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Transfer Learning for Convolutional Neural Networks

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Part I

Why Transfer Learning is fun and profit?

What will be talking about?

Transfer learning (Inductive transfer) for Convolutional Neural Networks (ConvNets).

Process where structure or knowledge from a learning problem is used to enhance learning on a related problem[a].

[a] West, Jeremy; Ventura, Dan; Warnick, Sean (2007), "A Theoretical Foundation for Inductive Transfer", `http://cpms.byu.edu/springresearch/abstract-entry?id=861`

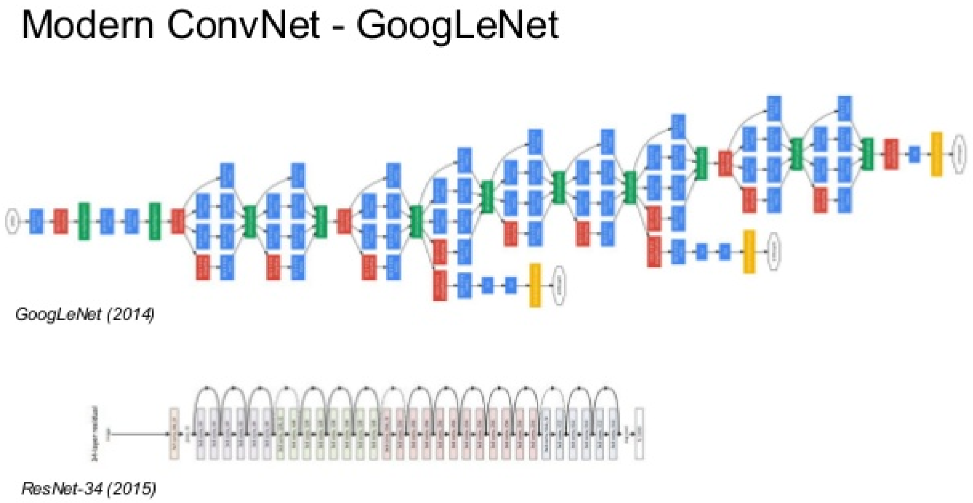
Example:
Take an image classification model that is capable to correctly label common objects (a dog, a tree or an airplane)
Retrain it to label types of yoghurt on a production lane.

First of all - why do we need Transfer Learning?

There is a lot of to be designed to build an image classification model:

- first layer:
    - data preprocessing,
    - feature extraction,
- middle layers:
    - what shall be in the middle layers
    - btw, what kind of a network shall it be?
- the last layer:
    - actual classification and labels.

Sounds easy, but in reality it looks something like this...



But there is a problem...

We usually don't really know what is the best solution to our specific case scenario.

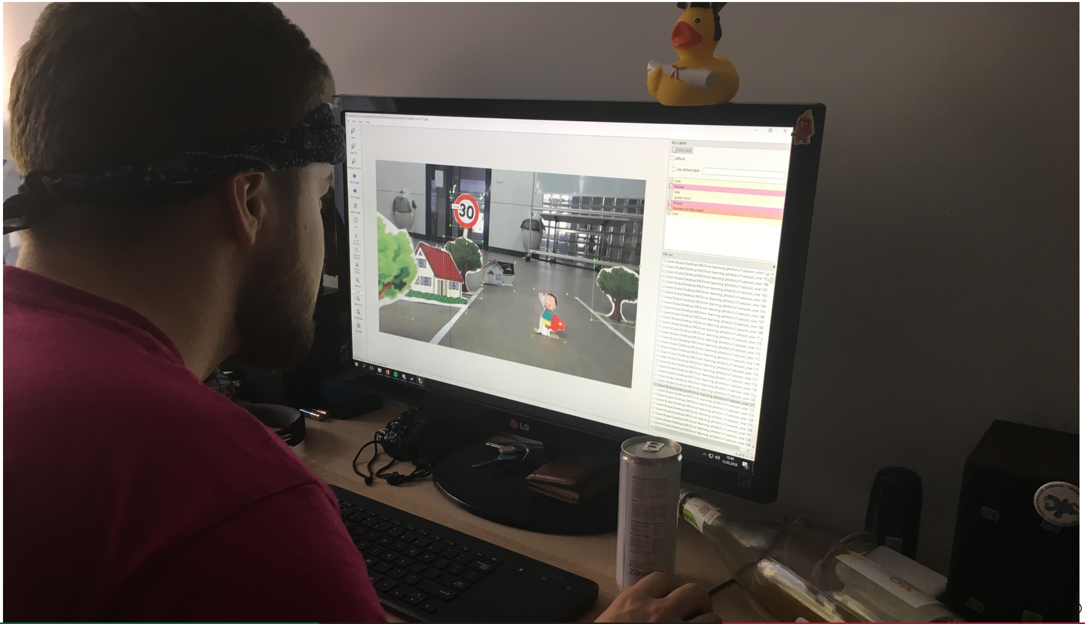
Usual methods consist of trial and error, blind luck, and intuition.

Big minds have done it better (probably)

Huge research centers and companies have the knowledge and resources to design and train good models:

- they have huge amounts of data (ImageNet has around 14 million of labeled images!)
- these models have been already trained (training on GPU can take weeks)

Labeling the images takes time and patience...



Can we just take a pretrained model and use it?

Of course we can, but:

- it will not exactly work,
- there is difference between butterflies, airplanes and printed circuit boards.

Can we train the defined model on our dataset?

We can take some shortcuts:

- let’s say that we have a huge amount of labeled data - that’s cool,
- we’re no researchers - we can take already designed neural network scheme,
- after training it on our dataset - we might expect good results.

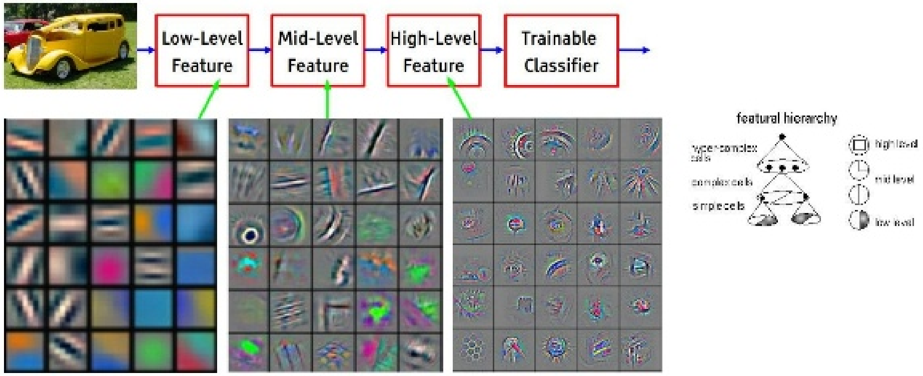
But what if I don't have a huge dataset?

If we have a significantly smaller dataset, we could try:

- take the weights from the model as it is already trained on some huge, generic dataset,
- retrain it from this point on our dataset - possibly freezing first and maybe even middle layers,
- depending on how similar our problem is to the original one - that good results.

How does transfer learning work?

ConvNet : Interpretation



Feature visualization of convolutional net trained on ImageNet from [Zeiler & Fergus 2013]

Let's sum this up!

We have three approaches possible to transfer learning:

- take the model as it is - and use it,
- take the model structure and train it on our (huge) dataset,
- take the model and it's weights and train it on our smaller dataset.

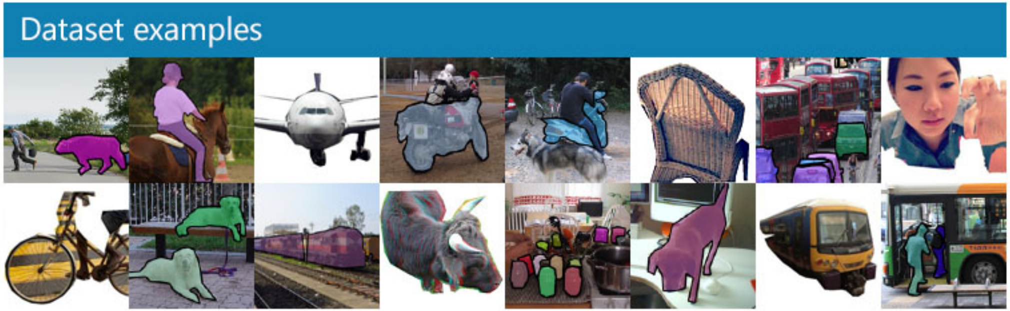
Examples

For our examples, we've taken Google's MobileNet (https://arxiv.org/abs/1704.04861) model, using reference TensorFlow implementation. We've also downloaded weights trained on the COCO dataset (http://cocodataset.org/#home).

We've only done 1000 steps of training with learning rate equal to 0.003.

Our dataset consisted of only 360 labeled photos.

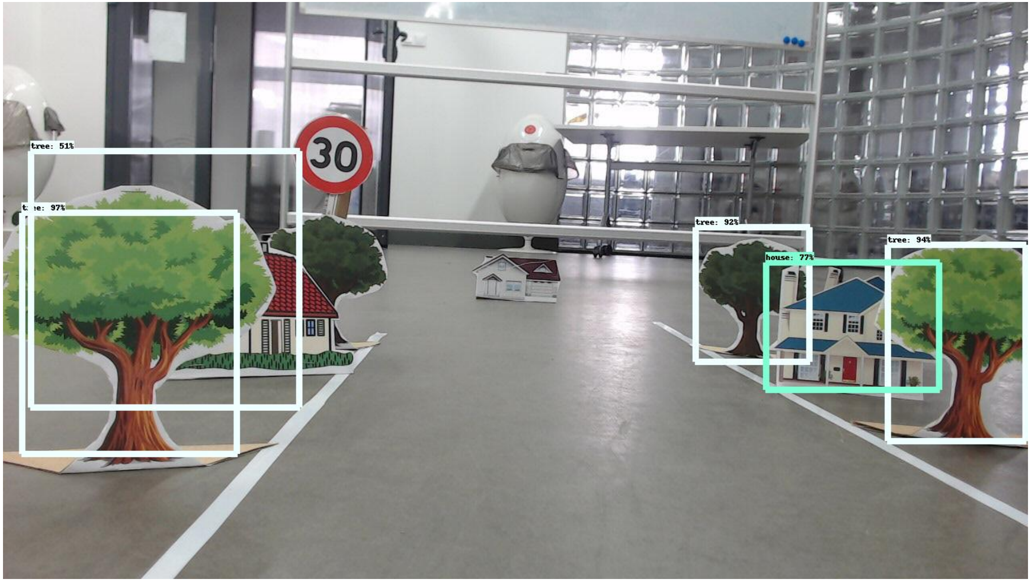
Examples - COCO



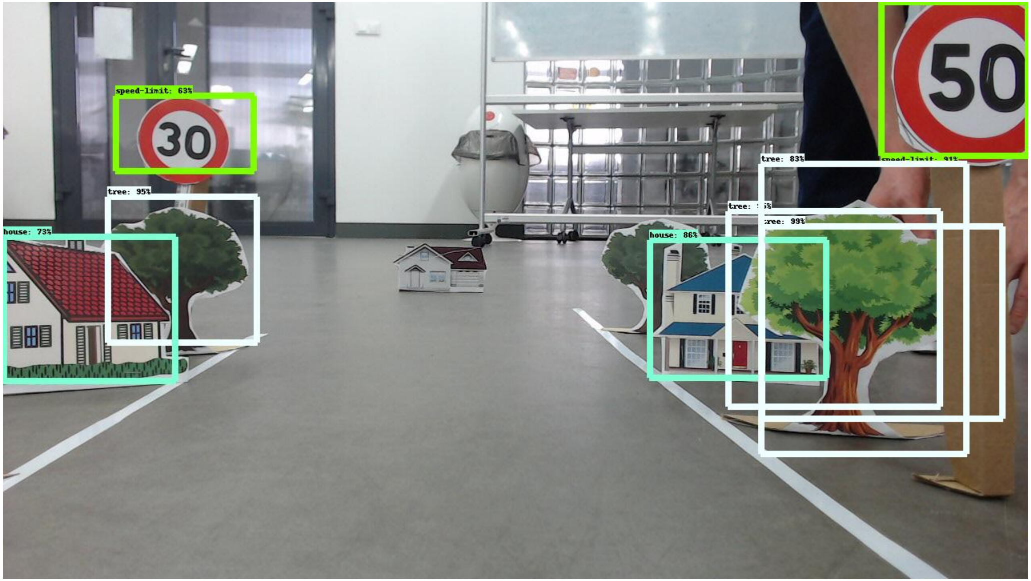
Examples - first example

First example used weights trained on the COCO dataset and used this as a base for training on our dataset.

Examples



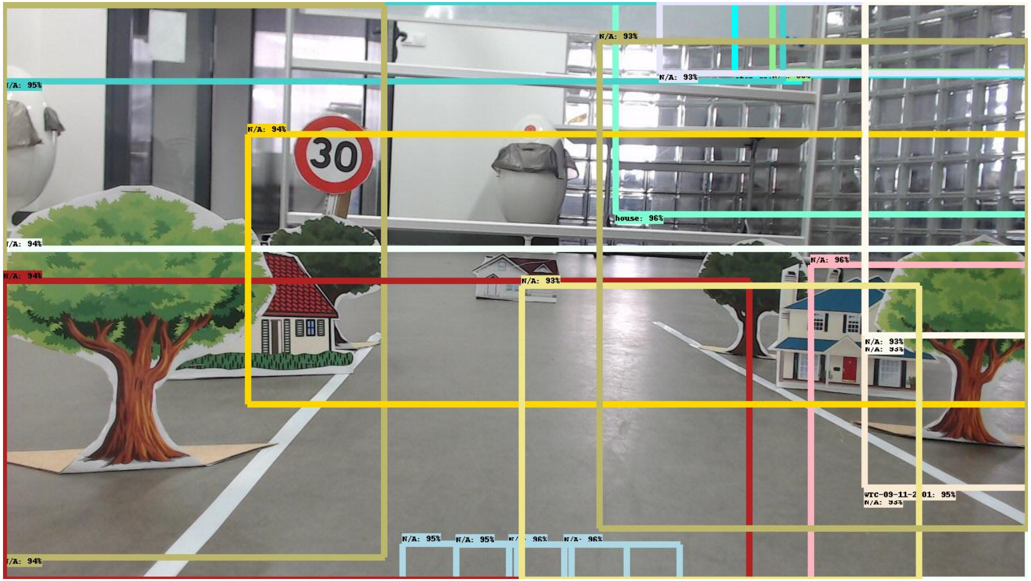
Examples


speed-limit: 63%
tree: 95%
house: 73%
tree: 83%
speed-limit: 91%
house: 86%
50
30

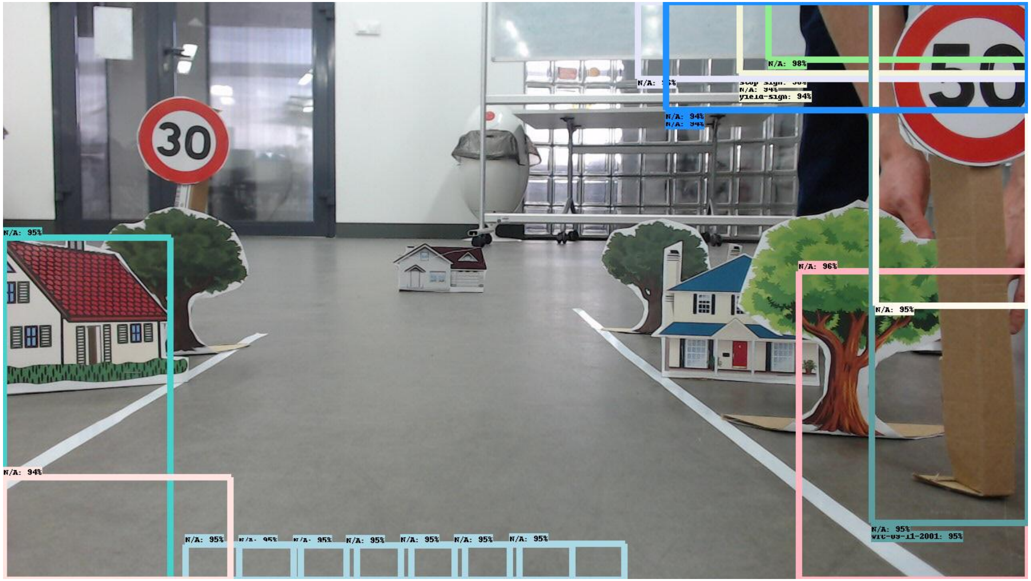
Examples - second example

Second example used the MobileNet model with weights trained on COCO dataset without additional training on our dataset.

Examples


N/A: 93%
/A: 95%
N/A: 93%
N/A: 94%
30
house: 96%
/A: 94%
N/A: 96%
/A: 94%
N/A: 93%
N/A: 93%
WTC-09-11-2 01: 95%
/A: 94%
N/A: 95%
N/A: 95%
96%
N/A: 96%

Examples



Examples - third example

Third example used the MobileNet model with random initial weights.

Examples

Examples

Examples

Now, let's see how it's done:

- how to label the images,
- preparing the structure,
- running the learning process,
- exporting the 'checkpoint',
- running the automatic classification

Part II

Time for you to build your own *teslas*!

How to get started easily

Follow the instructions here:
`https://github.com/pkazimierowicz/AI_TransferLearning_exercise`