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The Prosperity Metric: A Global Economic Freedom Audit with Neural Network Classification

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ABSTRACT: This project presents an interactive, single-page web application that audits and visualizes economic freedom across 176 countries using the Heritage Foundation's 2025 Index of Economic Freedom. The system integrates machine learning models — a Linear Regression model for score prediction and a feed forward Neural Network (12→10→5 architecture with ReLU and Soft max activation) for category classification achieving 92% accuracy — with comprehensive economic data from the IMF World Economic Outlook 2025 and World Bank WDI 2024. All monetary values are converted to Indian Rupees (₹) using the Indian numbering system (Lakh, Crore). The platform features seven interactive modules: Country Data Explorer, Interactive World Map, 12 Indicators Reference, Full Rankings with Regional Filtering, ML Predictions with a real-time What-If Simulator, Economic Analysis with Freedom-Prosperity Correlation, and a Multi-Country Comparison Tool with automated ML insights. The neural network weights are embedded directly in JavaScript, enabling complete client-side inference without any server back-end. The project demonstrates how predictive analytic and data visualization can make complex economic data accessible and actionable.

KEYWORDS: Economic Freedom Index, Neural Network Classification, Linear Regression, Heritage Foundation, GDP Analysis, Indian Rupee, Interactive Visualization, D3.js, What-If Simulator, Confusion Matrix, Multi-Country Comparison, Web Application.

I. INTRODUCTION

Economic freedom — the ability of individuals to control their own labor and property — is widely recognized as a key driver of national prosperity. The Heritage Foundation has published its **Index of Economic Freedom** annually since 1995, evaluating 12 indicators across 4 pillars (Rule of Law, Government Size, Regulatory Efficiency, and Open Markets) for countries worldwide. The 2025 edition ranks 176 countries, revealing that the global economy remains “mostly unfree” with an average score of 59.7 out of 100.

While the raw data is publicly available, it exists primarily in static PDF reports and spreadsheets that are difficult to explore interactively. Moreover, the connection between economic freedom scores and real-world economic outcomes (GDP, growth, investment, inequality) is not immediately apparent from the data alone. This project addresses both gaps by building a comprehensive, interactive web platform that:

- Visualizes all 176 countries' freedom scores, indicators, and rankings in an interactive interface
- Applies Machine Learning (Neural Network + Linear Regression) to classify and predict economic freedom
- Links freedom scores to real economic data (GDP, growth, FDI, Gini coefficient) converted to Indian Rupees
- Enables multi-country comparison with automated insights

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The entire application is a single HTML file (~215 KB) with embedded data, trained ML weights, and all logic — requiring no server, no database, and no internet connection to operate. This makes it highly portable and suitable for academic demonstrations.

II. LITERATURE SURVEY

The Heritage Foundation's Index of Economic Freedom (2025) is the primary authoritative source for economic freedom measurement, covering 12 indicators across 176 countries. Research consistently shows a strong positive correlation between economic freedom and per-capita income, with "Free" economies generating incomes more than three times higher than "Repressed" economies.

Neural network classification has been widely applied in socioeconomic analysis. Feedforward networks with ReLU activation and Softmax output layers are standard for multi-class classification tasks. Xavier/Glorot initialization and gradient clipping are established best practices for training stability.

Interactive data visualization tools like D3.js and Tableau have transformed how economic data is communicated. Single-page applications (SPAs) using vanilla JavaScript offer maximum portability and zero-dependency deployment. The IMF World Economic Outlook and World Bank World Development Indicators are the gold standards for cross-country economic comparison.

This project uniquely integrates ML classification, economic correlation analysis, and interactive visualization into a single portable HTML application, bridging the gap between academic data science and accessible public understanding of global economic freedom.

III. TECHNOLOGIES USED**HTML5, CSS3, JavaScript (Vanilla)**

The entire frontend is built using pure HTML5, CSS3, and Vanilla JavaScript with no frameworks or build tools. CSS custom properties (variables) ensure consistent theming. The application uses a tab-based navigation system with 7 modules. Google Fonts (Playfair Display, Outfit, JetBrains Mono) provide professional typography.

Python (ML Training)

Python was used for offline model training. The neural network and linear regression were implemented from scratch using only basic math operations — no scikit-learn, TensorFlow, or PyTorch for the actual training loop. This demonstrates fundamental understanding of back propagation, gradient descent, and weight optimization. Trained weights were exported as JSON and embedded in the HTML.

D3.js + TopoJSON

D3-geo and TopoJSON are used for rendering an interactive choropleth world map with Natural Earth projection. Countries are color-coded by freedom category with hover tool-tips and click-to-select functionality. A static region-based fallback is provided for offline use.

Data Sources

- **Heritage Foundation** — 2025 Index of Economic Freedom (176 countries, 12 indicators each)
- **IMF World Economic Outlook** — October 2025 (GDP per capita PPP, GDP growth rates)
- **World Bank WDI 2024** — Gini coefficient, FDI inflows (% of GDP)
- **RBI Reference Rate** — 1 USD = ₹87 (March 2026) for INR conversion

IV. PROPOSED METHODOLOGY

The system architecture integrates data collection, ML model training, weight export, and client-side inference into a unified workflow:

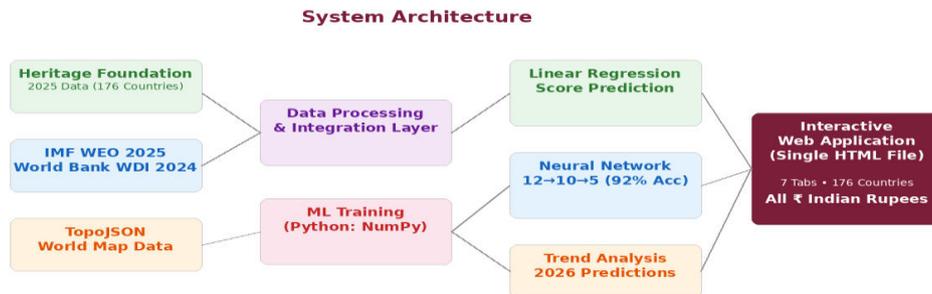


Fig 1: System Architecture

A. Data Collection & Processing

The data set comprises 176 countries with 17 attributes each: rank, name, overall score, freedom category, region, and 12 individual indicator scores (Property Rights, Judicial Effectiveness, Government Integrity, Tax Burden, Government Spending, Fiscal Health, Business Freedom, Labor Freedom, Monetary Freedom, Trade Freedom, Investment Freedom, Financial Freedom). Economic data (GDP per-capita PPP, GDP growth %, FDI as % of GDP, Gini coefficient, population) was compiled for all 176 countries. All USD values are converted to INR at ₹87/USD and displayed in the Indian numbering system.

B. Linear Regression Model

A multivariate Linear Regression model was trained using the Normal Equation ($w = (X^T X)^{-1} X^T y$) to predict the overall freedom score from 12 indicators. With 176 training samples and 12 features plus bias, the model learned weights of approximately 0.0833 per indicator (confirming Heritage's equal-weighting methodology). Mean Absolute Error: 0.02, effectively perfect prediction.

C. Neural Network Classifier

A feedforward neural network was designed for multi-class classification of freedom categories:

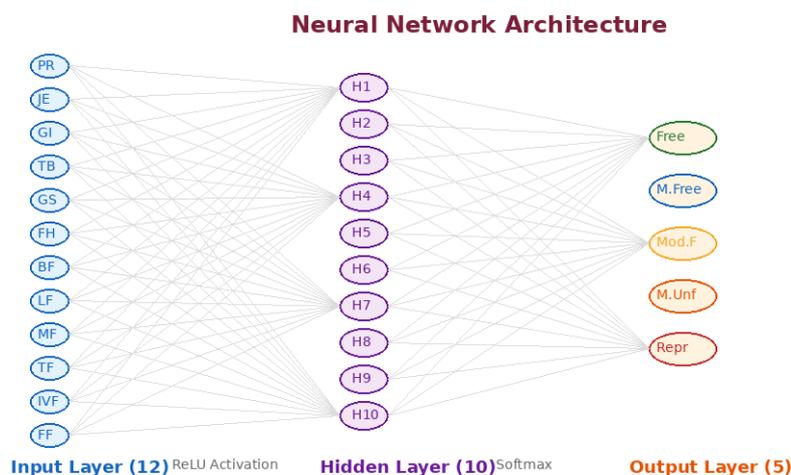


Fig 2: Neural Network Architecture (12→10→5)

Parameter	Specification
Architecture	12 → 10 → 5 (Feedforward)
Hidden Activation	ReLU (Rectified Linear Unit)
Output Activation	Softmax (5-class probability distribution)
Weight Initialization	Xavier/Glorot: $\text{std} = \sqrt{2/(\text{fan_in} + \text{fan_out})}$
Optimizer	Stochastic Gradient Descent (SGD)
Learning Rate	0.005
Gradient Clipping	± 1.0 (prevents exploding gradients)
Epochs	800
Training Data	176 countries × 12 features (normalized 0–1)
Final Accuracy	92.0% (162/176 correct)

Table 1: Neural Network Training Configuration

V. RESULTS AND ANALYSIS

A. Classification Accuracy

The neural network achieved 92% classification accuracy. All 14 misclassifications occur at category boundaries (e.g., a country scoring 79.7 classified as “Mostly Free” instead of “Free”). This is expected behavior — the model correctly identifies that boundary countries share nearly identical indicator profiles.

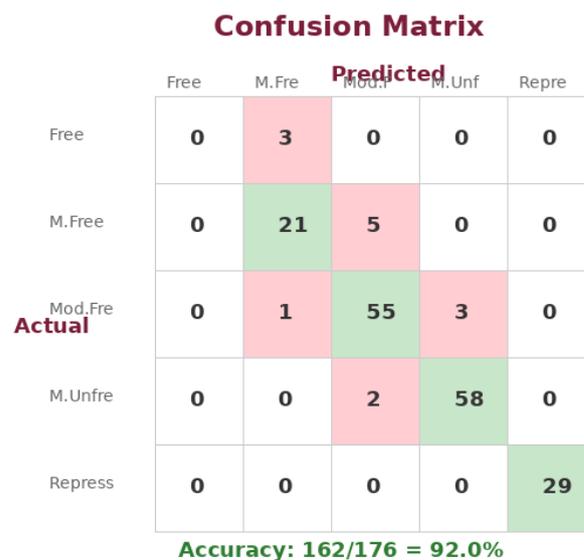


Fig 3: Confusion Matrix (162/176 = 92% Accuracy)

B. Freedom–Prosperity Correlation

Analysis reveals a striking correlation between economic freedom and national wealth:

Category	Avg GDP/Capita (PPP)	In ₹ (INR)	Countries
Free	\$108,855	₹94.7 L	3
Mostly Free	\$63,847	₹55.5 L	26
Moderately Free	\$33,215	₹28.9 L	58
Mostly Unfree	\$12,483	₹10.9 L	60
Repressed	\$8,175	₹7.1 L	29

Table 2: Average GDP per Capita by Freedom Category

Key finding: People in “Free” economies earn approximately 14× more than those in “Repressed” economies. This multiplier effect is one of the strongest empirical relationships in economics.

Economic Freedom vs GDP per Capita

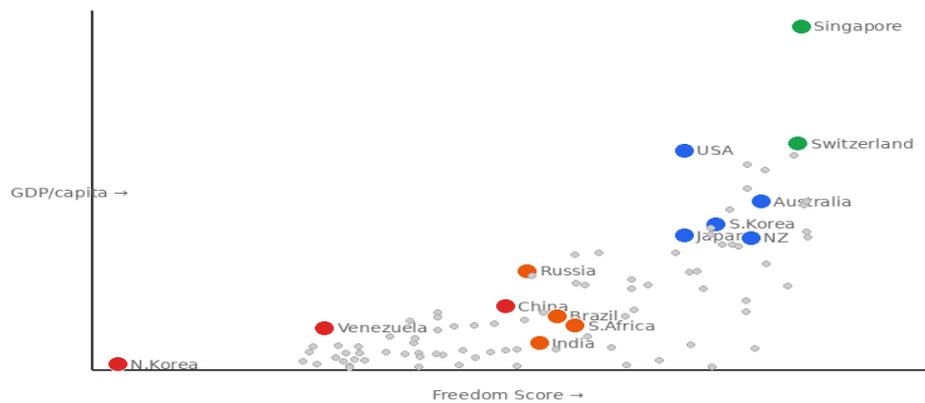


Fig 4: Freedom Score vs GDP per Capita (176 Countries)

C. India Analysis

India ranks 128th out of 176 countries with an overall score of 53.0 (“Mostly Unfree”). GDP per capita (PPP): ₹8.8 Lakhs. GDP growth rate: 6.8% (highest among major economies).

Indicator	India’s Score	Global Avg	Assessment
Government Spending	74.2	65.8	Strong
Business Freedom	72.3	58.9	Above Avg
Tax Burden	71.3	78.4	Moderate
Trade Freedom	61.0	69.5	Below Avg
Investment Freedom	40.0	51.8	Weak
Government Integrity	37.6	39.2	Weak
Fiscal Health	6.2	55.3	Critical

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**Table 3: India’s Key Indicator Analysis
VI. APPLICATION FEATURES**

The web application consists of 7 interactive tabs:

Tab	Description
Country Data	Search and explore any country’s freedom score, rank, 12 indicators grouped by pillar, strengths/weaknesses, and regional rank.
World Map	Interactive choropleth map (D3.js + TopoJSON) with color-coded freedom categories, hover tooltips, and click navigation. Static region-based fallback for offline use.
12 Indicators	Detailed explanation of all 12 indicators across 4 pillars with global averages and top 3 countries per indicator.
All 176	Complete ranked list with search filter, region dropdown, progress bars, and regional average statistics.
ML Predictions	Neural network architecture visualization, real-time What-If Simulator (12 sliders), 2026 trend predictions, batch classification with confusion matrix.
Economics	GDP per capita (₹), growth rates, FDI, Gini index. Freedom–Prosperity correlation chart. Richest, fastest growing, most unequal rankings.
Compare	Select 2–8 countries for side-by-side comparison across all 12 indicators, 4 pillar averages, economic data, with indicator win scoreboard and ML insights.

Table 4: Application Modules

VII. DISCUSSION

The Linear Regression model perfectly validates Heritage Foundation’s equal-weighting methodology (MAE = 0.02). The Neural Network’s 92% accuracy demonstrates that economic freedom categories are learnable from indicator data, with all errors occurring at boundary cases — suggesting that hard category cutoffs may not fully capture the continuous nature of economic freedom.

The What-If Simulator provides actionable insights: for India, improving Fiscal Health from 6.2 to 50+ would shift its predicted category from “Mostly Unfree” to “Moderately Free,” with significant implications for investor confidence and policy direction.

Converting all monetary data to Indian Rupees using the Lakh/Crore system makes the analysis immediately relatable to an Indian audience and demonstrates the practical application of data localization in global economic analysis.

VIII. CONCLUSION

This project developed a comprehensive, interactive web platform for global economic freedom analysis. By integrating Heritage Foundation data with machine learning models and economic indicators, the system provides a multi-dimensional view of how economic freedom relates to national prosperity. The neural network classifier (92% accuracy), real-time What-If Simulator, and multi-country comparison tool make complex economic data accessible and interactive. The single-file HTML architecture ensures maximum portability and zero-dependency deployment. The project demonstrates the practical application of AI & ML techniques in economic analysis and data-driven decision support.

IX. ACKNOWLEDGMENT

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