mxnet* ecosystem

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27th September 2018

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Apache MXNet - History

Created by academia
(CMU and UW)

amazon

Amazon's deep-learning
framework of choice
since November 2016.

Accepted into
Apache Incubator
in January 2017.

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Multi-language Support

R | Perl | Julia | Clojure

Python | Scala | C++

Frontend

While keeping high performance from efficient backend

Backend

C++

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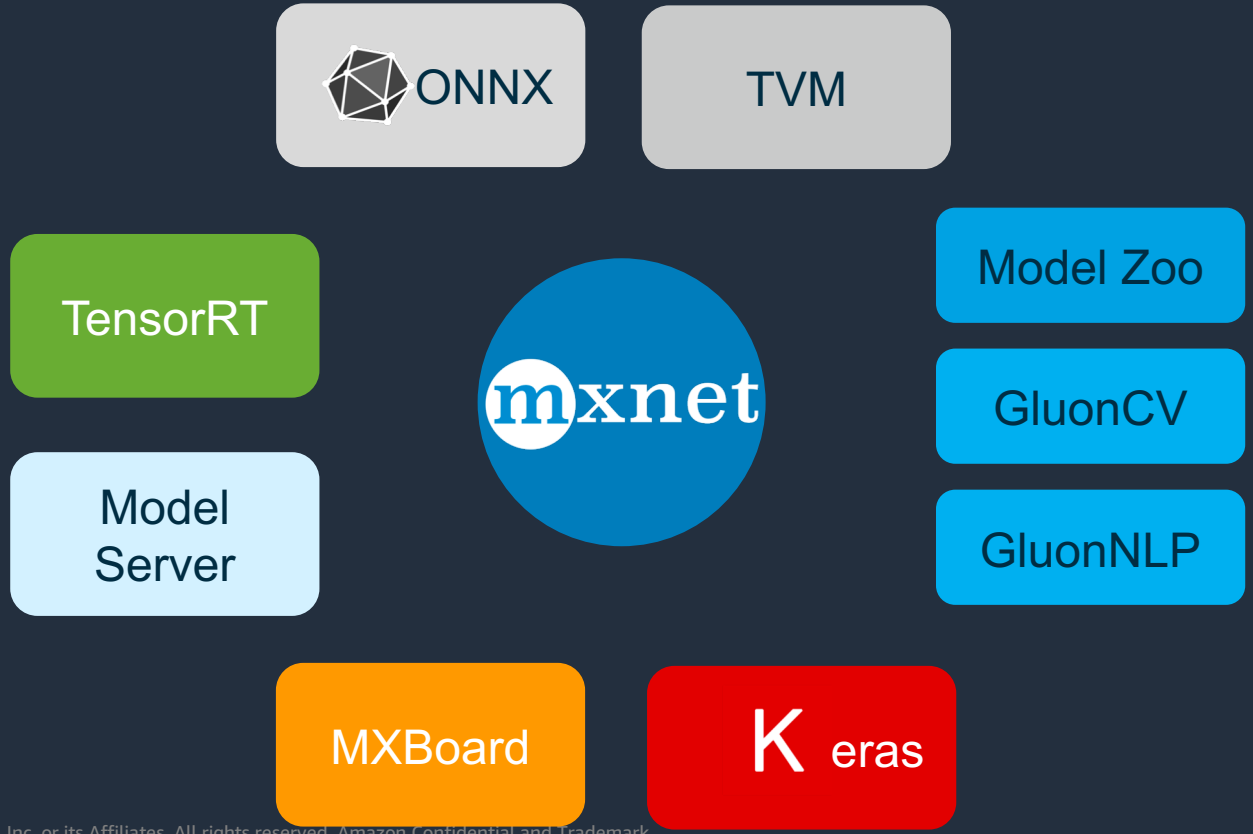
Apache MXNet Ecosystem



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Model Server

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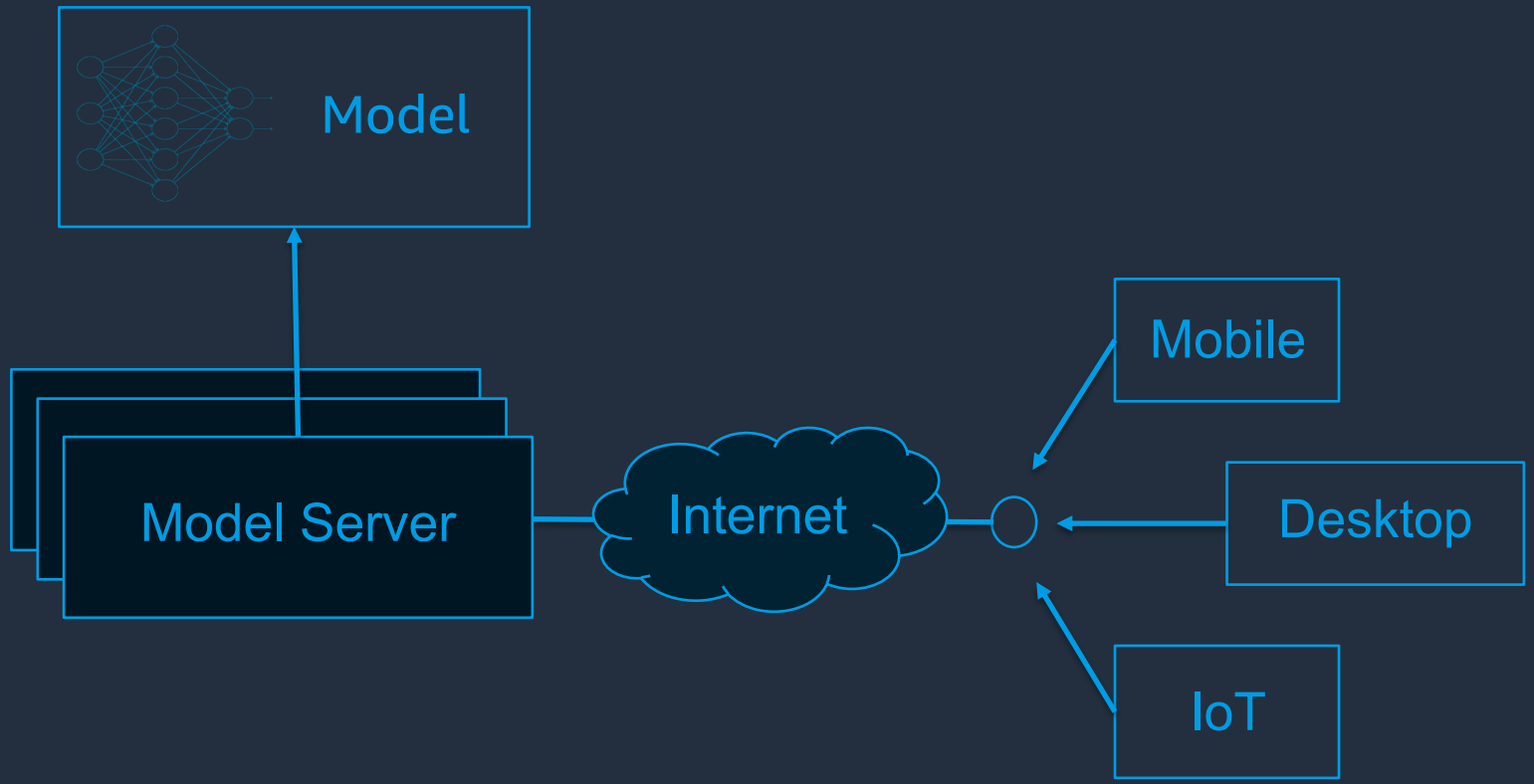
Credits: Hagay Lupesko

So what does a deployed model looks like?



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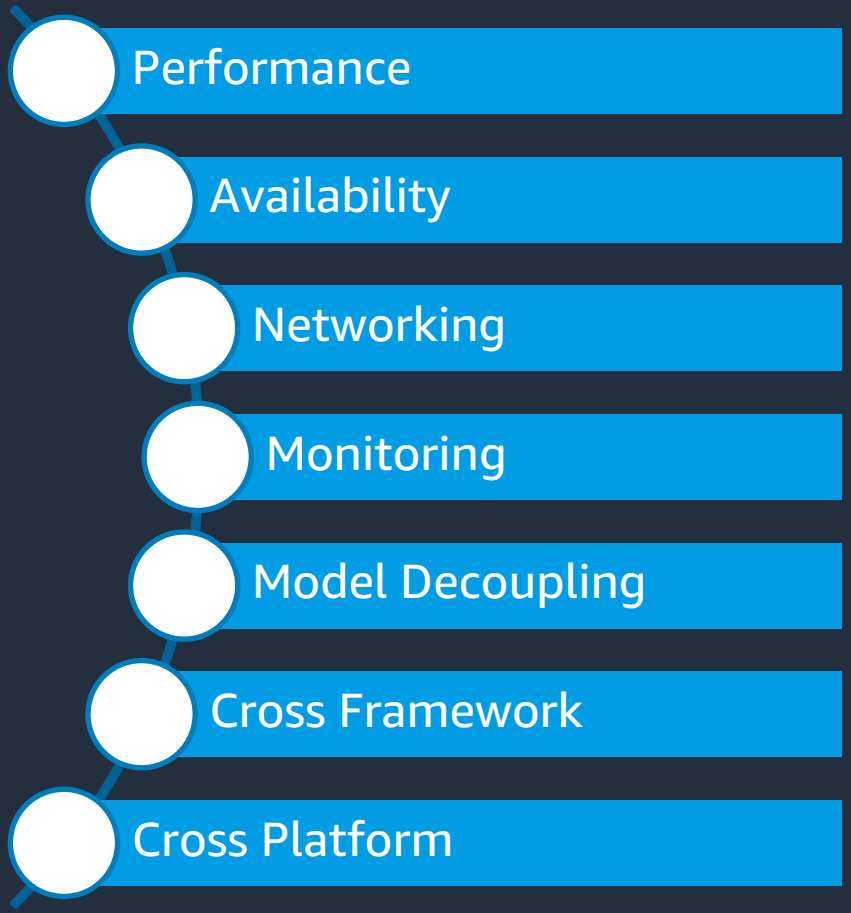
Credits: Hagay Lupesko

The Undifferentiated Heavy Lifting of Model Serving



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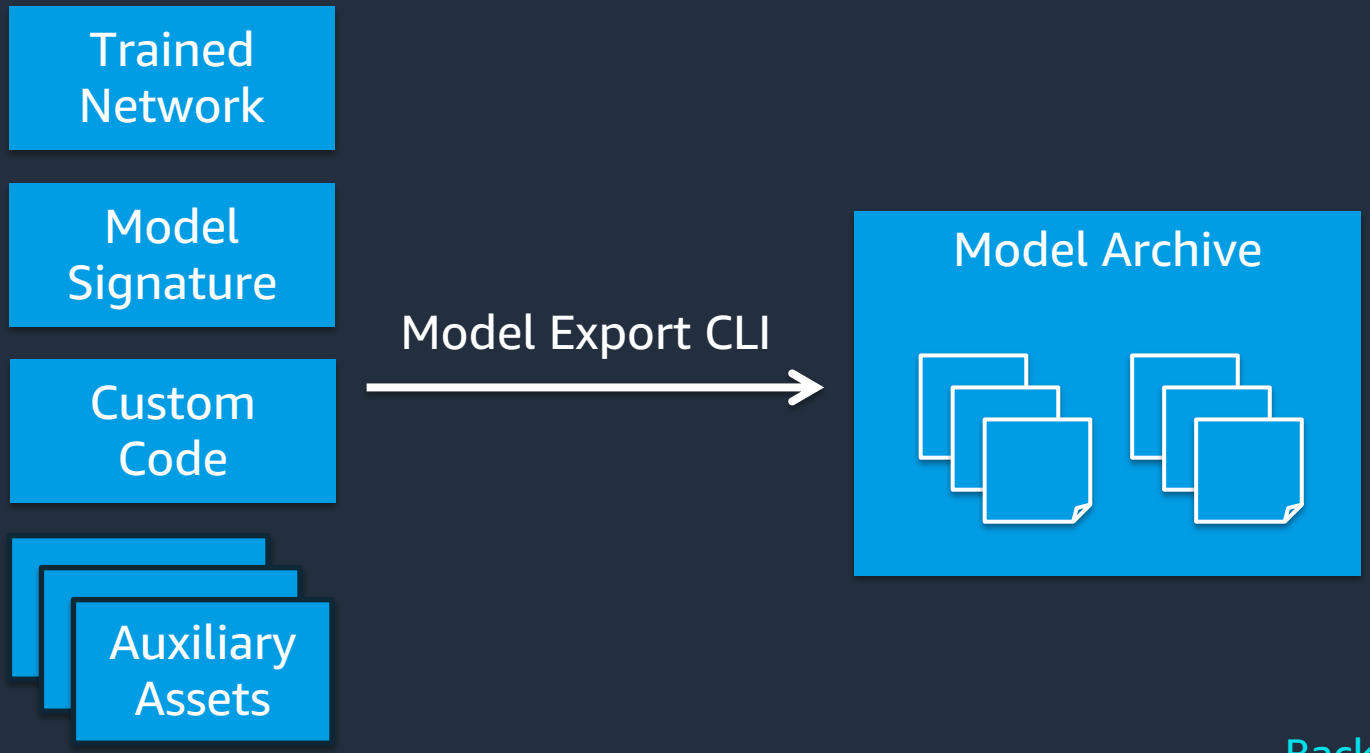
Model Archive



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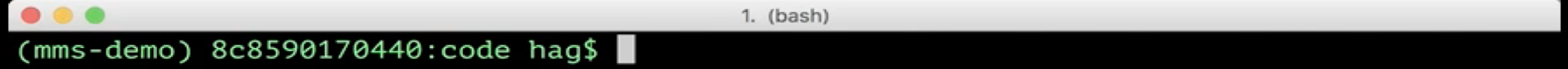

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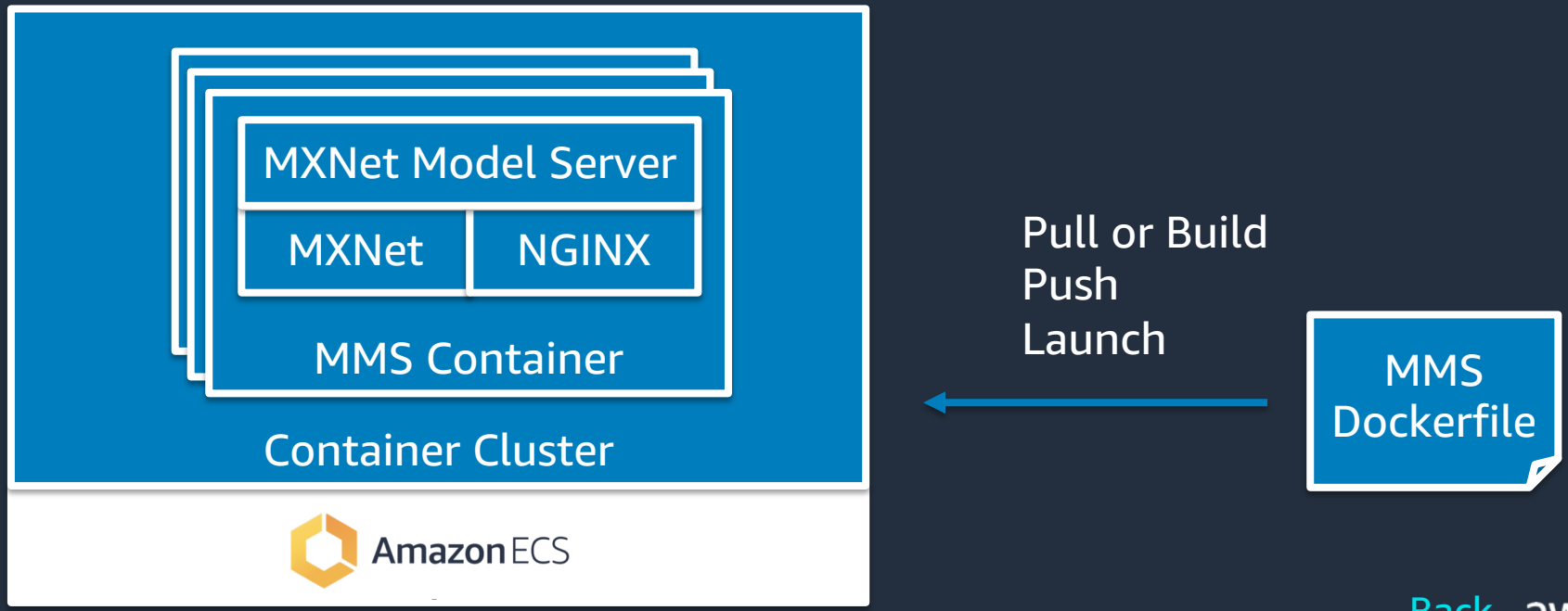
Containerization

Lightweight virtualization, isolation, runs anywhere



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ONNX

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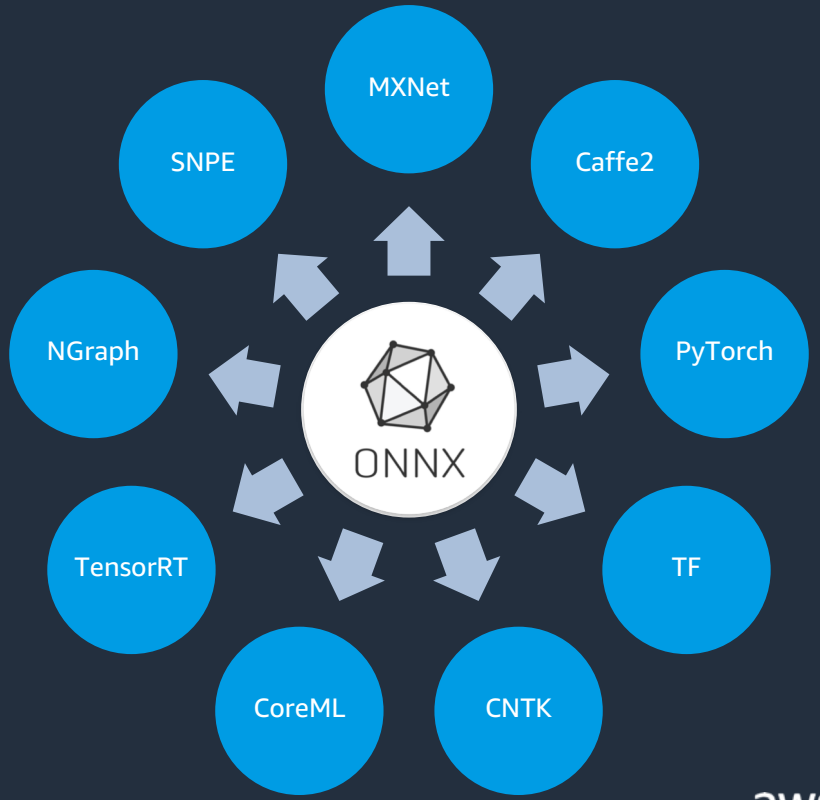
Open Neural Network eXchange - Overview

Many Frameworks
Many Platforms

ONNX: Common IR

- Open source
- Community driven
- Simple



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Import ONNX model in MXNet– Usage Example

Build and train your model with PyTorch

Load your ONNX model with MXNet

Run inference, fine tune or save as MXNet model.

```
# Import into MXNet (from MXNet 1.2)
sym, arg_params, aux_params = onnx_mxnet.import_model('model.onnx’)

# create module
mod = mx.mod.Module(symbol=sym, data_names=['input_0'], label_names=None)
mod.bind(for_training=False, data_shapes=[('input_0', input_img.shape)])
mod.set_params(arg_params=arg_params, aux_params=aux_params)
```

Credits: Hagay Lupesko

Export MXNet model to ONNX – Usage

Build and train your model in MXNet

Export trained MXNet model to ONNX format

Import in other framework like cntk, caffe2 for inference

```
# Export MXNet model to ONNX format(from MXNet 1.3)
onnx_file_path = onnx_mxnet.export_model(sym, params, [input_shape],
input_data_type, onnx_file_path)
```

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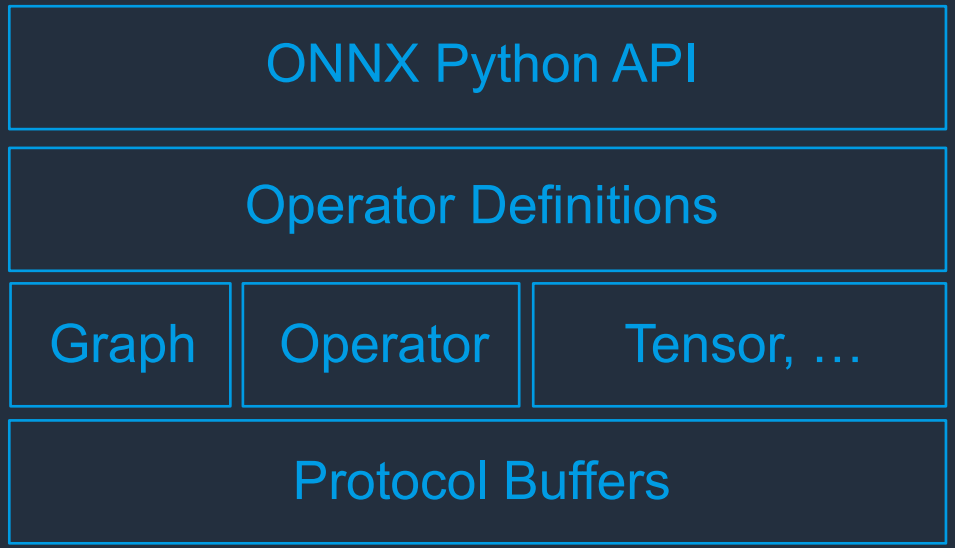
ONNX – Internals

Protocol Buffers:

- Binary compact format
- Statically defined
- APIs for de/serialization
- Cross platform



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ONNX – Coverage

Framework	Export	Import
MXNet	Supported	Supported
Caffe2	Supported	Supported
PyTorch	Supported	Coming…
CNTK	Supported	Supported
Chainer	Supported (external)	N/A
TensorFlow	Supported (external)	Supported (external)
CoreML	Supported (external)	Supported (external)
SciKit-Learn	Supported (external)	N/A

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Keras-MXNet

https://github.com/awslabs/keras-apache-mxnet

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Keras – Apache MXNet

- Deep Learning for Humans
- 2nd most popular Deep Learning framework
- Keras users leverage MXNet's great performance

```
from keras.models import Sequential
model = Sequential()
from keras.layers import Dense
model.add(Dense(units=64, activation='relu', input_dim=100))
model.add(Dense(units=10, activation='softmax'))
model.compile(loss='categorical_crossentropy',
              optimizer='sgd',
              metrics=['accuracy'])
model.fit(x_train, y_train, epochs=5, batch_size=32)
model.train_on_batch(x_batch, y_batch)
loss_and_metrics = model.evaluate(x_test, y_test, batch_size=128)
classes = model.predict(x_test, batch_size=128)
```

```
pip install mxnet-(mkl|cu92)
pip install keras-mxnet
---
~/.keras/keras.json
backend: mxnet
image_data_format: channels_first
---
```

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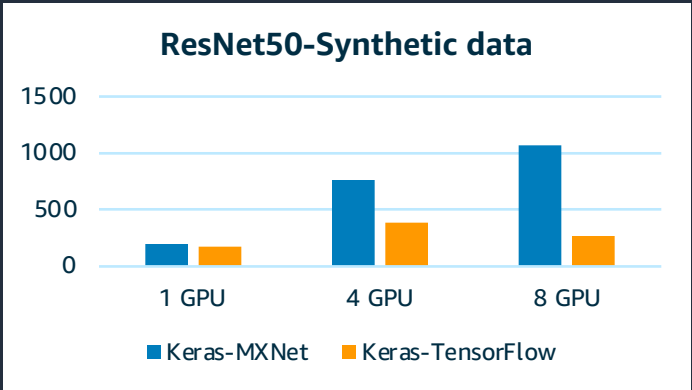
Keras Benchmarks

Setup: https://github.com/awslabs/keras-apache-mxnet/tree/master/benchmark

	Training	Inference
Instance	P3.8x Large, P3.16x Large	C5.xLarge, C4.8xLarge
Network	ResNet50v1	ResNet50v1
Batch size	32 * Num of GPUs	32
Image size	3*256*256	3*256*256



GPUs	Keras-MXNet [Image/sec]	Keras-TensorFlow [Image/sec]	Speed Up
1	194	184	1.05
4	764	393	1.94
8	1068	261	4.09

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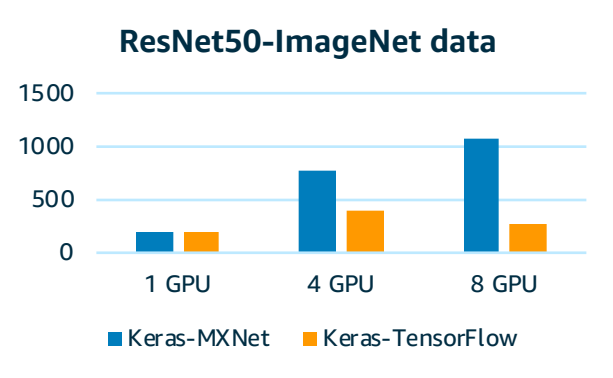
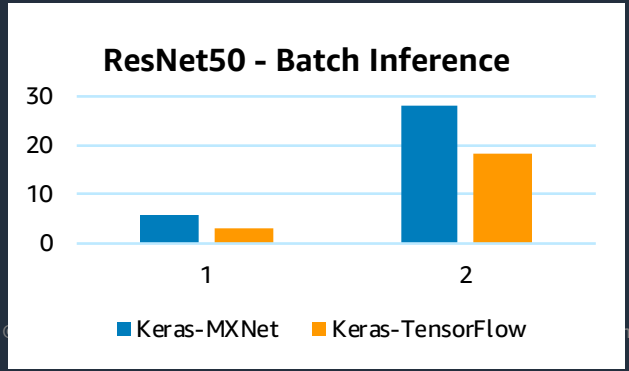
Keras Benchmarks



GPUs	Keras-MXNet	Keras-TensorFlow	Speed Up
1	135	52	2.59
4	536	162	3.30
8	722	211	3.42



Instance	Keras-MXNet	Keras-TensorFlow	Speed Up
C5.X Large	5.79	3.27	1.782
C5.8X Large	27.9	18.2	1.53

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Imperative API

Debuggable

Flexible

Scalable

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Symbolic vs Imperative

Symbolic is “define, compile, run”

```
model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3),
                 activation='relu',
                 input_shape=input_shape))
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
```

```
model.compile(loss=keras.losses.categorical_crossentropy,
              optimizer=keras.optimizers.Adadelta(),
              metrics=['accuracy'])

model.fit(x_train, y_train,
          batch_size=batch_size,
          epochs=epochs,
          verbose=1,
          validation_data=(x_test, y_test))
```

e.g. Inception Stage

Imperative is “define-by-run”

```
net = nn.Sequential()
with net.name_scope():
    net.add(
        nn.Conv2D(channels=6, kernel_size=5, activation='relu'),
        nn.MaxPool2D(pool_size=2, strides=2),
        nn.Conv2D(channels=16, kernel_size=3, activation='relu'),
        nn.MaxPool2D(pool_size=2, strides=2),
        nn.Flatten(),
        nn.Dense(120, activation="relu"),
        nn.Dense(84, activation="relu"),
        nn.Dense(10)
    )
net.initialize(init=init.Xavier())
```

```
for epoch in range(10):
    for data, label in train_data:
        with autograd.record():
            output = net(data)
            loss = softmax_cross_entropy(output, label)
        loss.backward()
        trainer.step(batch_size)
```

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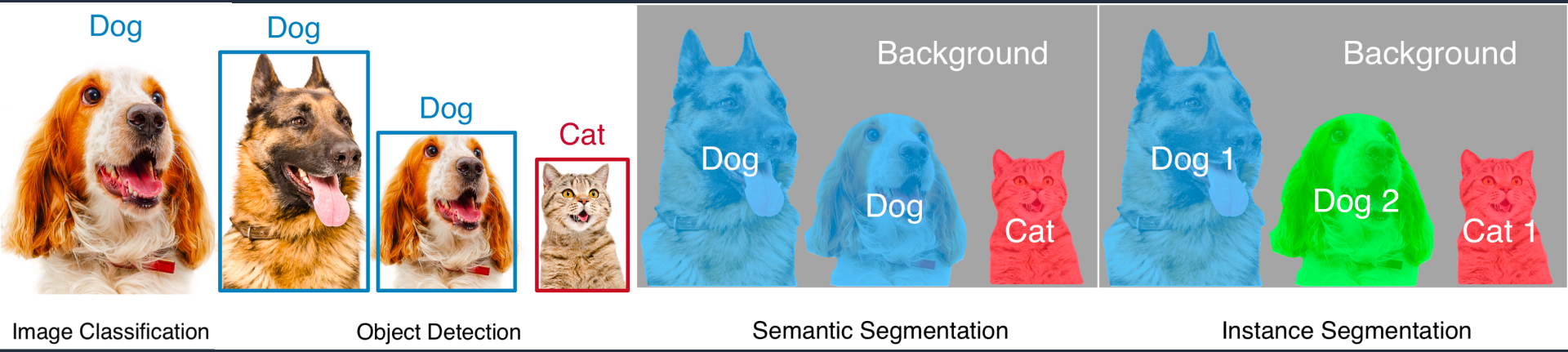
GluonCV: a Deep Learning Toolkit for Computer Vision

https://gluon-cv.mxnet.io



50+ Pre-trained models, with training scripts, datasets, tutorials

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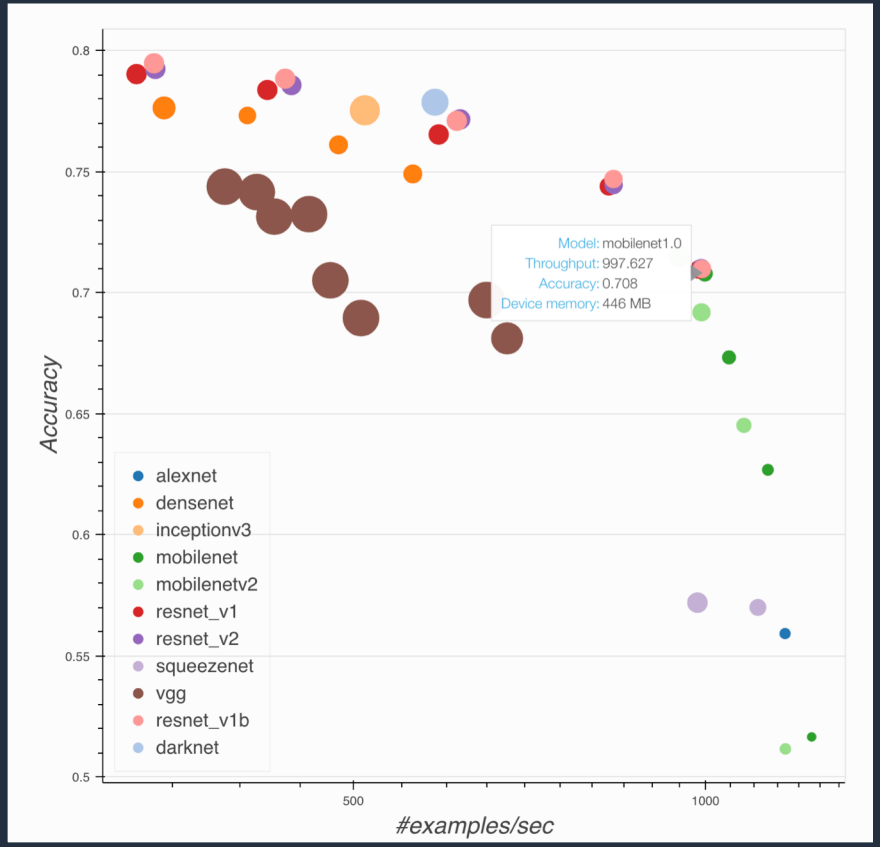
GluonCV: pre-trained models, help to choose



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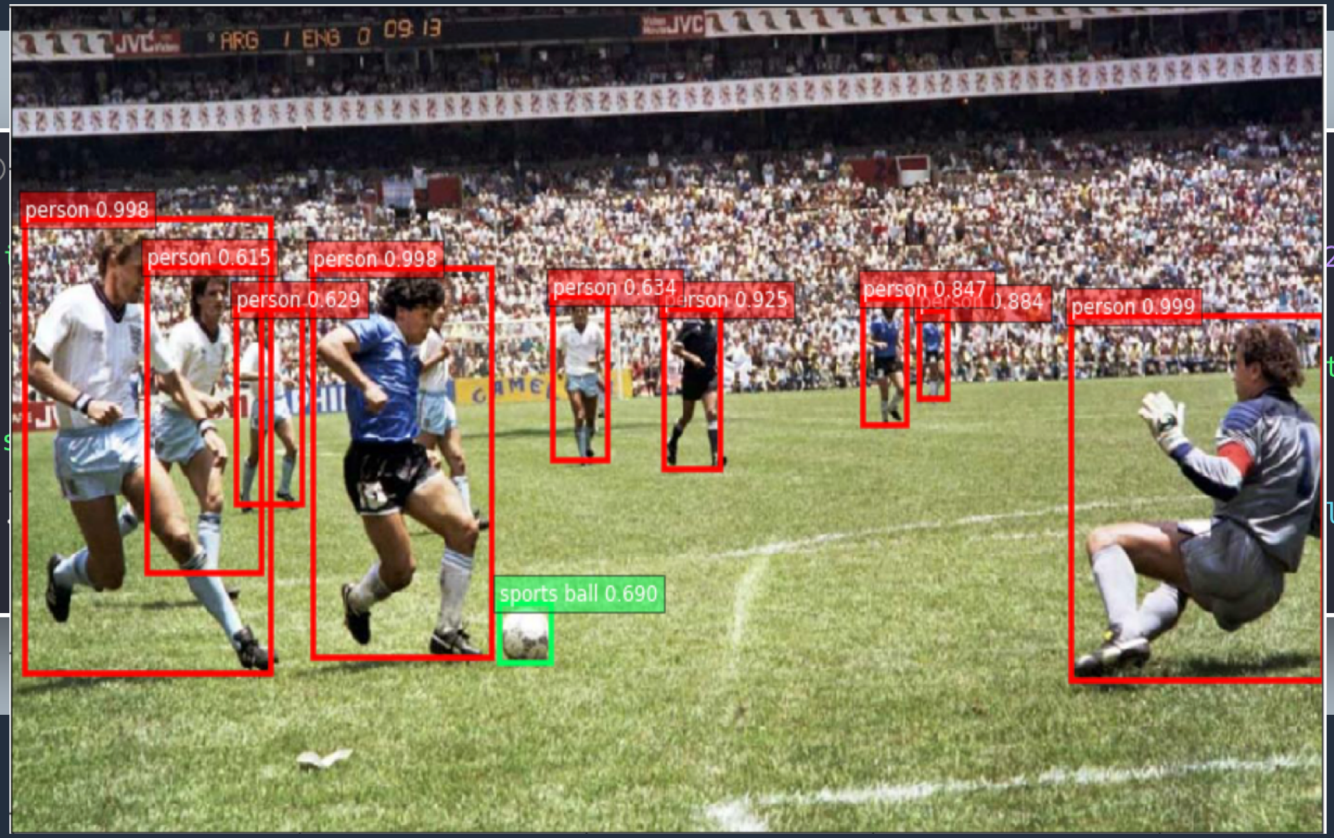
GluonCV: example code



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GluonNLP: a Deep Learning Toolkit for Natural Language Processing

https://gluon-nlp.mxnet.io

Features (as of 0.3.2)

- Pre-trained models: over 300 word-embedding
- 5 language models
- Neural Machine Translation (Google NMT, Transformer)
- Flexible data pipeline tools and many public datasets.
- NLP examples such as sentiment analysis.

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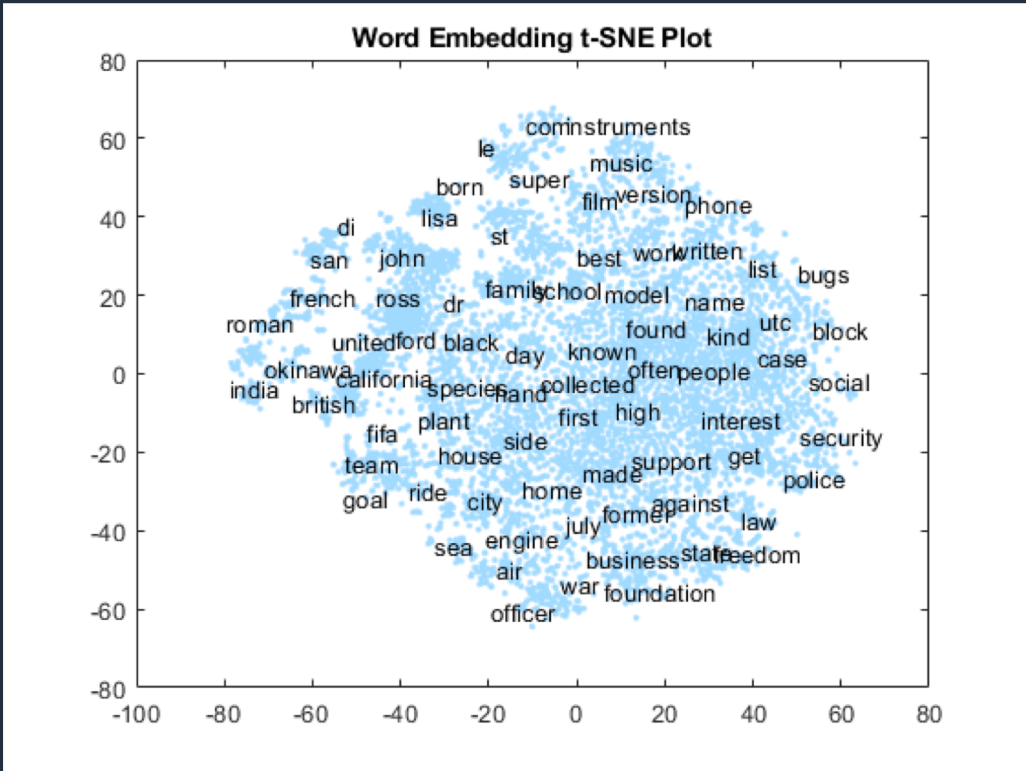
Word embedding:

	car
dog	0
apple	0
eat	0
car	1
van	0
leaf	0
the	0
at	0

car	van
0.1	0.2
0.5	0.3
-1.1	-1.0
0.4	0.5



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Language modeling

Trained to predict the next word ($P(w_n|w_i \dots w_{n-1})$):

- The winner of the 2018 FIFA world cup is ?

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```
lm_model, vocab = nlp.model.get_model(name='standard_lstm_lm_200', dataset_name='wikitext-2',
pretrained=True)
data = vocab[tokenizer("This movie is considered the")]

pred, _ = lm_model(mx.nd.array(data, dtype='float32').expand_dims(axis=1))

for p in pred[-1].squeeze().topk(k=20).asnumpy():
    print(vocab.idx_to_token[int(p)])
```

This movie is considered the <?>

first	greatest	highest
most	main	final
<unk>	second	worst
only	last	sixth
same	name	third
best	largest	way
		primary

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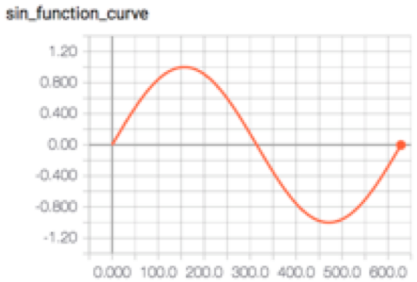
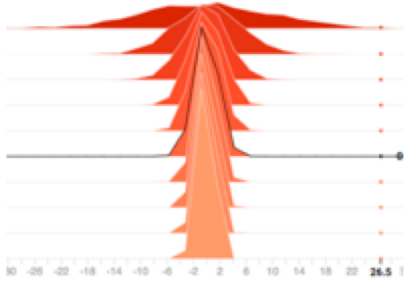
MXBoard: MXNet plugin to TensorBoard

Graph

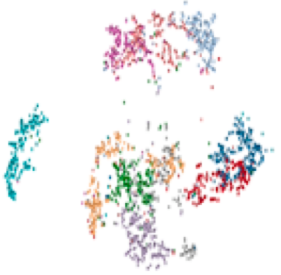
Scalar



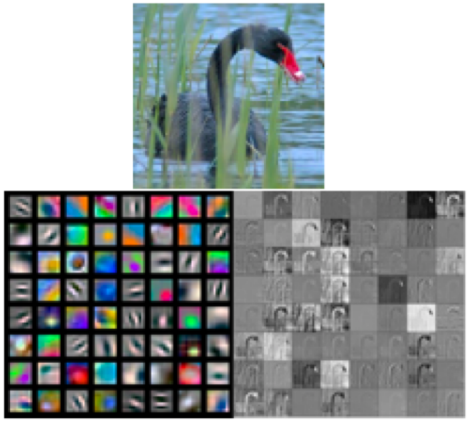
Histogram



Embedding

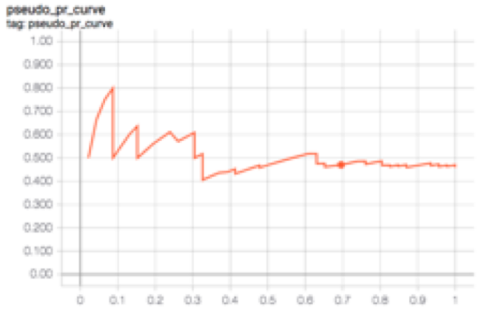


Image

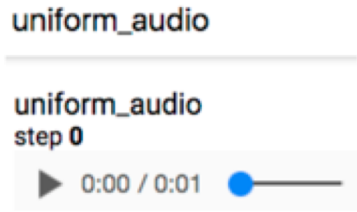


Text

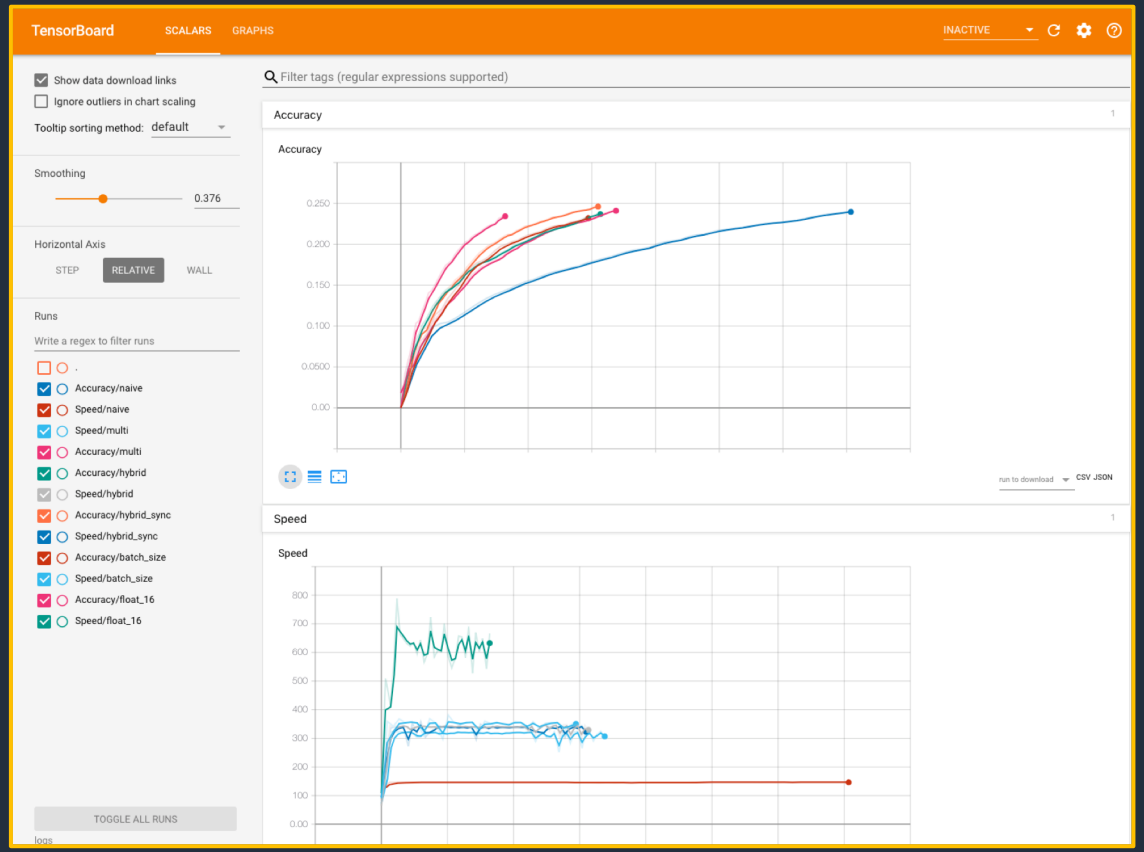
Precision-Recall Curve



Audio



MXBoard



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Deep Learning acceleration

CUDA & CuDNN

```
pip install mxnet-cu92
```

TensorRT

```
pip install mxnet-tensorrt-cu92
```

MKL, MKLML & MKLDNN

```
e.g. pip install mxnet-mkl
```

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Apache MXNet community

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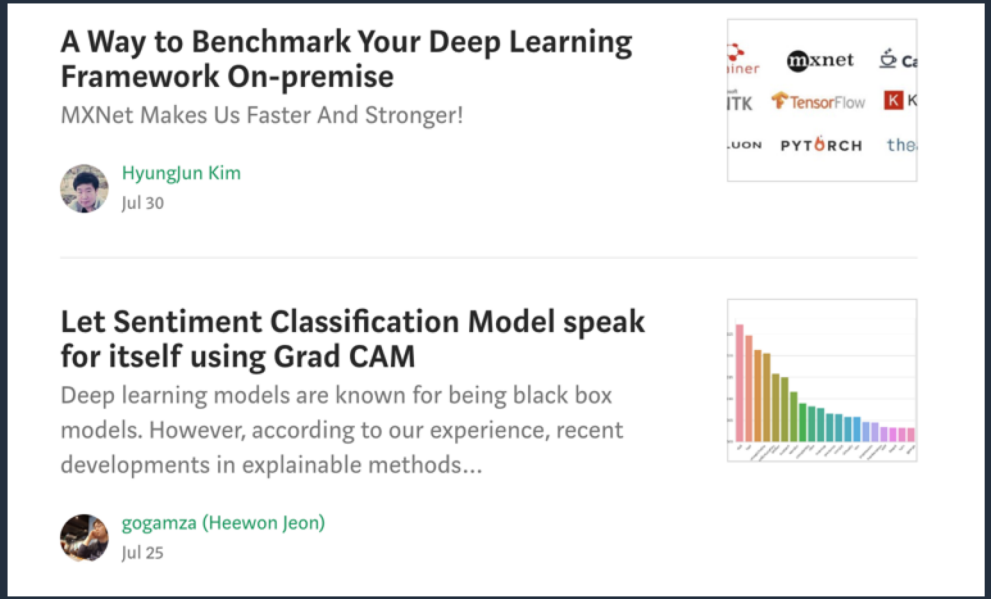
Keeping Up to Date

Medium: https://medium.com/apache-mxnet



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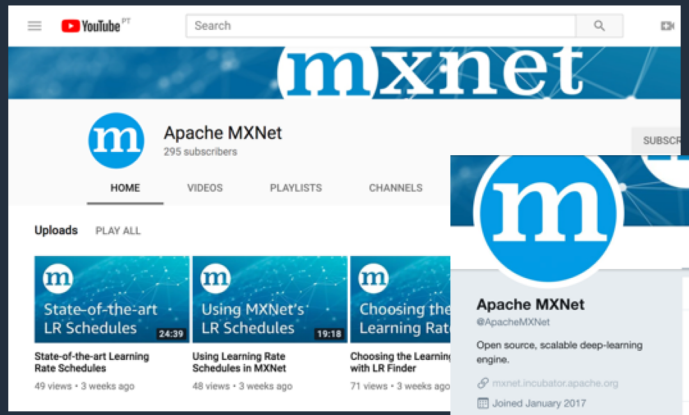
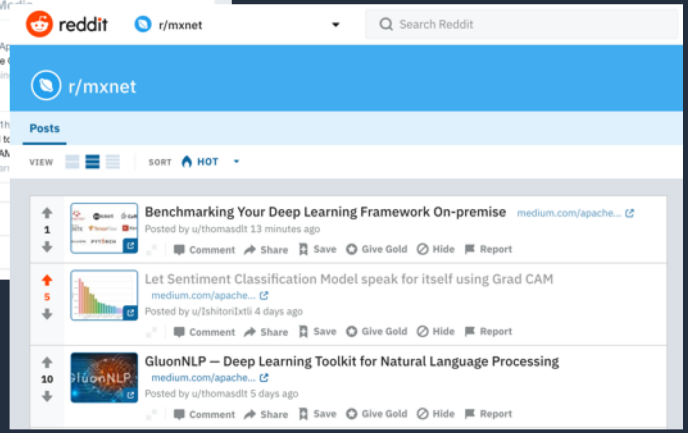
Keeping Up to Date: Social

YouTube: /apachemxnet



Twitter: @apachemxnet

Reddit: r/mxnet



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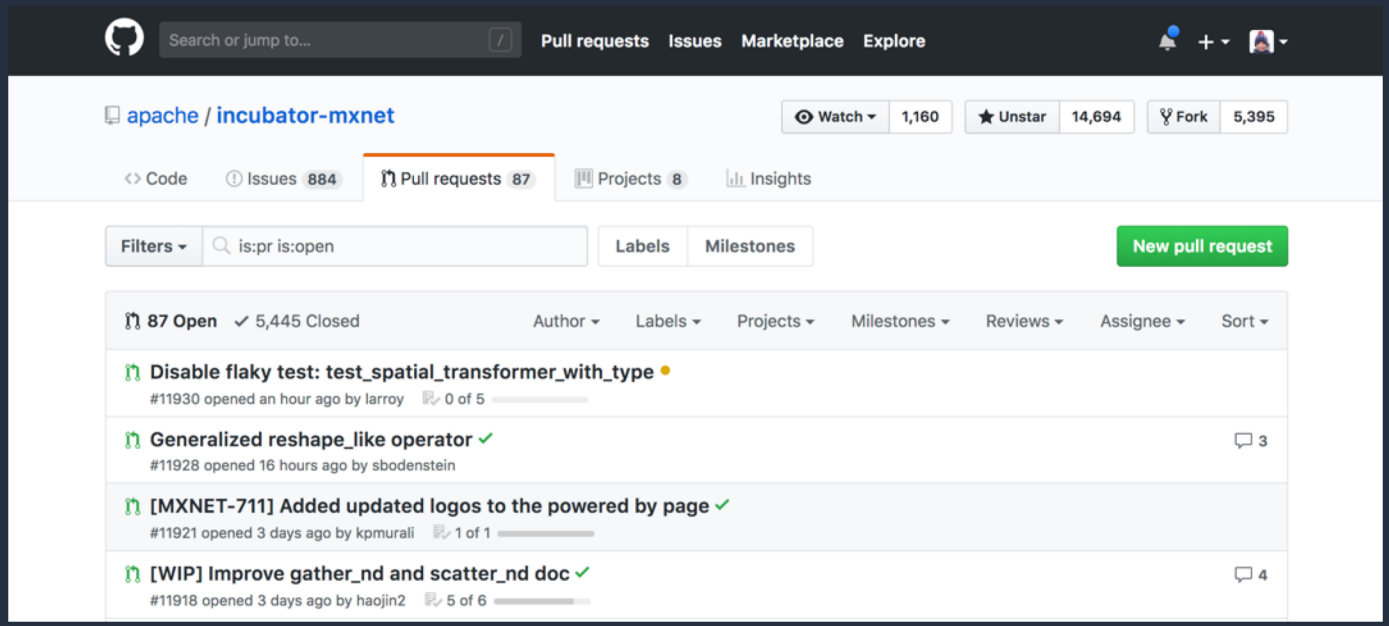
Community

GitHub: https://github.com/apache/incubator-mxnet



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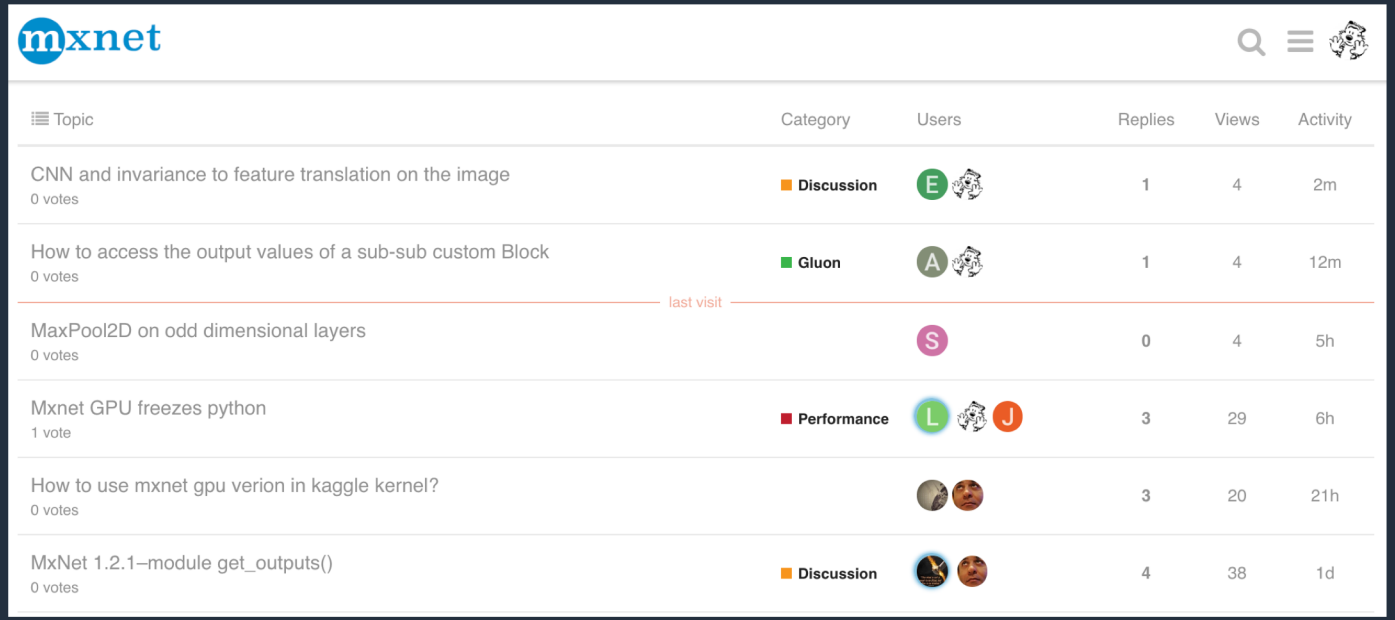
Community

Discuss Forum: https://discuss.mxnet.io/



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Community

Mailing list:

dev@mxnet.apache.org

user@mxnet.apache.org

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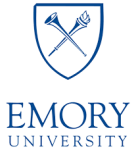
MXNet Customer Momentum



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