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TensorFlow World

PRESENTED WITH  TensorFlow

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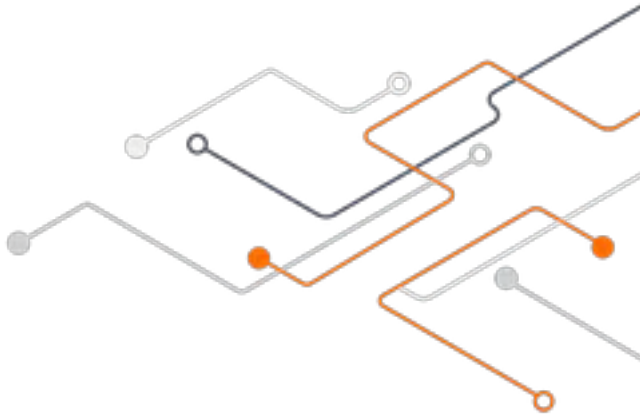
TensorFlow World
TensorFlow



MLIR

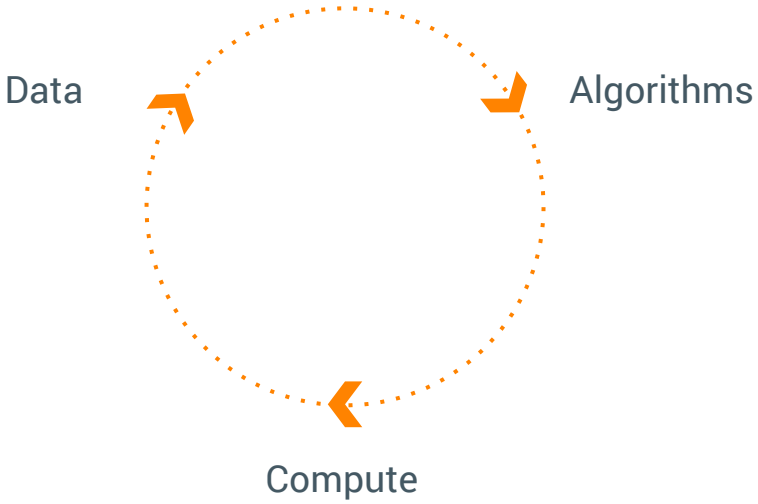
Accelerating AI

ML is a triumvirate: data, algorithms and compute

Data drives the continuous improvement cycle for ML models

Researchers provide new algorithmic innovations unlocking new techniques and models

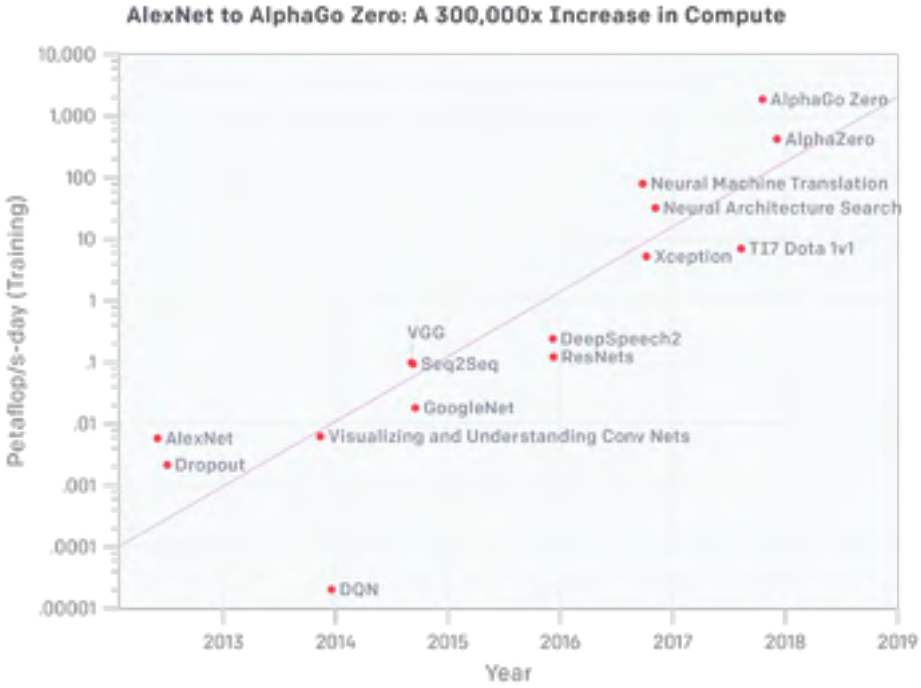
Compute allows it all to scale as datasets get larger and algorithms need to scale on that accordingly



Models are growing and getting more complex

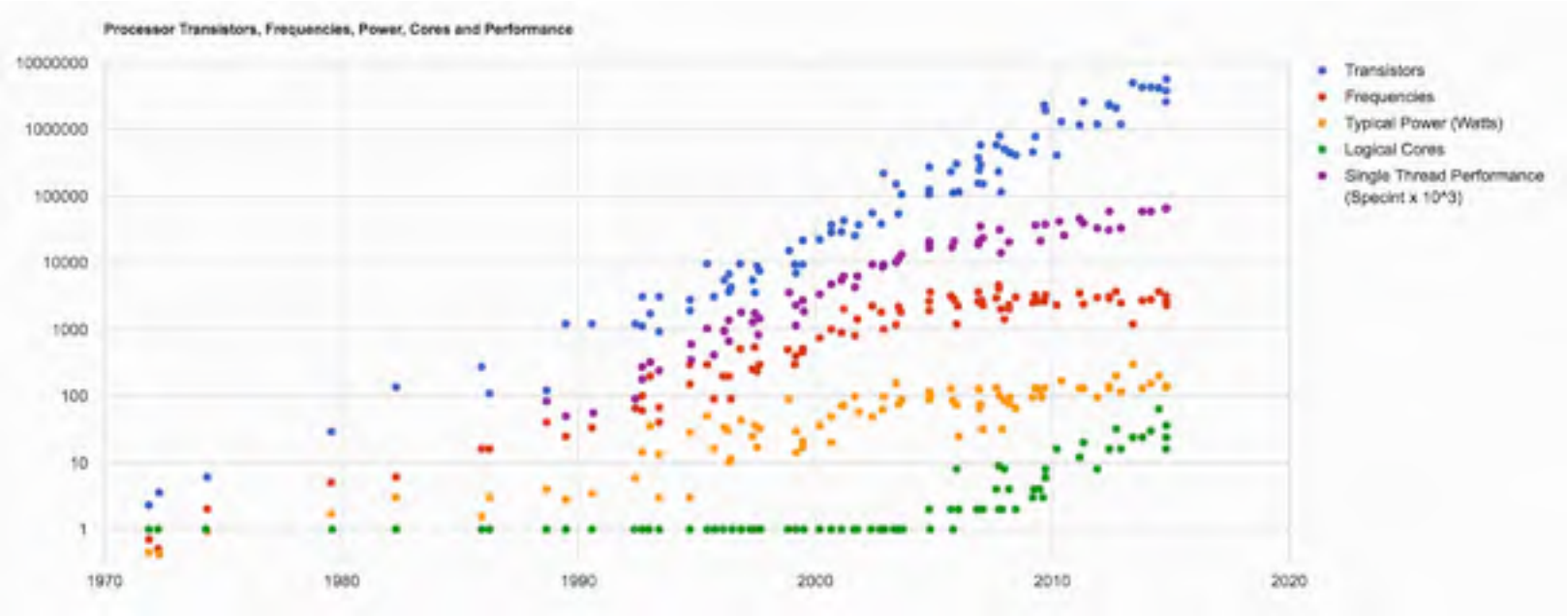
Model Size: larger models require more multiply accumulate operations.

Model Complexity: as model complexity increases it becomes harder to fully utilize hardware.



Source: OpenAI - AI & Compute

Moore’s law ending: new hardware needed



Source: 40 years microprocessor trend data

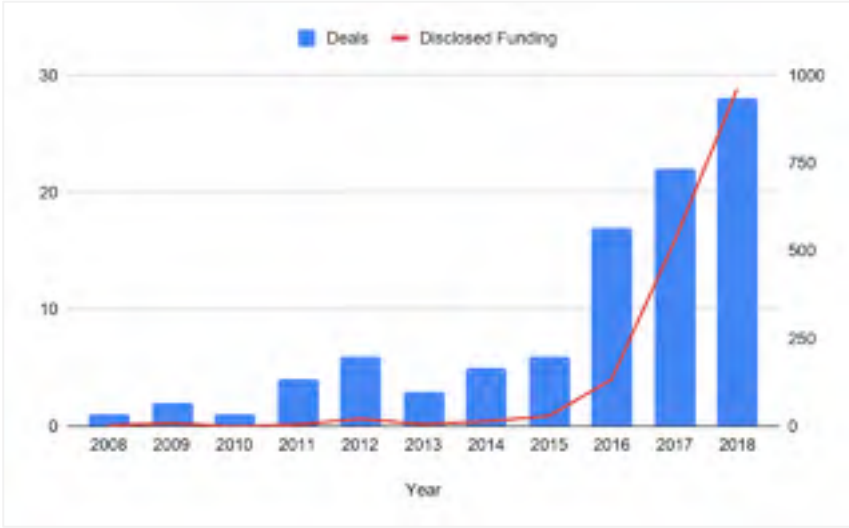
Explosion in HW startups & custom chips

Billions of dollars of funding going towards new ML ASICs

Rapid expansion of heterogeneous hardware solutions

Significant growth in deals and funding

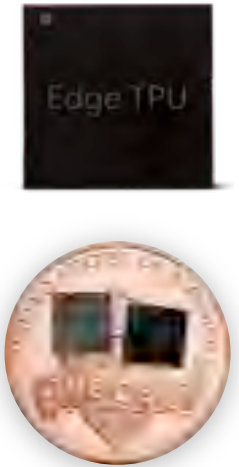
ML semiconductors global funding history
($M, # of deals)



Ongoing explosion in Edge Hardware

~5.5B Mobile Phones

250B+ Microcontrollers



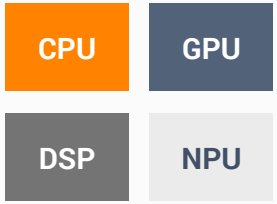
Edge TPUs

Heterogeneous Compute

Heterogeneous hardware is now the norm

Scaling from phones down to microcontrollers

Memory, energy, performance and latency constraints become paramount



Heterogeneous Compute

Datacenters

GPUs

CPUs

TPUs

and other hardware accelerators

More hardware features: complexity

- Many different hardware accelerators focused on ML
- Many different types and architectures: 4-bit, 16-bit, 32-bit…
- Inability to quickly scale up and down hardware consistently and varying levels of abstractions

TPU's

Cerebras Systems

Graphcore

Vibrant and expanding SW ecosystem

- Many frameworks & standards proposed
- Many different graph implementations
- Each framework is trying to gain a usability and performance edge over each other

PyTorch

mxnet

ONNX

Chainer

None of this is scaling!

What’s wrong?

- Systems don't interop
- Can’t handle all operators and types consistently on all hardware
- There is poor developer usability and debuggability across hardware

- No generalizable standard for ensuring software and hardware scales together
- Everyone is trying to build the same thing at great cost
- Fragmentation exists everywhere in the market today

So what would we want?

Common infrastructure: building blocks

- Best in class graph and compiler technology
- Designed for both training and inference, mobile and server
- The ability to scale ML from the edge all the way to the server

- A standard representation for types and operators, custom ops
- Framework independent
- Neutral governance

MLIR

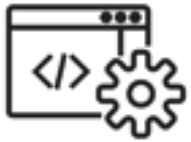
The industry agrees

- Largest HW partners in the world
- 95% of the world's data-center accelerator hardware
- 4 billion mobile phones countless IoT devices
- Governance moved to LLVM

What is MLIR?

A new **compiler infrastructure** that enables machine learning models to be consistently represented and executed **on any type of hardware**.

How is MLIR different?



State of Art Compiler Technology

MLIR is NOT just a common graph serialization format nor is there anything like it

Modular & Extensible

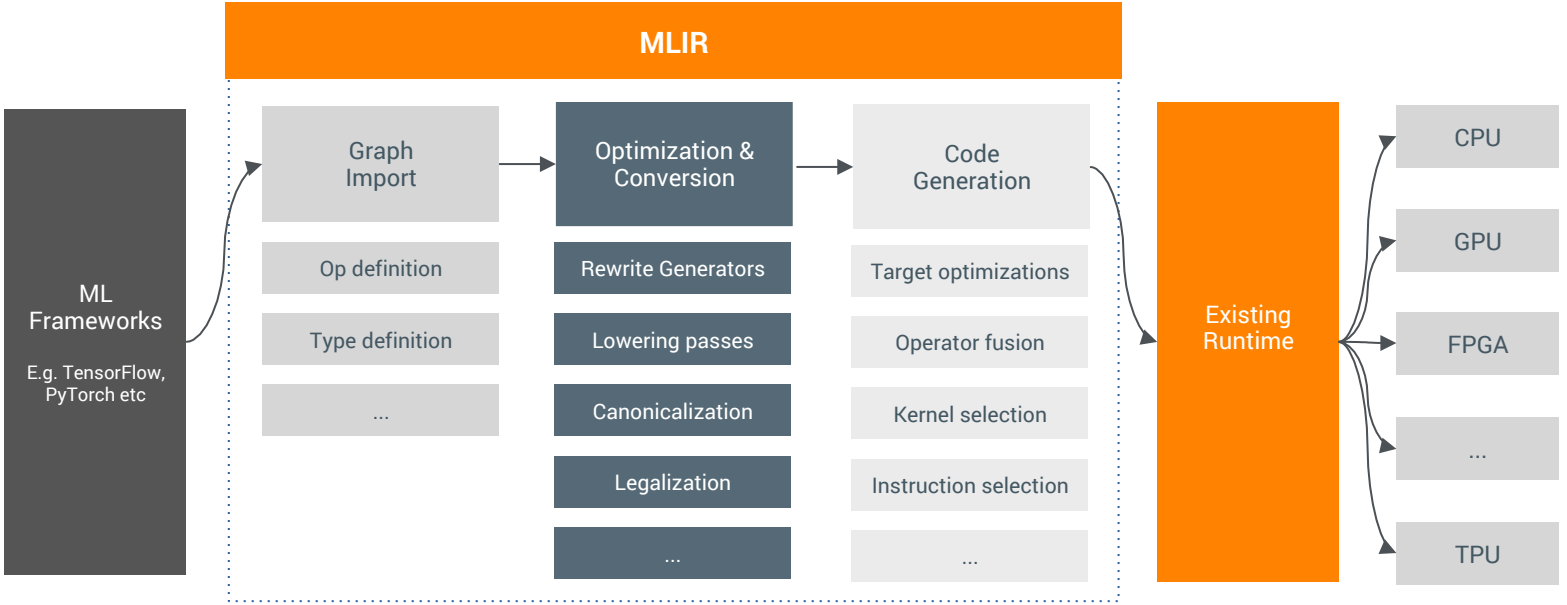
From graph representation through optimization to code generation

Not opinionated

Choose the level of representation that is right for your device

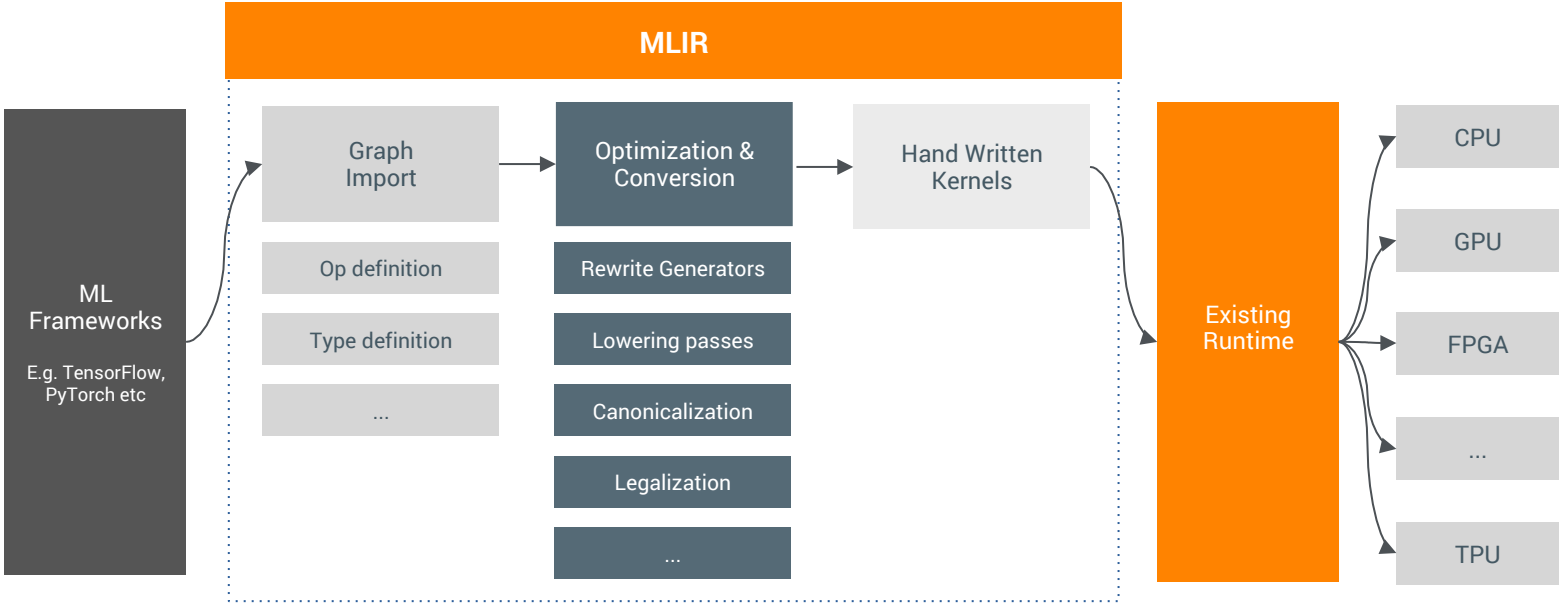
MLIR Compiler Infrastructure

TLDR: A common graph representation and legalization framework, a common set of optimization and conversion passes and a full code generation pipeline.



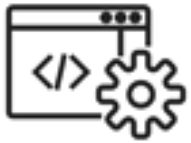
Enables many different approaches

You are free to utilize different components of the system as you need.
MLIR can also be modularized as a graph rewriting tool like we do for TensorFlow Lite.



What does this mean for TensorFlow?

Building a better TensorFlow



The Same Public Interfaces

We are maintaining all the public interfaces:

GraphDef, SavedModel, Python APIs, HLO, XLA, XRT, xprof, ...

Hardware Representation

Better flexibility and representation across all hardware

Higher performance and more reliable

Stack Convergence

Increased stack convergence

A better and more consistent user experience

Easier to try new hardware

What does this mean for you as a Python Developer?

A better TensorFlow developer experience

MLIR will make your TensorFlow development experience **so much better**.

How?

- Enable consistent model across different hardware
- Enable better out-of-the-box performance
- Pinpoint mistakes back to the line of python code

/** Current TensorFlow error experience */

F0122 11:20:14.691357 27738 import_tensorflow.cc:2549] Check failed: status.ok() Unexpected value for attribute 'data_format'. Expected 'NHWC'

*** Check failure stack trace: ***

…

*** SIGABRT received by PID 27738 (TID 27738) from PID 27738; ***

F0122 11:20:14.691357 27738 import_tensorflow.cc:2549] Check failed: status.ok() Unexpected value for attribute 'data_format'. Expected 'NHWC'

E0122 11:20:14.881460 27738 process_state.cc:689] RAW: Raising signal 6 with default behavior

Aborted

Obscure Error Details

/** MLIR improves your dev experience */

node “MobilenetV1/MobilenetV1/Conv2d_0/Conv2D” defined at 'convolution2d' tensorflow/contrib/layers/python/layers/layers.py:1156:
  conv_dims=2)
  ^

TF Source Location

…

at 'build_model' resnet/train_experiment.py:165:
  inputs, depth_multiplier=FLAGS.depth_multiplier)
  ^

Your Code Location

…

error: 'tf.Conv2D' op requires data_format attribute to be either 'NHWC' or 'NCHW'

Clear Error Details

MLIR: propelling the industry

Neutral governance through LLVM

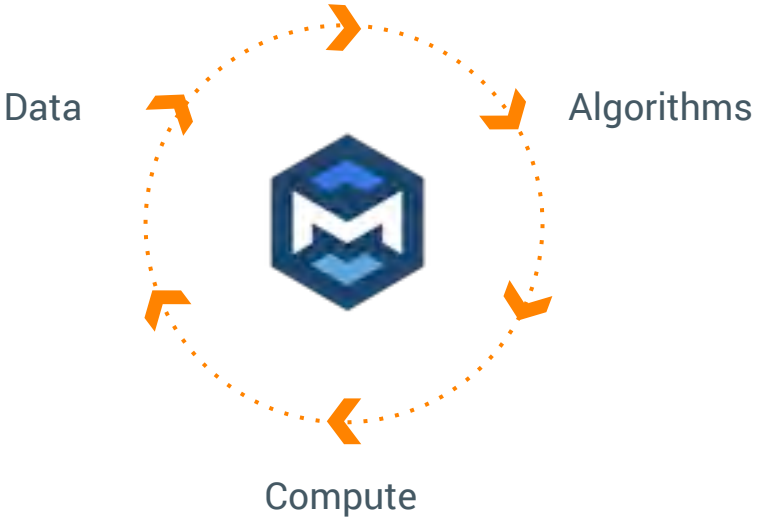
MLIR has been accepted as part of the **nonprofit LLVM Foundation**

This will enable even faster adoption of MLIR by the industry as a whole

MLIR is building a
global compiler **community**
to make ML better for **everyone.**

Together, lets advance the state of ML

MLIR is **accelerating data, algorithmic and HW innovation** through **open infrastructure** that ensures models will be **represented, executed and scaled correctly**.



MLIR: Accelerating AI for the world.

Thank you

github.com/tensorflow/mlir

Questions?

mlir@tensorflow.org