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Title: What Does Data Fusion bring to Mutlimodal Machine Learning

Short Description: It is well known that the performance of machine learning algorithms depends to a large extent on the quality of data available for training. When data are coming from various sensors, data fusion allows to create a higher quality model training. This preprocessing step will produce fused data sets of higher quality in terms of uncertainty, consistency, compactness and accuracy. Data Fusion (DF) is the process of combining observations from a number of different sensors to provide a robust and complete description of an environment or process of interest. Multisensor data fusion finds wide application in many areas, such as Robotics (object recognition, environment mapping, and localization), Satellite and aerial imaging, Medical imaging, Sonar and radar and imaging for aerospace applications, IoT platforms and Artificial Intelligence. As sensors are most often used under conditions that induce difficulties at different levels (- measurements may be imprecise, erroneous, incomplete, or ill suited to the problem - prior knowledge be incomplete, poorly defined, and may not fit any more with the reality encountered, especially when the context is evolving - observations may be ambiguous, either in space or in time), it is therefore necessary to define formalisms that are sufficiently general to represent and combine all types of information that may be encountered. In this talk, we discuss the principle of Multimodal Machine Learning (MML) and show the interest of DF in MML. Then, we present the foundations of Dempster-Shafer theory (named also belief functions or evidence theory) for data fusion purpose. It represents a general formalism in the sense that (i) it allows modeling both uncertainty and imprecision; (ii) it is a generalization of both Bayesian and Possibilistic models. We discuss the different evidential combination rules both from the semantic and computational sides. The important issues related to managing the level of conflict of the sources and to scalability are addressed as well.

Keywords: Machine Learning, Data fusion, Multisensor data, Dempster-Shafer theory, Belief functions, Uncertainty, Ambiguity, Combination rules, Degree of conflict, Decision making.

Short Bio: Allel HADJALI is Full Professor in Computer Science at the National Engineering School for Mechanics and Aerotechnics (ISAE-ENSMA), Poitiers, France. He is a member of the Data & Model Engineering research team of the Laboratory of Computer Science and Automatic Control for Systems (LIAS/ISEA-ENSMA). His main area of research falls within Data Science field, and more specifically, the research topics related to Data Exploitation & Analysis (sensor data, semantic data, incomplete data), Knowledge Extraction and Recommendation. His current research interests include Soft Computing and Computational Intelligence in Databases (Cooperative/Intelligent Databases, Data fusion/integration, Data quality, Data Uncertainty, Data Privacy and Trust), Machine Learning-based Recommendation and Explainable Artificial Intelligence. His recent works were published in well-known journals (e.g., Applied Soft Computing, Knowledge and Information Systems, Fuzzy Sets and Systems, International Journal of Intelligent Systems, Journal of Intelligent Information Systems and Annals of Mathematics and Artificial Intelligence). He also published several papers in International Conferences (ESWC, ICTAI, Fuzz-IEEE, DEXA, FQAS, SUM, ISMIS, IPMU, CoopIS, IFSA, ACM SAC, ICWS, SCC, ER, VLDB and EDBT (demo papers)). He co-organized several special sessions on "*Advances in Soft Computing Applied to Databases and Information Systems*" in conjunction with EUSFLAT (2009 and 2011) Conference, *"Advances in Bipolarity in Databases"* in conjunction with EUSFLAT (2013), *"Advances in Data Management in the Context of Incomplete Databases"* in conjunction with IFSA (2015) Conference, "*Uncertainty in Cloud Computing*" in conjunction with DEXA (2017) . He co-organized also several special issues in well-known journals, among them, *"Flexible Queries in Information Systems"* in Journal of Intelligent Information Systems (2009), *"On Advances in Soft Computing Applied to Databases and Information Systems"* in Fuzzy Sets and Systems Journal (2011), "*Post LFA 2015 Conference*" in Fuzzy Sets and Systems Journal (2017), *"Uncertain Cloud"* in International Journal of Approximate Reasoning (2019). The complete list of his publications is available in http://www.lias-lab.fr/members/allelhadjali.