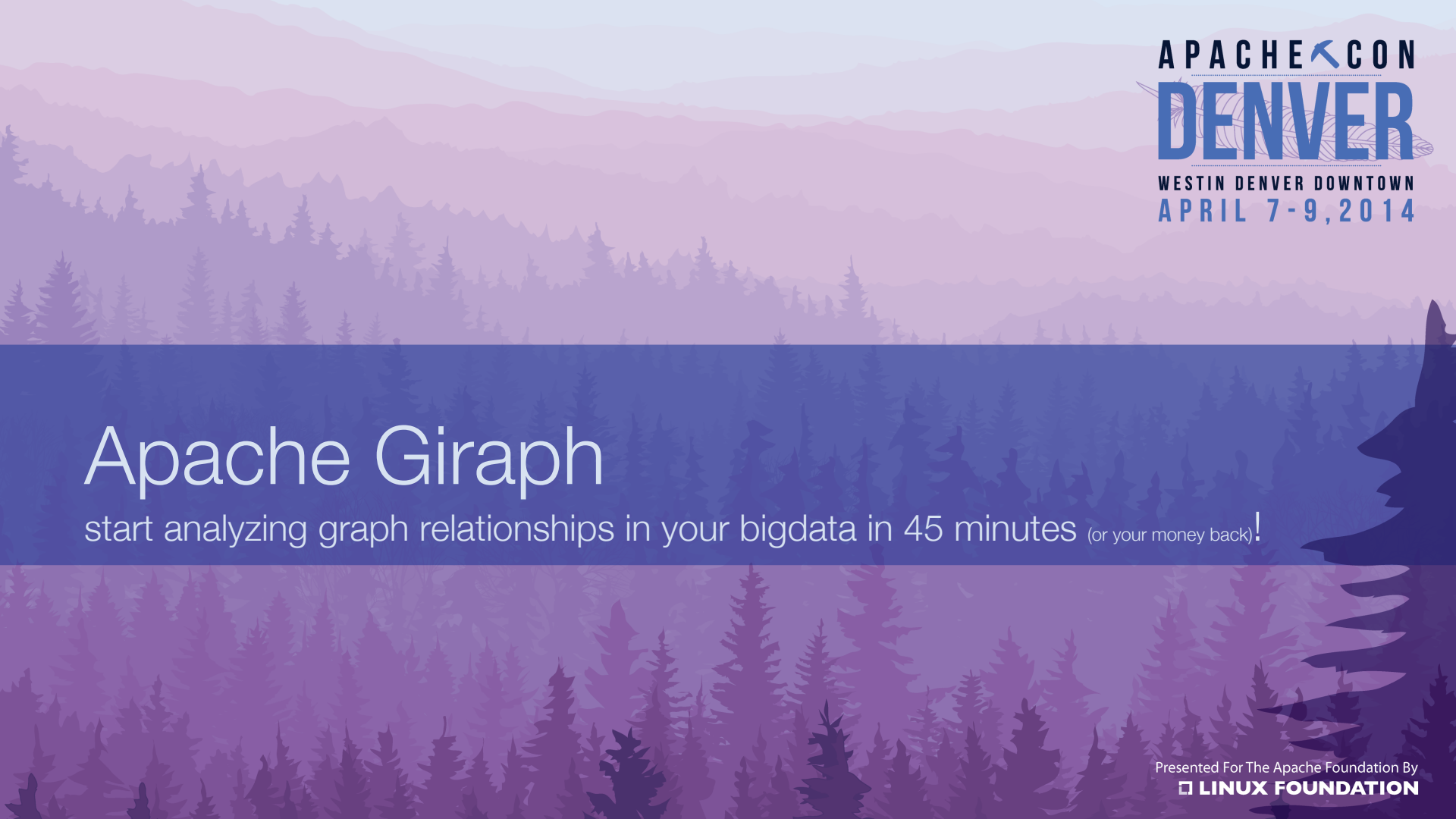
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Apache Giraph
start analyzing graph relationships in your bigdata in 45 minutes (or your money back)!
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Who's this guy?
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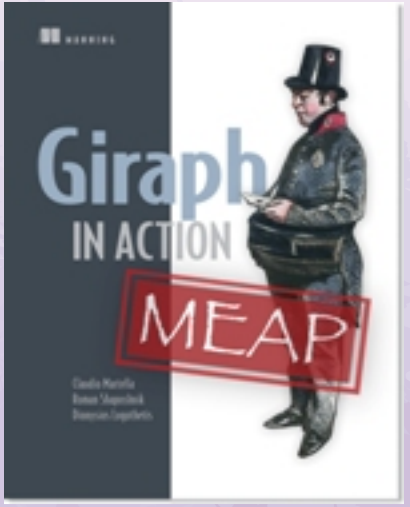
# Roman Shaposhnik


- Sr. Manager at Pivotal Inc. building a team of ASF contributors
- ASF junkie
  - VP of Apache Incubator, former VP of Apache Bigtop
  - Hadoop/Sqoop/Giraph committer
  - contributor across the Hadoop ecosystem)
- Used to be root@Cloudera
- Used to be a PHB at Yahoo!
- Used to be a UNIX hacker at Sun microsystems

# Giraph in action (MEAP)






http://manning.com/martella/

# What's this all about?

# Agenda


- A brief history of Hadoop-based bigdata management
- Extracting graph relationships from unstructured data
- A case for iterative and explorative workloads
- Bulk Sequential Processing to the rescue
- Apache Giraph: a Hadoop-based BSP graph analysis framework
- Giraph application development
- Demos! Code! Lots of it!

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# On day one Doug created HDFS/MR

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# Google papers

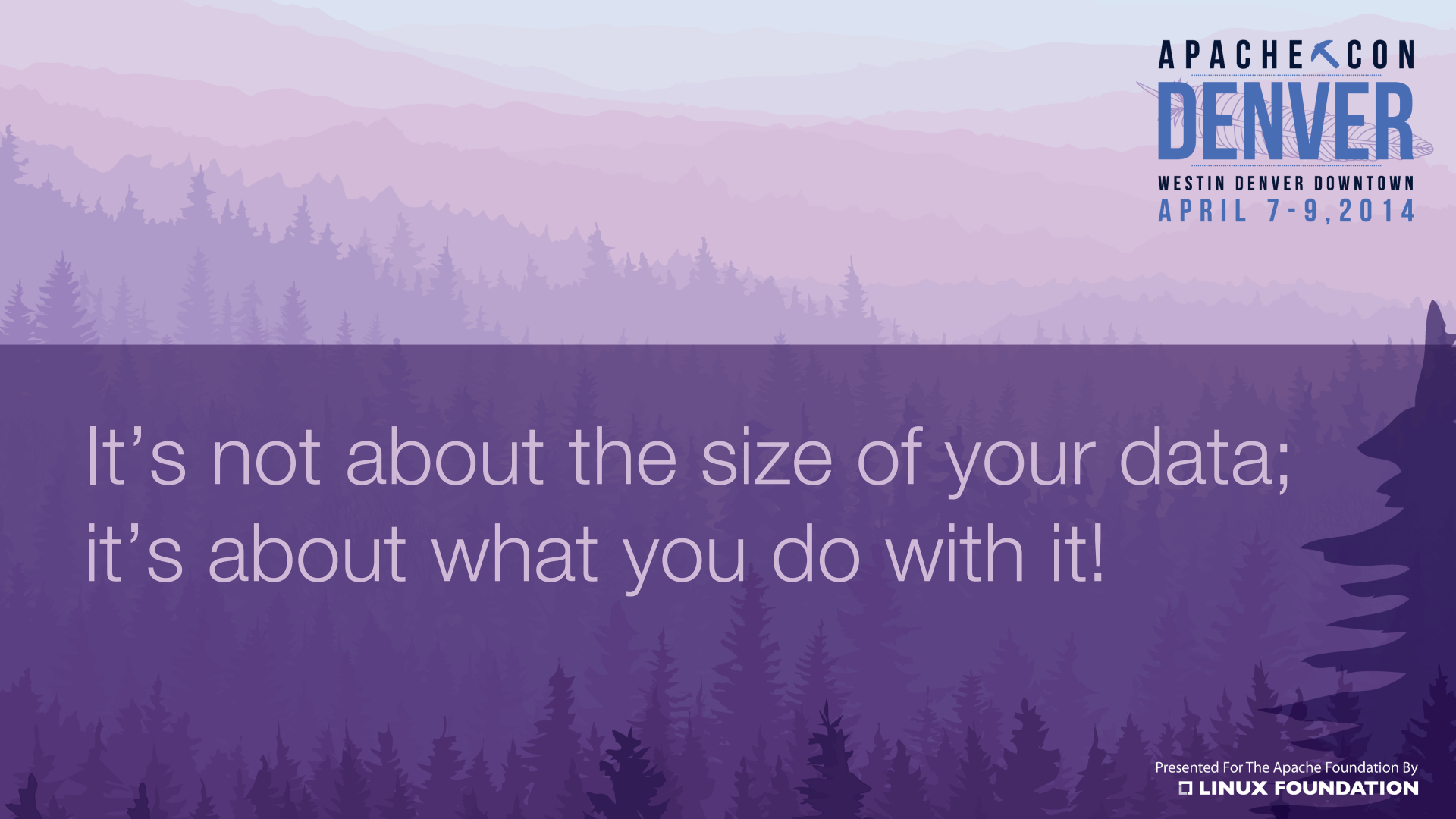


- GFS (file system)
  - distributed
  - replicated
  - non-POSIX
- MapReduce (computational framework)
  - distributed
  - batch-oriented (long jobs; final results)
  - data-gravity aware
  - designed for “embarrassingly parallel” algorithms

# One size doesn't fit all



- Key-value approach
  - map is how we get the keys
  - shuffle is how we sort the keys
  - reduce is how we get to see all the values for a key
- Pipeline approach
- Intermediate results in a pipeline need to be flushed to HDFS
- A very particular "API" for working with your data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It's not about the size of your data;
it's about what you do with it!
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# Graph relationships

- Entities in your data: tuples
  - customer data
  - product data
  - interaction data
- Connection between entities: graphs
  - social network or my customers
  - clustering of customers vs. products

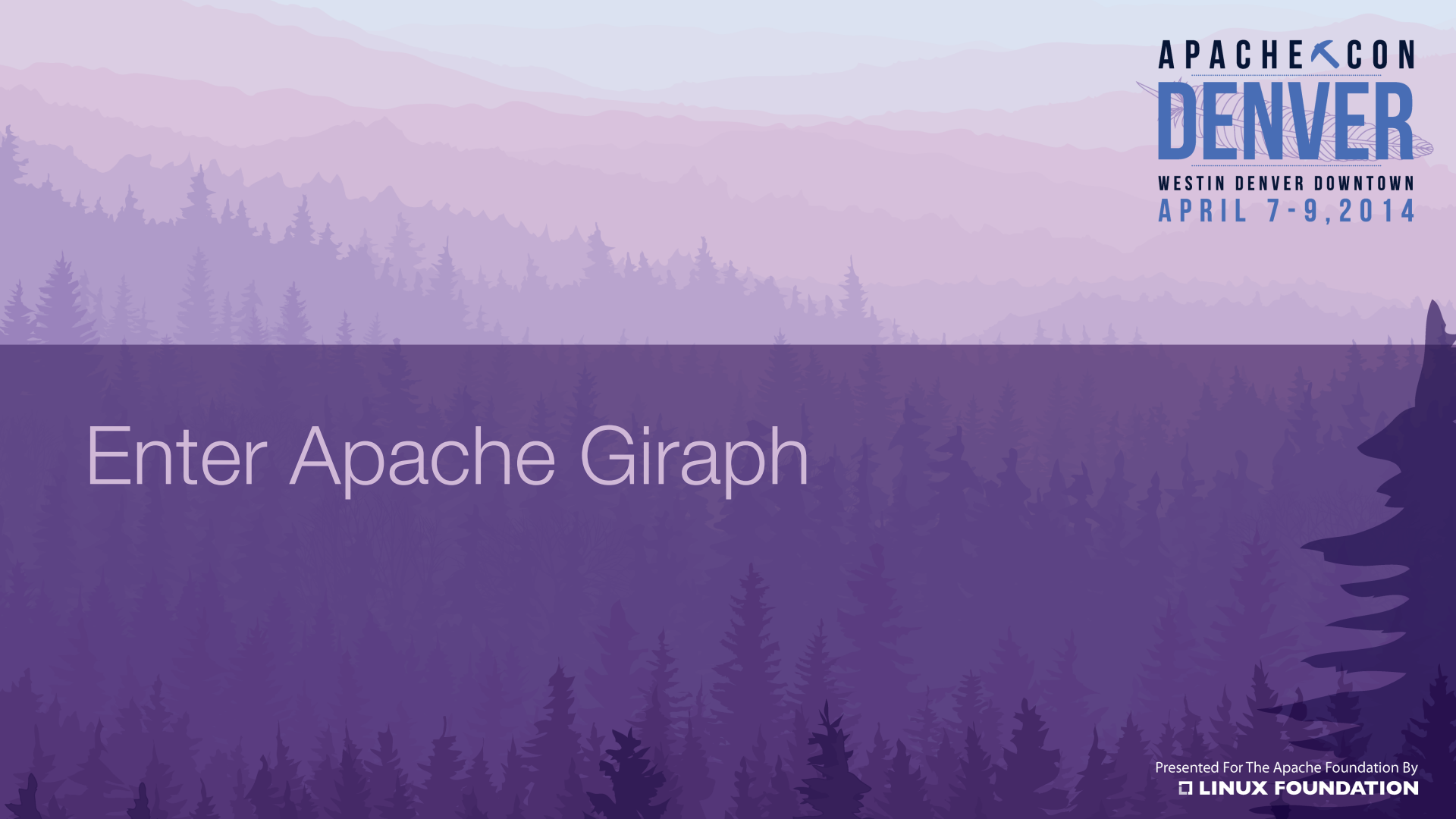
# Challenges

- Data is dynamic
  - No way of doing “schema on write”
- Combinatorial explosion of datasets
  - Relationships grow exponentially
- Algorithms become
  - explorative
  - iterative

# Graph databases



- Plenty available
  - Neo4J, Titan, etc.
- Benefits
  - Tightly integrate systems with few moving parts
  - High performance on known data sets
- Shortcomings
    - Don’t integrate with HDFS
    - Combine storage and computational layers
    - A sea of APIs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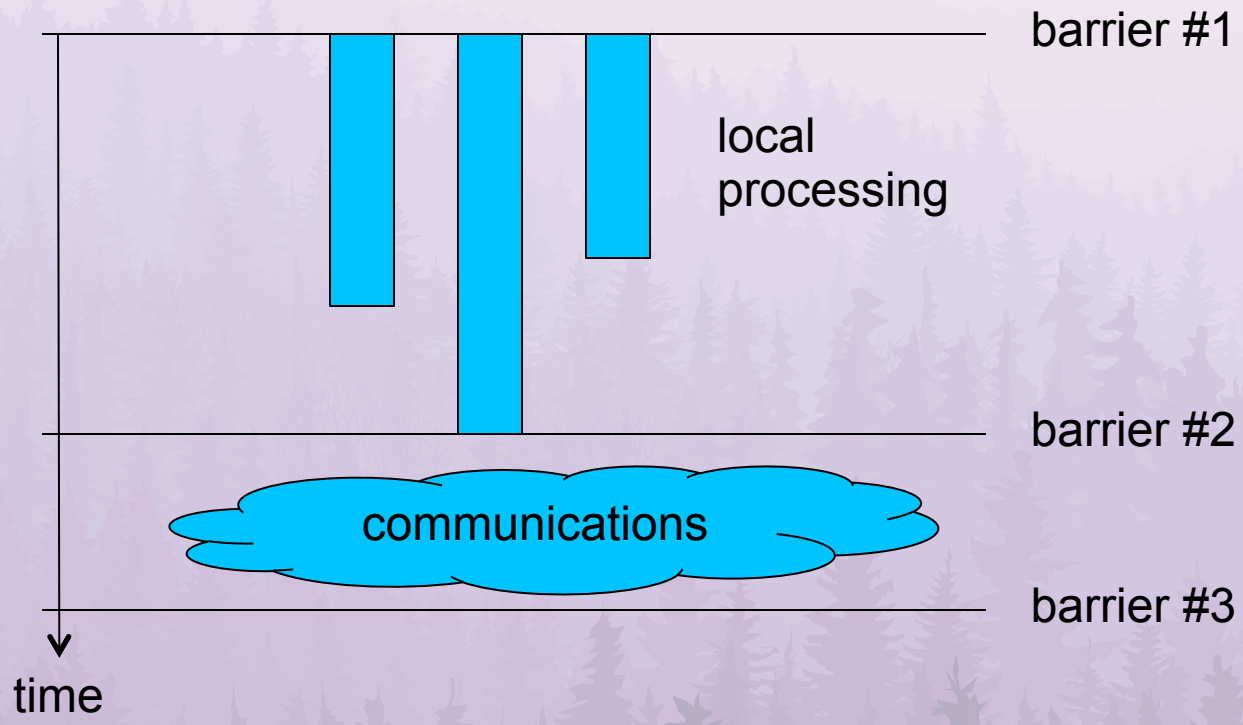
# Key insights

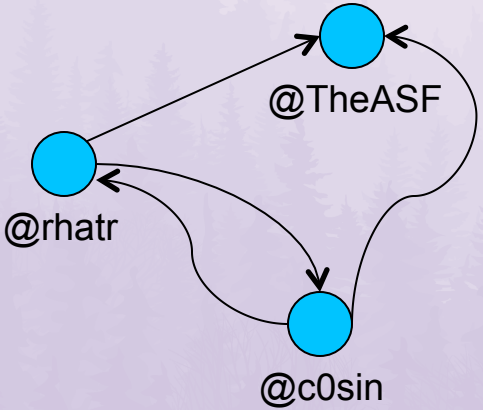
- Keep state in memory for as long as needed
- Leverage HDFS as a repository for unstructured data
- Allow for maximum parallelism (shared nothing)
- Allow for arbitrary communications
- Leverage BSP approach

# Bulk Sequential Processing



# BSP applied to graphs



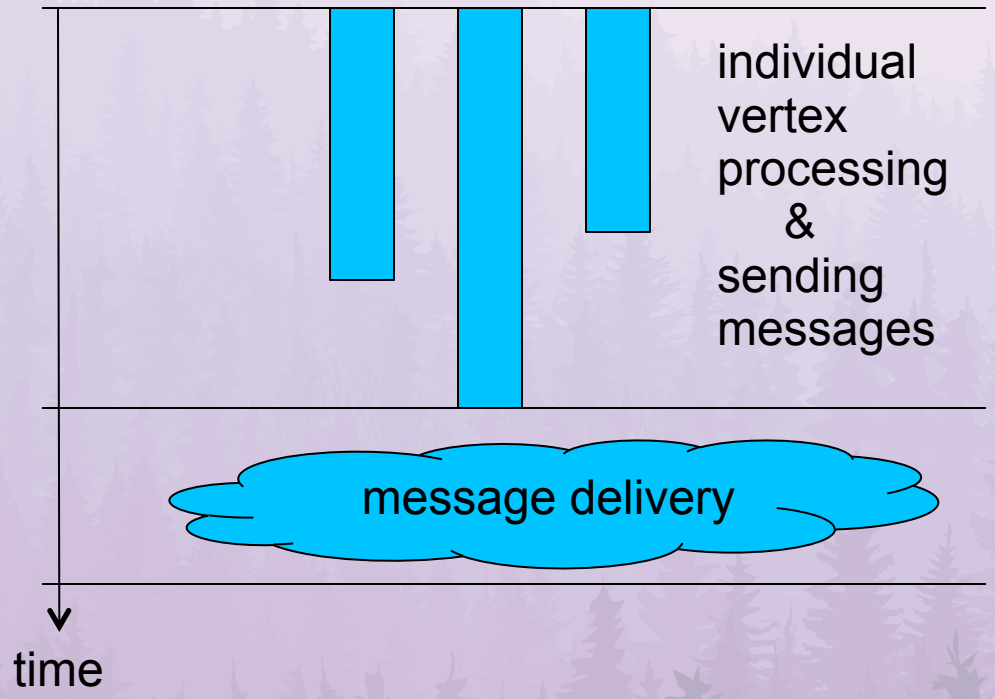



Think like a vertex:

- I know my local state
- I know my neighbours
- I can send messages to vertices
- I can declare that I am done
- I can mutate graph topology

# Bulk Sequential Processing





# Giraph “Hello World”



```
public class GiraphHelloWorld extends
    BasicComputation<IntWritable, IntWritable, NullWritable, NullWritable> {

    public void compute(Vertex<IntWritable, IntWritable, NullWritable> vertex,
                        Iterable<NullWritable> messages) {
        System.out.println(“Hello world from the: “ + vertex.getId() + “ : “);
        for (Edge<IntWritable, NullWritable> e : vertex.getEdges()) {
            System.out.println(“ “ + e.getTargetVertexId());
        }
        System.out.println(“”);
    }
}
```

# Mighty four of Giraph API


```
BasicComputation<IntWritable,   // VertexID  -- vertex ref
                 IntWritable,   // VertexData -- a vertex datum
                 NullWritable, // EdgeData -- an edge label datum
                 NullWritable>// MessageData -- message payload
```

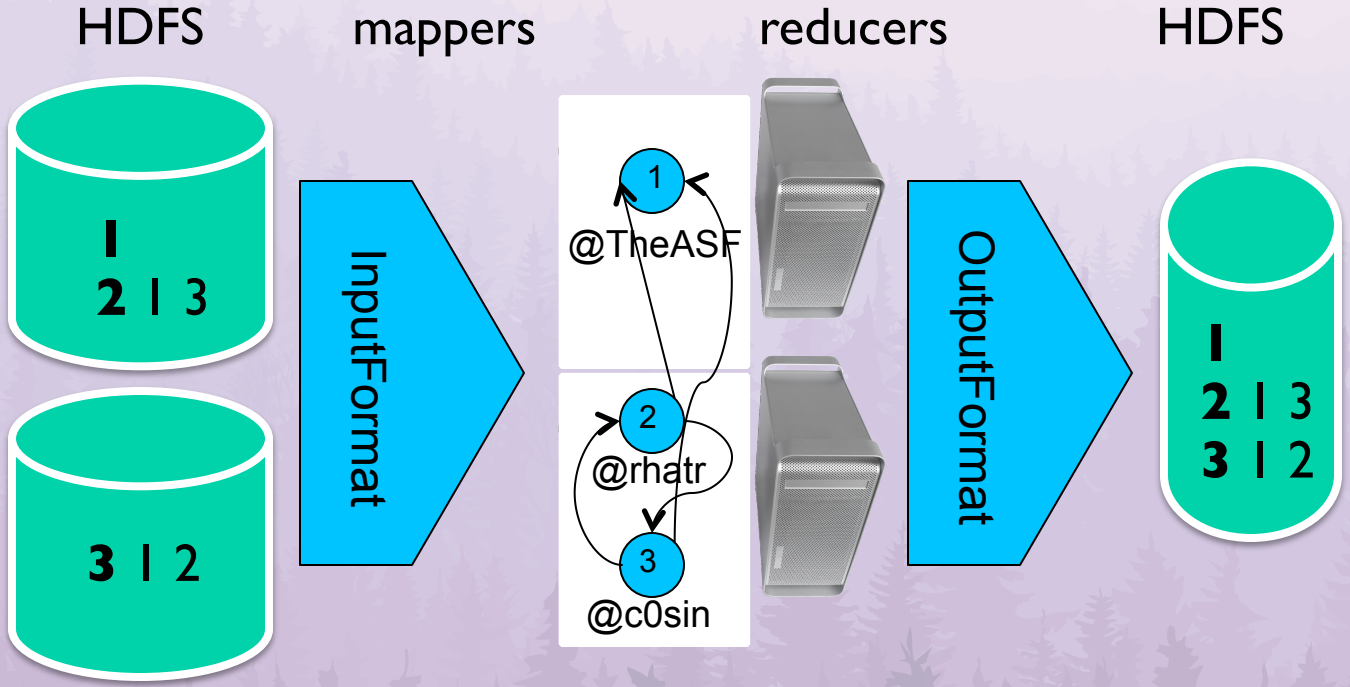
# On circles and arrows



- You don’t even need a graph to begin with!
  - Well, ok you need at least one node
- Dynamic extraction of relationships
  - EdgeInputFormat
  - VetexInputFormat
- Full integration with Hadoop ecosystem
  - HBase/Accumulo, Gora, Hive/HCatalog

# Anatomy of Giraph run

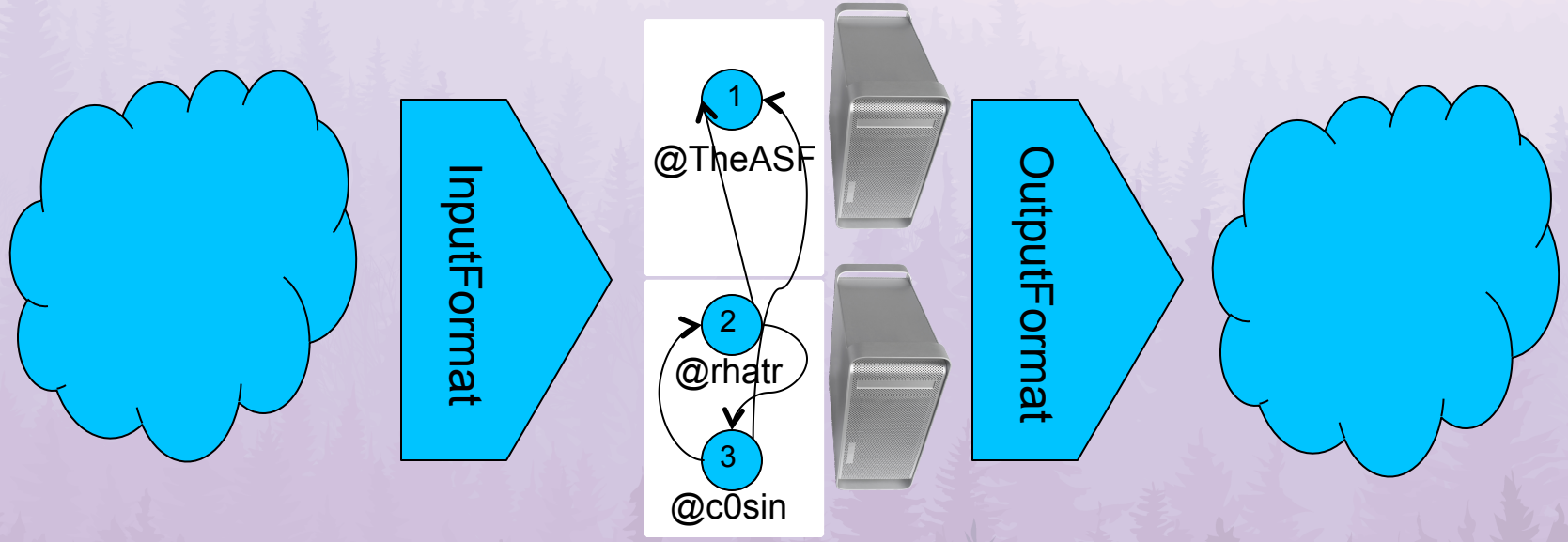




# Anatomy of Giraph run

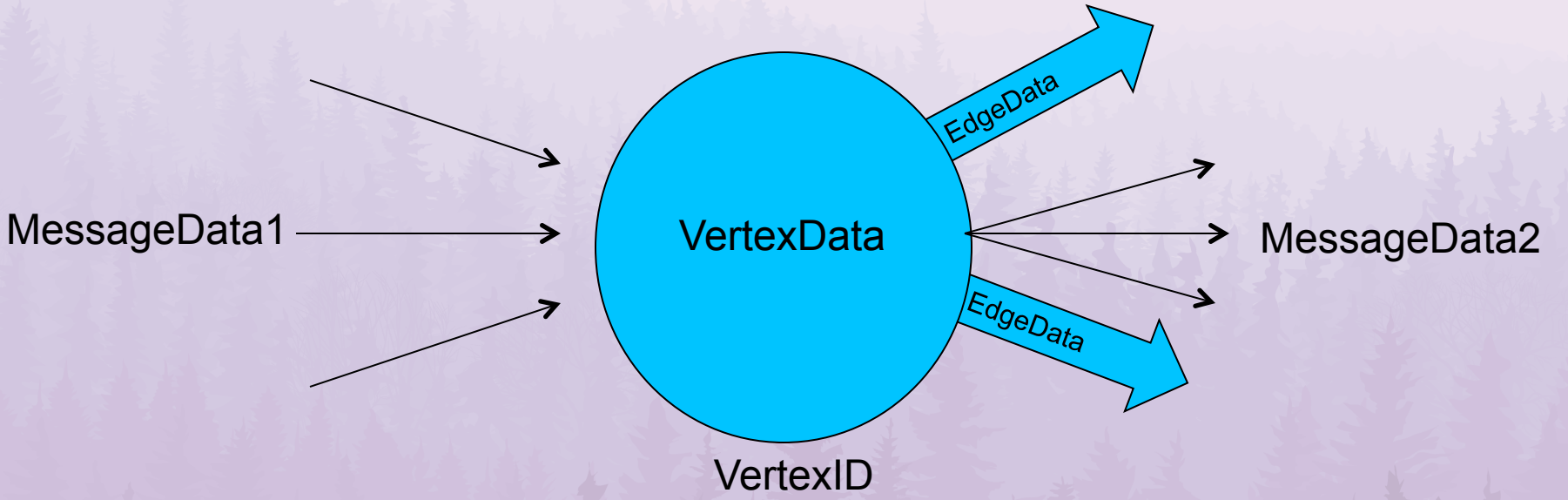


mappers or YARN containers



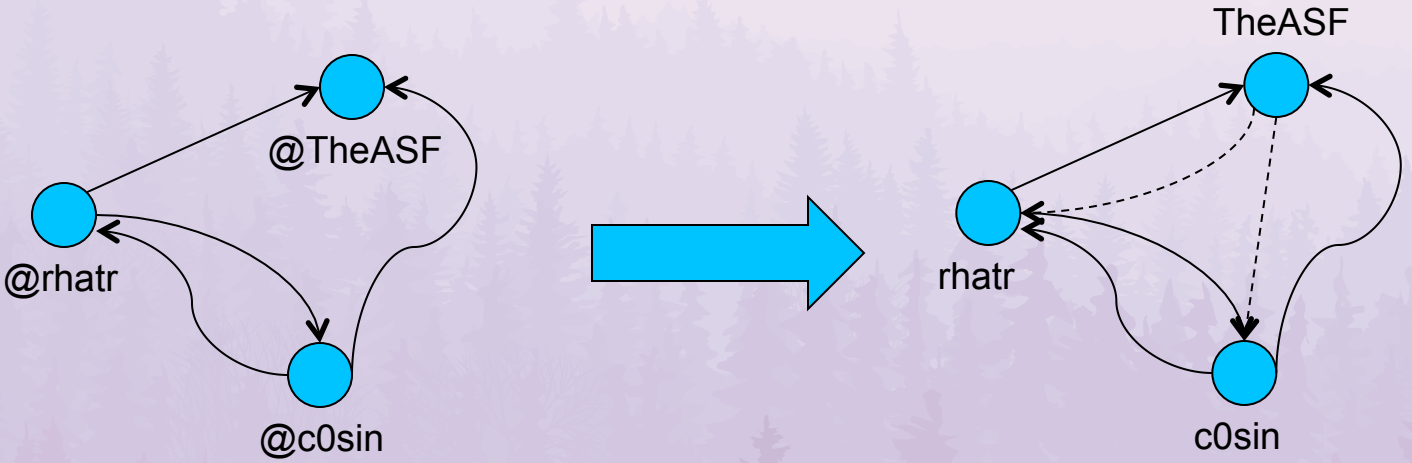
# A vertex view





# Turning Twitter into Facebook

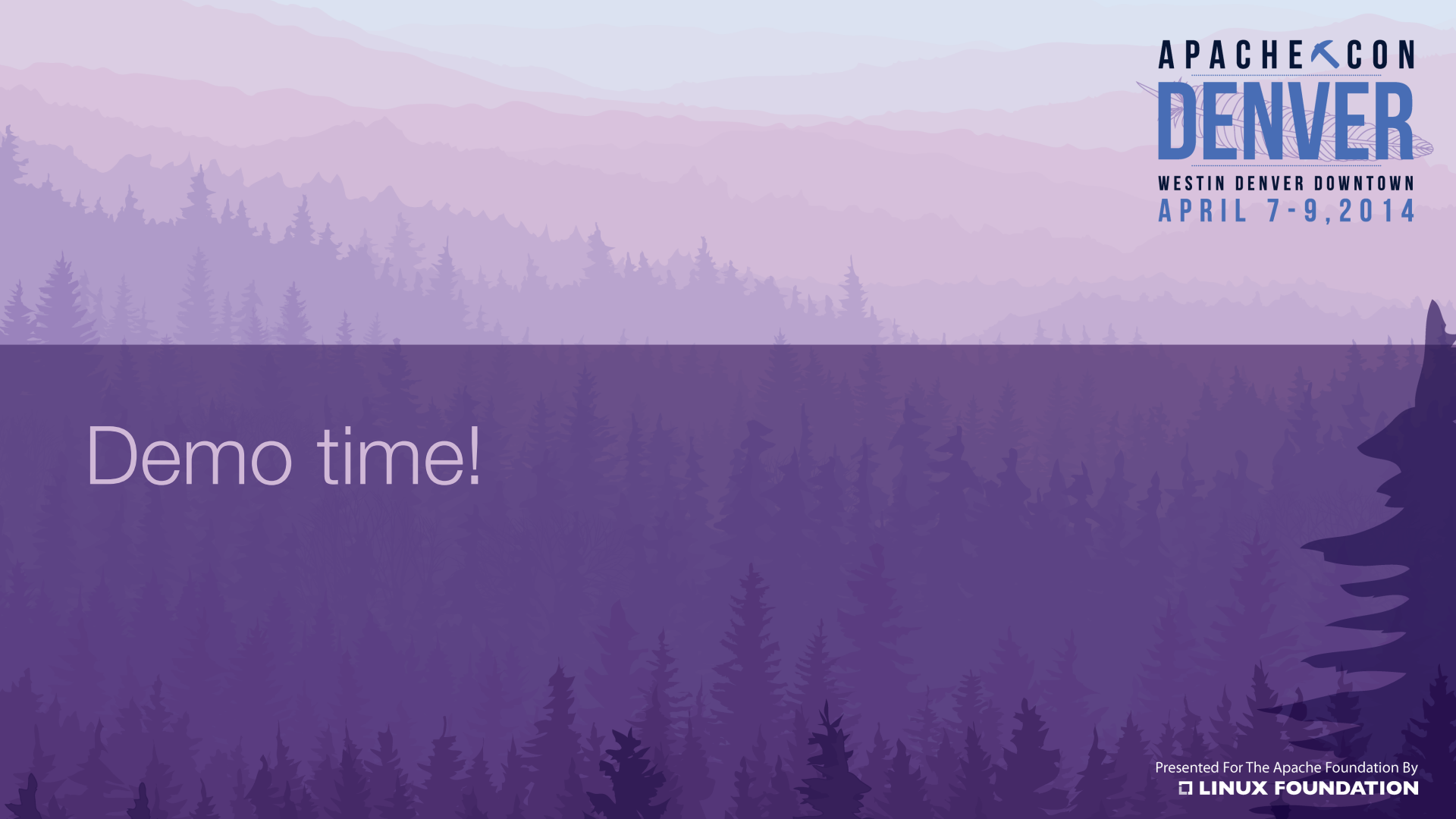




# Ping thy neighbours



```
public void compute(Vertex<Text, DoubleWritable, DoubleWritable> vertex, Iterable<Text> ms ){
        if (getSuperstep() == 0) {
           sendMessageToAllEdges(vertex, vertex.getId());
        } else {
            for (Text m : ms) {
              if (vertex.getEdgeValue(m) == null) {
                vertex.addEdge(EdgeFactory.create(m, SYNTHETIC_EDGE));
              }
            }
        }
        vertex.voteToHalt();
}
```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Demo time!
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# But I don't have a cluster!



- Hadoop in pseudo-distributed mode
  - All Hadoop services on the same host (different JVMs)
- Hadoop-as-a-Service
  - Amazon's EMR, etc.
- Hadoop in local mode

# Prerequisites

- Apache Hadoop 1.2.1
- Apache Giraph 1.1.0-SNAPSHOT
- Apache Maven 3.x
- JDK 7+

# Setting things up



```
$ curl hadoop.tar.gz | tar xzvf –
$ git clone  git://git.apache.org/giraph.git ; cd giraph
$ mvn –Phadoop_1 package
$ tar xzvf *dist*/*.tar.gz

$ export HADOOP_HOME=/Users/shapor/dist/hadoop-1.2.1
$ export GIRAPH_HOME=/Users/shapor/dist/
$ export HADOOP_CONF_DIR=$GIRAPH_HOME/conf
$ PATH=$HADOOP_HOME/bin:$GIRAPH_HOME/bin:$PATH
```

# Setting project up (maven)



```
<dependencies>
  <dependency>
    <groupId>org.apache.giraph</groupId>
    <artifactId>giraph-core</artifactId>
    <version>1.1.0-SNAPSHOT</version>
  </dependency>

  <dependency>
    <groupId>org.apache.hadoop</groupId>
    <artifactId>hadoop-core</artifactId>
    <version>1.2.1</version>
  </dependency>
</dependencies>
```

# Running it

```
$ mvn package
$ giraph target/*.jar giraph.GiraphHelloWorld \
    -vip src/main/resources/1 \
    -vif org.apache.giraph.io.formats.IntIntNullTextInputFormat  \
    -w 1 \
    -ca giraph.SplitMasterWorker=false,giraph.logLevel=error
```

# Testing it

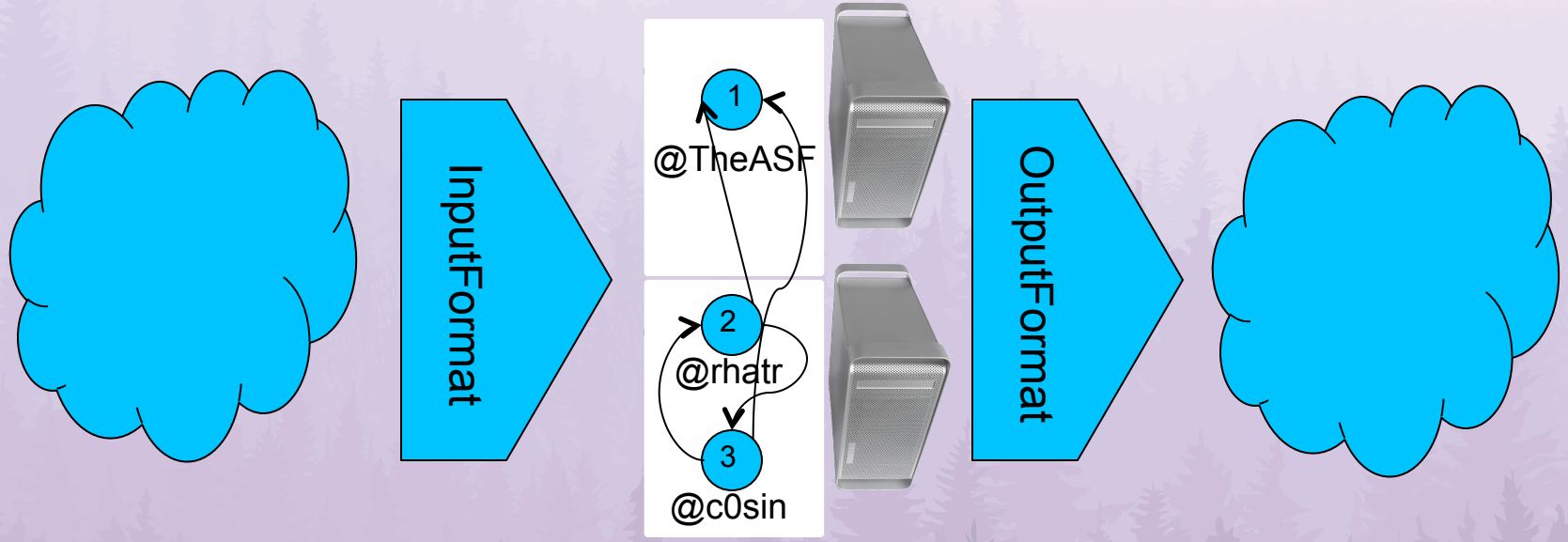


```
public void testNumberOfVertices() throws Exception {
    GiraphConfiguration conf = new GiraphConfiguration();
    conf.setComputationClass(GiraphHelloWorld.class);
    conf.setVertexInputFormatClass(TextDoubleDoubleAdjacencyListVertexInputFormat.class);
    …
    Iterable<String> results =
          InternalVertexRunner.run(conf, graphSeed);
    …
}
```

# Simplified view

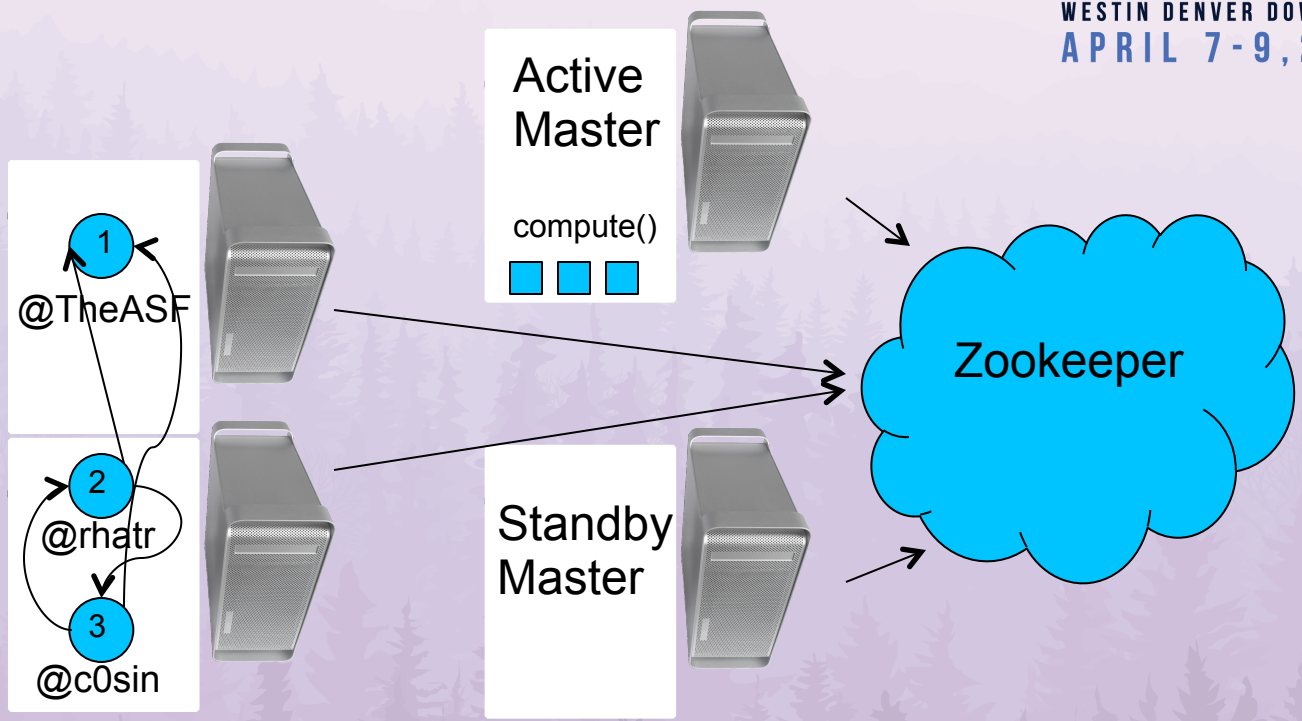


mappers or YARN containers



# Master and master compute



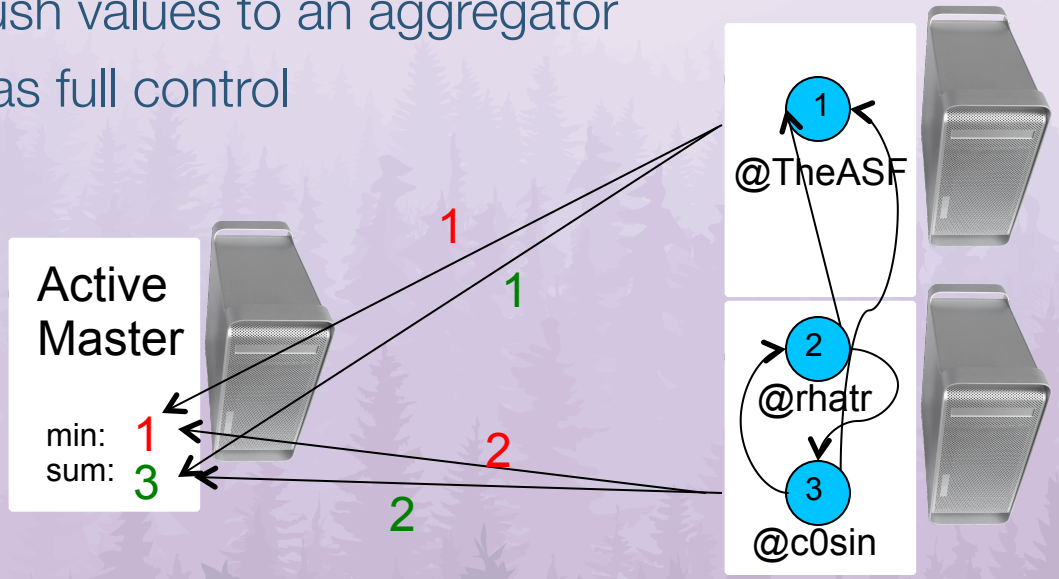


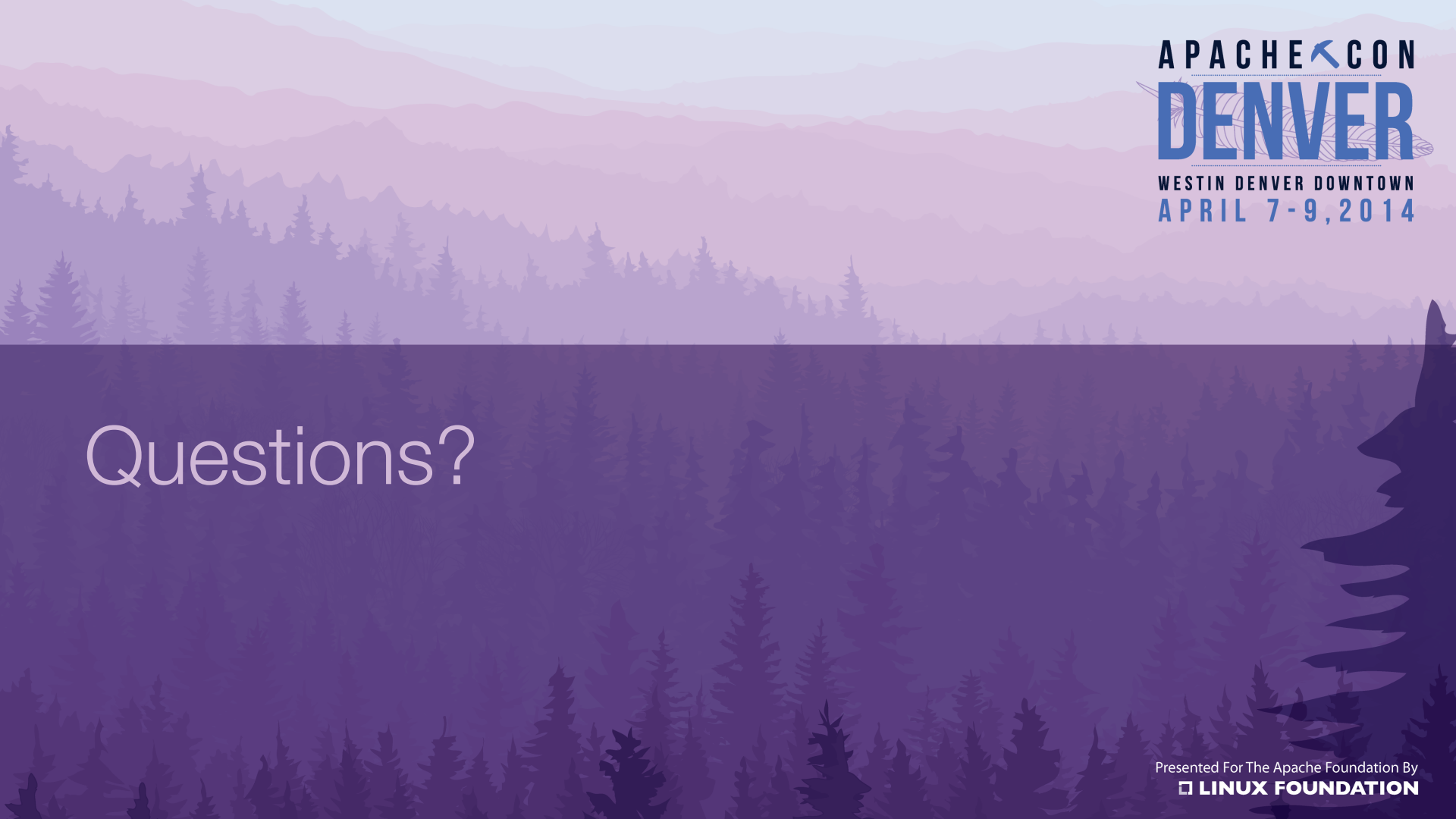
# Master compute

- Runs before slave compute()
- Has a global view
- A place for aggregator manipulation

# Aggregators

- “Shared variables”
- Each vertex can push values to an aggregator
- Master compute has full control

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