Price Calculation for Cashew using supervised learning techniques

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Abstract: Inconsistency and subjectivity in grading cashews result in price inefficiencies, market conflicts, and a lack of trust in agricultural value chains. To address this, this paper suggests a grading and price prediction framework for cashews using artificial intelligence, comprising machine learning, deep learning, and an agentic optimization component. The structured data set comprising 8,000 annotated cashew samples was constructed using official grading standards, considering visual attributes and contextual metadata such as size, quality, location, date, and market price. To classify cashew quality, this paper implemented a Random Forest classifier and a Support Vector Machine classifier as a baseline, and a neural network to predict visual quality. The proposed framework links visual quality assessment with economic intelligence, making it a potential tool for modernizing cashew trade, eliminating human bias, and promoting price transparency. The framework has wider implications for other quality-based agricultural commodities.

Keywords: Cashew Images; Price Calculation; Machine Learning; Deep Learning; Image Classification

Introduction

The process of agricultural commodity grading is important in product value determination, market transparency, as well as the efficiency of the supply chain. In cashew business, grading has been conducted manually using the hands of human beings who are qualified in terms of grading the kernels. This is despite the fact that the process, experience judgment of size, breakage and surface quality in the expert grading process is subjective, time consuming and the ultimate result of the process is inconsistency both in the region and among the inspectors. The effect of this fluctuation is that it creates a price conflict and inefficiency in agricultural trade and this occurs in the export based markets where it is needed to be standardized [1]. The recent development in computer vision and artificial intelligence (AI) has provided the gateway to automated inspection systems, which can produce objective quality assessment, which can be repeatedThe researchers have discovered that AIs-based food quality monitoring systems are less prone to human biases and are more scalable and enhance the consistency of food quality [2]. The DNNs (in particular, deep convolutional neural networks) have proved to be highly effective in detecting even the tiniest visual defects and change in the grade that could not have been detected otherwise by the human senses [3].

With all these developments, the majority of the current agricultural grading models were based on the arbitration of the correctness of the categorization, and was not economically smart (e.g., dynamic price estimation with regards to the quality properties).The recent studies in adaptive and agentic artificial intelligence have shown that it is essential to automatically optimize the models, ongoing retraining and intelligent decision levels that allow the system to adapt to new information [4]. These adaptive frameworks are now being considered as a major reducing deployment in digital farming [5]. Cashew nuts are even worse with grading due to the fine appearance of inter-grade, identification of broken kernels and by capture environment. An efficient and practical automated system should then be afterwards integrated in the form of pre-processing, segmentation, feature extraction, classification and economic modeling in a pipeline developed well and with adaptability. To do it, a regulated set of stamped cashew images which will align with formal grading and financial data is created. Secondly, machine learning and deep learning algorithms are also relatively compared to determine the accuracy of grading and price prediction. Third, an agentic AI layer is added to help in automated model selection, hyperparameter optimization, and adaptive retraining to make the system more robust in the long run. According to the proposed model, using smart automation, the agricultural commodity markets can be fair, efficient, and transparent and promote the use of AI in the framework of the contemporary digital agriculture [6].

Related work

A. Quality Grading Systems No substantial development was made on the use of automated quality grading system in agriculture. It is the fresh emerging events that have brought light of innovativeness to the grading system of agriculture based on artificial intelligence as an alternative to the manual system of agricultural grading. It has been mentioned that the CNNs-based image-based grading systems and the classical ML-based image-based grading systems have been reported to reduce labour usage and increase the throughput of the crop grading systems [8]. The CNNs were graded automatically which was convenient to replace the manual assessment and boost the level of uniformity in the grading of the entire industry [9].

Key Contribution

In-applicability to high-value products e.g. cashews: It is not documented in peer-reviewed articles on cashews, but in the fruits like apple, mango and sweetpotato [16]. Lack of harmonization of price forecast: According to the case study, there is little to no harmonization of quality of price judgment and market economies. Weakness in adaptive agentic AI: The vast majority of the models are not developed with dynamism in mind as a phenomenon of dynamically layer automated optimization of datasets or dynamically. Weakness of robustness testing Systems are not typically tested in literature under conditions of different lighting conditions and practiced under a market situation.

Method, Experiments and Results

In this paper, a graded dataset with 8,000 cashew nut images was utilized and where the dataset was supposed to reflect the variability of the real-world grading in commercial supply chains. Every sample has been graded according to the official standards of grading that are given by the Cashew Export Promotion Council of India that gives a domain-related tagging and industry relatability. Multi-task learning is facilitated by an attached structured metadata on each picture. The metadata fields include:

- Classification of commercial grade.
- Physical size category

- Quality indicators
- Market price
- Geographic origin
- Date of acquisition

It is a hybrid type of data that integrates visual and economic data whereby it is possible to classify (quality grading) and regress (price prediction). The stratification of sampling approach was executed to provide statistical fairness. The data was divided into:

- 70% training set
- 15% validation set
- 15% testing set

Stratification will ensure that distributions of grades across all splits will be similar and remove imbalance of classes and increase reliability of generalization. The experimental paradigm will test three types of computational paradigms based on the traditional machine learning, deep learning, and adaptive agentic AI layer.

Discussions

The dataset that would be developed would be 8,000 annotated cashew samples of which would be real world case and pricing. The classification was reasonably weight balanced with three dominant classes where three of them (Jumbo, Regular, and Special grades) were proportionate and it is this that results in the models being trained without any sort of discrimination.

Conclusions

The paper will demonstrate that it is feasible to replace human grading that is subjective with objective and consistent grading with the help of AI-based grading solutions. The methods of machine learning and deep learning demonstrated good results in recognizing the quality of cashews and predicting their economic value which affirms the promise of automated cashew grading in agricultural markets. An agentic AI layer also increases the efficiency of the operations due to the ability to automatically choose a model, optimize and continually optimize the performance. Based on the results of the experiments, it is proven that the given framework is resilient to changes in the real world, therefore, it could effectively be used in the working environment. The system allows the visual quality evaluation as well as intelligent price prediction to offer a single pipeline linking agricultural production and AI based economic analytics. The paper underlies the foundation of scaled electronic grading systems capable of facilitating the cashew trade processes and treat the export standardization. Also, the framework can be readily extended to other agricultural products where pricing also entails visual quality assessment, which facilitates a broader digital revolution in agri-economics.

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