

# Coffee Roasting Degree Identification and Interpretability Analysis Using Multi-dimensional Visual Features and CNNs-SHAP

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## Abstract

Developing a dedicated detection model with both high accuracy and strong interpretability has become an alternative approach to addressing the standardization challenge in Yunnan coffee roasting. However, research on applying SHapley Additive exPlanations (SHAP) interpretable models to coffee bean roast degree identification and feature analysis remains scarce. This study proposes an interpretable coffee roast degree identification method based on multi-dimensional visual features and CNNs-SHAP. We fused CIE Lab\* color histograms, Gray-level Co-occurrence Matrix-Local Binary Pattern (GLCM-LBP) texture features, and morphological parameters, and employed convolutional neural networks for classification. After SHAP-based feature selection, external validation accuracies reached 100.0% for dark-roasted, 93.8% for medium-roasted, and 91.5% for light-roasted samples, respectively. SHAP analysis revealed a significant negative linear correlation between key features and predicted values, with traceable decision logic. This work breaks the black-box limitation of deep learning, achieves high accuracy and strong interpretability, and provides a technical solution for standardized and intelligent quality control in coffee roasting.

## References

- [1] Lu, S., Qin, Q., Yu, Y., Ren, Z., & Li, Z. (2026). Machine learning-enhanced spectroscopic analysis in coffee quality assessment: Current challenges and future prospects. *Microchemical Journal* 223, 117363.
  - [2] Lu, S., Zhao, J., Qin, Q., Deng, W., Yu, Y., Huang, Y., . . . Li, Z. (2026). Identification of roasting degree and interpretability analysis of Yunnan arabica coffee beans based on multi-dimensional visual features and CNNs-SHAP. *Food Chemistry* 508, 148367.
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