# Business Report: Sentiment Analysis Classification System

# 1. Executive Summary

**Project Goal**  
Develop an end-to-end text classification system to analyze sentiment (positive, negative, neutral) from text data using deep learning and traditional machine learning models. The system is enhanced with MLOps and deployed in a real-time application.

**Time Frame**

* **Start Date**: March 1, 2025
* **Projected End Date**: May 15, 2025
* **Current Phase**: Final testing, deployment, and documentation

**Key Highlights**

* Trained and evaluated five models (LSTM, BERT, Logistic Regression, SVM, Random Forest)
* Integrated MLflow for experiment tracking
* Built an interactive Gradio-based application
* Deployed the system with public access using ngrok
* Logistic Regression was the most efficient model in terms of accuracy/performance tradeoff

# 2. Project Objectives

**Short-Term Objectives**

* Clean and preprocess a sentiment-labeled dataset
* Train and evaluate multiple machine learning models
* Use word embeddings (GloVe) and transformer models (BERT)
* Build visualizations for performance tracking

**Long-Term Objectives**

* Create a robust, scalable NLP pipeline for sentiment classification
* Incorporate MLOps tools (MLflow) for reproducibility and tracking
* Deploy a real-time demo interface using Gradio + ngrok
* Enable future model upgrades and integration with real-world feedback systems

# 3. Progress Report

**Tasks Completed**

* Data preprocessing, cleaning, and visualization
* Trained and tuned models (LSTM, BERT, Logistic Regression, SVM, RF)
* Implemented MLflow for model tracking and evaluation
* Built Gradio interface for real-time prediction
* Created visuals: word clouds, class distributions, confusion matrices

**Ongoing Work**

* Deployment testing using public links (ngrok)
* Documentation polish and report finalization

**Upcoming Work**

* Share public demo and collect user feedback
* Optional: connect to live data streams (e.g., Twitter API) for dynamic sentiment analysis
* Final project presentation preparation

# 4. Budget and Financials

**Budget Allocation**

* **Tools Used**: Google Colab (free), Hugging Face, Scikit-learn, MLflow (local), Gradio (open-source), Ngrok (free tier)
* **Total Budget**: $0 (academic project using open-source resources)

**Expenditures**

* No financial expenditure required; all tools were open-source or free tiers

**Remaining Budget**

* 100% of allocated budget remains

**Risks to Financials**

* **None** unless moving to paid tiers of ngrok or needing GPU support on a cloud platform for large-scale inference

# 5. Challenges and Risks

**Challenges**

* High training time for BERT on limited hardware
* Balancing performance vs simplicity for deployment
* Merging multiple models in a reproducible pipeline

**Risk Mitigation**

* Used pretrained BERT and GloVe to speed up training
* Switched to Logistic Regression as default deployed model
* Applied stratified splits and evaluation metrics beyond accuracy (F1-score, confusion matrix)

# 6. Team and Resources

**Team Structure**

* **Project Lead**: Marwan Shamel
* **Roles**:
  + Data Preprocessing and EDA
  + Model Training and Evaluation
  + MLOps Integration
  + Frontend Deployment

**Resource Allocation**

* Resources were adequate for the project scope
* Used Google Colab for GPU-based model training
* Open-source tools were sufficient for deployment and evaluation

# 7. Timeline and Milestones

**Completed Milestones**

| **Milestone** | **Status** | **On Time** |
| --- | --- | --- |
| Dataset Preparation | Done | Yes |
| Model Training (LSTM, ML Models) | Done | Yes |
| BERT Model Training | Done | Yes |
| MLOps Integration (MLflow) | Done | Yes |
| Gradio UI Development | Done | Yes |
| Deployment via ngrok | Done | Yes |

**Future Milestones**

* Final Report Submission – **May 11, 2025**
* Final Presentation – **May 12, 2025**

**Delays**

* None. All tasks were completed within the expected timeline.

**8. Stakeholder Updates**

* **Advisor/Instructor**: Regular weekly updates shared via progress notes
* **Peer Reviews**: Internal feedback collected on model performance and interface usability
* **Demo Review**: Stakeholder preview conducted before final deployment

**9. Next Steps**

* Finalize public access to the demo and share with stakeholders
* Prepare for final oral presentation
* Evaluate the potential of deploying this system on a scalable cloud infrastructure (e.g., AWS, Hugging Face Spaces)
* Collect feedback for potential expansion (multi-language support, dynamic data input)

**10. Conclusion and Recommendations**

The sentiment analysis system successfully meets its objectives by combining accurate model predictions with a smooth real-time deployment. The integration of MLOps and the open-source stack provides a scalable, reproducible framework.

**Recommendations:**

* For real-world use: consider transitioning deployment to Hugging Face Spaces or AWS Lambda
* Extend language support (Arabic, French, etc.) using multilingual BERT
* Collect more user feedback via the deployed demo
* Automate retraining pipeline for incoming data