CSE 4/587

Data Intensive Computing

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Day 24
Spark HW Review

Announcements and Feedback

- Project Phase 3 due Friday

Spark HW Q1a

List two benefits that spark has over MapReduce

Spark HW Q1a

List two benefits that spark has over MapReduce

1. Keeps data in memory as much as possible (good for iterative apps)
2. Better for productivity (higher level constructs, more operations)
3. Suitable for entire pipeline (cleaning, EDA, modeling, production)
4. Support for streaming data

Spark HW Q1b

Name one other technology in the Hadoop ecosystem that improves programmer productivity with MapReduce

Spark HW Q1b

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1. PIG
2. Hive/HBASE

Spark HW Q1c

In one sentence explain the primary way fault-tolerance is achieved in MapReduce

Spark HW Q1c

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Data is divided into blocks, and the blocks are replicated across multiple nodes/racks in the cluster.

Spark HW Q1d

In one sentence explain the primary way fault-tolerance is achieved in Spark

Spark HW Q1d

In one sentence explain the primary way fault-tolerance is achieved in Spark

The series of transformations used to derive an RDD are stored as a lineage graph that can be re-executed if data is lost.

Spark HW Q1e

Explain the difference between a transformation and an action in Spark

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Transformations on an RDD do not trigger any computation. An action requires computation to be performed.

Spark HW Q1f

Explain the difference between a narrow dependency and a wide dependency in Spark

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Spark HW Q1f

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Bonus: What does this mean for how these computations are performed?

Spark HW Q1f

Explain the difference between a narrow dependency and a wide dependency in Spark

For a narrow dependency, each parent partition has at most one child partition. For a wide dependency a parent may have multiple child partitions.

Bonus: What does this mean for how these computations are performed?

Narrow can be pipelined. Wide may require data to be shuffled.

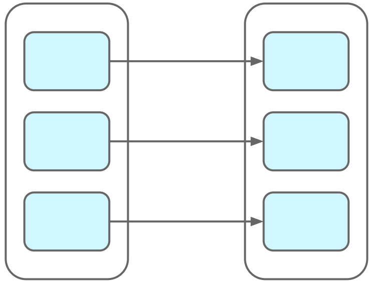
Spark HW Q1f(i)

Name one transformation that results in a narrow dependency, draw a DAG

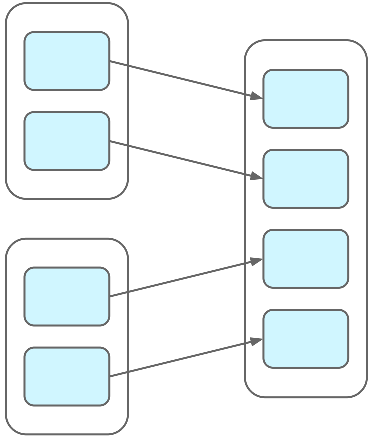
Spark HW Q1f(i)

Name one transformation that results in a narrow dependency, draw a DAG

1. map
2. filter
3. union



Map/Filter



Union

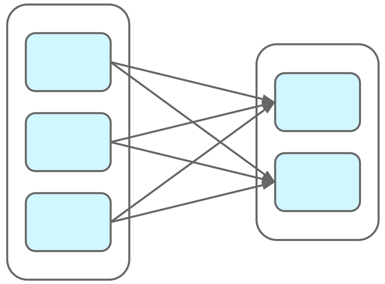
Spark HW Q1f(ii)

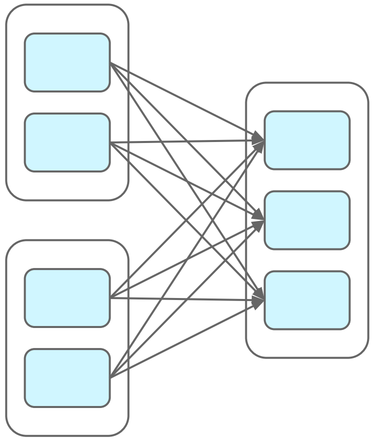
Same as above for wide dependency

Spark HW Q1f(ii)

Same as above for wide dependency

1. reduceByKey
2. groupByKey
3. join*


reduceByKey/groupByKey


join*

** depends on partitioning scheme*

Spark HW Q2 Code

```
lines = sc.textFile(sys.argv[1]).map(lambda r: r[0])
K = int(sys.argv[2])
convergeDist = float(sys.argv[3])

data = lines.map(parseVector).cache()
kPoints = data.takeSample(False, K, 1)
tempDist = 1.0

while tempDist > convergeDist:
  closest = data.map(
    lambda p: (closestPoint(p, kPoints), (p, 1)))
  pointStats = closest.reduceByKey(
    lambda p1_c1, p2_c2: (p1_c1[0] + p2_c2[0], p1_c1[1] + p2_c2[1]))
  newPoints = pointStats.map(
    lambda st: (st[0], st[1][0] / st[1][1])).collect()

  tempDist = sum(np.sum((kPoints[iK] - p) ** 2) for (iK, p) in newPoints)
  for (iK, p) in newPoints:
    kPoints[iK] = p
```

Spark HW Q2a

Given the above spark application, draw the lineage graph DAG for the RDD `newPoints`

Spark HW Q2a

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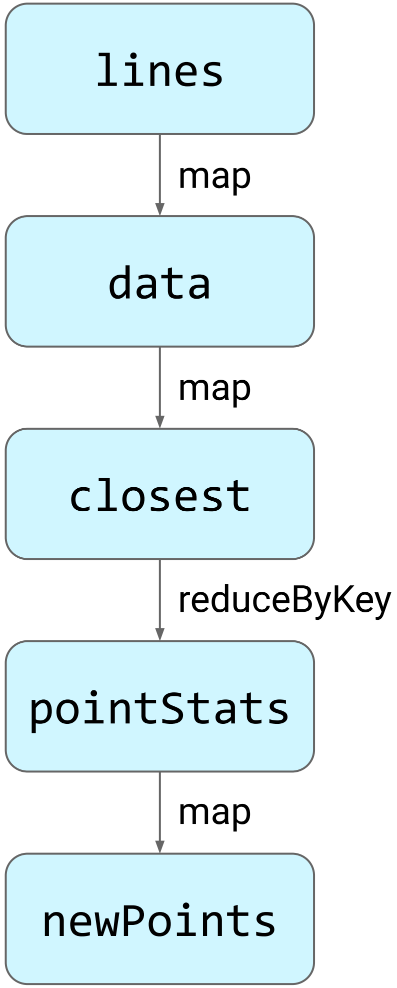

$$\begin{tikzcd}
\text{lines} \arrow[d, "\text{map}"] \\
\text{data} \arrow[d, "\text{map}"] \\
\text{closest} \arrow[d, "\text{reduceByKey}"] \\
\text{pointStats} \arrow[d, "\text{map}"] \\
\text{newPoints}
\end{tikzcd}$$

Spark HW Q2b

Identify in the above code one instance of:

i. A transformation that results in a wide dependency
ii. A transformation that results in a narrow dependency
iii. An action

Spark HW Q2b

Identify in the above code one instance of:

i. A transformation that results in a wide dependency

closest.reduceByKey(...)

ii. A transformation that results in a narrow dependency

data.map(...)

iii. An action

data.takeSample(...), or .collect()

Spark HW Q2c

How many "jobs" will the above code run?

Spark HW Q2c

How many "jobs" will the above code run?

1 per action =

    1 for takeSample + 1 per iteration for collect until convergence

Spark HW Q2d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)

Spark HW Q2d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)

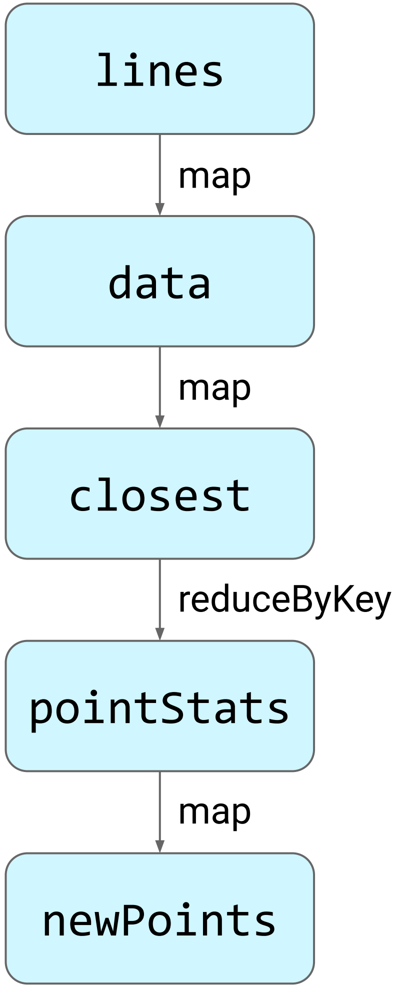
2 stages:

first stage is map, map, reduceByKey

second stage is map

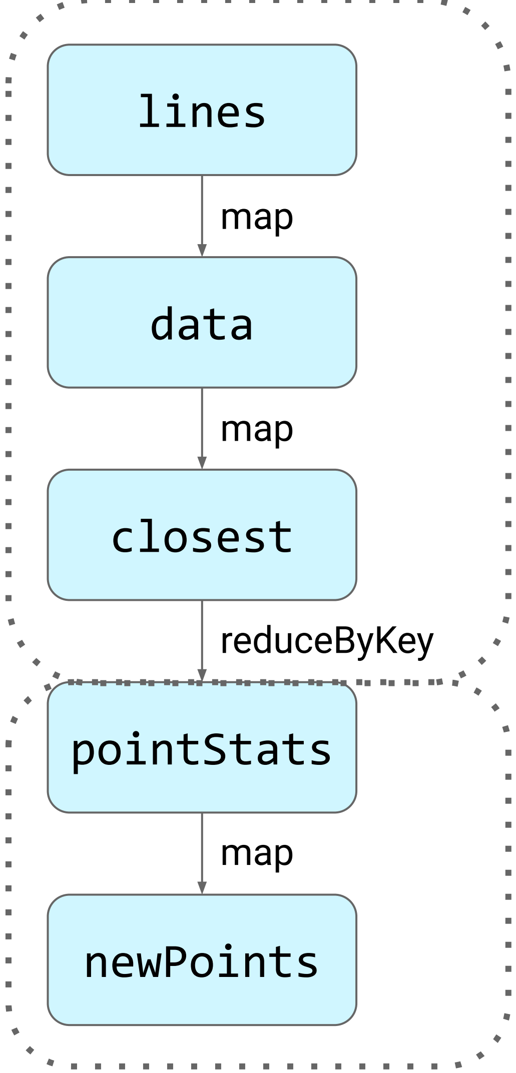
Spark HW Q2d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)



Spark HW Q2d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)



Spark HW Q2e

What algorithm is the above code an implementation of?

Spark HW Q2e

What algorithm is the above code an implementation of?

k-means clustering

Spark HW Q3 Code

```
lines = sc.textFile(file)
  links = lines.map(lambda urls: parseNeighbors(urls)) \
               .groupByKey()
               .cache()
  N = links.count()
  ranks = links.map(lambda u: (u[0], 1.0/N))

  for i in range(iters):
    contribs = links.join(ranks) \
                    .flatMap(lambda u: computeContribs(u[1][0], u[1][1]))

    ranks = contribs.reduceByKey(lambda a,b: a+b) \
                    .mapValues(lambda rank: rank * 0.85 + 0.15*(1.0/N))
  return ranks
```

Spark HW Q3a

Given the above spark application, draw the lineage graph DAG for the RDD ~~newPoints~~ ranks

Spark HW Q3a

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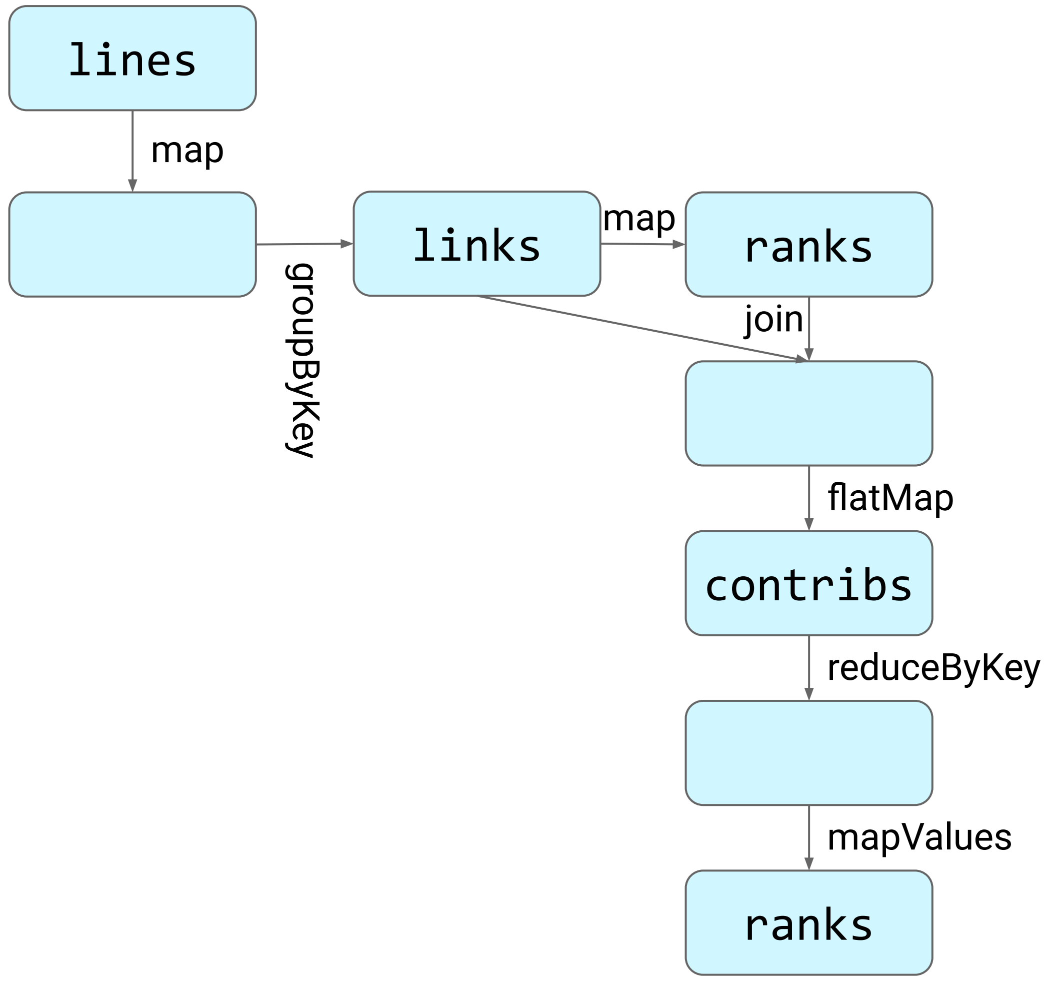


Spark HW Q3b

Identify in the above code one instance of:

i. A transformation that results in a wide dependency
ii. A transformation that results in a narrow dependency
iii. A transformation that may result in a narrow dependency OR a wide dependency
iv. An action

Spark HW Q3b

Identify in the above code one instance of:

i. A transformation that results in a wide dependency

groupByKey(...) or reduceByKey(...)

ii. A transformation that results in a narrow dependency

map(...), flatMap(...), or mapValues(...)

iii. A transformation that may result in a narrow dependency OR a wide dependency

join(...)

iv. An action

count()

Spark HW Q3c

How many "jobs" will the above code run?

Spark HW Q3c

How many "jobs" will the above code run?

1 per action = 1 (just the count action)

Spark HW Q3d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)

3 stages:

Stage one contains map and groupByKey

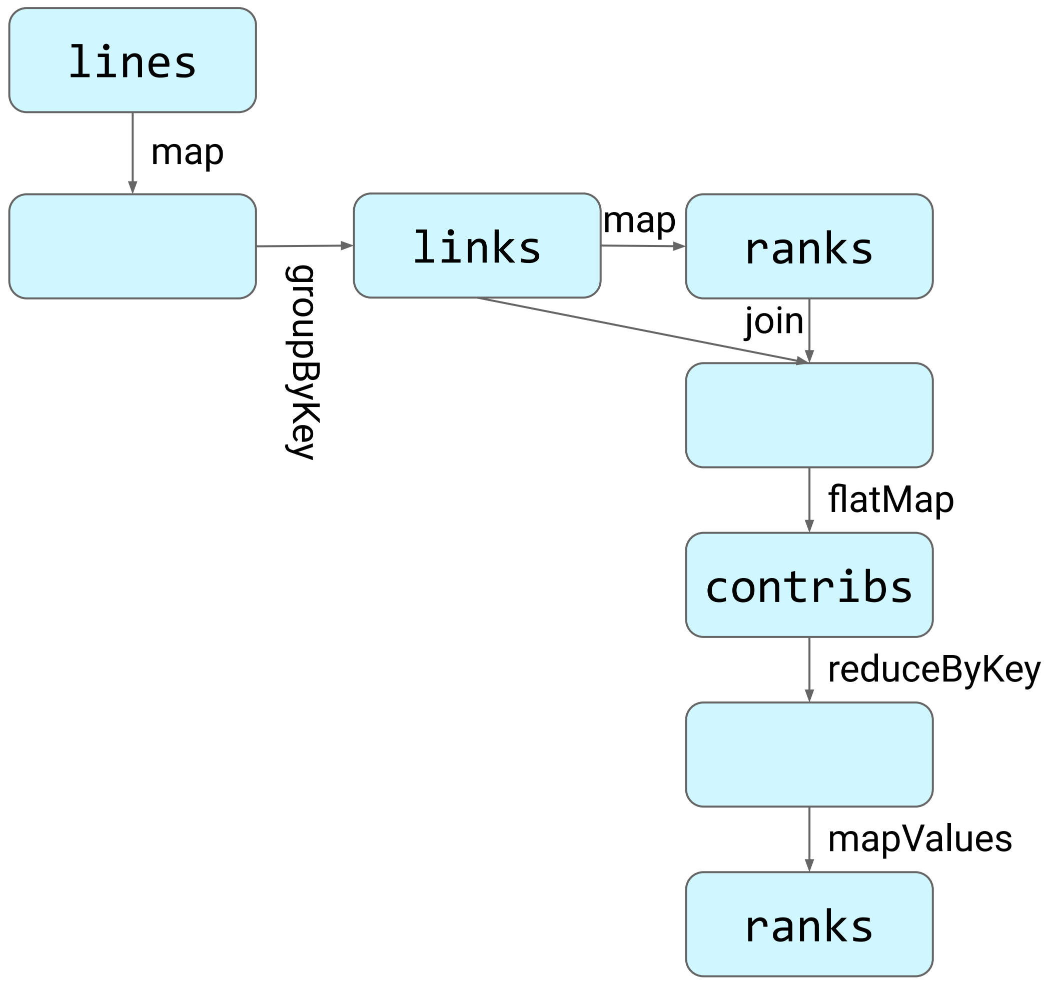
Stage two contains map, join*, flatMap, and reduceByKey

Stage three contains mapValues

** assuming that join is narrow*

Spark HW Q3d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)



Spark HW Q3d

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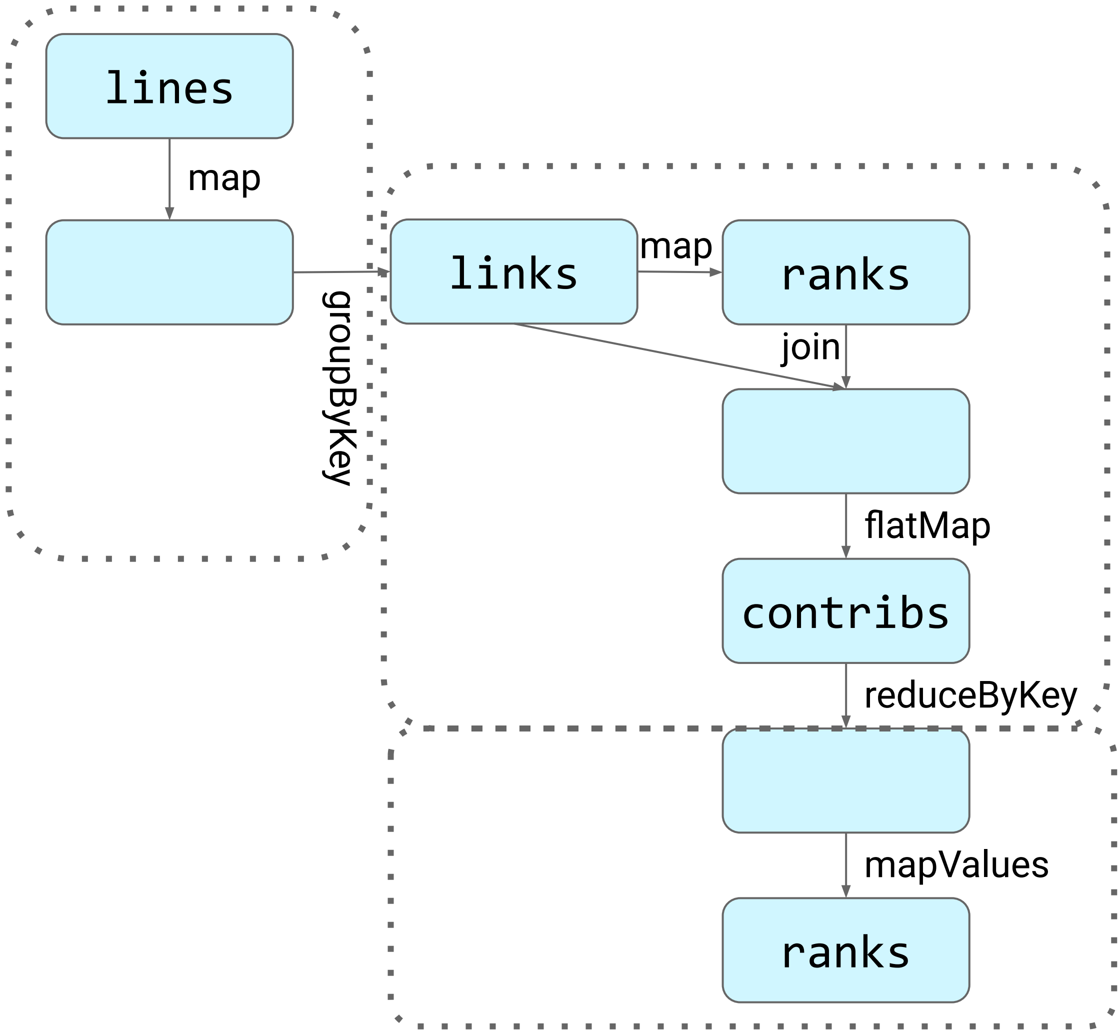


Spark HW Q3d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)

3 stages:

Stage one contains map and groupByKey

Stage two contains map, join*

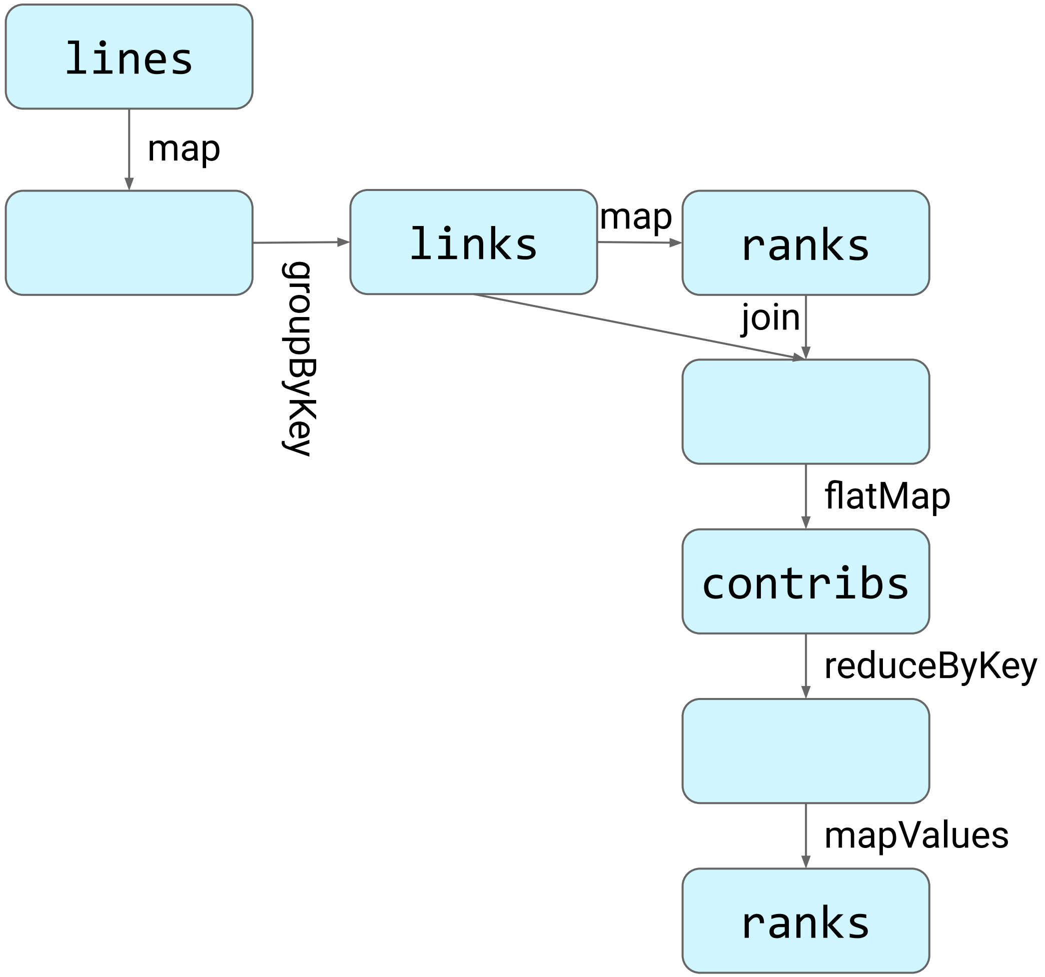
Stage three contains flatMap, and reduceByKey

Stage four contains mapValues

***** assuming that join is wide****

Spark HW Q3d

Based on your DAG, determine how it is broken up into stages (state the number of stages, and name the transformations in each stage)



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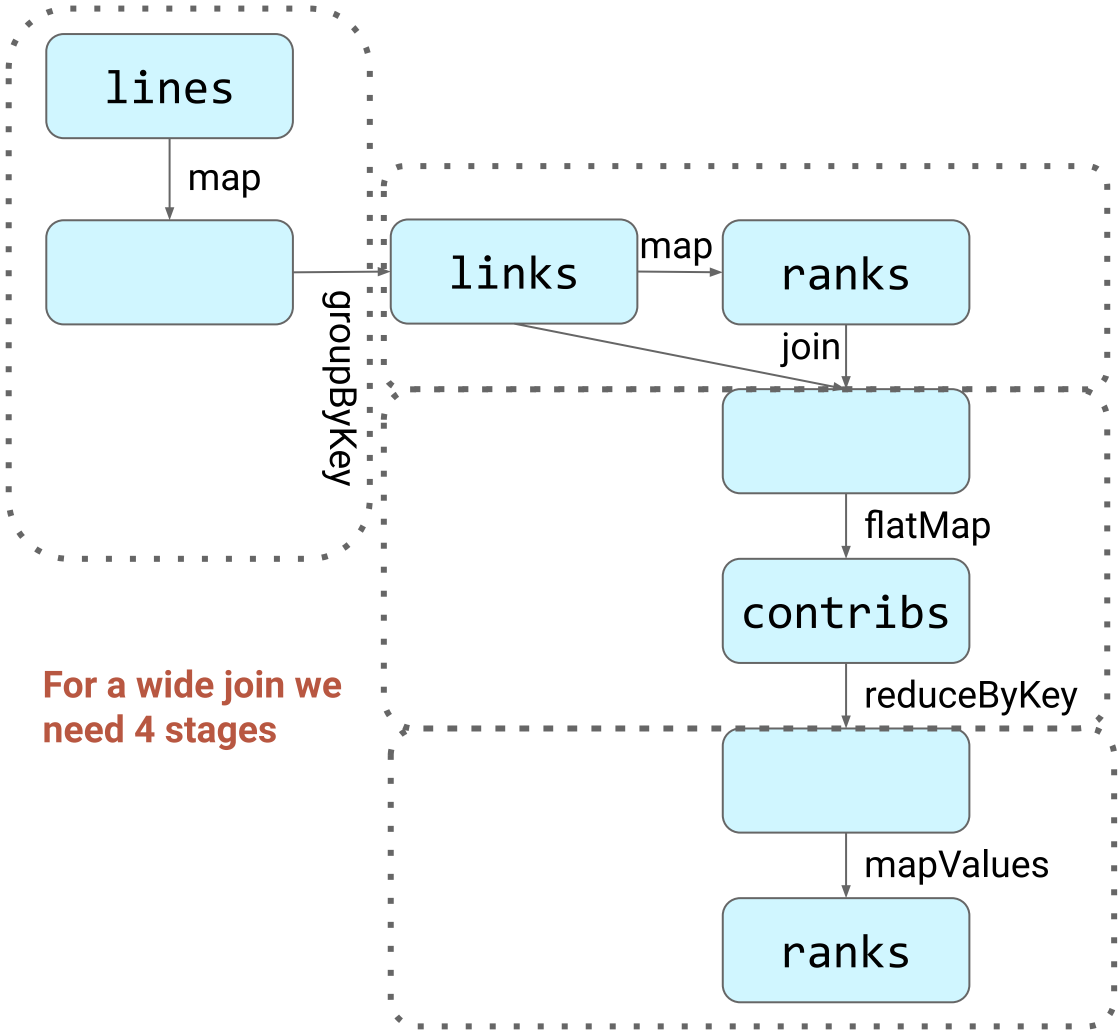

For a wide join we need 4 stages

Spark HW Q3e

What algorithm is the above code an implementation of?

Spark HW Q3e

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PageRank