大規模データ処理システム
Big Data Processing System

Hadoop streaming

- 基本的にはHadoopのプログラムはJavaで書く必要がある。
- Hadoopを使うためのツールの1つ
  - http://hadoop.apache.org/docs/r2.7.0/hadoop-streaming/HadoopStreaming.html
- Javaのプログラム(hadoop-streaming.jar)がラッパーとして動作する。
- MapperとReducerはコマンドを指定する
  - MapperやReducerとしてどのような言語でも利用することができる。

- Basically Hadoop program must be written in Java
- A tool to use hadoop platform
  - http://hadoop.apache.org/docs/r2.7.0/hadoop-streaming/HadoopStreaming.html
- Java program (hadoop-streaming.jar) runs as a wrapper.
- Mapper and Reducer are provided as commands.
  - Any programing language can be used as Mapper or Reducer

Wikipediaの閲覧状況を解析する (1)
Analysis of Wikipedia Page view statistics (1)

- Wikipediaは様々な情報を公開しています。http://dumps.wikimedia.org
- 中には page view の情報もあります。
  https://dumps.wikimedia.org/other/analytics/
- 2018年4月の統計をつかって、どのページが多く見られているかを調査。

- Wikipadia discloses various information; http://dumps.wikimedia.org
- There is Wikipedia pageviews dataset
  https://dumps.wikimedia.org/other/analytics/
- Try to analyze the page view statistics in April 2018

Format of the data

- https://meta.wikimedia.org/wiki/Research:Page_view
- Here are a few sample lines from one file:

```
fr.b Special:Recherche/Achille_Baraguey_d%5C%27Hilliers 1 624
fr.b Special:Recherche/Acteurs_et_actrices_N 1 739
fr.b Special:Recherche/Agrippa_d/%27Aubign%C3%A9 1 743
fr.b Special:Recherche/All_Mixed_Up 1 730
fr.b Special:Recherche/Andr%C3%A9_Gazut.html 1 737
```

- In the above, the first column "fr.b" is the project name. The following abbreviations are used:
  - wikibooks: ".b"
  - wiktionary: ".d"
  - wikimedia: ".m"
  - wikipedia mobile: ".mw"
  - wikinews: ".n"
  - wikiquote: ".q"
  - wikisource: ".s"
  - wikiversity: ".v"
  - mediawiki: ".w"

- The second column is ***the title*** of the page retrieved, the third column is ***the number of requests***, and the fourth column is ***the size of the content returned (dummy now?)***.

Wikipediaの閲覧状況を解析する (2)
Analysis of Wikipedia Page view counts (2)

- まずは、統計情報のダウンロード
- First of all, download the statistical information.

  – ダウンロードのためのリストを作る。/ make a list to download

```
$ curl -4 https://dumps.wikimedia.org/other/pageviews/2018/2018-04/| grep
'href="pageviews' | sed 's/.*href="//' | sed 's/".*//' > list.txt
```

  – ファイルをダウンロードする。 / download files

```
$ mkdir pv201804
$ for f in `cat list.txt`; do
> curl -4 -o pv201804/$f
https://dumps.wikimedia.org/other/pageviews/2018/2018-04/$f
> done
```

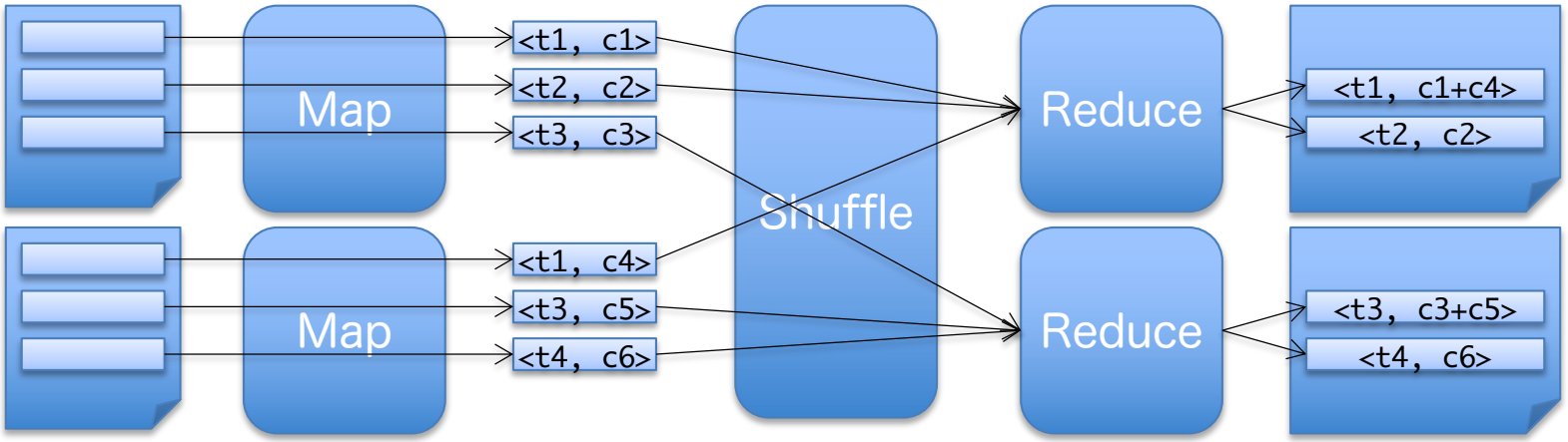
- ダウンロードしたファイルをHDFSに登録する。/ Put the files to HDFS

```
$ hdfs dfs -put pv201804
```

Wikipediaの閲覧状況を解析する (3)
Analysis of Wikipedia Page view counts (3)

- Map処理
  - 行毎に <タイトル, 閲覧数> というkey-valueの組を出力する。
- Reduce処理
  - Map処理が出力するkey-valueのkey（ここではタイトル）によってソートされてReduce処理に渡される。
  - 同じタイトルの場合は閲覧数を合計する。

- Map
  - make key-value pairs <title, count> per each line
- Reduce
  - Sorted key-value pairs which is made by Map is handed to Reduce. In this case, key is the title of pages.
  - Make total if title is same



Map, Shuffle and Reduce

Page view statistics
fr.b Acteurs_et_actrices_N 3 624
fr.b All_Mixed_Up 1 739
fr.b Acteurs_et_actrices_N 1 743
fr.b All_Mixed_Up 2 730
fr.b Acteurs_et_actrices_N 1 737

Map

Title	N
Acteurs_et_actrices_N	3
All_Mixed_Up	1
Acteurs_et_actrices_N	1
All_Mixed_Up	2
Acteurs_et_actrices_N	1

Shuffle

Title	N
Acteurs_et_actrices_N	3
	1
	1
All_Mixed_Up	1
	2

Reduce

Title	N
Acteurs_et_actrices_N	5
All_Mixed_Up	3

Wikipediaの閲覧状況を解析する (4)
Analysis of Wikipedia Page view counts (4)

- 行数を数えてみる。/ How many lines are there?

```
% hadoop jar /opt/cloudera/parcels/CDH/lib/hadoop-mapreduce/hadoop-streaming.jar -input pv201804 -output pv201804_out -mapper 'wc -l' -reducer cat
% hdfs dfs -cat 'pv201804_out/*' | awk '{sum = sum + $1} END{print sum}'
4569976697
```

  - もし、rubyの方が好みなら / if you prefer ruby

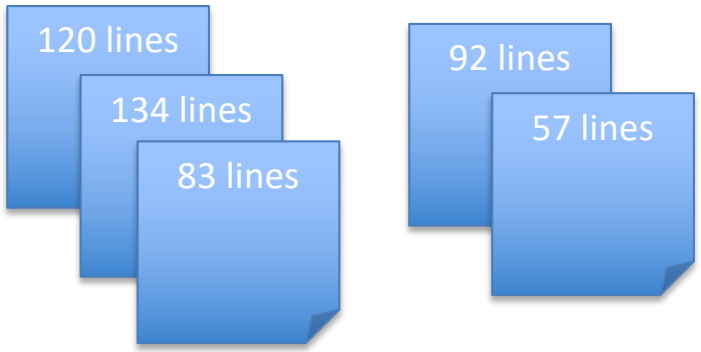
```
% hdfs dfs -cat 'pv201804_out/*' | ruby -ne 'BEGIN{$sum = 0}; $sum += $_.to_i; END{puts $sum}'
```

- 全てをHadoopで行う。/ Everything is done by Hadoop.

```
% hadoop jar /opt/cloudera/parcels/CDH/lib/hadoop-mapreduce/hadoop-streaming.jar -input pv201804 -output pv201804_out -mapper 'wc -l' -reducer 'awk "{sum = sum + $1} END{print sum}"' -numReduceTasks 1
```

Map, Shuffle and Reduce

```
% hadoop jar /opt/cloudera/parcels/CDH/lib/hadoop-mapreduce/hadoop-streaming.jar -input pv201804 -output pv201804_out -mapper 'wc -l' -reducer cat
```



Map

Lines
120
134
83
92
57

Shuffle

Lines
57
83
92

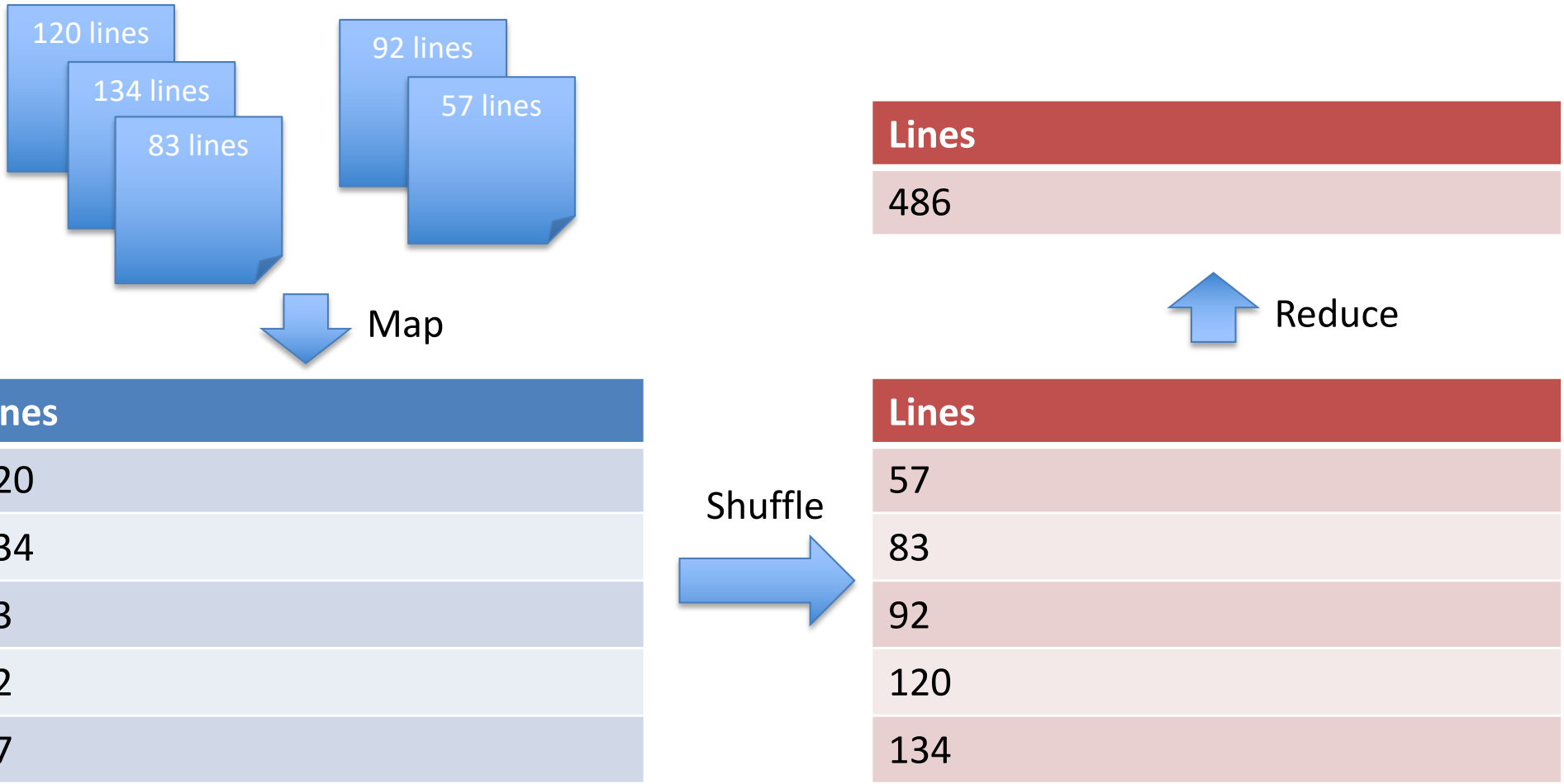
Lines
120
134

Reduce

Lines
120
134

Map, Shuffle and Reduce

```
% hadoop jar /opt/cloudera/parcels/CDH/lib/hadoop-mapreduce/hadoop-streaming.jar -input pv201804
-output pv201804_out -mapper 'wc -l' -reducer 'awk "{sum = sum + $1} END{print sum}"'
-numReduceTasks 1
```



Hadoop streaming

```
% hadoop jar /opt/cloudera/parcels/CDH/lib/hadoop-mapreduce/hadoop-streaming.jar [opt]
```

Parameter	Optional/ Required	Description
-input directoryname or filename	Required	Input location for mapper
-output directoryname	Required	Output location for reducer
-mapper executable or JavaClassName	Required	Mapper executable
-reducer executable or JavaClassName	Required	Reducer executable
-files filenames	Optional	Make the mapper, reducer, or combiner executable available locally on the compute nodes
-inputformat JavaClassName	Optional	Class you supply should return key/value pairs of Text class. If not specified, TextInputFormat is used as the default
-outputformat JavaClassName	Optional	Class you supply should take key/value pairs of Text class. If not specified, TextOutputformat is used as the default
-partitioner JavaClassName	Optional	Class that determines which reduce a key is sent to
-combiner streamingCommand or JavaClassName	Optional	Combiner executable for map output
-cmdenv name=value	Optional	Pass environment variable to streaming commands
-inputreader	Optional	For backwards-compatibility: specifies a record reader class (instead of an input format class)
-verbose	Optional	Verbose output
-lazyOutput	Optional	Create output lazily. For example, if the output format is based on FileOutputFormat, the output file is created only on the first call to Context.write
-numReduceTasks	Optional	Specify the number of reducers
-mapdebug	Optional	Script to call when map task fails
-reducedebug	Optional	Script to call when reduce task fails

Wikipediaの閲覧状況を解析する (3)
Analysis of Wikipedia Page view counts (3)

- Map処理
  - 行毎に <タイトル, 閲覧数> というkey-valueの組を出力する。
- Reduce処理
  - Map処理が出力するkey-valueのkey（ここではタイトル）によってソートされてReduce処理に渡される。
  - 同じタイトルの場合は閲覧数を合計する。

- Map
  - make key-value pairs <title, count> per each line
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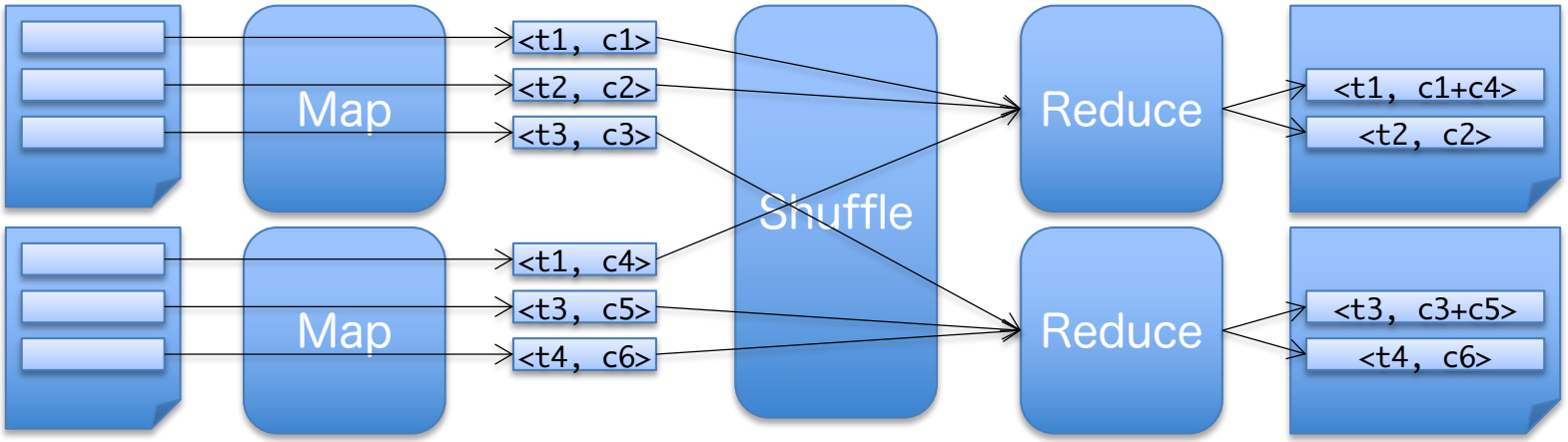

Wikipediaの閲覧状況を解析する (5) python
Analysis of Wikipedia Page view counts (5) python

- Mapper

mapper.py

```
#!/usr/bin/env python3.6
import sys

args = sys.argv

for line in sys.stdin:
    line = line.strip()
    if len(line.split()) != 4:
        continue
    projectName, title, count, size  = line.split()
    if projectName != args[1]:
        continue
    print(title, "¥t", count)
```

Wikipediaの閲覧状況を解析する (5) python
Analysis of Wikipedia Page view counts (5) python

- Reducer

reducer.py

```
#!/usr/bin/env python3.6
import sys

args = sys.argv

t, c = sys.stdin.readline().strip().split("¥t")
title, count = t, int(c)
for line in sys.stdin:
    t, c = line.strip().split("¥t")
    if title != t:
        if count > int(args[1]):
            print(title, "¥t", count);
        title, count = t, int(c)
    else:
        count += int(c)
if count > int(args[1]):
    print(title, "¥t", count);
```

Wikipediaの閲覧状況を解析する (5) ruby
Analysis of Wikipedia Page view counts (5) ruby

- Mapper

mapper.rb

```
#!/usr/bin/env ruby
STDIN.each do | l |
     projectName, title, count, size = l.chomp.split(" ")
     print "#{title}¥t#{count}¥n" if projectName == ARGV[0]
end
```

- Reducer

reducer.rb

```
#!/usr/bin/env ruby
t, c = STDIN.readline.chomp.split("¥t")
title, count = t, c.to_i
STDIN.each do | l |
     t, c = l.chomp.split("¥t")
     if title != t
          print "#{title}¥t#{count}¥n" if count > ARGV[0].to_i
          title, count = t, c.to_i
     else
          count += c.to_i
     end
end
print "#{title}¥t#{count}¥n" if count > ARGV[0].to_i
```

Wikipediaの閲覧状況を解析する (6)
Analysis of Wikipedia Page view counts (6)

- 少数のデータで、hadoopを使わずに処理の確認をする。
  Check the programs using small number of data without hadoop
  - 日本のWikipediaのみに着目し、1,000アクセス以上のものを表示する。
    Print page title which is viewed more than 1000 times and written in Japanese

```
% gzip -dc pv201804/pageviews-2018040[1-2]-000000.gz | ./mapper.py
ja | sort | ./reducer.py 1000 | nkf -w --url-input
```

- 全データでhadoopを使って処理する。/ process all data using hadoop

```
% hadoop jar /opt/cloudera/parcels/CDH/lib/hadoop-mapreduce/hadoop-
streaming.jar -files reducer.py,mapper.py -input pv201804 -output
pv201804_out -mapper 'mapper.py ja' -reducer 'reducer.py 100000'
```

- よくアクセスされたものを表示する。
  Print top accessed pages

```
% hdfs dfs -cat 'pv201804_out/part-*' | sort -r -n -k2 | nkf -w --
url-input | less
...
```

Hiveを使う
Using Hive

- HiveはHadoopファミリのデータウェアハウス。
  Hive is a data warehouse in Hadoop family.
- クエリを行うのにHiveQL (SQLのような言語)が用いられる。
  HiveQL (SQL like language) is used to make a query.

- データをHiveに登録する。/ Register data to Hive

```
% hive
hive> CREATE TABLE pv201804(proj STRING, title STRING, count INT, size INT) row
format delimited fields terminated by ' ' lines terminated by '¥n';
hive> LOAD DATA INPATH '/user/kei/pv201804/*' OVERWRITE INTO TABLE pv201804;
```

- 行数は? / How many lines?

```
hive> SELECT count(*) FROM pv201804;
```

- Hiveでトップ10を表示。/ Get top 10 page view counts

```
hive> SELECT title, SUM(count) AS num FROM pv201804 WHERE proj = "ja" GROUP BY title
ORDER BY num DESC LIMIT 10;
```

HiveQL

- Hiveでトップ10を表示。/ Get top 10 page view counts

```
hive> SELECT title, SUM(count) AS num FROM pv201804 WHERE proj = "ja" GROUP BY title
ORDER BY num DESC LIMIT 10;
```

  - SELECT: データの抽出 / retrieving data
  - SUM: 合計を算出する関数 / a function to make a summation
  - AS: 別名 / alias name
  - FROM: テーブル指定 / specify a table
  - WHERE: 条件 / condition
  - GROUP BY: グルーピング / Grouping（used with COUNT, SUM, AVE…）
  - ORDER BY … DESC: 並び替え(降順) / Sort (Descending order)
  - LIMIT: 個数制限 / limit lines

Impalaを使う
Using Impala

- Impalaは別のデータウェアハウス / Impala is another data warehouse
- ネイティブで実装されている / It is implemented in native language.
- 爆速 / Very high speed

- Hiveで作成したテーブルをImpalaで使えるようにする。
  Prepare the Impala's metadata used in Hive

```
% impala-shell -i dn01
> INVALIDATE METADATA;
```

- Impalaでトップ10を表示。/ Get top 10 PVC using Impala

```
> SELECT title, SUM(count) AS num FROM pv201804 WHERE proj = "ja"
GROUP BY title ORDER BY num DESC LIMIT 10;
```