AI 框架之争

ZOMI

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关于本内容

1. 内容背景

- AI框架的基础介绍

2. 具体内容

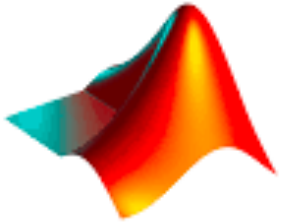
- AI框架作用：深度学习基础 – AI框架的作用 - AI框架的目的
- AI框架之争：第一代框架 – 第二代框架 – 第三代框架
- 编程范式：声明式编程 - 命令式编程

Gen 1 pre-2010

- **解决问题**
  - 机器学习ML中缺乏算法库
  - 稳定和统一的神经网络NN定义
- **主要特点 - Library**
  - 脚本式编程
  - 通过简单配置的形式定义神经网络
  - 针对特殊的ML、NN算法提供接口（MATLAB、SciPy）
  - 针对矩阵计算提供特定的计算接口（NumPy）
- **优点**
  - 提供了一定程度的可编程性
  - 计算性能高：支持CPU加速计算

NumPy

SciPy

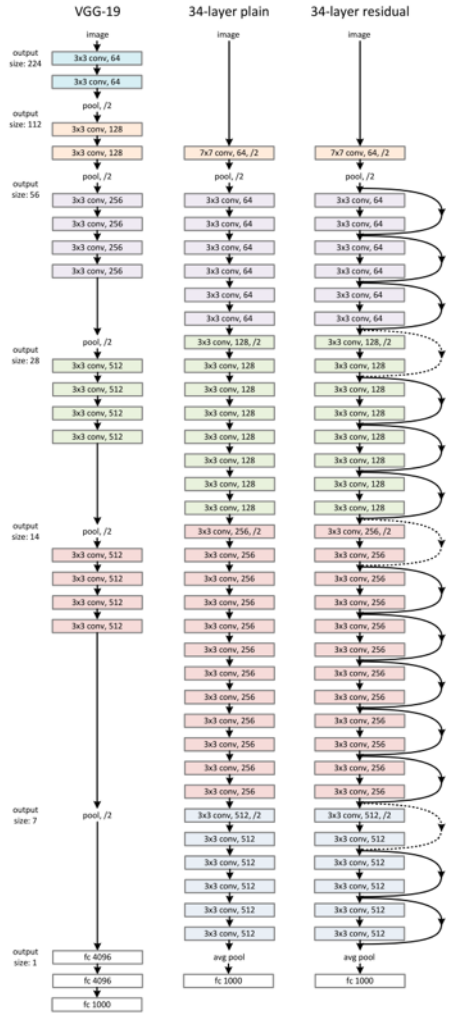


MATLAB®

Gen 1 pre-2010

- **解决问题**
  - 以CNN网络模型为主，由常用的layers组成，如：Convolution, Pooling, BatchNorm, Activation等
- **主要特点 – Layer Base**
  - 通过简单配置文件的形式定义神经网络
  - 模型可由一些常用layer构成一个简单的图
  - 框架提供每一个layer及其梯度计算实现
  - 支持多设备加速：CPU和GPU的高效计算
- **优点**
  - 提供了一定程度的可编程性
  - 计算性能高：支持GPU加速计算

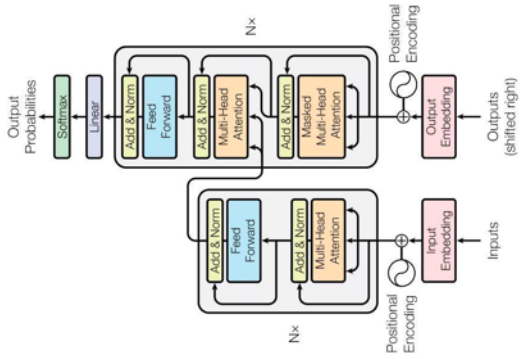
```
layer {
  name: "conv2"
  type: "Convolution"
  bottom: "pool1"
  top: "conv2"
  param {
    lr_mult: 1
  }
  param {
    lr_mult: 2
  }
  convolution_param {
    num_output: 50
    kernel_size: 5
    stride: 1
    weight_filler {
      type: "xavier"
    }
    bias_filler {
      type: "constant"
    }
  }
}
layer {
  name: "pool2"
  type: "Pooling"
  bottom: "conv2"
  top: "pool2"
  pooling_param {
    pool: MAX
    kernel_size: 2
    stride: 2
  }
}
```

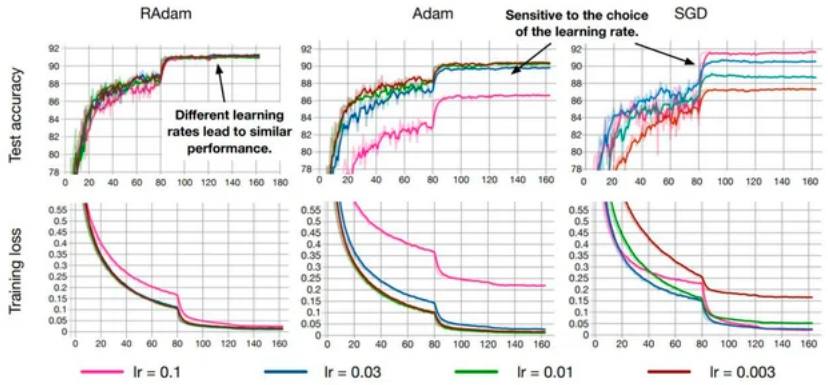


Gen 1 pre-2010 limitation (I)

灵活性的限制难以满足深度学习的快速发展

- 层出不穷的新型网络结构
- 新层需要重新实现前向和后向计算
- 非高级语言实现，修改和定制化成本高
- 新优化器要求对梯度和参数进行更通用复杂的运算

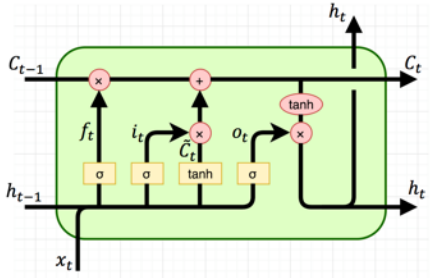


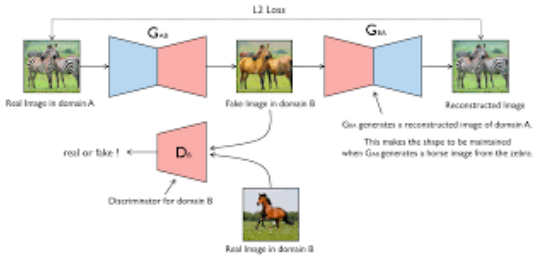


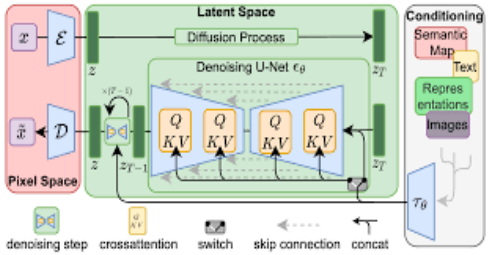
Gen 1 pre-2010 limitation (II)

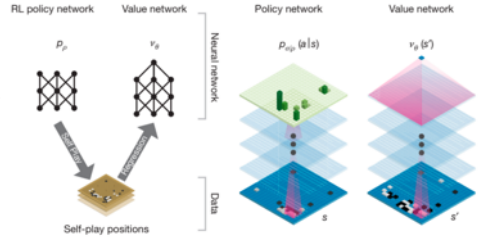
基于简单的“前向+后向” 的训练模式难以满足新的训练模式

- 循环神经网络需要引入控制流
- 对抗神经网络需要两个网络交替训练
- 强化学习模型需要和外部环境进行交互







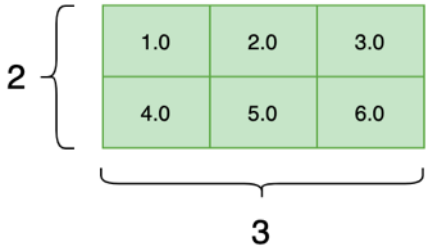


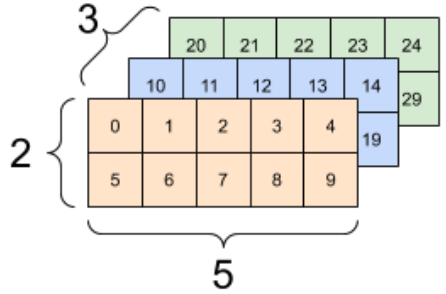
Gen 2 Present：Base DAG

基于数据流图（DAG）的计算框架

基本数据结构：Tensor 张量

- Tensor形状： [2, 3, 4, 5]
- 元素类型：int, float, string, etc.





基本运算单元：Operator 算子

- 由最基本的代数算子组成
- 根据深度学习结构组成复杂算子
- N个输入Tensor，M个输出Tensor

Add	Log	While
Sub	MatMul	Merge
Mul	Conv	BroadCast
Div	BatchNorm	Reduce
Relu	Loss	Map
Floor	Sigmoid	…..

Gen 2 Present：Base DAG

基于数据流图（DAG）的计算框架

DAG 表示计算逻辑和状态

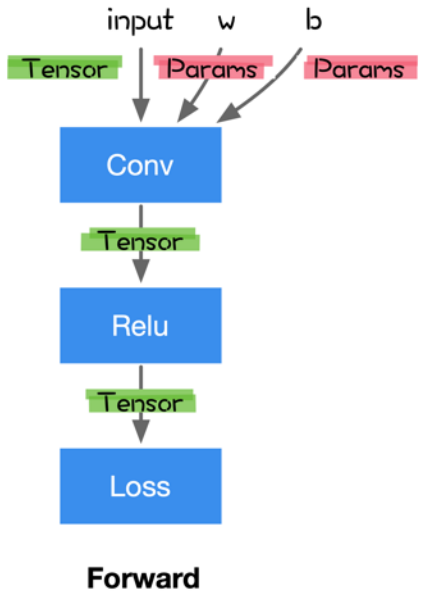
- 节点代表 Operator
- 边代表 Tensor

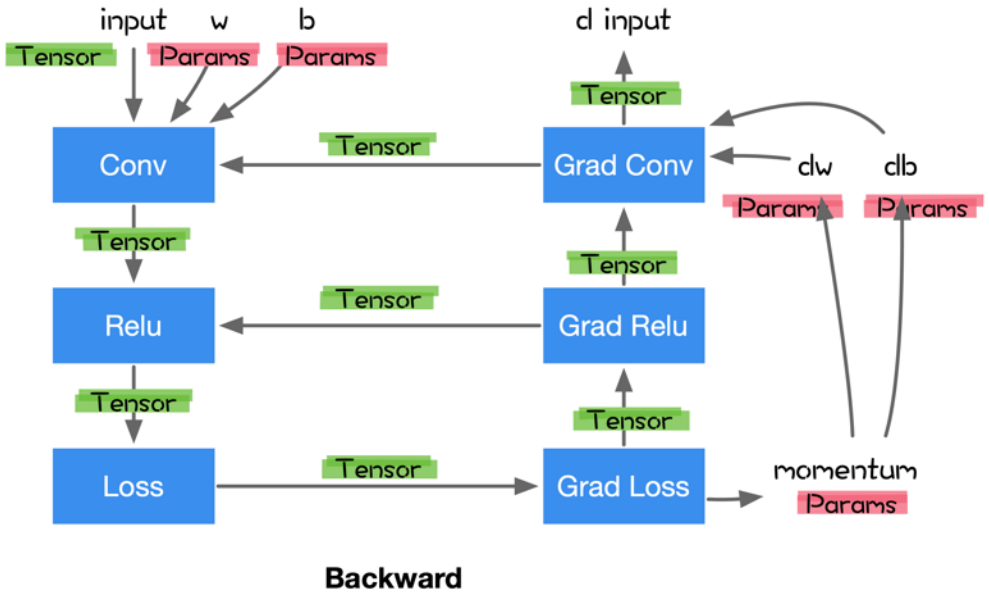
特殊的操作

- 如：For/While 等构建控制流

特殊的边

- 如：控制边表示节点间依赖

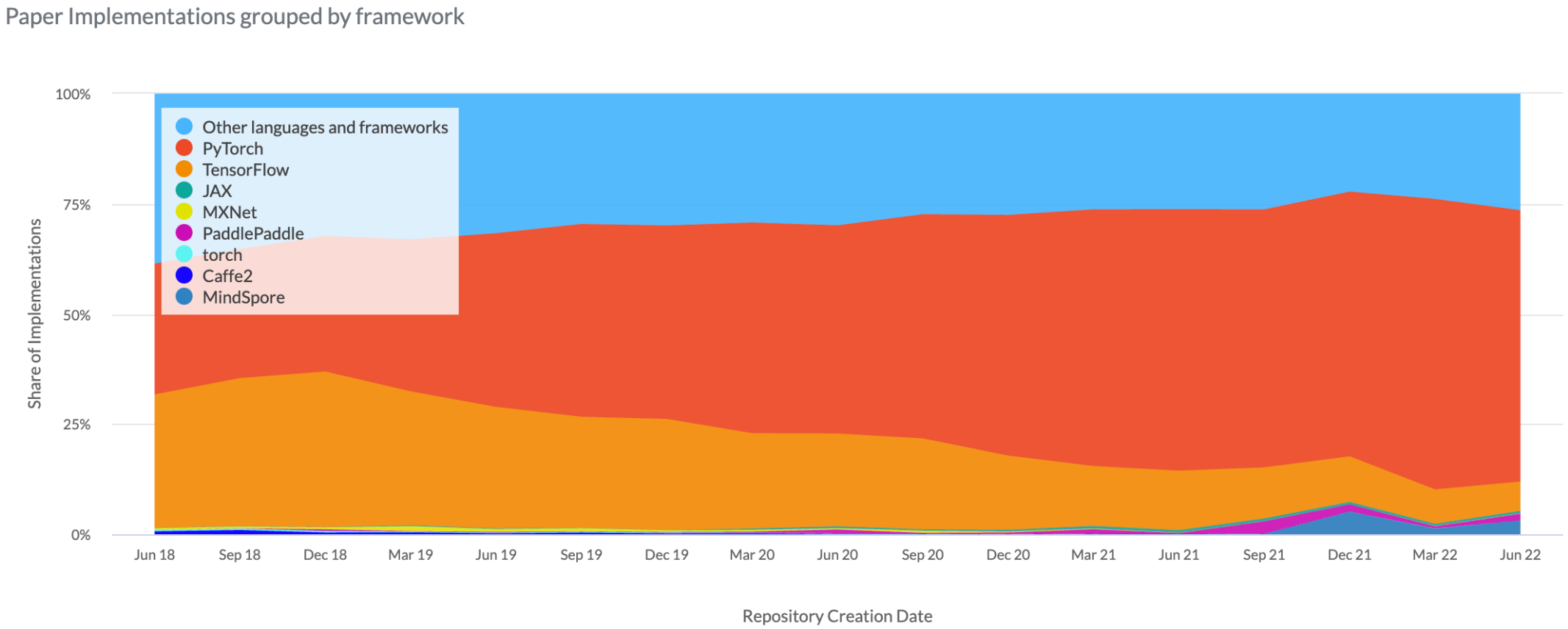




Gen 2 Present：Base DAG

TensorFlow vs PyTorch 代表深度学习框架两种不同的设计路径：

系统性能优先改善灵活性和灵活性易用性优先改善系统性能



Gen 3 Present：toward DSL

设计特定领域语言(Domain-Specific Language，DSL)


PyTorch 2.0

MindSpore


JAX


TF Eager

Gen 3 Present：toward DSL

兼顾编程的灵活性和计算的高效性

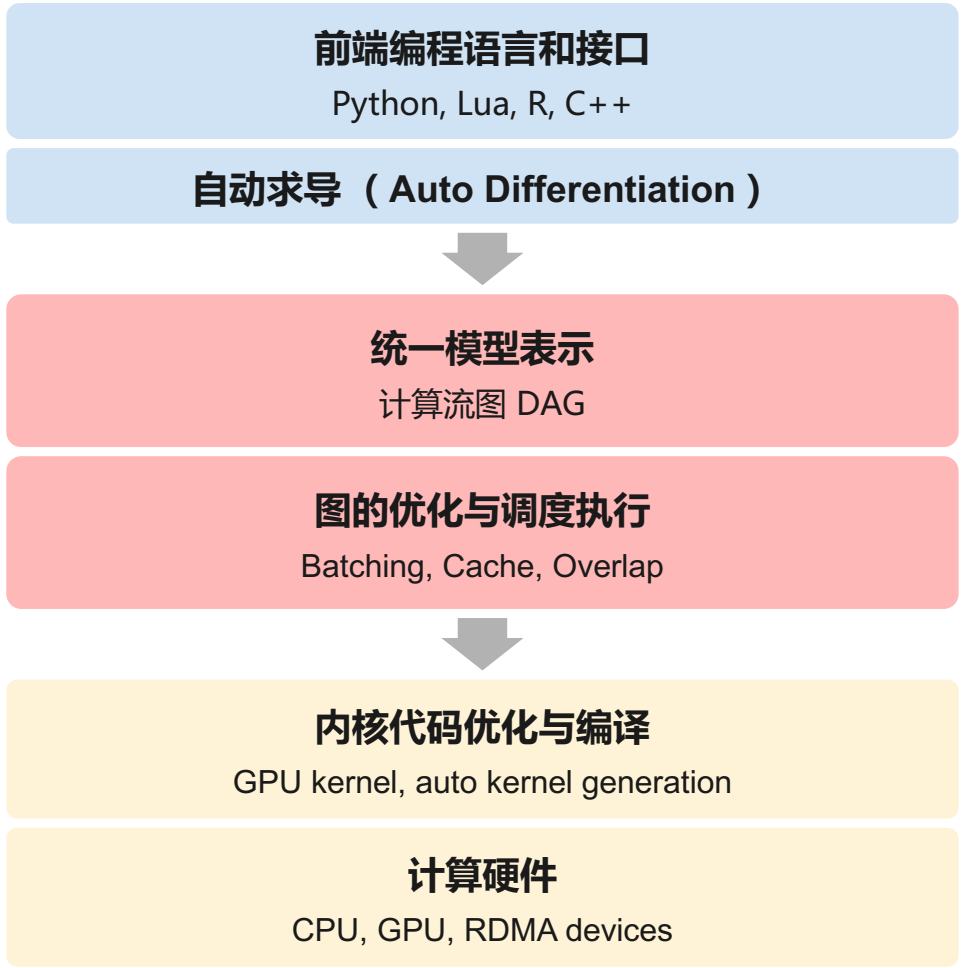
- 提高描述神经网络算法表达能力和编程灵活性
- 通过编译期优化技术来改善运行时性能

PyTorch JIT

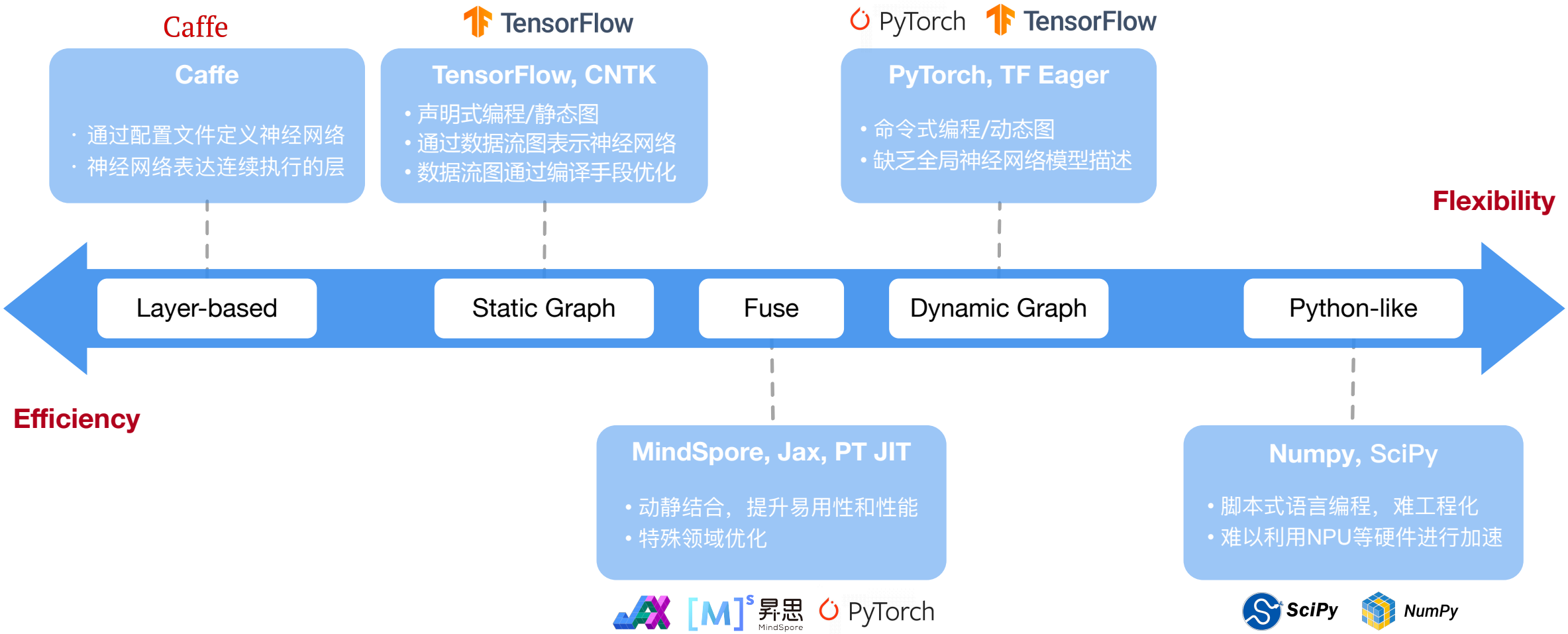
TF Eager

MindSpore

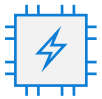
JAX



Advances in AI frameworks



Advances in AI frameworks

	Gen 1 *pre-2010*	Gen 2 *2010-present*	Gen 3 *present-*
Frameworks	**Custom** purpose machine learning **algorithms**  numpy SciPy	**Deep learning frameworks** provide easier ways to leverage various libraries  Theano Caffe TensorFlow PyTorch	**Machine Learning Language and Compiler**  A Full-Featured Programming Language for ML: • Expressive and flexible • Control flow • recursion  Powerful Compiler Infrastructure: • Code optimization • sparsity optimization • hardware targeting MindSpore, Jax PyTorch, TF Eager
Hardware	Algebra & linear libs • CPU • GPU	Neural network libs • CPU • GPU • NPU	 • SIMD → MIMD • Sparsity Support • Control Flow and Dynamicity • Associated Memory

Summary

1. 回顾了AI框架的发展趋势
   - 第一代解决深度学习编程问题
   - 第二代AI框架加速科研和产业落地
   - 第三代结合特定领域语言和任务，快速发展
2. 一起学习了AI框架随着的软硬件的发展升级而共同发展