15-440
Distributed Systems
Collective Routines in MPI

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Collective Communication

• Collective communication allows you to exchange data among a group of processes

• It must involve all processes in the scope of a communicator

• The communicator argument in a collective communication routine should specify which processes are involved in the communication

• Hence, it is the programmer's responsibility to ensure that all processes within a communicator participate in any collective operation
Patterns of Collective Communication

• There are several patterns of collective communication:

1. Broadcast
2. Scatter
3. Gather
4. Allgather
5. Alltoall
6. Reduce
7. Allreduce
8. Scan
9. Reducescatter
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Scatter and Gather

- **Scatter** distributes distinct messages from a single source task to each task in the group
- **Gather** gathers distinct messages from each task in the group to a single destination task

```
int MPI_Scatter ( void *sendbuf, int sendcnt, MPI_Datatype sendtype, void *recvbuf, int recvct, MPI_Datatype recvtype, int root, MPI_Comm comm )
```

```
int MPI_Gather ( void *sendbuf, int sendcnt, MPI_Datatype sendtype, void *recvbuf, int recvct, MPI_Datatype recvtype, int root, MPI_Comm comm )
```
### Reduce and All Reduce

- **Reduce** applies a reduction operation on all tasks in the group and places the result in one task.
- **Allreduce** applies a reduction operation and places the result in all tasks in the group. This is equivalent to an MPI_Reduce followed by an MPI_Bcast.

![Diagram of Reduce and Allreduce](image)

**MPI_Reduce**

```c
int MPI_Reduce ( void *sendbuf, void *recvbuf, int count, MPI_Datatype datatype, MPI_Op op, int root, MPI_Comm comm )
```

**MPI_Allreduce**

```c
int MPI_Allreduce ( void *sendbuf, void *recvbuf, int count, MPI_Datatype datatype, MPI_Op op, MPI_Comm comm )
```