

Assessing the Environmental Performance of the Food Industry Using Unsupervised Machine Learning

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Abstract. Due to the growing world population, the environmental impact of food production and consumption has increased, and traditional analytic methods have become automatically insufficient to assess the environmental performance in the agri-food sector. In the food industry, environmental impact assessments have usually been conducted on one representative of each food category, which does not provide a complete comprehension of any potential differences in environmental impacts within products in the same category. This paper seeks to answer the following question how to deploy unsupervised Machine Learning algorithms in order to evaluate the environmental performance of food products belonging to the same category? To answer this question, an academic case study has been carried out in which we applied unsupervised ML algorithms on the environmental impacts of an existing Life Cycle Assessment (LCA) dataset of 80 pizzas representative of the 2010 French retail market in order to cluster the LCA's values and create multiple groups, which would help to determine which pizzas varieties will have the highest impact on the environment. Spectral Clustering with 3 clusters yielded the highest silhouette score of 0.5885, indicating its superior performance in partitioning the reduced data into meaningful clusters compared to K-means and DBSCAN. The study found that the environmental impact of pizzas was significantly influenced by the presence of beef and "Edam cheese," as well as ingredient production, solid board, and plastic film packaging, while slight changes in ingredient processing can have an impact on the overall usage of ingredients and energy consumption during manufacturing.

Keywords: Machine Learning, Environmental Performance, Sustainability, Food Industry, Clustering Algorithms, Unsupervised Learning, Life Cycle Assessment.