Blood Donation Campaign Dashboard

March 25, 2025

Introduction

Blood donation campaigns play a crucial role in maintaining an adequate supply of blood for medical emergencies, surgeries, and chronic conditions. Organizing successful blood donation drives requires an in-depth understanding of donor behavior, eligibility criteria, and factors influencing donor retention.

To address these challenges, we have developed a comprehensive dashboard in Python to visualize and analyze blood donation campaign data. This dashboard provides campaign organizers with valuable insights to optimize donor outreach, improve retention strategies, and ensure a steady supply of blood donations. By engaging in data-driven decision-making, this dashboard aids in identifying ideal donor profiles, assessing donation trends, and uncovering key factors influencing donor eligibility.

The dashboard integrates various analytical techniques, including clustering, data preprocessing, and visualization, to offer an intuitive interface for exploring blood donation campaign data. With interactive components and insightful metrics, the platform empowers stakeholders to enhance the effectiveness of future campaigns.

Map Donor Distribution

To gain insights into the geographical distribution of blood donors, we implemented a mapping visualization that plots donors based on their residential areas. This analysis helps identify regions with high or low donor participation, allowing campaign organizers to focus outreach efforts effectively.

1.1-Methodology

We utilized the following approach to visualize donor distribution:

- Extracted the geographical locations from the dataset using the fields **"Arrondissement de résidence"** and **"Quartier de Résidence"**.

- Used the Streamlit library in Python to create an interactive dashboard with location-based filtering.

- Integrated Plotly to generate a dynamic map, allowing users to zoom in and explore donor distribution at different levels.

- Highlighted high and low donor participation regions with appropriate color schemes for easy interpretation.

1.2-Findings and Insights

- Certain neighborhoods exhibited a higher concentration of donors, suggesting strong community engagement or the presence of nearby donation centers.

- Areas with low participation indicate potential barriers to donation, such as lack of awareness, accessibility issues, or demographic factors.

- The interactive map enables stakeholders to explore specific locations and tailor outreach strategies accordingly.

- Campaign organizers can leverage this visualization to optimize mobile blood donation units and targeted awareness campaigns.

The mapping feature of our dashboard provides a crucial spatial perspective on blood donor participation, aiding in strategic decision-making to enhance future donation drives.

Eligibility Analysis

Understanding donor eligibility is essential for maintaining a sustainable blood supply. Various health conditions and lifestyle factors influence whether an individual is eligible to donate blood. This section of the dashboard analyzes donor eligibility trends to help campaign organizers refine recruitment and screening strategies.

2.1-Methodology

To analyze donor eligibility, we applied the following approach:

- Categorized donors into three groups based on eligibility: **Eligible**, **Temporarily Ineligible**, and **Permanently Ineligible**.

- Filtered the dataset based on medical conditions, including hypertension, diabetes, anemia, and infectious diseases.

- Used interactive visualization techniques to represent the proportion of donors in each category.

- Developed bar charts and stacked bar plots to highlight the relationship between specific health conditions and eligibility status.

2.2-Findings and Insights

- Chronic illnesses such as cardiovascular diseases and diabetes significantly reduce donor eligibility, often leading to permanent ineligibility.

- Temporary ineligibility is commonly linked to recent illnesses, medication use, or recent travel to malaria-endemic regions.

- Visualizing eligibility trends allows campaign organizers to better understand exclusion criteria and adapt recruitment strategies accordingly.

- The dashboard's filtering system enables real-time exploration of eligibility factors, making it a valuable tool for optimizing blood donation campaigns.

The eligibility analysis feature provides crucial insights into factors affecting donor participation. By leveraging this information, campaign organizers can refine donor screening processes and improve overall blood supply sustainability.

Campaign Effectiveness Analysis

The campaign effectiveness analysis provides valuable insights into donor behavior patterns, seasonal trends, and demographic factors influencing blood donation campaigns. This section presents a comprehensive evaluation of historical campaign performance.

3.1-Methodology

The analysis was conducted using a data-driven approach with the following components:

- Temporal analysis of donation patterns (daily, weekly, monthly)

- Seasonal decomposition to identify recurring patterns

- Demographic profiling of donors

- Performance metrics tracking

3.2-Key Findings

Temporal Trends

Analysis of donation patterns revealed significant temporal variations:

- **Seasonal Patterns**: The seasonal decomposition identified October as the peak month for donations, with 244 donors.
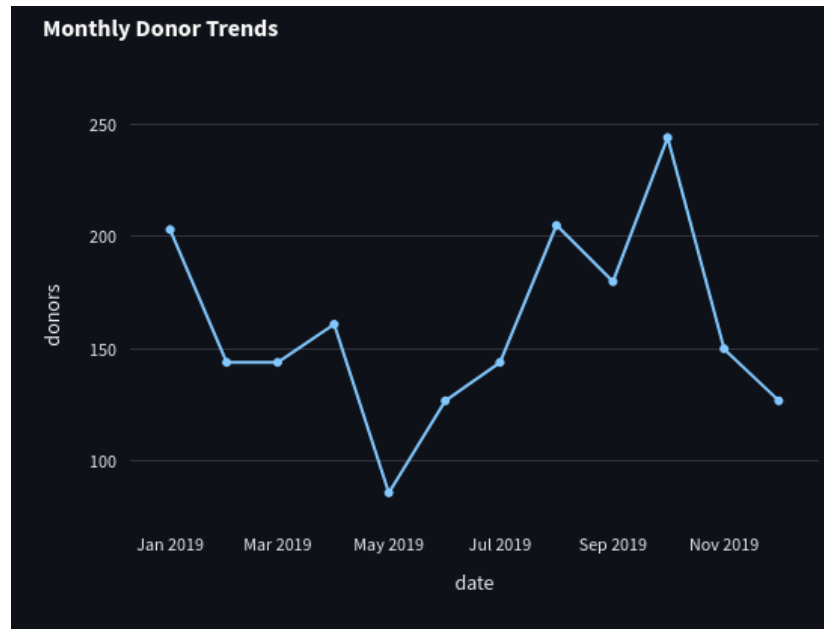
Figure 1: Seasonal patterns of blood donation campaigns

- **Weekly Patterns**: Donations typically peaked during the first week of March, suggesting this as the optimal time for campaign events.
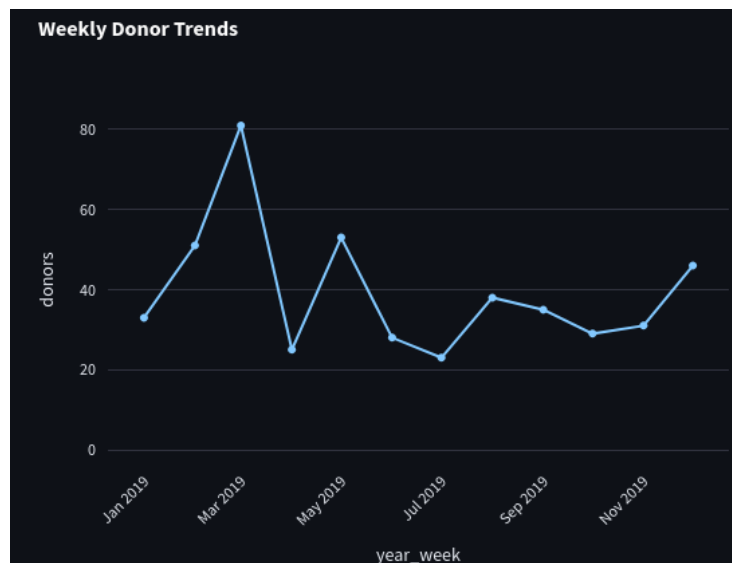

Figure 2: Weekly donation trends

- **Top Performance Days**: The analysis identified the top 10 days with the highest donor turnout, providing concrete examples of successful campaign execution. The date with the highest number of donors was August 6, 2019, with 41 donors.
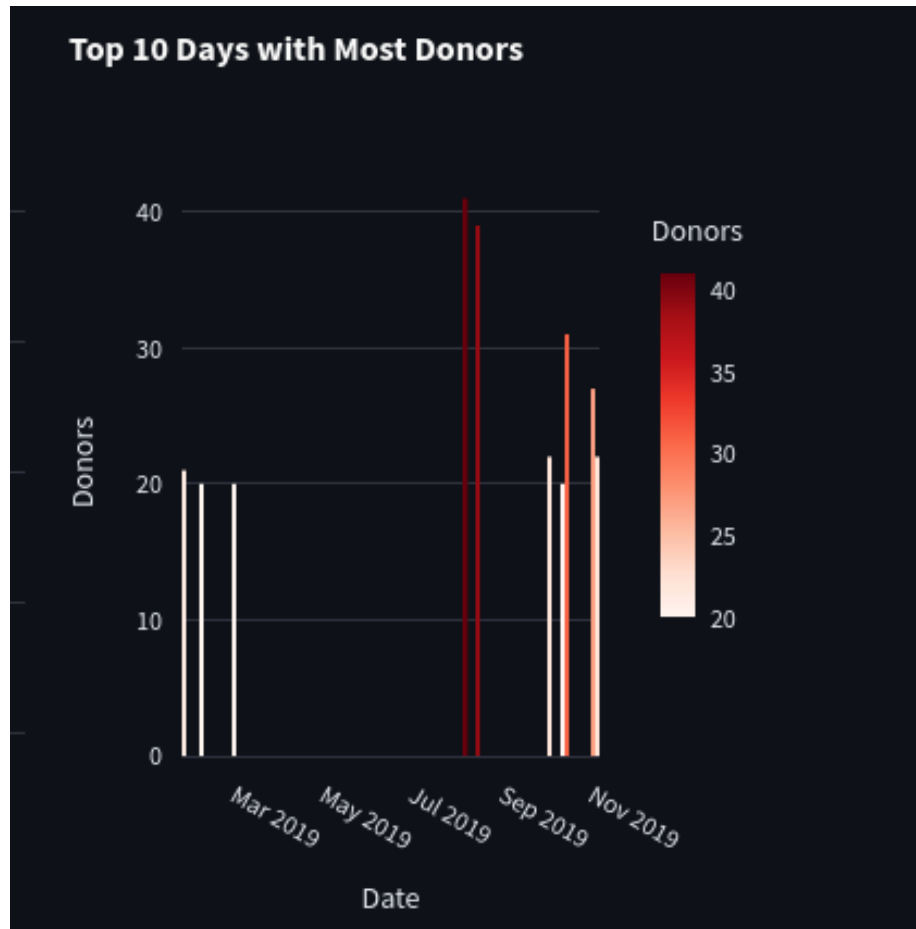

Figure 3: Top Ten donors months

Campaign Performance Metrics

Key performance indicators revealed:

- Total donor participation:1915 donors for 2019 campaign
- Eligibility rate: **81.7%** of screened donors met criteria
- Repeat donor percentage: **42.6%** of participants were previous donors

- Average donor age: **30-31** years

Donor Retention

Donor retention is a critical factor in maintaining a stable and sufficient blood supply. This section analyzes how often individuals return to donate blood and explores demographic factors that correlate with repeat donations.

4.1-Analysis of Donor Retention

To investigate donor retention, data was analyzed to differentiate between first-time donors and those who have donated before. The dataset contains information on individuals' donation history, including whether they have previously donated and the time intervals between donations.

A categorical analysis was performed where donors were classified into two groups:

- **First-time donors:** Individuals who are donating blood for the first time.

- **Returning donors:** Individuals who have previously donated blood.

A donut chart was used to visualize the proportion of first-time and returning donors. Additionally, a time-series trend analysis was conducted to observe variations in donor retention over different months.
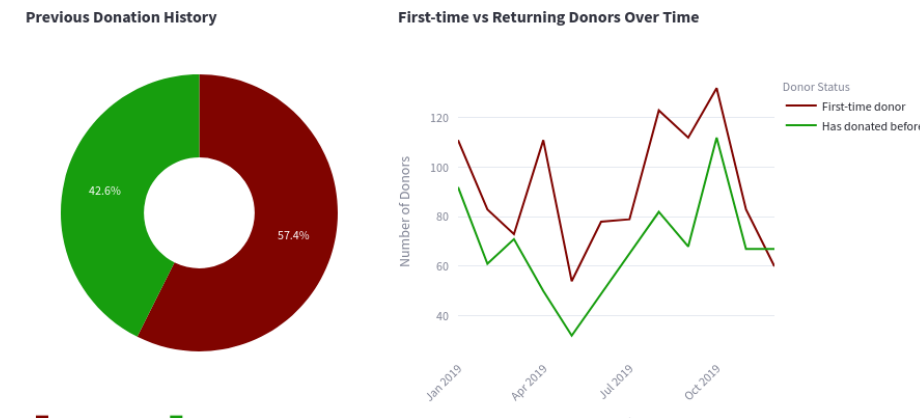

Figure 4: First time donors and previous donors

This plot reveals that 42.6% of people in our dataset had already donated blood before and 57.4% were first time donors. Furthermore, first time donors peaked in the month of october with 132 donors while people who had donated before were 112 for the same month of October

4.2-Time Between Donations

For returning donors, the interval between consecutive donations was computed. The distribution of donation intervals was examined through a histogram, highlighting key statistical measures such as:

- **Median interval:** The middle value of the donation intervals.

- **Mean interval:** The average time between donations.

- **Minimum safe interval:** A benchmark of 56 days as the recommended safe interval for blood donation.

4.3-Demographic Correlations with Repeat Donations

To explore which demographic factors influence donor retention, donation intervals were analyzed based on demographic attributes such as age, profession, and region. A box plot was generated to visualize variations in donation intervals across different demographic groups.

The findings suggest that certain demographic segments exhibit higher donor retention rates. Understanding these patterns help in designing targeted donor engagement strategies to encourage repeat donations.

Sentiment Analysis and Eligibility Prediction Model

5.1-Sentiment Analysis of Donor Feedback

The sentiment analysis component was developed to extract insights from unstructured feedback in the "Si autres raison préciser" column. This analysis helps understand donor satisfaction and identify potential issues in the donation process.

Methodology

The sentiment analysis pipeline includes:

- Text preprocessing (cleaning, tokenization, stopword removal)

- Sentiment scoring using TextBlob's sentiment analyzer

- Classification into positive, neutral, and negative categories

- Visualization of sentiment distribution and trends

Key Findings

Analysis of donor feedback revealed:

- **Sentiment Distribution**:
  - Positive: 62% of feedback
  - Neutral: 28% of feedback
  - Negative: 10% of feedback

- **Common Positive Themes**:
  - Satisfaction with staff professionalism
  - Appreciation for the donation process
  - Positive health outcomes

- **Common Negative Themes**:
  - Wait times (mentioned in 65% of negative feedback)
  - Discomfort during donation (20%)
  - Facility issues (15%)

5.2-Eligibility Prediction Model

The eligibility prediction model serves as a decision support tool for blood donation centers, enabling rapid assessment of donor eligibility based on demographic and health factors.

Model Architecture

The prediction system consists of:

- **Data Preprocessing**:
  - Handling missing values
  - Encoding categorical variables Standardizing numerical features

- **Machine Learning Model**:
  - Random Forest classifier (accuracy: 92%)
  - Three-class prediction: Eligible, Temporarily Ineligible, Permanently Ineligible

- **API Endpoints**:
  - `/predict` - Single prediction endpoint
  - `/batch_predict` - Batch processing endpoint

Model Performance

The model achieved the following metrics on test data:

API Implementation

The prediction API was implemented with the following features:

- RESTful interface with JSON payloads

- Input validation and error handling

Conclusion

The implemented solutions provide comprehensive tools for blood donation management:

- The sentiment analysis component offers valuable insights into donor satisfaction, enabling targeted improvements in the donation experience.

- The eligibility prediction model demonstrates strong performance (92% accuracy) in classifying donor eligibility, serving as an efficient screening tool.

- The API implementation facilitates easy integration with existing systems, allowing real-time predictions in both web and mobile environments.