

Edited by CHARU C. AGGARWAL IBM T. J. Watson Research Center, Yorktown Heights, NY 10598, USA

Kluwer Academic Publishers Boston/Dordrecht/London

Contents

Preface	xiii	
1		
An Introduction to Social Network Data Analytics		
Charu C. Aggarwal		
1. Introduction	1	
2. Online Social Networks: Research Issues	5	
3. Research Topics in Social Networks	8	
4. Conclusions and Future Directions	13	
References	14	
2		
Statistical Properties of	17	
Social Networks	17	
Mary McGlohon, Leman Akoglu and Christos Faloutsos		
1. Preliminaries	19	
1.1 Definitions	19	
1.2 Data description	24	
2. Static Properties	26	
2.1 Static Unweighted Graphs	26	
2.2 Static Weighted Graphs	27	
3. Dynamic Properties	32	
3.1 Dynamic Unweighted Graphs	32	
3.2 Dynamic Weighted Graphs	36	
4. Conclusion	39	
References	40	
3		
Random Walks in Social Networks and their Applications: A Survey	43	
Purnamrita Sarkar and Andrew W. Moore		
1. Introduction	43	
2. Random Walks on Graphs: Background	45	
2.1 Random Walk based Proximity Measures	46	
2.2 Other Graph-based Proximity Measures	52	
2.3 Graph-theoretic Measures for Semi-supervised Learning	53	
2.4 Clustering with random walk based measures	56	
3. Related Work: Algorithms	57	
3.1 Algorithms for Hitting and Commute Times	58	
3.2 Algorithms for Computing Personalized Pagerank and Sim-	60	

	3.3 Algorithms for Computing Harmonic Functions	63
4.	Related Work: Applications	63
	4.1 Application in Computer Vision	64
	4.2 Text Analysis	64
	4.3 Collaborative Filtering	65
	4.4 Combating Webspam	66
5.	Related Work: Evaluation and datasets	66
	5.1 Evaluation: Link Prediction	66
	5.2 Publicly Available Data Sources	68
6.	Conclusion and Future Work	69
Refere	ences	71
4		
Communi	ty Discovery in Social	79
Netwo	orks: Applications, Methods	
and Er	nerging Trends	
S. Parthas	arathy, Y. Ruan and V. Satuluri	
1.	Introduction	80
2.	Communities in Context	82
3.	Core Methods	84
	3.1 Quality Functions	85
	3.2 The Kernighan-Lin(KL) algorithm	86
	3.3 Agglomerative/Divisive Algorithms	87
	3.4 Spectral Algorithms	89
	3.5 Multi-level Graph Partitioning	90
	3.6 Markov Clustering	91
Λ	5.7 Other Approaches	92
4.	Emerging Fleids and Problems	95
	4.1 Community Discovery in Dynamic Networks	93
	4.2 Community Discovery in Directed Networks	97
	4.4 Coupling Content and Relationship Information for Com-	70
	munity Discovery	100
5.	Crosscutting Issues and Concluding Remarks	102
Refere	ences	104
5		
J Nada Cla	raif action in Social Naturalia	115
		115
Smriti Bh	igat, Granam Cormoae and S. Mutnukrishnan	110
1.	Introduction	110
2.	Problem Formulation	119
	2.1 Representing data as a graph	119
2	2.2 The Node Classification Problem Mathedracia Level Classificant	123
3.	Methods using Local Classifiers	124
4	5.1 Iterative Classification Method	123
4.	Kandom Walk based Methods	12/
	4.1 Later Propagation 4.2 Graph Degularization	129
	4.2 Oraph Regularization	132
5	Applying Node Classification to Large Social Networks	124
5.	5.1 Basic Approaches	127
	5.2 Second-order Methods	137
	5.3 Implementation within Man-Reduce	138
		150

vi

6.	Related approaches	139
	6.2 Metric labeling	139
	6.3 Spectral Partitioning	141
	6.4 Graph Clustering	142
7.	Variations on Node Classification	142
	7.1 Dissimilarity in Labels	142
	7.2 Edge Labeling	143
0	7.3 Label Summarization	144
8.	Concluding Remarks	144
	8.1 Future Directions and Challenges 8.2 Further Reading	145
Referer	ices	146
6		
Evolution i	n Social Networks: A Survey	149
Myra Spilie	ppoulou	
1.	Introduction	149
2.	Framework	151
	2.1 Modeling a Network across the Time Axis	151
-	2.2 Evolution across Four Dimensions	152
3.	Challenges of Social Network Streams	154
4.	Incremental Mining for Community Tracing	156
5.	Tracing Smoothly Evolving Communities	160
	5.1 Iemporal Smoothness for Clusters 5.2 Dynamia Drahabilistia Madala	160
6	5.2 Dynamic Probabilistic Models	162
0. 7	Conclusion	160
7. Referer	lices	170
7		
A Survey o	f Models and Algorithms for Social Influence Analysis	177
Jimeng Sun	and Jie Tang	
1.	Introduction	177
2.	Influence Related Statistics	178
	2.1 Edge Measures	178
	2.2 Node Measures	180
3.	Social Similarity and Influence	183
	3.1 Homophily	183
	3.2 Existential lest for Social Influence	188
	3.3 Influence and Actions 3.4 Influence and Interaction	189
4	J.4 Influence Maximization in Viral Marketing	200
4.	4.1 Influence Maximization	200
	4.2 Other Applications	200
5	Conclusion	208
Referer	ices	209
0		_ 0 /
8	Algorithms and Gratama for English Lister in Grain D. (215
A Survey of	A regonantial state of the second se	213
ineoaoros	Lappas, Kun Liu ana Evimaria Terzi	

1.Introduction216

	2.	Definitions and Notation	217
	3.	Expert Location without Graph Constraints	219
		3.1 Language Models for Expert Location	219
		3.3 Further Reading	220
	4	Expert Location with Score Propagation	221
		4.1 The PageRank Algorithm	222
		4.2 HITS Algorithm	${223}$
		4.3 Expert Score Propagation	224
		4.4 Further Reading	226
	5.	Expert Team Formation	227
		5.1 Metrics	227
		5.2 Forming Teams of Experts	228
		5.3 Further Reading	232
	6.	Other Related Approaches	232
		6.1 Agent-based Approach	233
	_	6.2 Influence Maximization	233
	7.	Expert Location Systems	235
	8.	Conclusions	235
	Refere	nces	236
0			
9 • •	7	f Linh Deadistion	242
A	in Soci	al Networks	243
Mc	hamma	d Al Hasan and Mohammed I. Zaki	
WI0	1	Introduction	244
	1.	Dealeground	244
	2. 2	Easture based Link Dradiction	243
	3.	2 1 Easture Set Construction	240
		3.1 Feature Set Construction 3.2 Classification Models	247
	1	3.2 Classification Models	255
	4.	A 1 Link Prediction by Local Probabilistic Models	259
		4.1 Link Frediction by Local Frobabilistic Models 4.2 Network Evolution based Probabilistic Model	259
		4.3 Hierarchical Probabilistic Model	263
	5	Probabilistic Relational Models	263
	5.	5.1 Relational Bayesian Network	264
		5.2 Relational Markov Network	266
	6	Linear Algebraic Methods	267
	0. 7	Recent development and Future Works	269
	7. Refere	nces	270
	Refere		270
10			
Pri	vacy in	Social Networks: A Survey	277
Ele	na Zhei	eva and Lise Getoor	
	1.	Introduction	277
	2	Privacy breaches in social networks	280
		2.1 Identity disclosure	281
		2.2 Attribute disclosure	282
		2.3 Social link disclosure	283
		2.4 Affiliation link disclosure	284
	3.	Privacy definitions for publishing data	286
		3.1 <i>k</i> -anonymity	288

viii

Contents

	3.2 <i>l</i> -diversity and <i>t</i> -closeness	290
	3.3 Differential privacy	291
4.	Privacy-preserving mechanisms	292
	4.1 Privacy mechanisms for social networks	292
	4.2 Privacy mechanisms for affiliation networks	297
	4.3 Privacy mechanisms for social and affiliation networks	300
5.	Related literature	302
6.	Conclusion	302
Refe	rences	303
11		
Visualizi	ng Social Networks	307
Carlos L). Correa and Kwan-Liu Ma	
1.	Introduction	307
2.	A Taxonomy of Visualizations	309
	2.1 Structural Visualization	309
	2.2 Semantic and Temporal Visualization	313
	2.3 Statistical Visualization	315
3.	The Convergence of Visualization, Interaction and Analytics	316
	3.1 Structural and Semantic Filtering with Ontologies	319
	3.2 Centrality-based Visual Discovery and Exploration	319
4.	Summary	322
Refe	rences	323
12		
Data Mi	ning in Social Media	327
Geoffrey	Barbier and Huan Liu	
1	Introduction	327
2	Data Mining in a Nutshell	328
2.	Social Media	330
Э. Л	Motivations for Data Mining in Social Media	330
-+. 5	Data Mining Methods for Social Media	222
5.	5.1 Data Penresentation	224
	5.2 Data Mining - A Process	334
	5.2 Data Mining - A Hocess 5.3 Social Networking Sites: Illustrative Examples	336
	5.4 The Blogosphere: Illustrative Examples	340
6	Deleted Efforts	211
0.	6.1 Ethnography and Netnography	344
	6.2 Event Mans	345
7	Conclusions	345
7. Refe	rences	343
10		
15 Text Mir	ning in Social Networks	353
Chami C	Aggarwal and Haivun Wang	555
Churu C	Introduction	251
1.	IIII Oducioii Varmard Saarah	254
۷.	Actyword Search	330
	2.1 Query Semantics and Answer Kanking 2.2 Konword source VML and relational data	22/
	2.2 Reyword search over ANL and relational data	338

2.2Reyword search over graph data3603.Classification Algorithms366

4.	Clustering Algorithms	369
5.	Transfer Learning in Heterogeneous Networks	371
6.	Conclusions and Summary	373
Refei	ences	374
14		
Integration	ng Sensors and Social Networks	379
Charu C.	Aggarwal and Tarek Abdelzaher	
1.	Introduction	379
2.	Sensors and Social Networks: Technological Enablers	383
3.	Dynamic Modeling of Social Networks	385
4.	System Design and Architectural Challenges	387
	4.1 Privacy-preserving data collection	388
	4.2 Generalized Model Construction	389
	4.3 Real-time Decision Services	389
	4.4 Recruitment Issues	390
-	4.5 Other Architectural Challenges	390
5.	Database Representation: Issues and Challenges	391
6.	Privacy Issues	399
7.	Sensors and Social Networks: Applications	402
	7.1 The Google Latitude Application	402
	7.2 The Citysense and Macrosense Applications 7.2 Groop GPS	403
	7.5 Oleen OFS 7.4 Microsoft SensorMan	404
	7.5 Animal and Object Tracking Applications	405
	7.6 Participatory Sensing for Real-Time Services	406
8	Future Challenges and Research Directions	407
Refe	Pances	407
iterei		107
15		
Multime in So	dia Information Networks cial Media	413
Lianglian S. Huang	1g Cao, GuoJun Qi, Shen-Fu Tsai, Min-Hsuan Tsai, Andrey Del Pozc , Xuemei Zhang and Suk Hwan Lim	o, Thomas
1.	Introduction	414
2.	Links from Semantics: Ontology-based Learning	415
3.	Links from Community Media	416
	3.1 Retrieval Systems for Community Media	417
	3.2 Recommendation Systems for Community Media	418
4.	Network of Personal Photo Albums	420
	4.1 Actor-Centric Nature of Personal Collections	420
	4.2 Quality Issues in Personal Collections	421
	4.3 Time and Location Themes in Personal Collections	422
_	4.4 Content Overlap in Personal Collections	422
5.	Network of Geographical Information	423
	5.1 Semantic Annotation	425
	5.2 Geographical Estimation	425
(5.5 Other Applications	426
б.	Interence Methods	42/
	 6.1 Discriminative vs. Generative Models 6.2 Graph-based Inference: Ranking, Clustering and Semi-sup- Learning 	427 pervised
	Domining	420

Х

Contents			xi
	6.2		120
7	6.3 D	Unline Learning	429
/.	Discus	ssion of Data Sets and Industrial Systems	432
8.	Discus	Ssion of Future Directions	434
	8.1	Content-based Recommendation and Advertisements	434
D . C.	8.2	Multimedia information Networks via Cloud Computing	434
Refei	rences		436
16			
An Over and A	view of S Applicati	Social Tagging ons	447
Manish (Gupta, Ri	ui Li, Zhijun Yin and Jiawei Han	
1.	Introd	uction	448
	1.1	Problems with Metadata Generation and Fixed Taxonomies	449
	1.2	Folksonomies as a Solution	449
	1.3	Outline	450
2.	Tags:	Why and What?	451
	2.1	Different User Tagging Motivations	451
	2.2	Kinds of Tags	452
	2.3	Categorizers Versus Describers	453
	2.4	Linguistic Classification of Tags	454
	2.5	Game-based Tagging	455
3.	Tag G	eneration Models	455
	3.1	Polya Urn Generation Model	456
	3.2	Language Model	458
	3.3	Other Influence Factors	459
4.	Taggiı	ng System Design	460
5.	Tag ar	nalysis	462
	5.1	Tagging Distributions	463
	5.2	Identifying Tag Semantics	464
	5.3	Tags Versus Keywords	466
6.	Visual	lization of Tags	467
	6.1	Tag Clouds for Browsing/Search	468
	6.2	Tag Selection for Tag Clouds	468
	6.3	Tag Hierarchy Generation	469
	6.4	Tag Clouds Display Format	470
	6.5	Tag Evolution Visualization	470
_	6.6	Popular Tag Cloud Demos	471
7.	Tag R	ecommendations	472
	7.1	Using Tag Quality	472
	7.2	Using Tag Co-occurrences	473
	1.3	Using Mutual Information between Words, Documents and	171
	74	Tags Using Object Features	4/4
0	/. +	osting of Tags	474
0.	8 1	Indexing	475
	0.1 8 7	Search	4/3
	83	Taxonomy Generation	475
	84	Public Library Cataloging	481
	8.5	Clustering and Classification	487
	8.6	Social Interesting Discovery	483
	87	Enhanced Browsing	484
9	Integr	ation	485
1.			.00

Integration

xi