PREDICTING DELIVERY DELAYS WITH MACHINE LEARNING: A CASE STUDY OF THE MULTIMETAL COMPANY

This teaching material presents a case study illustrating the application of machine learning in outbound logistics, based on the example of Multimetal, a family-owned company located in Częstochowa that has been operating since 1990. The company specializes in galvanization (zinc coating), welding services, and the production of construction fittings. It serves B2B clients across Poland and the European Union within a make-to-order production model.

The central problem concerns delivery delays, affecting an estimated 10–15% of orders and negatively impacting customer relationships and financial performance. The company's previous approach has been predominantly reactive, with issues identified only after delivery deadlines had been exceeded. The multi-stage production process, product diversity, fluctuations in the production queue, and dependence on material availability and transportation constitute the key risk factors.

The proposed solution involves implementing a proactive predictive model based on the H2O AutoML platform, which automatically trains more than 20 classification models, including Gradient Boosting Machines (GBM), XGBoost, Random Forest, deep learning models, and ensemble methods. For validation purposes, a synthetic dataset of 500 orders was developed, including 17 predictive variables grouped into four categories: order, customer, production, and time-related data. The target variable is defined as a binary classification of delivery delay (0/1). The implementation is planned across four phases over approximately 3–4 months, with relatively low costs due to the platform's open-source nature.

The best-performing model – StackedEnsemble_BestOfFamily – achieved an accuracy of 70% (AUC-ROC: 0.7476). Variable importance analysis identified *Product_Category* as the most influential predictor (100%), followed by *Quantity* (81%), *Production_Queue* (78%), *Distance_km* (65%), and *Order_Value* (58%). Based on these findings, three recommendations were formulated: (1) differentiated lead time standards for product categories, (2) automated alerts for orders exceeding 500 units, and (3) threshold-based notifications regarding production queue status.

The outcome is a validated concept of a decision-support tool, confirming the technical feasibility of the proposed solution. The expected impact of full-scale implementation includes a 10–20% reduction in delivery delays and a 15–25% increase in customer satisfaction, with a projected return on investment (ROI) within 6–12 months. Further development includes integration with enterprise resource planning systems, delay duration prediction, and AI-driven optimization of production planning.

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