ABSTRACT AND REFERENCES

MATHEMATICS AND CYBERNETICS – APPLIED ASPECTS

ANALYSIS OF ACCURACY IN EVALUATING GRAVIMETRIC COEFFICIENTS IN THE ALGORITHM OF SPATIAL MONITORING UNDER CONDITIONS OF EXCESS (p. 4-10)

Yuri Kulyavets, Oleg Bogatov, Elena Ermakova, Peter Karlash, Vladimir Popov

Information excess allows obtaining the resulting estimate by a variety of relatively simple measuring devices and using a minimally sufficient set of primary measurements. At the same time, the estimated parameters are typically associated with the initially measured estimates on the basis of nonlinear functional equations. Therefore, a direct use of the maximum likelihood method makes it necessary to solve a system of nonlinear equations. The use of the linearization method for nonlinear functional correlations allows obtaining explicitly optimal estimates (in this case, the most plausible ones) of the resulting parameter and the correlation matrix of assessment errors. The problem of an optimal use of assessments provided by the same state vector through different simultaneously applied methods can be solved by a consistent application of the estimates' filtering algorithm. However, the weight coefficient matrix in the expression for determining the resulting estimate depends on the measured parameter values, and it is not always known a priori. One of the possible methods of obtaining the estimates of the weight coefficients matrix is to calculate direct estimates of error correlation matrices on the basis of independent discrete samples of estimates for the parameter state vector. Analytical expressions were obtained for mathematical expectation and variance of the assessment components of the error correlation matrix for determining the parameter state vector. The study has shown that the assessment accuracy depends both on the accuracy of the measuring devices and the length of the samples' line taken to determine the error correlation matrix for the parameter evaluation.

Keywords: data integration, measuring of parameters, independent meters (measuring devices), filtering of estimates, weight coefficient matrix.

References

1. Abramov, Ju. O., Grinchenko, Je. M., Kirochkin, O. Ju. et. al. (2005). Monitoryng nadzvychajnyh sytuacij. Kharkiv: ACZU, 530.
2. Bessonnyj, V. L. (2008). Ispol'zovanie metoda informacionnoj izbytochnosti dlja obespechenija dostovernosti rezul'tatov monitoringa chrezvychajnyh situacij. Problemi nadzvichajnih situacij, 8, 44–51.
3. Kondratov, V. T. (2006). Teorija izbytochnyh izmerenij. Komp'juterni zasobi, merezhi ta sistemi, 5, 23–33.
4. Hrapov, F. I. (2010). K voprosu ispol'zovanija razlichnyh vidov izbytochnosti dlja ocenki sostojanija izmeritel'nyh sistem s trudnodostupnymi pervichnymi izmeritel'nymi preobrazovateljami v processe jekspluatacii. Vestnik metrologa, 3, 11–15.
5. Shirman, Ja. D., Manzhos, V. N. (1981). Teorija i tehnika obrabotki radiolokacionnoj informacii na fone pomeh. Moscow: Radio i svjaz', 416.
6. Motylev, K. I. (2011). Obrabotka izbytochnoj traektornoj informacii s uchetom korreljacii oshibok izmerenij. Avtomatika, telemehanika, zv'jazok, 27, 45–49.
7. Bystrov, V. A., Davydov, R. N., Lebedev, E. P., Mal'cev, A. G. (1988). Vlijanie izbytochnyh izmerenij na ocenku parametrov. Moscow: RTI im. akademika A. L. Minca AN SSSR, 20.
8. Motylev, K. I., Mihajlov, M. V., Paslen, V. V. (2008). Obrabotka izbytochnoj traektornoj informacii v izmeritel'novychislitel'nyh sistemah. Avtomatika. Avtomatizacija. Jelektrotehnicheskie kompleksy i sistemy: nauchno-tehnicheskij zhurnal, 2 (22), 112–116.
9. Bondarenko, L. N., Nefed'ev, D. I. (2014). Analiz testovyh metodov povyshenija tochnosti izmerenij. Izmerenie. Monitoring. Upravlenie. Kontrol', 1 (7), 15–20.
10. Tkachenko, V. N., Korotkov, V. V., Pozdnjakov, E. K. (2013). Primenenie izbytochnosti vhodnyh dannyh v zadache opredelenija koordinat celi passivnymi mnogopozicionnymi kompleksami. Nauka i tehnika Povitrjanih Sil Zbrojnih Sil Ukraini, 4 (13), 64–67.
11. Sejdzh, Je., Mils, Dzh.; Levin, B. R. (Ed.) (1978). Teorija ocenivanija i ee primenenie v svjazi i upravlenii. Moscow: Svjaz', 496.
12. Karavaev, V. V., Sazonov, V. V. (1987). Statisticheskaja teorija passivnoj lokacii. Moscow: Radio i svjaz', 240.
13. Hohlov, M. V. (2008). Algoritm opredelenija lokal'noj topologicheskoj izbytochnosti teleizmerenij na gipergrafe izmerenij. Jenergosistema: upravlenie, konkurencija, obrazovanie. V 2 t., 1, 423–427.
14. Nagin, I. A., Shatilov, A. Ju. (2012). Algoritm kompleksirovanija NAP SRNS i avtomobil'nyh datchikov skorostej vrashhenija koles. Radiotehnika, 6, 126–130.
15. Shatilov, A. Ju. (2008). Algoritm kompleksirovanija priemnika SRNS i INS po razomknutoj sheme. Radiotehnika, 7, 19–25.
16. Surkov, V. O. (2013). Analiz sostava navigacionnyh sistem dlja podvizhnyh nazemnyh ob'ektov i principov ih postroenija. Tehnicheskie nauki: tradicii i innovacii, 34–37.
17. Gross, J. N., Gu, Y., Rhudy, M. B., Gururajan, S., Napolitano, M. R. (2012). Flight-Test Evaluation of Sensor Fusion Algorithms for Attitude Estimation. IEEE Transactions on Aerospace and Electronic Systems, 48 (3), 2128–2139. doi: 10.1109/taes.2012.6237583
18. Zhou, Z., Li, B., Shen, Y. (2013). A Window-Recursive Approach for GNSS Kinematic Navigation Using Pseudo range and Doppler Measurements. Journal of Navigation, 66 (2), 295–313. doi: 10.1017/s0373463312000549
19. Bobylev, A., Kruchinin, P., Chertopolohov, V. (2014). O sovmestnoj obrabotke pokazanij inercial'nogo bloka i sistemy videoanaliza. Fizika i radiojelektronika v medicine i jekologii. FRJeMJe'2014 s jelementami nauchnoj molodezhnoj shkoly, 1, 344–346.
20. Tautges, J., Zinke, A., Krüger, B., Baumann, J., Weber, A., Helten, T. et. al. (2011). Motion reconstruction using sparse accelerometer data. ACM Transactions on Graphics, 30 (3), 1–12. doi: 10.1145/1966394.1966397
21. Benzerrouk, H., Salhi, H., Nebylov, A. (2013). Adaptive "Cubature and Sigma Points" Kalman Filtering Applied to MEMS IMU/GNSS Data Fusion during Measurement Outlier. Journal of Sensor Technology, 3 (4), 115–125. doi: 10.4236/jst.2013.34018
22. Nikitin, O. R., Kisljakov, A. N., Shuljat'ev, A. A. (2011). Kompleksirovanie dannyh mnogokanal'nogo monitoringa zemnoj poverhnosti. Metody i ustrojstva peredachi i obrabotki informacii, 13, 68–71.

23. Alguliev, R. M., Orudzhov, G. G., Sabziev, Je. N. (2012). Kompleksirovanie izmerenij dlja identifikacii traektorii poleta letatel'nogo aparata. Mehatronika, avtomatizacija, upravlenie, 2 (131), 57–60.
24. Kuljavec', Ju. V., Bogatov, O. I., Jermako, O. A. (2013). Combining excessive data for spatial environmental monitoring. Eastern-European Journal of Enterprise Technologies, 6/9 (66), 36–39. Available at: http://journals.uran.ua/eejet/article/view/18933/17043
25. Tihonov, V. I. (1982). Statisticheskaja radiotehnika. Moscow: Radio i svjaz', 624.
26. Mirskij, G. Ja. (1972). Apparaturnoe opredelenie harakteristik sluchajnyh processov. Moscow: Jenergija, 456.
27. Agadzhanov, P. A., Dulevich, V. E., Korostelev, A. A. (Eds.) (1969). Kosmicheskie traektornye izmerenija. Radiotehnicheskie metody izmerenij i matematicheskaja obrabotka dannyh. Moscow: Sov. radio, 504.
28. Kuljavec', Ju. V., Bogatov, O. I., Jermakova, O. A. (2015). Influence of errors on the accuracy of the spatial monitoring results under redundant information. Eastern-European Journal of Enterprise Technologies, 3/9 (75), 8–13. doi: 10.15587/1729-4061.2015.44235
29. Kendal, M. Dzh., St'juart, A.; Kolmogorov, A. N. (Ed.) (1973). Statisticheskie vyvody i svjazi. Moscow: IL, 900.
30. Anderson, T.; Gnedenko, B. V. (Ed.) (1963). Vvedenie v mnogomernyj statisticheskij analiz. Moscow: Fizmatgiz, 500.
31. Krasnogorov, S. I. (1998). Matrichnyj analiz v zadachah otyskanija jekstremumov. Noginsk: Nauchno-issledovatel'skij centr 30 CNII MO, 100.

AN ALGORITHM BASED ON A POSSIBILITY MEASURE AND USED TO EVALUATE THE JOB SATISFACTION INDEX (p. 11-18)

Latafat Abbas Gardashova

Job satisfaction has been a popular topic in research for many decades. The interest in this variable has spanned academic fields that have been broached by psychologists, management, and, more recently, economists. The present study is devoted to evaluating overall job satisfaction by using a fuzzy aggregation and a possibility measure.

Many studies have been published in the area of evaluating job satisfaction. However, their methods are insufficient as they are based only on a statistical method. Therefore, perceptual data rather than numbers have been specified in this study concerning the essentials and the basic factors of job satisfaction, including such parameters as activity, independence, variety, status, supervision-human resource, supervision-technical, moral values, security, social service, authority, ability, company policies and practices, compensation, advancement, responsibility, creativity, working conditions, co-workers, recognition, and achievement. It has been proven that information determined by perception can be processed by a more adequate method, e. g., by using a fuzzy logic theory and a possibility measure.

Keywords: job satisfaction, possibility measure, fuzzy expert system, Minnesota Satisfaction Questionnaire (MSQ).

References

1. Lu, H., Barriball, K. L., Zhang, X., While, A. E. (2012). Job satisfaction among hospital nurses revisited: A systematic review. International Journal of Nursing Studies, 49 (8), 1017–1038. doi: 10.1016/j.ijnurstu.2011.11.009
2. Spector, P. E. (1997). Job satisfaction: Application, assessment, causes, and consequences, London: Sage, SAGE Publications, 104.
3. Source: Boundless. "Defining Job Satisfaction." Boundless Management. Bound-less. Available at: https://www.boundless.com/management/textbooks/boundless-management-textbook/organizational-behavior-5/drivers-of-behavior-44/defining-job-satisfaction-231-7247/
4. Locke, E. A.; Dunnette, M. P. (Ed.) (1976). The Nature and Causes of Job Satisfaction. In Handbook of Industrial and Organizational Psychology, Chicago: Rand McNally, 1297–1350.
5. Maslow, A. (2009). Motivation and Personality. Moscow: Transl., 352.
6. Herzberg, F. (1966). Work and the Nature of Man. Cleveland, World Publishing Company, 203.
7. Hackman, J. R., Oldham, G. R. (1975). Development of the Job Diagnostic Survey. Journal of Applied Psychology, 60 (2), 159–170. doi: 10.1037/h0076546
8. Judge, T. A., Larsen, R. J. (2001). Dispositional Affect and Job Satisfaction: A Review and Theoretical Extension. Organizational Behavior and Human Decision Processes, 86 (1), 67–98. doi: 10.1006/obhd.2001.2973
9. Furnham, A., Eracleous, A., Chamorro Premuzic, T. (2009). Personality, motivation and job satisfaction: Hertzberg meets the Big Five. Journal of Managerial Psych, 24 (8), 765–779. doi: 10.1108/02683940910996789
10. Mitchell, O. S., Levine, P. B., Pozzebon, S. (2013). Aging, job satisfaction, and job performance (CAHRS Working Paper #90-02). Ithaca, New York: Cornell University, School of Industrial and Labor Relations, Center for Advanced Human Resource Studies.
11. Nagy, M. S. (2002). Using a single-item approach to measure facet job satisfaction. Journal of Occupational and Organizational Psychology, 75 (1), 77–86. doi: 10.1348/096317902167658
12. Astrauskaite, M., Vaitkevicius, R., Perminas, A. (2011). Job Satisfaction Survey: A Confirmatory Factor Analysis Based on Secondary School Teachers' Sample. International Journal of Business and Management, 6 (5), 41. doi: 10.5539/ijbm.v6n5p41
13. Ewen, R. B. (1964). Some determinants of job satisfaction: A study of the generalisability of Herzberg's theory. Journal of Applied Psychology, 48 (3), 161–163. doi: 10.1037/h0048383
14. Manisera, M., Dusseldorp, E., van der Kooij, A.J. (2005). Component structure of job satisfaction based on Herzberg's theory, Rapporti di Ricerca del Dipartimento di Metodi Quantitativi, Brescia University, Working Paper, 253.
15. Behson, S. J. (2010). Using Relative Weights To Reanalyze Settled Areas Of Organizational Behavior Research: The Job Characteristics Model And Organizational Justice. International Journal of Management & Information Systems (IJMIS), 14 (5), 43. doi: 10.19030/ijmis.v14i5.12
16. Fried, Y., Ferris, G. R. (1987). The validity of the job characteristics model: a review and meta-analysis. Personnel Psychology, 40 (2), 287–322. doi: 10.1111/j.1744-6570.1987.tb00605.x
17. Gerhart, B. (2004). The (affective) dispositional approach to job satisfaction: sorting out the policy implications. Journal of Organizational Behavior, 26 (1), 79–97. doi: 10.1002/job.298

18. Seashore, S. E., Taber, T. D. (1975). Job Satisfaction Indicators and Their Correlates. American Behavioral Scientist, 18 (3), 333–368. doi: 10.1177/000276427501800303
19. Taber, T. D., Alliger, G. M. (1995). A task-level assessment of job satisfaction. Journal of Organizational Behavior, 16 (2), 101–121. doi: 10.1002/job.4030160202
20. (MSQ) Minnesota Satisfaction Questionnaire. Available at: http://vpr.psych.umn.edu/msq.html
21. Beynon, M. J., Heffernan, M., McDermott, A. M. (2012). Psychological contracts and job satisfaction: clustering analysis using evidential c-means and comparison with other techniques. Intelligent Systems in Accounting, Finance and Management, 19 (4), 247–273. doi: 10.1002/isaf.1334
22. Corrado, C., Giuseppe, D. (2007). A Fuzzy Measure of Satisfaction for University Education as a Key for Employment, Effectiveness of University education in Italy: employability, competences, human capital. Physica-Verl., 11–27.
23. Comparison of Sugeno and Mamdani Systems. Available at: http://www.mathworks.com/help/fuzzy/comparison-of-sugeno-and-mamdani-systems.html
24. Aliev, R. A., Huseynov, O. H. (2014). Decision theory with imperfect information. World Scientific Pub. Singapour, 444.
25. Zadeh, L. A. (1965). Fuzzy sets. Information and Control, 8, 338–353.
26. Aliev, R. A., Aliev, R. R. (2001). Soft Computing and its applications. World Scientific Publ., 444.
27. Klir, G. J., Folger, T. A. (1988). Fuzzy Sets, Uncertainty, and Information, Prentice-Hall of India Pvt. Ltd., New Delhi, 355.
28. Fasangarhi, M., Roudsari, F. H. (2008). The fuzzy Evaluation of E-Commerce Customer Satisfaction. World Applied Sciences Journal, 4 (2), 164–168.
29. Manua for the MN Satisfactoriness Scales. Available at: http://vpr.psych.umn.edu/assets/pdf/Monograph%20XXVII%20-%20Manual%20for%20the%20MN%20Satisfactoriness%20Scales.pdf
30. Dubois, D., Prade, H. (1980). Fuzzy sets and Systems: Theory and Applications. New York: Academic Press, 393.
31. Pappis, C. P. (2005). Constantinos I. Siettos Fuzzy reasoning. Part 15. Springer US, 437–474. doi: 10.1007/0-387-28356-0_15
32. Eyupoglu, S. Z., Saner, T. (2009). The relationship between job satisfaction and academic rank: a study of academicians in Northern Cyprus. Procedia – Social and Behavioral Sciences, 1 (1), 686–691. doi: 10.1016/j.sbspro.2009.01.120
33. Aliyev, R. A., Gulko, D. E., Shakhnazarov, M. M. (1988). Expert system for production planning. J. News of Academy of Sciences of the USSR, 5, 25–30.
34. Gardashova, L. A. (2012). Decision making in management systems of oil refinery enterprise under fuzzy environment. Baku, 308.
35. Gardashova, L. A., Aliyev, E. H. (2014). A Fuzzy approach to evaluation of democracy index. International journal of Business, Humanities and Technology, 4 (5), 94–98.
36. Gardashova, L. A. (2015). Modeling Of Decision Maker Under Imperfect Information, International Journal of Case Studies (IJCS), 4 (11), 29–40.

GRAPH THEORY METHODS IN ANALYSING COMMUTING NETWORKS OF MUNICIPAL ELECTRIC TRANSPORT (p. 19-25)

Olexiy Kuzkin

The article presents an analysis of the development of route networks of municipal passenger electric transport in five large cities of Ukraine – Donetsk, Zaporizhia, Odesa, Lviv, and Kryvyi Rih. A comparative analysis of the topological characteristics of the networks and their impact on passenger traffic is based on the graph theory and the theory of complex networks. The surveyed route networks presented in the spaces of stops, connections and routes were processed with calculations of the average degrees of vertices, the value of the average shortest path, as well as the clustering and assortativity coefficients. Passenger traffic was determined on the basis of statistical data on the annual number of shuttle trips per one city resident.

The research findings show that the electric transport networks in major cities of Ukraine occupy an intermediate position between regular and random graphs and contain features of the "tight world" The method of correlation and regression analysis has revealed that passenger traffic on average increases linearly in route networks with higher values of the average shortest path and the assortativity coefficient in the space of connections, and linearly decreases in route networks with higher values of the average vertex degree and clustering coefficient in the space of routes. The study presents a substantive interpretation of the results that can be used to substantiate route networks' development and assess the variation in passenger traffic.

Keywords: complex network, urban/municipal public transport, route network, passenger traffic.

References

1. Baxandall, P., Dutzik, T., Hoen, J. (2008). A better way to go: Meeting America's 21st century transportation challenges with modern public transit, 76.
2. Statystychnyy shchorichnyk Ukrayiny za 2015 rik (2015). Kyiv: Derzhavna sluzhba statystyky Ukrayiny, 552.
3. Shevchenko, I. Yu. (2015). Rehional'na dyferentsiatsiya avtomobilizatsiyi naselennya Ukrayiny. Ekonomika: realiyi chasu, 3 (19), 41–46.
4. Yudyn, V. A., Samoylov, D. S. (1975). Horodskoy transport. Moscow: Stroyyzdat, 287.
5. Efremov, I. S., Kobozev, V. M, Yudin V. A. (1980). Teoryia horodskykh passazhyrskykh perevozok. Moscow: Vysshaya shkola, 535.
6. Stoilova, S., Stoev, V. (2015). An application of the graph theory which examines the metro networks, 10 (2), 35–48.
7. Barthélemy, M. (2011). Spatial networks. Physics Reports, 499 (1-3), 1–101. doi: 10.1016/j.physrep.2010.11.002
8. Holovatch, Y., Olemskoi, O., von Ferber, C., Holovatch, T., Mryglod, O., Olemskoi, I., Palchykov, V. (2006). Skladni merezhi. Zhurnal fizychnykh doslidzhen', 10, 247–289.
9. Derrible, S., Kennedy, C. (2010). Evaluating, Comparing, and Improving Metro Networks. Transportation Research Record: Journal of the Transportation Research Board, 2146, 43–51. doi: 10.3141/2146-06
10. Lu, H., Shi, Y. (2007). Complexity of public transport networks. Tsinghua Science and Technology, 12 (2), 204–213. doi: 10.1016/s1007-0214(07)70027-5
11. Chatterjee, A., Manovar, M., Ramadurai, G. Statistical Analysis of Bus Networks in India. Available at: http://arxiv.org/abs/1509.04554
12. Kuz'kin, O. F. (2014). Rozvytok marshrutnykh merezh hromads'koho transportu velykykh mist Ukrayiny. Naukovi notatky, 46, 332–340.
13. Derrible, S., Kennedy, C. (2009). Network Analysis of World Subway Systems Using Updated Graph Theory. Transporta-

tion Research Record: Journal of the Transportation Research Board, 2112, 17–25. doi: 10.3141/2112-03
14. Parthasarathi, P. (2014). Network structure and metropolitan mobility. Journal of Transport and Land Use, 7 (2), 153–170. doi: 10.5198/jtlu.v7i2.494
15. Osnovni pokaznyky roboty pidpryyemstv mis'koho elektrotransportu Ukrayiny za 2013 rik [XLS document]. Available at: http://www.korpmet.org.ua/?page_id=48
16. Harary, F. (2003). Graph theory. Edytoryal URSS, 296.
17. Von Ferber, C., Holovatch, T., Holovatch, Y., Palchykov, V. (2009). Public transport networks: empirical analysis and modeling. The European Physical Journal B, 68 (2), 261–275. doi: 10.1140/epjb/e2009-00090-x
18. Dorogovtsev, S. M., Mendes, J. F. F. (2004). A shortest path to complex network, 25. Available at: http://arxiv.org/abs/cond-mat/0404593
19. Kobzar', A. Y. (2006). Prykladnaya matematycheskaya statystyka. Dlya ynzhenerov y nauchnykh rabotnykov. FYZMATLYT, 816.
20. Lashchenykh, O. A., Kuz'kin, O. F. Hrytsay, S. V. (2012). Imovirnisni i statystyko-eksperymental'ni metody analizu transportnykh protsesiv i system. Zaporizhzhya: ZNTU, 419.

FORMALIZATION OF NON-LINEAR PATTERNS OF EVOLUTIONARY ECOSYSTEM PROCESSES UNDER ANTHROPOGENESIS INFLUENCE (p. 25-31)

Leonid Plyatsuk, Yelizaveta Chernysh

The analysis of non-linear aspects of the kinetics of organic contaminants' decomposition in an aquatic ecosystem has substantiated the destruction patterns for environmental pollutants with regard to the biotic component. The findings of studying transformations in oil fractions of porous matters concern a number of indicators that are related to the biotic component of the ecosystem and previously disregarded in the sample models. In particular, it concerns the extent of biodegradation, bioassimilation and biotoxication of the natural environment. The study has revealed that these indicators influence the quality of assessing the carrying capacity of an ecosystem.

The developed formalized model of synergistic patterns in the evolution of species allows us to consider the reconstructive potential of the corresponding ecosystem and a possibility to assimilate all types of pollutants due to the genesis of species and their populations. This entails that the model includes bifurcation of genetic variability, which manifests itself through an autocatalysis process of mutations at different organisation levels of living organisms under the influence of external environmental factors (including determinism of resources and their quality). The study has disclosed a possibility of formalizing the living systems of different taxonomic ranks. The modelling accounted for the factors of self-regulation and autocatalysis at different organisation levels of the population and organisms.

Keywords: non-linear kinetics, ecosystem processes, models, anthropogenic factors, synergistic patterns.

References

1. Nikolos, G. (1990). Poznanie slozhnogo [Exploring Complexity]. Moscow: «Mir», 345.
2. Fritef, K. (2003). Pautina zhizni. Novoe nauchnoe ponimanie zhivyh sistem [The Web of Life. New scientific understanding of living systems]. Kyiv : Sofiya, 336.
3. Zimnitsky, A. V. (2003). Single model of nature is the future of modern modeling. Biosphere, 1. Available at : http://www.ihst.ru/~biosphere/03-1/Zimnigky.htm
4. Barsky, V. G. (2002). Project is the international program "The dynamic model of the biosphere". Biosphere, 1. Available at: http://www.ihst.ru/~biosphere/Mag_1/model.htm
5. Kolesnikov, A. A. (2005). Sinergeticheskie metody upravleniya slozhnymi sistemami: teoriya sistemnogo sinteza [Synergetic complex systems management methods: theory system synthesis]. Moscow: Editorial, 228.
6. Sidorenko, E. S., Khalil, V. V. (2013). Fractals in modeling of environmental systems. Energoefektivnist' v budivnictvi ta arhitekturi, 5, 125–129.
7. Malineckij, G. G. (2009). Matematicheskie osnovy sinergetiki: haos, struktury, vychislitel'nyj ehksperiment [Mathematical Foundations of Synergetics: Chaos, structures, computational experiment]. Moscow: Knizhnyj dom «LIBROKOM», 312.
8. Malineckij, G. G. (2012). Synergetics is from the past to the future. Model. i analiz inform. sistem, 19 (3), 5–31.
9. Wang, S. L., Jin, X. L., Huang, Z. L., Cai, G. Q. (2015). Break-out of dynamic balance of nonlinear ecosystems using first passage failure theory. Nonlinear Dynamics, 80 (3), 1403–1411. doi: 10.1007/s11071-015-1951-2
10. Maystruk, V., Abdella, K. (2011). Modelling the Effects of Pollution on a Population and a Resource in a Polluted Environment. Applied Mathematics, 2011, 1–31. doi: 10.5402/2011/643985
11. Tian, D., Niu, S., Pan, Q., Ren, T., Chen, S., Bai, Y., Han, X. (2015). Nonlinear responses of ecosystem carbon fluxes and water-use efficiency to nitrogen addition in Inner Mongolia grassland. Functional Ecology, 30 (3), 490–499. doi: 10.1111/1365-2435.12513
12. Destania, Y., Jaharuddin, Sianturi, P. (2015). Stability Analysis of Plankton Ecosystem Model: Affected by Oxygen Deficit. Applied Mathematical Sciences, 9 (81), 4043–4052. doi: 10.12988/ams.2015.53255
13. Bratus', A. S., Novozhilov, A. S., Platonov, A. P. (2010). Dinamicheskie sistemy i modeli biologii [Dynamic systems biology models]. Moscow: FIZMATLIT, 400.
14. Bratus', A. S., Novozhilov, A. S., Rodina, E. V. (2005). Diskretnye dinamicheskie sistemy i matematicheskie modeli v ehkologii [Discrete dynamical systems and mathematical models in ecology]. Moscow: MIIT, 139.
15. Novozhilov, A. (2002). Mathematical model of interaction with the environment pollution. Moscow: MIIT, 84.
16. Sokolov, E. M., Sheinkman, L. E., Dergunov, D. V. (2014). Nonlinear decay kinetics of phenolic compounds in the aquatic environment. Fundamental'nye issledovaniya, 9, 2677–2681.
17. Civina, I. M. (2013). Prirodno-tehnogennye kompleksy i osnovy prirodoobustrojctva. Novocherkassk: NGMA, 79.
18. Golovanov, A. I. (2001). Osnovy prirodoobustrojstva [Fundamentals of Environmental Engineering]. Moscow: Kolos, 214.
19. El'kin, Yu. E. (2006). Autowave processes. Matematicheskaya biologiya i bioinformatika, 1 (1), 27–40.
20. Aladjev, V. Z., Boica, V. K., Rouba, Y. A. (2008). Klassicheskie odnorodnye struktury: Teoriya i prilozheniya [Classical Cellular Automata: Theory and Applications]. Grodno: GrGU, 486.
21. Gordienko, V. A., Starkov, M. V. (2011). Simulation of biospheric processes and prediction in ecology from the

standpoint of synergy. Fizicheskie problemy ehkologii (ehkologicheskaya fizika), 17, 98–117.

ERGONOMICS OF IT OUTSOURCING. DEVELOPMENT OF A MATHEMATICAL MODEL TO DISTRIBUTE FUNCTIONS AMONG OPERATORS (p. 32-42)

Evgeniy Lavrov, Nadezhda Pasko, Anna Krivodub, Natalia Barchenko, Valery Kontsevich

The study suggests an optimization model for distributing a multitude of applications to implement digital control functions between operators of an IT outsourcing system. The importance of the developed model is determined by the increased complexity of human activities in automated systems and the need for prompt decisions in organizing execution of applications that are made at random times. We have proved that the task of optimizing activity selection algorithms can be achieved through describing the processes of human-computer interaction with the help of the functional network instruments that are accepted in the functional and structural theory of ergotechnical systems; ways of assigning functions to network operators can be perceived as alternatives. Furthermore, we have specified that the optimization task can be accomplished through using an activity graph and an event graph. We have studied the possibility of devising the most versatile model in the form of an event graph to formalize the tasks of distribution of functions. Each task is reduced to a linear programming problem. The suggestion can facilitate formation of decision support systems of operations managers or ergonomists-practitioners and significantly improve working conditions, operators' motivation, and cost-effectiveness of system management by increasing the correctness and timeliness of implementing activity selection algorithms for the operating personnel.

Keywords: IT outsourcing, polyergatic system, reliability, activity selection algorithm, distribution of functions.

References

1. Rothmore, P., Aylward, P., Karnon, J. (2015). The implementation of ergonomics advice and the stage of change approach. Applied Ergonomics, 51, 370–376. doi: 10.1016/j.apergo.2015.06.013
2. Bentley, T. A., Teo, S. T. T., McLeod, L., Tan, F., Bosua, R., Gloet, M. (2016). The role of organisational support in teleworker wellbeing: A socio-technical systems approach. Applied Ergonomics, 52, 207–215. doi: 10.1016/j.apergo.2015.07.019
3. Wang, Y., Zheng, L., Hu, T., Zheng, Q. (2014). Stress, Burnout, and Job Satisfaction: Case of Police Force in China. Public Personnel Management, 43 (3), 325–339. doi: 10.1177/0091026014535179
4. De Felice, F., Petrillo, A. (2011). Methodological Approach for Performing Human Reliability and Error Analysis in Railway Transportation System. International Journal of Engineering and Technology, 3 (5), 341–353.
5. Cacciabue, P. C. (2004). Human error risk management for engineering systems: a methodology for design, safety assessment, accident investigation and training. Reliability Engineering & System Safety, 83 (2), 229–240. doi: 10.1016/j.ress.2003.09.013
6. Anohin, A. N. (2014). Otechestvennaja jergonomika i jergonomicheskoe soobshhestvo: sostojanie i napravlenija razvitija. Chelovecheskij faktor: problemy psihologii i jergonomiki, 1 (68), 4–15.
7. Dul, J., Bruder, R., Buckle, P., Carayon, P., Falzon, P., Marras, W. S. et. al. (2012). A strategy for human factors/ergonomics: developing the discipline and profession. Ergonomics, 55 (4), 377–395. doi: 10.1080/00140139.2012.661087
8. Anokhin, A., Ivkin, A. (2014). Evaluation of ecological interface design for supporting cognitive activity of nuclear plant operators. Proceedings of the 5th International Conference in Applied Human Factors and Ergonomics 2014 and the Affiliated Conferences, 260–270.
9. Anokhin, A., Gorodetskiy, I., Lvov, V., Paderno, P. (2014). Education and professional development of ergonomists in Russia. Proceedings of the 5th International Conference in Applied Human Factors and Ergonomics 2014 and the Affiliated Conferences, 1017–1024.
10. Haji Hosseini, A. R., Jafari, M. J., Mehrabi, Y., Halwani, G. H., Ahmadi, A. (2012). Factors influencing human errors during work permit issuance by the electric power transmission network operators. Indian J. Sci.Technol, 5 (8), 3169–3242.
11. Anokhin, A. N. (2008). The system approach to analysis and description of operator activity. Cybernetics and Systems, 1, 82–87.
12. Adamenko, A. N., Asherov, A. T., Berdnikov, I. L. et. al. (1993). Informacionno-upravljajushhie cheloveko-mashinnye sistemy: Issledovanie, proektirovanie, ispytanija: spravochnik. Moscow: Mashinostroenie, 528.
13. Grif, M. G., Sundui, O., Tsoy, E. B. (2014). Methods of desingning and modeling of man-machine systems. Proc. of International Summerworkshop Computer Science 2014, 38–40.
14. Paderno, P., Sattorov, F. (2009). Sistemnyj administrator lokalnoj vychislitelnoj seti. Zadachi, trebovanija, otbor. Vestnik akademii nauk Respubliki Tadzhikistan, 52 (6), 437–442.
15. Lavrov, E., Pasko, N., Krybidub, A., Tolbatov, A. (2016). Mathematical models for the distribution of functions between the operators of the computer-integrated flexible manufacturing systems. Proceedings of the XIIIth International Scientific Conference TCSET'2016, 72–75.
16. Lyubchak, V., Lavrov, E., Pasko, N. (2011). Ergonomic support of man-machine interaction. Approach to designing of operators' group activities. International Journal of Bio-Medical Soft Computing and Human Sciences, 17 (2), 53–58.
17. Lavrov, E., Pasko, N. (2011). Planning of group activity of man-operators in information systems. Proceedings of the International Scientific Conference On "UNITECH '11", 1, 371–377.

DEVELOPMENT OF THE METHOD FOR TESTING OF EFFICIENCY CRITERION OF MODELS OF SIMPLE TARGET OPERATIONS (p. 42-50)

Igor Lutsenko, Elena Vihrova, Elena Fomovskaya, Olga Serdiuk

The problem of verification of indicators which are supposed to be used as criteria of efficiency of models of simple target operations is solved. For realization of such opportunity, it is offered to test the indicators on couples of reference models of simple target operations, the efficiency of which is calculated previously with the help of the developed technique and predictive indicator.

Now more than one thousand indicators are developed, which the authors-developers define as efficiency indicators. As the criterion of efficiency is a global criterion of optimization, the indicator offered for the solution of optimization tasks has to provide an adequate assessment of efficiency of the optimized process in the whole range of management. This is particularly relevant for the automatic control systems.

As a result of the research, it is established that the efficiency of target operations in some cases can be defined by using a method of a direct assessment of the process that is generated by the initial target operation. For this purpose, performance of a number of conditions is necessary: the studied target operation has to be simple; the compared operations have to be comparable relative to the starting investments; it is necessary to consider not only the data from the process generated by the cyclic performance of target operations, but also from the processes generated by the use of their target product.

The received results allow revealing the indicators that can be used to solve the optimization problems by the criterion of efficiency. Such opportunity allows passing from a paradigm of process automation to full automation of management processes by the criterion of resource efficiency.

Keywords: efficiency, method of direct efficiency evaluation, reference models of simple target operations.

References

1. Golovin, A. A., Kurasova, I. I., Chzhan-Sen, A. Ju. (2014). Faktory formirovanija pribyli v APK. Agrarnyj vestnik Urala, 1 (119), 80–83.
2. Demchuk, O. V., Aref'eva, S. G. (2015). Pribyl' i rentabel'nost' predprijatija: sushhnost', pokazateli i puti povyshenija. Problemy jekonomiki i menedzhmenta, 8 (48), 6–9.
3. Ghiani, G., Laganà, D., Manni, E., Musmanno, R., Vigo, D. (2014). Operations research in solid waste management: A survey of strategic and tactical issues. Computers & Operations Research, 44, 22–32. doi: 10.1016/j.cor.2013.10.006
4. Zheng, Y.-J., Ling, H.-F., Xue, J.-Y. (2014). Ecogeography-based optimization: Enhancing biogeography-based optimization with ecogeographic barriers and differentiations. Computers & Operations Research, 50, 115–127. doi: /10.1016/j.cor.2014.04.013
5. Makarevich, O. A. (2012). Modeli ocenki jekonomicheskoj jeffektivnosti i sistemnogo (sinergicheskogo) jeffekta tehnologicheski integrirovannoj proizvodstvennoj sistemy. Politematicheskij setevoj jelektronnyj nauchnyj zhurnal Kubanskogo gosudarstvennogo agrarnogo universiteta, 75, 1–21.
6. Baholdina, I. V., Shherbinina, Ju. V. (2013). Pribyl' na akciju kak instrument ocenki jeffektivnosti delovoj aktivnosti jekonomicheskogo sub'ekta. Upravlenie jekonomicheskimi sistemami, 11, (59).
7. Kisel'nikov, E. A., Sorochajkin, A. N., Tjukavkin, N. M. (2013). Ocenka strategii povyshenija jeffektivnosti funkcionirovanija predprijatij mashinostroenija na osnove kapitalizacii pribyli. Vestnik Samarskogo gosudarstvennogo universiteta, 4 (105), 34–42.
8. Maiju, V., Lonnqvis, A., Schiuma, G. (2014). Development of key performance indicators and impact assessment for SHOKs . Publication of the Ministry of Employment and the Economy Innovation, 27, 47.
9. Sun, Y. (2015). A new management model of university scientific research funds based on the BSC. Education Management and Management Science, 303–306.
10. Cirlin, A. M. (1986). Optimal'noe upravlenie tehnologicheskimi processami. Jenergoatomizdat, 400.
11. Lutsenko, I. (2015). Identification of target system operations. Development of global efficiency criterion of target operations. Eastern-European Journal of Enterprise Technologies, 2/2 (74), 35–40. doi: 10.15587/1729–4061.2015.38963
12. Lutsenko, I. (2015). Identification of target system operations. 2. Determination of the value of the complex costs of the target operation. Eastern-European Journal of Enterprise Technologies, 1/2 (73), 31–36. doi: 10.15587/1729-4061.2015.35950