ENHANCING PUBLIC HEALTH: LEVERAGING MULTI-ARMED BANDIT FOR VACCINATION OUTREACH

"Empowering Health, One Arm at a Time"

**BACKGROUND**
- Extremely low current vaccination rate via SMS outreach
- Large volume of messages via traditional A/B testing
- Traditional A/B testing tests the contextual and interpretability

**SOLUTION**
- Create personalized SMS campaign with different variables by developing multi-armed bandit (MAB) models
- Measure the uplift in performance to enhance efficiency and cost-effectiveness in expression
- To utilize the effectiveness of contextual MAB in incorporating different factors to derive actionable interpretable insights

**IMPACT**
- $1M → $12M
  - Projected Cost savings per campaign
  - Cost savings per annum
- 85%
  - Decrease in message overload
- Better Adaptivity & interpretable
- 5%
  - Increase in flu vaccination rates across all features
- Millions of patients
  - Get vaccinated with boosted engagements & enhanced loyalty

**Dataset Overview**
- 100 FEATURES
- 100M PATIENTS
- 7 TYPES OF VACCINES

**Model 1: Segmented MAB**
1. Put eligible patients into pre-defined clusters
2. ACTION/ initiation and subsequently send a verbiage to patients per cluster
   - Age Group: 35-65
   - Epstein-Barr algae
   - Thompson sampling
3. REWARD: update rewards for that verbiage based on patient’s vaccination response
   - Thompson Sampling with Time Distribution
   - We update the beta distribution weekly for a faster shift change for the MAB

**Model 2: Contextual Bandit**
- Goal: To maximize the rewards (flu vaccination rate)
- Explore for knowledge from earlier rounds and exploit using the current feedback
- Epistemology
- Synthetic Response Data

**Adaptivity of MAB**
- Unlike A/B testing, MAB efficiently leverages past periods of flu campaigns, leading to escalated vaccination rates.
- Foster convergence with less volume of messages

**Contextual Bandit Performance**
- 4.6% improvement in vaccination rate across all features

**Propotion Wins**
- The proportion Wins is computed as the proportion of times where the best arm outperforms other arms using Monte Carlo simulations.

**Model: Segmented MAB - Thompson Sampling**
- Features: Age, Income
- Model: Contextual MAB
- Features: Age, Income
- 4.6% improvement in vaccination rate across all features

**Synthetic Data**
- Create counterfactuals for each patient for each verbiage
- Estimate vaccination rate for verbiage
- Initially sample-drifted segment patients

**Data Preprocessing**
- Feature Engineering
- Clustering Techniques
- Exploratory Data Analysis
- Identified the right features for the contextual MAB

**A/B Testing vs MAB**
- Case of Segmented MAB based on Age
- Thompson Sampling is performing better in more cases and requires 1/4th volume of messages compared to A/B testing

**Scoring**
- Best Verbiage: 1
  - Replicates A/B testing with 100% confidence interval [0.8-0.8]
- Confidence interval: [0.9-0.9]
- Best Verbiage: 2
  - Replicates Thompson sampling with 100% confidence interval [0.8-0.8]