CARPATHIAN J. MATH.
Volume **41** (2025), No. 4,
Pages 1061 - 1077

Online version at https://www.carpathian.cunbm.utcluj.ro/
ISSN 1584-2851 (Print edition); ISSN 1843-4401 (Electronic)
DOI: https://doi.org/10.37193/CJM.2025.04.14

A glimpse of some common concepts in algebras of logic and uncertain environments

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ABSTRACT. The aim of this paper is to investigate some concepts that appear both in algebras of logic and in various uncertain environments. The first part of the paper is devoted to study F-ideals in residuated lattices and some of their properties. If L is a residuated lattice and μ is a F-ideal in L then the binary relation $\sim_{\mu_{\mu(0)}}$ is an equivalence relation on L and we investigate the algebraic structure of the factor set.

In the second part of the paper, some applications of FNs in uncertain environments are discussed. Inventory games are considered in the case of imprecise parameters of EOQ and EPQ models. Computing with $TrFNs$ is detailed and some formulas for solving games when players cooperate are presented. Computational details and numerical examples are included.

ACKNOWLEDGMENTS

The authors are grateful to the referees for their useful suggestions and comments which led to an improvement of the paper.

REFERENCES

[1] Attallah, M. Completely fuzzy prime ideals of distributive lattices. *The Journal of Fuzzy Mathematics.* **8** (2000), no. 1, 153-156.
[2] Andriolo, A.; Battini, D.; Grubbström, R.W.; Persona, A.; Sgarbossa, F. A century of evolution from Harris's basic lot size model: Survey and research agenda, *Int. J. Production Economics.* **155** (2014), 16-38.
[3] Björk, K.-M. A multi-item fuzzy economic production quantity problem with a finite production rate. *Int. J. Production Economics.* **135** (2012), 702-707.
[4] Borzooei, R. A.; Kologani, M. A.; Rezaei, G. R.; Takallo, M. M. Closure operators on hoops. *An. Ştiint. Univ. Ovidius, Constanta Ser. Mat.* **32** (2024), no.1, 85-104.
[5] Buşneag, D.; Piciu, D.; Dina, A. Ideals in residuated lattices. *Carpathian J. Math.* **37** (2021), no.1, 53-63.
[6] Buckley, J.J.; Feuring, T.; Hayashi, Y. Solving fuzzy problems in operations research: inventory control. *Soft Comput.* **7** (2002), 121-129.
[7] Cignoli, R.; D'Ottaviano, I.M.L.; Mundici, D. *Algebraic Foundations of many-valued Reasoning*. Trends in Logic-Studia Logica Library 7, Dordrecht: Kluwer Academic Publishers, 2000.
[8] Chang, C.C. Algebraic analysis of many-valued logic. *Trans. Amer. Math. Soc.* **88** (1958), 467-490.
[9] Chang, S.-C. Fuzzy production inventory for fuzzy product quantity with triangular fuzzy number. *Fuzzy Sets and Systems.* **107** (1999), 37-57.
[10] Chen, S.H.; Wang, C.-C.; Chang, S.M. Fuzzy Economic Production Quantity Model for Items With Imperfect Quality. *International Journal of Innovative Computing, Information and Control.* **3** (2007), no. 1, 85-95.
[11] Fiestras-Janeiro, M.G.; García-Jurado, I.; Meca, A.; Mosquera, M.A. Cooperative Game Theory and Inventory Management. *European J. Oper. Res.* **210** (2011), no. 3, 459-466.
[12] Ganga, G.M.D.; Carpinetti, L.C.R. A fuzzy logic approach to supply chain performance management. *Int. J. Production Economics.* **134** (2011) 177-187.
[13] Gagolewski, M. (aut, cre); Caha, J (ctb). FuzzyNumbers. *CRAN repository*. https://cran.r-project.org/ web/ packages/FuzzyNumbers/FuzzyNumbers.pdf (2019).

Received: 01.04.2025. In revised form: 31.07.2025. Accepted: 11.09.2025
2020 *Mathematics Subject Classification.* 06D35, 68T99, 93C42, 90B30, 90C70, 91B06.
Key words and phrases. *Residuated lattice; F-ideal; Inventory model; Inventory game.*
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[14] Gagolewski, M.; Caha, J. A Guide to the 'Fuzzy Numbers' Package for R. *CRAN*. https://cran.r-project.org/web/packages/FuzzyNumbers/vignettes/Fuzzy NumbersTutorial.pdf (2019).
[15] Hoo, C. S. Fuzzy ideals of BCI and MV-algebras. *Fuzzy Sets and Systems*. **62** (1994), 111-114.
[16] Hsieh, C.H. Optimization of fuzzy production inventory models. *Inform. Sci.* **146** (2002), 29-40.
[17] Iorgulescu, A. Classes of BCK algebras-Part III. *Preprint Series of The Institute of Mathematics of the Romanian Academy*. **3** (2004), 1-37.
[18] Klir, G.J.; Yuan, B. *Fuzzy sets and fuzzy logic*. Theory and applications, Prentice Hall PTR, New Jersey, 1995.
[19] Karwowski, W.; Evans, G.W. Fuzzy concepts in production management research: a review. *Int. J. Prod. Res.* **24** (1986), no. 1, 129-147.
[20] Lin, D.-C.; Yao, J.-S. Fuzzy economic production for production inventory. *Fuzzy Sets and Systems*. **111** (2000), 465-495.
[21] Liu, L.; Li, K. Fuzzy filters of BL-algebras. *Inform. Sci.* **173** (2005), no. 1-3, 141-154.
[22] Liu, Y.; Qin, Y.; Qin, X.; Xu, Y. Ideals and fuzzy ideals in residuated lattices. *Int. J. Math. Learn and Cyber*. **8** (2017), 239-253.
[23] Meca, A.; Timmer, J.; García-Jurado, I.; Borm, P. Inventory games. *European J. Oper. Res.* **156** (2004), 127-139.
[24] Meca, A.; García-Jurado, I.; Borm, P. Cooperation and competition in inventory games. *Math. Meth. Oper. Res.* **57** (2003), 481-493.
[25] Meca-Martinez, A.; Timmer, J. B.; Garcia-Jurado, I.; Borm, P. E. M. Inventory Games. *Center Discussion Paper* **1999-53** (1999), Tilburg: Microeconomics, https://pure.uvt.nl/ws/portalfiles/portal/532178/53.pdf
[26] Mula, J.; Poler, R.; García-Sabater, J.P.; Lario, F.C. Models for production planning under uncertainty: A review. *Int. J. Production Economics*. **103** (2006), 271-285.
[27] Nieves, A.S. Inventorymodel. *CRAN repository*. (2017) https://cran.r-project.org/web/packages/Inventorymodel/ Inventorymodel.pdf .
[28] Pai, P.-F.; Chang, P.-T.; Wang, S.-S.; Lin, K.-P. A fuzzy logic - based approach in capacity - planning problems. *Int. J. Adv. Manuf. Technol*. **23** (2004), 806-811.
[29] Park, K.S. Fuzzy-set theoretic interpretation of economic order quantity. *IEEE Transactions on Systems, Man and Cybernetics*. **17** (1987), no. 6, 1082-1084.
[30] Piciu, D. Prime, minimal prime and maximal ideals spaces in residuated lattices. *Fuzzy Sets and Systems*. **405** (2021), 47-64.
[31] Piciu, D.; Dan, C.; Boboc, F. Remarks on some connections between ideals and filters in residuated lattices. *An. Ştiint. Univ. Ovidius, Constanta Ser. Mat.* **32** (2024), no.2, 145-155.
[32] Turunen, E. *Mathematics Behind Fuzzy Logic*. Physica-Verlag, 1999.
[33] Turunen, E.; Mertanen, J. States on semi-divisible residuated lattices. *Soft Comput.* **12** (2008), 353-357.
[34] Vujošević, M.; Petrovicć, D.; Petrovicć, R. EOQ formula when inventory cost is fuzzy. *Int. J. Production Economics*. **45** (1996), 499-504.
[35] Ward, M.; Dilworth, R. P. Residuated lattices. *Trans. Amer. Math. Soc.* **45** (1939), no. 3, 335-354.
[36] Wang, Y.-M.; Yang, J.-B.; Xu, D.-L.; Chin, K.-S. On the centroids of fuzzy numbers. *Fuzzy Sets and Systems.* **157** (2006), no.7, 919-926.
[37] Zadeh, L. A. Fuzzy sets. *Information and Control*. **8** (1965), no. 3, 338-353.
[38] Zadeh, L. A. The concept of linguistic variable and its application to approximate reasoning. I. *Inform. Sci.* **8** (1975), no.3, 199-249.
[39] Zadeh, L. A. The concept of linguistic variable and its application to approximate reasoning. II. *Inform. Sci.* **8** (1975), no.4, 301-357.
[40] Zadeh, L. A. The concept of linguistic variable and its application to approximate reasoning. III. *Inform. Sci.* **9** (1975), no.1, 43-80.

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