Image Segmentation using Fully Convolutional Neural Networks

Who am I?

Teera Laiteerapong
mrteera

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Thailand
http://mrteera.com

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OnAVOS
A fork of OnAVOS
http://davischallenge.org/challenge2017/papers/DAVIS-Challenge-5th-Team.pdf
Python ★ 1

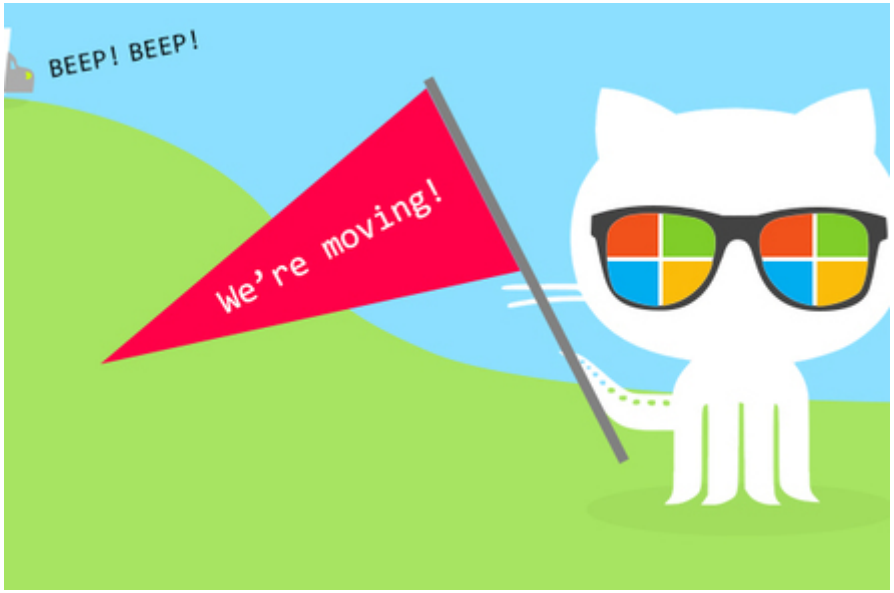
chainer
Forked from chainer/chainer
A flexible framework of neural networks for deep learning
Python

bridgedegradationseg
Forked from bridgedegradationseg/bridgedegradationseg
Shell

LearnVIORB
Forked from jingpang/LearnVIORB
C++ 1

s3cmd
Forked from KayEss/s3cmd
Official s3cmd repo -- Command line tool for managing Amazon S3 and CloudFront services -- this fork includes fixes for use with Swift
Python

code-battle-mrteera
Code Battle by Python Coder in Thailand
Shell



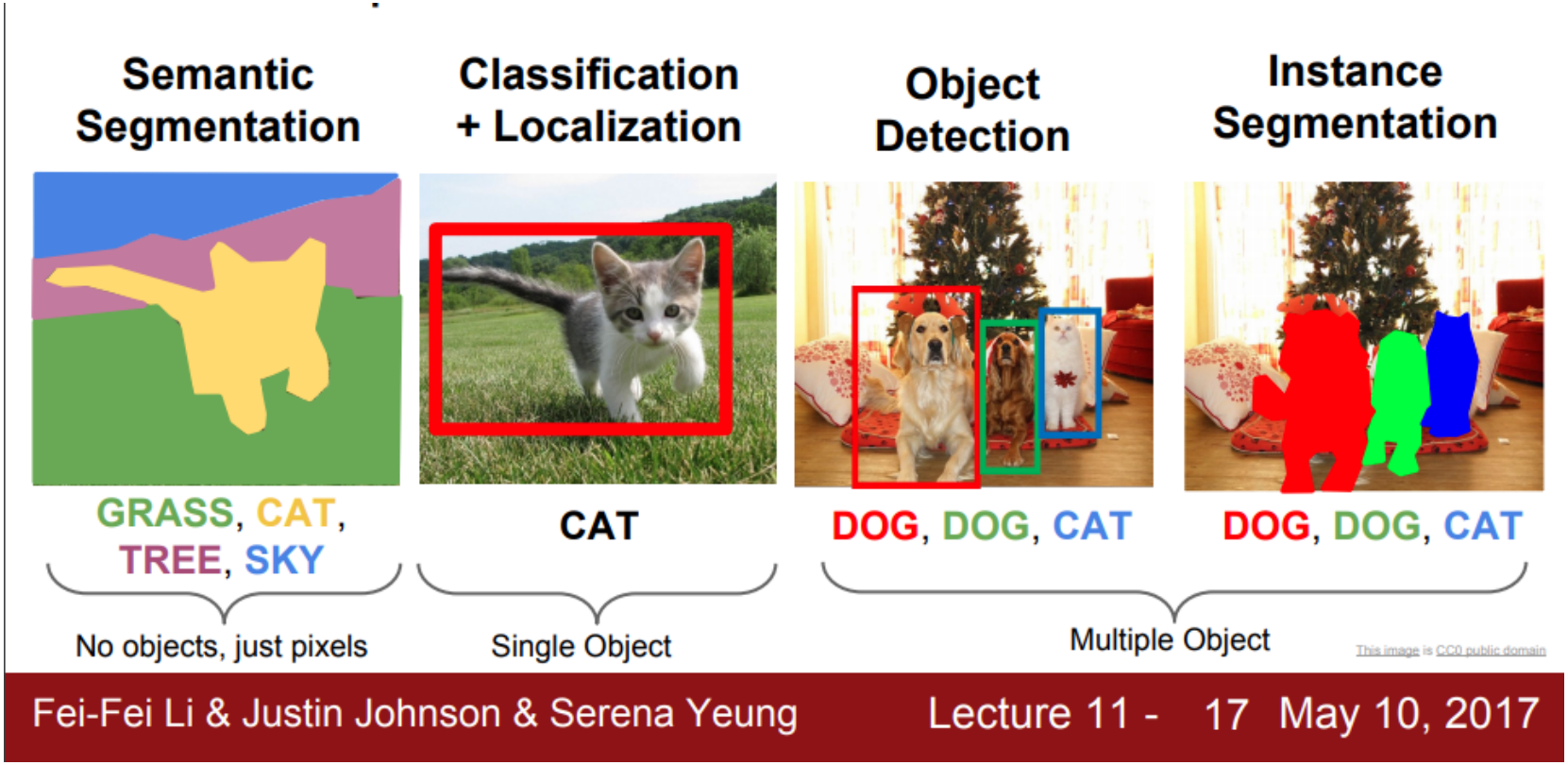
https://github.com/mrteera/CodeMania111-FCN

Photo credit: https://www.theregister.co.uk/2015/01/15/codeplex_repository_out_of_favour_as_microsoft_moves_major_projects_to_github/

Agenda

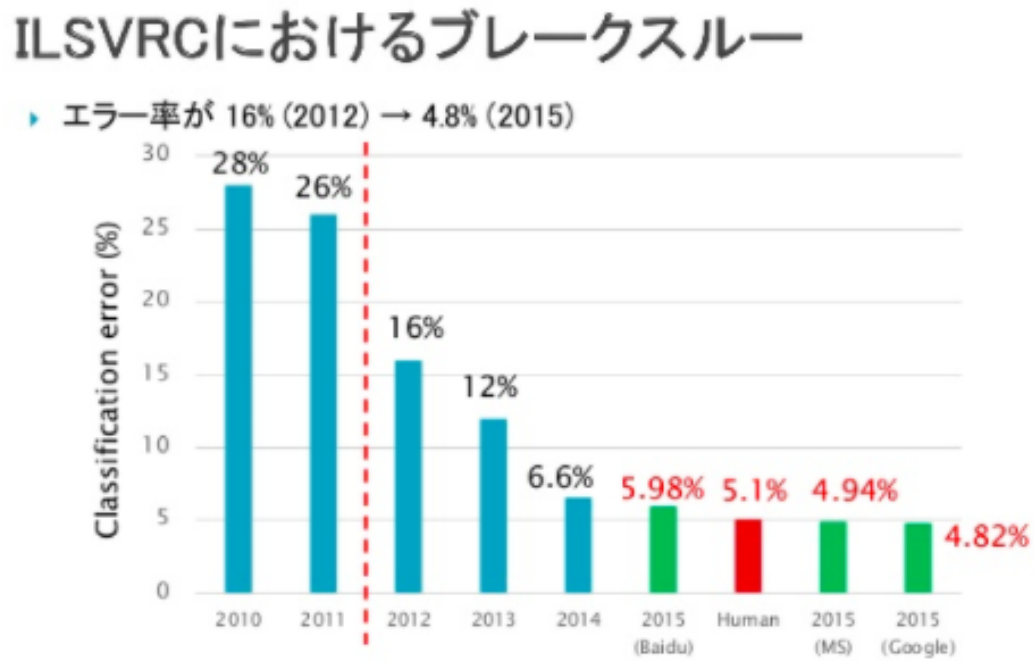
- Convolutional Neural Network (Image Classification)
- Fully Convolutional Neural Network (Image Segmentation)
- Train Machine Learning Model for Only a Half Price on Preemtible VM instance on GCP

Computer Vision Tasks



source: http://cs231n.stanford.edu/slides/2017/cs231n_2017_lecture11.pdf

Image Classification Development



source: https://shift.newco.co/there-is-one-thing-that-computers-will-never-beat-us-at-f66af30565f0

DAWNBench

An End-to-End Deep Learning Benchmark and Competition

ImageNet Training

Submission Date	Model	Time to 93% Accuracy	Cost (USD)	Max Accuracy	Hardware	Framework
Apr 2018	AmoebaNet-D N6F256 *Google Cloud TPU* source	7:28:30	$49.30	93.11%	GCP n1-standard-2, Cloud TPU	TensorFlow 1.8.0-rc0
Apr 2018	ResNet50 *Google Cloud TPU* source	8:52:33	$58.53	93.11%	GCP n1-standard-2, Cloud TPU	TensorFlow v1.8rc1
Apr 2018	Resnet 50 *fast.ai + students team: Jeremy Howard, Andrew Shaw, Brett Koonce, Sylvain Gugger* source	2:57:28	$72.40	93.05%	8 * V100 (AWS p3.16xlarge)	fastai / pytorch

source: https://dawn.cs.stanford.edu/benchmark/ImageNet/train.html

Deep Learning Framework

source: https://www.slideshare.net/yutakashino/pytorch

The Matrix

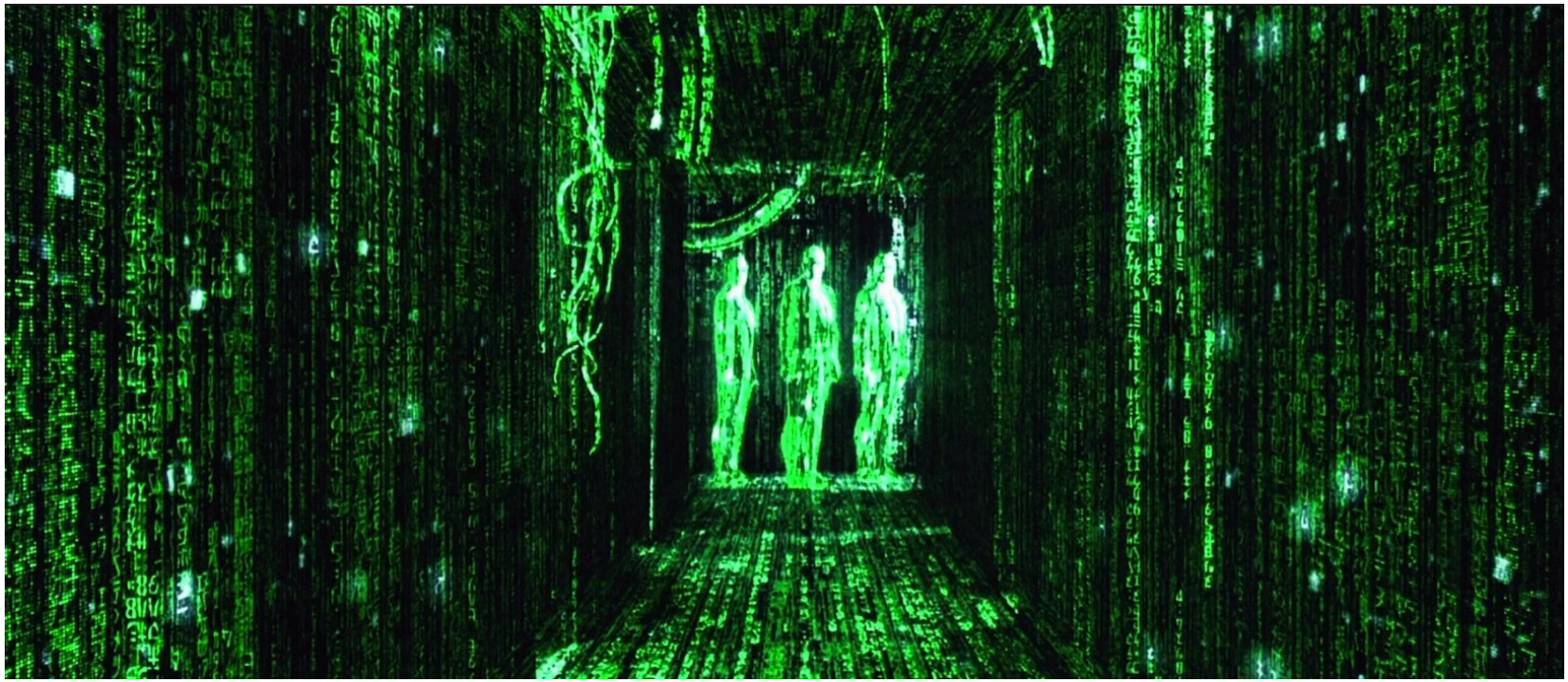
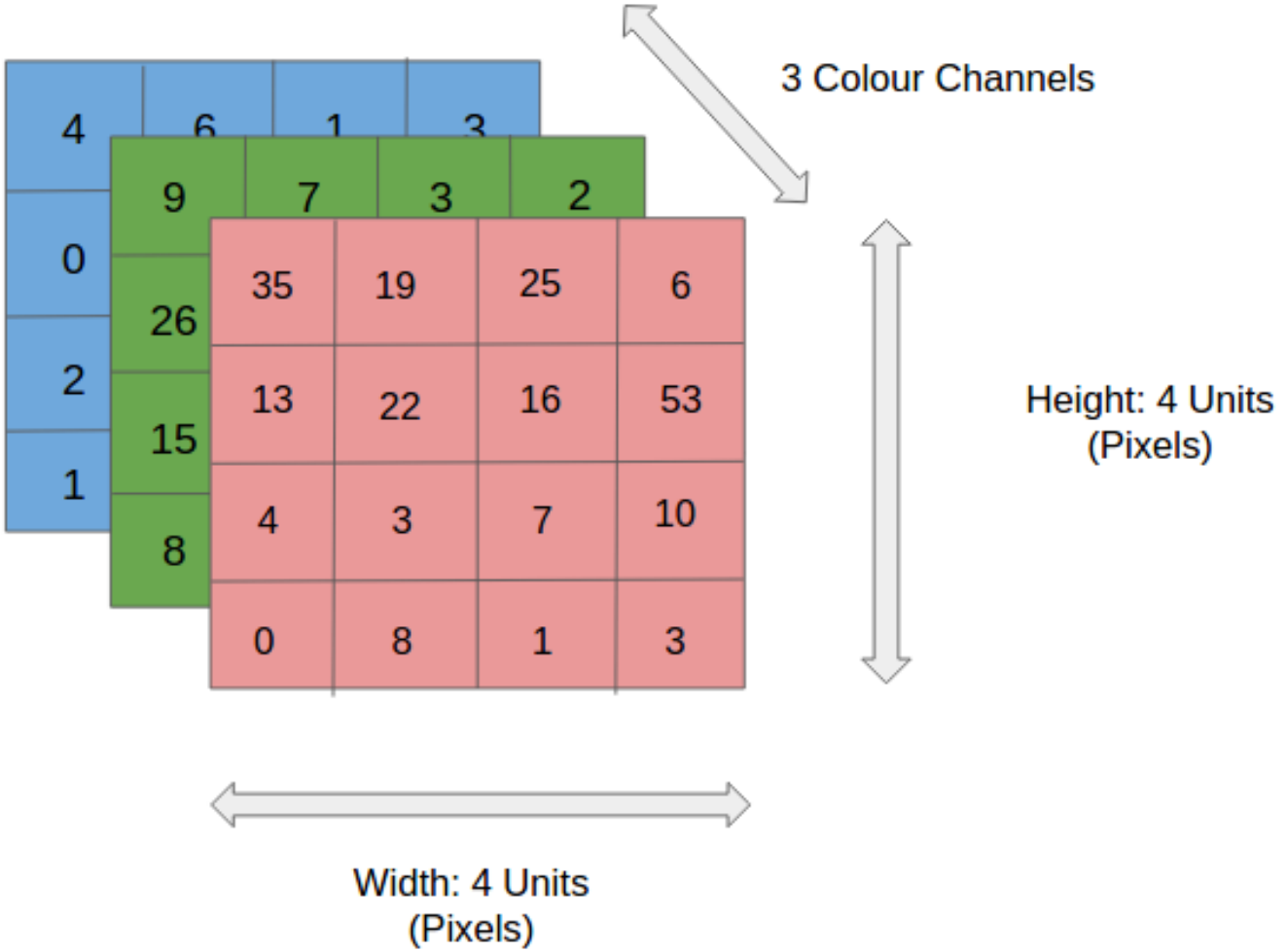
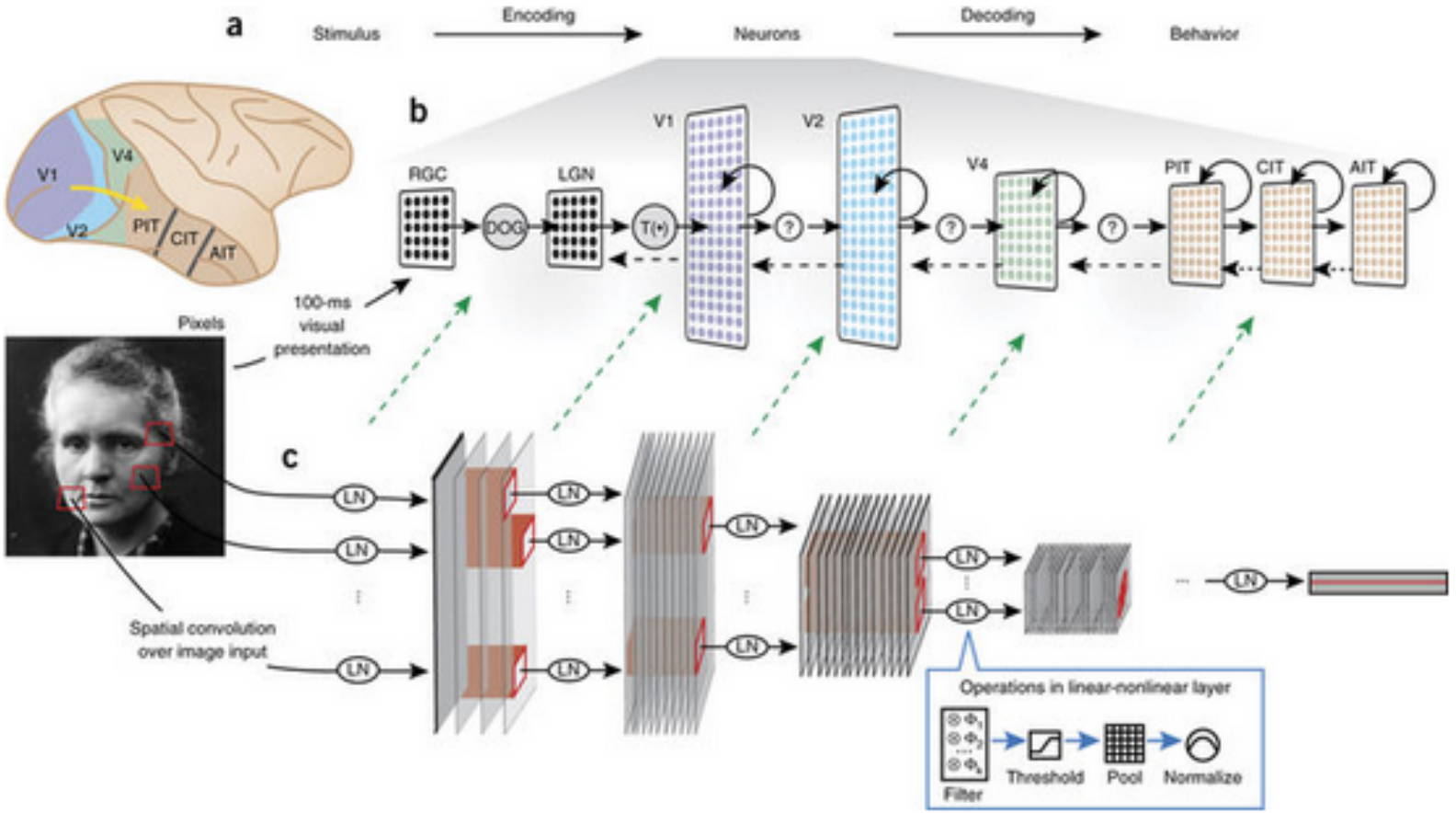


Image as a Matrix

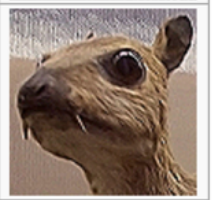
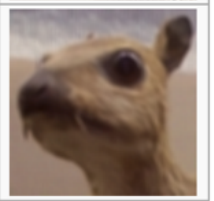
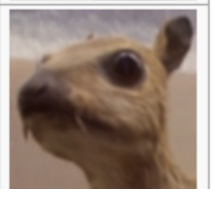


Inspiration from Human Brain

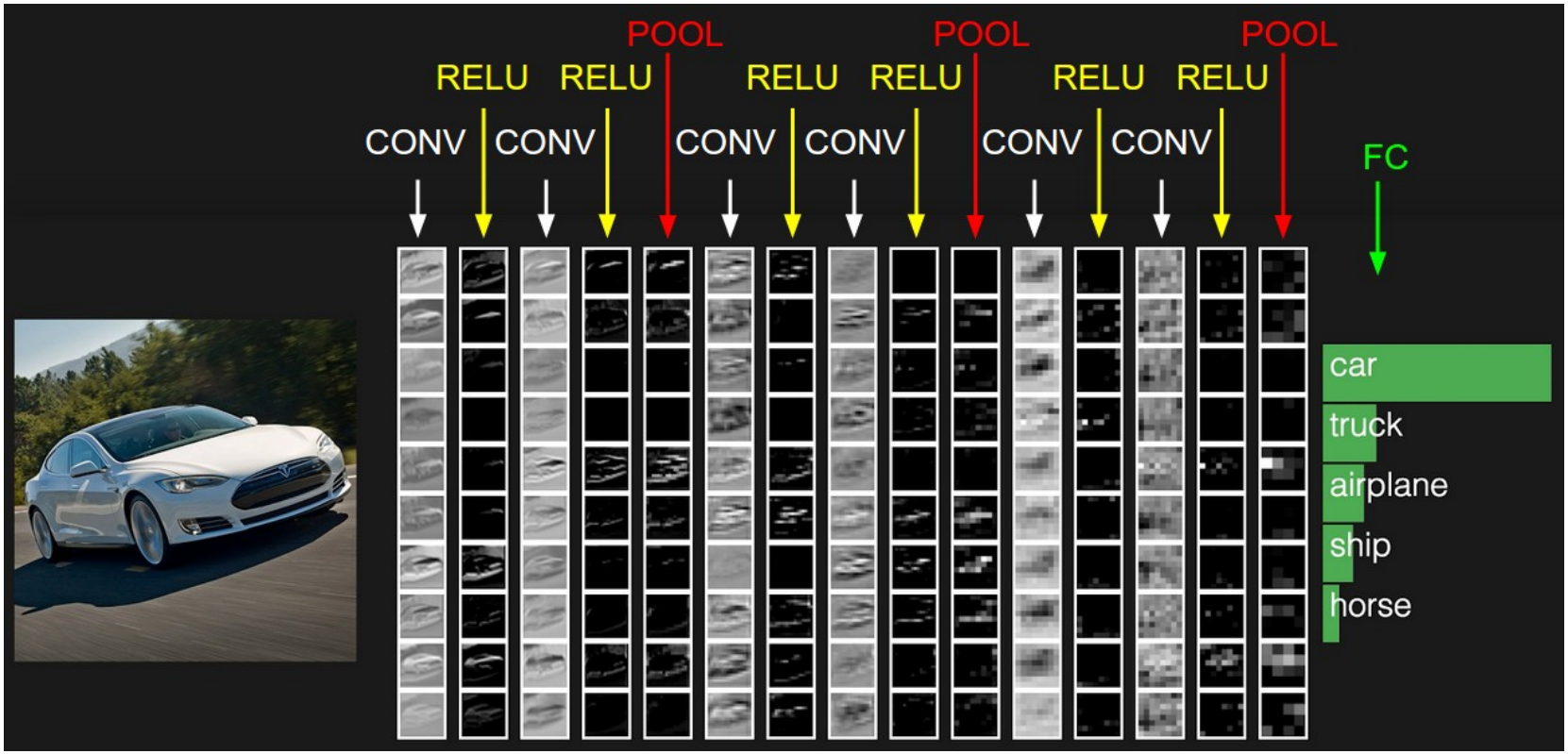


source: https://neurdiness.wordpress.com/2018/05/17/deep-convolutional-neural-networks-as-models-of-the-visual-system-qa/

What is convolution?

Operation	Filter	Convolved Image
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

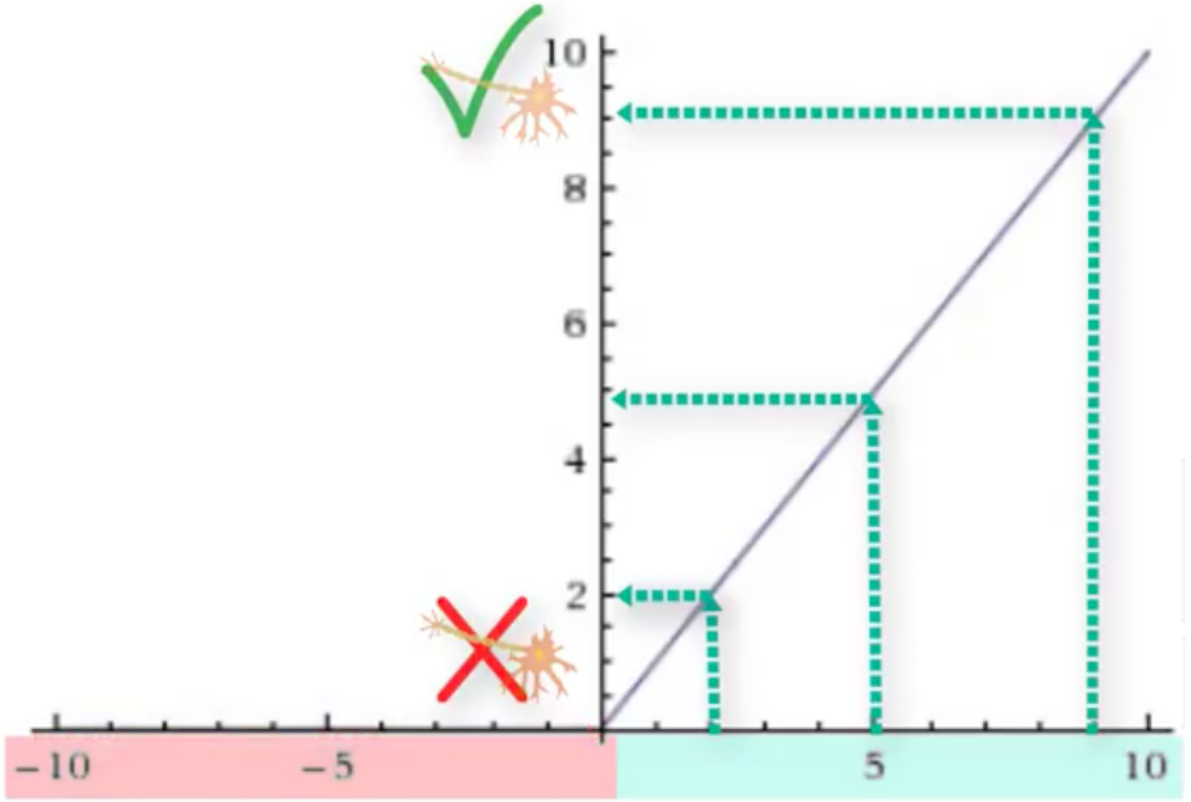
Convolutional Neural Network



source: http://cs231n.github.io/convolutional-networks/

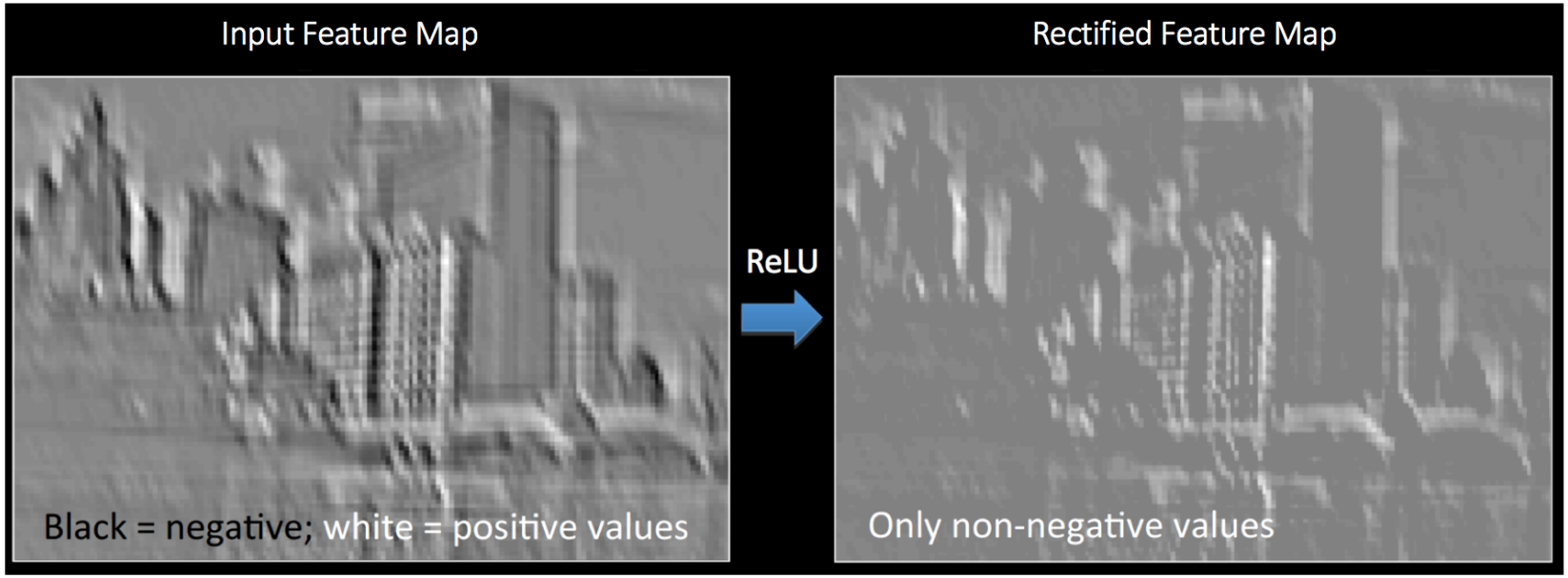
Activation Function (ReLU)

$$f(x) = \max(0, x)$$



source: https://www.youtube.com/watch?v=m0pIlLfpXWE

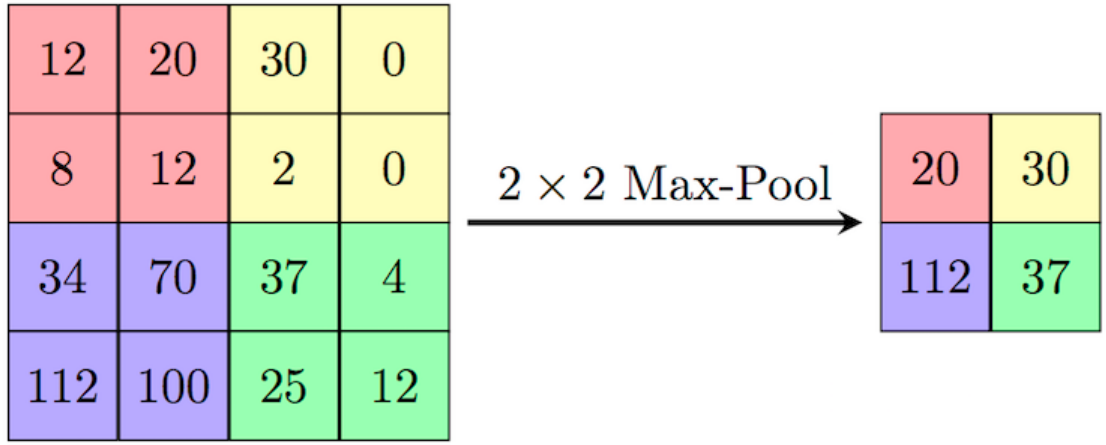
ReLU Example



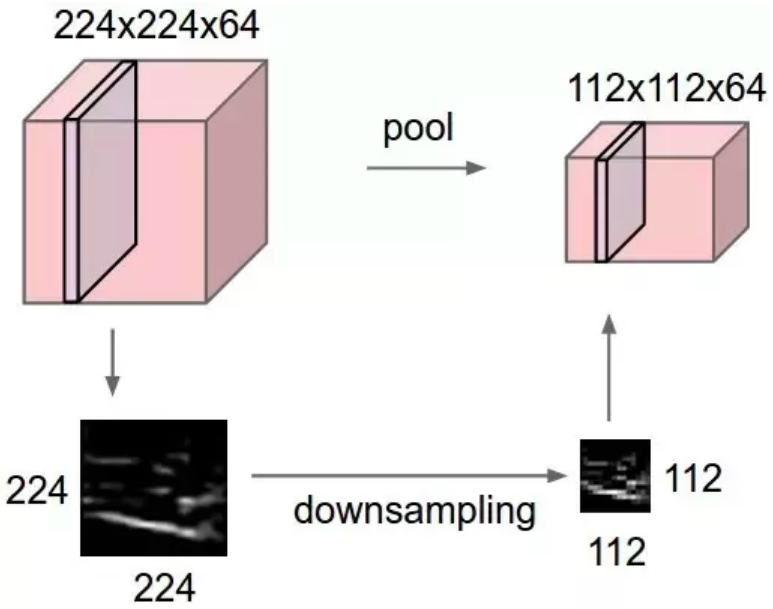
source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

Max Pooling

Pictorial representation:



Real-life example:



source: https://computersciencewiki.org/index.php/Max-pooling_/_Pooling

Dermatologist-level classification of skin cancer

In a 2017 Nature article, Esteva et al. describe an AI system trained on a data set of 129,450 clinical images of 2,032 different diseases and compare its diagnostic performance against 21 board-certified dermatologists. They find the AI system capable of classifying skin cancer at a level of competence comparable to the dermatologists.

In [4]:
```
YouTubeVideo('toK1OSLep3s', 800, 600, start=419)
#https://youtu.be/toK1OSLep3s
```

Out[4]:

Image Segmentation in Self-Driving Car

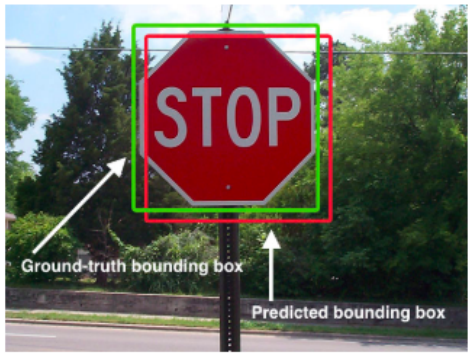
In [7]:
```
YouTubeVideo('s8Ui_kV9dhw', 800, 600)
#https://youtu.be/s8Ui_kV9dhw
```

Out[7]:

Fully Convolutional Neural Network

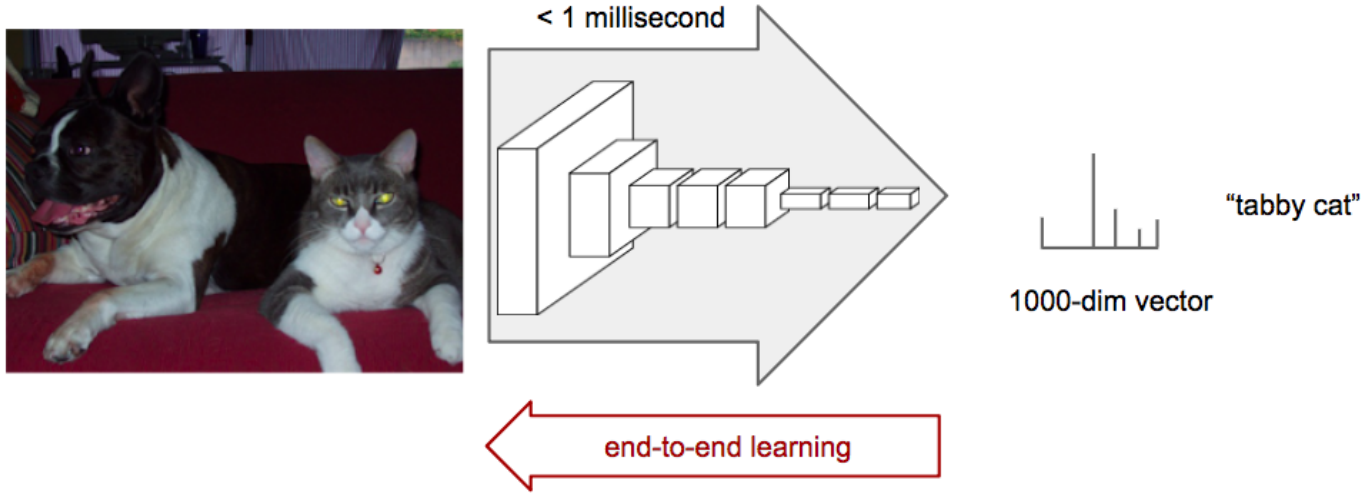
Metrics: Intersection over Union (IoU)

$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$



- Standard metric for segmentation
- Ratio of overlap/union
- Range from 0 (no overlap) to 1 (full overlap)
- Precision not reliable for unbalanced class

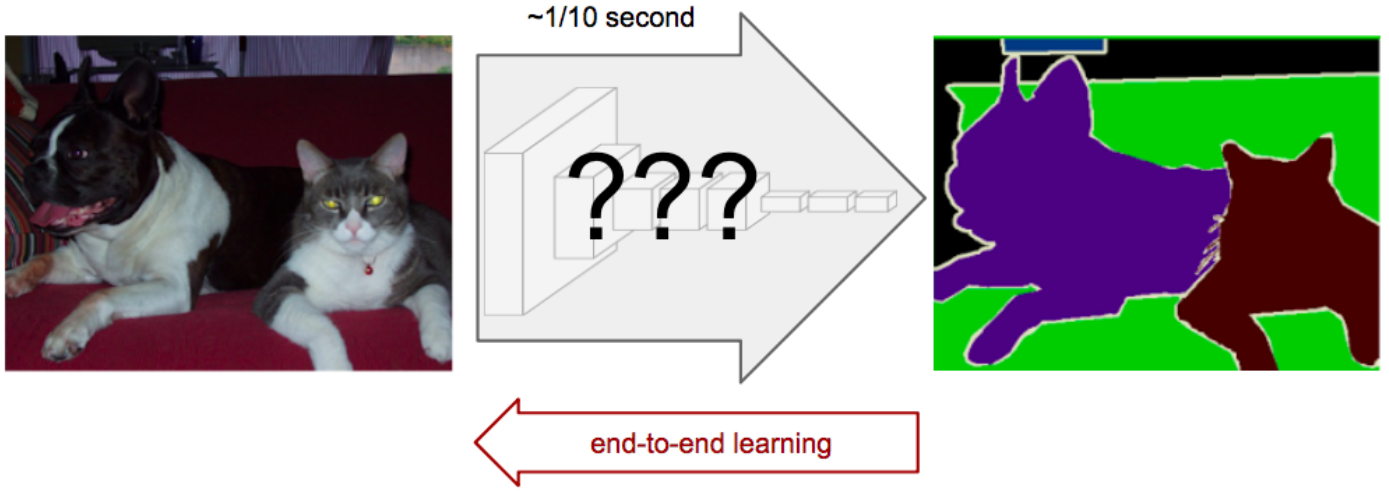
CNNs Perform Classification



source:

https://docs.google.com/presentation/d/1VeWFMpZ8XN7OC3URZP4WdXvOGYckoFWGVN7hApoXVnc/edit#slide=id.g19540bd54f_0_32

End to End Learning for Image Segmentation



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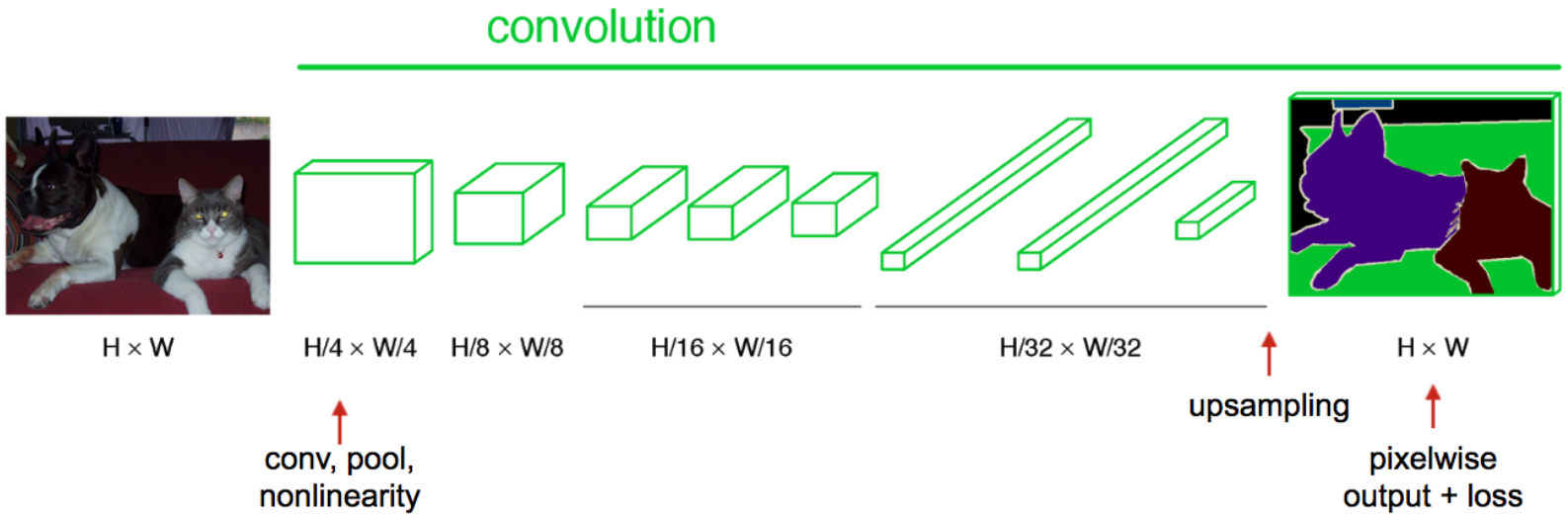
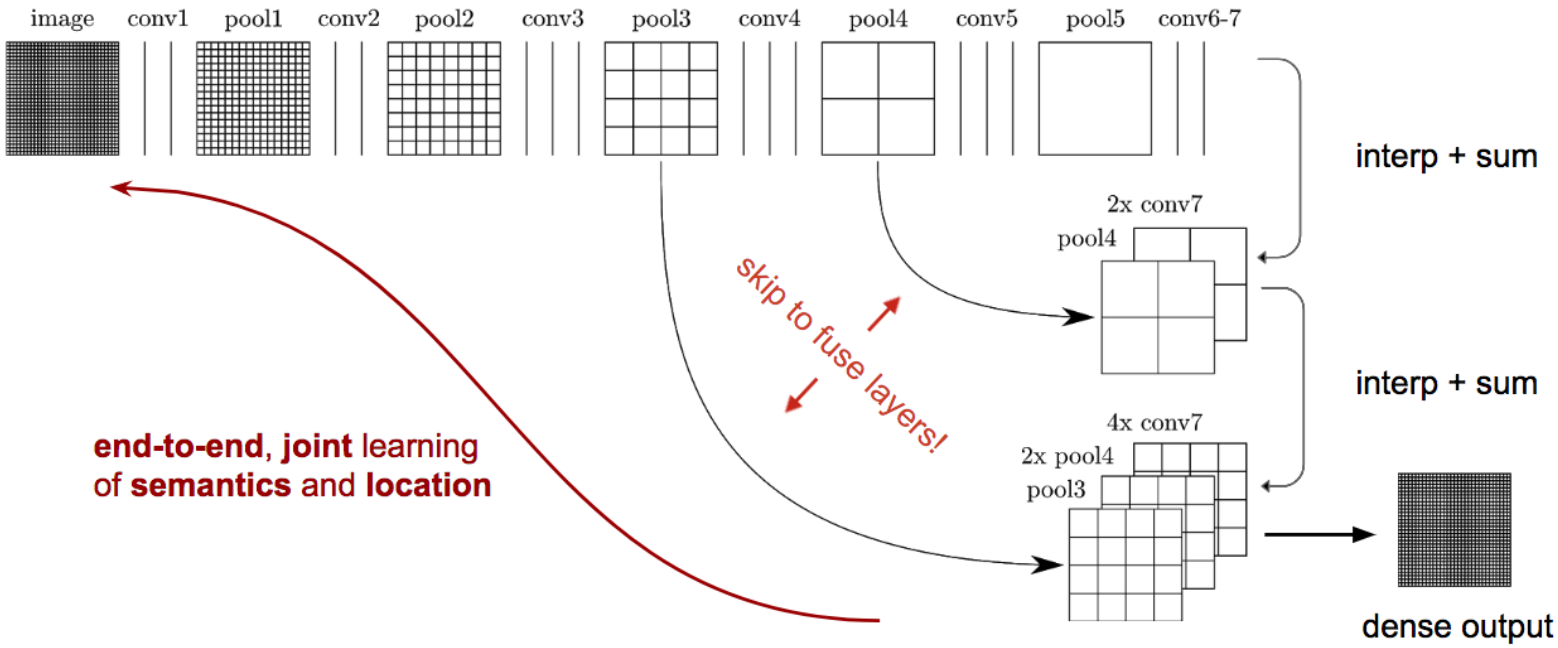
FCN Architecture



source:

https://docs.google.com/presentation/d/1VeWFMpZ8XN7OC3URZP4WdXvOGYckoFWGVN7hApoXVnc/edit#slide=id.g19540bd54f_0_32

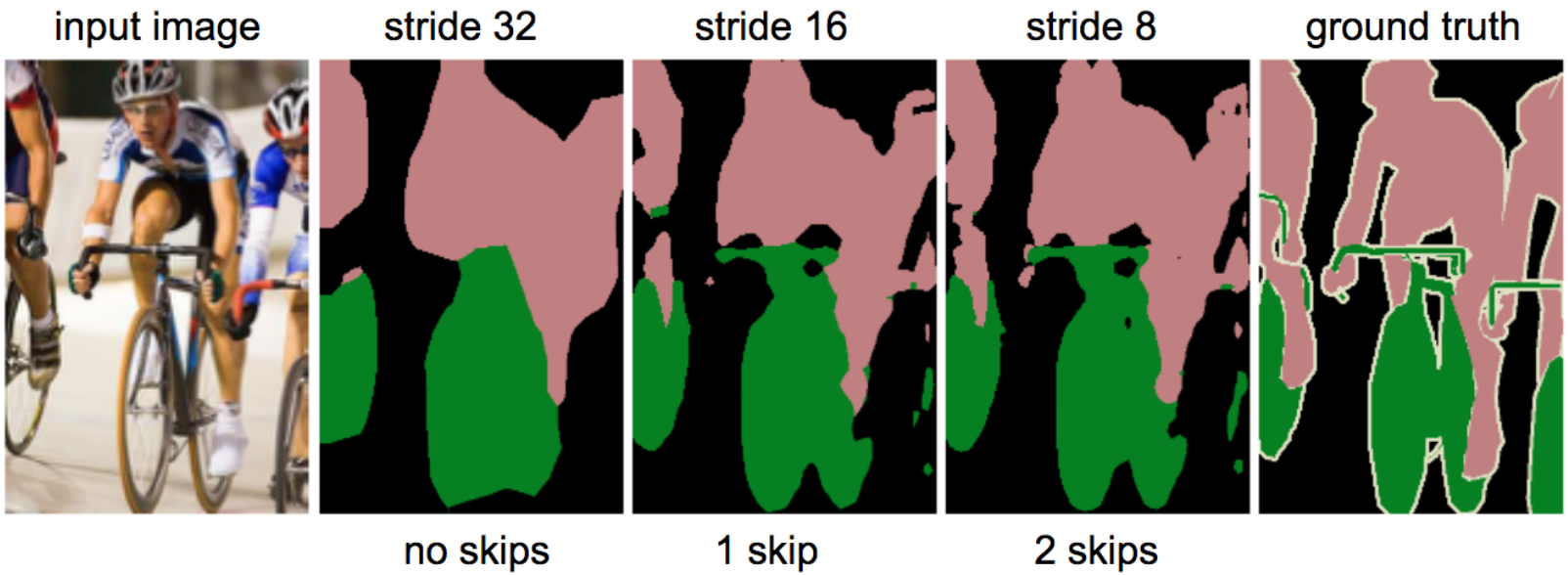
Skip Connections



source:

https://docs.google.com/presentation/d/1VeWFMpZ8XN7OC3URZP4WdXvOGYckoFWGVN7hApoXVnc/edit#slide=id.g19540bd54f_0_32

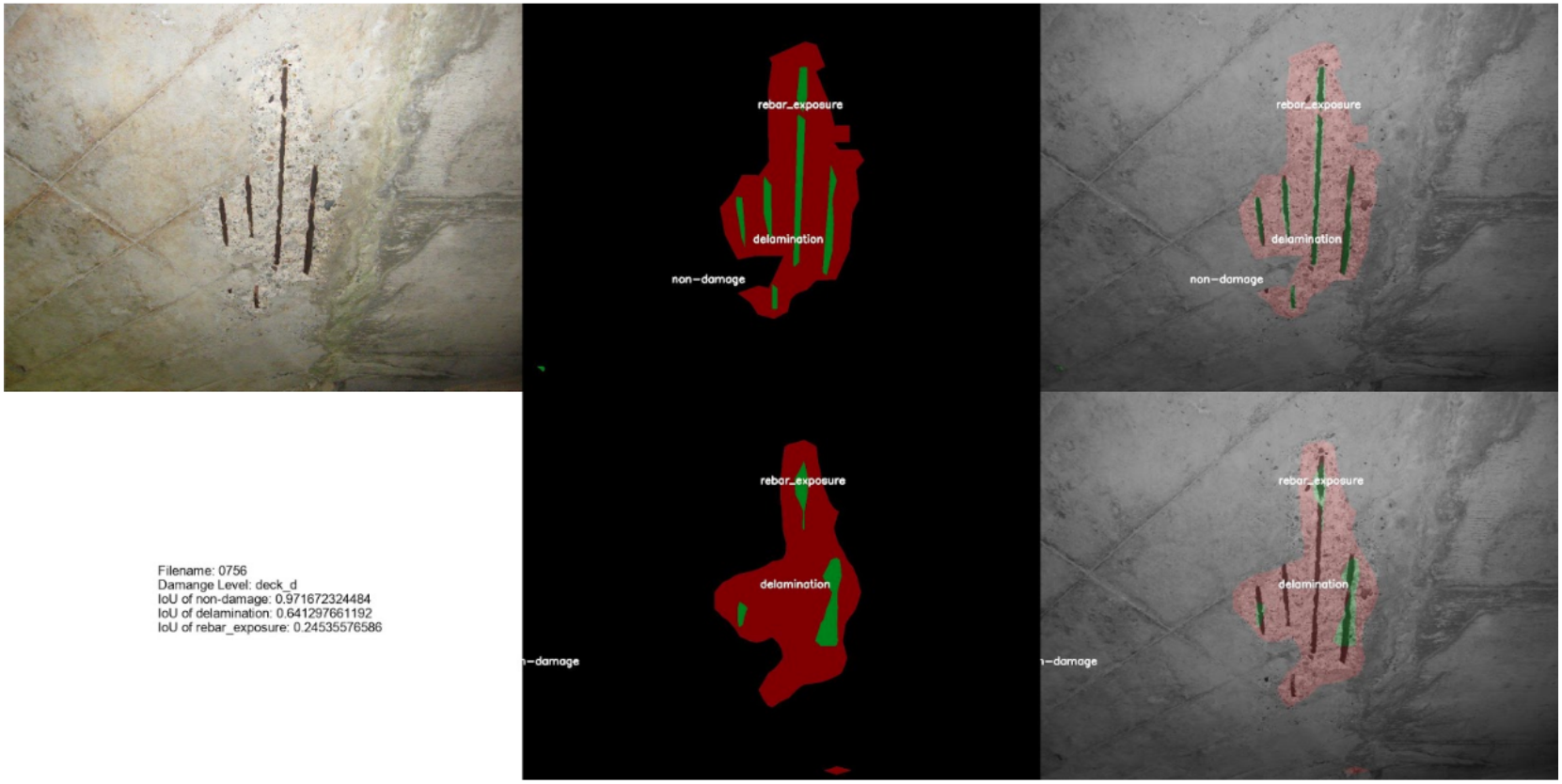
Skip Layer Refinement



source:

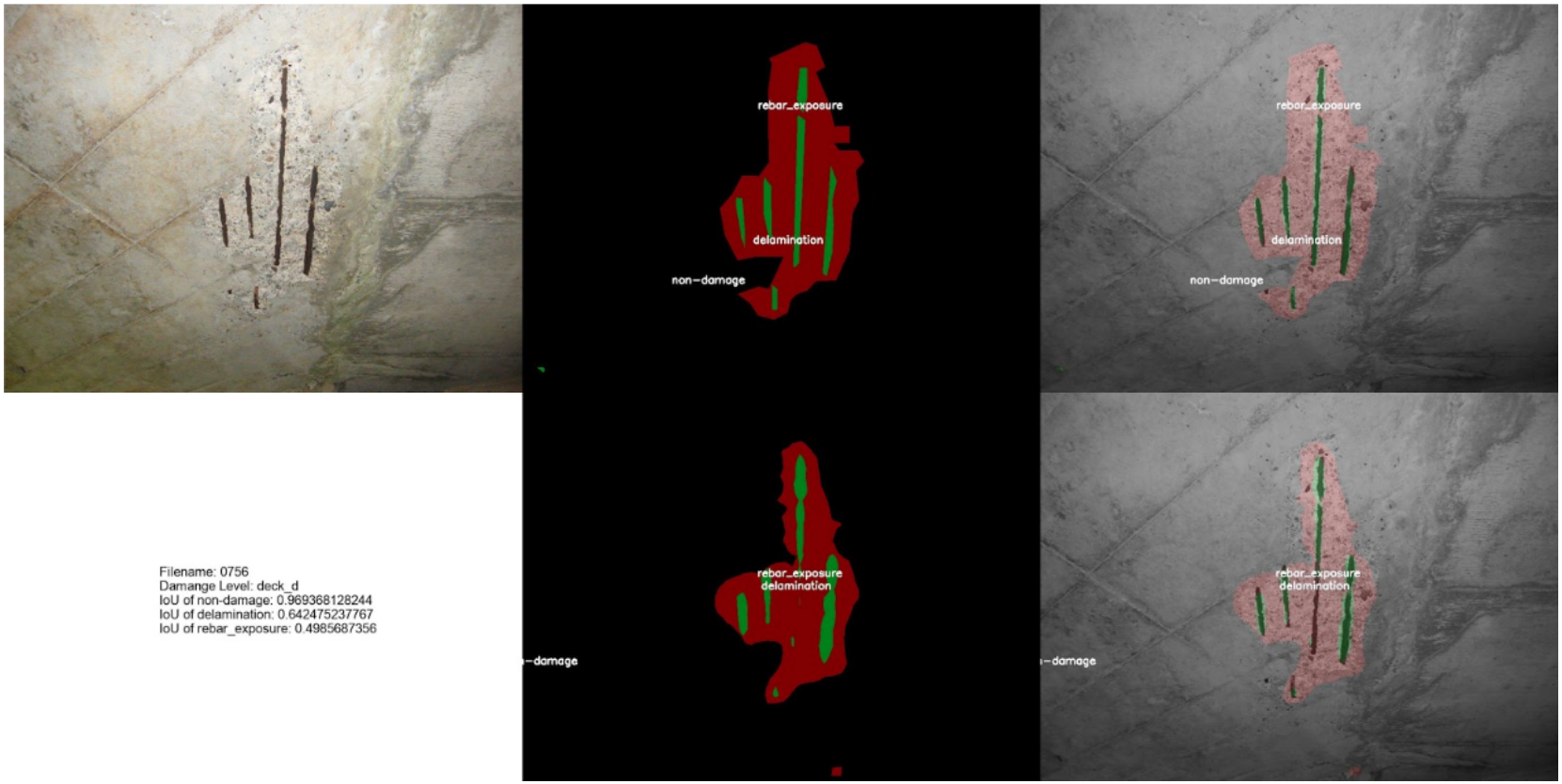
https://docs.google.com/presentation/d/1VeWFMpZ8XN7OC3URZP4WdXvOGYckoFWGVN7hApoXVnc/edit#slide=id.g19540bd54f_0_32

FCN32s on Custom Dataset

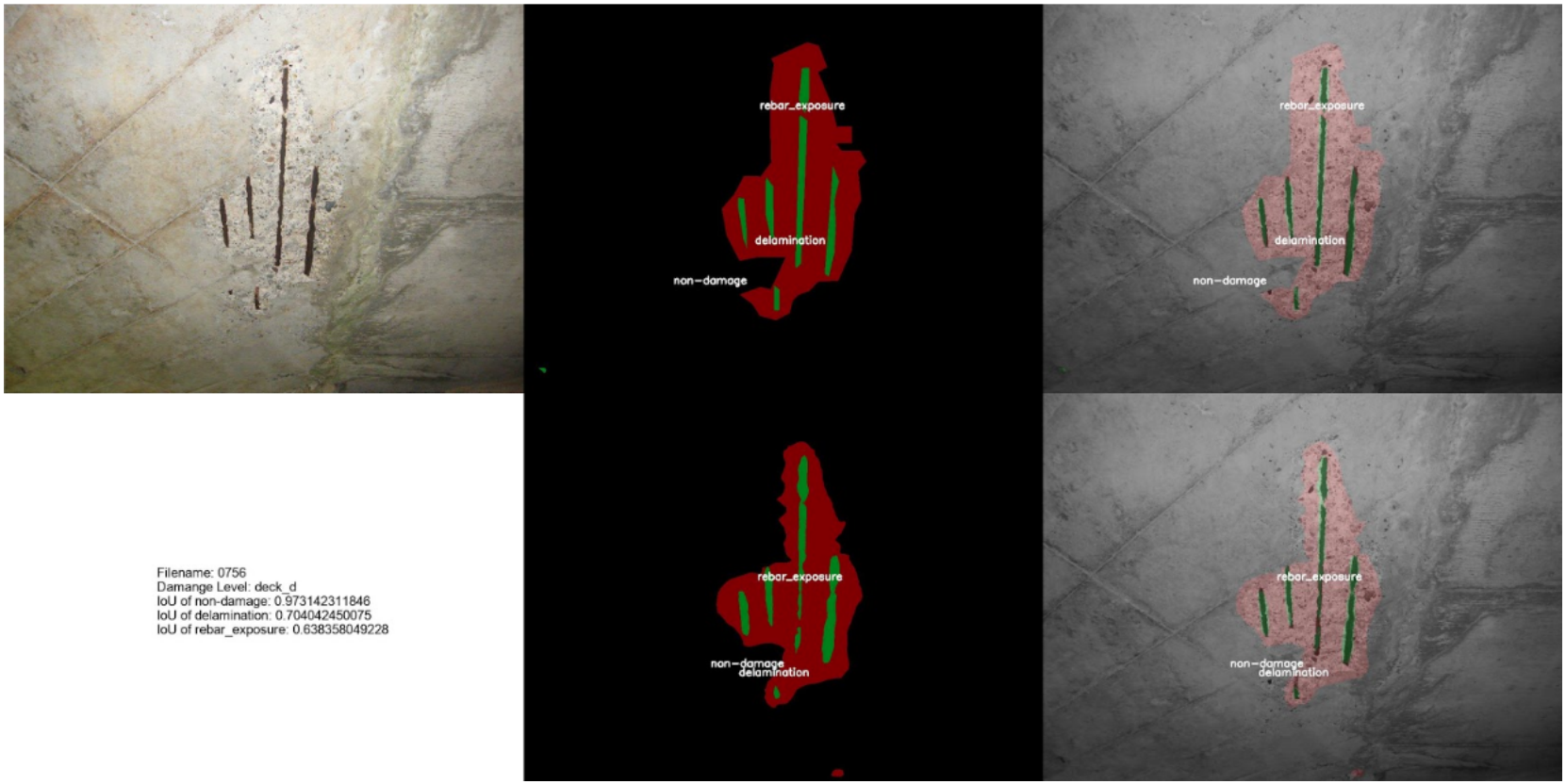


Filename: 0756
Damange Level: deck_d
IoU of non-damage: 0.971672324484
IoU of delamination: 0.641297661192
IoU of rebar_exposure: 0.24535576586

FCN16s on Custom Dataset



FCN8s on Custom Dataset



Filename: 0756
Damange Level: deck_d
IoU of non-damage: 0.973142311846
IoU of delamination: 0.704042450075
IoU of rebar_exposure: 0.638358049228

FCN8s on Custom Dataset

Code to follow along with the paper

Kentaro Wada
wkentaro

I am a second year Computer Science student at University of Tokyo advised by Prof. Masayuki Inaba and Prof. Kei Okada. I work on computer vision and robotics.

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Tokyo, Japan
www.kentaro.wada@gmail.com
https://wkentaro.com

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Popular repositories

labelme
Image Polygonal Annotation with Python.
Python ★ 765 ⑂ 291

pytorch-fcn
PyTorch Implementation of Fully Convolutional Networks.
Python ★ 383 ⑂ 115

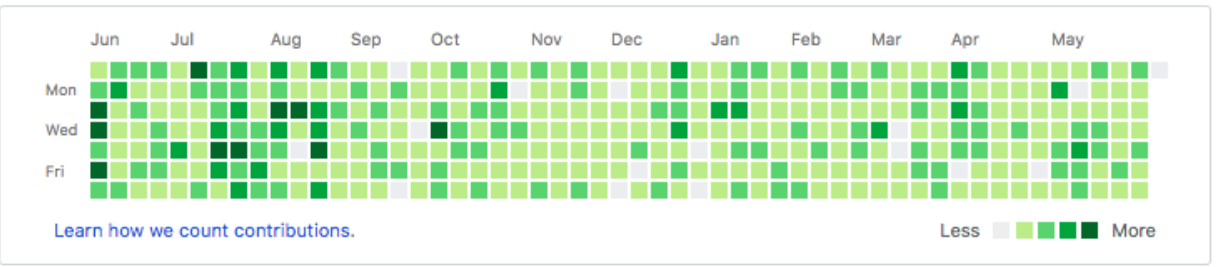
pytorch-for-numpy-users
PyTorch for Numpy users.
Python ★ 164 ⑂ 10

fcn
Chainer Implementation of Fully Convolutional Networks.
Python ★ 132 ⑂ 79

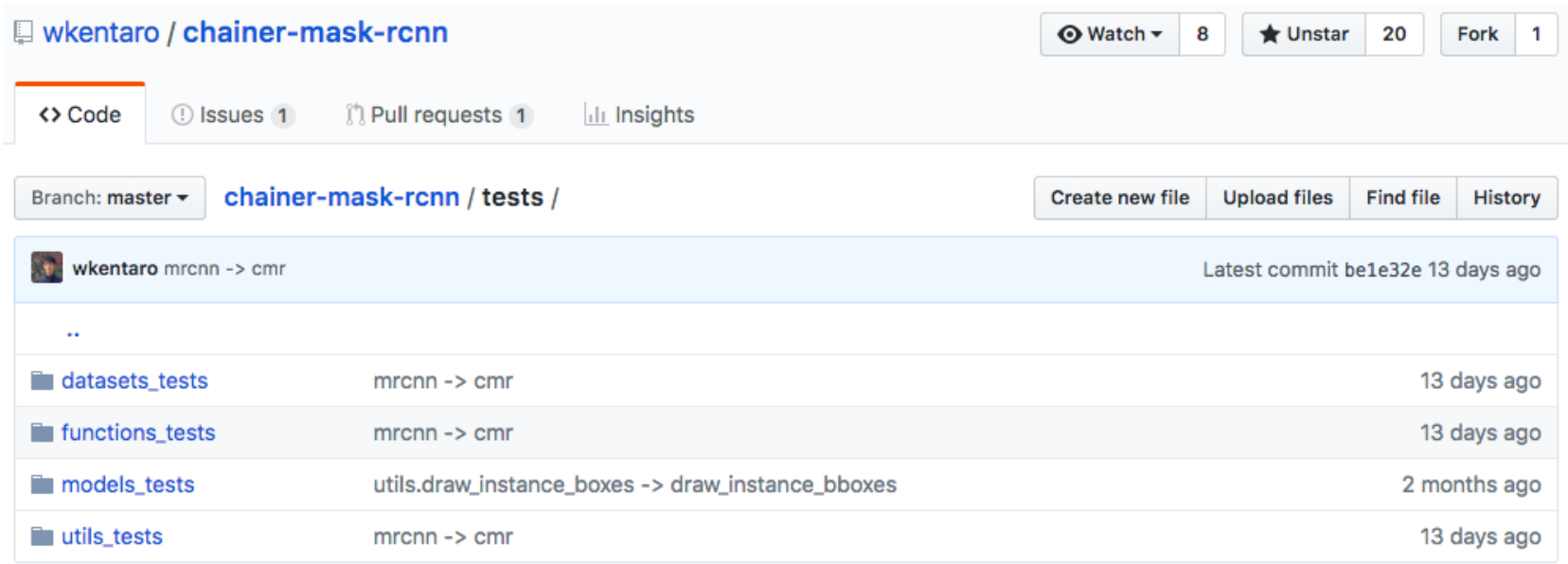
chainer-mask-rcnn
Chainer Implementation of Mask R-CNN.
Python ★ 20 ⑂ 1

gdown
Download a large file from Google Drive (curl/wget fails).
Python ★ 16 ⑂ 4

7,201 contributions in the last year



Testing for Machine Learning?

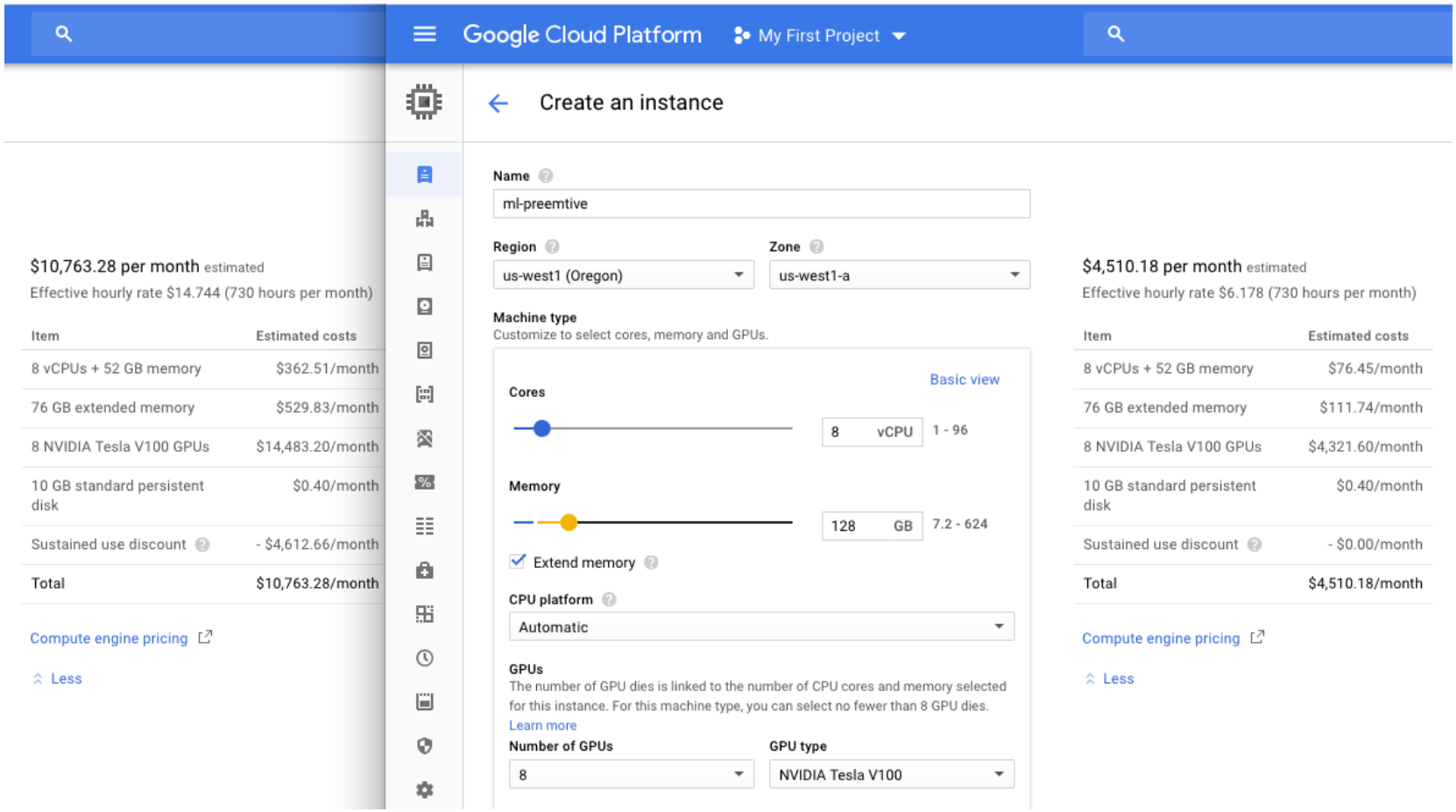


Preemtible GPU instance on Google Cloud Platform

"Most researchers in developing countries will find it hard to own a single GPU for themselves. Often these researchers also need to share resources with other researchers. If such a researcher could at most claim a single GPU for two months or two two weeks, respectively, then given the current growth in computation, this researcher would be able to replicate this research in the year 2029 or 2035, respectively, for a double period of 2 years. If the doubling period is three years, then these numbers are the year 2035 and 2044, respectively."

-- Tim Dettmers,
http://timdettmers.com/2017/08/31/deep-learning-research-directions
(http://timdettmers.com/2017/08/31/deep-learning-research-directions)

Train Machine Learning Only Half Price on Google Compute Engine



Availability policy

Preemptibility

A preemptible VM costs much less, but lasts only 24 hours. It can be terminated sooner due to system demands. Learn more

On

Automatic restart

Compute Engine can automatically restart VM instances if they are terminated for non-user-initiated reasons (maintenance event, hardware failure, software failure, etc.)

Off

On host maintenance

When Compute Engine performs periodic infrastructure maintenance it can migrate your VM instances to other hardware without downtime

Terminate VM instance

How to train a model on preemtive GPU instance?

```
python cifar10_main.py \
    --data-dir <GCS path to data bucket> \
    --job-dir <GCS path to checkpoint bucket> \
    --num-gpus 4 \
    --train-steps 99999999 \
    --momentum 0.9 \
    --weight-decay 0.0002 \
    --learning-rate 0.1 \
    --batch-norm-decay 0.997 \
    --batch-norm-epsilon 0.00001
```

More information: https://github.com/GoogleCloudPlatform/ml-on-gcp/blob/master/gce/survival-training/README-tf-estimator.md

Google TPU Pods

Using Cloud TPUs on Google Kubernetes Engine User Guide (EAP)

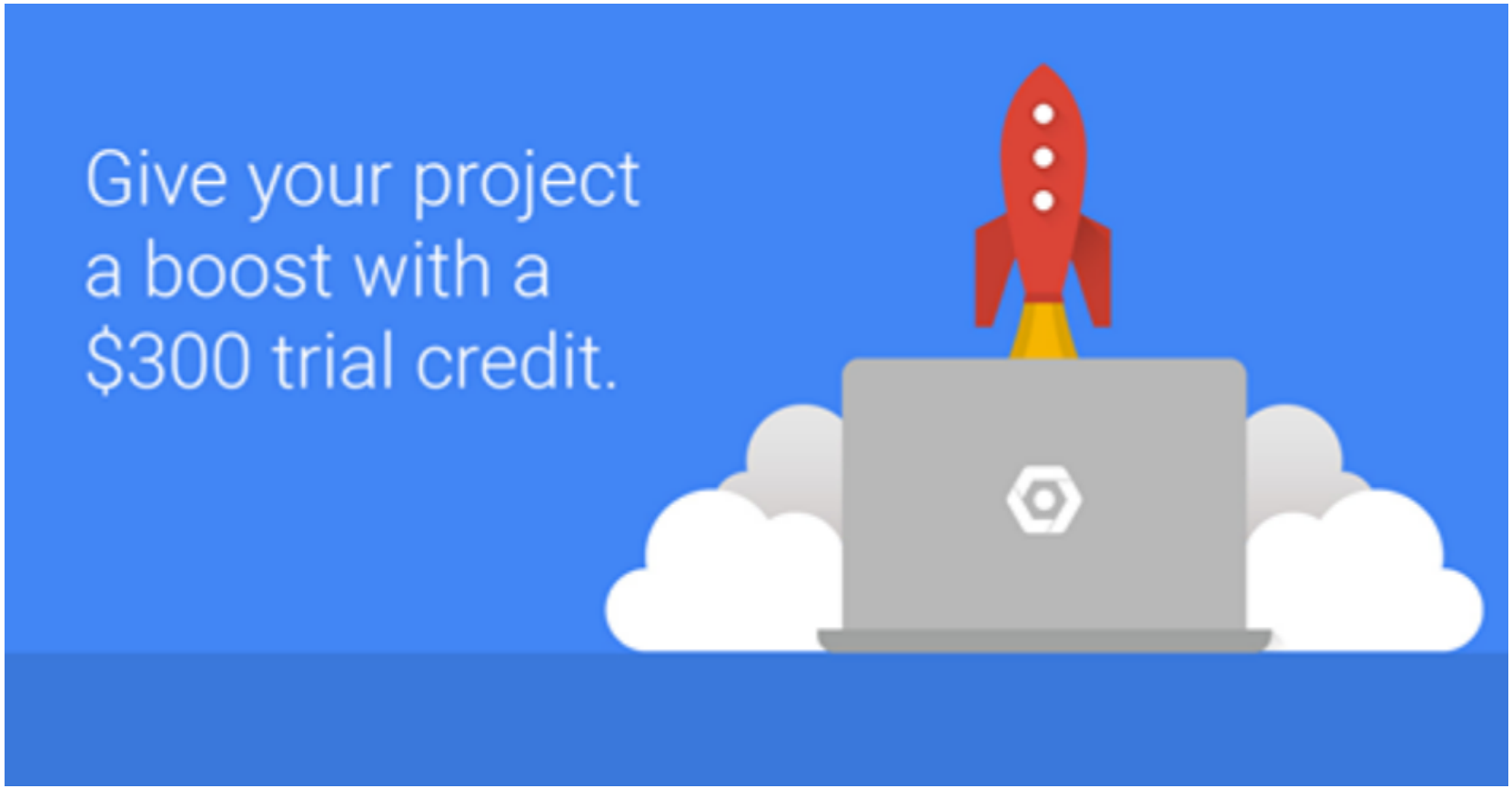
Last update: 3/5/2018

Overview

This document provides instructions for consuming Google Cloud TPUs in Google Kubernetes Engine (GKE). See Cloud Tensor Processing Units (TPUs) for an overview of Cloud TPUs and whether they are suitable for your workloads.

Requirements

- Your project must be whitelisted for using Cloud TPUs on GKE by submitting this form.
- Cloud TPUs can currently only be used in Alpha Clusters.
- IP Aliases must be enabled in your cluster.
- Must use Google Kubernetes Engine version 1.9.3-gke.0 and above.
- Must use Tensorflow 1.6 and above.


Give your project
a boost with a
$300 trial credit.

```
3.times { puts "Thank you ❤️" }
```

```
Thank you ❤️
Thank you ❤️
Thank you ❤️
```

Question?