Enabling Machine Learning to Explode with Open Standards and Collaboration

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It’s Time To Work Together

Machine learning (ML) is maturing in many fields

Arm is donating Arm NN to help this effort
I Doubt You Missed ML’s Impact

ML enables new use cases

- Robust autonomous driving
- New authentication methods

ML improves existing applications

- Accurate speech recognition
- Image processing improvements
Challenges with Machine Learning

• You can become expert in machine learning
  • But not all the application domains
• You can become an expert in a specific domain
  • But not all frameworks and platforms
• You can build a machine learning SoC
  • But it can’t address all markets

We need to come together to solve this problem
### ML’s Software Challenges

<table>
<thead>
<tr>
<th>Application</th>
<th>Use Case</th>
<th>CPU and GPU alone</th>
<th>CPU and GPU and dedicated AI hardware</th>
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<tbody>
<tr>
<td>Access control</td>
<td>Face identification</td>
<td>✓</td>
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<tr>
<td><strong>Camera stills</strong></td>
<td>Object detection</td>
<td>✓</td>
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<td>Noise reduction</td>
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<td>Super resolution</td>
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<td>Semantic segmentation</td>
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<tr>
<td><strong>Video</strong></td>
<td>Super resolution</td>
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<td></td>
<td>Semantic segmentation</td>
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<td>✓</td>
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<tr>
<td><strong>Voice assistants</strong></td>
<td>Keyword spotting</td>
<td>✓</td>
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<td>Natural language processing</td>
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<td></td>
<td>Text to speech</td>
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<td>✓</td>
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<td><strong>Driving</strong></td>
<td>Autonomous driving</td>
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<td>✓</td>
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<td>Driver assistance</td>
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<td>✓</td>
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This Software Needs to be on the Edge

- Bandwidth
- Power
- Latency
- Cost
- Reliability
- Security
Project Trillium: Arm’s ML Computing Platform

**Ecosystem**

**Software Products**

**Hardware Products**

**AI/ML Applications, Algorithms and Frameworks**

- TensorFlow
- Caffe
- Caffe2
- mxnet
- Android NNAPI

**Software Libraries Optimized for Arm Hardware**

- CMSIS-NN
- armNN
- arm COMPUTE LIBRARY
- Object Detection Libraries

**Arm Hardware IP for AI/ML**

- **CPU**
  - arm CORTEX-A
  - arm NEON
  - arm CORTEX-M
  - Armv8 SVE
  - arm DynamIQ

- **GPU**
  - arm MALI

- **NPU and ODP**
  - Machine Learning (ML)
  - Object Detection (OD) processors

- **Partner IP**
  - DSPs, FPGAs, Accelerators
Domain Experts Needed

Object identification is ‘simple’

Husky Classified as Wolf*

Neural Network Interpretation*

If only every use case was this simple to understand...
We need domain expertise

ML is the Wild West

We have a strong code base to leverage

Caffe  
Caffe2  
xnet  
ONNX  
PyTorch  
TensorFlow Lite

Multiple, intermediate forms

FlatBuffers  
NNEF  
ONNX  
protobuf

A number of inference interfaces, which share core technology

Android NNAPI  
armNN  
MACE  
Paddle
We Need to Bring these Disciplines Together

Domain experts

Machine learning experts

Platform developers

We need to teach people to fish, across a wide array of problem domains and platforms.
We Think This Is So Important...

Linaro Machine Intelligence Initiative

- A centre of excellence for ML on Arm
- Exploiting existing code bases and member efforts

Arm is donating Arm NN to this effort

- Arm NN is already open source
- It will move to be managed by Linaro
- We hope the community finds this useful – and contributes!
What is Arm NN?

An inference engine for edge machine learning

1. Connect through high-level frameworks
2. Connect to existing inference engine
3. Integrate your own IP

Key Arm NN aims

- Strong optimization for Arm CPUs, GPUs and NPUs
- Interoperation with other inference engines
Make the Most of this Week for ML Discussions

AI and Neural Networks on Arm Summit

- **Deep dive on Arm NN**, Robert Elliott, Arm
- **TensorFlow for Arm**, Pete Warden, Google TensorFlow
- **Snapdragon in Arm NN**, Mark Charlebois, Qualcomm
- ....
Join Us

• Start contributing code
• Help us add exciting new features
• Speak to Linaro to learn more...
Thank You!
Danke!
Merci!
谢谢!
ありがとう!
Gracias!
Kiitos!
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