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

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Problem: Waste on Campus

Over 2000 Metric tonnes of waste was generated on campus in 2017 [1]. 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.

Solution: Pinpointr

Pinpointr is an app that allows anyone 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 Strategy

Phase 1 (January 2019)

- Beta version of app with basic functionality (Upload and Classify photos, display location on map)
- Small team of testers to determine the ease of use of the app, identify bugs on the users side

Phase 2 (February 2019)

- Revised Pinpointr app including QR code recognition
- Place QR codes on facilities that may need servicing (Trash bins, water fountains)
- A small team of custodial staff testing the software to see if it makes their work easier and more efficient, identify bugs on the staff side

Phase 3 (Late February)

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

Phase 4 (March 2019)

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

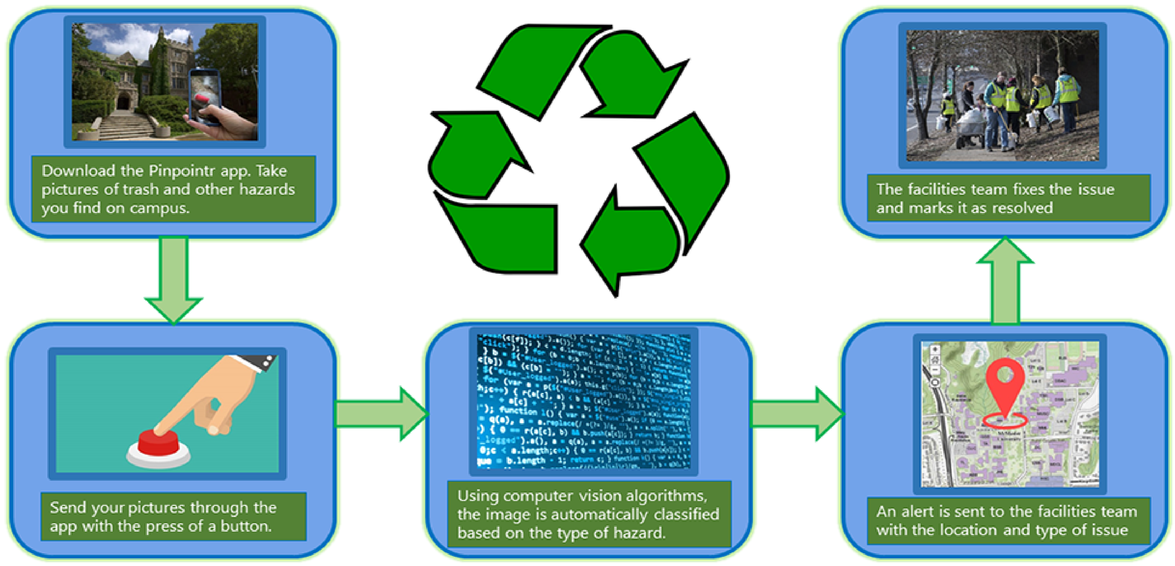

Image Classification And Object Recognition with TensorFlow

TensorFlow

- Built by GoogleBrain, combines several machine-learning models and algorithms into an open-source library.

MobileNets Via TensorFlow Lite

- TensorFlow Lite models such as MobileNets provide low-latency, lightweight TensorFlow solution for mobile devices.
- On-device machine learning inference.
- Model-training methodology based on convolutional neural network architecture.

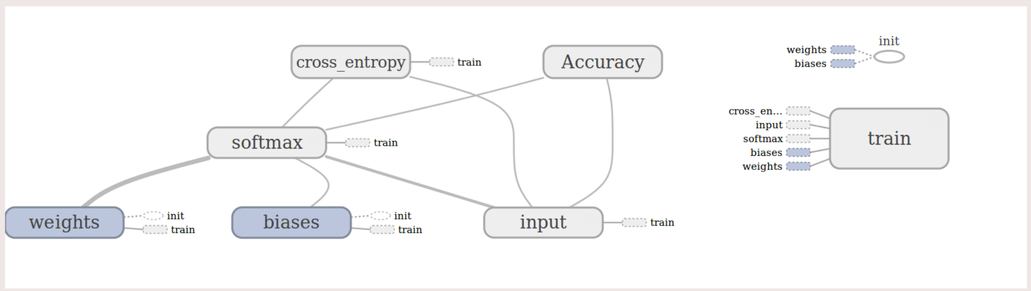

Figure 1: "softmax" represents the final output layer, providing the final object categorization and probability. The bottleneck nodes to the right represent a series of layers created during the training process.

TensorBoard

- Data visualization platform for model training analysis.
- Continuous monitoring of model accuracy.

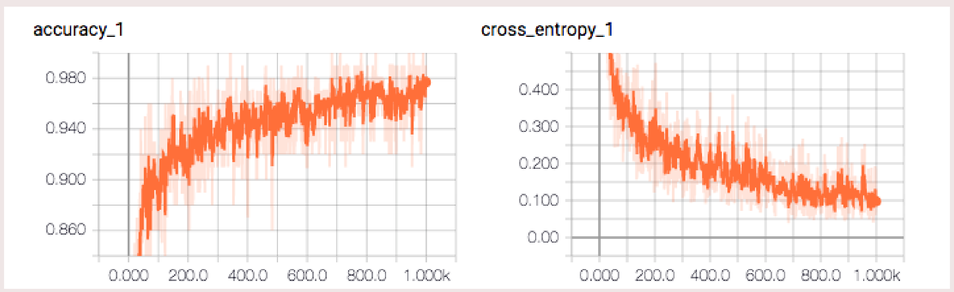

Figure 2: Tensorboard Interface: As the training dataset grows and the number of training sessions increases, the accuracy of the model approaches 1, while cross entropy approaches 0.

Overall Goals

- Decrease response time for dealing with environmental hazards and broken facilities
- 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 having users participate in keeping the campus clean

Other Tools

Tools to help display hazards and their location on the Pinpointr website

- ArcGIS and Leaflet to place points on map, categorize points in sections of campus or by buildings
- ESRI to provide a ArcGIS javascript API for applying location-based analytics and loading results to the web
- Leaflet to provide an open-source javascript library for mobile-friendly interactive maps

Improvements on Existing Software

Litterati is an app with a similar purpose. It tracks litter collected by its users on a map, using user submitted tags to group litter based on the brand and material. The collected data has been used succesfully to justify changes in environmental policy at parks and purchasing decisions at schools [2]. /par To improve and differentiate our software, we use computer vision to classify the litter rather than relying on user submitted tags. We also integrate alerts into our map feature, allowing us to work directly with custodial staff to clean up our campus.

References

[1] W. R. G. Inc, "Mcmaster university 2017 solid non-hazardous waste audit," *Waste Reduction Group Project P0769 Rev2*, 2018.

[2] L. Litterati, "Litterati - a litter free world," 2018.