**DIMAOND PRICE PREDICTION USING COMPUTER VISION WITH SENSOR NETWORK**

**A MINOR PROJECT SYNOPSIS**

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**INTRODUCTION**

Diamond price prediction involves forecasting the price of a diamond based on various characteristics, commonly referred to as the "4 Cs": Carat, Cut, Colour, and Clarity. These features significantly influence a diamond's market value, along with other factors such as market demand, economic conditions, and global trends.

The main motivation for this paper is to initiate a supervised machine learning technique for predicting diamond prices.

**OBJECTIVE**

The objective of a diamond price prediction project is to develop a reliable model that accurately estimates the price of a diamond based on its characteristics. The project aims to:

* **Enhance Pricing Accuracy**: Provide precise and consistent pricing for diamonds, minimizing human error and subjectivity.
* **Support Retailers:** Help jewellers set competitive and fair prices for their diamond inventory.
* **Guide Investment Decisions:** Assist investors in evaluating the potential value and appreciation of diamonds as assets.
* **Empower Consumers:** Enable consumers to make informed purchasing decisions by providing accurate price estimates.
* **Adapt to Market Trends:** Ensure the model is responsive to changes in the diamond market, including economic fluctuations and shifts in consumer preferences.

**METHODOLOGIES AND TOOLS USED**

**Data Collection:**

**Objective:** Gather a comprehensive dataset containing diamond features (Carat, Cut, Colour, Clarity, Shape, etc.) and corresponding prices.

**Tools:** Web scraping tools (e.g., BeautifulSoup, Scrapy), APIs from diamond marketplaces, CSV files from grading laboratories.

**Data Preprocessing:**

**Objective:** Clean and prepare the data for modelling by handling missing values, outliers, and converting categorical features.

**Steps:**

* Data Cleaning: Remove or impute missing values.
* Data Transformation: Normalize or scale numerical data, encode categorical data (e.g., using one-hot encoding).
* Feature Engineering: Create new features or refine existing ones to improve model performance.

**Tools:** Python libraries (Pandas, NumPy, Scikit-learn).

**Exploratory Data Analysis (EDA):**

**Objective:** Understand the data distribution, relationships between variables, and identify patterns.

**Steps:**

* Visualize data distribution and correlations.
* Identify key features influencing the diamond prices.

**Tools:** Matplotlib, Seaborn, Plotly.

**Model Selection:**

**Objective:** Choose the appropriate machine learning model(s) for predicting diamond prices.

**Common Models:**

**Linear Regression:** Simple model to understand the linear relationship between features and price.

**Decision Trees/Random Forests:** For capturing non-linear relationships.

**Gradient Boosting Machines (GBMs):** For high accuracy through boosting.

**Neural Networks:** For complex, non-linear relationships.

**Tools:** Scikit-learn, XGBoost, TensorFlow, Keras.

**Model Training:**

**Objective:** Train the selected model on the training dataset to learn the relationship between diamond features and prices.

**Steps:**

* Split the dataset into training and testing sets.
* Train the model on the training set.

**Tools:** Scikit-learn, TensorFlow, Keras.

**Model Validation and Evaluation:**

**Objective:** Validate the model’s performance on the testing dataset and evaluate using relevant metrics.

**Steps:**

* Evaluate using metrics like Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), R-squared.
* Perform cross-validation to ensure robustness.

**Tools:** Scikit-learn, Pandas.

**Model Optimization (Optional):**

**Objective:** Improve model performance by tuning hyperparameters or using more advanced techniques.

**Steps:**

* Hyperparameter tuning using GridSearchCV or RandomizedSearchCV.
* Experiment with different model architectures (for neural networks).

**Tools:** Scikit-learn, TensorFlow, Keras, Optuna.

**Prediction:**

**Objective:** Use the trained and validated model to predict prices for new diamonds.

**Tools:** Trained machine learning model, Scikit-learn, Pandas.

**Deployment:**

**Objective:** Deploy the model for real-time predictions in a production environment.

**Tools:**

* APIs: Flask, FastAPI for creating web services.

Cloud Platforms: AWS, Google Cloud, Azure for deployment

* Docker: For containerizing the application.

**Monitoring and Updating:**

**Objective:** Continuously monitor model performance and update with new data to maintain accuracy.

**Tools:** Monitoring tools (e.g., Prometheus, Grafana), retraining pipelines (e.g., using MLFlow, TensorFlow Extended).

Tools Summary:

1. Data Handling: Pandas, NumPy.

2. Visualization: Matplotlib, Seaborn, Plotly.

3. Modeling: Scikit-learn, TensorFlow, Keras, XGBoost.

4. Model Evaluation: Scikit-learn, Cross-validation tools.

5. Deployment: Flask, FastAPI, Docker, Cloud Platforms (AWS, GCP, Azure).

6. Monitoring: Prometheus, Grafana, MLFlow.

**ADVANTAGES**

1. **Increased Pricing Accuracy:** Provides objective, data-driven price estimates, reducing human error.

2. **Efficiency:** Automates pricing, saves time, and can handle large inventories.

3. **Market Competitiveness:** Enables competitive pricing and quick adaptation to market trends.

4. **Better Investment Decisions:** Helps investors assess diamond value and reduce risks.

5. **Customer Empowerment:** Ensures transparency and helps consumers make informed purchasing decisions.

6. **Cost Savings:** Reduces appraisal costs and lowers operational expenses.

7. **Standardization:** Ensures consistent pricing across similar diamonds and industry benchmarking.

8. **Faster Time-to-Market:** Speeds up the pricing and market entry process.

9. **Enhanced Consumer Confidence:** Builds trust and educates consumers on fair pricing.

10. **Scalability and Adaptability:** Easily scales and updates with new data or market changes.

**APPLICATIONS**

1. **Market Analysis:** Helps investors and traders understand market trends, make informed investment decisions, and identify profitable opportunities.

2. **Inventory Management:** Assists jewellers and dealers in managing their inventory by predicting future prices, helping them decide when to buy or sell diamonds.

3. **Insurance Valuation:** Provides accurate valuations for insurance purposes, ensuring that diamonds are properly insured against loss or damage.

4. **Consumer Decision-Making:** Guides consumers in making informed purchases by predicting future price trends, potentially saving money on high-value purchases.

5. **Supply Chain Optimization:** Enhances efficiency in the diamond supply chain by predicting price fluctuations, which can impact sourcing and distribution strategies.

6. **Economic Research:** Contributes to broader economic studies by providing insights into the diamond market’s behaviour and its impact on global economic co