StreamApprox

Approximate Stream Analytics in Apache Flink

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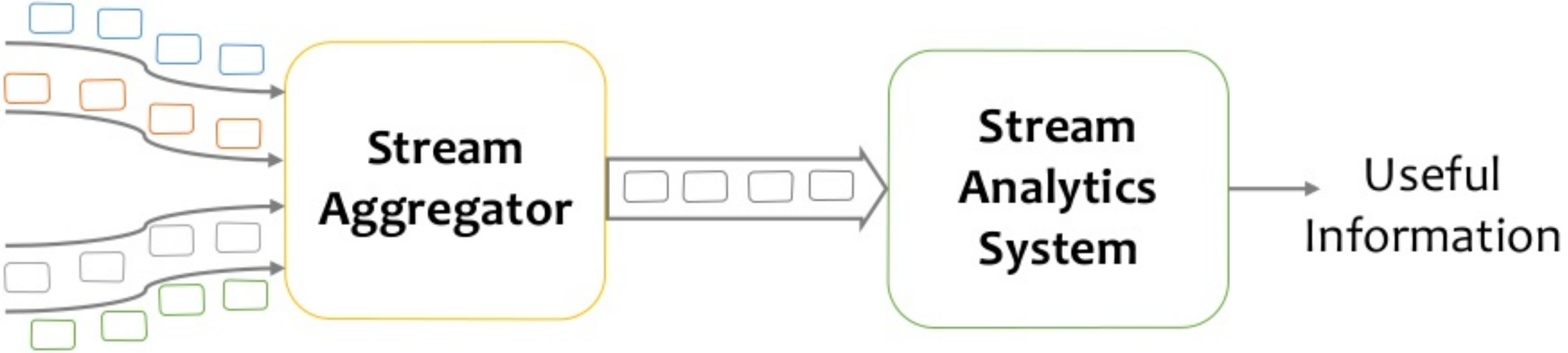
Modern online services



Modern online services

Approximate computing

Tension

Low latency

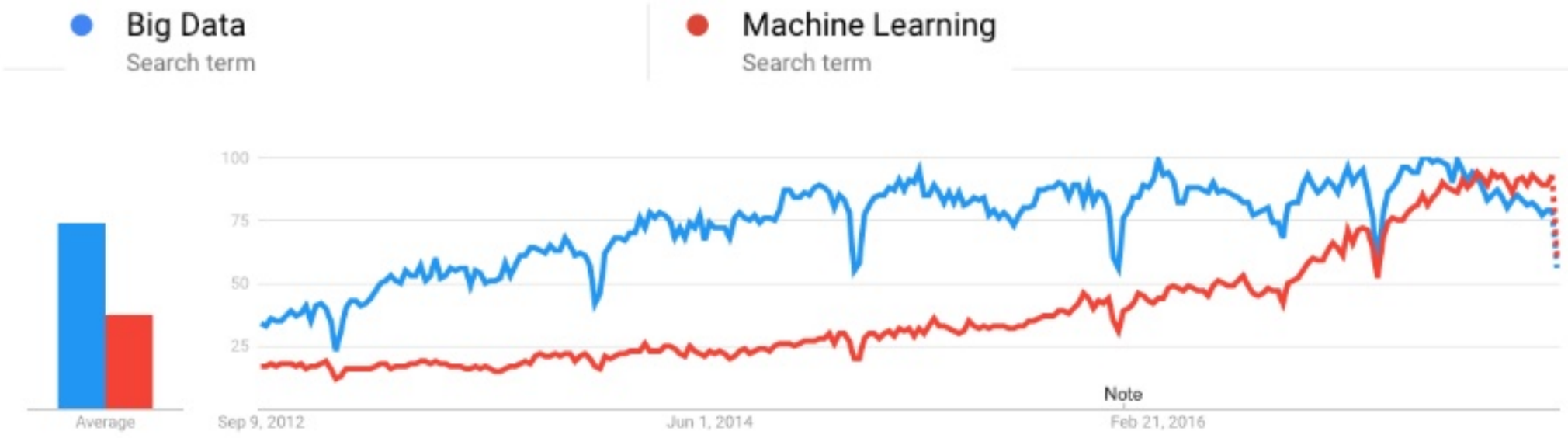
Efficient resource utilization

Approximate Computing

Many applications:
Approximate output is good enough!

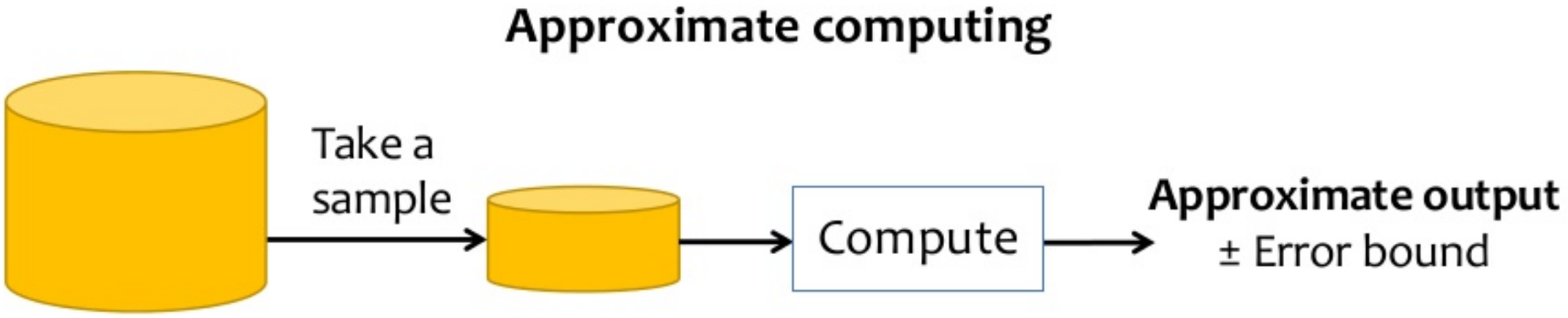
The trend of data is more important than the precise numbers

E.g. : Google Trends -- Big Data vs Machine Learning (Sep/2012 – Sep/2017)



Approximate Computing

Idea: To achieve low latency, compute over a sub-set of data items instead of the entire data-set



State-of-the-art systems

BlinkDB [EuroSyS'13]

Using pre-existing samples

Not designed for stream analytics

ApproxHadoop [ASPLOS'15]

Using multi-stage sampling

Quickr [SIGMOD'16]

Injecting samplers into query plan

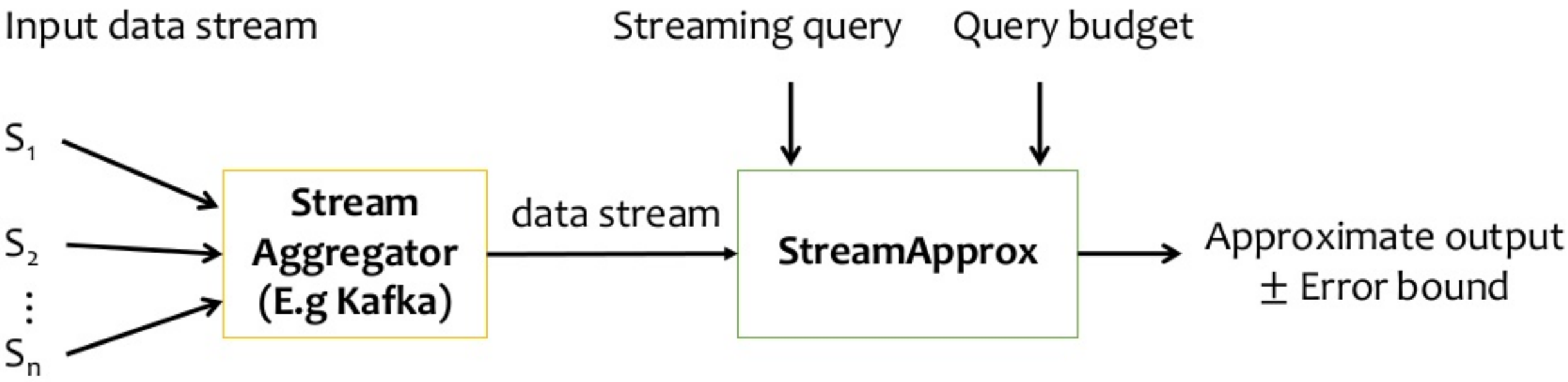
StreamApprox: Design goals

Transparent	Targets existing applications w/ minor code changes
Practical	Supports adaptive execution based on query budget
Efficient	Employs online sampling techniques

Outline

- ~~Motivation~~
- Design
- Evaluation

StreamApprox: Overview

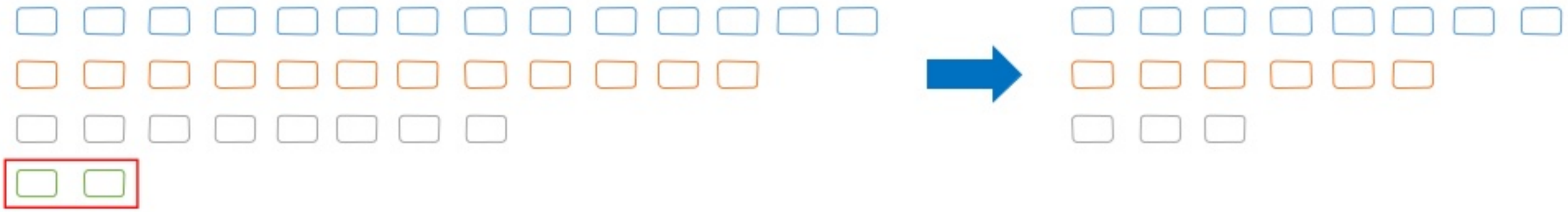


Query budget:

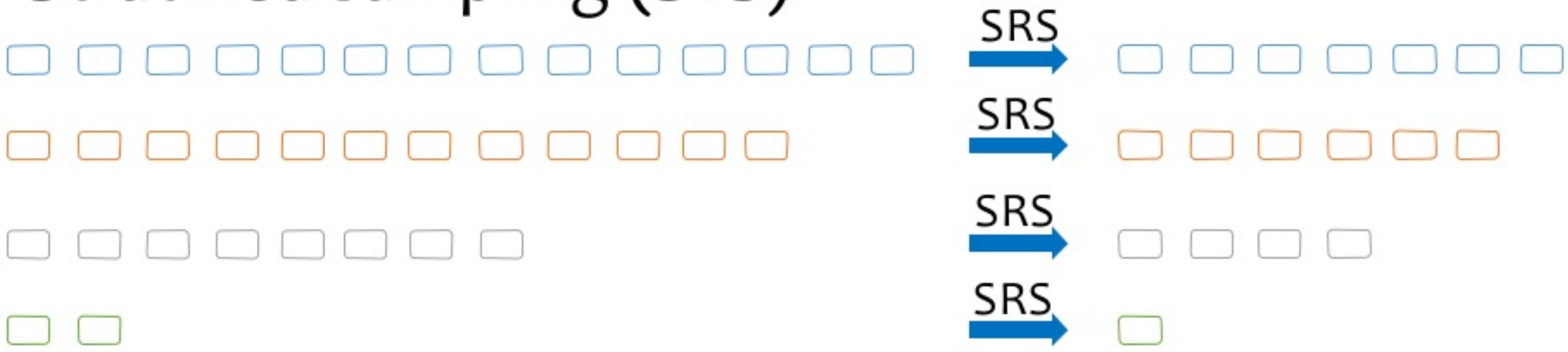
- **Latency/throughput** guarantees
- Desired **computing resources** for query processing
- Desired accuracy

Key idea: Sampling

Simple random sampling (SRS):

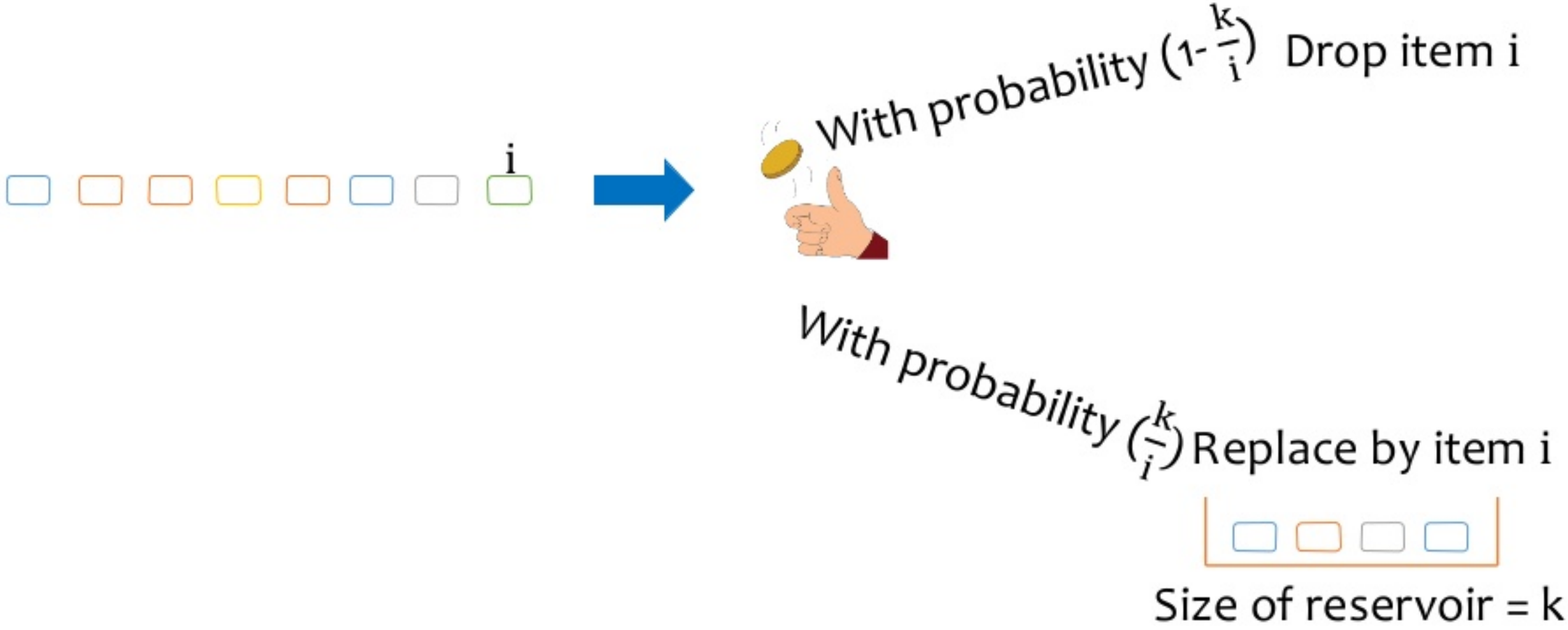


Stratified sampling (STS):



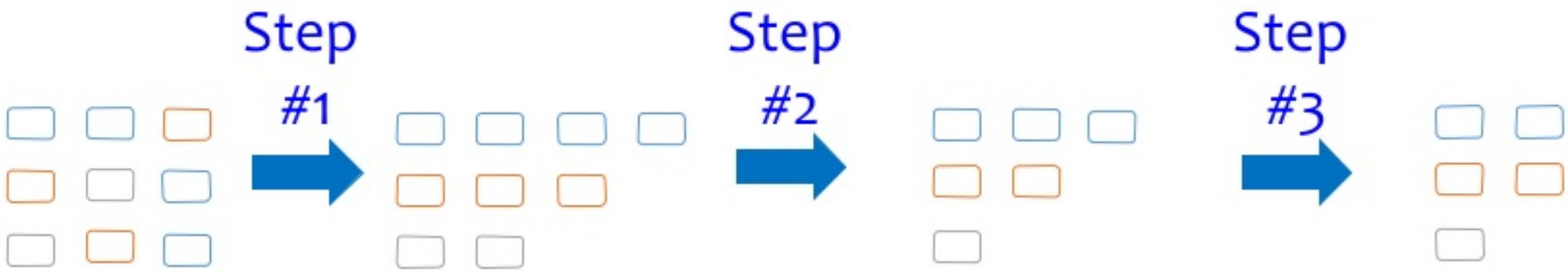
Key idea: Sampling

Reservoir sampling (RS):



Spark-based Sampling

Spark-based Stratified Sampling (Spark-based STS)



Create strata using *groupByKey()*

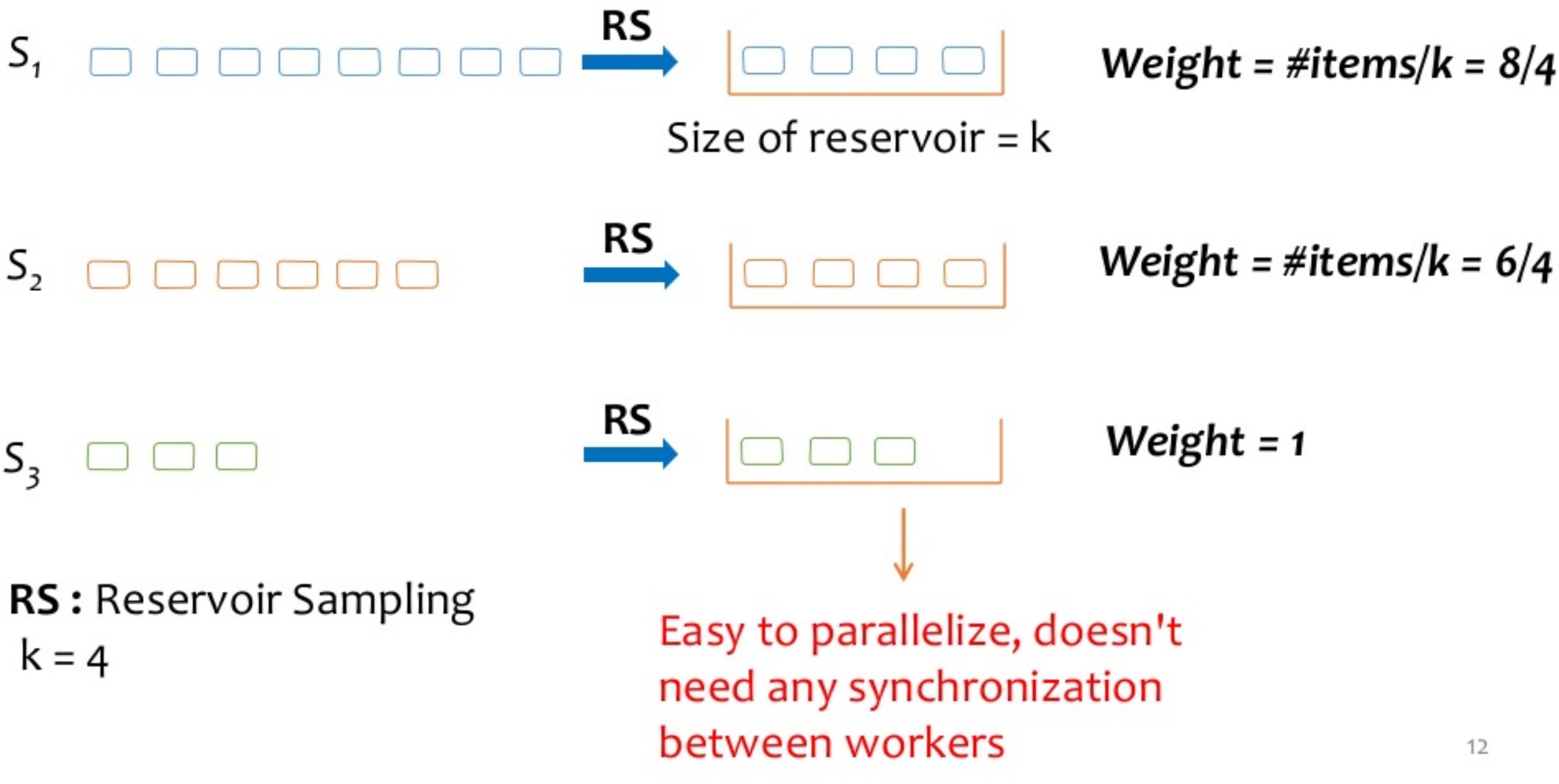
Apply SRS to each stratum S_i

Synchronize between worker nodes to select a sample of size *k*

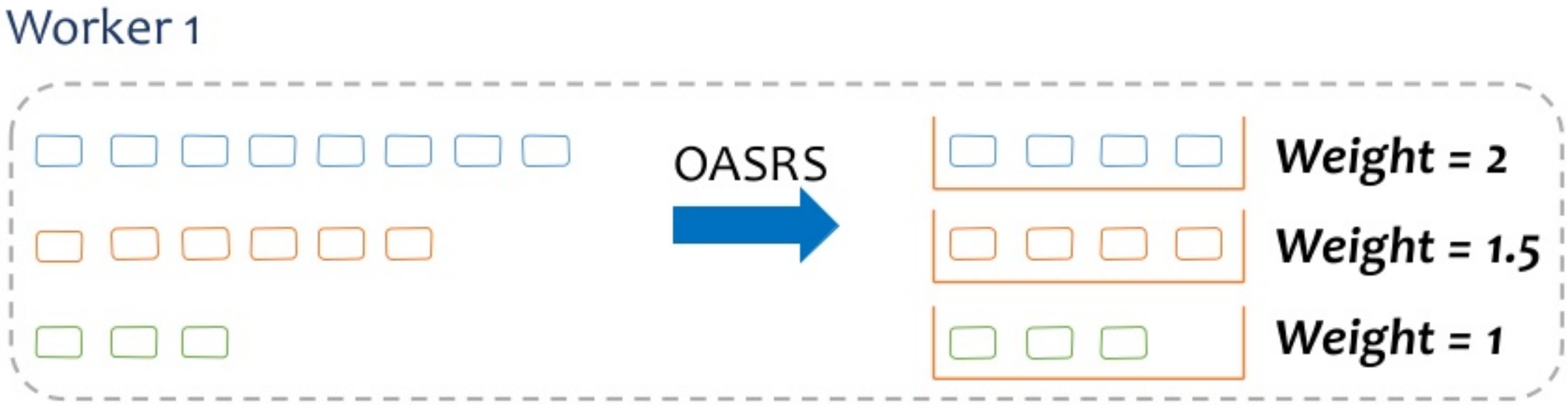
These steps are very expensive

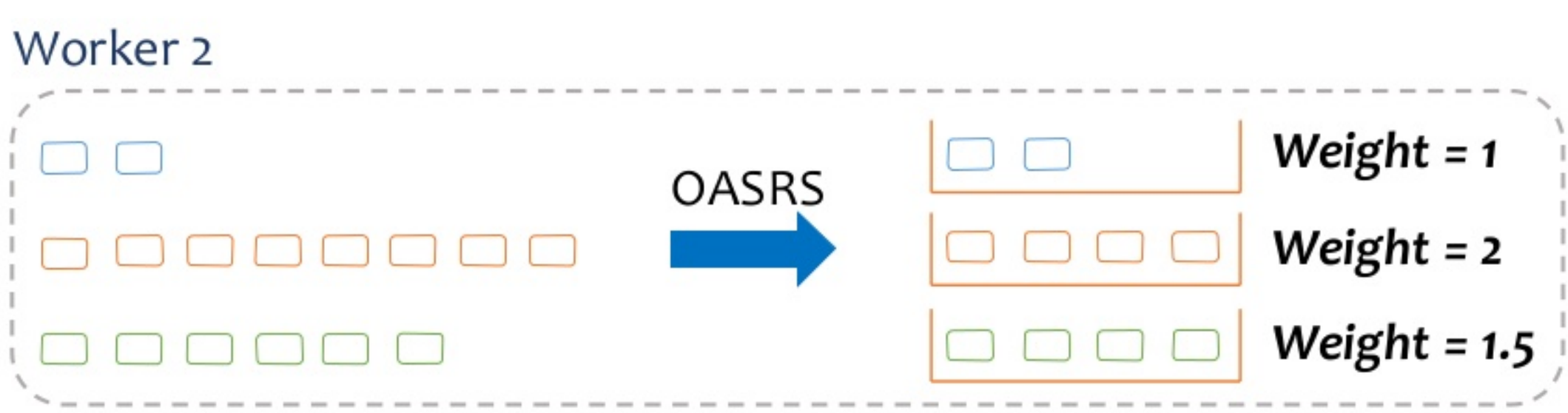
StreamApprox: Core idea

Online Adaptive Stratified Reservoir Sampling (OASRS)



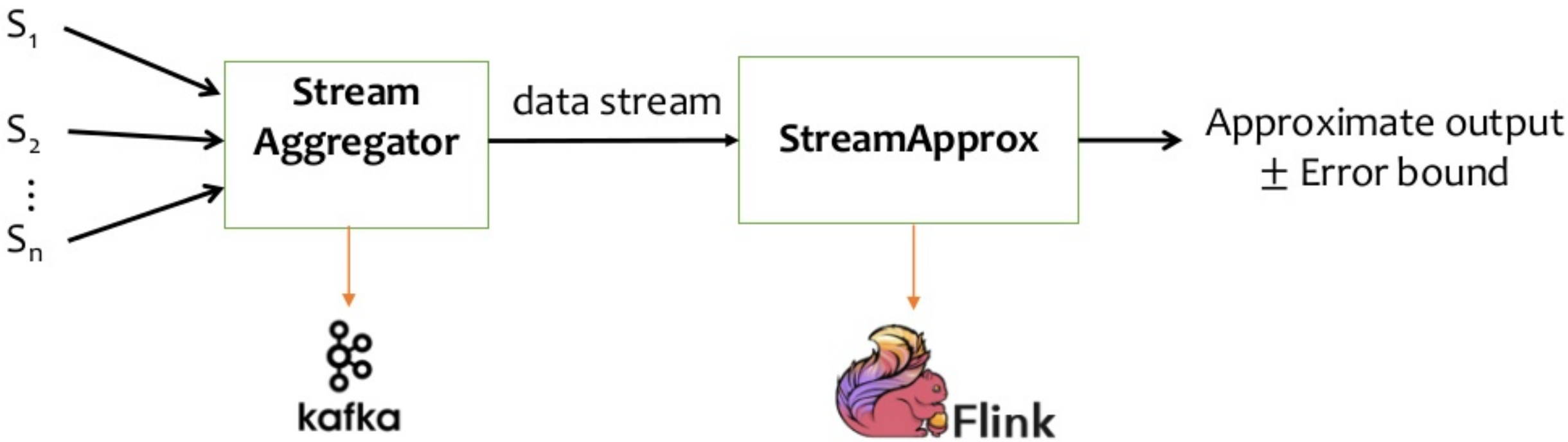
StreamApprox: Core idea



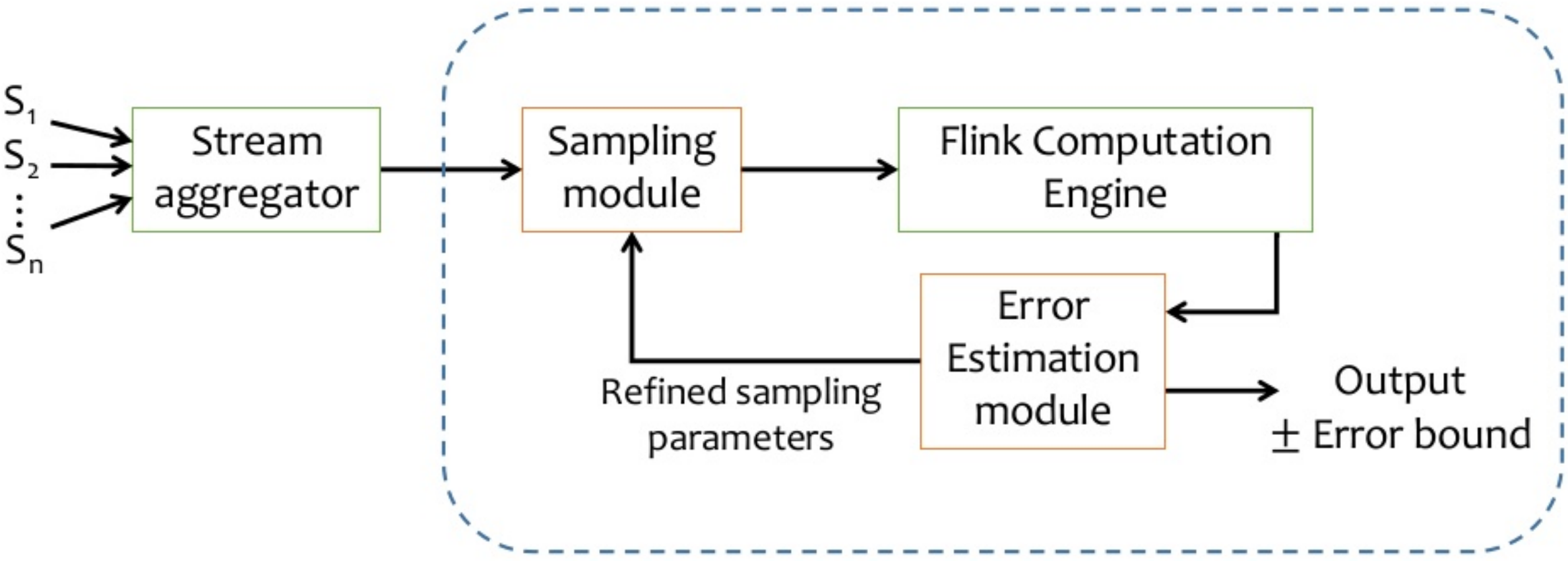


Size of reservoir = 4

Implementation



Implementation



Flink-based StreamApprox

Outline

- ~~Motivation~~
- ~~Design~~
- Evaluation

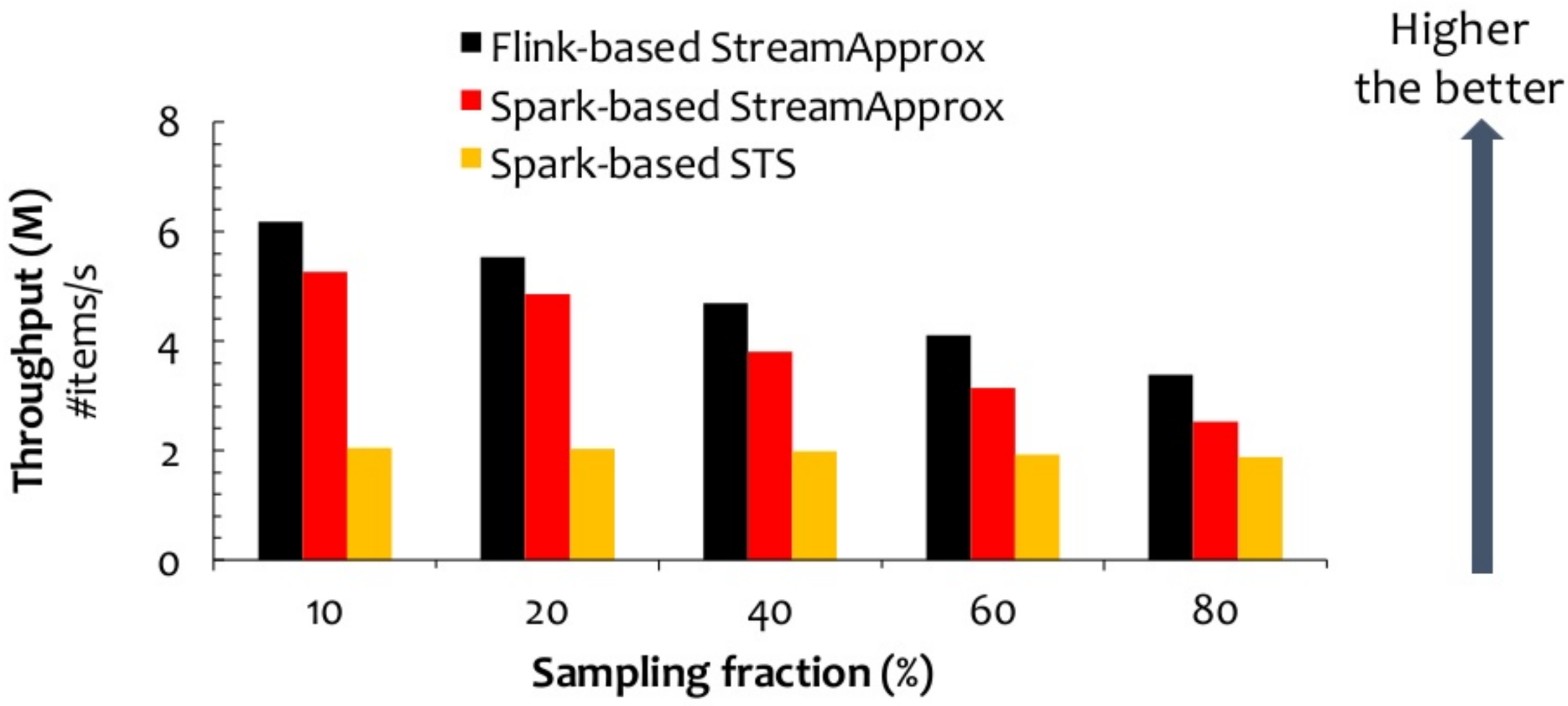
Experimental setup

- Evaluation questions
  - Throughput vs sample size
  - Throughput vs accuracy

See the paper for more results!

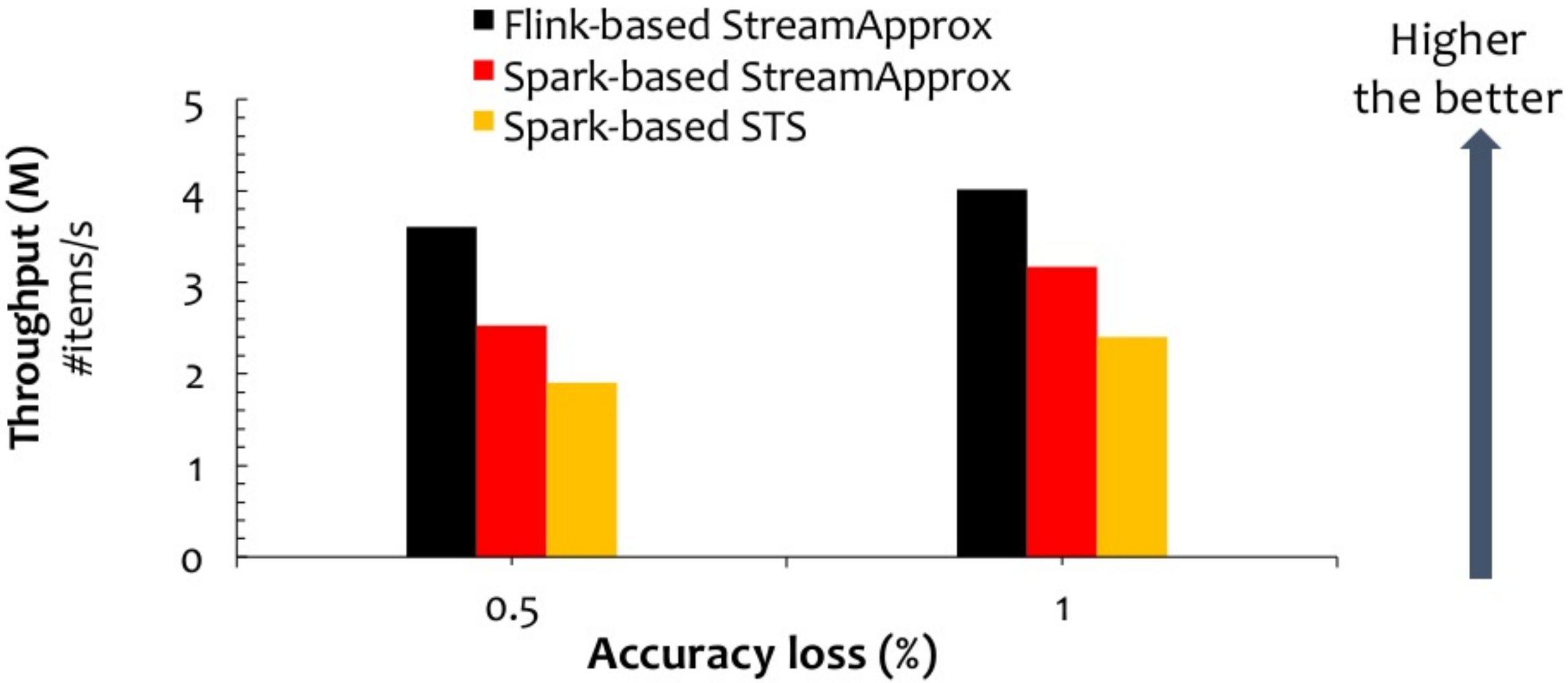
- Testbed
  - Cluster: 17 nodes
  - Datasets:
    - Synthesis: Gaussian distribution, Poisson distribution datasets
    - CAIDA Network traffic traces; NYC Taxi ride records

Throughput



Spark-based StreamApprox: ~2X higher throughput over Spark-based STS
Flink-based StreamApprox: 1.3X higher throughput over Spark-based StreamApprox
With sampling fraction < 60%

Throughput vs Accuracy



Spark-based StreamApprox: ~1.32X higher throughput over Spark-based STS
Flink-based StreamApprox: 1.62X higher throughput over Spark-based StreamApprox
With the same accuracy loss

Conclusion

StreamApprox: Approximate computing for stream analytics

Transparent	Supports applications w/ minor code changes
Practical	Adaptive execution based on query budget
Efficient	Online stratified sampling technique

Thank you!

Details: StreamApprox [Middleware'17]

https://streamapprox.github.io