

# The European Stave

A Statistical Study of the Relationship between Nationalism and Music

## 1 Introduction

The development of classical music has always been influenced by the style, culture and history of each country. Apart from the differences between Baroque, Classical and Romantic music, the nationality of each composer is crucial to understand the wide variety of musical tendencies throughout history. For instance, the German and French schools of the late 19th century had opposed styles. These observations led us to ask ourselves if this nationalism in European countries still persists nowadays. Thus our aim is to investigate if the scheduling frequency of pieces and operas is influenced by the country of origin of their composers. We want to find out if, for instance, pieces by Polish composers are performed more often in Poland than in Germany. Moreover, we want to know which are the most performed composers in Europe and their distribution in each country.

For this purpose, we have chosen ten European countries with relevant music tradition, namely Germany, Austria, Russia, Italy, Poland, Hungary, France, Czech Republic, Spain, and England. In each country we have picked the most renowned concert halls and we have gathered data of the concerts that are being scheduled during the 2016–2017 season. We have collected 300 concerts per country, and for each one we have recorded the names of the composers and their nationality. Hence, we have gathered information from 3,000 concerts in total.

With this information we have used statistical tools to ascertain if there is a significant relationship between the country of origin of each composer and the country in which his pieces are more often performed. Hence, we were able to quantify the nationalism present in classical music nowadays. We have used a  $Z$ -test to check the significance of differences of proportions between countries and we have computed five-number summaries of percentages of musical nationalism of European countries in our study. Furthermore, we have calculated the distribution of composers in each country and determined which ones are the most often performed in Europe. We have used the programming language C++ to carry out the calculations.

## 2 Method

In order to obtain enough data, we collected more than 3,000 classical pieces of music from 10 different European countries, together with their authors and the nationality of those. As we have explained in the previous section, we have selected ten European countries that we consider especially relevant in the classical music world. We have also collected data from the United Kingdom and Spain, because these are countries that have not been culturally linked to their neighbor countries throughout history and hence they have little musical influence from them (on the contrary, for instance Austria and Germany have a similar musical style due to their mutual influence). The pieces in each country have been searched from websites of the most famous concert halls of each country. We have chosen the concert halls taking into account their relevance, assistants per year, historical importance and recommendations of travel agencies. We have also tried to balance the number Opera Halls and Symphonic Halls in order to control the variables that could affect the statistical results (because for example normally there are more Italian composers when it comes to Opera but more German composers regarding Symphonic pieces). For each country we have collected 300 pieces. For each concert, if there was more than one piece of the same composer we only counted it once so that it would not alter the data. The list of Concert Halls for each European country is the following.

1. Austria: Musikverein Wien, Grosses Festspielhaus, Salzburger Festspiel, Brucknerhaus Linz, Konzerthaus Wien.
2. Germany: Frankfurt Oper, Festspielhaus Baden-Baden, Berliner Philharmoniker, Deutsche Oper Berlin, National Theater Munich, Staatsoper Hamburg, Komische Oper Berlin.
3. Italy: Teatro La Fenice, Classicitic Roma.
4. France: Opéra Lyon, Opéra Marseille, Opéra National du Rhin, Opéra National de Paris.
5. Russia: Tchaikovsky Concert Hall, Great Hall of the Moscow Conservatory, Rachmaninov Concert Hall, Bolshoi Theatre Moscow.
6. Poland: Kraków Philharmonic, Rzeszów Philharmonic, Warsaw Philharmonic, Filharmonia Poznańska.
7. Czech Republic: Classicitic Prague, Národní divadlo Praha.
8. Hungary: Magyar Állami Operaház, Franz Liszt Academy.
9. Spain: Auditori de Barcelona, Auditorio Nacional de Música, Auditorio de Galicia, Teatro Real, Teatro de la Maestranza.
10. United Kingdom: Royal Albert, Conway Hall, Royal Festival Hall.

The websites of these concert halls can be found in the same order in the Bibliography.

### 3 Collected Data and Comparisons Between Countries

| From           | To | Germany | Austria | Spain | France | Hungary | Italy | Poland | United Kingdom | Czechia | Russia |
|----------------|----|---------|---------|-------|--------|---------|-------|--------|----------------|---------|--------|
| Germany        |    | 47%     | 17%     | 0%    | 7%     | 1%      | 13%   | 1%     | 0%             | 6%      | 8%     |
| Austria        |    | 27%     | 25%     | 1%    | 8%     | 3%      | 10%   | 0%     | 3%             | 7%      | 16%    |
| Spain          |    | 23%     | 17%     | 15%   | 14%    | 3%      | 7%    | 2%     | 3%             | 2%      | 13%    |
| France         |    | 20%     | 15%     | 1%    | 31%    | 2%      | 18%   | 1%     | 3%             | 4%      | 7%     |
| Hungary        |    | 24%     | 9%      | 2%    | 9%     | 31%     | 21%   | 1%     | 1%             | 1%      | 2%     |
| Italy          |    | 17%     | 6%      | 1%    | 7%     | 2%      | 59%   | 1%     | 1%             | 2%      | 4%     |
| Poland         |    | 23%     | 18%     | 1%    | 11%    | 1%      | 10%   | 23%    | 2%             | 3%      | 9%     |
| United Kingdom |    | 39%     | 11%     | 0%    | 9%     | 3%      | 5%    | 4%     | 11%            | 2%      | 17%    |
| Czechia        |    | 29%     | 17%     | 1%    | 11%    | 0%      | 19%   | 3%     | 1%             | 17%     | 3%     |
| Russia         |    | 28%     | 6%      | 0%    | 7%     | 1%      | 5%    | 6%     | 1%             | 4%      | 40%    |

Table 1: Summary of the collected data of all European countries

Table 1 is a summary of all the data that we collected. In the left column and the top row we find the ten countries selected for our study. The column represents the host countries (countries where the concerts took place). The top column stands for the nationality of the composers. The percentages in the table were computed in the following way: there are 300 concerts from each host country, and we counted the number of composers in those concerts that are nationals from each one of the countries, and another category called *Others*, where we could find Finish, Armenian, Georgian, American, and even Singaporean composers. Once we had all the composers classified, we took the sum of the frequencies of the countries in our study and the percentage of each country with respect to these sums.

For example, in Poland we have 300 composers, and 14 of them are in the *Others* category. Then we have 286 composers belonging to the countries studied. In Poland, 65 composers were German. Therefore, the percentage resulted from dividing 65 over 286, and this yields 23%. Hence this is the percentage of German composers performed in Poland that can be found in Table 1. We calculated all the percentages in the table in the same way. Therefore, it is obvious that each row should add to 100%, because 100% is the sum of all the composers who are not in the *Others* category.

To make it more visual, we decided to color some special values. We painted in yellow those cells of a host country that most often performed a specific nationality. For example, if the country with more Spanish composers were Spain, then the cell Spain-Spain would have been painted in yellow. Every nationality should have at least one yellow cell (or, as it will be explained now, a green one). The blue cells stand for the nationality mostly represented in each host country. If German composers are the most performed in the United Kingdom, then the United Kingdom-Germany cell has been painted in blue. But it can occur that the two circumstances coincide, the blue and the yellow ones. This would be, for example, the case of Italy. Italy is where Italian composers are most scheduled, and those who are more performed in Italy are Italian composers. As such cells should be both blue and yellow, we decided to paint them in green. Two basic observations are that each column will have a yellow or green cell, and each row (each host country) will have a blue or green cell, as one nationality must be the one most represented. In Poland, we have the unique circumstance that the composers most represented are the German and Polish ones, with 65 representations. Both have been painted: the first one in blue and the second one in green.

Looking at the table we can find to clear tendencies. The first one we call it the *diagonal tendency*. The whole diagonal is painted, either in yellow or green. This means

that each nationality is most represented in its own country. This is very plausible. Czech composers are more likely to be performed in the Czech Republic more than in any other country. But this is not bidirectional, since the nationality most represented in a host country it is not always the self one. This only happens in the green cells. For example, in the United Kingdom we find more British composers than elsewhere, but we find more German than British composers, as the level of German composers is higher than the national ones. This is what we could call the *vertical tendency*. This is the reason why Germany is the only nationality that achieved blue cells. Or, in other words, all host countries either represent the most themselves or Germany, and in the first case, German composers are always the second ones more represented. These two tendencies explain why there are two lines in Table 1, a vertical one and a diagonal one.

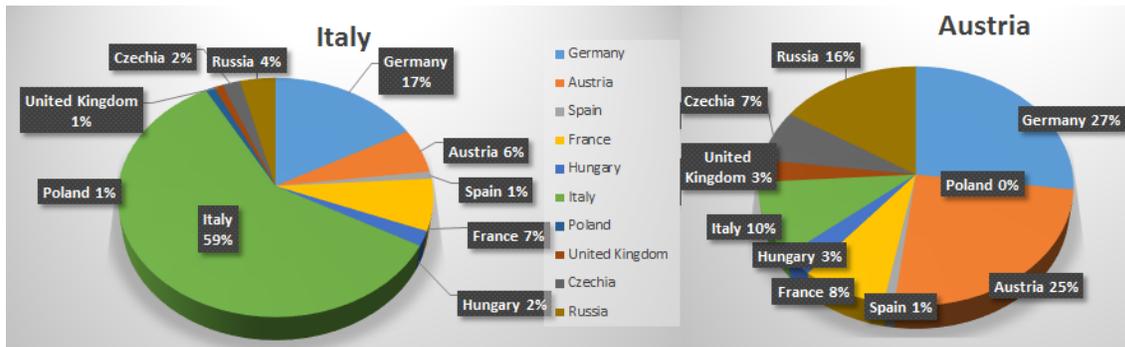


Figure 1: Pie charts of the data obtained in Austria and in Italy respectively

We will do first a comparison between Austria and Italy. Both countries are cultures with a big classical tradition. Composers such as Mozart, Haydn, Verdi and Puccini were born in these countries. It would be logical to think that both countries would empower their own musicians. After collecting all the data we did those pie charts found in Figure Whatever. The results were kind of unexpected, and the differences were big enough to study them with depth.

On the one hand, the pie chart in Italy results one of the more monochromatic ones. It is understood that the ten colors are almost in every chart, but Italy has the biggest portion of pie of the ten countries. Italian composers are the 59% of the representations of concerts and operas in Italy, and the next nationality, Germans, are not even a third of importance as Italians. There is no other nationality that reaches the 10%, and Spanish, Hungarian, British and Czech composers together weight only the 7% of the total number of concerts. This gives as a chart with a leading color, the green of Italy, a relatively big piece representing German composers, and lots of little piem portions for the other countries. This suggests us that the Italian public is very nationalist and loves to see Italian Operas and concerts, as they are more used to the passionate way of Italian music, meanwhile they see the foreign music as strange and do not feel comfortable with it.

Moreover, the Austrian pie chart resulted to be one of the more surprising ones. With the number of great composers who were from Austria, and the musical tradition of the Austrian, it was expected that Austrian composers were to lead the chart in Austria. It was not like this, and finally happen to be that German music was the most listened in the concert halls of Wien, Salzburg, Linz and all the other Austrian cities. Well-known by the *Neujahrskonzert*, where all the Strauss family is played, it resulted that in the normal days is played a lot of German, Austrian, Russian, Italian and French music, while the

other countries are less represented. Italy and Austria are two examples of how a country with great composers can behave. It can be like Italy, and represent almost only their own music, or be more *polyglottal* and play world-wide music.

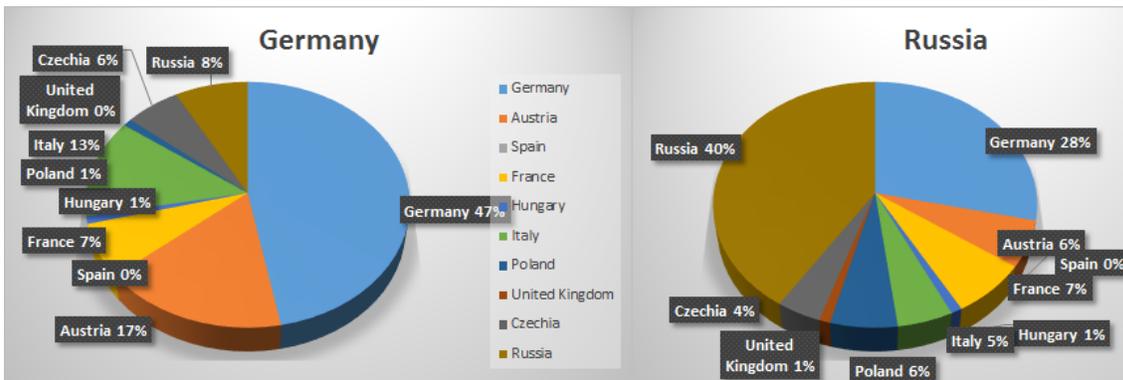


Figure 2: Pie charts of the data obtained in Germany and in Russia respectively

The others two countries that we will study more specifically are Germany and Russia, two other musical potencies which reunite composers such as Beethoven, Bach, Wagner, Stravinsky or Tchaikovsky. These countries tend more to the Italian way, but with slight differences and not so extreme. Germany is almost all the right part of Germany's pie. The 47% of German concerts and operas are from German composers, this means that, approximately, for every two pieces one was from a German composer. But this could be understood once we take into account that German composers are the ones that like more to the public, and this phenomenon gets even bigger in their own country. The German tradition is in some ways also unique, and Germans are more used to it than to any other national tradition. Austria receives a piece of pie of the 17%, which does not correspond to what Austria gave to Germany, but even though Germany is one of the countries which plays most Austrian composers. This can be explained from a cultural point of view, since both nations have lots of things in common: their language, their geographical location, their traditions, etc.

There are also relations between Poland and Russia, two countries with a strong cultural relation. Even though Polish composers are just the 6% of Russian concerts, it is one of the places where it is more played. Austria has a lot more of classical tradition and it is also only a 6% of all music played in Russia. The own Russians play themselves a 40% of the times, and occupy almost all the left part of the chart. Germany has also a lot of presence in Russia. In fact, it is even more played in Russia than in Austria. The fact that these two countries monopolize almost everything played in Russia leaves all the countries with a minor importance. Russia and Germany represent two musical potencies who empower their own composers, but not reaching the level of Italy. Having almost half of the representations of national composers and leaving the other half to a more open range of possibilities is the way both countries deal with their own classical potential. And is important to notice how cultural bonds affect to the music played, and close countries as Poland (in the Russian case) and Austria (in the German one) take so much importance. The pie charts of the other countries represent graphically the information of Table 1 and they can be found on the annex.

## 4 Five-number summary

We have considered relevant to present the five-number summary of the percentages of pieces of each country with authors of the same country, so that we can see the tendency of each country to represent their own music. This statistical tool allows us to analyze the obtained results in a more proper way so that we can establish an average percentage. The obtained nationalist-percentages are shown in Table 2.

| Country        | Percentage |
|----------------|------------|
| Germany        | 47%        |
| Austria        | 25%        |
| Spain          | 15%        |
| France         | 31%        |
| Hungary        | 31%        |
| Italy          | 59%        |
| Poland         | 23%        |
| United Kingdom | 11%        |
| Czech Republic | 17%        |
| Russia         | 40%        |

Table 2: Percentage of pieces of each European country composed by a musician of the same country

We are going to analyze this information. The first thing we observe is that the country with less representation of his own music is the United Kingdom with 11% and the most is Italy with 59%. The arithmetic mean of a set of  $n$  measurements is equal to the the sum of the measurements divided by  $n$ <sup>1</sup>.

$$\mu = \frac{\sum_{i=1}^n x_i}{n} \quad (1)$$

In our case the mean would be:

$$\frac{47 + 25 + 15 + 31 + 31 + 59 + 23 + 11 + 17 + 40}{10} = 30 \quad (2)$$

Hence, the average representation in a country of a piece of the same country is 30%. Now we are going to calculate the median and the quartiles. The median is the value in the middle position when the measurements are ordered from smallest to largest<sup>2</sup>. The first quartile divides the ordered data such that 25% of the observations are at or below this value<sup>3</sup> while the third quartile divides the ordered data such that 75% of the observations are at or below this value<sup>4</sup>. In our case the median is 28%, the first quartile is 16.5% and the third quartile is 41.75%. With all this information we can represent the data with a box-and-whisker plot. We obtain the plot shown in Figure 3.

---

<sup>1</sup>Definition of arithmetic mean by the Mathematics higher level book editorial Pearson page 481.

<sup>2</sup>Definition of median by the Mathematics higher level book editorial Pearson page 481.

<sup>3</sup>Definition of first quartile by the Mathematics higher level book editorial Pearson page 491

<sup>4</sup>Definition of third quartile by the Mathematics higher level book editorial Pearson page 491.

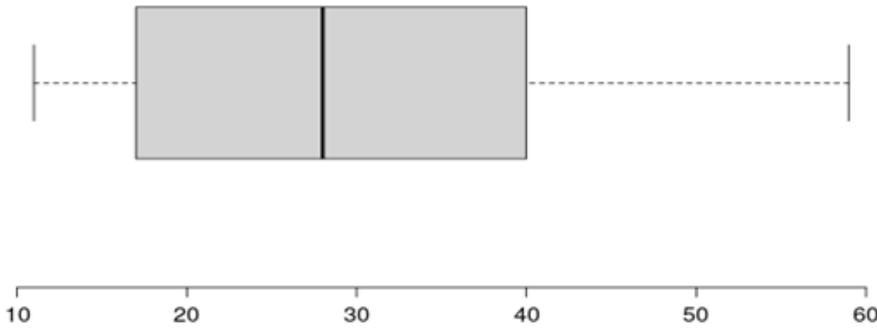


Figure 3: Box-and-whisker plot of the percentages of composers represented in their native country

We can see that the data is not symmetric because the median is not at the center of the plot and, the interquartile range (Q3-Q1), which measures the spread in the middle 50% of the data, in the plot is represented with the box, also is not symmetric; most of it is at the left of the middle. The fact that most of the data is at the left of the plot indicates that the high percentages of concerts of the same country being represented in the same one, are really singular and rare, actually there are only two countries of the 10 that we have chosen with percentages over 40% (Italy and Germany). Finally, the standard deviation is the square root of the sum of the squared differences between each observation and the population mean divided by the population size<sup>5</sup>:

$$s_n = \sqrt{\frac{\sum_{i=1}^n (x_i - \mu)^2}{n - 1}} \quad (3)$$

Using this definition, we obtain that the standard deviation of the percentages that show the tendency of each country to represent music from their own composers is 16.04%. That is because the music with a lot of tradition in classical music such as Germany, Italy or Russia are clearly above the mean (47%, 59% and 40% respectively), whereas countries such as Spain or the Czech Republic have lower percentages (15% and 17% respectively). Table 3 shows the five number-summary of our data.

| Minimum | Q1    | Median | Q3     | Maximum |
|---------|-------|--------|--------|---------|
| 11%     | 16,5% | 28%    | 41,75% | 59%     |

Table 3: Five-number summary of the nationalism percentages of the ten countries

## 5 Z-test

Once we have analyzed the table of composers between countries, we use the statistical test Z-test in order to compare the percentages and see if we can prove statistically their significance. This statistical test can compare two populations of groups when the variable is categorical and we want to compare the proportions to see if the difference between the percentages is significant <sup>6</sup>. In order to make this comparison, two independent samples

<sup>5</sup>Definition of standard deviation by the Mathematics higher level book editorial Pearson page 488.

<sup>6</sup>Explanation in the book Basic Statistical Analysis book editorial Pearson.

are selected. For this reason, for each country we have divided the data as it is shown in Table 4 using Germany as an example:

|                 | German composers | Composers from other countries | Total |
|-----------------|------------------|--------------------------------|-------|
| Germany         | 141              | 159                            | 300   |
| Other countries | 653              | 2055                           | 2708  |
| Total           | 794              | 2214                           | 3008  |

Table 4: Table used for the  $Z$ -test regarding Germany

We define  $p_1$  to be the percentage of composers of the host country interpreted in the host country in comparison to the total number of composers interpreted in the host country. For instance, in Germany  $p_1$  equals  $\frac{141}{300}$ . We define  $p_2$  to be the percentage of composers of the host country interpreted in the other countries in comparison to the total number of composers interpreted in other countries. For instance, in Germany  $p_2$  equals  $\frac{543}{2408}$ . Moreover,  $n_1$  is defined as the total number of composers interpreted in the host country (sample size) and  $n_2$  as the total composers interpreted in other countries. For example, in Germany  $n_1$  equals 300 and  $n_2$  2708 (these two numbers are the same for all countries because we collected same amount of data). Our null hypothesis  $H_0$  stated that  $p_1 = p_2$ . Moreover,  $p$  is defined as shown in Equation 1.

$$p = \frac{n_1 \cdot p_1 + n_2 \cdot p_2}{n_1 + n_2} \quad (4)$$

Also,  $z$  is expressed as shown in Equation 2.

$$Z = \frac{p_1 - p_2}{\sqrt{p \cdot (1 - p) \cdot (\frac{1}{n_1} + \frac{1}{n_2})}} \quad (5)$$

The denominator is designed as the standard error (SE). Then, if we look for the value of  $Z$  on the  $Z$ -table we will obtain the standard normal distribution and the  $p$ -value, which refers to the probability that the percentages obtained are random. If the null hypothesis were true,  $Z$  would follow a standard normal distribution.

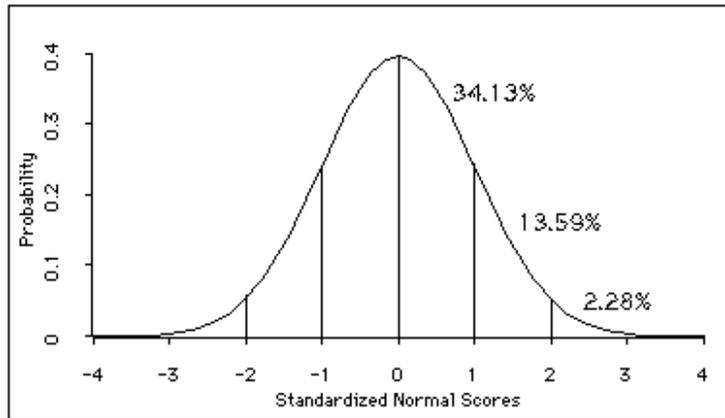


Figure 4: Curve of the normal distribution in which we observe the value of  $Z$  and the  $p$ -value

We have computed the value of  $Z$  for the ten European countries using C++ (the code can be found on the annex) and we have obtained the following results, which are resumed in Table 5.

| Country        | Z     |
|----------------|-------|
| Germany        | 8,53  |
| United Kingdom | 8,98  |
| Russia         | 15,81 |
| France         | 10,82 |
| Austria        | 4,85  |
| Hungary        | 21,79 |
| Italy          | 20,16 |
| Poland         | 16,58 |
| Czech Republic | 10,51 |
| Spain          | 15,58 |

Table 5: The value of  $Z$  obtained in each European country

Since for all values of  $Z$  we have obtained a value bigger than 4, the  $p$ -value is smaller than 0.001 and hence there is sufficient evidence to conclude that the two percentages differ and we can reject the null hypothesis. In all European countries the value of  $p_1$  is much bigger than the value of  $p_2$ , and this means that there is statistical evidence to show that in all European countries they represent more composers with the nationality of the country than in the rest of Europe. We can then claim that nationalism in music is present in all European countries. Moreover, it is interesting to see that the countries with less famous composers (such as Hungary or Poland) have very high  $Z$  values because since they are not represented very much in the other European countries but they are very interpreted in their own country the difference between the percentages is much more notable. On the other side, since Germany is always either the first or the second most represented country in all Europe, the proportion between German composers in Germany and in the rest of Europe is not as considerable as other countries that do not have many well-known composers. Although from the raw data it was quite clear that the place in which the pieces of a certain composer were more performed was in his own country, we needed a test in order to prove statistically the significance of these differences. Now we can claim that our previous observations are relevant enough.

## 6 Top composers

Furthermore, we also wanted to study the frequencies in which the different composers where played in the countries of our sample. As we have seen in the previous sections, we had a very big database with over 3000 concerts from the 10 countries in our sample which we used to make this part of the study. The second program is just an ordering program, which places first the composer which the highest frequency. An image of the code can also be found on the annex.

We used two computer programs written in C++ to count and order the 3000 concerts in the sample. The counting program uses a dictionary structure called map which relates every composer to the number of times he has appeared in our database. An image of

the code can be found on the annex. After processing the data, we made 10 bar plots (histograms) which represented the frequency of each composer played in every country of our sample. The entire 10 plots will be annexed at the end of the document. Out of these 10 graphs, we will analyze two - the one from Germany (see Figure 7), because of its musical history and culture, and the one from Spain (see Figure 8), because since there are not very internationally famous composers the number of total European composers and their frequency is much different.

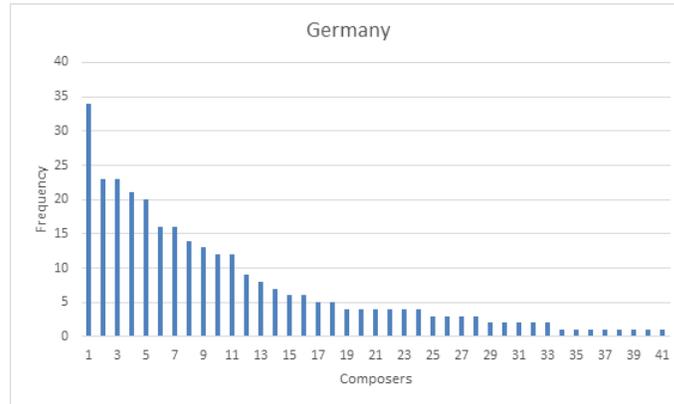


Figure 5: Histogram of the frequency of composers played in Germany

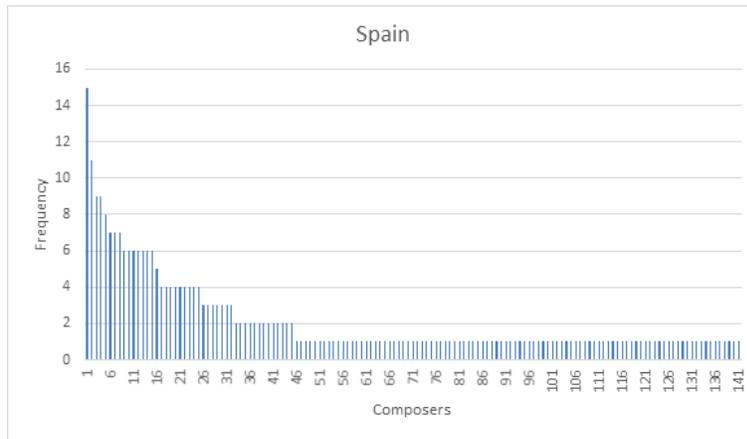


Figure 6: Histogram of the frequency of composers played in Spain

There are two main differences between these two plots. Germany's plot contains a very graded descent and has 41 composers but, instead, Spain's plot contains an exponential descent and more than 140 composers. Therefore, Germany has very few composers in a great frequency while Spain plays a lot of composers in lower frequencies. Moreover, Germany follows an exponential function with a correlation  $R^2$  of 0.98 as it is shown in Figure 9.

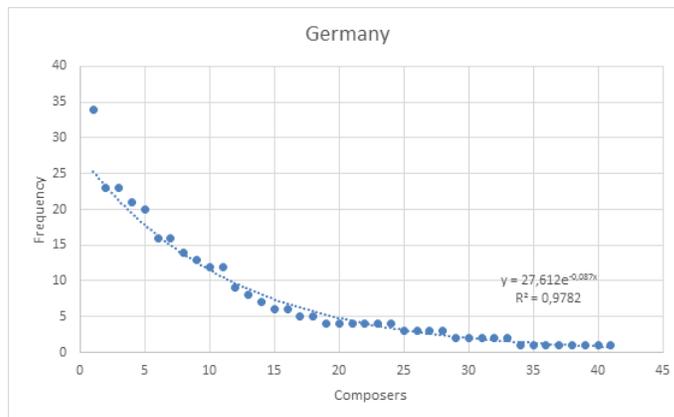


Figure 7: Exponential function followed by the frequency of European composers in Germany

This might be caused by Germany's wide musical culture and history, which makes its inhabitants like a very specific type of music because of a traditional movement. As inverse, Spain is not an important musical exporter and, therefore, its inhabitants do not have a favorite type of music. This argument could be enhanced looking at the top 5 composers of these countries. If our hypothesis is right, the top composers of Germany will be Germans whereas the top composers of Spain will not be Spanish.

| Spain |                         | Germany |                         |
|-------|-------------------------|---------|-------------------------|
| #     | Composer                | #       | Composer                |
| 1     | Wolfgang Amadeus Mozart | 1       | Wolfgang Amadeus Mozart |
| 2     | Ludwig van Beethoven    | 2       | Ludwig van Beethoven    |
| 3     | Richard Wagner          | 3       | Johann Sebastian Bach   |
| 4     | Maurice Ravel           | 4       | Johannes Brahms         |
| 5     | Johannes Brahms         | 5       | Robert Schumann         |

Table 6: frequency of the top 5 composers in Germany and in Spain

In this table we can clearly see that our hypothesis is right, with the only exception of Wolfgang Amadeus Mozart, who is Austrian. However, we already discussed that the influences between Austria and Germany have to be taken into account and hence with this, we can conclude that the countries with a wide musical culture tend to be more nationalists when choosing its favorite music than the ones with a poor musical history. As you can check in the annex section, the data from the other 10 countries also follows this rule, which divides our sample in two groups: the most nationalist countries (Germany, Austria, Italy and Russia) and the less nationalist countries (Spain, Czech Republic, Poland, France, Hungary and England). It is easy to see that the countries in the nationalist group have a wider musical culture whereas the countries in the other group do not. lo

Lastly, we made an overall top 5 composers, to see which countries were most musically represented. The following list represents the overall top, as well as with its frequency (over 3000, since this is the size of our sample).

| Overall Sample |                         |
|----------------|-------------------------|
| F              | Composer                |
| 156            | Wolfgang Amadeus Mozart |
| 148            | Ludwing van Beethoven   |
| 115            | Johannes Brahms         |
| 83             | Guissepe Verdi          |
| 78             | Richard Wagner          |

Table 7: frequency of the 5 top composers in Europe

## 7 European Concert Hall

### 7.1 By nationalities

After having studied the concerts and operas that were played in all the 10 countries, we asked ourselves how would we plan an hypothetical classical music season in a European Concert Hall. So we created what we call the European Concert Hall, in which we try to balance the percentage of nationalism found in this study according to the population of each country. This way, European spectators are offered the most objective program of classical music according to the percentage of nationalism of each of the 10 European countries we studied. With this purpose we intended to find the average values of the representation of composers of each nationality. We have already collected and worked with these data so we know the percentages of each nationality represented in the same country. Since it is unfair to weight all countries with the same size (for instance, there is more public in Germany that in Czechia since the population is much different), we used the criteria of population to give a specific weight to each country. The population we have taken into account is the population on 2017<sup>7</sup> rounded up to the millions. The population assigned to each state appears in the first column of Table 7. Once we have the population, we can proceed to calculate the weighted mean. For each nationality (the columns in Table 1), we multiply the percentage of representations in each country by the weight of that country and we add all these 10 values (of the 10 countries). For example, French composers are represented a 7% in Germany and 8% in Austria (the populations are 81 and 9 million respectively) so we multiply 7% by 81, 8% by 9 and so on. We repeat this process for each nationality and we obtain a certain value for that nationality. The result of dividing each one of this values by their total sum is what we call *Percentage*, and represents the percentage of representations a given nationality would have in our European Concert Hall. Since we have studied 300 concerts per country, we decided that if our Hall should ever exist, it should program 300 concerts per year. For this reason we multiplied the percentage by 300 the number of concerts that would be of each of the nationalities.

---

<sup>7</sup><http://www.populationpyramid.net/>

| Country        | Population<br>(in millions) | Percentage | Concerts |
|----------------|-----------------------------|------------|----------|
| Germany        | 81                          | 29%        | 88       |
| Austria        | 9                           | 12%        | 36       |
| Spain          | 46                          | 2%         | 5        |
| France         | 65                          | 11%        | 34       |
| Hungary        | 10                          | 2%         | 7        |
| Italy          | 60                          | 15%        | 44       |
| Poland         | 39                          | 4%         | 13       |
| United Kingdom | 66                          | 3%         | 8        |
| Czechia        | 11                          | 4%         | 12       |
| Russia         | 143                         | 18%        | 53       |

Table 7: Population and weight of each European country

The results obtained are very similar to the results we obtained in all countries except for the cases of high nationalism in the country. So we could say that our European Concert Hall is, in fact, feasible. What we observe is that Germany is in the lead, followed by a list of countries that go over the 10%. These are: Austria, France, Italy and Russia. Together with Germany these are the countries with the most cultural tradition in classical music and this is reflected in the rest of Europe. The other five countries are countries that have produced a smaller number of great composers and are therefore less represented. Once we had calculated the non-nationalist distribution of concert halls, we asked ourselves: which will be the country with a less subjective view of classical music? This means that we want to find the country with less deviation with respect of the European Concert Hall's distribution. With this in mind we applied a simple method: we took a country, and for each nationality represented we took the positive difference between the percentage on the country and the one on the Concert Hall, and we added all of them. This way we obtained what we called the degree of deviation. The degrees of deviation of each country are shown in Table 8.

| Country | Degree of deviation | Country        | Degree of deviation |
|---------|---------------------|----------------|---------------------|
| Germany | 50                  | Italy          | 88                  |
| Austria | 35                  | Poland         | 48                  |
| Spain   | 46                  | United Kingdom | 37                  |
| France  | 50                  | Czechia        | 43                  |
| Hungary | 69                  | Russia         | 50                  |

Table 8: Degree of deviation of each European country

We observe a wide diversity of degrees of deviation, because for instance Italy's is two and a half times Austria's one. After doing this analysis we can conclude that Austrians are the most neutral spectators in the whole Europe followed by the British. As we have already done, we want to remark the importance of the fact that it is precisely Austria, a country with long musical tradition, which is the most objective one. The most deviated countries are Hungary and Italy. In both cases we see the same pattern: the own nationality is widely listened and the others are not so much. These two factors increment

the degree of deviation. For example, in Italy, Italian composers represent a 59%, whereas in Europe they only represent the 15%, which is a huge difference.

## 7.2 By composers

We also wanted to create the schedule of our European Concert Hall but taking into account the composers instead of the nationalities. To do this we had to compute the relative frequency of every composer in our sample. We computed the relative frequency of every composer in the sample and we realized that we had a very big 'others' section, of over a 50%. Since we were not interested in this section, we reduced the sample to the top 20 most listened composers and we did the relative frequency of such list. Obtaining the following plot:

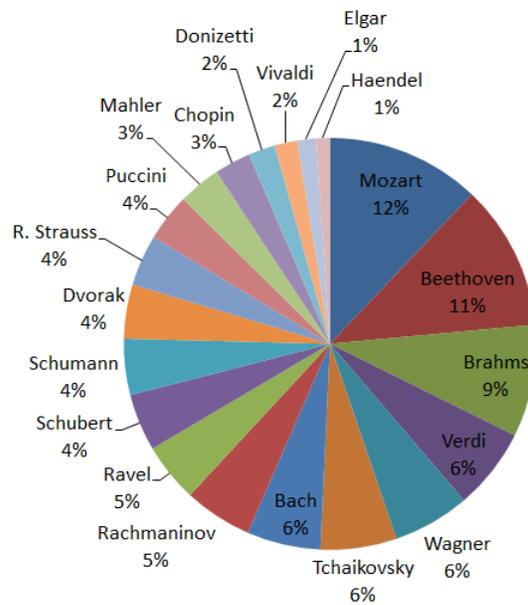


Figure 8: Percentages of the top composers in all Europe

Then, we supposed that our European Concert Hall had 300 concerts per year (like in the previous section) and we wanted to compute how many concerts each composer would have. The results of such study are shown in Table 9.

| COMPOSER     | # CONCERTS |
|--------------|------------|
| Mozart       | 36         |
| Beethoven    | 34         |
| Brahms       | 26         |
| Verdi        | 19         |
| Wagner       | 18         |
| Tchaikovsky  | 18         |
| Bach         | 17         |
| Rachmaninov  | 16         |
| Ravel        | 14         |
| Schubert     | 13         |
| Schumann     | 13         |
| Dvorak       | 13         |
| R. Strauss   | 12         |
| Puccini      | 11         |
| Mahler       | 10         |
| Chopin       | 9          |
| Donizetti    | 6          |
| Vivaldi      | 5          |
| Elgar        | 4          |
| Handel       | 3          |
| <b>TOTAL</b> | <b>300</b> |

Table 9: Number of concerts per composers in our European Concert Hall

## 8 Conclusions

Our aim in this exploration was to see in which way were nationalism and music are related. We wanted to see how the nationality of a composer would affect the frequency in which he is performed in a certain European country. We decided to search 300 concerts and operas represented the season of 2016-2017 in each of the European countries selected for our study. The country selection was made in accordance to the musical tradition these countries.

We studied the percentage of nationalism in each country, which means the number of composers that are performed in their country of origin with respect to the overall. Using this data we made pie charts of each country and we compared the relations between countries. We saw that each country represents the most either Germany or themselves, and that each nationality is most represented is in their own country without exception. We made comparisons of the data between Germany, Russia, Italy and Austria, and we noted significant influences between countries that are bounded by their common history and culture, such as Poland and Russia. We also calculated the mean of the percentage of nationalism in each country (30%), its standard deviation (16.04%) and the five-number summary. Plus, we created a box-and-whiskers plot of this data. Moreover, we proved statistically the percentage of nationalism of each country using the  $Z$ -test. For all countries we obtained a  $Z$  value bigger than 4, which implies a  $p$ -value less than 0.001. We also observed that countries with less known composers had higher values of  $Z$ . Finally, we wanted to study not only the nationality of the composers, but the composers themselves. For each country, we studied the frequency of each composer and we saw that the pieces of reduced group of composers were much more often performed than the ones of the rest of composers. The top 5 composers were different in each country, but we determined the top 5 composers in Europe: Wolfgang Amadeus Mozart, Ludwig van Beethoven, Johannes Brahms, Pyotr Ilyich Tchaikovsky and Johann Sebastian Bach. Finally, we created our

own European Music Hall and we programmed two seasons: in the first one we weighted the percentage of nationalism of each country and in the second one we calculated the number of concerts that should be played for each top 20-composers in Europe.

After all the work done, we can conclude that the nationality matters when it comes to classical music. If you are in a certain country, you are more likely to hear an opera or concert of that country more than anywhere else. We obtain a high statistical significance on the percentages and our results were uniform, as we found no exceptions in our results. Lastly, we saw that not only the nationality is important but also the ability of the composer, since the pieces of a few geniuses are performed much more than a lot of good but not excellent composers. In conclusion, when we study the classical music performances that are being carried out nowadays, apart from the quality of these works we can not forget the cultural and historical links between a country and its composers. Patriotism and nationalism are inherent parts of the human condition and in consequence they are inevitably linked to our personal and professional life and work.

## 9 Annex

In this annex we first include the pie charts of the other 6 European countries as mentioned in Section 3, the C++ code used to compute the  $Z$  value and the standard error explained in Section 5, the two C++ codes used in order to count the number of composers represented in each country and the graphics of the composers of each country that have not been included in Section 7 and the histograms of the frequency of composers of all European countries except those that appeared in Section 8.

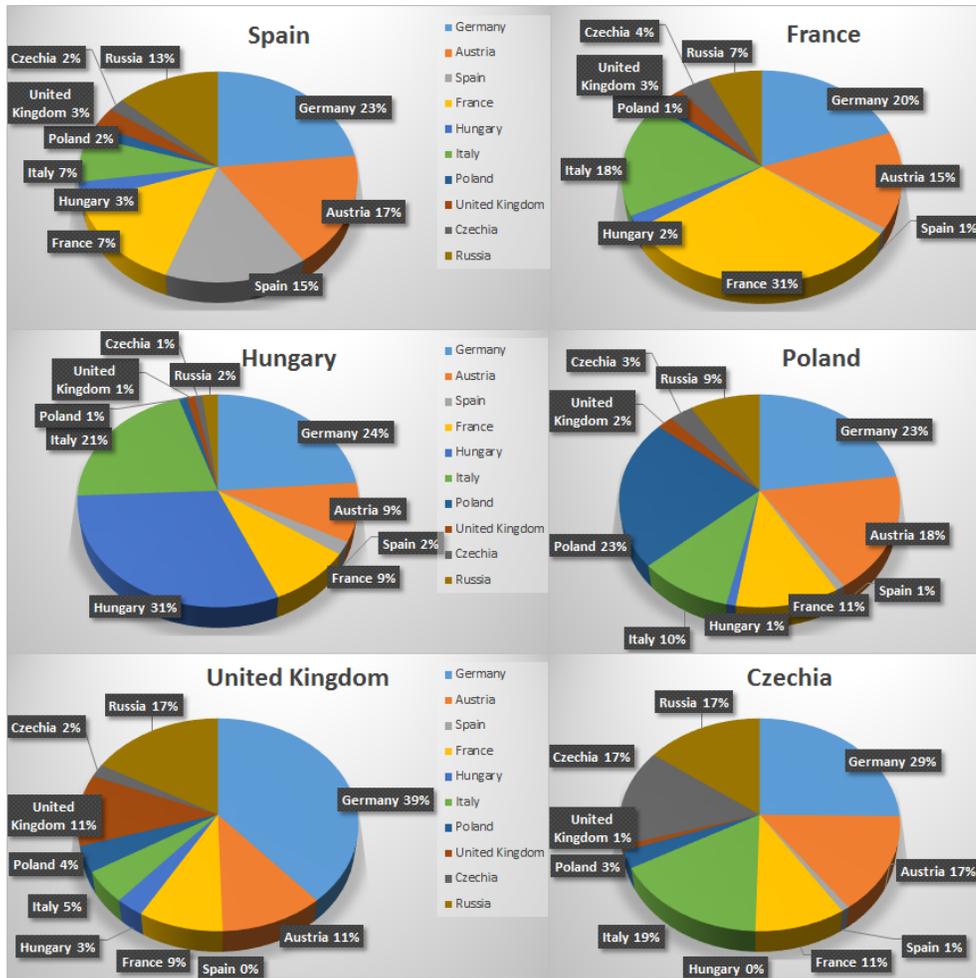


Figure 9: Pie charts of country of origin of the composers interpreted in Spain, France, Hungary, Poland, the United Kingdom and Czechia

```

1  #include<iostream>
2  #include<cmath>
3  #include<vector>
4
5  using namespace std;
6
7  int main(){
8      double a, b, c, d, n1, n2;
9      double p1, p2, p, z, se;
10     cin>>a>>c;
11     b = 300;
12     d = 2708;
13     n1 = b;
14     n2 = d;
15     p1 = a/b;
16     p2 = c/d;
17     p = (n1*p1+n2*p2)/(n1+n2);
18     se = sqrt(p*(1-p)*(1/n1 + 1/n2));
19     z = (p1-p2)/se;
20     cout<<"standard error "<<se;
21     cout<<endl;
22     cout<<"z "<<z;
23 }

```

Figure 10: Code needed to compute the value of the standard error and Z for the Z-test

```

int main(){
    map <string, int> Comp;

    ifstream in;
    in.open("InputFile.txt");
    ofstream out;
    out.open("OutputFile.txt");

    string s;
    while(getline(in, s)){
        Comp[s]++;
    }
    for(auto x : Comp){
        out << x.first << " " << x.second << endl;
    }
}

```

Figure 11: Code needed to compute the frequency of composers in each country

```

int main(){
    vector <pair <string, int> > S;
    ifstream in;
    in.open("InputFile.txt");
    ofstream out;
    out.open("OutputFile.txt");

    string n;
    while(getline(in, n)){
        int s=0;
        if('0' <= n[n.size()-1] and n[n.size()-1] <= '9') s+=(n[n.size()-1] - '0');
        if('0' <= n[n.size()-2] and n[n.size()-2] <= '9') s+=(n[n.size()-2] - '0')*10;
        n.pop_back(); n.pop_back();
        S.push_back(make_pair(n, s));
    }
    sort(S.begin(), S.end(),
        [](pair <string, int> A, pair <string, int> B){
            return A.second > B.second;
        });
    for(int i=0; i<S.size(); i++) out << S[i].second << " " << S[i].first << endl;
}

```

Figure 12: Code needed to compute the frequency of composers in each country

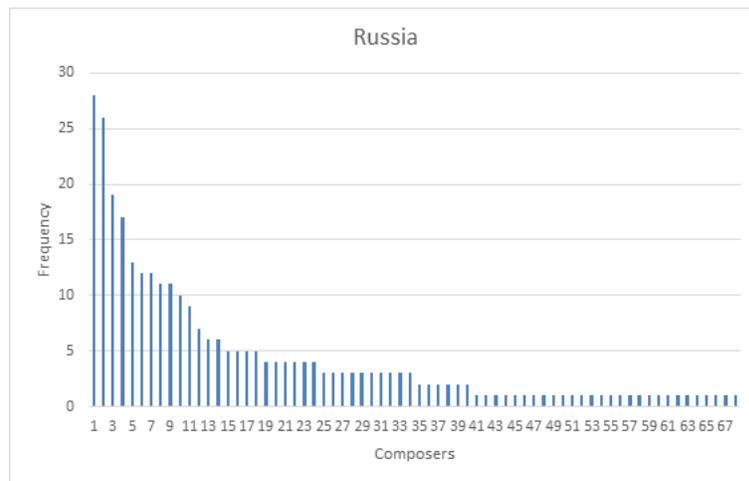


Figure 13: Histogram of the frequency of composers in Russia

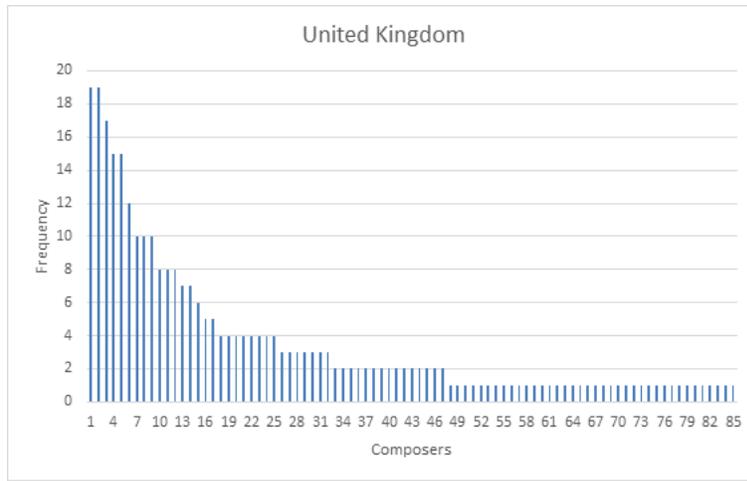


Figure 14: Histogram of the frequency of composers in the United Kingdom

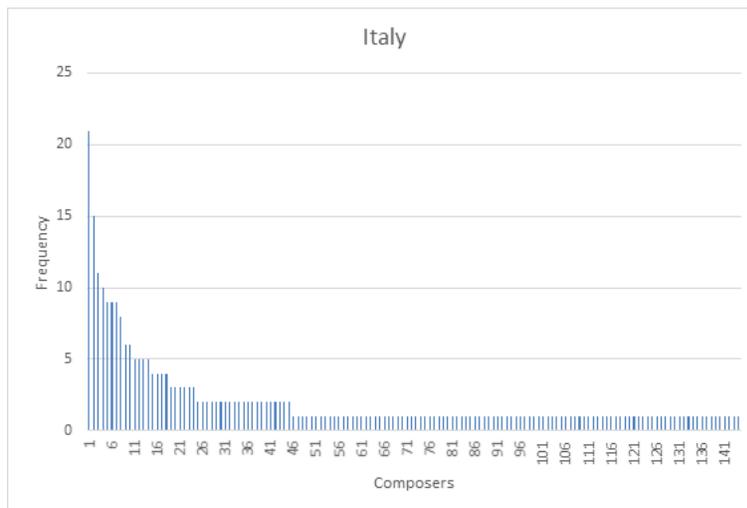


Figure 15: Histogram of the frequency of composers in Italy

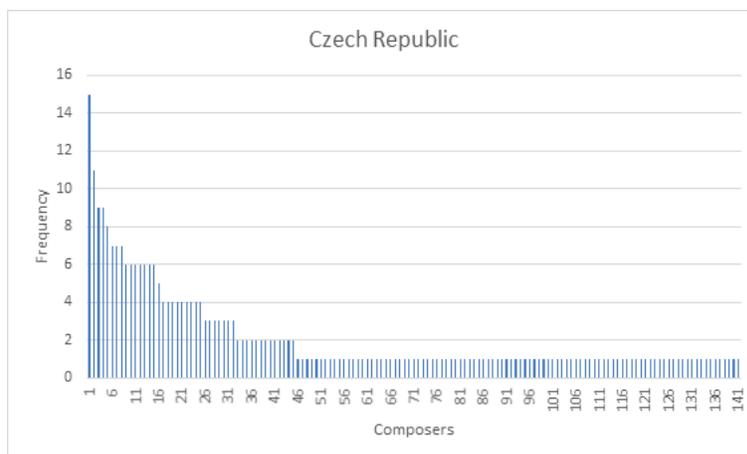


Figure 16: Histogram of the frequency of composers in Czech Republic

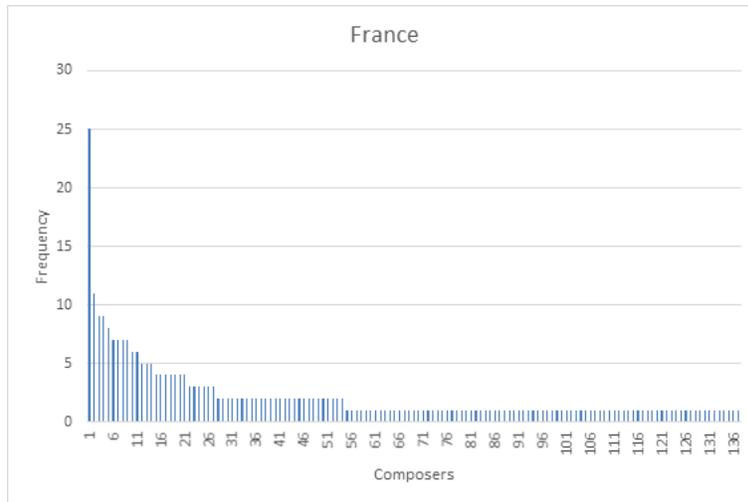


Figure 17: Histogram of the frequency of composers in France

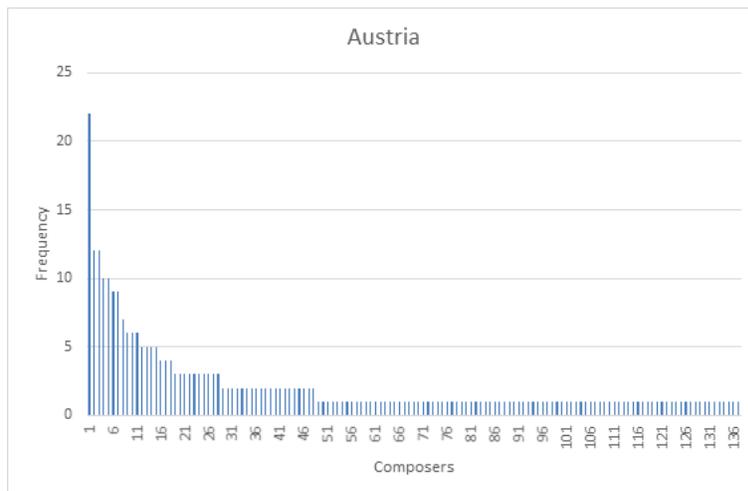


Figure 18: Histogram of the frequency of composers in Austria

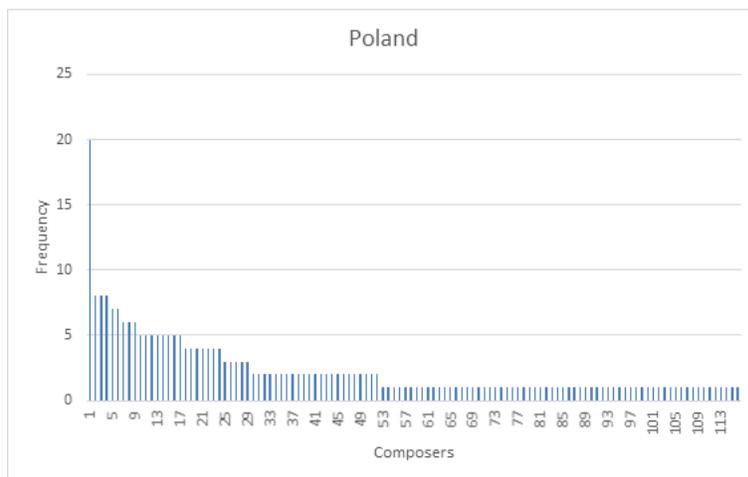


Figure 19: Histogram of the frequency of composers in Poland

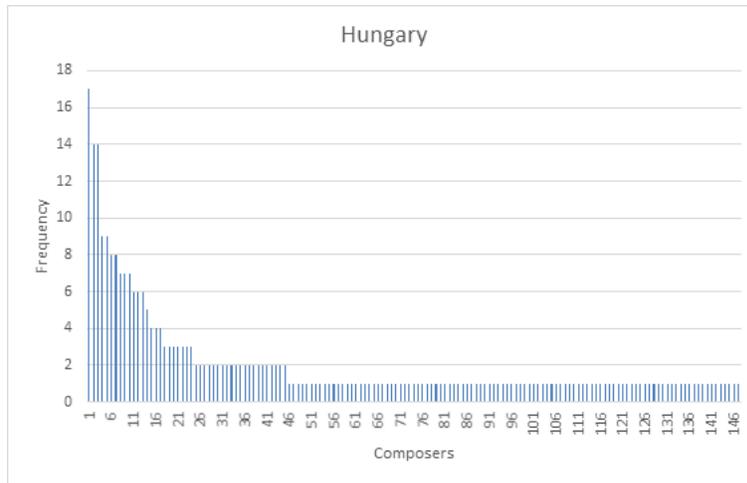


Figure 20: Histogram of the frequency of composers in Hungary

## References

- [1] Wazir, I., Garry, T. (2012). Mathematics Higher Level. Pearson Education.
- [2] Sprinthall, R. C. (2011). Basic Statistical Analysis (9th ed.). Pearson Education.
- [3] Wazir, I., Garry, T. (2012). Mathematics Higher Level. Pearson Education.
- [4] Sprinthall, R. C. (2011). Basic Statistical Analysis (9th ed.). Pearson Education.
- [5] <http://www.populationpyramid.net/>
- [6] Musikverein Wien: <https://www.musikverein.at/konzerte/konzerte.php>
- [7] Grosses FestSpielhaus: <http://www.kulturvereinigung.com/Jahresprogramm.pdf>
- [8] Salzburger Festspiel: <http://www.salzburgerfestspiele.at/spielplan>
- [9] Brucknerhaus Linz: <http://www.brucknerhaus.at/veranstaltungen/seite/2.html>
- [10] Konzerthaus Wien: <https://www.konzerthaus.at/kalender>
- [11] Frankfurt Oper: <http://www.oper-frankfurt.de/>
- [12] Festspielhaus Baden-Baden: <https://www.festspielhaus.de/>
- [13] Berliner Philharmoniker: <https://www.berliner-philharmoniker.de/>
- [14] Deutsche Oper Berlin: <https://www.deutscheoperberlin.de/>
- [15] National Theater Munich: <https://www.staatsoper.de/en/schedule-tickets/ticket-information>
- [16] Staatsoper Hamburg: <http://www.staatsoper-hamburg.de/>
- [17] Komische Oper Berlin: <https://english.komische-oper-berlin.de/schedule/>
- [18] Teatro La Fenice: <http://www.teatrolafenice.it/site/index.php>
- [19] Classicic Roma: <https://www.classictic.com/en/special/romeconcerts/219/>

- [20] Opera Lyon: <http://www.opera-lyon.com/agenda>
- [21] Opera Marseille: <http://www.opera-lille.fr/fr/saison1617/>
- [22] Opera National du Rhin: <http://www.operanationaldurhin.eu/index.html>
- [23] Opera National de Paris: <http://stargonaut.com/concert.html>
- [24] Tchaikovsky Concert Hall: <http://meloman.ru/hall/koncertnyjzalchajkovskogo/>
- [25] Great Hall of the Moscow Conservatory: <http://www.mosconsv.ru/en/>
- [26] Rachmaninov Concert Hall: <https://www.operaandballet.com/theatre/mosphilrachmanch/>
- [27] Bolshoi Theatre Moscow: <http://www.bolshoi.ru/en/>
- [28] Krakow Philharmonic: <http://www.filharmonia.krakow.pl/Repertoire/Calendar/>
- [29] Rzeszow Philharmonic: <http://www.filharmonia.rzeszow.pl/>
- [30] Warsaw Philharmonic: <http://filharmonia.pl/strona-glowna>
- [31] Filharmonia Poznanska: <http://www.filharmoniapoznanska.pl>
- [32] Narodn divadlo Marionette: <http://www.mozart.cz/>
- [33] Classicitic Prague: <https://www.classictic.com/>
- [34] Magyar Allami Operahaz: <http://www.opera.hu/programme>
- [35] Franz Liszt Academy: <http://lfze.hu/en/all>
- [36] Auditori de Barcelona: <https://www.auditori.cat/concerts>
- [37] Auditorio Nacional de Musica: <http://www.auditorionacional.mcu.es/programacion>
- [38] Auditorio de Galicia: <http://www.auditoriodegalicia.org/programacion/>
- [39] Teatro Real: <http://www.teatro-real.com/es/calendario>
- [40] Teatro de la Maestranza: <https://www.teatrodelamaestranza.es/programacion/calendario.html>
- [41] Royal Albert: <http://www.royalalberthall.com/>
- [42] Conway Hall: <https://www.cadoganhall.com/>
- [43] Royal Festival Hall: <https://www.southbankcentre.co.uk/x>