GENERAL SCHEMES OF THE COMBINING RULES OF EVIDENCE AND A POSTERIORI CHARACTERISTICS OF QUALITY OF COMBINING

Lepskiy Alexander Evgenyevich
Professor of Higher Mathematics department,
National Research University Higher School of Economics
Russia, 101000, Moscow, 20 Myasnitskaya str., HSE. E-mail: alepskiy@hse.ru.

Received 11.08.2014, revised 08.11.2014.

Some general schemes and examples of aggregation of two belief functions into a single belief function are considered in this paper. We find some sufficient conditions of change of ignorance when evidences are combined with the help of various rules. It is shown that combining rules can be regarded as pessimistic or optimistic depending on the sign of the change of ignorance after applying.

Keywords: evidence theory, belief function, combining rules, imprecise index.

Nechetkie Sistemy i Myagkie Vychisleniya [Fuzzy Systems and Soft Computing], 2014, vol. 9, no. 2, pp. 93–114.

References

[1] Dempster A.P. Upper and lower probabilities induced by a multivalued mapping. *The Annals of Mathematical Statistics*, vol. 38, no. 2, 1967, pp. 325–339. doi:10.1214/aoms/1177698950

[2] Zadeh L.A. Review of a mathematical theory of evidence. *AI Magazine*, vol. 5, no. 3, 1984, pp. 81–83. doi:10.1609/aimag.v5i3.452

[3] Yager R. On the Dempster-Shafer framework and new combination rules. *Information Sciences*, vol. 41, no. 2, 1987, pp. 93–137. doi:10.1016/0020-0255(87)90007-7

[4] Dubois D., Prade H. Representation and combination of uncertainty with belief functions and possibility measures. *Computational Intelligence*, vol. 4, no. 3, 1988, pp. 244–264. doi:10.1111/j.1467-8640.1988.tb00279.x

[5] Sun Q., Ye X.Q., Gu W.K. A new combination rules of evidence theory. *Acta Electronica Sinica*, vol. 28, no. 8, 2000, pp. 117–119.

[6] Xin G., Xiao Y., You H. An improved Dempster-Shafer algorithm for resolving the conflicting evidences. *International Journal of Information Technology*, vol. 11, no. 12, 2005, pp. 68–75.

[7] Deqiang H., Chongzhao H., Yi Y. A modified evidence combination approach based on ambiguity measure. *Proc. of the 11th International Conference on Information Fusion*. Cologne, Germany, 2008, pp. 1–6.

[8] Sentz K., Ferson S. Combination of evidence in Dempster-Shafer theory. Report SAND 2002-0835, Sandia National Laboratories, 2002.

[9] Grabisch M., Marichal J.L., Mesiar R., Pap E. *Aggregation Functions*. Cambridge University Press, Cambridge, 2009.

[10] Smets P. The combination of evidence in the transferable belief model. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 12, no. 5, 1990, pp. 447–458. doi:10.1109/34.55104

[11] Cheng Y., Kashyap R.L. An axiomatic approach for combining evidence from a variety of sources. *Journal of Intelligent and Robotic Systems*, vol. 1, no. 1, 1988, pp. 17–33. doi:10.1007/BF00437318

[12] Johnson N.L., Kotz S. Axiomatic approaches to formulas for combining likelihoods or evidence. *Journal of Statistical Computation and Simulation*, vol. 31, no. 1, 1989, pp. 49–54. doi:10.1080/00949658908811113

[13] Jiao L., Pan Q., Liang Y., Feng X., Yang F. Combining sources of evidence with reliability and importance for decision making. *Central European Journal of Operations Research*. Springer, Berlin, Heidelberg, 2013. doi:10.1007/s10100-013-0334-3

[14] Shafer G. *A Mathematical Theory of Evidence*. Princeton University Press, Princeton, 1976.

[15] Lepskiy A. About relation between the measure of conflict and decreasing of ignorance in theory of evidence. *Proc. of the 8th conference of the European Society for Fuzzy Logic and Technology (EUSFLAT-13)*. Atlantis Press, Amsterdam, Beijing, Paris, 2013, pp. 355–362. doi:10.2991/eusflat.2013.56

[16] Inagaki T. Interdependence between safety-control policy and multiple-sensor schemes via Dempster-Shafer theory. *IEEE Transactions on Reliability*, vol. 40, no. 2, 1991, pp. 182–188. doi:10.1109/24.87125

[17] Bronevich A., Lepskiy A. Measuring uncertainty with imprecision indices. *Proc. of the Fifth International Symposium on Imprecise Probability: Theories and Applications (ISIPTA'07)*. Prague, Czech Republic, 2007, pp. 47–56.

[18] Dubois D., Prade H. A note on measures of specificity for fuzzy sets. *International Journal of General Systems*, vol. 10, no. 4, 1985, pp. 279–283. doi:10.1080/03081078508934893

[19] Dubois D., Prade H. On the combination of evidence in various mathematical frameworks. *Reliability Data Collection and Analysis*. Ed. by J. Flamm, T. Luisi. Springer, 1992, pp. 213–241.

[20] Lepskiy A. General schemes of combining rules and the quality characteristics of combining. *Lecture Notes in Computer Science*, vol. 8764. Belief Functions: Theory and Applications. Ed. by F. Cuzzolin. Springer, 2014, pp. 29–38. doi:10.1007/978-3-319-11191-9_4

[21] Zhang L. Representation, independence, and combination of evidence in the Dempster-Shafer theory. *Advances in the Dempster-Shafer Theory of Evidence*. Ed. by R.R. Yager, J. Kacprzyk, M. Fedrizzi. John Wiley and Sons, New York, 1994, pp. 51–69.

[22] Deza E.I., Deza M.M. *Entsiklopedicheskii slovar' rasstoyanii* [Encyclopedic Dictionary of Distances]. Nauka Publ., Moscow, 2008. 444 p. (in Russian)

[23] Bronevich A.G., Lepskiy A.E. Operators for convolution of fuzzy measures. *Advances in Intelligent and Soft Computing*, vol. 16. Soft Methods in Probability, Statistics and Data Analysis. Ed. by P. Grzegorzewski, O. Hryniewicz, M.A. Gil. Physica-Verlag HD, 2002, pp. 84–91. doi:10.1007/978-3-7908-1773-7_5

[24] Bronevich A.G. On the closure of families of fuzzy measures under eventwise aggregations. *Fuzzy Sets and Systems*, vol. 153, no. 1, 2005, pp. 45–70. doi:10.1016/j.fss.2004.12.005

[25] Bronevich A.G. Necessary and sufficient consensus conditions for eventwise aggregation of lower probabilities. *Fuzzy Sets and Systems*, vol. 158, no. 8, 2007, pp. 881–894. doi:10.1016/j.fss.2006.10.020

[26] McConway K.J. Marginalization and linear opinion pools. *Journal of the American Statistical Association*, vol. 76, no. 374, 1981, pp. 410–414. doi:10.1080/01621459.1981.10477661

[27] Bronevich A.G., Lepskiy A.E. On axiomatic approach to the definition of an index of fuzzy measures error. *Trudy 2-go mezhdunarodnogo seminara «Integrirovannye modeli i myagkie vychisleniya v iskusstvennom intellekte»* [Proceedings of the 2nd International Workshop «Integrated Models and Soft Computing in Artificial Intelligence»]. Fizmatlit Publ., Moscow, 2003, pp. 127–130. (in Russian)

[28] Higashi M., Klir G.J. Measures of uncertainty and information based on possibility distributions. *International Journal of General Systems*, vol. 9, no. 1, 1983, pp. 43–58. doi:10.1080/03081078208960799

[29] Golub G.H., Ortega J.M. *Scientific Computing and Differential Equations: An Introduction to Numerical Methods*. Academic Press, 1991. 344 p.

[30] Dubois D., Prade H. A set-theoretic view of belief functions. Logical operations and approximation by fuzzy sets. *International Journal of General Systems*, vol. 12, no. 3, 1986, pp. 193–226. doi:10.1080/03081078608934937

Bibliographic citation

Lepskiy A.E. General schemes of the combining rules of evidence and a posteriori characteristics of quality of combining. *Nechetkie Sistemy i Myagkie Vychisleniya* [Fuzzy Systems and Soft Computing], 2014, vol. 9, no. 2, pp. 93–114. (in Russian)