TorchBench: quantifying PyTorch performance during the development loop

Holding the line of performance and boosting optimizations for the PyTorch ecosystem.

Abstract

Goal: Quantifying PyTorch performance during the development loop.

Fig. 1: Quantification of PyTorch performance in 2022.

Specifically, we answer the following questions:

- How do we know a GitHub PR speeds up or slows down PyTorch?
- How do we know an update in vendor libraries (e.g., CUDA) affect PyTorch performance?
- How do we find out the commit that caused PyTorch performance regression?

Technologies

Slicing model code We run one iteration per train/inference test with data prefetched to the device to achieve fast Time-To-Signal.

Tuning performance on public cloud We carefully tune the AWS/GCP hardware to stabilize performance results.

Bisection We implement a bisector to automatically find out which commit caused the performance signal, including both optimization and regression.

Performance Signals Detected

<table>
<thead>
<tr>
<th>Date</th>
<th>Root Cause</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022-03-25</td>
<td>builder#1000</td>
<td>Speedup: cuDNN upgrade</td>
</tr>
<tr>
<td>2022-07-11</td>
<td>pytorch#65839</td>
<td>Regression: additional runtime check</td>
</tr>
<tr>
<td>2022-10-04</td>
<td>pytorch#84948</td>
<td>Speedup: enable new cuDNN front-end API</td>
</tr>
</tbody>
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Boosting PyTorch backend development

Simple interface to add a new backend

```
1 # Example: torchscript backend
2 @create_backend
3 def torchscript(model: BenchmarkModel, args: List[str]):
4     module, example_input = model.get_module()
5     model.set_module(torch.jit.script(module, example_inputs))
```

```
$ python run.py resnet50 --backend torchscript --profile
```

Benchmarks-as-a-service

PR-level benchmarking With a magic word "RUN_TORCHBENCH" in PR, users can choose to benchmark their PR and visualize results at PyTorch HUD.

User customized benchmark Sometimes users want customized performance metrics or simply microbenchmarks, we support this through user-defined benchmark scripts. GPU memory leak and utilization signals are working-in-progress.

Nightly and Pre-release testing

TorchBench supports both Nightly and Pre-release testing CIs to catch performance bugs before production.

Challenges

Fast response Each test must finish in seconds instead of minutes or hours.

Coverage Need to cover both train and inference across a wide range of PyTorch models and devices.

Stableness Need to tune the benchmark environment to achieve stable results.

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