Detecting Plastic Soup automatically

Using pre-trained Convolutional Neural Networks and Support Vector Machines

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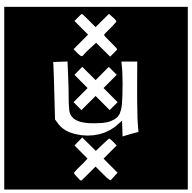

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Plastic Soup

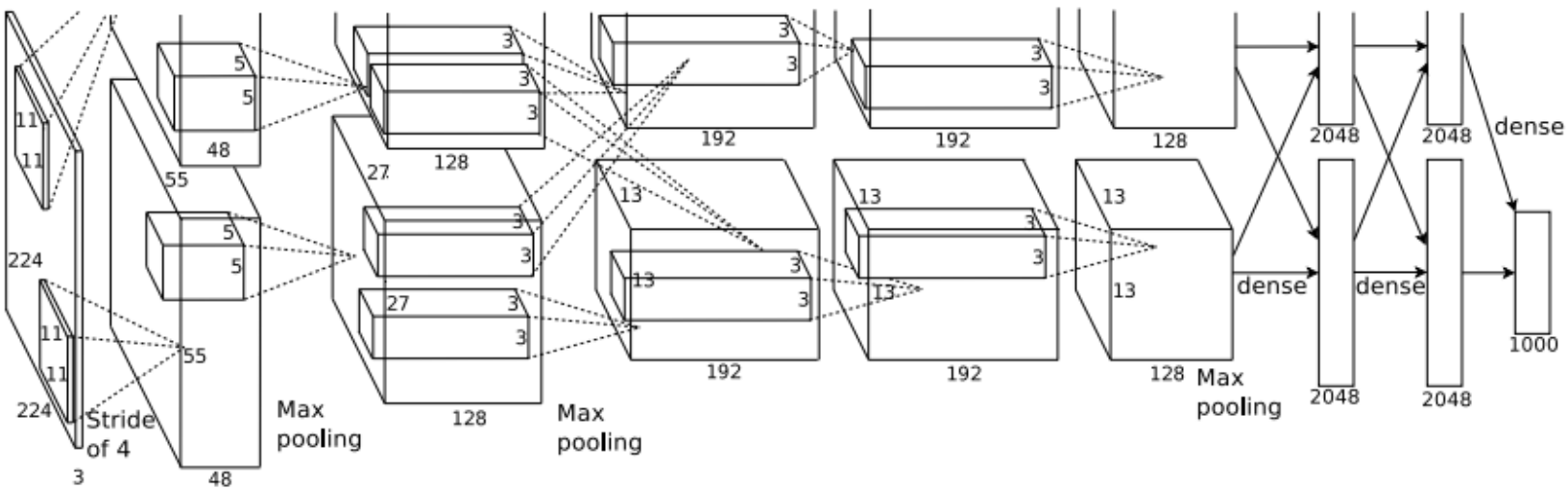
- Large amounts of plastic end up in the world ocean [1]
- Automate the clean-up process
- Develop plastic soup recognition

Figure 1: Boat in plastic soup

Current state of the art image techniques I

Convolutional Neural Networks

- Alexnet implementation to train large amounts of data [2]
- Current CNNs very high accuracy [3]

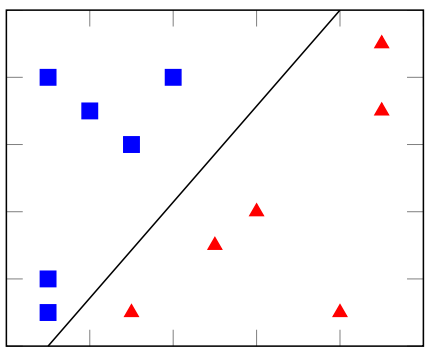


Current state of the art image techniques II

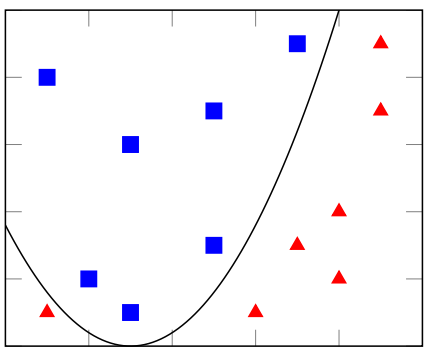
Support Vector Machine

- Classification algorithm widely used in CV
- Fit a hyperplane in the feature-space
- Side of the hyperplane on which a data-point lies is the classifier

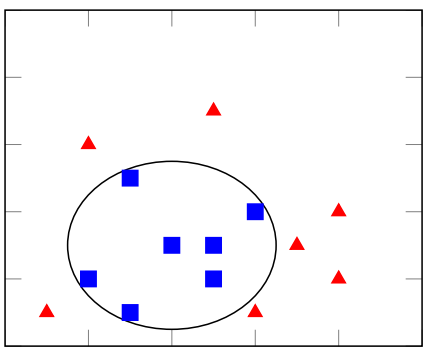
SVM with linear hyperplane



SVM with polynomial hyperplane



SVM with RBF hyperplane

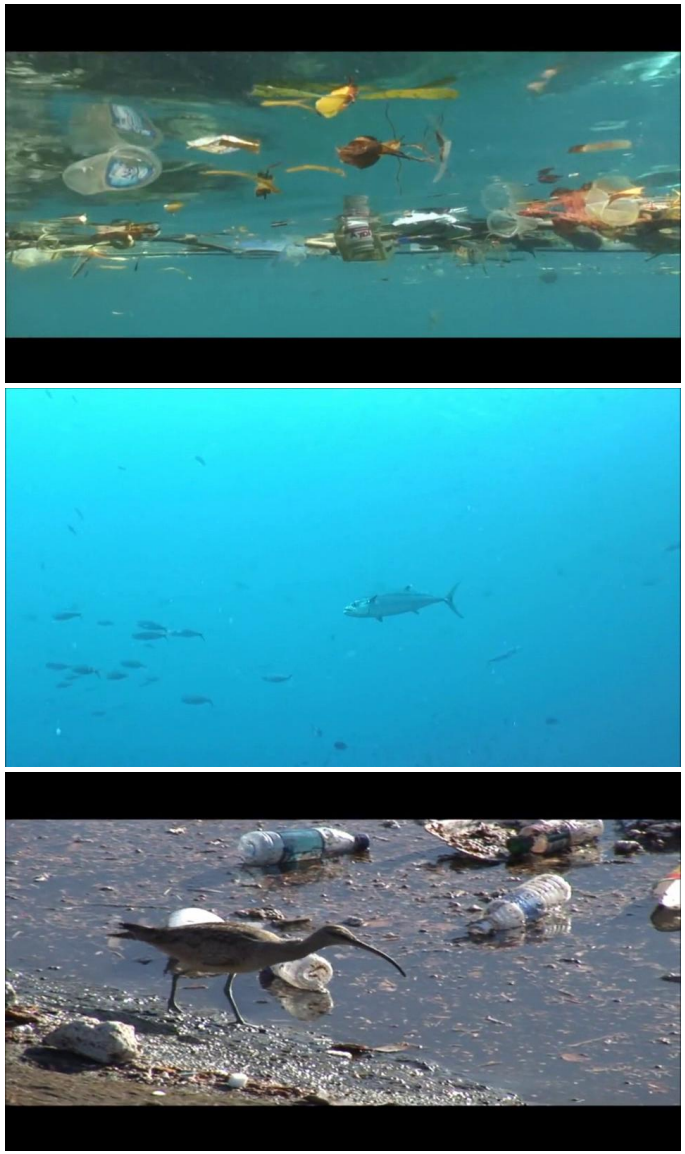


Research question

How does a pre-trained CNN in combination with an SVM perform when used for other classifications without being trained on a large amount of domain-specific data?

Dataset

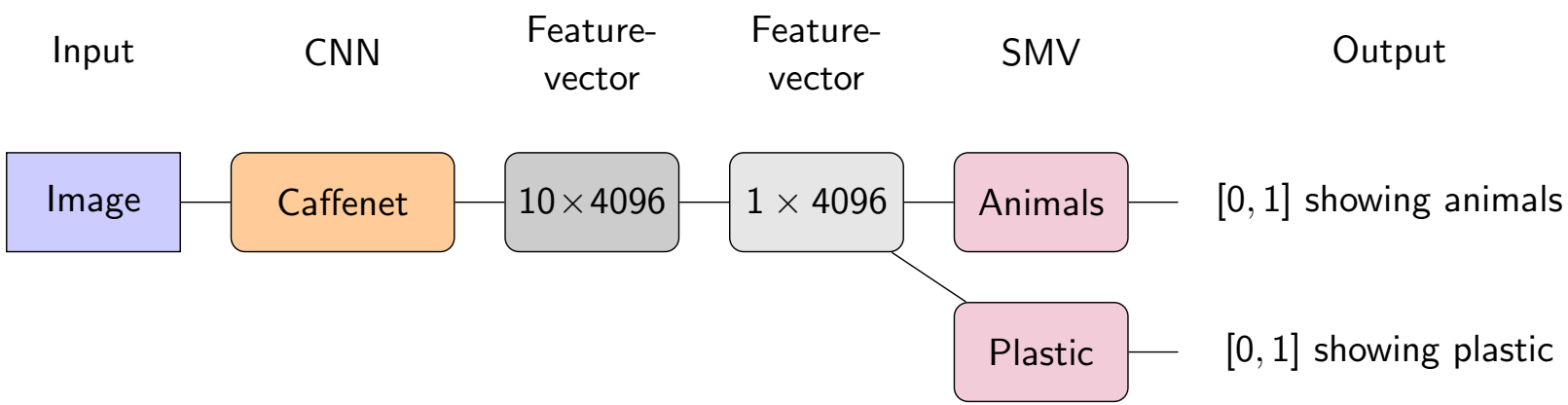
- 37165 images from short films
- annotated by my hand
- 16553 images above and 20612 images below water
- 20635 show plastic only
- 6972 show animals only
- 8502 show both



Method and evaluation

Approach

- Use a pre-trained Convolutional Neural Network as feature extractor
- Train an SVM on the second-to-last layer for this specific domain



Method and evaluation

Approach

- Use a pre-trained Convolutional Neural Network as feature extractor
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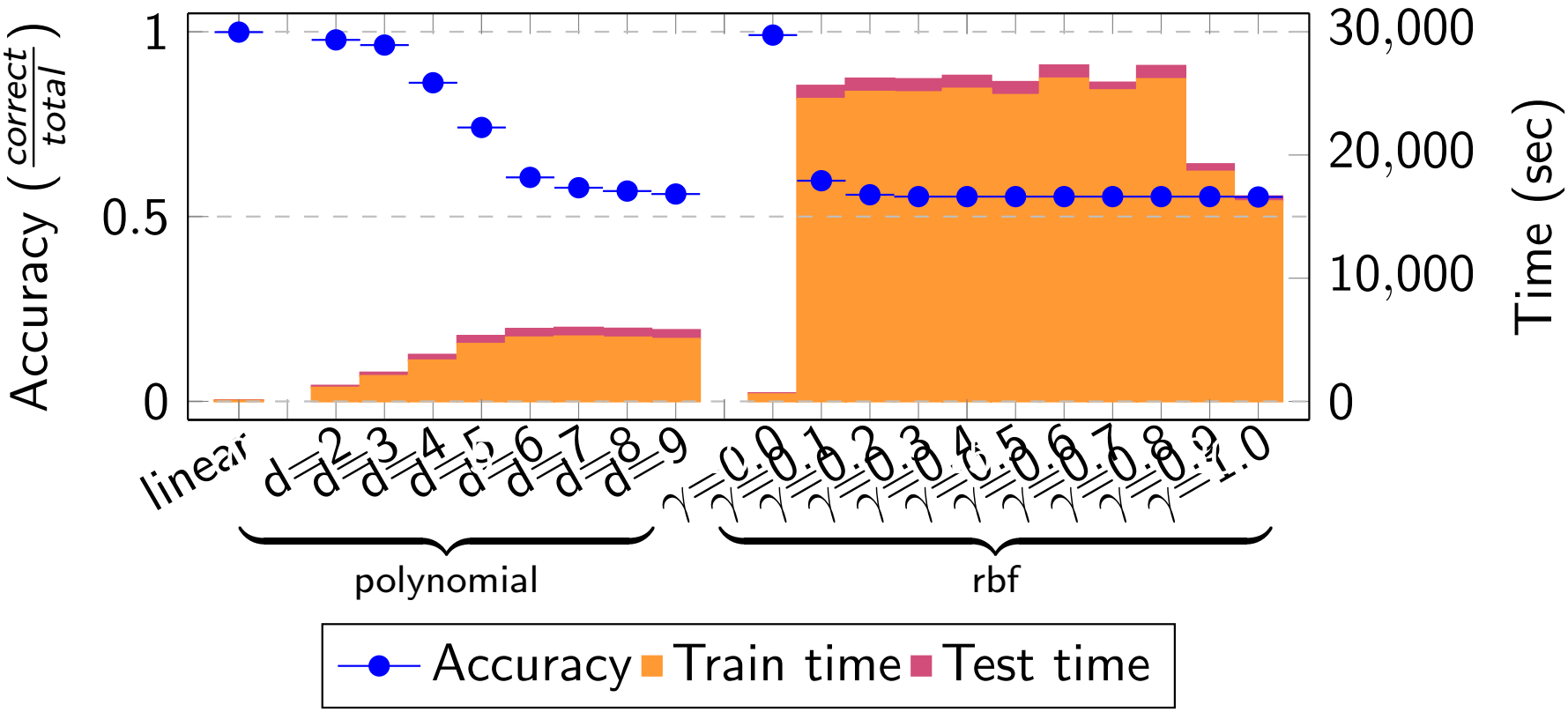
Evaluation

- split dataset in train, validate and test
- score the results on the annotated data

$$\frac{\#(Outcome_{True} \text{ and } Label_{True}) + \#(Outcome_{False} \text{ and } Label_{False})}{\#tested\ images}$$

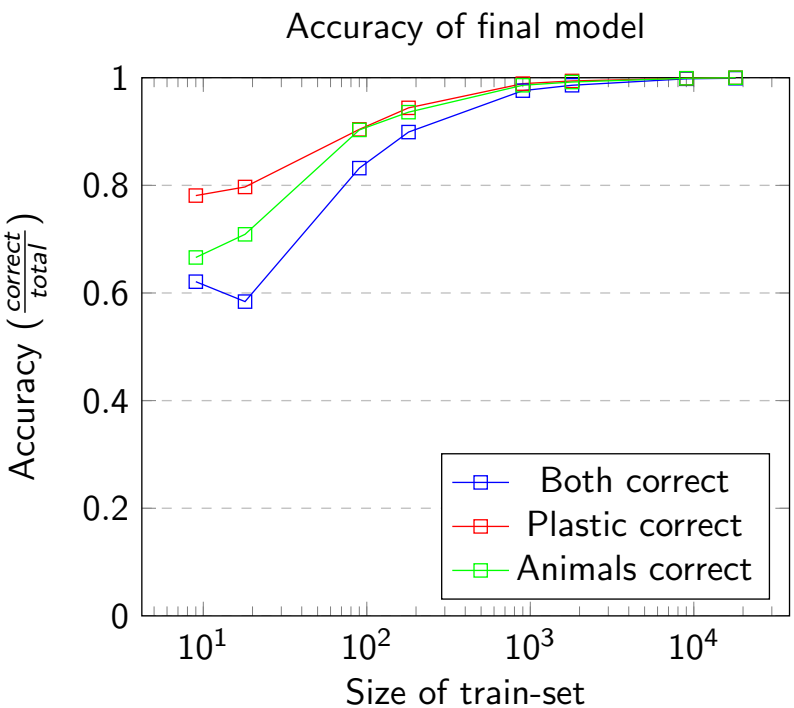
Results of the pipeline I

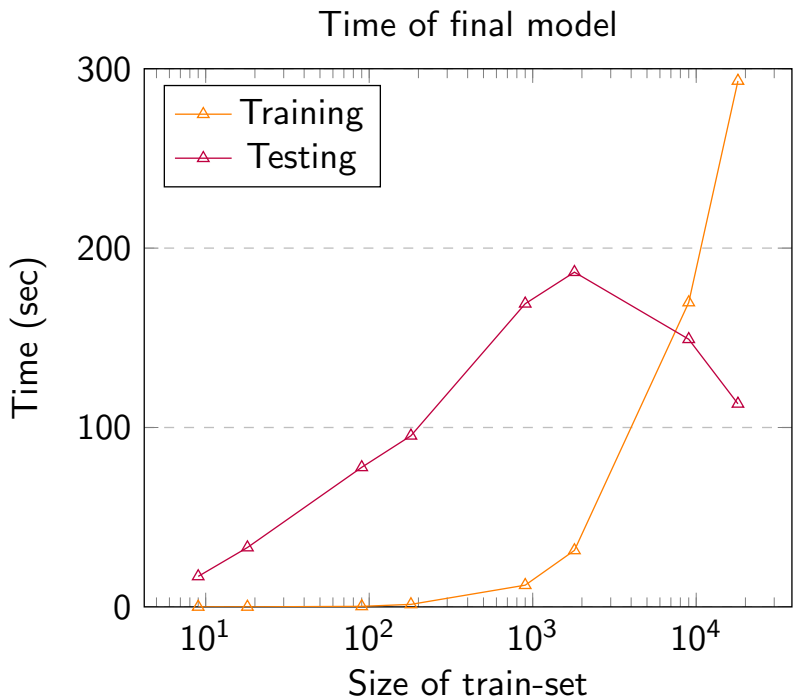
- linear SVM model works best
- 99.9% accuracy on the test-set



Results of the pipeline II

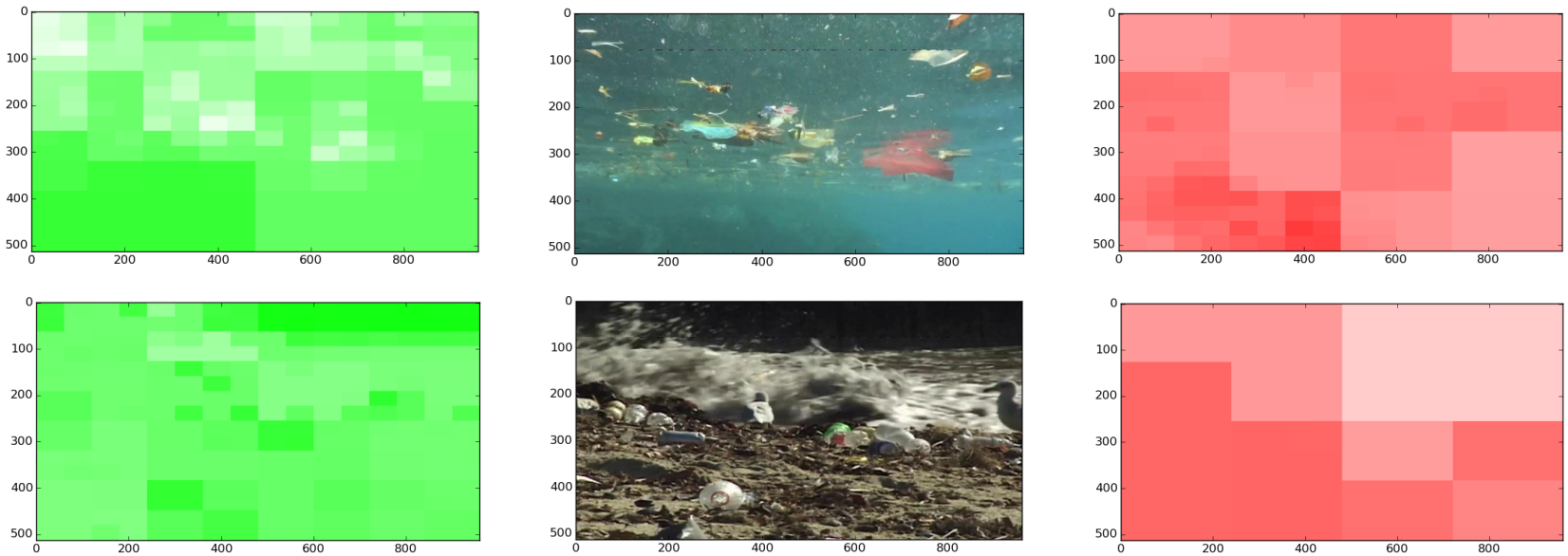
- chance of overfitting
- using small amounts of train-data
- high accuracy with small amounts of train-data





Localisation of plastic

- segment image, run each part through the pipeline
- results in heat-map that shows confidence of detecting plastic or animals



Conclusion

Research question

How does a pre-trained CNN in combination with an SVM perform when used for other classifications without being trained on a large amount of domain-specific data?

Answer

A Linear SVM trained on the second-to-last layer of a pre-trained CNN results in a high accuracy for the task of this project.

Discussion

Improvements for further research

- construct a better dataset to train and test the CNN and SVM
- use more cross-validation on finding parameters
- improve localisation of plastic
- improve time performance of the pipeline

A step closer to clean up the oceans of Plastic Soup

References I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