The Economic Value of Information

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With 45 Figures

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To Gail, Sarah, and Dan

Preface

The Scope of This Book

Popular culture often refers to current times as the Information Age, classifying many of the technological, economic, and social changes of the past four decades under the rubric of the Information Revolution. But similar to the Iron Age before it, the description "Information Age" suggests the idea that information is a commodity in the marketplace, one that can be bought and sold as an item of value. When people seek to acquire information yet complain about information overload, and when organizations invest millions in information systems yet are unable to pinpoint the benefits, perhaps this reflects a difficulty with the assessment of the value of this commodity relative to its cost, an inability to discern the useless from the useful from the wasteful. The Information Age requires us to assess the value, cost, and gain from information, and to do it from several different viewpoints.

At the most elementary level is the individual who perceives a need for information—her current state of knowledge is insufficient and something needs to be understood, or clarified, or updated, or forecast. There is a universe of alternative information sources from which to choose, some more informative than others, some more costly than others. The individual's problem is to evaluate the alternatives and choose which sources to access.

An organization comprising many information-seeking employees and agents must take a somewhat broader viewpoint. The organization's problem is to design and manage a system for information that can meet the needs of diverse groups of individuals as those needs arise, while maximizing the organization's net gain from the services the system provides.

This is a book about the evaluation and choice of information sources by individuals and the design and management of information systems by organizations. These topics are unified by the thesis that both information sources and information systems are valuable to the extent they contribute to better decision making. Since the incorporation of information is costly in terms of money, time, and effort, optimal information use and system design involves classic economic tradeoffs between value and cost. This book studies the determinants of the value and cost of information, both to the individual and to the organization, provides techniques for the assessment of the value of information and the com-

parison of informativeness among alternative sources, and presents principles for the optimal design and management of information systems.

Decision theory is a ready-made methodology for assessing the economic value of information. Since many activities can be cast into a decision making framework, applications of decision theory are widespread, ranging from the notorious [the Ford Pinto gas tank decision, Gioia (1992)] to the nutritious [the foraging decisions of bumblebees, Real (1993)]. Applications of decision theory to the evaluation of information appear in such diverse scientific disciplines as accounting, economics, engineering, environmental science, geology, information science, management information systems, medical science, meteorology, operations research, psychology, and statistics. As Chapter 1 demonstrates, nowadays the applications are becoming more multidisciplinary in nature—decisions to study the banning of a potential carcinogen or the consequences of global warming necessarily require contributions from many fields.

Unfortunately, much of the existing literature tends to be highly specialized and technical, with little notational uniformity. Even basic words such as data, knowledge, information, and information system have different meanings in different contexts. An integrative understanding of the many aspects of information evaluation, choice, and system design requires consistency and precision in the definition of terms. One of the purposes of this book is to provide students and researchers with a unified and coherent notation and approach to this diverse multidisciplinary literature.

Research described in Chapter 9 indicates that as individuals and teams face more complex and multidisciplinary decision problems, the role of the information system becomes more critical. It is my belief that decision theory has not yet achieved its potential as a tool for corporations, governments, and other organizations to use when evaluating their information systems. One of the goals of this book is to improve the integration of the decision-theoretic approach to information value with the knowledge from information science on the design, management, and cost of cooperative information systems.

This book concentrates on a subset of a vast literature known collectively as the economics of information. The focus is on the evaluation and incorporation of information by a single decision maker, and on the cooperative facilitation of that task by an organization; with only a few exceptions, strategic and noncooperative uses of information, along with the market consequences of differential information, are excluded.

A Reader's Guide

The basic plot of this book is to move from the assessment of the economic value of a specific source, to the choice of source or sources, to the design of an organization's system for information. Although the mathematical prerequisite

for the material is no more than undergraduate courses in calculus and probability theory, there may be different ways to read this book depending upon the reader's background and interest. A student who desires to learn decision theory and its application to the evaluation of information will find Chapters 1 through 4, Sections 5.1, 5.2, 5.4, 6.1, 6.2, 7.1, 7.3, and 8.1 to be most helpful. The reader interested primarily in information systems will find Chapters 1 and 9 most pertinent. Indeed, the book is written so that those interested primarily in information science can skip directly from Chapter 1 to Chapter 9 without loss, picking up the material in between as need be. Researchers who are already familiar with decision theory and who are interested in a particular application or in the more theoretical aspects of information value will find this in Chapters 5 through 8. The primarily technical and mathematical material of this book is constrained to these four chapters; there is a detailed symbol glossary beginning on page 365 to help with the notation. Subsections that are marked with an asterisk (*) contain either peripheral or highly technical material that can be bypassed without loss of continuity.

The ideas and techniques are illustrated throughout the book by means of examples which are set off from the text by black diamonds (♦). Since they may continue through several chapters, the examples are numbered according to the section in which they first appear: Example 4.2 first appears in Section 4.2. Each example hones in on the substance of the most recently introduced topic; the purpose is to fix ideas and not to provide immediate generality. The proximate text, however, presents citations for models and theories that offer more general, technical, complex, or realistic applications.

The book holds to a number of conventions throughout. The first definition of an important term is indicated by placing that term in italics. In equations, parentheses () always denote functional dependence, and brackets [] and braces {} always indicate separation for arithmetic operation. Finally, the protagonist in this book is the decision maker. The decision maker is considered to be a person and it is convenient to use a pronoun for reference; in many languages such pronouns are indicative of gender. We can use that to our advantage by adopting the following convention from the principal–agent literature: in this book the decision maker is the principal and so is always referred to as "she," and the information source, when human, is the agent and so is always "he."

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tion, but because of depth, rigor, and clarity, in my view the greatest contributor is Jacob Marschak (1974). "It's all in Marshall" students of microeconomic theory often say; students of the economics of information and organization can equally say, "It's all in Marschak!" I would also like to thank Karl A. Fox, who introduced me to the topic, Anne Mayère of ENSSIB, whose 1995 conference on the economics of information stimulated me in several directions, and Drake University, whose generous sabbatical policy gave me the time to do this work. Special appreciation and love go to Gail, Sarah, and Dan, who tolerated a lot and to whom this book is dedicated. Finally, there are the people who put me on the right track from the very beginning: Alpha, Louise, George, Jackie, George, Annette, and Doug. Thank you.

David B. Lawrence
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