Towards an Ecological Theory of Military Revolutions

Aaron B. Frank
Center for Social Complexity
George Mason University

Disclaimer

- Emphasis on creation of research plan and agenda
- Seeking feedback on how to structure, prioritize, and focus research
  - Historical
  - Theoretical
  - Computational
- Findings and ideas offered today are highly fragile and preliminary

What are Military Revolutions

- The central theme is that changes in the character of warfare drive changes in social, economic, and political life
  - Security and insecurity play a central role in social systems
  - Deep and profound changes can occur rapidly with little warning
- The study of military revolutions constitutes an examination of interfaces and interactions
  - Between competing military organizations and alliances
  - Between traditional and innovative technologies, organizations, and doctrine
  - Between domestic and international politics
  - Between military and society

Why Study Military Revolutions

- Central role in the unfolding of world history
- Emergent phenomenon whose complexity is greater than any of its participants can understand
- Basis of a theory on military innovation
- Practical implications/applications

Military Revolutions and RMAs

- Original theory advanced in the 1950s
  - Lecture by Michael Roberts
- Primarily investigated as a means for understanding the “Rise of the West”
  - Development of Modern Europe
- Recently spawned a secondary theory on “Revolutions in Military Affairs”
  - Emphasis on technical innovation, organizational structure, and operational concepts
- While similar, each theory emphasizes different levels of analysis and lessons
  - Military revolutions are macroscopic, examining the social, political and economic, drivers and consequences of military innovations
    - System or environmental level
  - RMAs are microscopic, seeking to provide prescriptive guidance to military organizations and policy-makers with respect to initiating and responding to military innovation in pursuit of strategic advantage and survival
    - Agent level
    - “What could/would/should Chucky do?”

A Significant Gap

- “Military history, despite its advanced age, has yet to achieve maturity, but remains in a permanent state of adolescence. A characteristic of this immaturity is the relative lack of fundamental debate that transcends the level of refighting past wars; and this paucity is one of the central reasons why there still exists no body of general theory on military change.” – John Lynn

- What to generalize?
  - Aside from identifying the importance of history and experience, what else can we say?
- What is the micro-macro link between RMAs and Military Revolutions?
  - Is there a link between national, international, and human/global security?

Complexity of Military Revolutions

- Currently, no analytic framework exists to link the study of RMAs and Military Revolutions
  - Conduct of individual organizations
  - Competition between military organizations
  - Civil military relations
  - Technological innovation
  - Social consequences of military innovation

Properties of Past Revolutions

- Path-Dependence
- Uncertainty
- Spatial Properties (Strategic Geography)
- Heterogeneity
- Co-Evolution
- Bounded Rationality
- Punctuated Equilibrium

An Ecological Turn

- Belief in an ecological approach to the study of military competition
  - Deep interactions and dependencies between organisms and populations
  - Co-Evolution
    - Variable fitness
    - Strategic interaction
    - Red Queen
  - Spatial competition and interaction
  - Direct physical coercion and destruction
    - Predation and violence

What Does “Ecological” Mean?

- Assumption of interconnectedness
  - No exogenous assumptions of system boundaries
    - Spatial
    - Levels of aggregation/interaction
    - Temporal
- No exogenous measures of fitness
  - Military effectiveness is contingent on others
- Dissolving distinctions between organism and environment
- Does not imply that states or militaries are analogous to plants or animals
  - Strategic behavior
  - Lamarckian vs. Darwinian evolution
  - Psychological and Social Psychological properties, such as morale
- Genotypic vs. Phenotypic selection and adaptation is unclear

War in Perspective

- “Disease germs are the most important microparasites humans have to deal with. Our only significant macroparasites are other men who, by specializing in violence, are able to secure a living without themselves producing the food and other commodities they consume. Hence a study of macroparasitism among human populations turns into a study of the organization of armed force with special attention to changes in the kinds of equipment warriors used. Alterations in armaments resemble genetic mutations of microorganisms in the sense that they may, from time to time, open new geographic zones for exploitation, or breakdown older limits upon the exercise of force within the host society itself .” – William McNeill

- Military organizations are the interface between the international system and society, and changes within the military can affect either/both sides of the interface

Ecological Approaches of Interest

- Bak-Sneppen Punctuated Equilibrium
- Kauffman NKC Models of Co-Evolution
- Food Webs
- Spatial Competition and Invasive Species
- RPS Evolution/Adaptation
- Allometric Scaling

Bak-Sneppen Model

- Examined punctuated equilibrium in a highly-simplistic form
  - Assumed agents were stationary and represented fitness of species
  - No decision-making
- Highly attractive from perspective of Military Revolutions at macroscopic level
  - Problematic at micro-level from RMA perspective
  - Military organizations exist in order to preserve the independence of the polity
    - Successful organizations should reduce the likelihood that a state will become extinct due to a weak neighbor

Why Punctuated Equilibrium Models?

- “In 1972, Stephen Jay Gould and Niles Eldridge proposed a new model for the evolutionary formation of species, which they dubbed "punctuated equilibrium." They argued that evolution proceeded by short bursts of rapid change interspersed with long periods of near stasis rather than constant, slow alteration... This newer conception of punctuated equilibrium evolution, combining both incremental and "revolutionary" change, seems to describe the process of military innovation extraordinarily well. After a long period of near-stasis, infantry began to evolve very rapidly around the beginning of the fourteenth century. Cannon appeared about that time, evolved incrementally for a century, then in a burst of rapid advancement revolutionized war in Europe. Artillery fortification began to develop at about the same time as artillery reached its height; evolved gradually over the course of a century; then in their turn effected a military revolution. A similar process of punctuated equilibrium in military technology continues even today.” – Clifford Rogers

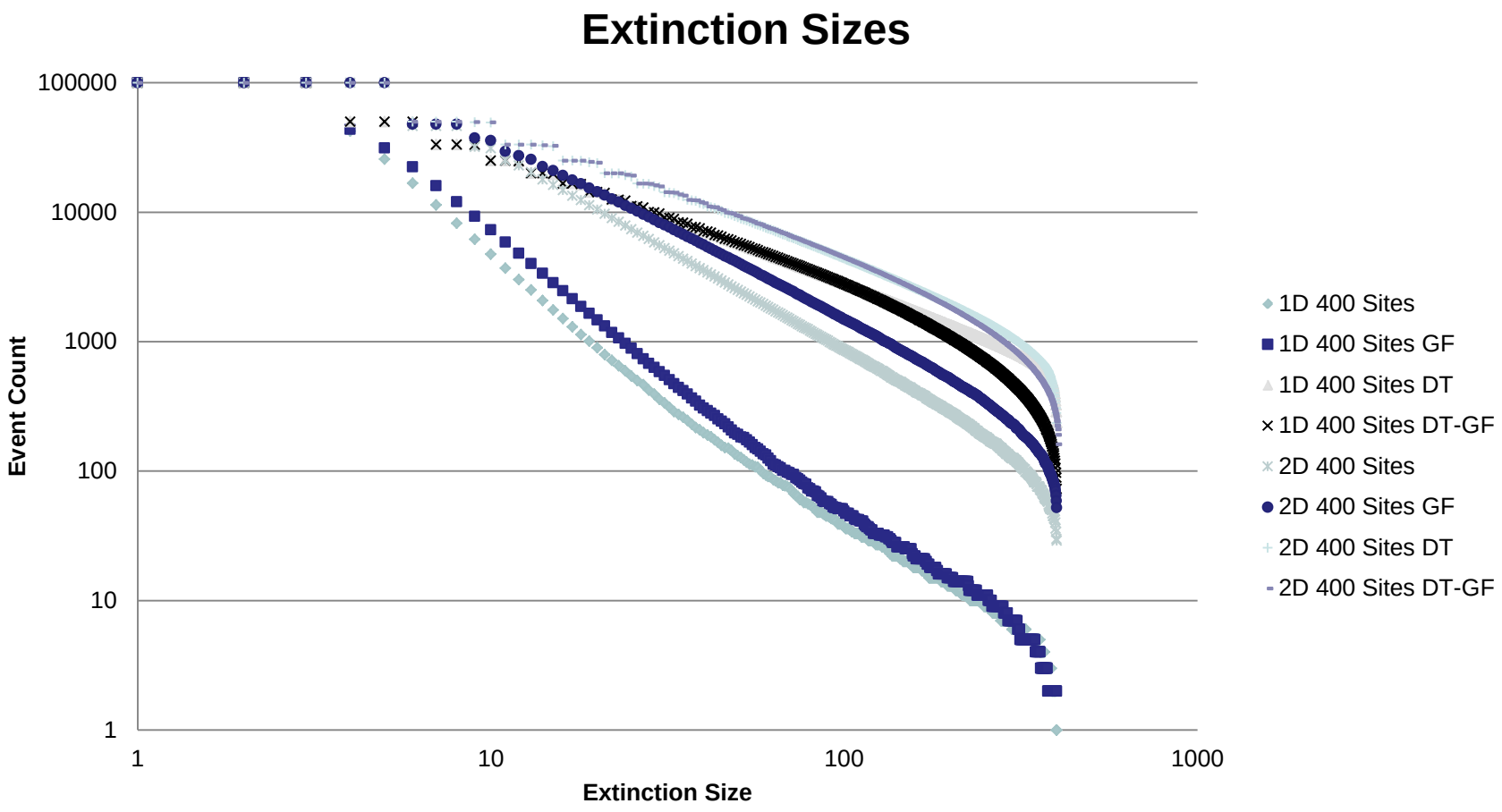
Modifying Bak-Sneppen

- Changing topology
  - 1D to 2D
  - Networks
- Introducing decision-making
  - Sites can demand fitness “tribute” from weaker neighbors
  - Sites can give “fitness” to weaker neighbors that are at risk of replacement
- Altering Replacement
  - Random replacement
  - Replacement by largest fitness gap

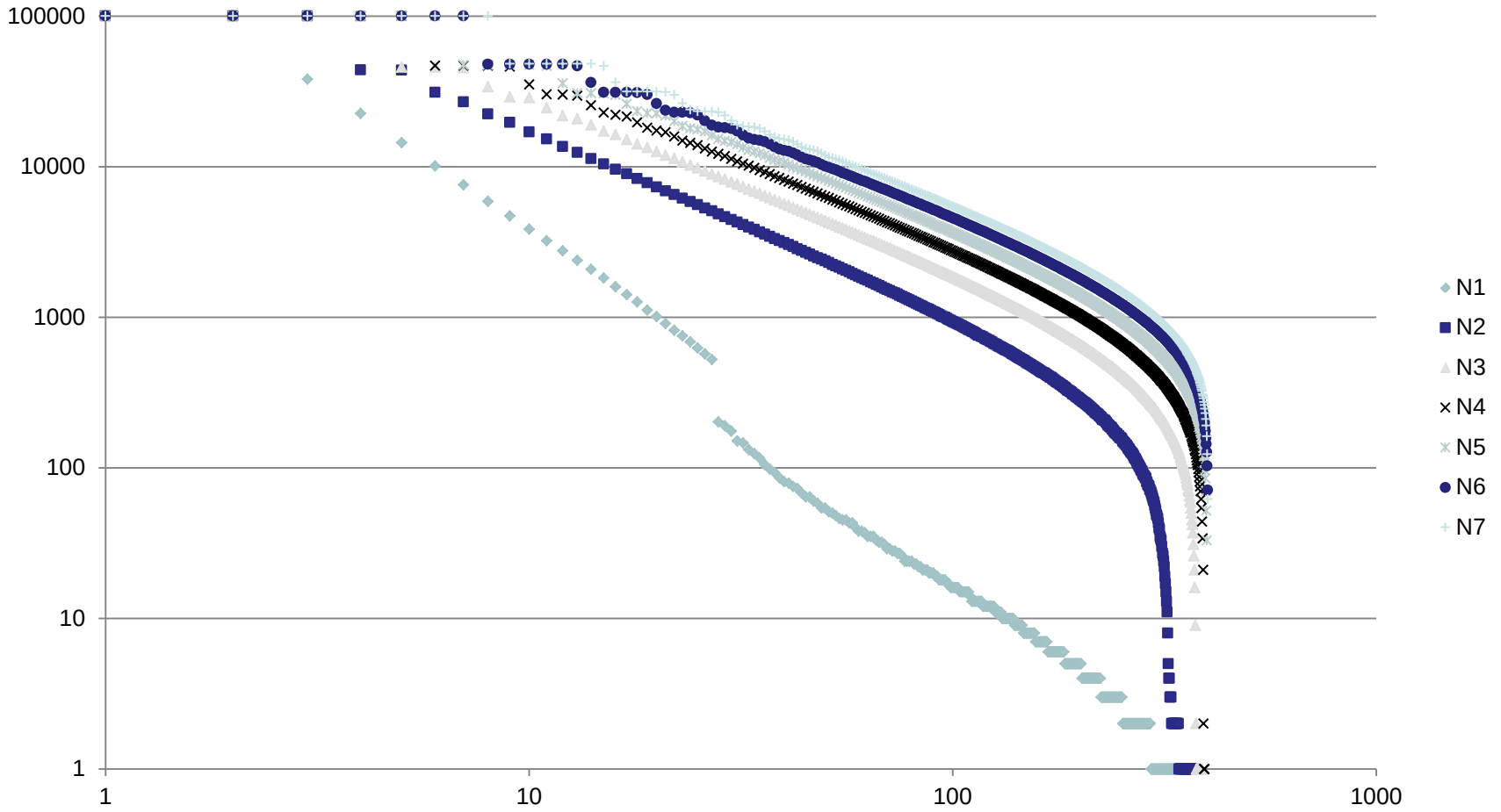
Preliminary Findings

- Modifications to topology and decision-making increase the likelihood of larger extinctions
  - High fitness sites are replaced more frequently
  - Sites don’t achieve extreme ages
  - Increased connectivity accelerates global adaptation
- Modifications to replacement rule destroys self-organized criticality
  - Model gets “stuck” in bifurcated state where same site is usually replaced

Lattice with Interactions



Network Topology



Key Challenges

- Selection
  - War is not persistent, feedback on strategic sufficiency or fitness is irregular and ambiguious
- Interpreting fitness
  - Bak-Sneppen model fitness applies to species
  - Is a species the proper way to think of military forces?
    - Classes of weapons or combinations of weapons?
    - Military forces of particular actors?
      - Must then link to interactive/contingent fitness
- Current interpretation
  - Fitness replacement refers to an incident of military change
  - Replacement of site means that the military has gone through an adaptation
    - Some sites must adapt rapidly, while others are rarely threatened
  - Confuses highly fit states with military organizations that are constantly searching and competing
  - States seek to reduce obsolescence of military investments by increasing fitness of connected sites

NKC Model

- Developed to examine rugged landscapes and co-evolution
- Particularly interesting because of its ability to accommodate fitness at individual/species level
- Landscape is traversed differently due to the presence of others in the system

NKC Model and Military Revolutions

- NKC models has opportunity to cover both domestic and international aspects of military competition
- Provides opportunity to represent detailed technical, conceptual, doctrinal components as well as linkages to domestic political structure
  - Components of structure that cannot be modified in the absence of especially fit competitors
  - Clausewitz wrestling analogy
- Military organizations and states traverse the landscape differently in the presence of competitors

Food Webs

- Interactive networks of predation
  - Interest at interpretive levels of nodes constituting organisms and species
    - Cannibalism
      - From species level may suggest symmetric vs. asymmetric conflict – conflict within or between trophic levels
      - From organism level may suggest internal vs. external war
    - Cycles
      - Non transitive aspects of conflict

Spatial Competition

- Ecological models of animal foraging, predation, and plant dispersion and patch competition
  - Competition vs. colonization
  - Formation of hierarchical spatial structures
- Militaries and polities establish themselves based on their ability to take and hold territory
  - Offense-Defense Balance
  - Military innovations and actors as invasive species

Rock-Paper-Scissors

- Strategic interaction and adaptation
  - Replicator vs. Best Response
- Proliferation vs. Counterproliferation
  - Copy successful/threatening innovations
  - Counter successful/threatening innovations

Allometric Scaling

- Changing proportions and properties of an organism based on body size and environment
- Social theory has emphasized changing forms or governance as a result of population size and spatial span
  - Increases in social complexity
  - Military structure and ability to innovate should correspond with social and environmental complexity