

Sample result of DDP benchmark:

Key takeaway: 1) In the forward path, Python impl is 1% faster than DPP Core. Python SYNC and ASYNC are on-par 2) re2 backward, speed ranking: DDPCore > Python Async > Python SYNC. 3) Python ASYNC - backward is [2%-20%] slower than DDPCore, varies by buffer size slightly * It's expected since larger buffer size means less parallelization as number of buckets decreases * No difference once buffer size is larger than total elements (24.37M) such as 25M, 26M, 27M 3) Python SYNC - backward is 20% slower than DDP Core, independent of buffer size

The following is generated summary from compare_ddp.py

```

=== Summary for buffer_size: 3M ===
DDP: [forward]
-----
DDPOption.DDP_CPP_CORE          210.141    0          210.042    0          210.64    0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION 208.221 -0.913365 208.235 -0.860175 208.376 -1.07
DDPOption.PYTHON_DDP_SYNC_REDUCTION 208.272 -0.889167 208.269 -0.843666 208.399 -1.06

DDP: [backward]
-----
DDPOption.DDP_CPP_CORE          471.928    0          471.874    0          472.614    0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION 483.761  2.50722  483.565  2.4776  485.201  2.6632
DDPOption.PYTHON_DDP_SYNC_REDUCTION 566.434 20.0254  567.739 20.3159  571.238 20.8676

=== Summary for buffer_size: 4M ===
DDP: [forward]
-----
DDPOption.DDP_CPP_CORE          210.668    0          210.536    0          211.12    0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION 208.519 -1.0202  208.526 -0.954858 208.652 -1.169
DDPOption.PYTHON_DDP_SYNC_REDUCTION 208.17  -1.18543 208.188 -1.1155  208.304 -1.334

DDP: [backward]
-----
DDPOption.DDP_CPP_CORE          470.809    0          470.785    0          471.277    0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION 485.663  3.15505  484.757  2.96779  487.478  3.4377
DDPOption.PYTHON_DDP_SYNC_REDUCTION 567.582 20.5547  569.553 20.9794  575.34  22.0812

=== Summary for buffer_size: 5M ===
DDP: [forward]
-----
DDPOption.DDP_CPP_CORE          210.501    0          210.56    0          211.131    0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION 208.274 -1.05815 208.286 -1.08026 208.39  -1.2983
DDPOption.PYTHON_DDP_SYNC_REDUCTION 208.205 -1.09092 208.209 -1.11681 208.373 -1.3065

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DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	471.921	0	471.908	0	472.321	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	491.629	4.176	491.88	4.23226	492.99	4.3760
DDPOption.PYTHON_DDP_SYNC_REDUCTION	568.702	20.5077	570.053	20.7975	574.92	21.7225

=== Summary for buffer_size: 6M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
-----	-----	-----	-----	-----	-----	-----
DDPOption.DDP_CPP_CORE	210.357	0	210.192	0	211.027	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.218	-1.01707	208.208	-0.943888	208.37	-1.25
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.299	-0.978459	208.287	-0.906401	208.47	-1.23

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
-----	-----	-----	-----	-----	-----	-----
DDPOption.DDP_CPP_CORE	471.916	0	471.911	0	472.311	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	491.337	4.11541	491.197	4.08693	492.112	4.1924
DDPOption.PYTHON_DDP_SYNC_REDUCTION	570.087	20.8028	570.468	20.8848	574.322	21.5982

=== Summary for buffer_size: 7M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
-----	-----	-----	-----	-----	-----	-----
DDPOption.DDP_CPP_CORE	210.471	0	210.23	0	211.335	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.3	-1.03175	208.283	-0.926544	208.452	-1.364
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.35	-1.00775	208.322	-0.907727	208.457	-1.362

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
-----	-----	-----	-----	-----	-----	-----
DDPOption.DDP_CPP_CORE	475.447	0	475.652	0	476.054	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	495.606	4.24003	495.646	4.20351	496.405	4.2748
DDPOption.PYTHON_DDP_SYNC_REDUCTION	570.23	19.9356	570.335	19.9059	574.516	20.683

=== Summary for buffer_size: 8M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
-----	-----	-----	-----	-----	-----	-----
DDPOption.DDP_CPP_CORE	210.426	0	210.404	0	210.867	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.223	-1.0471	208.211	-1.04268	208.378	-1.180
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.441	-0.943627	208.416	-0.94522	208.594	-1.077

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	471.366	0	471.394	0	471.727	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	503.342	6.7838	503.624	6.83717	504.701	6.9900
DDPOption.PYTHON_DDP_SYNC_REDUCTION	571.185	21.1767	571.836	21.3075	574.946	21.8813

=== Summary for buffer_size: 9M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	210.666	0	210.605	0	211.053	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.262	-1.14128	208.247	-1.11954	208.39	-1.2613
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.249	-1.14753	208.231	-1.12721	208.421	-1.2466

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	475.742	0	475.783	0	476.311	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	505.635	6.2835	505.944	6.33916	507.325	6.5112
DDPOption.PYTHON_DDP_SYNC_REDUCTION	571.18	20.0608	570.698	19.9493	574.136	20.538

=== Summary for buffer_size: 10M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	210.235	0	210.238	0	210.766	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.364	-0.889884	208.367	-0.890317	208.483	-1.08
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.303	-0.918867	208.306	-0.91942	208.423	-1.11

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	471.262	0	471.33	0	471.687	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	506.905	7.56332	506.819	7.52959	507.886	7.6744
DDPOption.PYTHON_DDP_SYNC_REDUCTION	568.922	20.723	569.875	20.9079	572.408	21.3534

=== Summary for buffer_size: 11M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	210.124	0	210.003	0	210.431	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.387	-0.82678	208.382	-0.772006	208.526	-0.90
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.59	-0.730352	208.559	-0.68767	208.795	-0.77

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	470.129	0	470.107	0	470.559	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	512.012	8.90881	510.767	8.64915	516.538	9.7710
DDPOption.PYTHON_DDP_SYNC_REDUCTION	571.999	21.6685	571.894	21.6519	574.109	22.0057

=== Summary for buffer_size: 12M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	210.276	0	210.11	0	210.724	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.166	-1.00303	208.158	-0.929433	208.319	-1.14
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.195	-0.989416	208.204	-0.907414	208.337	-1.13

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	477.764	0	477.682	0	478.799	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	518.928	8.61592	519.858	8.82943	521.836	8.9884
DDPOption.PYTHON_DDP_SYNC_REDUCTION	570.09	19.3244	571.131	19.5631	574.142	19.9129

=== Summary for buffer_size: 13M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	210.758	0	210.618	0	211.531	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.119	-1.25216	208.104	-1.19357	208.269	-1.5420
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.122	-1.25057	208.106	-1.19253	208.245	-1.5538

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	471.435	0	471.443	0	471.977	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	514.153	9.06126	512.027	8.60847	521.519	10.496
DDPOption.PYTHON_DDP_SYNC_REDUCTION	567.48	20.3729	567.488	20.3725	570.315	20.839

=== Summary for buffer_size: 14M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	210.501	0	210.384	0	210.973	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.199	-1.09343	208.211	-1.03275	208.334	-1.2511
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.285	-1.0527	208.27	-1.0047	208.434	-1.2036

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
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DDPOption.DDP_CPP_CORE	475.438	0	475.465	0	476.153	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	524.349	10.2876	527.475	10.9388	530.305	11.372
DDPOption.PYTHON_DDP_SYNC_REDUCTION	573.611	20.649	573.127	20.5405	577.294	21.24
=== Summary for buffer_size: 15M ===						
DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.461	0	210.391	0	210.934	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.274	-1.03918	208.266	-1.01032	208.43	-1.1872
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.227	-1.06146	208.226	-1.02924	208.357	-1.2218
DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	473.942	0	473.82	0	474.751	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	531.04	12.0476	532.847	12.4576	534.748	12.637
DDPOption.PYTHON_DDP_SYNC_REDUCTION	572.339	20.7615	572.451	20.816	574.846	21.083
=== Summary for buffer_size: 16M ===						
DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	211.386	0	211.473	0	211.924	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.352	-1.43535	208.349	-1.47735	208.534	-1.5998
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.166	-1.52366	208.154	-1.56983	208.277	-1.7207
DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	471.396	0	471.431	0	471.741	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	532.423	12.946	532.087	12.8663	534.801	13.367
DDPOption.PYTHON_DDP_SYNC_REDUCTION	570.831	21.0937	573.693	21.6918	576.25	22.153
=== Summary for buffer_size: 17M ===						
DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.329	0	210.456	0	210.703	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.179	-1.02248	208.168	-1.08692	208.31	-1.1359
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.107	-1.05666	208.081	-1.1281	208.288	-1.1463
DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%

DDPOption.DDP_CPP_CORE	485.222	0	485.197	0	486.18	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	527.389	8.69042	526.905	8.59613	534.23	9.8832
DDPOption.PYTHON_DDP_SYNC_REDUCTION	575.94	18.6963	576.127	18.7408	578.749	19.04

=== Summary for buffer_size: 18M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.382	0	210.297	0	210.785	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.444	-0.92151	208.417	-0.893902	208.535	-1.067
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.25	-1.01326	208.241	-0.977957	208.412	-1.123

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	480.523	0	480.491	0	481.178	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	537.206	11.796	539.801	12.3435	542.149	12.671
DDPOption.PYTHON_DDP_SYNC_REDUCTION	561.54	16.8601	561.221	16.8016	563.942	17.200

=== Summary for buffer_size: 19M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	209.971	0	209.939	0	210.15	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.381	-0.757295	208.33	-0.766203	208.497	-0.78
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.311	-0.790664	208.309	-0.776575	208.457	-0.80

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	478.77	0	478.715	0	479.343	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	540.249	12.8409	538.619	12.5133	547.754	14.271
DDPOption.PYTHON_DDP_SYNC_REDUCTION	570.878	19.2385	571.444	19.3702	574.852	19.923

=== Summary for buffer_size: 20M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.733	0	210.718	0	211.035	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.228	-1.18869	208.236	-1.17816	208.353	-1.2705
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.293	-1.15816	208.277	-1.1586	208.444	-1.2273

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	475.089	0	475.206	0	475.633	0

DDPOption.PYTHON_DDP_ASYNC_REDUCTION	550.877	15.9523	553.077	16.3869	555.351	16.760
DDPOption.PYTHON_DDP_SYNC_REDUCTION	574.111	20.8427	574.816	20.9615	578.774	21.685

=== Summary for buffer_size: 21M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.853	0	210.825	0	211.183	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.372	-1.1765	208.361	-1.16885	208.561	-1.2415
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.202	-1.25715	208.198	-1.24621	208.368	-1.333

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	473.293	0	473.282	0	473.808	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	538.12	13.697	536.046	13.2614	551.029	16.298
DDPOption.PYTHON_DDP_SYNC_REDUCTION	575.191	21.5296	574.89	21.4687	578.517	22.095

=== Summary for buffer_size: 22M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.444	0	210.341	0	210.864	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.367	-0.986748	208.36	-0.941914	208.51	-1.11
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.511	-0.918347	208.496	-0.877387	208.637	-1.05

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	482.097	0	482.406	0	483.012	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	560.875	16.3408	560.893	16.2698	562.507	16.458
DDPOption.PYTHON_DDP_SYNC_REDUCTION	575.81	19.4387	575.681	19.3353	578.208	19.708

=== Summary for buffer_size: 23M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.215	0	210.037	0	210.684	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.129	-0.992138	208.114	-0.915331	208.252	-1.15
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.427	-0.850357	208.408	-0.77528	208.616	-0.98

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	481.245	0	481.24	0	481.688	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	564.44	17.2875	566.225	17.6597	568.807	18.08

DDPOption.PYTHON_DDP_SYNC_REDUCTION	571.43	18.7401	573.479	19.1671	576.317	19.645
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=== Summary for buffer_size: 24M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.227	0	210.143	0	210.604	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.228	-0.95065	208.224	-0.913135	208.358	-1.06
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.23	-0.949705	208.218	-0.915672	208.435	-1.02

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	478.429	0	478.608	0	479.358	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	553.532	15.6977	548.179	14.536	566.12	18.099
DDPOption.PYTHON_DDP_SYNC_REDUCTION	572.728	19.71	572.48	19.6134	574.355	19.817

=== Summary for buffer_size: 25M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.478	0	210.405	0	210.763	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.363	-1.00473	208.344	-0.979519	208.545	-1.051
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.297	-1.03607	208.289	-1.00562	208.429	-1.107

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	478.977	0	478.951	0	479.407	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	569.299	18.8573	573.043	19.6453	574.805	19.899
DDPOption.PYTHON_DDP_SYNC_REDUCTION	572.347	19.4937	573.636	19.7691	575.768	20.1

=== Summary for buffer_size: 26M ===

DDP: [forward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.289	0	210.129	0	210.915	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.237	-0.975918	208.204	-0.91614	208.435	-1.17
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.108	-1.03731	208.098	-0.966869	208.264	-1.23

DDP: [backward]	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	475.649	0	475.81	0	476.438	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	574.232	20.726	574.333	20.7063	577.995	21.3
DDPOption.PYTHON_DDP_SYNC_REDUCTION	574.607	20.8051	574.994	20.8453	577.543	21.22

=== Summary for buffer_size: 27M ===

DDP: [forward]

	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	210.39	0	210.259	0	210.829	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	208.36	-0.964811	208.358	-0.903892	208.496	-1.106
DDPOption.PYTHON_DDP_SYNC_REDUCTION	208.45	-0.922151	208.443	-0.863724	208.581	-1.066

DDP: [backward]

	Mean	delta%	mean	delta%	p90	delta%
DDPOption.DDP_CPP_CORE	475.294	0	475.299	0	476.014	0
DDPOption.PYTHON_DDP_ASYNC_REDUCTION	570.313	19.9917	572.485	20.4473	574.882	20.77
DDPOption.PYTHON_DDP_SYNC_REDUCTION	571.216	20.1816	572.884	20.5313	574.973	20.78