



# Poop Tracker

Predictive modeling of dog movements through sensors  
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## Introduction

Dogs poop a lot, and leaving poop on the ground poses environmental and public health concerns and may result in fines in certain municipalities. Our project aims to create a system consisting of an app connected via Bluetooth to a collar equipped with an Arduino microcontroller. This will allow a user to get notified on their dogs' defecation even when not physically present.

## Requirements

- Functional Requirements
- Bluetooth connection between the collar and the application capable of transferring data in real-time with at least 99% reliability within 40 feet
  - The 3D printed Arduino collar attachment securely holds a power bank and the Arduino
  - The application exports data to other locations such as the centralized cloud database
  - The machine learning algorithm detects defecation events with at least 80% precision and 90% sensitivity
- Non-Functional Requirements
- The machine learning algorithm runs efficiently on the Arduino without increasing latency
  - The application never crashes during standard use
  - Connection between devices in 10 seconds
  - The application displays defecation locations accurate to 3 feet on a map

## Testing

- We tested our collar on real dogs during actual excursions for live data collection in real-world conditions.
- Before live testing, we generated mock data to verify system behavior and database connectivity under controlled conditions.
- External testers also gathered additional data, helping us evaluate reliability of data collection across different users and environments.
- We used simulators and desktop testing tools to run and validate the app across multiple platforms, including iOS, Android, and Windows.
- Testing of Bluetooth connection was conducted initially at close ranges between devices connected to a power source, then later ran on its own battery

## Evaluation

- Results
- Connection: Reliable Bluetooth connectivity was maintained within 40 feet.
  - Poop Detection Accuracy: Still under evaluation through continued testing.
  - Application: The app successfully displays detected events and sends notifications to users.
- Project Outcome
- The main project goals were achieved despite challenges such as account restrictions and gathering enough Arduinos for data collection.
  - Future improvements could include user accounts, expanded testing, improved detection accuracy, and additional app-side features.

## Design

- Full System
- The Arduino connects through Bluetooth to the Device and Flutter app.
  - Firebase hosts all data collection for ML training
  - The user has access to the app
- Physical Component
- 3D printed to fit the Arduino
  - Battery soldered and attached through a gap
  - Velcro holds them together to a collar
- Application
- MVC pattern used
  - Model holds the data
  - App displays data and map
  - Flutter app uses Bluetooth to communicate with the Arduino

## Diagrams

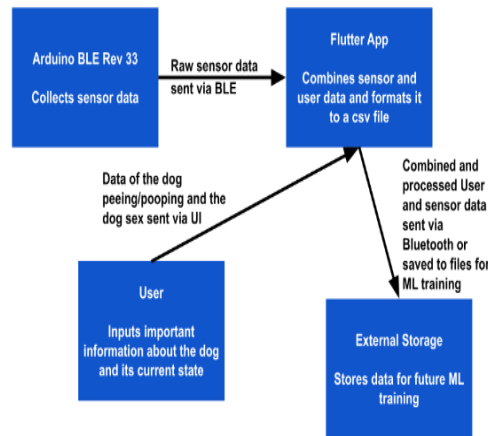


Figure 1: Data flow diagram of full system

```

INFO: Created TensorFlow Lite XNNPACK delegate for CPU.
-- Model tensor info
Input shape: [ 1 100 6]
Input dtype: <class 'numpy.int8'>
Input scale: 0.061259
Input zero_point: -15
Output shape: [1 1]
Output scale: 0.003906
Output zero_point: -128

-- Arduino sketch values
// Paste these into your .ino file:
const float INPUT_SCALE = 0.06125890f;
const int8_t INPUT_ZERO_POINT = -15;
const float OUTPUT_SCALE = 0.00390625f;
const int8_t OUTPUT_ZERO_POINT = -128;

-- Loading test data
Loaded 2,907 rows from 9 file(s).
Windows: 113 | normal=108 pooping=5 pos_rate=4.4%
Test samples: 23 (normal=22 pooping=1)

-- Classification report
precision    recall  f1-score   support

 Normal     1.000    0.727    0.842     22
 Pooping    0.143    1.000    0.250      1

 accuracy   macro avg 0.571    0.864    0.546     23
 weighted avg 0.963    0.739    0.816     23

-- Sample predictions
Actual Predicted Confidence
Normal Normal 0.473 ✓
Normal Pooping 0.516 ✗
Normal Normal 0.465 ✓
Normal Normal 0.473 ✓
Normal Normal 0.465 ✓
Normal Normal 0.465 ✓
Normal Normal 0.496 ✓
Normal Normal 0.477 ✓
Normal Normal 0.496 ✓
  
```

Figure 2: Completed Test

## Acknowledgements

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