Distributed Graph Processing:

Theoretical TLAV vs. Pregel

PETAR JOVANOVIC

Introduction

Distributed graph processing

Thinking Like a Vertex (TLAV) framework

- iterative execution of a user-defined vertex program over vertices of the graph
  - Vertices pass messages to adjacent vertices
- Two views: **vertices view** and **edges view**
- Synchronous (BSP)
  - Computation is based on **supersteps**, which serve as sync barriers

Pregel – most famous implementation of BSP TLAV framework

- Besides vertices and edges, it also maintains a triplets view

Theoretical TLAV

- ***Apply***: also known as vertex program, applies a user-defined **function** to each vertex in parallel; meaning that the function specifies the behavior of a single vertex v at a particular superstep S. On the first iteration, the vertex program is invoked on all vertices and the pre-defined message is passed. On subsequent iterations, the vertex program is only invoked on those vertices that receive messages.
- ***Scatter***: also known as send message, sends messages to other vertices, such that those vertices will receive the messages in the next superstep S+1.
- ***Gather***: receives and reads messages that are sent to a node v from the previous superstep S – 1 and apply the function. This function must be commutative and associative.

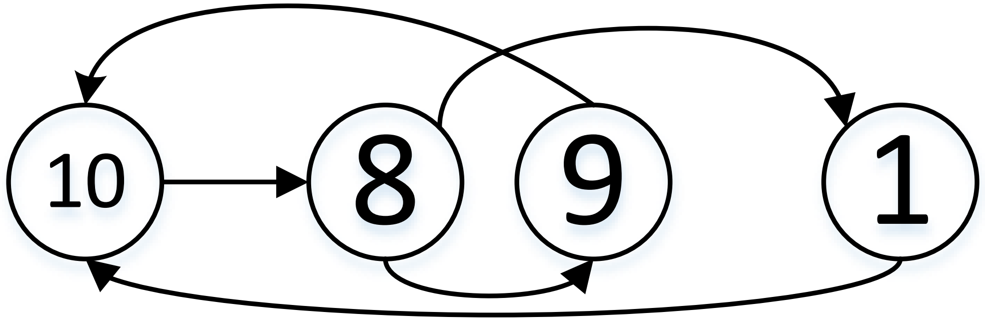
Pregel

Implementation of the Apply / Gather / Scatter

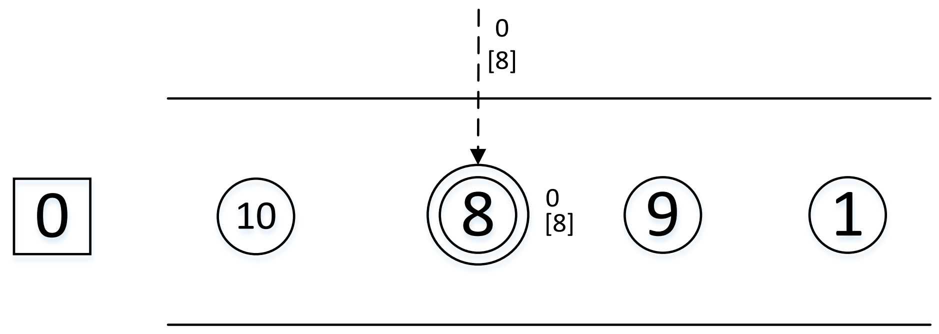
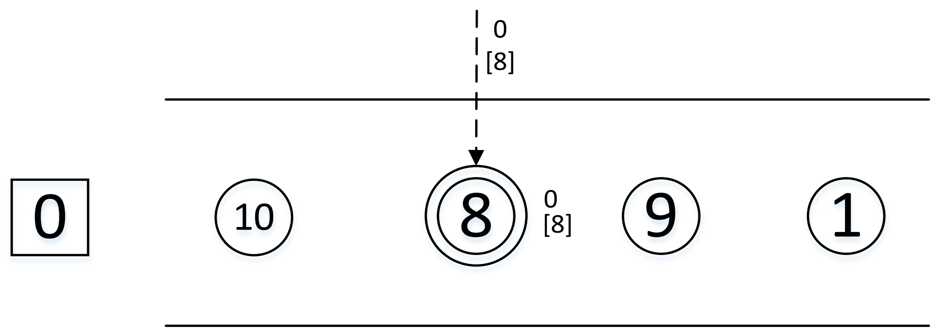
- **VProg** (corresponding to the **Apply** phase): in the case of the first superstep, the vertex value, otherwise applies the **function** over the vertex value and the received message and sends the result.
- **sendMsg** (corresponding to the **Scatter** phase): by accessing the **triplets view*** *checks if it the current vertex value can **change** the destination vertex value, and if so, it sends the current value to it. Otherwise, does not send anything.*
- **merge** (corresponding to the **Gather** phase): receives messages from previous supersteps and applies the **function**.

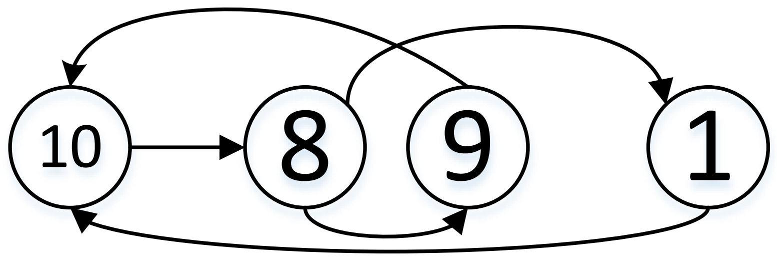
* **Triplets view:** in addition to the vertex and edge views of the property graph, GraphX also exposes a **triplet view**. The triplet view joins the vertex and edge properties yielding an RDD that contains instances of the EdgeTriplet class. EdgeTriplet class extends the Edge class by adding the **srcAttr** and **dstAttr** members which contain the **source** and **destination** properties, respectively.

Example: Maximal value



Example: Maximal value

Theoretical TLAV algorithm	Pregel framework
	



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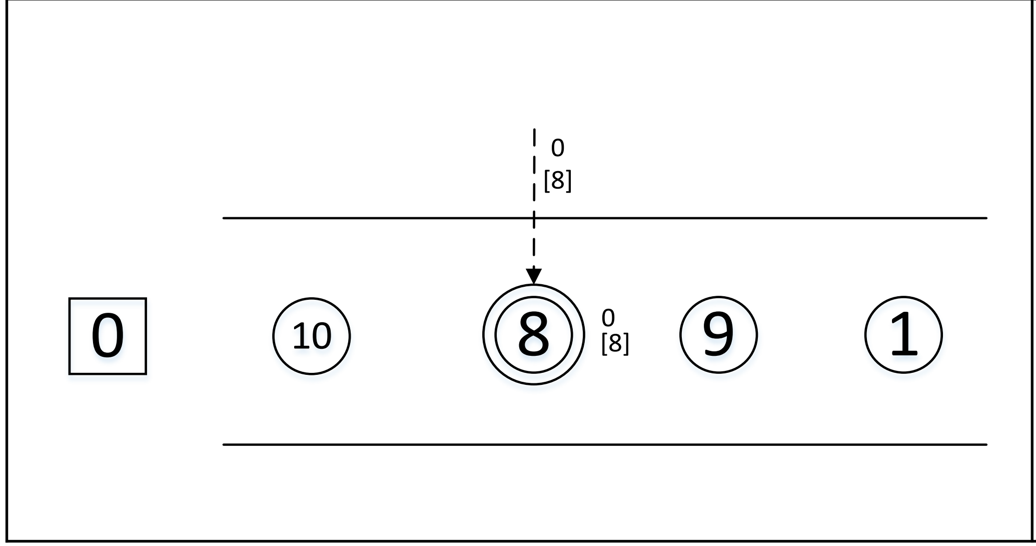	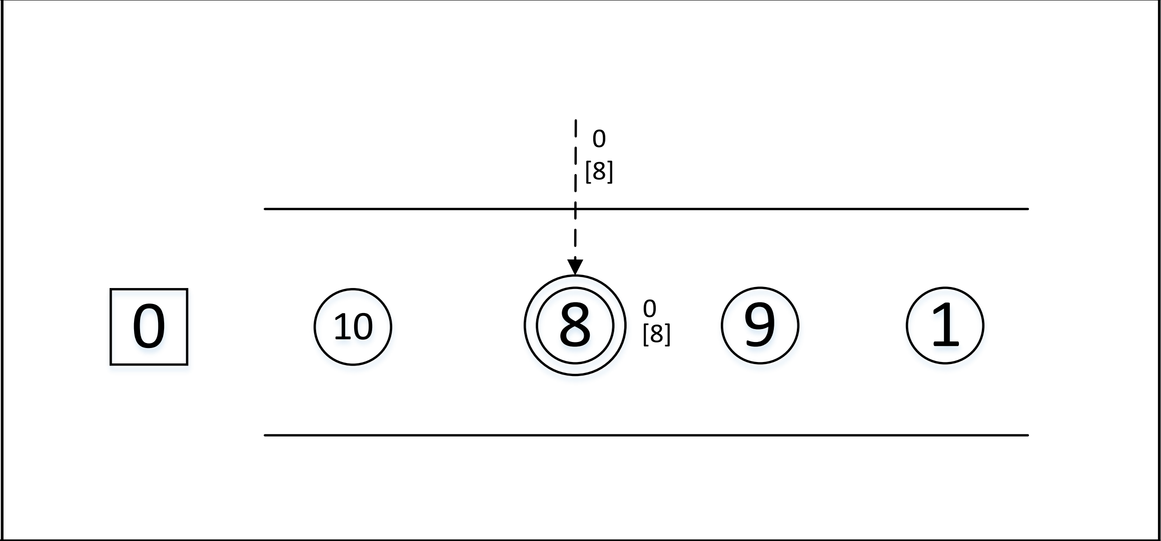

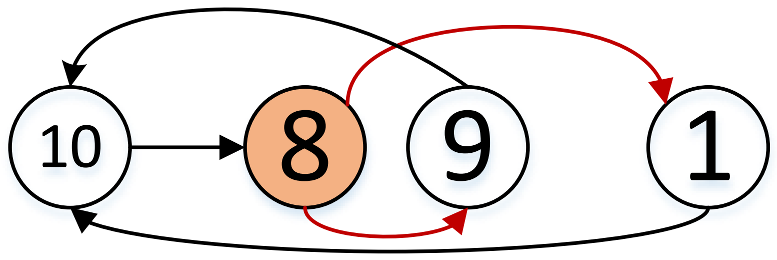

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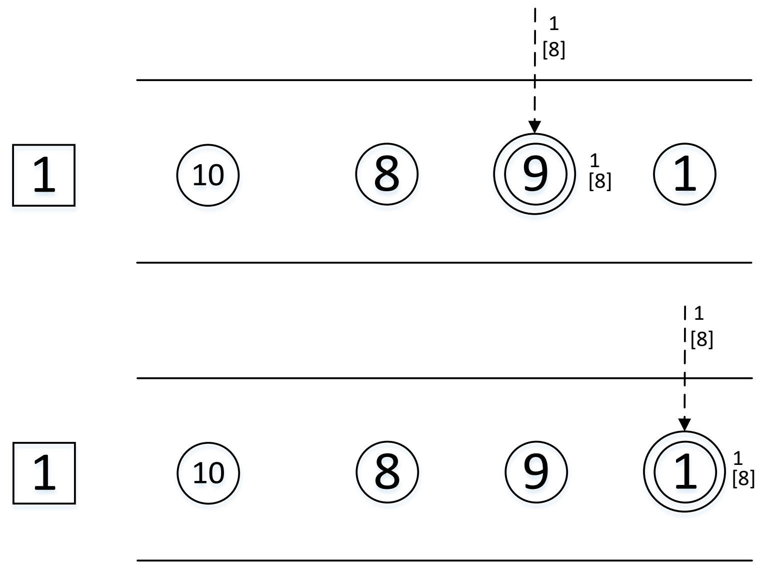	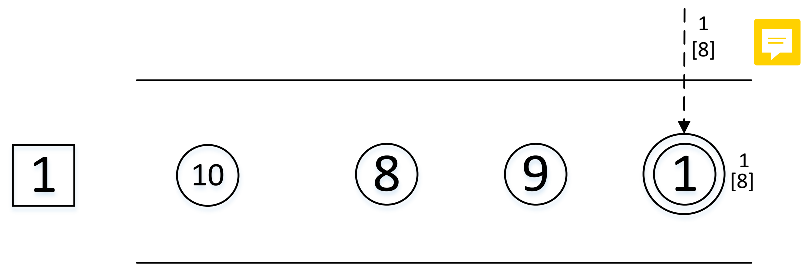

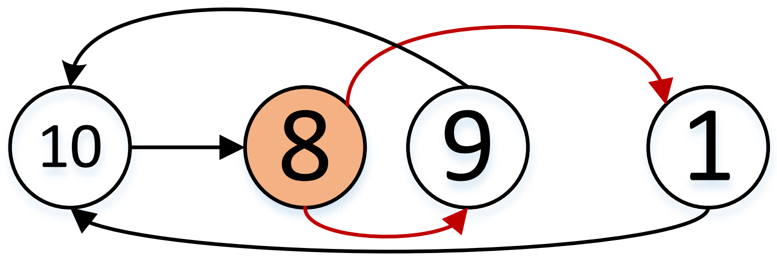

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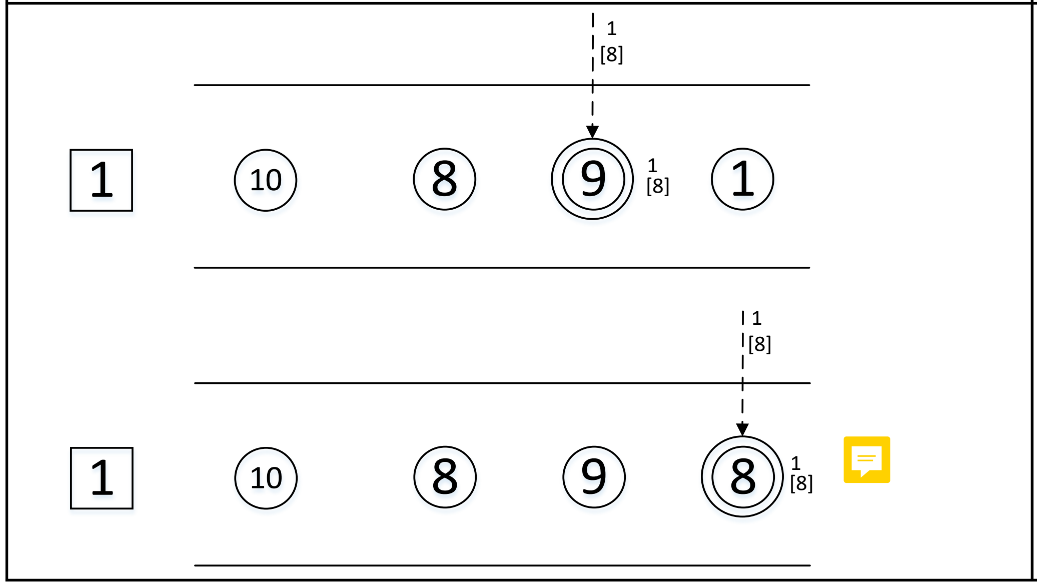	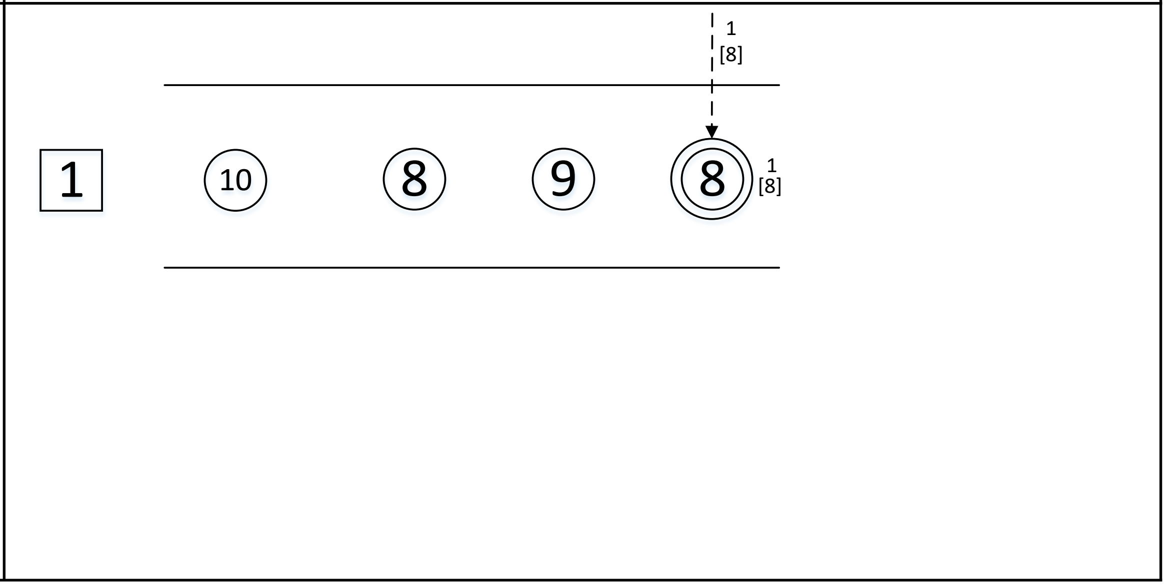

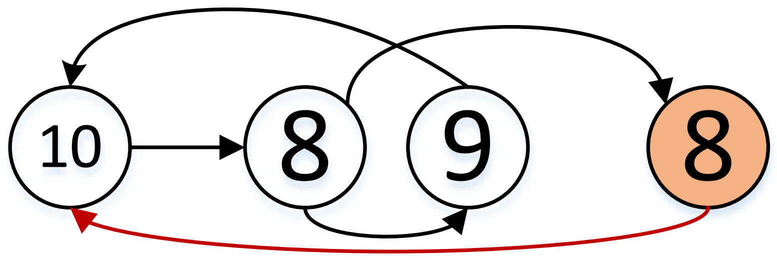

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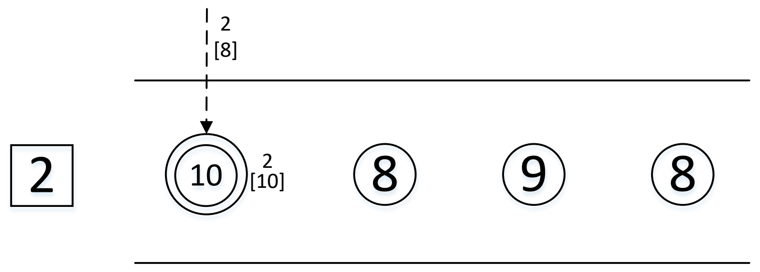	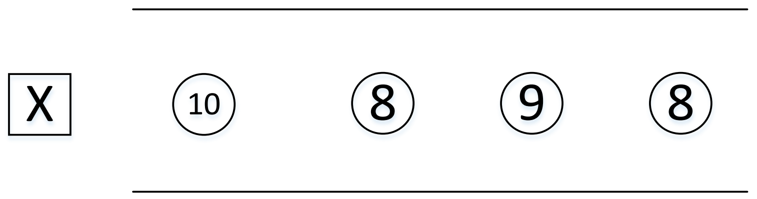

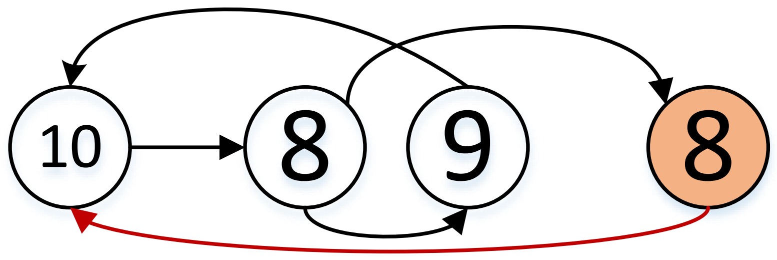

Conclusions

Pregel and GraphX implement the theoretical TLAV framework by maintaining the three views:

- **Vertices, edges, triplets** (source & destination attributes).

+ Triplets view saves us from unnecessary message sending by allowing vertices to check the destination value.

− Maintenance of the triplets view has additional overhead, especially in the case of evolving graph topologies.

Thank you!

Questions?