Chapter 19

“Evolutionary genius” and the intensity of artistic life: who makes musical history?

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Abstract

Genius is known to have at least two certain features, which are: an extremely high level of creativity and the ability to strongly affect the evolution of artistic life. The measuring of creativity level is a rather popular problem nowadays. But how does a great artist affect the evolution of the artistic life? And how can we measure this influence?

The concept of the **intensity of artistic life** provides answers to these questions. The analysis based on the creativity of 6453 European composers of the 13th—20th centuries belonging to 39 national schools, comes to six versions of evolution of the intensity parameters: **rise**, **decline**, **dissipation**, **accumulation**, **external growth**, **external destruction**.

A particular version of evolution often seems to be "made-up" almost exclusively by rather small group of composers or sometimes by one composer. We regard this phenomenon as an **"evolutionary genius."** To measure the "evolutionary genius," a method was used based on the concept of fuzzy sets, which permitted to identify 41 genius composers. The most favorable version for **evolutionary genius** is **rise**. The composers of such type of the **evolutionary genius** are almost always innovators, often known as founders of a national tradition or school (e.g. J.S. Bach, G. Verdi, H. Berlioz). **Accumulation** is a less favorable version for **evolutionary genius**. Great composers of such type of genius provide for an advanced stage of evolution of the national school, summarizing earlier artistic discoveries and realizing them as a whole continuous tradition (e.g. L. Beethoven, J. Rameau). All other versions of evolution are unfavorable for **evolutionary genius**.

Introduction

Genius is one of the most interesting and enigmatic problems of creativity researches. There are a lot of approaches and concepts which try to describe this phenomenon in qualitative or quantitative terms. All such concepts look incomplete and conflict with each other. For example, most of them consider people of genius to differ from other human beings qualitatively. In other words there is an unbridgeable gap between true genius and all kinds of talent. But there exist also a well-known another concept: genius composers (painters, writers, poets etc.) usually strongly affect the evolution of the entire artistic life. So the evolution of artistic life is created both by geniuses (rarely) and non-genius artists (rather often). But how "usual" artists can apprehend the achievements of an "unusual-minded" genius? It's not quite clear. Hans Eysenck (1995) said that there is only a hierarchy of several degrees of genius, and a frontier between great and non-great persons is likely to disappear. Hence this logic prevents us from regarding genius to be quite different from great talent and further, there are no strict (sharp) frontiers in the whole hierarchy?

Fortunately there are two firm cornerstones for our consideration. Genius is known to have at least two certain features, which are: an extremely *high level of creativity* and the ability to intensely *affect the evolution* of artistic life (Eysenck, 1995). The measurement of creativity level is a rather popular problem nowadays. Even a student can succeed in this field. But the second feature of genius cannot be studied as easily as the first one. How does a great artist affect the evolution of artistic life? And how can we *measure* this influence? The concept of the **intensity of artistic life** allows us to calculate the "greatness" of each composer as well as to study quantitatively the evolutionary dynamics of any national school. So we can easily see each composer's influence on musical life.

The Concept of the Intensity of Artistic Life

When speaking of the intensity of a certain social or cultural phenomenon, we usually think about certain events inherent to this phenomenon, changes in its character, and so forth. In the case of artistic life we do see such events: creation of outstanding works of art, arising new stylistic directions, innovations such as new devices of art, etc. The majority of the most substantial of such events, are hopefully reflected by various encyclopedias, special dictionaries, handbooks of the history of art, and numerous analogous *sources*. Hence, an idea arises: to use such sources for measurement of the intensity of artistic life.

The "zest" of our approach consists in that most events of artistic life are tightly connected with *concrete* creative persons which realized works of art, invented new devices, and so on. These persons are composers, painters, poets, etc., described in the above mentioned sources. We may expect that the more significant was the impact of a given creative person into the artistic life, the more expanded would be the *description* of this person (and his/her activity) in each source. Therefore, if we wish to characterize quantitatively the **intensity** of the artistic life of a certain *temporal range* (e.g. a definite decade), it seems reasonable to summarize the *volumes* (lengths) *of descriptions* concerning those creative persons which were active within this range. Naturally, this sum would reveal changes (when turning from one temporal range to another) characterizing the *dynamics* of artistic life, evolution of its **intensity**.

However, usually it is difficult to clear up exact dates of active work of creative persons considered. The only reliable information available concerns the data of life of creative persons: their birth and death. Meanwhile, there exist a statistical regularity which seems to be obvious and can be used in the practice of measurements: usually the time of active creative activity of a person starts 20—30 years after his/her birth. Due to this, it is possible to take into account only the *years of birth* of creative persons, and to rely only these dates when summarizing descriptions of different temporal ranges of the evolution. The only complication arising when using such a

method, is that we should deal with a certain 20—30 year shift of the dynamic regularities obtained, but this shift can be easily taken into account when analyzing these dynamical results. Namely such was our approach in the given investigation.

Earlier such a method was used in the investigation of the **intensity of literary life** based on the creativity of 307 Russian poets and 480 prose writers of the 18^{th}—20^{th} centuries (Petrov & Mazhul, 2002) as well as in the investigation of the *intensity of musical life* on the basis of data concerning 6453 European composers of the 16^{th}—20^{th} centuries (Kulichkin, 2004). We consider that the degree of a composer's "greatness" (significance) may be measured by the *size of the article* devoted to him in a specialized encyclopedia (because this size should be determined by the interest of experts who compiled this encyclopedia).

Of course, on one hand, such evaluation doesn't look like an objective one. There exist a lot of musical dictionaries and encyclopedias of different sizes, imprint dates, editors (of different countries!) and of many other differences. Each of the sources presents its own description of various composers of different length. On the other hand, the hierarchy of composers' significance is expected to be the same irrespective of encyclopedia used. For example, Wolfgang Amadeus Mozart's greatness is obvious for all encyclopedia compilers in all countries both edited in 1930 and 2000. Hence, in any encyclopedia the description of Mozart's activity should be much more expanded than descriptions of most other composers. May be, we can use such facts when *choosing the source* for our empirical investigation?

We compared mathematically two diametrically opposed sources: the one-volume Russian musical dictionary (Keldysh, 1990) and the ten-volume English encyclopedia (Grove, 1954). Despite of all their differences, they appear to give **statistically similar hierarchies** of composers' greatness for each separate national school (See in detail: Kulichkin (2004a), Kulichkin, Tolstunova & Petrov (2002)). Hence, the "relative greatness" of composers is invariant over the sources used for the evaluation. So we're allowed to use only one encyclopedia for our research. Therefore we have chosen the most comprehensive one (Grove, 1954).

Then, in line with the existing tradition (Martindale, 1990), the data were taken out from the encyclopedia: composers' *years of birth* and the *length of an article* devoted to each composer's creative activity (number of lines). In total our sample embraced 487659 lines devoted to 6453 composers of the 13th—20th centuries: 1177 Austrian and German composers, 1052 Italian composers, 663 French composers, … (in total 39 countries). All composers were grouped into 10-year intervals depending on their birthdates (for each national school): 1500-1509, 1510-1519, etc. For every 10-year interval (***t***) the total **number of composers** (***n***) and **number of lines** devoted to them (***N***) were calculated. The last value (***N***) seems to be the indicator of the **intensity** of musical life.

Earlier researches established that the intensity of artistic life is known to have *two fundamental features*. The *first* one is a *hill-like trend*: this intensity is low in remote epochs, as well in the contemporary epoch, passing through a certain maximum between these epochs (see also below).

> The *nature of the long-term trend* is connected with the *procedure of measurements* which was used in the study. In other words, the hill-like trend is nothing but an *artifact* caused by the procedure of compiling encyclopedias. Moreover, this artifact had been predicted before the beginning of the empirical study. The heart of the matter is in the *superposition of two long-range tendencies* (two kinds of artifacts). The first tendency is nothing other than the *decay of the interest* (of experts who compiled the encyclopedia) in authors of more *remote eras*. <…> That is why we should assume that indicators of literary life *increase with time*. But there is an *opposite effect* relating primarily to *more recent periods*, especially the 20th century. This second tendency deals with authors who are *living now* (or died just a little while ago). The problem is that now it is still difficult to forecast which of them will become "classics" of literature, and therefore deserve a wordy description. That is why the indicators of literary life should *decrease with time* (Petrov & Mazhul, 2002, pp. 33-35).

After subtracting this hill-like trend from the value of the intensity of artistic life, usually we can easily see its *periodical character* (see Petrov & Mazhul, 2002 as well as figures below). It is

the *second* fundamental feature of the intensity. The cause of such periodical effect is nothing else than well-investigated cyclic processes, such as:

—oscillations in social climate (Maslov, 1983);

—alteration of primordial and conceptual processes in art (Martindale, 1990);

—various consequences of brain asymmetry influencing upon the evolution of art (Petrov, 1992);

—evolution of introversion and extraversion in poetry (Koshkin, 1997);

—other periodical processes of any kind connected with changes of generations.

It's important to note that basing on such measurements, we cannot study long-time tendencies because of the hill-like artifact. The only thing which can be investigated on the basis of such data is *short-time changeability* (not longer than 40—50 years) and some actual current distributions.

Studying current distributions, we can find out some interesting regularities, and first of all *interconnections* between the number of authors (***n***) and the intensity of artistic life (***N***). One of such regularities was discovered earlier when studies of Russian literary life: *strong positive* statistical *correlation* between the number of authors and the value of intensity (Petrov & Mazhul, 2002): the more the number of authors which were born during a definite temporal range, the more the entire intensity of the literary life of appropriate range.

Measuring the intensity parameters: primary empirical data

The above statistical link gives us a hint: may be, a description of the evolution shouldn't be limited by the main parameter—intensity of artistic life (***N***). May be, it would reasonable to introduce certain additional parameter(s)?

We wish to examine interconnections between n and N in detail. The major part of all works (in art, science etc.) is known to be created by the minor part of authors. The statistical link between the number of authors and the number of works (articles, musical pieces, poems etc.) created by them usually is described by Zipf's law which relates to the class of the so-called "hyperbolic distributions" (see, e.g., Petrov & Yablonsky, 1980):

$$w_i = w_1 i^{-\beta},$$

w_i being the number of authors which created i works (during the temporal range studied), w_1 the number of authors each of them created only one work, β the coefficient characterizing the steepness of the dependence, i.e. the "concentration" of *creativity* in the top part of the authors. Usually $\beta = 2$, so, e.g., if there are 100 authors each of them created only one work, we can calculate the number of authors each of them created 4 works: $w_4 = 100*4^{-2} \approx 6$ authors. As a rule, 50 percent of the entire number of works is created by 5 percent of authors (Martindale, 1995). In other words, a rather strong *concentration of creativity* takes place.

It's rather interesting to find analogous Zipf's dependences (though if slightly differing from the above ones) in our case. Let's rank composers by the number of lines devoted to them in encyclopedia (NB! Composers must be of one and the same national school; besides, we're forced to ignore the long-term trend and so composers had to be of the same 10-year interval (at the worst of 20-year interval)).

Fig. 1a presents one of the dependences of the type considered, relating to the musical life of Germany and Austria: 108 composers which were born in temporal range from 1750 till 1769. The number of lines w_i devoted to a composer with rank i, is plotted in function of this composer's rank i; logarithmic coordinates on both axes are used. Two specific features are inherent to this dependence, as well as most other dependences of such a type.

First, these dependences are really *Zipfean*, i.e. *linear*, with slope β equal to $1\pm0,2$. This magnitude of the coefficient β is usually met in linguistics (dependence of the frequency of words in the given text, vs the ranks of these words—see, e.g., Petrov & Yablonsky, 1980). Hence, in such

cases we really deal with a kind of a "text" which is organized in a proper manner, or a "well-organized system." Exactly such situations were observed by Martindale (1995) when studies of literature devoted to various poets: strong concentration of attention paid to the "top" poets.

Second, as a rule, one composer accounts for more than 50 percent of the total intensity (If we exclude this composer—see Fig. 1b, the curve would be again zipfean, though with the other value of the coefficient $\boldsymbol{\beta}$). In the given concrete case such a composer is Mozart. What is the most important in such situations? We can easily see (Fig. 1a) that one the most significant composer can "violate" almost perfect zipfean curve! It's a very simple way to exclude "non-zipfean" composers from all evolutionary curves and to come to perfect zipfean dependences. But it would be a strange musical history: without Johann Sebastian Bach, Joseph Haydn, Wolfgang Amadeus Mozart, Ludwig van Beethoven, Franz Schubert…

Insert Fig. 1.

What should we do in such situations? May be, it is possible to *use* the second specific *feature* for our *measurements*?

External and Internal Forces

In our investigation we deal with a sample of composers—those ones which were included in the encyclopedia—the heterogeneous "musical elite." For each 10-year interval $\boldsymbol{t}$ we know values of $\boldsymbol{n}$ and $\boldsymbol{N}$. The intensity number ($\boldsymbol{N}$) is the *"total power"* of the national school in each given moment of its evolution—it's quite clear. But what does number of composers ($\boldsymbol{n}$) mean? This parameter characterizes the kind of *"popularity"* (or "prestige") of music for newcomers. Indeed a young man choosing future profession in art, would become a musician if he feels that music is

more “high, enhanced” kind of art than poetry. If his feelings are opposite may be he would become a poet (or a painter). That is why we may treat such a choice as a procedure of “measuring,” as if newcomers estimated the influence of certain “external factors” upon the evolution of musical life these outer factors being not caused by the “internal technical essence” of music.

Then how the “total power” of national school (***N***) is distributed among several composers (***n***) for each 10-year interval (***t***)? The features indicated above (Fig. 1) prevent us to use formulas of Zipf’s law, but there is a way to receive due information without them! Let’s calculate the *average value* over this distribution—**specific intensity *q***:

$$q(t)=N(t)/n(t).$$

The parameter ***q*** characterizes the *“quality of creation”*—the *“average mastery,”* or the mastery of a certain “average composer” of the temporal range studied. Strictly speaking, it is incorrect to realize averaging when dealing with hyperbolic distributions, because they are “too inhomogeneous.” Nevertheless, some rough estimations seem to be admissible, as soon as for our further consideration we need only “semi-quantitative” results: signs of evolutionary changes when turning from one distribution to another. The parameter ***q*** may be treated as an indicator of a certain *“internal factor,”* i.e., some processes acting within the musical life. Of course, the product of “prestige of music” (***n***) and “average mastery” (***q***) is the total intensity (***N***). It’s important, that the same level of the intensity would be obtained if the value of ***n*** is rather high and the value of ***q*** is low, or vice versa. In the first case music is a popular kind of art, musician is rather respectable profession for newcomers, though all contemporary composers are not very great. In the other case there are a few great composers though almost unknown for contemporaries, and music as a profession occurs not so attractive for newcomers as it was in the previous case.

Now let us turn to the *evolution* (dynamics). We remember that here the main obstacle “enemy” of the researcher is the hill-like trend: we don’t know the explicit function of this artifact. However we may compare distributions of *adjacent 10-year intervals* (like **1600-09** and **1610-19**) and ignore the long-term artifact (neglecting its small changes). In other words, we may focus on

"local evolutionary changes." (A propos, exactly such local changes should be of most importance for the individual fate, choice of profession, creativity, etc.: the temporal scales of these changes are commensurable both with the duration of human life and the duration of individual creative activity). We can watch the *sign of changes*: if each of our parameters (***n***, ***N*** and ***q***) increases or decreases? Depending on their changes, we single out *six logically possible versions* of the evolution. But before analyzing these versions we should make a digression devoted to the very *sample* of composers we are dealing with.

Digression: The phenomenon of centralization—"core" and "periphery" of the national school

Regarding composers included in the encyclopedia as "artistic elite," we should take into account no national school consisting only of such composers. Really, beside eminent composers, there exist a lot of unknown ones, including not talented persons, amateurs, and so forth. Nevertheless, the artistic elite becomes the "core" (the "control centre") of the entire national school, because of the phenomenon of reflection, which is inherent to any advanced system, irrespective of its nature. Golitsyn (2000, pp. 31-42) wrote about reflection:

> In its general sense, we shall define reflection as the transformation of means into an end or, to use the language of the theory of control, as the transformation of the condition of control into the object of control and the shift of control from the effect to the cause. <…> Reflection is one of the most important principles of the evolutionary process. <…> What is important for us <…> namely, the capacity for self-reflection is only a particular of the capacity for reflection in general and the higher the culture and the greater the variety of possible cultural responses to the external environment, the greater its capacity for reflecting <…> Any elitist culture has such a central character with

regard to all other peripheral cultures, irrespective of whether they are drawn to it or repelled by it, it serves as a general point of reference for these cultures. They link first to it and only subsequently (and then extremely rarely) to one another. This center inevitably becomes the tone-setter that organizes diversity and unity or, as it is termed in synergetics, "the parameter of order."

Exactly similar are the relationships within national culture between its "central core" and the periphery as well as within national artistic elite.

Of course, changes of parameters ***n***, ***N*** and ***q*** have to provide for an "echo" at the "periphery" of the national school (i.e. some mass phenomena). In general, intensity related to each 10-year interval ***t***, contains two parts: the intensity of the "centre" and the intensity of the "periphery." But the impact of the "periphery" may be ignored because of two reasons:

1) the value of the "peripheral" intensity is much smaller than the value of the "central core" (see also Fig. 1);

2) changes in the peripheral intensity (at least meaning their signs) are supposed to coincide with the changes in the intensity of the core.

That is why we have a right to study the evolution of the *artistic elite*, changes in which are indicative of the changes in the intensity of the entire artistic life.

Evolutionary Dynamics: Quality in Quantity (Versions of Evolution)

So, there are six versions of changes of three parameters (***n***, ***N*** and ***q***) (Fig. 2a—f), which can be illustrated with the data on 6453 composers belonging to 39 national schools of music of the 13^{th}—20^{th} centuries (see also Kulichkin, 2004, 2004a):

Insert Fig. 2.

1) ***n*** up, ***N*** up, ***q*** up—**rise**. This version usually relates to the arising of a national school. The given kind of art becomes popular in the professional artistic environment, the internal resources increase, as well as the mastery. So the potential of the national school is rather high. *This version took place in Russia in* **1830-49** (Fig. 2a)[here and later birthdates of composers are meant]. *In this time such well-known composers were born as Modest P. Mussorgsky (1839—1881, 1503 lines) and Pyotr I. Tchaikovsky (1840—1893, 3139 lines). Russian national musical school became famous all over the world.*

2) ***n*** down, ***N*** down, ***q*** down—**decline**. If this version of change in the intensity parameters continues for a long time, the potential of the national school is likely to be exhausted. Then, if any sources (internal or external) are not found, the national school disappears surely. But short-time **decline** is not dangerous, because it doesn't destruct the control centre. *The Italian national school experienced* ***rise*** *in* **1710-19**. *The most significant composer of this period was Giovanni Pergolesi (1710—1736, 1043 lines). But despite rather high level of the total intensity, Giovanni Pergolesi and his contemporaries didn't make the "prestige" of music to grow (perhaps because of Pergolesi's early death). This fact provides for* ***decline*** *in* **1720-39** (Fig. 2b). *The most significant composer of that* ***decline*** *was Niccolo Piccini (1728—1800, 529 lines).*

3) ***n*** up, ***N*** down, ***q*** down—**dissipation**. This fundamental phenomenon takes place in evolutionary dynamics of almost all national schools. There are some **rises** connected with very high level of intensity, so the next generation of authors cannot repeat such achievements. It means that specific intensity ***q*** and general intensity ***N*** are both down. But the given kind of art is "mechanically" becoming more and more popular. This rapid growth of popularity causes the exhaustion of the internal potential. Downward trend in the quality combined with a high level of popularity of the given kind of art may become true "horrible nightmare" at the periphery of national school. Here are some features of a long-time **dissipation**: expansion of graphorrhea, spreading of doubtful artistic values, "fashion instead of mastery," etc. But if the "artistic elite" really control evolutionary process, the national school can survive. *For example, Czech national school*

*achieved the major level of the intensity during **rise** in* **1840-49**. *This level was almost "exclusively" created by Antonin Dvořák (1841—1904, 1922 lines). The next generation of composers (the most significant of them were Leoš Janáček (1854—1928, 806 lines) and Zdeněk Fibich (1850—1900, 425 lines)) couldn't keep up such high level of mastery but made music "popular" for "newcomers." This growth of "popularity" activized some negative processes at the periphery. As a result, Czech national school experienced **dissipation** in* **1850-69** (Fig. 2c). *Mainly connected with the necessity to solve several "conceptual problems" caused by "values of fashion."*

4) ***n*** down, ***N*** up, ***q*** up—**accumulation**. This is only possible effective anti-dissipation action. The "artistic elite" separates itself sharply from its "periphery." However this essential action is really "unpopular." Given kind of art becomes "art for high-brows." Only a few newcomers from periphery may "gain access" to real artistic elite: not because of difficult "entrance examinations" but because of the simple reason: almost nobody knows something about this elite. So the national school resists "author-replication" and makes its potential raise. And as a result of very low level of mastery, the "scum of periphery" vanishes as far as it arose during **dissipation**. *In* **1810-19** *Austrian and German national school experienced **rise** that is almost exclusively created by the activity of Robert Schumann (1810—1856, 4955 lines) and Richard Wagner (1813—1883, 4200 lines). Then, Anton Bruckner (1824—1896, 910 lines) and Johann Strauss (1825—1899, 658 lines) started to work in the **dissipation** era: Wien was transforming from the "city of opera houses and concert halls" into the "suburb of restaurants and cabarets." Despite such quite negative effect, this national school survived: Johannes Brahms (1833—1897, 3459 lines) almost exclusively realized **accumulation** in* **1830-39** (Fig. 2d). *The tradition had been saved and later continued by Gustav Mahler, Arnold Schönberg and other composers.*

5) ***n*** up, ***N*** up, ***q*** down—**external growth**. This variant takes place if internal potential of the "centre" decreases. But something makes to grow the popularity of given kind of art. This fact can be explained only by the influence of another national schools, kinds of art, or other external causes. However, rather long **external growth** can lead to "default" of control centre and the na-

tional school might disappear or become a part of another more powerful national school. *Such version took place in England in* **1730-39** (Fig. 2e). *No significant or well-known composers were born during this period. So we would suppose that English national school was influenced by Austrian and German music. Johann Christian Bach, also known as "London Bach" (1835—1782, 363 lines), lived in London since 1762. As well, Joseph Haydn (1732—1809, 8677 lines) visited England twice.*

6) ***n*** down, ***N*** down, ***q*** up—**external destruction**. The national school accumulates its internal resources, but popularity of the kind of art declines. The artistic elite vanishes, the periphery collapses rapidly. So evidently there exist certain external causes (political, religious, social, cultural, etc.) that lay obstacles for the successful development of the national school. After this variant of the evolution, the given kind of art usually experiences global style transformations. ***external destruction*** *struck French national school in* **1850-59** (Fig. 2f). *We really can see the significant stylistic transformation. For example, works of Claude Debussy (1862—1918, 1104 lines) and Maurice Ravel (1875—1937, 993 lines) seem to be the "music of quite another sort" than compositions of George Bizet (1838—1875, 2446 lines) or Gabriele Fauré (1845—1924, 1117 lines). The causes of such effect are complicated. We can suspect two causes: changes in the political climate and processes in the evolution of artistic life related to painting (impressionism).*

Models of evolution: how musical history is made

Let's look at evolutionary dynamics of three well-known national musical schools: Austrian and German (Fig. 3, Table 1), Italian (Fig. 4, Table 2) and French (Fig. 5, Table 3). [On all fig-

ures and tables each 10-year interval is indicated by bottom date only: **1500** means 10-year interval **1500-09**, **1510** means the interval **1510-19**, etc.].

Insert Fig. 3
Insert Table 1
Insert Fig. 4
Insert Table 2
Insert Fig. 5
Insert Table 3

It's obvious that cycle **rise—dissipation—accumulation—rise** took place in musical history of these three national schools (at least twice). Besides that, Austrian and German music experienced more complicated modification of this cycle: **rise—dissipation—rise—dissipation—accumulation—decline—accumulation—decline—rise**. (Other national schools didn't show such a behavior.) These facts provide for long lifetime and stability of the national schools considered. How does it appear? During initial **rise** one generation of authors creates major achievements. Significant composers of such **rise** are usually innovators. So they can be metaphorically called *"evolutionary pioneers."* The examples may be French composer Hector Berlioz (1803—1869) or Austrian Joseph Haydn (1732—1809). After major artistic achievements created by one generation of composers during **rise**, the next generation cannot keep up such high level of mastery. **Dissipation** comes. Music becomes popular, the periphery (i.e., rather large number of insignificant composers) assimilates the achievements of preceding grand composers. So, significant composers of **dissipation** may be regarded as *"evolutionary professors:"* they "translate" the achievements of previous generation into "peripheral language." Corresponding examples are German composer Georg Vogler (1749—1814) or Italian Marco da Gagliano (1575—1642). As a result, every author can reproduce means and devices introduced by the previous generation, but

nobody can propose productive way for further development. If such a way is not found, the musical history of the national school is probably over. Only few composers can withstand the pressure of "total repetition" and develop the ideas of the grand masters of the past. But only such composers are able to realize **accumulation**. Significant composers of similar **accumulation** (included into the cycle) are *"evolutionary academicians"* (for example, Ludwig van Beethoven (1770—1827) or George Bizet (1838—1875)). On one hand, they summarize the "knowledge" of "pioneers" and "professors" and make an advanced stage of the evolution. But on the other hand, their artistic logic is already "out of peripheral mind," and the popularity of music decreases. So the "scum" of the periphery rapidly vanishes and the foundations for new innovations are laid. Finally, if "evolutionary professors and academicians" really keep in mind the experience of previous pioneers—then the national school passes these three phases of evolution "without errors" and another **rise** comes surely.

The duration of the full cycle **rise—dissipation—accumulation—rise** is about 40-50 years. If it is realized, then rather mighty *national tradition* is formed. Its memory may last for about next 50 years. Due to this, the national school becomes *leading*. So such cycle is capable of providing the leadership of this national school, its *central position* in the world art during centuries.

Evolutionary genius: problem statement

So now the artistic life is characterized both with *quantitative characteristic* (***N***) *and qualitative* one (one of the above versions of the evolution). Hence, quite natural idea appears: if a certain composer's impact into the value of ***N*** is, e.g., 80%—then he/she is 80% "guilty" in determining the choice of the version of the evolution. Perhaps, exactly this composer can be called **"evolutionary genius"**? But how this idea looks in general case?

Let us summarize our previous consideration.

We analyzed the regularities of the dynamics of artistic life. Can we apply these considerations strictly to calculate composers' significance? And how can we measure the degree of effect that genius composers have on the musical life? The problem appears complicated. For example, there are two authors: the English composer William Byrd (1543—1623) and Russian Pyotr Tchaikovsky (1840—1893). Let's try to compare their significance. Encyclopedia compilers devoted 1479 lines to William Byrd and 3139 lines to Pyotr Tchaikovsky. At the first glance Pyotr Tchaikovsky seems to be more significant because 3139 is more than 1479. But on the other hand, we must keep in mind the long-term trend! The hill-like effect forces the intensity indices to increase with time. So 1479 lines related to the interval **1540-49** may mean a greater significance than 3139 lines related to **1840-49**. Suppose we have approximated the long-term trends both for English and Russian national schools (it's not so easy, by the way). Let cured indices be 976 lines devoted to William Byrd and 834 lines—to Pyotr Tchaikovsky. Would it mean that we're allowed to consider William Byrd more significant than Pyotr Tchaikovsky? Unfortunately, no! These composers belong to different national schools, so the encyclopedia compilers might not have evaluated their significance objectively.

But there's a solution of the problem. If we regard composers of the same national school nothing could prevent us from comparing the number of lines devoted to composers relating to the same 10-year interval! We may ignore any artifacts connected with the long-term trend within 10 years. In other words, for each 10-year interval t we compare composers' "contributions" to the intensity index N. Such "contributions" may be very different. It's a curious fact that there are even a lot of 10-year intervals where one or a few composers account for the major part (about 80 percent and more) of the **intensity** (N). In this case the version of evolution seems to be "made up" almost exclusively by this small group of composers or by one composer alone. We treat this phenomenon as an **"evolutionary genius"**. So exactly the **influence** on musical life of this small

group of **evolutionary genius** composers may be characterized by three parameters of the **intensity** (***n***, ***N***, ***q***) and by one of six **versions** of the evolution described above (**rise**, **decline** etc.).

Evolutionary genius in mathematical terms: example of single genius

What method can we use for describing the **evolutionary genius** in mathematical terms? As far as the problem is connected with studying distributions, one way is to calculate statistical parameters. Such as the *expectation value* of the distribution (specific intensity ***q***) and the *coefficient of excess* (using corresponding statistical formulas). If we deal with **evolutionary genius**, the value of the last parameter would be rather high. Of course, such method may be applied. But we would propose another one that is simpler and more adequate for our problem.

Let's consider, for instance, Italian composers relating to the 10-year interval **1790-99** (the numbers of lines devoted to these composers are indicated in parentheses). They are eleven: Rossini (1536), Donizetti (544), Mercadante (186), Pacini (95), Vaccai (49), Gnecco (44), Coppola (30), Romani (20), Conti (17), Gordigiani (15), Rolla (8). On one hand, Rossini seems to be single **evolutionary genius** composer among all of them. His contribution to the total intensity is almost three times more than contribution of Donizetti. But is it enough? Or we may consider difference between contributions of genius composers to be about four times? Or even ten times? It's difficult to answer correctly. On the other hand, Rossini accounts for 60 percent of the intensity. But Rossini and Donizetti together account about 82 percent of the intensity. Rossini, Donizetti, Mercadante and Pacini take even 93 percent. Which case is more adequate to be regarded as **evolutionary genius** phenomenon: 60 percent for one composer, 82 percent for two composers or 93 for four ones? It's not quite clear.

Of course, we know two certain features of genius: 1) genius has to be "much greater" than non-genius; 2) genius' contribution to the intensity has to be much more than non-geniuses' one. In a figurative sense, we construct two mathematical "separating sieves." The first "sieve" individually separates "suspicious to be genius" composers from "obviously non-genius" ones. Then, "suspicious" composers are aggregated to a group. And finally, the second "sieve" defines if this "suspicious group" is a group of evolutionary genius composers or not.

Let's try to answer *two* next *questions* as accurately as possible (for each 10-year interval ***t***):

1) Which composers are more significant than the others?

2) Which groups of composers really make up the value of the intensity (***N***)?

Trying to answer the first question, we can calculate "relative" degree (***r***) of each composer's significance, and this value would answer "accurately" if the composer is more significant than the other or not. The relative degree of significance (***r***) equals the number of lines devoted to composer divided by the maximum of such numbers (1536 in our case). Let's calculate values of ***r*** for our eleven composers:

r*(Rossini)=1536/1536=1.000,* ***r****(Donizetti)=544/1536=0.354,* ***r****(Mercadante)=186/1536=0.121,* ***r****(Pacini)=95/1536=0.062,* ***r****(Vaccai)=49/1536=0.032,* ***r****(Gnecco)=44/1536=0.030,* ***r****(Coppola)=30/1536=0.020,* ***r****(Romani)=20/1536=0.013,* ***r****(Conti)=17/1536=0.011,* ***r****(Gordigiani)=15/1536=0.010,* ***r****(Rolla)=8/1536=0.005.*

For each composer we can ask: "Is he more significant than the other?" And our answer would be the value of ***r***! The maximum value of ***r*** is "1." So if this value equals "1" (Rossini is meant) we answer the question: "Yes, of course." In other cases we deal with *fuzzy answers*. For example, ***r****(Mercadante)=0.121*. Corresponding fuzzy answer is: 0.121 for "Yes" (Mercadante is *more significant* than the others) and 0.879 for "No" (Mercadante is *less significant*). In general case we deal with a continuum of degrees between "Yes" and "No."

Thus, answering the first question *accurately*, we should aggregate our eleven composers with values of ***r*** (relating to them) into a **greatness ranking class** (**R**). Elements of this class are pairs

consisting of: the degree of membership related to the composer (for example, *0.354*) and the composer's name (for example, *Donizetti*) [here and later we use symbol "/" to divide the degree of membership from the composer's name]:

***R**=(**r**(composer)/composer) or*

***R**=(1.000/Rossini, 0.354/Donizetti, 0.121/Mercadante, 0.062/Pacini, 0.032/Vaccai, 0.030/Gnecco, 0.020/Coppola, 0.013/Romani, 0.011/Conti, 0.010/Gordigiani, 0.005/Rolla)*

Such classes (like **greatness ranking class *R***) are known as fuzzy sets ***R*** characterized by membership function ***r(composer)*** (Zadeh, 1965, p.339):

> A fuzzy set ***A*** in ***X*** is characterized by a membership function $f_A(x)$ which associates with each object ***x*** in ***X*** a real number in the interval [0, 1], with the value of $f_A(x)$ at ***x*** representing the "grade of membership" of ***x*** in ***A***.

Greatness ranking class *R* is the *first*, "individual" *mathematical sieve*. Now, we'll construct the *second*, "group" *mathematical sieve*, and after that proceed to the procedure of *screening*.

Let's consider various groups of our eleven Italian composers. Like *relative degree* of significance (***r***) of *each composer* we can calculate the *relative contribution* (***g***) of *each group of composers* to the total intensity (***N***). Of course, we are not interested in all such groups. We need combined contributions of groups consisting of the most significant composers. These groups are:

{Rossini},

{Rossini, Donizetti},

{Rossini, Donizetti, Mercadante},

{Rossini, Donizetti, Mercadante, Pacini},

{Rossini, Donizetti, Mercadante, Pacini, Vaccai},

{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco},

{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola},

{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani},

{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti},

{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti, Gordigiani},

{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti, Gordigiani, Rolla}.

For each such group the relative contribution (***g***) equals the total number of lines devoted to composers of the given group divided by the number of the intensity (***N***):

N*=1536+544+186+95+49+44+30+20+17+15+8=2544;*

g*({Rossini})=1536/2544=0.604,*

g*({Rossini, Donizetti})=(1536+544)/2544=0.818,*

g*({Rossini, Donizetti, Mercadante})=(1536+544+186)/2544=0.891,*

g*({Rossini, Donizetti, Mercadante, Pacini})=(1536+544+186+95)/2544=0.928,*

g*({Rossini, Donizetti, Mercadante, Pacini, Vaccai})=(1536+544+186+95+49)/2544=0.947,*

g*({Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco})=(1536+544+186+95+49+44)/2544=0.965,*

g*({Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola})=(1536+544+186+95+49+44+30)/2544=0.976,*

g*({Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani})=(1536+544+186+95+49+44+30+20)/2544=0.984,*

g*({Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti})=(1536+544+186+95+49+44+30+20+17)/2544=0.991,*

g*({Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti, Gordigiani})=(1536+544+186+95+49+44+30+20+17+15)/2544=0.997,*

g*({Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti, Gordigiani, Rolla})=(1536+544+186+95+49+44+30+20+17+15+8)/2544=1.000.*

On the analogy of previous, individual approach, we can ask (for each group): "Does this group of composers really make up the value of the intensity (***N***)?" Our answer would be the value of ***g***. The maximum value of ***g*** is "1." So if this value equals "1" (the group of all eleven composers is meant) we answer the question: "Yes, of course." In other cases we deal with *fuzzy answers*. For example, ***g****({Rossini, Donizetti})=0.818*. Corresponding fuzzy answer is: 0.818 for "Yes" (the group *{Rossini, Donizetti} does* exclusively *make up* the value of the intensity) and 0.182 for "No" (the group *does not* exclusively *make up* the value of the intensity). In general case we deal with a continuum of degrees between "Yes" and "No."

Answering the second question *accurately*, we should aggregate our eleven groups of composers with values of ***g*** (relating to them) into a **group contribution class** (**G**). Elements of this fuzzy set are pairs consisting of: the degree of membership related to the group (for example, *0.891*) and corresponding group of composers (for example, *{Rossini, Donizetti, Mercadante}*):

G*=(****g****({group of composer(s)})/{group of composer(s)}) or*

G*=(0.604/{Rossini}, 0.818/{Rossini, Donizetti}, 0.891/{Rossini, Donizetti, Mercadante},*

0.928/{Rossini, Donizetti, Mercadante, Pacini},

0.947/{Rossini, Donizetti, Mercadante, Pacini, Vaccai},

0.965/{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco},

0.976/{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola},

0.984/{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani},

0.991/{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti},

0.997/{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti, Gordigiani},

1.000/{Rossini, Donizetti, Mercadante, Pacini, Vaccai, Gnecco, Coppola, Romani, Conti, Gordigiani, Rolla}

Group contribution class *G* is the *second*, "group" *mathematical sieve*. Now we are ready for *screening*.

Thus, there we have for each 10-year interval ***t*** two fuzzy sets: **greatness ranking class *R*** and **group contribution class *G***. Let's define two coefficients: $0 \le \alpha(R) \le 1$ and $0 \le \alpha(G) \le 1$—critical values for membership functions of the above two fuzzy sets. If we know these critical values then procedure of screening is rather simple. Namely, the conditions of **"evolutionary genius"** for each interval ***t*** are:

—r *(composer)*$> \alpha(R)$ for each composer included in *{group of composers}*

—g *({group of composers})*$> \alpha(G)$.

The first condition *separates the small group* of great composers from their non-great contemporaries. The second one *defines* if only that small group *controls* the evolution during 10-year interval ***t*** or a lot of composers (both great and non-great) make the intensity ***N***. Using the first condition we find out some great composers. We regard them as evolutionary genius "candidates" and unify them into a *{group of "candidates"}*. Then we calculate g *({group of "candidates"})* and check up the second condition. If the check is successful we may regard "candidates" as **evolutionary genius** composers.

Therefore it remained only to define values of $\alpha(R)$ and $\alpha(G)$. Are there any considerations in this respect? On the basis of some general considerations derived in the theory of fuzzy sets, it's possible to clarify that the sufficient requirements are:

1) $\alpha(R)=0.5$ (for each composer)
2) $\alpha(G)=c/(c+1)$, where ***c*** is the number of composers included in *{group of composers}*, i.e. $\alpha(G)$=1/2 (per composer), $\alpha(G)$=2/3 (per two composers), $\alpha(G)$=3/4 (per three ones) etc. (some additional considerations concerning this subject, are presented below).

We can apply these requirements to our eleven Italian composers (Fig. 6):

1) r*(Rossini)=1.000>* $\alpha(R)$=0.5, r*(Donizetti)=0.354 <* $\alpha(R)$*=0.5,*

r*(the rest of composers)<* $\alpha(R)$*=0.5.*

Then, {group of "candidates"} is equal {Rossini}, c*=1.*

2) g*({Rossini})>1/2 (per one composer).*

Thus, we deal with **evolutionary genius** phenomenon, and the small group, that almost exclusively make up the intensity, consists of only one great composer (Rossini).

Insert Fig. 6.

But why we regard such requirements for critical values ***α(R)*** and ***α(G)*** as sufficient? Sufficiency of the second requirement is rather clear: the contribution of a "genius" composer to the intensity must be more than the total contribution of all "non-genius" composers. It's simply the roughest requirement. But why do we require just ***α(R)***=0.5 (but not ***α(R)***=0.3 or ***α(R)***=0.8)? There are some theoretical and empirical causes for such condition. On the one hand, this requirement takes place by analogy with the concept of half-value relaxation used in natural sciences. On the other hand, ***α(R)*** is nothing else than the "degree of separability" for various levels of greatness. Recalling H. Eysenck's research, we expected that the borderline between great and non-great composers would disappear (Eysenck, 1995). But the frontier does exist: no great composer has the value of ***r*** between 0.5 and 0.7!

Example of several geniuses

Let's illustrate our words with another example: Austrian and German composers relating to the 10-year interval **1680-89**. Is there **evolutionary genius** phenomenon in this case or not? The first step of our algorithm is to find the most significant composer (of this 10-year interval). That is Johann Sebastian Bach (3984 lines). The relative degree ***r(Bach)*** equals the number of lines devoted to Johann Sebastian Bach (3984 lines) divided by the maximum of such numbers (3984 lines too):

r*(Bach)=3984/3984=1.000.*

The second step is organization of the group of composers that is "suspicious" of being evolutionary genius. There we have just one member of this group yet—the most significant composer of 10-year interval (Johann Sebastian Bach). But should any other composer be included into this group? Let's order the rest of composers in dependence of the number of lines: George Frideric Handel (2833 lines), Georg Philipp Telemann (184 lines), Johann Mattheson (156 lines), etc. The most significant of them is George Frideric Handel. The value of ***r*** for him is:

r*(Handel)=2833/3984=0.711.*

Then we examine that 0.711 is more than 0.5 (recurring to the above conditions that ***r*** *(composer)* must be more than ***α(R)***, and ***α(R)=0.5***) and so George Frideric Handel has to be included into the group. The next composer is Georg Philipp Telemann:

r*(Telemann)=184/3984=0.046.*

We see that 0.046 is less than 0.5 and so Georg Philipp Telemann and all less significant than him composers are not allowed to be included into "suspicious" group. The last step is a test connected with the value of ***g***.The total number (***N***) of the intensity (for 10-year interval **1680-89**) is 7774. The number of composers (***c***) included in *{group of composers}* is 2. Hence:

α(G)=c/(c+1)*=2/(2+1)=2/3≈0.667;*

g*({Bach, Handel})=(3984+2833)/7774=0.877.*

Recurring to the above conditions that ***g****({group of composers})* must be more than ***α(G)***, we see that 0.877 more than 0.667, and **evolutionary genius** phenomenon take place in this case. We should also consider the total number of the intensity (***N***=7774) to be almost exclusively "made" by only two genius composers: Johann Sebastian Bach and George Frideric Handel (Fig. 7). And these two composers realize **rise** (that took place in Austrian and German musical life in **1680-89**) almost exclusively as well.

Insert Fig. 7.

How composers affect musical life: results of the research

Thus we have five parameters characterizing **evolutionary genius**: the 10-year interval ***t***, the intensity of artistic life ***N***, one of six versions of evolution indicated above, values of ***r*** and ***g***. Using our method we researched evolutionary dynamics of 39 national schools basing on creative activity of 6453 composers. The total number of 10-year intervals (related to different national schools!) where a few composers almost exclusively make up the level of the intensity is 60. The example of corresponding results for Austrian and German, Italian and French national schools is below (Table 4).

Insert Table 4

Our model doesn't prohibit any composer to possess the status of the **evolutionary genius** if the level of intensity (***N***) is low. And in general case it seems very difficult to differ "true" evolutionary genius from artifacts connected with low level of the intensity (***N***). But in fact we can easily see a large gap between really great and "genius-like" composers: "low" level of the intensity is much smaller than "high" level. For example (see Table 4), the numbers of the intensity connected with 1520-29, 1570-79, 1690-99 10-year intervals in Austrian and German musical life and with 1510-19 10-year interval in Italian life are about four—seven times less than the intensity in corresponding adjacent intervals. Therefore we have to exclude 22 10-year intervals (out of a total of 60) because of low level of intensity connected with them. Finally, we deal with true **evolutionary genius** phenomenon only in 38 cases. Corresponding 41 composers are: Giovanni Peirluigi da Palestrina (1525—1594, Italy), Orlande de Lassus (1532—1594, the Netherlands), Thomas Morley (1557—1603, England), Claudio Monteverdi (1567—1643, Italy), Orlando Gib-

bons (1583—1625, England), Heinrich Schutz (1585—1672, Germany), Jean-Baptiste Lully (1632—1687, France), John Blow (1649—1708, England), Henry Purcell (1659—1695, England), Alessandro Scarlatti (1660—1725, Italy), François Couperin (1668—1733, France), Jean-Philippe Rameau (1683—1764, France), Johann Sebastian Bach (1685—1750, Germany), George Frideric Handel (1685—1759, Germany), Franz Joseph Haydn (1732—1809, Austria), André Gretry (1741—1813, France), Wolfgang Amadeus Mozart (1756—1791, Austria), Ludwig van Beethoven (1770—1827, Germany), Gaspare Spontini (1774—1851, Italy), Niccolò Paganini (1782—1840, Italy), Carl Maria von Weber (1786—1826, Germany), Gioacchino Rossini (1792—1868, Italy), Franz Schubert (1797—1828, Austria), Hector Berlioz (1803—1869, France), Felix Mendelssohn-Bartholdy (1809—1847, Germany), Frédéric Chopin (1810—1849, Poland), Robert Schumann (1810—1856, Germany), Franz Liszt (1811-1886, Hungary), Giuseppe Verdi (1813—1901, Italy), Richard Wagner (1813—1883, Germany), César Franck (1822—1890, Belgium), Bedřich Smetana (1824—1884, Czechia), Johannes Brahms (1833—1897, Germany), Georges Bizet (1838—1875, France), Pyotr Tchaikovsky (1840—1893, Russia), Antonin Dvořak (1841—1904, Czechia), Edvard Grieg (1843—1907, Norway), Edward Elgar (1857—1934, England), Jean Sibelius (1865—1956, Finland), Béla Bartók (1881—1945, Hungary), Zoltánne Kodály (1882—1967, Hungary).

Conclusions

The analysis of the results permits to come to the following conclusions. The most favorable version for the **evolutionary genius** is **rise** (24 out of 38 cases). Only **rise** provides for the most powerful growth of “artistic elite.” The “artistic elite” accumulates its control potential and fills up with “migrants” from the “periphery.” The composers of such type of **evolutionary genius** are

almost always innovators often known as founders of a national tradition or school. Their works are usually democratic, they can even be very popular during their authors' lifetime, but the true significance of such composers would be realized many years after their death (appropriate examples are Johann Sebastian Bach, Henry Purcell, Wolfgang Amadeus Mozart, Giuseppe Verdi, Hector Berlioz, Frédéric Chopin, Franz Liszt, Pyotr Tchaikovsky, Edvard Grieg).

Accumulation is a less favorable version for the **evolutionary genius** (9 out of 38 cases). Lack of popularity (***n*** down) creates an "anti-dissipation barrier" that is very difficult to overcome. It's connected with "artificial selection" into the "artistic elite" that takes place during **accumulation**. So if there are any composers of such **evolutionary genius**, the national school is likely to be mature and stable. Such great composers provide for an advanced stage of evolution of the national school, summarizing earlier artistic discoveries and realizing them as a whole continuous tradition. Works of composers of this kind of genius are usually "high-brow," and the authors may be evaluated by contemporaries as "trendsetters" or extremely strange persons as well (examples: Ludwig van Beethoven, Franz Schubert, Johannes Brahms, Jean-Philippe Rameau, Gioacchino Rossini).

Other versions of evolution are unfavorable for the **evolutionary genius**. Their level of the intensity is usually not too high. But there is an exception. We mean two **decline** periods in Austrian and German national school. Composers of such evolutionary genius (Carl Maria von Weber Weber and Felix Mendelssohn-Bartholdy) are like "conservative" and their major significance is really connected with a stability of their musical mastery. There are *no* **evolutionary genius** composers falling on **external growth**: this version reduces the "quality of intensity" (***q***) and the national school appears to be controlled "from outside."

Who makes musical history and what can we say about it now? Let's illustrate our following sentences with Fig. 8, presenting the evolution of three national schools of music: Austria and Germany, Italy, France.

Insert Fig. 8

Of course, a lot of authors make their contributions to the intensity. But we can easily see that composers of "evolutionary genius" are "general managers" of the musical life. Not only do they produce a high intensity level (like other significant composers) but indeed control the evolutionary dynamics. Besides their major significance, they initiate cycles like **rise—dissipation—accumulation—rise**, even realize **accumulation** alone. They really control evolutionary process throughout centuries (see for example Fig. 8, upper graph, the intensity of "the great classical music" of 18^{th}—19^{th} centuries is created exclusively by just nine (!) composers: Joseph Haydn, Wolfgang Amadeus Mozart, Ludwig van Beethoven, Carl Maria von Weber Weber, Franz Schubert, Felix Mendelssohn-Bartholdy, Robert Schumann, Richard Wagner and Johannes Brahms).

Grand masters of "evolutionary genius" obviously have to be regarded as the *central part* of the "artistic elite" (Fig. 9).

Insert Fig. 9

It's a more powerful control centre than the "artistic elite" as the whole. In this case we really deal with the phenomenon of centralization (Golitsyn & Petrov, 1997; Golitsyn, 2000)! Let's make a comment. Studying evolution of the intensity we took into account only the impact of "artistic elite" (6453 composers included in encyclopedia) that may be regarded as a control centre of the whole musical life. It's the lowest level of centralization. But composers included in this "elite," play different roles in evolutionary process. They all make contributions in the intensity, but the musical life is directed by only a few of them (we mean evolutionary genius composers). In other words, the "artistic elite" needs a few "conductors." That's the next, *higher level of centralization*. We could find some qualitative differences between genius composers too. The major part of such composers is connected with single **rises** or **accumulations**, but a few of them ini-

tialize cycles like **rise—dissipation—accumulation—rise**. Climbing higher and higher we can discover *many levels of centralization*. But how far may we climb?

How far can genius control the artistic life? Did Mozart or Beethoven influence the literary life? or the evolution of painting? Did Michelangelo affect musical life? On the one hand our common sense seems to suggest us that they did. On the other hand genius is a "curtained window" for it (Simonton, 1994, p. 19):

> So there we have it: Shakespeare, Newton, Beethoven, and Michelangelo—four creative minds of the highest order. We frequently put geniuses of this high caliber in a class by themselves. In doing so, we implicitly acknowledge that their configurations of traits are so distinctive that the occurrences of such personalities on this planet are few and far between.

Unfortunately, lack of empirical data does not permit us to answer these questions definitely. But when appropriate data become available, they could be recalled, and another research would clarify such enigmatic problems connected with genius.

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Table 1. Evolution of musical life. Austria and Germany.

t	Version of evolution	N
1490	**rise**	118
1500	**decline**	45
1510	**dissipation**	29
1520	**rise**	203
1530	**decline**	70
1540	**rise**	173
1550	**rise**	583
1560	**external growth**	660
1570	**external destruction**	446
1580	**rise**	2131
1590	**decline**	221
1600	**accumulation**	228
1610	**rise**	421
1620	**rise**	631
1630	**dissipation**	433
1640	**accumulation**	585
1650	**decline**	294
1660	**rise**	906
1670	**decline**	475
1680	**rise**	7774
1690	**dissipation**	996
1700	**dissipation**	855
1710	**rise**	3290
1720	**decline**	1232
1730	**rise**	10657
1740	**dissipation**	2094
1750	**rise**	11192
1760	**dissipation**	2007
1770	**accumulation**	11560
1780	**decline**	5945
1790	**accumulation**	9849
1800	**decline**	5724
1810	**rise**	12048
1820	**dissipation**	3765
1830	**accumulation**	5513
1840	**dissipation**	1404
1850	**accumulation**	1619
1860	**accumulation**	6293
1870	**dissipation**	4683
1880	**dissipation**	3280
1890	**decline**	2622

Table 2. Evolution of musical life. Italy.

t	Version of evolution	N
1490	**rise**	62
1500	**external growth**	89
1510	**rise**	503
1520	**rise**	3310
1530	**dissipation**	924
1540	**external growth**	993
1550	**accumulation**	1351
1560	**rise/accumulation**	2883
1570	**dissipation**	1437
1580	**decline**	1145
1590	**decline**	785
1600	**rise/accumulation**	1190
1610	**decline**	118
1620	**rise**	807
1630	**external destruction**	499
1640	**rise**	988
1650	**external growth**	1195
1660	**accumulation**	1991
1670	**external growth**	2063
1680	**rise**	2478
1690	**dissipation**	2370
1700	**decline**	1271
1710	**rise**	2777
1720	**decline**	1815
1730	**decline**	1231
1740	**rise**	1932
1750	**rise/accumulation**	2209
1760	**decline**	1483
1770	**accumulation**	1523
1780	**external destruction**	1437
1790	**rise/accumulation**	2544
1800	**decline/dissipation**	751
1810	**rise**	2888
1820	**decline**	423
1830	**external destruction**	256
1840	**rise**	1147
1850	**rise/accumulation**	1271
1860	**external growth**	1721
1870	**decline**	1132
1880	**rise**	2085
1890	**decline**	951

Table 3. Evolution of musical life. France.

t	Version of evolution	N
1510	**rise**	312
1520	**dissipation**	214
1530	**dissipation**	41
1540	**accumulation**	69
1550	**rise**	142
1560	**rise**	323
1570	**external destruction**	88
1580	**dissipation**	78
1590	**accumulation**	131
1600	**external growth**	163
1610	**decline/dissipation**	58
1620	**rise**	347
1630	**rise**	1051
1640	**decline**	100
1650	**rise**	813
1660	**rise**	2812
1670	**dissipation**	412
1680	**accumulation**	1494
1690	**decline**	354
1700	**dissipation**	190
1710	**rise**	308
1720	**rise**	866
1730	**dissipation**	397
1740	**rise**	1313
1750	**decline**	635
1760	**rise**	1263
1770	**dissipation**	1255
1780	**decline**	692
1790	**accumulation**	964
1800	**rise**	3110
1810	**dissipation**	2065
1820	**decline**	1239
1830	**accumulation**	4029
1840	**dissipation**	3087
1850	**external destruction**	2607
1860	**rise**	4292
1870	**dissipation**	3058
1880	**decline**	828
1890	**rise**	3871

Table 4. «Evolutionary genius». Austrian or German ("AG"), Italian ("I") and French ("F") composers, "true genius" (+) and "genius-like" (–) depending on the level of the intensity.

t	<composer> (r), g		Version of evolution	N	
1520	H. Finck (1), 0.63	AG	**rise**	203	–
1570	M. Praetorius (1), 0.54	AG	**ex. destruction**	446	–
1580	H. Schutz (1), 0.60	AG	**rise**	2131	+
1680	J.S. Bach (1), G.F. Handel (0.71), 0.88	AG	**rise**	7774	+
1690	J. Hasse (1), 0.51	AG	**dissipation**	996	–
1730	J. Haydn (1), 0.81	AG	**rise**	10657	+
1750	W.A. Mozart (1), 0.80	AG	**rise**	11192	+
1770	L. Beethoven (1), 0.84	AG	**accumulation**	11560	+
1780	C.M. Weber (1), 0.59	AG	**decline**	5945	+
1790	F. Schubert (1), 0.79	AG	**accumulation**	9849	+
1800	F. Mendelssohn (1), 0.68	AG	**decline**	5724	+
1810	R. Schumann (1), R. Wagner (0.85), 0.76	AG	**rise**	12048	+
1830	J. Brahms (1), 0.63	AG	**accumulation**	5513	+
1510	A. Scandello (1), 0.70	I	**rise**	503	–
1520	G. Palestrina (1), 0.88	I	**rise**	3310	+
1560	C. Monteverdi (1), 0.59	I	**rise**	2883	+
1660	A. Scarlatti (1), 0.61	I	**accumulation**	1991	+
1770	G. Spontini (1), 0.54	I	**accumulation**	1523	+
1780	N. Paganini (1), 0.51	I	**ex. destruction**	1437	+
1790	G. Rossini (1), 0.60	I	**accumulation**	2544	+
1810	G. Verdi (1), 0.81	I	**rise**	2888	+
1630	J. Lully (1), 0.61	F	**rise**	1051	+
1660	F. Couperin (1), 0.69	F	**rise**	2821	+
1680	J. Rameau (1), 0.81	F	**accumulation**	1494	+
1740	A. Gretry (1), 0.56	F	**rise**	1313	+
1800	H. Berlioz (1), 0.71	F	**rise**	3110	+
1830	G. Bizet (1), 0.61	F	**accumulation**	4029	+

FIGURE CAPTIONS

Fig. 1. Austrian and German musical life **1750-1769** (years of birth are meant). The distribution of the number of lines devoted to a composer (w_i) depending on his rank in the hierarchy of significance (i) including Wolfgang Amadeus Mozart (left graph) and without him (right one). Logarithmic coordinates on both axes are used.

Fig. 2. Six versions of the evolution of three parameters characterizing the intensity of musical life in various national cultures: the number of composers n, the intensity of musical life N and the specific intensity q.

Fig. 3. Evolution of musical life: Austria and Germany.

Fig 4. Evolution of musical life: Italy.

Fig. 5. Evolution of musical life: France.

Fig. 6. Measuring **evolutionary genius**. The procedure of screening for single genius composer on the example of Italian composers relating to 10-year interval **1790-99** (years of birth are meant).

Fig. 7. Measuring **evolutionary genius**. The procedure of screening for two genius composers on the example of Austrian and German composers relating to 10-year interval **1680-89** (years of birth are meant).

Fig. 8. Intensity of musical life “made” by genius and non-genius composers. Austria and Germany, Italy, France.

Fig. 9. Centralization in musical life.

FIGURES

Figure 1

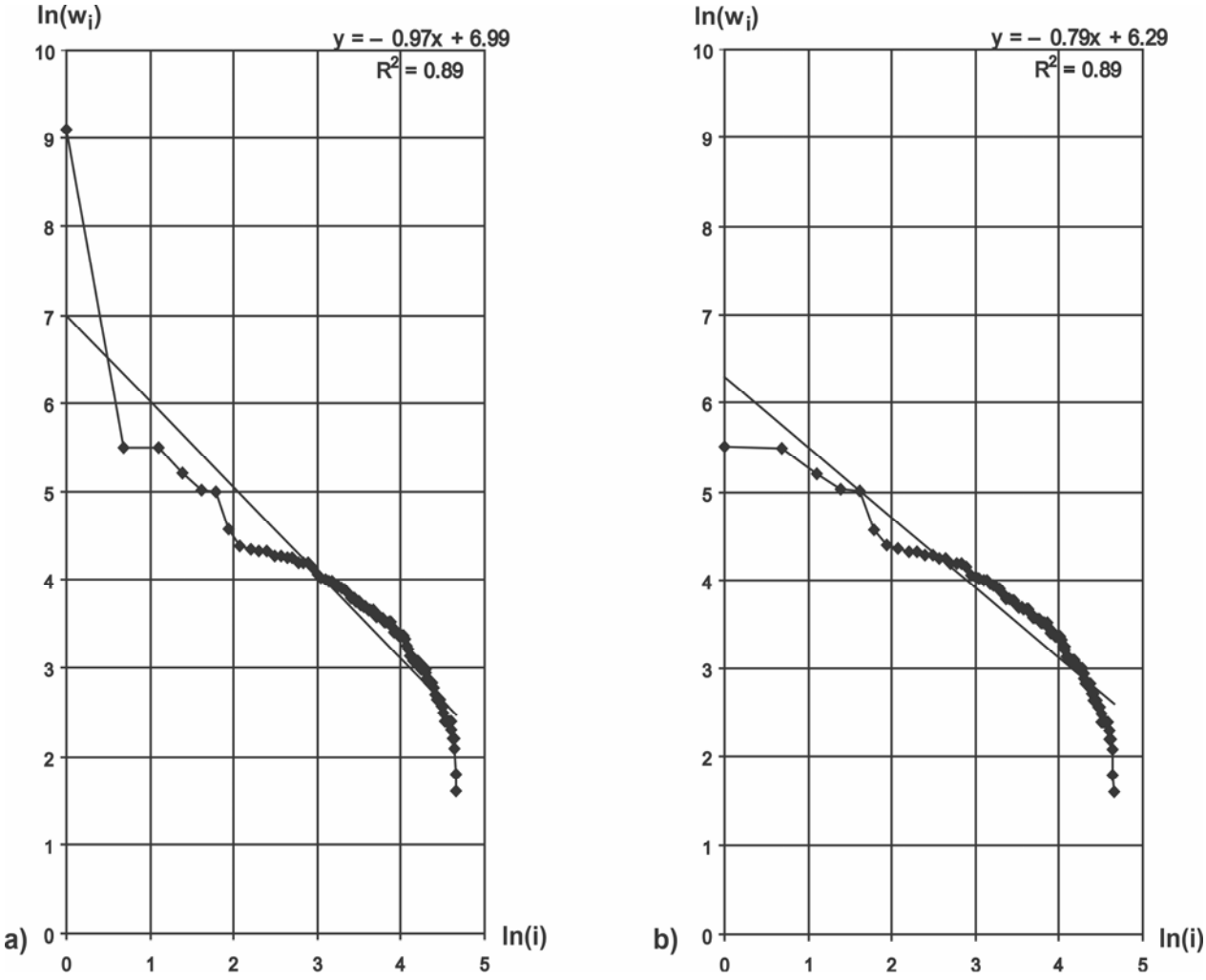
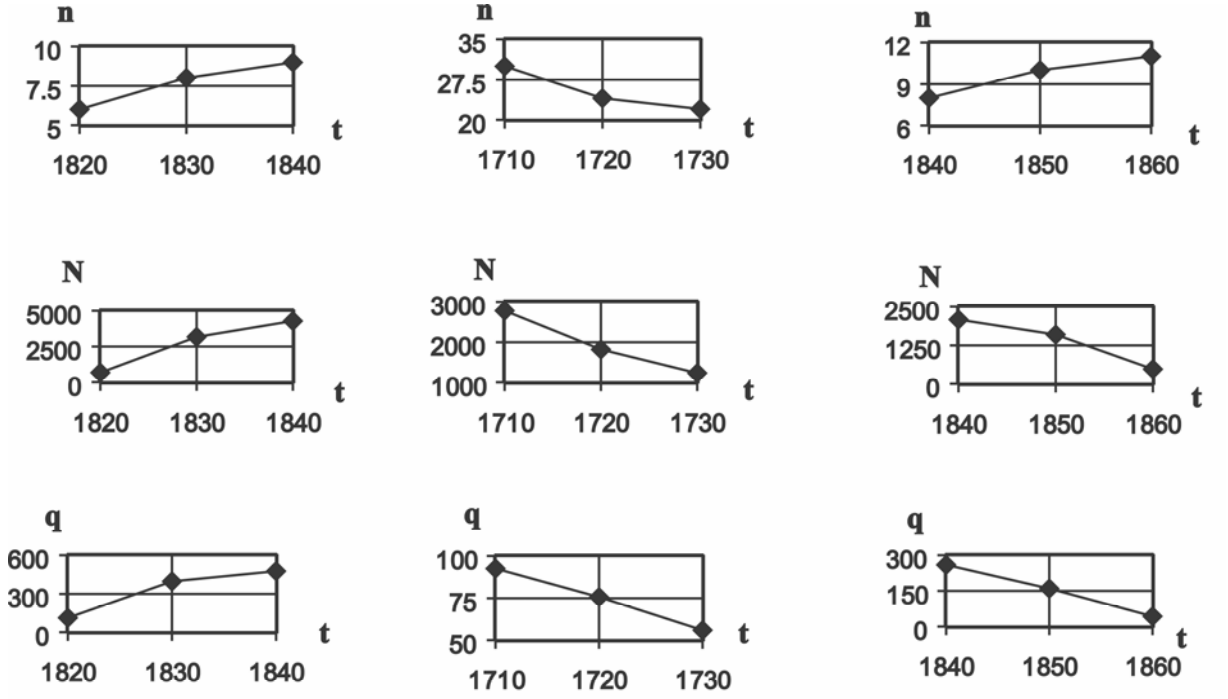


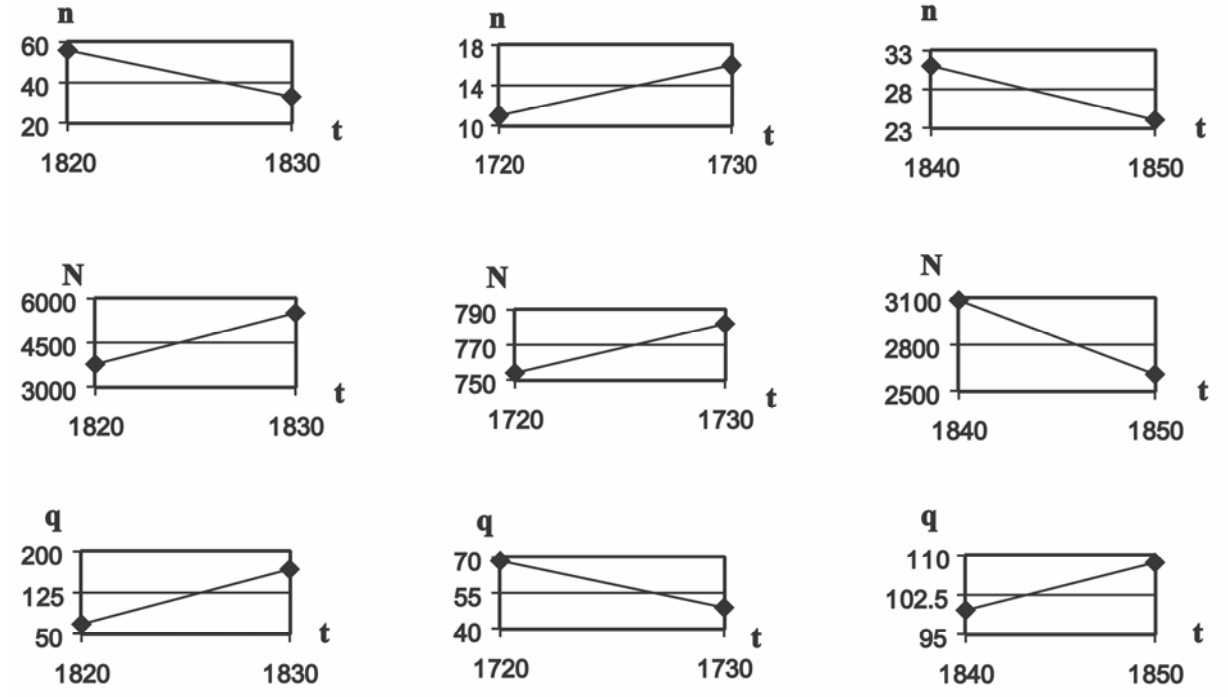
Figure 2



a) RISE (Russia)

b) DECLINE (Italy)

c) DISSIPATION (Czechia)

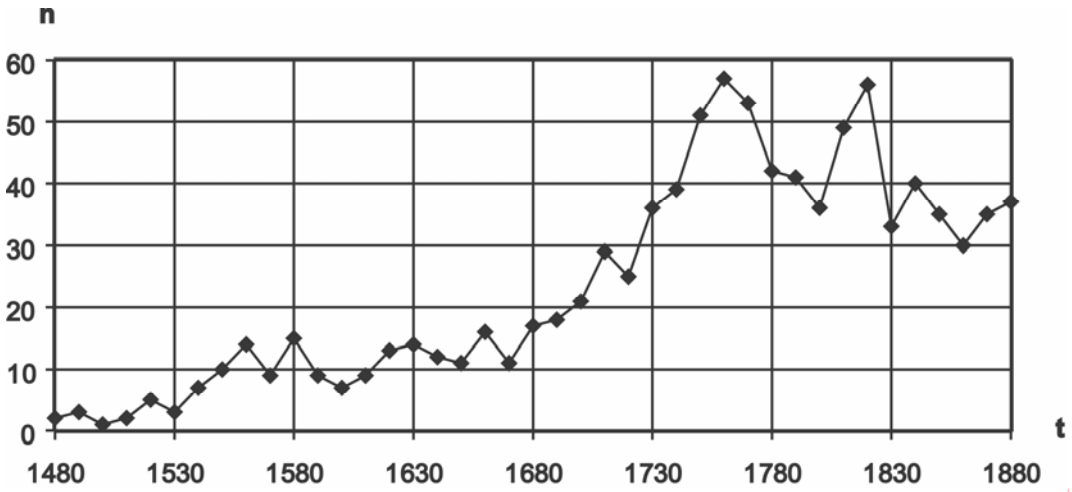


d) ACCUMULATION (Austria and Germany)

e) EXTERNAL GROWTH (England)

f) EXTERNAL DESTRUCTION (France)

Figure 3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50
40
30
20
10
0
t
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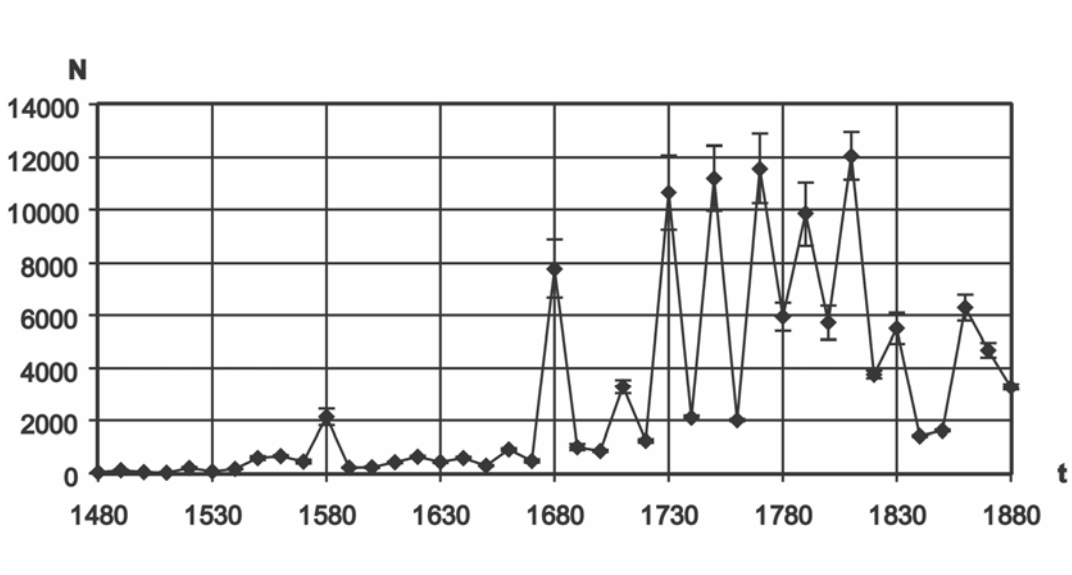
1530
1580
1630
1680
1730
1780
1830
1880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12000
10000
8000
6000
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t
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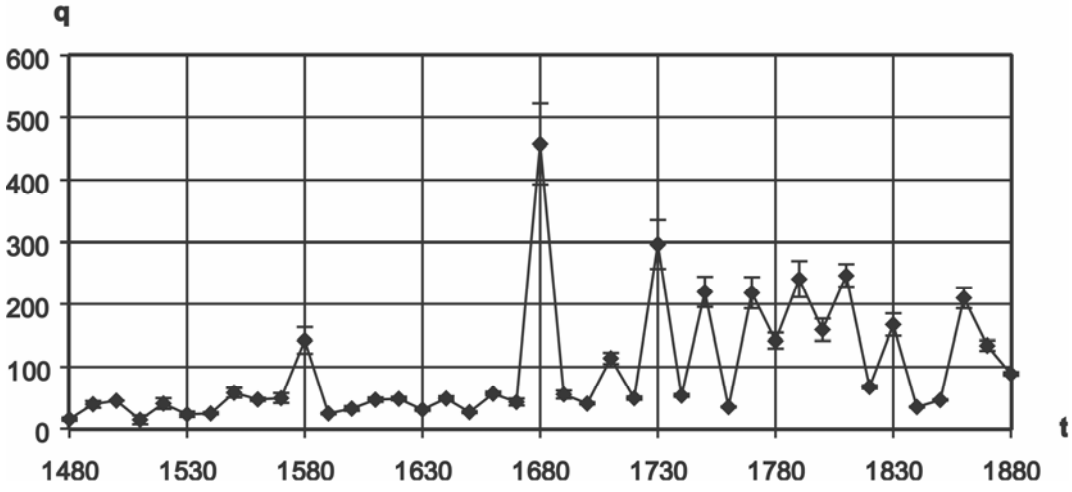
1830
1880


q
600
500
400
300
200
100
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t
1480
1530
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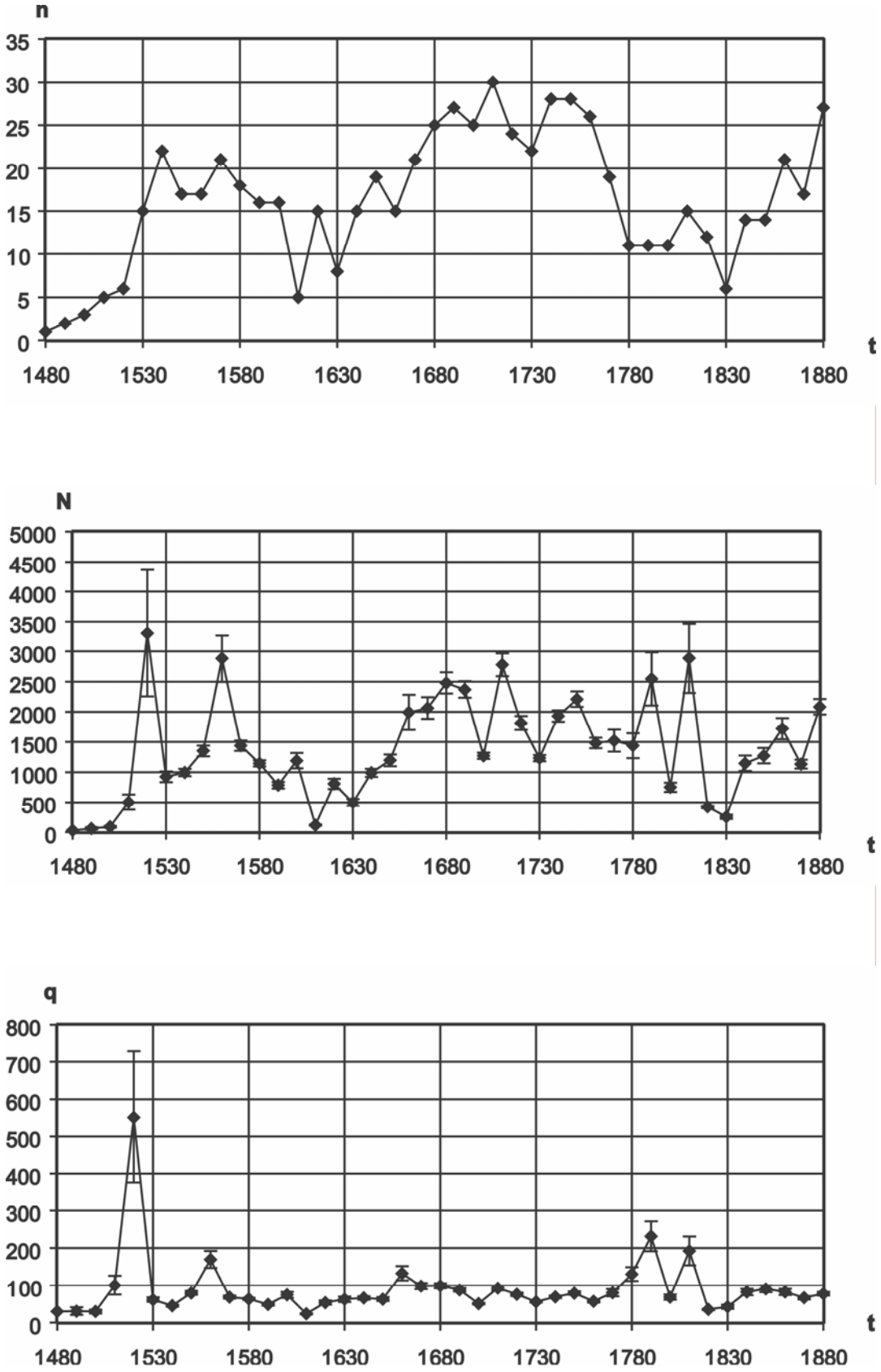
1630
1680
1730
1780
1830
1880

Figure 4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1680
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t
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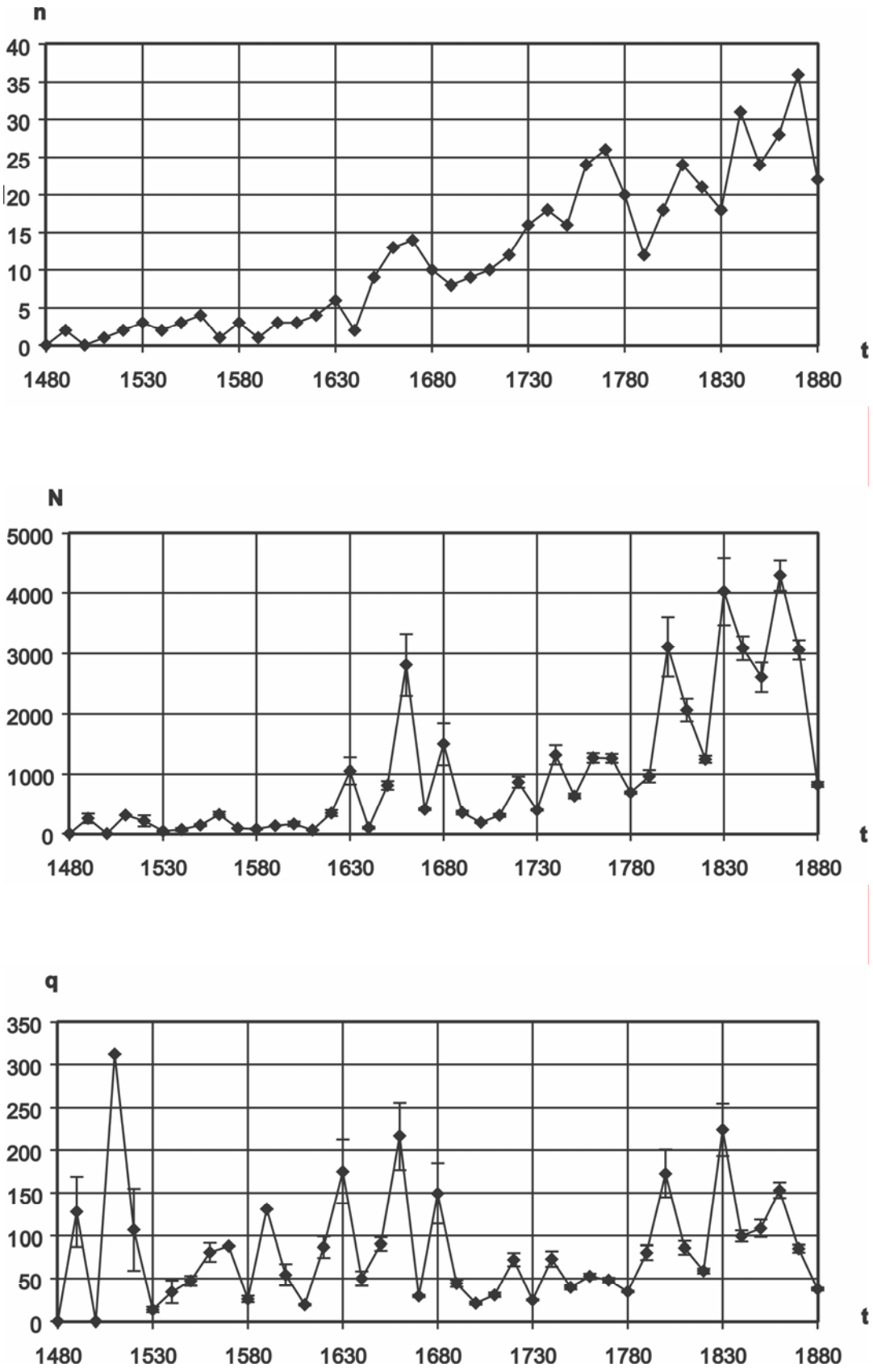
t

Figure 5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4000
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2000
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1630
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q
350
300
250
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150
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1780
1830
1880

Figure 6

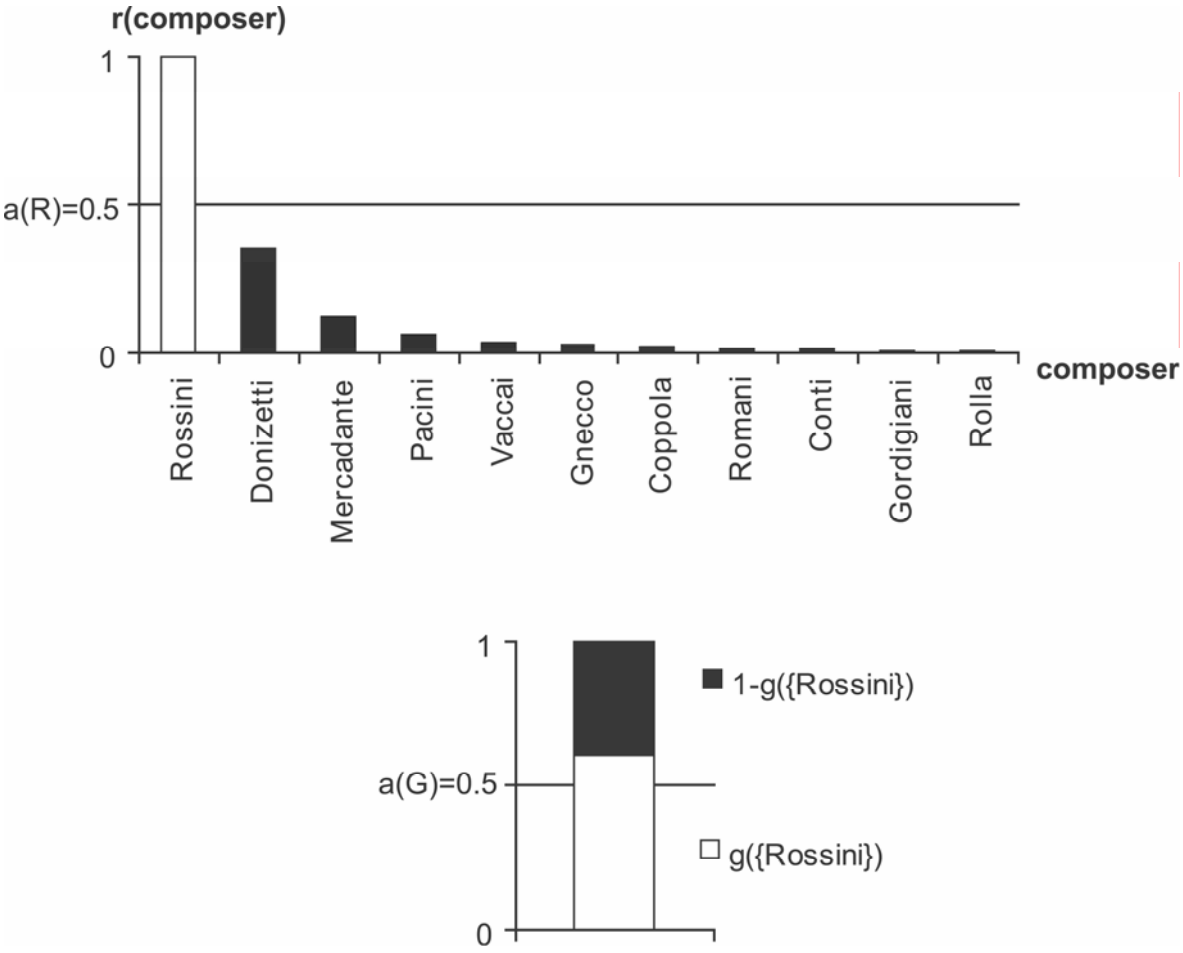

r(composer)
1
a(R)=0.5
0
composer
Rossini
Donizetti
Mercadante
Pacini
Vaccai
Gnecco
Coppola
Romani
Conti
Gordigiani
Rolla
1
a(G)=0.5
0
1-g({Rossini})
g({Rossini})

Figure 7

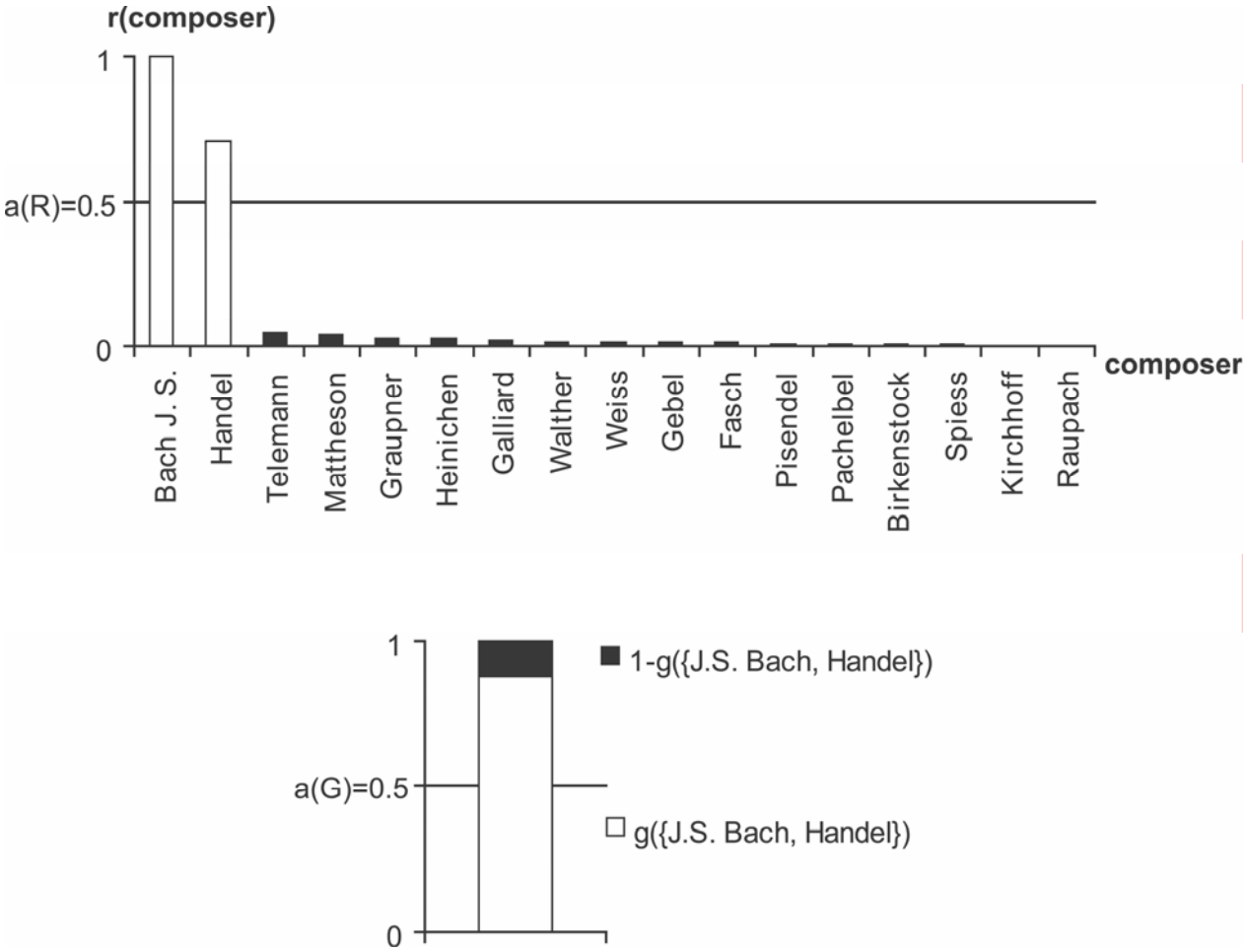
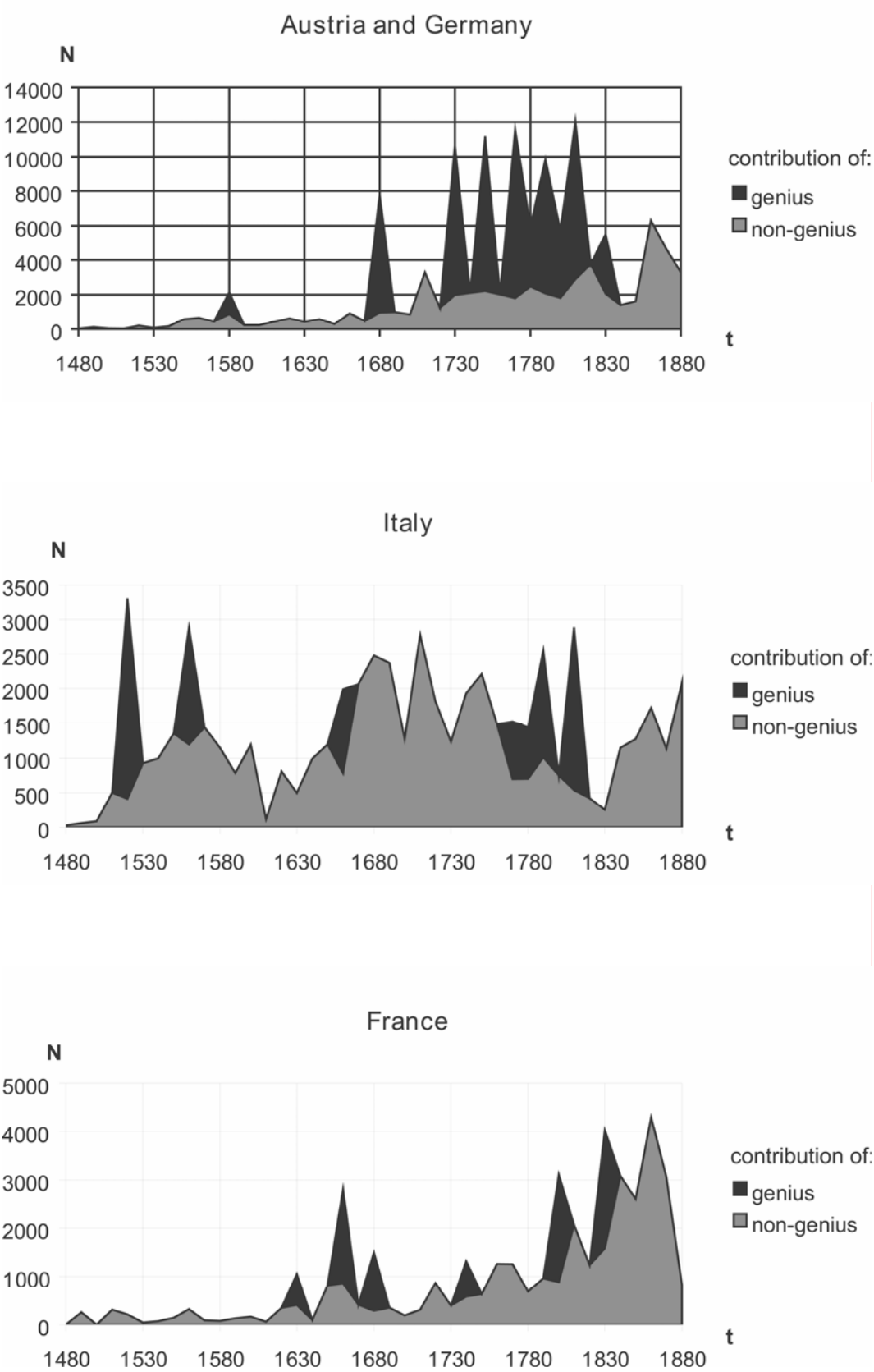

r(composer)
1
a(R)=0.5
0
composer
Bach J. S.
Handel
Telemann
Mattheson
Graupner
Heinichen
Galliard
Walther
Weiss
Gebel
Fasch
Pisendel
Pachelbel
Birkenstock
Spiess
Kirchhoff
Raupach
1
a(G)=0.5
0
1-g({J.S. Bach, Handel})
g({J.S. Bach, Handel})

Figure 8


Austria and Germany
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Italy
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contribution of:
genius
non-genius
France
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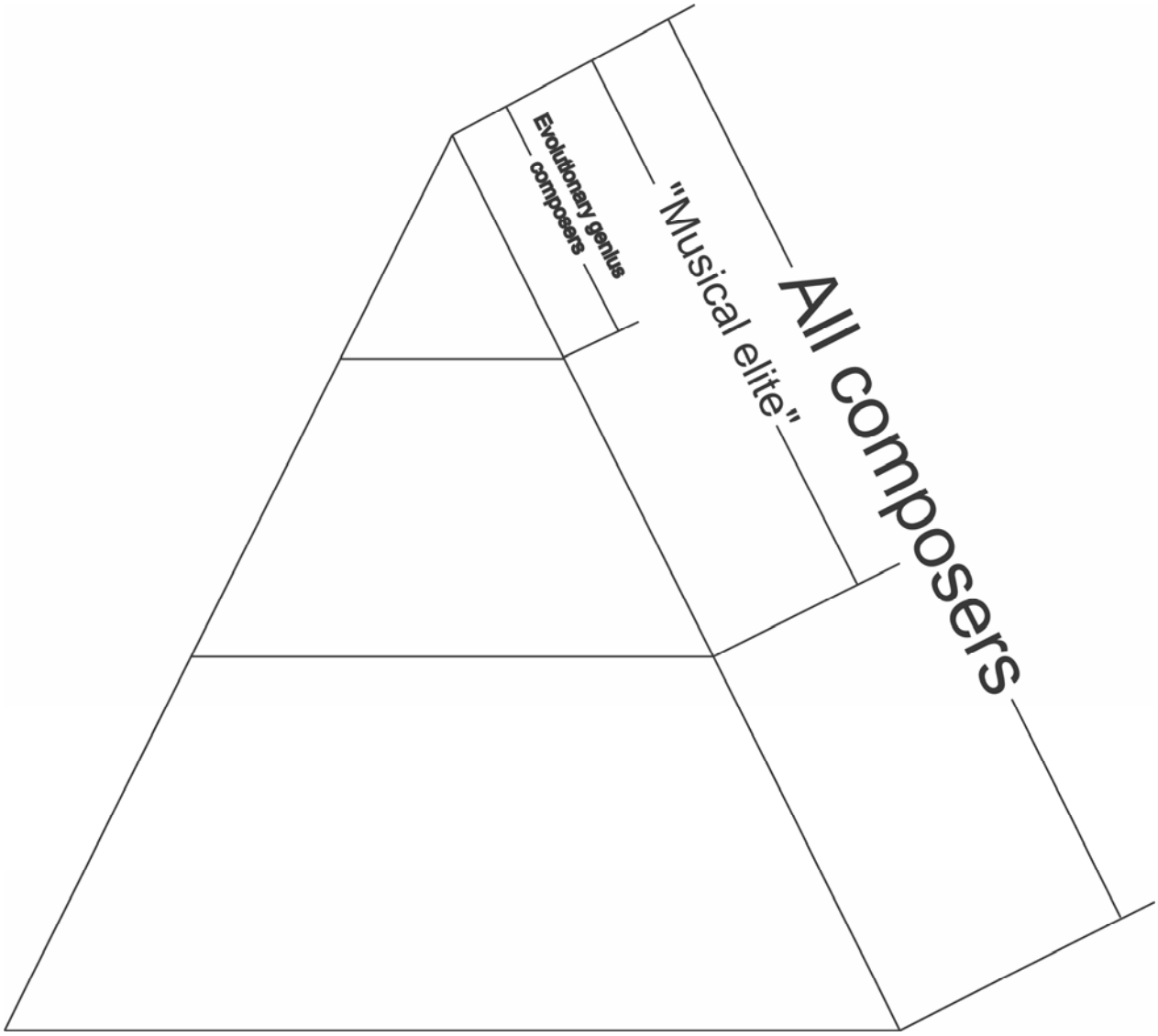
t
contribution of:
genius
non-genius

Figure 9


Evolutionary genius composers
"Musical elite"
All composers