Variety Dynamics in Operational Research

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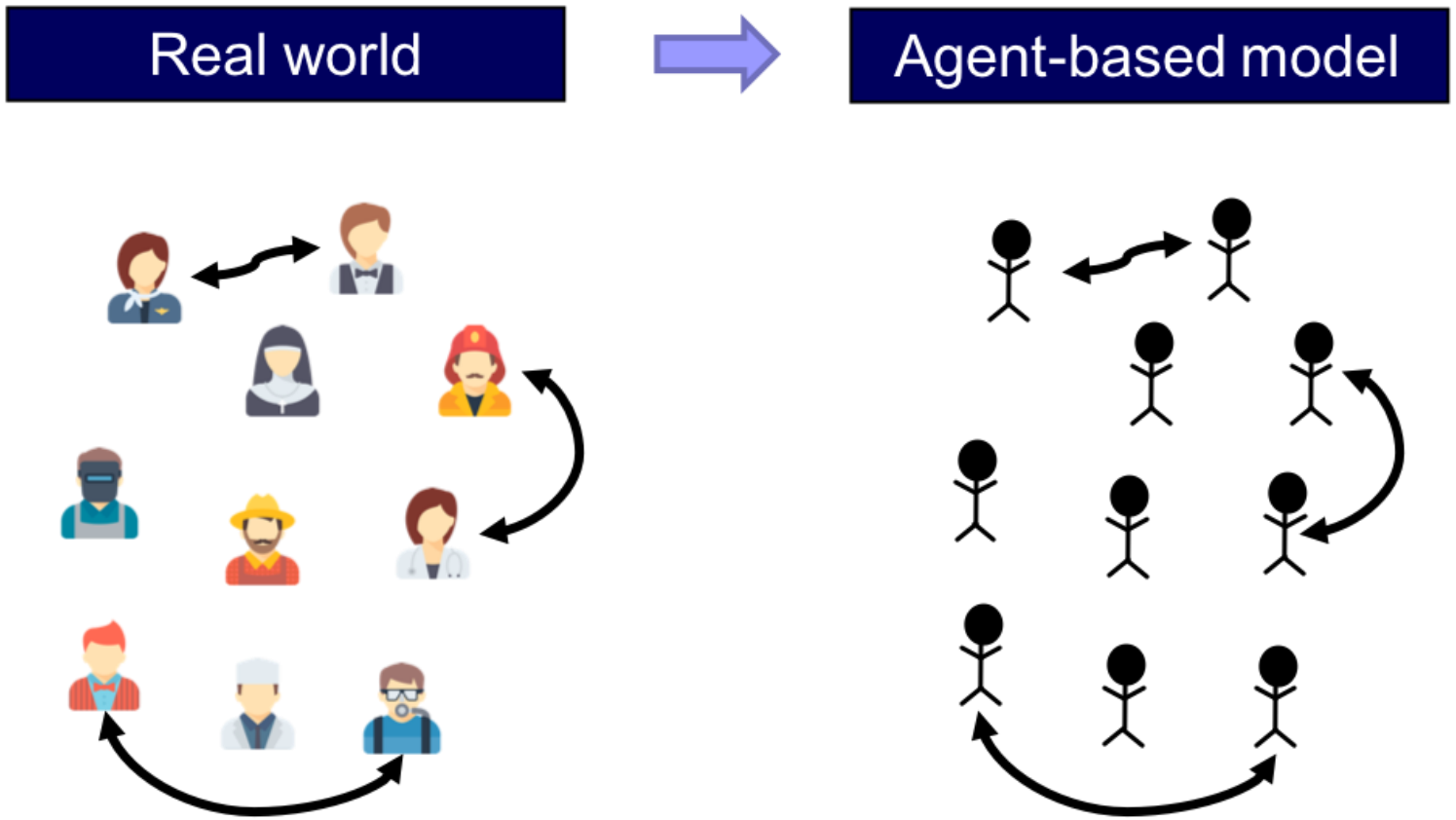
Analytical structures of OR analyses and modeling

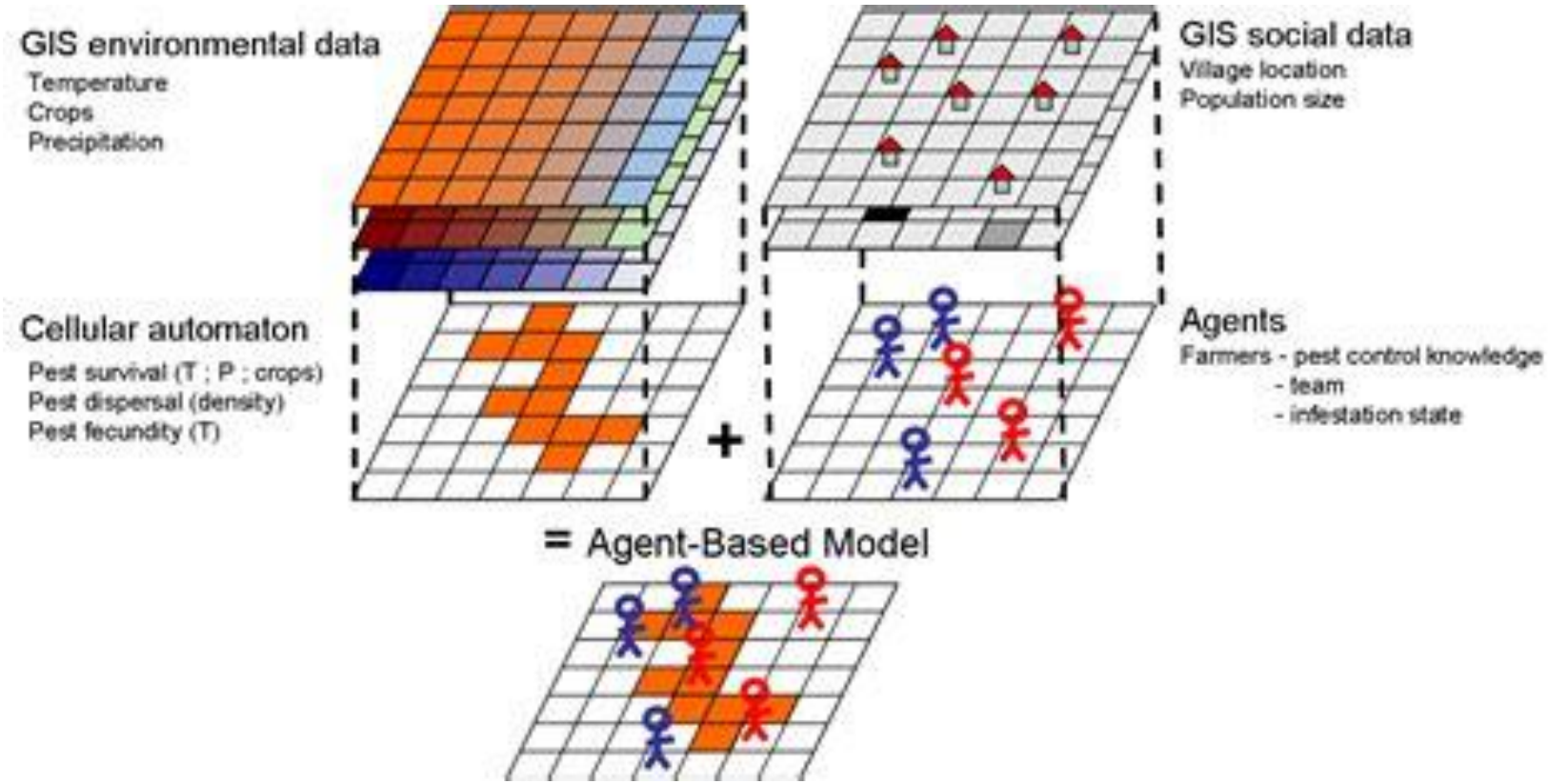
OR methods are typically based on:

- Events, elements, causal relationships and behaviours
- Stakeholder understanding and values
- Predictive models for decision-making

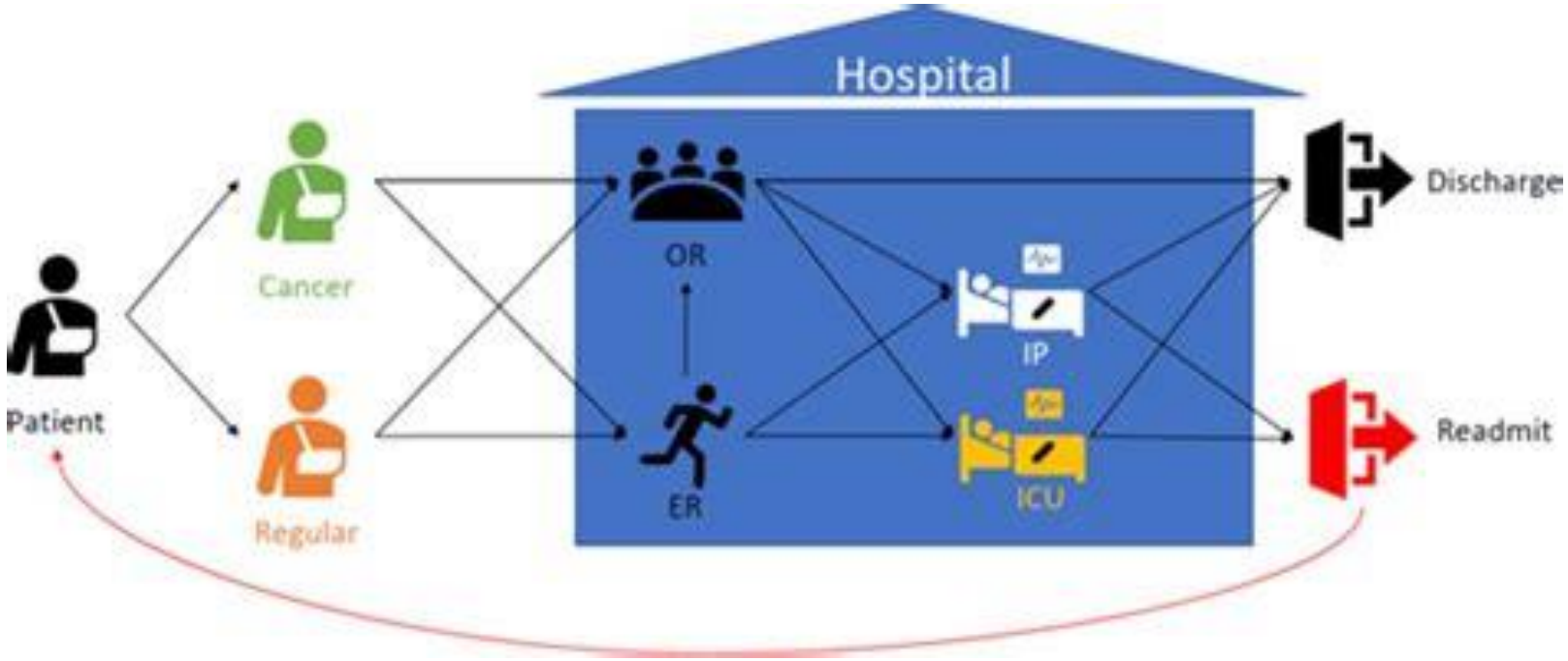
Example: Agent-based modeling 1



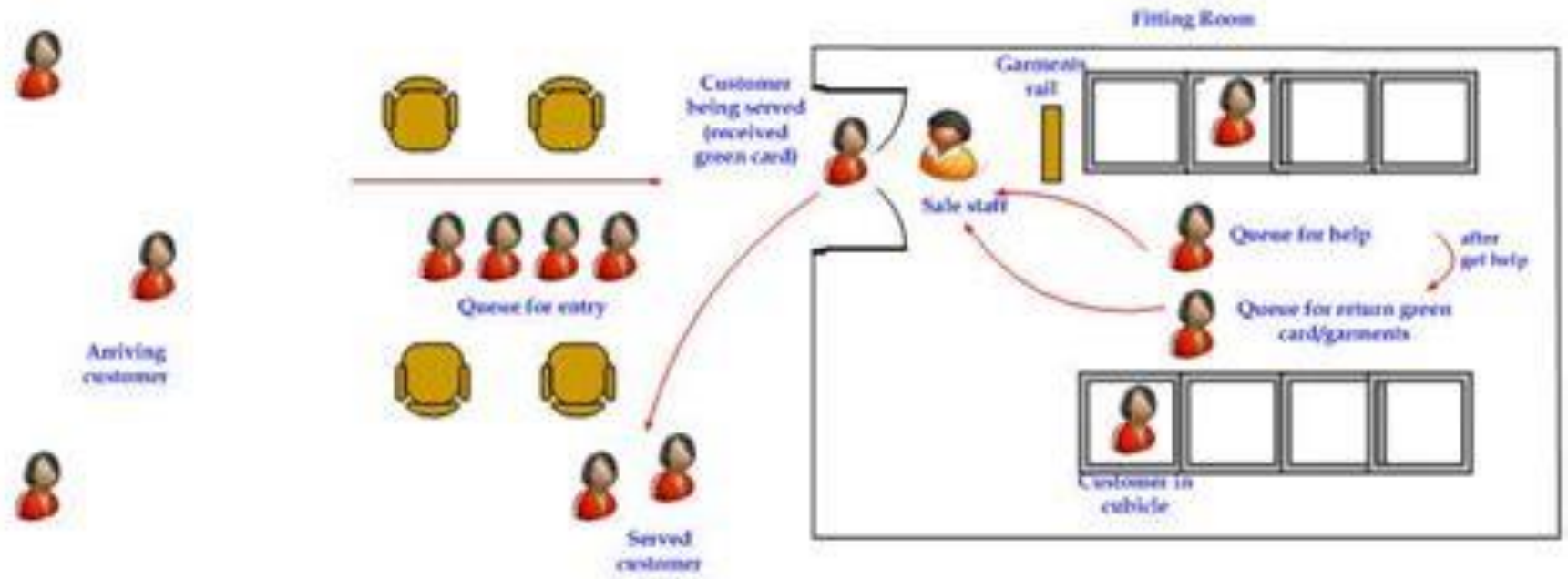
Example: Agent-based modeling 2



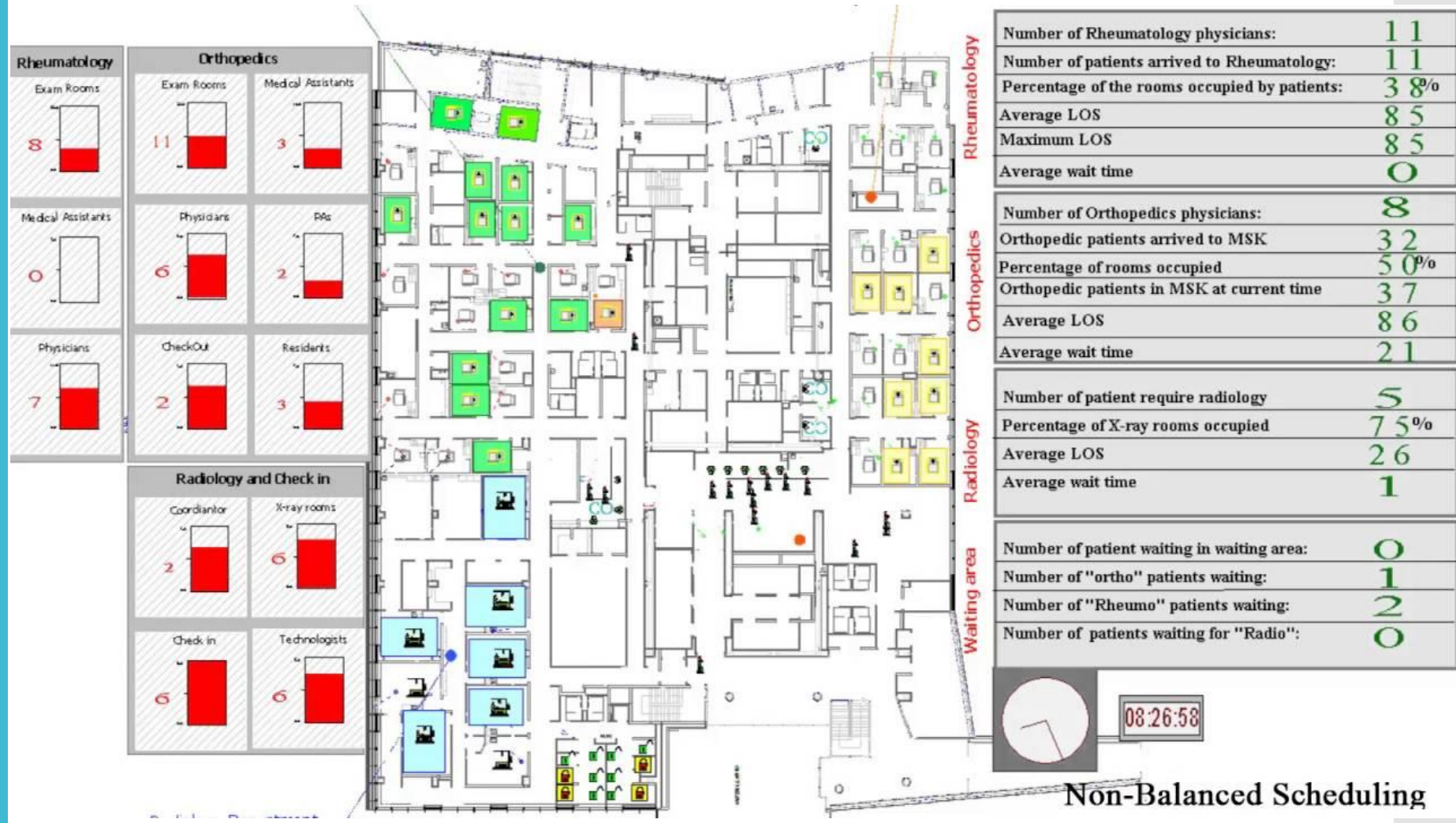
Example: Discrete Event Simulation 1



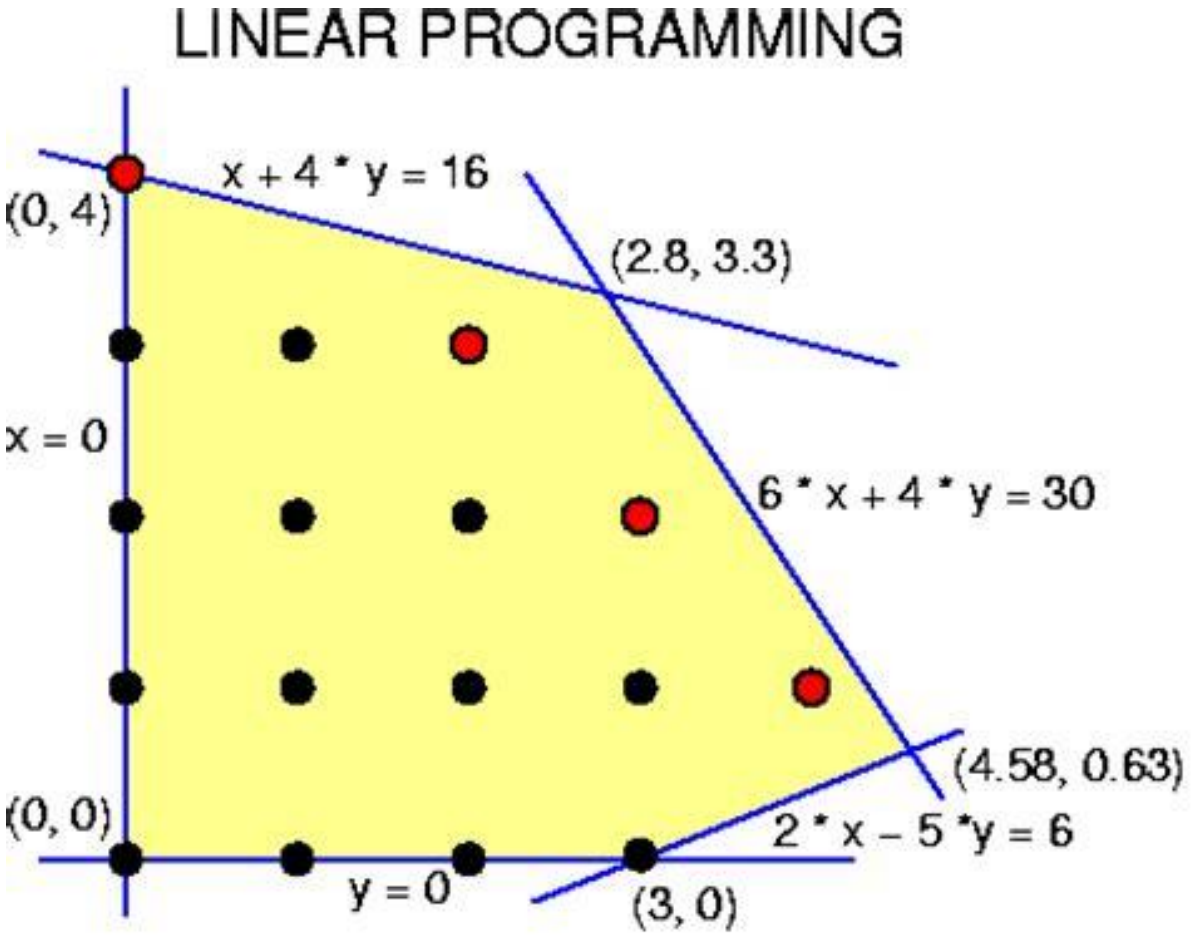
Example: Discrete Event Simulation 2



Example: Discrete Event Simulation 3

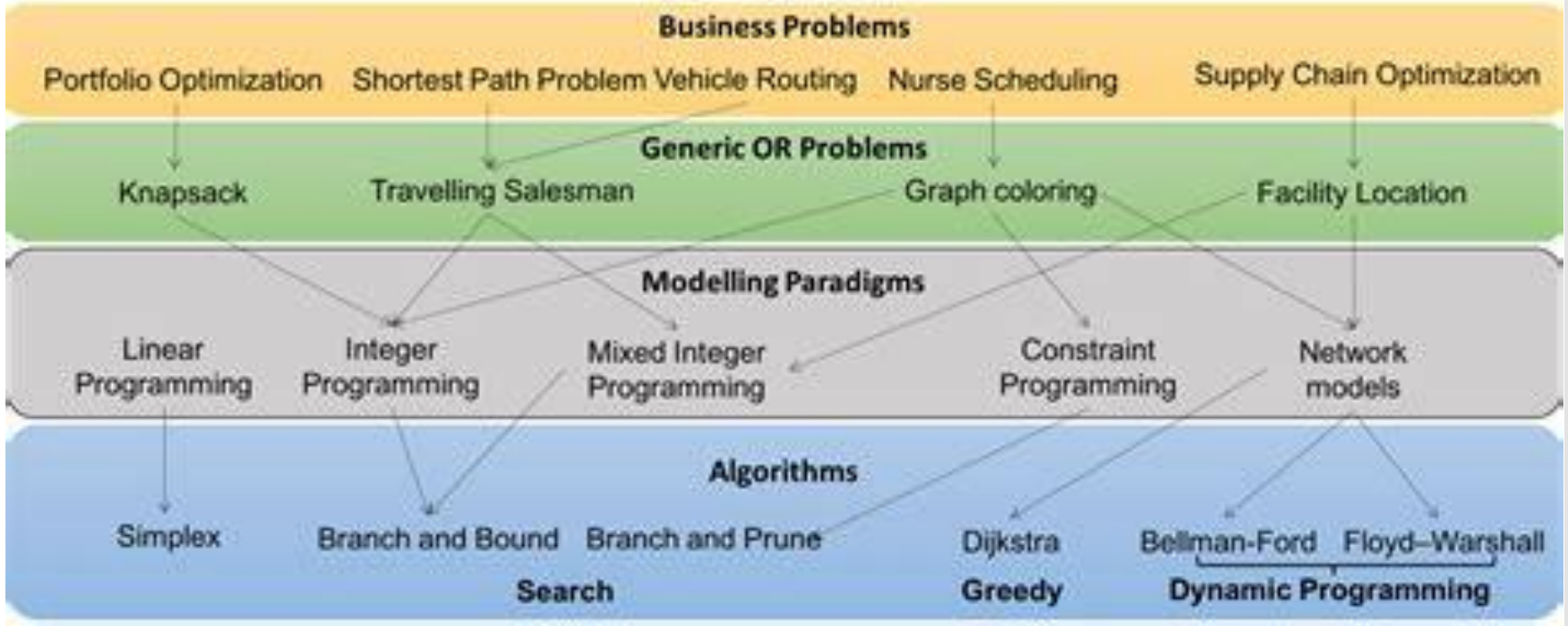


Linear programming or DEA



Function to maximize: f(x, y) = 6 * x + 5 * y
Optimum LP solution (x, y) = (2.4, 3.4)
Pareto optima: (0, 4), (2, 3), (3, 2), (4, 1)
Optimum ILP solution (x, y) = (4, 1)

Viewpoints within OR



OR Process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Real System
Identifying a decision problem
Setting the model's scope
Constructing the mathematical model
Deriving a solution methodology
Testing the model with real data
Establishing controls over the solution
Implementing the Solution
Operations Research

Serious challenges for OR

Predicting behaviour of complex situations with:

- Large numbers of feedback loops
- Coercive systems
- Multiple dynamics of power and control
- Asymmetric power where the manager/controller system has less power
- Unresolvable conflict between multiple key stakeholders

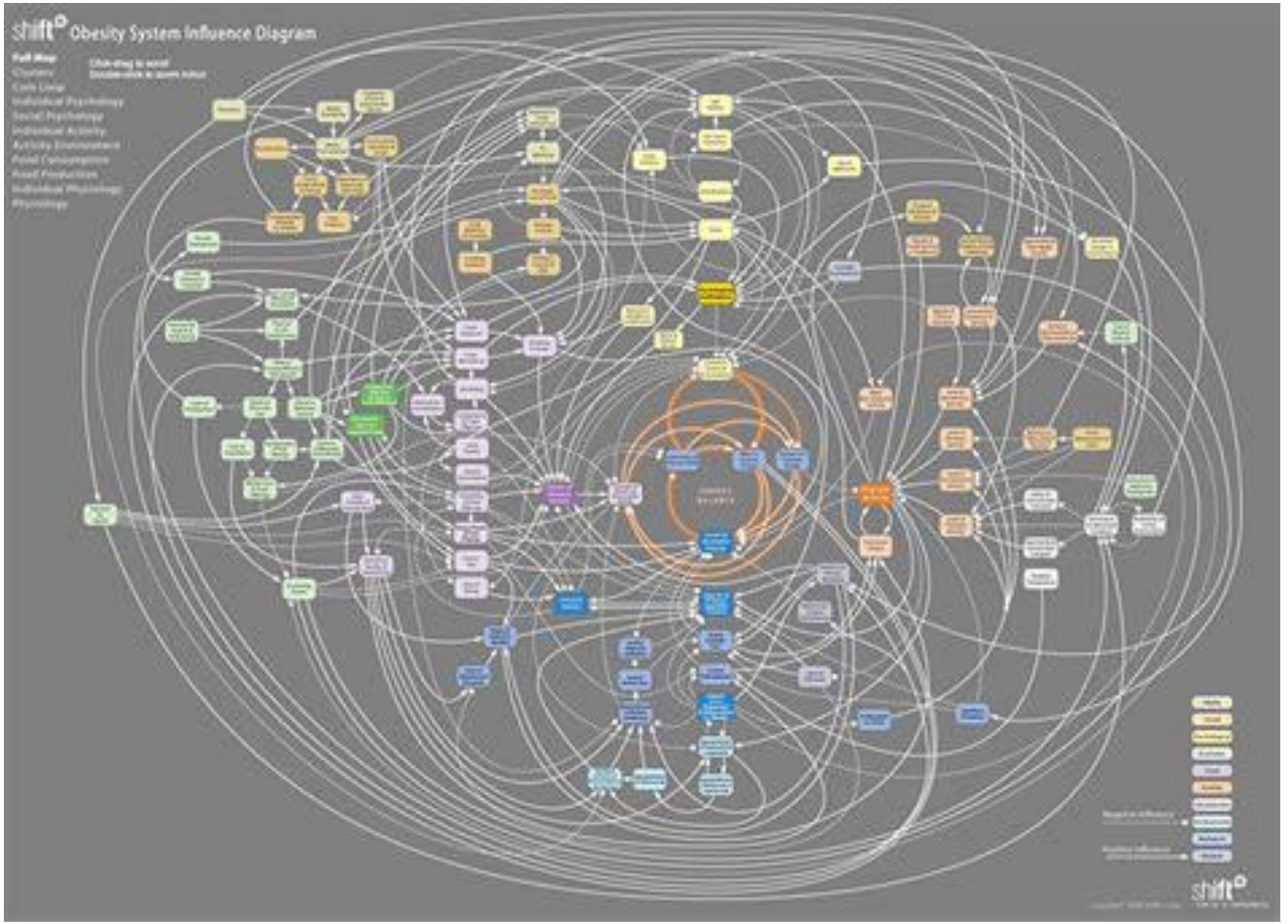
Example

Details of serious challenges for OR

Highly complex situations where:

- System boundary is dynamic and not closed
- Subsystems have overlapping and dynamically changing boundaries
- Dynamically changing roles, purposes, ownerships, power arrangements, and control structures of subsystems
- Subsystems and their control partially located outside system boundary
- Coercive situations involving multiple asymmetric power relations unaligned to subsystems
- Control and system behaviours operating outside of the OR variables being addressed
- Parts of system and environment are chaotic

Example



Variety Dynamics

- Variety Dynamics is a new field to powerfully address such OR challenges
- Conceptually different to convention OR methods
- New mathematical, systems and OR concepts
- Also provides theory foundations for Constructor Theory and Counterfactual Analysis

Purpose of Variety Dynamics

Variety Dynamics was developed to address the above OR challenges

A new basis for successfully wresting control in highly complex coercive situations

A new body of OR and Systems Thinking methodologies

A new area of mathematics

Foundations of Variety Dynamics

- **Variety** is the number of **options** possible of any aspect of a situation
- Variety Dynamics focuses on distributions, dynamics, ownership and control of varieties in complex systems
- It does **not** directly address causal relations between elements

Uses of Variety Dynamics

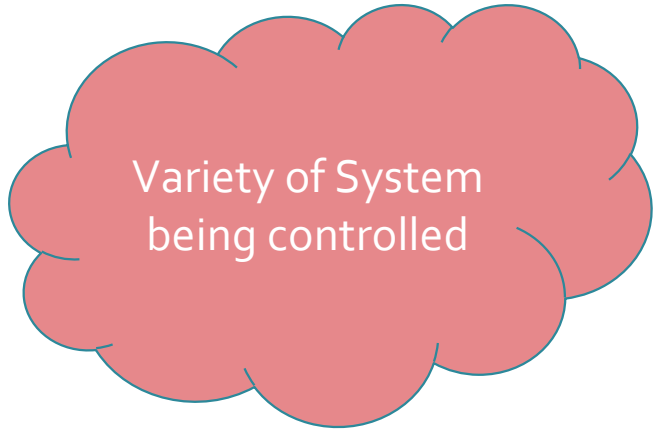
- Complex multi-stakeholder organizational problems
- Controlling pandemics
- Resolving wicked problem situations
- Taking control in complex geo-political contexts
- Business advantage in entrepreneurial and innovation pathways
- Governing complex polities
- Safety systems for complex multi-technology 4H scenarios
- Warfare and military decision making, especially in asymmetric multi-participant warfare
- Managing risk in large single design infrastructure projects
- New mathematical basis for theorising about quantum physical events

Origins of Variety Dynamics

- Design optimisation
- Ashby's Law of Requisite Variety
- Multi-order differential combinatorics of variety rather than outcomes
- Tellefsen's problem of Machiavelli's Prince

Ashby's Law of Requisite Variety

For control must be LARGER THAN ->

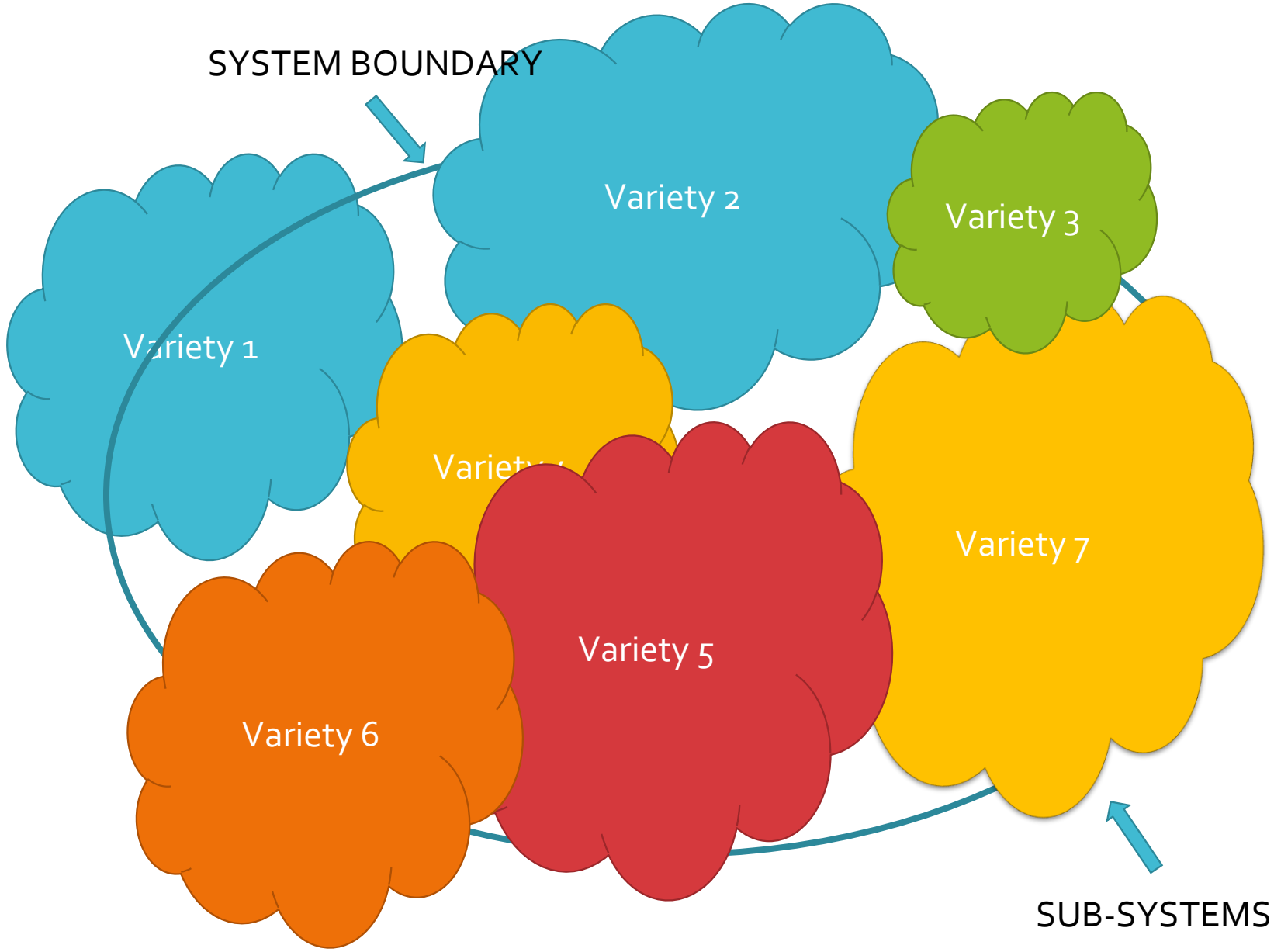


The variety available to the controller to control the system must be larger than the variety able to be generated by the system.

Example: Variety in simple power and control context - school

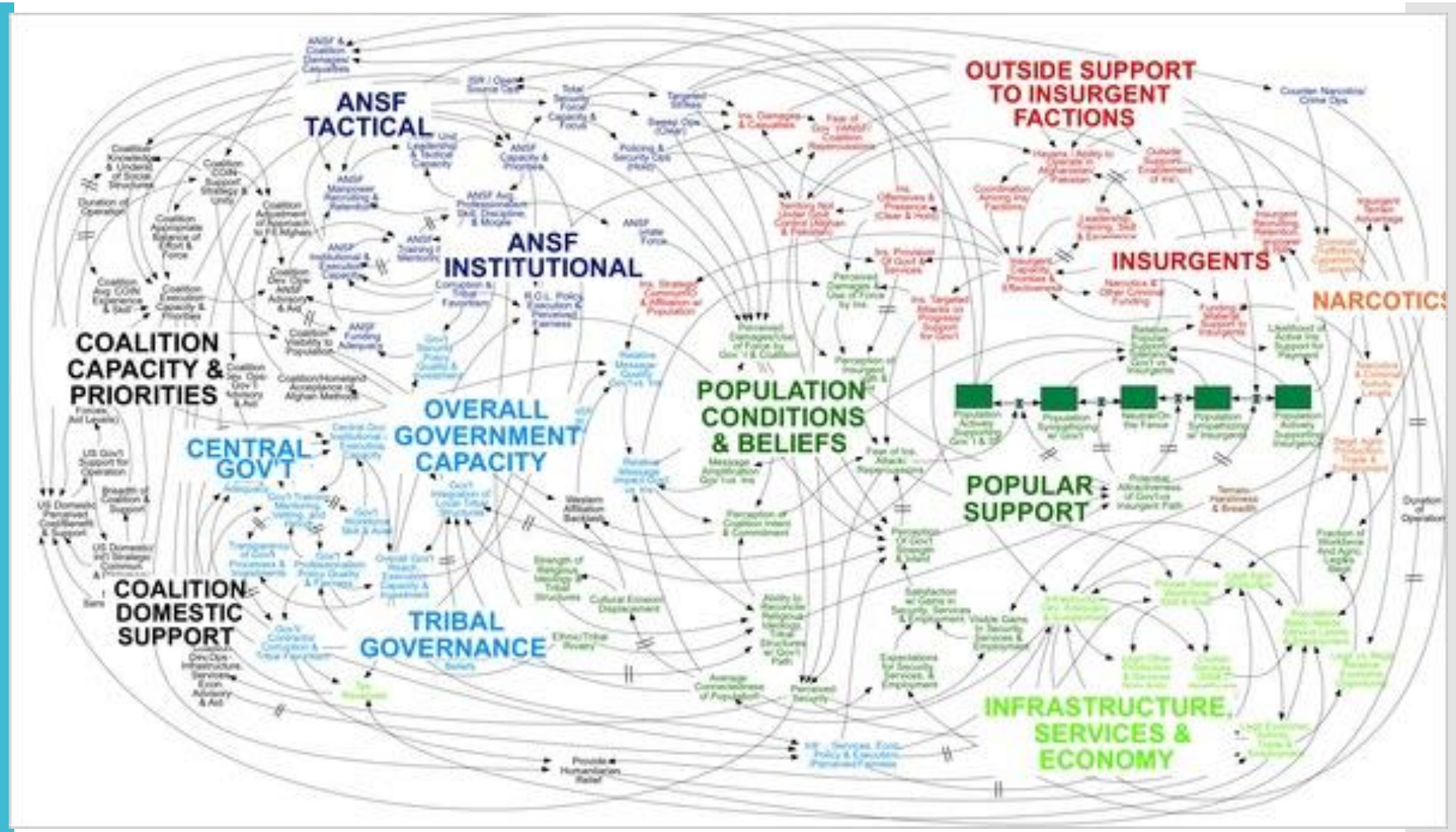
Variety available to teacher must be greater than that generated by pupils

Real situations with dynamic variety distributions



- Distributions of variety and control and ownership are changing continuously in highly interrelated ways

Example of variety in a typical complex power and control context



Variety available to military **less than** variety available to other factors and to system

State of Variety Dynamics field

- **Concepts** (systemic and mathematical)
- **Axioms** describing patterns of control influence and outcomes (14 to date)
- **Practical strategies** for achieving control in highly complex situations
- **New mathematical field** interacting with set theory, function analysis, combinatorics, topology of variable spaces etc.
- **Note: Variety Dynamics** was developed by Dr Terence Love and Dr Trudi Cooper starting around 1972 with initial published papers around 2005.

Example of a Variety Dynamics Axiom

Axiom 1:

For complex, layered and hierarchical systems involving multiple constituencies in which the distribution of variety generation and control is uneven across the system

THEN

the differing distributions of generated and controlling variety result in a structural basis for differing amounts of power and hegemonic control over the structure, evolution and distribution of benefits and costs of the system by particular constituencies.

Practical example of use of Axiom 1:

Activists vs motor industry

Environmental activists were able to overcome motor industry resistance to emissions control:

1. Activists asked motor industry to implement strict emission control standard - motor industry refused
2. Activists persuade each state to implement **different** emission control standards (i.e. increased the variety to be addressed beyond motor industry's ability to control)
3. Offered to resolve via a single national emission standard
4. Motor industry agrees new national emission standard

Management of changes of variety resulted in power to activists from motor industry.

Questions?

For more information and training in variety dynamics or for consultations please contact:

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