

smart bins



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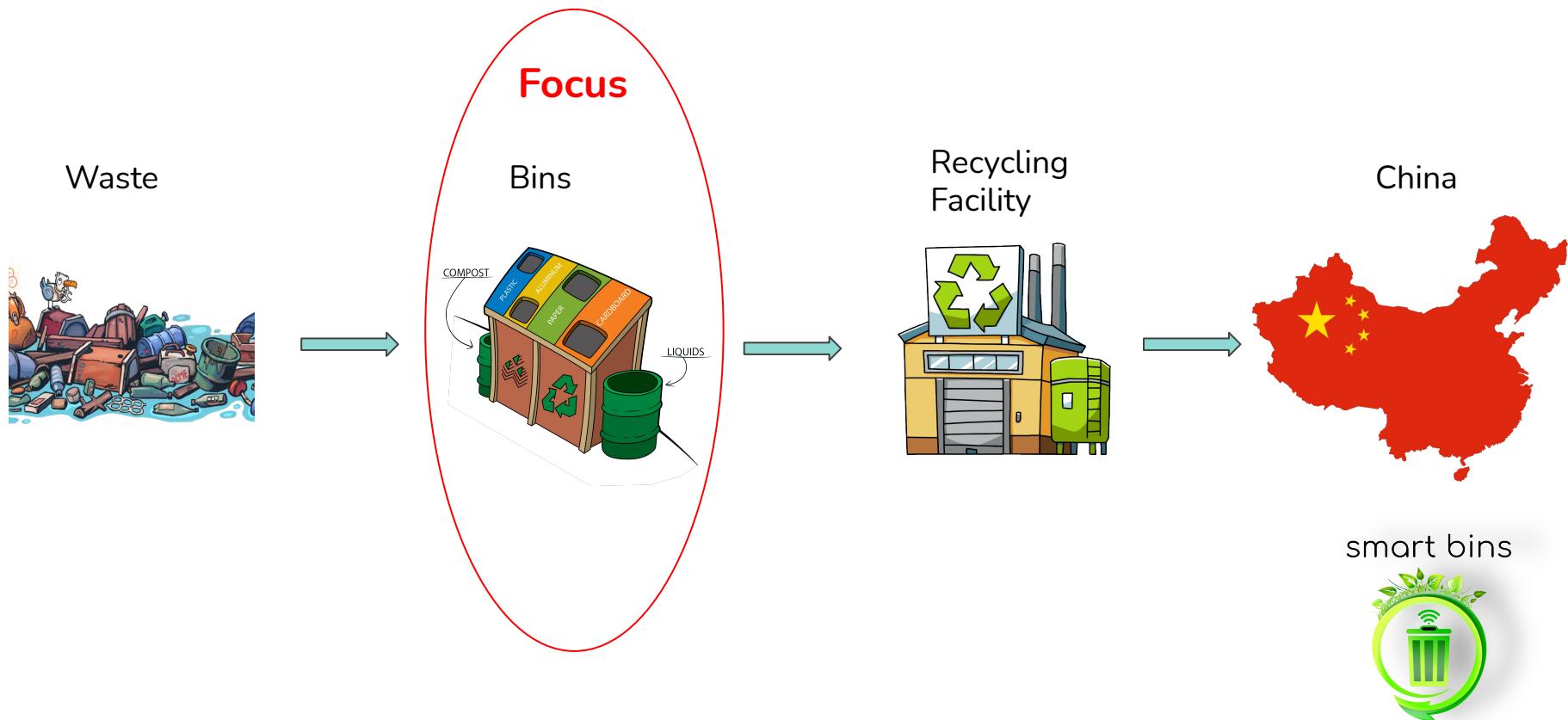
Waste Management is a problem in the US

- 52.5% of US total waste goes to landfill
- 49% of survey respondents do not know where to throw trash
- China reduced its tolerance for contamination rate to 0.5% in 2018
- More than 1000 Recycling Facilities have shut down

smart bins



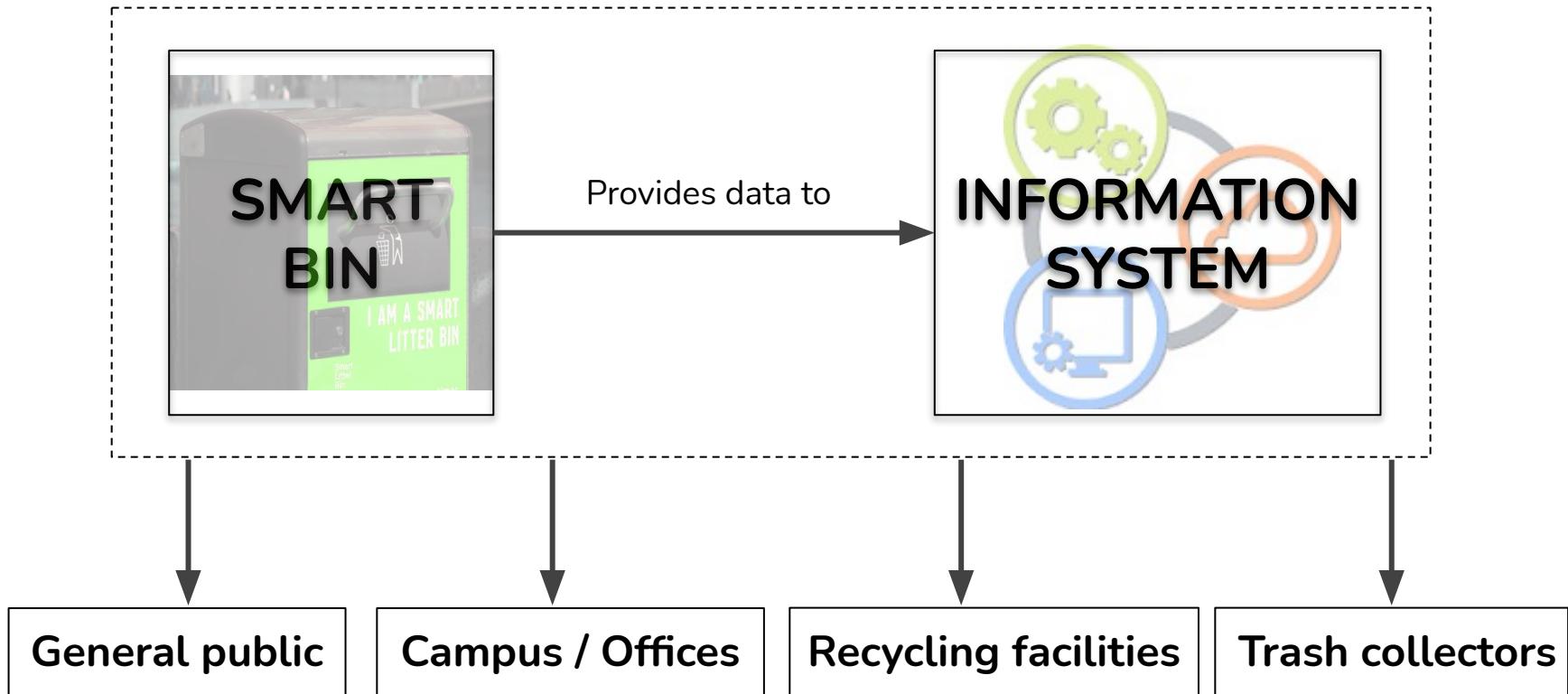
Contamination must be solved at the beginning of the chain



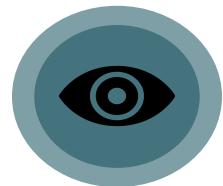
Our value proposition impacts multiple stakeholders

- Make the recycling process **easier** and **faster** and educate → **General public**
- Help organizations improve the recycling rate and **reach sustainability goals** → **Campus/Offices**
- **Reduce contamination** rate and therefore increase profitability → **Recycling facilities**
- **Improve efficiency** of trash collection → **Trash collectors**

Hardware + Software



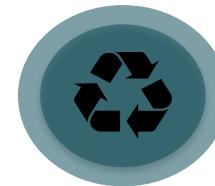
The hardware component aims to classify trash with the help of AI and 5G



Computer Vision



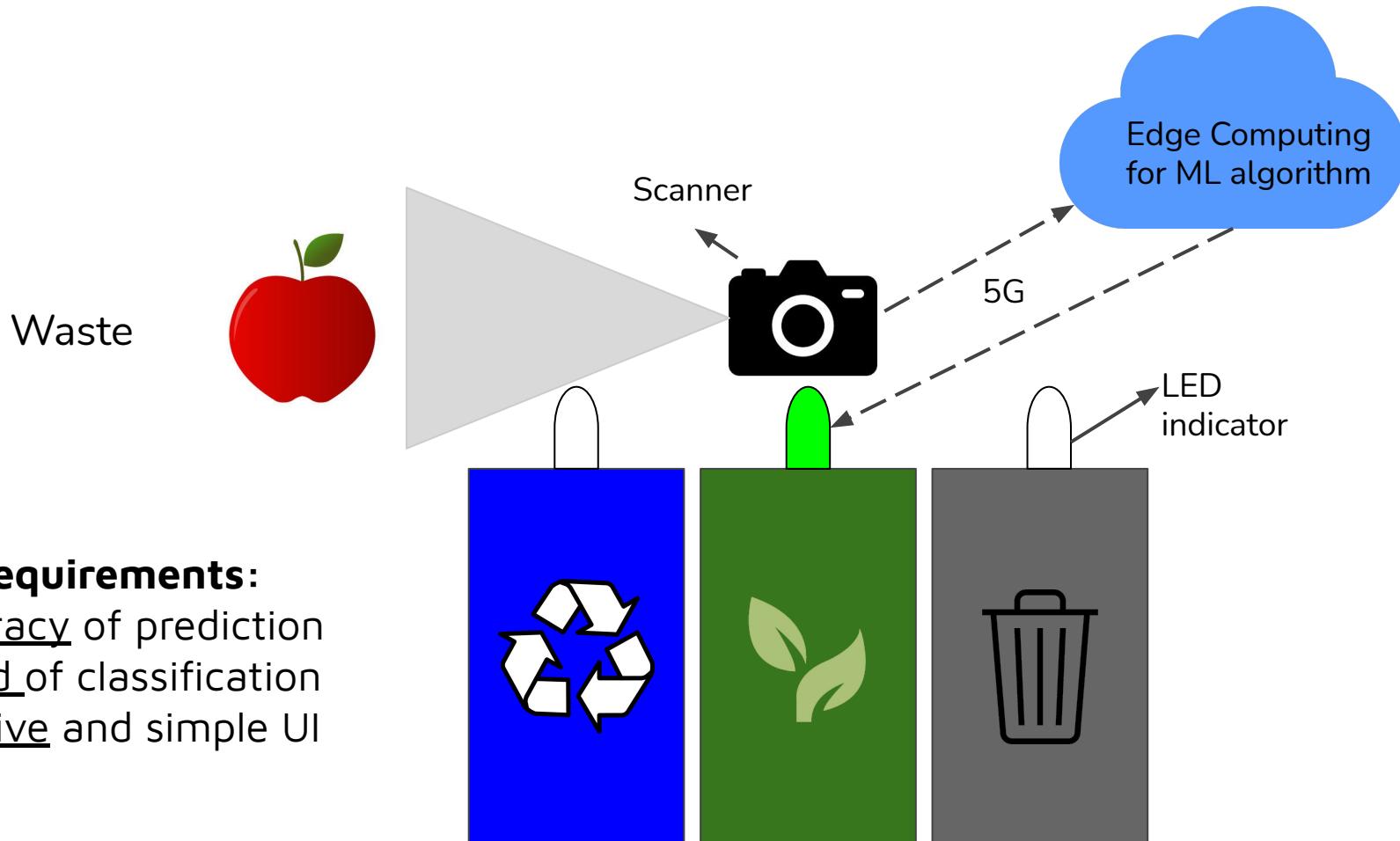
5G technology



Recycling bin

smart bins



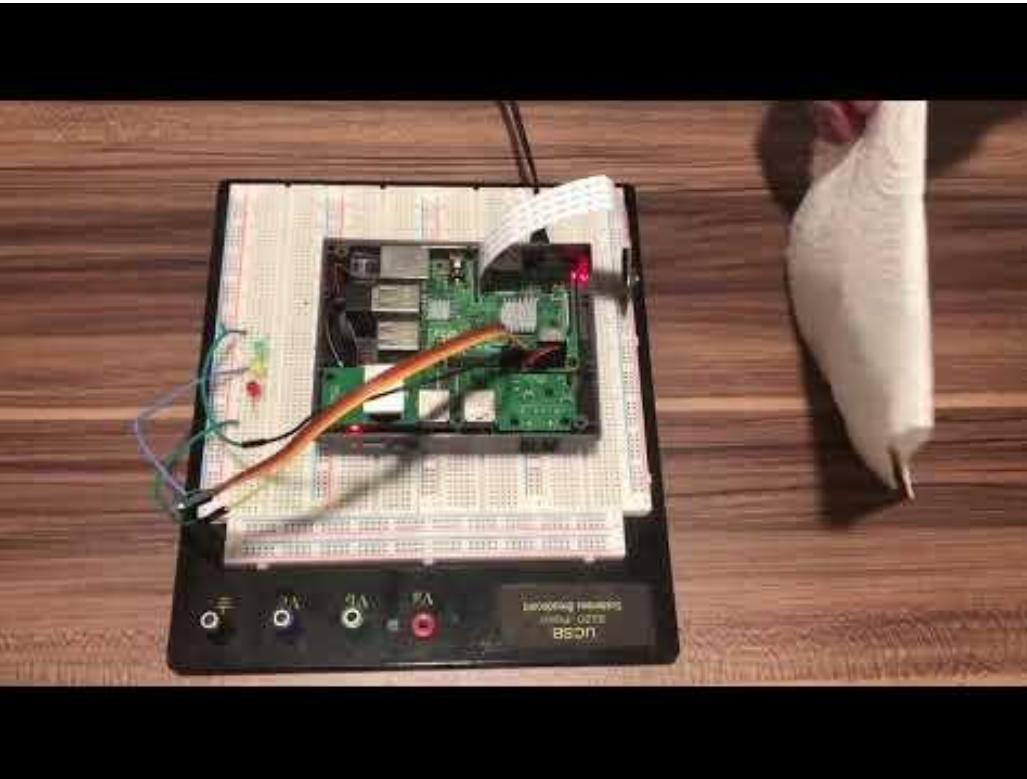


Top user requirements:

1. Accuracy of prediction
2. Speed of classification
3. Intuitive and simple UI



Hardware Demo



Red: Metal/Glass

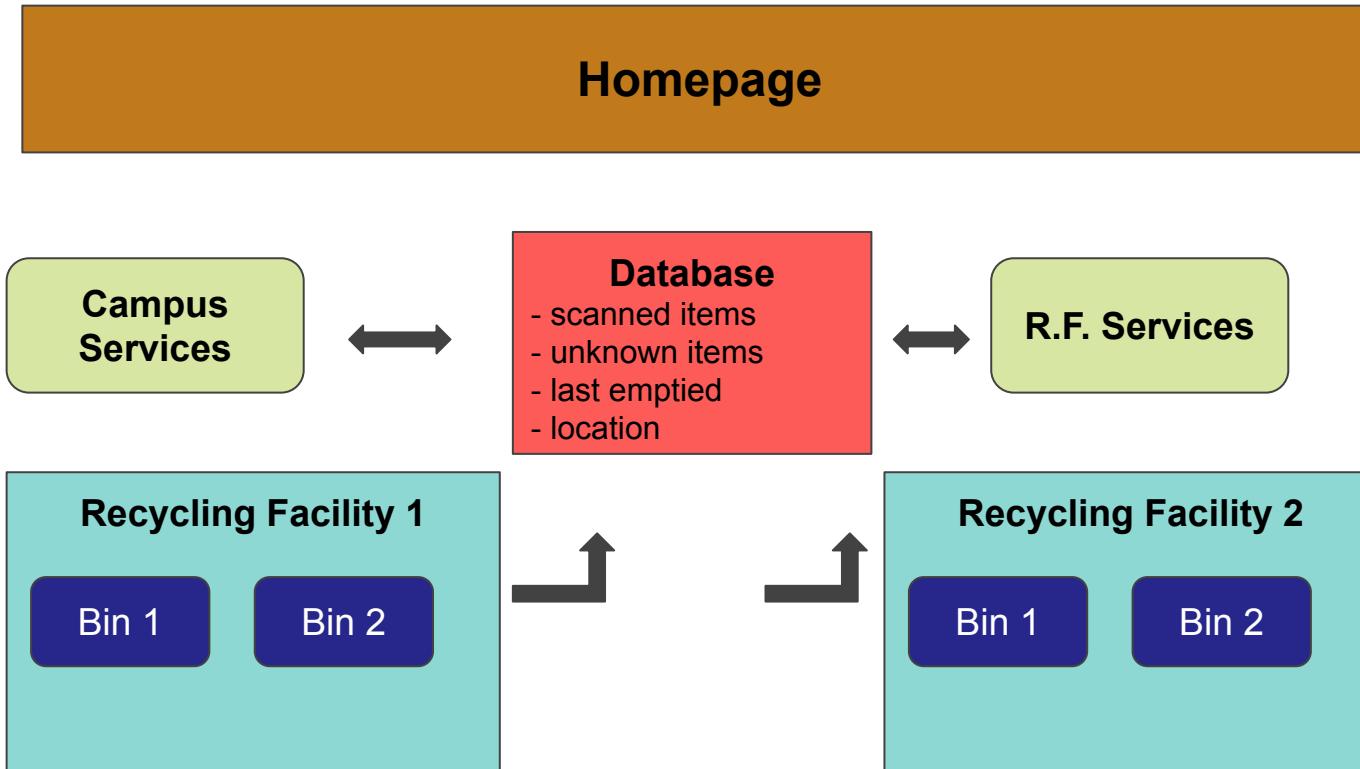
Yellow:
Paper/Cardboard

Green: Plastic

Why 5G?

- **Low latency:** we need a fast response from the system (less than 1 second between scanning the image and turning on the light)
- **Greater bandwidth:** we will have multiple smart bins powered by 5G close to each other and uploading images to the server
- **Limited Wifi** connection coverage outside of campuses
- **Expensive** to reach fast response time using internal processor

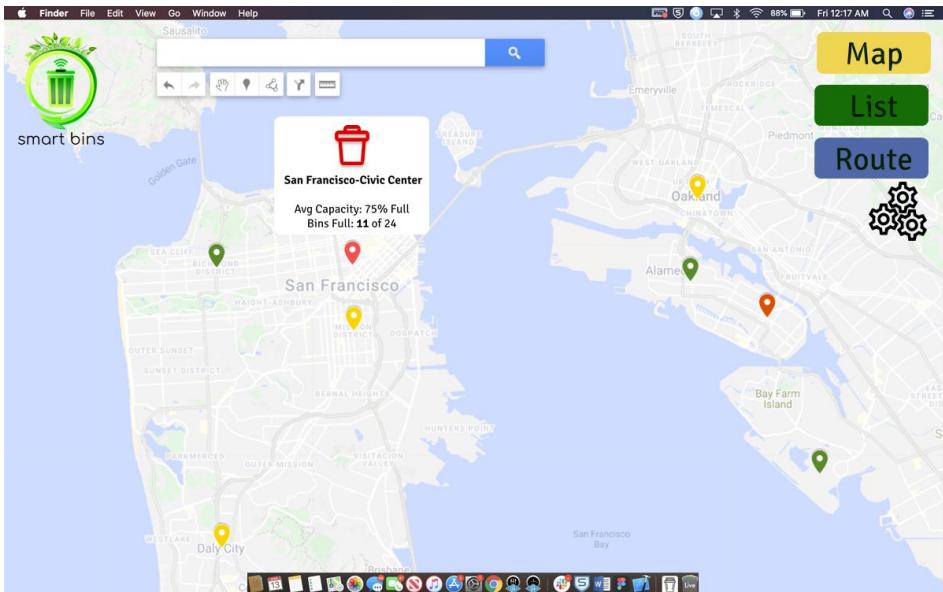
The software component is an information system with multiple services



Smart Bin Real-Time Analytics Platform

A platform for waste managers to quickly view:

- Overview of neighborhoods
- Statistics and status of Smart Bins in each region



smart bins

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smart bins

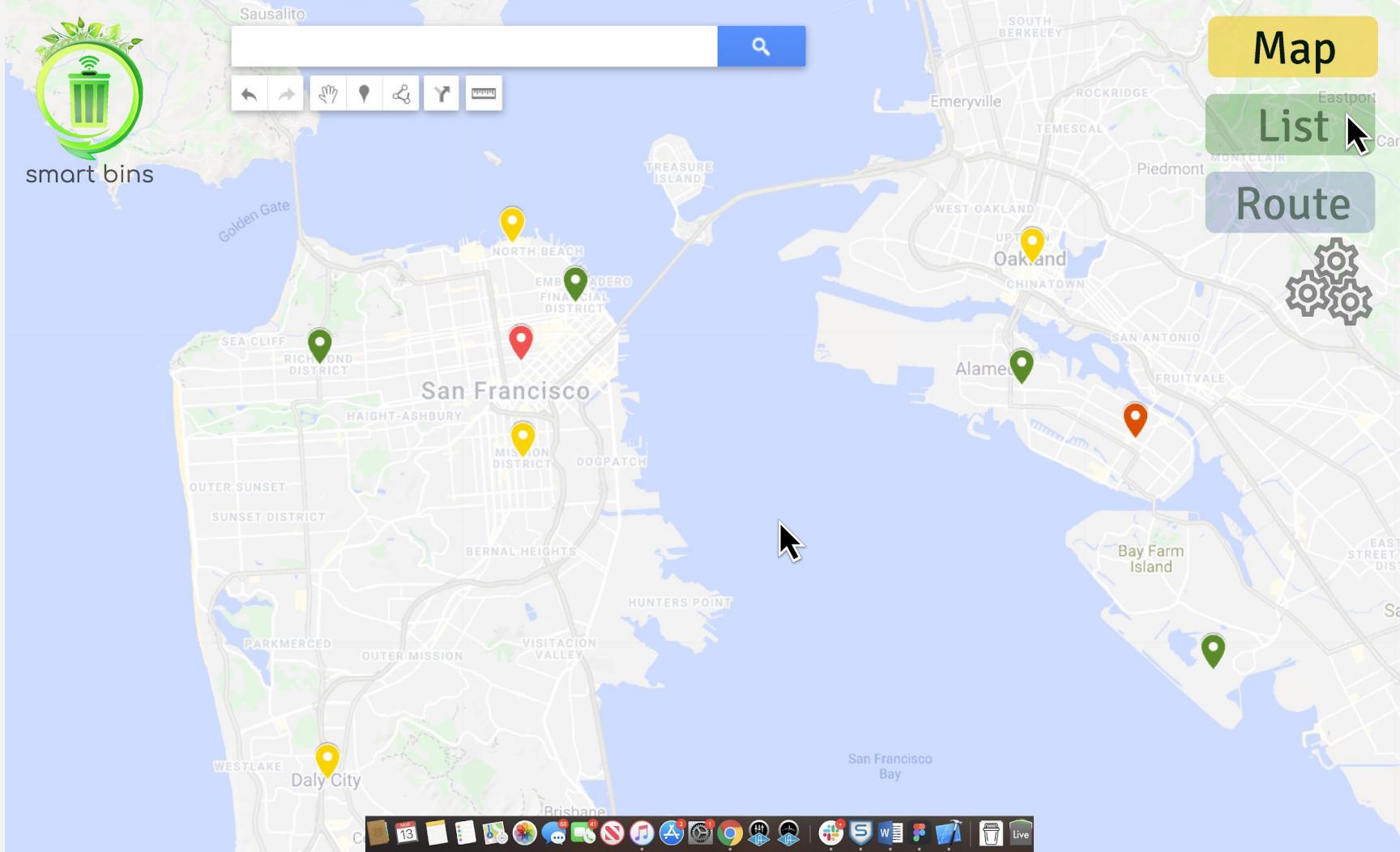
Log in

oskibear@berkeley.edu

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LOG IN







Region Information

**Map****List****Route****San Fransisco - Richmond District**

Capacity Utilization: 32% Full
Bins Full: 0 of 19
Sort Accuracy: 92%

**Daly City - Downtown**

Capacity Utilization: 50% Full
Bins Full: 2 of 9
Sort Accuracy: 82%

**South SF - Downtown**

Capacity Utilization: 38% Full
Bins Full: 0 of 7
Sort Accuracy: 72%

**Oakland - Downtown**

Capacity Utilization: 50% Full
Bins Full: 2 of 8
Sort Accuracy: 93%

**Oakland International Airport**

Capacity Utilization: 35% Full
Bins Full: 3 of 32
Sort Accuracy: 95%



Bin Capacity

Oakland-Downtown

[Map](#)[List](#)[Route](#)

Bin #131
Location: 1807 Telegraph Ave
Status: ~32% Full



Bin #132
Location: 2255 Telegraph Ave
Status: ~64% Full



Bin #133
Location: 180 Grand Ave
Status: ~45% Full



Bin #134
Location: 1333 Broadway
Status: ~87% Full



Bin #135
Location: 230 Bay Pl
Status: ~20% Full



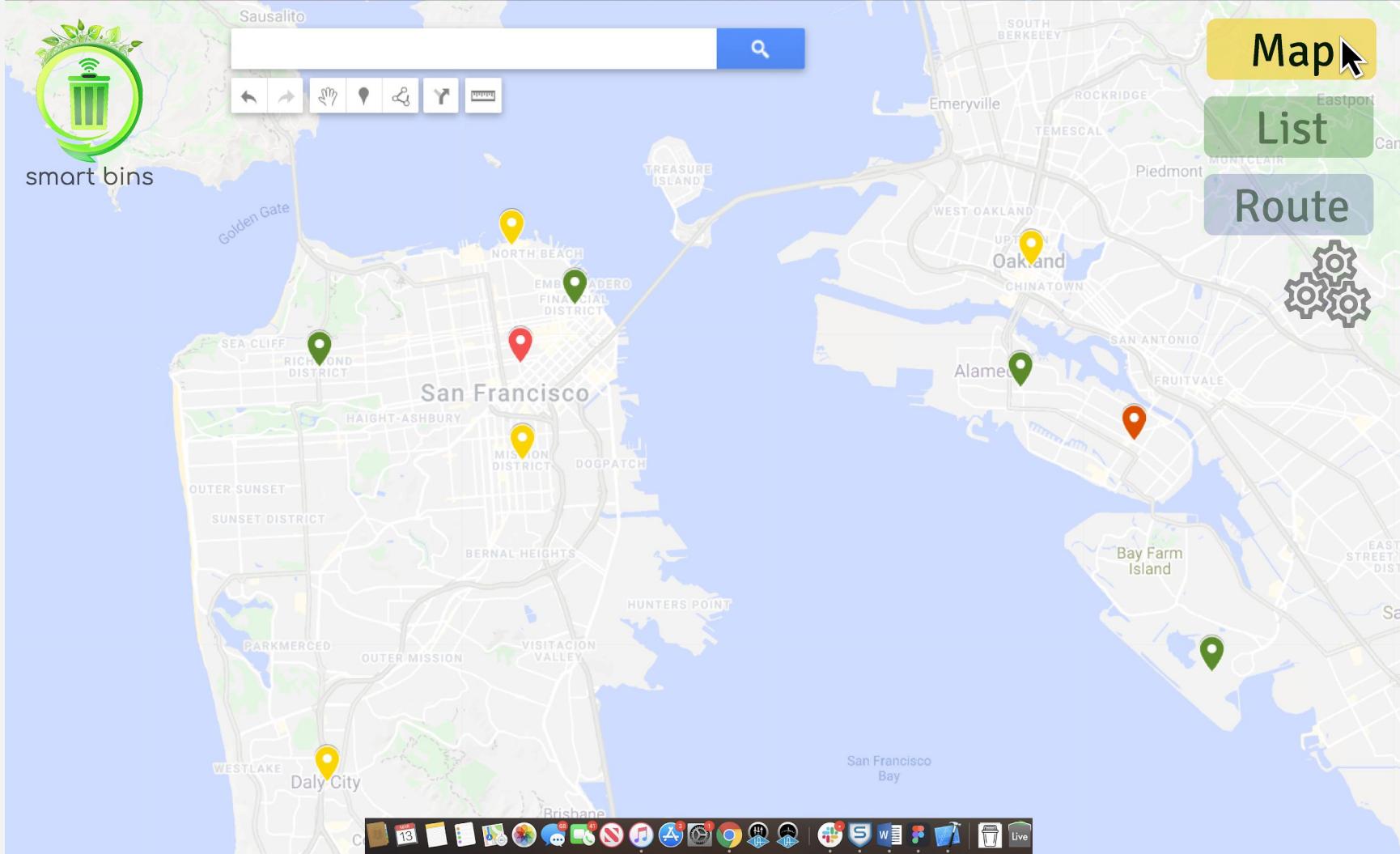
Bin #136
Location: 825 Jackson St
Status: ~35% Full

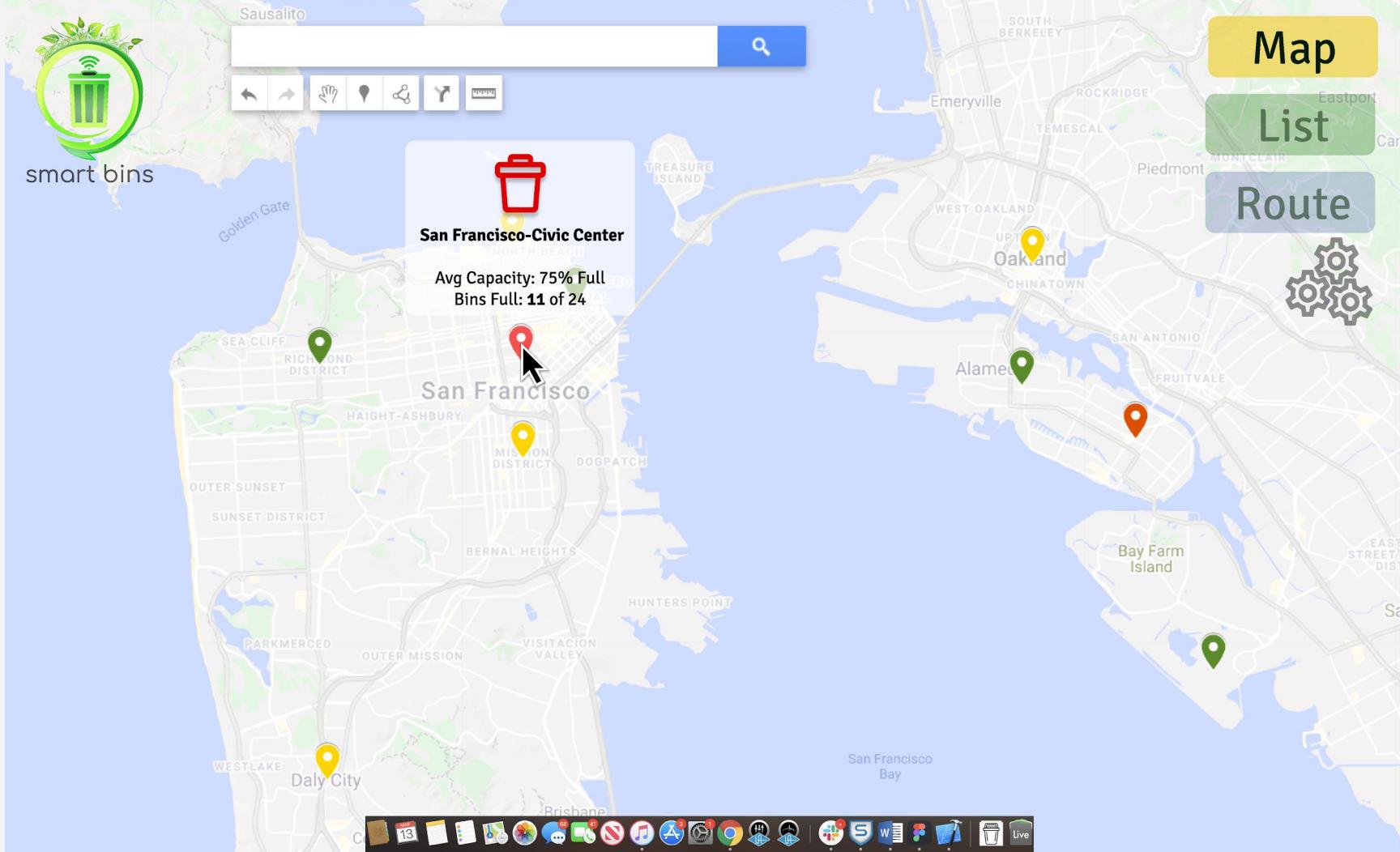


Bin #137
Location: 101 Webster St
Status: ~100% Full



Bin #138
Location: 308 14th St
Status: ~10% Full





The image shows a map application interface for managing smart bins. The main map displays the San Francisco Bay Area, including San Francisco, Oakland, and parts of Alameda and Contra Costa counties. Key locations labeled include Sausalito, Golden Gate, North Beach, Financial District, Chinatown, Alameda, Fruitvale, and Bay Farm Island. A legend in the top left corner identifies icons for trash, recycling, and composting. A search bar and a magnifying glass icon are also present.

Map

Oakland-Downtown

Avg Capacity: 50% Full
Bins Full: 2 of 8

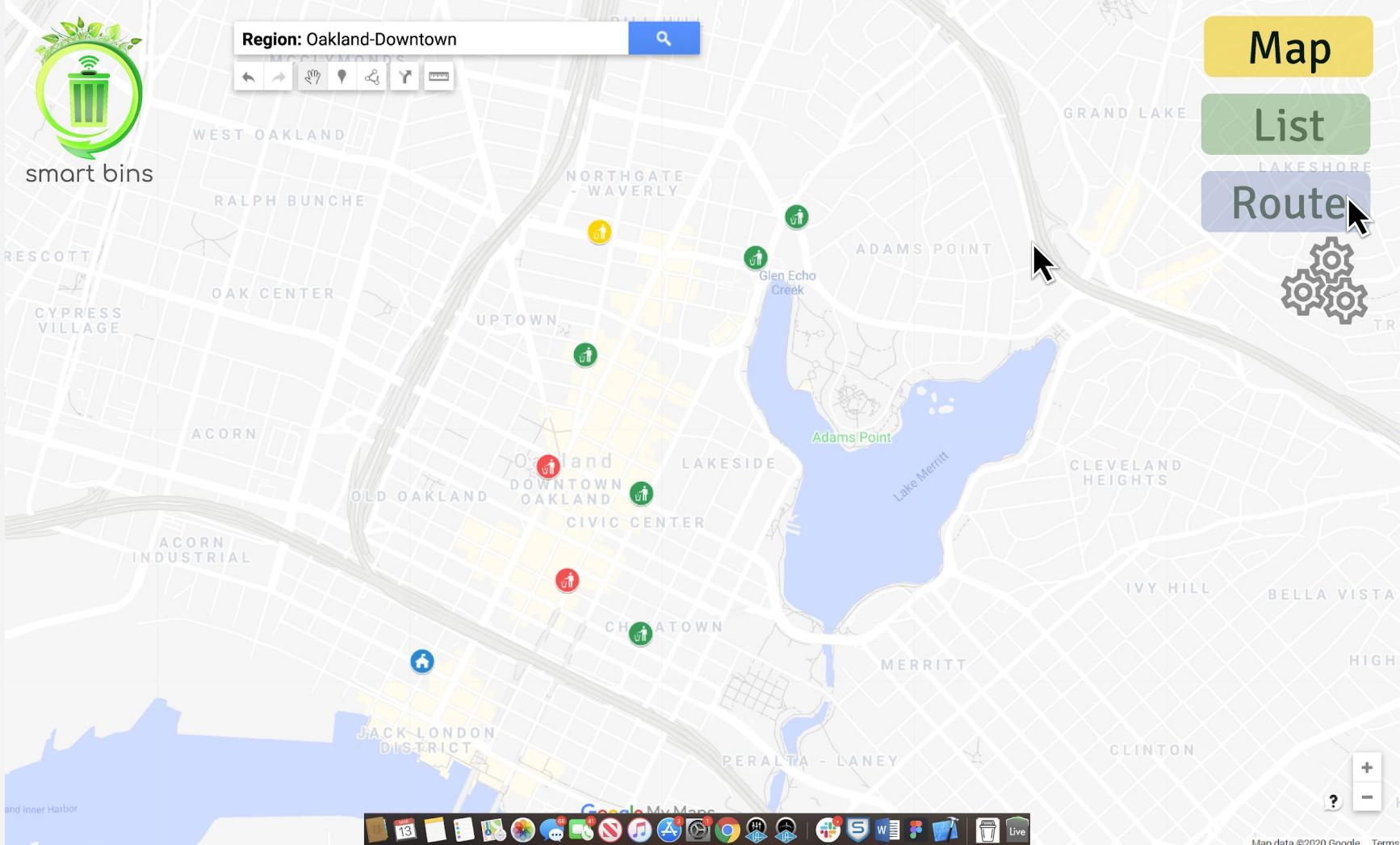
List

Route

smart bins

San Francisco Bay

Map icons: trash, recycling, composting, search, zoom, location, route, layers.



A map of the Oakland-Downtown region showing the locations of smart bins. The map includes labels for various neighborhoods such as West Oakland, Ralph Bunche, Rescott, Cypress Village, Acorn, Old Oakland, Downtown Oakland, Civic Center, Chinatown, Jack London District, Northgate-Waverly, Adams Point, Glen Echo Creek, Lake Merritt, Cleveland Heights, Ivy Hill, Bella Vista, Merritt, Peralta-Laney, and Clinton. The map also shows the location of Grand Lake and the Inner Harbor. A legend in the top left corner identifies the icons: a green bin with a recycling symbol, a red bin with a recycling symbol, a blue bin with a recycling symbol, and a green bin with a trash symbol.

Region: Oakland-Downtown

Map

List

Route

smart bins

WEST OAKLAND

RALPH BUNCHE

RESCOTT

CYPRESS VILLAGE

ACORN

OLD OAKLAND

DOWNTOWN OAKLAND

CIVIC CENTER

CHINATOWN

JACK-LONDON DISTRICT

NORTHGATE - WAYERLY

GLEN ECHO CREEK

ADAMS POINT

LAKESIDE

Lake Merritt

CLEVELAND HEIGHTS

IVY HILL

BELLA VISTA

MERRITT

PERALTA - LANEY

CLINTON

GRAND LAKE

Inner Harbor

Google My Maps

Map data ©2020 Google Terms



Region: Oakland-Downtown



Map

List

Route



Drive 2 mi, 14 minutes

A 512 3rd St, Oakland, CA 94607, USA

0.751 mi, 5 minutes

Head southeast on 3rd St toward Washington St

466 ft

Turn left onto Broadway

0.431 mi

Turn right onto 11th St

758 ft

Turn right at the 2nd cross street onto Webster St

469 ft

B 101 Webster St, Oakland, CA 94607, USA

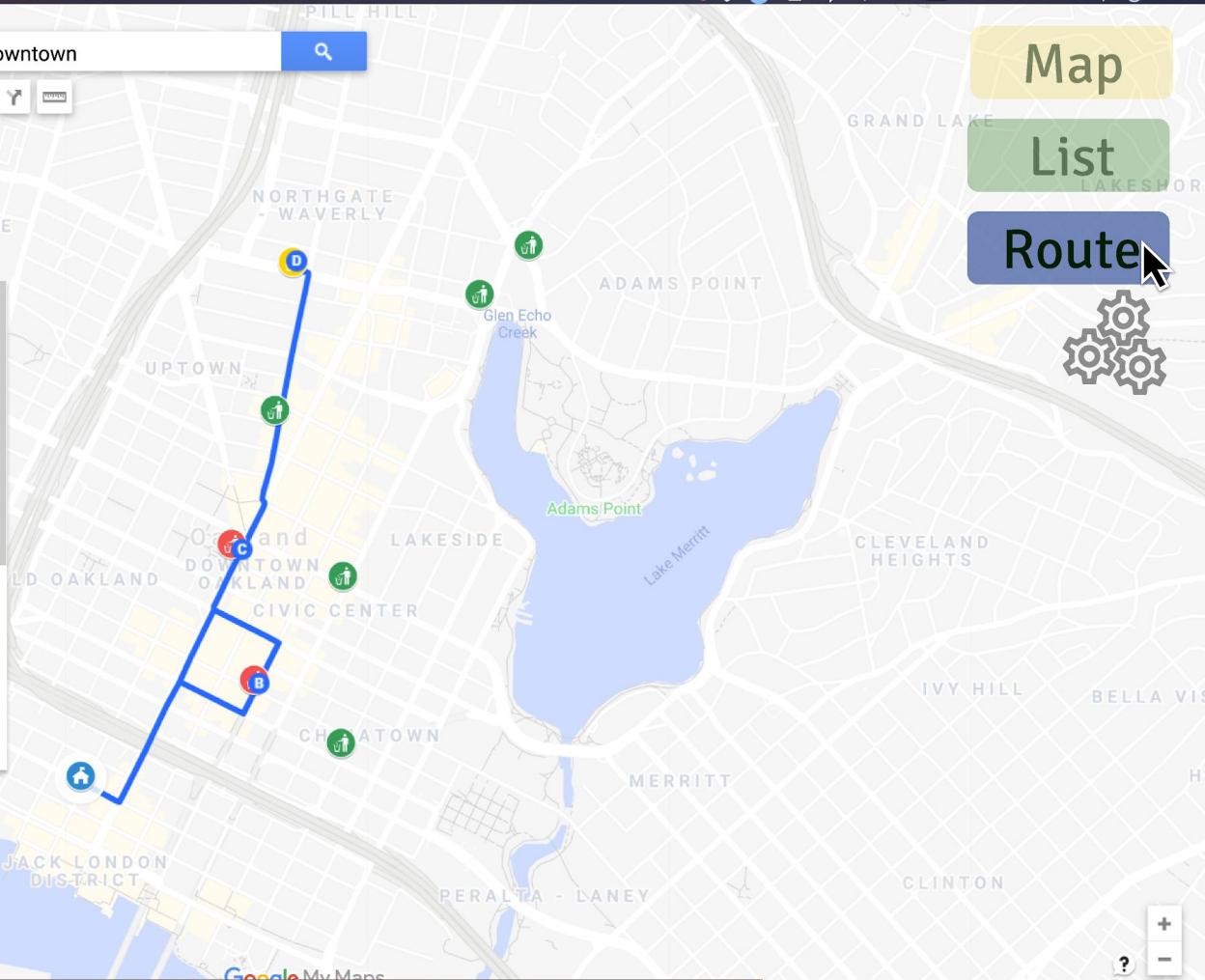
0.503 mi, 3 minutes

Head southwest on Webster St toward 9th St

364 ft

Turn right at the 2nd cross street onto 8th St

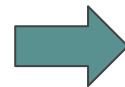
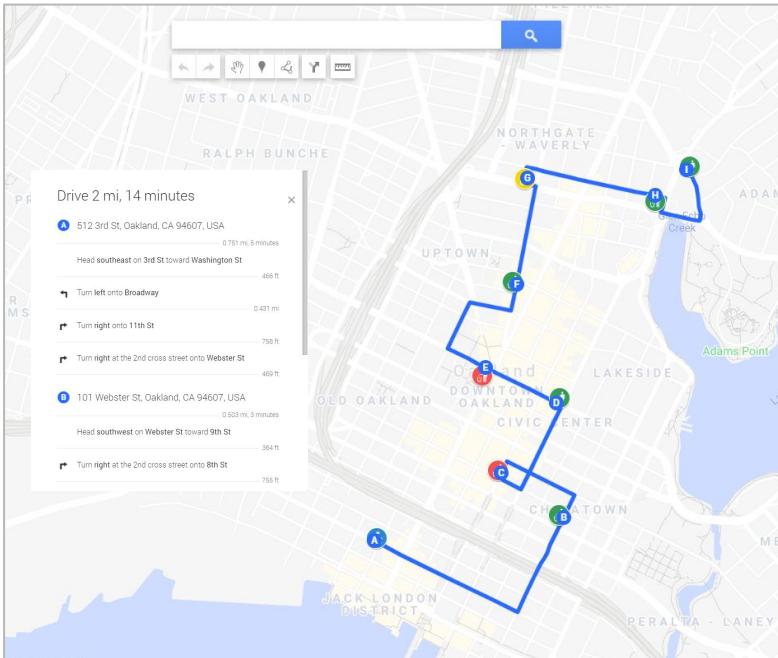
755 ft



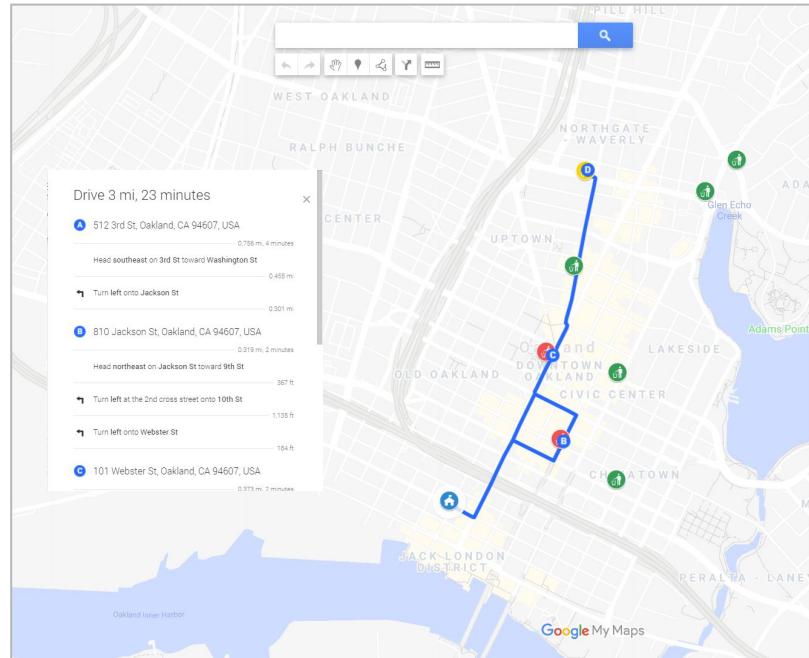
Oakland Inner Harbor

Improving Efficiency with Smart Waste Management

Current System

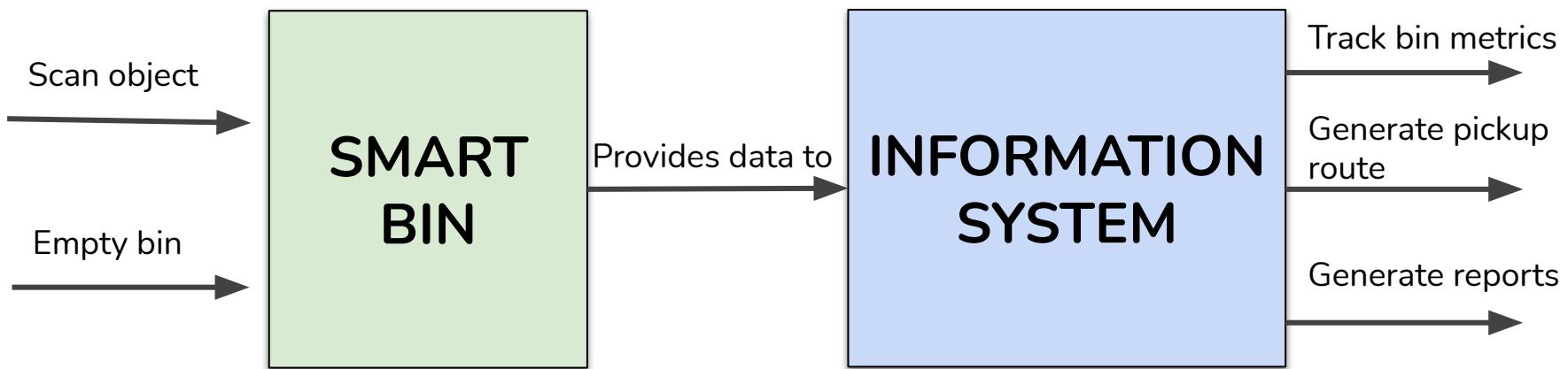


Smart Routing

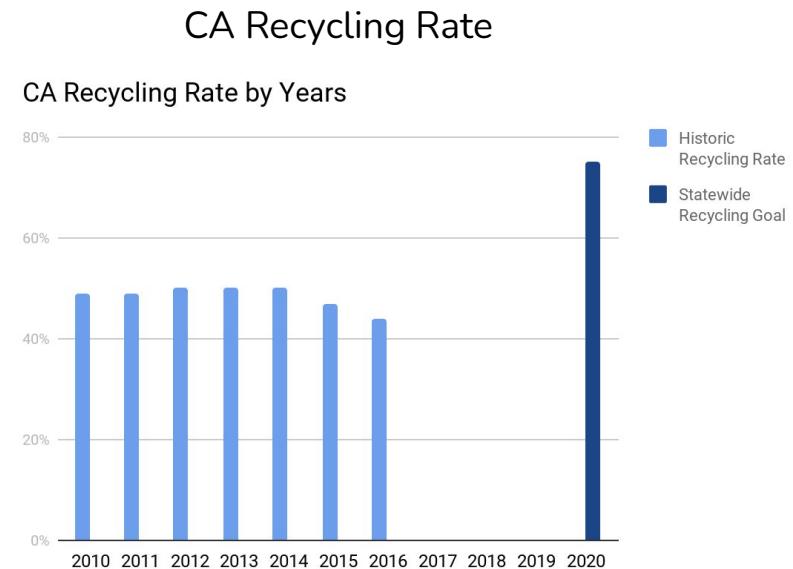
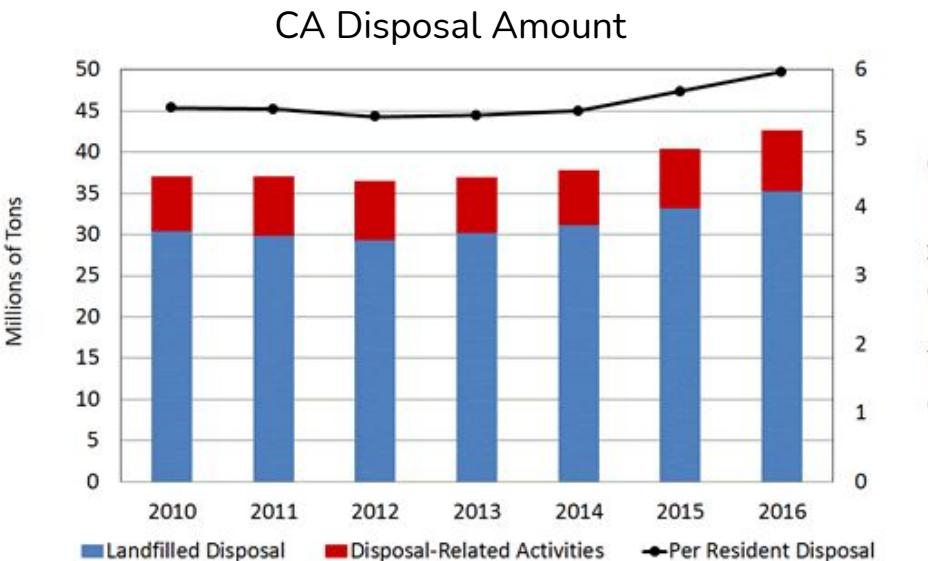


Google My Maps

Current Use Case



Our Impact



Thank You!

Our business model relies on a monthly subscription and a setup fee



Future Opportunities

- Provide a complete waste management system
 - Monitor bin capacities so the system can schedule workers to empty the bin
 - Workers no longer have to check the bins everyday and empty them, which saves on labor costs
 - Calculate bin composition to ensure organizations are meeting their recycling and waste goals.
 - Ex: Berkeley wanted to go to zero waste by 2020. Our system can easily calculate how far they are along with their goal.
 - Ensures recycled material is of higher quality so they can be sold to recycling facilities to be processed.



Lower Operation Costs with Analytics

- Current Situation:
 - Collection service on predefined route on a regular basis
- Smart waste management:
 - Intelligently collect and service bins above 50% capacity
 - Reduce waste collection costs by 40 percent ^[1]
 - Lower carbon emissions in cities up to 60 percent ^[1]

^[1] <https://www.iotforall.com/smart-waste-management/>

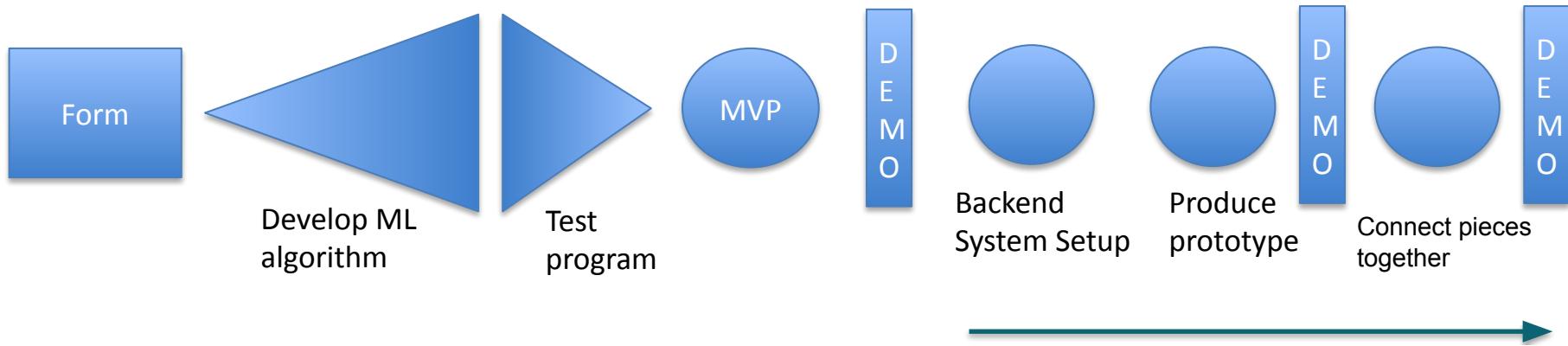
Why will we win?

- Recycling companies are desperate to lower contamination rates. We will make their jobs easier by reducing contamination before the waste even reaches their facility
- By providing quick responses to people looking for a place to throw their trash, people will be more willing to place their trash in the right bin
- Eco-friendly initiatives like “Zero Waste on Campus” will see our product as an effective way to reach their goal faster

Summary of Learning



Timeline



Core Responsibilities

Lead: Nikash, Felipe

Software: Abhi, Adiyan

Prototyping: Gary, Nick

Market and Cost Analysis: Gary, Abhi

Raspberry Pi for Machine Learning?

- Low cost starting at \$35 for the base model
- No licensing fee after initial investment and setup
 - Linux based using Python or R
- Capable of running simple Machine Learning models
- Built-in Wifi connection
- Add-ons available to increase processing power
 - Intel Movidius AI accelerator
 - Google's Edge TPU Accelerator
- Low power consumption



Tech/Cost Breakdown

Raspberry Pi model

- Raspberry Pi 4 \$40
- Raspberry Pi Camera v2 \$25
- Google USB Edge TPU Accelerator \$70
- Adjustable Pi Camera Mount \$5
- Flex cable for RPi Camera \$3

Total for 1 bin: \$143

Arduino with 5G Chip

- Estimated: \$150 for chip with base rate of \$10/month for data plan
- Arduino Chip \$18
- Raspberry Pi Camera v2 \$25
- Adjustable Pi Camera Mount \$5
- Flex cable for RPi Camera \$3

Total for 1 bin/ first year: \$325

5G integration is nearly 2x cost of Raspberry Pi solution