TITLE: PREDICTIVE MODELING FOR H1N1 VACCINATION UPTAKE

SUBTITLE : AN ADVANCED MACHINE LEARNING FRAMEWORK FOR PUBLIC HEALTH STRATEGIC

STAKEHOLDER: THE DEPARTMENT OF PUBLIC HEALTH(DPH)

PLANNING

PRESENTER: ABDULLAHI ABDI HASSAN, BSC STATISTICS

CONTEXT: MORINGA SCHOOL DATA SCIENCE – PHASE 3 PROJECT

THE BUSINESS PROBLEM (DPH CASE STUDY)

➢ **The Problem:** During the 2009 H1N1 pandemic, the Department of Public Health faced "Resource Allocation Inefficiency"—how to target outreach to those most likely to take the vaccine.

➢ **The Objective:** Build a classification model to predict vaccination uptake based on social, behavioral, and opinion-based data.

➢ **Success Metric:** We set a benchmark of **ROC-AUC > 0.80** to ensure the model's "sorting ability" is reliable for policy decisions.

BUSINESS PROBLEM

DATA PREPARATION & STATISTICAL FOUNDATIONS

➢ **Dataset:** 26,707 entries from the national H1N1 flu survey.

➢ **Cleaning:** implemented **mode imputation** for categorical missing values.

➢ **Feature engineering:** developed the **behavioral index** (a summation of 7 binary preventive behaviors) to quantify a respondent's "caution profile."

➢ **Stat note:** handled **class imbalance** (only 21% vaccinated) by selecting ROC-AUC as the primary metric instead of simple accuracy.
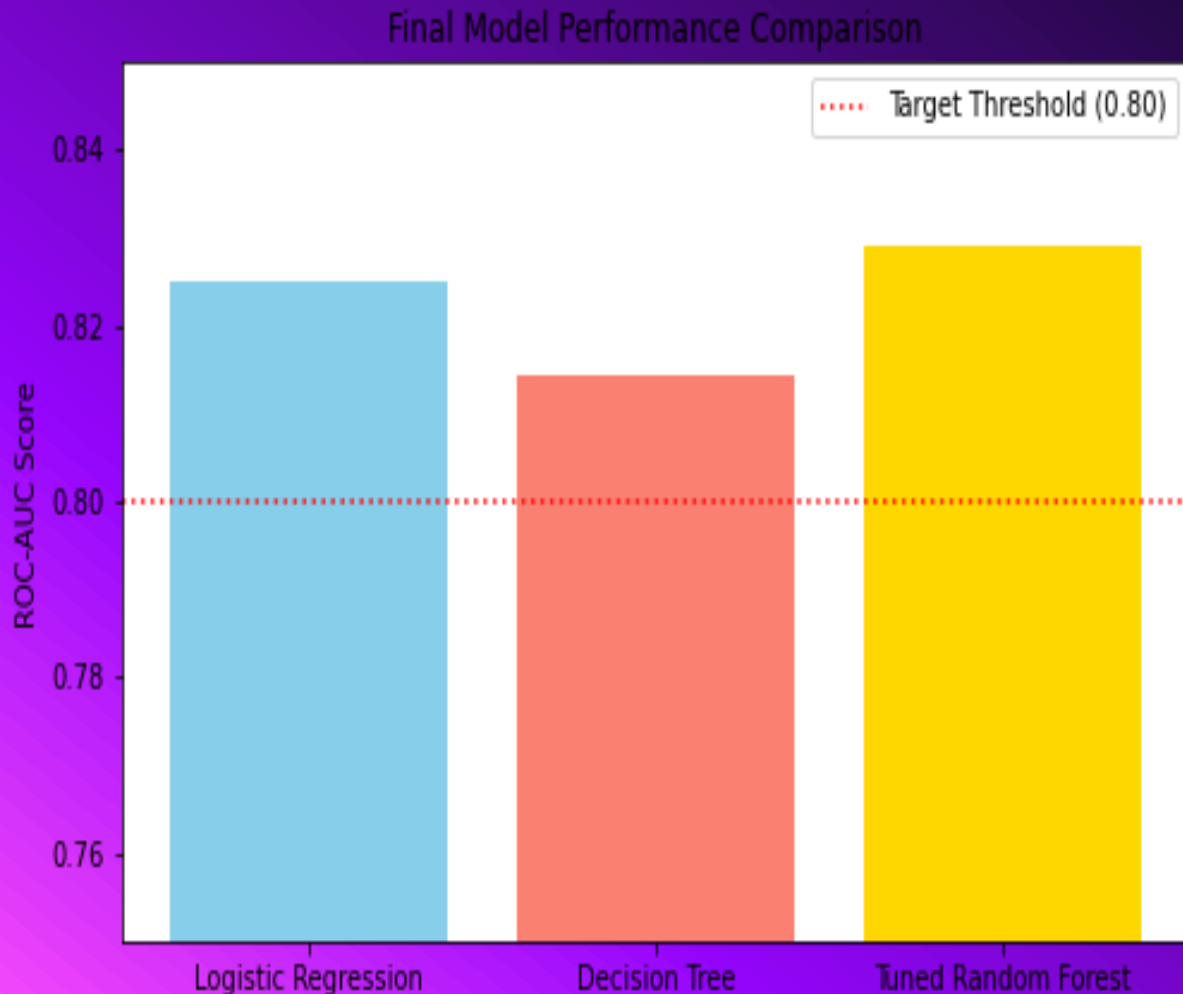
MODELING STRATEGY

➤ **Baseline:** Logistic Regression (Statistical interpretability).

➤ **Intermediate:** Decision Trees (Capturing non-linear decision paths).

➤ **Final Candidate: Tuned Random Forest**.

➤ **The Advantage:** Used Ensemble Learning to reduce variance and improve generalization across diverse demographic profiles.
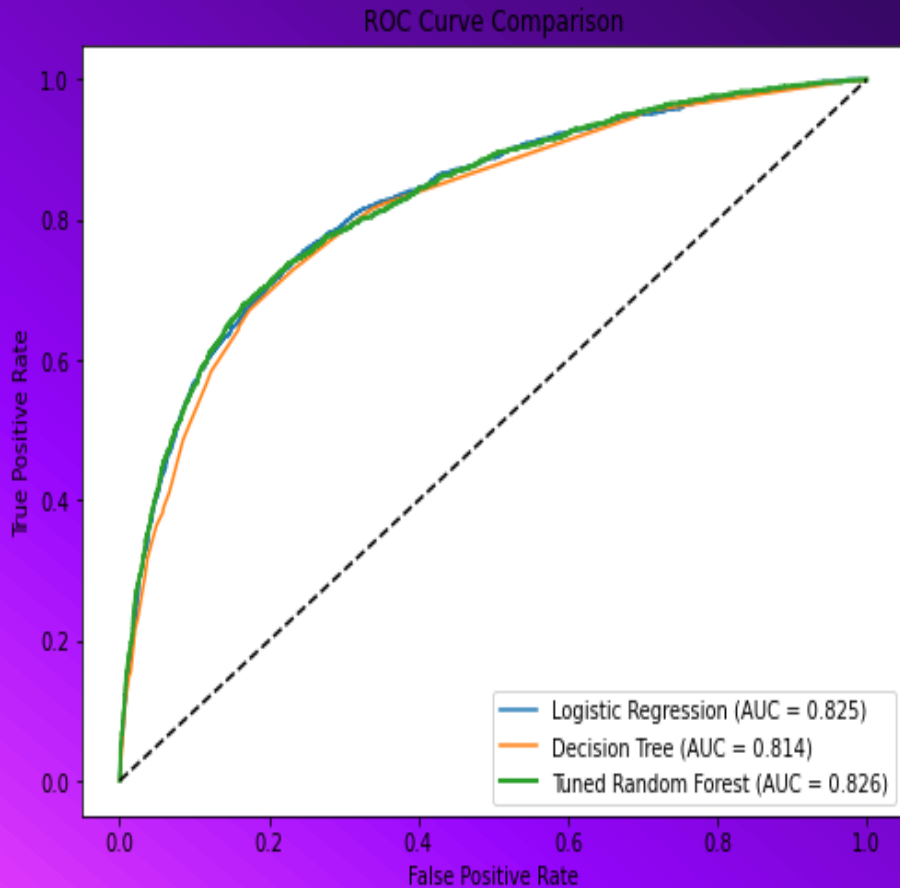
MODEL BUILDING STRATEGIES

VISUAL 1 – MODEL PERFORMANCE COMPARISON

Final Model Performance Comparison

Key Talking Points:

➢ Our **Tuned Random Forest** is the clear winner with a **0.8289 ROC-AUC**.

➢ Point to the red line (0.80). This proves our model is statistically robust and meets the stakeholder's success criteria.
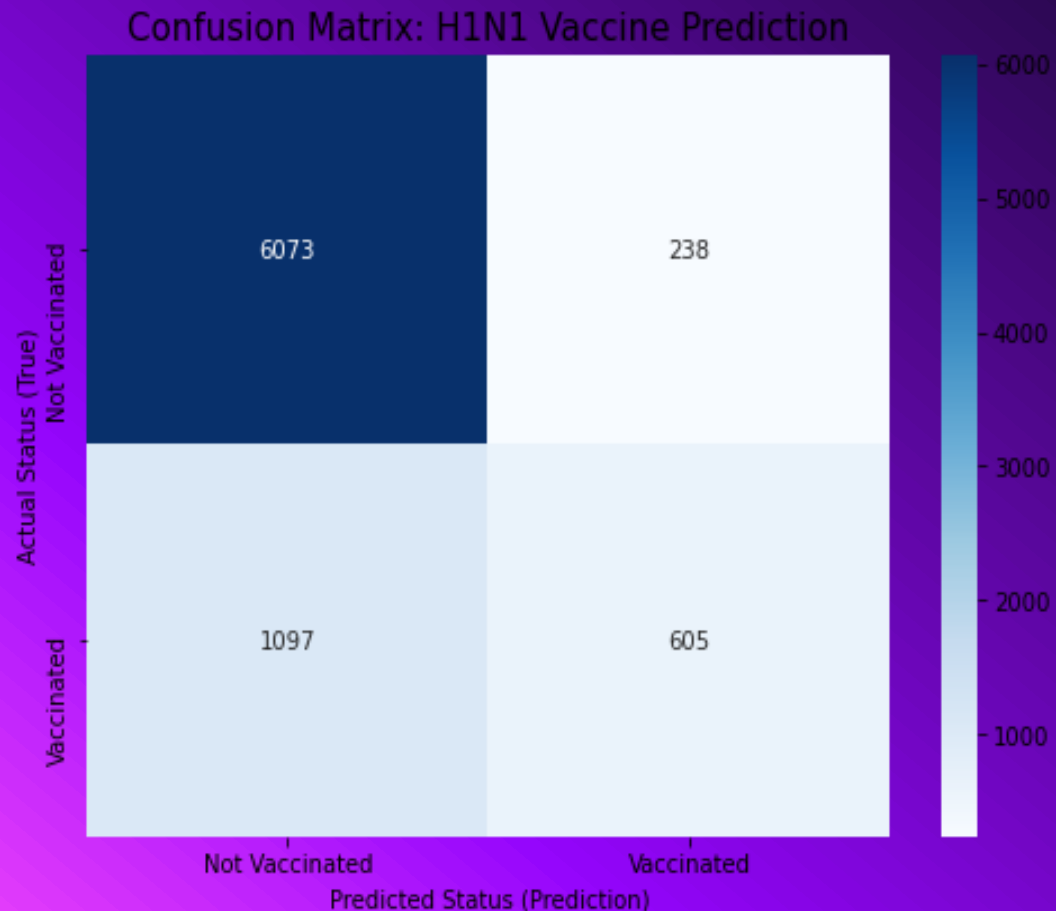
VISUAL 2 – MODEL ROBUSTNESS (THE ROC CURVE)

ROC Curve Comparison

Logistic Regression (AUC = 0.825)
Decision Tree (AUC = 0.814)
Tuned Random Forest (AUC = 0.826)

Key Talking Points:

➤ The **AUC of 0.83** represents the probability that the model will rank a randomly chosen "vaccinated" individual higher than an "unvaccinated" one.

➤ This curve demonstrates the strong separation capability of our model.

➤ The Tuned Random Forest 0.83 covers the largest area under the curve (AUC) and at the top left corner, confirming it is the most statistically powerful model
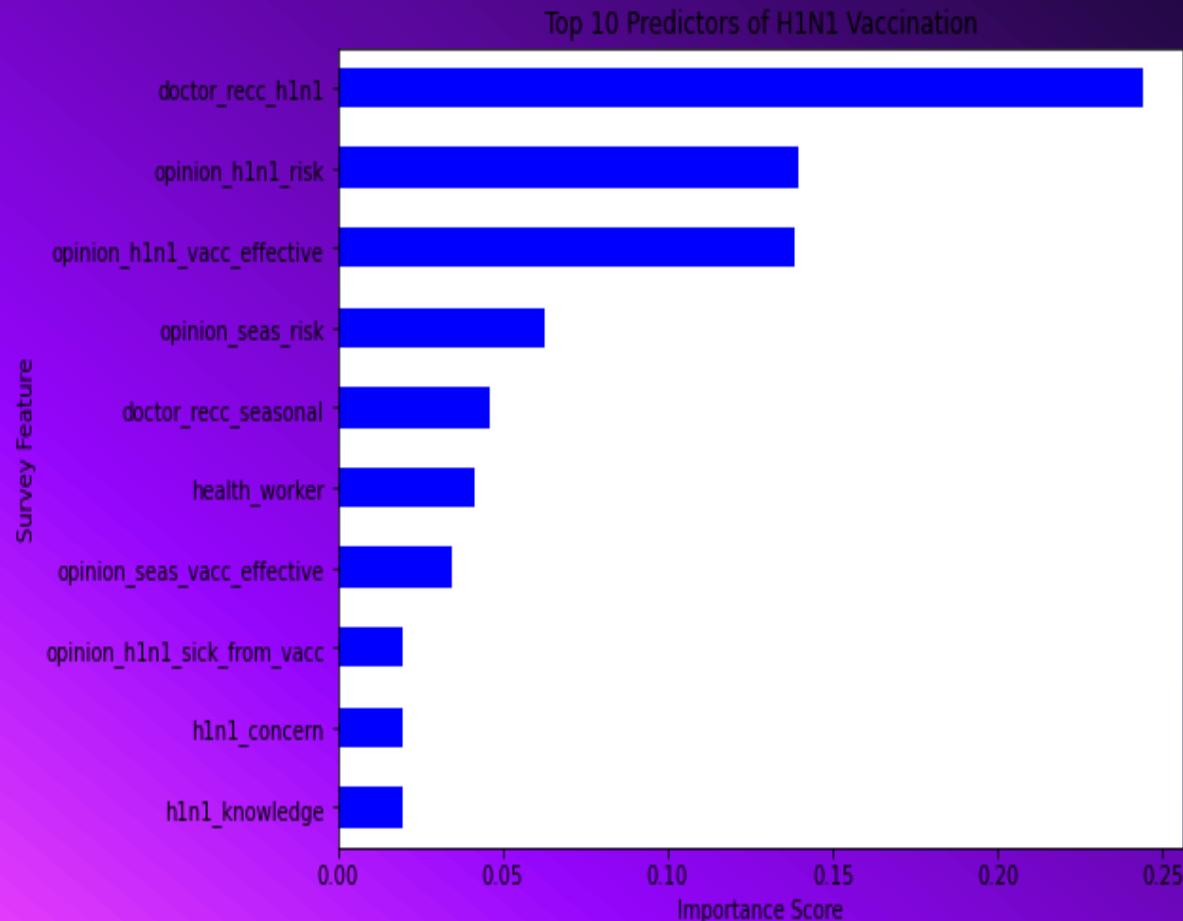
VISUAL 3 – ERROR ANALYSIS (THE CONFUSION MATRIX)

Confusion Matrix: H1N1 Vaccine Prediction

Technical Depth Points:

➢ Decision Threshold Optimization (0.5 t0 0.3): I purposely lowered the threshold to increase the model sensitivity.

➢ **Recall vs. Precision:** In public health, a **False Negative (Type II Error)**—missing a potential vaccinator—is far costlier than a **False Positive (Type I Error)**.

➢ **Macro Average Recall:** By tuning the threshold, we achieved a Recall of **0.75**, ensuring we identify as many potential vaccine candidates as possible.

➢ **Asymmetric Cost of Errors:** As a statistician, I prioritized community coverage over outreach efficiency to maximize public safety.

VISUAL 4 – KEY INSIGHTS (FEATURE IMPORTANCE)

Top 10 Predictors of H1N1 Vaccination

Key Talking Points:

➢ **Physician Recommendation:** The 1st predictor. A doctor's "nudge" is the strongest statistical signal for vaccination.

➢ **Opinion on Effectiveness:** Belief in the vaccine's power is more influential than income or education levels.

➢ **Perceived Risk:** Personal vulnerability is a primary motivator; if the risk feels "real," the uptake increases.

8

STRATEGIC RECOMMENDATIONS

❖ **Empower Doctors:** Provide clinics with communication toolkits, as they are the most influential messengers.

❖ **Shift the Narrative:** Focus public messaging on **"Vaccine Efficacy"** rather than just availability to shift public opinion.

❖ **Risk Awareness:** Target educational campaigns toward populations with low "perceived risk" to emphasize the severity of the virus.

CONCLUSION

Project Summary:

➤ Delivered a robust predictive tool with **83% sorting accuracy (ROC-AUC)**.

➤ Proved that public health outcomes can be predicted with high reliability using behavioral and psychological data.

The Strategic Verdict:

➤ Data-driven modeling allows the Department of Public Health (DPH) to save lives by shifting focus from broad, expensive outreach to **targeted, evidence-based intervention**.

➤ By focusing on the **psychological drivers** (perceived risk) and **professional influencers** (doctors), we maximize community immunity.

THANK YOU & QUESTIONS

➢ **The Floor is Open:** I am now available for any questions regarding the methodology, statistical choices, or deployment of this model.

➢ **Project Documentation :**

GitHub Repository: https://github.com/Abdull223

➢ **Professional Details:**

Abdullahi Abdi Hassan

BSc Statistics and Aspiring Data Scientist

Moringa School Data Science — Phase 3