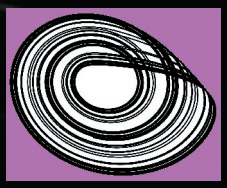
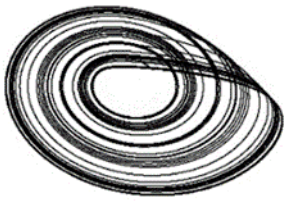
Society for Chaos Theory in Psychology & Life Sciences
NEWSLETTER
Vol. 31, No. 4

Abstracts to the 34th Annual International Conference, Cincinnati July 31-August 2, 2024





Society for Chaos Theory in Psychology & Life Sciences

Alphabetical List of Authors & Abstracts

Presented to the

34th Annual International Conference

University of Cincinnati, Ohio, USA
July 31st-August 2nd, 2024

Blanca Alhely Ceballos Chevez, Instituto Politecnico Nacional
Oswaldo Morales Matamoros, Instituto Politecnico Nacional
Jese Jaime Moreno Escobar, Instituto Politecnico Nacional
Jose Guillermo Takeo Nava, Instituto Politecnico Nacional, Stellantis
Jorge Armando Rojas Ramírez, Instituto Politecnico Nacional

Meta-methodology SSM+VSM+MA for improving Quality Performance in the Automotive Industry

The automotive sector has been compelled to innovate its methodologies to counter challenges such as fluctuating vehicle demand, stringent regulatory frameworks, and rapid technological advancements. An automotive enterprise constitutes a complex system characterized by dynamic, non-linear interactions among the myriad stakeholders critical for its operational efficacy and overall performance. Consequently, we conducted a diagnostic evaluation of the Quality Department within a global automotive corporation, utilizing analytical tools derived from Network Science. Through the examination of dynamic, non-linear interactions among the stakeholders, we developed a network topology for the Quality Department and its Issue Resolution sector, revealing that both networks are sparse and exhibit stochastic behaviors within a Supercritical Regime; that is, the interconnections (non-linear interactions) among the nodes (agents) are markedly insufficient. As a result, quality analysts and their supervisors are unable to respond promptly to customer-reported defects. In light of these insights, we advocate for the adoption of the Meta-methodology SSM+VSM+MA to navigate and elucidate such complex systems, aiming to augment the density of interconnections within our networks to expedite the detection and resolution of customer-reported issues, thereby transitioning to a Connected Regime and diminishing network complexity. The SSM+VSM+MA framework is underpinned by methodologies from the Systems Sciences, specifically: i) Soft Systems Methodology and Viable System Model. This meta-methodology is structured into nine distinct phases: 1) Identification of problematic situations, 2) Delineation of the system under scrutiny, 3) Execution of structural diagnostics and quantitative network analysis, 4) Definition of pertinent systems, 5) Creation of conceptual models, 6) Conducting agility assessments via the agile taxonomy, 7) Comparative analysis of conceptual models, 8) Implementation of systemic modifications, and 9) Integration of enhancements into the model. Furthermore, the integration of agility within the SSM+VSM+MA framework furnishes the requisite resilience to enhance quality performance within the automotive industry.

Avril Cowo, Psychology, University of Central Oklahoma
Juniper Wolcott, Psychology, University of Central Oklahoma
Jake Yost, Psychology, University of Central Oklahoma
Mickie Vanhoy, Psychology, University of Central Oklahoma

Disentangling Top-Down and Bottom-Up Influences on Eye Movements: A Multifractal Detrended Fluctuation Analysis Approach

Yarbus showed that observers' eye movements and fixation patterns on an image are strongly modulated by the specific task or cognitive goals they are given. A central controversy surrounding these findings is whether the observed effects truly reflect top-down cognitive strategies or merely arise from bottom-up influences of visual salience. Traditional scanpath analysis techniques used to study Yarbus' results may conflate and fail to disentangle these top-down and

bottom-up factors. Multifractal detrended fluctuation analysis (MFDFA) was used on eye movement data from observers performing a visual task with carefully controlled salience distributions. Participants viewed Yarbus' images while answering questions that emphasized distinct cognitive goals (e. g., evaluating ages, memorizing clothing). While conventional scanpath metrics could be influenced by both top-down task demands and bottom-up saliency, MFDFA quantifies the intrinsic multifractal scaling properties and long-range correlations present in the eye movement time series data. If top-down cognitive influences play a dominant role, as proposed by Yarbus, the multifractal spectra and generalized Hurst exponents will exhibit divergence across task conditions, despite equivalent visual salience. Conversely, if bottom-up saliency is the primary driver of eye movements, the multifractal scaling should remain largely similar regardless of the assigned task. By directly comparing the multifractal characteristics across task manipulations with tightly controlled bottom-up signals, we seek novel insights into the degree of top-down modulation of eye movements during cognitive viewing tasks and informing debates surrounding Yarbus' findings.

Stephen J. Guastello, Marquette University
Laura McGuigan, Marquette University

Cusp Catastrophe Models and the Role of Synchrony in Cognitive Workload and Fatigue in Teams

This study evaluated the role of autonomic synchrony as part of the cusp catastrophe models of workload and fatigue for teams making dynamics decisions. In this experiment, 136 undergraduates were organized into 32 groups of three, four, and five members playing an online computer game while wearing electrodermal sensors. They also completed cognitive measures of elasticity-rigidity and situation awareness during the games. Synchrony was calculated using the S_E coefficient from the driver-empath model and the SyncCalc program. Analyses were constructed to determine whether S_E or S_E variability added value to the cusp catastrophe models previously determined in Guastello and McGuigan (2024). Results indicated that SE made a strong impact as a bifurcation variable in both the workload (R^2 = .72) and fatigue (R^2 = .75) models. SE variability also made a strong impact as a bifurcation variable in the workload load model (R^2 = .69 - .75), and a strong impact as a compensatory ability in the fatigue model (R^2 = .75 - .77). The study opened new questions regarding the role of weak ties in a closed network.

Stephen J. Guastello, Marquette University
Nicholas R. Peters, Marquette University
Anthony F. Peressini, Marquette University

Simultaneous Emergent Phenomena: Leadership and Team Synchrony

Emergent phenomena exhibit interesting dynamics when considered individually. The present (proposed) article examines two emergent processes that could be occurring simultaneously in an intense team interaction: the emergence of leaders and the emergence of autonomic synchrony within teams making dynamic decisions. Research participants were 136 undergraduates who were organized into teams of three to five members playing the computer-game Counter-Strike while wearing GSR sensors. After approximately two hours of interaction, team members rated each other on leadership behaviors. Autonomic synchrony was measured in terms of individual driver scores (the total influence of one person on the rest of the group) and empath scores (the total influence of the group on one person). Data analyses compared the statistical distributions of driver scores, empath scores, and leadership ratings to their degree of fit with swallowtail catastrophe, inverse power laws, and lognormal distributions, which are known to characterize emergent processes of different types. The objective was to determine the extent to which two the processes reflected the same dynamics. Results showed that leadership emergence followed the swallowtail rule as evidenced in prior studies. Lognormal distributions were second-best representations of all variables, with the empath scores approaching swallowtail distributions toward the end of the experimental session. Inverse power laws were least descriptive of any of the research variables.

Raymond, Hawkins, Fielding Graduate University & University of Texas, Austin

Systems contextual integrative model of personality and psychotherapy: Application to biphasic phase shifts in mood

This paper presents a contemporary systems contextual integrated model of personality (SCIM) in which contrasting pairs (Hawkins & Meier, 2015) are synergistically coordinated (Kelso, 2021a,b). The positive and negative aspects of these complementary pairs are described and contrasted (e.g., health vs. neurosis). This presentation will illustrate the application of SCIM to the nonlinear dynamics of biphasic shifts in mood. The SCIM 'healing cycle' is an allostatic hedonic affective-cognitive right-hemisphere' left hemisphere coordinated process (Comer et al., 2015) involving positive alliesthesia (Cabanac, 2009) that mitigates trauma sequelae and generates psychological flexibility. The SCIM 'trauma cycle' is an allostatic overload alliesthesia opponent process (Solomon, 1980) with long-lasting pathology sequelae (Koob, 2015). Angyal's (1965) holistic theory contrasted the healthy system and neurotic system principles. Repeated evocation of the ' healing cycle' in a therapeutic relationship (Mergenthaler, 1996) can relieve trauma sequelae, which is further optimized by facilitative changes in the broader social environment. This healing mechanism may involve structural coupling between two autopoietic systems (i.e., the client and the therapeutic relationship) (Maturana & Varela, 1998). These systems may be considered as homeostatic property clusters (Boyd, 1999). These changes improve the "goodness of fit" (Chess & Thomas, 1999) for the person(s) and potentially enhance human relationships across other systems levels (i.e., family, community, and society). Scott Kelso in The Complementary Nature (Kelso & Engstrom, 2006) and in Kelso (2009 / 2013) described coordination dynamics as integrating contraries into metastable coordinated states. Self-organization

(spontaneous) vs. directed (intentional) occurs. The SCIM model illustrates coordination dynamics phase shifts (see Kelso, 2021b). This is a nonlinear flow process that is a synergistic coordination that reconciles opposites, shifts mood, and promotes wellness. This theoretical perspective is a complex adaptive systems model that accounts for sudden shifts in mood and the metastability of depression.

James Hazy (**Guest Speaker**), Willumstad School of Business, Adelphi University, Garden City NY

Are you an APPRECIATOR? How Reinforcing Twelve Interactions that Create Social Capital Grows Financial Value in Organizations.

The term social capital is often used in organizations, but it is rarely described in detail or quantified as a component of an organization's financial value creation potential. In this discussion, I will address this practical and research gap by proposing initiatives along two complementary dimensions.

First, I will propose an initial step on the road to clarifying and quantifying the nonlinear behavioral drivers that constitute social capital and describe how the value of social capital increases, or appreciates, over time and can potentially be quantified. To do this he will identify twelve specific behaviors from the literature, collectively called the APPRECIATOR Algorithm that individual team members can iteratively enact and also reinforce in others as each team member contributes individually and in collaboration to the appreciation of the value of social capital across various types and phases of complex organizing.

Second, I will introduce a design for an AI-enabled Work Team Process Engineering (WTPE) platform that supports the gathering, analysis, and use of previously hidden or "missing" human interaction information that can be used to quantify the increasing value creating potential of human and social capital. In addition to supporting the valuation of social capital along three dimensions: asset value, optionality, and portfolio diversification, the platform supports individual professional development by delivering context-specific, personalized smart-coaching insights and opportunities for virtual human mentoring on the user's smartphone. Importantly, equity is enhanced because each user owns and controls its data, and privacy is secure and protected because each user's data can only be accessed and used by that particular user.

Adam Kiefer, Exercise and Sport Science, University of North Carolina at Chapel Hill
Pincus David, Department of Psychology, Chapman University

Symposium Title: **Beyond Bounce Back: Innovations in Antifragility and Resilience in Complex Systems.**

This 60-minute symposium will highlight advancements in how self-organization theory and nonlinear dynamics can revolutionize our understanding of biopsychosocial resilience. By bridging cutting-edge theoretical concepts with empirical research, the presentations aim to propel the field forward and inspire further exploration into the dynamic processes underlying human resilience. The session will begin with a brief overview of the novel ways in which self-organization theory and nonlinear dynamics provide a robust framework for understanding biopsychosocial resilience, without the limitations of traditional linear perspectives. Key terms such as robustness, classic resilience, antifragility, and grit will be briefly defined, setting the context for two subsequent presentations focused on the latest breakthroughs in this area. 1) Presentation on Biopsychosocial Resilience in Psychological Health (20 minutes) David Pincus, PhD Dr. Pincus will delve into recent advancements in applying nonlinear dynamics to psychological health, focusing on self-organization, fractals and meta-flexibility. Meta-flexibility refers to a system's ability to transition smoothly between states of rigidity and flexibility in response to perturbations, without getting stuck or falling apart. This presentation will include an overview of empirical examples of personality structure, emotion, cognition, behavior, and interpersonal dynamics. Altogether, these results may provide a compelling answer to the most vexing question in Clinical Psychology: How does psychotherapy work? 2) Antifragility in Action: Enhancing Athlete Performance through Resilience (20 minutes) Adam Kiefer, PhD Dr. Kiefer will explore resilience in the context of athlete performance and health, with a particular focus on potential links between antifragility and metastability. Antifragility is the capacity of a system to grow stronger in response to stress, rather than merely recovering. This presentation will introduce case studies and empirical data demonstrating how athletes exhibit antifragile behaviors in areas such as visual perception, decision-making, and motor control. Specific examples will be drawn from vision-in-action across basketball, football and his team's innovative automated digital assessment for precision training (ADAPT) virtual reality (VR) platform. These insights will be contextualized through self-organizing principles of antifragility and metastability, which describe the dynamic stability athletes maintain in the face of varying demands. The presentation will conclude with a discussion around the practical applications of these concepts in enhancing athlete resilience in performance and health. The symposium will conclude with a 10 minute discussion session, allowing attendees to ask questions and engage with the speakers on the presented topics. This interactive segment aims to deepen the understanding of how self-organization and nonlinear dynamics can be applied to various domains of biopsychosocial resilience.

Andrew Klafter, Psychiatry, University of Cincinnati College of Medicine
Heidi Kloos, Psychology, University of Cincinnati

Applying Complexity to Psychoanalytic Thought

In the current presentation, we use the framework of complexity to explore contemporary psychoanalytic thought. The central idea of contemporary psychoanalysis is that an intense emotional experience of the client can bring about personal growth. The goal of the analyst, therefore, is to create a therapeutic relationship that allows for such intense emotional experience. The processes involved in this therapeutic approach are nonlinear in nature and, thus, have

the signature of complexity. Building on this insight, we use the complexity framework of thermodynamics to formalize psycho-analysis. A thermodynamic framework to complexity states that a system seeks to counter outside pressure via the circular coordination of its elements. Applied to the therapeutic context, the analyst entering a therapeutic relationship can be seen as the pressure applied to the system. In contrast, the client's prior experiences can be seen as the elements that interact in circular fashion. This conceptualization makes it possible to identify the circumstances in which the psychoanalytic approach is indicated, versus traditional cognitive-behavioral therapy. Implications for practice will be discussed.

Heidi Kloos, Zack Streit, University of Cincinnati

Complexity in education: A review

Children's learning is a fitting example of an outcome of a complex system. There are outside influences that create internal impressions, which, in turn, interact in ways that give rise to knowledge. Children's learning is also embedded in children's attitudes, emotional readiness, and attentional skills, all of which interact in non-linear ways. And then there are the interactions with teachers and other adults who can amplify positive or negative tendencies in interdependent ways. It is no surprise then that complexity has move into the field of education. This has taken place on the level of the mind, for example in the study of misconceptions and conceptual change. It has also taken place on the level of motivation and other emotional components. And it happens on the level of the system of teachers interacting with the students and each other. In the current talk, we seek to provide the results of a systematic review of research on complexity in education. One objective was to consolidate the existing methodologies and create a repository of insights that have been gained with the use of a complexity framework in the field of education. Our second objective was to uncover inconsistencies and gaps that remain in the efforts to apply a complexity framework to questions of education. Results show important advances in understanding the nonlinearity of children's learning. Building on these results, we propose a model of complexity that has the potential to provide an impetus to increase the outcome of this kind of work.

Brandon Le, Quantum Lab, Thomas Jefferson High School for Science and Technology, VA
Nivika Gandhi, Quantum Lab, Thomas Jefferson High School for Science and Technology, VA

Exploring Geometrical Properties of Chaotic Systems Through an Analysis of Rulkov Neuron Maps

While extensive research has been conducted on chaos emerging from a dynamical system's temporal dynamics, our research examines extreme sensitivity to initial conditions in discrete time dynamical systems from a geometrical perspective. Specifically, we focus on developing methods of detecting, classifying, and quantifying geometric structures and qualitative changes that lead to chaotic dynamics in maps, such as certain bifurcations, fractal geometry, strange attractors, multistability, fractal basin boundaries, and Wada basins of attraction. We also develop slow-fast dynamical systems theory for discrete-time systems, with a specific application to modeling the spiking and bursting behavior emerging from the electrophysiology of biological neurons. Our research focuses mainly on two simple low-dimensional slow-fast maps introduced by Nikolai F. Rulkov in the early 2000s that model both non-chaotic and chaotic spiking-bursting neuronal behavior. We begin by exploring the maps' individual dynamics and parameter spaces, performing bifurcation analyses, describing and quantifying the maps' chaotic dynamics, and modeling the injection of current into these Rulkov neurons. Then, by coupling these neurons with a flow of current, we find that complex dynamics and geometries emerge from the existence of multistability in the maps, and we analyze the complexity and fractalization of the attractors and basin boundaries for the coupled neurons using our mathematical and computational methods. This paper provides a conversational introduction to the geometry of chaos and integrates mathematics, physics, neurobiology, computing, computational modeling, and electro-chemistry to present research that provides a novel perspective on how types of geometric sensitivity to initial conditions appear in discrete-time neuronal systems.

Wei Shan Lee, Pui Ching Middle School Macau
Man U Kwan, Pui Ching Middle School Macau
Kuan Ieong Chan, Pui Ching Middle School Macau
Tin Tai Ao Ieong, Pui Ching Middle School Macau
Kei Chon Sio, Pui Ching Middle School Macau

Chaotic Dynamics in Animal Sex Change: A Two-Dimensional Logistic Mapping Approach with Lotka-Volterra Characteristics

We propose a three-dimensional logistic model of the Lotka-Volterra type to explore the dynamics of sex change in a predator species coexisting with prey. This model introduces ordinary differential equations (ODEs) which are discretized using Eulers scheme to formulate a dynamic system. The model incorporates (at most) nine parameters including the growth rates of the predator (either male or female), the prey, predation and sex alteration rates (transitions from male to female or vice versa), and interspecies interactions (male vs. female, male vs. prey, and female vs. prey). A rigorous analysis of the dynamical system is performed, involving the calculation of fixed points, the eigenvalues of the Jacobian matrix at each fixed point, and the stability of these points. Stability analysis is based on linearization for hyperbolic points and the application of center manifold theory for non-hyperbolic points. Dulac criterion provides necessary conditions for the absence of closed orbits, while the Poincare-Bendixson theorem establishes conditions for their existence. In the non-chaotic regions of the models, three distinct evolutionary patterns emerge, influenced by ecological factors: stable populations, dominance by a single sex, and sinusoidal population oscillations. More intriguing are the chaotic behaviors (confirmed by studying the Lyapunov spectra); in the continuous model, a strange attractor akin to the Lorenz model is identified, particularly as the system undergoes a Hopf bifurcation, suggesting

aperiodic sex change dynamics. Conversely, the discrete model indicates that food availability significantly affects sex-dominant outcomes-scarcity tends to result in male dominance, while abundance promotes female prevalence, and extreme scarcity can even lead to the extinction of females. The theoretical and practical implications of our findings emphasize the potential for adaptive sex ratio management in conservation strategies. These strategies are crucial for addressing the challenges posed by environmental changes on species survival and biodiversity. Overall, our research offers profound insights into the adaptive capabilities of predator species, highlighting the significance of sex ratio dynamics in ecological and evolutionary contexts. This study lays a foundational framework for future research into similar ecological interactions, enhancing our understanding of how intrinsic and extrinsic factors influence population dynamics and ecosystem stability.

Ricardo Lopez-Ruiz, University of Zaragoza

Gas-like Models: Inequality in Random Markets

Abstract: Some economic gas-like models for random conservative markets are addressed in this communication. [1, 2, 3]. In these models the agents trade by pairs bringing the system toward an statistical equilibrium, this is the asymptotic wealth distribution. The time evolution of these models are given by nonlinear functional mappings. These maps are nonlinear operators in the space of wealth distributions, which are shown to conserve the total and mean wealth of the economic system. Different asymptotic results for several models are presented. The decay to the exponential distribution or gamma-like distributions are found in some of these models. Simulations and implementations of these systems in different topologies are also presented. As a common point of all these models, inequality is reached in the collectivity as a natural consequence of randomness without the need of some special force or intervention from the exterior. Even more, different types of randomness give place to different kinds of natural inequality. REFERENCES: [1] Lopez-Ruiz R., Lopez J.L., Calbet X. Exponential wealth distribution: A new approach from functional iteration theory. ESAIM: Proceedings (of ECIT-2010 Conference) 36 183-190 (2012). [2] Martinez-Martinez I., Lopez-Ruiz, R. Directed Random Markets: Connectivity determines Money. Int. J. Mod. Phys. C 24 ID-1250088(14) (2013). [3] Pomeau Y., Lopez-Ruiz, R. Study of a Model for the Distribution of Wealth. Springer PROMS, vol. 112, Lopez-Ruiz et al. (Eds.), Ch. 1, pp. 1-12 (2015).

Staša Milojević (Guest Speaker), Indiana University, Bloomington, IN

Science of Science

Global contemporary science is a vast dynamical undertaking comprised of complex social and cognitive structures. It represents a multi-scale, evolving, self-organizing system in which social and cognitive elements are connected through formal and informal flow of information and ideas. In order to help solve increasingly complex outstanding problems and questions, contemporary science has adopted new approaches to knowledge production that are predominantly team based and are less confined by disciplinary boundaries. The study of the character of and the interplay between the social, institutional and intellectual aspects of science has recently received a major boost. In this talk I will showcase some of the studies that use the data from scientific publications to shed light on contemporary research practices, research teams, research workforce, interdisciplinarity, and citation dynamics.

Oswaldo Morales Matamoros, Instituto Politécnico Nacional
Jesús Jaime Moreno Escobar, Instituto Politécnico Nacional
Ixchel Lina Reyes, Instituto Politécnico Nacional
Hugo Quintana Espinosa, Instituto Politécnico Nacional
Mauro Daniel Castillo Pérez, Instituto Politécnico Nacional

Assessing the Impact of Dolphin-Assisted Therapy on Brain Activity in patients with Down Syndrome, Applying Fractal Analysis and for Characterizing Nonlinear EEG Signals

Down syndrome (DS) is the most common complex genetic developmental disorder in humans and is caused by triplication of human chromosome 21. DS complexity turns out in multiple lifelong health problems, such as intellectual disability and delays in speech, memory, and learning, as well as cardiac defects, pulmonary arterial hypertension, low blood pressure, and differences in autonomic regulation. Exercise, medical, surgical, cell and gene therapies are performed to improve both length and quality of life for individuals with DS. Nonetheless, there is a non-invasive alternative and complementary therapy, known as Dolphin-Assisted Therapy (DAT), applied to reduce anxiety levels, stress relief and provide some physical benefits to patients with physiological and mental disorders. This work is focused on measuring and assessing scientifically possible positive changes in brain activity of a patient diagnosed with DS undergone to DAT. We developed a brain-computer interaction system for capture, filtering, and adapting of EEG signals from patients with brain disorders. The EEG Raw data were time series showing the electrical activity before, during, and after DAT of a patient with DS. Likewise, the EEW RAW data were collected and recorded by the first frontopolar electrode (FP1) by means of an EEG biosensor TGAM1 Module. We measured and evaluated the nonlinear EEG time series by applying the Self-Affine Analysis, and Detrended Fluctuation Analysis methods. We find the presence of long-range power-law correlations in the fluctuations of EEG signals over multiple time scales. Moreover, we identified a crossover time scale separating two distinct regimes, each one exhibiting different fractal scaling behaviors at low and high frequency ranges. These results suggest that DAT may induce measurable changes in brain activity in DS patients, offering insights into the therapy's efficacy and potential mechanisms of action.

Vikas O'Reilly-Shah, University of Washington

Delay Coordinate Embedding as Neuronally Implemented Information Processing: The State Space Theory of Consciousness

Despite intensive effort, a satisfactory scientific theory of consciousness remains elusive. This paper introduces the State Space Theory, aiming to meet key criteria for a theory of consciousness while providing a satisfactory framework consistent with neurobiological and philosophical considerations. The theory posits that the cortex processes information through delay coordinate embedding within recurrent neural networks. These networks create state space representations of reality, forming hierarchical, pseudo-hierarchical, and parallel pathways. Consciousness arises at the highest-order engines in this hierarchy, with complex behavioral options competing within these engines. The theory emphasizes that consciousness is a dynamic process, not representable within a static neuronal state, and develops uniquely in each individual due to history-dependent development of the processing engines. Neuronally, delay coordinate embedding engines are recurrent networks that process information by integrating current and past data. These engines themselves exhibit nonlinear dynamics sensitive to initial conditions. This mechanism aligns with the subjective and emergent properties of consciousness, explaining phenomena like binocular rivalry and ambiguous figures. The theory also addresses cortical plasticity and the heuristic nature of cortical processing, aligning with neurobiological evidence supporting the idea that the cortex's information processing is generic rather than specialized. The State Space Theory aligns with and expands upon major theories like Higher-Order Theories, Global Workspace Theories, Integrated Information Theory, and Predictive Processing Theories by providing a computational mechanism for hierarchical integration and recurrent processing. Philosophically, it reconciles dualist intuitions with a monist perspective, positing that consciousness emerges from dynamic brain processes rather than static states. The theory addresses the unity of consciousness and the privacy of subjective experiences, offering a new framework to understand free will within deterministic systems. Future work will refine this theory, exploring its neural mechanisms and validating its predictions, advancing our understanding of consciousness.

David Pincus, Psychology, Chapman University

Romantic Resilience: Fractal Conflict Dynamics and Network Flexibility Predict Dating Satisfaction and Commitment

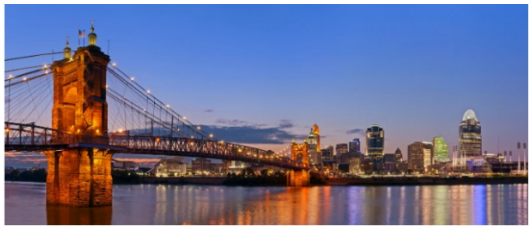
Previous research has demonstrated that interpersonal dynamics are fractal, and that conflict is a key control parameter that drives fractal complexity. The present study aimed to extend this line of research to examine the putative fractal structure of conflict dynamics over time, and the role that this self-organizing fractal structure may play in the resilience of romantic relationships. An experience sampling methodology was used to assess levels of conflict, satisfaction, and commitment in the dating relationships of undergraduate students, three times per day for 30 days. Hypothesis 1 was supported, with conflict ratings over time generally conforming to an inverse power-law distribution (IPL) distribution. Hypothesis 2 was supported as well, with better IPL fits (measured as variance accounted for; R2) predicting higher levels of satisfaction and commitment over the 30 days. Hypothesis 3 showed mixed support, with moderate network linkages (i.e., soft assembly) between conflict and satisfaction and commitment predicting higher IPL fits (the linkage of satisfaction and commitment did not predict IPL fit as predicted). Hypothesis 4 predicted that IPL fit would interact with mean conflict, buffering the impacts of conflict on mean satisfaction and commitment across the 30 days. This hypothesis was not supported; however, several statistical factors may have obscured the buffering effects of higher IPL fit and so results may be inconclusive. These methodological factors, and others, will be discussed along with the potential theoretical and practical implications of the current results.

Stella Rostkowski, Union College

The Etiology of Survival

Research regarding Domestic Violence or IPV revealed that prevention programs do not address the needs of children living in an abusive household and professional counselors do not feel they have adequate training in both domestic violence and working with children to be effective in treating the needs of the woman in the abusive relationship and the needs of the child who is living in the home where the abusive relationship is taking place. In an attempt to fill this gap and show through evidence-based practice psychological programs, Parent-Child Interaction Therapy (PCIT) was selected. PCIT is comprised of child-directed interaction (CDI) and parent-directed interaction (PDI). CDI ' resembles traditional play therapy and focuses on strengthening the parent-child bond, increasing positive parenting, and improving child social skills' (Kaslow & Patterson, 2002, p.92). During CDI, 'the child guides the direction of play and makes autonomous decisions, not the parent. During CDI, Parents are reminded not to give commands, ask questions, or criticize the child; instead they are prompted to praise, imitate, and reflect on the child's actions' (Ward, Theule, & Cheung, 2016, p.677). PDI 'resembles clinical behavior therapy and focuses on improving parents' expectations, ability to set limits, and fairness in discipline and reducing child noncompliance and other negative behavior' (Kaslow & Patterson, 2002, p.92). In order to lead the play session, parents learn to provide their children with effective, developmentally appropriate directions. Parents are also prompted to reinforce their child's desirable behavior and to discourage undesirable behavior by using consistent and suitable consequences' (Ward, Theule, & Cheung, 2016, p.677). NHS CAPSTONE TEMPLATE 3 Past research has revealed that PCIT teaches parents specific techniques that can help a parent build a better relationship with their child, which were shown in research to include, 'emotion regulation' (Zimmer-Gembeck et al., 2018, p.340) and 'improvement in children

externalizing behaviors' (Zimmer-Gembeck et al., 2018, p.340). 'Emotion regulation refers to the ability to use internal and external resources to monitor, maintain, and modulate the occurrence, duration, and intensity of emotional responses' (Zimmer-Gembeck et al., 2018, p.341). External behaviors were shown in research to be directed at the child's physical environment (Batzer, Berg, Godinet, & Statzer, 2018; Borelli, St John, Cho, & Suchmann, 2018) and included, ' aggression (Rostad & Whitaker, 2016, para.12), along with lying, cheating, and stealing (Batzer, Berg, Godinet, & Statzer, 2018). The aims of this study were determined through the review of evidenced based psychological programs to answer the research question of For Professional counselors and outreach counselors who work with women in Domestic Violence and IPV Relationships (P), will the use of an EBP Parent-Child Intervention Therapy (I) training program increase counselors knowledge, skills and competence (O) at the end of the two-week intervention (T)? Data collected in this study was quantitatively analyzed using a Paired-T-Test to determine if the outreach counselors in this study felt after receiving PCIT training that they have the ability to (a) teach techniques to parents targeting positive discipline, (b) teach techniques to children to learn new communication skills, (c) teach techniques to parents regarding strengthening their relationship with their children (d) teach techniques that instill confidence in parents regarding child discipline, (e) teach techniques for parents to appropriately assess their child's behavior and compliance. NHS CAPSTONE TEMPLATE 4 Data findings from the Paired T-Test showed there was a significant increase in confidence for professional counselors feeling more equipped and knowledgeable to address the needs of a woman in a domestic violence relationship and the child who is living in the home where the abusive relationship is taking place after completing PCIT training (M= 24.2, SD = 6.11). Findings were re- affirmed through the use of the ECBI Questionnaire (M=13.7, SD =3.27 Findings from this study are relevant to public health practice because domestic violence and child abuse were shown to be two separate public health issues. In 2020, the Center for Disease Control (CDC) reported that an estimated '5.3 million women' (CDC, 2017, para.5), '18 years or older' (CDC, 2017, para.5) were victims of domestic violence. Of the ' 5.3 million women' (CDC, 2017, para.5), '2 million women sustained injuries that were reported, 145,000 of the women's injuries required hospitalization, and 1,300 women died from the injuries they sustained from domestic violence' (CDC, 2017, para.5). In 2017, the CDC reported that '674,000 children were victims of child abuse', (CDC, 2020, para.2), '1,720 children died from abuse and neglect' (CDC, 2020, para.2), and 'one in four children have experienced abuse or neglect at some point in their lives' (CDC, 2020, para.2).



Alessandro Maria Selvitella, Department of Mathematical Sciences & Laboratory of Data Science | Purdue University Fort Wayne

On the representation capacity of Neural Ordinary Differential Equations and Residual Neural Networks: A chaos theory perspective

Finite difference schemes for PDEs such as the Fisher-KPP equation can produce bifurcations and chaos and, ultimately, non-physical solutions. These solutions are some sort of spurious signal left by the difference equation (e.g. logistic map) and are not a feature of the original PDE. In recent years, machine learning methods, such as residual neural networks, have been implemented to provide data-driven solutions to prediction problems. Residual neural networks can be seen as the Euler discretization of some particular ODEs, called Neural Ordinary Differential Equations. Neural ODEs describe the dynamics of hidden units of a neural network using highly nonlinear dynamical systems. These continuous-depth networks bring with them many advantages. In fact, these models have low memory cost, they adapt their evaluation strategy to each input, they are able to explicitly control the numerical error and trade numerical precision for speed, and they also scale linearly with complexity. On the other hand, it is well known that discrete dynamical systems, such as the logistic map, can exhibit strange attractors whatever their dimensionality is, while continuous dynamical systems cannot have a strange attractor in dimensions 1 and 2 (Poincare' Bendixson theorem). Limited work has been done on the relationship between chaos theory and universal approximation capabilities of neural networks. Therefore, it is interesting to understand if Neural ODEs can represent a family of distributions as rich as ResNets can, at least in some examples. In this talk, we embrace this new perspective to discuss the properties of a family of first and second order Neural ODEs and their corresponding discrete dynamical systems; we give conditions for chaotic behavior, and analyze their consequences for the representation capacity of Neural ODEs and ResNets.

Brandon Thomas, University of Wisconsin-Whitewater

The Time-expanding Self: Cosmological Considerations about Cognition

I explore the nature of space and time at the scale of organisms-environment interaction (ecological niche) and its implications for the time perception. Rather than treat the traditionally cognitive phenomenon of time perception as a feed-forward inference engine that manipulates three-dimensional representations of the environment, I review a space-time ontology that redefines the role of time in cognition as the perception of affordances (i.e., action capabilities) that concurrently emerge with the universe itself (i.e., evolving block universe theory). I tested this theory in two experiments that explore the role of speed, effort, distance, and postural configuration in the perception of time. The results suggest that organisms are poised between

past and future events with different space-time properties, which is the nature of the time-expanding self.

Heather Thompson, Psychology, University of Central Oklahoma
Jake Yost, Psychology, University of Central Oklahoma
Juniper Wolcott, Psychology, University of Central Oklahoma
Avril Cowo, Psychology, University of Central Oklahoma
Heather Thompson, Psychology, University of Central Oklahoma
Mickie Vanhoy, Psychology, University of Central Oklahoma

Revisiting Yarbus: The Robustness of Top-Down Cognitive Influences on Eye Movement Dynamics Using Multifractal Analysis

Yarbus' eye-tracking experiments in the 1960s revealed that observers' eye movements could be influenced by the specific cognitive task or instructions given to them. The Yarbus illustrations showed distinct scanpaths for the same image when observers evaluated different aspects like activities or ages but the robustness and reliability of this top-down effect on gaze behavior remains controversial. Perhaps the results were an artifact of the particular scene used. Typical scanpath analysis techniques, examining fixation and saccade patterns, can be used to study Yarbus' findings. While valuable, such approaches may overlook important temporal dynamics and long-range correlations in the eye movement data that could provide insights into the underlying cognitive processes. Alternatively, multifractal detrended fluctuation analysis (MFDFA) can quantify how strongly different viewing instructions modulate the intrinsic multifractal dynamics of eye movements. Observers eye movements were recorded as they viewed novel stimuli inspired by the Yarbus images with similar task manipulations. MFDFA can extract multifractal features like the multifractal spectrum width, asymmetry, and generalized Hurst exponents from eye movement time series. If Yarbus' findings on top-down influences were robust, significant differences in these multifractal properties across tasks should emerge, reflecting divergent cognitive processes. Conversely, similar scaling across tasks could suggest the effects are less reliable. By quantifying the multifractal complexity in eye movement dynamics, this approach offers a novel, objective perspective beyond typical scanpath inspection. The findings contributed to understanding the specificity and reliability of top-down cognitive influences on eye movements during visual tasks.

Michael Tolston, Air Force Research Laboratory

Optimzing Distributed Teaming and Communica-tions in the Air Force: The Role of Nonlinear and Complex Team Measurement Approaches

Future military operations will rely on distributed teams of human and intelligent machine warfighters facing increase-ingly complex teaming and communication challenges. In this talk, I will cover research efforts in the Distributed Teaming and Communications Core Research Area (CRA) of the Air Force Research Laboratory, which is developing technologies to enhance the formation, performance, and resilience of military teams. Our research employs a range of cutting-edge methods, such as dynamic team performance assessment through nonlinear analyses, contextualized communication machine learning, and advanced network-based metrics of team interaction. The CRA's goals include using these metrics and models to ensure agile team communications, to create adaptive interfaces for multi-domain operations, and to enable grounded conversation with contextually aware intelligent agents. By integrating these innovative approaches, the CRA aims to ensure robust information exchange, effective cross-domain collaboration, and superior decision-making capabilities in dynamic and uncertain scenarios, ultimately empowering future warfighters to operate cohesively and effectively in high-stakes environments.

Ken Ware, NeuroPhysics Therapy Institute, Gold Coast, Queensland Australia

CALIBRATE - A Multi International Award Winning Documentary

Former Mr. Universe Ken Ware and founder of NeuroPhysics Therapy does not have any formal medical qualification. Yet for more than 30 years he has studied and worked with the human system to develop recovery therapy like no other ' one that works across the spectrum of human conditions. Based upon well-known features of Chaos and Complexity Theories, NeuroPhysics Therapy uses gym equipment as a mechanism to feed prescribed and purposeful information into the body to enable the psychophysical complex adaptive system to dispose of its quite visible incoherent noise to appropriately ' calibrate' itself to environmental stimuli and self-organize to higher states of complexity and fix itself. It sounds too good to be true, hence it has its critics. Some doctors and scientists prefer to pinpoint exactly what is wrong with a patient, rather than look at their whole system. When a spinal patient is told they will never walk again, Ken Ware tells them the opposite. Then he adds: 'but only if you want it bad enough'. This documentary follows patients who have tried everything else under the sun to recover from strokes, brain tumors, paraplegia and chronic pain. Professional big wave surfer Mark Mathews claims that the starkest of methods within this therapy are the 'tremors', the emergence of the systems natural underlying chaotic rhythms. This is the effect that helps produce the greatest outcomes, but it also generates the greatest controversy. 'Tremors' can make patients appear to be possessed by the devil, but the results are astounding. After four days of NeuroPhysics Therapy, Paralympian John Maclean stepped out of his wheelchair, and walked for the first time in 25 years. Like John Maclean, the stars of this film are aiming to reclaim their quality of life. The question is: Do these relatable and endearing characters have what it takes to ' fix' themselves and move forward from life-defining events. We follow the twists and turns as they attempt to do so. As past SCTPLS president the late Dr. Sara Ross puts it in the film 'The human system was the laboratory that gave rise to this therapy'. Hence the paradigm shift of this method is that any

person, with any condition or disorder can apply it. Whilst Ken Ware must often defend criticism of NeuroPhysics Therapy by explaining the science behind his methods. At the end of the day though, the proof is in the pudding's Keywords: Calibrate, Chaos, Complexity, Emergence, Self-organization, Sensitive dependence upon initial conditions.

Willoughby Dominic, University of North Carolina at Chapel Hill
Jeffrey Turner, University of North Carolina at Chapel Hill
Nicholas Buoncristiani, University of North Carolina at Chapel Hill
Darin Padua, University of North Carolina at Chapel Hill
Adam Kiefer, University of North Carolina at Chapel Hill

Beyond Body Weight: The Influence of Added Load on Joint-Specific Landing Kinematics and Coordination Dynamics

Effective motor coordination is essential for adaptive athletic performance, including musculoskeletal injury prevention, particularly in high-impact activities. Under-standing how the lower extremities adapt to added constraints, such as increased load, can provide valuable insights into the resilience of movement patterns. This study examined the influence of added load on intralimb coordination during a drop-vertical jump (DVJ). Twenty-six participants (14 female, age = 23.10 ± 3.97 years, 76.81± 18.73kg) performed 5 body weight DVJs and 5 with an additional 25% body weight using a weighted vest. Three-dimensional joint kinematics were recorded using OpenCap markerless motion capture (OpenCap, Menlo Park, CA). Linear measures were calculated for the knee and hip, while nonlinear cross recurrence quantification analysis indexed intralimb coordination between the knee and hip joints. Alpha level was set a priori at $\alpha = .05$. Paired-sample t-tests revealed lower peak knee flexion ($p = .013$) and decreased total range of motion in both the hip and knee ($p = .014$ and .013, respectively) in the +25% body weight condition. Additionally, recurrence rate ($p = .036$), determinism ($p = .046$), adjusted mean line ($p = .023$), and adjusted trapping time ($p = .011$) were all lower in the +25% body weight condition. These results indicate that weight-based constraints lead to stiffer landing mechanics and noisier, less tightly coupled hip-knee intralimb coordination. These findings highlight the need to consider both the landing mechanics and coordination dynamics when considering the implementation of movement assessments for athletic performance and injury prevention under increased load conditions.

Zimin Mikhail, 2554620 Ontario Ltd., Canada
Svetlana Zimina, 2554620 Ontario Ltd., Canada
Olga Kumukova, High-Mountain Geophysical Institute, Russia
Taras Gavrilenko, Surgut State University, Russia

Mathematical Modeling of Collective Intelligence Decision Making

Quite often in real life, decisions are made on the ground of conclusion of experts' council, wherein its chief need to be able to take final decision, accounting for as well his or her opinion as estimation of other professionals. Under due building such group, its operation can be very effective even though uncertainty takes place. Therefore, its work modeling is promising approach for making decision in challenging and questionable situations. Opinion of each expert is considered as an element of fuzzy set of certain decision of a problem, and membership degree shows level of accepting such decision by this specialist. At the first step, it is supposed that each professional estimates state with the help of magnitude of one parameter only. Dependence of accepting under examination decision on this parameter is approximated by a function, which domain is the interval of [0; 1]. For example, it may be hyperbolic tangent. At the second step, taking into account cooperation of group members, levels of their consent with the decision may be changed if each of them makes allowance for opinions of other experts. For each professional, it is counted by a function constituting dependence of influence on membership degree for him or her on opinions of other specialists at the first step. For instance, it is possible to utilize functions like , where $\mu i, 1$ is membership degree of level of acceptance of the ith expert with under examination decision at the first step, $\mu i, 2$ is membership degree of level of the ith expert with under examination decision at the second step, m is number of experts. At the third step, the team leader fuses of opinions of experts together and makes decision. It is simulated by a function having form of , where q is membership degree of the group of experts to the decision, β is a number, which is greater than zero and less than one ($0 < \beta < 1$), f is some function. Forms of functions being used and their parameters are selected with the help of Monte Carlo technique so as results of analysis are as near as possible to known data obtained from experience. By applying such approach, some systems having reasonable effectiveness are developed. They are utilized nowadays.

Zimin Mikhail, 2554620 Ontario LTD.
Taras Gavrilenko, Surgut State University
Anna Gavrilenko, Surgut State University
Maxim Zimin, 2554620 Ontario LTD.
Oksana Kulikova, The Siberian State Automobile and Highway University

Nonlinear Dynamic of Weighting Factors Values during Neural Network Training

Artificial neural networks have used for a long time. For example, they are utilized for complex and multi-level analysis of a large volume of clinical data. In addition, such studies help to predict course and, most importantly, outcome of diseases, as well as help doctors to make a decision on treatment plan for a particular patient. Therefore, their perfection presents some features of interest. More than once it is noted that during training process, artificial neural network first stabilizes, but after a certain step, significant fluctuations in values of weighting coefficients occur. In some cases, it leads to the fact that neural networks become ineffective. In order to overcome this problem, detailed analysis and repeated verification of the result are used. Such analytical treatment includes

identification of the most promising initial values of weighting coefficients, study of possible bifurcation points that allow learning algorithms not to get stuck and move on to finding more effective solution, determination of influence of number of iterations on the final result in each case. Results of application of this approach show that effectiveness of neural networks can be significantly improved, which is especially important for solving complex problems in medicine, biology, economics, and predicting emergencies in real time. So, it may be considered as a promising area for development of artificial intelligence systems.

It's a Datapalooza!

What's a Datapalooza?...

We invite interested researchers to share data, nonlinear methodologies, and content expertise in a comfortable, productive and unique collaborative environment. The primary goal of the Nonlinear Datapalooza is to connect people in each of the three roles of data analyst, data producers, and content specialists to work together during the conference on at least one publishable empirical paper within the six months following the conference. In the process, methods experts will be able to disseminate and train other researchers in their favorite nonlinear analyses; participants with data will get results and a hands on practical training in new nonlinear methodologies; and content experts will share their expertise with others as they gain hands on access to methods and data that will drive their scientific discovery. Our goal is for all participants to gain a significant acceleration in their productivity, through publication co-authorship, new analytic abilities, shared data, and ongoing collaborative relationships. Beyond the benefits to those participating, we expect that Nonlinear Datapalooza will make a significant impact within the paradigm of nonlinear science by creating these productive collaborations, and by producing solid empirical results - ideally those that employ a variety of converging nonlinear methodologies.

Some of the analysts coming to Datapalooza 2024

STEPHEN GUASTELLO: I can offer assistance with analyses involving nonlinear time series statistics for determining **Lyapunov exponents** and **fractal dimensions**, **catastrophe models**, **synchronization** of time series for dyads and larger groups and **orbital decomposition (ORBDE)** analysis. Those who are interested in synchrony studies should have a version of R handy when they arrive. There are additional freely available programs that you can download that will do the R part of the analysis and finish the job. SyncCalc was designed for group-level (3 or more people) indicators of synchrony. It produces analyses for correlations among possibly-nonlinear time series, individual metrics for the influence of each person on the total group (driver scores and empath scores), and a measure of total group synchrony.

Those who are interested in working with nonlinear time series or catastrophe theory should have an SPSS program ready for use in the workshop. I will also bring some time-series data for COVID infections 2020-2022 before the vaccine was introduced. The data set lends itself to several possible nonlinear analyses, depending on what questions you would like to ask.

ORDBE is a symbolic dynamics program for sequences of events that can be coded in one or multiple ways. It does not require that the sequences of events are chaotic, but it assumes that they could be so. As such it decomposes the sequence of events to limit cycles (orbits) that are entangled enough to produce chaos. It produces specific temporal patterns of events, topological entropy, Shannon entropy, and measures of degree-of-fit. There is a freely available program for this procedure that you can download.

SJG is a professor of psychology at Marquette University in Milwaukee WI, specializing in human factors engineering and industrial-organizational psychology. He is also published in economics, epidemiology, and personality and social psychology.

ADAM KIEFER: The methodology I would like to share with attendees is **Recurrence Quantification Analysis (RQA),** an analysis developed by Charles Webber and Joe Zbilut in 1992. RQA is an amalgamation of univariate, bivariate and multivariate nonlinear analyses that quantify the nature of recurrent patterns, or repeating states, within or between discrete or continuous behavioral time series. Norbert Marwan has developed a powerful Cross-Recurrence Plot Toolbox of MATLAB routines that is freely available: http://tocsy.pik-potsdam.de/CRPtoolbox/ (mac and windows versions). There is also a wonderful version in 'R' by Coco et al. here: https://cran.r-

project.org/web/packages/crqa/index.html. RQA produces metrics such as: the degree of deterministic or random processes present in the time series, the average number of consecutive points in which the phase space trajectory converges, the exponential divergence (or convergence) of the phase space trajectory, Shannon entropy, and the stationarity, or drift, of the time series. These measures can inform on the behavioral dynamics of the system such as piecewise determinism, stability and, in well-understood systems, the presence of singularities.

AK is an assistant professor in the Department of Exercise and Sport Science at the University of North Carolina at Chapel Hill. His research takes a complex systems approach to performance enhancement and system resiliency. His expertise in both behavioral dynamics and dynamical disease provide for an innovative approach to measuring, modeling and analyzing the complexity of human behavior, and associated biomedical signals.

DAVID PINCUS: I will be bringing a data set comprised of 200 individuals' experience sampling time series data, gathered three times per day for three weeks. The time-series variables include a narrative response for primary stressor/problem/concern along with: emotion ratings (6 positive, 6 negative); coping behaviors; interpersonal conflict and support; self-esteem/conflict; and cognitive perspective (i.e., an 'embodiment' scale). The start and end of the three-week experience sampling are anchored by full-scale assessments of each of the variables (emotion, cognition, behavior, and self-, other-relations) as well as the five-factor personality inventory and brief mental health screeners (anxiety, depression, stress, and psychosis). I can also offer assistance with analyses involving **ORBDE and power law analysis**.

DP is a professor of psychology at Chapman University in Orange CA. He specializes in clinical psychology topics, but has been known to take a dive into other topics he considers relevant and fascinating for the broader picture of nonlinear science.

BERNARD RICCA: I am well versed in many different nonlinear approaches to data analysis, and would be happy to work with almost any dataset, but my greatest expertise lies in working with time series data, including: Burstiness and power-law distributions within time series, which each provide insight into aspects of self-organization; Markov (transition) analysis to explore categorical time series; dynamic systems analysis to look at the levels, velocities, and accelerations associated with time series, motivated by theoretical consideration; and sparse identification of nonlinear dynamics (SINDy) to look at the coevolution of time series, particularly as an exploratory approach.

ALLESANDRO MARIA SELVITELLA: The methodology I would like to share the algorithm called **Sparse Identification of Nonlinear Dynamics** (**SINDy**). SINDy is a data-driven approach that can discover nonlinear dynamical systems from data. From a multivariate time series, SINDy determines the most sparse (e.g. with the least number of nonlinear terms) governing ODEs or PDEs, using regularization methods, such as LASSO. SINDy takes advantage of the fact that most natural phenomena are described by systems of differential equations with only a few nonlinear terms and so it produces interpretable models. SINDy is a fast and robust algorithm and it has been widely applied for model identification in a broad range of research areas including fluid dynamics, chemistry, environmental science, biology, physics, epidemiology, engineering, social sciences, etc. SINDy can be used to identify the dynamics of polynomial chaotic systems, reproducing the strange attractors and therefore reproducing the fundamental dynamics.

AMS is an Assistant Professor of Data Science and Applied Statistics, at Purdue University, Fort Wayne, IN. He develops new quantitative methods in mathematics, statistics, and machine learning to solve concrete problems emerging in organismal biology, health sciences, neuroscience, ecology, and epidemiology. The methodological approaches that he developed includes the use of combinations of tools from differential equations, nonlinear dynamical systems, physics-informed neural networks, and transfer learning, are general and apply to different fields.