Python vs. Scala

Comparing speed, scalability and performance for a distributed movie recommender using ALS

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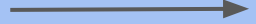
MovieLens Datasets

- MovieLens 100K (2.3 MB): 100,000 ratings from 1000 users on 1700 movies
- MovieLens 1M dataset (12 MB): 1 million ratings from 6000 users on 4000 movies
- MovieLens 20M dataset (305.2 MB): 20 million ratings on 27,000 movies by 138,000 users
- MovieLens 25M dataset (390.2 MB): 25 million ratings on 62,000 movies by 162,000 users.

Raw Data from ratings.csv

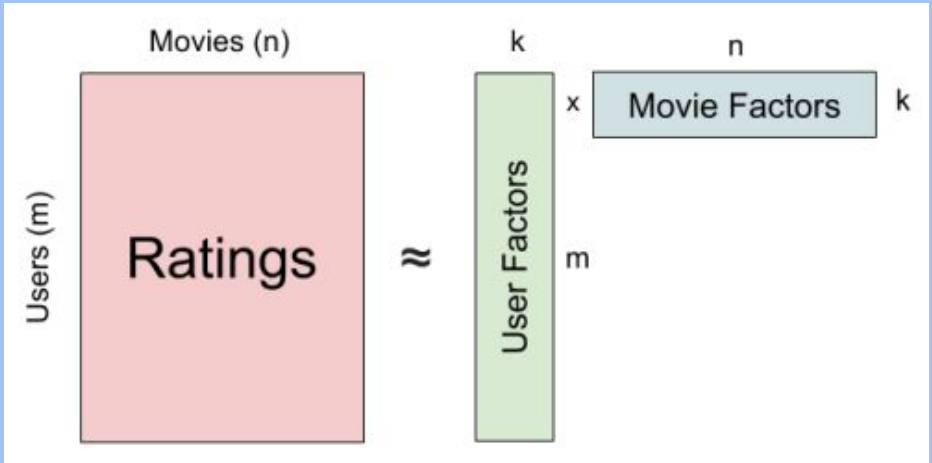
userid	movieid	rating	timestamp
1257	22349	4.0	964982703
2945	203948	1.0	964983605
6404	3038372	3.0	964984100



Utility Matrix

	movie1	movie2	movie3
User1	4.0		3.0
User2		2.0	
User3			5.0

Alternating Least Squares (ALS) algorithm



R (mxn) = W (mxk) x H (kxm)

'Block-to-block join' used to distribute user, item and ratings matrices efficiently.

'Hybrid partitioning' can reduce shuffling.

AWS Architecture

GPU + CPU

AWS emr-6.2.0 cluster: Spark 3.0.1 on Hadoop 3.2.1 YARN (1 master and 1 worker node)

GPU Only

- g4dn.2xlarge, 1 GPU, 8 vCPUs, 32 GiB of memory, 225 NVMe SSD, up to 25 Gbps network performance
- **NVIDIA spark-rapids**

CPU Only

- m4.2xlarge: 32 GiB of memory, 8 vCPUs, EBS-only, 64-bit platform

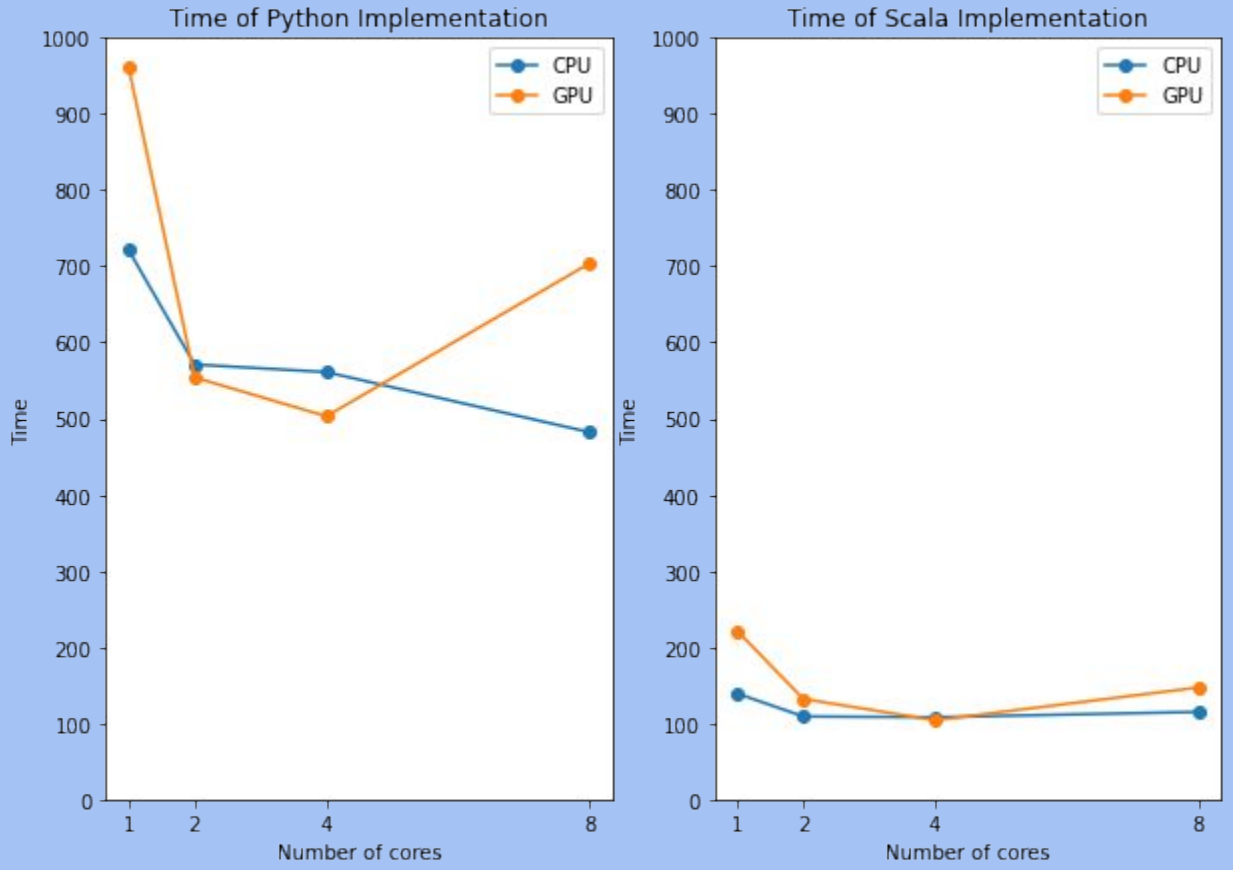
PySpark

RAPIDS

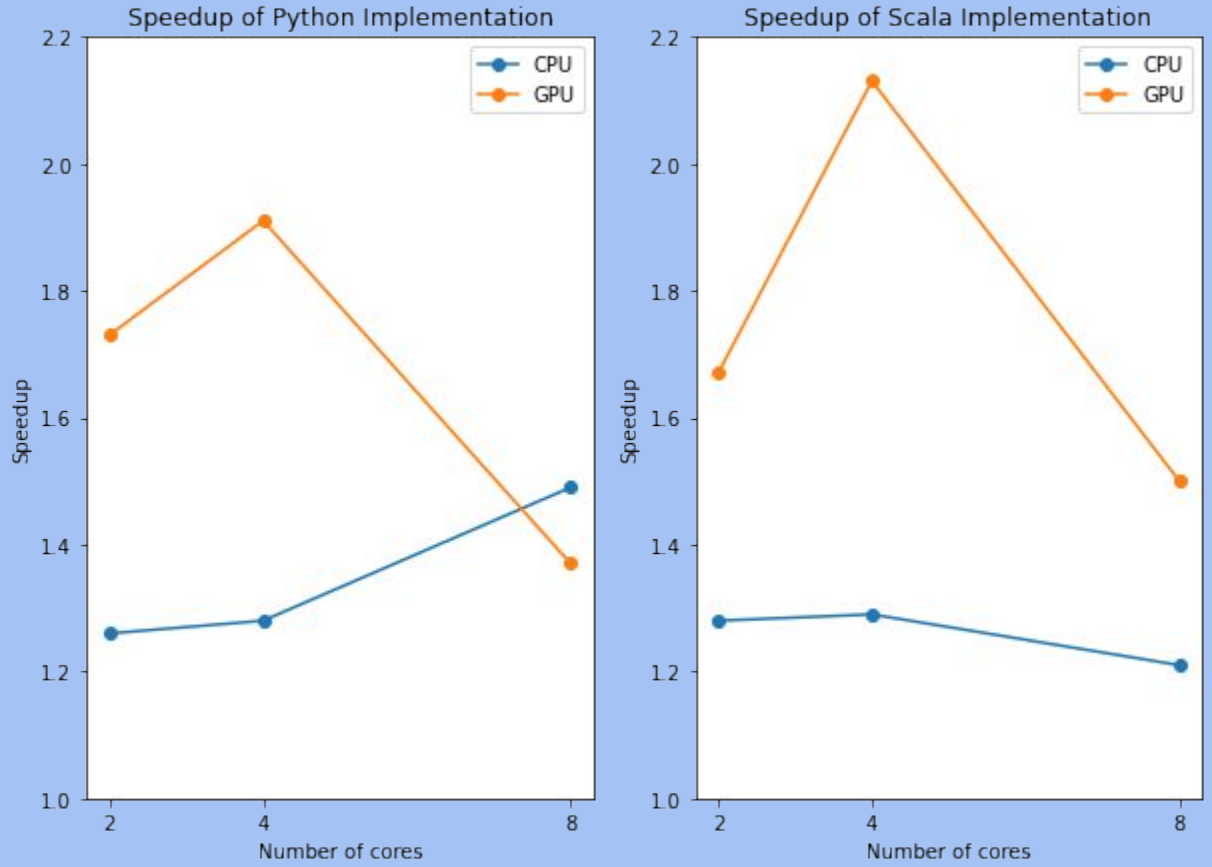
movielens → **ALS recommender** → **Acceleration**

Scala

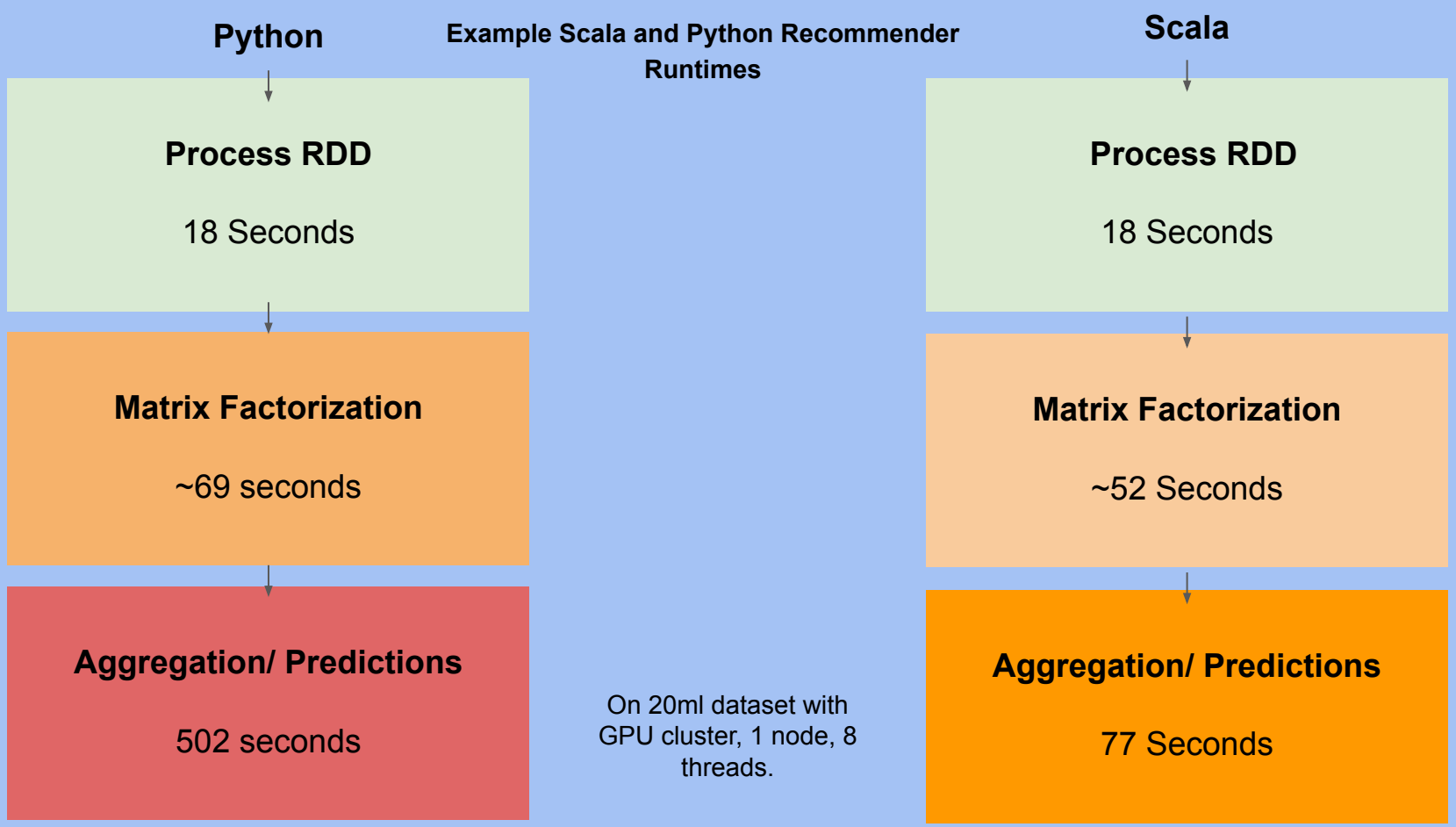
GPU vs CPU Execution Time



GPU vs CPU Speedup



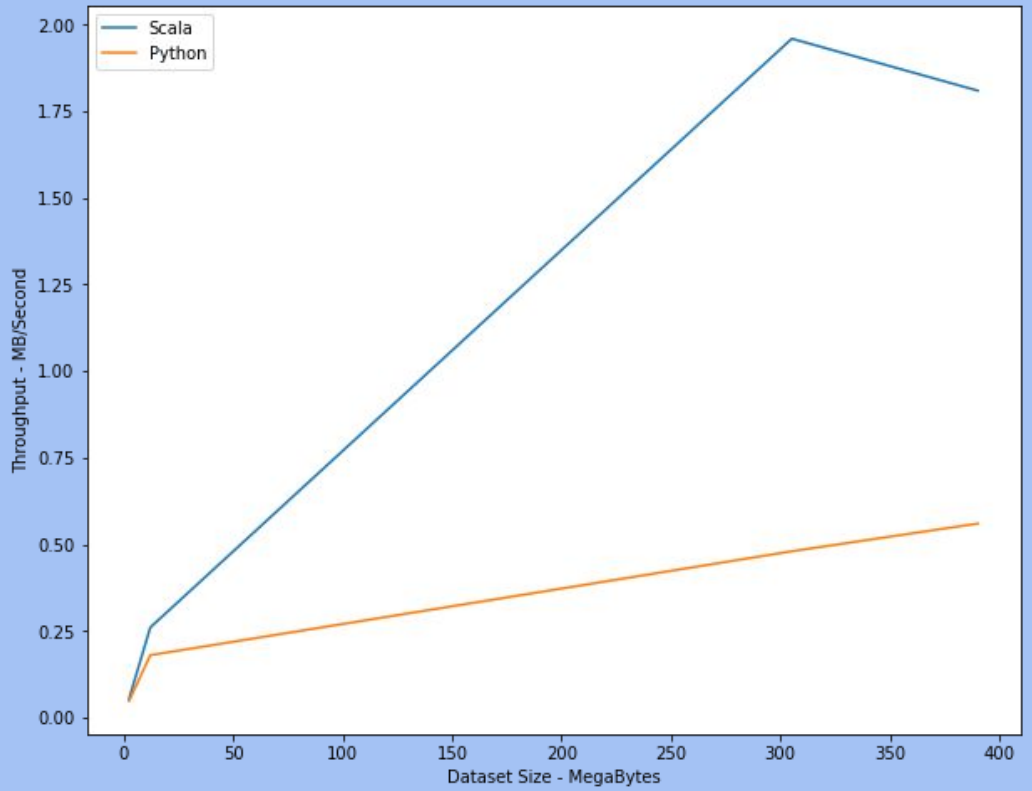
Example Scala and Python Recommender Runtimes



On 20ml dataset with GPU cluster, 1 node, 8 threads.

Weak Scaling

- Scala programme scales to large datasets more effectively than Python implementation.
- The throughput declines from using the 20ml dataset to the 25 ml dataset.
- This may reveal a limit of Scala's scalability to the ALS recommender application.

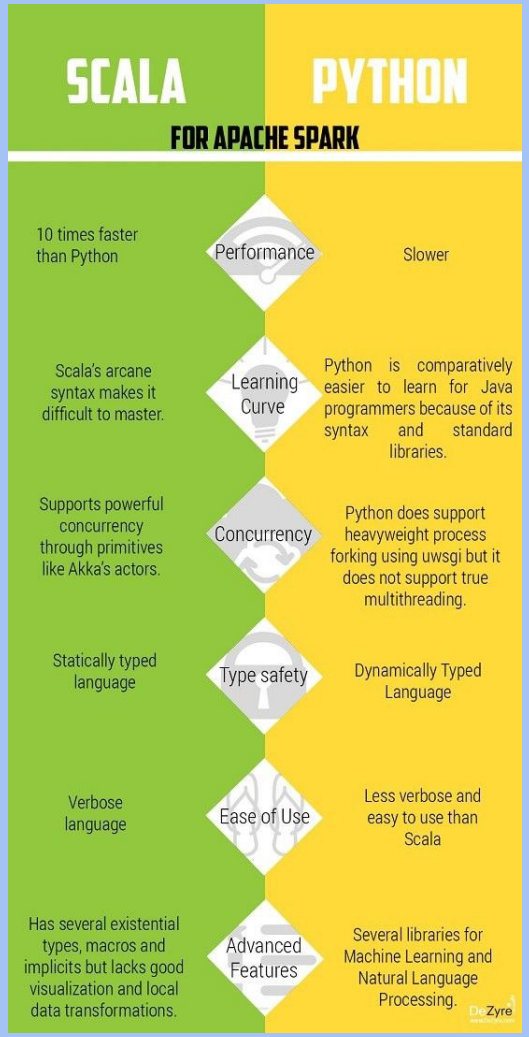


Let a hundred big data languages bloom?

- The trend towards heterogeneous programming languages may not be as strong as the trend towards heterogeneous hardware.

Comparison with other research

- JVM is a critical reason that Scala scales better than Python.
- Difficult to disentangle this from other Scala features.
- ALS is thought to scale badly to large datasets.



Conclusion

- Scala is a little more challenging to use but provides better performance for this task.
- Integrating GPUs with Spark may not be the best option for some applications.
- Distributing ALS matrix factorisation is not enough to fully parallelise an ALS recommender.

Next Steps

- Compare with Java to compare two languages that use the JVM.
- Use 1B dataset to test Scala scalability past 300mb.
- Compare RDD implementation and dataframe implementation.
- Speed up the aggregation and MSE.