МАТЕМАТИКА И МАТЕМАТИЧЕСКО ОБРАЗОВАНИЕ, 2007
MATHEMATICS AND EDUCATION IN MATHEMATICS, 2007
*Proceedings of the Thirty Sixth Spring Conference of
the Union of Bulgarian Mathematicians
St. Konstantin & Elena resort, Varna, April 2–6, 2007*

# REDUSCING OF DATA SET OF EXTANT COINS IN GRAPH REPRESENTATION*

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In this paper we consider the possibility to reduce the data when we construct a graph of chronological distribution of a set of old coins. The study is based on the paper of Tabov and Hristova [1]. The analysis of the polygons constructed here shows that processing a smaller number of coins we get an enough precise polygon of chronological distribution. We process the data by MS Excel.

**1. Introduction.** Fomenko [3] introduces the so-called “volume function” which describes the chronological distribution of a set of ancient events. On the basis of this “volume function” are constructed chronological distributions of information drawn from different ancient sources as well as appropriate modifications of the “volume function” are applied depending on the object. Fomenko pays a great attention to the chronological distribution of information in historical texts [4]. Tabov [5] writes about this problem too, and offet other modifications of this function. The “volume function” is applied in constructing the chronological distributions of coins [1, 6, 7, 8] and [9], ancient manuscripts [10] and museum exhibits [11].

Coins finding give us valuable information about the economic development of the country in which the coins are emitted. This is the reason we to be interested in the character of these coins find out. We construct variations of the “volume function” which are suitable for the case of coins find out and after that we obtain their polygons. So that, we obtain visual pictures of the chronological distributions of these coin finds. On the basis of these pictures we can draw our conclusions about the history of the countries.

But the number of researched coins is usually quite large. That is why we take up the following problem – can we reduce the processed data? Our researches are based on the study on extant Roman bronze coins published in [1]. The cited study uses information drawn from the catalogue of David Sear [2]. As a result of the present study we get the following: the polygon constructed on the basis of a part of the data is much the same as the polygon constructed in the above mentioned study.

**2. Method of study.** We have a set of ancient events and we want to obtain their graph representation. We realize it in the following way:

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*The author is very grateful to Mr Tabov for his contribution to this study.
**2000 Mathematics Subject Classification:** 91F10
**Key words:** extant Roman bronze coins, chronological distribution, polygon

For each event $i$ we construct its characteristic function – $f_i(t) = 1$, $t_{i1} \le t \le t_{i2}$; $f_i(t) = 0$, $t < t_{i1}$ or $t > t_{i2}$. Here $t_{i1}$ and $t_{i2}$ are the beginning and the end of the interval of time during which the event $i$ happened. After summing up all these functions we obtain the volume function: $f(t) = \Sigma f_i(t)$. Now we can construct the polygon of the obtained volume function. This polygon represent the chronological distribution of the considered set of ancient events.

In [1] an approximate comparative estimate of the quantities of extant Roman "bronze" coins (saying "bronze" we mean any coins other than gold and silver ones) is made and the polygon of chronological distribution of these coins is constructed. The research is based on the information published in [2]. In this catalogue about 4330 different coins, dated to the period 269 B.C. – 518 A.D., are represented together with their numismatic values (prices). 2465 of them are "bronze" coins and we consider only these ones.

The above mentioned term "comparative estimate" means that we are not interested in the exact number of coins but in their relations or, in other words, the amount for each period is rounded off to one general coefficient of proportionality. Thus, on the basis of the polygon which we build, we can compare the amounts of extant coins for each two periods of time.

In our researches we use the following modification of the Principle of Information Preservation:

*It is highly probable that from periods of time during which more coins were emitted, there are more coins coming to us as well.* (We suppose that the compared periods of time are near to each other and have equal lengths.)

We need the approximate relative number of coins of each particular kind. In determining this number we use indirect information – the market price of the coins. We assume that the main factor in determining the price of a coin is the number of coins found that are the same as this one. In other words, the more bigger the number of the extant coins of a certain kind is, the more lower the price of each of these coins is. Furthermore, we have a reason to suppose that the price and the number of coins are in inverse proportion.

We process the data by MS Excel. We generate a table which consists of 2465 rows corresponding to the number of bronze coins in [2] and 154 columns, each one corresponding to 5 years of the period covering the dates of the coins (269 B.C. – 498 A.D.). The first column corresponds to the period 270 B.C. – 266 B.C., the second – to the period 265 B.C. – 261 B.C. , ... and the last – to the period 495 A.D. – 500 A.D. To each coin corresponds a certain row in the table. In this row, in the cells which are in the columns including the period of emitting the coin, we enter the result from the division of the price of the coin to the number of these cells. For instance, if the coin is emitted during the period 247 – 264, then in its row, in the cells which are placed in the columns corresponding to the periods 246 – 250, 251 – 255, 256 – 260 and 261 – 265 (in this case 4 cells in total), we write the value of $x/4$ where $x$ is the price of the coin in [2]. In the rest cells of the row we write 0. We do this for all bronze coins.

We transform this table using the function $f(x) = k/x$ where $x$ is the price of the coin in [2], and $k$ is a constant which we choose in a suitable way. Since the value of the most expensive bronze coin is 4 000, we choose for $k$ the number 100 000. In the table we replace $x$ by $f(x)$ and for each column we sum up the values and write the result under this column. Finally, we obtain a row which presents the values of the volume function for these coins.

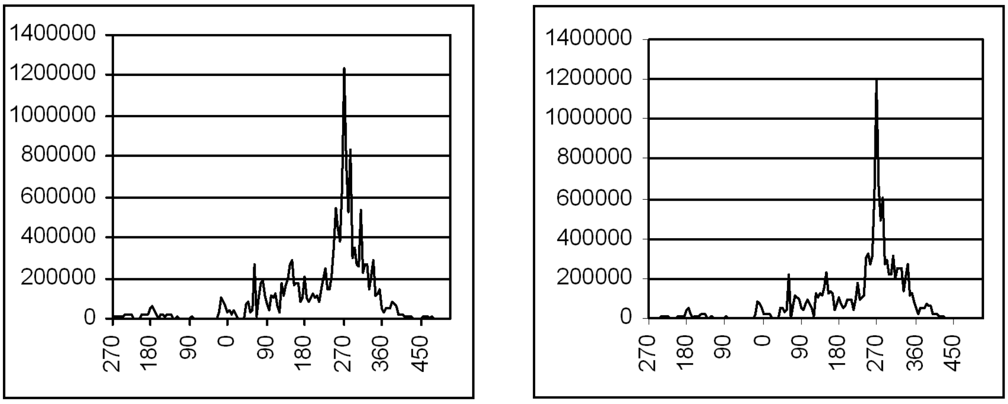


Figure 1. The polygons of chronological distributions of extant Roman bronze coins: on the left – for all bronze coins; on the right – for those ones whose prices are lower than 18

After that we construct (by MS Excel) the polygon of chronological distribution of extant Roman bronze coins. It is shown in Fig. 1. Here, the $x$-axis is the time-axis and the $y$-axis is the axis of the relative number of bronze coins.

Let us once again emphasize the fact that by the means of this method we cannot count the coins; we obtain only a rough picture of the distribution over time of the studied coins, i.e. taking into account the maxima and minima, the periods of increasing and decreasing we can make comparisons between the different periods.

In the same paper we smooth the polygon, i.e. we we obtain a polygon where the small fluctuations are removed and the main alterations are approximately the same. This polygon is used to draw conclusions about the dynamics of the currency in Roman Empire.

Now, we go on to the present problem. The bronze coins with lower prices (their number is much greater than those of the expensive bronze coins) have the main contribution to the function of chronological distribution constructed in [1]. So that, we eliminate coins from the generated in [1] table gradually, beginning with the most expensive ones, we subtract one tenth of the difference between the highest and the lowest prices of bronze coins in the catalogue (4000 and 3, respectively) from the highest price and construct the polygon of chronological distribution of the coins with prices not higher than the result of these operations. We compare this polygon with the polygon of chronological distribution of all bronze coins in the catalogue. If the two polygons are identical, then we eliminate the next portion of coins. This process continues until the moment when significant differences between the constructed polygon and the first one (for all bronze coins) appear and we take a look at the last polygon constructed before this moment. There is a close resemblance between this polygon and the first one, i.e. the differences are negligible. This polygon is constructed on the basis of the coins with prices lower than 18. These coins are 1079 in number, and the total number of bronze coins in the catalogue is 2465, i.e. the coins with prices lower than 18 are about 44% (as a percentage of all bronze coins). In Fig. 1 two polygons are represented – the polygon describing all bronze coins and that one describing the bronze coins with prices lower than 18.

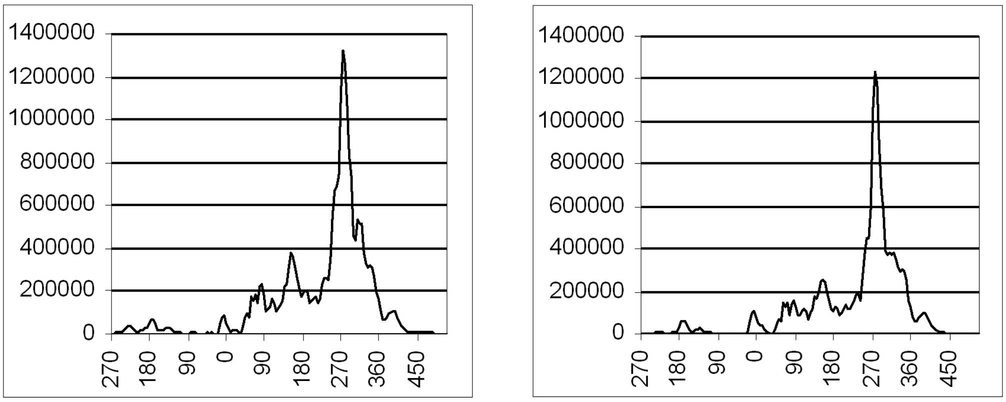


Figure 2. The smooth polygons of chronological distributions of extant Roman bronze coins: on the left for all coins; on the right – for those ones whose prices are lower than 18

We "smooth" the new polygon (presented in Fig. 1) and obtain a more clear shape of this one. It is done using the method of moving averages with lag 2:

Under the total row written under the table we make two more copies of it and then we move the first new row one cell to the right and the second – two cells to the right. In the obtained three-row table for each column we sum up the three numbers in it, divide the sum by 2 and enter the result just under it. The result is a new row, the numbers in which are the values of the smooth function of chronological distribution of the considered bronze coins. The smooth polygons are represented in Fig. 2.

**3. Analysis of the results.** The two graphs in Fig. 2 are pretty much alike. From this fact it follows that using only the bronze coins with prices lower than 18, we can draw conclusions which are the same as the conclusions about all bronze coins. Furthermore, this new polygon shows more clear the periods when there almost is not bronze coinage.

On the basis of these results we suppose the following:

*When we construct the polygon of chronological distribution of a set of coins, then it is enough to process only 50% of these coins. This polygon is much the same as the polygon constructed for all coins (i.e. it does not reflect on our conclusions).*

Further, statistical test of comparison will be applied to prove this hypothesis.

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## РЕДУЦИРАНЕ НА МНОЖЕСТВОТО ОТ СЪХРАНИЛИ СЕ МОНЕТИ ПРИ ГРАФИЧНО ПРЕДСТАВЯНЕ

**Свилена Й. Христова**

В тази статия разглеждам възможността да се намали броят на данните, когато конструираме графика на хронологично разпределение на някакво множество от стари монети. Изследването е базирано на статията на Табов и Христова [1]. Анализът на конструираните тук полигони показва, че обработвайки по-малко монети, получаваме достатъчно прецизен полигон на хронологично разпределение. Данните обработвам с помощта на MS Excel.