

Caching

INTRODUCTION TO SPARK SQL IN PYTHON



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What is caching?

- Keeping data in memory
- Spark tends to unload memory aggressively

Eviction Policy

- Least Recently Used (LRU)
- Eviction happens independently on each worker
- Depends on memory available to each worker

Caching a dataframe

TO CACHE A DATAFRAME:

```
df.cache()
```

TO UNCACHE IT:

```
df.unpersist()
```

Determining whether a dataframe is cached

```
df.is_cached
```

```
False
```

```
df.cache()  
df.is_cached
```

```
True
```

Uncaching a dataframe

```
df.unpersist()  
df.is_cached()
```

```
False
```

Storage level

```
df.unpersist()  
df.cache()  
df.storageLevel
```

```
StorageLevel(True, True, False, True, 1)
```

In the storage level above the following hold:

1. `useDisk` = True
2. `useMemory` = True
3. `useOffHeap` = False
4. `deserialized` = True
5. `replication` = 1

Persisting a dataframe

The following are equivalent in Spark 2.1+ :

- `df.persist()`
- `df.persist(storageLevel=pyspark.StorageLevel.MEMORY_AND_DISK)`
- `df.cache()` is the same as `df.persist()`

Caching a table

```
df.createOrReplaceTempView('df')  
spark.catalog.isCached(tableName='df')
```

False

```
spark.catalog.cacheTable('df')  
spark.catalog.isCached(tableName='df')
```

True

Uncaching a table

```
spark.catalog.uncacheTable('df')  
spark.catalog.isCached(tableName='df')
```

```
False
```

```
spark.catalog.clearCache()
```

Tips

- Caching is lazy
- Only cache if more than one operation is to be performed
- Unpersist when you no longer need the object
- Cache selectively

Let's practice

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The Spark UI

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Use the Spark UI inspect execution

- **Spark Task** is a unit of execution that runs on a single cpu
- **Spark Stage** a group of tasks that perform the same computation in parallel, each task typically running on a different subset of the data
- **Spark Job** is a computation triggered by an action, sliced into one or more stages.

Finding the Spark UI

1. [http://\[DRIVER_HOST\]:4040](http://[DRIVER_HOST]:4040)
2. [http://\[DRIVER_HOST\]:4041](http://[DRIVER_HOST]:4041)
3. [http://\[DRIVER_HOST\]:4042](http://[DRIVER_HOST]:4042)
4. [http://\[DRIVER_HOST\]:4043](http://[DRIVER_HOST]:4043)
- ...

Spark Jobs (?)

User: mark

Total Uptime: 3 s

Scheduling Mode: FIFO

► [Event Timeline](#)

Spark Jobs (?)

User: mark

Total Uptime: 9.1 min

Scheduling Mode: FIFO

Completed Jobs: 1

▶ Event Timeline

Completed Jobs (1)

Job Id ▼	Description	Submitted	Duration	Stages: Succeeded/Total	Tasks (for all stages): Succeeded/Total
0	load at NativeMethodAccessorImpl.java:0	2018/12/23 19:56:18	0.5 s	1/1	1/1

Storage

RDDs

RDD Name	Storage Level	Cached Partitions	Fraction Cached	Size in Memory	Size on Disk
*FileScan parquet [word#9,id#10L,title#11,part#12] Batched: true, Format: Parquet, Location: InMemoryFileIndex[file:/Users/mark/code/datacamp_py/sherlock_full_parts.parquet], PartitionFilters: [], PushedFilters: [], ReadSchema: struct<word:string,id:bigint,title:string,part:int>	Memory Deserialized 1x Replicated	1	100%	554.9 KB	0.0 B

Spark catalog operations

- `spark.catalog.cacheTable('table1')`
- `spark.catalog.uncacheTable('table1')`
- `spark.catalog.isCached('table1')`
- `spark.catalog.dropTempView('table1')`

Spark Catalog

```
spark.catalog.listTables()
```

```
[Table(name='text', database=None, description=None, tableType='TEMPORARY', isTemporary=
```

Storage

RDDs

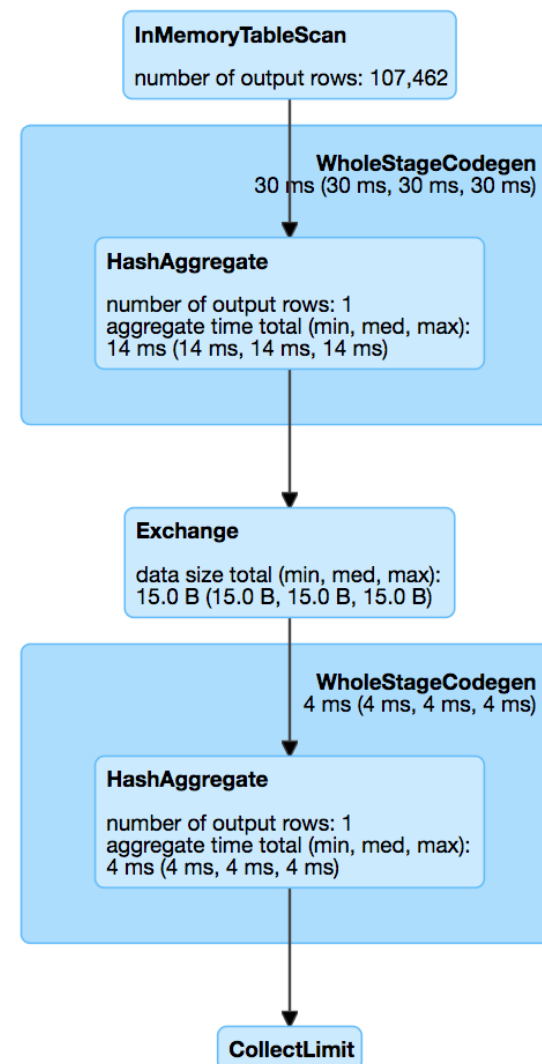
RDD Name	Storage Level	Cached Partitions	Fraction Cached	Size in Memory	Size on Disk
In-memory table df	Memory Deserialized 1x Replicated	1	100%	554.9 KB	0.0 B

Details for Query 1

Submitted Time: 2018/12/23 20:16:51

Duration: 0.9 s

Succeeded Jobs: 2



► [Details](#)

Spark UI Storage Tab

Shows where data partitions exist

- in memory,
- or on disk,
- across the cluster,
- at a snapshot in time.

Spark UI SQL tab

```
query3agg = """
SELECT w1, w2, w3, COUNT(*) as count FROM (
    SELECT
    word AS w1,
    LEAD(word,1) OVER(PARTITION BY part ORDER BY id ) AS w2,
    LEAD(word,2) OVER(PARTITION BY part ORDER BY id ) AS w3
    FROM df
)
GROUP BY w1, w2, w3
ORDER BY count DESC
"""

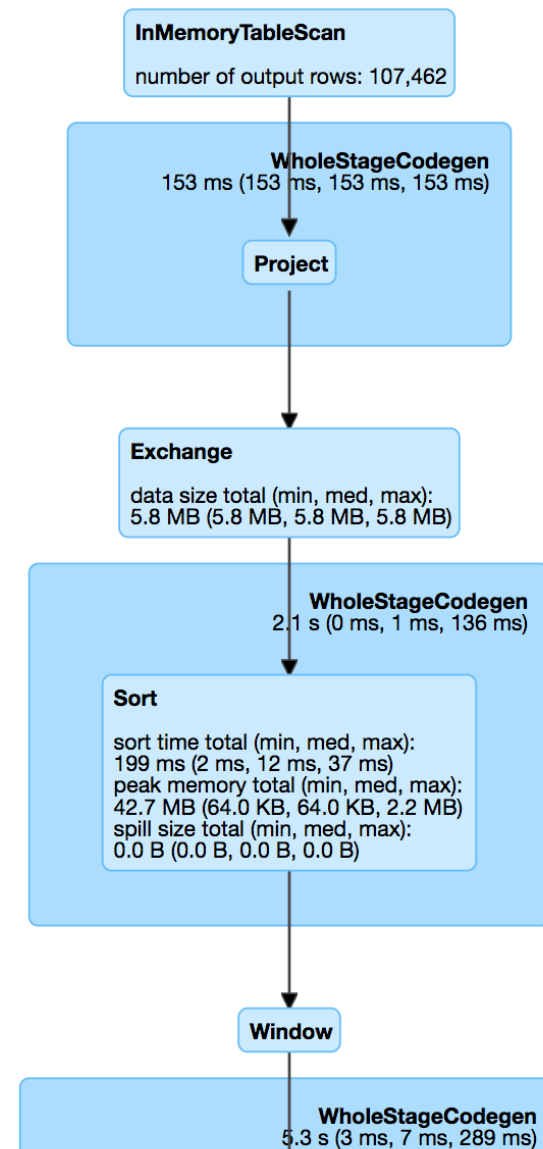
spark.sql(query3agg).show()
```

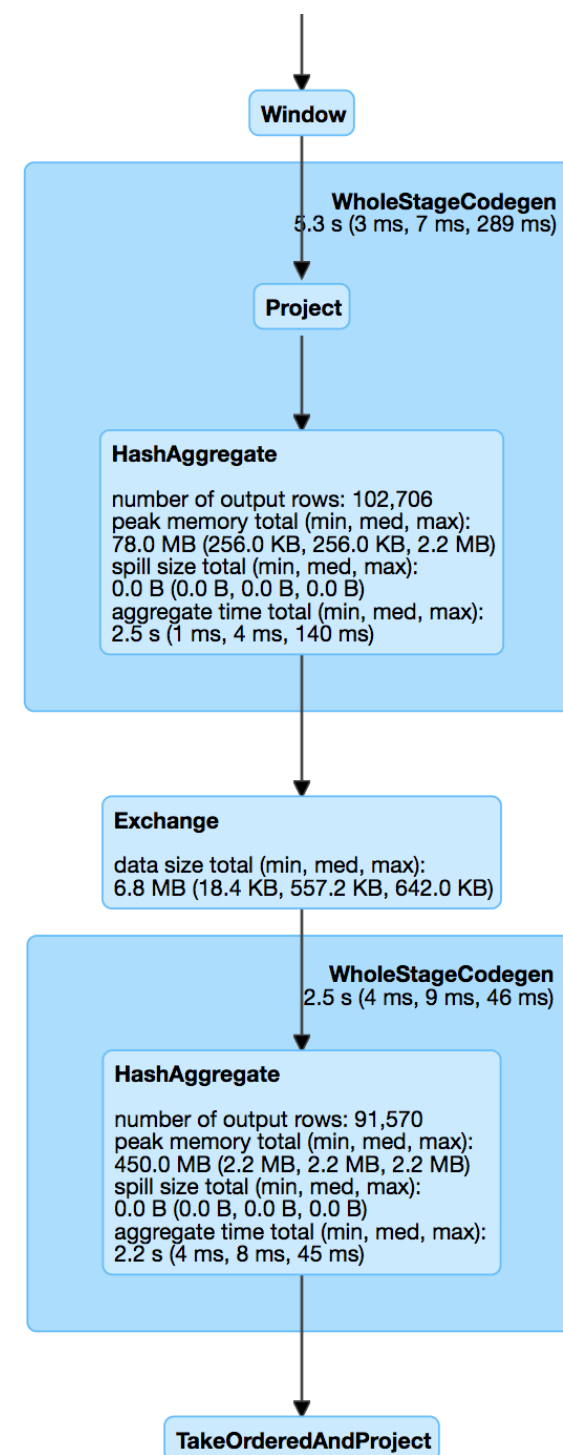

Details for Query 2

Submitted Time: 2018/12/23 20:54:16

Duration: 4 s

Succeeded Jobs: 3





► Details

Stages for All Jobs

Completed Stages: 6

Completed Stages (6)

Stage Id ▼	Description	Submitted	Duration	Tasks: Succeeded/Total	Input	Output	Shuffle Read	Shuffle Write
5	showString at NativeMethodAccessorImpl.java:0 +details	2018/12/23 20:54:19	0.6 s	200/200			3.7 MB	
4	showString at NativeMethodAccessorImpl.java:0 +details	2018/12/23 20:54:17	2 s	200/200			1972.4 KB	3.7 MB
3	showString at NativeMethodAccessorImpl.java:0 +details	2018/12/23 20:54:16	0.8 s	1/1	677.8 KB			1972.4 KB
2	hasNext at NativeMethodAccessorImpl.java:0 +details	2018/12/23 20:52:41	12 ms	1/1				
1	hasNext at NativeMethodAccessorImpl.java:0 +details	2018/12/23 20:52:41	11 ms	1/1				
0	load at NativeMethodAccessorImpl.java:0 +details	2018/12/23 20:52:33	0.3 s	1/1				

Spark Jobs (?)

User: mark

Total Uptime: 18 min

Scheduling Mode: FIFO

Completed Jobs: 4

▶ [Event Timeline](#)

Completed Jobs (4)

Job Id ▼	Description	Submitted	Duration	Stages: Succeeded/Total	Tasks (for all stages): Succeeded/Total
3	showString at NativeMethodAccessorImpl.java:0	2018/12/23 20:54:16	4 s	3/3	401/401
2	hasNext at NativeMethodAccessorImpl.java:0	2018/12/23 20:52:41	20 ms	1/1	1/1
1	hasNext at NativeMethodAccessorImpl.java:0	2018/12/23 20:52:41	18 ms	1/1	1/1
0	load at NativeMethodAccessorImpl.java:0	2018/12/23 20:52:33	0.5 s	1/1	1/1

Let's practice

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Logging

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Logging primer

```
import logging
logging.basicConfig(stream=sys.stdout, level=logging.INFO,
                    format='%(asctime)s - %(levelname)s - %(message)s')
logging.info("Hello %s", "world")
logging.debug("Hello, take %d", 2)
```

```
2019-03-14 15:92:65,359 - INFO - Hello world
```

Logging with DEBUG level

```
import logging
logging.basicConfig(stream=sys.stdout, level=logging.DEBUG,
                    format='%(asctime)s - %(levelname)s - %(message)s')
logging.info("Hello %s", "world")
logging.debug("Hello, take %d", 2)
```

```
2018-03-14 12:00:00,000 - INFO - Hello world
2018-03-14 12:00:00,001 - DEBUG - Hello, take 2
```


Debugging lazy evaluation

- lazy evaluation
- distributed execution

A simple timer

```
t = timer()  
t.elapsed()
```

```
1. elapsed: 0.0 sec
```

```
t.elapsed() # Do something that takes 2 seconds
```

```
2. elapsed: 2.0 sec
```

```
t.reset() # Do something else that takes time: reset  
t.elapsed()
```

```
3. elapsed: 0.0 sec
```

class timer

```
class timer:
    start_time = time.time()
    step = 0

    def elapsed(self, reset=True):
        self.step += 1
        print("%d. elapsed: %.1f sec %s"
              % (self.step, time.time() - self.start_time))
        if reset:
            self.reset()

    def reset(self):
        self.start_time = time.time()
```

Stealth CPU wastage

```
import logging
logging.basicConfig(level=logging.INFO,
                    format='%(asctime)s - %(levelname)s - %(message)s')

# < create dataframe df here >

t = timer()
logging.info("No action here.")
t.elapsed()
logging.debug("df has %d rows.", df.count())
t.elapsed()
```

```
2018-12-23 22:24:20,472 - INFO - No action here.
1. elapsed: 0.0 sec
2. elapsed: 2.0 sec
```

Disable actions

```
ENABLED = False

t = timer()
logger.info("No action here.")
t.elapsed()
if ENABLED:
    logger.info("df has %d rows.", df.count())
t.elapsed()
```

```
2019-03-14 12:34:56,789 - Pyspark - INFO - No action here.
1. elapsed: 0.0 sec
2. elapsed: 0.0 sec
```

Enabling actions

Rerunning the previous example with `ENABLED = True` triggers the action:

```
2019-03-14 12:34:56,789 - INFO - No action here.  
1. elapsed: 0.0 sec  
2019-03-14 12:34:58,789 - INFO - df has 1107014 rows.  
2. elapsed: 2.0 sec
```

Let's practice!

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Query Plans

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Explain

```
EXPLAIN SELECT * FROM table1
```

Load dataframe and register

```
df = sqlContext.read.load( '/temp/df.parquet' )
```

```
df.registerTempTable( 'df' )
```

Running an EXPLAIN query

```
spark.sql('EXPLAIN SELECT * FROM df').first()
```

```
Row(plan='== Physical Plan ==\n\n*FileScan parquet [word#1928,id#1929L,title#1930,part#1931]\n\n  Batched: true,\n  Format: Parquet,\n  Location: InMemoryFileIndex[file:/temp/df.parquet],\n  PartitionFilters: [],\n  PushedFilters: [],\n  ReadSchema: struct<word:string,id:bigint,title:string,part:int>')
```

Interpreting an EXPLAIN query

== Physical Plan ==

- FileScan parquet [word#1928,id#1929L,title#1930,part#1931]
- Batched: true,
- Format: Parquet,
- Location: InMemoryFileIndex[file:/temp/df.parquet],
- PartitionFilters: [],
- PushedFilters: [],
- ReadSchema: struct<word:string,id:bigint,title:string,part:int>'

df.explain()

```
df.explain()
```

```
== Physical Plan ==  
FileScan parquet [word#963,id#964L,title#965,part#966]  
Batched: true, Format: Parquet,  
Location: InMemoryFileIndex[file:/temp/df.parquet],  
PartitionFilters: [], PushedFilters: [],  
ReadSchema: struct<word:string,id:bigint,title:string,part:int>
```

```
spark.sql("SELECT * FROM df").explain()
```

```
== Physical Plan ==  
FileScan parquet [word#712,id#713L,title#714,part#715]  
Batched: true, Format: Parquet,  
Location: InMemoryFileIndex[file:/temp/df.parquet],  
PartitionFilters: [], PushedFilters: [],  
ReadSchema: struct<word:string,id:bigint,title:string,part:int>
```

df.explain(), on cached dataframe

```
df.cache()  
df.explain()
```

```
== Physical Plan ==  
InMemoryTableScan [word#0, id#1L, title#2, part#3]  
  +- InMemoryRelation [word#0, id#1L, title#2, part#3], true, 10000, StorageLevel(disk, memory, deserialized, 1 replicas)  
    +- FileScan parquet [word#0,id#1L,title#2,part#3]  
       Batched: true, Format: Parquet, Location:  
       InMemoryFileIndex[file:/temp/df.parquet],  
       PartitionFilters: [], PushedFilters: [],  
       ReadSchema: struct<word:string,id:bigint,title:string,part:int>
```

```
spark.sql("SELECT * FROM df").explain()
```

```
== Physical Plan ==  
InMemoryTableScan [word#0, id#1L, title#2, part#3]  
  +- InMemoryRelation [word#0, id#1L, title#2, part#3], true, 10000, StorageLevel(disk, memory, deserialized, 1 replicas)  
    +- FileScan parquet [word#0,id#1L,title#2,part#3]  
       Batched: true, Format: Parquet,  
       Location: InMemoryFileIndex[file:/temp/df.parquet],  
       PartitionFilters: [], PushedFilters: [],  
       ReadSchema: struct<word:string,id:bigint,title:string,part:int>
```

Words sorted by frequency query

```
SELECT word, COUNT(*) AS count
FROM df
GROUP BY word
ORDER BY count DESC
```

Equivalent dot notation approach:

```
df.groupBy('word')
    .count()
    .sort(desc('count'))
    .explain()
```

Same query using dataframe dot notation

```
== Physical Plan ==
*Sort [count#1040L DESC NULLS LAST], true, 0
+- Exchange rangepartitioning(count#1040L DESC NULLS LAST, 200)
   +- *HashAggregate(keys=[word#963], functions=[count(1)])
      +- Exchange hashpartitioning(word#963, 200)
         +- *HashAggregate(keys=[word#963], functions=[partial_count(1)])
            +- InMemoryTableScan [word#963]
               +- InMemoryRelation [word#963, id#964L, title#965, part#966],
                  true,10000, StorageLevel(disk, memory, deserialized,
                  1 replicas)
                     +- *FileScan parquet [word#963,id#964L,title#965,part#966]
                        Batched: true, Format: Parquet,
                        Location: InMemoryFileIndex[file:/temp/df.parquet],
                        PartitionFilters: [], PushedFilters: [],
                        ReadSchema: struct<word:string,id:bigint,title:string,part:int>
```


Reading from bottom up

- FileScan parquet
- InMemoryRelation
- InMemoryTableScan
- ``HashAggregate(keys=[word#963], ...)``
- ``HashAggregate(keys=[word#963], functions=[count(1)])``
- ``Sort [count#1040L DESC NULLS LAST]``

Query plan

```
== Physical Plan ==
*Sort [count#1160L DESC NULLS LAST], true, 0
+- Exchange rangepartitioning(count#1160L DESC NULLS LAST, 200)
   +- *HashAggregate(keys=[word#963], functions=[count(1)])
      +- Exchange hashpartitioning(word#963, 200)
         +- *HashAggregate(keys=[word#963], functions=[partial_count(1)])
            +- *FileScan parquet [word#963] Batched: true, Format: Parquet,
               Location: InMemoryFileIndex[file:/temp/df.parquet], PartitionFilters: [],
               PushedFilters: [], ReadSchema: struct<word:string>
```

The previous plan had the following lines, which are missing from the plan above:

```
...
+- InMemoryTableScan [word#963]
   +- InMemoryRelation [word#963, id#964L, title#965, part#966], true, 10000,
      StorageLevel(disk, memory, deserialized, 1 replicas)
...
```

Let's practice

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