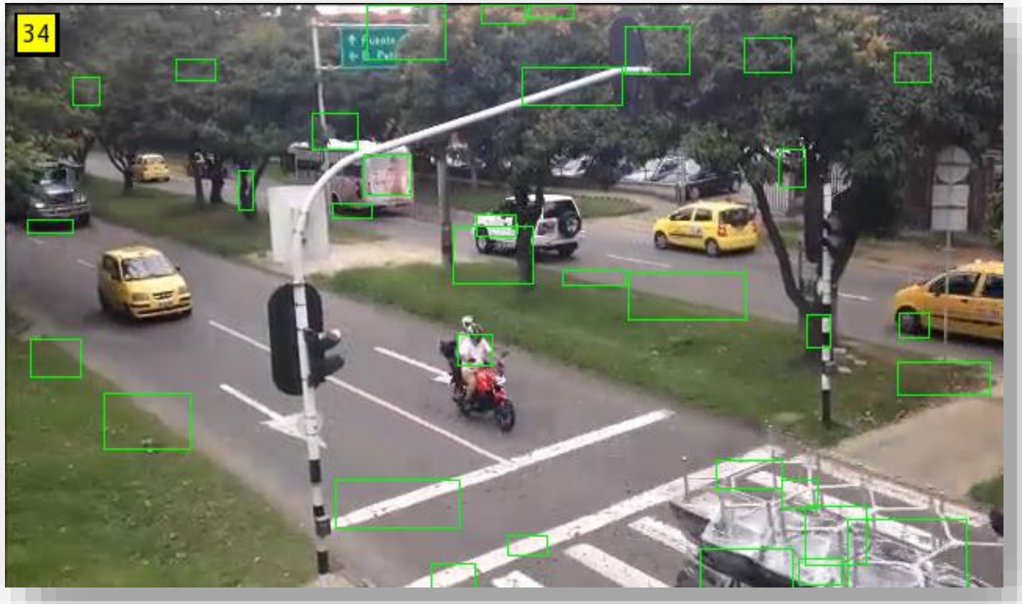
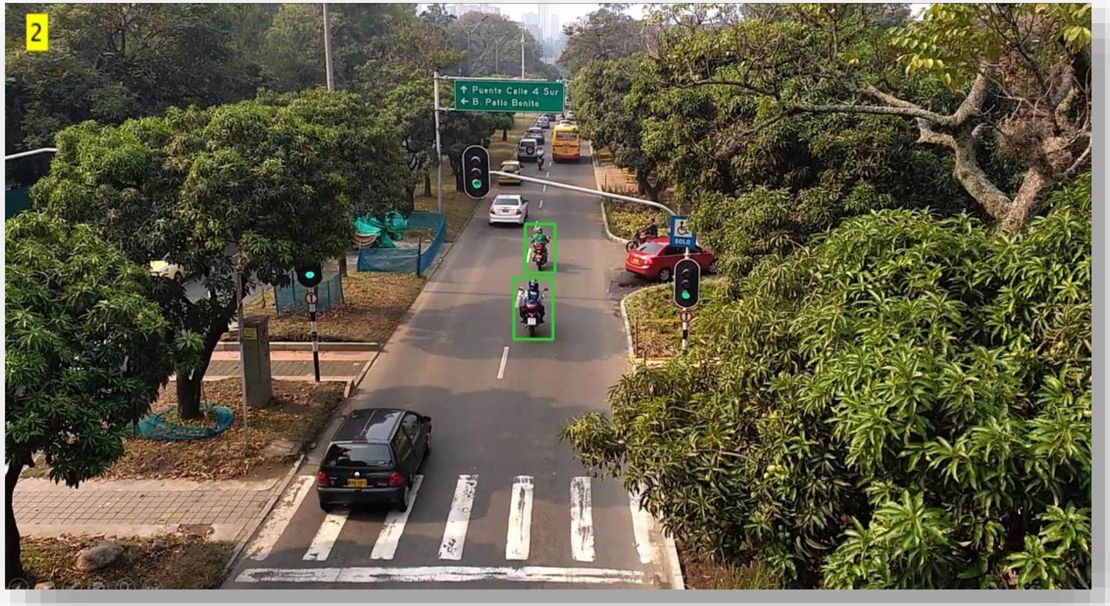
8th International Conference of Pattern Recognition Systems
11-13 July 2017, Madrid, Spain

Motorcycle Classification in Urban Scenarios using Convolutional Neural Networks for Feature Extraction



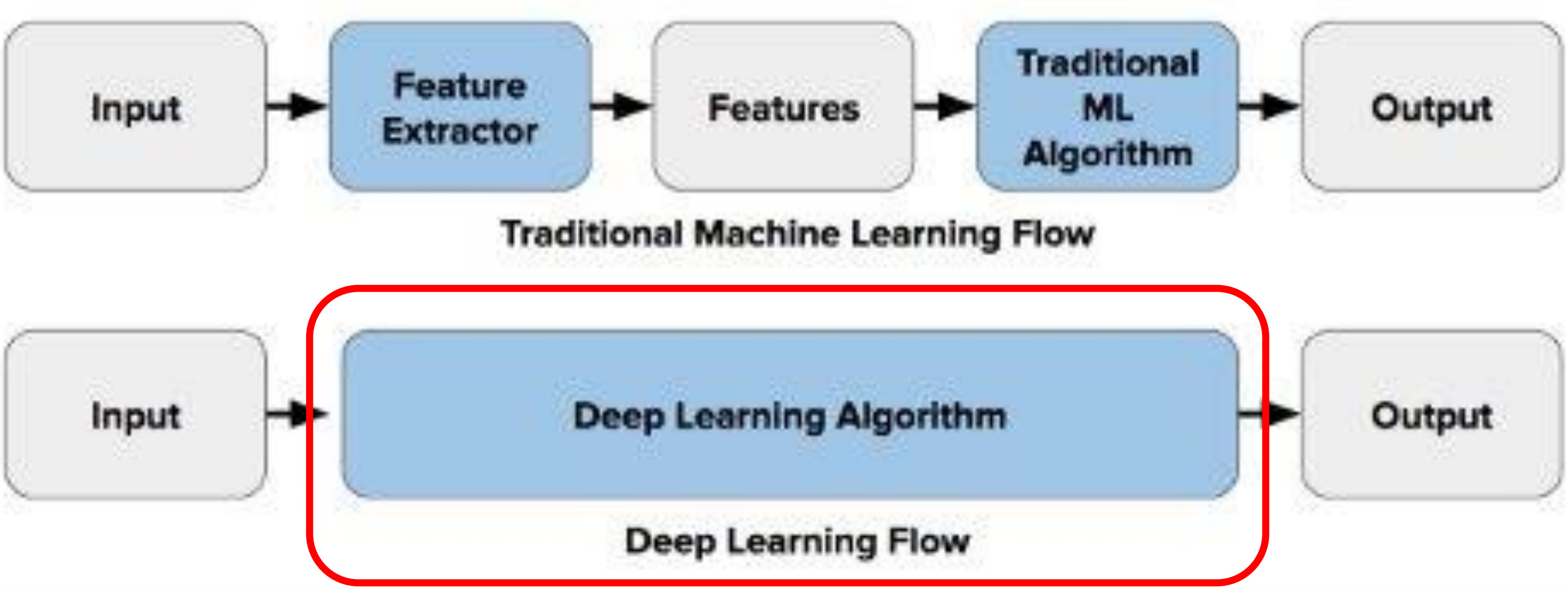
Experimentation Image



Experimentation Image

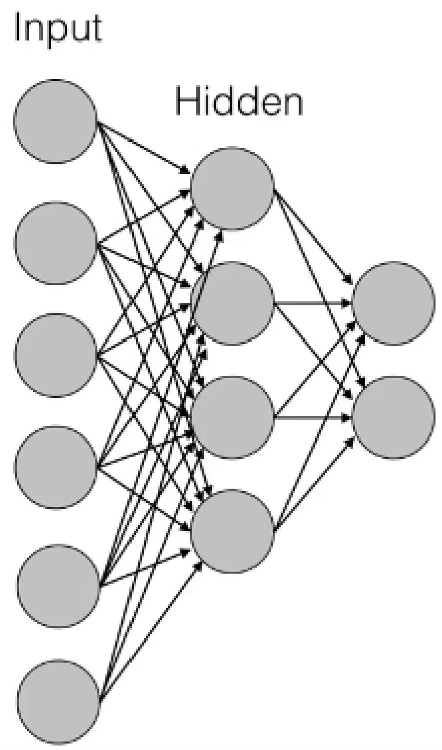
Universidad Carlos III de Madrid
Jorge E. Espinosa, Sergio A. Velastin , and John W. Branch
POLITÉCNICO COLOMBIANO JAIME ISAZA CADAVID
FACULTAD DE INGENIERÍAS
UNIVERSIDAD NACIONAL DE COLOMBIA

Computer Vision Workflow



Convolutional Neural Networks

Computational Implications

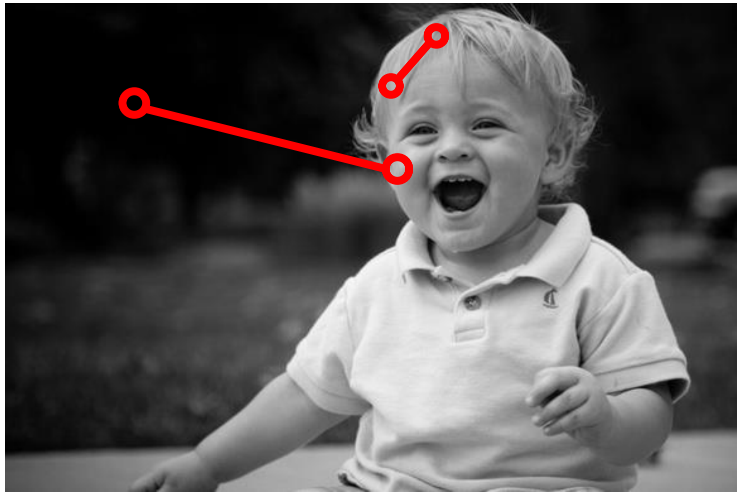


NN MLP Tradtional Architecture

MNIST dataset: 28 x28 pixels (784 pixels)
First layer weights: ~78k parameters

Typical Image: 256 x 256 (56,000 pixels)
First layer weights: 560k parameters !

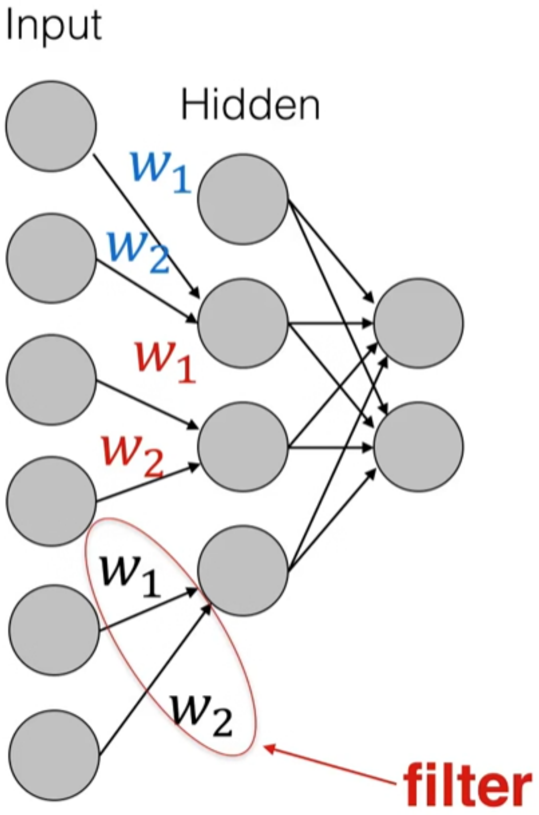
Too many parameters!!



Space Matters!!

Deep Learning for Vehicle Classification

Convolutional Neural Networks
Why Convolution?



- Edges are filtered – Pixel with high contrast
- This operation is perfomed all around the image

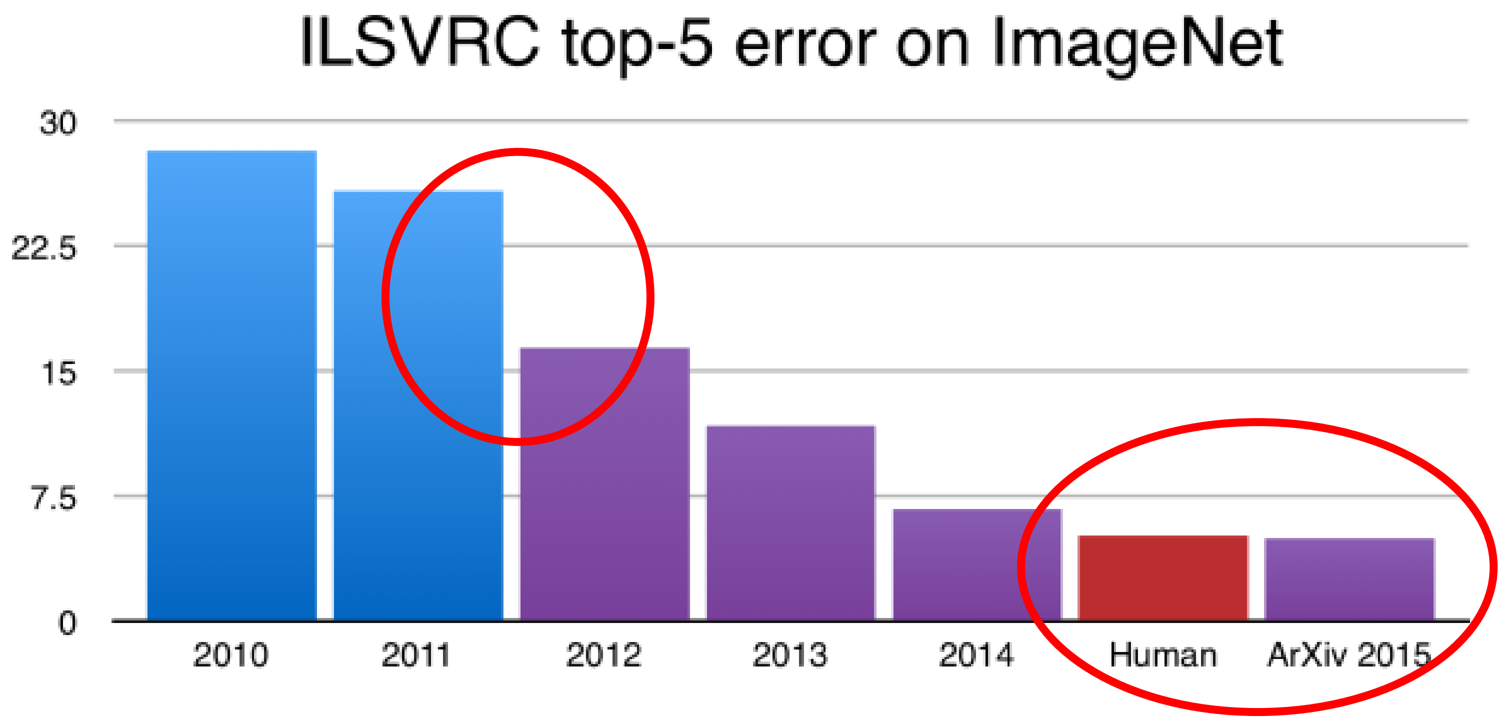
$$y = w_1 x_1 + w_2 x_2$$

If $(\mathrm{w}_1, \mathrm{w}_2) = (1, -1)$: $y = x_1 - x_2$

y maximal when $(x_1, x_2) = (1, 0)$

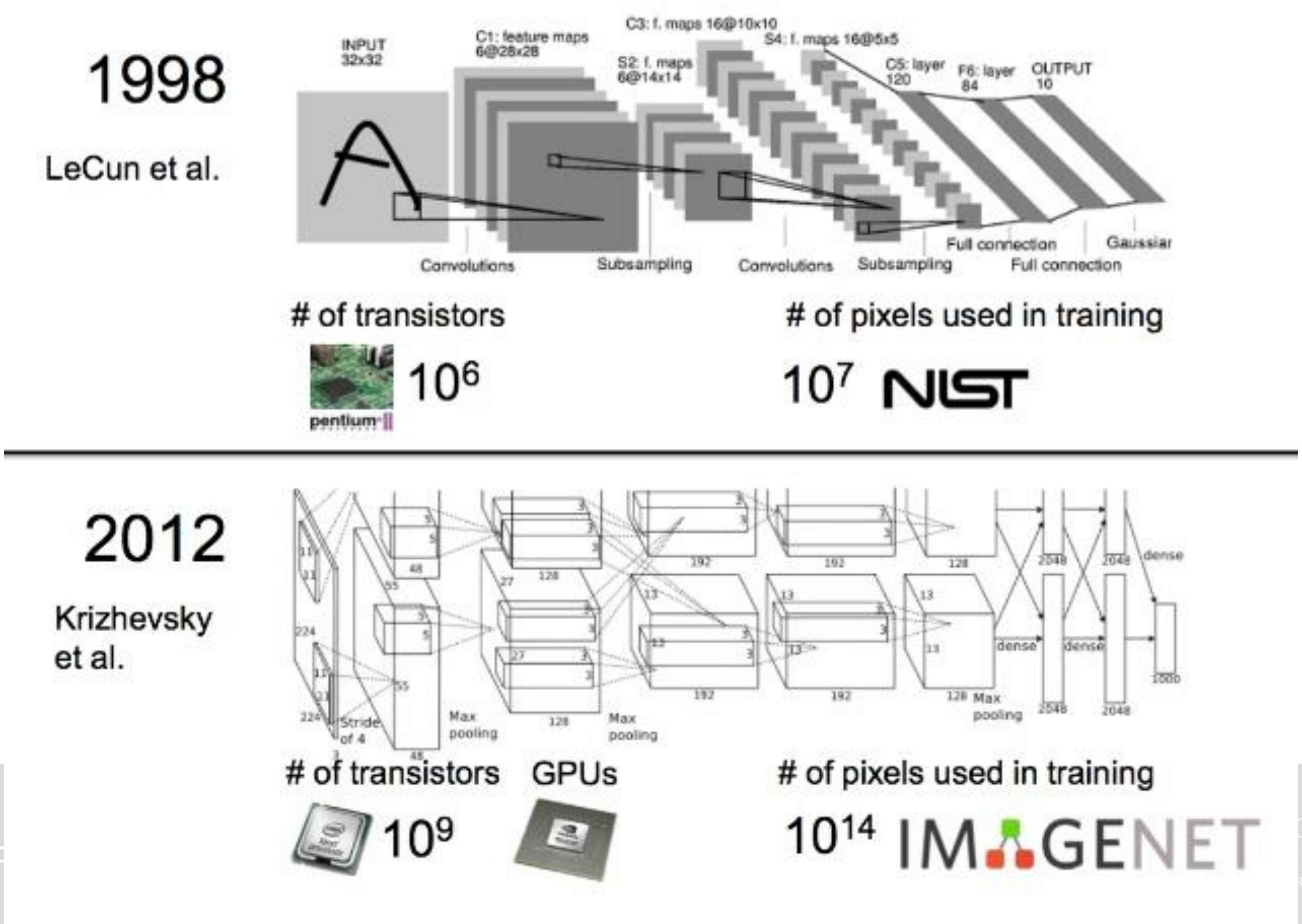
Deep Learning for Vehicle Classification

IMAGENET Image Large Scale Visual Recognition Challenge



Source: http://image-net.org/

Deep Learning for Vehicle Classification



Deep Learning for Vehicle Classification

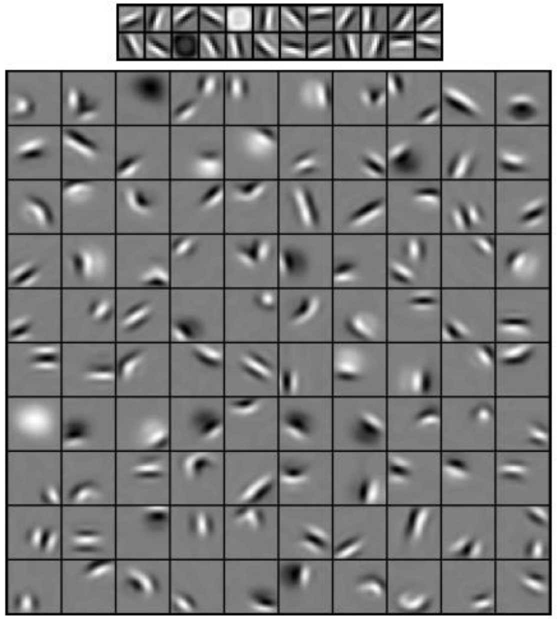
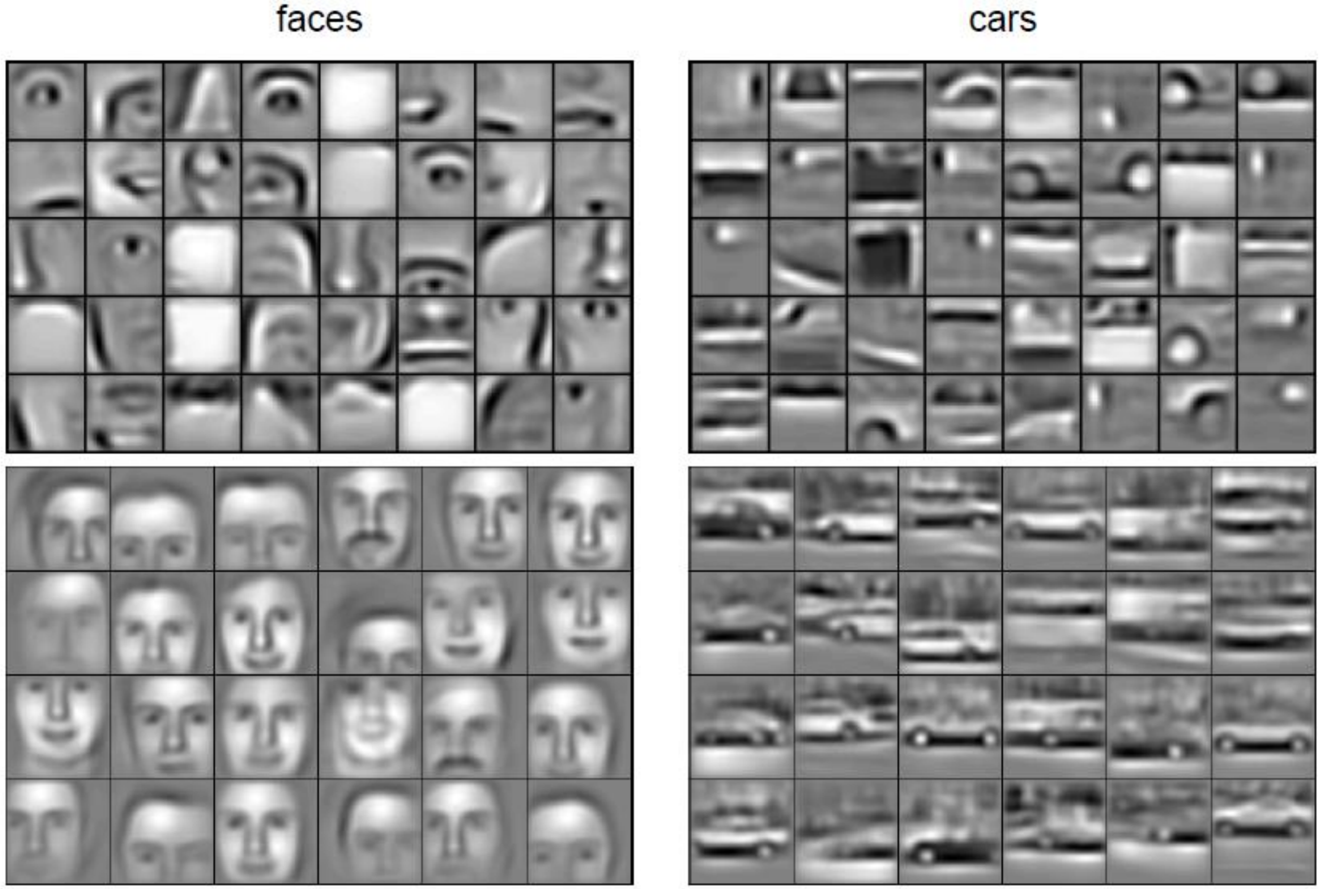


Figure 2. The first layer bases (top) and the second layer bases (bottom) learned from natural images. Each second layer basis (filter) was visualized as a weighted linear combination of the first layer bases.



[8] H. Lee, R. Grosse, R. Ranganath, y A. Y. Ng,

Deep Learning for Vehicle Classification

Pretraining CNN

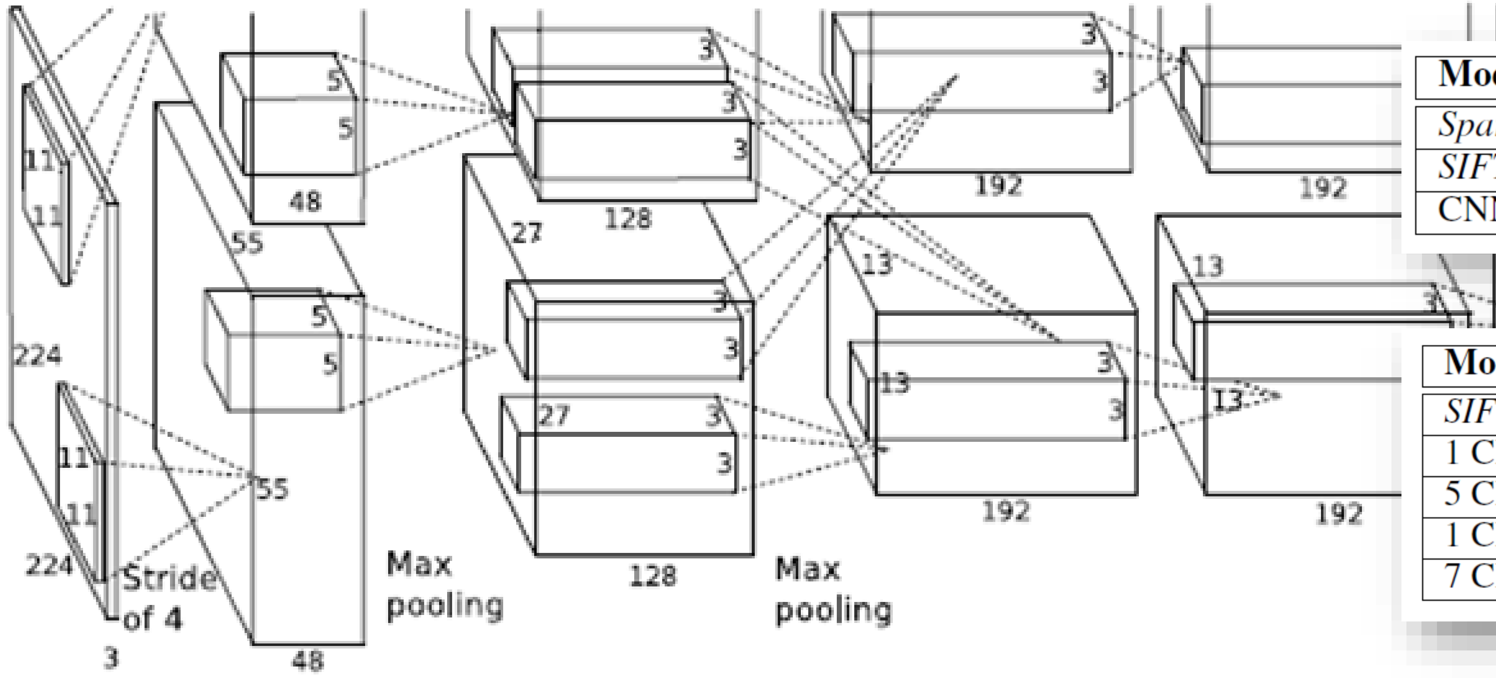
- AlexNet (ImageNet [2]) took almost a **entire week** for traininig , running in two GPUs GTX 580 3GB, **ImagineNet** dataset contains more than 15 millions of high res images, distributed in around 22 thousand categories and labelled and classified on 1000 categories.

- CNN can be pretrainned, for two purposes:
  - **Feature extraction:** Feature extraction: where a CNN is used to extract features from data (in this case images) and then use the learned features to train a different classifier, e.g., a support vector machine (SVM).
  - **Transfer learning:** Where a network already trained on a big dataset is retrained in the last few layers on a more compact data set.

  This can be verified in Razavian et al. [10], where a generic descriptor is generated from a CNN and then it is used in the net OverFed[11] to perform task of object recognition and classification.

Deep Learning for Vehicle Classification

AlexNet



Model	Top-1	Top-5
Sparse coding [2]	*47.1%*	*28.2%*
SIFT + FVs [24]	*45.7%*	*25.7%*
CNN	**37.5%**	**17.0%**

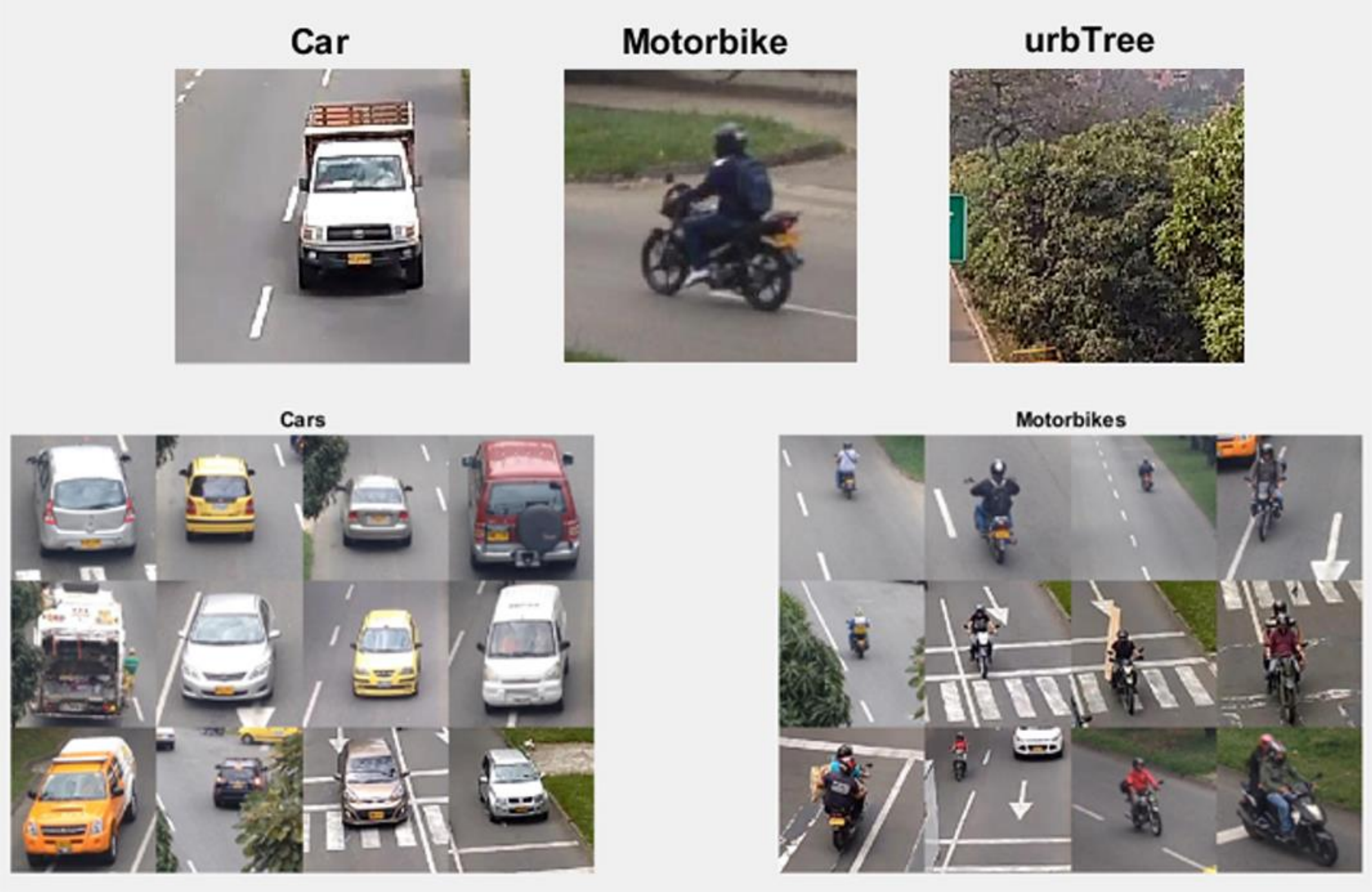
Model	Top-1 (val)	Top-5 (val)	Top-5 (test)
SIFT + FVs [7]	—	—	*26.2%*
1 CNN	40.7%	18.2%	—
5 CNNs	38.1%	16.4%	**16.4%**
1 CNN*	39.0%	16.6%	—
7 CNNs*	36.7%	15.4%	**15.3%**

8 Layers network, first 5 of Convolution last three Fully Connected. The output of the last fully-connected layer is fed to a 1000-way softmax which produces a distribution over the 1000 class labels.

The neural network, which has 60 million parameters and 650,000 neurons, consists of five convolutional layers, some of which are followed by max-pooling layers, and three fully-connected layers with a final 1000-way softmax

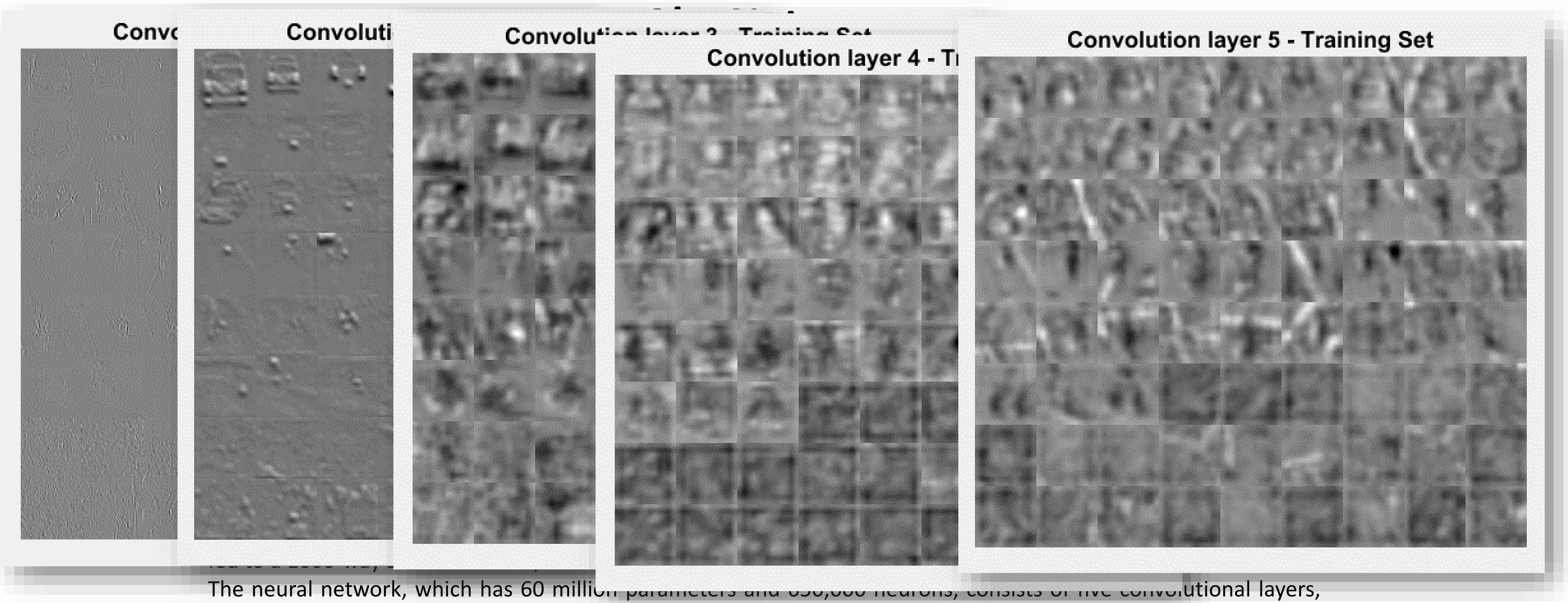
AlexNet - A. Krizhevsky, I. Sutskever, y G. E. Hinton, [2]

Deep Learning for Vehicle Classification



The three categories for Dataset created for classification
Only 80 Examples per Category = 240 Total

Deep Learning for Vehicle Classification

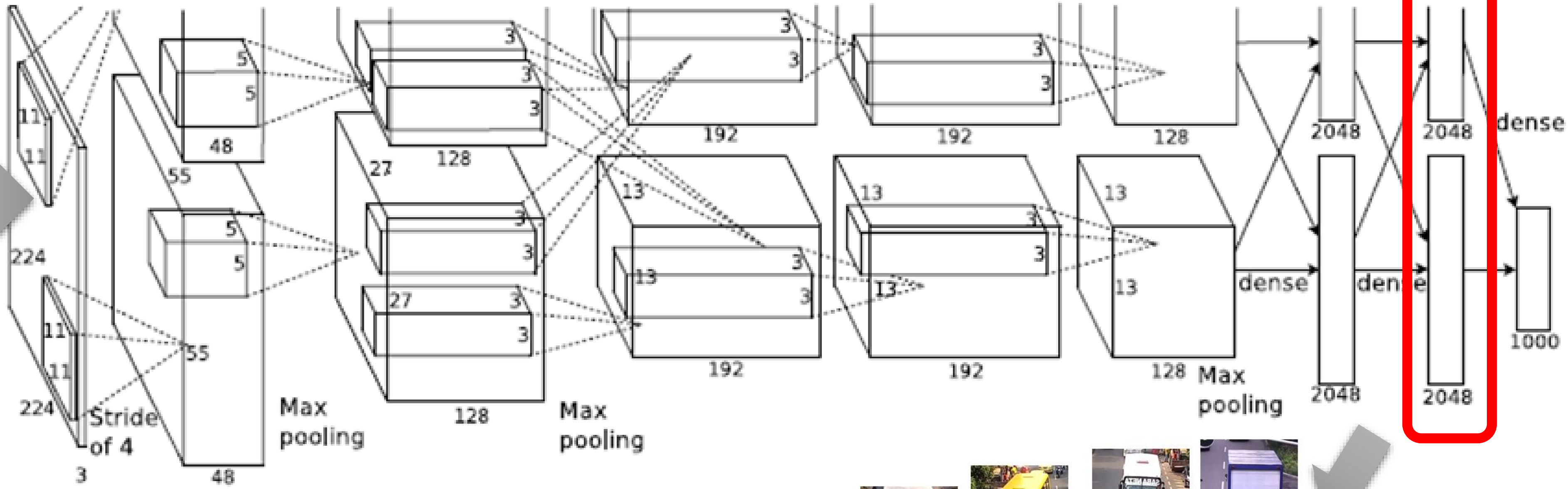


The neural network, which has 60 million parameters and 650,000 neurons, consists of five convolutional layers, some of which are followed by max-pooling layers, and three fully-connected layers with a final 1000-way softmax

AlexNet - A. Krizhevsky, I. Sutskever, y G. E. Hinton, [2]

AlexNet for Vehicle Classification

AlexNet



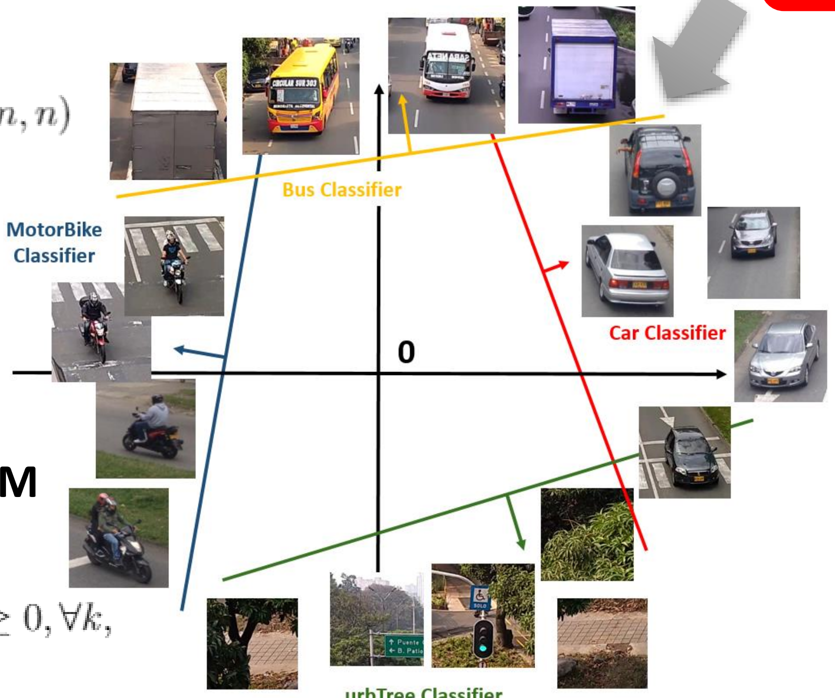
$$S(i,j) = (I*K)(i,j) = \sum_m \sum_n I(i+m, j+n)K(m,n)$$

$$x_j^l = f\left(\sum_{i \in M_j} x_i^{l-1} * k_{ij}^l + b_j^l\right)$$

Linear SVM

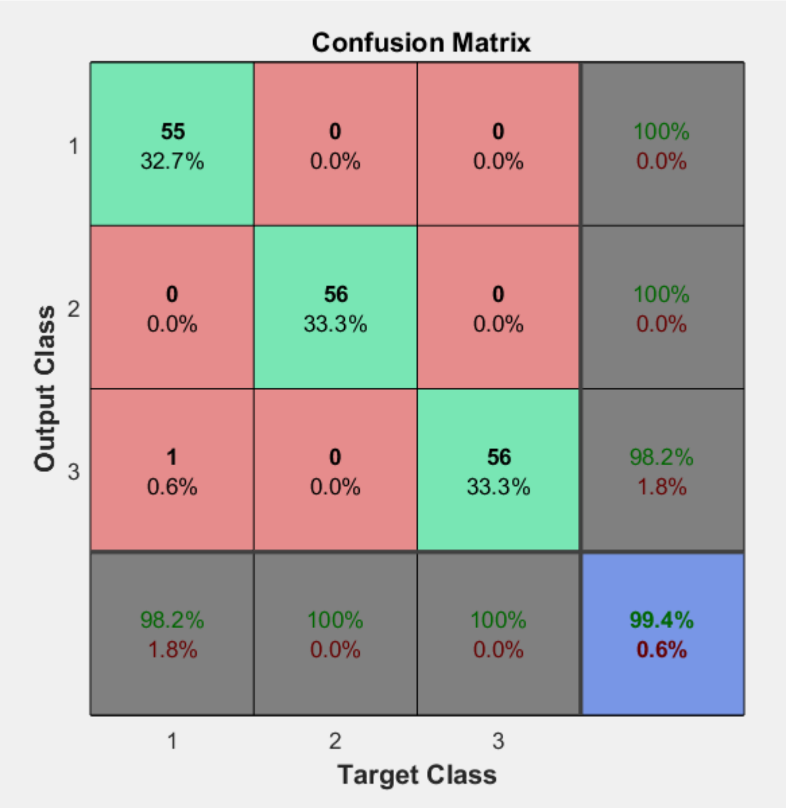
$$\min_{\mathrm{w},b,\xi} \frac{1}{2}||\mathrm{w}||^2 + C\sum_{k=1}^{M} \xi k$$

$$s.t. \quad y_k(\mathrm{w}^T\phi(x_i,y)+b) \geq 1-\xi k, \xi k \geq 0, \forall k,$$



Deep Learning for Vehicle Classification

Results

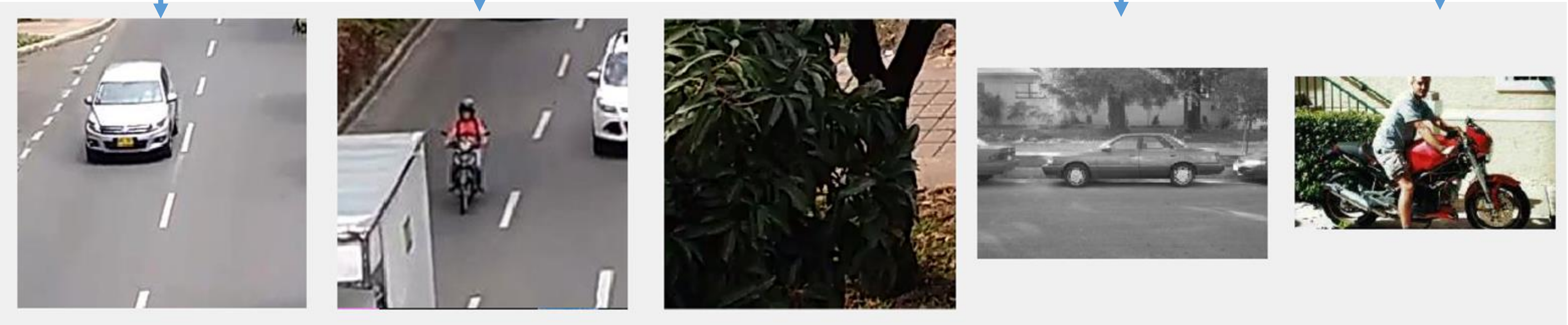


1. Cars 2. Motorbikes 3. UrbTree

- Mean Accuracy: 99,40%
  (Training 30% – Test 70 %)
- Cross Validated Mean Accuracy : 100%
  (k=10, Training 90% – Test 10 %)
- Cross Validated Mean Accuracy : 99,31%
  (k=10, Training 10% – Test 90 %)

Deep Learning for Vehicle Classification

5 Classes

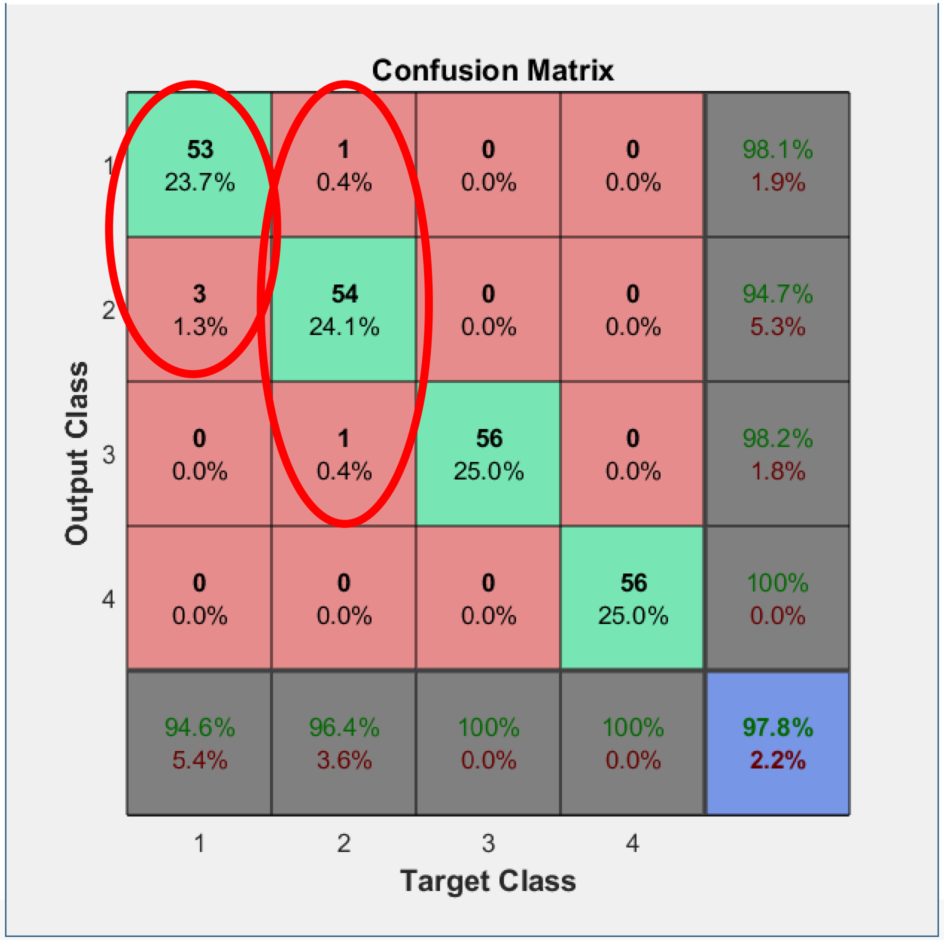


Experiment Set extension. (Class 1=Cars, 2 = Motorbikes, 3 = urbTree, 4=Car side, 5=Motorbikes side (Las two from Caltech-101) [12]

- Try to evaluate if the Features obtained for Motorcycles forces the classifier to treat all motorbikes as single class, and if it I also happen with cars.

AlexNet for Vehicle Classification

Classification Results



Confusion Matrix of the experiments.
(Class 1: Buses 2: Cars 3: Motorcycles 4: urbTree)

- Mean Accuracy: 97,80%
  (Training 30% – Test 70 %)
- Cross Validated Mean Accuracy : 100%
  (k=10, Training 90% – Test 10 %)
- Cross Validated Mean Accuracy : 99,31%
  (k=10, Training 10% – Test 90 %)

Deep Learning for Vehicle Classification

Results

Source Internet

Cars (Top_Carro)	82 %
Motorbike (Top_Moto)	40 %
UrbTree	58 %

Deep Learning for Vehicle Classification

Results

Source Internet

Carros (Cars_top)	73, 5%
Motos (Motos_top)	62,3%
UrbTree	22 %

Deep Learning for Vehicle Classification

Results

Source Google Street View at Medellin

Cars (Top_Carro)	61 %
Motorbike (Top_Moto)	85 %
UrbTree	31 %

Deep Learning for Vehicle Classification

Results

Source Internet

Cars (Top_Carro) 34 %

Motorbike (Top_Moto) 21 %

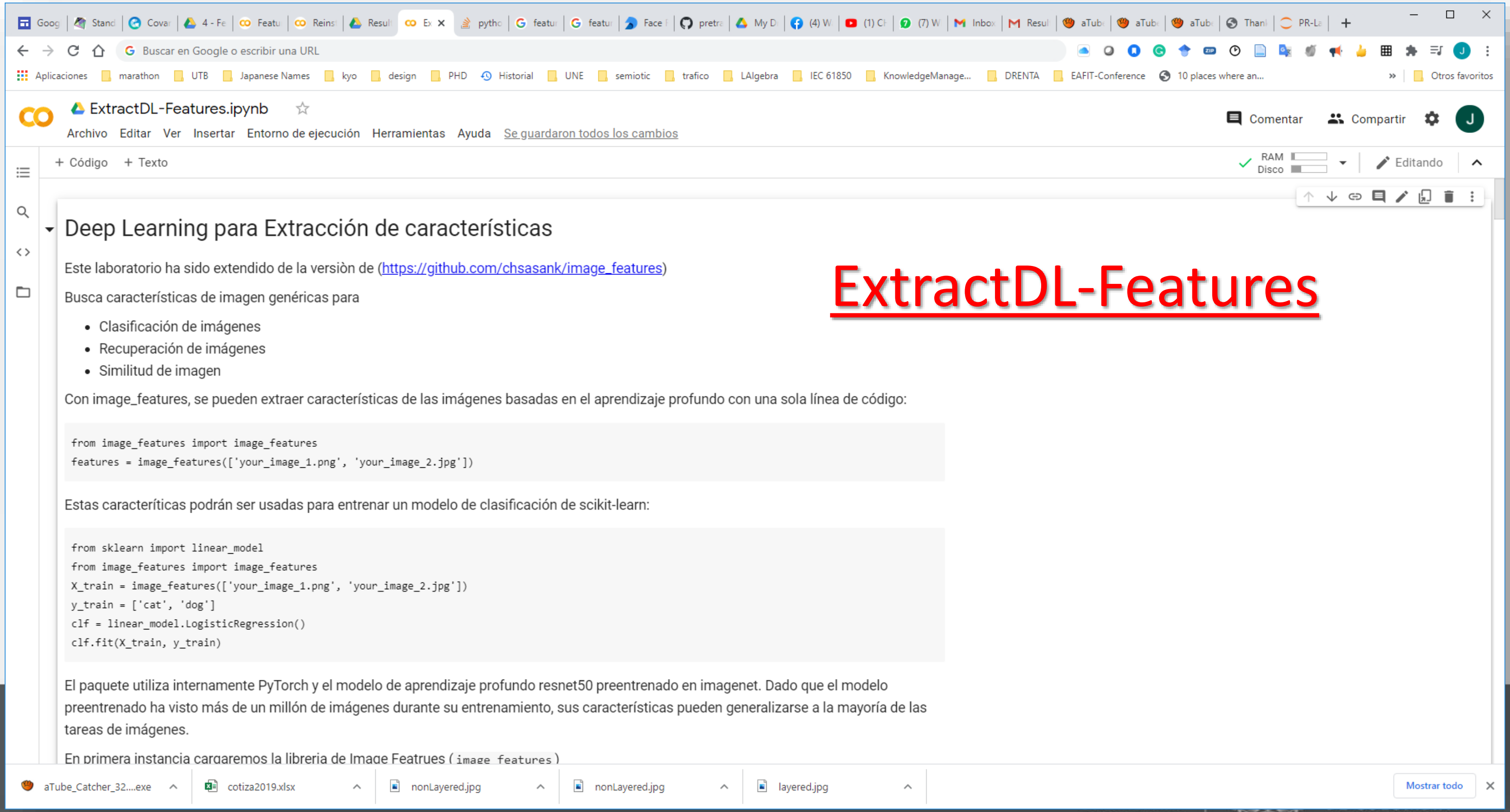
UrbTree 32%

Conclusions

- In this research it is proposed the implementation of a motorbike classification scheme in urban scenarios using CNNs for feature extraction.
- CNNs already trained with millions of examples and able to classify 1000 categories can be used for feature extraction to train a linear SVM and then classifying for instance three different classes.
- GPUs use on CNN are critical: For instance Benchmark reports [15]: The Pascal Titan X with cuDNN is 49x to 74x faster than dual Xeon E5-2630 v3 CPUs.
- Region of Interest (ROI) can accelerate the speed of CNN analysis; this can be evaluated overall in video detection and classification analysis.

Laboratorio 6

https://colab.research.google.com/drive/1VEvimwUdwKJnRUld4aaC5yRSrsdj2ThW?authuser=2#scrollTo=-q4saIeoZbWj



Gracias !!!

© Man Bouncing Question Mark Towards Doctor - Artist: Art Glazer