APRIORI: A Depth First Implementation

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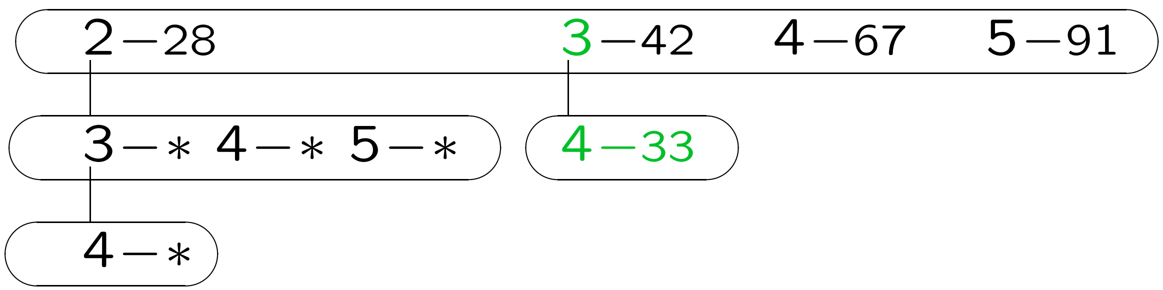
`http://www.liacs.nl/home/kosters/df/`

DF–2 **idea**

Given a dataset of transactions, the Depth First implementation $\mathcal{DF}$ of APRIORI (Pijls & Bioch 1999) builds a trie that contains all frequent itemsets.



For example, the itemset $\{3, 4\}$ has support 33, i.e., 33 transactions contain this itemset. Apparently, $\{4, 5\}$ is not frequent. A $*$ denotes "not known yet".
The right hand part of the trie has just been copied underneath bucket 2, providing the candidates for the next step.
Now every transaction is in a depth first way "pushed" through this subtrie, meanwhile updating the counters.

Suppose the frequent items $i_1, i_2, \ldots, i_n$ are sorted with respect to increasing support. Then $\mathcal{DF}$ proceeds as follows:

> *$T :=$ the trie including only bucket i_n;*
> **for** $m := n - 1$ **downto** *1* **do**
>   *$T' := T$;*
>   *$T := T'$ with i_m added to the left and*
>   *a copy of T' appended to i_m;*
>   *$S := T \backslash T'$ (= the subtrie rooted in i_m);*
>   *count(S, i_m);*
>   *delete the infrequent itemsets from S;*
> **procedure** *count(S, i_m) ::*
> **for** *every transaction t including item i_m* **do**
>   **for** *every itemset I in S* **do**
>   **if** *t supports I* **then** *I.support++;*

- The sorting requires some simple preprocessing.

- Counting is done "efficiently": once a bucket is not included in a transaction, the transaction does not go any deeper in the trie.

- The newest implementation (that combines and improves upon the two versions included in the FIMI'03 comparison) avoids unnecessary copying of buckets and deletions of subtries.

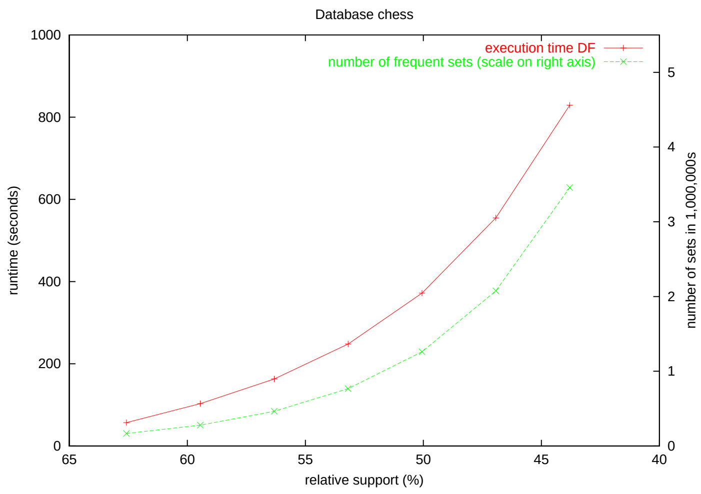
- Both the database and the trie reside in main memory.

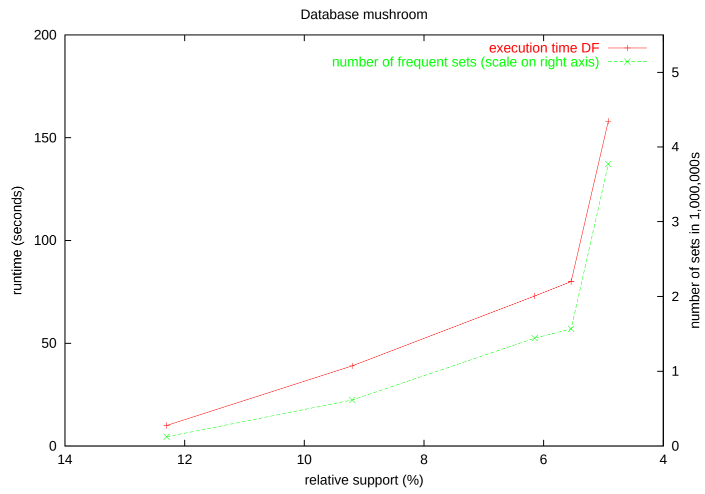
The number of database queries equals

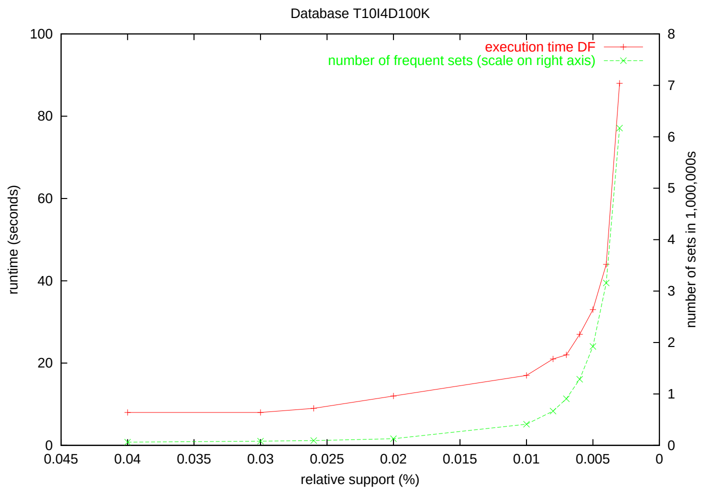
$$m(n-1) + \sum_{\substack{A \neq \emptyset \\ A \text{ frequent}}} \sum_{j=1}^{sm(A)-1} supp(\{j\} \cup A \setminus \{la(A)\}) \ ,$$

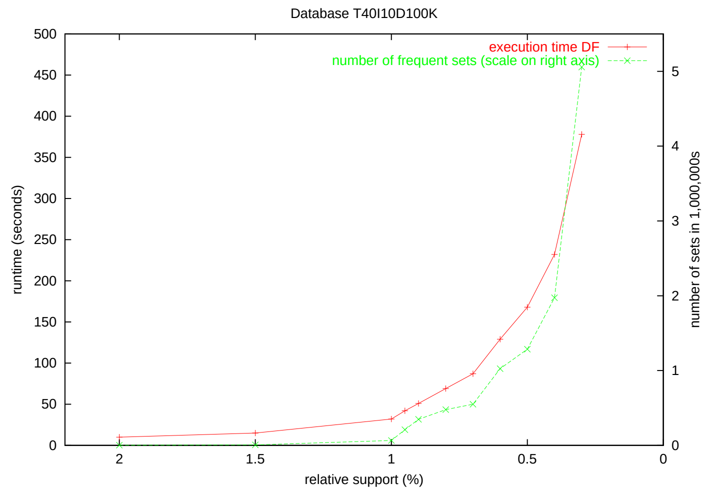
where m is the number of transactions, n is the number of frequent items, and for a non-empty itemset $A \subseteq \{1, 2, \ldots, n\}$ $sm(A)$ is its smallest number and $la(A)$ is its largest number.

The proof relies on the fact that in order for a bucket to occur in the trie the path to it (except for the root) should be frequent, and on the observation that this particular bucket is “questioned” every time a transaction follows this same path.


Database chess
execution time DF
number of frequent sets (scale on right axis)
runtime (seconds)
number of sets in 1,000,000s
relative support (%)


Database mushroom
execution time DF
number of frequent sets (scale on right axis)
runtime (seconds)
number of sets in 1,000,000s
relative support (%)


Database T10I4D100K
execution time DF
number of frequent sets (scale on right axis)
runtime (seconds)
number of sets in 1,000,000s
relative support (%)


Database T40I10D100K
execution time DF
number of frequent sets (scale on right axis)
runtime (seconds)
number of sets in 1,000,000s
relative support (%)

- The $\mathcal{DF}$ algorithm is simple and transparent.

- The $\mathcal{DF}$ algorithm performs well on sparse datasets (e.g., real transaction databases).

- Future research: reduce the number of database passes. This may be achieved by adding two or three subtries at a time in each iteration of the main loop.
  Also, an own dedicated memory management system might improve the runtime.