CS 744: GRAPHX

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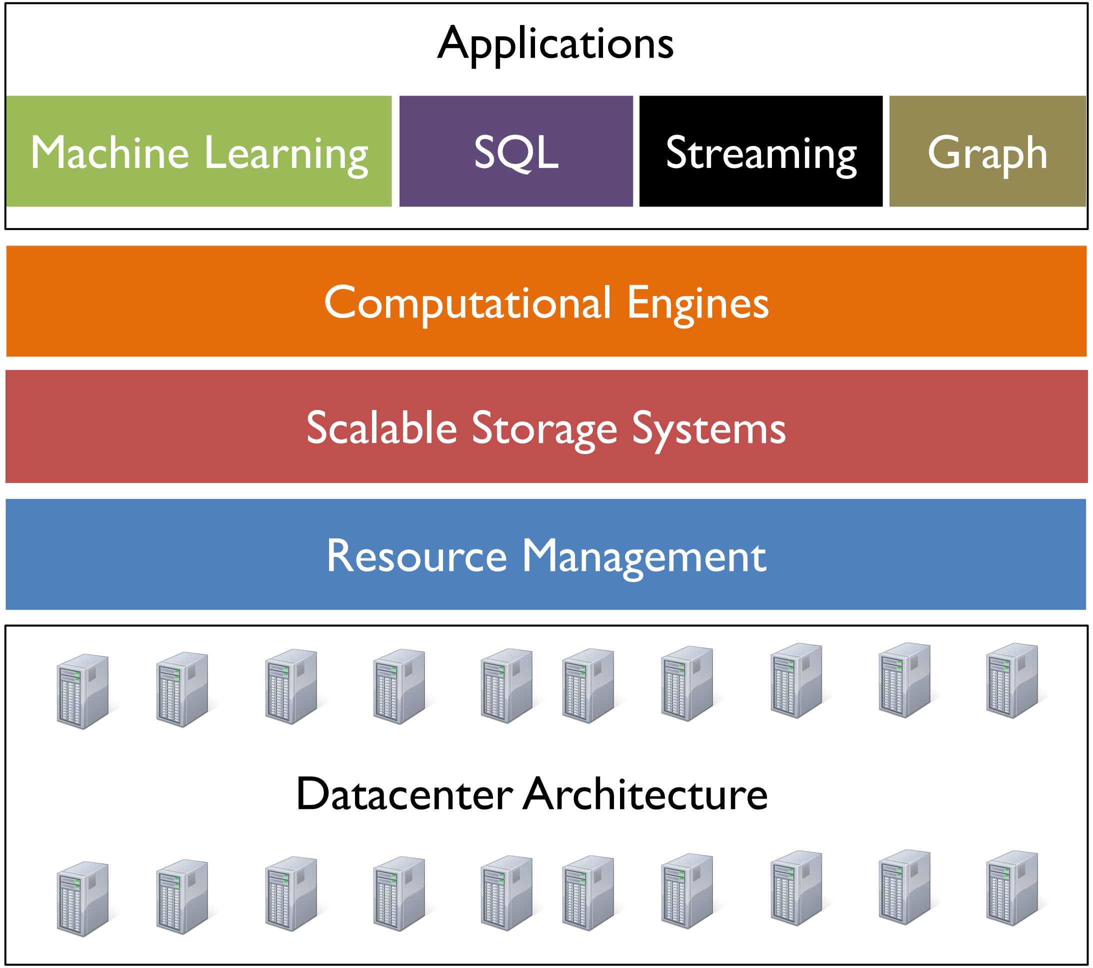
Fall 2019

ADMINISTRIVIA

- Midterm grades are up!
- Course Project: Check in meetings Thu, Mon



Applications

Machine Learning

SQL

Streaming

Graph

Computational Engines

Scalable Storage Systems

Resource Management

Datacenter Architecture

POWERGRAPH

What is different from dataflow system e.g., Spark?

Programming Model:
Gather-Apply-Scatter

Better Graph Partitioning
with vertex cuts

What are some shortcomings?

Distributed execution
(Sync, Async)

THIS CLASS

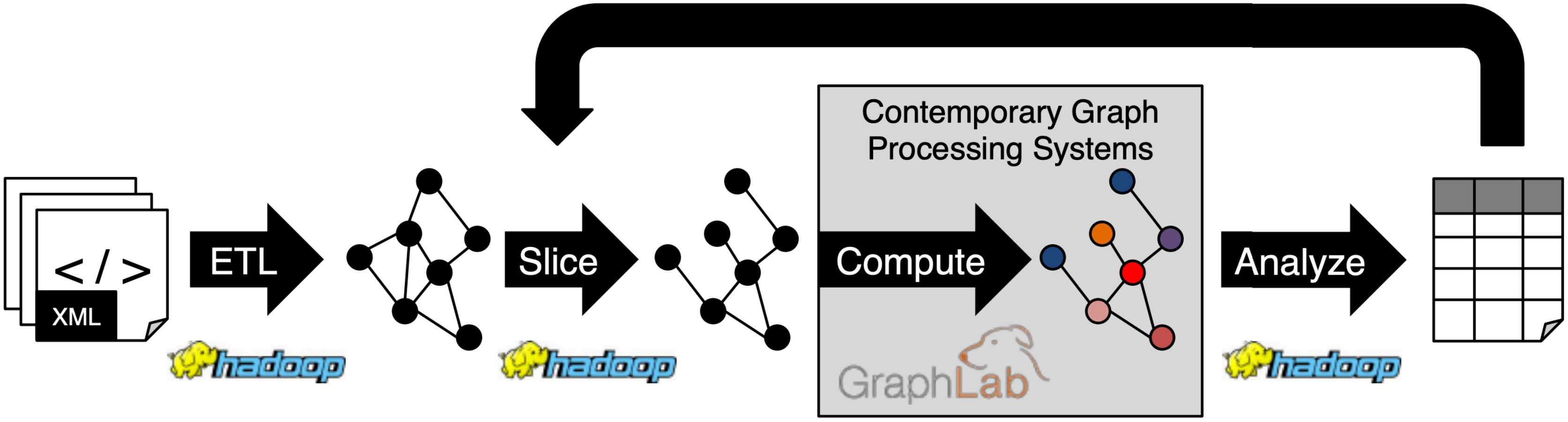
GraphX

Can we efficiently map graph abstractions to dataflow engines?

Scalability! But at what COST?

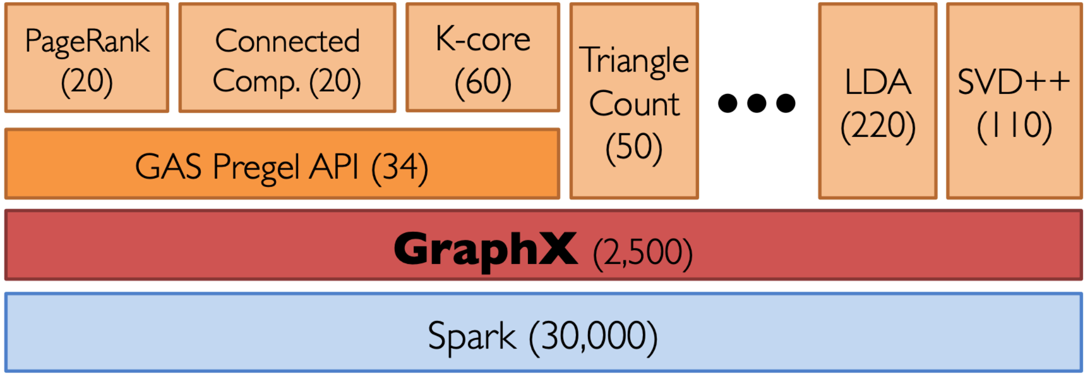
When should we distribute graph processing?

MOTIVATION



< / >
XML
ETL
hadoop
Slice
hadoop
Contemporary Graph Processing Systems
Compute
GraphLab
Analyze
hadoop

SYSTEM OVERVIEW



Advantages?

PROGRAMMING MODEL

```
class Graph[V, E] {
  // Constructor
  def Graph(v: Collection[(Id, V)],
            e: Collection[(Id, Id, E)])
  // Collection views
  def vertices: Collection[(Id, V)]
  def edges: Collection[(Id, Id, E)]
  def triplets: Collection[Triplet]
  // Graph-parallel computation
  def mrTriplets(f: (Triplet) => M,
      sum: (M, M) => M): Collection[(Id, M)]
  // Convenience functions
  def mapV(f: (Id, V) => V): Graph[V, E]
  def mapE(f: (Id, Id, E) => E): Graph[V, E]
  def leftJoinV(v: Collection[(Id, V)],
      f: (Id, V, V) => V): Graph[V, E]
  def leftJoinE(e: Collection[(Id, Id, E)],
      f: (Id, Id, E, E) => E): Graph[V, E]
  def subgraph(vPred: (Id, V) => Boolean,
      ePred: (Triplet) => Boolean)
    : Graph[V, E]
  def reverse: Graph[V, E]
}
```

Constructor

Triplets

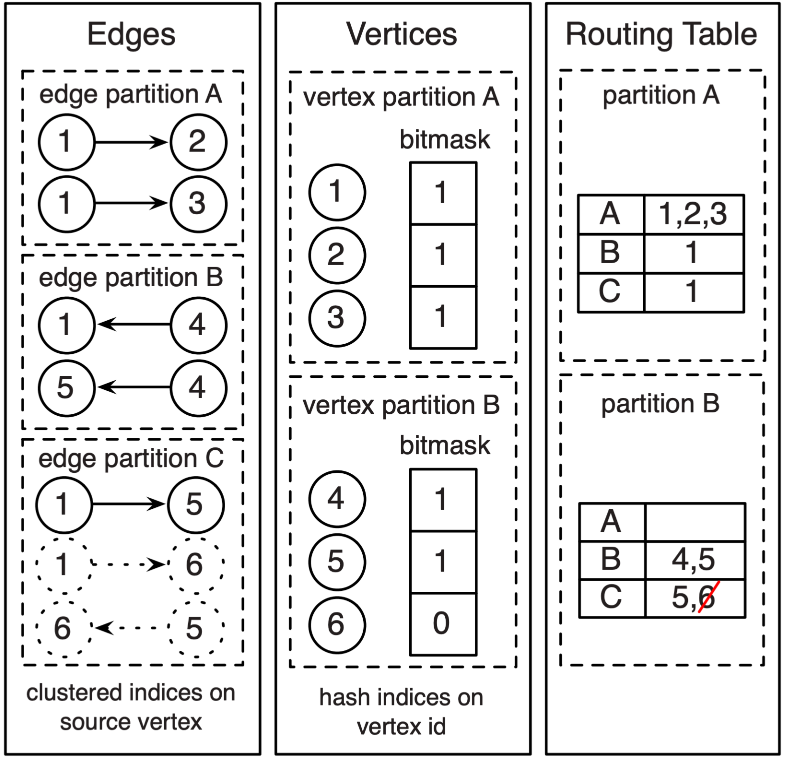
MR TRIPLETS

```
mrTriplets(f: (Triplet) => M, sum: (M, M) => M): Collection[(Id, M)]
```

PREGEL USING GRAPHX

```
def Pregel(g: Graph[V, E],
      vprog: (Id, V, M) => V,
      sendMsg: (Triplet) => M,
      gather: (M, M) => M): = {

  g.mapV((id, v) => (v, halt=false))

  while (g.vertices.exists(v => !v.halt)) {
    val msgs: Collection[(Id, M)] =
        g.subgraph(ePred=(s,d,sP,eP,dP)=>!sP.halt)
         .mrTriplets(sendMsg, gather)

    g = g.leftJoinV(msgs).mapV(vprog)
  }

  return g.vertices
}
```

IMPLEMENTING TRIPLETS VIEW



A	1,2,3
B	1
C	1

A	
B	4,5
C	5,~~6~~

Join strategy

- Send vertices to the edge site

Multicast join

- Using routing table

OPTIMIZING MR TRIPLETS

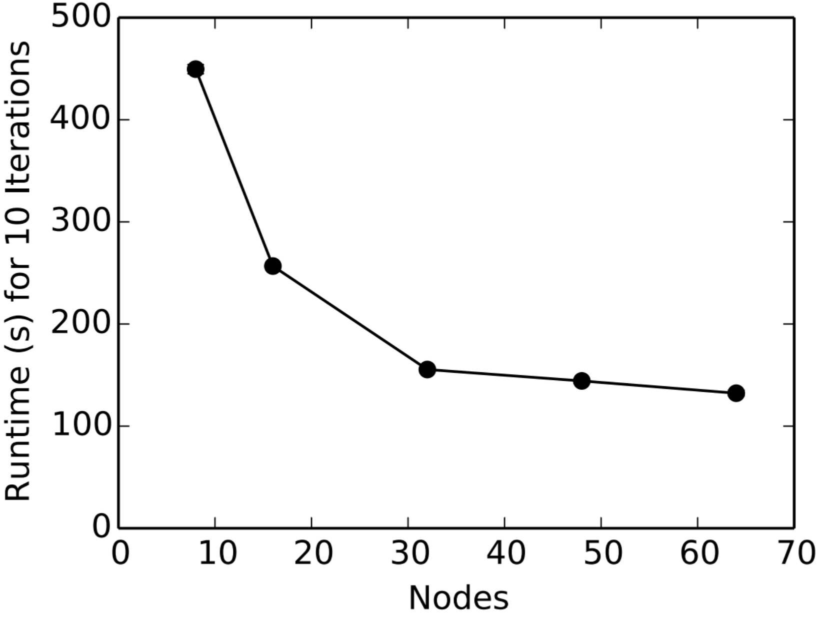
Filtered Index Scanning

- Store edges clustered on source vertex id
- Filter triplets using user-defined predicate

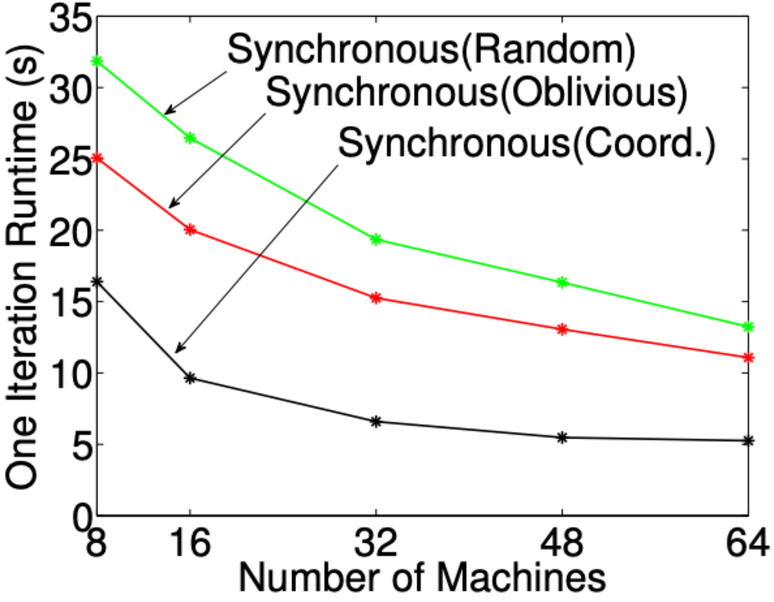
Automatic Join Elimination

- Some UDFs don’t access source or dest properties
- Inspect JVM byte code to avoid joins

SCALABILITY VS. ABSOLUTE PERFORMANCE



GraphX
3x from 8 to 32 machines



PowerGraph
2.6x from 8 to 32

DISCUSSION

https://forms.gle/ARaU8Ce9XCpkZznn6

Consider a single-threaded PageRank implementation as shown and the performance comparison shown in the corresponding table. What could be some reasons for this performance gap?

Now consider a distributed QR decomposition workload shown in Figure below with corresponding performance breakdown. How would you expect a single-thread implementation to perform here?

What are some workload properties that could explain the difference?

SUMMARY

GraphX: Combine graph processing with relational model

COST

- Configuration that outperforms single-thread
- Measure scalability AND absolute performance
  - Computation model of scalable frameworks might be limited
  - Hardware efficiency matters
  - System/Language overheads

NEXT STEPS

Next class: Weld

Project check-in meetings