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RECOGNITION OF DEPENDENCES AND STRATIFIED STRUCTURES IN NARRATIVE TEXTS

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1. A number of empirical statistical methods for the detection of dependent historical texts were proposed by the author in [1-4]. Some of these ideas were further developed by Fedorov, Fomenko, and Shiganov [5]. New results in this direction were recently obtained by Kalashnikov, Rachev, Fomenko, and Rives [6]. The present paper consists of two parts. In Part I we briefly present the results obtained jointly with S. T. Rachev, which in particular develop an idea of V. M. Zolotarev. Part II presents tables of code questionnaires developed by the author following the procedure of [1, 4].

I. TEXT VOLUME FUNCTIONS, THE PRINCIPLE OF RESPECT OF INFORMATION, AND THE PRINCIPLE OF AMPLITUDE CORRELATION OF TEXT VOLUME GRAPHS

2. Following [1], two historical texts are called dependent if they describe approximately the same events over the same time interval (A, B) in the history of the same region, have a common origin, or go back to the same source. It is useful to identify texts that are a priori known to be dependent or independent, namely texts whose dependence or independence can be reliably established by various methods. We use the concepts introduced in [1-4, 6]. We assume that the text X describes events over the time interval (A, B) and the parameter t runs over the years from A to B, X(t) is the part of the text X describing the events of the year t. By $\text{vol } X(t) = f(t)$ we denote the volume, or size of the fragment ("chapter") X(t), measured in lines (or pages) say. The specific unit of volume measurement is immaterial, because we anyhow resort to normalization. We call f(t) the volume function of a historical text. The maximum correlation principle was formulated and experimentally tested in [1]: the splash points of the volume graphs of two dependent texts are correlated (close) when the corresponding periods are superimposed on one another. For independent texts, the splash points are not correlated (when the corresponding time intervals are overlapped). The general idea of correlation of the parameters of volume functions of dependent texts was extended by Kalashnikov, Rachev and Fomenko [6] to entire volume functions, i.e., allowing for the splash amplitudes. The comparison algorithms proposed in [6] proved to be sufficiently effective for the comparison of texts having roughly the same volume (density). But the picture became

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"fuzzy" when we attempted to compare texts having essentially different volume. Analyzing the source of the difficulties, Rachev and the present author proposed a new technique which compares rich and poor texts (i.e., texts of different volume) proceeding from somewhat different considerations. This technique, in particular, develops an interesting idea of V. M. Zolotarev, who suggested to associate to each historical text a function (from some appropriate family) approximating the qualitative behavior of the volume graphs.

3. Let us briefly describe the method of Rachev and Fomenko. The concept of primary sources of information $C(t)$ about the events of the epoch (A, B) was introduced in [1-3]. Here $C(t)$ is the volume of all the text written by contemporaries about the events of the year t . A chronicler X who lives in the year $T = T(X)$, where $X > B$, is not a contemporary of the epoch (A, B) and in his description of the events in that epoch he will have to rely on the residual sources of information $C_T(t)$, i.e., on the volume of surviving texts that reached the time T from the initial sources $C(t)$ (Fig. 1).

In each text, we can isolate the rich and the poor zones. A text is poor if most $\text{vol } X(t)$ are zero, i.e., most of the years in the epoch (A, B) are not described by the chronicler. If there is a sufficient number of nonzero $\text{vol } X(t)$ and the amplitudes are sufficiently large (plenty of information), then the text is rich. It is now clear how to identify the rich and the poor zones of a particular text or of the residual sources of information $C_T(t)$ (Fig. 2). Our method is based on the idea that the chronicler X writing about the past treats differently the poor and the rich zones of the residual sources of information about the relevant epoch (A, B) . We can formulate the Principle of respect of information: the respect of information by the chronicler is inversely proportional to its volume.

Let us elucidate this principle. Assume that little information has survived about a particular year, and that nothing is known to the chronicler about the adjacent years on both sides (a poor zone of the residual sources of information). Under these conditions, the chronicler will greatly value the rare surviving information. Despite his personal attitude to this information, the chronicler ("on average") is obliged to transcribe it accurately, with

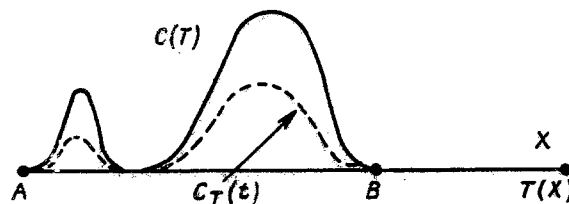


Fig. 1

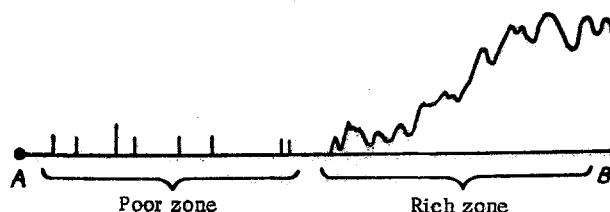


Fig. 2

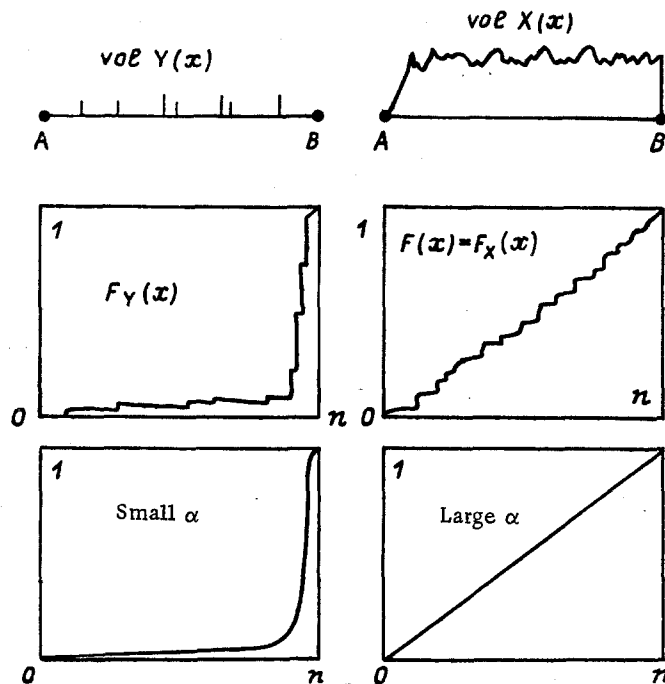


Fig. 3

maximum care and integrity (each word is valuable). In a poor zone of the residual sources, the chronicler "has nothing to choose from." The situation is markedly different when the chronicler is inside a rich zone of the residual sources. Here he faces the tough problem of selection of information (because of space limitations of his chronicle). He selects only the data that in his opinion provide a best characterization of the epoch being described. The greater the volume of surviving information, the less valuable (on average) are its separate fragments to the chronicler. Here subjective factors, such as the personal sympathies of the chronicler, begin playing an important part.

4. The model described in Sec. 3 requires experimental verification. We will now list the experimentally testable conclusions of this model. Assume that two chroniclers X and Y describe the same epoch (A, B). They rely approximately on the same residual sources of information. Each of them "copies" fairly accurately the amplitudes of the volume graph in the poor zone of the residual sources (see Sec. 3). Therefore, the volume functions of the chronicles of X and Y are fairly close (in terms of their amplitudes) inside the poor zones. Inside a rich zone, this amplitude correlation may break down.

5. Define the coordinate $x = t - A$ in the interval (A, B). Denote by $\bar{F}(x) = \sum_{s=1}^x f(s)$ the so-called accumulated sum (for the text X) [6]. Now consider the normalized accumulated sum

$F(x) = \bar{F}(x) / \text{vol } X$, where $\text{vol } X$ is the total volume of the text X. Take $g(x) = 1 - F(x)$. We can use the Weibull-Gnedenko distribution to describe our model (hypothesis). Our hypothesis claims that the function $1 - F(x)$ should behave (at least in the initial, poor zone of the text) as the function $\exp(-\lambda x^\alpha)$. Given two degrees of freedom, namely the parameters α and λ , we can try to fit the function $1 - F(x)$. If we manage to do this for real texts, then the result will support our model. A numerical experiment has shown that the decay of

$1 - F(x)$ is indeed closely approximated by the function $\exp(-\lambda x^\alpha)$ with appropriately chosen α and λ (see Table 1 below). Thus, to each particular text we can associate two numbers α and λ representing its volume function and the features of the historical period described in that text. We call α the shape parameter and λ the volume (or scale) parameter. The parameter α , as we shall see, is particularly important, since it provides an indication of dependence or independence of texts. The parameter λ "senses" to what extent the text is rich or poor. We will represent the pair of numbers (α, λ) by a point in the Euclidean plane with the Cartesian coordinates α and λ .

6. Hypothesis of the Increase of α over Time. Consider two different historical epochs: an epoch with poor residual sources of information and an epoch with rich residual sources. In the second case, we assume that the sources of information are roughly constant for each year (Fig. 3). In the first case, the accumulated sum increases very slowly. In the second case, the accumulated sum is close to a linear function. It is easy to see that if we fit the curves $1 - F(x)$ by the function $\exp(-\lambda x^\alpha)$, then the value of α in the second case is greater than the value of α in the first case. Thus, poor primary (residual) sources are characterized by small values of α , while rich sources are characterized by large values of α . Since the preservation of primary sources of information progressively improves over time, the value of α should increase "on average" as the epoch (A, B) is shifted from left to right (closer to the present).

7. The List of Historical Texts Analyzed. 1) Tale of Bygone Years (known in English as Russian Primary Chronicle) [12] (a rich text) 850-1110 A.D. 2) Nikoforovskaya chronicle [14] (a poor text) 850-1450 A.D. 3) Suprasl'skaya chronicle [14] (a poor text) 850-1450 A.D. 4) Akademicheskaya chronicle [14] (partly poor, partly rich) 1338-1378 A.D. 5) Kholmogorskaya chronicle [13] (contains poor and rich zones) 850-1560 A.D. 6) Dvinskaya chronicle [13] (contains poor and rich zones) 1390-1750 A.D. 7) Livy. History of Rome [17] (starts with a poor zone, followed by a rich zone) 753-240 B.C. 8) V. S. Sergeev, Essays in the History of Ancient Rome in the Middle Ages [18] (starts with a poor zone, followed by a rich zone) 300-1700 A.D.

This list includes three pairs of texts that are known to be dependent: Nikoforovskaya and Suprasl'skaya chronicles, Livy and Sergeev, Tale of Bygone Years and Nikoforovskaya (and hence also Suprasl'skaya) chronicle. Pairs of a priori independent texts can be defined as follows: the part of the Dvinskaya chronicle describing the 14th century A. D. and its part describing the 15th century A.D.; Sergeev's text and "inverted Sergeev," obtained by reversing the sequence (numbering) of chapters and dates. For other examples of independent texts, see below.

8. These texts were split into fragments describing a hundred (sometimes two hundred) years each. For each fragment we calculated the parameters α_x and λ_x , and also the correlation coefficient r_x , which indicates the goodness of fit of the estimated function $\exp(-\lambda x^\alpha)$ to the decaying curve $1 - F(x)$, where $F(x)$ is the accumulated sum of the text X. The parameters α_x and λ_x were estimated by linear (mean square) regression $y = \lambda + t\alpha$, where $y = \ln(-\ln g(x))$, $t = \ln x$ and x takes the values 1, 2, ..., with each step representing two years. The pairs (α_x, λ_x) were plotted as points on a plane (Fig. 4). The vertical axis is a variable scale. The corresponding text X is indicated next to each point (α_x, λ_x) . The

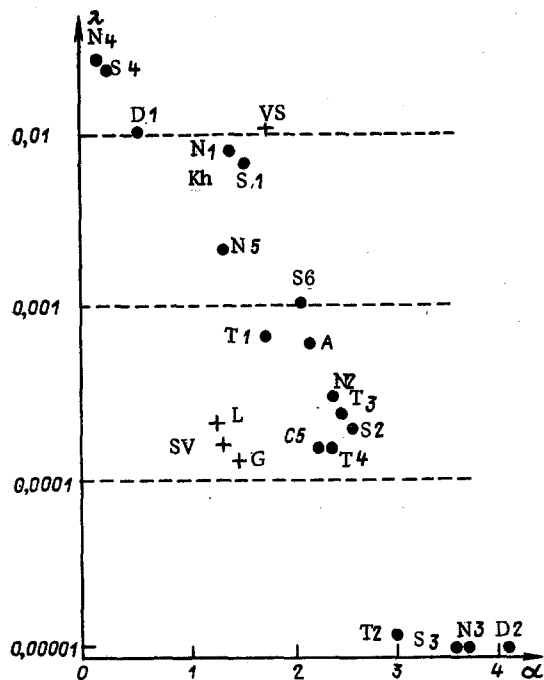


Fig. 4

four crosses represent Roman history texts. From Table 1 we see that in most cases the coefficient r_x is close to 1, which is an indication of close correlation. We have thus detected an interesting regularity: the volume function of historical texts may be modeled by the Weibull-Gnedenko distribution (possibly, this distribution is not unique).

9. Comparison of Dependent Texts. We see from Table 1 and Fig. 4 that all pairs of texts that are known to be dependent and have approximately the same volume "fall next to each other" in the plane (α, λ) .

Let us compare two dependent texts, one of which is poor and the other rich: Nikoforovskaya chronicle and the Tale of Bygone Years. The point T1 (854-950) appears to be fairly far from the points N1 and S1, which virtually coincide (Nikoforovskaya and Suprasl'skaya 854-950). However, the important factors for us are the shape parameter α (and the scale parameter λ). Comparing these parameters for T1 and N1, S1, we see that all the three values are indeed very close. The values of λ differ because we are comparing a poor text with a rich text. The points T3, N2, S2 virtually coincide. The points T4, N2, S2 are also close to each other. Thus, the dependence of T, N, S is borne out in this case also, and the slight change of the time interval (960-1060 and 998-1098) has a small effect on the dependence of the texts (see Table 1). The point T2 (918-1018) has shifted slightly to the right and down relative to the close triple T3, N2, S2. Thus, the parameters α and λ have been "correctly estimated" in the sense that they react to changes in the time interval and correctly separate the points (α, λ) , corresponding to independent texts. Yet this separation is small, since the time interval is not much different. We omit the analysis of the other dependent pairs, but see Table 1 and Fig. 4.

10. Comparison of Independent Texts. Omitting the details, we only note that the a priori independent texts are represented by widely separated points.

TABLE 1. Results of a Numerical Experiment

Symbol	Chronicle (text)	Time interval described	α	λ	r
T1	Tale of Bygone Years	854—950 A.D.	1,847	$3.9 \cdot 10^{-3}$	0,953
T2	Tale of Bygone Years	918—1018	3,003	$1.6 \cdot 10^{-5}$	0,955
T3	Tale of Bygone Years	960—1060	2,497	$4 \cdot 10^{-4}$	0,956
T4	Tale of Bygone Years	998—1098	2,378	$1.3 \cdot 10^{-4}$	0,954
N1	Nikoforovskaya	854—950	1,511	$9.3 \cdot 10^{-3}$	0,966
N2	Nikoforovskaya	960—1060	2,406	$5 \cdot 10^{-4}$	0,917
N3	Nikoforovskaya	1110—1310	3,685	$7 \cdot 10^{-9}$	0,660
N4	Nikoforovskaya	1236—1340	0,341	0,488	0,768
N5	Nikoforovskaya	1330—1432	1,390	$3.9 \cdot 10^{-3}$	0,953
S1	Suprasl'skaya	854—950	1,604	$8.2 \cdot 10^{-3}$	0,969
S2	Suprasl'skaya	960—1060	2,584	$3 \cdot 10^{-4}$	0,943
S3	Suprasl'skaya	1110—1310	3,617	$7.8 \cdot 10^{-3}$	0,656
S4	Suprasl'skaya	1236—1340	0,405	0,384	0,808
S5	Suprasl'skaya	1330—1432	2,354	$1.6 \cdot 10^{-4}$	0,983
S6	Suprasl'skaya	1336—1374	2,089	$1.3 \cdot 10^{-3}$	0,977
A	Akademicheskaya	1336—1374	2,185	$8 \cdot 10^{-4}$	0,960
D1	Dvinskaya	1396—1498	0,648	0,119	0,844
D2	Dvinskaya	1500—1600	4,060	$2.2 \cdot 10^{-7}$	0,875
Kh	Khologorskaya	852—946	1,311	$7.3 \cdot 10^{-3}$	0,960
L	Livy	750—510 B.C.	1,289	$3.7 \cdot 10^{-3}$	0,979
SV	Sergeev	750—510	1,358	$2.3 \cdot 10^{-3}$	0,980
VS	Inverted Sergeev	510—750	1,900	0,01	0,961
G	Gregorovius	300—540 A.D.	1,505	$1.282 \cdot 10^{-3}$	0,979

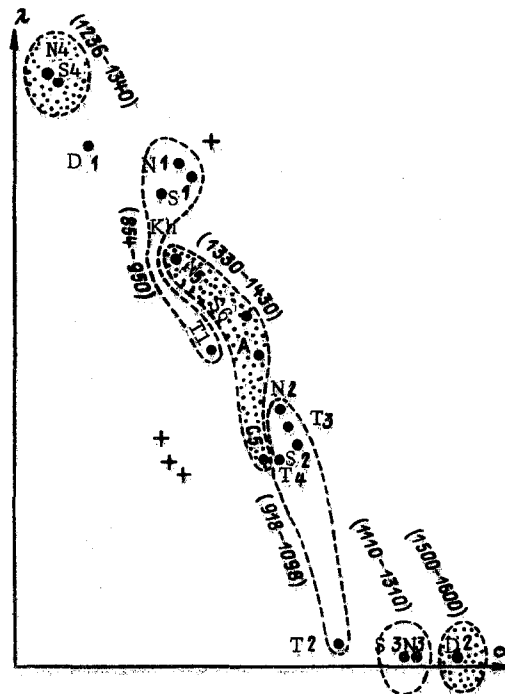


Fig. 5

11. Increase of α over Time for Groups of Texts. Let us consider groups of texts corresponding roughly to the same period (50 or 100 years, say). First let us consider only reliably dated texts, starting around 1200 A.D. Figure 5 reproduces the points of Fig. 4 grouped by time period.

The group (1236—1340) includes two texts, N4 and S4. The group (1330—1430) includes four texts, N5, S6, A, S5. The group (1500—1600) consists of one text, D2. We clearly see from Fig. 5 that each successive group lies to the right of its predecessor, which corresponds to increase of α over time. The only exception is the text D1 (1396—1498), which lies next to the group (1236—1340).

Let us now consider the chronicles describing the events of 9th to 13th centuries. They are also combined into groups describing close periods. The group (854-950) includes four texts, N1, Kh, S1, T1. The group (918-1098) includes five texts, N2, S2, T2, T3, T4. The group (1110-1310) includes two texts, S3, N3. We see from Fig. 5 that each successive group lies to the right of its predecessor, i.e., α again increases over time. Thus, the parameter α on average increases monotonically both within the texts of 9th-13th century and within the texts of 13th-16th century. On the other hand, the group (918-1098) lies next to the group (1330-1430) (see Fig. 5). The group (854-950) is located between the groups (1236-1340) and (1330-1430). Finally, the group (1110-1310) lies next to the group (1500-1600). It thus appears that the character of the residual sources for the period 9th-13th century is close (from the point of view of the parameters α and λ) to the character of the residual sources for the period 13th-16th century. This effect requires further analysis.

12. We see from Fig. 4 that the point G (Gregorovius [18]), corresponding to 300-540 A.D., virtually coincides with the two points L and SV (Livy and Sergeev, respectively) corresponding to 750-510 B.C.

Summarizing our findings, we can state the following hypothesis: each 100-year or 200-year historical epoch (more precisely, its residual sources of information) is characterized by "its own" values of the parameter α (and possibly in part λ). Different chroniclers describing the same epoch in the past apparently rely roughly on the same residual sources, which leads to close values of α and λ for these chroniclers.

13. The proposed method was applied to a number of texts for which the maximum correlation principle had indicated possible dependence in [1-4]. The volume functions of the "biographies" of the Holy Roman emperors of the German Nation in 10th-13th century were calculated in [4]. A "biography" is the part of the text describing the rule of the particular emperor. If the beginning of the corresponding period was not dated exactly in the text, then a mention of the ruler's name in connection with the events of a certain epoch was used as the "beginning of the biography." We analyzed the books of Kohlrausch [19] and Fedorova [20] describing the period 919-1300 A.D. The volume curves of these dependent texts were found to be closely correlated in terms of the amplitude correlation principles:

$$\lambda = 1,455 \cdot 10^{-3}, \quad \alpha = 1,457, \quad r = 0,930 \quad \text{for Kohlrausch}$$

$$\lambda = 1,165 \cdot 10^{-3}, \quad \alpha = 1,497, \quad r = 0,922 \quad \text{for Fedorova.}$$

With these curves we also compared the volume functions of the "biographies" of the Judean kings of 8th-6th century B. C. Here $\lambda = 1.807 \cdot 10^{-3}$, $\alpha = 1.355$, $r = 0.960$ (from Bible). The closeness of the three values of α (and the high correlation r) point to a degree of dependence of these "biographies" which is close to that of a priori dependent texts. The difference in λ (the scale parameter) is suggestive of volume differences. We then compared (in the process of construction of the global chronological chart GCC, see [1-4]) the volume functions of F. Gregorovius' The History of the City of Athens in the Middle Ages (1254-1350 A.D.) and of Herodotus' History (560-464 B.C.). We calculated the volumes of the "biographies" of Croesus, Cyrus I, Cambyses, Darius I, Xerxes (from Herodotus) and, respectively, of Manfred,

TABLE 2. Code Questionnaires (abridged version)

- 1) Lucius Sulla 82-78 or 83-78 (5) or (4). Name Lucius. Official title Restitutor Urbis - Restorer of the City. Unique title in the Second Empire. Received the title of emperor from his troops. Gained power following a long and bloody civil war. Elected dictator by the Senate. Actually founded the empire after anarchy [32, Vol. 2, pp. 137-138], [33, p. 197].
- 2) Unrest 78-77 (1). Civil war after the death of Sulla. Two brilliant generals are nominated: Junius Brutus and Marcus Aemilius Lepidus. Their troops are defeated [33, pp. 207-208].
- 3) Sertorius 78-72 (6). Gains power after unrest, murdered in a conspiracy [33, pp. 208-209].
- 4) Heavy unrest 72-71 (2): the uprising of Spartacus. Pompey (Pompeius) and Crassus are the leading generals in these years [33, p. 215].
- 5) Gnaeus Pompeius Magnus Triumphator 70-49 (21), the initiator of the 1st Triumvirate, one of the greatest Roman rulers. Deified in his lifetime [16, Vol. 1, p. 279]. His rule is known as the Pompeian Principate [16, Vol. 1, Chap. 11]. Instituted major democratic reforms of the judicial and military system [33, p. 277]. In 49 B.C., Pompey was stripped of his powers by the Senate [16, Vol. 1, p. 329]. Title: emperor [32, Vol. 2, p. 338], [35, p. 91, No. 34].
- 6) Joint rule of Pompey and Julius Caesar 60-49 (11). The 1st Triumvirate: Pompey, Caesar, Crassus [33, p. 227]. Pompey first reaches an agreement with Crassus, later forms a coalition with Caesar. Caesar is less popular than Pompey but more than Crassus [33, pp. 226-228]. (Galerius in the right column - a secondary role).
- 7) Unrest 49-45 (4) [33, pp. 244-247]. Covers the entire rule of Caesar and the 2nd Triumvirate. Followed by the promotion of Augustus.
- 8) Julius Caesar 45-44 (1), the winner of the 1st Triumvirate. Adopts and promotes the 19-year-old Octavian, destined to become the famous Augustus, a demigod. Emperor [35, p. 184, No. 137].
- 9) Triumvirs, with one of them (Octavian Augustus) gaining an increasing role 44-27 (17), unrest. After the death of Caesar, Octavian supported by the troops (with which he was very popular) lays claim to the throne and is proclaimed emperor. The 2nd Triumvirate is formed with the participation of Octavian [16, Vol. 1, pp. 346, 351-352].
- 10) Gaius Julius Caesar Octavian Augustus, the winner of the 2nd Triumvirate 27 (or 23) B.C.-14 A.D. (41). In a naval battle in Actium finally defeats his last opponent - Antony. This ends the period of civil wars (at the beginning of the Second Empire) [33, p. 259]. One of the greatest Roman emperors. The defeated Antony was initially a friend and a co-ruler. Before the beginning of his rule, Octavian served with the troops in the East. Proclaimed "Holy" [36, p. 339]. Augustus marks the beginning of a new stage in imperial history [36, p. 339]. Prominent legislative activity by Augustus [16, Vol. 2, p. 408]. Initially, without a permanent residence. After the end of the war, based in Rome, transforming it into a major center [16, Vol. 2, p. 408]. Rome is transformed from timber and brick into a marble city, 82 temples are built and restored. Jesus Christ is born in the 27th year of Octavian (1st A.D.). Parallelism with Basil the Great, see [8].
- 11) Tiberius 14-37 (23). After the death of Augustus, who did not leave a natural heir, Tiberius and Germanicus fight for succession. Tiberius was the stepson of Augustus [16, Vol. 2, p. 412]. Strangled under blankets [16, Vol. 2, p. 423].
- 1) Lucius Aurelianus 270-275 (5). Name Lucius. Official title Resitutor Orbis - Restorer of the World, the State. Unique title in the Third Empire. Proclaimed Roman emperor by the troops. Gained power following a bloody war with the Goths (the famous civil war in Italy in the 3rd century A.D.). Confirmed by the Senate. Restored the Empire after anarchy [33, 34].
- 2) Unrest 275-276 (1). A rebellion after the death of Aurelianus (his successor Tacitus is killed). Two emperors are nominated: Florian and Probus. Florian's troops are defeated [33, pp. 446-447].
- 3) Probus 276-282 (6). Gains power after unrest, later murdered in a soldiers' rebellion [33, p. 413].
- 4) Heavy unrest 282-284 (2). Aurelius Carinus and Numerian are the leading generals of this period [33, pp. 647-648].
- 5) Diocletian the God 284-305 (21), one of the greatest Roman rulers. "Deified" in his lifetime [33, pp. 422-424]. The beginning of a new epoch - the Dominate [33, p. 413]. Institutes major democratic reforms (fiscal, legal, military) [16, Vol. 2, p. 649]. Abdicates [33, p. 424]. Title: Emperor of Rome. The first rulers in left column are also emperors (see Plutarch, the inscriptions on coins).
- 6) Joint rule of Diocletian and Constantius I Chlorus 293-305 (12). The 1st Tetrarchy: Diocletian, Constantius Chlorus, Maximinus, Galerius. Diocletian first reached an agreement with Maximinus, then added Constantius Chlorus and Galerius to the coalition [33, p. 420]. Chlorus is less popular than Diocletian but more than Maximinus.
- 7) Unrest 305-309 (4) [16, Vol. 2]. Covers the entire rule of Constantius Chlorus and the 2nd Tetrarchy. Followed by the accession of Constantine I.
- 8) Constantius I Chlorus 305-306 (1), the winner of the 1st Tetrarchy. Crowns his 20-year-old son Constantine, later the famous Augustus, a god and a saint, Emperor of Rome.
- 9) Tetrarchs, with one of them (Constantine Augustus) gaining increasing influence 306-324 (18), unrest. After the death of Constantius Chlorus, the troops proclaim Constantine Caesar in the West (he was particularly popular with the troops). Then the 2nd Tetrarchy is formed with the participation of Constantine [33, pp. 249-258], [16, Vol. 1, pp. 424-425].
- 10) Gaius Flavius Valerius Constantine Augustus, the winner of the 2nd Tetrarchy 306-337 (31). In a naval battle in Adrianople finally defeats his last opponent - Licinius. This ends the period of civil wars (at the beginning of the Third Empire) [33, p. 429]. One of the greatest Roman emperors. The defeated Licinius was initially a friend and a co-ruler. Before the beginning of his rule, Constantine I served with the troops in the East. Proclaimed the son of the Sun god. The church declared his a saint and the equal of the apostles [16, Vol. 2, p. 674]. Constantine marks the beginning of a new "holy" stage (with Christianity allegedly receiving state support). Famous legislative activity of Constantine [16, Vol. 2, p. 669]. Initially, without a permanent residence. Then moves the capital from Rome to New Rome - Constantinople [33, p. 436]. The city is finished in marble, a special administrative division is introduced, similar to the structure of Rome in Italy. Basil the Great, a famous saint, is born in the 27th year of Constantine's rule (333).
- 11) Constantius II 337-361 (24). After the death of Constantine, the empire is divided between his three sons and two nephews, who fight for power. Constantius II kills the families of Constantine's two stepbrothers [33, p. 438]. Constantius II was the son of Constantine I. "Died unexpectedly..." [33, pp. 440].

12) Struggle between Tiberius and Germanicus. Assassination of Germanicus. Germanicus is a nephew of Tiberius [16, Vol. 2, p. 414]. At the beginning of his career, Germanicus won a number of major victories over the barbarians in the West [16, Vol. 2, p. 414]. Germanicus was murdered by Piso. Tiberius launched a trial against Piso and had him executed. The "joint rule" of Tiberius and Germanicus lasted for 13 years, 6-19.

13) Gaius Caesar Caligula 37-41 (4). Little information, a sick person, regarded himself as an "earthly diety" [33, p. 300], [16, Vol. 2, pp. 423-424]. Murdered in a conspiracy [33, p. 301]. The name "Caligula" = "soldier's boot," signifying that even as a child he wore little boots.

14) Brief unrest of 41 (1). Death of Caligula, Claudius proclaimed emperor by the troops, the Senate tries to resist for a few months [33, p. 301].

15) Claudius 41-54 (13). Confirmed emperor. After 1 year in the northern provinces, a major rebellion of Scribonianus [33, p. 301]. In Rome at that time a conspiracy of Scribonianus' followers is exposed. The troops of Scribonianus and his conspirators are defeated. Massive reprisals. Claudius is poisoned.

16) "Joint rule" of Claudius and Pallans as part of a "triumvirate": 1) Claudius, 2) Pallans, 3) Narcissus. Pallans (=Valens?) and Narcissus (=Gratian?) - the most influential contemporaries of Claudius [16, Vol. 2, p. 426]. The length of the "joint rule" not more than 13 years (41-54).

17) Nero 54-68 (14). The stepson of Claudius. The rule is characterized by assassinations, persecutions, and confiscations [16, Vol. 2, p. 431]. The consequence is "the conspiracy of 65." The conspiracy is exposed and crushed. Massive reprisals. Cruel persecution of the Christians. Marked deterioration in the state of the Empire toward the end of Nero's rule. Culmination: the revolt of Vindex in Aquitania, on the border of the Empire [33, p. 306]. The rebels turn for help to Western provinces [16, Vol. 2, p. 438]. The Spanish provinces join the revolt. The Upper Germanic Legions defeat Vindex, and immediately turn against Nero demanding his abdication [33, p. 306]. Nero escapes and dies during pursuit [16, Vol. 2, p. 438]. Nero's full name is close to that of his predecessor Claudius. Both were Claudius Tiberius Nero Drusus Germanicus.

18) "Co-rulers": 1) Nero, 2) Burrus, 3) Seneca. The last two were the political leaders in the first half of the rule [16, Vol. 2, p. 430]. "Joint rule" with Burrus for 8 years, 54-62 [33, p. 305]. "Joint rule" with Seneca 54-65 (11).

19) Galba 68-69 (1). Crowned by the troops, abolished virtually all the decrees of his predecessor [16, Vol. 2, p. 789], [33, p. 208].

20) Unrest and civil war of 69 (1) [33, p. 309].

21) Two Titus Flavius Vespasians (father and son with identical full names) 69-81 (12) rule in the West [16, Vol. 2, p. 789], [33, pp. 309-310].

22) Domitian 81-96 (15). The chronicles stress his enormous powers. "The Roman provinces of the Balkan peninsula were threatened" [33, p. 314]. Uprising of the Dacians. Heavy defeat of Domitian's border troops. A protracted war with the Dacians. A peace treaty with the Dacians signed in the 8th year of Domitian's rule. Then internal disorder in the Empire (the rebellion of Saturninus), reprisals [33, pp. 314, 316], [34, Table 16].

23) Nerva 96-98 (2). Rules in the West. During his entire reign, coruler with Trajan - a famous Roman emperor.

24) Trajan 98-117 (19). His rule is regarded as the beginning of the "golden age" of the Empire [33, p. 317]. Three major wars. The opponent in the Balkans

12) Struggle between Constantius II and Constans. Assassination of Constans. Constans is a brother of Constantius II. At the beginning of his career, Constans won a number of victories over the barbarians in the West. Constans was murdered by the usurper Magnentius. Constantius II launched a campaign against Magnentius and executed him. The joint rule of Constantius II and Constans lasts 13 years 337-350 (since the death of Constantine I).

13) Caesar Julian 361-363 (2). Rich information, although the data are extremely contradictory. A great reformer of religion, ritual, and the church. Called "god incarnate." Killed in a campaign [33, p. 441]. A believer in the god Mitra, and as his priest was obliged to wear red soldiers' boots (caligula).

14) Brief unrest 363 (1). Death of Julian, Jovianus proclaimed emperor by the troops in the East. He "rules" for not more than 7 months [33, p. 441], [34, Table 16].

15) Valentinian I 364-375 (11). Valentinian I is elected emperor. After 1 year in northern and eastern provinces, a major rebellion of Procopius [33, p. 442]. In Rome at that time a conspiracy of Procopius' followers is exposed. The troops of Procopius and his followers are defeated. Massive reprisals. Valentinian "died unexpectedly" [33, p. 442].

16) Joint rule of Valentinian I and Valens as part of a "triumvirate": 1) Valentinian I, 2) Valens, 3) Gratian [33, pp. 441-442]. The length of the joint rule 11 years (364-375). Names without vowels: PLLNS-VLNS.

17) Valens 364-378 (14). The brother of Valentinian I. Often supplemented executions with mass confiscations. A series of murders. Consequence: the conspiracy and rebellion of Procopius. The rebellion is crushed. Massive reprisals. Cruel persecution of the Christians. Deterioration of the state of the empire at the end of his rule. Culmination: the revolt of the Danubian Goths, on the border of the empire [33, p. 443]. The rebels turn to Western provinces for help [16, Vol. 2, p. 443]. Moesia and Thrace join the revolt. The rebels defeat the imperial troops sent against them [16, Vol. 2, p. 443]. Valens escapes and dies during pursuit [16, Vol. 2, p. 443]. The name Valens is close to the name of his predecessor Valentinian. Valens is apparently a duplicate of "King Herod" of the New Testament. The struggle between Valens and Basil the Great also has a biblical parallel, see [8].

18) Corulers: 1) Valens, 2) Valentinian I, 3) Gratian. Initially, the oldest of the three, Valentinian I, was the political leader. Joint rule with Valentinian I for 11 years, 364-375. Joint rule with Gratian 357-378 (11).

19) Jovianus (?) 363-364 (1). Crowned by the troops, abolished virtually all the ritual and religious decrees of his predecessor [16, Vol. 2, p. 793].

20) Unrest and civil war of 378 (1) [33, p. 443].

21) Gratian and Valentinian II after the death of Valens and unrest 379-392 (13). Both rule in the West [16, Vol. 2, p. 793].

22) Theodosius I the Great 379-395 (16). The chronicles note his enormous powers. The Roman provinces in the Balkans were threatened by the uprising of the Goths. A heavy defeat of Theodosius' troops. A protracted war with the Goths. A peace treaty with the Goths signed in the 7th year of Theodosius' rule. Then internal disorder, allegedly on religious grounds, massacres, reprisals [33, pp. 444, 445], [16, Vol. 2, p. 793].

23) Eugenius 392-394 (2). Rules in the West. During his entire reign, co-ruler with Theodosius I - a famous Roman emperor.

24) Arcadius 395-408 (13). "Happy" = Arcadius rules over "the rich and civilized East" [33, pp. 445]. Three major wars. The opponent in the Balkans is the famous

is the famous Decebalus, the Dacian king. The first war starts soon after Trajan's accession. A large Roman army is engaged in a heavy war with Decebalus for two years, then a peace treaty is signed [16, Vol. 2, p. 789]. Decebalus breaks the treaty and the second war starts (for a few years). Undecided outcome, a truce. Then the third war of Trajan, the war against Parthia. Rome loses this war.

25) Hadrian 117-138 (21). Trajan's stepson and a relative of Trajan's wife. Deterioration in the Roman army, the legions become a motley of tribal troops. "The legionnaires finally lost their 'Roman' character" [33, p. 324]. Suffered from a serious disease, no children [33, pp. 322-325]. Suddenly suspecting a plot "among the high command of the army," Hadrian summarily executed many of his generals.

26) Titus Aurelius Antoninus Pius 138-161 (23) [16, Vol. 2, p. 789]

After Honorius, the 6-year-old Valentinian III is proclaimed emperor in the West, with his mother Placidia ruling as regent. Placidia falls under the influence of Aetius, one of the Roman generals [37, pp. 33-40]. He is appointed the guardian of Valentinian III [16, Vol. 2 p. 757], Aetius is the de facto ruler, his co-ruler in the East is Theodosius II, a minor figure [37, p. 35].

The rule of Antoninus Pius is marked by military activity, many wars. A very successful general. Highly resourceful in internal politics because of the generally unstable state of the empire, limits the rights of the masters with respect to their slaves [33, p. 325], [16, Vol. 2, p. 789].

27) Marcus Aurelius 161-180 (16). The adopted son of Antoninus Pius. Co-ruler with the younger Lucius Verus, who is dominated by Marcus Aurelius [33, pp. 326-327]. "A time of cruel wars and economic hardships" [33, p. 326]. The hardest war with the famous Attila. Variable fortunes. A peace treaty. Right after that, a war with nomadic tribes on the Danube [33, p. 280].

28) Commodus 176-192 (16). His rule is characterized by numerous favorites [36, pp. 405-406]. This period of favorites or puppets on the right and on the left is unique in the Second and the Third Empires. The first favorite, Perennis, soon murdered [36, pp. 405-406]. The second favorite, Cleander, quickly removed from power by Commodus, who then grants the power to another favorite, Eclectus, only to remove him soon after that. There is also evidence of other favorites (the emperor's mistress Marcia). The "musical chairs" end with the death of Commodus.

29) Pertinax 193 (1). Little data. Decline of the empire.

30) Didius Julianus 193 (1). Little data, rules in a time of unrest [36, p. 407].

31) Clodius Albinus 193 (1). Little data, unrest [36, p. 407].

32) Pescennius Niger 193-194 (1).

33) Septimus Severus 193-211 (18). Proclaimed emperor in Germany [36, p. 408]. Defeated Niger, who was killed after the battle. A strong emperor, "wise and just ruler" [36, p. 409]. His rule is "a major watershed in many respects..." [36, p. 409]. A heavy war, with variable fortunes, against the Parthian king Vologaeses. Suppresses the northern border people [36, p. 410].

34) Caracalla 193-217 (24). Co-ruler of Severus in the West. Struggle between Caracalla and his co-ruler Geta (goths?) [36, p. 410]. The troops are bribed. "Granted full citizenship to all inhabitants of the empire" [36, p. 410]. Died in the heat of preparations for a campaign against the Parthians. On the right: Zeno recognizes Theodoric in 497.

35) The Second Empire ends in wars and anarchy 217-270. "Political anarchy of the mid-3rd Century" [36, p. 406]. "Soldier emperors."

Alaric, the king of the Goths. The first war starts almost immediately after Arcadius' accession. A large Roman army fights for two years with Alaric, and then a peace treaty is signed [16, Vol. 2, p. 793]. Alaric breaks the treaty and the second war starts (for a few years). Undecided outcome, a truce. Then the third war of Arcadius with Alaric. The Roman general Stilicho loses this war.

25) Honorius 395-423 (28). Honorius and Arcadius were brothers. Deterioration in the Roman army: "These were now troops of barbarian mercenaries... Most of the generals were barbarian tribal chiefs bearing Roman military names" [33, p. 446]. Mentally deficient, no children [33, p. 449], [37, p. 33]. In 408, Honorius treacherously killed his best general Stilicho, accusing him of a plot [16, Vol. 2, p. 793]. This was apparently a lie.

26) Aetius (?) 423-444 or 423-438 (21) or (14) (until the beginning of Valentinian III).

Under Aetius, Rome fights many wars with barbarians. An excellent professional commander [37, p. 34]. Being a barbarian by birth, he strengthened his position by adroitly flirting with different strata of society. Valentinian III came of age in 437, but Aetius retained his authority until 444 (a military defeat) [37, p. 486].

27) Valentinian III 437-455 or 444-455 (18) or (11). The "adopted son" of Aetius (his former guardian). Co-ruler with the younger Theodosius II, who is dominated by Valentinian. A time of serious difficulties in the empire, "the decline of the Roman empire" begins [33]. A major war with the Parthian king Vologaeses. Variable fortunes. A peace treaty. Right after the treaty, the empire is invaded by the barbarians [16, Vol. 2, p. 38].

28) Ricimer 456-472 (16), 456-472 (16). The military commander "Ricimer now became one of the most influential persons in western Rome" [36, p. 487]. He appointed many puppet rulers - emperors who reigned for a short time. The first emperor, Petronius Maximus, was killed after 3 months [36, p. 487]. The second emperor, Mecilius Avitus, was quickly deposed by Ricimer. Next he makes Flavius Julius Majorianus emperor, and soon after that dethrones him. Little data on other puppets (Libius Severus, Anthemius). The "musical chairs" end with Ricimer's death.

29) Olybrius 472 (1). Little data. Decline of the empire, unrest.

30) Glycerius 473 (1). Little data, rules in a time of unrest [36, p. 490].

31) Julius Nepos 474 (1). Little data, unrest [36, p. 490].

32) Romulus Augustulus 475-476 (1).

33) Odoacer 476-493 (17). Commander of German troops in the Roman army, proclaimed emperor (acknowledged by Constantinople) [16, Vol. 2, p. 760]. Defeated the troops of Romulus under the command of Orestes, Romulus' father. Orestes was killed [36, p. 493]. A powerful and just ruler. A watershed: end of the "pure Roman" Third Empire, decline of the empire, the last two rulers are barbarians. War with Theodoric, who invaded Italy from the North (invasion of the Goths).

34) Theodoric the Great 493-526 or 497-526 (33) or (29). Co-ruler with Odoacer in the West. Struggle with the eastern co-ruler Anastasius [36, pp. 495-496]. The troops are bribed. Granted equal rights to barbarians and Romans. Died in the heat of preparations for a campaign against the barbarians. Theodoric is a leader of the Goths.

35) The Third Empire in the West ends in wars and anarchy 526-552. "Political anarchy of the mid-6th century" [36]. Goths rule in Italy.

36) Julia Maesa 217 [33, pp. 404-406]. A relative of Caracalla. Supported by her daughter Julia Mamaea in a "minor role." The name without vowels MSL. A famous woman - an emperor maker. The first of them is her eldest son Elagabalus. Totally dominated by Maesa. Ruled for 4 years 128-222 until murdered. The power passed to Alexander Severus, who ruled for 13 years (222-235). Julia Maesa was killed in 234. End of the Second Empire. The beginning of a major war with the Goths 238-251. Anarchy.

36) Amalasantha [36, pp. 498-499]. Daughter of Theodoric. Supported in a "minor role" by her sister Matesuntha. Name without vowels MLSNT. A famous woman - a king maker. The first of them is her son Amalaric. Totally dominated by Amalasantha, ruled for 5 years 526-531 until murdered. The power passed to Athalaric, who ruled for 8 years 526-534 [34, Table 18]. Amalasantha was killed in 535. End of the Third Empire. The beginning of the famous Gothic war of the 4th century [36]. Anarchy.

Charles of Anjou, Charles II of Naples, Frederick II of Sicily, Duke Walter of Brienne - Medieval rulers (from Gregorovius). Formal statistical superposition of these dynastic streams is described in [1-4, 26]. These volumes were allocated to the time interval using the known lengths of rule of the kings, i.e., the volume of the "biography" was divided by the length of rule and the resulting number was assigned to each year during the reign of the king. More detailed distribution of volume by years cannot be derived for these rulers. Amplitude correlation of the volume functions was detected (Fig. 6):

$$\lambda = 4,977 \cdot 10^{-4}, \alpha = 2,126, r = 0,964 \text{ for Herodotus}$$

$$\lambda = 1,327 \cdot 10^{-3}, \alpha = 1,827, r = 0,967 \text{ for Gregorovius.}$$

II. SOME CODE QUESTIONNAIRES AND STATISTICAL SHIFT

Here we reproduce one of the tables of statistical parallelism resulting from a shift of around 300-360 years in Roman chronology. The existence of such parallels was first noted by Morozov in his seminal work [8]. The present author proposed in [3] an empirical statistical technique of looking for duplications by analyzing the lengths of rule (see the tables in [26]). A method of comparison of code questionnaires was proposed in [1] for the analysis of "biographical parallelisms" (see also [4]). As an example, Table 2 is an abridged version of one such table, expanding the information presented in compressed form in [26, Table 9, pp. 164-165]. Note that not all the names of the rulers in the table have a meaningful translation: mighty, just, etc. Second Roman Empire designates the period from Sulla (1st century B.C.) to Caracalla (3rd century A. D.) and Third Roman Empire the period from Aurelian (3rd century A. D.) to Theodoric (6th century A.D.). The dynastic strand from the Second Empire represented in [26, Table 9] virtually exhausts the entire Second Empire. The strand of the Third Empire in [26, Table 9] represents only a part of the full dynastic stream and

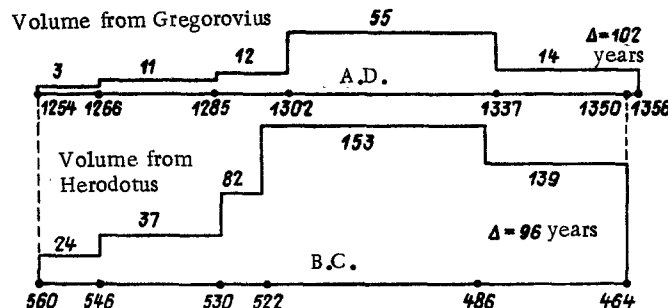


Fig. 6

has been detected as a result of a statistical experiment [3, 26]. The actual data in Table 2 are taken from [32, 18, 19, 16, 32-37]. The lengths of rule are given in parentheses.

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