

## Behavior Dynamics in Media-Sharing Social Networks

In large-scale media-sharing social networks, where millions of users create, share, link, and reuse media content, there are clear challenges in protecting content security and intellectual property, and in designing scalable and reliable networks capable of handling high levels of traffic.

This comprehensive resource demonstrates how game theory can be used to model user dynamics and optimize design of media-sharing networks. It reviews the fundamental methodologies used to model and analyze human behavior, using examples from real-world multimedia social networks. With a thorough investigation of the impact of human factors on multimedia system design, this accessible book shows how an understanding of human behavior can be used to improve system performance.

Bringing together mathematical tools and engineering concepts with ideas from sociology and human behavior analysis, this one-stop guide will enable researchers to explore this emerging field further and ultimately design media-sharing systems with more efficient, secure, and personalized services.

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**To Our Families**

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## Preface

In the past decade, we have witnessed the emergence of large-scale media-sharing social network communities such as Napster, Facebook, and YouTube, in which millions of users form a dynamically changing infrastructure to share multimedia content. This proliferation of multimedia data has created a technological revolution in the entertainment and media industries, bringing new experiences to users and introducing the new concept of web-based social networking communities. The massive production and use of multimedia also pose new challenges to the scalable and reliable sharing of multimedia over large and heterogeneous networks; demand effective management of enormous amounts of unstructured media objects that users create, share, link, and reuse; and raise critical issues of protecting the intellectual property of multimedia.

In large-scale media-sharing social networks, millions of users actively interact with one another; such user dynamics not only influence each individual user but also affect the system performance. An example is peer-to-peer (P2P) file sharing systems, in which users cooperate with one another to provide an inexpensive, scalable, and robust platform for distributed data sharing. Because of the voluntary and unregulated participation nature of these systems, user cooperation cannot be guaranteed in P2P networks, and recent studies showed that many users are free riders, sharing no files at all. To provide a predictable and satisfactory level of service, it is important to analyze the impact of human factors on media-sharing social networks, and to provide important guidelines for better design of multimedia systems. The area of human and social dynamics has recently been identified by the US National Science Foundation (NSF) as one of its five priority areas, which also demonstrates the importance of this emerging interdisciplinary research area.

This book, *Behavior Dynamics in Media-Sharing Social Networks*, aims to illustrate why human factors are important, to show that signal processing can be used effectively to model user dynamics, and to demonstrate how such understanding of human behavior can help improve system performance. We cover recent advances in media-sharing social networks, and study two different types of media-sharing social networks, multimedia fingerprinting and P2P live streaming social networks. We review the fundamental methodologies for modeling and analyzing human behavior, and investigate the impact of human dynamics on multimedia system design. Our goal is to encourage researchers from different areas to further explore the emerging research field of behavior modeling and forensics, to improve our understanding of user dynamics in media-sharing social



networks, and ultimately to design systems with more efficient, secure, and personalized services.

We partition the book into five parts. In Part I, we illustrate the fundamental issues of media-sharing social networks, including quantitative social network analysis and media semantics, in Chapter 1; provide overviews on multimedia fingerprinting and P2P video streaming in Chapters 2 and 3, respectively; and offer an introduction to game theory that will be used throughout the later chapters in Chapter 4.

In Part II, the focus is on user dynamics in media-sharing social networks. The notion of equal-risk fairness in multimedia fingerprinting colluder social networks is addressed in Chapter 5, followed by the study of how to leverage side information to reach a better equilibrium via game-theoretical analysis in Chapter 6. The concept of risk–distortion tradeoff is considered in Chapter 7 to understand how optimal strategies may vary and depend on decisions of both attackers and detectors.

Because of the constant user interactions in social networks, cooperation becomes a major issue. Therefore, Part III is dedicated to the consideration of cooperation stimulation with the notion of fairness. Game-theoretic models with different bargaining strategies and fairness criteria are developed in Chapter 8 to study optimal strategies of feasible attacks in multimedia fingerprinting colluder social networks. In Chapter 9, an optimal cooperation strategy of cooperative stimulation in P2P video streaming is considered, followed by the study of the optimal price setting for mobile P2P video streaming in Chapter 10.

In Part IV, we turn our attention to the identification of misbehaving users. In multimedia fingerprinting social networks, even when colluders agree on a strategy, they may not execute accordingly. Instead, for example, they may cheat to take more advantage in further minimizing their own risk. In Chapter 11, such a traitor-within-traitor phenomenon is investigated. Similarly, the presence of the malicious attack will discourage nonmalicious users to join the social network. In Chapter 12, the design of methodologies to identify hostile users and the cheat-proof cooperation strategies against malicious attacks are considered.

Finally, in Part V, the impact of social network structure on the performance of social networking is discussed. In Chapter 13, the impact of centralized social networks with trusted ringleaders and distributed peer-structured social networks on multimedia fingerprinting collusion is considered, and in Chapter 14, forming a social structure with a group lead agent is investigated for P2P streaming social networks.

This book is intended to be a reference book or textbook for graduate-level courses such as social computing and networking, image and video communications and networking, and network/information security. We hope that the comprehensive coverage and a holistic treatment of media-sharing social networking will make this book a useful resource for readers who want to understand this emerging technology, as well as for those who conduct research and development in this field.

We would like to thank Mr. Yan Chen for his research contributions that are included in this book.