MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

GROUP B-12 THESIS PROPOSAL

Research Title: Performance Analysis of Cutting-Edge Machine Learning and Deep Learning Algorithms in Designing a Customer Assessment Tool for Business Service Providers

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MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY, DHAKA

Department of Computer Science and Engineering

Application for the **Approval of B.Sc. Engineering Project/Thesis Proposal**

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7. **Thesis Title:**
   PERFORMANCE ANALYSIS OF CUTTING-EDGE MACHINE LEARNING AND DEEP LEARNING ALGORITHMS IN DESIGNING A CUSTOMER ASSESSMENT TOOL FOR BUSINESS SERVICE PROVIDERS
8. **Background and Present State of the Problem:**
   In today's rapidly evolving business landscape, the ability to accurately predict and manage various aspects of business performance has become increasingly critical. The application of machine learning (ML) and artificial intelligence (AI) techniques to business and finance has gained significant traction in recent years, offering new avenues for more sophisticated and accurate predictive models [1].
   One key area of focus has been the prediction of macroeconomic indicators, which play a crucial role in sustainable business management. Research has shown that ML techniques such as Support Vector Machines (SVM) and Artificial Neural Networks (ANN) can be effective in forecasting inflation rates and exchange rate movements [1]. However, there is still a need for more comprehensive studies comparing various ML algorithms across different economic contexts and expanding the analysis to include a broader range of macroeconomic indicators. In the realm of e-commerce, ML algorithms have been employed to predict market growth, understand customer needs, and identify profitable product categories. These applications demonstrate the potential of ML in helping businesses adapt to changing market conditions and customer behaviors [2]. However, the effectiveness of these models often depends on the availability of large volumes of high-quality data, which can be a limiting factor for smaller businesses. The prediction of business success or failure using ML algorithms has also emerged as a critical area of research. By leveraging data from various sources, including questionnaires and historical business records, models have been developed to help entrepreneurs and business owners make informed decisions about

their ventures [3]. While promising, these models often face challenges in providing real-time, individualized explanations for their predictions, highlighting an area for future improvement.
Pricing mechanisms represent another crucial aspect of business management where ML is making significant inroads. Intelligent business models that combine ML with business intelligence have been proposed to facilitate effective product pricing and demand prediction [4]. However, these models may require substantial data and time to produce optimal results, presenting challenges for immediate implementation, especially in global and enterprise-scale businesses.
Despite these advancements, several challenges and opportunities remain in the application of ML to business and finance. There is a growing need for more interpretable models that can explain their decision-making processes to non-technical stakeholders [5]. Additionally, the integration of social network analysis, causality exploration, and the handling of real-time data and noise issues represent promising avenues for future research. Furthermore, while numerous studies have explored individual algorithms for business analytics, there is a lack of comprehensive comparative analyses that evaluate multiple approaches across different paradigms (e.g., fuzzy logic, traditional Machine Learning, and Deep Learning) within a unified framework [6] [3] [7]. This gap in the literature presents an opportunity to contribute valuable insights into the relative strengths and weaknesses of these methods in real-world business scenarios.
Another critical area for development is the integration of predictive analytics into user-friendly interfaces for business owners. While powerful analytical tools exist, their adoption and effective use by non-technical stakeholders remain challenging [7]. There is a pressing need for intuitive systems that can bridge the gap between complex analytical outputs and actionable business insights.
This research aims to address these gaps by conducting a rigorous comparative analysis of various predictive algorithms, potentially developing a novel hybrid approach, and designing an accessible interface for practical application in business settings. By doing so, it seeks to contribute to the growing body of knowledge on ML applications in business and finance, while also providing practical tools for business decision-makers.

9. **Objective with Specific Aims and Possible Outcome:**
   The main objectives of this study are:

   (a) To prepare a custom dataset for training and evaluating predictive models through data collection, pre-processing and data engineering.

   (b) To conduct a comparative analysis among predictive algorithms across various AI domains like Traditional Machine Learning, Deep Learning, Quantum Machine Learning, Natural Language Processing and Fuzzy Logic.

   (c) To design and develop an AI integrated web based customer assessment tool for business servide providers.

10. **Outline of Methodology/Experimental Design:**
    The research methodology comprises the following key stages:

    (a) Data Acquisition and Preprocessing

        - Systematic collection of multidimensional customer experience data, encompassing variables such as food quality, ambiance, hygiene, service efficiency, pricing, and overall satisfaction.
        - Implementation of robust data preprocessing techniques, including:
          – Handling of missing values through imputation or exclusion.
          – Elimination of duplicate entries and resolution of data inconsistencies.
          – Feature engineering to derive potentially informative attributes.
          – Normalization and standardization of features to ensure comparability.

- Stratified partitioning of the dataset into training, validation, and test sets to ensure representative sampling.

(b) Exploratory Data Analysis and Visualization

- Utilization of advanced statistical and graphical techniques to elucidate data distributions and relationships, including:
  - Multivariate scatter plots for feature correlation analysis.
  - Kernel density estimation for probability density visualization.
  - Box plots and violin plots for distributional comparisons.
  - Time series analysis through line plots for temporal trends.
  - Categorical data analysis via bar plots, count plots, and pie charts.

(c) Model Selection and Implementation

- Systematic evaluation of diverse predictive models, including:
  - Fuzzy Logic systems for handling uncertainty and imprecision.
  - Traditional Machine Learning algorithms (e.g., Random Forests, Support Vector Machines, Gradient Boosting).
  - Deep Learning architectures (e.g., Multi-layer Perceptrons, Convolutional Neural Networks, Recurrent Neural Networks).
- Implementation of feature selection techniques to identify optimal feature subsets for each model paradigm.

(d) Model Training and Optimization

- Utilization of the curated training dataset for model fitting and parameter estimation.
- Application of cross-validation techniques to mitigate overfitting and ensure generalizability.
- Hyperparameter optimization through grid search, random search, or Bayesian optimization approaches.

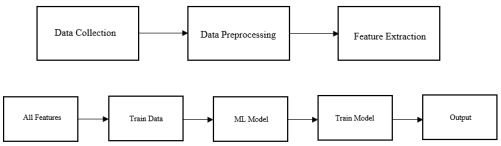

Figure 1: Model Training

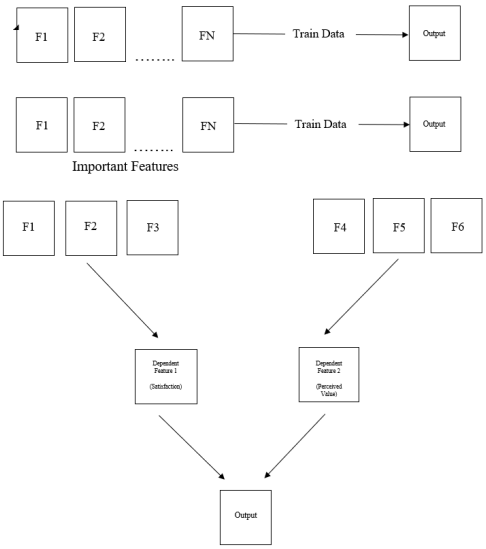

Figure 2: Analytical Approach

(e) Performance Evaluation and Comparative Analysis

- Rigorous assessment of model performance using appropriate metrics:
  - For classification tasks: Accuracy, Precision, Recall, F1-score, and ROC-AUC.
  - For regression tasks: Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R-squared.
- Comparative analysis of model performance across different algorithmic paradigms.
- Statistical significance testing to validate performance differentials.

(f) User Interface Design and Implementation

- Development of an intuitive, web-based interface for visualizing analytical insights.
- Integration of real-time data processing and predictive capabilities.
- Implementation of interactive dashboards for customizable business performance metrics.
- Usability testing and iterative refinement based on user feedback.

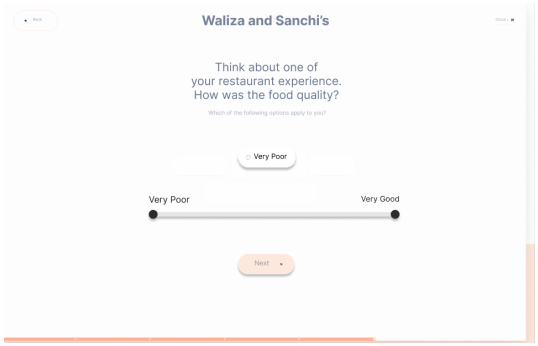

Figure 3: Proposed Interface

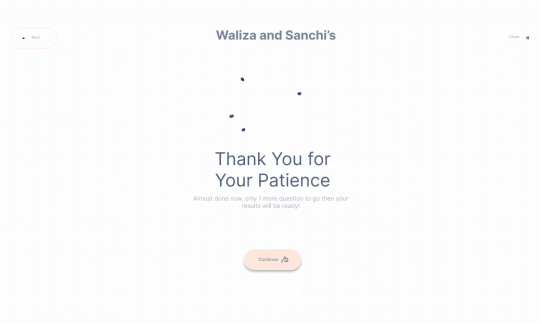

Figure 4: Proposed Interface

11. **Cost Estimate:**

Ser	Items	Quantity	Unit Cost	Cost (BDT)
1	AWS Braket(Gate-based QPU)*	1 task (10,000 shots)	$0.30 / task, $0.00090 / shot	1,110.94
2	Data Collection **	-	-	6250
Total Amount				7361

* A quantum algorithm on the Rigetti Ankaa quantum computer in the AWS US West (N. California) Region. This task includes 10,000 repeated shots of the same circuit design. The cost to run this task includes a per-task charge of $0.30, plus 10,000 shots at a per-shot price of $0.00090. One "shot" represents one execution of a quantum circuit.

** The data collection process includes -

- **Survey Form**: 150 surveys x 15 (3 pages, 5 tk each) = 2250/-
- **Conveyance**: Transportation and other cost - 1000 /-
- **Food and Souvenirs**: For each participant - 150 x 20 tk each = 3000/-

12. References

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[7] S. Kulshrestha and M. L. Saini, "Study for the prediction of e-commerce business market growth using machine learning algorithm," in *2020 5th IEEE International Conference on Recent Advances and Innovations in Engineering (ICRAIE)*, 2020, pp. 1–6.

Signature of the Students

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Signature of the Supervisor
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Signature of the Head of the Department
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