

# M4: A Visualization-Oriented Time Series Data Aggregation

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## I. INTRODUCTION

Visualization of large scale time series data is a crucial need of modern exploratory bigdata analysis [1]. But the huge size of the data is a barrier to visualization [2], [3], [4]. To address this challenge of bigdata different data reduction and sampling strategies are used to overcome the barrier [5], [6]. But for preserving the semantics of trend line of time series data these sampling strategies show huge limitations [7].

In this review paper we present a review of the paper [7] which address this issue of preserving the semantic of time series data and present some related works in the line. The paper appeared in the Proceedings of the VLDB Endowment, 2014.

The authors present M4, an aggregation based time series data reduction strategy that guarantees error free visualization of time series data as line chart as well as higher rate of data reduction. The approach is generic to any visualization system as long as the visualization systems uses RDBMS as data source.

## II. CONTRIBUTIONS OF THE PAPER

The authors of the paper rewrite visualization queries  $Q$  using data reduction operator  $M_R$  such that the visualization of the original data from query  $Q$  and the visualization from the query  $Q_R = M_R(Q)$  are similar and error free. As

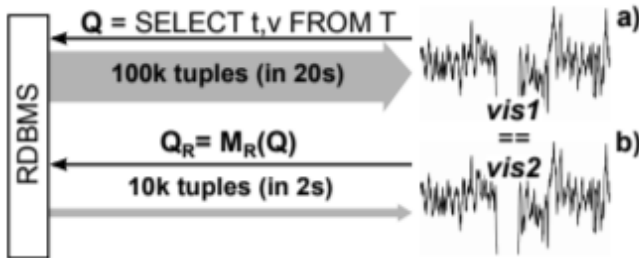


Figure 1. Time series visualization: a) based on original data; b) Using data reduction operator;

shown in Figure 2  $Q_R$  produced the same visualization as  $Q$  with almost 10 times less tuples and 10 times reduced time. The main contributions of the paper are following:

- Proposed a visualization driven query rewriting technique relying on relational operators and parameterized with width and height of the desired visualization
- Focusing on the detailed semantics of the line charts, they propose a visualization driven aggregation strategy that only select necessary points needed for visualization. For visualization, in every time interval which corresponds to a pixel column in the visualization they select four tuples. The starting tuple, ending tuple, max tuple and the min tuple.

### A. Query Rewriting

Most queries for time series visualization are of the form **SELECT time, value FROM SERIES WHERE time >  $t_1$  AND time <  $t_2$** . In addition to the query the visualization parameters like width and height are also passed for query rewriting. The rewritten query  $Q_R$  contains the following subqueries:

- 1) Original Query  $Q$
- 2) A cardinal query  $Q_C$  on  $Q$
- 3) a cardinality check (conditional execution)
- 4) to either use the result of  $Q$  directly or to execute an additional reduction  $Q_D$  on  $Q$ .

M4 system composes all those subqueries into single SQL query to avoid bandwidth consumption.

### B. M4 Aggregation

M4 is a value preserving aggregation strategy for time series data. It divides the entire time series dataset into  $w$  equal groups and thus each pixel column in the visualization takes only one group. For each group M4 select the aggregates  $\min(v)$ ,  $\max(v)$ ,  $\min(t)$ ,  $\max(t)$  and that is why it is called M4 aggregation and then it joins the aggregated data to the time series and add missing timestamps  $t_{bottom}, t_{top}$  and missing values  $v_{first}$ ,  $v_{last}$ . In Figure ?? an example M4 query and the corresponding visualization is shown.

### C. Time Series Data Reduction

## III. EVALUATION

## IV. RELATED WORKS

TODD

a) value-preserving M4 aggregation query

```
SELECT t,v FROM Q JOIN
(SELECT round($w*(t-$t1)/($t2-$t1)) as k, --define key
min(v) as v_min, max(v) as v_max, --get min,max
min(t) as t_min, max(t) as t_max --get 1st,last
FROM Q GROUP BY k) as QA --group by k
ON k = round($w*(t-$t1)/($t2-$t1)) --join on k
AND (v = v_min OR v = v_max OR --&(min|max|
t = t_min OR t = t_max) -- 1st|last)
```

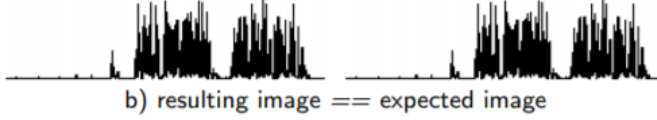


Figure 2. M4 query and visualization

## V. OUR PROPOSAL

TODO

## VI. CONCLUSION

The conclusion goes here. this is more of the conclusion

## REFERENCES

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