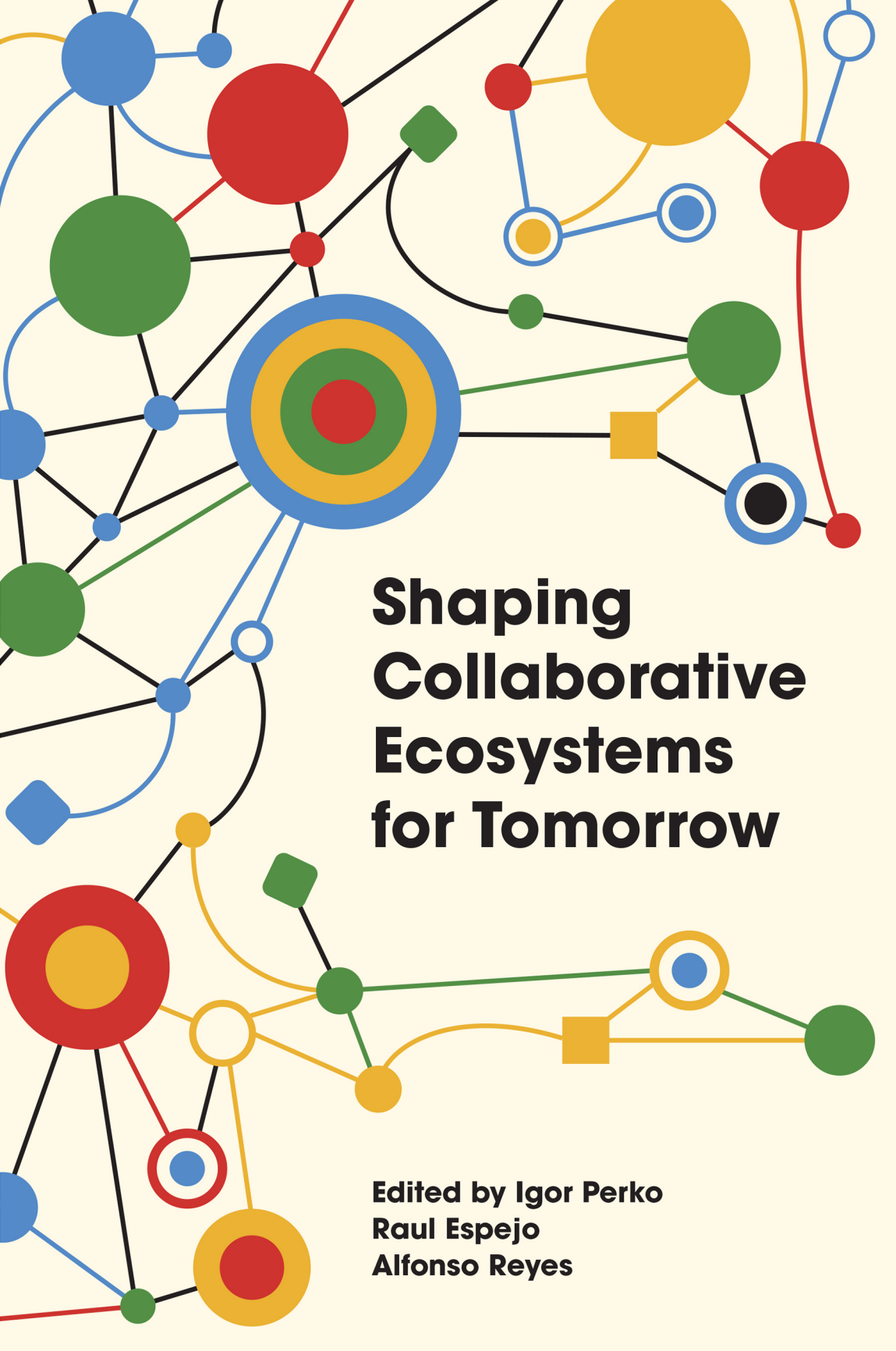




Shaping Collaborative Ecosystems for Tomorrow

**Edited by Igor Perko
Raul Espejo
Alfonso Reyes**

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INVESTOR IN PEOPLE

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diagnosis to achieve well-being and a new quality of life. Furthermore, the participants co-created new models to improve the situation in response to the results.

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Foreword

What is this Book About?

This is a book emerging from varied scientific collaborations in the 19th Congress of the World Organisation of Systems and Cybernetics (WOSC), in September 2024, at Oxford Lady Margaret Hall. Its overall theme is Shaping Collaborative Ecosystems for Tomorrow. More than a discussion of theories, its aim is practical elaborations of interactions and relationships for collaborative processes to improve organisations and implement desirable change in a chaotic world.

Often people in our institutions and organisations lack closure in their decision processes. In practice, they lack knowledge on how to respond to unpredictable situations, or more precisely, how to deal with people who are not covered by the existing processes and routines. In these situations, they find themselves in the hands of organisational members who make decisions without their collaborative understanding of what is acceptable, justifiable, and ethical. As Dan Davies (2024) elaborates in his book *The Unaccountability Machines*, participants in these institutions are forced to act in ways that are unacceptable and go beyond their competence to subvert. These are situations where the ‘whole’ doesn’t know how to manage or regulate the situation’s complexity. Those who have control impose their limited understanding of the situation over the most that happen to be in direct interactions with environmental customers; these are situations where those operating locally are forced by hierarchical decisions to rules and policies having a limited grasp of the complexities restricting their behaviours; they are operating without flexibility and autonomy. Davies’ book is aware of organisational cybernetics in general and most directly of the works of Ross Ashby and Stafford Beer. He argues compellingly for a cybernetic approach to overcome these situations of unaccountability, underpinned by poor decisions. In fact, our work in the WOSC 19th Congress, as elaborated in several of the chapters of this book, offers contributions to improve these situations.

Organisational cybernetics and systems thinking, which are called throughout this book as CybersyStemics, offer contributions to ecology, economics, and society in general. They offer a discussion of citizenship and democracy, and also offer methodological support to overcome hierarchies, and make customer–supplier relationships more manageable. In this sense, this is a book about more effective citizenship, that is, about people’s improved contributions to decision making.

We argue that deep in the overall integration of parts of a situation into a cohesive whole are conversations, which align decision-makers' decisions with the actions of people and groups at their local levels. The purpose of these conversations, as explained in the book, is the collaboration and alignment of participants' purposes at all structural levels, those that Beer refers to as recursion levels. It is important to understand these alignments to avoid inadequate decisions. We argue that they are necessary to achieve collaborative purposes. What emerges from this proposition is that it doesn't help to believe that top people in a situation are the only ones defining purposes and imposing them throughout the institution; the argument developed in the third part of this book is how to overcome disparities in purposes between the global and the local. It is argued for reflexive structures and issues so that recursive structures support achieving aligned purposes between those clearly focussed on implementing actions in a chaotic environment and those clearly focussed on defining policies. These are structures supporting discussions of policy issues throughout a situation. It is important to clarify from varied perspectives, among others, the perspectives of technology, customers, markets, time, values, and, most significantly, ethics and the alignment of complexity and purposes; achieving these alignments is referred here as ontological cybernetics. The complexity of structural conversations and the complexity of relevant issues such as ecology, distribution of resources, education, learning, and so forth, help overcoming social inequalities and influence each other reflexively, overcoming silos. It is through these conversations that purposes should be clarified at all structural levels of social situations. Most important in these conversations is the management of proliferating data through digital technology and artificial intelligence (AI). This is an aspect of practice that is widely explored in Section I of this book.

Conceptually, managing complexity requires a deeper understanding of interactions at all levels of biological and social aspects, but most fundamentally, in the context of this book, requires understanding social relationships. The integration of relationships in this book is supported by Ashby's concept of variety and, in practice, by his law of requisite variety. The chaotic nature of our world triggers the need for the management of complexity; in particular, in Section III of this book, this management is related to variety, or the number of possible states of a situation, and the law of requisite variety. The book relates the harnessing of data proliferation to the need to improve the management of situational complexity. The concept of variety is related methodologically to balancing the related interactions towards a distributed alignment of purposes. This alignment is achieved, and it is possible through effective ecological management, which is proposed as the central concept of this book. Most fundamentally, concepts of self-regulation and self-organisation emerge as strategic concepts for complexity management. In Section II of the book, these ideas are put into practice, along with policy issues like democracy, local societal management, migration, tourism, and others. From a pragmatic perspective, requisite variety is related to achieving balances of interactional complexity, which in Section III is offered as the strategy to move from the open interactions offered by Section II, to the purposeful relationships of

ecological management. This is the way the book offers to close the gap between interactions in general and organisational relationships for ecological management. Through this strategy, which is referred to as variety engineering, the huge variety of interactions in any situation is transformed into purposeful relationships for ecological balances. Indeed, finding out residual varieties and working out strategies to balance relationships are proposed as the main strategies for problem solving. This book proposes to recognise a variety of imbalances as means to improve the management of data and make meaningful AI.

The book is focussed on Beer's viable system model (VSM) and its mechanisms to understand issues of complexity management in organisations through self-organisation and self-regulation. It is a model to understand sustainability and ecological management. These aspects are mostly discussed in Sections II and III of the book. It is the model that deals with interactions in general but most fundamentally with balanced relationships to achieve, as far as possible, people–nature interactions. In today's digital world, organisational complexity goes beyond seeing these organisations as black boxes, as proposed by first-order cybernetics. First-order cybernetics observes organisations and institutions as input–output situations where the focus is on the transformations they perform. These transformations are observed from an outside perspective, the perspective of first-order cybernetics. One of the implications of high complexity is that their complexity is not captured by external observers from one viewpoint, but by avatars experiencing their huge distributed digital complexity or variety from multiple viewpoints. In fact, people within organisations influence each other and what appears to be an objective view of inputs and outputs by one viewpoint, in practice, is the outcome of situations changing their identity over time from a variety of viewpoints. The implications of this larger grasp of relationships are that the outcomes of organisations are recognised from the perspective of avatars that construct the input–output situations from varied viewpoints. These multiple avatars support operational descriptions of situations strongly influenced by the relationships of multiple people and groups, offering evolving constructions of situations. These are the foundations of second-order cybernetics of organisational systems. Black box and operational descriptions of organisations are intertwined and offer a much richer perspective of operationally closed systems, as is discussed in Section III of the book.

Operationally closed systems, observing organisations as black boxes together with their embedded relationships, are the practical direction offered by this book to discuss the ecology of human–resources interactions, avoiding either top-down hierarchical approaches or situations disproportionately oriented towards the conservation of local physical resources. Effective recursive structures, with the necessary relationships for policymaking, regulation, and implementation, should support self-constructed interactions of organisations with their environments in as many structural levels as necessary. However, this is not achieved by formal institutions which often do not possess an adequate distribution of policy, regulation, and implementation complexities, possibly over-emphasising global issues at the expense of proper attention of what is available and possible locally.

It is also possible to over-emphasising the conservation of resources, failing to integrate issues and also failing to distribute issues at several structural levels. An approach towards effective structural recursion in situations of this kind is discussed in Section III as an enterprise complexity model, which is proposed as an extension of Beer's VSM and is proposed as a central tenet for ecological management in this book.

Raul Espejo

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This book stands as a testament to the fruitful engagements of the CyberSystemic community and simultaneously serves as an invitation to both longstanding and prospective members to co-create the trajectory of our shared future. The content herein has been shaped by the intellectual and creative contributions of numerous authors and reviewers, whose collective energy underpinned its development.

This endeavour is one of the outcomes of a collaborative effort among various CyberSystemic organisations and academic institutions, united in the conception and realisation of the 2024 World Organisation of Systems and Cybernetics (WOSC) Congress, held in Oxford, UK. It is only through the dedicated involvement of many individuals that the exchange of ideas and insights could flourish.

Our deepest gratitude is extended to all organisations that participated in the WOSC Congress 2024, and to the many individuals who contributed as authors, peer reviewers, and members of the scientific and programme boards. Their unwavering support has been instrumental in advancing the concepts and research findings presented within these pages and, more importantly, in sustaining the ongoing evolution of this intellectual field.

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The Editorial Team

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Book Introduction

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The complexity of interactions and relationships in our world consistently surpasses our ability to fully comprehend and govern. The emergence of intelligent tools, spanning both digital and physical realms, is progressively enhancing our capacities to act on personal, organisational, national, and international levels. These transformations bring both intended and unintended consequences, reshaping our primary habitat – the planet Earth – at an unprecedented speed and scale. In the midst of uncertainty, the development and utilisation of these new capabilities would greatly benefit from CyberSystemic approaches and advanced methods of learning, which are crucial for fostering a sustainable understanding and taking action to mitigate major threats to our civilisation.

The latest World Organisation of Systems and Cybernetics (WOSC) discussions build upon previous explorations into organisational systems, interactions, and technology, including the Cybersyn project in Chile (1971–73). Advancing this long row of discussions, this book emphasises the future of governance and the role of CyberSystemic methodologies in addressing societal and environmental complexities.

Fundamental aspects of this discourse are based on a vast CyberSystemic Toolset, among them Stafford Beer's viable system model, systems dynamics, participative approach, and soft systems, to name a few. This CyberSystemic toolset offers a meta platform for modelling structured yet adaptable perspectives on the interactions within organisations, among individuals, and between humanity and the environment.

Interactions influence not only our identity and consciousness but also governance systems and societal frameworks. The rapid expansion of digital and physical tools enhances our ability to act locally and globally, fostering new relationships across various domains. However, these interactions yield emergent consequences – both beneficial and disruptive – that demand critical evaluation. It is proposed that the responsible development of new capabilities in this dynamic environment necessitates further development of CyberSystemic methodologies

that enhance sustainability and resilience, mitigating the risks that threaten our collective future.

The WOSC 2024 book, in collaboration with several CyberSystemic organisations, serves as a platform for fostering interdisciplinary discourse. It provides a path to explore how Society and Nature can integrate with modern technology, avoid past pitfalls, and empower citizens to rethink organisations, shape intelligent societies, and co-design democracy to establish viable relationships within the planetary ecosystem.

This book invites readers to engage with narratives that examine evolving interactional dynamics. Traditionally, governance and organisational structures have relied on hierarchical management approaches, where individuals followed directives from leadership. Over time, this paradigm shifted towards a consumer-driven perspective, with interactions shaped by market negotiations and power dynamics. Today, CyberSystemic thinking invites us to advance this perspective by recognising individuals not just as subjects or consumers but as active citizens. This participatory perspective redefines the role of individuals in co-designing organisations and policies, prioritising collaboration, adaptability, and shared purpose.

This participatory model prioritises addressing a variety of imbalances in interactions, fostering correction over unilateral imposition of views or the dominance of power dynamics. Citizens' narratives within this framework are characterised by participation, collaboration, trust, and respect. The book presents contributions that illuminate and demonstrate these perspectives on citizenship in organisational and social contexts.

CyberSystemic examination interactions across disciplines are inherently complex, requiring a systemic examination of structures, properties, and relationships that extend beyond superficial connections. To address this challenge, the book's authors explore interactions as a unifying concept for interdisciplinary communication, applicable to social, organisational, biological, and technological systems. This interdisciplinary approach encourages systems thinkers and cyberneticians to refine methodologies for conceptualising and analysing interactions, leading to transdisciplinary research and living results.

The book synthesises insights across three topics:

- (1) Combining interactions in physical, digital, natural, and artificial worlds into CyberSystemic realities.
- (2) Integrating ecological, social, and economic dimensions of organisational governance and management.
- (3) Enhancing active citizenship and democratic processes.

The book aims to construct a more holistic understanding of the world, fostering intelligent strategies for observation, understanding, adaptation, and co-evolution. The collective knowledge presented in this book aims to drive meaningful change, equipping individuals and organisations with the tools to navigate complexity and contribute to a more resilient, equitable, and sustainable future.

This book represents the collaborative effort of a diverse network of researchers, practitioners, and organisations, merging emerging intelligent toolsets with established CyberSystemic knowledge. Through a combination of these contributions, we seek to inspire individuals, institutions, and policymakers to engage in this initiative. The objective is clear: to shape a future where human originality, technological advancement, and ecological stewardship converge to cultivate a more harmonious and adaptive world.

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Section 1

Introduction: Combining Interactions in Physical, Digital, Natural, and Artificial Worlds into CyberSystemic Realities

The new, hugely *artificial intelligence* (AI)-based tools provide us with the opportunity to redesign our understanding of the world we live in. Through the convergence of physical, digital, natural, and artificial research domains, we can reshape how we understand and interact with the world around us. This integration has given rise to what can be described as ‘CyberSystemic realities’, complex environments where these different domains intersect to create new ways of thinking, working, and living. This section delves into the dynamics of these interconnected realities, exploring both the opportunities they present and the challenges they pose.

At the heart of this discussion is the concept of *interactions* – the dynamic relationships that connect systems and their components. We argue that interactions are fundamental to the very existence of systems, serving as the basis for complexity and adaptability. By providing a general model of interactions and an observation framework, we can focus on the nature and significance of interactions and reshape our understanding of the systems around us.

A key part of this exploration is the re-examination of methodologies like *critical systems intervention*, offering new ways to approach the complexities of systems intervention. By integrating principles from cybernetics, operational research, and transformative methodologies, these chapters propose innovative frameworks for effecting meaningful change in complex systems.

Emerging technologies are a major theme, with AI highlighted as a transformative force in modern systems. AI is presented as a tool that not only enhances our ability to analyse and address complex problems but also raises important questions about ethics, transparency, and accountability. Complexity analysis and case studies in healthcare and decision-making showcase the potential of AI to drive innovation while stressing the need for systems that are adaptive, ethical, and robust.

The section also examines the growing role of *collaborative robots* (Cobots) in reshaping industries. By enhancing workflows and addressing challenges like workforce shortages, cobots are positioned as catalysts for change. However, their integration is not without challenges. These chapters address the cultural and ethical considerations required to ensure that human–robot collaboration achieves its full potential in a way that benefits society.

Innovations in technology extend beyond AI, with this section introducing advances like *photonic artificial intelligence*. This emerging field leverages analogue photonic processes to model hybrid realities, offering a potential breakthrough in addressing challenges related to energy efficiency, speed, and computational accuracy.

The section also takes a closer look at the concept of intelligence itself – how it is defined, classified, and applied. By exploring the foundations of both natural intelligence and AI, the chapters provide insights into how intelligence evolves and is used to manage change and complexity in interconnected systems.

Together, these themes weave a comprehensive narrative about the realities of CyberSystemic environments. This section invites readers to consider how integrated systems can navigate complexity, uncertainty, and interdependence. Combining theoretical insights with practical examples, it offers a pathway towards creating adaptive systems that are sustainable, ethical, and capable of addressing the challenges of a rapidly changing world.

Chapter 1

Interactions – A CyberSystemic Model and an Observation Framework Proposal

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Abstract

Interactions are the dynamic part of every system, which is elaborated in nearly every domain of human exploration. However, to the best of our knowledge, a general formulation of interactions is not provided. Therefore, a CyberSystemic model of interaction with an observation framework is proposed in this chapter to help in closing this gap. To address the complexity of interactions, a combination of CyberSystemic concepts and methodologies is utilised in a comprehensive interactions model. The chapter proposes an interaction model and an observation framework leading towards an interaction meta-framework, which could be used to generate more holistic observation records, enabling reasoning on a selected interaction performance. The proposed model, invoking related structures and interactions, and a multi-point observation framework, is intended to be applicable to all instances of interactions. Its purpose is to help define and standardise interaction observation data needed for understanding each selected interaction in its environment. It proposes researchers to define complex ontologies on interactions in order to understand the interaction requisitely enough to predict their development and propose measures for reaching interaction goals. The interactions model and observation framework proposal are enabled by artificial intelligence (AI) capacity to augment human limited capacity to store and reason upon large data quantities. By formalising related data models, it enables combining data from multiple sources, enlarging data structures, the number of cases and the overall data quality, all of which affect the level of understanding of the observed interaction. Additionally, due to the standardised observation formalism, building multiple models according

to a general meta-framework enables data sharing and identifying patterns across different disciplines.

Keywords: Interactions; general meta-framework; CyberSystemics; systems thinking; cybernetics; structures

1. Introduction

Let us open the discussion with the bold statement, which leads us to start reasoning on interactions: Interactions are the reason for the existence of systems: agents, frameworks and relations exist with the single purpose of planning, preparing for and executing interactions. The background of this statement can be derived from the famous Stafford Beer quote: ‘The purpose of a system is what it does’ (Beer, 1979).

In simple terms, we can talk about interactions as actions executed between systems, triggering a reaction (Cox, 1984). They are the core communication activities within space and time. Interactions are omnipresent on all levels of existence, between (and possibly within) quarks and leptons (Afik et al., 2022), (bio)chemical interactions (Nel et al., 2009), social (Pask & de Zeeuw, 1992) and the physics of the universe (Battiston et al., 2021). The word interactions is used more than 700,000 times in Web of Science document titles.

Even though a standard definition of interaction can be found in Merriam-Webster (2024), several domain-based interaction definitions and classifications exist. From the interactions model, we can conclude that the interactions are (usually) examined as tools, a means to achieve goals. It seems that it is simpler to examine the related interaction outcomes than interactions themselves, as is the case in many models, as for instance, viable system model (VSM) (Schuhmann, 2004). We will try to open this blind spot by putting interactions in the focus point and elaborating on which structures and interactions are important for the emergence and success of an interaction.

Why should we focus on examining interactions now? Let's admit that we, people, have a relatively limited capacity to observe all the details of interactions. Usually, we focus on results only or observe a limited number of parameters of a single-player action in an interaction. To understand interactions more holistically, multiple perspectives of many interactions should be examined thoroughly. AI seems to offer tools with the capacity to measure, store and reason upon interaction data (Babina et al., 2024; Dwivedi et al., 2021). One of the important AI-related issues is the inadequate quality of data for understanding phenomena (Duan et al., 2019). An interaction-focussed perspective may help address this issue by providing organised data that AI can understand and reason upon.

We will start our journey swiftly by examining the most common definitions from various domains, such as social interactions, interactions in physics, biochemistry, visualisations and others. We then briefly introduce some of the CyberSystemic models and tools, such as the VSM (Espejo & Reyes, 2011),