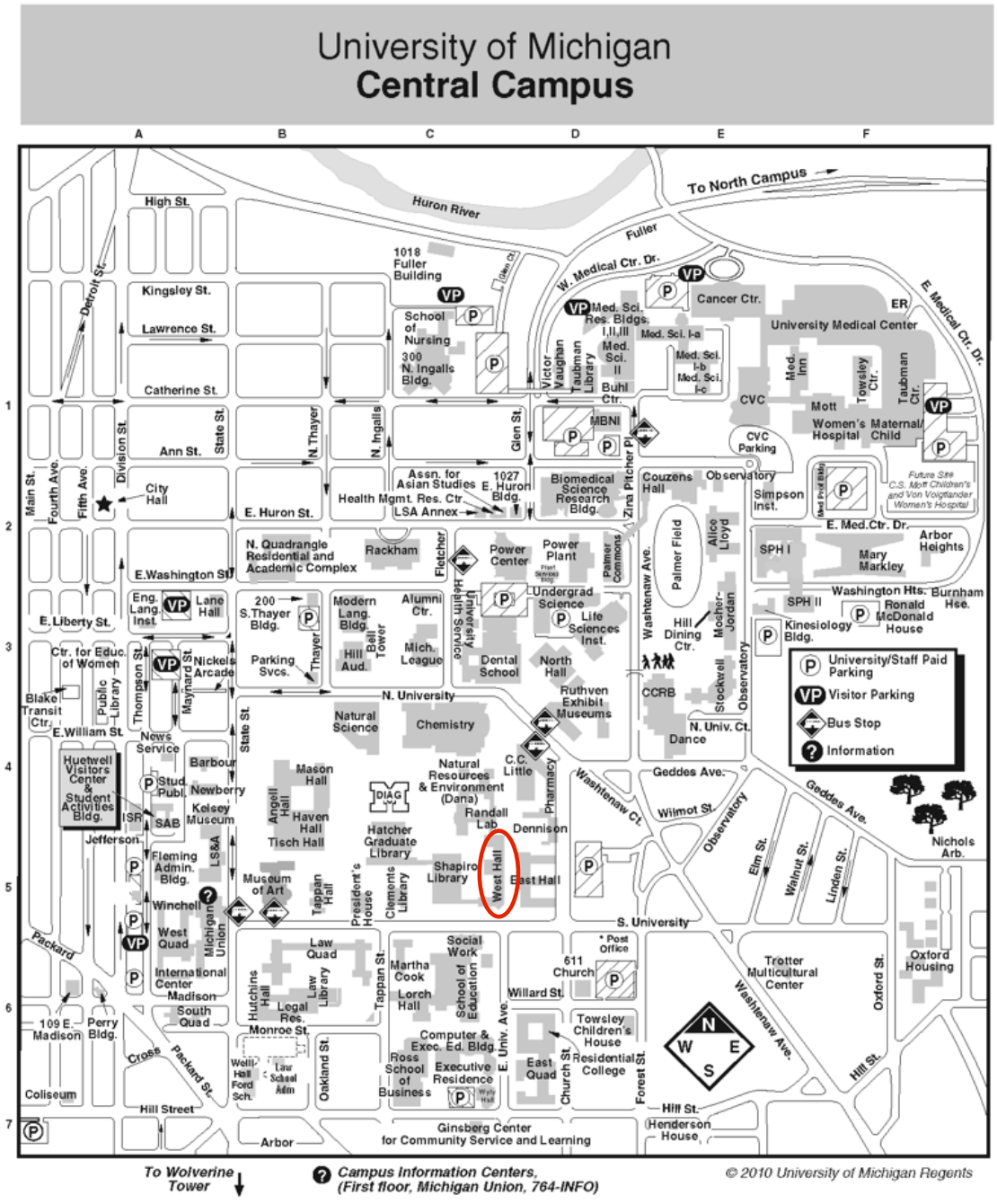
Proceedings of Michigan Complexity Mini-Conference

May 13 ,2013
Ann Arbor, MI

Organizers:
Pablo F. Damasceno
Nguyen H.P. Nguyen
Rick Riolo

Map and Logistics



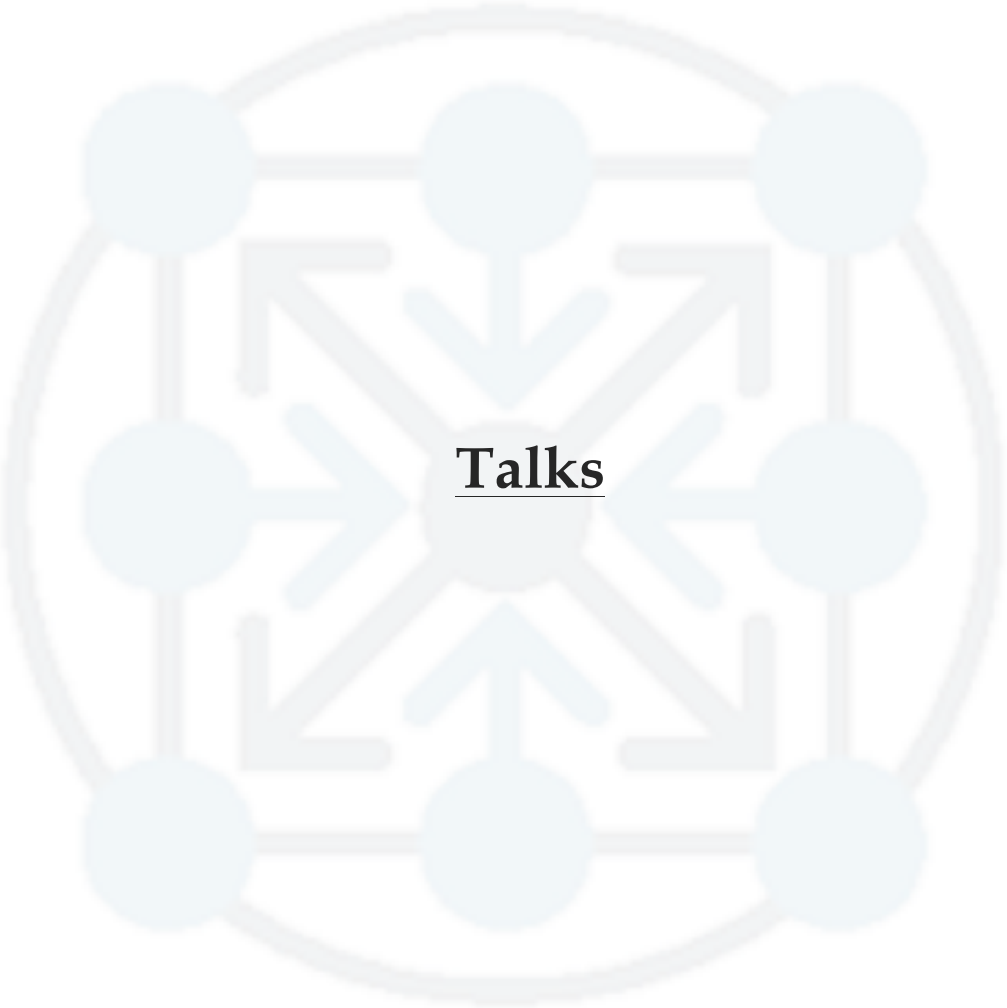
1. **Parking for visitors:** Either on the streets east of West Hall or search for Visitor Parking on the map above.
2. **Once in West Hall**, follow directions to the 4th floor. The room (411) will be located in the south of the building.

Schedule: Session I

Time	Activity	Speaker	Title
08:30-09:20am		**Continental Breakfast**	
		Epidemiology, Health and Society	
09:20-10:00am	Keynote Speaker	Dr. Ana Diez-Roux (UM)	Transcending impasses in health disparities research: can complex systems approaches help?
10:00-10:20am	Contributed Talk	Michele Battle-Fisher (Wright State)	The structural and ethical complexity of private and public health
10:20-10:40am	Contributed Talk	Michelle Saksena (Ohio State)	An Agent-Based Modeling Approach to Understanding the Obesity Epidemic in the US
10:40-11:00am		**Coffee Break**	
		Digital Humanities and Genre Evolution	
11:00-11:40pm	Keynote Speaker	Dr. Eric Rabkin (UM)	People Hear the Title First: A Mixed-Method Study of the Cultural Place of Science Fiction Across Media, Genres, and Decades
11:40-12:10pm	Invited Talk	Graham Sack (Columbia U.)	Simulating the Cultural Evolution of Literary Genres
12:10-12:30pm	Contributed Talk	Sayan Bhattacharyya (UM)	Student-written text at different levels of conceptual abstraction represented as a complex network
12:30-01:30pm		**Lunch Break / Poster Session**	

Schedule: Session II

Time	Activity	Speaker	Title
Social and Biological Systems			
01:30-02:10pm	Keynote Speaker	Dr. Scott Page (UM)	TBA
02:10-02:30pm	Contributed Talk	Maria Riolo (UM)	Evolving booster vaccination strategies
02:30-02:50pm	Contributed Talk	Joshua Sims (UM)	An agent-based model of a Hemlock Woolly Adelgid Adelges tsugae A. infestation, (…).
02:50-03:00pm	**Coffee Break**		
Urban Planning and Applied Complexity			
03:00-03:30pm	Invited Talk	Dr. Robert Reynolds (Wayne State U.)	Evolving Functional Models of Ancient Urban Centers Using Cultural Algorithms
03:30-03:50pm	Contributed Talk	Theodore Belding (Belding Consulting, Inc.)	Applied Complexity, Or: Is This Stuff Actually Useful in the Real World?
03:50-04:10pm	Contributed Talk	Jose Alfaro (UMich)	An Agent Based Model for Renewable Electrification Planning
Closing Remarks			



Talks

Transcending impasses in health disparities research: can complex systems approaches help?

Dr. Ana Diez-Roux

Professor and Chair, Epidemiology
Director, Center for Integrative Approaches to Health Disparities
Director, Center for Social Epidemiology and Population Health
Research Professor, Survey s

This presentation will review some of the current challenges in understanding the determinants of health disparities (and population heath more generally) and outline the ways in which complex systems thinking may be useful. It will provide illustrative examples of the types of questions to which these approaches have been applied. The presentation will conclude with a discussion of some of the challenges ahead.

The structural and ethical complexity of private and public health

Michele Battle-Fisher

Assistant Program Director and Instructor of Community Health
Wright State Boonshoft School of Medicine (OH)

Due to the immense health consequences left to a society by not allowing and supporting such intervention through health based intervention and surveliance, effective public health action requires that the private sphere be under the watch of the public for the sake of the society as a whole. As such, public health is borne of the personal affliction of illness that becomes nested as a "public" incidence. Habermas (1989) posited that in order to begin to understand the public sphere in its present form, this analysis must begin with examining changing in organizational structure. This paper, in homage to Habermas, will present a ecological approach that examines a reconceptualization of organ donation and health (in general) as a dance between the directives of the public to save lives and the private sphere lives that make up a population in a population risk equation.

An Agent-Based Modeling Approach to Understanding the Obesity Epidemic in the United States

Michelle Saksena

Phd Student
Agricultural, Environmental and Development Economics (AEDE)
The Ohio State University

Despite growing concern for the obesity epidemic in the United States, data constraints have limited social science analyses to correlative studies. This limits our capacity to make causal statements of which factors contribute to weight gain. This is further compounded by the fact that the nature of the obesity problem is plagued with endogeneity issues as it is not clear whether lifestyle choices lead to weight gain or if weight status dictates behavioral changes. Currently, no national database within the United States collects longitudinal data on individuals' weight outcomes, dietary intake and economic and geographic indicators. However, this form of data is necessary in order to treat endogeneity problems and thus has thwarted more sophisticated examinations of the obesity problem.

In this paper I treat the obesity epidemic as a complex system. The obesity epidemic warrants a complex systems analysis because individuals are highly heterogeneous both in their preferences and local environments while the existence of social contagion effects have been shown to have significant influences on lifestyle choices. I am particularly interested in the consumptive behavior of individuals by income class. I theorize that the lowest income individuals will tend to be the most obese because they are relegated to food choices, which are calorically dense, but nutrionally lax and thus these individuals will tend to over-consume. Furthermore, cohorts of like income ranges will have a tendency to live close to each other. This may result in altered individual behavior based on observing and mimicking consumption patterns of his or her cohort.

Preliminary results show that in fact the lowest income individuals do not tend to be overweight. This is because they are heavily dominated by negative income effects and are still not able to purchase enough calories to maintain or increase weight. Middle class individuals show the highest prevalence of obesity, which may indicate that incremental increases in income have very large effects on calorie availability. These individuals tend to be overweight because they can afford more calories yet are out-priced from purchasing healthy, less calorie dense foods. My further research will focus on implementing social networks and testing how influential social effects are on obesity outcomes.

People Hear the Title First:
A Mixed-Method Study of the Cultural Place of Science Fiction Across Media, Genres, and Decades

Dr. Eric S. Rabkin

Arthur F. Thurnau Professor
Professor of English Language and Literature
Professor of Art and Design
University of Michigan

Titles of novels, short stories, films, and video games across all genres (Science Fiction, Romance, Westerns, and so on) are generally short, succinct to the point of being cryptic, yet at the same time they are often both the first point of contact for the consumer--reader, viewer, listener, or player--and also the kernel that lodges itself in people's minds before, during, and after consuming the titled work. As such, titles play a vital role in media consumption experiences. Aside from simply recruiting people's attention, titles can convey and label the content of the media product they represent and, by their at least subliminal persistence during the extended consumption experience, titles influence that experience. In subtle ways, reading *Gatsby* would be different from reading *The Great Gatsby* or one of several alternative titles Fitzgerald seriously entertained such as *Trimalchio in West Egg*. Assuming that texts, films, and games are not produced in a contextual vacuum but rather mark products within complex cultural systems of production and consumption, we expect titles to follow (after the fact), track (coeval with the fact), or even lead (before the fact) cultural dynamics noticed through other lenses (such as news media reports of prominent activities, such as war). Because of its wide cultural diffusion (in most entertainment media, in industrial design, in city planning, and so on), Science Fiction provides a superb field for cultural analysis. To understand the differences among works of Science Fiction in different media and to study the status of Science Fiction titles as markers of cultural dynamics, we employ an innovative approach to performing data mining on titles from several different media. We conduct cross-sectional as well as longitudinal (across several decades dating back to the 1930s where possible) frequency analysis of title words of Science Fiction novels, short stories, films, and video games to detect textual patterns that correlate with medium-specific consumption experiences and cultural dynamics. In addition to using publicly available databases (ISFDB for novels and short stories, IMDB for movies, and GiantBomb for video games), we also use our custom built GEP (Genre Evolution Project) database of short stories published in American Science Fiction magazines (1923-2000). For the GEP database, we have coded thousands of short stories along many dimensions of content and style which

allows us to identify much more detailed patterns of textual and cultural correlations than would title-analysis alone. The GEP database provides a well-defined snapshot of the overall textual production in Science Fiction short stories. In the present study, we extend results obtained from analyzing GEP data and results obtained by title analysis across media by linking both sets of observations and demonstrating that the more and less detailed approaches reinforce each other. A main methodological conclusion is that our minimalist approach to textual data mining of titles is sufficient for the detection of patterns that correlate with (follow, track, or lead) actual cultural dynamics.

Eric S. Rabkin, English Language & Literature and Art & Design
Rainer Hilscher, Epidemiology, University of Michigan

Simulating the Cultural Evolution of Literary Genres

Graham Sack

PhD Student
Department of English & Comparative Literature
Columbia University

The purpose of this paper is to explore the evolutionary dynamics of literary genre: the development of the 19th Century British novel is used as a motivating case study. The authors construct an agent-based model consisting of two interacting levels: (I) A genetic algorithm in which cultural forms (e.g., works of literature, pieces of music, etc.) are represented as binary feature strings. Cultural forms evolve across generations via asexual and sexual reproduction. Genres are represented as hierarchical clusters of similar feature strings. (II) Cultural forms are subjected to the selection pressure of consumer preferences. Preferences are heterogeneous: each consumer's tastes are represented by an ideal point in feature space. Preferences are configured in landscapes that vary in their levels of structure, entropy, and diversity. Landscapes are dynamic and may change due to (1) exogenous demographic shifts (e.g., population growth, generational turnover) or (2) endogenous feedback effects (e.g., preference co-evolution, conformity / anti-conformity effects)

Student-written text at different levels of conceptual abstraction represented as a complex network

Dr. Sayan Bhattacharyya

Masters Student
Department of Comparative Literature
School of Information
University of Michigan

The paper describes an architecture for representing student writing as a complex network in a pedagogically useful way. Students in our test course were expected to submit weekly blog posts about these readings and create and apply descriptive keywords (which functioned as conceptual categories) to each other's writings. These descriptive keywords functioned as conceptual categories guiding their work in the course. We developed digital tools that made use of these keywords that they applied to each other's writings, in creating networks representing a collective meaning for the work the students produced. This network representation provided an opportunity for each student to critically reflect on the relationships between these conceptual categories and writing, both his/her own and others'. Additionally, we had students construct a separate network as a concept map, which encoded two different kinds of relationships between meronymic (part-of) and hyponymic (is-a) relationships. These relationships, encoded through the concept map, afford a way to represent any complex network of student writing at different levels of abstraction. The paper will speculate on the philosophical question what it might mean to symbolically represent cultural practices (such as writing) as a complex network when the representation is additionally mediated by another level of subjective cultural practice (in the form of the multi-level concept map), and what, if anything, any observed regularities (such as small-world or power-law regularities) could signify under such circumstances. The paper will also discuss alternative approaches (such as automated, text-mining based methods) for conceptual category generation, which may lead to a different answer to the above question.

TBA

Dr. Scott Page

Leonid Hurwicz Collegiate Professor of Complex Systems, Political Science, and Economics
The University of Michigan
Director, Center for the Study of Complex Systems
External Faculty, The Santa Fe Institute.

…

Evolving booster vaccination strategies

Maria Riolo

PhD Student
Applied & Interdisciplinary Math
Complex Systems Certificate Program
University of Michigan

With pertussis incidence on the rise in many countries, a variety of booster vaccination strategies have been proposed. However, complex mixing patterns among age groups and the possibility of waning vaccine-derived immunity make it unclear who should be vaccinated to most effectively control pertussis. Is it most effective to give booster vaccinations to adults, whose immunity is more likely to have faded? Or maybe to school kids, whose high contact rates with their peers make them effective transmitters of disease? I use a genetic algorithm to explore the space of pulse vaccination strategies and present some preliminary results comparing strategies for a vaccine conferring long-lasting immunity and one whose protection wanes rapidly.

An agent-based model of a Hemlock Woolly Adelgid *Adelges tsugae A.* infestationimplemented in the Python language with optional biocontrols

Joshua Sims

M. S. Candidate
School of Natural Resources
University of Michigan

The latest exotic tree pest to arrive in the Northeastern U.S. is the Hemlock Woolly Adelgid (HWA) *Adelges tsugae* Annand. This aphid-like insect is capable of killing eastern hemlock *Tsuga canadensis* throughout most of the Appalachian range. The unique role hemlock plays in these ecosystems will cause its loss to dramatically alter the landscape of this region. This study seeks to develop a method to model the dynamics of HWA infestations and find pathways to control them. The model will allow for the study of the dynamics of the infestation on the forest composition, and the possible options for biocontrol strategies. Here a predator prey competition style model is developed in the Python scripting language to capture the dynamics of the spread of the Hemlock Woolly Adelgid across a forest in Central Massachusetts. Multiple two-parameter sweeps are used to evaluate the functioning of the model. These sweeps confirm the model to behave as expected but suggest the need for further tuning and development. Future directions involve integration with an existing cellular automata to model the spread of the HWA across a landscape, and three-dimensional visualization of the affected forest stands.

Evolving Functional Models of Ancient Urban Centers Using Cultural Algorithms

Dr. Robert G. Reynolds

Professor Computer Science
College of Engineering
Wayne State University

Numerous functional models of modern urban centers have been proposed such as the concentric zine model. *The concentric zone model* based upon the growth of modern cities, with a city center surrounded by concentric zones of activity as shown in Figure 1. In the figure Region I is the center of the city surrounded by ring like regions, where each ring presents a particular functional zone.

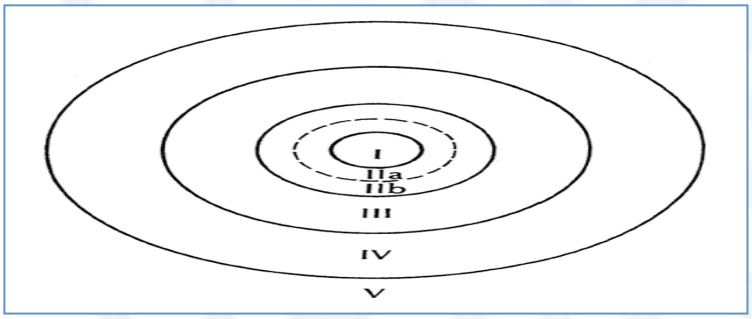


Figure 1: The concentric zone city model. The city center is in area I, surrounded by a factory district and retrogressing neighborhoods in areas IIa and IIb. Areas III, IV, and V are worker residences, middle class residences, and commuter residences respectively [Marcus, 1983].

The goal of this study is to use techniques from Complex Systems, Data Mining, and Computational Intelligence to produce functional models of ancient urban centers such as the one given above. These models can then be compared with models of modern cities like the concentric zone model above. Such comparisons may afford the opportunity to better understand the mechanisms behind the formation of ancient urban centers as well as indicating their similarities to modern cities.

Specifically, Cultural Algorithms are employed to evolve models for ancient cities based upon available archaeological data. This data is collected at the micro- or household level. The households are then used as building blocks to produce emergent neighborhood structures. These abstract neighborhoods are then combined in order to produce a functional model at the level of the ancient site. The combination process is guided by set of rules extracted at each level that constrain how the building blocks can be combined at that level in order to be consistent with basic patterns of occupancy within the site. These rules are extracted via data mining and machine learning techniques. In other words, the

system learns to incrementally build a model of a city that is consistent with contextual rules extracted at various spatial scales from the site. Models are evaluated relative to their fit with the extracted rules at each level. Thus, building blocks at the micro-level can be mapped into emergent structures at the meso-level. Those emergent meso-level structures are combined to produce a functional model of the city.

Here, this technique is applied to the modeling of an example archaic urban center, Monte Alban, in the Valley of Oaxaca Mexico as shown in Figure 2. There the basic building blocks are terraces, the combination of terraces produces neighborhoods or barrios, and the combination of these abstract barrios produces a functional model of the ancient city. However, this technology can also be applied to modern cities as well in order to abstract emergent functional patterns where the building blocks may now have different architectural forms.

An advantage of this approach is that it can be used as a ubiquitous process to produce models of cities, ancient or modern, in a standard framework that facilitates their functional and structural comparison. The results of such comparisons can potentially lead to the development of meta-models of urban formation and expansion.

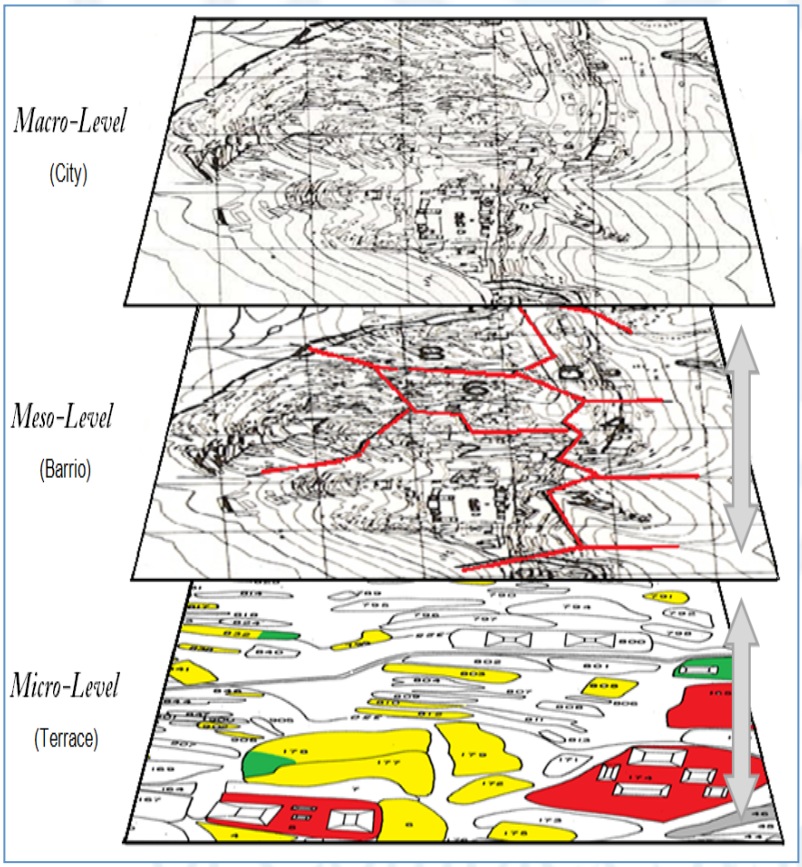


Figure 2: The three different spatial scales: the macro-level (the site), the meso-level (neighborhoods or barrios), and the micro-level (terraces and individual residences) for the site of monte Alban.

Applied Complexity, Or How Can I Use This Stuff After I Graduate?

Theodore Belding

President
Belding Consulting, Inc.

Complex systems tools, techniques, concepts, and mindset all have a wide variety of applications for solving real-world problems, by practitioners in industry and non-profits as well as in academia. In this talk, I will give an overview of several completed or proposed projects, including such topics as weather forecasting, cybersecurity, big data analytics, logistics, social media, web design, counter-terrorism, and business process optimization. I will also give some general advice on making a living in complex systems outside academia.

An Agent Based Model for Renewable Electrification Planning

José Alfaro

NSF Graduate Student Fellow
Center for Sustainable Systems
University of Michigan

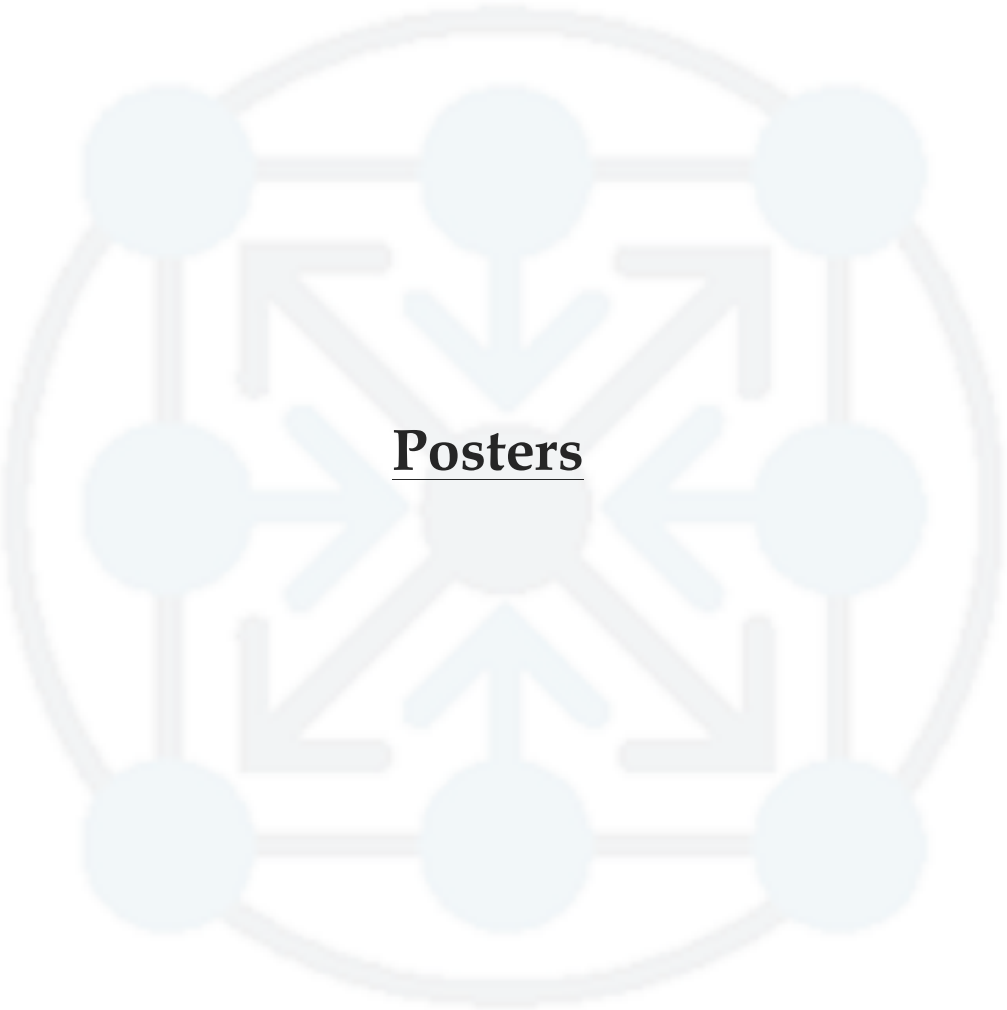
Literature acknowledges that increasing the electrification rate in developing countries is key for a sustainable future. However, the increase in electrification cannot follow the trends that developed countries have taken. Instead a new path should be cut, one that uses appropriate fuels and infrastructure patterns. Shifts away from centralized infrastructure schemes and fossil fuels towards decentralized generation and renewable energy fuels are suggested widely as the solutions. However, planning of adequate electricity systems will likely depend on regions' particular situations.

The planning of electrical grids requires good modeling and data that allow the consideration of different scenarios. There are few models for policy makers to study the optimal deployment of renewable energy stores and mix of centralized grid extension with decentralized generation. An agent-based model is presented that allows policy makers to explore this issue.

The model considers renewable energy stores; population density, location, size and electricity demand; and costs of generation and transmission assets. The model allows policy makers to explore decisions schemes to minimize the cost of the overall electricity network through the appropriate use of renewable energy stores, grid extension, and decentralized generation. This model provides an intuitive graphic user interphase appropriate for policy makers to run their own studies and scenario building.

The model is used in this paper to create a generalized decision space that provides trends for guidance in the general creation of electricity networks. The trends are created through the use of expected values in rural areas and developing countries the parameters in the model and the exploration of six different decision schemes. The decision schemes illustrate decision makers and consumers' preference for initial location of an electric generation project and economic indicators for expansion.

The results of the generalized scenario show the appropriate levels of network expansion and decentralization and expected trends of transmission and generation costs as related to the different parameters studied. These results provide policy makers with information that can help their own planning process considering their particular conditions.



Posters

The Emergence of Dominance Hierarchies in Ant Social Networks

Senay Yitbarek[1] & Stacy Philpott[2]

[1]Ecology & Evolutionary Biology Department (U of Michigan)
[2]Environmental Studies Department (UC Santa Cruz)

Social network analysis is widely used in disciplines such as sociology and physics, but it has only been in recent years that ecologists have begun to utilize social network analysis in understanding the self-organization of ecological communities. An emergent property found across many animal societies is the occurrence of dominance hierarchies, in which lower ranked animals in the network are controlled by higher ranked animals in the network. We investigate dominance relationships found of tropical arboreal ants competing for twig-nesting resources in southern Mexico. To examine competitive relationships in a 10-species ant network, we apply a commonly used technique in network analysis, motif analysis, to reveal sub-structures in the network. Motif analysis deconstructs networks in triads (composed of three-nodes) that represents patterns of interactions between species. Our study assess the frequency of transitive triads (A-->B, B-->C, A-->C) and cyclical triads (A-->B, B-->C, C-->A) as compared to null models of random networks. Our analysis shows an excess of transitive triads and a deficit of cyclical triads in the network as compared to random networks. Temporal dynamics of dominance relationships revealed less frequent rank order changes in the network (mean stability = 0.69). We conclude from our study that dominance relationships for arboreal ant species self-organize in a highly transitive manner, with a scarcity of cyclical relationships, and a high temporal ranking stability.

Boundary effects in time and space

Maria Riolo

PhD Student
Applied & Interdisciplinary Math
Complex Systems Certificate Program
University of Michigan

I examine the dynamics near spatial and temporal heterogeneities in two systems: insect populations at the border between high and low quality habitats and an infectious disease in the decades following the introduction of a vaccine. In both models, interactions near the boundary generate behaviors that are more than a linear combination of the two homogeneous cases.

Simulation of Shape-Driven Self-Assembly

Samanthule Nola

PhD Student
Physics Department
University of Michigan

Understanding the kinetics of entropy-driven assembly in systems of hard faceted nanoparticles will facilitate the ability to self-assemble nanostructures. Real systems have complex energy interactions at varying length scales, making it difficult to isolate the effect of particle shape. We are interested in isolating the effects of entropy, due only to the shape of the particles. Computer simulations facilitate this study by allowing us to consider an idealized system with no energetic interactions.

Emergence of Structural Complexity in Systems of Entropic Agents

Pablo F. Damasceno

PhD Student
Applied Physics Program
University of Michigan

Crystallization is a collective effect where individual building blocks give away their individual freedom to, cooperatively, maximize their overall *free energy*. In this work, we investigate the spatial structures emerging from this phenomenon, particularly when the attributes of the building blocks (shape) are varied. We find that, from the competition between the particles' versus the group's desire to maximize their freedom, several complex structures emerge – rivaling and interestingly related to those formed from atomistic elements. Those results can have impact in the emergence of complex social structures between agents striving to maximize their overall space, while confined to a region with neighbors with similar goals.

TBA

Nguyen H.P. Nguyen

PhD Student
University of Michigan

Swarms of self-propelled particles exhibit complex behavior that can arise from simple models, with large changes in swarm behavior resulting from small changes in model parameters. We investigate the steady-state swarms formed by self-propelled Morse particles in three dimensions using molecular dynamics simulations optimized for graphics processing units. We find a variety of swarms of different overall shape assemble spontaneously and that for certain Morse potential parameters at most two competing structures are observed. We report a rich "phase diagram" of athermal swarm structures observed across a broad range of interaction parameters. Unlike the structures formed in equilibrium self-assembly, we find that the probability of forming a self-propelled swarm can be biased by the choice of initial conditions. We investigate how thermal noise influences swarm formation and demonstrate ways it can be exploited to reconfigure one swarm into another. Our findings validate and extend previous observations of self-propelled Morse swarms and highlight open questions for predictive theories of nonequilibrium self-assembly.

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Michigan Complexity
Mini-Conference

Center for the Study
of Complex Systems