Learning objectives

- Explore a wide range of organizational research
- Understand what organizational design entails including the possible design variables
- Examine a few simple models related to organizational design to understand status and possible applicability
- Appreciate one organizational modeling approach relative to our growing understanding of the use of network models

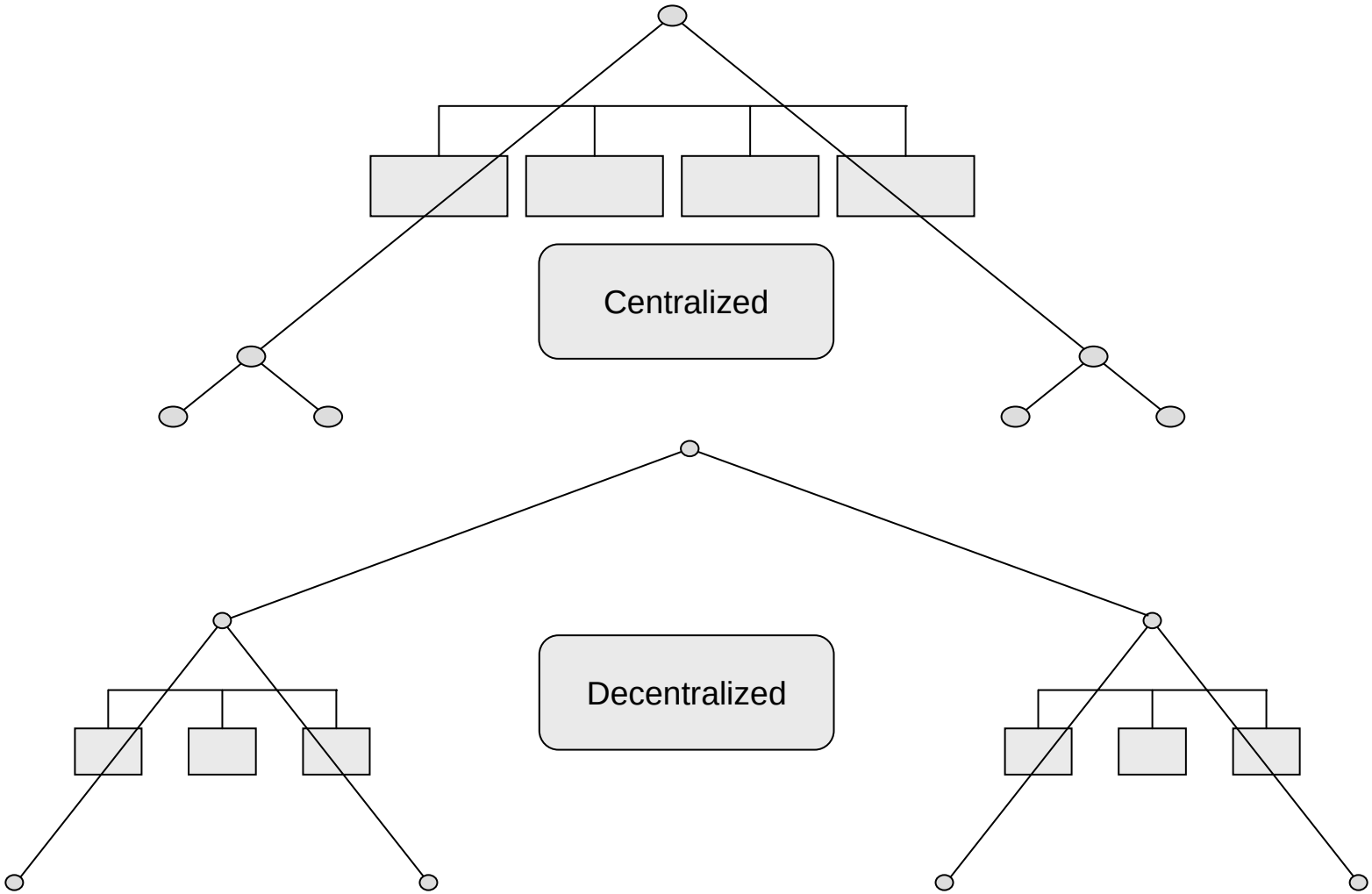
Lecture 17: Outline

- A brief tour of research on organizations
- The organizational design problem
  - Design variables, fundamental metrics and the bottom line
  - Processes
  - Properties
- Organizational Design/Architectural Analysis by selected, simple quantitative models
  - Arrow; Sah and Stiglitz
    - Simple decision-making non-network models
  - Dodds, Watts and Sabel
    - Network model incorporating hierarchy as base
    - Information transfer for problem solving
    - Robustness assessments and identification of superior structure
    - Assessment of the contribution of DWS paper
- Possible future work and Conclusions

Organizational thinking

Theory area	Concerns
• "Classical" Organizational Theory (1900-19xx) Taylor, *task breakdowns*, practitioners –Sloan; *levels and span of control*, *staffs*	• Efficiency, division of labor in production and in management, hierarchy, authority and motivation, power distribution, centralization

Line-staff models of organization.



Organizational thinking b

Theory area	Concerns
• "Classical" Organizational Theory (1900-19xx) Taylor, *task definition*; practitioners – Sloan; *levels and span of control*, *staffs*	• Efficiency, division of labor in production and in management, hierarchy, authority and motivation, power distribution, centralization
→ • "Human Relations" School , Hawthorne effect (1930-1965)	• *Incentives* and leadership style

The organizational problem stated in "classical + incentives" form

- "The artificial quality of organizations, their high concern with performance, their tendency to be far more complex than natural units, all make informal control inadequate and reliance on identification with the job impossible. Most organizations most of the time cannot rely on most of their participants to internalize their obligations to carry out their assignments voluntarily, without additional incentives"
  - A. Etzioni(1963, p. 59)

- Reactions??

Organizational thinking

Theory area	Concerns
• "Classical" Organizational Theory (1900-19xx) Taylor, practitioners –Sloan; *levels and span of control*, *staffs*	• Efficiency, division of labor in production and in management, hierarchy, authority and motivation, power distribution, centralization • *Incentives* and leadership style
• "Human Relations" School , Hawthorne effect (1930-1965)	
→ • Information flow and decision-making (1945- present), Simon, Simon and March, Arrow, Galbraith and many others	• Information quality, human cognition, communication and noise, decision quality, strategies, etc.

Organizational thinking

Theory area	Concerns
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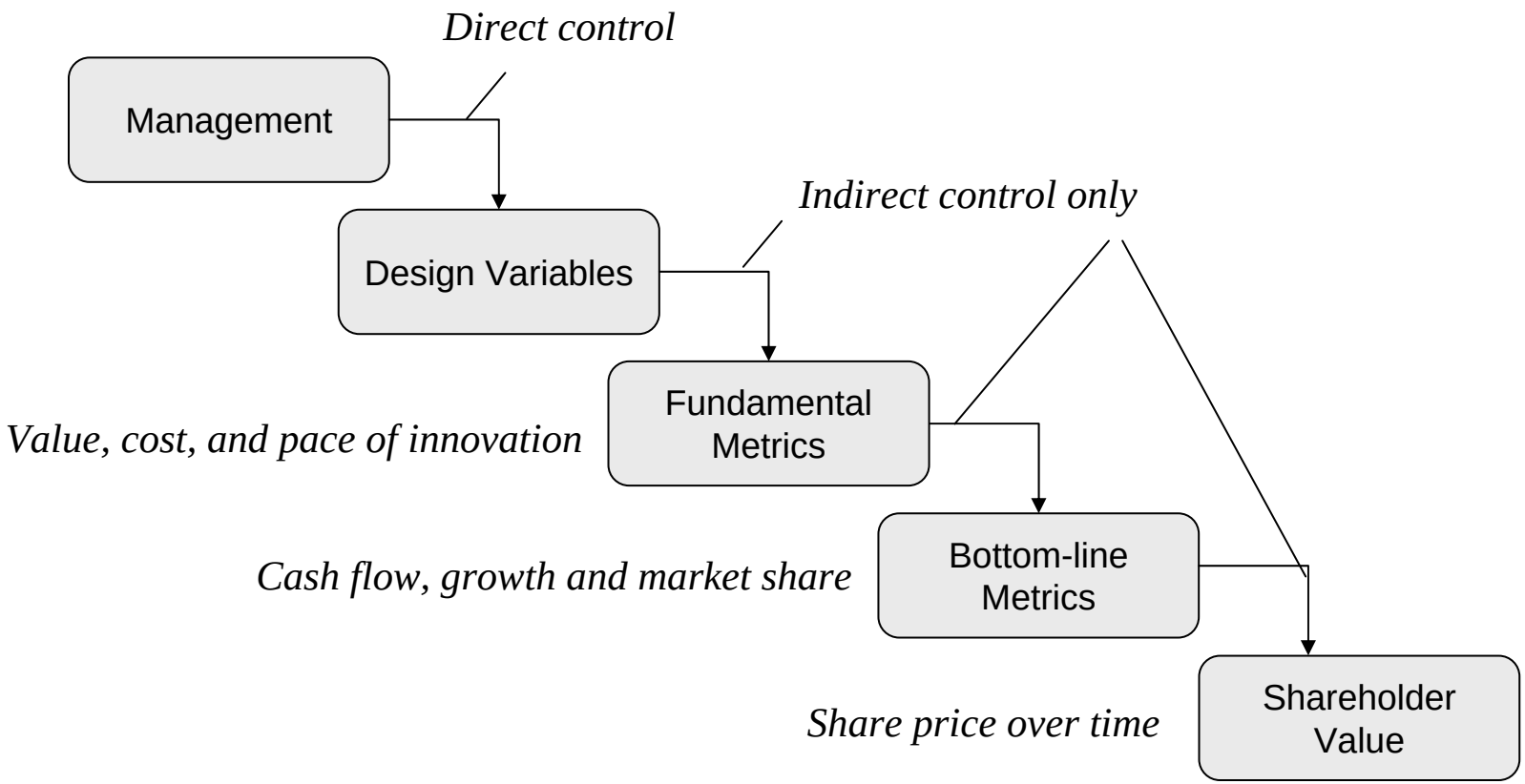
• "Human Relations" School , Hawthorne effect (1930-1965) • Information flow and decision-making (1945- present), Simon, Simon and March, Arrow, Galbraith and many others	• Information quality, human cognition, communication and noise, decision quality, strategies, etc.
→ • **Contingency** theory (1960-present),Burns and Stalker, Lawrence and Lorsch) **people** (McGregor, Schein, Oichi), **process, culture, learning, lean,** etc. "paradigm de jour",	• Rate of change, reward systems, socialization and teams, structure variation within the larger structure, leadership style as a function of all else, etc.

Purposes of organizations

- Managers work for owners – to maximize owners' **long-term** satisfaction-usually =wealth
- To **satisfy** the organization's **customers**
- To satisfy other "stakeholders"
  - In order for managers and other employees to maximize their wealth (or have "good" jobs or feel respected or be part of a social community-loyalty, pride, etc.)
  - To be a good citizen
- For non-profits (&Gov't?): Managers work to **fulfill a mission-** to educate , to assure long-term survival of a worthwhile entity
- It is apparently easier to substitute some manager and employee goals in not-for-profits but there is still an assumption of their "moral superiority".
- Does management in general design the organization in a way to **directly** affect purpose/function?

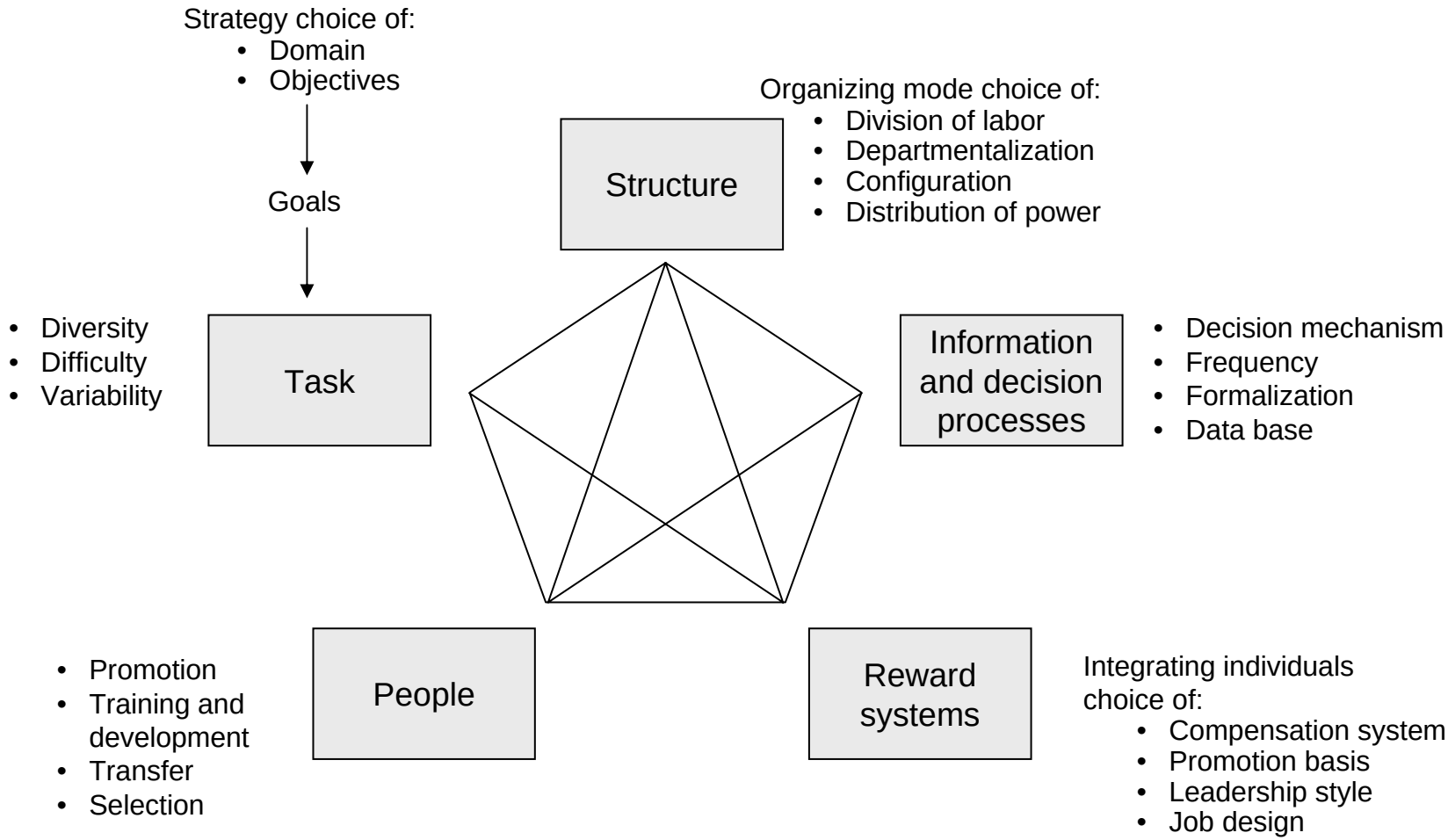
Management is three steps from managing the bottom line directly.



The strategic metrics are divided into fundamental and bottom-line.

Strategic Metrics	
Fundamental	**Bottom Line**
Value to customer	Cash flow
Cost (variable, fixed, investment)	Market share
Pace of innovation	Price
	Return on investment
	Growth rate of Profit
	Share Price

Organization design



Organizational or Enterprise Architecting

- Assume the previous slide lists the organizational variables, what do you think ***organizational architecting*** involves?

- Thus, how do we describe different ***organizational architectures***?
- Mental Models
- Roles of key people (middle-management)
- The hard-to-change or longest lived design variables is my preferred means of assessing which variables in a complex system are the architecture
- Those design variables with the **greatest leverage** and are hardest to change are the **essential** architecture descriptors

Organizational Design/architecting: CLM bias

- Least effective efforts focus on boxes and lines on organizational charts
- More effective efforts focus on identifying the design variables which can most effectively improve key processes
- Most effective efforts (perhaps) will focus on identifying the key design variables which accomplish the best tradeoff among the **properties** associated with key ***processes***.

Key Organizational Processes that enable fulfilling of the Organizational Purposes

- Planning and coordinating
- Decision-making about
  - Personnel-hiring, evaluation and rewards,
  - Products, technologies, manufacturing and supply chains
  - Markets, distribution channels, locations
- Problem identifying and problem solving
- Task and process structure development for adding value
- Building capability
  - People development-education and socialization
  - Process and interaction development
  - Knowledge capture
  - Knowledge generation
- Conflict management and resolution
- Rule development and enforcement
- Communication to analysts and business reporters
- Fund-raising from donors (not-for-profit major process)

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Key organizational Properties

- **Decision-making**
  - speed and time coordination
  - correctness
  - efficiency (minimal resources)
- **Problem-recognizing and problem-solving**
  - Speed
  - Correctness
  - efficiency
- **Robustness**
  - To node removal (personnel turnover) and to unexpected "failures" in links
  - To variability in loads due to normal environmental changes
  - To major unexpected events such as fires, natural disasters
- **Flexibility**
  - For significant competitive thrusts
  - For change in methods and products
  - For need for new skills and knowledge

Modeling Organizational issues

After this introduction about organizational design, several aspects of modeling that relate to **organizational structure** (or architecture) are now briefly explored:

- **Decision Theory**

- **Communication**

- Note that both of these are properties models and do not discuss or try to look at models for formation or evolution of actual organizational structure or the development of rules, etc.

Modeling Organizational issues

After this introduction about organizational design, several aspects of modeling that relate to **organizational structure** (or architecture) are now briefly explored:

- **Decision Theory**
- **Communication**
- Note that both of these are properties models and do not discuss or try to look at models for formation or evolution of actual organizational structure or the development of rules, etc.
- Note that many other key processes and properties that are important in organizations are not covered (knowledge development and capture, reward structures, personnel development, etc.)

Modeling Decision Making Processes

- Items to be covered (briefly)
  - An axiom concerning multiple decision makers (team or organizations) with multiple alternatives (Arrow)
  - Multiple decision makers and decision structures/organizations (Sah & Stiglitz)

Arrow's Impossibility Theorem

Individual	Preferences	A vs. B	B vs. C	A vs. C
I	A>B> C, A> C	A	B	A
II	B>C> A, B> A	B	B	C
III	C>A> B, C> B	A	C	C
Group preferences		A>B	B>C	C>A

Groups using ***majority rule***
are not necessarily transitive

Implications to Consensus Decisions, Cooperation and Organizations

- There is a real difficulty with ***intransitivity-almost certain in a large group with a large number of options-***
  - ***Large teams*** with ***multiple choices*** to rank are ***unproductive*** and should be avoided
  - Single person decision after all team input is heard is one possible alternative
  - Sum ranking votes on single alternatives (with an arbitrary tie-breaking rule and/or elimination of lowest total)
  - Facilitators (and/or decision-makers) can force a series of two way choices and eliminate any losers from further consideration

- ***Some organizational hierarchy*** is ***essential to effectiveness***

Decision-making Structures and Organizational Implications

- Sah and Stiglitz work is foundation and expanded by Catalani and Clerico
- Models for different decision-making structures
  - Framework involves “approving (or not) Projects”
  - Good (g) or bad (b) projects can be accepted (a) by individuals with probabilities p_1 and p_2

	"good" project or design change	**"bad" project or design change**
Accept	Ideal = 1.0 p_1	Type II errors p_2
Reject	Type I error $1-p_1$	Ideal = 1.0 $1-p_2$

Amount of Type I and II Errors for individual decision-maker

Decision-making Structures and Organizational Implications II

- Sah and Stiglitz work is foundation and expanded by Catalani and Clerico
- Models for different decision-making structures
  - Framework involves "approving (or not) Projects"
  - Good (g) or bad (b) projects can be accepted (a) by individuals with probabilities p_1 and p_2
  - for "polyarchy"-simultaneous judgment and

    any **one** person acceptance

    $P_a^g = p_1(2-p_1)$ and $P_a^b = p_2(2-p_2)$

  - for "hierarchy"-series of decisions with only approved considered at next level, $P_a^g = p_1^2$ and $P_a^b = p_2^2$

Decision-making Structures 2

- Hierarchy of n people rarely accepts anything bad (but often rejects good changes)
  - "and gate" analogy and redundancy
- Polyarchy of n people rarely rejects anything good (but often accepts bad changes)
  - "or gate" analogy

Generalization to "Committees"

- Can vary number of people on committee, n and number who must approve for acceptance, v. Optimum decision structure depends on :
  - Quality of deciders (p_1, p_2 for each person)
  - Quality of suggested changes (proportion good and good and bad impacts for suggested changes)
  - Decision Resource Constraints-how many evaluations, how much time to evaluate, how much effort to get information- and the value of good decisions in specific cases

Application of concepts

- Where might you apply polyarchy? Of committees?

- Where might you apply hierarchy? Of committees?

Application of concepts II

- Where might you apply polyarchy? Of committees
  - Choosing low-cost pilot programs with large opportunity
  - It is more or less the way the United States runs it national research agenda (many federal agencies (DARPA, NSF, DOE etc… and some states .. each agency has a different selection process, different goals and different biases)
- Where might you apply hierarchy? Of committees?
  - High downside risk with some forgiveness for missing out on some positive results
  - Essentially applied in tenure cases in universities, hiring in many firms and in some inappropriate places in industry and government.
  - Other appropriate examples include product programs, manufacturing expansion and others within industry

Possible Implications to Organizational Structure for Decision-Making

- With Speed and Quality as the major constraints, committees of ***simultaneous reviewers*** have significant advantages.
- Use Hierarchy of Committees for High Risk (big downside only) Decisions-hiring, promoting to key jobs, new products
- Use polyarchy for small risk improvement ideas to be "piloted".
- If speed, correctness and efficiency are all important (as they usually are in a competitive situation)
  - ***expertise*** of decision-makers is ***critical***
  - ***alignment around definition of "goodness"***
- For organizations**,**
  - Expertise and alignment give meaning to the well-known advice: ***"make decisions at the right level"***
  - The extremely ***high value*** of expertise promotes ***learning,*** knowledge capture (and hiring) to a critical property of organizations undergoing moderate rates of change

Modeling Decision Making Processes

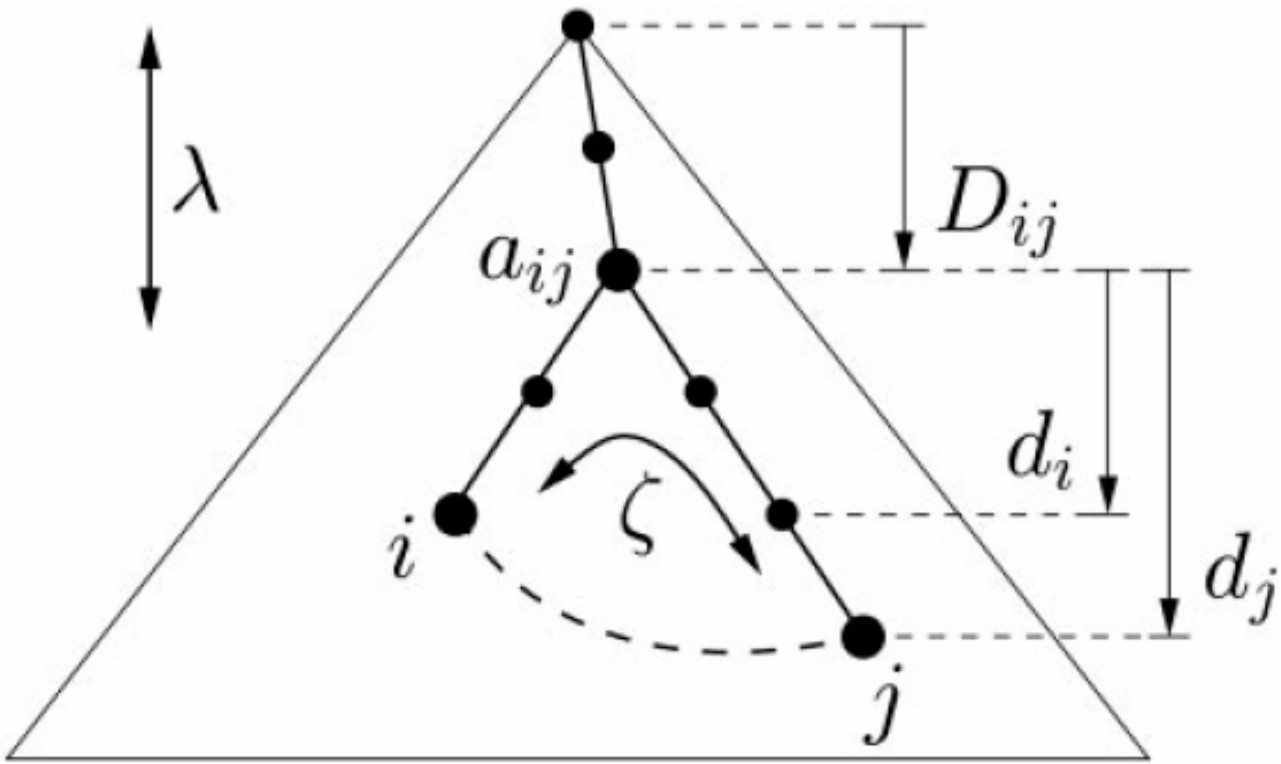
- Items covered (briefly)
  - An axiom concerning multiple decision makers (team or organizations) with multiple alternatives (Arrow)
  - Multiple decision makers and decision structures/organizations (Sah & Stiglitz)
- Items not covered
  - Garbage-can models (and other messes)
  - Repetitive Game Theory (ala Axelrod but being done by economists in business schools- a leading example is R. Gibbons at MIT), social and informal contracts etc.
  - Agent-based models (e.g. Carley)
- Modeling communication (necessary for decision making but not sufficient)- following slides

Dodds, Watts and Sabel Organizational Modeling for Communication Robustness

- The questions being addressed are:
  - Topologies (architectures) of total organization
  - Choice of topology for robust problem solving
- In order to develop a diverse set of organizational structures relative to communication, DWS develop an organizational structure generator
  - Starts with **hierarchy with L levels** and branching ratio b (the formal organization)
  - m additional links are added ("informal organization" or actually the method they use to develop different organizational structures)

Dodds, Watts and Sabel Organizational Model for Communication Robustness

- The organizational structure generator
  - The questions being addressed are:
    - Topologies (architectures) of total organization
    - Choice of topology for robust problem solving
  - Starts with **hierarchy with L levels** and branching ratio b (the formal organization)
  - Randomly **adds m weighted links** ("informal organization")
  - Probability of two nodes being linked, P(i,j) depends on depth of lowest common ancestor and also their own depths

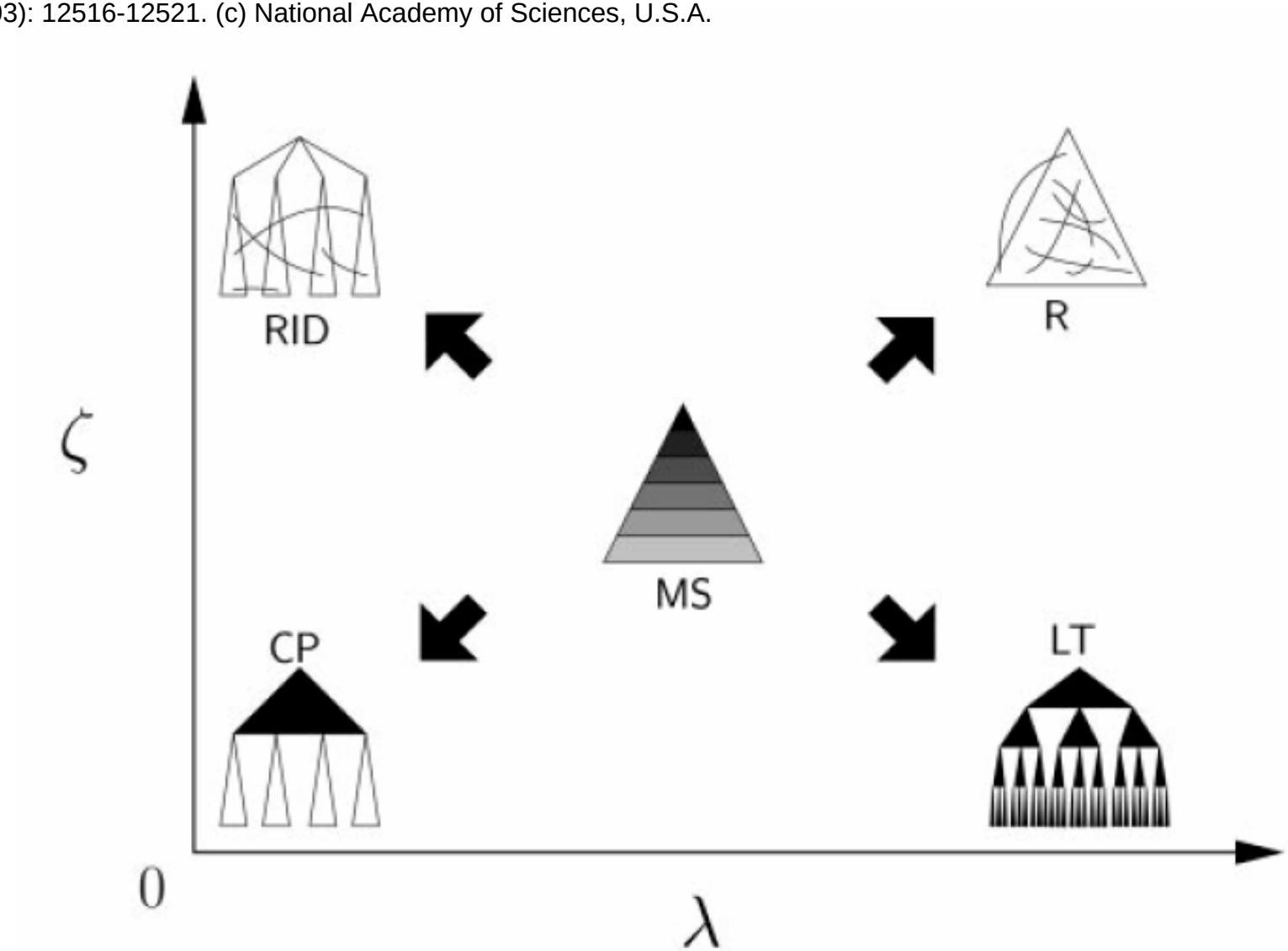


Defining key parameters

Dodds, Watts and Sabel Network Organizational Model for Communication Robustness

- The organizational structural generator
  - Starts with **hierarchy with L levels** and branching ratio b
  - Randomly **adds m weighted** links
  - Probability of two nodes being linked, P(i,j) depends on depth of lowest common ancestor and also their own depths
  - Organizational distance $x_{ij} = (d_i^2 + d_j^2 - 2)^{\frac{1}{2}}$
  - Overall $P(i,j) \propto e^{\frac{-D_{ij}}{\lambda}} e^{\frac{-x_{ij}}{\zeta}}$
  - Where $\lambda \; and \; \zeta$ are adjustable parameters allowing different organization structures to be generated by their network model. Varying **these parameters** leads to

Courtesy of National Academy of Sciences, U.S.A. Used with permission. Source: Dodds, P. S., D. J. Watts, and C. F. Sabel. "Information exchange and the robustness of organizational networks." *Proc Natl Acad Sci* 100, no. 21 (2003): 12516-12521. (c) National Academy of Sciences, U.S.A.



Organization Categories from the DWS Model

- **RID** (Random Interdivisional) high ζ and low λ

Links are allocated **exclusively** between node that have as their lowest common superior the "top node". Links between random levels as homophily is unimportant

- **CP** (Core Periphery) low ζ and low λ

Links are added **primarily** between subordinates of the top node alone

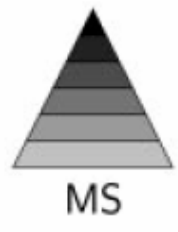
- **LT** (Local Team) low ζ and high λ

Links are added **exclusively** between pairs of nodes that share the same immediate superior

- **MS** (Multiscale) intermediate ζ and λ

Connectivity at all levels but the density of connections is **greater the higher** one goes in the hierarchy

- R (Random) the extra m links are added to the hierarchy randomly (not shown)



Processes Used in the Organization Model Study in DWS

- The study basically models ***information exchange*** with a stated purpose to study distributed **"Problem Solving"** (decision-making?). Model assumptions:
  - Information passing based on local + "pseudo-global" knowledge (higher nodes know less and less about more)
  - The task environment is characterized by a rate of information exchange, μ and variable amounts of ***problem decomposability*** weighted by the social distance, x_{ij} and the "decomposability" parameter ξ according to

the weight, S, related to distance and ξ as

$$S = e^{-\frac{x_{ij}}{\xi}}$$

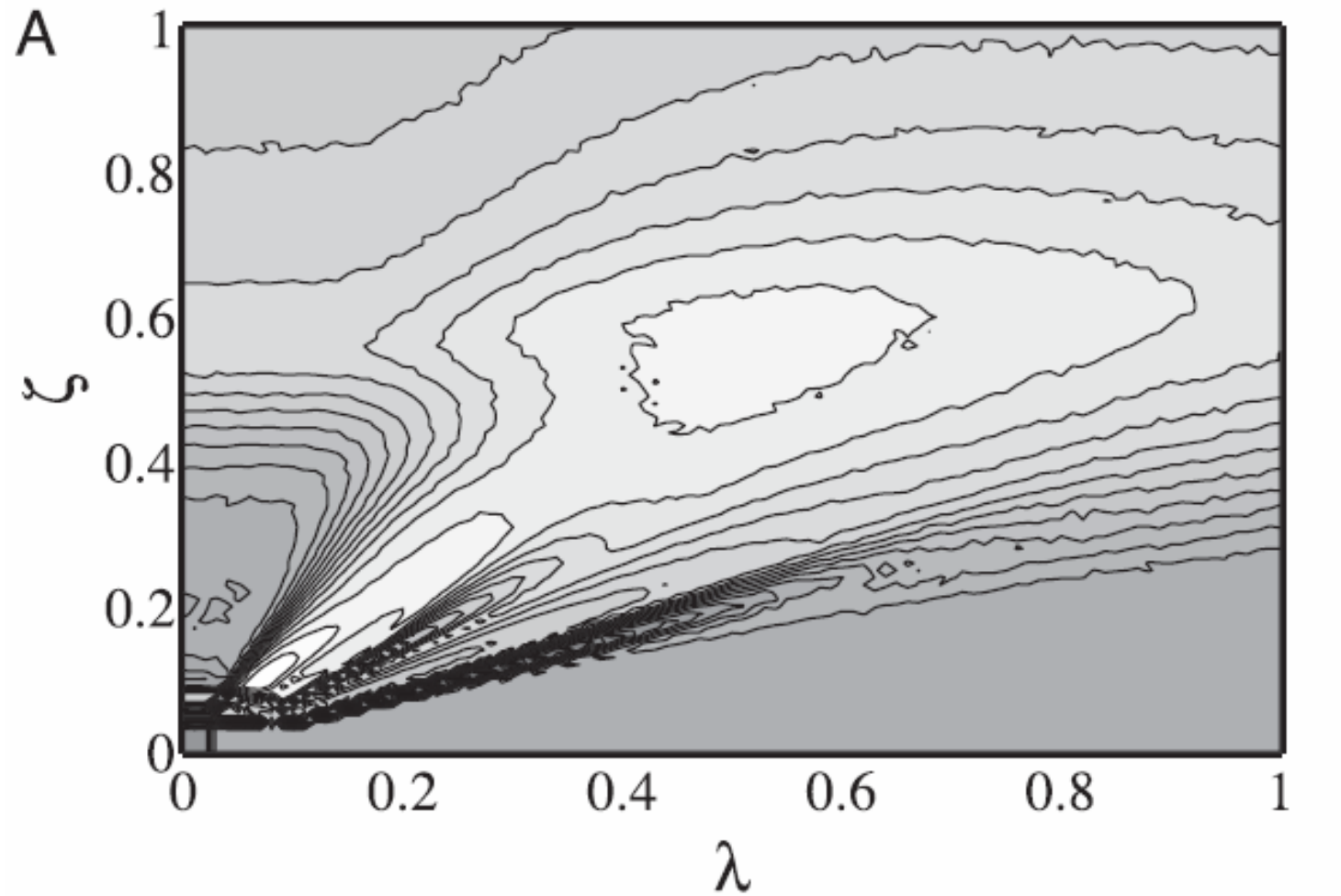
As ξ becomes large, problems that are **not dependent** on social distance become important in the organization. This is a useful modeling device

Properties of the Organizational Models studied by DWS

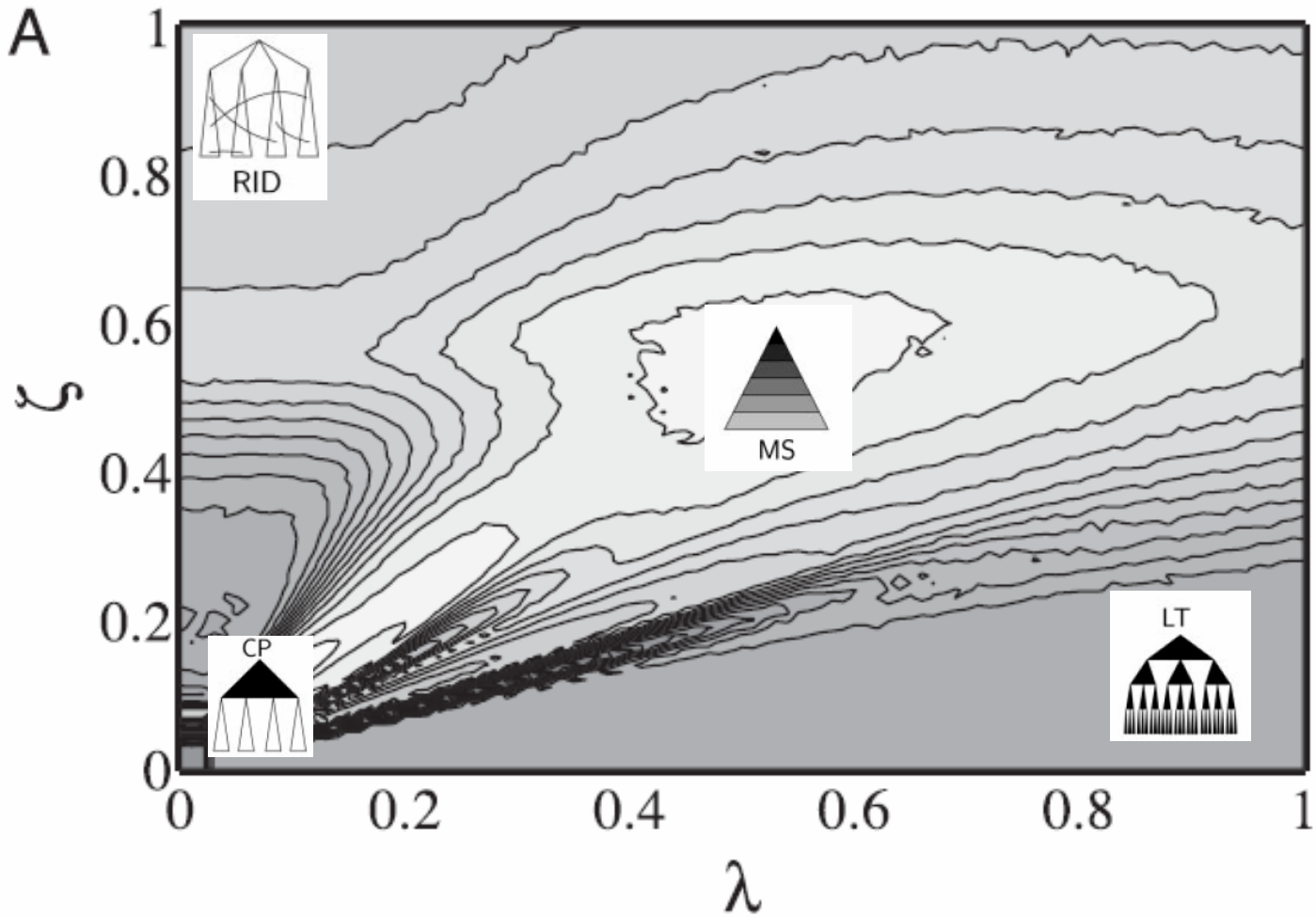
- Robustness
  - Congestion robustness: the capacity to protect individual nodes from congestion (overload).
  - Connectivity robustness:
  - Ultrarobustness:

Properties of the Organizational Models studied by DWS

- Robustness
  - Congestion robustness: the capacity to protect individual nodes from congestion (overload). **This is accomplished by the structure giving the minimum of the maximum congestion centrality**
  - Connectivity robustness:
  - Ultrarobustness:
- Results



Congestion metric over the ζ, λ plane



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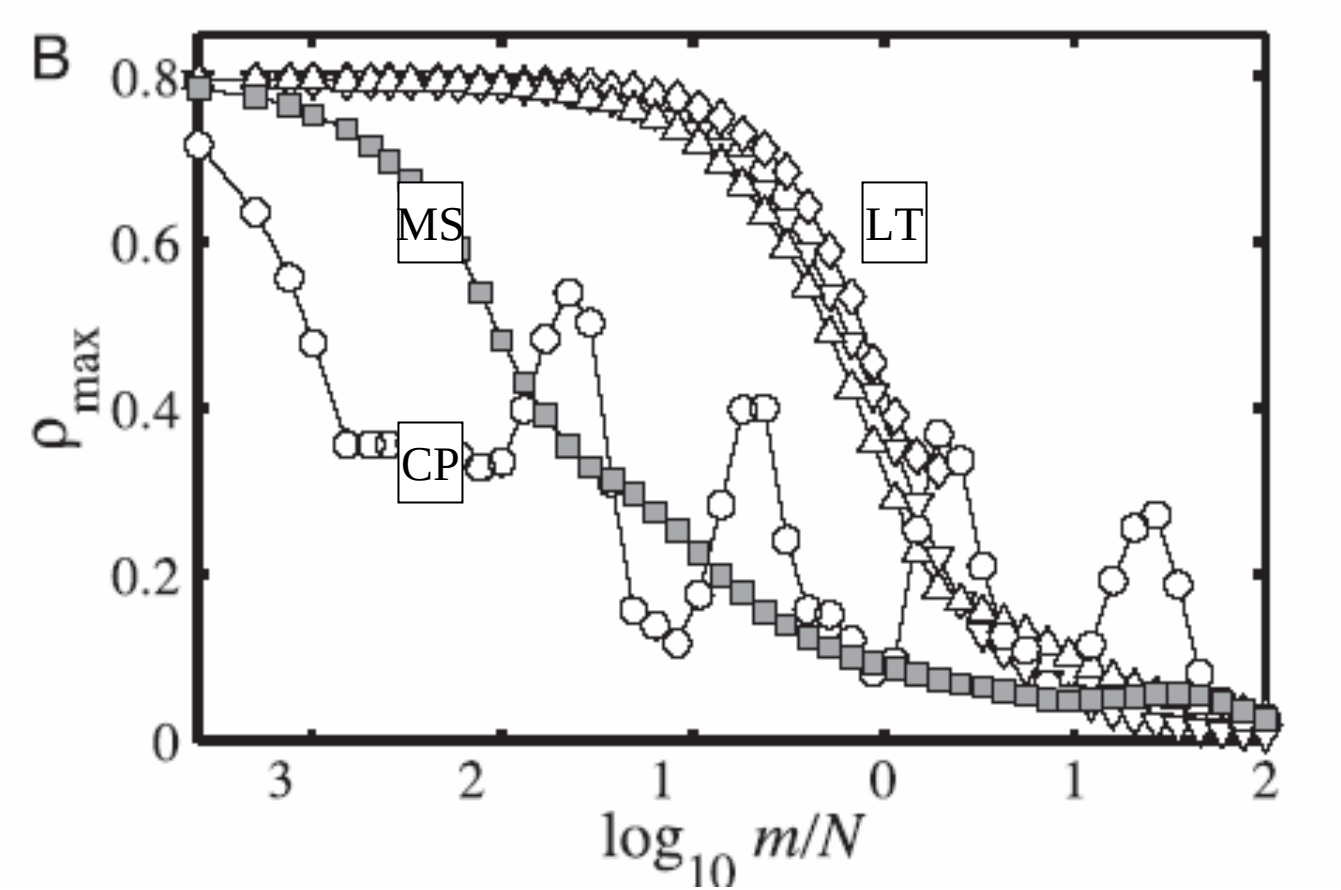
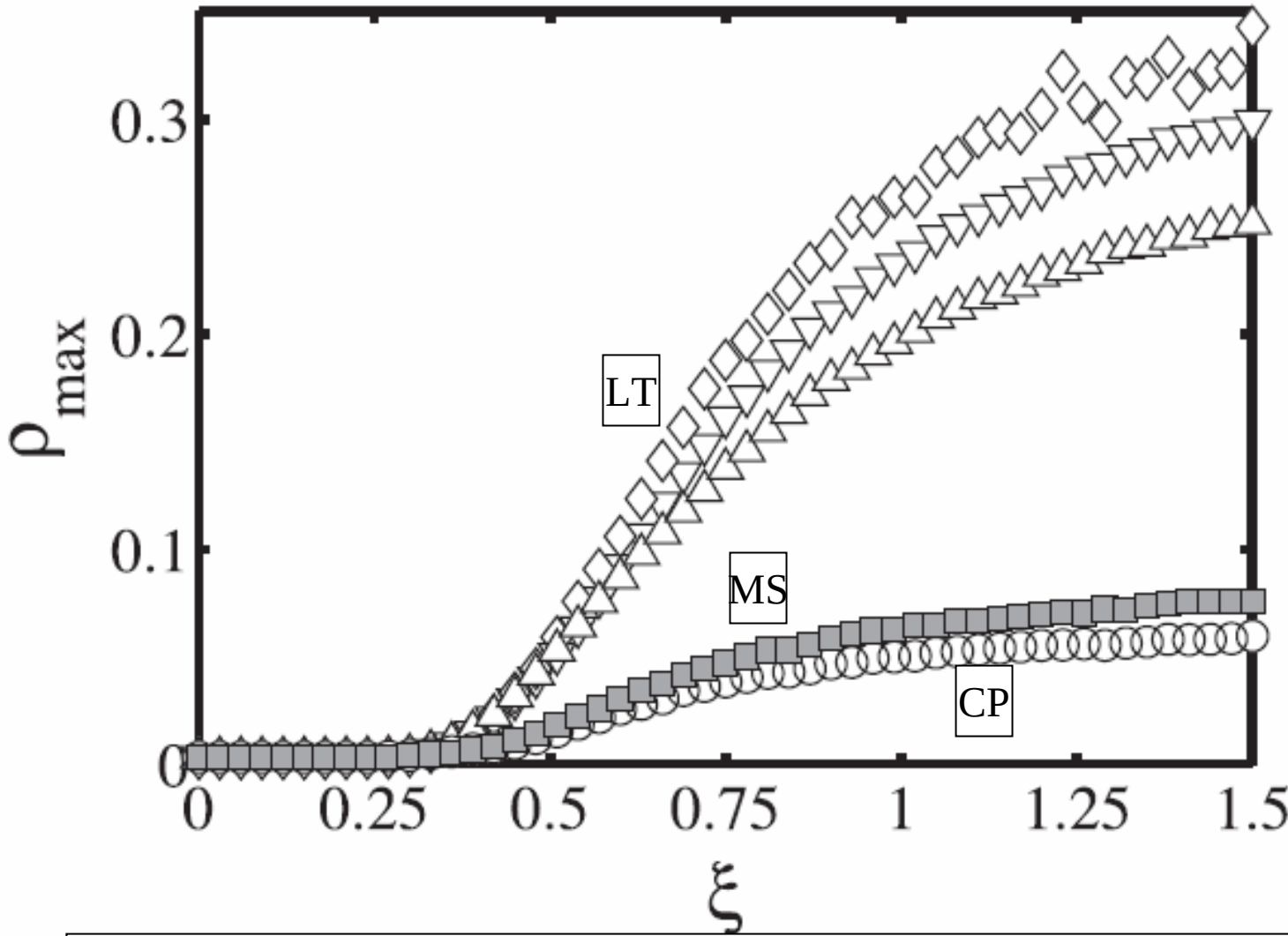


Congestion metric as links are added

Properties of the Organizational Models studied by DWS

- Robustness
  - Congestion robustness: the capacity to protect individual nodes from congestion (overload).
    - Better structure results in **Minimal congestion centrality and this is shown for MS (only CP is competitive but *not as reliable***)



Congestion centrality with **decreasing** task decomposability, ξ

Properties of the Organizational Models studied by DWS

- Robustness
  - Congestion robustness: the capacity to protect individual nodes from congestion (overload).
    - Better structure results in Minimal congestion centrality and this is shown for MS (only CP is competitive but *not as reliable*)
    - **All structures are OK with decomposable tasks** (excepting the pure hierarchy?) **but MS and CP are best when larger scale interactions are significant.**

Properties of the Organizational Models studied by DWS

- Robustness
  - Congestion robustness: the capacity to protect individual nodes from congestion (overload).
    - Minimal congestion centrality is better structure and this is shown for MS (only CP is competitive but not as reliable)
    - All structures are OK with decomposable tasks but MS and CP are best when larger scale interactions are key.
    - **Maximum uncongested size is for MS (CP again second)**

Properties of the Organizational Models studied by DWS

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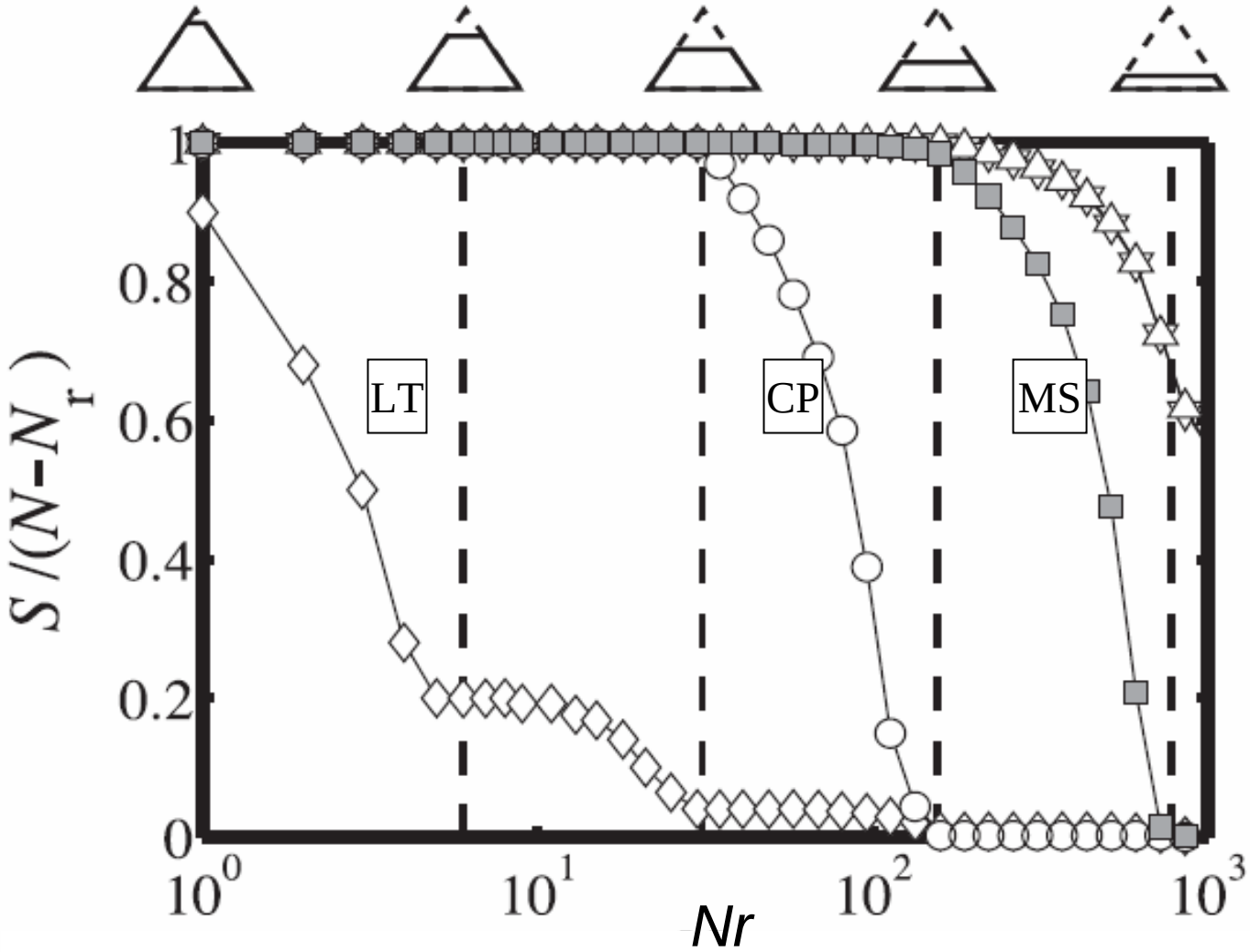
  - Connectivity robustness: The capacity to remain connected even when individual failures do occur.



Connectivity robustness (largest cluster size) after top-down targeted removal of N nodes

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    - All structures are OK with decomposable tasks but MS and CP are best when larger scale interactions are key.
    - Maximum uncongested size is for MS
  - Connectivity robustness: The capacity to remain connected even when individual failures do occur.
    - **Random best for targeted attack but MS as good until 4 of the 6 hierarchy levels are removed (LT and CP are significantly worse)**

Properties of the Organizational Models studied by DWS

- Robustness
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  - **Ultrarobustness**: A simultaneous capacity to exhibit superior Congestion and Connectivity robustness

Properties of the Organizational Models studied by DWS

- Robustness
  - Congestion robustness: the capacity to protect individual nodes from congestion (overload).
    - Minimal congestion centrality is better structure and this is shown for **MS**
    - All structures are OK with decomposable tasks but **MS** and CP are best when larger scale interactions are key.
    - Maximum uncongested size is for **MS**
  - Connectivity robustness: The capacity to remain connected even when individual failures do occur.
    - Random best for targeted attack but **MS** as good
  - **Ultrarobustness**: A simultaneous capacity to exhibit superior Congestion and Connectivity robustness—clearly **MS** fits this definition by their measures and simulation

Ultra robustness

- Dodds, Watts and Sabel argue that one of their 5 structures is Ultrarobust.
  - The “Multiscale” Structure has superior (or at least near best) robustness and reliability to a variety of failure modes
    - Congestion
    - Node Failure
    - Link disconnection
- Reactions ?

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