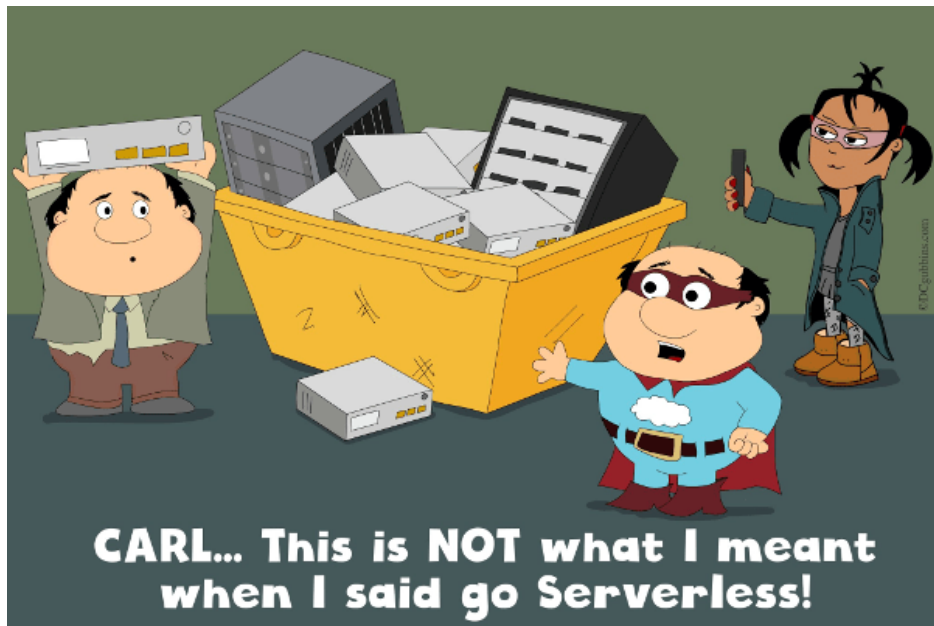


Serverless Machine Learning on Modern Hardware

IBM Research

#Res6SAIS

Serverless Computing



- No need to setup/manage a cluster
- Automatic, dynamic and fine-grained scaling
- Sub-second billing
- AWS Lambda, Google Cloud Functions, Azure Functions, Databricks Serverless

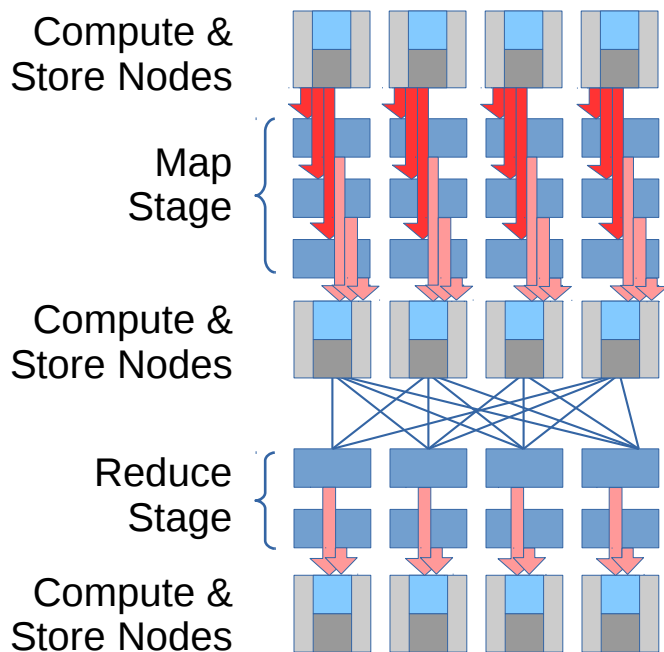
Challenge: Performance

- **Container startup:** may have to dynamically spin up containers per function call
 - Takes several 200-300 milliseconds for a “cold” container
- **Storage:** input data needs to be fetched from remote storage (e.g., S3 object store)
 - As opposed to compute-local storage, e.g., HDFS
- **Data sharing:** intermediate needs to be temporarily stored on remote storage (e.g. S3, Redis)
 - Becomes problematic as workloads get more complex
 - Affects operations like shuffle, broadcast, etc.,

Challenge: Performance

- **Container startup:** may have to dynamically spin up containers per function call
 - Takes several 200-300 milliseconds for a “cold” container
- **Storage:** input data needs to be fetched from remote storage (e.g., S3 object store)
 - As opposed to compute-local storage, e.g., HDFS
- **Data sharing:** intermediate needs to be temporarily stored on remote storage (e.g. S3, Redis)
 - Becomes problematic as workloads get more complex
 - Affects operations like shuffle, broadcast, etc.,

Example: MapReduce (Cluster)

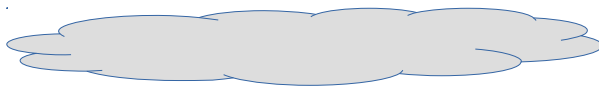


data is mostly
written and
read locally

Serverless MapReduce

Dynamically
growing/shrinking
compute cloud

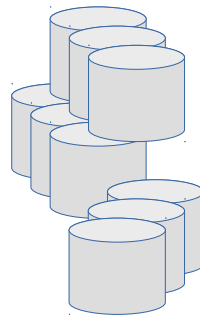
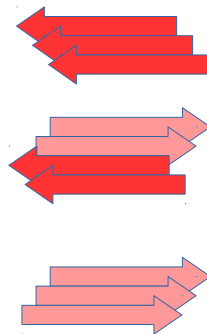
Map
Stage



Shuffle



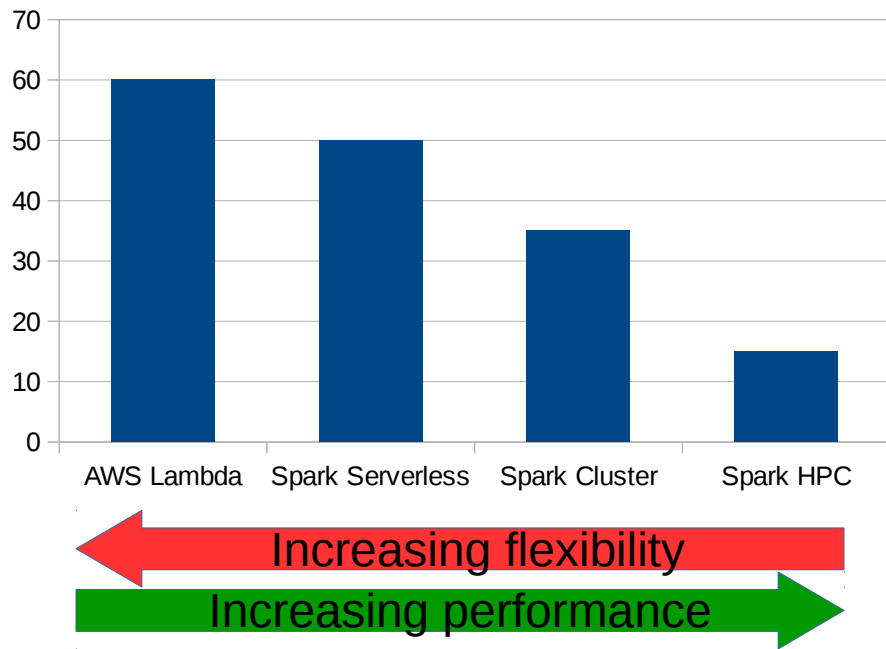
Reduce
Stage



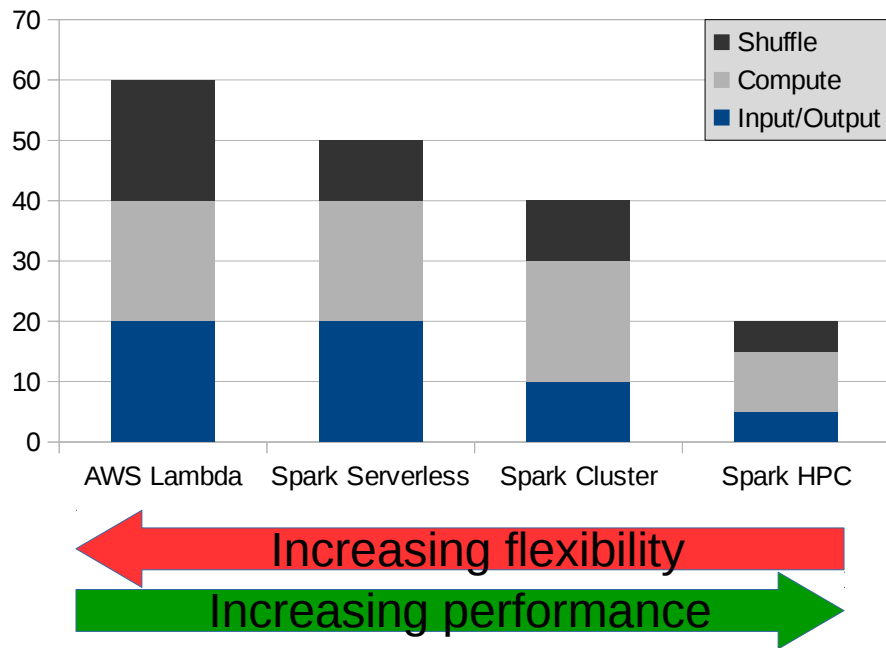
Storage Service
(e.g, S3, Redis)

data is
exclusively
written and
read remotely

Sorting 100GB

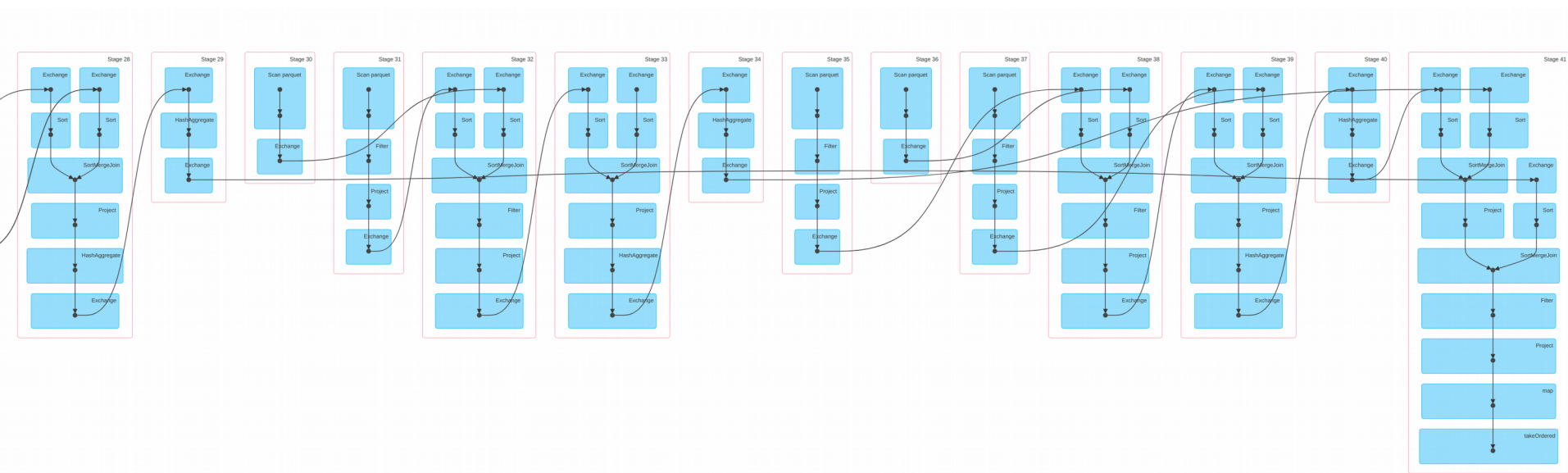


Is I/O a problem?



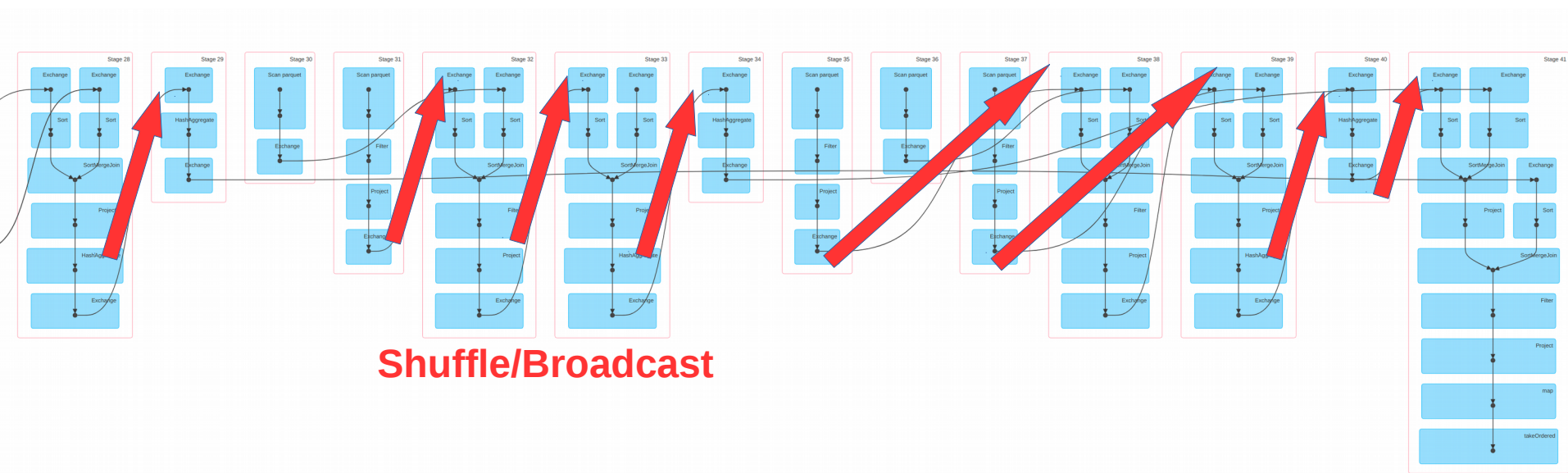
What about other workloads?

Example: SQL, Query 77 / TPC-DS benchmark



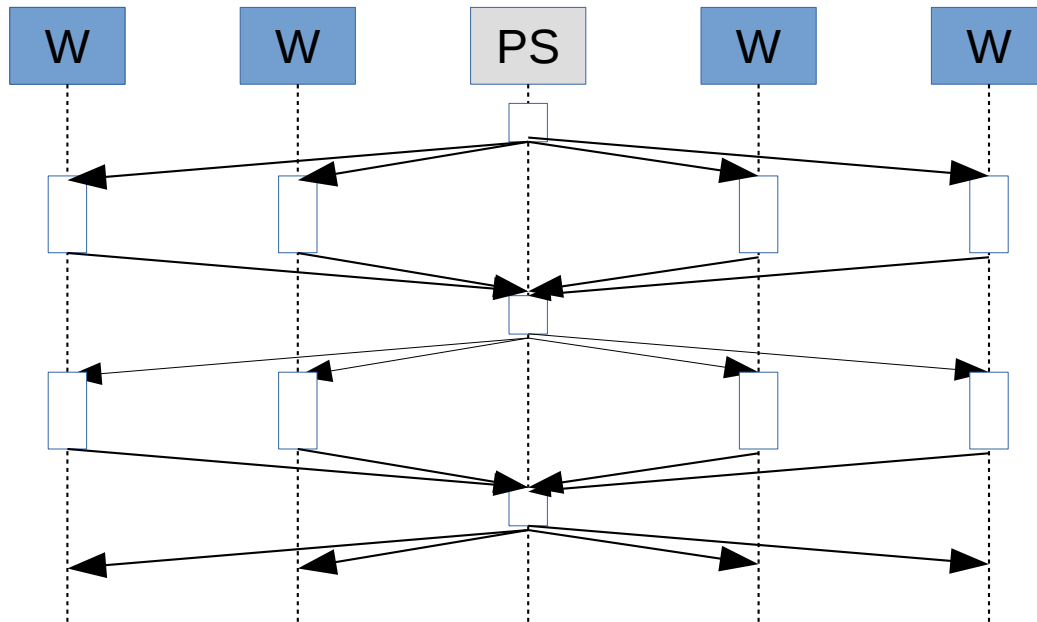
What about other workloads?

Example: SQL, Query 77 / TPC-DS benchmark



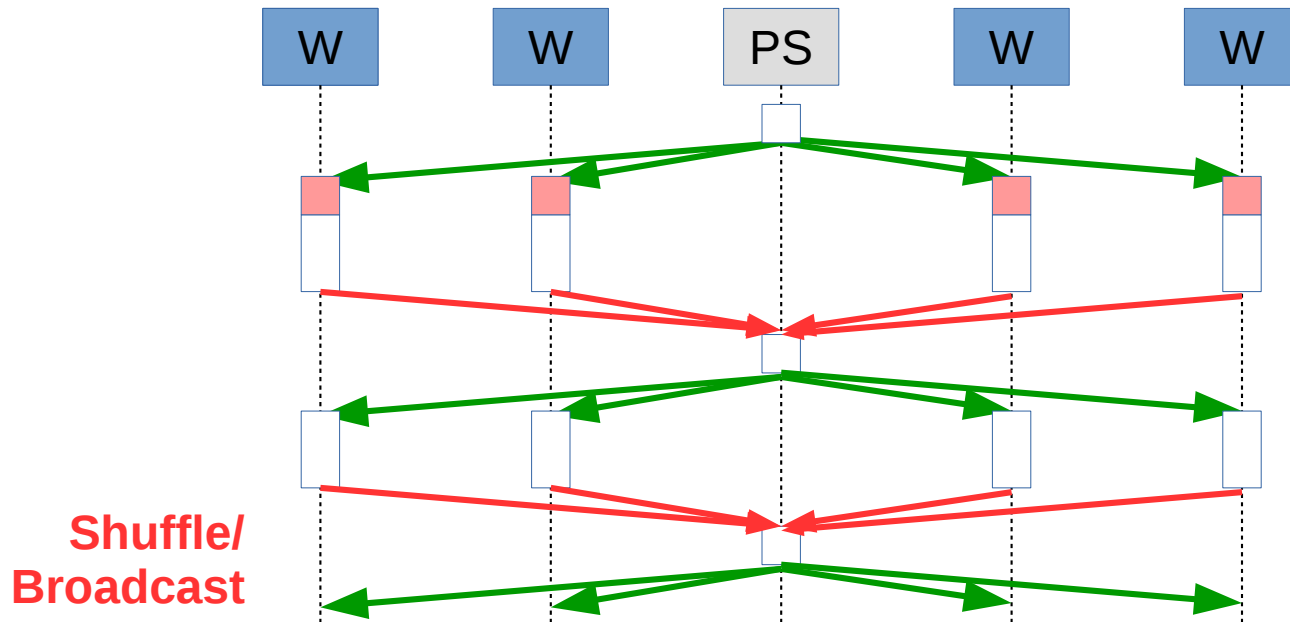
What about other workloads?

Example: RandomForest



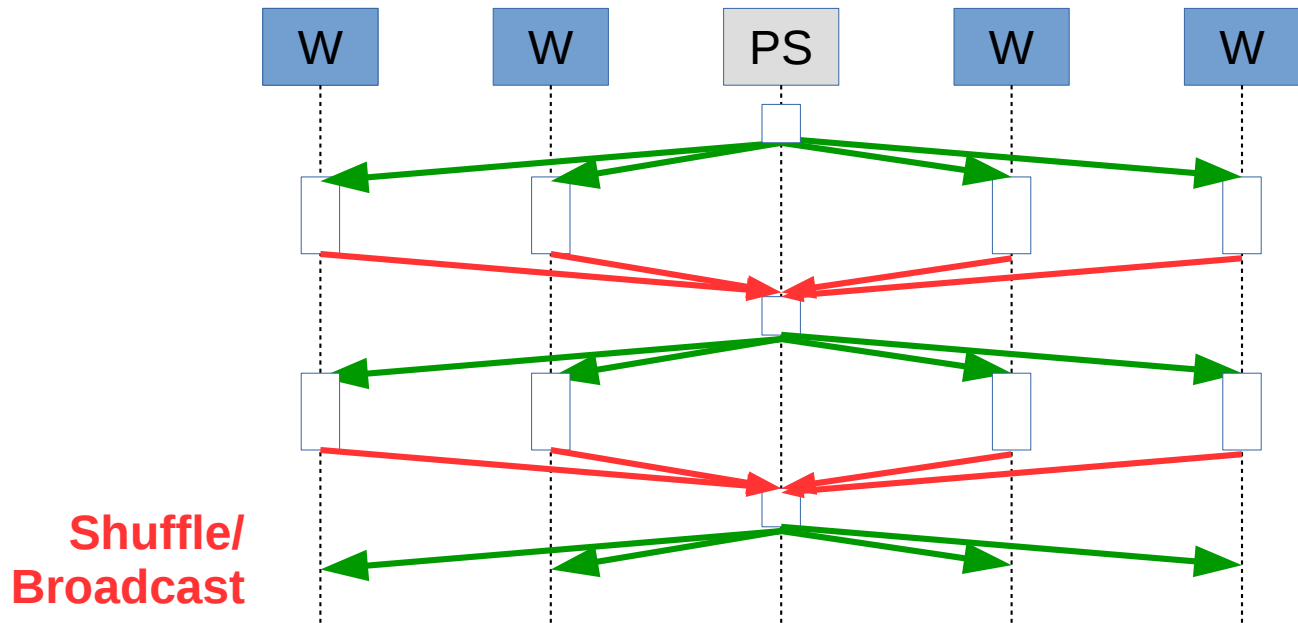
What about other workloads?

Example: RandomForest



What about other workloads?

Example: RandomForest



Can we..

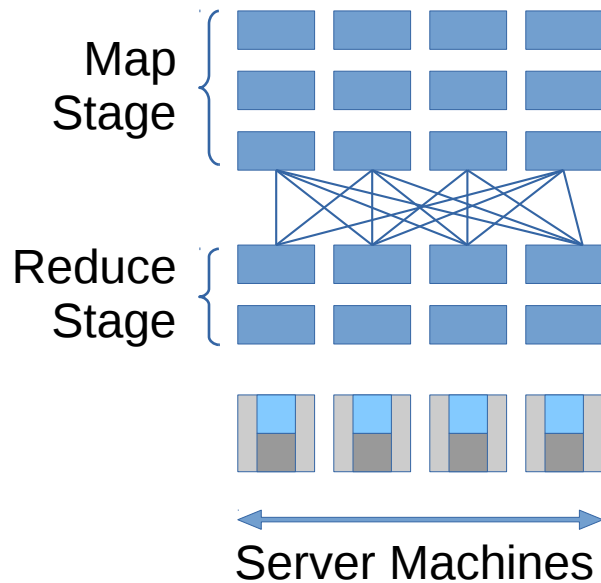
- ..use Spark to run such workloads in a serverless fashion?
 - Dynamic scaling of compute nodes as jobs are running
 - No cluster configuration
 - No startup time
- ..reduce the performance overheads?

Backup

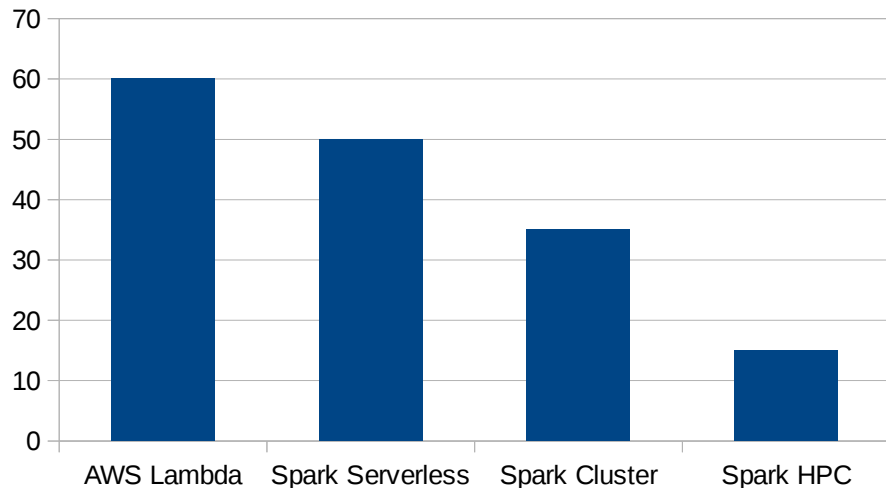
Template Tite

- Template List
- Template List
 - Template item

Example: MapReduce

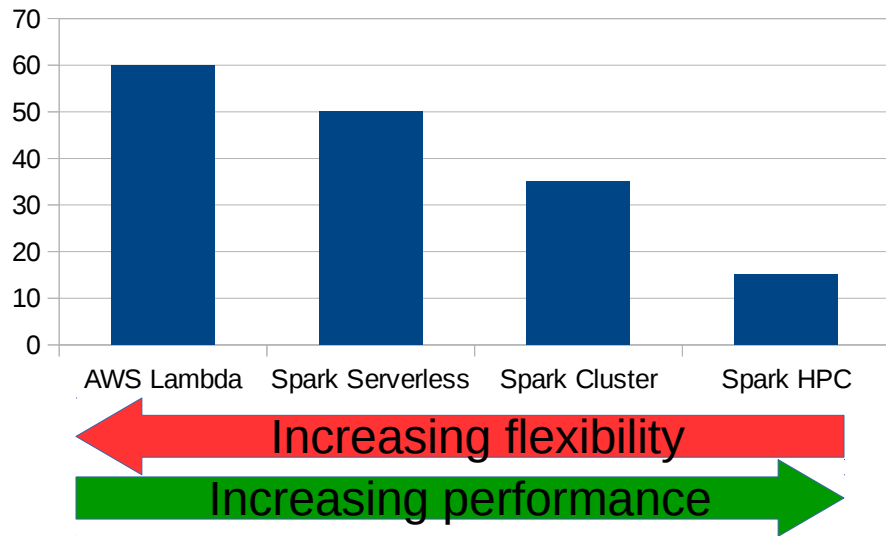


Sorting 100GB



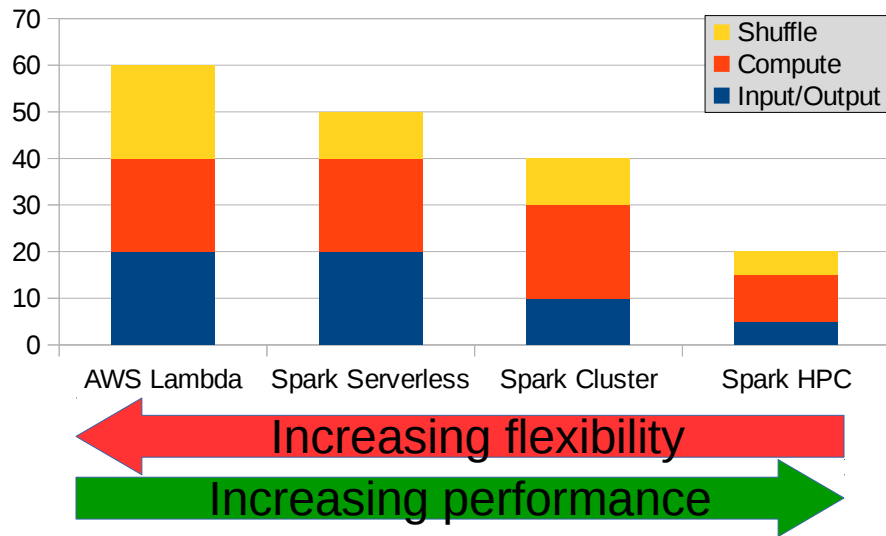
Serverless execution is 3-4x slower than an optimized cluster configuration

Sorting 100GB



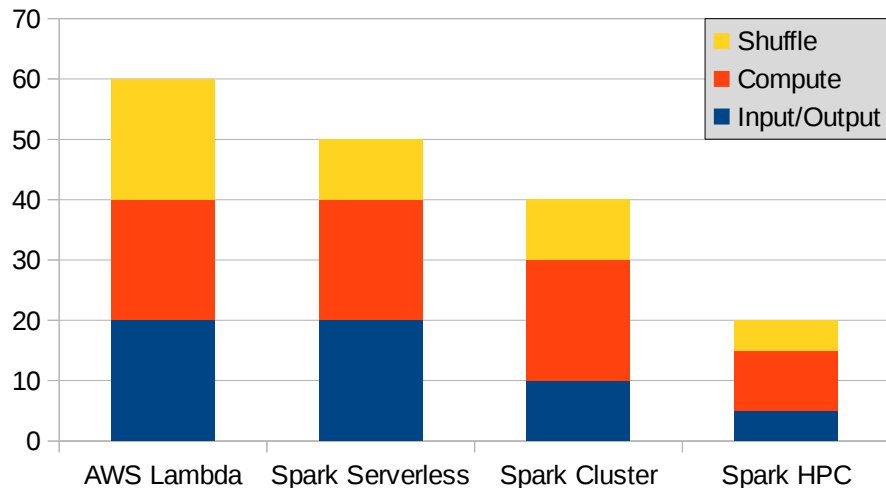
Serverless execution is 3-4x slower than an optimized cluster configuration

Sorting: Is I/O a problem?



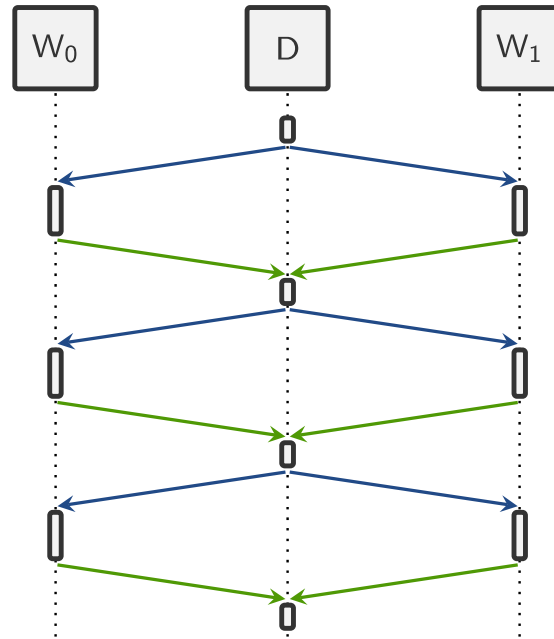
With serverless, substantial amount of time is spent on reading from remote storage

Sorting: Is I/O a problem?



With serverless, substantial amount of time is spent on reading from remote storage

Can we..



Workloads and Frameworks

	Microservices	Workflows	MapReduce	SQL	ML
AWS λ, Google CF, Azure F					
AWS λ + AWS StepFunction					
PyWren					
Databricks Serverless					

Serverless frameworks not designed to run arbitrary workloads

What about other workloads?

Example: RandomForest

