

## REFERENCES

1. Tocoglu M.A., Ozturkmenoglu O., Alpkocak A. Emotion Analysis From Turkish Tweets Using Deep Neural Networks. *IEEE Access*, 2019. Vol. 7. Pp. 183061–183069. DOI: 10.1109/ACCESS.2019.2960113.
2. Kumar A., Narapareddy V.T., Aditya Srikanth V. et al. Detection Using Multi-Head Attention Based Bidirectional LSTM. *IEEE Access*, 2020. Vol. 8. Pp. 6388–6397. DOI: 10.1109/ACCESS.2019.2963630.
3. Dong Y., Fu Y., Wang L. et al. A Sentiment Analysis Method of Capsule Network Based on BiLSTM. *IEEE Access*, 2020. Vol. 8. Pp. 37014–37020. DOI: 10.1109/ACCESS.2020.2973711.
4. Liang H., Ganeshbabu U., Thorne T. A Dynamic Bayesian Network Approach for Analysing Topic-Sentiment Evolution. *IEEE Access*, 2020. Vol. 8. Pp. 54164–54174. DOI: 10.1109/ACCESS.2020.2979012.
5. Kumar A., Narapareddy V.T., Aditya Srikanth V. et al. Aspect-Based Sentiment Classification Using Interactive Gated Convolutional Network. *IEEE Access*, 2020. Vol. 8. Pp. 22445–22453. DOI: 10.1109/ACCESS.2020.2970030.
6. Ding W. SVM-Based Feature Selection for Differential Space Fusion and Its Application to Diabetic Fundus Image Classification. *IEEE Access*, 2019. Vol. 7. Pp. 149493–149502. DOI: 10.1109/ACCESS.2019.2944899.
7. Li M., Wu H., Zhang H. Matrix Factorization for Personalized Recommendation with Implicit Feedback and Temporal Information in Social Ecommerce Networks. *IEEE Access*, 2019. Vol. 7. Pp. 141268–141276. DOI: 10.1109/ACCESS.2019.2943959.
8. Xu J., Xu Z., Chen J. Semantic retrieval system based on ontology. *Proceedings of the 5th WSEAS International Conference on Information Security and Privacy*. World Scientific and Engineering Academy and Society, Stevens Point, Wisconsin, USA. 2006. Pp. 124–129.
9. Zhao Y., Pan S., Wu J. et al. *IEEE Access Special Section Editorial: Advanced Data Mining Methods for Social Computing*. *IEEE Access*, 2020. Vol. 8. Pp. 228598–228604. DOI: 10.1109/ACCESS.2020.3043060.
10. Rush N., Abets P., Lalue M. *Prjamoj metod Ljapunova v teorii ustojchivosti* [Lyapunov's direct method in stability theory]. Moscow: Mir, 1980. 300 p. (In Russian)
11. Cimfer S.A. Estimation of the parameters of the transition process of a linear system based on the direct Lyapunov method. *Processy upravlenija i ustojchivost'* [Control Processes and Stability]. 2016. Vol. 3. No. 1. Pp. 138–143. (In Russian)
12. Kalitine B.S. On solving the problems of stability by Lyapunov's direct method. *Russian Mathematics*. 2017. Vol. 61. No. 6. Pp. 27–36. DOI: 10.3103/S1066369X17060044.
13. Guljaeva D.R., Kiselev A.V. Application of Lyapunov methods to study the stability of systems. *Informacionnye sistemy i tehnologii: materialy dokladov II mezhdunarodnoj nauchno-tehnicheskoj zaochnoj konferencii «IST-2016»*. [Information systems and technologies: materials of reports of the II International Scientific and Technical Correspondence Conference "IST-2016"]. Kursk: Jugo-Zapadnyj gosudarstvennyj universitet, [South-West State University] 2016. Pp. 40–44. (In Russian)
14. Pljusnina T.Ju., Fursova P.V., D'jakonova A.N. et al. *Matematicheskie modeli v biologii: uchebnoe posobie* [Mathematical models in biology: a textbook]. Moscow – Izhevsk: NIC: «Reguljarnaja i haoticheskaja dinamika», 2021. 174 p. (In Russian)
15. Shchurov I.V. *Obyknovennye differencial'nye uravnenija. Interaktivnyj uchebnik* [Ordinary differential equations. Interactive textbook]. URL: <https://ode.mathbook.info/> (accessed 25.09.2020). (In Russian)
16. Vasiliev F.P. *Chislennye metody reshenija jekstremal'nyh zadach* [Numerical methods for solving the extremal problems]. Moscow: Nauka, 1988. 552 p. (In Russian)

17. Yakimov I.M., Kirpichnikov A.P., Ustinov R.D. et al. Simulation modeling in the "IThink" structural and simulation modeling system. *Vestnik Tehnologicheskogo universiteta* [Bulletin of the Technological University]. 2019. Vol. 22. No. 2. Pp. 159–164. (In Russian)

18. Minaev V.A., Sychev M.P., Kulikov L.S., Vaitz E.V. Modeling manipulative influences in social networks. *Modelirovanie, optimizacija i informacionnye tehnologii* [Modeling, optimization and information technology]. 2019. Vol. 7. No. 1. Pp. 494–510. DOI: 10.26102/2310-6018/2019.24.1.003. (In Russian)

19. Minaev V.A., Dvoryankin S.V. Foundation and description of informational and psychological destructive nature influences dynamics model in social networks. *Bezopasnost informatsionnykh tekhnologiy* [IT Security]. 2016. Vol. 23. No. 3. Pp. 35–48. (In Russian)

20. Cheng X., Fu S., de Vreede G.J. Understanding trust influencing factors in social media communication: A qualitative study. *International Journal of Information Management*. 2017. Vol. 37. No. 2. Pp. 25–35. DOI: 37.10.1016/j.ijinfomgt.2016.11.009.

MSC: 37N35; 91D30; 93D05

Original article

## DYNAMIC SYSTEM OF FUNCTIONING OF SOCIAL NETWORK COMMUNITIES

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**Abstract:** Social networks are no longer used only as a tool for global communication of various segments of society in different countries. It is turned into a socio-political asset in the struggle for the specific interests of a group of people who can acquire and/or manage this asset. In the paper we use data of a number of communities of the Russian-Ukrainian segment of the social network «Vkontakte». The study formalizes one of the functional features of a social network: a community (group). The community is considered from the position of a tool for forming opinions and aggressive influence on

a single person, some small or wide community. The issue of using information and communication technologies in a destructive way is being updated. The processes occurring in the social network community are shown in the form of a system of first-order differential equations. The system is investigated for stability by the method of Lyapunov functions. One of the tasks of the study is to identify and characterize the border regimes in which the functioning of the community goes from a stable state to chaos. The simulation model of the constructed dynamic system under different initial simulation conditions is considered. The use of mathematical physics tools to describe the processes of cyber-physical systems, including in the task of evaluating text messages with signs of aggression, in a distributed computing environment allows us to assess the trajectory of their evolution under various initial conditions.

**Keywords:** differential equations, social network services, system dynamics, information and communication technologies, stability analysis, simulation modeling, dynamic equilibrium

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