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[2.25](<https://docs.nvidia.com/deeplearning/sdk/nccl-archived/index.html>)

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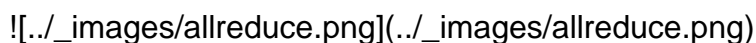
Collective Operations¶

Collective operations have to be called for each rank (hence CUDA device), using the same count and the same datatype, to form a complete collective operation. Failure to do so will result in undefined behavior, including hangs, crashes, or data corruption.

AllReduce¶

The AllReduce operation performs reductions on data (for example, sum, min, max) across devices and stores the result in the receive buffer of every rank.

In a `_sum_` allreduce operation between `_k_` ranks, each rank will provide an array `in` of `N` values, and receive identical results in array `out` of `N` values, where $out[i] = in_0[i] + in_1[i] + \dots + in_{(k-1)}[i]$.

The diagram shows a sequence of ranks (0 to k-1) each with an input buffer 'in' and an output buffer 'out'. Arrows indicate data flow from each 'in' buffer to a central reduction point, and then from that point to each 'out' buffer, illustrating that all ranks receive the result of the reduction.

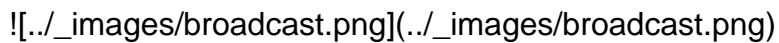
All-Reduce operation: each rank receives the reduction of input values across ranks.

Related links: `[`ncclAllReduce()`](../api/colls.html#c.ncclAllReduce "ncclAllReduce")`.

Broadcast¶

The Broadcast operation copies an `N`-element buffer from the root rank to all

the ranks.

![_images/broadcast.png](../_images/broadcast.png)

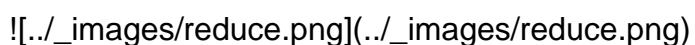
Broadcast operation: all ranks receive data from a "root" rank.

Important note: The root argument is one of the ranks, not a device number, and is therefore impacted by a different rank to device mapping.

Related links: [ncclBroadcast()](../api/colls.html#c.ncclBroadcast "ncclBroadcast").

Reduce¶

The Reduce operation performs the same operation as AllReduce, but stores the result only in the receive buffer of a specified root rank.

![_images/reduce.png](../_images/reduce.png)

Reduce operation: one rank receives the reduction of input values across ranks.

Important note: The root argument is one of the ranks (not a device number), and is therefore impacted by a different rank to device mapping.

Note: A Reduce, followed by a Broadcast, is equivalent to the AllReduce operation.

Related links: `[`ncclReduce()`](../api/colls.html#c.ncclReduce "ncclReduce")`.

AllGather¶

The AllGather operation gathers N values from k ranks into an output buffer of size $k*N$, and distributes that result to all ranks.

The output is ordered by the rank index. The AllGather operation is therefore impacted by a different rank to device mapping.

`![_images/allgather.png](../_images/allgather.png)`

AllGather operation: each rank receives the aggregation of data from all ranks in the order of the ranks.

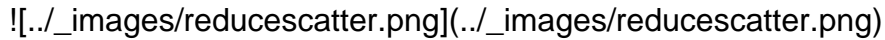
Note: Executing ReduceScatter, followed by AllGather, is equivalent to the AllReduce operation.

Related links: `[`ncclAllGather()`](../api/colls.html#c.ncclAllGather "ncclAllGather")`.

ReduceScatter¶

The ReduceScatter operation performs the same operation as Reduce, except that the result is scattered in equal-sized blocks between ranks, each rank getting a chunk of data based on its rank index.

The ReduceScatter operation is impacted by a different rank to device mapping since the ranks determine the data layout.

The diagram illustrates the ReduceScatter operation. It shows a sequence of input data being reduced across ranks, with each rank receiving a subpart of the result.

Reduce-Scatter operation: input values are reduced across ranks, with each rank receiving a subpart of the result.

Related links: [\[`ncclReduceScatter\(\)`\]\(../api/colls.html#c.ncclReduceScatter"ncclReduceScatter"\)](#)

[\[Next \]\(data.html "Data Pointers"\)](#) [\[Previous\]\(communicators.html "Creating a Communicator"\)](#)

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