Application of input data characteristics to forecast computational time of a mathematical optimisation module to settle financial transactions

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Since 2015 the Target2Securities (T2S) platform allows investors across Europe to realise financial transactions [5]. In this context, a transaction is a transfer of financial resources: a certain quantity of a given security (for example, shares) and/or a certain amount of cash between security and/or cash accounts. Transaction is settled if there are enough resources on the corresponding accounts. Two financial features are applied to reduce the number of failed transactions: the partial settlement of eligible transactions and a credit mechanism. Some business situations generate additional constraints that must be taken into account in the settlement process. For example, the transfers of cross-border investors represent a set of linked transactions that must be settled together.

Mathematical Optimisation Module (MOM) is a component of the T2S platform [1]. Every weekday it is triggered several times in sequence during the night period. Each time it manages a batch of transactions of different financial nature and size that varies from several thousands to one million. It aims to settle as many transactions as possible from a given batch in a limited computational time maximising the total settled amount, respecting all business and resources constraints and taking advantage of the financial features mentioned above. Depending on a batch, MOM calls different series of multiple mathematical programming and heuristic algorithms [1, 6].

In [2] many characteristics were introduced to describe the structure of MOM input data. They are based on the representation of every transaction by cash and securities directed graphs where each arc starts at a node corresponding to a debiting account and ends at a node corresponding to a crediting account. Each cash/security graph's arc is weighted by the corresponding transaction's amount/quantity. The characteristics are inspired by a classical mathematical analysis of graph structures and include the size, node-degree, distance and connectivity related metrics [3, 7]. They give an understanding of MOM input data and allow observing the T2S clients' activity and any fluctuations from one business day to another.

In [2] it was shown that MOM algorithms are sensitive to batch's data structures. As a rule, MOM computational time correlates strongly and positively with such characteristics as the number of transactions, their concentration on one node in cash based graph and the number of strongly connected components in securities based graph. For some batches the high number of transactions debiting one cash account could result in increased computational efforts for the corresponding series of MOM algorithms, in particular, to solve the lack of cash.

This work presents a multi-variable regression approach using the graph-based characteristics of MOM input data to forecast its run time. It is a statistical method [4] that expresses a dependent variable (MOM run time) as a linear function of multiple independent variables (cash and securities graph-based characteristics) different for each batch of transactions.

The approach was tested on the training and test sets with 269 and 33 weekdays, respectively. For each weekday six batches of transactions were processed by MOM. Table 1 resumes the average production run time and its standard deviation for 33-day period. MOM starts with

Batch 1 composed mostly of cash only transfers. Its settlement process lasts a short time (around 29 sec.) in average, but varies from one day to another. Settlement of transactions from Batches 3 and 5 lasts longer than others as Batch 3 has the highest number of transactions to process. MOM run time varies highly for Batch 5 due to the partial settlement functionality of eligible transactions available only for this batch.

MOM run time (in sec.)	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Batch 6
Average	29	13	478	117	705	29
Standard deviation	99	3	78	46	289	5

TAB. 1: Average MOM production run time and its standard deviation over 33-day period in seconds for six batches of transactions of different financial nature.

Forecasting error	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Batch 6
Average in sec. (in %)	5 (20)	4 (26)	35 (7)	17 (14)	165 (17)	2 (8)

TAB. 2: Forecasting results for production data over 33-day period for six batches of transactions of different financial nature. Average error is calculated as an absolute in sec. or relative difference in % between the MOM forecasting and production run time (known a posteriori and presented in Table 1).

The forecasts have an average error between 7% (for Batch 3) and 26% (for Batch 2), Table 2. Since Batches 3 and 5 are of the largest sizes, forecasting of their run time is the most of interest, and the results obtained are good with the average errors 7% and 17% for Batches 3 and 5, respectively. To sum up, this work presents an approach that predicts the computational time of the transactions settlement engine of T2S platform based only on its input data before launching its optimisation algorithms. It could allow informing the MOM support team about an atypical business scenario, adjusting algorithms time and memory limits according to the scenario, and, finally, it helps to explain a posteriori unusual algorithms run time.

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