GraphFrames: Graph Queries in Apache Spark SQL

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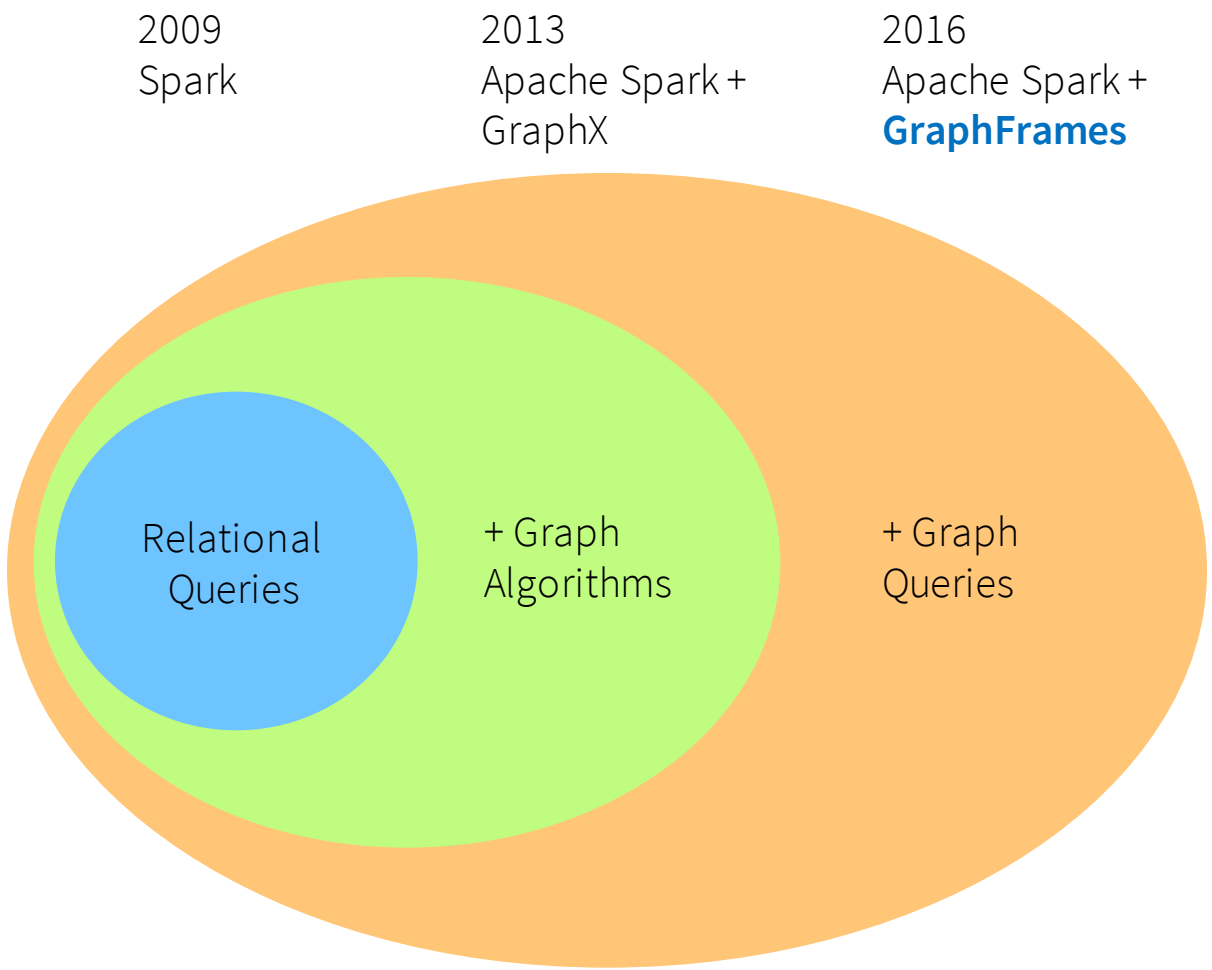
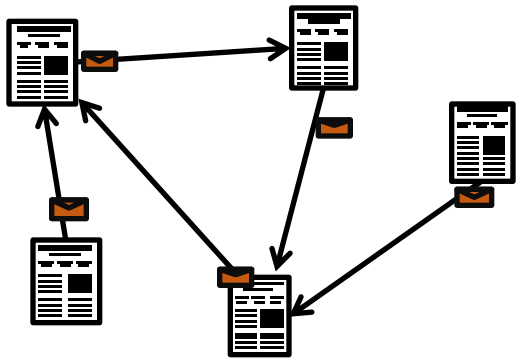
GraphFrames (2016)



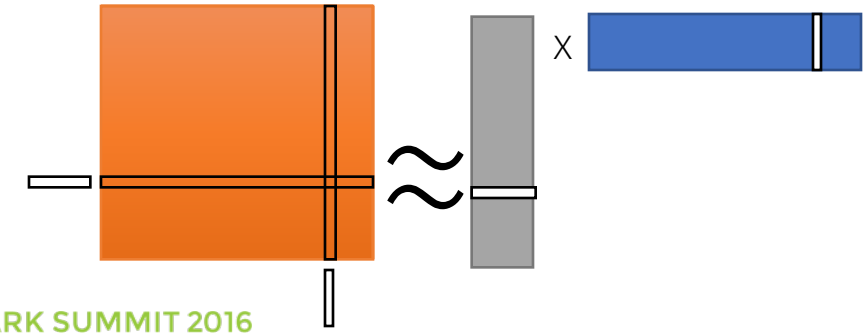
Graph Algorithms vs. Graph Queries

Graph Algorithms

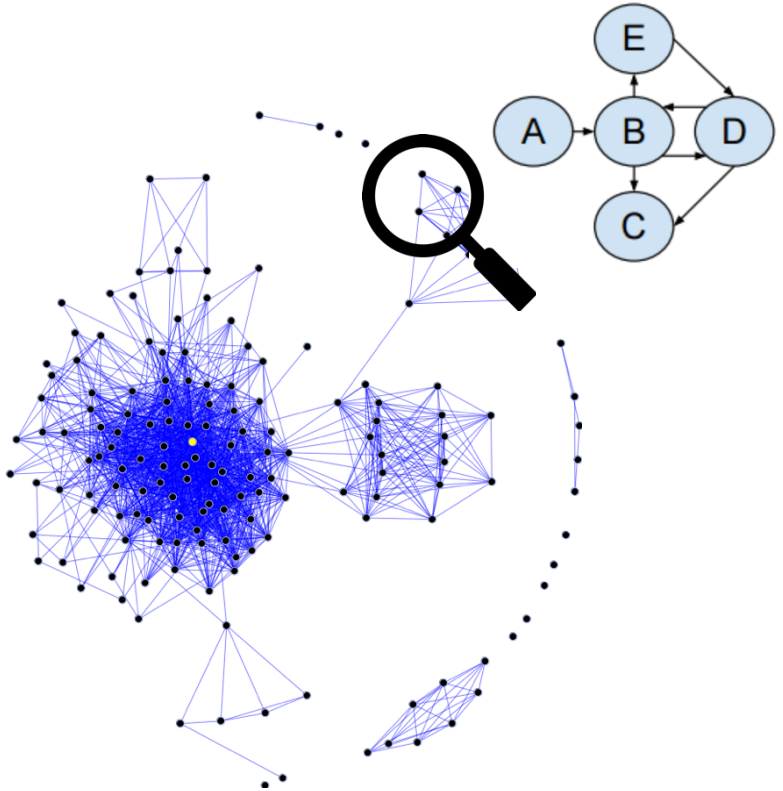
PageRank



Alternating Least Squares

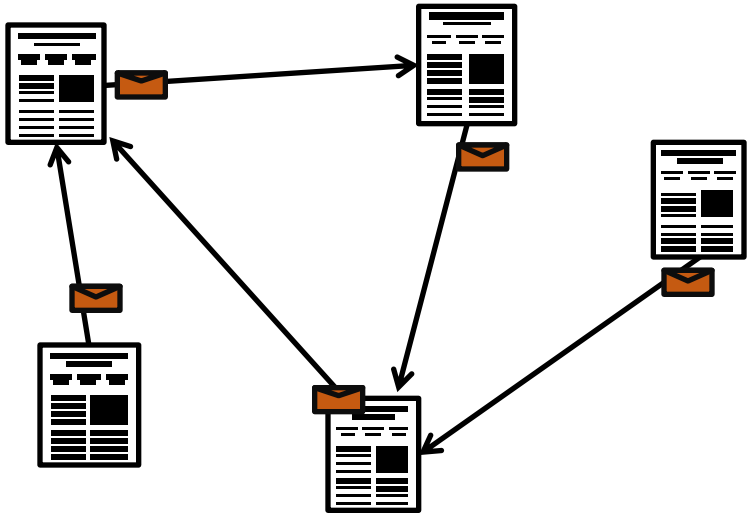


Graph Queries

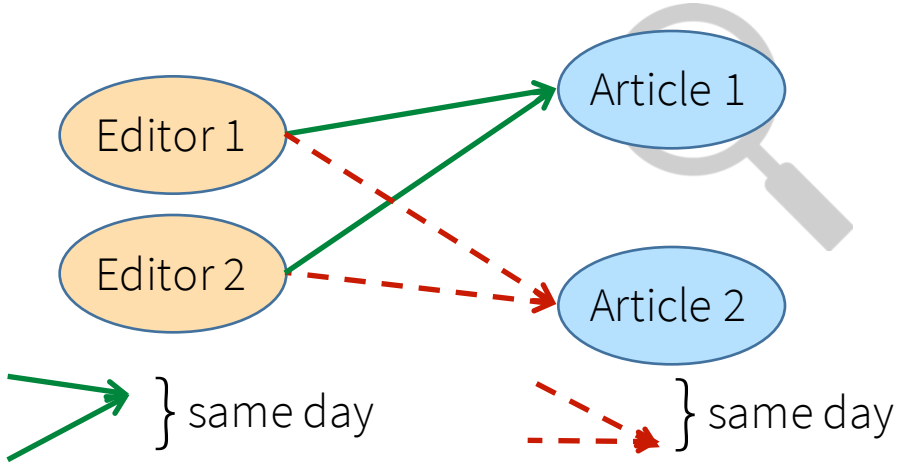


Graph Algorithms vs. Graph Queries

Graph Algorithm: PageRank



Graph Query: Wikipedia Collaborators



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Graph Algorithms vs. Graph Queries

Graph Algorithm: PageRank

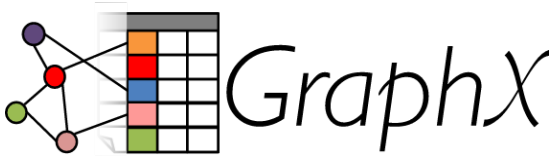
```
// Iterate until convergence
wikipedia.pregel(
  sendMsg = { e =>
    e.sendToDst(e.srcRank * e.weight)
  },
  mergeMsg = _ + _,
  vprog = { (id, oldRank, msgSum) =>
    0.15 + 0.85 * msgSum
  })
```

Graph Query: Wikipedia Collaborators

```
wikipedia.find(
  "(u1)-[e11]->(article1);
   (u2)-[e21]->(article1);
   (u1)-[e12]->(article2);
   (u2)-[e22]->(article2)")
 .select(
   "*",
   "e11.date - e21.date".as("d1"),
   "e12.date - e22.date".as("d2"))
 .sort("d1 + d2".desc).take(10)
```

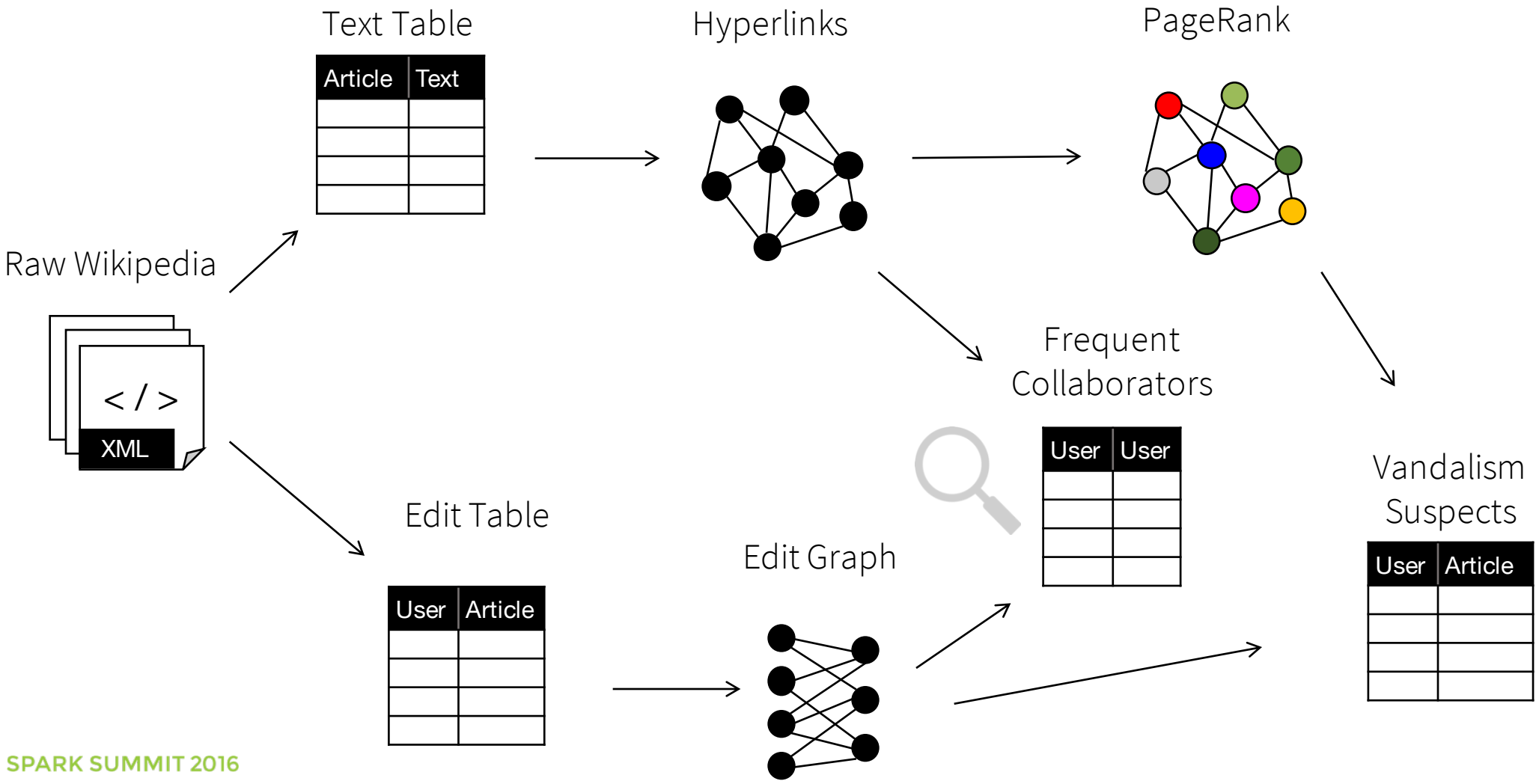
Separate Systems

Graph Algorithms

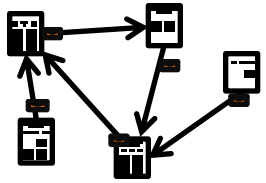


Graph Queries

Problem: Mixed Graph Analysis

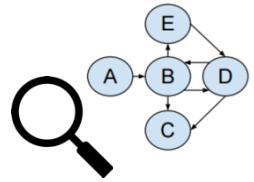


Solution: GraphFrames



Graph Algorithms

Graph Queries



GraphFrames API

Pattern Query Optimizer

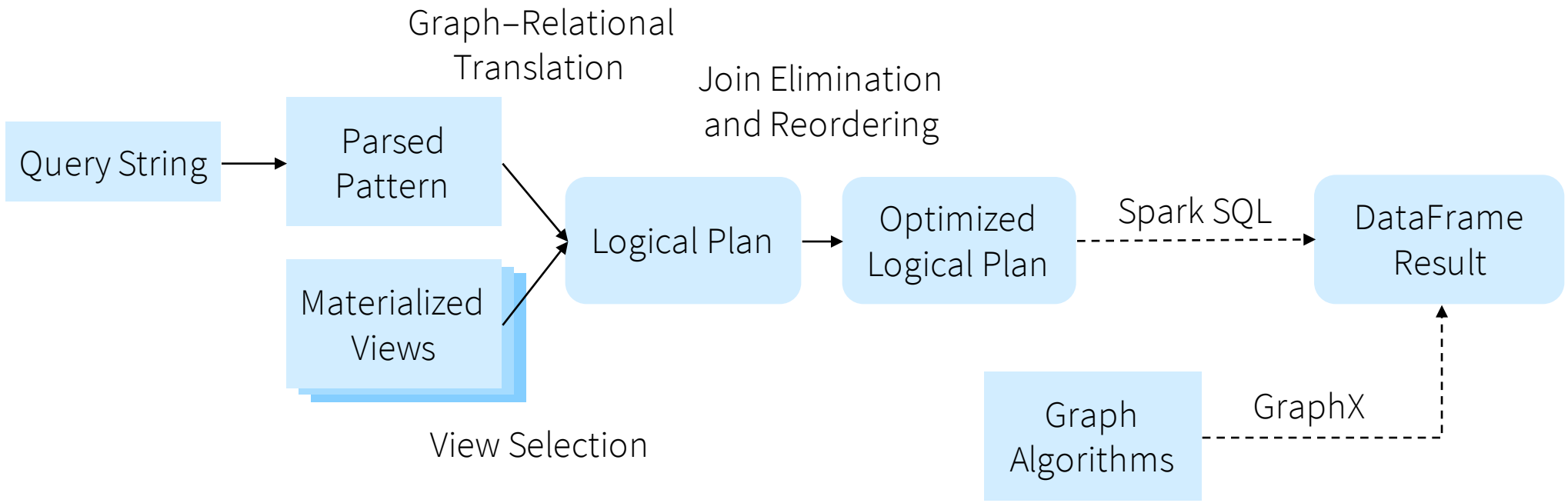
Spark SQL

GraphFrames API

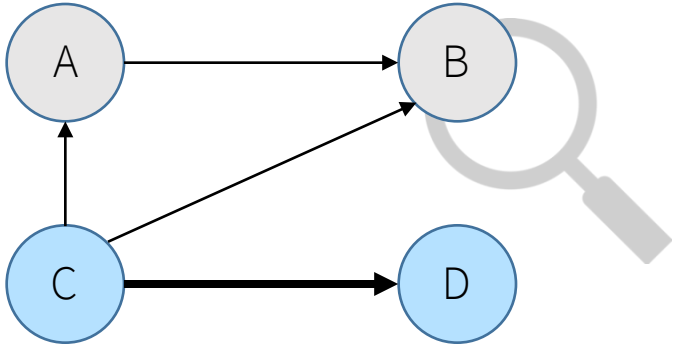
- Unifies graph algorithms, graph queries, and DataFrames
- Available in Scala, Java, and Python

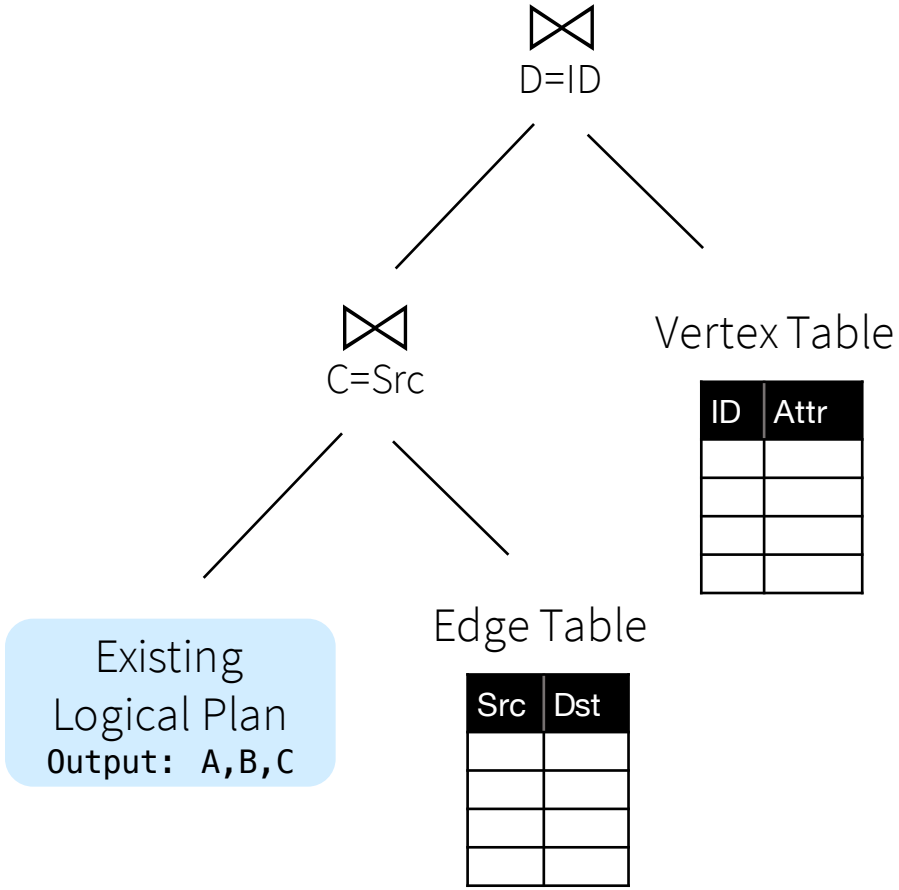
```
class GraphFrame {
  def vertices: DataFrame
  def edges: DataFrame

  def find(pattern: String): DataFrame
  def registerView(pattern: String, df: DataFrame): Unit

  def degrees(): DataFrame
  def pageRank(): GraphFrame
  def connectedComponents(): GraphFrame
  ...
}
```

Implementation

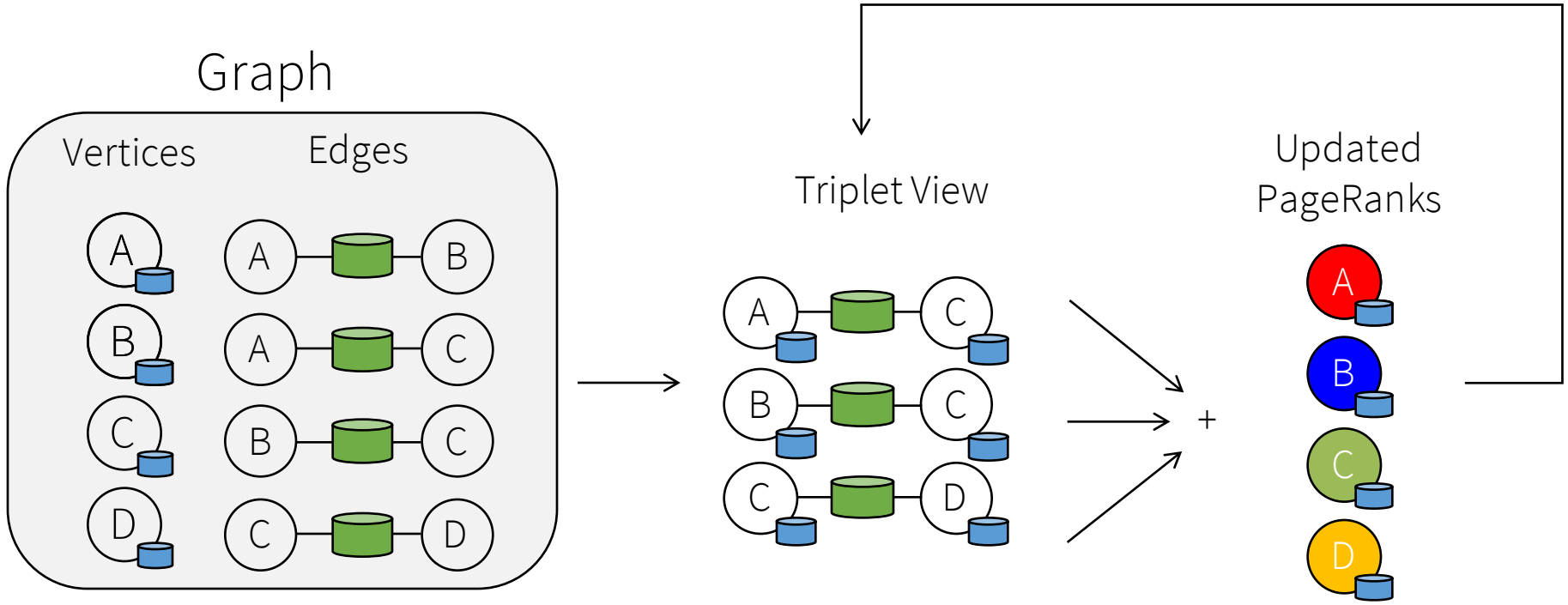


Graph–Relational Translation



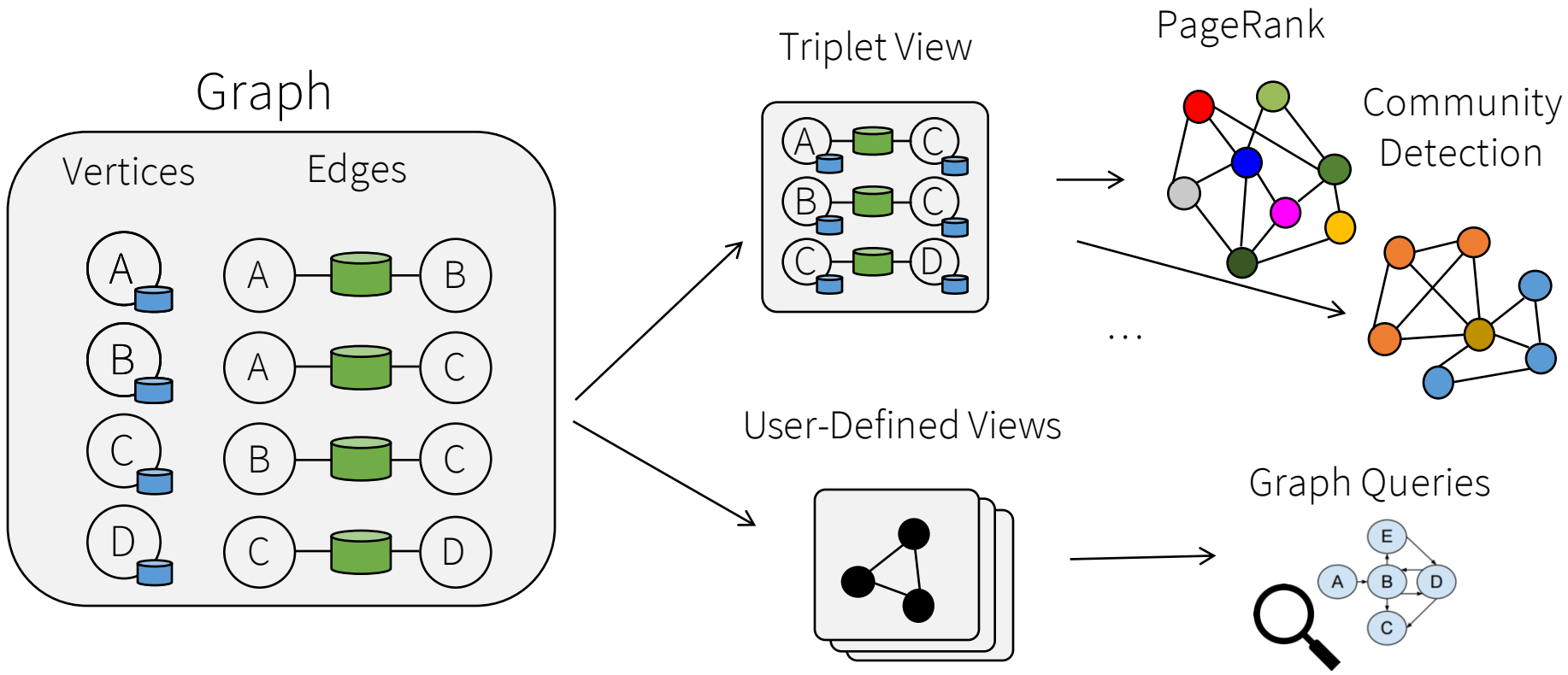


Materialized View Selection



GraphX: Triplet view enabled efficient message-passing algorithms

Materialized View Selection



GraphFrames: User-defined views enable efficient graph queries

Join Elimination

Edges

Src	Dst
1	2
1	3
2	3
2	5

Vertices

ID	Attr
1	A
2	B
3	C
4	D

Unnecessary join

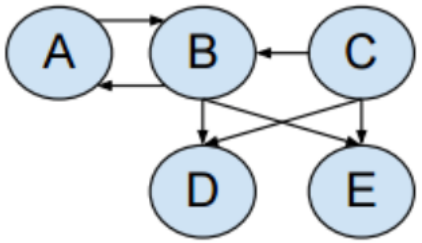
```
SELECT src, dst
FROM edges INNER JOIN vertices ON src = id;
```

can be eliminated if tables satisfy referential integrity, simplifying graph–relational translation:

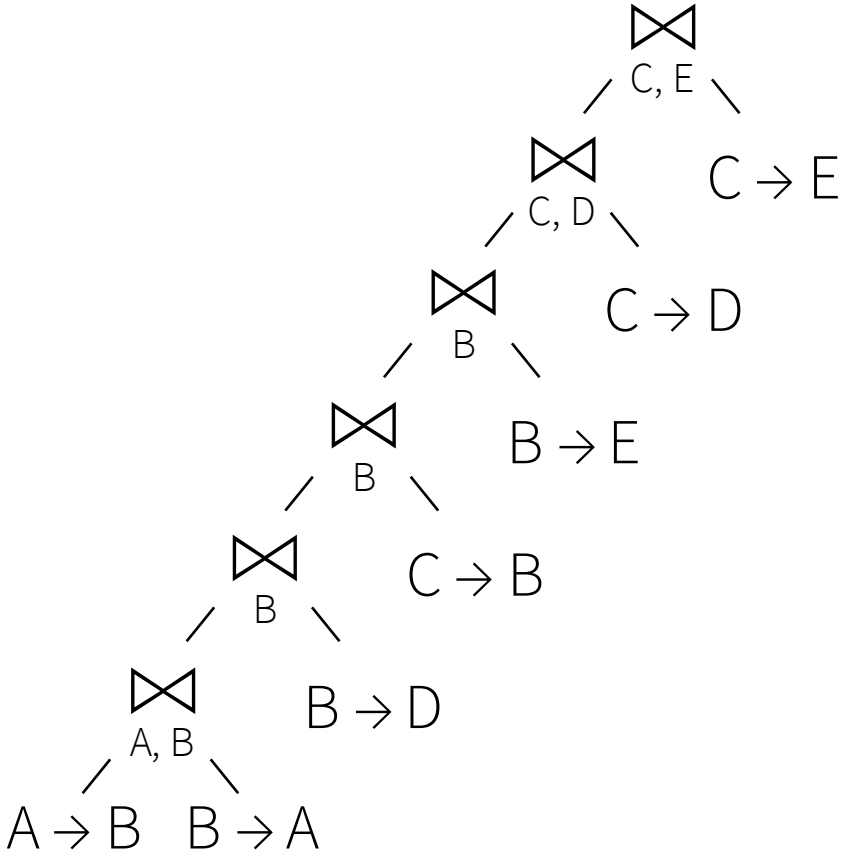
```
SELECT src, dst FROM edges;
```

Join Reordering

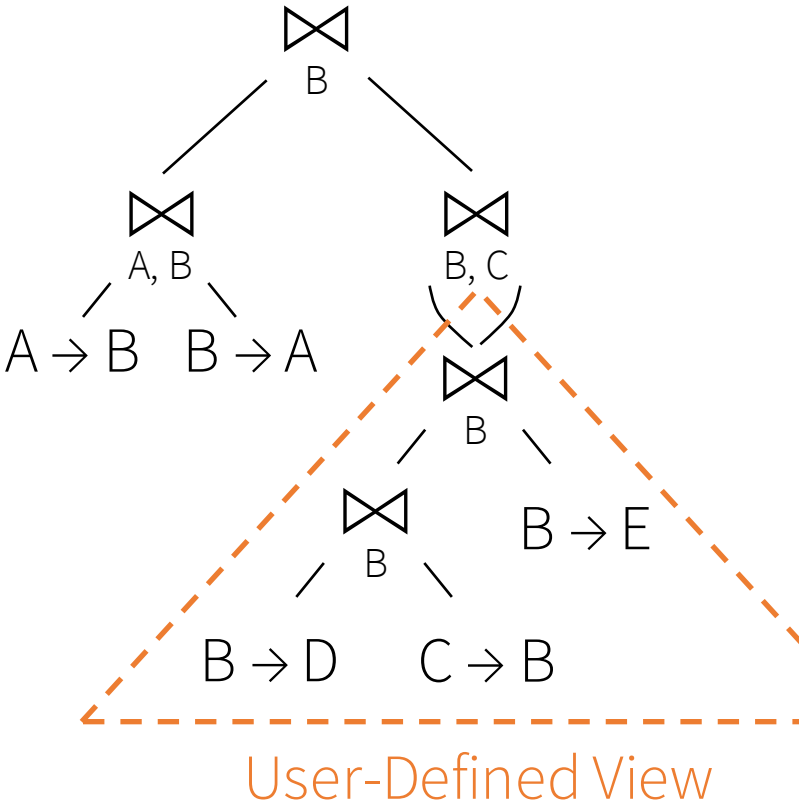
Example Query



Left-Deep Plan

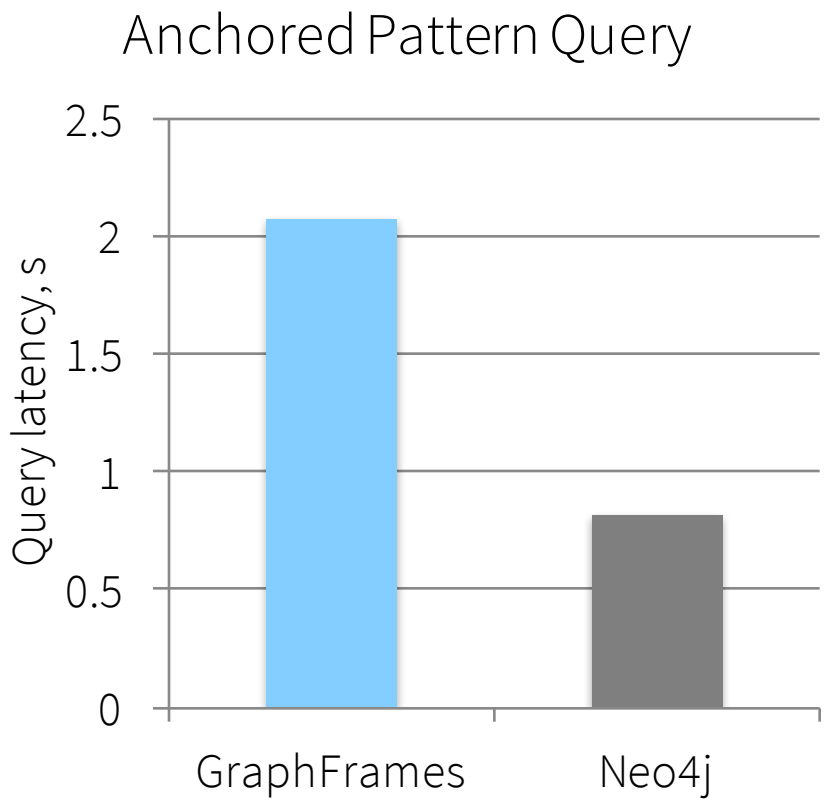


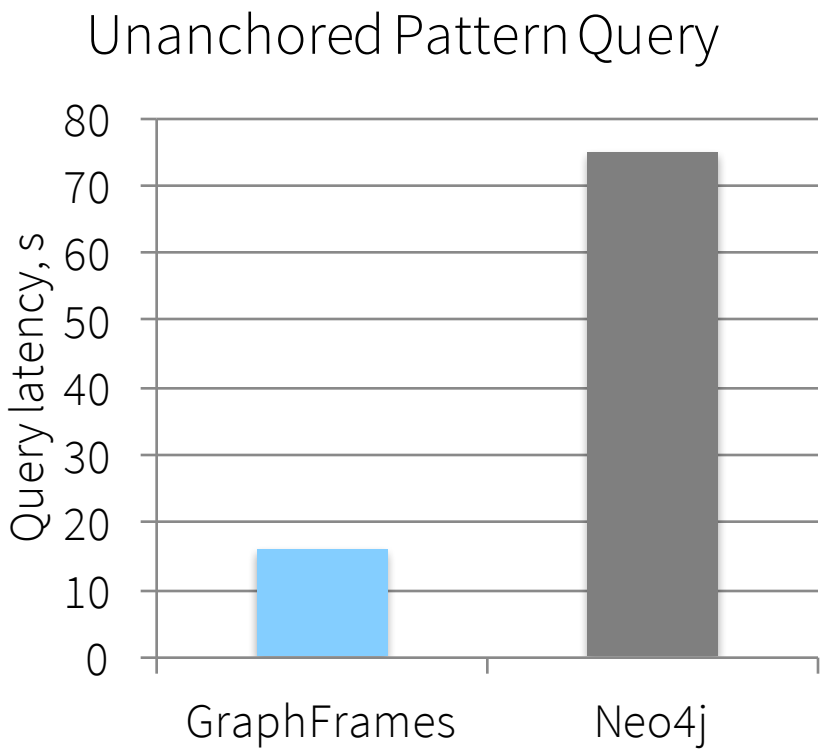
Bushy Plan



Evaluation

Faster than Neo4j for *unanchored* pattern queries

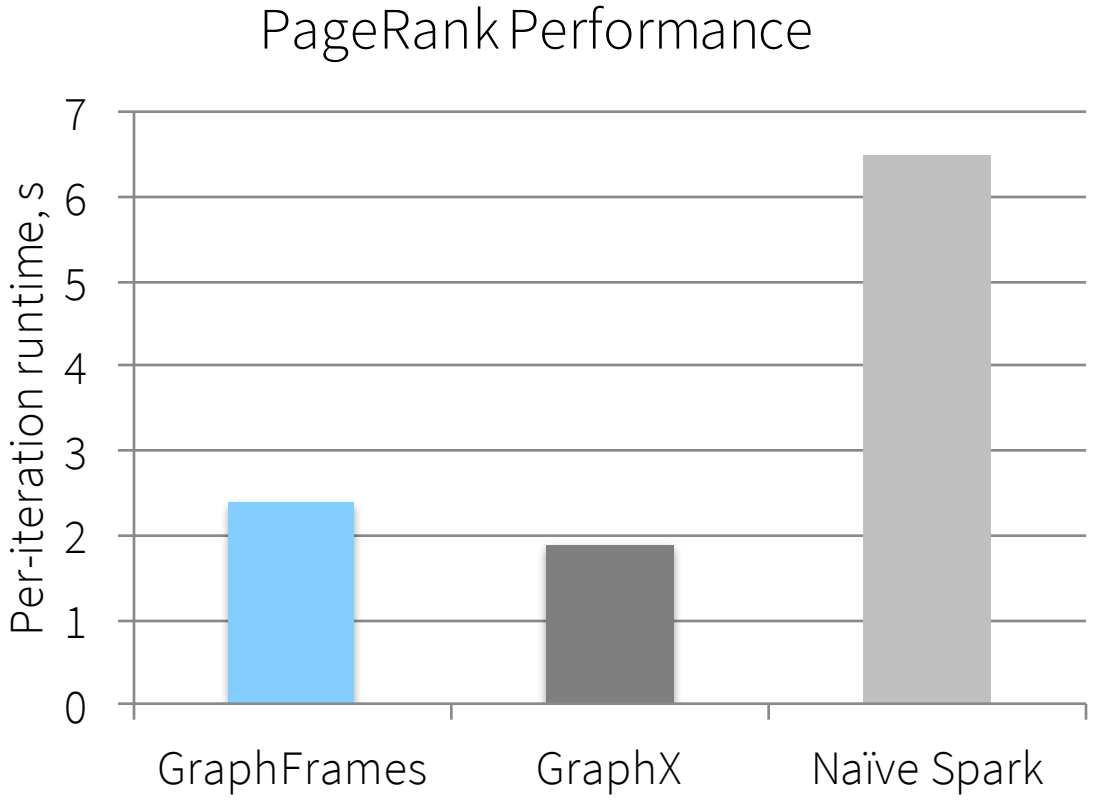




Triangle query on 1M edge subgraph of web-Google. Each system configured to use a single core.

Evaluation

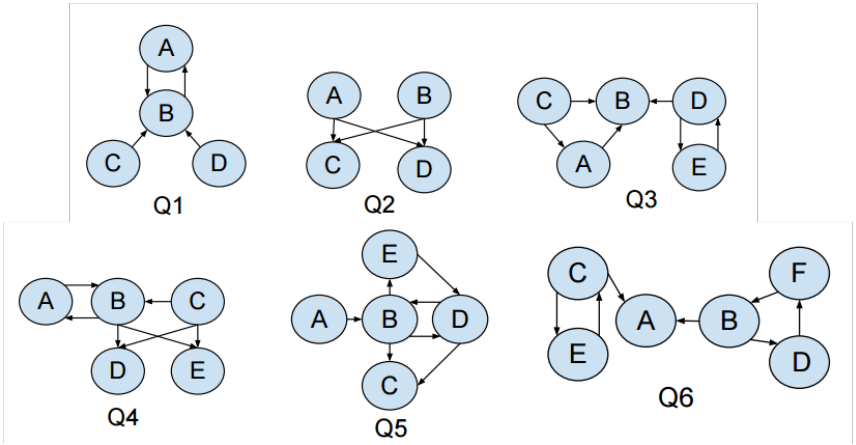
Approaches performance of GraphX for graph algorithms using Spark SQL whole-stage code generation



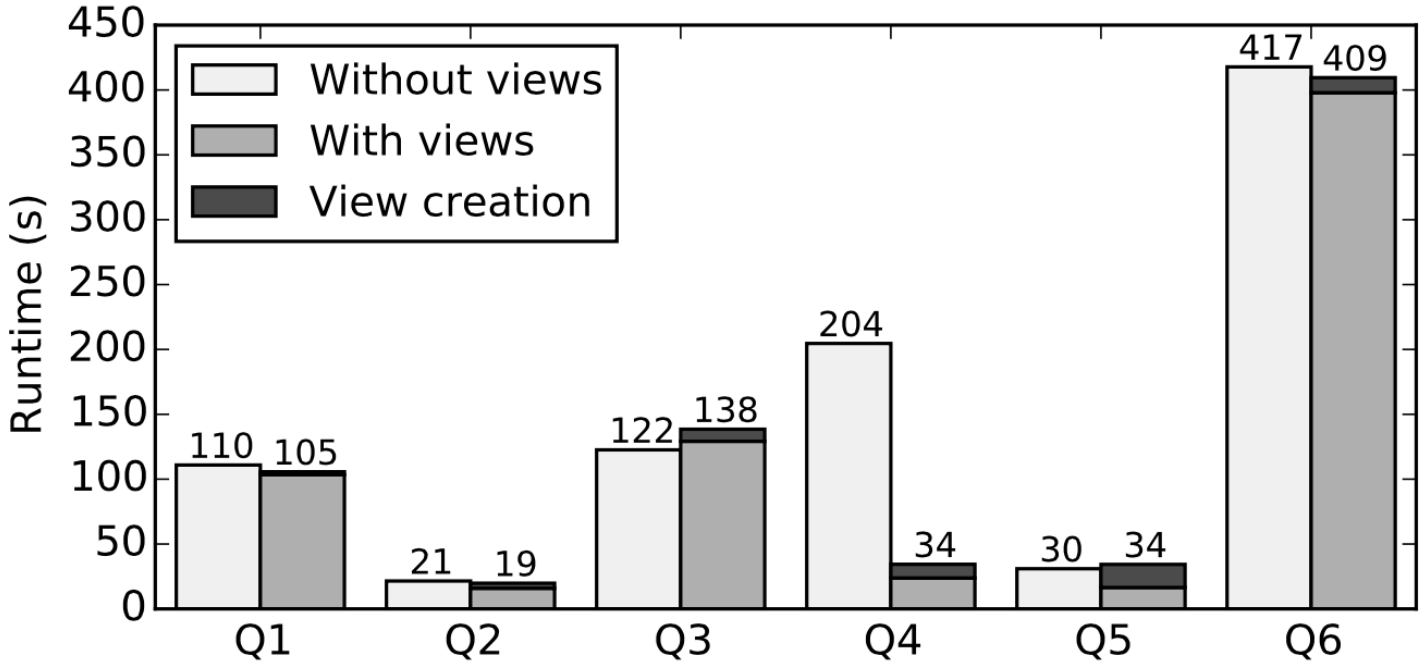
Per-iteration performance on web-Google, single 8-core machine. Naïve Spark uses Scala RDD API.

Evaluation

Registering the right views can greatly improve performance for some queries



View	Query	Size in Google graph
2-cycle	(a)->(b)->(a)	1,565,976
V	(c)<-(a)->(b)	67,833,471
Triangle	(a)<-(b)->(c)->(a)	28,198,954
3-cycle	(a)->(b)->(c)->(a)	11,669,313



Workload: J. Huang, K. Venkatraman, and D.J. Abadi. Query optimization of distributed pattern matching. In ICDE 2014.

Future Work

- Suggest views automatically
- Exploit attribute-based partitioning in optimizer
- Code generation for single node

Try It Out!

Released as a Spark Package at:

https://github.com/graphframes/graphframes

Thanks to Joseph Bradley, Xiangrui Meng, and Timothy Hunter.

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