Applying TensorFlow Machine Learning and Crowd Sourced Data to Better Understand Campus Environments: Pinpointr

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Introduction

Over 2000 Metric tonnes of waste was generated on campus in 2017. To reduce the amount of waste disposed of improperly it's important to have everyone on campus participate
Issues from full garbage cans to broken water fountains can increase the amount of waste generated.
To make reporting any environmental hazards or facilities issues on campus easier, we created Pinpointr, an integrated solution for managing waste on campus.

What is Pinpointr?

Pinpointr is an app that allows anyone on campus to document an issue on campus with a single photo and a button press. The app uses machine learning technology and geolocation to figure out where and what the issue is. From there, it sends an alert to facilities services, so they can create a work order to deal with the issue. It also includes the ability to scan QR codes placed on facilities around campus, in order to report issues with specific trash cans, water fountains, etc.

User Adoption

Phase 1

- Beta version of an app for uploading and classifying photos, locating them on a map
- Small team of testers to determine the ease of use of the app, identify bugs on the users side

Phase 2

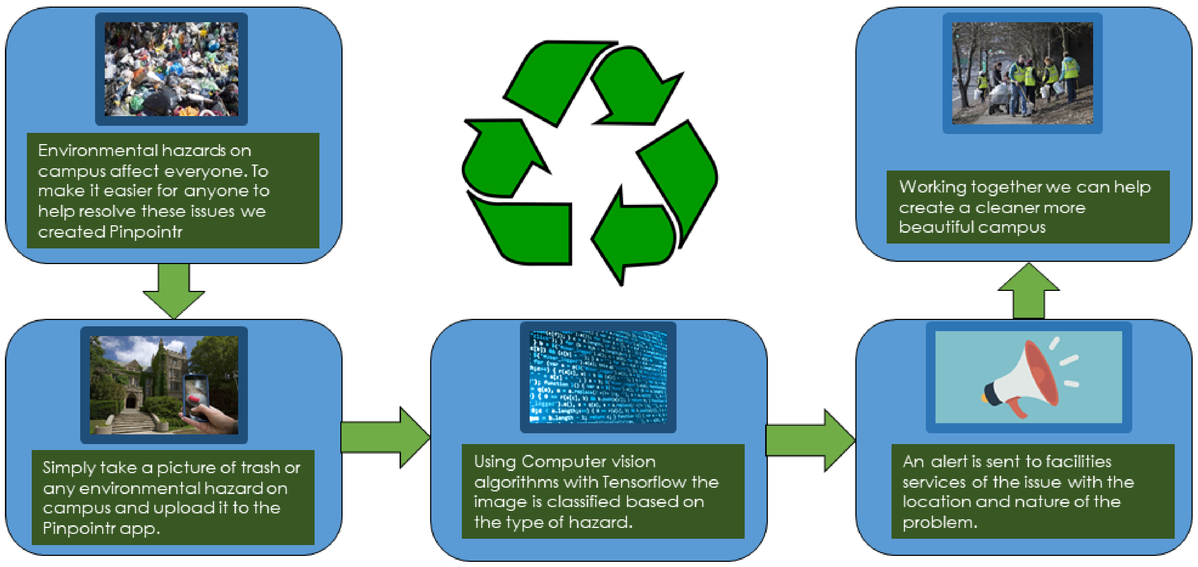
- Release revised Pinpointr app
- A small team of janitorial staff testing the software to see if it makes their work easier or more efficient, and identifying any existing bugs or improvements that can be made on the staff side

Phase 3

- Multiple platforms for sending pictures (Text, Twitter, App)
- Greater adoption by janitorial staff

Phase 4

- Promotion and incentives for downloading the app and reporting environmental hazards, increasing the user base
- Use derived metrics from the app to inform and improve purchasing decisions for other staff on campus



Object Recognition with TensorFlow

Tensor Flow

- Built by Google Brain, Tensorflow is an open-source combines several machine learning and deep learning models and algorithms.
- C++ back end, Python front end.

MobileNets

- TFLite ("Tensorflow Lite") models such as MobileNets provide low-latency, on-device machine learning inference requiring minimal storage space, optimal for mobile devices.
- MobileNets model provides a lightweight, yet powerful model with training methodology based on convolutional neural network architecture.

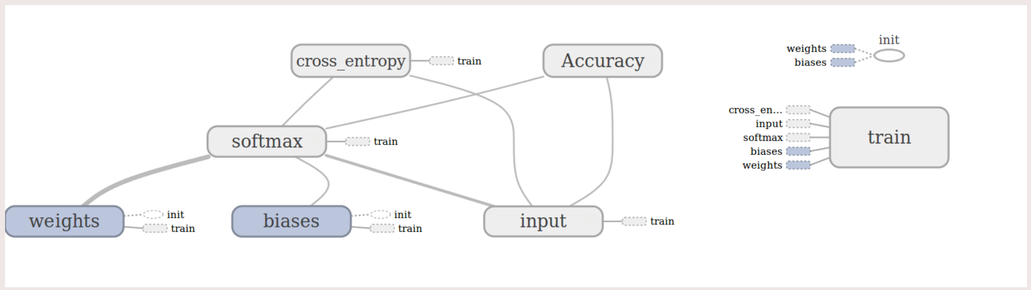


Figure 1: "softmax" represents the final output layer, providing the final object categorization and probability. The bottleneck nodes to the right represent a series of layers created during the training process.

TensorBoard

- Data visualization tool for model training. Provides a platform for continuous monitoring of model accuracy.

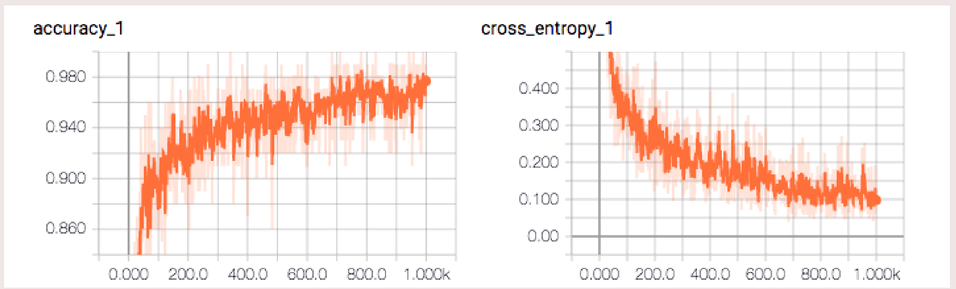


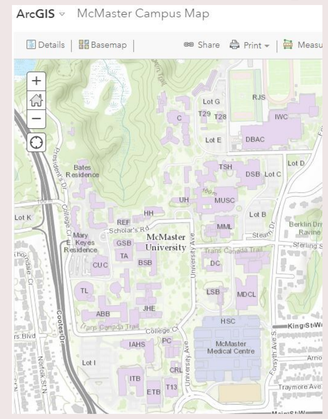
Figure 2: Tensorboard Interface: As the training dataset grows and the number of training sessions increases, the accuracy of the model approaches 1, while cross entropy approaches 0.

Overall Goals

- Decrease response time for dealing with environmental hazards and broken facilities
- Provide better work metrics for custodians
- Identify problem areas around campus, so steps can be taken to add more waste disposal options
- Identify common sources of waste that originate on campus, so steps can be taken to reduce unnecessary packaging or transition to more environmentally friendly options
- Reduce the amount of waste on campus by promoting awareness amongst the user base

Conclusions & Future Work

- Create working AI prototype that classifies differences between different waste materials based on only a small data set.
- Display points on map, categorize points in sections of campus or by buildings



- Display graduated colour charts to find hot spots around campus
- Dynamic heatmaps based on submitted data
- Use ESRI and ArcGIS services and maps
- Leaflet.js mapping API based interface

References

[1] N. Cerpa, P. Chandler, and J. Sweller, "Some conditions under which integrated computer-based training software can facilitate learning," *Journal of Educational Computing Research*, vol. 15, no. 4, pp. 345–367, 1996.

Google Brain TensorFlow esri