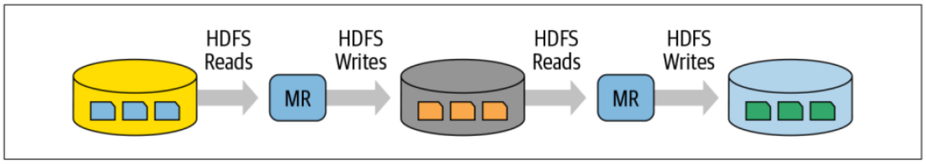
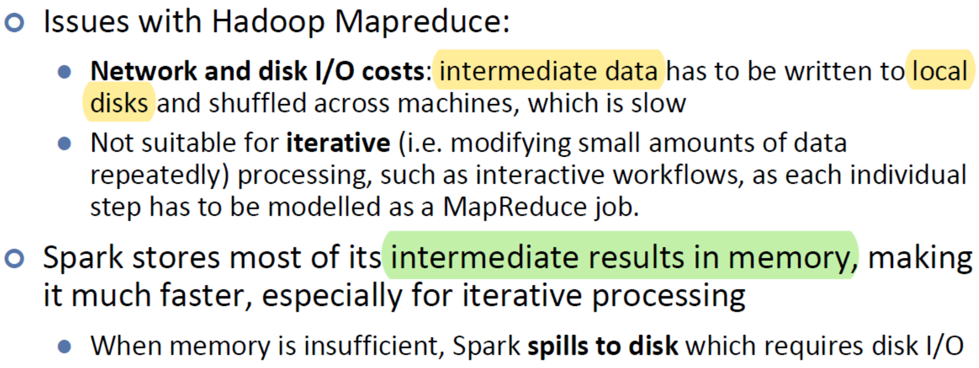
CS4225/CS5425 BIG DATA SYSTEMS FOR DATA SCIENCE

Tutorial 3: Spark

a) Why Spark is more suitable for iterative processing compared to Hadoop?

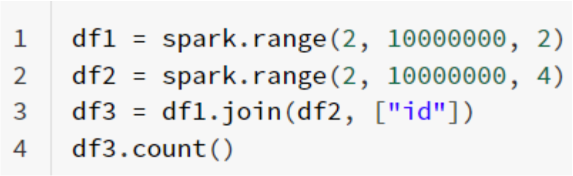
Answer:
Spark stores most of its intermediate results in memory, making it much faster, especially for iterative processing.





- Issues with Hadoop Mapreduce:
  - **Network and disk I/O costs**: intermediate data has to be written to local disks and shuffled across machines, which is slow
  - Not suitable for **iterative** (i.e. modifying small amounts of data repeatedly) processing, such as interactive workflows, as each individual step has to be modelled as a MapReduce job.
- Spark stores most of its intermediate results in memory, making it much faster, especially for iterative processing
  - When memory is insufficient, Spark **spills to disk** which requires disk I/O

b) In the below spark code block, please indicate which lines are transformation and which lines are action. For transformation, please also indicate whether it is a narrow transformation or wide transformation.

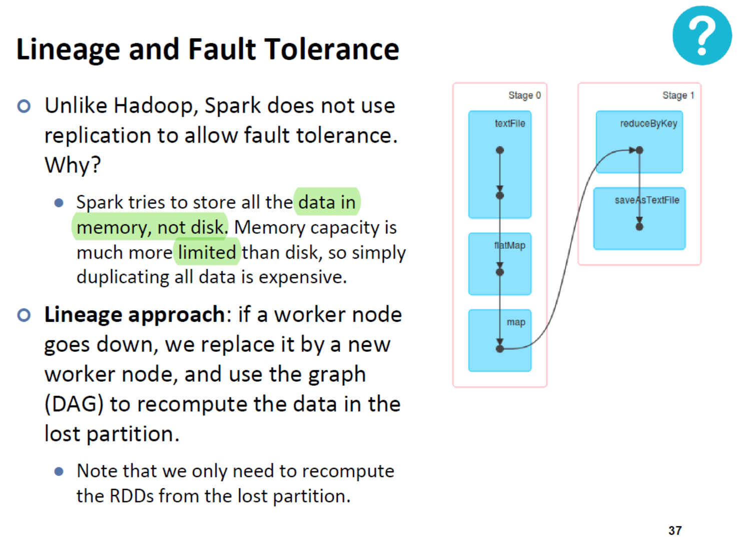


```
1  df1 = spark.range(2, 10000000, 2)
2  df2 = spark.range(2, 10000000, 4)
3  df3 = df1.join(df2, ["id"])
4  df3.count()
```

Answer:
Line 1: Narrow Transformation
Line 2: Narrow Transformation
Line 3: Wide Transformation
Line 4: Action

c) In HDFS, each chunk is replicated for three times by default. In contrast, in Spark, RDD uses lineage for reliability. What is a major problem if Spark also uses replications for reliability?

Answer:
Consumes a lot of memory; memory is much more scarce than disk space



Lineage and Fault Tolerance

- Unlike Hadoop, Spark does not use replication to allow fault tolerance. Why?
  - Spark tries to store all the data in memory, not disk. Memory capacity is much more limited than disk, so simply duplicating all data is expensive.
- **Lineage approach**: if a worker node goes down, we replace it by a new worker node, and use the graph (DAG) to recompute the data in the lost partition.
  - Note that we only need to recompute the RDDs from the lost partition.

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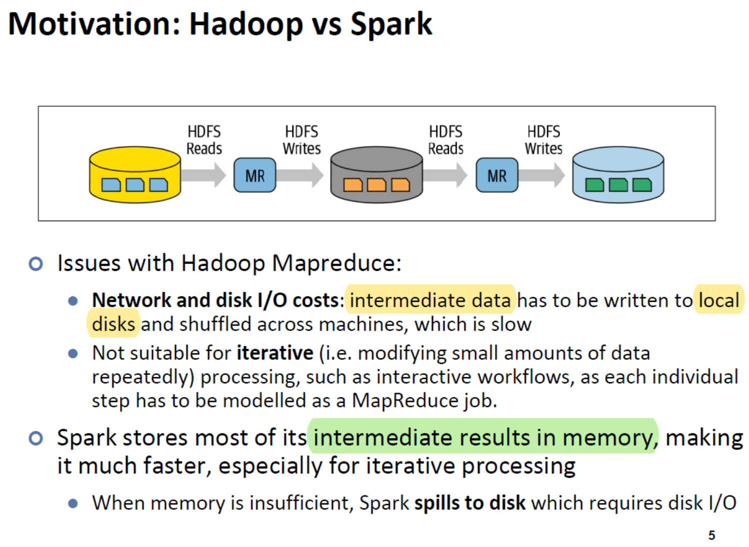
d) Is it true that in the Spark runtime, RDD cannot reside in the hard disk?

Answer:

False. RDD can also be in the disk if out of memory



Motivation: Hadoop vs Spark

- Issues with Hadoop Mapreduce:
  - **Network and disk I/O costs**: intermediate data has to be written to local disks and shuffled across machines, which is slow
  - Not suitable for **iterative** (i.e. modifying small amounts of data repeatedly) processing, such as interactive workflows, as each individual step has to be modelled as a MapReduce job.
- Spark stores most of its intermediate results in memory, making it much faster, especially for iterative processing
  - When memory is insufficient, Spark **spills to disk** which requires disk I/O

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e) Explain how the following program can be sped up.

```
1   lines = spark.textFile("hdfs://log")
2   errors = lines.filter(lambda s: s.startswith("INFO"))
3   info = errors.map(lambda s: s.split("\t")[2])
4   info.filter(lambda s: "hadoop" in s).count()
5   info.filter(lambda s: "spark" in s).count()
```

Line 1: Reads a file from HDFS
Line 2: Filter to extract lines starting with "INFO"
Line 3: Split string by tab and extract 2nd component
Line 4: Count the number of lines with "hadoop"
Line 5: Count the number of lines with "spark"

Answer:

How to speed-up: we should add info.cache() (or info.persist()) before line 4, to cache the RDD in memory (or hard disk) so it doesn't have to be re-computed in line 5.