**Q. How node Failure is handled in Hadoop.**

In Hadoop, node failure is managed with a combination of redundancy, monitoring, and automatic recovery mechanisms to ensure data availability and processing continuity. Here's how Hadoop handles node failure in both HDFS (Hadoop Distributed File System) and MapReduce:

## 1. Node Failure Handling in HDFS

- **Data Replication**:
  - HDFS stores each block of data in multiple copies (typically three replicas) across different nodes. When a node fails, other replicas of the data remain accessible on different nodes.
  - This redundancy allows HDFS to continue serving data to applications even if one or more nodes are down.
- **Heartbeat Mechanism**:
  - Each DataNode sends periodic **heartbeats** and **block reports** to the Namenode. The heartbeat signals that the DataNode is active, while the block report provides information about the blocks stored on that node.
  - If the Namenode does not receive a heartbeat from a DataNode within a certain period, it marks the node as failed or unavailable.
- **Automatic Re-replication**:
  - When the Namenode detects that a DataNode has failed, it initiates a **re-replication** process to restore the replication factor of lost data blocks.
  - The Namenode identifies the missing replicas and arranges for these blocks to be copied from remaining healthy nodes to other available DataNodes.
  - This ensures data durability and prevents further data loss if additional nodes fail.
- **Rack Awareness**:
  - Hadoop uses a rack awareness policy to spread replicas across different racks, reducing the impact of rack-level failures. For example, with a replication factor of three, HDFS typically stores two replicas on different nodes in one rack and one replica on a different rack.
  - This policy ensures that even if an entire rack fails, data is still available from replicas on other racks.

## Advantages of Hadoop's Failure Management

- **High Fault Tolerance**: Data replication and speculative execution allow Hadoop to handle node failures gracefully.
- **Automatic Recovery**: Re-replication and task re-assignment occur automatically, minimizing the need for manual intervention.
- **Data Availability**: The system remains operational with minimal performance impact, ensuring data and job availability.