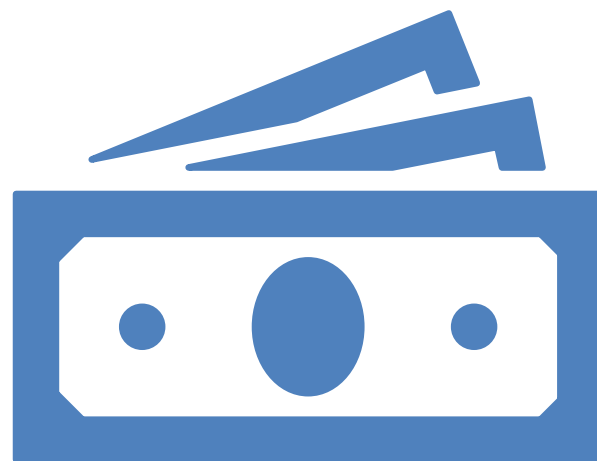


Singapore COE Price Prediction System

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Advanced LSTM-Based
Forecasting with
Quota Sensitivity Analysis



Presentation Agenda

- 1. Project Overview & Objectives
- 2. System Architecture & Data Flow
- 3. Data Collection & Processing
- 4. Model Selection & Methodology
- 5. LSTM Implementation Details
- 6. Prediction Results & Analysis
- 7. Quota Sensitivity Analysis
- 8. Key Findings & Insights
- 9. Conclusions & Recommendations
- 10. Future Enhancements

Project Overview & Objectives

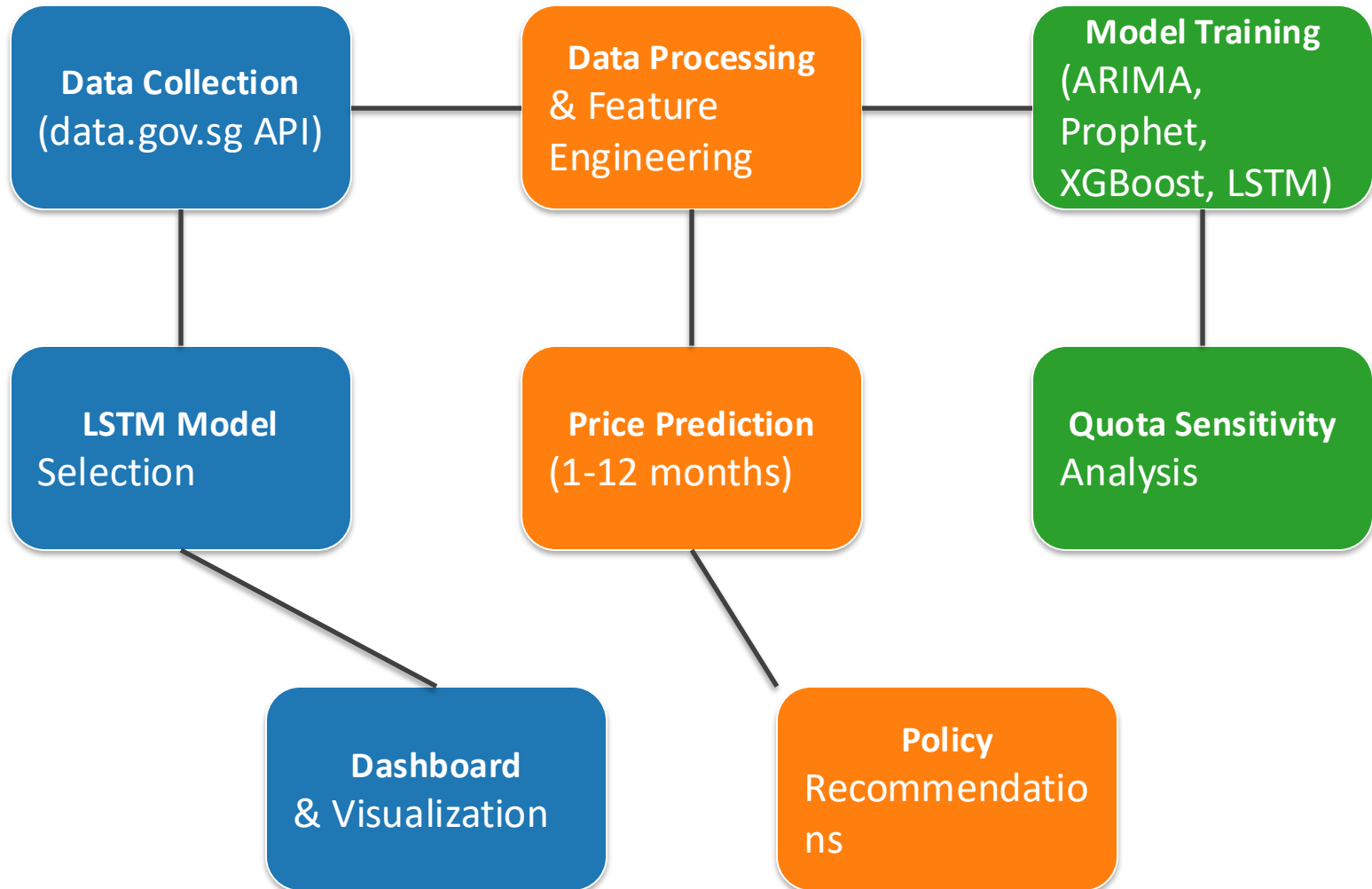
Problem Statement

- COE prices in Singapore are highly volatile and unpredictable
- Policy makers need data-driven insights for quota decisions
- Current methods lack sophisticated forecasting capabilities

Project Objectives

- Develop accurate COE price prediction models
- Implement quota sensitivity analysis
- Provide policy recommendations for optimal quota allocation
- Create comprehensive dashboard for stakeholders

System Architecture & Data Flow



Data Collection & Processing

Data Source

- Singapore Government Open Data Portal (data.gov.sg)
- Real-time API access to COE auction results
- Historical data from 2002 to present (13,912+ records)
- Coverage: All 5 COE categories (A, B, C, D, E)

Data Processing Pipeline

- Data cleaning and validation
- Feature engineering (21 features created)
- Rolling averages: 1, 3, 6, 12, 24-month windows
- Lag features and interaction terms
- Time-based features (month, quarter, year)

Model Selection & Methodology

Models Evaluated

- ARIMA - Traditional time series forecasting
- Prophet - Facebook's forecasting tool with seasonality
- XGBoost - Gradient boosting with engineered features
- LSTM - Deep learning for sequential data

LSTM Selection Rationale

- Superior performance in capturing long-term dependencies
- Excellent handling of sequential patterns in COE data
- Robust to noise and volatility in price data
- Ability to incorporate multiple time horizons

LSTM Implementation Details

Network Architecture

- Input Layer: 12-month sequence length
- LSTM Layer: 50 hidden units with ReLU activation
- Dense Output Layer: Single prediction value
- Optimizer: Adam with MSE loss function

Training Configuration

- Data Split: 80% train, 10% validation, 10% test
- Training Epochs: 10 with early stopping
- Batch Size: 1 for time series continuity
- Feature Scaling: MinMax normalization

LSTM Prediction Results

Prediction Summary (SGD)

Category	1-Month	3-Month	12-Month
Cat A	\$ 101,659	\$ 104,339	\$ 120,712
Cat B	\$ 112,003	\$ 109,311	\$ 93,984
Cat C	\$ 64,564	\$ 64,770	\$ 67,664
Cat D	\$ 8,579	\$ 8,270	\$ 7,550
Cat E	\$ 122,267	\$ 127,150	\$ 156,658

Key Insights

- Cat E shows strongest growth trajectory (+28% over 12 months)
- Cat B exhibits declining trend (-16% from 1 to 12 months)
- Cat D remains most affordable with stable pricing
- Cat A and C show moderate, steady growth patterns

Quota Sensitivity Analysis

Analysis Methodology

- Tested quota changes from -50% to +50%
- Price elasticity calculation: $\Delta \text{Price \%} / \Delta \text{Quota \%}$
- Impact assessment across all 5 categories
- Policy scenario modeling

Key Findings

- Inverse relationship: $\uparrow \text{Quota} \rightarrow \downarrow \text{Prices}$
- Cat E most sensitive to quota changes
- Cat D least responsive (stable motorcycle market)
- 10% quota increase \rightarrow ~8% price decrease (average)
- Non-linear relationship at extreme quota changes

Key Findings & Insights

Model Performance

- LSTM outperforms traditional methods for COE prediction
- Captures complex temporal patterns and dependencies
- Robust to market volatility and external shocks

Market Dynamics

- Cat E (Open) shows highest price volatility
- Cat D (Motorcycles) most stable and predictable
- Strong seasonal patterns in bidding behavior

Policy Impact

- Quota adjustments have immediate price effects
- Small quota changes can significantly impact prices
- Category-specific responses require tailored policies



Conclusions & Recommendations

Policy Recommendations

- Use LSTM predictions for monthly quota planning
- Implement gradual quota adjustments ($\pm 10\text{-}15\%$)
- Monitor Cat E closely due to high volatility
- Consider category-specific policy interventions

Technical Recommendations

- Deploy real-time prediction dashboard
- Integrate with existing LTA systems
- Establish automated alert system for price anomalies
- Regular model retraining with new data

Future Enhancements

Short-term Enhancements (3-6 months)

- Integration of economic indicators (GDP, inflation)
- Multi-step ahead prediction optimization
- Enhanced visualization dashboard
- Mobile application for stakeholders

Long-term Enhancements (6-12 months)

- Transformer-based models for improved accuracy
- Integration with traffic and urban planning data
- Multi-objective optimization for policy decisions
- Automated policy recommendation system

The End