SpringerBriefs in Computer Science

Series editors

Stan Zdonik, Brown University, Providence, Rhode Island, USA
Shashi Shekhar, University of Minnesota, Minneapolis, Minnesota, USA
Xindong Wu, University of Vermont, Burlington, Vermont, USA
Lakhmi C. Jain, University of South Australia, Adelaide, South Australia, Australia
David Padua, University of Illinois Urbana-Champaign, Urbana, Illinois, USA
Xuemin Sherman Shen, University of Waterloo, Waterloo, Ontario, Canada
Borko Furht, Florida Atlantic University, Boca Raton, Florida, USA
V. S. Subrahmanian, University of Maryland, College Park, Maryland, USA
Martial Hebert, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA
Katsushi Ikeuchi, University of Tokyo, Tokyo, Japan
Bruno Siciliano, Università di Napoli Federico II, Napoli, Italy
Sushil Jajodia, George Mason University, Fairfax, Virginia, USA
Newton Lee, Newton Lee Laboratories, LLC, Tujunga, California, USA

SpringerBriefs present concise summaries of cutting-edge research and practical applications across a wide spectrum of fields. Featuring compact volumes of 50 to 125 pages, the series covers a range of content from professional to academic.

Typical topics might include:

- A timely report of state-of-the art analytical techniques
- A bridge between new research results, as published in journal articles, and a contextual literature review
- A snapshot of a hot or emerging topic
- An in-depth case study or clinical example
- A presentation of core concepts that students must understand in order to make independent contributions

Briefs allow authors to present their ideas and readers to absorb them with minimal time investment. Briefs will be published as part of Springer's eBook collection, with millions of users worldwide. In addition, Briefs will be available for individual print and electronic purchase. Briefs are characterized by fast, global electronic dissemination, standard publishing contracts, easy-to-use manuscript preparation and formatting guidelines, and expedited production schedules. We aim for publication 8–12 weeks after acceptance. Both solicited and unsolicited manuscripts are considered for publication in this series.

More information about this series at http://www.springer.com/series/10028

Zhi Wang · Wenwu Zhu · Shiqiang Yang

Online Social Media Content Delivery

A Data-Driven Approach

Springer

Zhi Wang
Graduate School at Shenzhen
Tsinghua University
Shenzhen, China

Shiqiang Yang
Department of Computer Science
Tsinghua University
Beijing, China

Wenwu Zhu
Department of Computer Science
Tsinghua University
Beijing, China

ISSN 2191-5768 ISSN 2191-5776 (electronic)
SpringerBriefs in Computer Science
ISBN 978-981-10-2773-4 ISBN 978-981-10-2774-1 (eBook)
https://doi.org/10.1007/978-981-10-2774-1

Library of Congress Control Number: 2018947498

© The Author(s) 2018
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

The delivery of online social video content has become an intriguing research area, along with the increasing popularity of online social networks. Traditional content delivery approaches that are designed without considering social topology and user behaviors are less efficient—if not completely ineffective—for social and socialized content delivery. To address the social video delivery problem, this book studies data-driven solutions, which jointly consider social relationship, user behavior, and content features. It focuses on the characteristics of user preferences in social media, network topology optimization and resource allocation for social content delivery, propagation-based social content replication, and social video service deployment.

1. **Joint Content- and Social-Based User Preference Mining.** The rapid growth of user-generated social videos requires content delivery systems to understand user preferences. To date, user preference inference for social video content has been studied separately: based on either content similarity or user relationships. We investigate a joint social content preference mining framework by using social factors and content factors to jointly learn which content a user will import or re-share in an online social network. In particular, we study a joint matrix completion framework. Experimental results demonstrate that the proposed approach substantially improves the preference mining relative to the baseline approaches.
2. **Enhancing Multimedia Network Resource Allocation Using Social Prediction.** Popularity patterns of social video content have greatly changed: video popularity is highly affected by online social networks, and videos can become 'viral' almost instantaneously. These changes make traditional popularity-based network resource allocation for video services suboptimal. It is intriguing to study a proactive network resource allocation strategy for social video services. Using influential factors summarized from measurement studies, we propose a learning-based framework that uses propagation parameters to predict the number of potential viewers and their geographic distribution. We present proactive strategies that determine the upload capacities of servers in

different regions. We also present experimental results that verify the effectiveness of the proposed algorithms.

3. **Propagation-Based Socially Aware Content Replication.** Online social networks have reshaped the manner in which content is generated, distributed, and consumed on today's Internet. It is intriguing to study service provision of social content for global users with satisfactory quality-of-experience. We conduct large-scale measurements of real-world online social networks to study social propagation and discover important propagation patterns, including social locality, geographical locality, and temporal locality. Motivated by the findings from the measurements, we propose a propagation-based socially aware content delivery framework that uses a hybrid edge-cloud and peer-assisted architecture. Replication strategies are further designed for the architecture based on three propagation predictors designed by jointly considering user, content, and context information. These findings and strategies change the prevalent method of content delivery, which is only based on content popularity, and significantly improve the user experience in receiving social content.
4. **Joint Online Processing and Geo-Distributed Delivery for Dynamic Social Streaming.** Adaptive social streaming has grown rapidly in popularity because it allows heterogeneous users to receive different bitrates. To date, the two important components in dynamic adaptive social streaming—video transcoding, which generates the adaptive bitrates for a video, and video delivery, which streams videos to users—have been separately studied, resulting in a significant waste of computation and storage resources due to transcoding unneeded video data and suboptimal streaming quality due to homogeneous video replication. We investigate the possibility of jointly performing video transcoding and video delivery for adaptive social streaming in an online manner according to the user preferences that are learned from their social behaviors and their preferences of edge servers to receive the video chunks. The proposal significantly improves both the user experience in adaptive social streaming and computational resources utilization of the system.

Shenzhen, China — Zhi Wang
Beijing, China — Wenwu Zhu
Beijing, China — Shiqiang Yang

Acknowledgements

We would like to express our gratitude to our colleagues, friends, and our families, who saw us through this book; to the editors and reviewers; and to all those who provided support and engaged in useful discussions.

Contents

1 Introduction 1
1.1 Background 1
1.2 Research Challenges 2
1.3 Organization and Contributions 4
References 5

2 Joint Content- and Social-Based User Preference Mining 7
2.1 Introduction 7
2.2 Related Work 9
2.2.1 Online Social Networks 10
2.2.2 Social Recommendations 10
2.2.3 Video Recommendation in the Context of Online Social Networks 11
2.3 Framework 11
2.3.1 Recommendation for Importing and Re-Sharing 12
2.3.2 Recommendation Input: Matrices from Social Networks and Content Networks 12
2.3.3 Framework of Our Recommendation 14
2.4 User-Content Matrix Update Based on Social Propagation and Content Similarity 16
2.4.1 Selecting the Entries to Update 16
2.4.2 Updating the Missing Entries 17
2.5 User-Content Space Construction and the Recommendation 19
2.5.1 Construction of the Joint User-Content Space 19
2.5.2 Recommendation Based on the User-Content Space 25
2.6 Experimental Results 25
2.6.1 Experiment Setup 25
2.6.2 Algorithm Verification 26
2.6.3 Performance Evaluation 27

2.7 Discussion . . . 30
2.7.1 Efficiency of the Recommendation Algorithms . . . 30
2.7.2 Extension of the Matrix . . . 31
References . . . 31

3 Enhancing Multimedia Network Resource Allocation Using Social Prediction . . . 33
3.1 Introduction . . . 33
3.2 Related Work . . . 34
3.3 Measurements and Analysis . . . 35
3.3.1 Collection of Traces . . . 35
3.3.2 View Number Predictability . . . 37
3.3.3 Geographic Distribution Predictability . . . 39
3.3.4 Impact of Measures at Different Time Lags . . . 40
3.4 Neural Network for View Prediction . . . 41
3.4.1 Using Neural Networks for Prediction Models . . . 42
3.4.2 Constructing Input Features . . . 42
3.4.3 Samples for Training and Evaluation . . . 43
3.4.4 Training Neural Networks . . . 44
3.4.5 Evaluating the Predication Accuracy . . . 44
3.5 Enhanced Video Service Deployment . . . 45
3.5.1 Deployment Scheme and Objective . . . 45
3.5.2 Regional Upload Bandwidth Reservation . . . 46
3.5.3 Video Replication . . . 47
3.6 Evaluating the Video Service Performance . . . 50
3.6.1 Setup of Trace-Driven PlanetLab Experiments . . . 50
3.6.2 Experimental Results . . . 51
References . . . 54

4 Propagation-Based Social Video Content Replication . . . 57
4.1 Introduction . . . 57
4.2 Related Work . . . 59
4.2.1 Propagation in Online Social Networks . . . 59
4.2.2 Social Content Replication . . . 59
4.3 Measurement of Social Content Propagation . . . 61
4.3.1 Framework . . . 61
4.3.2 Measurement Setup . . . 61
4.3.3 A Glance at the Generation, Distribution and Popularity of Social Content . . . 62
4.4 Replication Architecture Based on Propagation Patterns . . . 65
4.4.1 Social Propagation Patterns . . . 65
4.4.2 Edge-Cloud and Peer-Assisted Replication Architecture . . . 67

4.5 Replication Strategies Based on Propagation Prediction 70
4.5.1 Propagation Prediction 70
4.5.2 Replication Strategies Based on Propagation Prediction 73
4.6 Performance Evaluation 76
4.6.1 Experiment Setup 76
4.6.2 Efficiency of Edge-Cloud Replication 77
4.6.3 Efficiency of Peer-Assisted Replication 80
4.7 Discussion 81
References 82

5 Joint Online Processing and Geo-Distributed Delivery for Dynamic Social Streaming 85
5.1 Introduction 85
5.2 Related Work 87
5.3 Measurements and Observations 88
5.3.1 Measurement Setup 88
5.3.2 Measurement Insights 89
5.4 Joint Online Transcoding and Geo-Distributed Delivery 93
5.4.1 Framework 93
5.4.2 Quality-Driven Redirection 95
5.4.3 Region-Preference-Aware Transcoding Schedule 96
5.5 Performance Evaluation 99
5.5.1 Experimental Setup 99
5.5.2 Experimental Results 100
References 104

6 Concluding Remarks 107

Index 109