Cleaning the Streets of Montevideo

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INF634 - Computer Vision 2022

Motivation

- Started from an idea to help the Uruguayan community → Kaggle challenge

- Add our insight to an **interesting visual computing exercise**

https://i.ytimg.com/vi/YZ-uGYw6HpY/mqdefault.jpg
https://uploads-ssl.webflow.com/61a937b95aaa9b3fe7b49b3e/62a3a723f401379ba10eee79_Smart_citites4.jpeg

Outline

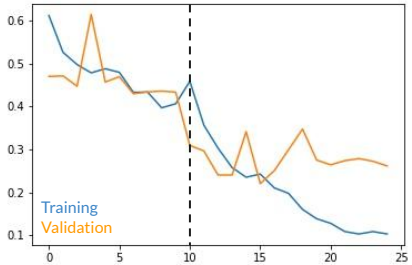
- Clean/Dirty Classification
  - Setup
  - Results
- Garbage Detection
  - Class Activation Maps
- Garbage Removal
  - Cycle GAN
  - Image Inpainting
- Future Work

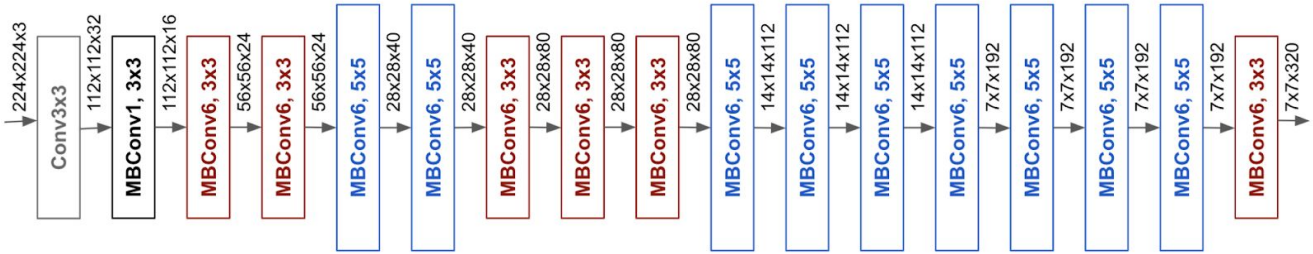
https://ip.loszona.com/p/1b9c
https://uploads-ssl.webflow.com/61a937b95aaa9b3fe7b49b3e/62a3a6c49af71d2bea6cce3f_Smart_citites3.jpeg

Clean/Dirty Classification with CNNs

Pre-trained **ResNet** or **EfficientNet** architectures as convolutional encoders
+ **fully-connected classifier network** with variable length and width

Fine-tuning on augmented data with initial freezing of convolutional layers





https://ai.googleblog.com/2019/05/efficientnet-improving-accuracy-and.html

Clean/Dirty Classification with CNNs

Table 1. Evaluation of a selection of trained models to identify garbage piles.

Base model	EfficientNet-B0	ResNet-50	ResNet-18
Classifier	[1024, 256, 32]	[512, 128, 32]	[512, 256, 64]
Training strategy	Alternating Freezing / Augmentation	Alternating Freezing / Augmentation	No Freezing
TPR (Recall)	**0.9563**	0.9378	0.9261
FPR	0.0867	**0.0783**	0.0800
TNR	0.9133	**0.9217**	0.9200
FNR	**0.0437**	0.0622	0.0739
Precision	0.9163	**0.9223**	0.9199
Accuracy	**0.9347**	0.9297	0.9230
F1	**0.9359**	0.9300	0.9229

Clean/Dirty Classification with CNNs

False Positives

Predicted: 0.65 - True Label: 0

Predicted: 0.55 - True Label: 0

Predicted: 0.58 - True Label: 0

Predicted: 0.72 - True Label: 0

Predicted: 0.85 - True Label: 0

False Negatives

Predicted: 0.36 - True Label: 1

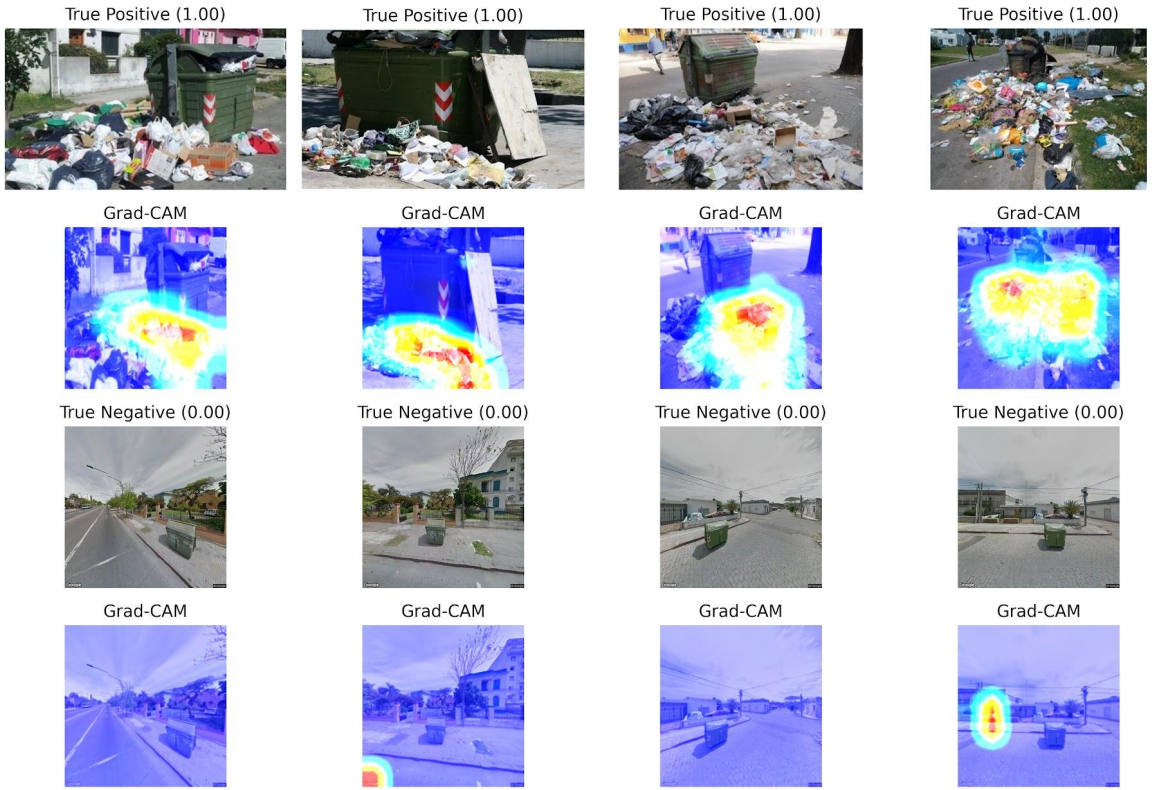
Predicted: 0.05 - True Label: 1

Predicted: 0.24 - True Label: 1

Predicted: 0.05 - True Label: 1

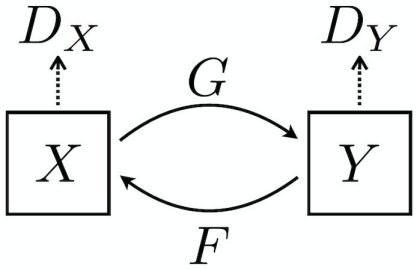
Predicted: 0.45 - True Label: 1

Garbage Detection with Class Activation Maps



Garbage Detection with Class Activation Maps

Garbage Removal with the Cycle-GAN



Cycle GAN: Cycle-consistent Adversarial Network

Two mappings: G : X → Y and F : Y → X , joining the dirty images (X) and the clean ones (Y).

Goal of the network: learn the function G such that the distribution of cleaned images G(X) is indistinguishable from the distribution Y.

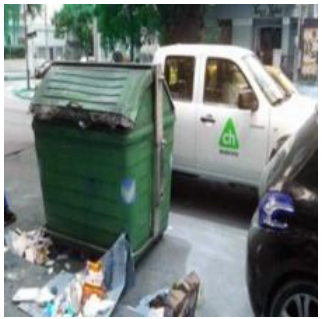
Inconclusive results…

https://arxiv.org/pdf/1703.10593.pdf

Garbage Removal with ~~the Cycle-GAN~~ Image Inpainting

Why not use the available information on garbage locations?








Future Work

- Improve the Cycle GAN
- Replace the classic inpainting methods by neural networks
- Quantify the amount of trash
- Improve the dataset quality
- Real-world deployment of (cleaning) robots or cameras to detect and report pollution

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