

Marija Mitrović

On-line social
communities

Network
representation
and topology

Community
structure

Emotions and
temporal
patterns

Summary and
Conclusion

User communities and emotions on popular stories

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Outline

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On-line social communities

Network representation and topology

Community structure

Emotions and temporal patterns

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Collaboration

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Summary and Conclusion

- Prof. Dr Bosiljka Tadić, Department of Theoretical Physics, Institute Jožef Stefan, Ljubljana, Slovenia.
- Dr Georgios Paltoglou, Statistical Cybernetics Research Group, School of Computing and Information Technology University of Wolverhampton, United Kingdom.

On-line social interactions

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Summary and Conclusion

- **Social media revolution.**
- Face-to-face vs. computer mediated communication.
- Web portals:
 - Blog and news sites: BBC Blog, B92 Blog, Digg, Blogspot, Wordpress,...
 - Social networks: MySpace, Facebook, Twitter, LinkedIn,...
 - Consumer and product review portals: Amazon, IMDb,...

Studies of phenomena and behaviors at scales that before were not possible!

Data from BBC Blog and Digg

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Detail records of human activity:

- High resolution in time.
- User:unique ID; details of actions.
- Posts and Comments: unique ID; ID of related users and posting times; Comment-on-Comment; texts for emotional classification.
- Users + Posts and Comments - connected network of techno-social interactions.
- Type of analysis: time series statistics; network analysis (topology and user communities) and emotional avalanches.

Emotions in text

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Summary and Conclusion

- Text of Comments (Posts) collected as data.
- Text \Rightarrow content, keywords, emotions (opinions)
- Different ways of emotion classification:
- Different scales of emotions:[0.2cm]
 - Binary scale - $e \in \{-1, 0, 1\}$ ($0 \equiv$ objective, $1 \equiv$ positive and $-1 \equiv$ negative).
 - Discrete double scale - $e_- \in \{-5, \dots, -1\}$ (degree of negative emotions) and $e_+ \in \{1, \dots, 5\}$ (degree of positive emotions).

Data size

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Source	Size	Emotional content	C-on-C
BBC	$N_U = 21426$ $N_P = 3972$ $N_C = 80873$	YES	NO
DIGG	$N_U = 484986$ $N_P = 1195808$ $N_C = 1646153$	YES	YES

Bipartite network

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communities

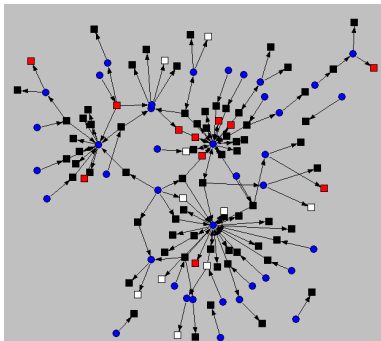
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Data within the specified time interval are mapped onto bipartite graph.



Partitions: *Users* and
Post&Comments
 $N_U + N_P + N_C$

Node representation:

- User ●
- Post or Comment: ■ (negative), ■ (positive) and □ (objective)

Link rules:

- User reading a Post(Comment): □ → ●.
- User posting a Post(Comment): ● → □.

Weighted bipartite networks

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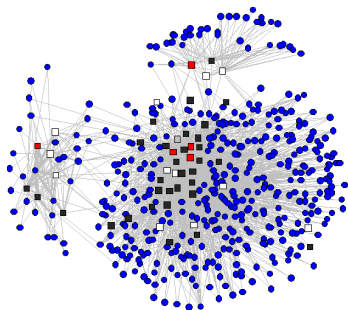
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Partitions: *Users* and
Posts
 $N_U + N_P$

Node representation:

- User ●
- Post: ■ ($Q_{av} < -0.25$), ■ ($Q_{av} > -0.25$) and □ ($|Q_{av}| < 0.25$)

Link rules:

- User left a comment on (is author of) Post: ● → □.
- Link weight - number of Comments user left on Post.

Phys. Eur. J. B, Vol. 73, 293-301, (2010)

Topological properties

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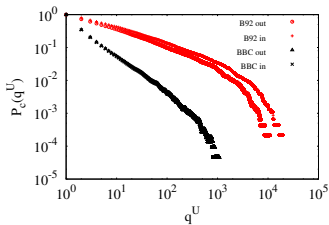
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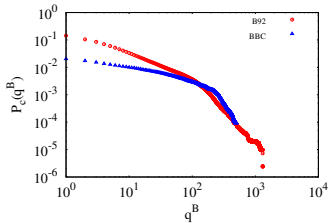
Community structure

Emotions and temporal patterns

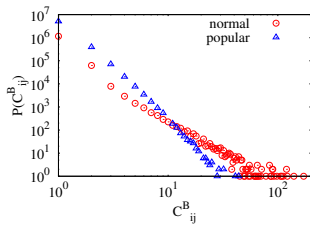
Summary and Conclusion



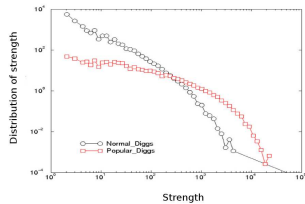
User degree



Post&Comment degree



Commons per pair of Users



User strength

EV. Spectral analysis method

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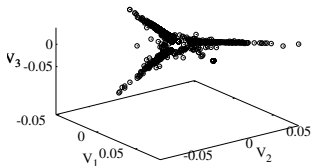
Summary and Conclusion

DATA \Rightarrow bipartite Network \Rightarrow projected Network (weighted links \Rightarrow commons, number of comments)

EV. Spectral analysis (Laplacian) \Rightarrow E. Vector -scatterplots \Rightarrow Community branches \Rightarrow ! (\Rightarrow ID of Nodes \Rightarrow ID of Posts)

$$L_{ij} = \delta_{ij} - \frac{C_{ij}}{\sqrt{l_i l_j}}$$

$$C_{ij}, W_{ij}, l_i \equiv \sum_j C_{ij}$$



[spectra of modular networks: Phys.Rev.E vol. 80, 026123 2009]

User communities BBC Popular post

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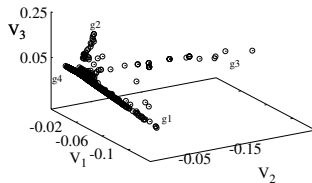
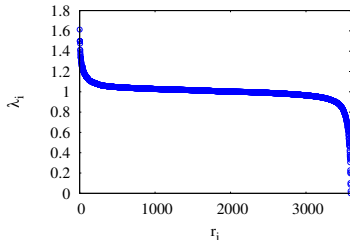
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Users related to BBC popular Posts ($n_{com} > 100$).



$$N_U = 3592, N_P = 242$$

Communities of posts and users

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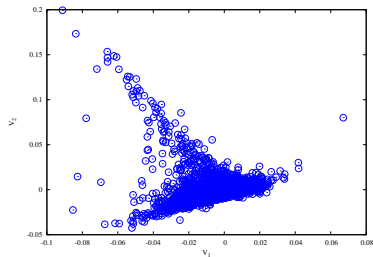
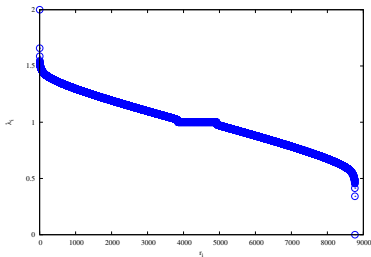
Community structure

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Summary and Conclusion

Popular discussions (more than 50% C-on-C) and Users ($l_i > 100$)

$$N_U + N_P = 4918 + 3848$$



Weighted bipartite network

Emotions on Popular stories

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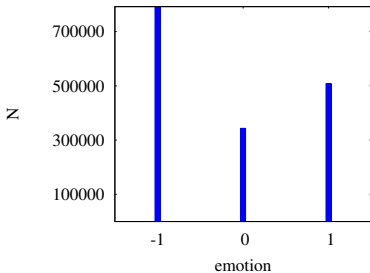
Network representation and topology

Community structure

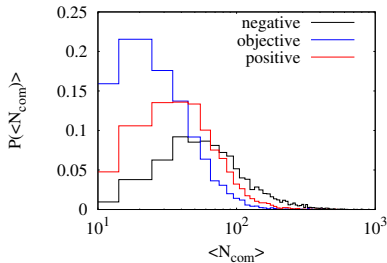
Emotions and temporal patterns

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All Posts



Popular Posts



Patterns of User emotional behaviour

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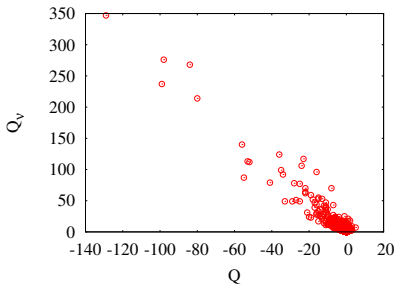
Network representation and topology

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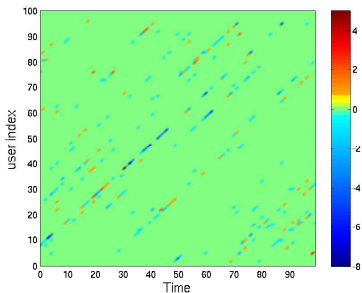
Summary and Conclusion

BBC popular Posts



$$Q = N_+^U - N_-^U$$

$$Q_v = N_+^U + N_-^U$$



Emotional series for 100 most active Users

Community evolution

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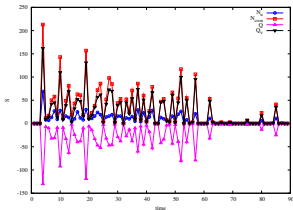
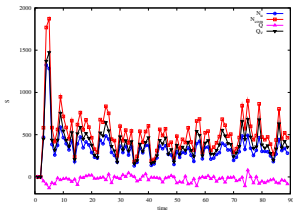
On-line social communities

Network representation and topology

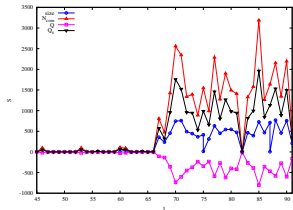
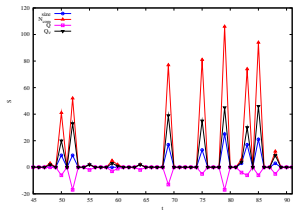
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Discussion driven popular
Digg stories



BBC popular Blogs

Emotional time series

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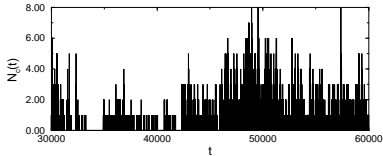
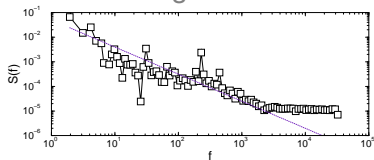
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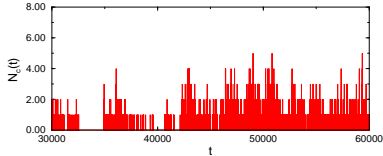
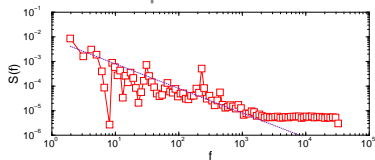
Power spectrum $S(f) = f^{-\alpha}$

negative



$\alpha = -1.1$

positive



$\alpha = -1.0$

Self-organized criticality

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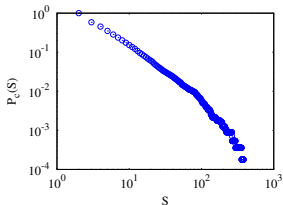
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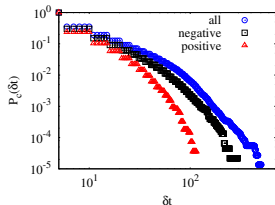
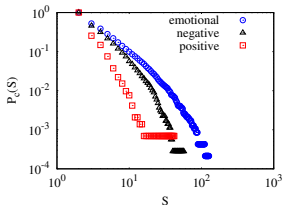
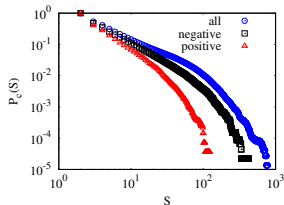
Summary and Conclusion

Distribution of avalanche sizes and time intervals between two successive avalanches - strong evidence of SOC.

BBC popular Blogs



Popular ddDigg posts



Summary

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Summary and Conclusion

- Social Media data can be represented by bipartite networks and their projections.
- Systematical detection of communities based on Eigenvalue Spectral Analysis Method.
- Evolution of communities related to emotional content of related comments.
- Analysis of time series of number of comments indicates SOC.

References I

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Appendix
For Further Reading
Sponsors



M. Mitrović and B. Tadić,

Spectral and dynamical properties in classes of sparse networks with mesoscopic inhomogeneities,
Phys. Rev. E Vol. 80, 026123 (2009)



M. Mitrović and B. Tadić

Bloggers behavior and emergent communities in Blog space
Eur. Phys. J. B Vol. 73, pp. 293-301 (2010)



J. Grujić, M. Mitrović and B. Tadić

Mixing patterns and communities on bipartite graphs of web-based social interactions
IEEE Xplore, Proceedings 16th Digital signal processing conference, (2009)



M. Mitrović, G. Paltoglou and B. Tadić

Networks and Emotions in User Communities at Popular Blogs,
DRAFT, (2010);

Projects

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Appendix

For Further Reading
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CYBEREMOTIONS

CYBEREMOTIONS EU Large Scale Integrating Project
within the 7th Framework Programme in FET ICT.

