

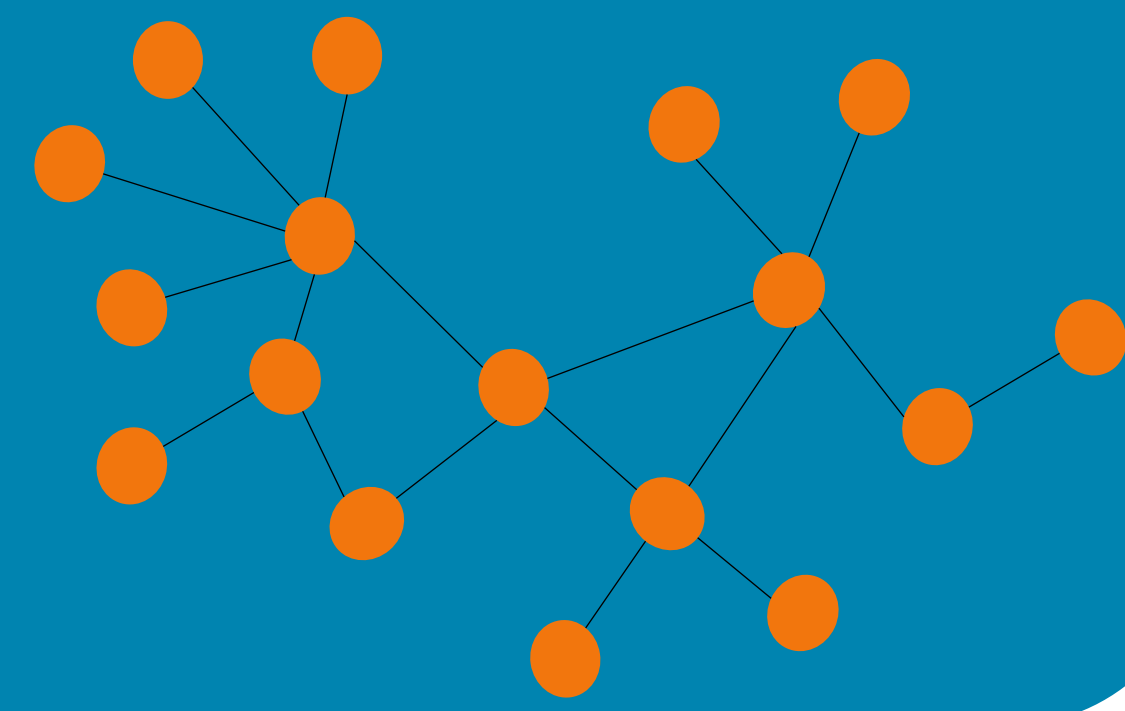
Cost Model Based Approach for Graph Partitioning in Spark GraphX

Rohit Kumar^{1,2}, Alberto Abello² and Toon Calders^{1,3}

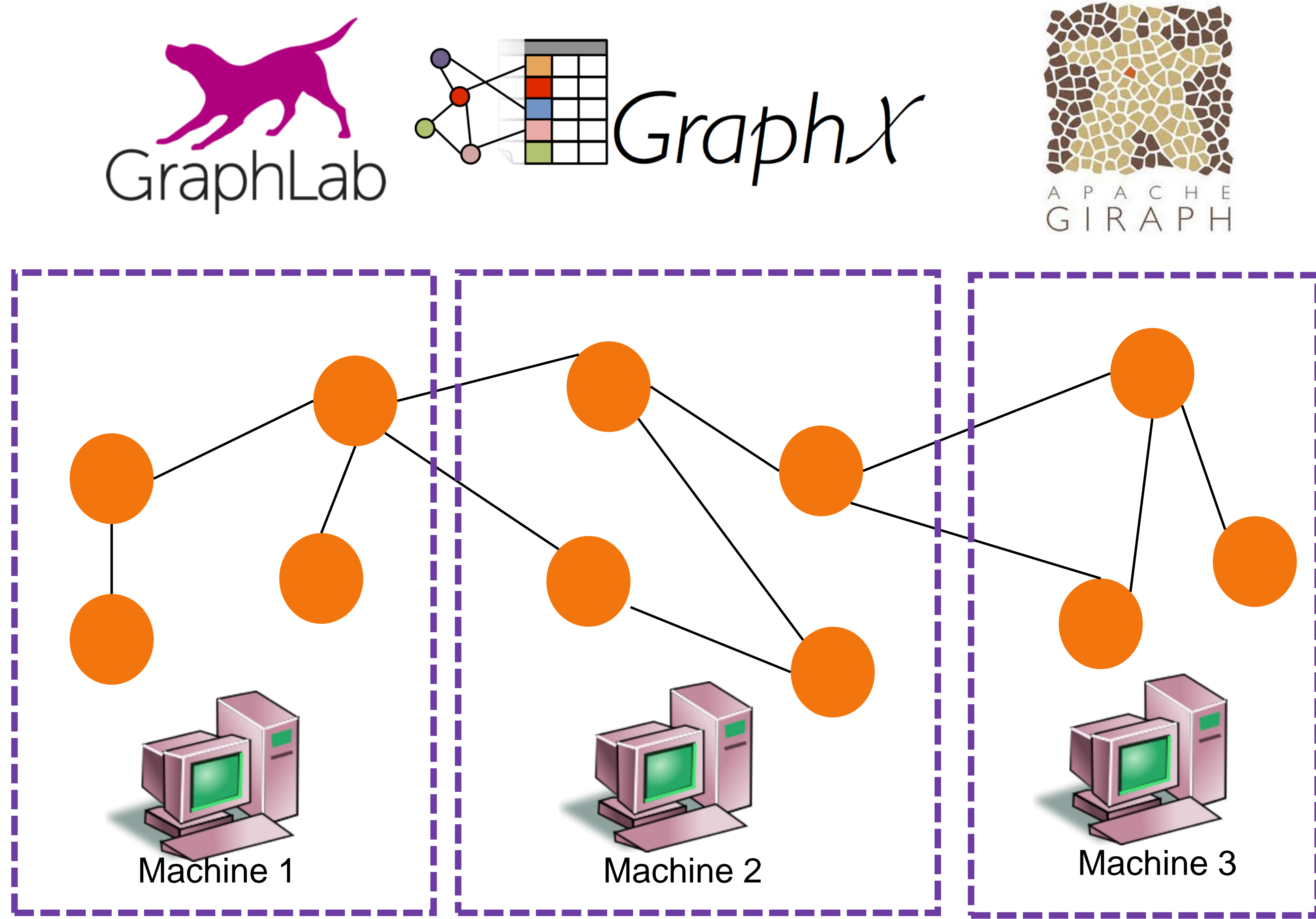
¹Department of Computer and Decision Engineering
Université Libre de Bruxelles, Belgium

²Department of Service and Information System Engineering
Universitat Politècnica de Catalunya (BarcelonaTech), Spain

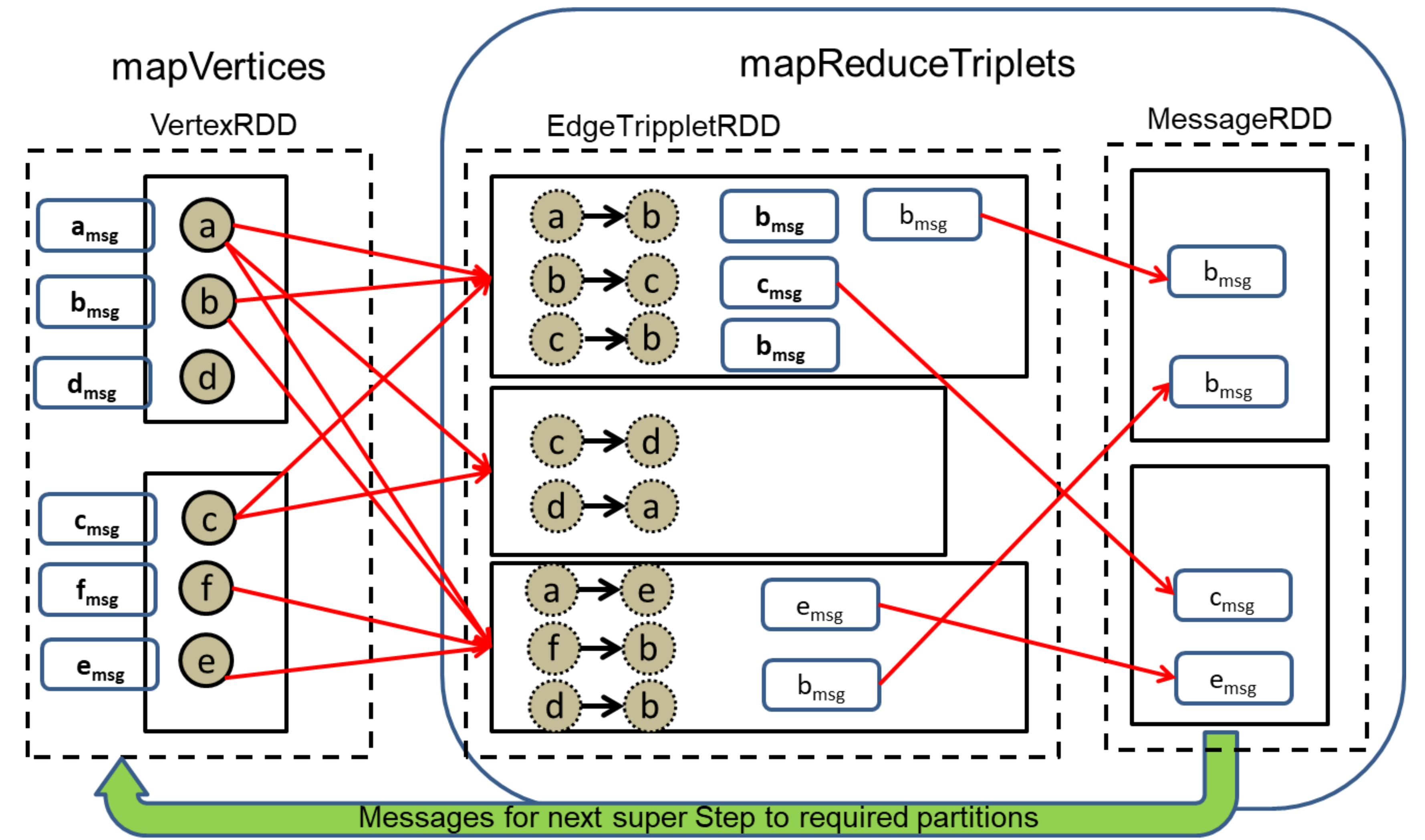
³Department of Mathematics and Computer Science
Universiteit Antwerpen, Belgium



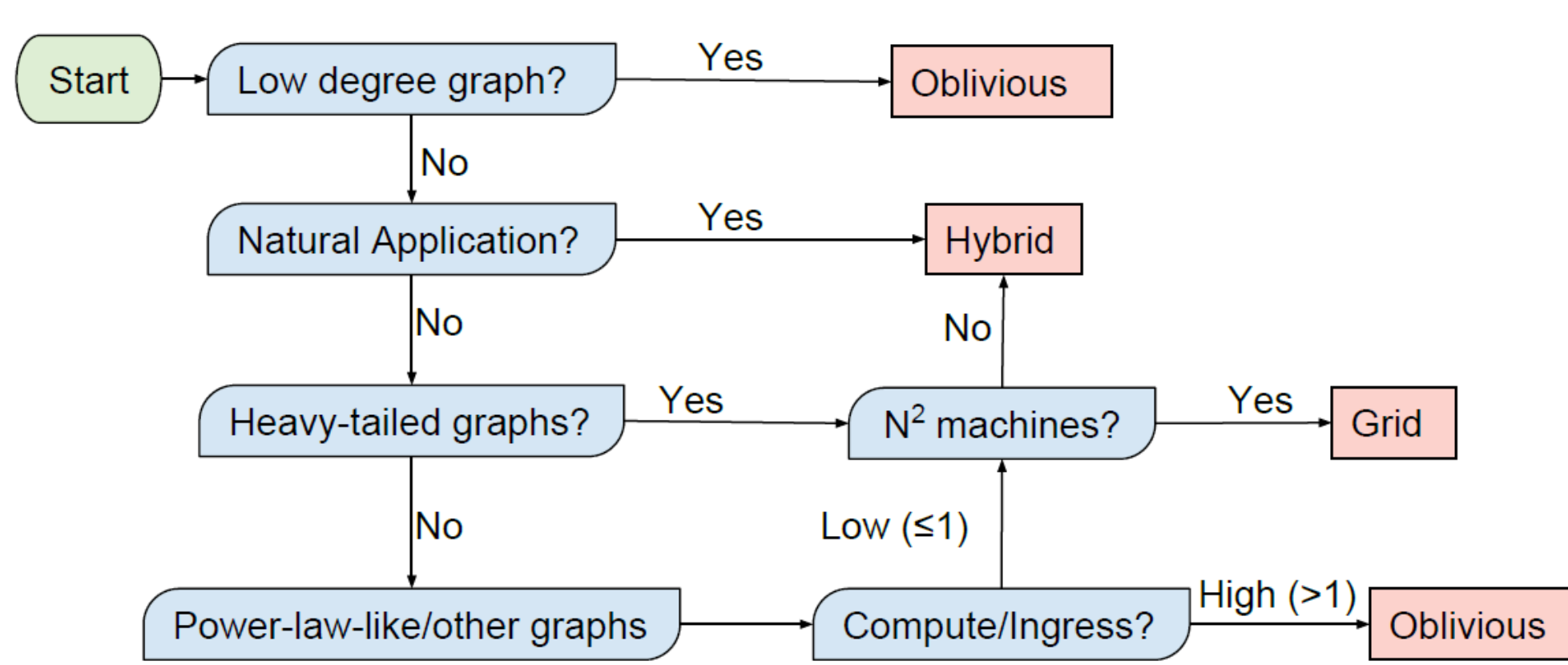
1. Distributed Graph Processing



5. Pregel Model in GraphX



2. Our Ambition!

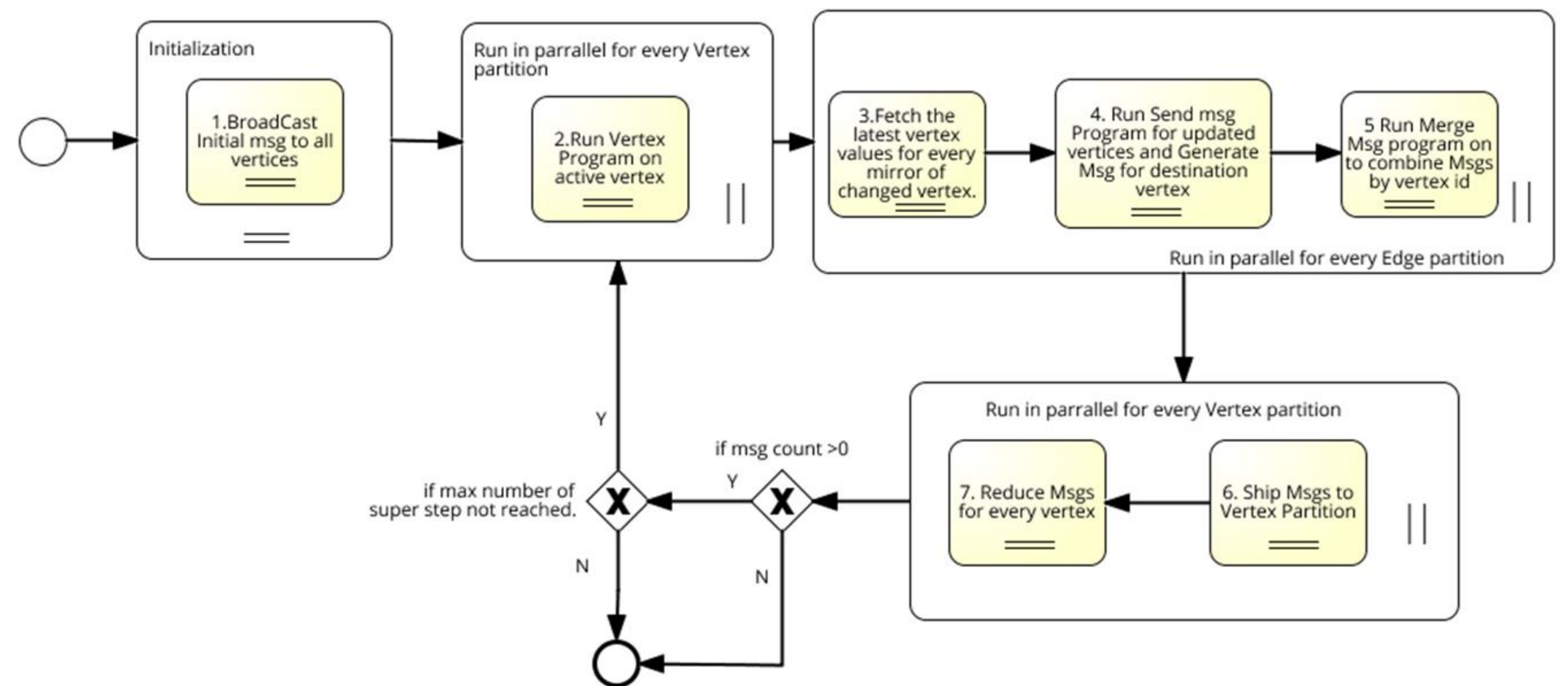


Verma et. al. (VLDB 2017) An experimental comparison of partitioning strategies in distributed graph processing.



Optimal Partitioning strategy

6. BPMN for Pregel



3. Our Approach

Using system specific cost models for Pregel implementation.



Why Pregel?

Pregel is the most popular programming abstraction to define distributed graph processing algorithms

- We provide cost model for Pregel API in Spark GraphX.
- We validate the cost model on multiple combination of graph and algorithm.

7. Derived Cost functions

$$cPregel(V, E, s, A, P_e, P_v) := cInit(V, A, |P_v|) + \sum_{i=1}^s cSuperStep(V_i, E_i, A, M_{i-1}, P_e, P_v) \quad (1)$$

$cApply$ = cost of running vertex Program on active vertex + β_w Data written on disk + α_1

$cGather$ = β_r read data from previous step + cost of running sendMsg Program on active edges + cost of merging all messages locally + β_w Data written on disk + α_2

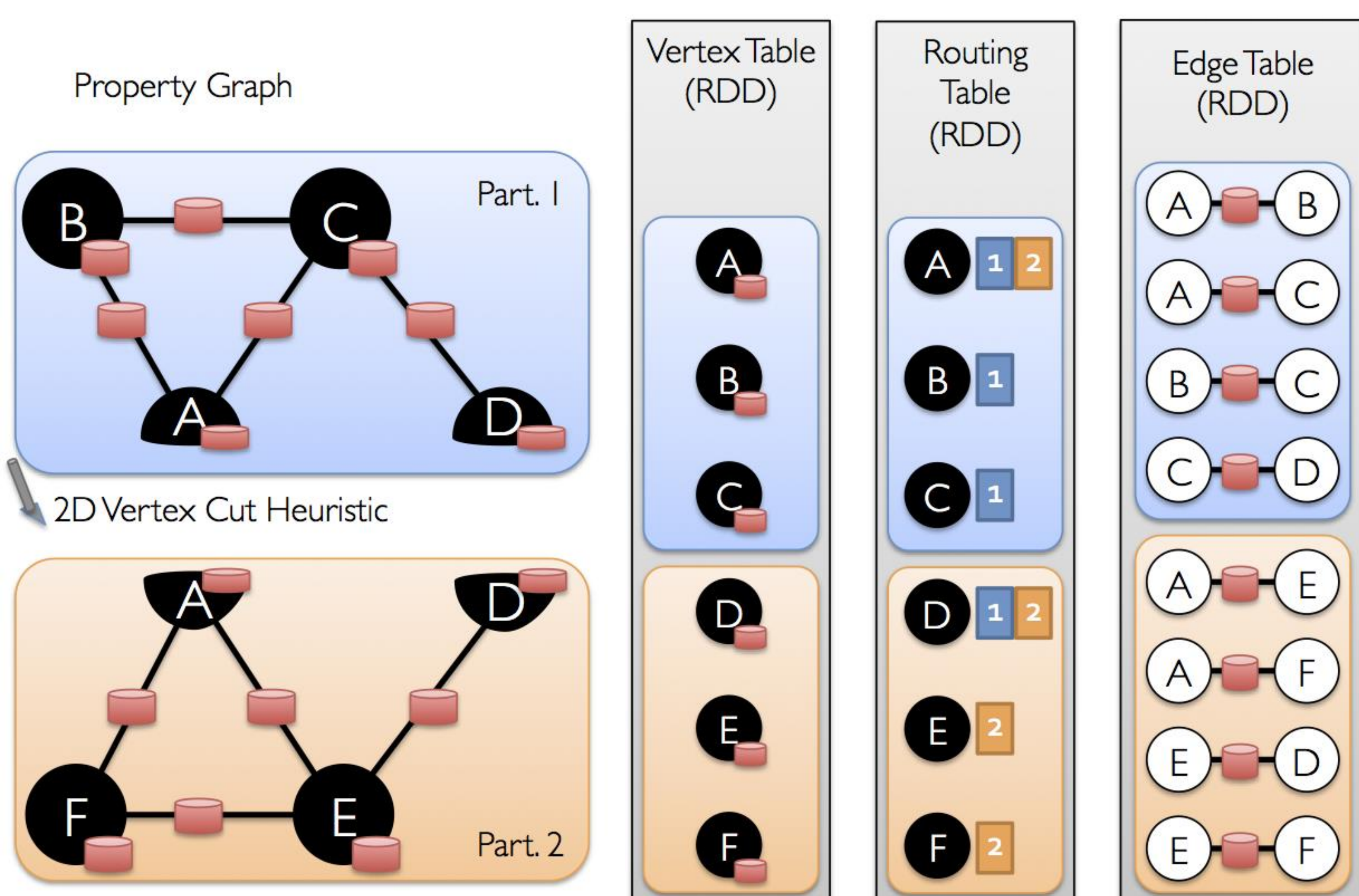
$cReduce$ = γ reading all messages + cost to merge all messages for one vertex + α_3

$$cSuperStep(V_i, E_i, A, M_{i-1}, P_e, P_v) := \max_{0 \leq q \leq |P_v|} \{cApply(V_i^q, M_{i-1}^q, A_v, P_e, P_v)\} + \max_{0 \leq k \leq |P_v|} \{cGather(E_i^k, M_i^k, V_i^k, A_s, A_m, P_e)\} + \max_{0 \leq r \leq |P_v|} \{cReduce(M_i^r, V_i^r, A_m, P_e, P_v)\} \quad (2)$$

We obtained the system specific constants i.e. alphas, betas and gamma and validated on different dataset, algorithm and partitioning strategy combinations.

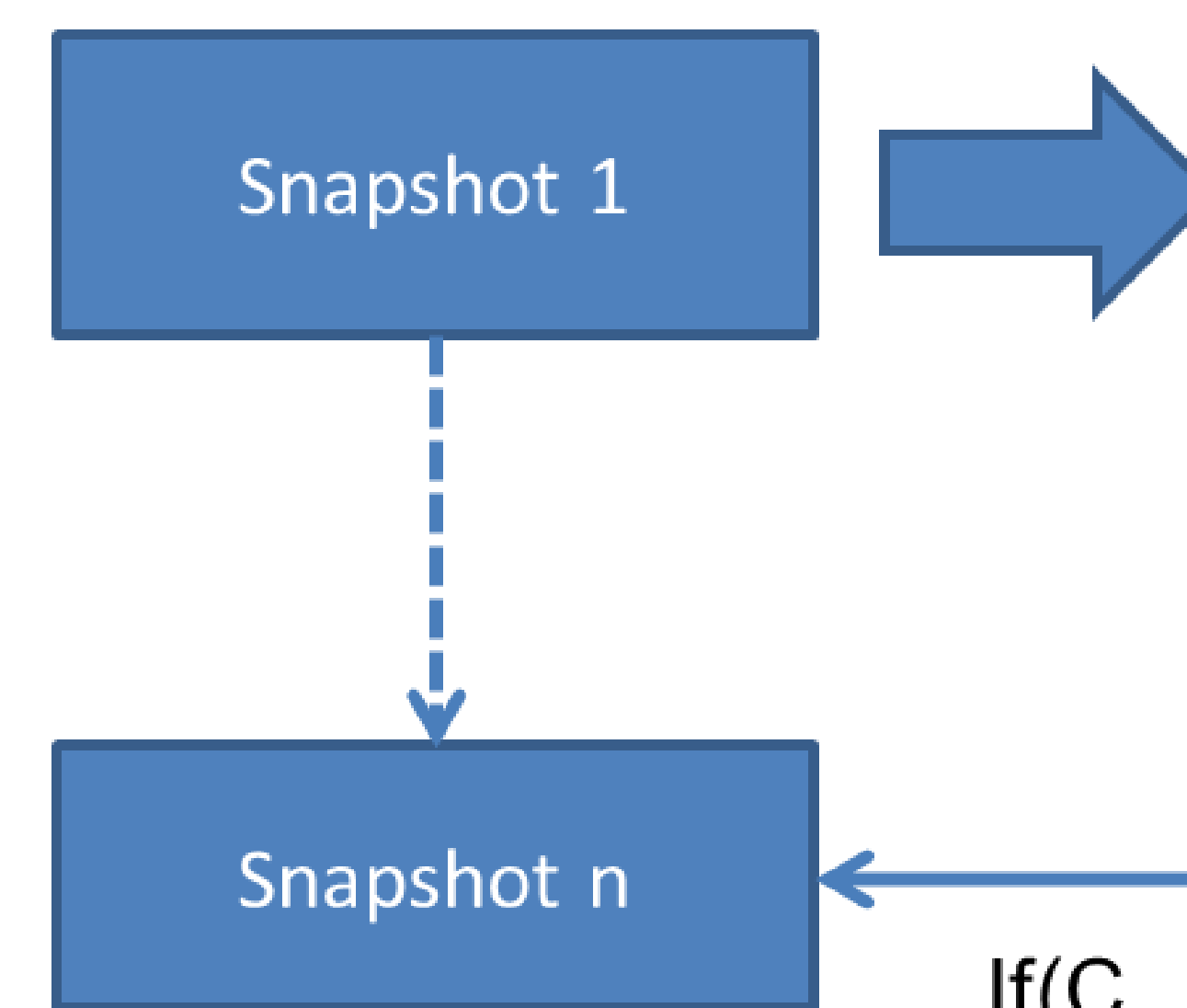
Dataset	Algorithm	Partition Strategy		
		EdgePartition2D	CRVC	DBH
CollegeMsg	PageRank	96.4	97.9	97.7
	CC	97.6	96.1	96.7
twitter	PageRank	97.7	-	99.3
	CC	98.9	98.7	97.1
Higgs	PageRank	94.6	97.2	99.8
	CC	97.9	95.9	94.9

4. Graph Representation in GraphX



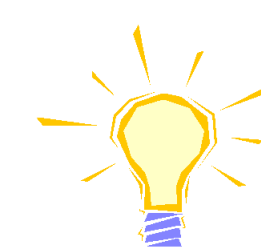
8. The Future

1. Use Rule based strategy to determine Partitioning strategy.



1. Calculate repartition cost. (C_R)
2. Estimate cost for new partitioner (C_{new})
3. Estimate cost using old partitioner. (C_{old})

If $(C_{new} - C_{old}) > C_R + \epsilon$
Use New partitioning.



Similar to cost based query optimization in RDBMS use cost models to pick most optimal partitioning strategy for a given input graph and algorithm.

References:

- Rohit et. al. (ADBIS 2017) Cost Model for Pregel on GraphX
- Verma et. al. (VLDB 2017) An experimental comparison of partitioning strategies in distributed graph processing.