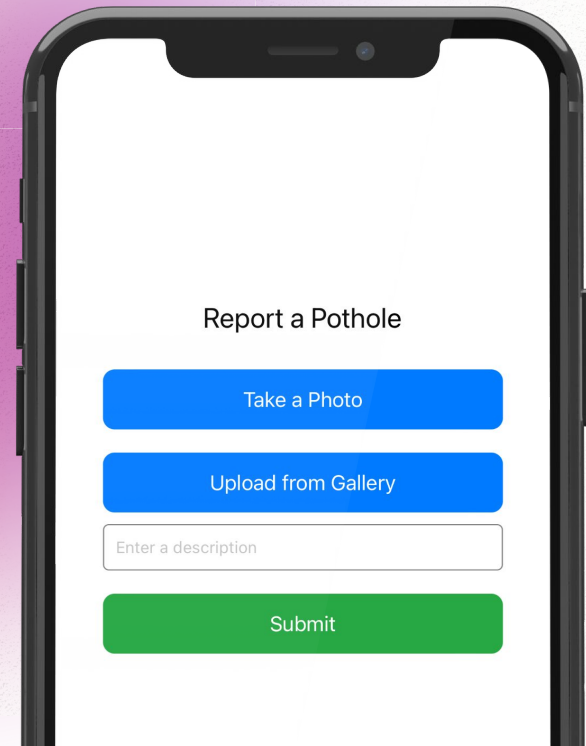
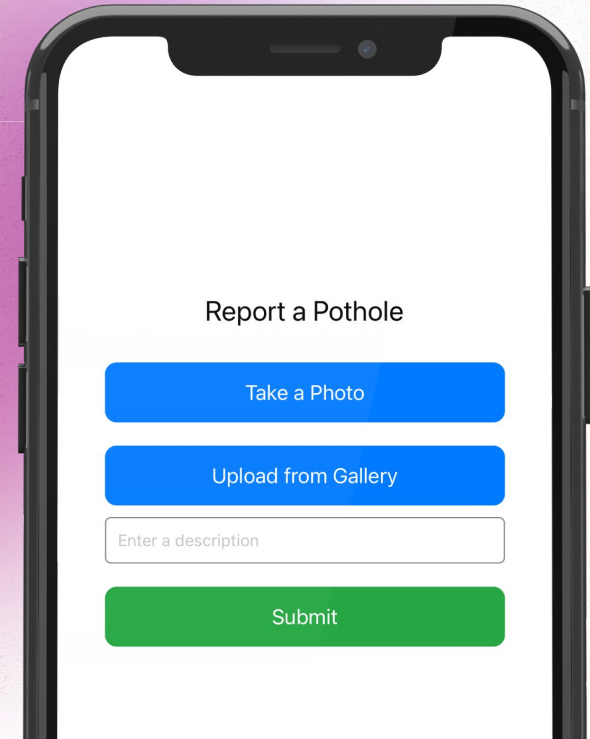


Patch Perfect



Team: ComSigh

Steffan Schoonbee, Gunther Tonitz Dirk Hoffmann,
Shriyan Singh, Franco Uys



The Problem

Inefficient, reactive repair methods

- Potholes addressed only after complaints
- No system for proactive identification

Escalating costs

- Delayed repairs lead to larger, costlier fixes
- Budget overruns due to emergency repairs

Increasing safety hazards

- Unrepaired potholes pose risks to vehicles
- Potential for accidents and injuries rises



Our Innovative Solution

Data science pipeline for pothole reporting

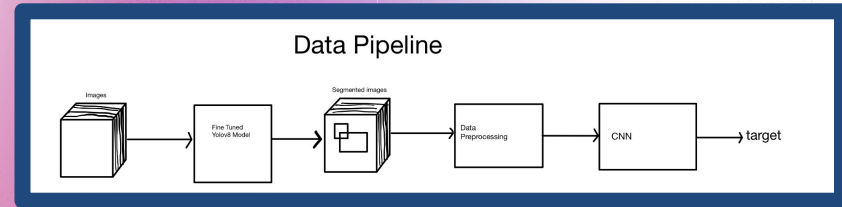
- Streamlines the process of identifying issues
- Enables real-time data collection and analysis

Deep learning model for:

- Accurate pothole detection • Uses AI to identify potholes from images • Reduces human error in assessment
- Asphalt quantity prediction • Estimates required materials for repairs • Optimizes resource allocation

User-friendly platform for municipal teams

- Intuitive interface for easy adoption
- Centralizes data for efficient decision-making



YOLOv8 Model: Key Insights

Model Fine-Tuning Challenges

- Integrated an external pothole dataset
- Caused data imbalance (5x more potholes than sticks)
- Negatively impacted model performance

AWS Training & Results

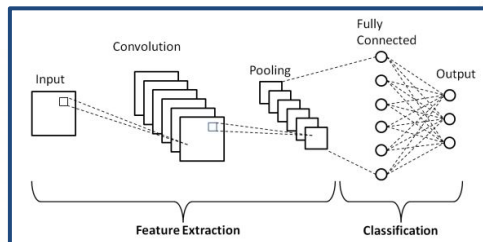
- Spun up an AWS instance for approx 1.5-day training session
- Achieved mAP50 of 95%
- 93% precision/recall

Segmentation Model Hurdle

- Discovered a pre-trained pothole model for segmentation on Hugging Face
- Time constraints and prior results further fine-tuning was not pursued

Models

Convolutional Neural Network



A Convolutional Neural Network (CNN) is a type of deep learning model that is particularly well-suited for image analysis tasks.

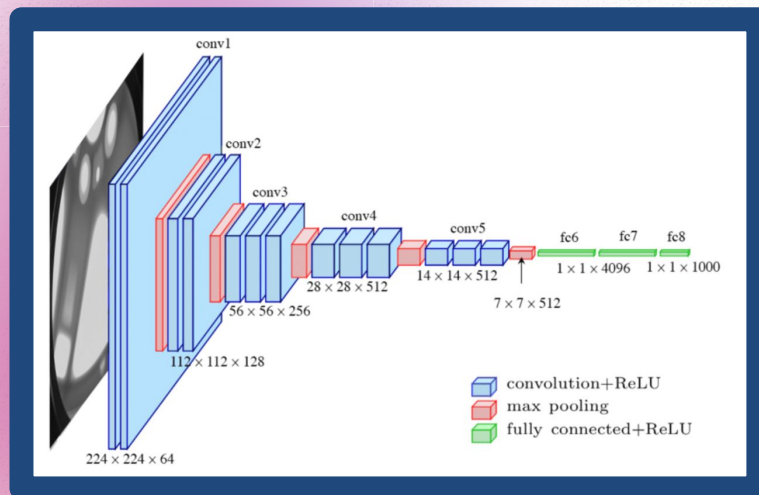


Image Preprocessing: Enhancing Data Quality

The images go through the following steps to incorporate the information from the annotations:

1. Calculate the **size of the stick** relative to the photo (stick will be the same size in each photo)
2. The image is **resized** based on the stick size (we use the inverse)
3. Now the dimensions of the image **encodes** information
4. The images are resized to **512x512** with **padding** so that the largest image has dimensions 512x512
5. The **black padding** around the image now encodes information

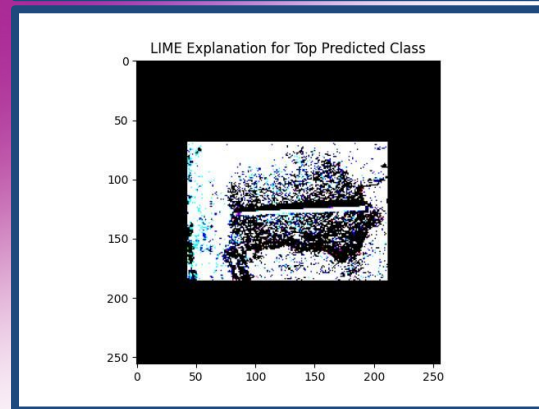
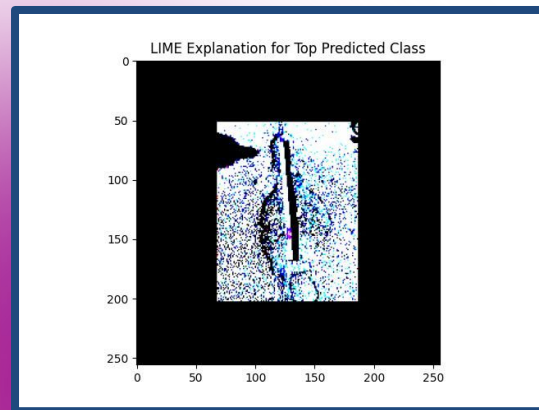


Custom CNN Model Architecture

- **Custom Image Augmentation Layer** • Enhances model robustness • Avoids inaccurate vertical shifts • Alternative to TensorFlow built-in augmentation
- **Augmentation Capabilities** • Horizontal and vertical image flips • 90-degree rotations • Random adjustments to:
 - Contrast
 - Brightness
 - Hue • Simultaneous random application of effects
- **Model Structure** • 2 Convolutional layers with max pooling • 2 Dense layers with dropout

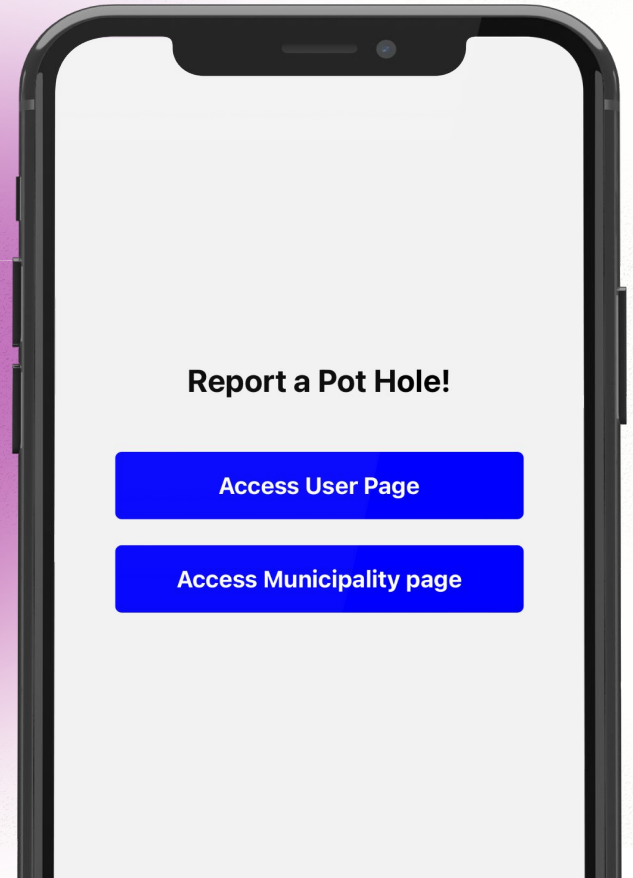
Model Performance and Interpretability

- **Final R2 Score** • Achievement: 0.21
- **LIME** (Local Interpretable Model-agnostic Explanations) • Purpose: Explain individual model predictions • Method: Approximates complex models with simpler, local ones • Output: Reveals features influencing predictions
- **Key Insights** • LIME exposes factors behind model decisions • Enhances understanding of model output • Builds trust in model predictions



Let's apply this!

A **React Native mobile app** was designed to streamline the process of reporting and repairing potholes!

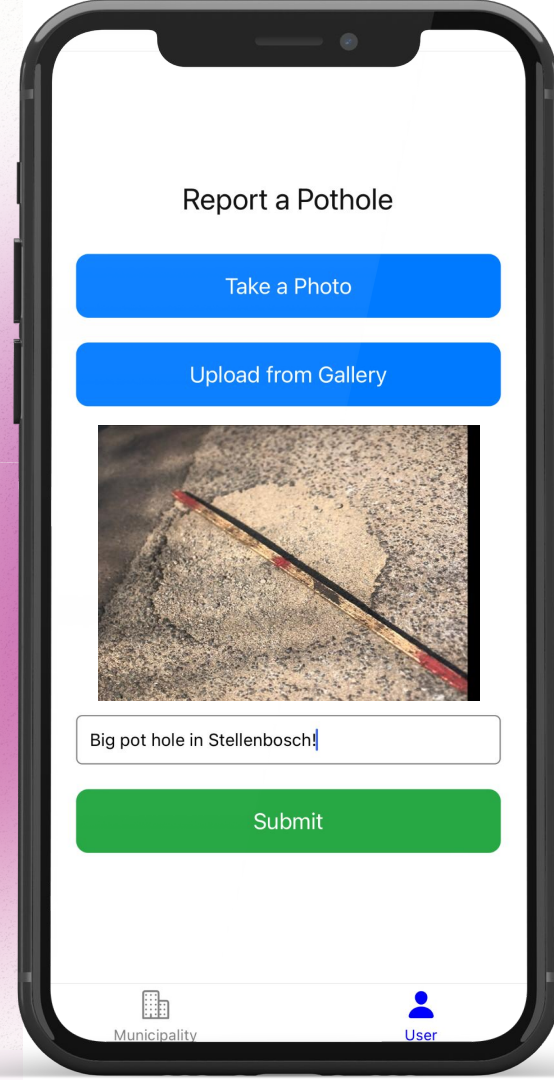


User Side

Capture & Upload: Users can report potholes by taking a photo directly within the app or uploading an existing image from their gallery.

Location-Based Reporting: Users can provide specific details about the pothole location, ensuring accurate and timely responses.

Effortless Submission: The app streamlines the process, enabling users to quickly submit reports directly to the relevant municipality with a single click.

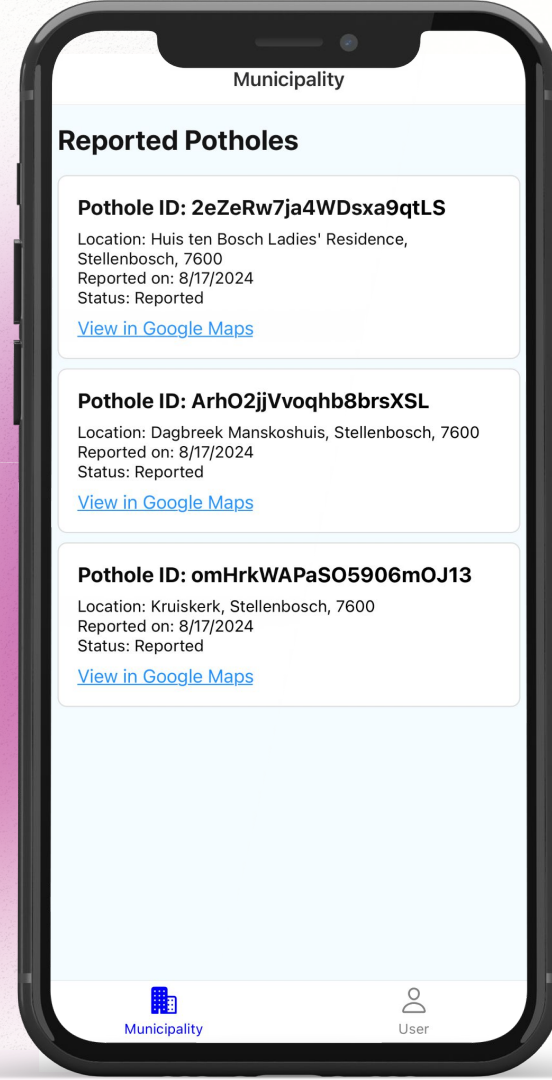


Municipality side

Review Reports: Municipalities can easily review submitted pothole reports, complete with detailed descriptions, location information and number of bags of tar needed.

Track & Assign: Officials can track the status of each pothole report.

Update & Communicate: Municipalities can update the status of repairs and communicate progress with the community, ensuring transparency and accountability.



Cloud Functionality

Firebase Firestore: NoSQL database that stores pothole submissions and information in real time.

Firebase Storage: Stores pothole images for processing with the model.

Firebase Functions: Serverless execute which automatically triggers when new pothole submissions are made. Allowing the model to compute in cloud to save time and keep things asynchronous.



Firebase