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Summarization Patterns

Summarization Patterns are used to implement applications that produce top-level/summarized view of the data, such as

- Numerical summarizations (Statistics)
- Inverted index
- Counting with counters

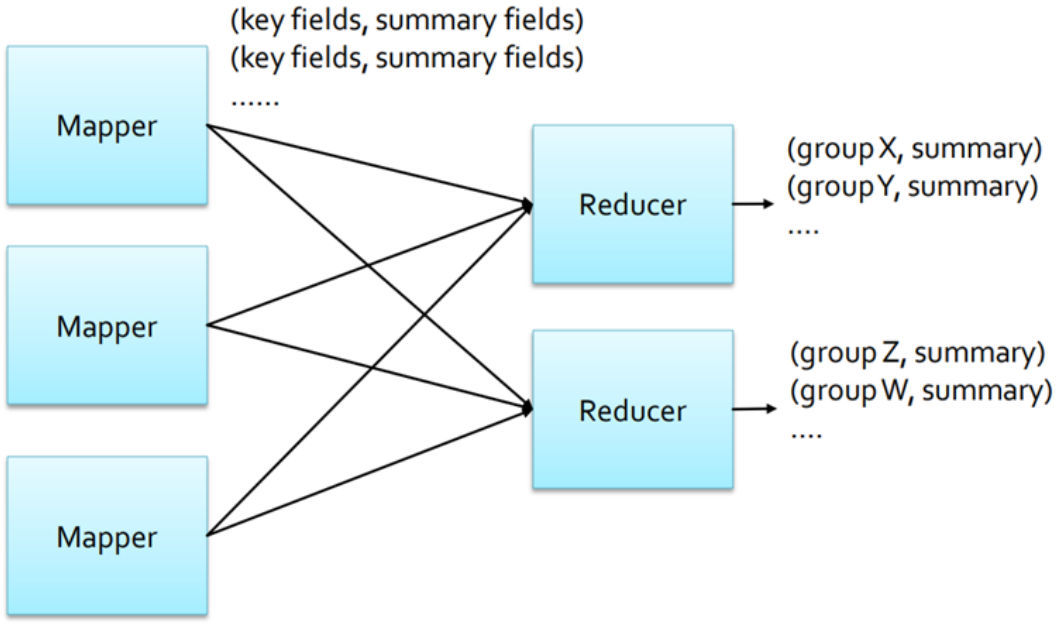
Numerical summarizations

The goal is to group records/objects by a key field(s) and calculate a numerical aggregate (e.g., average, max, min, standard deviation) per group, to provide a top-level view of large input data sets so that a few high-level statistics can be analyzed by domain experts to identify trends, anomalies, etc.

Structure

- Mappers output `(key, value)` pairs where
  - key is associated with the fields used to define groups;
  - value is associated with the fields used to compute the aggregate statistics.
- Reducers receive a set of numerical values for each "group-by" key and compute the final statistics for each "group". Combiners can be used to speed up performances, if the computed statistic has specific properties (e.g., it is commutative and associative).

Figure 1: Numerical summarization structure



Use cases are

- Word count
- Record count (per group)
- Min/Max/Count (per group)
- Average/Median/Standard deviation (per group)

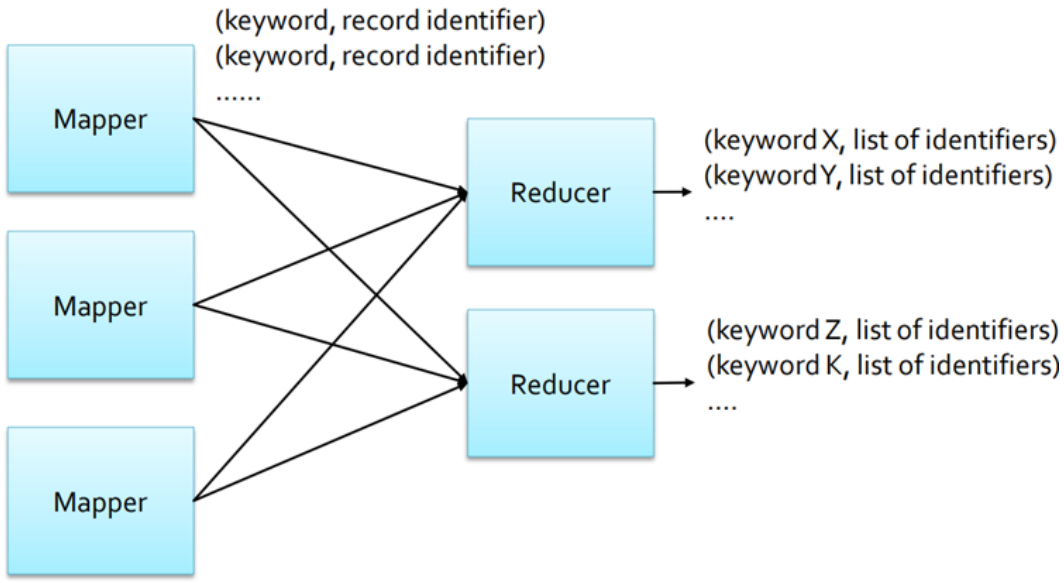
Inverted index summarization

The goal is to build an index from the input data to support faster searches or data enrichment: it maps terms to a list of identifiers to improve search efficiency.

Structure

- Mappers output `(key, value)` pairs where
  - key is the set of fields to index (a keyword)
  - value is a unique identifier of the objects to associate with each "keyword"
- Reducers receive a set of identifiers for each keyword and simply concatenate them
- Combiners are usually not useful when using this pattern, since there are no values to aggregate

Figure 2: Numerical summarization structure



A use case is a web search engine (word – List of URLs, i.e. Inverted Index).

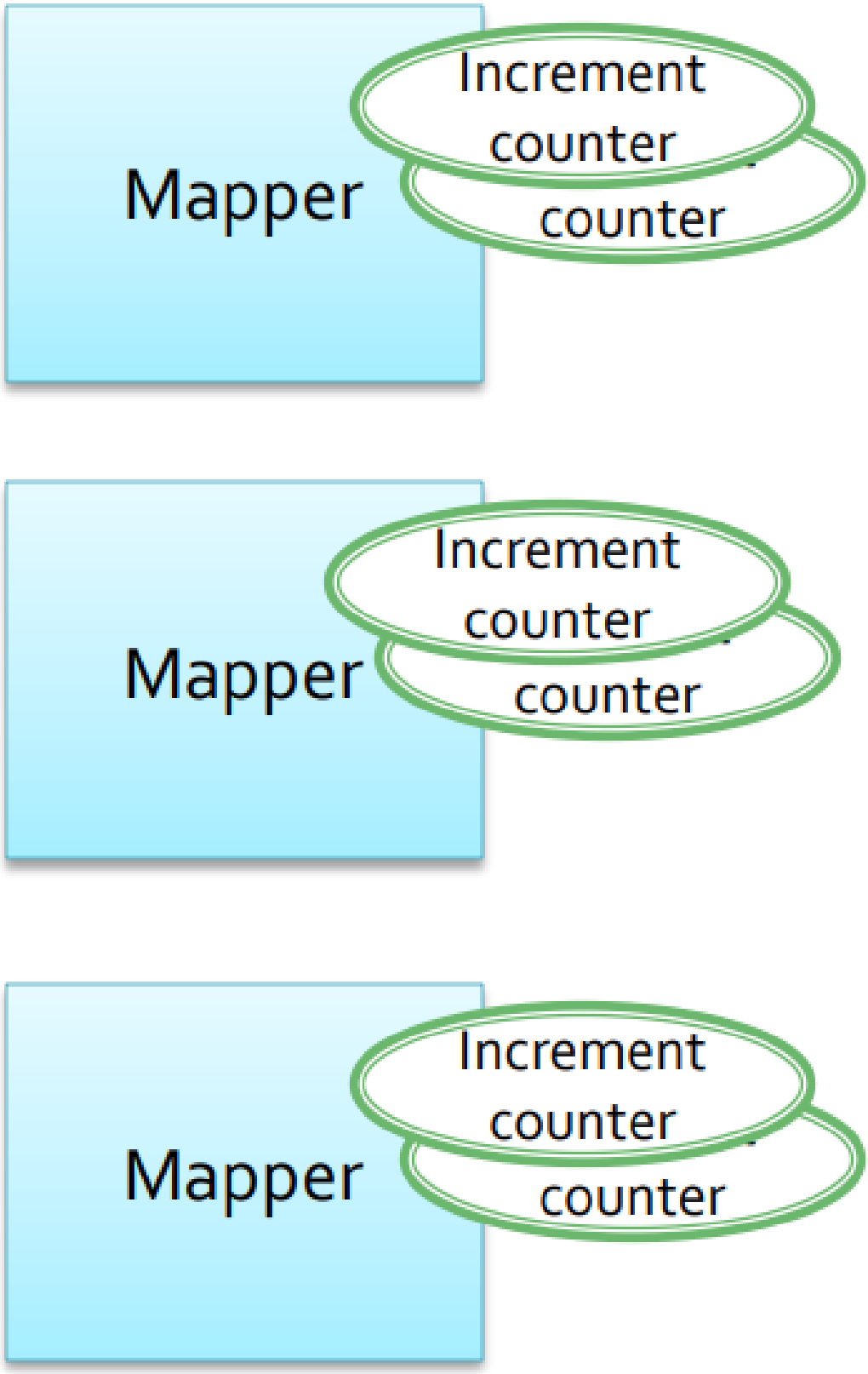
Counting with counters

The goal is to compute count summarizations of data sets to provide a top-level view of large data sets, so that few high-level statistics can be analyzed by domain experts to identify trends, anomalies, …

Structure

- Mappers process each input record and increment a set of counters
- This is a map-only job: no reducers and no combiners have to be implemented
- The results are stored/printed by the Driver of the application

Figure 3: Numerical summarization structure



Use cases

- Count number of records
- Count a small number of unique instances
- Summarizations

Filtering patterns

Are used to select the subset of input records of interest

- Filtering
- Top K
- Distinct

Filtering

The goal is to filter out input records that are not of interest/keep only the ones that are of interest, to focus the analysis of the records of interest. Indeed, depending on the goals of your application, frequently only a small subset of the input data is of interest for further analyses.

Structure

The input of the mapper is a set of records

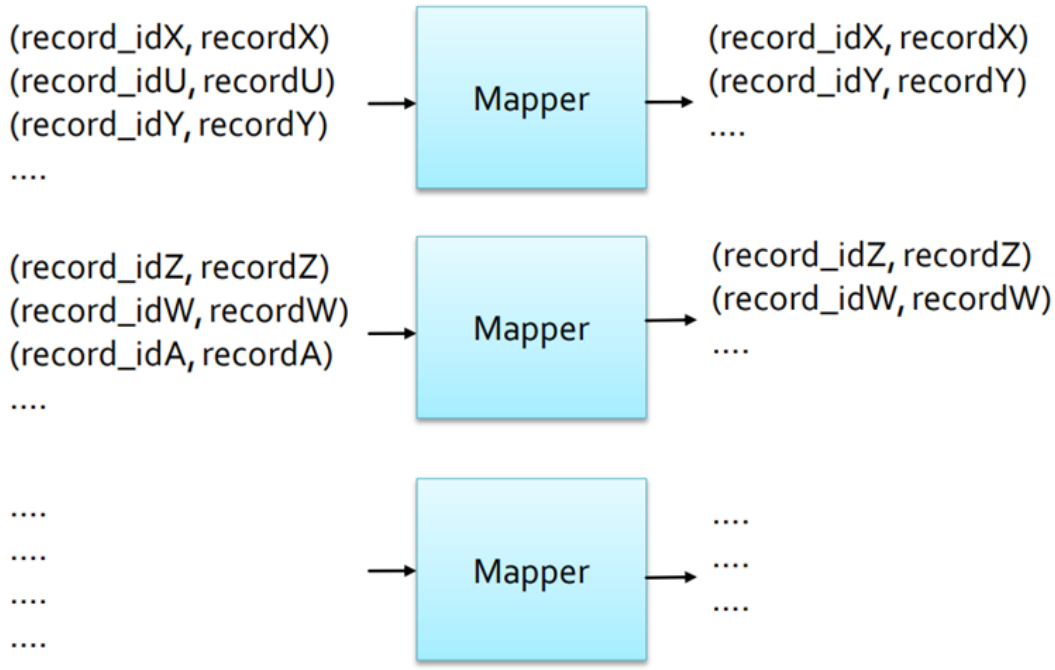
- Key = primary key
- Value = record

Mappers output one `(key, value)` pair for each record that satisfies the enforced filtering rule

- Key is associated with the primary key of the record
- Value is associated with the selected record

Reducers are useless in this pattern, since a map-only job is executed (number of reduce set to 0).

Figure 4: Numerical summarization structure



Use cases

- Record filtering
- Tracking events
- Distributed grep
- Data cleaning

Top K

The goal is to select a small set of top K records according to a ranking function to focus on the most important records of the input data set: frequently the interesting records are those ranking first according to a ranking function (i.e., most profitable items, outliers).

Structure

Mappers

Each mapper initializes an in-mapper (local) top k list. k is usually small (e.g., 10), and the current (local) top k-records of each mapper(i.e., instance of the mapper class) can be stored in main memory

- The initialization is performed in the setup method of the mapper
- The map function updates the current in-mapper top k list

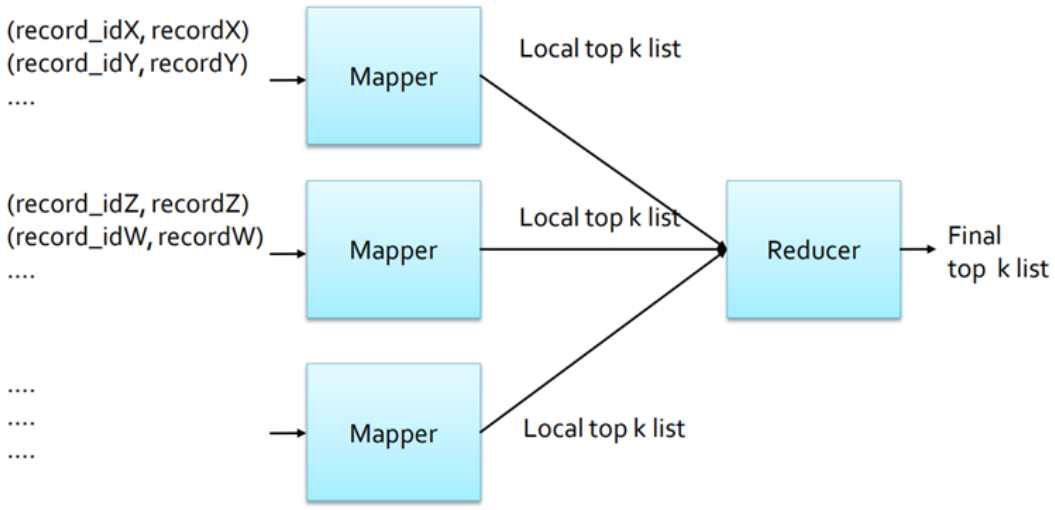
The cleanup method emits the k `(key, value)` pairs associated with the in-mapper local top k records

- Key is the "null key"
- Value is a in-mapper top k record

Reducer

A single reducer must be instantiated (i.e., one single instance of the reducer class). One single global view over the intermediate results emitted by the mappers to compute the final top k records. It computes the final top k list by merging the local lists emitted by the mappers. All input `(key, value)` pairs have the same key, hence the reduce method is called only once

Figure 5: Numerical summarization structure



Use cases

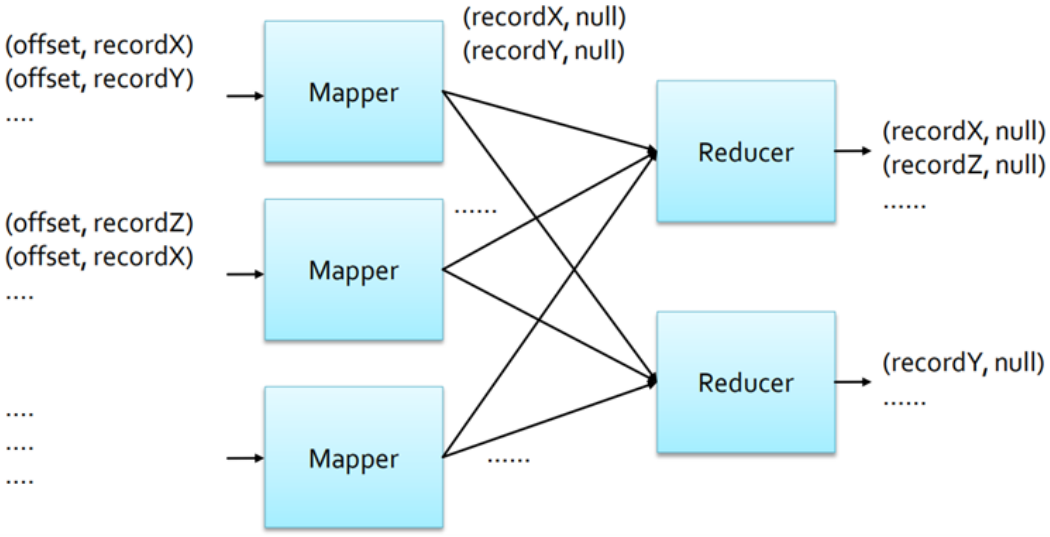
- Outlier analysis (based on a ranking function)
- Select interesting data (based on a ranking function)

Distinct

The goal is to find a unique set of values/records, since in some applications duplicate records are useless (actually duplicated records are frequently useless).

- Mappers emit one `(key, value)` pair for each input record
  - Key = input record
  - Value = null value
- Reducers emit one `(key, value)` pair for each input `(key, list of values)` pair
  - Key = input key, (i.e., input record)
  - Value = null value

Figure 6: Numerical summarization structure



Use cases

- Duplicate data removal
- Distinct value selection