> <li>- System Concepts web site  <a href="http://www.systemsconcept.org/">http://www.systemsconcept.org/</a></li> </ul>