International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 5, July-August 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Eko: Artificial Life, Determinacy of Ecological Resilience and Classification of Closed Ecosystems

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ABSTRACT

Simulating the effects of biotic and a biotic interactions with or without human interference to compute ecological resilience within a closed ecosystem. Simulating a set food chain in the said ecosystem and studying the effects of biotic factors on the biotic chains and vice versa. Classifying and comparing various closed ecosystems on the said parameters and determinacy of the stability of an ecosystem over time. Study of various a biotic compound statistics via graphical representations in a time-controlled order. Ability to introduce new species, remove existing ones or change the concentration amounts of current biotic parameters and thus study various results in a cause-effect relationship. Time factoring and control over biotic gene pool to affect ecosystems on both a macro and micro scale. In-depth latency about ecosystems in the gaming industry, weather simulators, and life perseverance of various endangered and threatened species along with sustainable resource control.

KEYWORDS: *Ecosystem, Ecological Resilience, Latitude, Panarchy, Resistance, Precariousness, Classification of Ecosystem, Artificial Life, Ecological Function*

***How to cite this paper**:* Ankita Dhillon | Kirti Bhatia | Rohini Sharma "Eko: Artificial Life, Determinacy of Ecological Resilience and Classification of Closed Ecosystems" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-5, August 2021, pp.2218-2223, URL: www.ijtsrd.com/papers/ijtsrd46318.pdf

IJTSRD46318

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INTRODUCTION

Artificial life is a field of study in which scientists employ computational models, automation, and biotechnology to investigate systems relevant to natural life, its mechanisms, and progression. There are three basic types of life, each named after its methodology: soft, which comes from software; hard, which comes from hardware; and wet, which comes from microbiology. Researchers that explore artificial life strive to reproduce parts of biological processes in order to learn more about conventional biology. It investigates the basic mechanisms of biological systems in artificial surroundings in order to acquire a better comprehension of the sophisticated processing of information that characterizes such systems. These subjects are diverse, but they frequently encompass adaptive dynamics, spontaneous qualities of cooperative systems, biomimetic, and similar problems such as philosophical outlook and the application of lifelike qualities in art forms.

The power of an ecosystem to rebound to a disruption or change by enduring destruction and recuperating fast is known as ecological resilience.

Closed ecological systems (CES) are ecosystems that do

Closed ecological systems (CES) are ecosystems that do not interchange matter with any other parts of the system. An ecosphere is an enclosed ecological system that covers the complete world.

LITERATURE SURVEY

Genetic algorithms are computerized evolution methods that are used in numerous artificial-life simulations. We examine the past and present breadth of genetic algorithm research in artificial life, including instances of how the genetic algorithm can be used to mimic ecosystems, immunity, sensory information, and welfare systems, as well as to study the learning and adaptation of interaction. We also evaluate a variety of unanswered questions and future prospects in artificial-life study for genetic algorithms [5].

Conventional methods of the relation between biodiversity and ecosystem processes are described, and a hypothesis development relating species variety, ecological endurance, and size is proposed. We propose that species communicate with spectrum ecological systems and mechanisms to define functional possibilities. We suggest that ecological endurance is created by different but overlapping functions within a layer, as well as by seemingly superfluous species differently at higher scales, promoting function through scales. The dispersal of functional variety within and through scales allows for restoration and resurrection in the aftermath of ecological disturbance on a large scale [6].

The purpose of this work is to provide an overview of the development and application of multi-agent simulations (MAS) in ecosystem management. The application of this technique and the instruments that go with it coincides with changes in several concepts about the analysis of ecological complexities. Models are utilized in a scientific manner to understand and model ecological organization. Behavior and interactions are becoming significant topics for comprehending and simulating ecosystem organization (figure1). The notion of MAS is explained, and it is likened to individual based modelling systems. Several agent designs are discussed, as well as the importance of the environment and several computer applications. A discussion follows on the use of MAS for ecosystem management. The strength of MAS has been discussed for social sciences and for spatial issues such as land-use change. In this paper, we argue that MAS are effective for challenges involving the integration of social and spatial components. Then we discuss how MAS can be used for several purposes, from theorization to collective decision-making support. Specific decision-making mechanisms, organizations, levels, model trustworthiness, and the application of MAS are some of the research topics we recommend. Finally, we argue that experts in the field of ecosystem management can utilise multi-agent systems to go above the role of the person and research the various forms of organization (spatial, networks, hierarchies) and conversations among various managerial levels in greater depth and effectiveness. There is a lot more fruit on the tree of cooperation between sociological, environmental, and computer experts for that goal than has been gathered thus far[6].

Since Holling's initial study in 1973, the definition has expanded significantly. Specific aspects of what resilience entails, on the other hand, can be perplexing. The characteristics that regulate the system's dynamics must be assessed while determining a system's resiliency. Resilience, adaptability, and adaptivity are three associated characteristics of social–ecological systems (SESs) that govern their future trajectories. Resilience (a system's capacity to transfer disruption and reorganise while facing challenges and maintaining generally the identical function, system, individuality, and suggestions) has four aspects: latitude, resistance, precariousness, and panarchy, which are most easily represented using the metaphor of a stabilisation environment. Adaptability refers to a system's actors' ability to impact resilience (in a SES, essentially to manage it). This can be done in four different ways, each of which corresponds to one of the four factors of resilience. When ecological, economical, or sociological dynamics render the old system unworkable, transformability is the ability to build a completely different system [3]

This paper takes an interdisciplinary approach to the important aspects of ecosystems and the methods for simulating them in order to investigate theoretical challenges related to Artificial Life and Ecology. The majority of Artificial Life research has focused on evolutionary ecosystems of agents in trivial surroundings. Ecology frequently develops models of specific environments and organism populations that are unsuitable for broad theoretical inquiry. We postulate that by replicating ecosystems at the level of artificial chemistry, the constraints of simulations in these areas can be overcome. We show the approach's viability by detailing a number of virtual species that are reproduced at this level. Organisms adopt trophic levels on their own, generating energy from chemical bonds and transforming matter in the process. Virtual organisms can use the same chemistry to interact with one another and their abiotic environment. This technique can also be used to model biosynthesis and degradation [8].

Physical ecosystem engineering by organisms, while well-recognized as an essential type of ecological interaction, is diverse and has a wide range of implications, posing obstacles for building and applying broad understanding. There is also some doubt about what it is, as well as some scepticism that the diversity of engineering and its impacts can be conceptualized and understood. What then, are the key cause/effect relationships and what underlies them? The first two relationships describe an ecosystem engineering process and abiotic dynamics, while the second two describe biotic consequences for other species and the engineer. The four relations can be normalised and related using time-indexed equations that describe designed system dynamics. After explaining the connections, we describe the framework's functionality, how it could be improved, and momentarily how it can be used to recognise intersections of ecosystem engineering with fields other than ecology[9].

Membrane Computation has been proven to be an appropriate paradigm for modelling dynamical biological systems in general, and ecosystems in specifically. Because biological systems are inherently random and uncertain, the validation and virtual experimentation processes, rather than formal verification, should be addressed while creating a model. As a result, relying on software implementations of efficient simulation methods is critical. This paper depicts a simplified (but realistic) environment in which a carnivore interacts with various herbivorous species. The ecosystem model was used to compare the performance of two distinct simulation algorithms in an experimental setting [10].

Each individual's FCM is unique, and it is the result of the simulation's evolution process. The concept of species is also constructed in such a way that species arise from a population of agents that is expanding. Our approach is the only one we know of that can model the relationships among patterns of behaviour and divergence. The simulation generates a large amount of data, including the number of individuals, their energy levels, their actions, their ages, the average FCM connected with each species, and the diversity of plants. This research looks at patterns of macro evolutionary mechanisms like species emergence in a simulated ecosystem and presents a broad framework for analyzing specific ecological issues like invasive species and species diversification patterns. We report promising results that demonstrate the simulation's overall coherence, as well as the creation of strong correlation patterns that have been found in genuine ecosystems. [11]

Ecosystem architecture, or the physical change of the environment by organisms, is a frequent and often significant activity with little understanding of its impact on food web structure and dynamics. We look at how we might best integrate ecosystem management and food webs in light of current recommendations to broaden food web studies to include non-trophic relationships. We present rationales for their integration and a preliminary framework that identifies how ecosystem engineering can affect food web nodes and links, as well as overall organisation; how trophic interactions with the engineer can affect the engineering; and how feedbacks between engineering and trophic interactions can affect food web structure and dynamics [12].

The application of Soft Systems Methodology (SSM) in solving managerial challenges has grown in response to concerns of structural complexity, on which stakeholders have differing perspectives. Furthermore, the shortcomings of this methodology in terms of considering all points of view and guaranteeing the efficacy of the proposed adjustments has motivated the use of Fuzzy Cognitive Map (FCM) in SSM. When you use FCM as a modelling framework, you can mix the opinions of various specialists to create a group FCM (GFCM). In the stage of making suggestions and improvements, GFCM has the possibility to be a beneficial decision support tool. This system, which is influenced by a variety of policies and viewpoints, is examined using the established approach, and then options for improving the system are highlighted. [13]

Within a previously established individual-based developing predator-prey ecosystem simulation, we provide a new method for modelling evolution. K-means clustering, as a replacement to the original classical speciation procedure, provides a more realistic way for simulating speciation that, among other things, allows for the restoration of the species tree of life. This talk discusses the k means evolution mechanism, explains the benefits it brings, and compares it to the traditional technique of speciation [14]

Spatial Resilience is a brand-new interdisciplinary field of study. It focuses on the impact of spatial variation on the resilience of complex systems, along with things like specific position, circumstances, interconnection, and dispersal, as well as the responsibilities that resilience and self-organization perform in creating spatial heterogeneity. Professor Cumming gives a comprehensible initiation and a first detailed formulation of spatial resilience's basic methods and approaches to the analysis of human systems. The book study follows a path from theories to frameworks, methodology, and case study analyzation before returning to the central issues in the field's continued theoretical structure. The author travels from the mobility of lions in northern Zimbabwe to the urban jungles of Europe, and from the breakdown of past societies to the social consequences of modern conflict in the process. The book's numerous case studies and instances demonstrate how the concept of spatial resilience can help solve some of the world's most pressing problems by providing valuable insights into the spatial dynamics of social-ecological systems. Even though it was written principally for students, this book will appeal to interdisciplinary scientists at all stages of their careers, as well as the general public. Graeme Cumming provides a novel, and People assume significant, formation of piece geometry of the resilience of combined ecological and social systems in this engagingly written research. [15]

The Everglades of Florida, USA, the lakes in Wisconsin's northern highlands, the lakes and wetlands of Kristianstads Vattenrike in southern Sweden, and the lakes and wetlands of Kristianstads Vattenrike in southern Sweden provide case studies that can be used to compare the links between ecological resilience and social dynamics. Ecological resilience in underwater and marshland ecosystems is frequently eroded as a result of previous management actions, manifesting as a real or perceived ecological crisis. In response to the loss of ecological resilience, knowledge is a critical component. Learning is aided by networks that operate in different arenas and are structured for dialogue, synthesis, and imaginative solutions in order to chart desired future. The networks also aid in the fight against maladaptive processes like information control and deception, bureaucracy, and fraud. The networks assist in the development of institutional arrangements that promote greater learning, adaptability, and adaptability. Adaptability and transformability appear to be dependent on trust and governance. [16]

Coral reefs are among the best acknowledged of marine benthic people in terms of the indicators of foremost production and prebiotic fluxes, as well as their alteration, at various event levels of integration, due to the abundance of interdisciplinary studies of coral reef digestion. Our knowledge of the variation in coral reef productivity at different spatial and temporal scales has grown in recent years. Nutrient restriction of production at scales ranging from the species to the ecosystem is currently one of the most popular topics, with implications far beyond the tropical regions. [17]

A deeper understanding of the field's complicated processes, including the biological, chemical, and technical basics required to build more successful approaches. The book gives a chapter to each of the four major fields of environmental biotechnology: wastewater treatment, soil treatment, solid waste treatment, and waste energy treatment, including both microbiological and process engineering elements. [18]

A combo of physical-chemical and bioregenerative life support systems is used in most manned lunar base scenarios. Yet, there are a number of unique environmental conditions that have a significant impact on the species that are suited for agricultural production and biological restoration of the habitat's atmosphere and water, particularly on the lunar surface. For example, the lunar day/night cycle poses challenges to higher plant cultivation. The study reviews the existing scientific methods to bio regenerative life support systems for a lunar outpost and critically evaluates their feasibility. Furthermore, an empirical process is designed from a biologist's perspective to enact bio regenerative life - supporting components into a lunar base in a stepwise manner, covering the opportunities of chemolytotrophic bacteria, microalgae, and higher plants, as well as animal breeding and protein production in advanced aquaculture structures. [7]

ECOLOGICAL RESILIENCE

Ecological Resilience is the ability of an ecosystem to maintain a balance between nutrient cycles and biomass production after it has been disrupted by an ecological disruption. The capacity of a system to keep working and recovering from a disruption is described by resilience, which is synonymous with ecosystem robustness.

We can determine ecological resilience using the four elements listed below, and we estimated our results using these parameters.

A. Latitude

The maximum amount of change that can be made to a system before it loses its ability to recover (before crossing a threshold which, if crack open, makes retrieval tough or unmanageable).

B. Resistance

The system's “resistance” to change; how easy or difficult it is to alter.

C. Precariousness

How near is the system's present state to a limit or "threshold"?”

D. Panarchy

The extent to which different layers of an ecosystem impact a particular hierarchical level. For instance, animals living in isolated communities may be organized differently from the identical sort of organism living in a huge continuous community, implying that population-level interactions impact community-level organization.

IJTSRD International Journal of Trend in Scientific Research and Development ISSN: 2456-6470

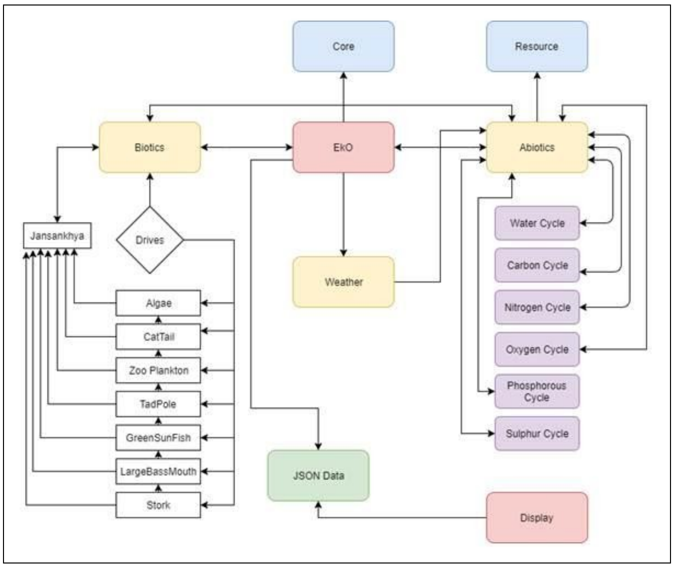

Fig 1: ER Diagram of Ecosystem

CONCLUSIONS

The proposed system advocates for using a thread based system to simulate various ecosystems with a high accuracy percentage. Balanced ecosystem states achieved with pre-set values, considerate changes lead to different balanced ecosystems whereas as random arbitrary changes lead to the death of various species and an imbalance in the chemical compound concentrations in the nature. This is represented and shown via dynamically plotted pie and line charts for concentration/population over time.

The set food chains and animal drives for the project have been simulated to fruition. Animals are sentient towards basic drives like PAIN, DANGER, HUNGER, LIBIDO and CURIOSITY. Animal gene pools are the driving forces behind the actions of a particular animal. Asexual reproduction constitutes the animal multiplication factors on reaching sexual maturity. Death is controlled by factors of a predator-prey relationship and due to life expectancy. The behaviour of the top predator in the food chain is highlighted on the ecosystem throughout.

Ecological Resilience is calculated via computations on concentrations of different biotic and abiotic constituents and various closed ecosystems have been classified on its basis. Factors like Latitude, Resistance and Precariousness are calculated keeping Panarchy highlighted.

Human Impacts on closed ecosystems are measured in an immediate and long-term fashion and displayed via suitable statistical methods. All data has been logged and displayed in a user-friendly UI system and the limitations are discussed along with the scope for future innovation.

REFERENCES

[1] "Dictionary.com Unabridged," Nov. 2017.

[2] M. Bedau, J. S. McCaskill, and N. H. Packard, "Open problems in artificial life," vol. 376, no. 2000, pp. 363–376, 2000.

[3] B. Walker, C. S. Holling, S. R. Carpenter, and A. Kinzig, "Resilience, Adaptability and Transformability in Social – ecological Systems," Ecol. Soc., vol. 9, no. 2, p. 5, 2004.

[4] J. I. Gitelson and G. M. Lisovsky, Man-Made Closed Ecological Systems. Taylor & Francis, 2002.

[5] M. Mitchell and S. Forrest, "Genetic Algorithms and Artificial Life," Artif. Life, vol. 1, no. 3, pp. 267–289, 1994.

[6] F. Bousquet and C. Le Page, "Multi-agent simulations and ecosystem management: A review," Ecol. Modell., vol. 176, no. 3–4, pp. 313–332, 2004.

[7] V. Blüm, J. I. Gitelson, G. Horneck, and K. Kreuzberg, "Opportunities and constraints of closed man-made ecological systems on the moon," Adv. Sp. Res., vol. 14, no. 6, pp. 271–280, 1994.

[8] A. Dorin and K. B. Korb, "Building virtual ecosystems from artificial chemistry," Proc. 9th Eur. Conf. Adv. Artif. life, vol. ECAL '07, pp. 103–112, 2007.

[9] C. G. Jones, J. L. Gutiérrez, J. E. Byers, J. A. Crooks, J. G. Lambrinos, and T. S. Talley, "A framework for understanding physical ecosystem engineering by organisms," Oikos, vol. 119, no. 12, pp. 1862–1869, 2010.

[10] M. A. Colomer, I. Pérez-Hurtado, M. J. Pérez-Jiménez, and A. Riscos Núñez, "Comparing simulation algorithms for multi environment probabilistic P systems over a standard virtual ecosystem," Nat. Comput., vol. 11, no. 3, pp. 369–379, 2012.

[11] [11] R. Gras, D. Devaurs, A. Wozniak, and A. Aspinall, "An Individual Based Evolving Predator-Prey Ecosystem Simulation Using a Fuzzy Cognitive Map as the Behavior Model," Artif. Life, vol. 15, no. 4, pp. 423–463, 2009.

[12] D. Sanders et al., "Integrating ecosystem engineering and food webs," Oikos, vol. 123, no. 5, pp. 513–524, 2014.

[13] P. Hanafizadeh and R. Aliehyaei, "The Application of Fuzzy Cognitive Map in Soft System Methodology," Syst. Pract. Action Res., vol. 24, no. 4, pp. 325–354, 2011.

[14] A. Aspinall and R. Gras, "K-means clustering as a speciation mechanism within an individual-based evolving predator-prey ecosystem simulation," in Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2010, vol. 6335 LNCS, pp. 318–329.

[15] G. S. Cumming, Spatial resilience in social-ecological systems. 2011.

[16] L. H. Gunderson, S. R. Carpenter, C. Folke, P. Olsson, and G. Peterson, "Water RATs (resilience, adaptability, and transformability) in lake and wetland social-ecological systems," Ecol. Soc., vol. 11, no. 1, 2006.

[17] B. G. Hatcher, "Coral-Reef Primary Productivity - a Hierarchy of Pattern and Process," Trends Ecol. Evol., vol. 5, no. 5, pp. 149–155, 1990.

[18] M. Nelson, N. S. Pechurkin, J. P. Allen, L. A. Somova, and J. I. Gitelson, "Closed Ecological Systems, Space Life Support and Biospherics," in Environmental Biotechnology2, vol. 10, 2010, pp. 517–565.

International Journal of Trend in Scientific Research and Development
IJTSRD
International Journal of Trend in Scientific Research and Development
ISSN: 2456-6470