Tanzania Water Well Classification

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Introduction and Contents

Business Understanding

Background | **Goals** | **Success Criteria**

- Tanzania faces challenges providing clean water
- Costly & complex:
  - ***70k*** water wells
  - ***67 million*** citizens
- NGO seeks efficient well-repair solutions

Business Understanding

Background | **Goals** | Success Criteria

- Assist NGO in identifying wells needing repair
- Prioritize minimizing false negatives for safety
- Ensure reliable access to clean water

Business Understanding

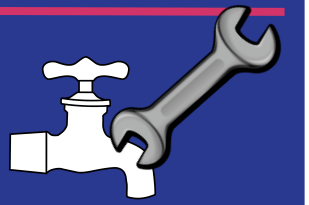
Background → Goals → **Success Criteria**

Positive:

Needs Repair

+

Correctly identified



Business Understanding

Background → Goals → **Success Criteria**

Negative:

Repair not needed

+

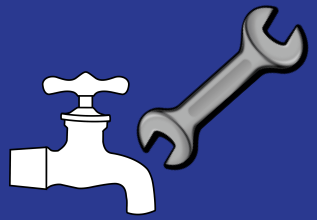
Correctly identified

Positive:

Needs Repair

+

Correctly identified



Business Understanding

Background → Goals → **Success Criteria**

Negative:

Repair not needed

+

Correctly identified

False Positive:

Repair not needed

+

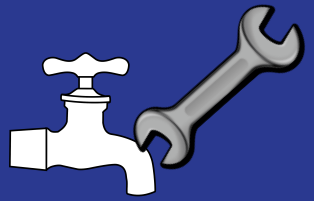
Wrongly flagged

Positive:

Needs Repair

+

Correctly identified



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Negative:

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+

Correctly identified

False Positive:

Repair not needed

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Wrongly flagged

False Negative:

Needs Repair

+

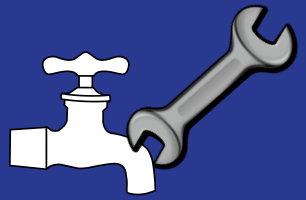
Missed

Positive:

Needs Repair

+

Correctly identified



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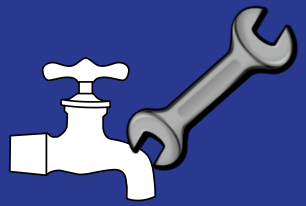


Business Understanding

Background → Goals → **Success Criteria**

Key Metric: **Recall**

- Minimizes false negatives

False Negative:

Needs Repair

+

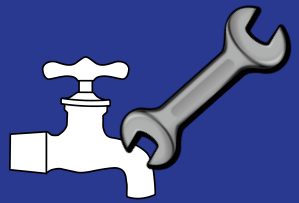
Missed

Positive:

Needs Repair

+

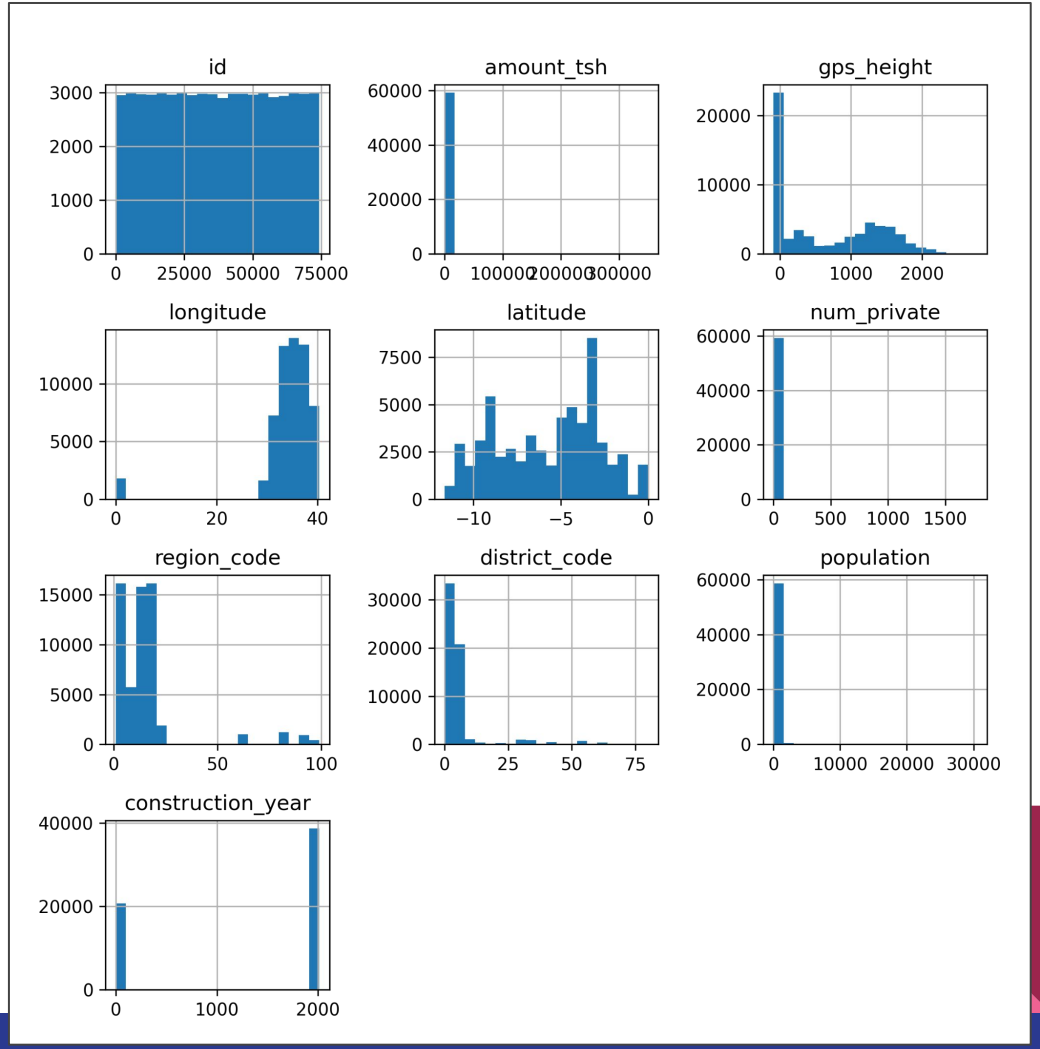
Correctly identified



Data Understanding

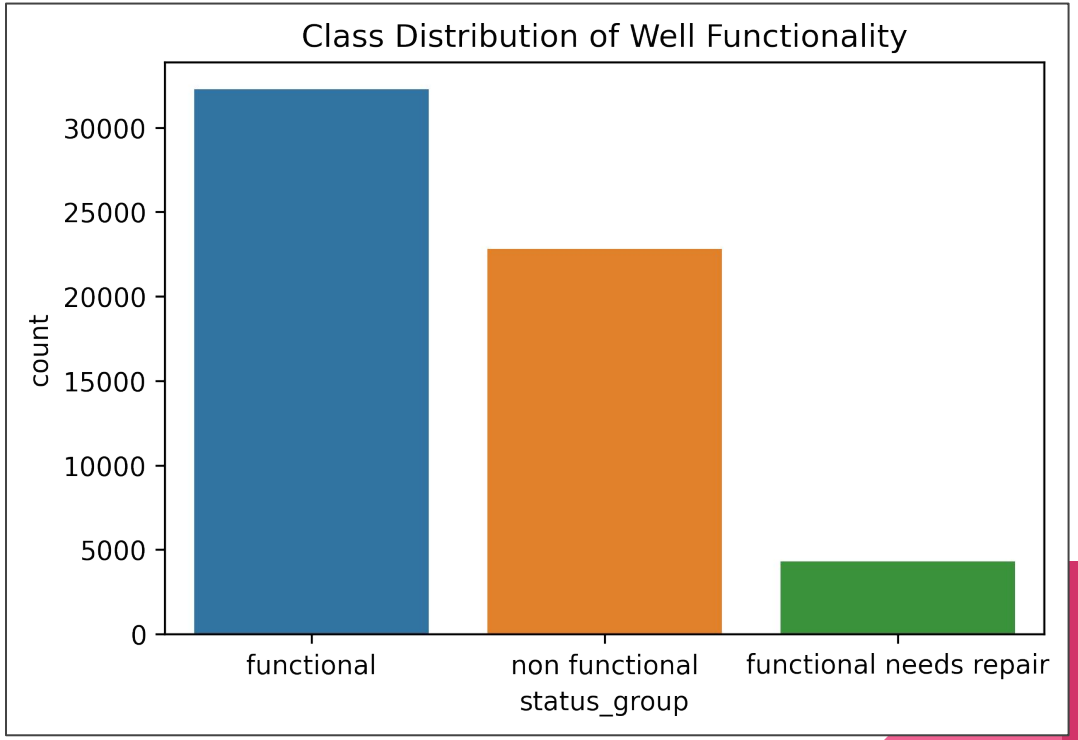
Data: ***41*** features, almost ***60k*** wells

Features: Included location, water source, installer



Data Understanding

Target: Well functionality with ***3*** classes



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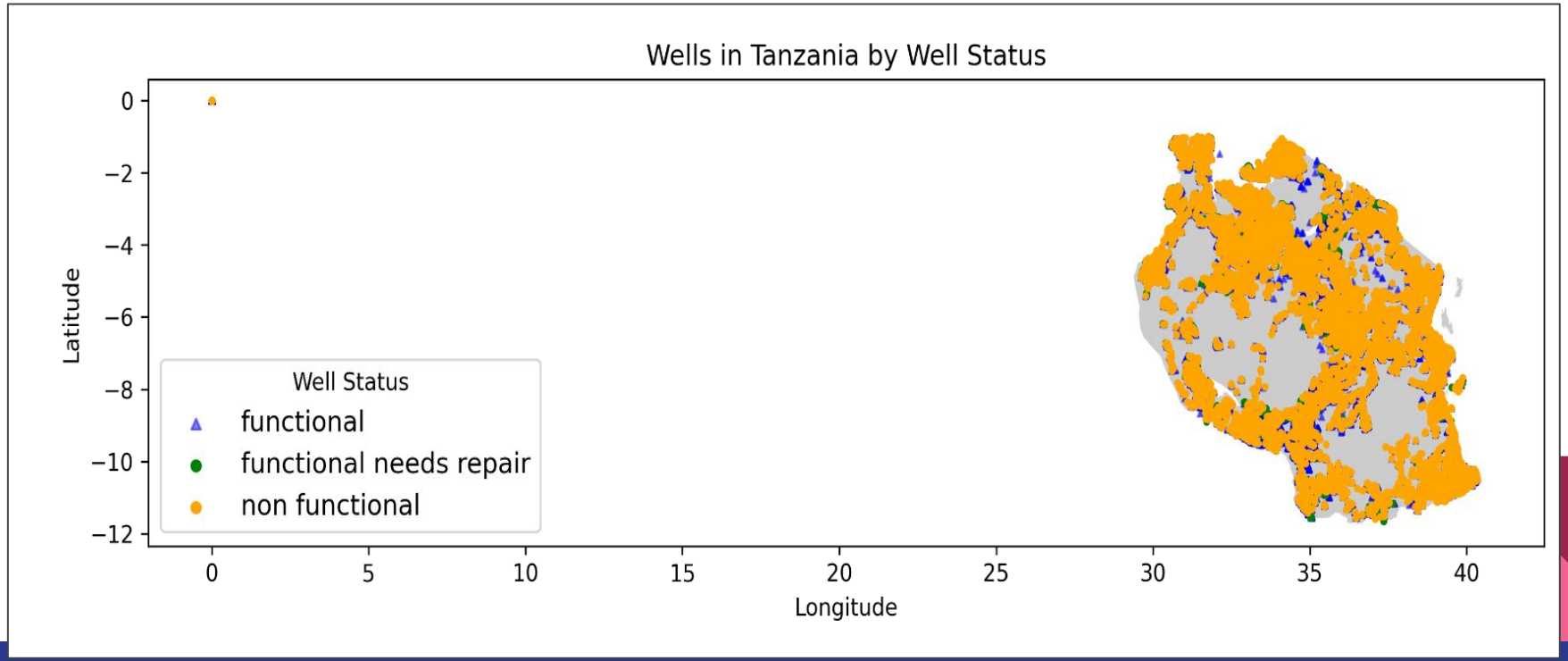
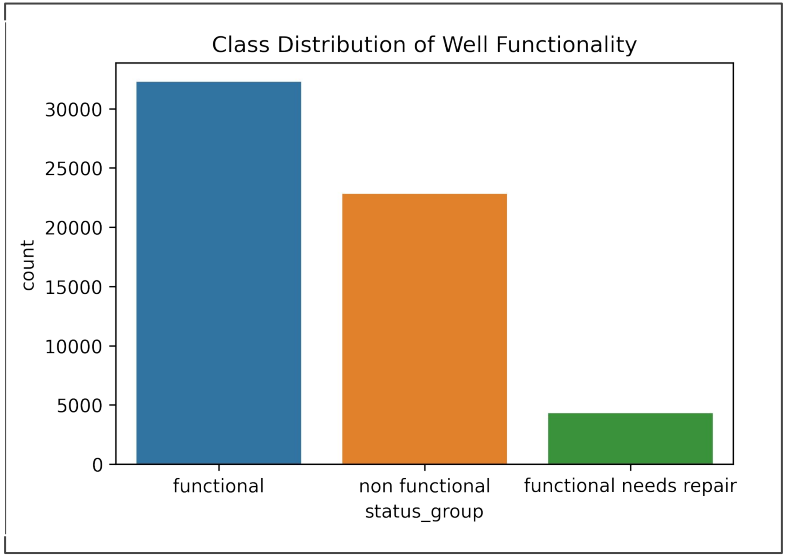
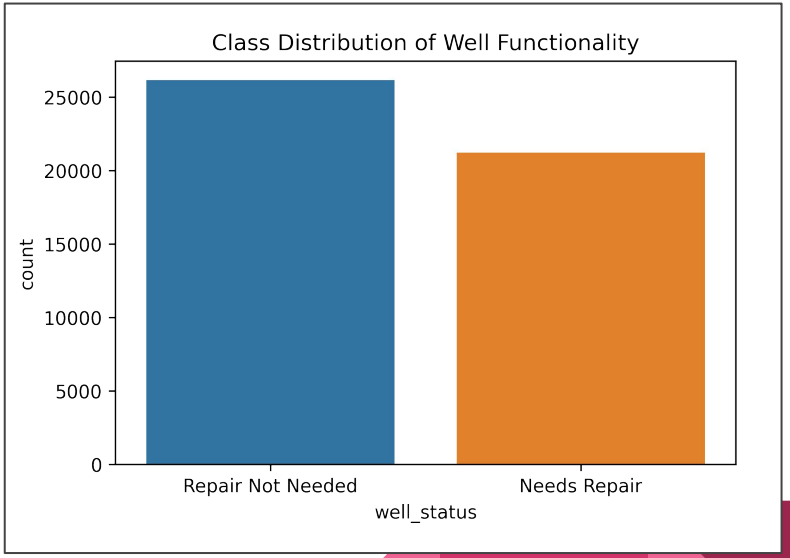


Data Preparation

1. Handled Duplicates
2. Processed features reducing cardinality:
3. Handled Null Values
4. Reclassified the Target Variable to Binary
5. Cleaned Dataset Overview:
    - Reduced to ***19*** features, ***47k*** rows

Data Preparation: Reclassified Target to Binary





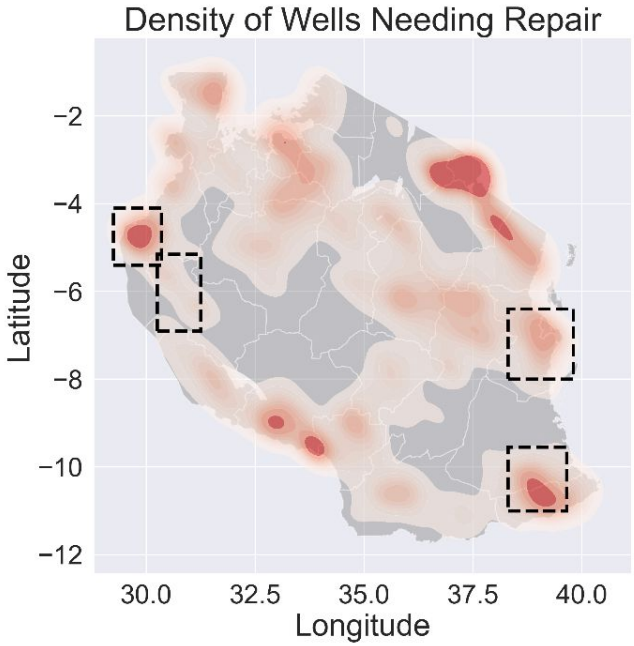
Exploratory Data Analysis

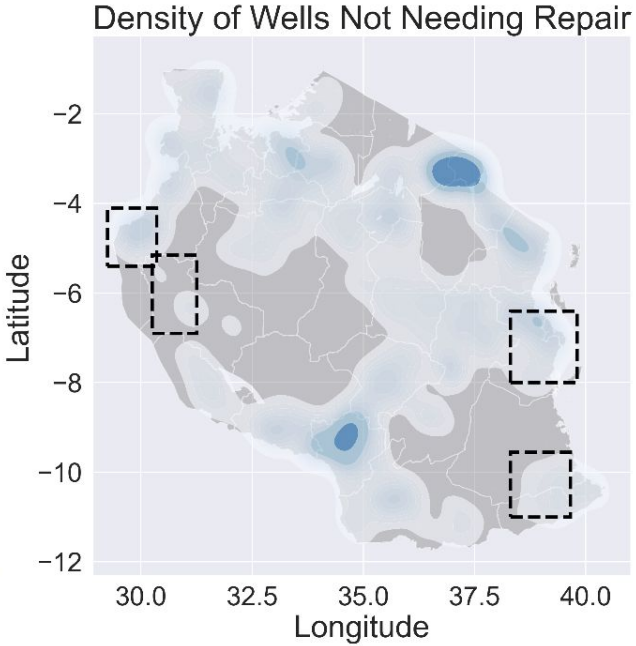
Findings

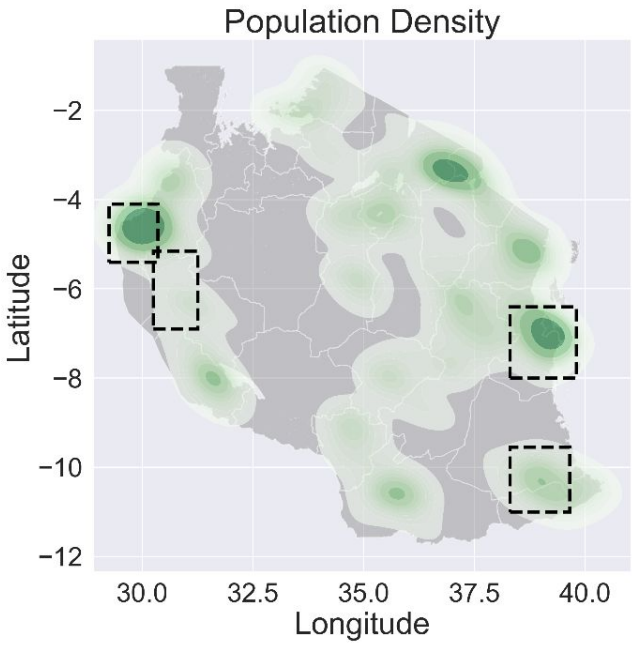
1. Government installer = higher non-functioning well rates
2. Ruvuma/Southern Coast and Lake Rukwa basins = higher non-functioning well rates
3. High-Priority Areas:
    - Areas with **high repair needs**, **low functional wells**, and **high population density**.

Exploratory Data Analysis: High-Priority Areas

Areas with **high repair needs**, **low functional wells**, and/or **high population density**.







Modeling and Evaluation: Key Components

- **Feature Selection & Hyperparameter Tuning**
  - Refined number of features and adjusted hyperparameters to reduce model complexity (overfitting)
- **Model Comparison**
  - Evaluated ***decision tree*** and ***random forest*** models against ***baseline logistic regression*** to measure performance
- **Validation Approach**
  - Assessed performance on validation and test datasets, focusing on recall to minimize ***false negatives***

Modeling and Evaluation

	Model Name	Training Recall (%)	Test/Val Recall (%)	Difference (Training - Test/Val Recall) (%)	False Negatives (%)
0	Decision Tree with RFE (val data)	100.00	78.60	21.40	9.70
1	Final Decision Tree (test data)	45.03	44.36	0.67	24.80
2	Final Random Forest (test data)	58.86	58.80	0.06	18.40
3	Initial Random Forest (test data)	99.90	77.45	22.45	10.10
4	Baseline Logistic Regression (test data)	66.85	66.00	0.85	15.20

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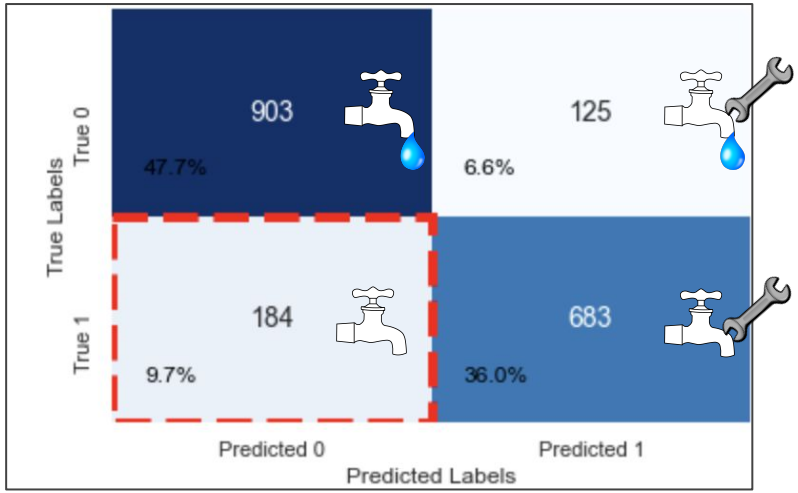
Modeling and Evaluation: Confusion Matrices

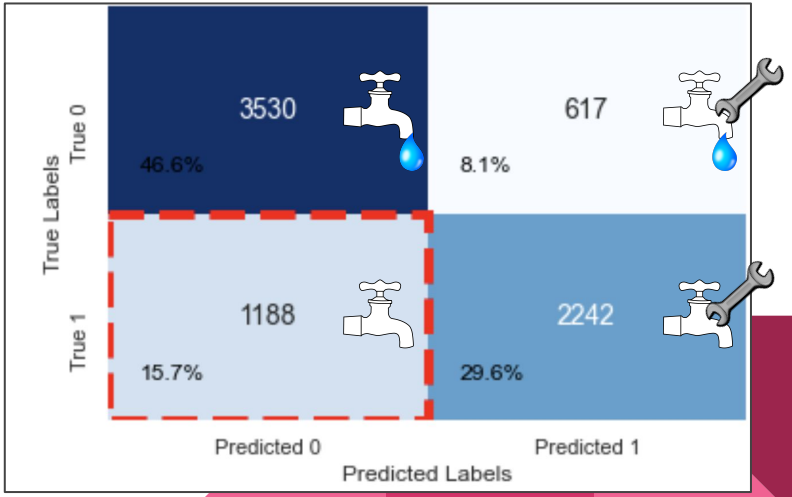
Decision Tree Model with RFE

Train recall score: ***100***%
Test recall score: ***78.6***%



Logistic Regression Model

Train recall score: ***66.85***%
Test recall score: ***66***%



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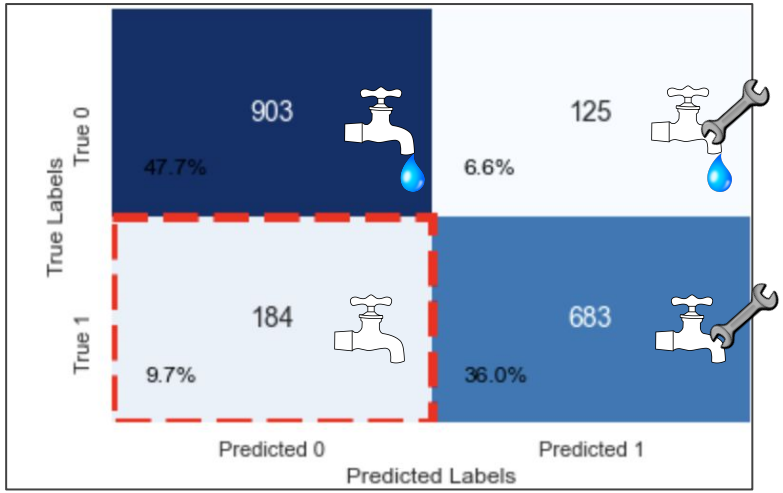

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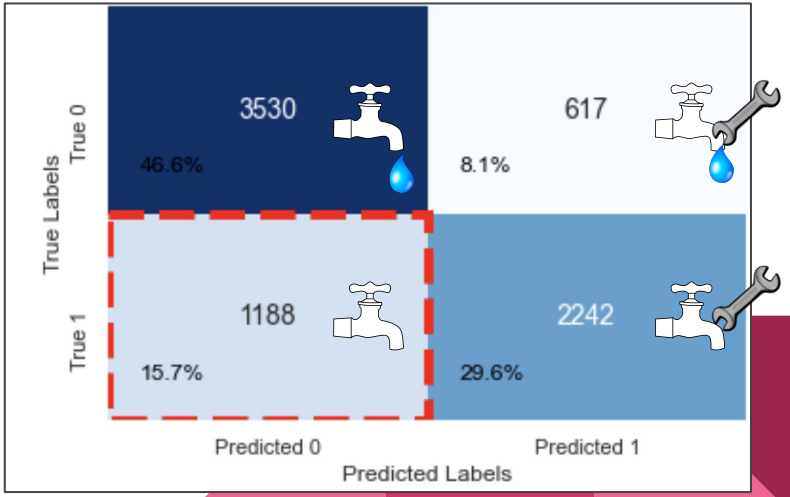

Limitations

- **Data Quality**:
  - Model is only as good as its data
- **Computing Constraints**:
  - Restricted parameter grid exploration
- **Time Constraints**:
  - Impacted model optimization
- **Domain Knowledge**:
  - Lack of local expertise affected feature selection

Recommendations

Recommendation 1: **High-Demand Areas**

Focus repairs in following regions:

- **Northwest (Kigoma)**
- **Southeast (Dar Es Salaam, Mtwara)**

Recommendation 2: **Logistic Model**

Choose **logistic regression model** for unseen data

Recommendation 3: **Reduce Model Complexity**

To reduce overfitting

- Improve **feature selection**
- Apply **cross-validation**

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Next Steps

1. Enhance Data Collection
2. Reduce Overfitting in Models
3. Explore Advanced Algorithms

Thank you!

Github Repository:
https://github.com/ckucewicz/water_well_classification

Contact Chris Kucewicz at
cfkucewicz@gmail.com with additional questions