Preface

Dynamics of Information plays an increasingly critical role in our society. Networks affect our lives every day. The influence of information on social, biological, genetic, and military systems must be better understood to achieve large advances in the capability and understanding of these systems. Applications are wide-spread and include: the detection of terrorist networks, the design of highly functioning businesses and computer networks, modeling the distributed sensory and control physiology of animals, quantum entanglement, genome modeling, multi-robotic systems, and industrial and manufacturing safety.

Classical Information Theory is built upon the notion of entropy which states that for a message to contain information it must dispel uncertainty associated with the knowledge of some object or process. Hence, large uncertainty means more information, small uncertainty means less information. For a networked system, classical information theory describes information that is both joint and time varying. However, for networked systems, information theory can be of limited value. It is cumbersome if not confusing to define joint and conditional information in even relatively small (Bayesian) networks. The curse of dimensionality is one large factor. So is causality, which is functionally critical to determine yet often difficult to ascertain. Entropy does not attend to the value or influence of information, even though in a network, some information, though potentially large in its entropy, could have little value or influence on the rest of the network, while another, less entropic, piece of information may have a great deal of influence on the rest of the system. How information flows and is modified through a system is not dependent upon entropy but more likely on how potentially useful the information is. How the value of information is linked to the connectedness of the network (and vice versa) is critical to analyzing and designing high performing distributed systems, yet is not well studied.

This book presents the state of the art concerning how information, usually in the form of sensing and control, influences the evolution of a distributed or networked system. Fundamentally, this deals with the potential influence information has on the system and how that information flows through a system and is modified in time and space. The chapters in this book relate to concepts that increase knowledge of the relational aspects of information as opposed to the entropic content of information.

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