OPEN DATA SCIENCE CONFERENCE

London | Nov. 19 - Nov. 22 2019

FROM RESEARCH TO PRODUCTION:

performant cross-platform

ML/DNN model inferencing

on cloud and edge

with ONNX Runtime

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Agenda – What we'll cover today

- **INTRODUCTION TO ONNX**
- **ACTIVITY A:** Train an image classification model in PyTorch and convert to ONNX format for inferencing
- **ACTIVITY B:** Train a PyTorch model and deploy for production usage

Why now?

Trends and Growth Areas

Research -> Industry

- Automated Machine Learning services
- Startups – applied AI
- Hosted services for cloud compute
- Hardware investments

Connectivity, compute, and resources

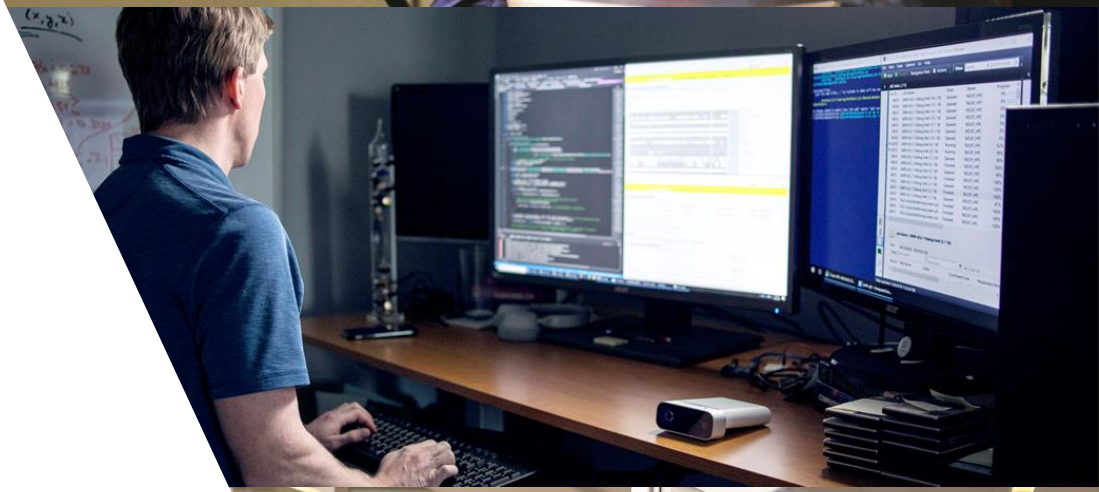
- Infinite storage and compute in the cloud
- CPU, GPUs for training
- LOTS of data

Application spans across all industries

- Healthcare, farming, gaming, manufacturing, consumer products, and more

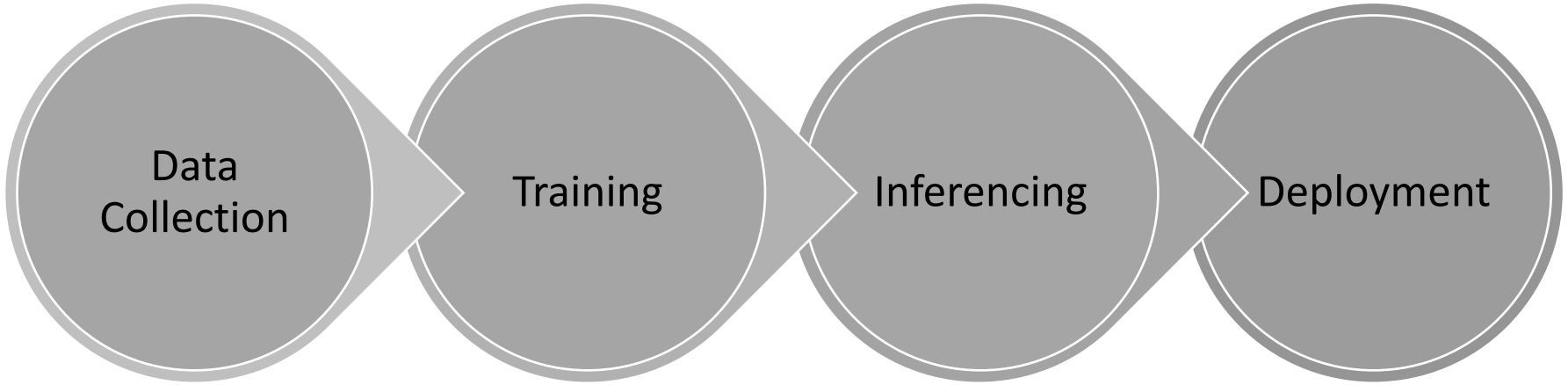
Investments in AI education and jobs

- Universities
- ML Engineer



Product teams want to incorporate ML

ML Models: Research to Production



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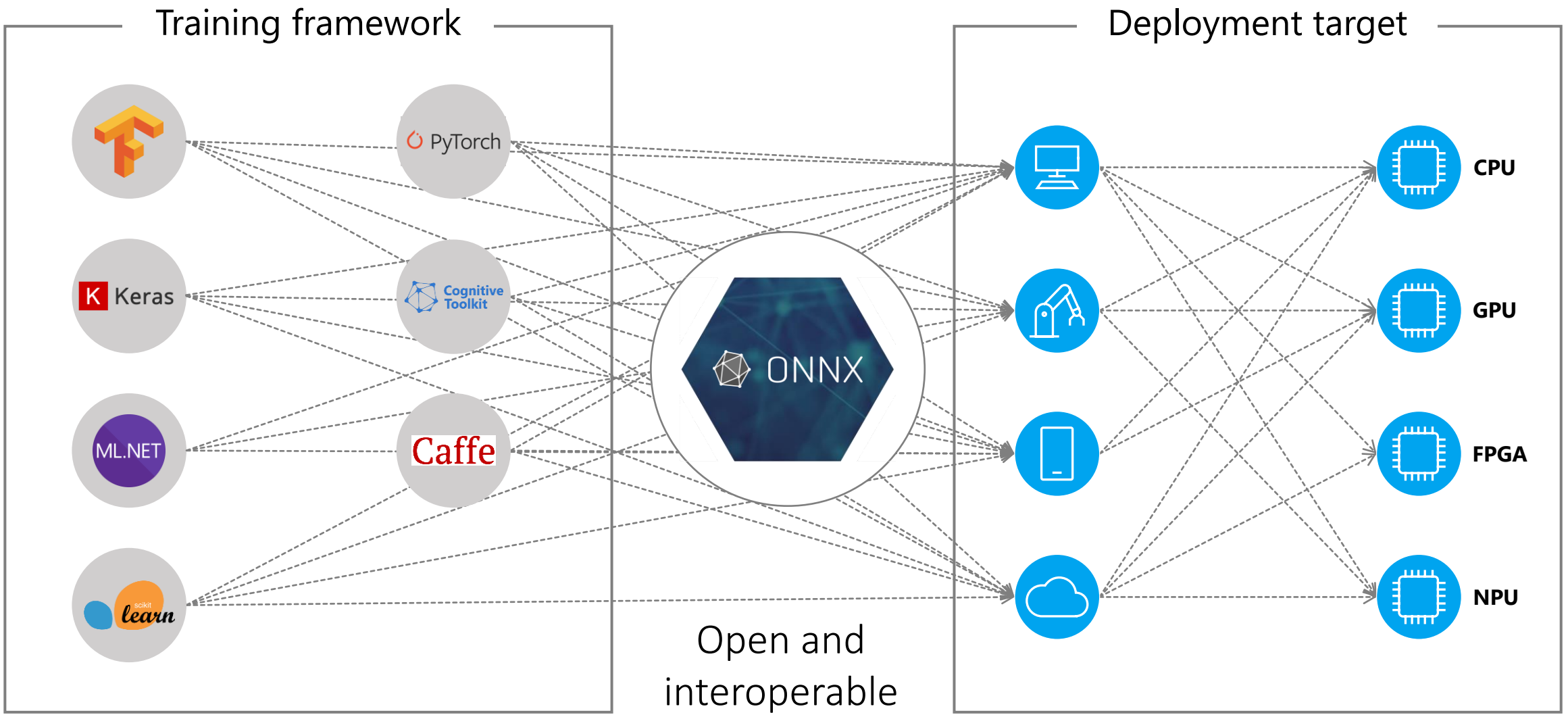
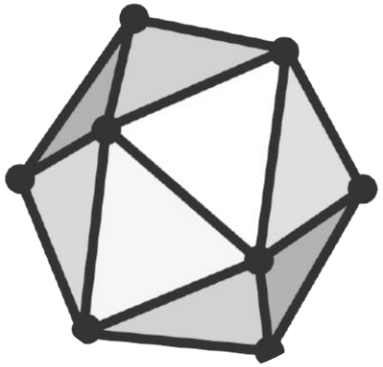
Reality


Training framework
PyTorch
Keras
Cognitive Toolkit
ML.NET
Caffe
scikit learn
ONNX
Deployment target
CPU
GPU
FPGA
NPU
Open and interoperable



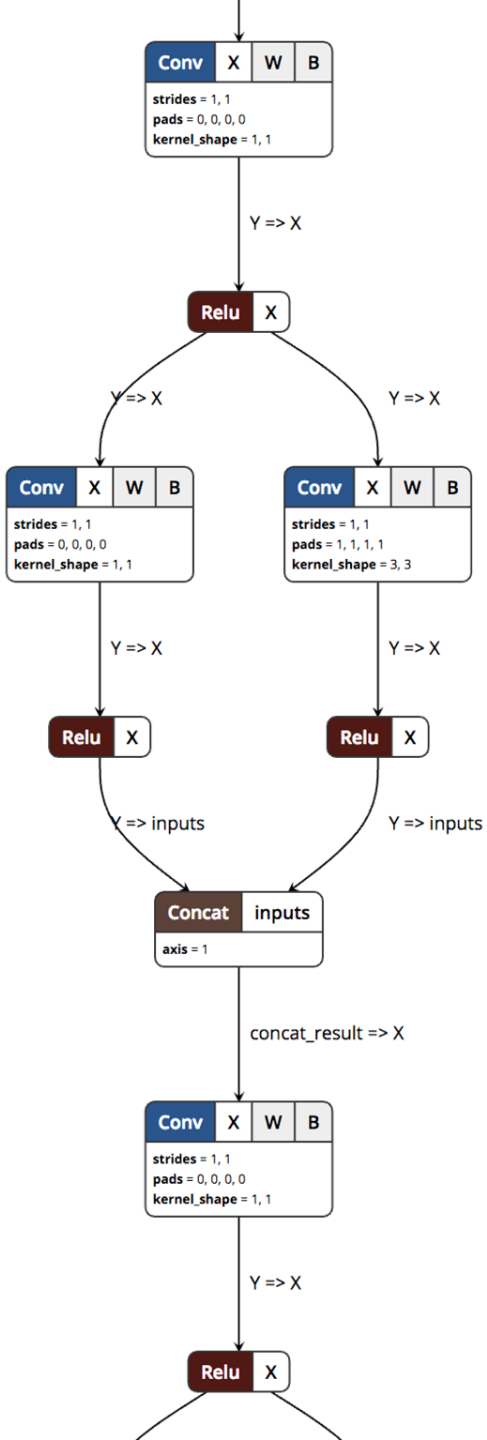
ONNX

https://github.com/onnx

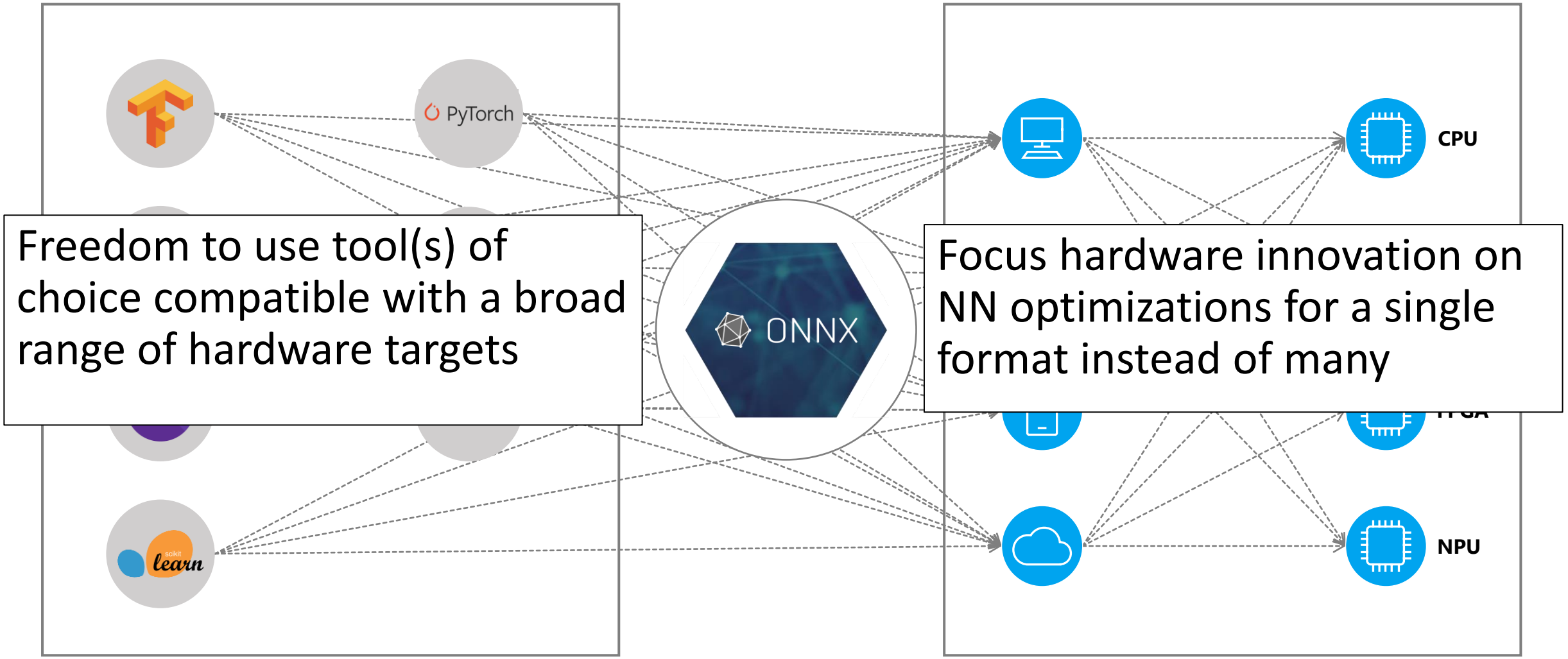
OPEN **N**EURAL **N**ETWORK E**X**CHANGE

What is ONNX?

- **Interoperable standard** format for AI models consisting of:
  - common Intermediate Representation (**IR**)
  - full operator **spec**
- Model = graph composed of computational nodes, based on Google protobuf
- Graph = Compact and cross-platform representation for serialization
- Supports both DNN and traditional ML
- Backward compatible with comprehensive versioning



What does this provide?



Framework Compatibility

ONNX Community

Alibaba Group 阿里巴巴集团 · AMD · arm · aws · Baidu 百度 · BITMAIN

CEVA · Facebook Open Source · GRAPHCORE · habana · Hewlett Packard Enterprise · HUAWEI

IBM · Idein Inc · intel AI · MathWorks · MAXAR · MEDIATEK · Microsoft

Neural Network Libraries · mi · NVIDIA · NXP · Oath: A Verizon company · OctoML

Preferred Networks · Qualcomm · sas · skymizer · SYNOPSYS · Tencent · unity

Open Governance

Steering Committee

Prasanth Pulavarthi (Microsoft)

Joe Spisak (Facebook)

Vin Sharma (Amazon)

Harry Kim (Intel)

Dilip Sequeira (NVIDIA)

SIG (special interest group)

Architecture/Infrastructure

Lu Fang (Facebook)

Ke Zhang (Microsoft)

Operators

Michał Karzyński (Intel)

Emad Barsoum (Microsoft)

Converters

Chin Huang (IBM)

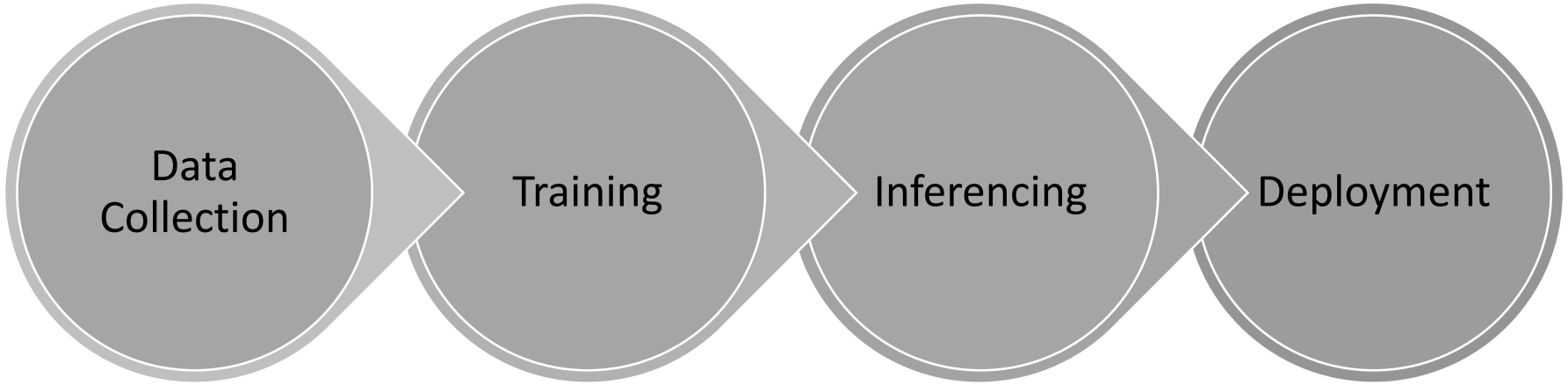
Guenther Schmuelling (Microsoft)

Working Groups

Training

Edge/Mobile

ML Models: Research to Production



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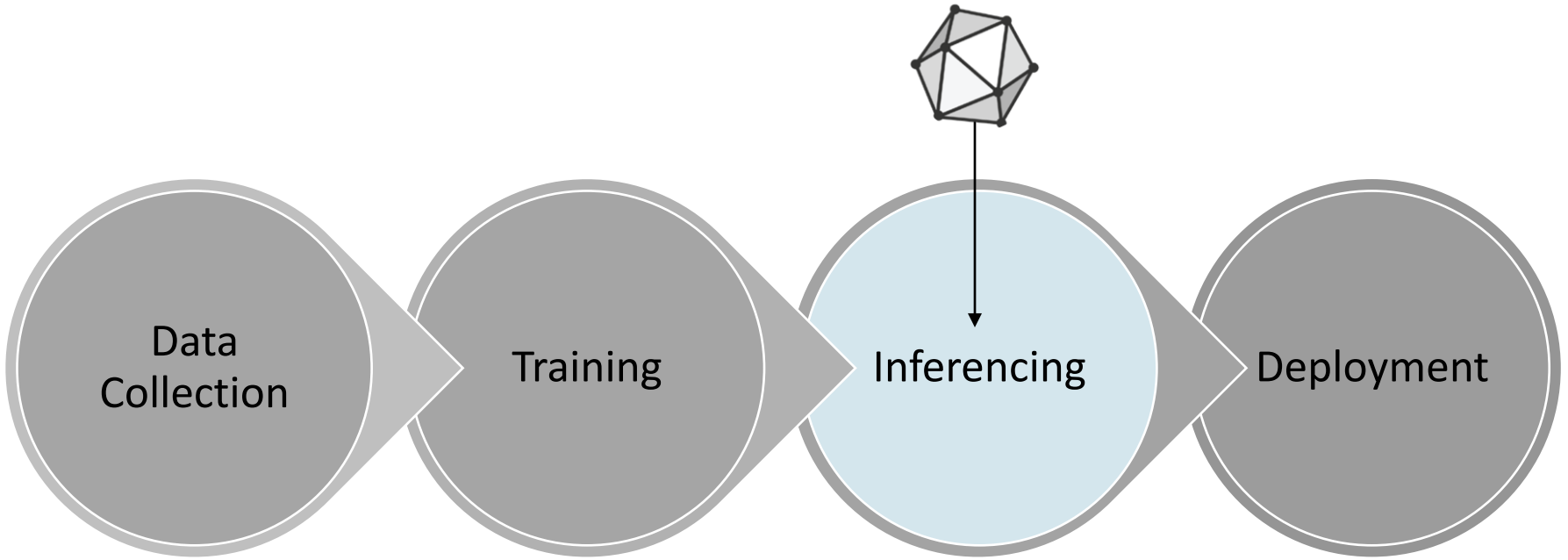
ML Models: Research to Production



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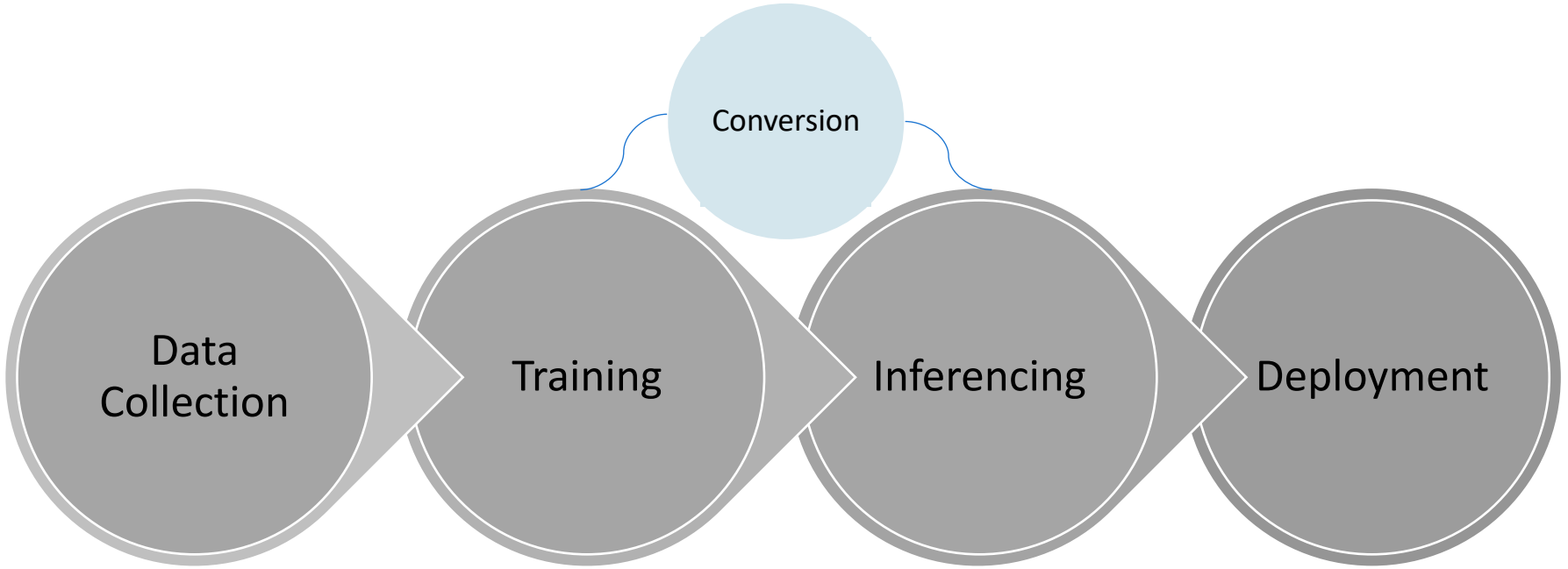
How do I get an ONNX model?

- Get a pre-trained ready to use model from the ONNX Model Zoo
- Use a model builder service that supports export to the ONNX format
- **Convert an existing model from another framework**

ML Models: Research to Production



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Open Source converters for popular frameworks

Tensorflow: onnx/tensorflow-onnx

PyTorch (native export)

Keras: onnx/keras-onnx

Scikit-learn: onnx/sklearn-onnx

CoreML: onnx/onnxmltools

LightGBM: onnx/onnxmltools

LibSVM: onnx/onnxmltools

XGBoost: onnx/onnxmltools

SparkML (alpha): onnx/onnxmltools

CNTK (native export)

Examples: Model Conversion

```
from keras.models import load_model
import keras2onnx
import onnx

keras_model = load_model("model.h5")

onnx_model = keras2onnx.convert_keras(keras_model,
keras_model.name)

onnx.save_model(onnx_model, 'model.onnx')
```

```
import torch
import torch.onnx

model = torch.load("model.pt")

sample_input = torch.randn(1, 3, 224, 224)

torch.onnx.export(model, sample_input, "model.onnx")
```

```
python -m tf2onnx.convert
          --input frozen_model.pb
          --inputs input_batch:0, lengths:0
          --outputs top_k:1
          --fold_const
          --opset 8
          --output deepcc.onnx
```

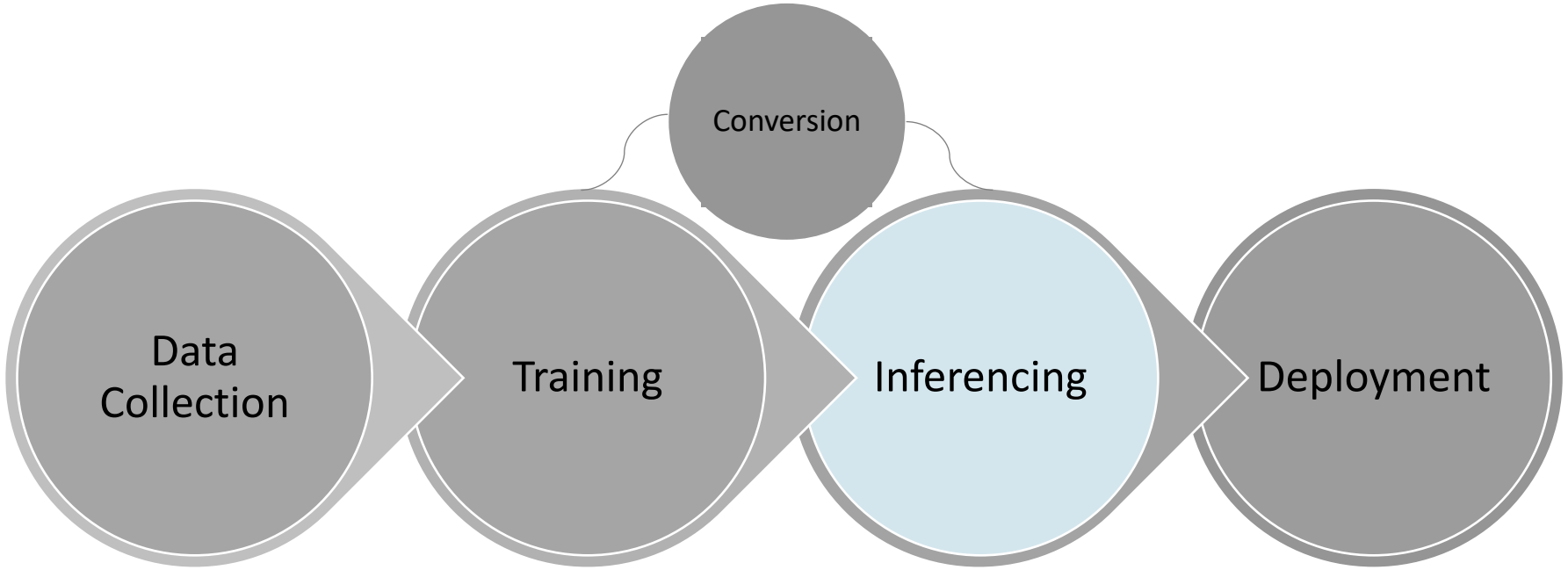
```
import numpy as np
import chainer
from chainer import serializers
import onnx_chainer

serializers.load_npz("my.model", model)

sample_input = np.zeros((1, 3, 224, 224), dtype=np.float32)
chainer.config.train = False

onnx_chainer.export(model, sample_input, filename="my.onnx")
```

ACTIVITY A

Train an image classification model in PyTorch and convert to ONNX format for inferencing

Inferencing ONNX models

ML Models: Research to Production



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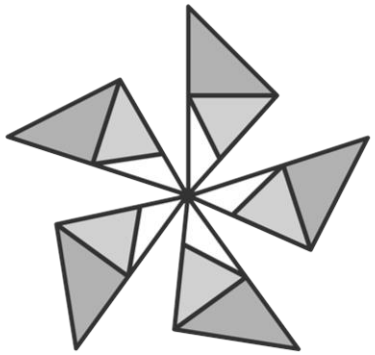


ONNX Runtime

aka.ms/onnxruntime

github.com/microsoft/onnxruntime

ONNX Runtime is an open source high performance **Inference Engine** for ONNX models

github.com/microsoft/onnxruntime

ONNX Runtime can run all operators defined in the ONNX spec

- ONNX domain (DNN) and ONNX-ML (traditional)
- Backwards and forwards compatible to minimize versioning issues with software or model upgrades
- Flexibility for custom operators not in the spec

Cross platform, multi language API

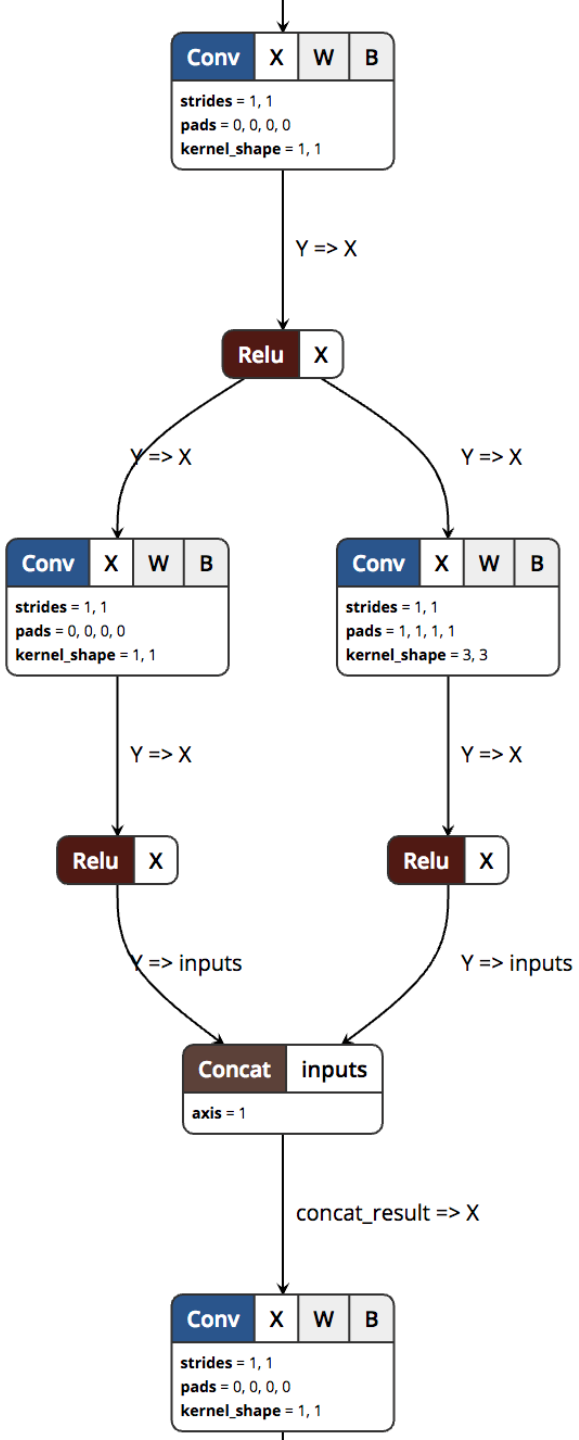
- Windows, Linux, Mac
- X64, X86, ARM
- CPU, GPU
- Python, C, C++, C#, Ruby, Java (future)

Inferencing with ONNX Runtime

```python
import onnxruntime

session =
onnxruntime.InferenceSession("mymodel.onnx")

results = session.run([], {"input": input_data})
```

```
using Microsoft.ML.OnnxRuntime;

var session = new InferenceSession("model.onnx");

var results = session.Run(input);
```

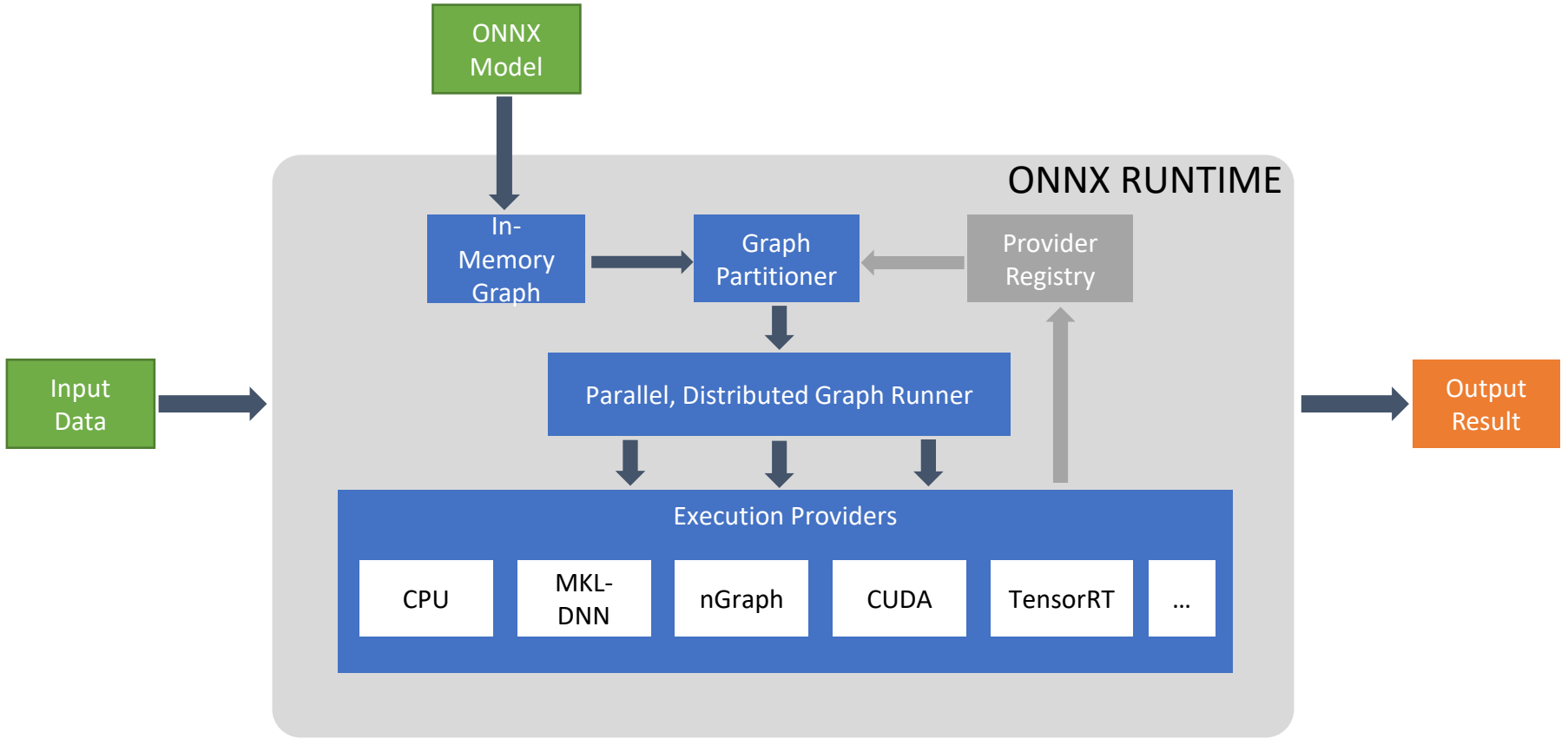
C#



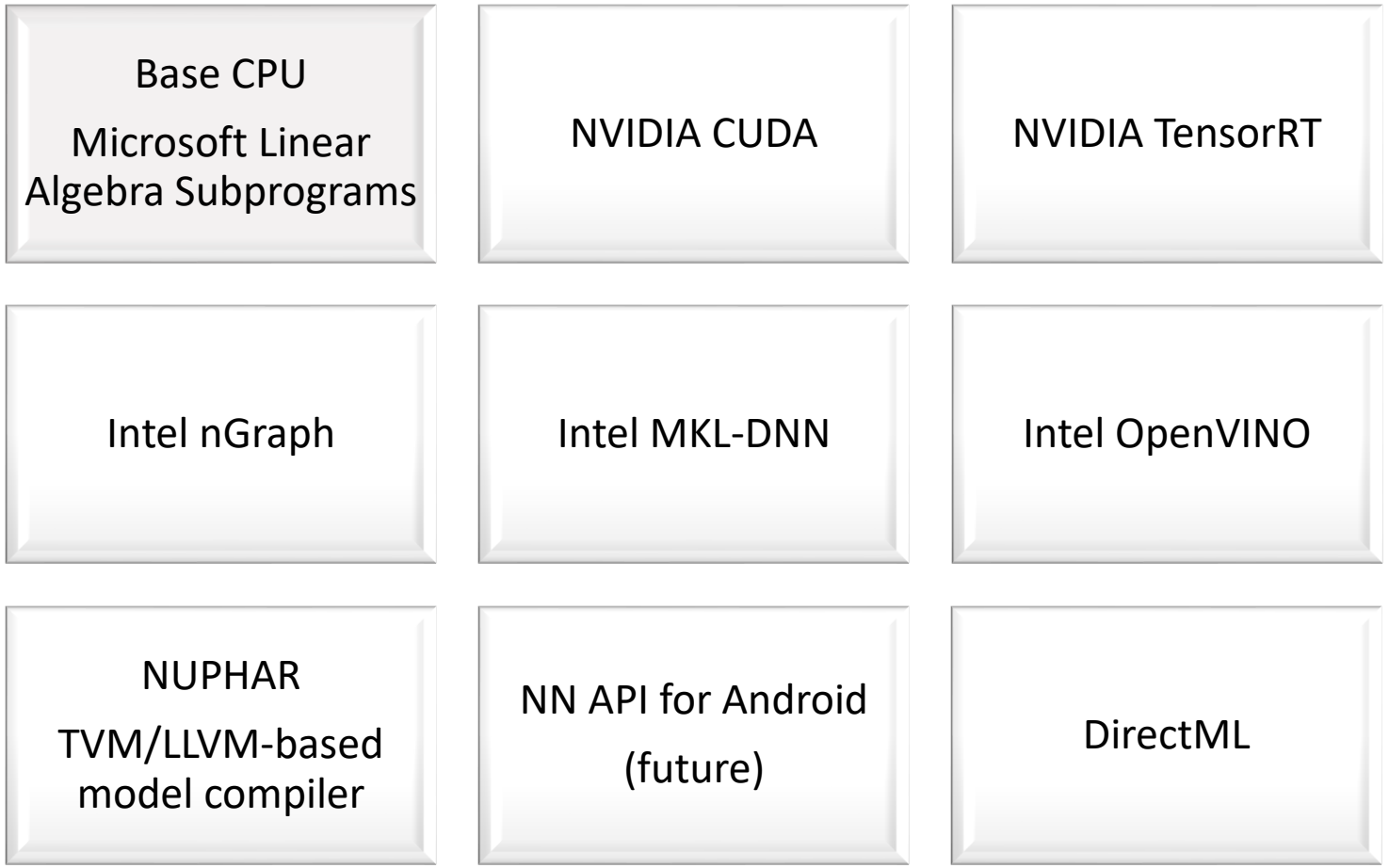
Graph optimizations for performance

- Constant folding
- Node eliminations
- Simple and complex node fusions
- Layout optimizations (e.g. NCHWc vs NCHW)
- Extendible and pluggable to add new optimizations

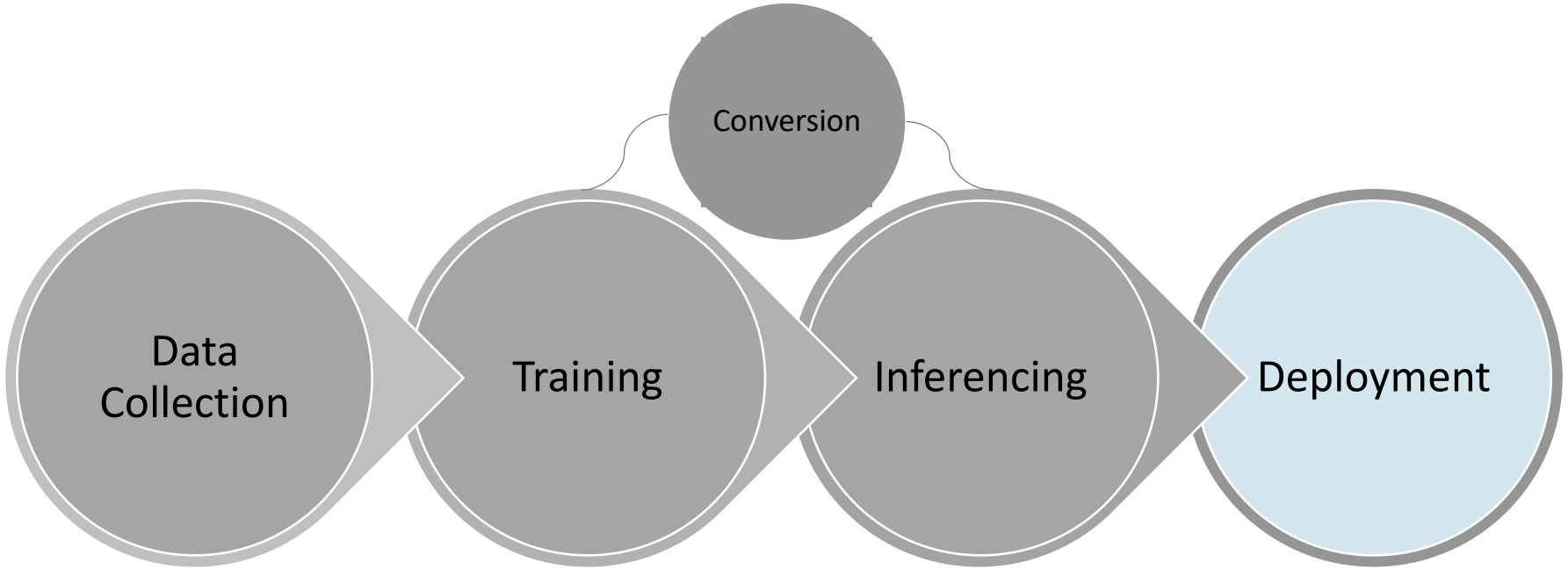
Leverages and abstracts hardware accelerators



Accelerators for a range of hardware



ML Models: Research to Production



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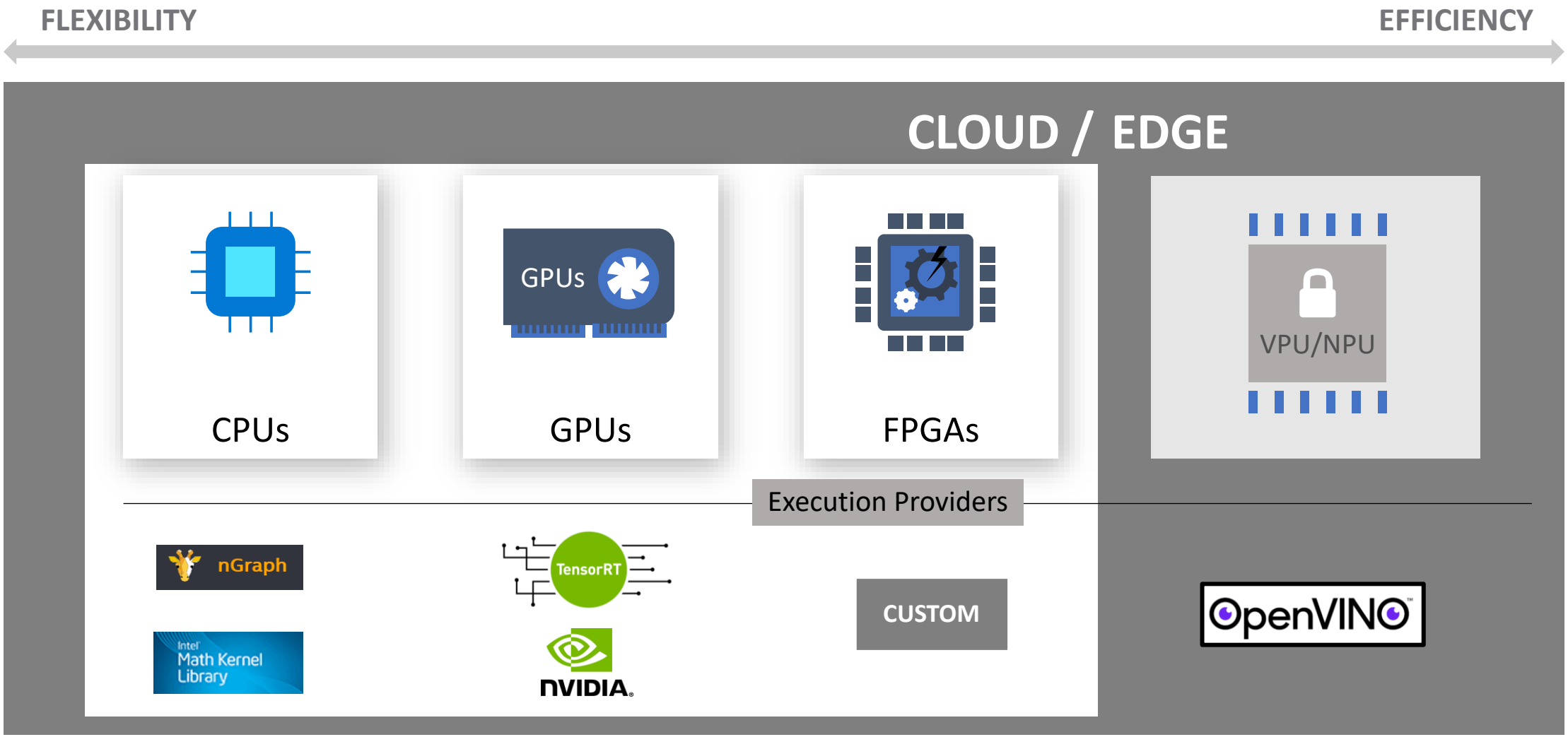
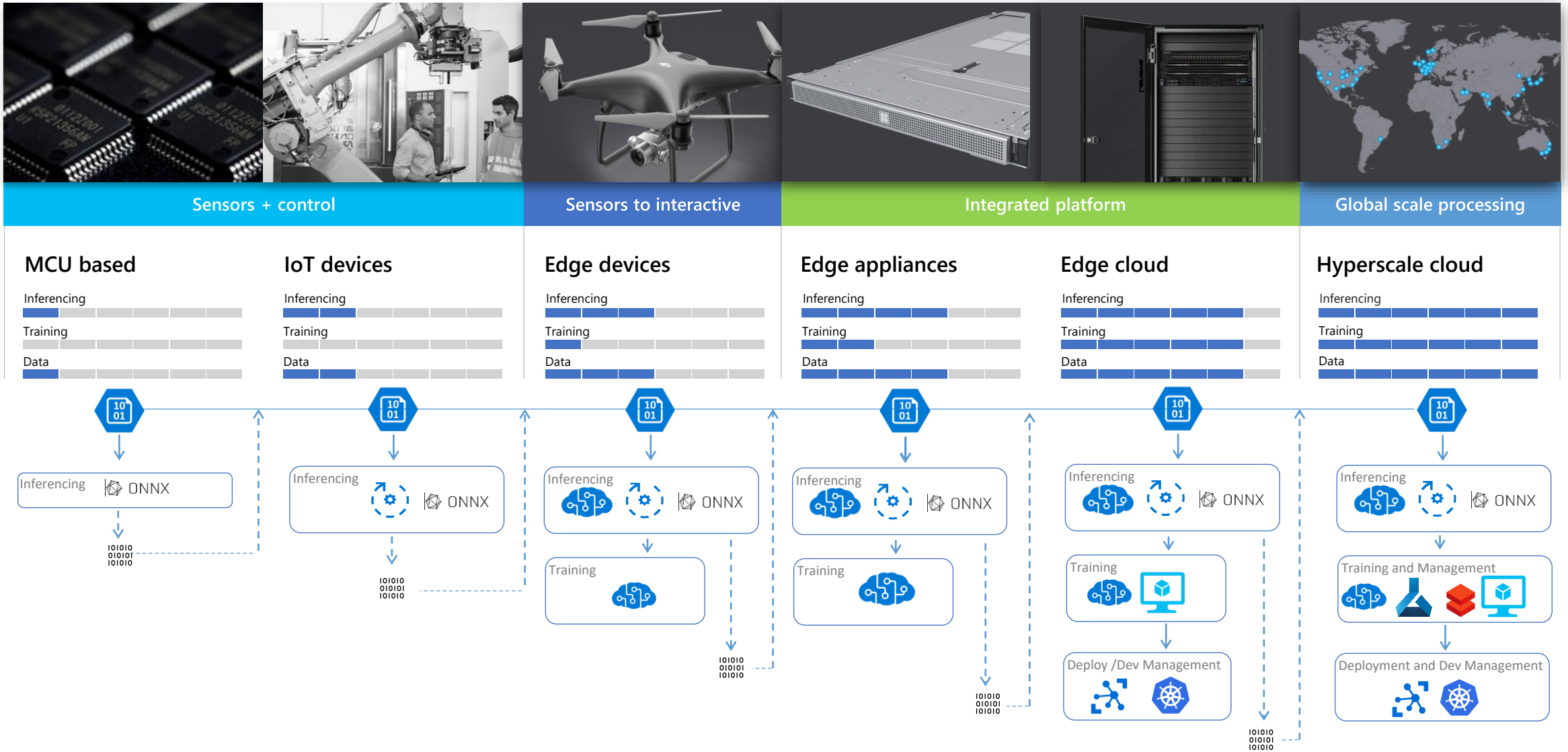
Variety of Deployment Options



Deployment targets with varying compute power



ACTIVITY B

Train a PyTorch model and deploy for production usage

References

- ONNX: https://github.com/onnx/onnx
- ONNX Converters: https://github.com/onnx/onnxmltools/tree/master/onnxmltools
- ONNX Tutorials: https://github.com/onnx/tutorials
- ONNX Runtime: https://github.com/microsoft/onnxruntime
- ONNX Runtime Tutorials: https://github.com/microsoft/onnxruntime#examples-and-tutorials
- Performance Tuning with ONNX Runtime: https://github.com/microsoft/onnxruntime/blob/master/docs/ONNX_Runtime_Perf_Tuning.md
- Training, Inferencing, and deployment in AzureML with ONNX models: https://aka.ms/onnxnotebooks
- AzureML resources: https://azure.microsoft.com/en-us/services/machine-learning/
- Deploying to Edge and IoT devices: Deploying to Intel OpenVINO based devices, Deploying to NVIDIA Jetson Nano (ARM64)
- Windows ML: https://docs.microsoft.com/en-us/windows/ai/windows-ml/

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