

33rd Vienna  
**Deep Learning**  
Meetup



26<sup>th</sup> February 2020  
**#VDLM**

**Magenta<sup>®</sup>**

# Vienna Deep Learning Meetup

The Organizers:



Thomas Lidy  
Musimap



Alex Schindler  
AIT & TU Wien



Jan Schlüter  
JKU Linz



René Donner  
contextflow

# Topics for Today

## Welcome & Introduction

**And then they began to speak! Towards end-to-end speech synthesis, and back again?**

*by Markus Toman, neuratec and VocaliD*

<Break>

**Deep Learning Hardware Overview: What and where to buy or rent**

*by Jan Schlüter, René Donner and Thomas Lidy*

**Tensorflow 2.1 optimization and deployment** *by Franz Fürbass*

**Hot Topics and Latest News** *by Elisabeth Weigl and Michael Pieler*

<Networking>

# Announcements

# VDLM on Github

<https://github.com/vdlm/meetups>

- all talks
- slides
- photos
- videos
- Wiki

Meetups						
#	Date	Place	Topic	Link	Video	Meetup.com
1	2016-04-07	Sector 5	intro	<a href="#">more</a>		<a href="#">link</a>
2	2016-05-09	Sector 5		<a href="#">more</a>		<a href="#">link</a>
3	2016-06-06	Sector 5		<a href="#">more</a>		<a href="#">link</a>
4	2016-07-07	TU Wien		<a href="#">more</a>		<a href="#">link</a>
5	2016-09-22	Automic Software GmbH		<a href="#">more</a>		<a href="#">link</a>
6	2016-10-12	Sector 5		<a href="#">more</a>		<a href="#">link</a>
7	2016-12-01	Agentur Virtual Identity		<a href="#">more</a>		<a href="#">link</a>
8	2017-01-17	TU Wien Informatik		<a href="#">more</a>		<a href="#">link</a>
9	2017-02-21	bwin.party services (Austria) GmbH		<a href="#">more</a>		<a href="#">link</a>

Talks				
Date	MU#	Speaker	Topic	Slides
2016-04-07	1	Thomas Lidy	An overview presentation of Deep Learning	<a href="#">pdf</a>
2016-04-07	1	Jan Schlüter	History, Approaches, Applications	<a href="#">pdf</a>
2016-05-09	2	Alex Champandard	Neural Networks for Image Synthesis	
2016-05-09	2	Gregor Mitscha-Baude	Recurrent Neural Networks	<a href="#">pdf</a>
2016-06-06	3	Jan Schlüter	Open-source Deep Learning with Theano and Lasagne	<a href="#">pdf</a>
2016-09-22	5	Josef Puchinger	Deep Learning & The Future of Automation	
2016-09-22	5	Christoph Körner	Going Deeper with GoogLeNet and CaffeJS	<a href="#">pdf</a>

Screenshot of the vdlm/meetups GitHub repository page.

Key statistics:

- 49 commits
- 1 branch
- 0 releases
- 2 contributors

Recent activity:

- stychief update photos (20 days ago)
- Logo (25 days ago)
- Meetups (20 days ago)
- README.md (21 days ago)

Buttons at the bottom right:

- Create new file
- Upload files
- Find file
- Clone or download



## Overview

Deep Learning is currently a big & growing trend in data analysis and prediction - and the main fuel of a new era of AI. Google, Facebook and others have shown tremendous success in pushing image, object & speech recognition to the next level.

But Deep Learning can also be used for so many other things! The list of application domains is literally endless.

Although rooted in Neural Network research already in the 1950's, the current trend in Deep Learning is unstoppable, and new approaches and improvements are presented almost every month.



# VDLM Youtube Channel

The screenshot shows the YouTube channel page for 'Vienna Deep Learning Meetup'. At the top, there's a video thumbnail of a meetup event with people seated at tables. Below the video, the channel's logo (a stylized brain icon) and name 'Vienna Deep Learning Meetup' are displayed, along with the subscriber count '198 Abonniert'. A 'SUBSCRIBE' button with a bell icon is also present. The main navigation bar includes links for 'ÜBERSICHT', 'VIDEOS', 'PLAYLISTS', 'KANÄLE', 'DISKUSSION', and 'KANALINFO'. The 'ÜBERSICHT' tab is currently selected. Below this, there are sections for 'Uploads' and 'BELIEBTE KANÄLE'. The 'Uploads' section shows three video thumbnails: 'Ethics and Bias in Artificial Intelligence - 18th Vienna' (2:54:03), 'Ethics and Bias in Artificial Intelligence - 18th Vienna' (Keine Aufrufe), and '17th Vienna Deep Learning Meetup (part 2):' (54:49). The 'BELIEBTE KANÄLE' section lists three channels with 'SUBSCRIBE' buttons: 'Kurzgesagt – In a Nut...', '7-SEKUNDEN-RÄTSEL', and 'Dinge Erklärt – Kurzge...'. The overall theme of the page is dark with light-colored text and icons.

<https://www.youtube.com/ViennaDeepLearningMeetup>

# ML Prague 2020 - Speakers



**François Chollet**

SOFTWARE ENGINEER,  
GOOGLE



**Tomas Mikolov**

RESEARCH SCIENTIST,  
FACEBOOK AI RESEARCH



**Vojta Jína**

PRIVACY ENTHUSIAST,  
APPLE



**Ashish Kapoor**

SR. PRINCIPAL RESEARCHER,  
MICROSOFT

Code 20% off - **vdlm20**



Machine Learning Prague

# Machine Learning Prague 2020

MARCH 20 - 22

1 000+

ATTENDEES

45

SPEAKERS

10

WORKSHOPS

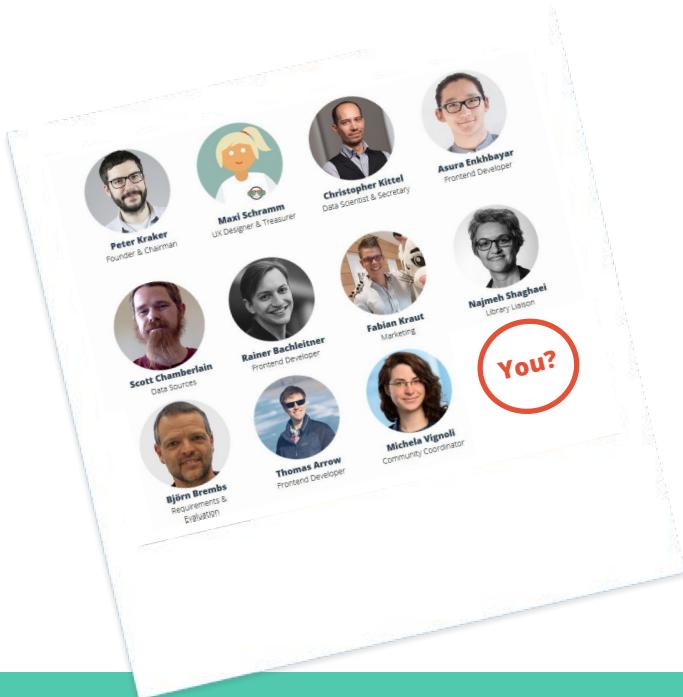
eMail Raffle for 1 free ticket:

WINNER: Martin Krasser

# Open Knowledge Maps



# We're hiring!



## UX-minded frontend developer (f/x/m)

Help us move our visual interface to a reactive framework

Work on a positive, impact-generating product

Apply now: <https://openknowledgemaps.org/jobs>

# Job announcement: 1-year part time (15–20h) position Python programmer with machine learning background

- Arts-based research project:  
DUST AND DATA - The Art of Curating in the Age of Artificial Intelligence (see <http://www.dustanddata.at/>)
- Interdisciplinary project between curators, AI experts and exhibition architects

## Your responsibilities:

- apply machine learning tools to digital data bases of museum collections (images and text)
- program software prototypes of interfaces to museum collections
- participate in our team effort to develop new tools for digital curation
- help with students during hack days in the course of the project

## Required skills:

- programming in Python
- knowledge of machine learning tools is a bonus
- a university degree is not a prerequisite for this position
- realization of a master thesis within this project is also possible!



Send CV and motivational statement to Dr. Arthur Flexer ([arthur.flexer@ofai.at](mailto:arthur.flexer@ofai.at)) by 13th of March 2020

## Ask The Locals

new slot before the break, possibly included in every meetup:  
pose a question that you would need help with, or like to discuss  
anybody capable of answering or discussing will join you in the break

Optional: Send us your question in advance ([tom.lidy@gmail.com](mailto:tom.lidy@gmail.com))  
or just come up spontaneously!

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**Hot Topics and Latest News** *by Elisabeth Weigl and Michael Pieler*

<Networking>

# Tensorflow 2.1 optimization and deployment

33<sup>rd</sup> Vienna Deep Learning Meetup

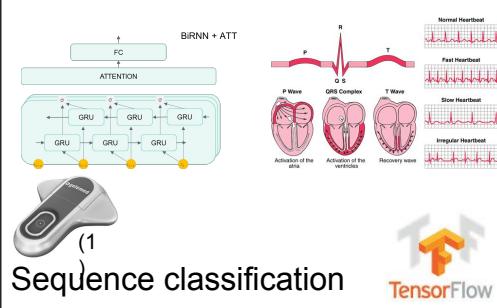


Dr. Franz Fürbass

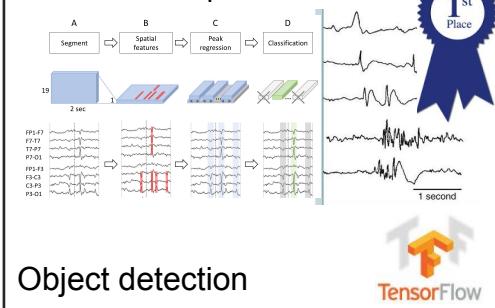
[franz.fuerbass@ait.ac.at](mailto:franz.fuerbass@ait.ac.at)

[www.encevis.com](http://www.encevis.com) | [www.ait.ac.at](http://www.ait.ac.at)

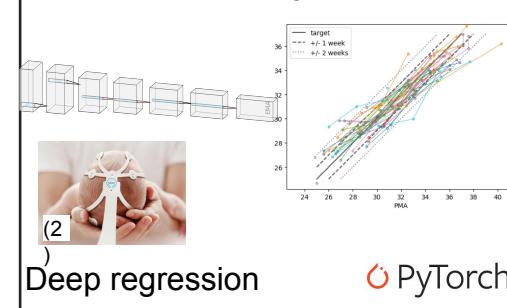
## ECG Atrial Fibrillation Detection



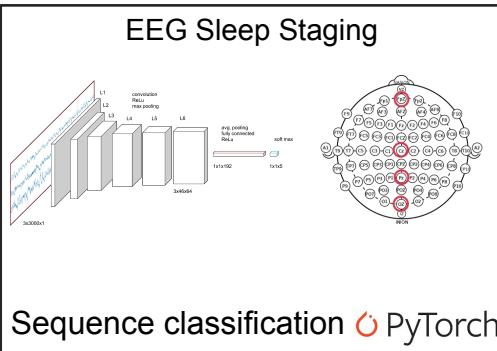
## EEG Spike Detection



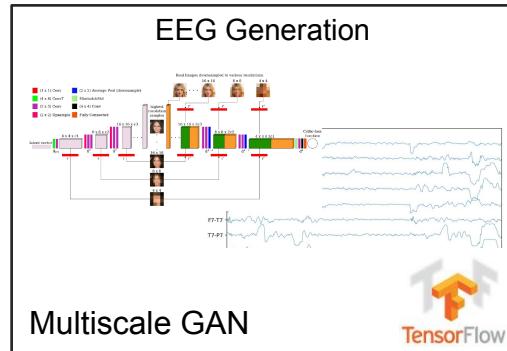
## EEG Neonatal Age Estimation



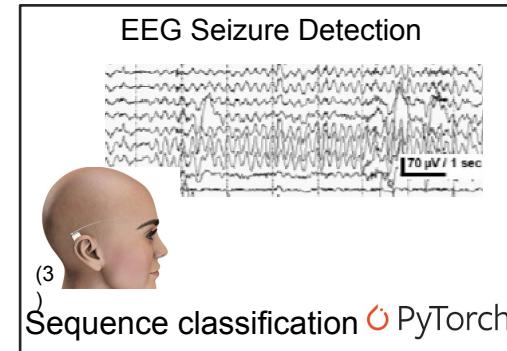
## EEG Sleep Staging



## EEG Generation



## EEG Seizure Detection



(1) Source: [www.getemed.de](http://www.getemed.de), CM 100

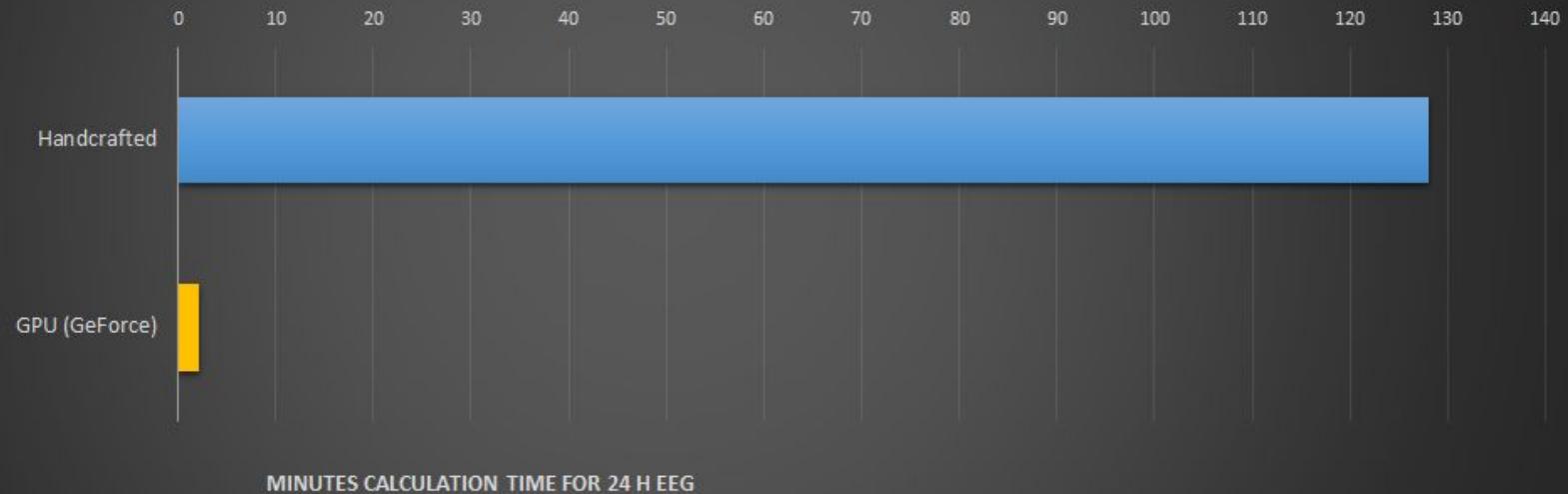
(2) Source: [www.cephalon.eu/products/eeg-erp/neon-cap](http://www.cephalon.eu/products/eeg-erp/neon-cap)

(3) Source: [www.uneeg.com](http://www.uneeg.com)  
[www.encevis.com](http://www.encevis.com)

# Runtime Performance

Spike detection calculation test, faster is better

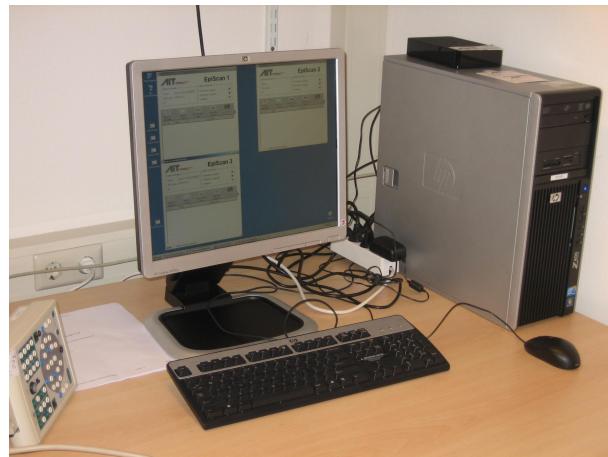
N1.edf (30min)



# Hospital Deployment



INTERNET



CE Medical Product



SOUP  
Software of unknown Provenance

Best Practice: DLL



# Compile Tensorflow on Windows

Why not prebuild?

- No TF2.x
- std::error channel is messed up
- Prebuild binaries with AVX2 only
- Tensorflow Lite, Tensorflow C-API not available

Follow [https://www.tensorflow.org/install/source\\_windows](https://www.tensorflow.org/install/source_windows)

Undocumented: **BAZEL\_SH=C:\msys64\usr\bin\bash.exe**

- bazel build -c opt //tensorflow/tools/lib\_package:libtensorflow
- bazel build -c opt //tensorflow/lite/c:tensorflowlite\_c

tensorflow.dll

tensorflow.dll.if.lib

tensorflow-lite\_c.dll

tensorflow-lite\_c.dll.if.lib

# Tensorflow C-API

```
#include <c_api.h>

TF_Buffer* buffer = ReadBufferFromFile("myfile.pb");

TF_GraphImportGraphDef(graph, buffer, opts, status);

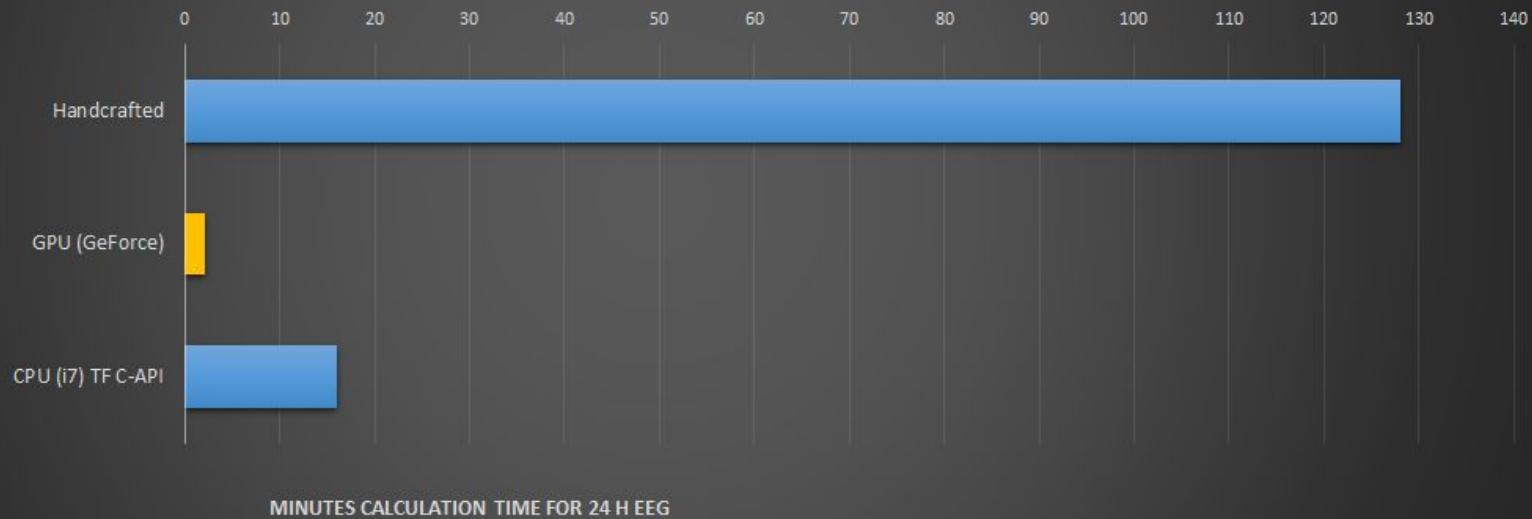
TF_Session* session = TF_NewSession(graph, options, status);

TF_SessionRun(session,
nullptr, // Run options.
inputs, input_tensors, static_cast<int>(ninputs), // Input tensors, input tensor values,
number of inputs.
outputs, output_tensors, static_cast<int>(noutputs), // Output tensors, output tensor
values, number of outputs.
nullptr, 0, // Target operations, number of targets.
nullptr, // Run metadata.
status // Output status.
);

void* tensor_data = TF_TensorData(tensor);
if (tensor_data == nullptr) {
TF_DeleteTensor(tensor);
return nullptr;
}
```

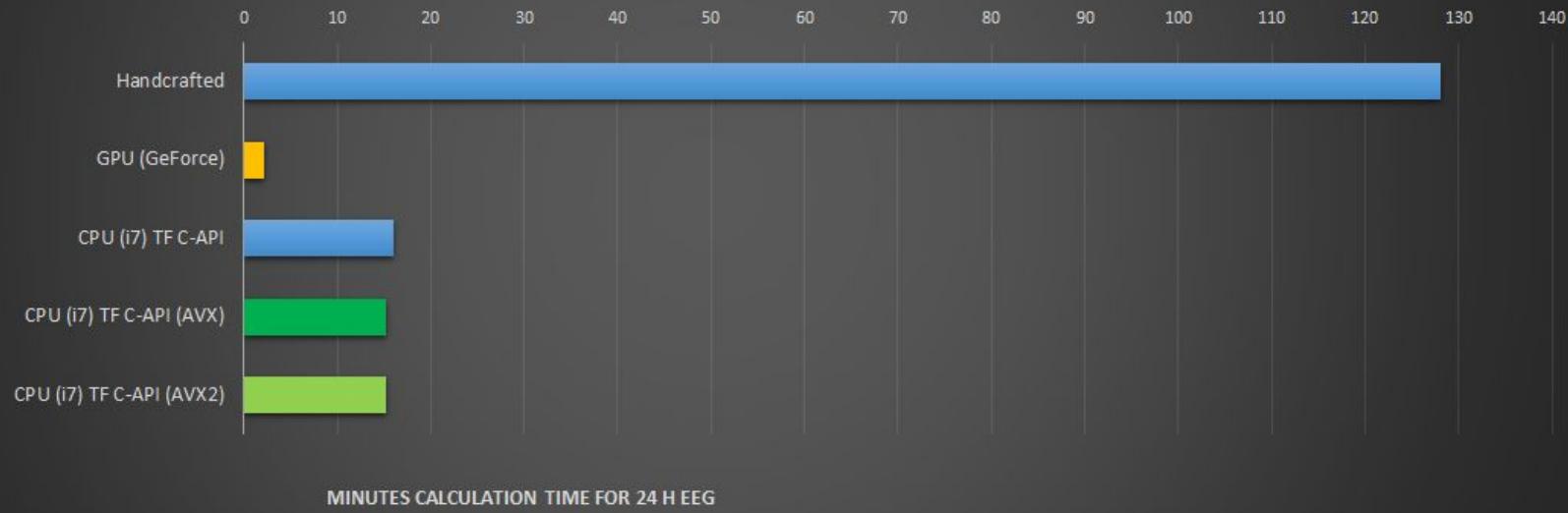
# Runtime Performance

Spike detection calculation test, faster is better  
N1.edf (30min)



# Runtime Performance

Spike detection calculation test, faster is better  
N1.edf (30min)



# Model Pruning in Tensorflow 2.x

## Gradient Tape

```
@tf.function
def train_step(self, data, label):
    with tf.GradientTape() as train_tape:

        outputs = self.DeepSpike(x=data, training=True)
        loss = self.calc_loss(outputs=outputs, labels=label)

    gradients = train_tape.gradient(loss, self.DeepSpike.trainable_variables)
    self.optimizer.apply_gradients(zip(gradients,
                                      self.DeepSpike.trainable_variables))
    return outputs, retmat
```

+ maximum flexibility

## Keras Training

- callbacks = [  
 TensorBoard(log\_dir=config['logdir']),  
]  
  
self.DeepEval.model.compile(optimizer=self.optimizer,  
loss=self.calc\_loss)  
  
self.DeepEval.model.fit(  
 x=dataGenerator(),  
 epochs=config['epochs'],  
 steps\_per\_epoch=batch\_per\_epoch,  
 verbose=2,  
 callbacks=callbacks,  
 workers=1,  
)

+ Model pruning  
+ Tensorboard support  
...

# Model Pruning in Tensorflow 2.x

## 1. Add pruning layers to model

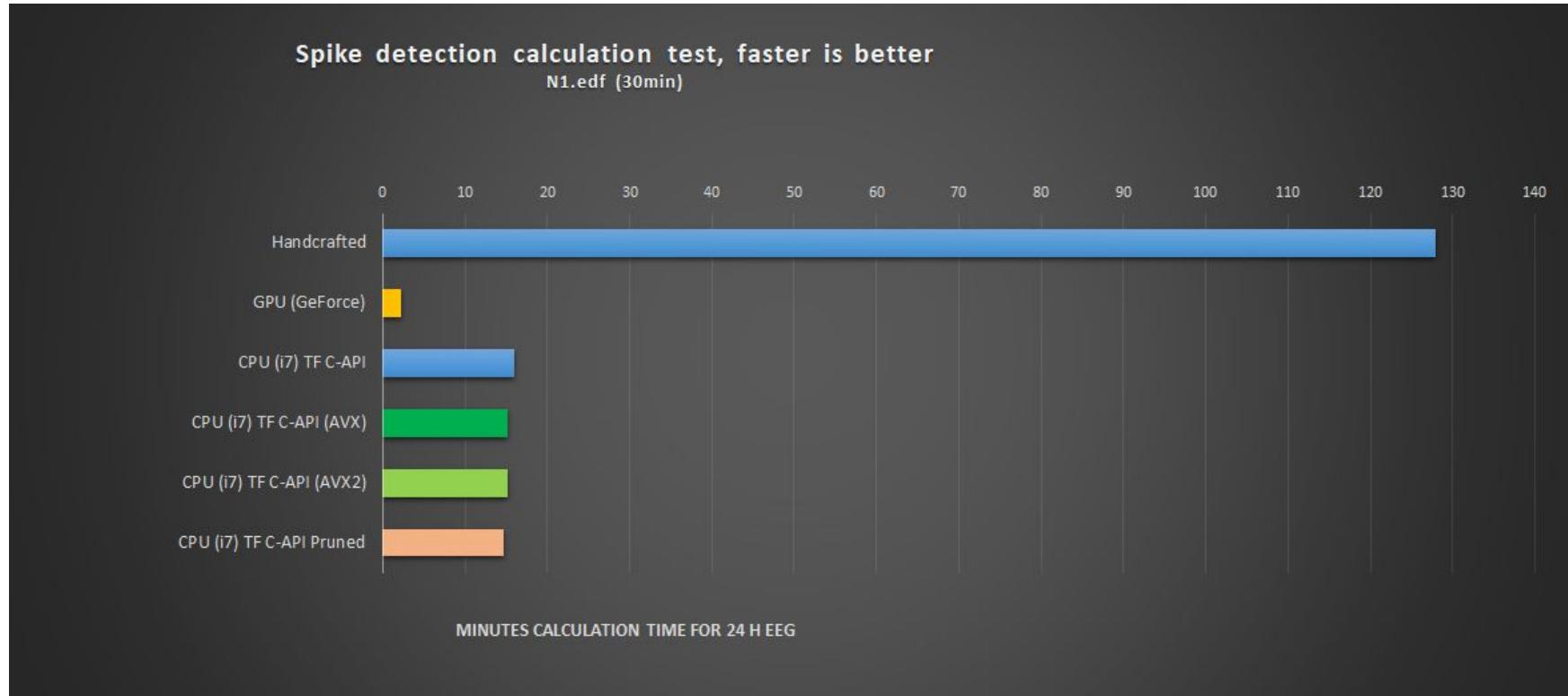
```
from tensorflow_model_optimization.sparsity.keras import sparsity
pruning_params = {
    'pruning_schedule': sparsity.PolynomialDecay(initial_sparsity=self.config['prune_init_sparsity'],
                                                final_sparsity=self.config['prune_final_sparsity'],
                                                begin_step=self.config['prune_begin'],
                                                end_step=self.config['prune_end'],
                                                frequency=self.config['prune_freq']))
}
y = sparsity.prune_low_magnitude(k.Conv1D(filters=1, kernel_size=(1), activation=None), input_shape=x.shape[1:], **pruning_params)
(x)
```

## 2. Train with pruning callbacks

```
callbacks = [
    sparsity.UpdatePruningStep(),
    sparsity.PruningSummaries(log_dir=config['logdir'] + "\\prune",
    ]
self.DeepEval.model.fit(
    x=dataGenerator(),
    epochs=config['epochs'],
    steps_per_epoch=batch_per_epoch,
    verbose=2,
    callbacks=callbacks,
    workers=1,
)
```

TimeDistributed,  
BiDirectional, etc.  
unsupported!!

# Runtime Performance



# Tensorflow Lite

- + Post training optimization (8-bit integer, etc)
- + Mobile platforms

```
with sparsity.prune_scope():
    model = tf.keras.models.load_model(model_path + "/model.h5")

pruned_model = sparsity.strip_pruning(model)

newInput = tf.keras.Input(batch_shape=myshape)
newOutputs = pruned_model(newInput)
fixedModel = tf.keras.Model(inputs=newInput, outputs=newOutputs)

fixedModel.set_weights(pruned_model.get_weights())

converter = tf.lite.TFLiteConverter.from_keras_model(fixedModel)
bin_path = os.path.dirname(sys.executable)
if 'PATH' in os.environ:
    os.environ['PATH'] += ';' + bin_path
else:
    os.environ['PATH'] = bin_path

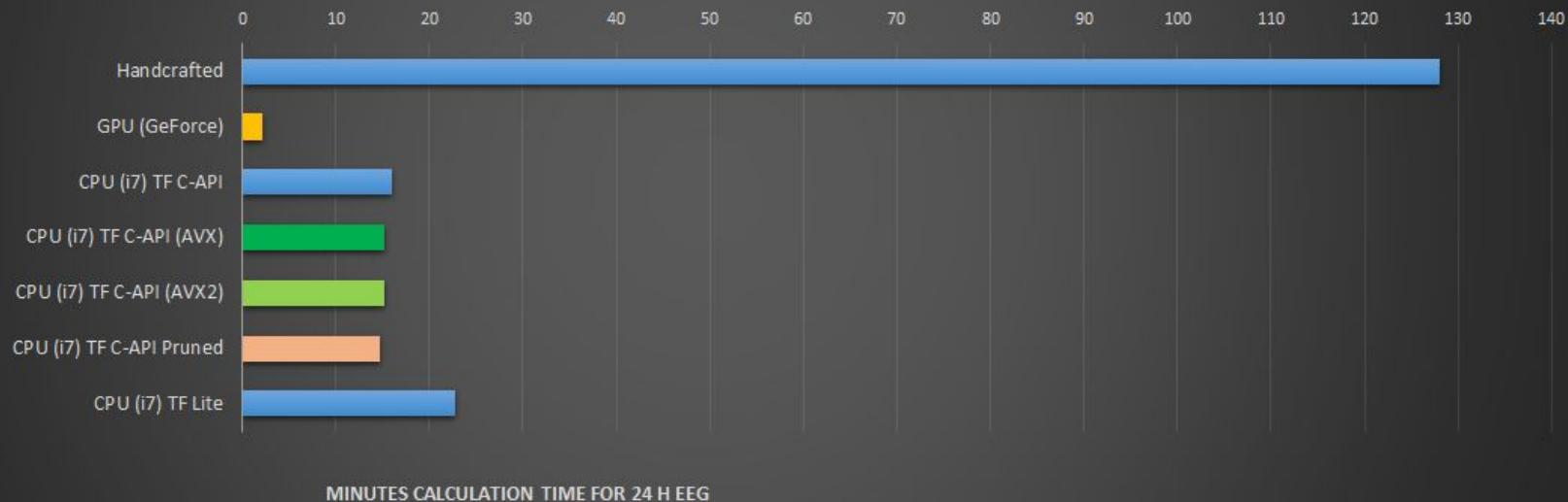
converter.optimizations = [tf.lite.Optimize.DEFAULT]
tflite_model = converter.convert()

with open("model.tflite", 'wb') as f:
    f.write(tflite_model)
```

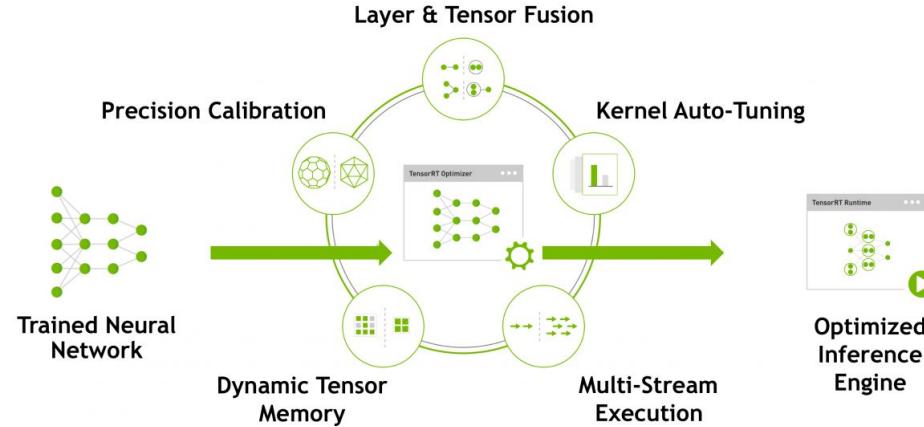
!! R-CNN not convertible !!

# Runtime Performance

Spike detection calculation test, faster is better  
N1.edf (30min)



# TensorRT



	Linux x86-64	Windows x64	Linux ppc64le	Linux AArch64
Supported CUDA versions	<ul style="list-style-type: none"><li>10.2</li><li>10.0</li><li>9.0</li></ul>	<ul style="list-style-type: none"><li>10.2</li><li>10.0</li><li>9.0</li></ul>	10.2	10.0
Supported cuDNN versions	7.6.5	7.6.5	7.6.5	7.6.5
TensorRT Python API	Yes	No	Yes	Yes
NvUffParser	Yes	Yes	Yes	Yes
NvOnnxParser	Yes	Yes	Yes	Yes
Loops	Yes	Yes	Yes	No

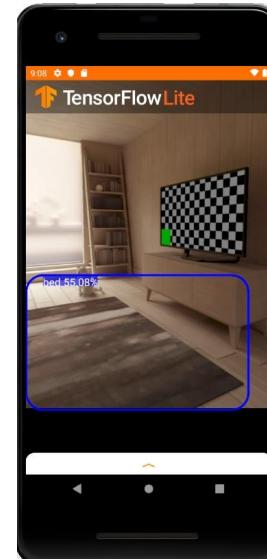
!! No Python support on Windows, GPU only!!

## Conclusions:

Running TF in restricted environment is possible

Runtime optimization is a pain

Too many options



# Thank You!

## Hot Topics & Latest News

a short block at every meetup  
to briefly present recent papers and news in Deep Learning

Send us contributions ([tom.lidy@gmail.com](mailto:tom.lidy@gmail.com))  
or come with slides to do a short block yourself!

Elisabeth Weigl

# StyleGAN 2

- Automated human image synthesis
- Creation of not existing persons/cats/horses in photos
- StyleGAN 2 fixed several image quality issues in StyleGAN
  
- <https://www.thispersondoesnotexist.com/>
- <https://thiscatdoesnotexist.com/>

[https://github.com/vdlm/meetups/blob/master/Meetups/Meetup\\_14/slides/14th\\_Deep\\_Learning\\_Meetup\\_Intro\\_Announcements\\_Hot\\_Topics.pdf](https://github.com/vdlm/meetups/blob/master/Meetups/Meetup_14/slides/14th_Deep_Learning_Meetup_Intro_Announcements_Hot_Topics.pdf)

[https://github.com/vdlm/meetups/blob/master/Meetups/Meetup\\_19/slides/1\\_intro\\_and\\_hot\\_topcis.pdf](https://github.com/vdlm/meetups/blob/master/Meetups/Meetup_19/slides/1_intro_and_hot_topcis.pdf)

<https://www.derstandard.de/story/2000114080141/neue-ki-generiert-fotorealistische-menschen-und-katzen>

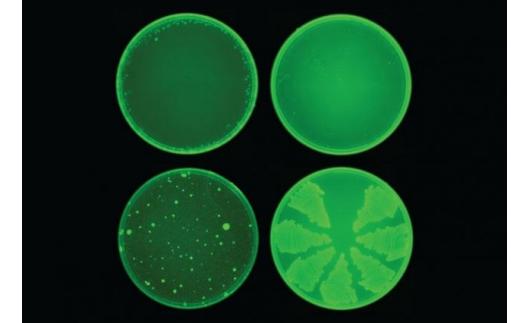
<https://arxiv.org/abs/1912.04958>

# StyleGAN2



Source: <https://www.youtube.com/user/keeroyz>

# AI antibiotic discovery



- MIT publication in *Cell*
- computer model picks out potential antibiotics with different mechanisms than those of existing drugs
- discovered new antibiotic compound: *Halicin*
- system finds molecular structures more effectively than previous systems
- currently only tests in mice were positive

<http://news.mit.edu/2020/artificial-intelligence-identifies-new-antibiotic-0220>  
<https://www.engadget.com/2020-02-22-ai-discovers-powerful-antibiotic.html>

# Corona-Virus Deep Learning Competition



<https://www.youtube.com/watch?v=1LJgkovowgA>

# Corona-Virus Deep Learning Competition

- Prizes: 3.500\$ for top 3 submissions
- Deadline: March 2, 2020, 12 pm PST (=9 pm Vienna time)
- kaggle Corona Virus data set:  
<https://www.kaggle.com/sudalairajkumar/novel-corona-virus-2019-dataset/kernels>

<https://www.youtube.com/watch?v=1LJgkovowgA>

# 1896 movie to 4k

- 50 seconds movie of a train arriving in Gare de La Citotat
- 16-24 frames per second
- transformed into a 4k 60 fps clip with publically available enhancement programs:
  - **DAIN** - deep convolutional neural networks
  - **Topaz Labs' Gigapixel AI** - image upsampling

<https://www.engadget.com/2020-02-04-how-ai-helped-upscale-an-antique-1896-film-to-4k.html>

<https://help.topazlabs.com/hc/en-us/articles/360012419692-Introducing-Gigapixel-AI>

<https://arxiv.org/abs/1811.10515>

# 1896 movie to 4k



# Identifying Earth-impacting asteroids



- **Identifying Earth-impacting asteroids using an artificial neural network**
- currently: *Sentry* earth impact monitoring system
- expected to be reliable for at most a few dozen years
- New approach: **fairly simple neural network**
- goal: classify asteroids with the potential to impact the Earth over the coming 20.000 years

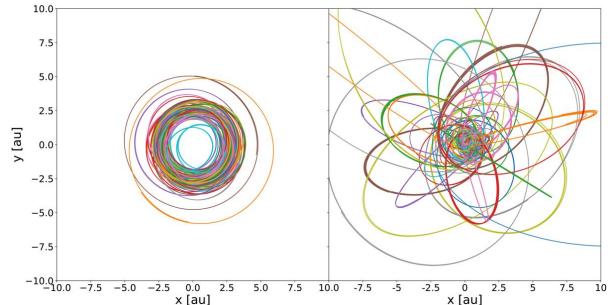
[https://github.com/vdlm/meetups/blob/master/Meetups/Meetup\\_10/slides/10th\\_Deep\\_Learning\\_Meetup\\_Intro\\_Hot\\_Topics.pdf](https://github.com/vdlm/meetups/blob/master/Meetups/Meetup_10/slides/10th_Deep_Learning_Meetup_Intro_Hot_Topics.pdf)

<https://futurezone.at/science/kuenstliche-intelligenz-warnt-vor-11-asteroiden/400756740>

[https://www.aanda.org/articles/aa/full\\_html/2020/02/aa35983-19/aa35983-19.html](https://www.aanda.org/articles/aa/full_html/2020/02/aa35983-19/aa35983-19.html)

# Identifying Earth-impacting asteroids

- pick out 95.25% of known impacts
- network classification faster than Monte-Carlo method by NASA
- found 11 new potential impactor asteroids



[https://github.com/vdlm/meetups/blob/master/Meetups/Meetup\\_10/slides/10th\\_Deep\\_Learning\\_Meetup\\_Intro\\_Hot\\_Topics.pdf](https://github.com/vdlm/meetups/blob/master/Meetups/Meetup_10/slides/10th_Deep_Learning_Meetup_Intro_Hot_Topics.pdf)

<https://futurezone.at/science/kuenstliche-intelligenz-warnt-vor-11-asteroiden/400756740>

[https://www.aanda.org/articles/aa/full\\_html/2020/02/aa35983-19/aa35983-19.html](https://www.aanda.org/articles/aa/full_html/2020/02/aa35983-19/aa35983-19.html)

Michael Pieler

# “Compounding the Performance Improvements of Assembled Techniques in a Convolutional Neural Network”

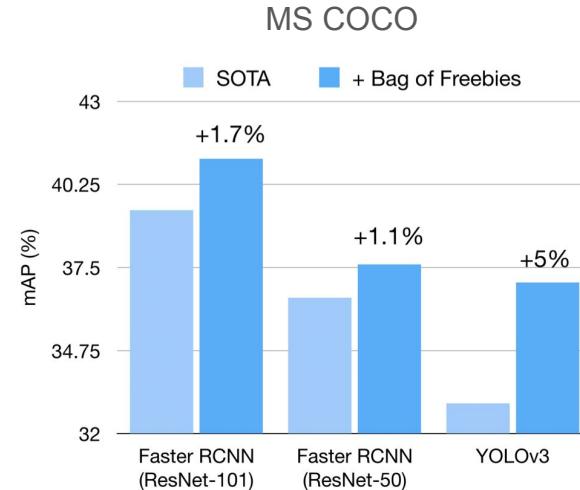
Compiled by Michael M. Pieler

# History

- “Bag of tricks/freebies”<sup>[1,2]</sup>

ImageNet (ILSVRC2012)

Model	FLOPs	top-1	top-5
ResNet-50 [9]	3.9 G	75.3	92.2
ResNeXt-50 [27]	4.2 G	77.8	-
SE-ResNet-50 [12]	3.9 G	76.71	93.38
SE-ResNeXt-50 [12]	4.3 G	78.90	94.51
DenseNet-201 [13]	4.3 G	77.42	93.66
ResNet-50 + tricks (ours)	4.3 G	<b>79.29</b>	<b>94.63</b>



- In the meantime new powerful architectures and tricks!

[1] [Bag of Tricks for Image Classification with Convolutional Neural Networks](#)

[2] [Bag of Freebies for Training Object Detection Neural Networks](#)

# Compounding the Performance Improvements of Assembled Techniques in a Convolutional Neural Network<sup>[3]</sup>

- Studied several CNN-related techniques and how they can be assembled into a single network.
- Goal: Improve
  - Accuracy
  - Robustness (mean corruption error “mCE”)
  - Throughput (images/sec, instead of FLOPS, because they are not proportional to the inference speed.)

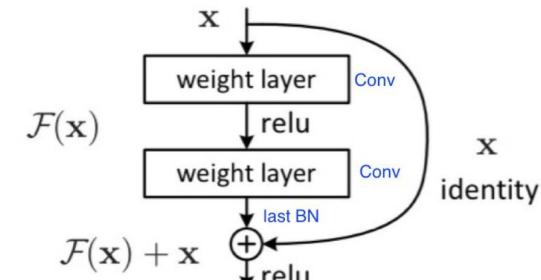
[3] [Compounding the Performance Improvements of Assembled Techniques in a Convolutional Neural Network](#) & <https://github.com/clovaai/assembled-cnn>

# Focus on network tweaks & regularization

- “Network tweaks are methods that modify the CNN architectures to be more efficient”
- “Regularization is a method that prevents overfitting by increasing the training data through data augmentation processes... or by limiting the complexity of the CNN”

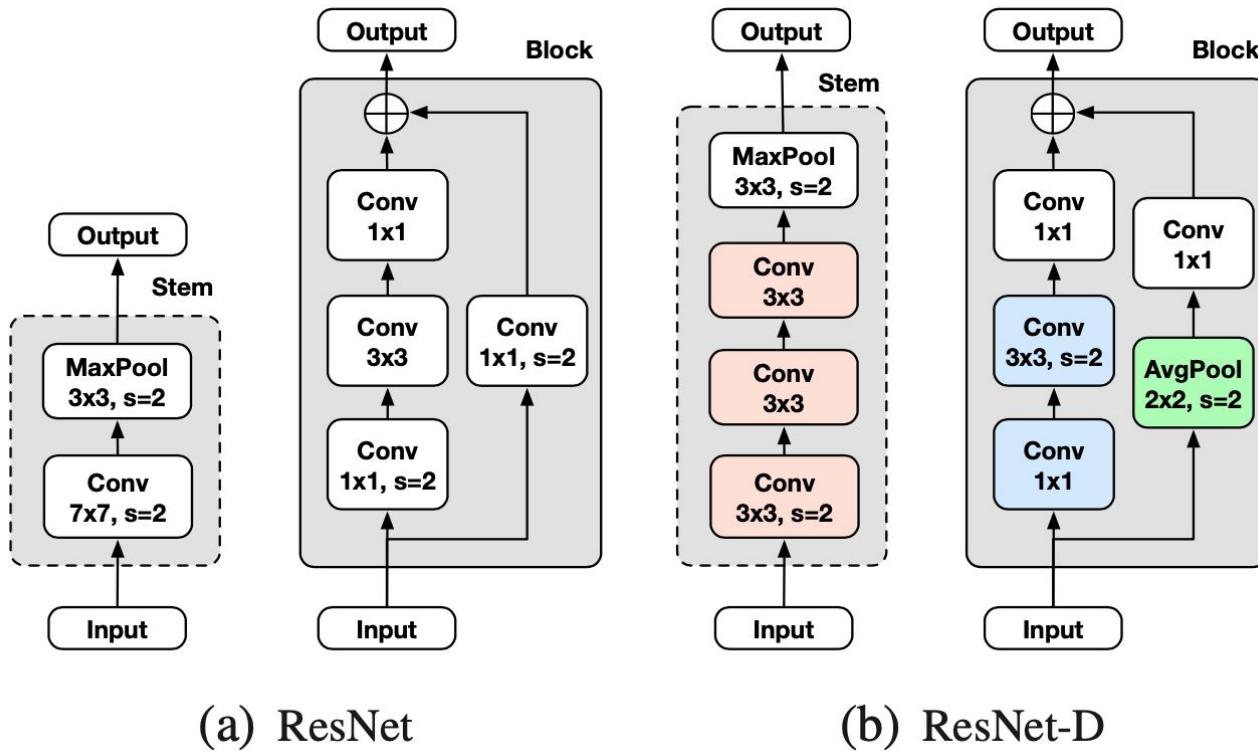
# Training Procedure

- Image preprocessing: normalize & random crop, resize, flip
- Hyperparameter: initial lr = 0.4, wd = 0.0001, epochs = 120, optimizer: SGD, mom = 0.9
- Learning rate warmup: 0 to initial lr in the first 5 epochs
- Cosine learning rate decay
- Mixed precision training (FP32 & FP16)
- **Zero γ init:** Initialize  $\gamma = 0$  for all BN layers at the end of a res-block. Returns identity at the beginning!



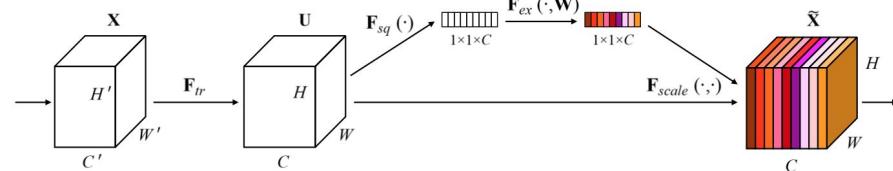
$$\gamma \left( \frac{(x - \mu_B)}{\sigma_B + \epsilon} \right) + \beta$$

# Network tweaks: ResNet-D

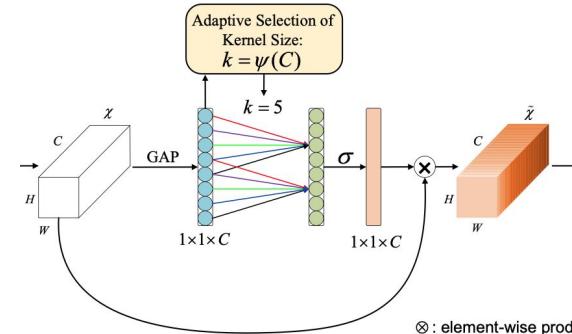
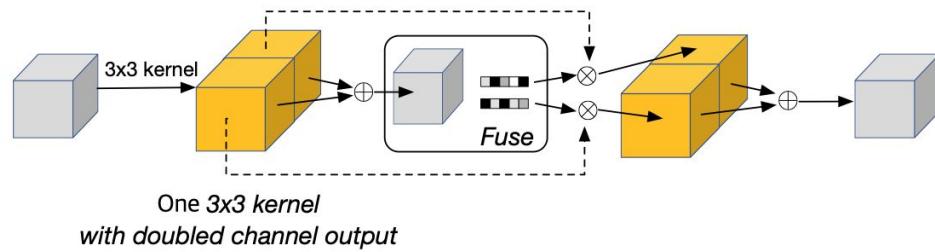


# Network tweaks: Channel attention

- Squeeze & Excite (SE)<sup>[4]</sup>



- Selective Kernel (SK)<sup>[5]</sup>



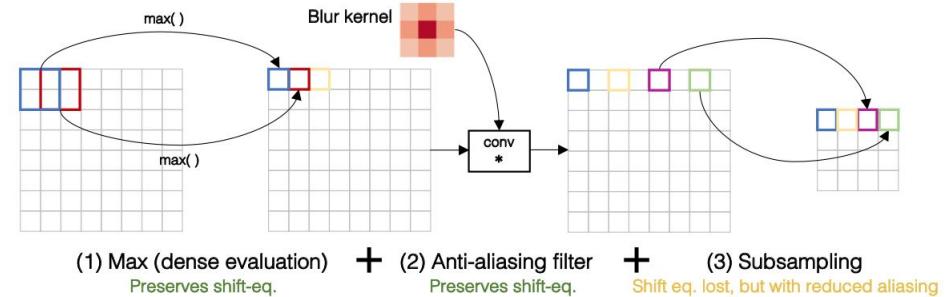
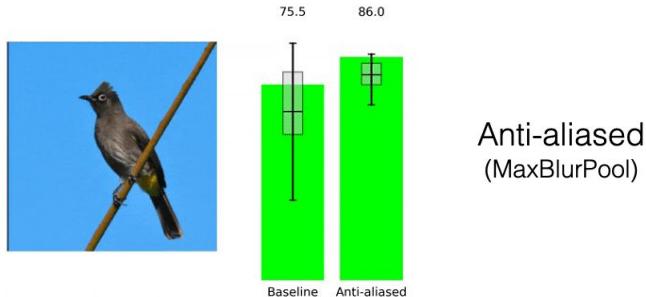
[4] [Squeeze-and-Excitation Networks](#)

[5] [Selective Kernel Networks](#)

[6] [ECA-Net: Efficient Channel Attention for D-CNNs](#)

# Network tweaks: AA downsampling & Big Little Net

- Anti-alias downsampling<sup>[7]</sup>: Improves the shift-equivariance

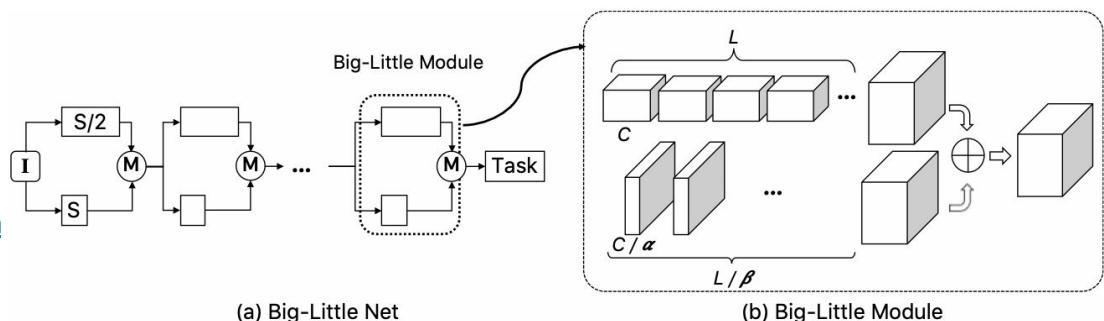


- Big Little Net<sup>[8]</sup>

[7] [Making Convolutional Networks Shift-Invariant Again](#)

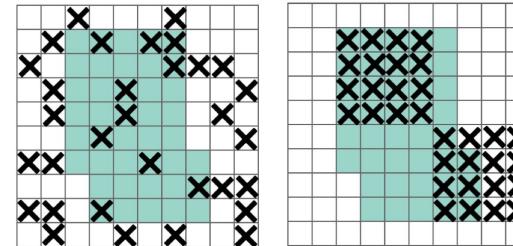
& <https://github.com/adobe/antialiased-cnns>

[8] [Big Little Net](#)

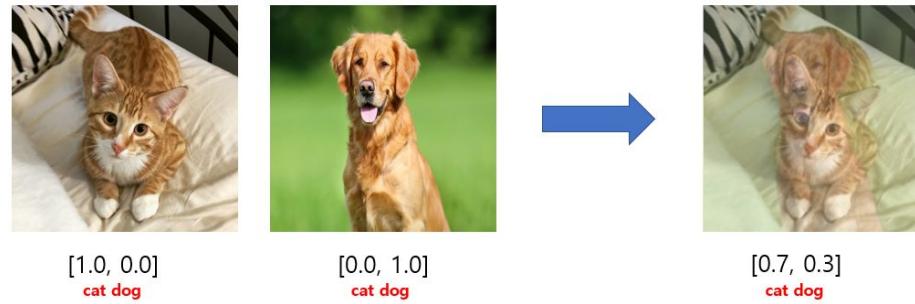


# Regularization

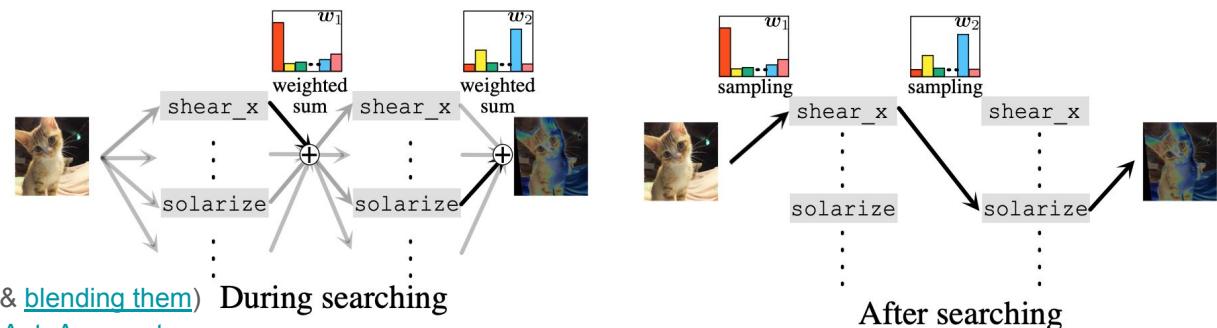
- DropOut and DropBlock<sup>[9]</sup>



- MixUp<sup>[10]</sup>



- AutoAugment<sup>[11]</sup>



[9] [DropBlock](#)

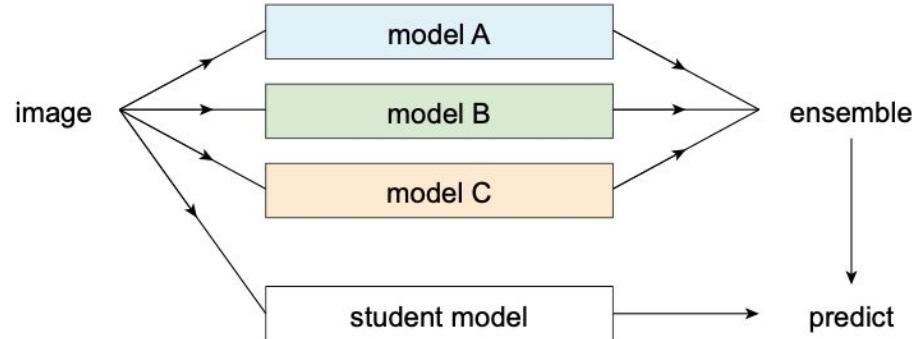
[10] [MixUp](#) & [blog post \(CutOut, Ricap, CutMix & blending them\)](#)

[11] [AutoAugment](#), [Fast AutoAugment](#) & [Faster AutoAugment](#)

# Regularization

- **Label Smoothing<sup>[12]</sup>**
  - avoid overconfidence
  - smoothing factor  $f = 0.1$
  - Pos.  $p_i$ :  $1 \rightarrow 1 - f = 0.9$
  - Neg.  $p_j$ :  $0 \rightarrow f / (N-1)$
  - different implementations!
- **Knowledge Distillation<sup>[13]</sup>**

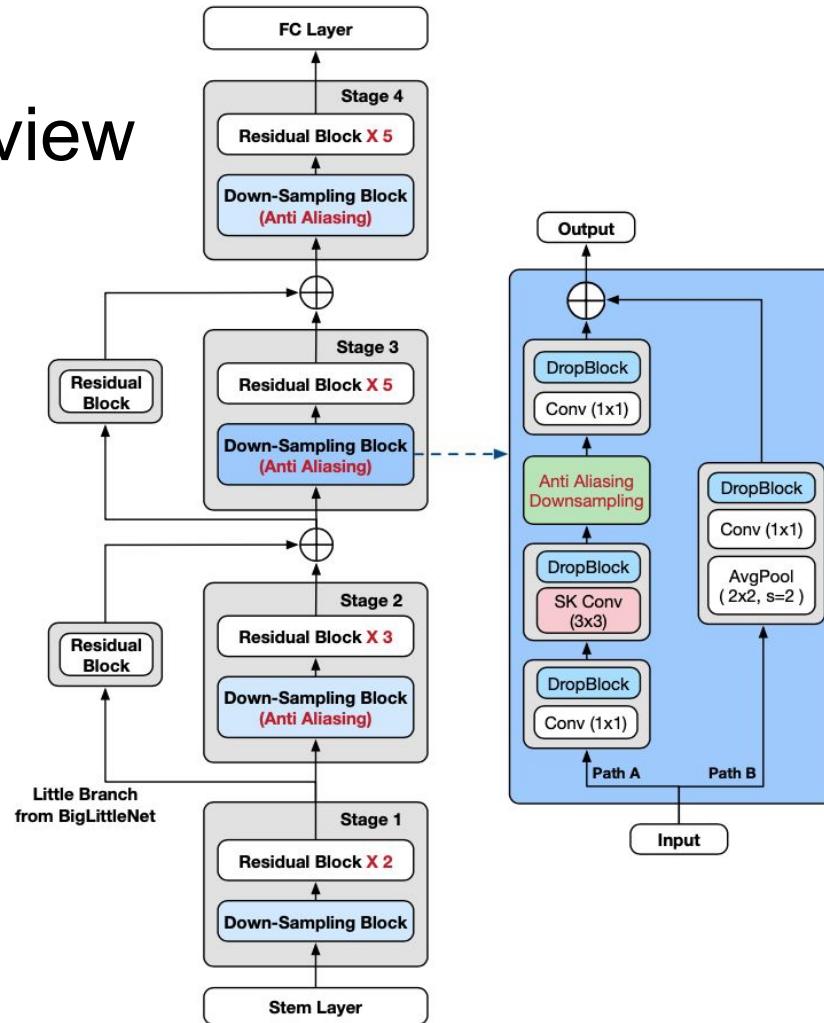
$$(1 - \text{eps}) (-\log(p_i)) + \sum_{j \neq i} \frac{\text{eps}}{N-1} (-\log(p_j))$$



[12] [Regularizing Neural Networks by Penalizing Confident Output Distributions](#), [When Does Label Smoothing Help?](#) & [blog post](#)

[13] [Distilling the Knowledge in a Neural Network](#) & [Data Distillation](#)

# Network overview



# Results

ImageNet (ILSVRC2012)

Model	top-1	mCE	throughput
EfficientNet B4 [34]+AutoAugment [4]	83.0	60.7	95
EfficientNet B6 [34]+AutoAugment [4]	84.2	60.6	28
EfficientNet B7 [34]+AutoAugment [4]	84.5	59.4	16
ResNet-50 [9] (baseline)	76.3	76.0	536
Assemble-ResNet-50 (ours)	82.8	48.9	312
Assemble-ResNet-152 (ours)	84.2	43.3	143

*Questions?*

Vienna



# Deep Learning

Meetup

Next Meetup: to be announced

[www.meetup.com/Vienna-Deep-Learning-Meetup](https://www.meetup.com/Vienna-Deep-Learning-Meetup)