Test Plan: PyTorch Collective Operations

# Category: PyTorch Collective Operations

## Test Case TC001

Description: Functional test for torch.distributed.all\_reduce. Validate that the operation correctly reduces tensors across all processes. Parameterize on data types (float32, float16, int64), tensor sizes (small, medium, large), and world sizes (2, 4, 8). Ensure synchronization across processes. Expected result: The reduced tensor should be the sum of all tensors across processes.

## Test Case TC002

Description: Performance test for torch.distributed.all\_reduce using torch\_profiler. Measure the time taken and memory usage for different tensor sizes and world sizes. Parameterize on data types and tensor shapes. Expected result: The operation should scale efficiently with increasing world size and minimize memory overhead.

## Test Case TC003

Description: Edge case test for torch.distributed.all\_reduce with zero-sized tensors. Validate that the operation handles empty tensors without errors. Parameterize on data types and world sizes. Expected result: The operation should complete successfully without modifying the empty tensor.

## Test Case TC004

Description: Edge case test for torch.distributed.all\_reduce with single-element tensors. Validate correct reduction behavior. Parameterize on data types and world sizes. Expected result: The reduced tensor should be the sum of single-element tensors across processes.

## Test Case TC005

Description: Functional test for torch.distributed.all\_reduce on different devices (CPU, GPU, HPU). Validate correct operation across devices. Parameterize on data types, tensor sizes, and world sizes. Expected result: The reduced tensor should be consistent across all devices.

## Test Case TC006

Description: Synchronization test for torch.distributed.all\_reduce. Validate that processes are properly synchronized during the operation. Parameterize on data types, tensor sizes, and world sizes. Expected result: All processes should complete the operation simultaneously.

## Test Case TC007

Description: Bandwidth utilization test for torch.distributed.all\_reduce. Measure the bandwidth usage during the operation for different tensor sizes and world sizes. Parameterize on data types. Expected result: The operation should efficiently utilize available bandwidth.