IVU LECTURES

PYTORCH BASIC KNOWLEDGE

FACTS ON TENSORS, MODULES AND FUNCTIONALS FOR YOUR DAILY DEEP LEARNING ROUTINE

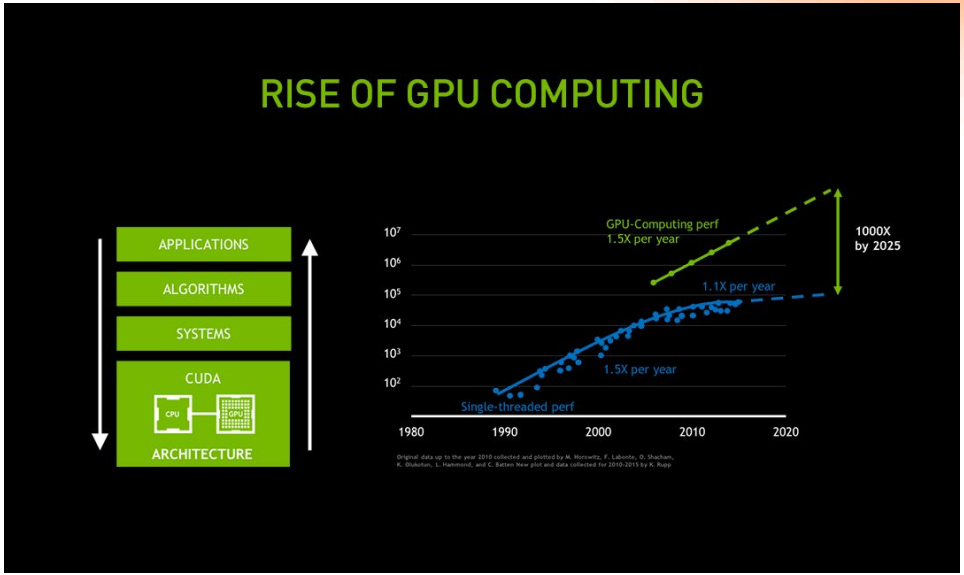
PYTORCH

PyTorch is a Python library mainly used to perform deep learning tasks such as building, training and evaluating neural network models.

GPU-Accelerated Computing

PyTorch is deeply integrated with CUDA, to run the training of models directly in the GPU

- Tensors and models can be sent to the GPU
- Gradient checkpointing can be used if GPU memory is slow
- GPU acceleration dramatically improves the time performances



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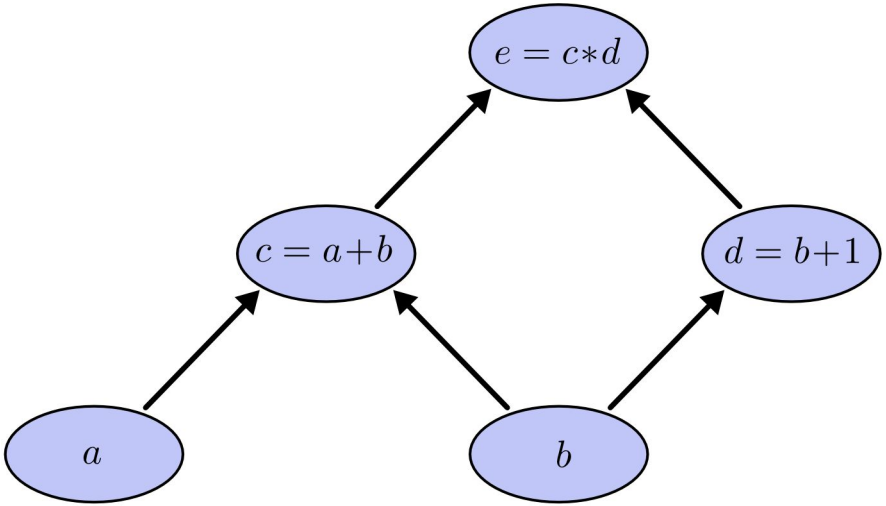


Dynamic Derivative Graph

PyTorch allows user to change dynamically the model structure at runtime:

- Network defined in a modular way. Modules can be deleted and added
- Useful for RNNs/LSTMs and model pruning
- Require the user to manually zero out gradients

PYTORCH

Its father

- Lua-based framework with the same purposes
- Inspirational source of Pytorch and the two frameworks share some authors
- **Not actively supported anymore**

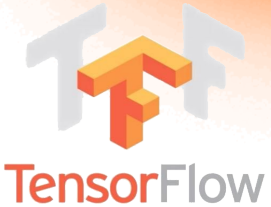
Its mother

- Python-based framework with the same purposes
- Has dynamic graphs too
- Uses autograd too
- **Lot of backend in Python**
- **Worse efficiency**

Its cousin

- Python-based MATLAB-like library for scientific computing
- Popular tensor indexing and slicing mechanics
- Lots of scientific computing algorithms (check also SciPy, scikit-learn, matplotlib)
- **Poor GPU support for Deep Learning tasks**

Its rival



- Python-based too
- Older than PyTorch
- Largely used in production environments
- **Harder to debug**
- **Default static differentiation graph**
- Will switch to a PyTorch-inspired framework within months

Basic structures

Tensor: the most important one. It's used to perform array-like computations i.e. vectorial sums, vectorial/element-wise products, etc.

Characteristics

- Very similar to NumPy's *ndarray* structure (efficient NumPy conversion)
- Advanced indexing/slicing (since v0.3)
- Can store associated derivatives values:
  - v0.4: *requires_grad/requires_grad_()*
  - v0.3: *Variable* wrapping
- Can be sent to GPU for faster computations:
  - v0.4: *to(device='gpu:0')*
  - v0.3 *cuda()*

Basic structures

Module: base class used to create NNs building blocks. It is used to represent convolutional operators, non-activation function, losses, grouping of Modules, etc.

Characteristics

- Defines a *forward* abstract method, for the forward pass
- *forward* is then called by *__call__* method
- Has methods to easily debug gradients (*register_*_hook*)
- It usually stores a *Functional* performing the operation (not covered in this tutorial)

Parameter: subclass of Tensor used for model weights that need to be updated.

Characteristics

- Each *Parameter* field of a Module object will receive gradient updates during the backward pass

Basic structures

_Loss: Module subclass which represents losses. Includes MSE, cross-entropy, etc.

Characteristics

- Calling *backward* method will results in computing all the needed gradients.

Optimizer: Base class for optimizers. Includes SGD, Adam, etc.

Characteristics

- Accept a group of arguments (*lr*, *momentum*, *weight_decay*, etc.) and a group of weights to be updated (just call *Module.parameters* method on your model)
- Call *step* method to start the weights update

Basic structures

Dataset: base class representing a train or test dataset.

Characteristics

- Two methods must always be present:
  - *__len__* to retrieve the length of the dataset
  - *__getitem__* to get items from the dataset.
- Lots of standard datasets are already defined in *torchvision* library

DataLoader: base class which automatizes the batches generation from Dataset objects.

Characteristics

- Requires a *Dataset* object to iterate on
- Usually the standard *DataLoader* suffices for classification tasks, however more specialized ones are defined
- It is used in for cycles. *__iter__* method returns an iterator on the *Dataset* object

@googleslides

LET'S START