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# Untangling the Social Network of Musicians

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## Introduction

As opposed to the former idea of creative autonomy, in recent years, humanities research tends to investigate cultural contexts and circumstances, inspirational models, and the ways that knowledge, experience and expertise have been transferred over time. We address the question of "creative transfer" within the field of music. Due to the everlasting significance of musical works, relationships between musicians – the entry point for such an investigation – are well documented in archives, libraries and museums. In print media, usually only a single relation between two musicians is narrated. Furthermore, it is common for the biography of only one of the two musicians to report on the relationship. Larger overviews of social networks between several musicians seldom exist. Although some digital resources exist, these are often reduced to the milieu of popular musicians like Mozart and Beethoven.

Since 2005, musicologists of the project Bavarian Musicians Encyclopedia Online ([Bayerisches Musiker Lexikon Online](#), BMLO) have systematically collected biographical data (an example is given in Figure 1) and examined relationships between musicians from print media – a tedious work that results in a unique database of great value for musicology. The BMLO contains musicians from all kinds of musical professions (e.g., composers, singers, musicologists, instrument makers, ...), most of whom had an active lifetime period living in Bavaria or a considerable influence on Bavaria. Now providing information about around 28,000 musicians, the BMLO has achieved global scope, one that is underpinned by the many musicologists worldwide who use the BMLO for their daily work.

Schumann, Robert (Robert Alexander)  
\* 8. Juni 1810 Zwickau, † 29. Juli 1856 Bonn  
Geschlecht männlich  
Konfession evangelisch-lutherisch

- Beziehungen
  - Partner
    - Schumann, Clara (1819–1896), Pianistin
  - Schwiegereltern
    - Wieck, Friedrich (1785–1873), Musikpädagoge
  - Schüler
    - Wolfssohn, Martin Gustav (1817–1882), Musikforscher
    - Wasielewski, Wilhelm Joseph von (1822–1896), Musikforscher
  - Kollegen
    - Häglmann, Moritz (1792–1868), Geiger
    - Mendelssohn Bartholdy, Felix (1809–1847), Komponist
  - Netzwerk
    - Fandora, Heinrich (1807–1887), Gesangslehrer
    - Chopin, Frédéric (1810–1849), Komponist
    - Joachim, Joseph (1831–1907), Geiger
    - Bräuner, Johannes (1833–1897), Komponist

Musikalische Berufe Pianist, Komponist  
Weitere Tätigkeiten Journalist, Jurist  
Träger/Sparte Medien  
Wirkungsorte Bayreuth, Berlin, Bonn, Colditz, Dresden, Düsseldorf, Frankfurt/Main, Hamburg, Heidelberg, Karlsbad, Köln, Kreischau, Leipzig, Mailand, Maxen, Moskau, München, St. Petersburg, Wien, Zwickau



Figure 1: Biographical information about Robert Schumann in the [BMLO](#). Alongside information about a musician's lifetime, denomination, professions or places of activity, the database provides a number of relationships by type. Next to his partner Clara Schumann, further relations are listed to Robert Schumann's father in law, to his students, colleagues, and other acquainted musicians in his social network

In earlier works, we developed visual interfaces on the basis of the BMLO data for profiling musicians (Jänicke et al, 2016), and for the distant reading of musicians' biographies (Khulusi et al, 2016). However, the social network inherent in the BMLO has remained untouched so far. Using the BMLO, only the social network of single musicians can be observed, as is the case when using print media. In order to facilitate an extensive analysis of the entire social network concealed in the BMLO, we designed a visualization that brings together all of the relationships in the form of an interactive social network graph. In contrast to previous means of investigating the transfer of musical knowledge, we allow for the dynamic exploration of relationships among musicians over generations.

## Graph Topology

Information regarding relationships to other musicians in the database is provided for 9,805 musicians of the BMLO. Only one relation exists for around 46,5% of these musicians, and just 261 musicians have ten or more relations. Adolf Wilhelm August Sandberger is the musician with most relations (97). The average number of relations for musicians is 2.6. The resultant graph structure of the social network consists of 1,420 connected components, the largest component connects 5,539 musicians, the second largest only 56 musicians – 1,385 connected components contain less than ten musicians.

Due to the above mentioned topological features of the graph, the typical, straightforward visualization using a force-directed layout approach, e.g., by using tools such as Gephi (Bastian, 2009), leads to a global

overview of the social network (see Figure 2). However, local structures are hardly readable, which makes an interactive exploration nearly impossible. The objective of this work was to develop a graph design that makes the social network of musicians visually accessible for the first time, and, moreover, capable of being explored in accordance with the research questions of the collaborating musicologists. We focused on the largest connected component that causes the greatest challenges for this task.

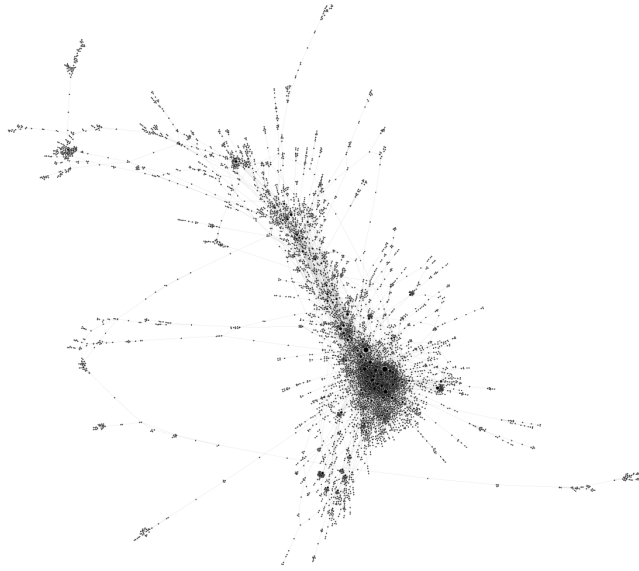


Figure 2: The largest connected component with 5,539 musicians visualized using Gephi.

### Graph & Interface Design to Analyze Teacher-Student Relationships

The preliminary step when generating the social network graph is filtering according to the underlying research question. At first, a filtering can be done by relationship type(s). Second, it is possible to focus exclusively on musicians with specific professions (e.g., instrumentalists). In the following discussion, we focus on the motivating example for this work: the analysis of teacher-student relationships to investigate how musical knowledge, experience and expertise have been transferred over time. The corresponding filter keeps 3,994 musicians, the largest connected component of this sub-network – the research object of the musicologists – contains 2,769 teachers and students. The Gephi output for this graph is given in Figure 3.

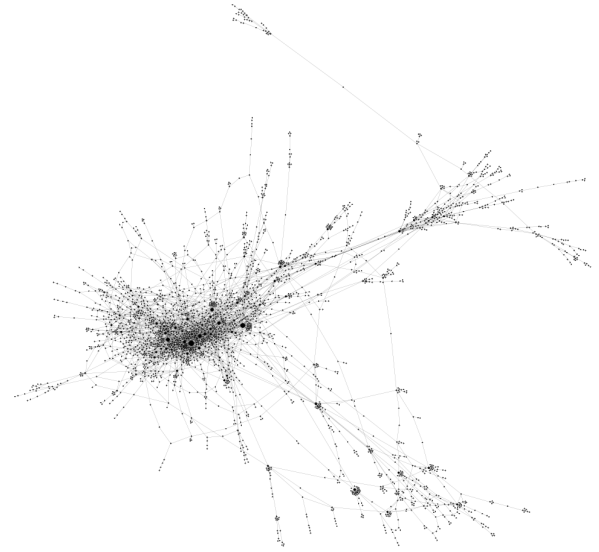


Figure 3: The largest connected component of the teacher-student network with 2,769 musicians visualized using Gephi.

Although the structures are slightly finer due to the reduced number of nodes and edges, the highly connected part in the interior of the graph remains cluttered. Here, we list our design decisions applied in order to generate a readable graph (see Figure 4) and a navigable interface.

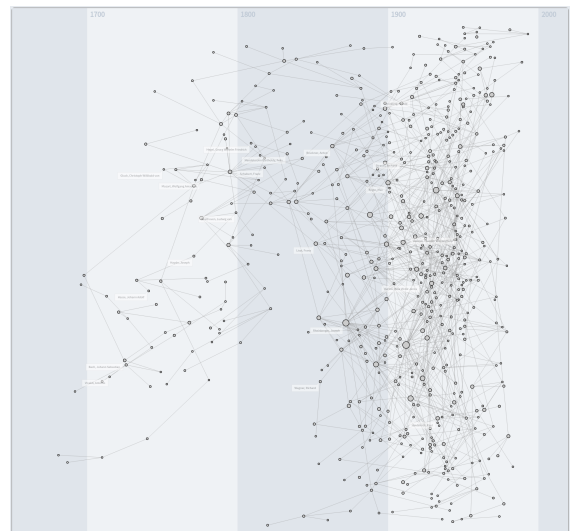


Figure 4: The largest connected component of the teacher-student network with 2,769 musicians (608 nodes) visualized with our method.

- **Temporally aligned graph:** It was particularly important for the musicologists that the graph layout includes a temporal dimension, so that relations can be chronologically analyzed from left-to-right. Therefore, we applied a force-directed graph layout and used fixed x-values that represent a time-stamp, which reflects the middle of a musician's creative lifetime (see Jänicke 2016), on a horizontal time axis. As a result, the nodes only spread vertically and the chronological order remains intact.
- **Node grouping:** Because the underlying research question investigates transfer paths of musical knowledge, we hide the nodes of musicians who never had the role of a teacher. Still, these musicians are grouped to their teachers, and can be accessed in the exploration process. This design decision reduces the number of nodes to be displayed from 2,769 to 608.
- **Node layout:** To illustrate the significance and the influence of personalities, the sizes of nodes reflect the number of students of the corresponding teachers, which makes teachers with many students salient. Per default, node labels are hidden, but for navigation purposes, a user-defined number of node labels with the corresponding musicians names can be shown on demand. Either the most popular musicians or the teachers with most students can be highlighted.
- **Interactivity:** Hovering over a node shows the corresponding musician and two lists of students (those who became teachers and those who did not) in a popup box. Clicking a node highlights all connections to a teacher's students who became themselves teachers. This way, transfer paths of musical knowledge can be assembled interactively.
- **Musical profession analysis:** For the selected (via mouse click) musicians in the graph, the evolution of musical professions can be analyzed. Therefore, all musical professions of the teachers' students are listed by decreasing frequency. For each profession, a bar chart illustrates when they have been pursued.

## Analysis of Teacher–Student Relationships

This section outlines a usage scenario of the teacher-student network taking the example of Adolf Wilhelm August Sandberger who established musicology as a subject of study in Munich.

First, we compare Sandberger to one of his teachers, Joseph Rheinberger, both being the teachers with the highest numbers of students (the BMLO lists 97 students for Sandberger and 87 students for Rheinberger). Of special interest was the comparative analysis of the musical professions of their students in order to assess the similarity of both teachers' studentries. Figure 5 shows the two selected teachers in the social network, and a view at the summarized musical professions of their students is given. While composition was the major musical profession of Rheinbergers students (70x), this number drops for Sandbergers students (52x). On the other hand, the number of musicologists increase (10x → 65x). Other significant changes can be seen for the professions choirmaster (29x → 9x), organist (19x → 8x), music writer (12x → 29x) and music editor (5x → 26x). Thus, the visualization reflects a change of the musical profile of both studentries from composition to composition science– a hypothesis that could be verified with our system.

Second, we examined the change of teaching since Sandberger established musicology in Munich. Therefore, we observed the musical professions of the students of Sandberger and his successors in Munich, Rudolf von Ficker, Thrasybulos Georgios Georgiades and Theodor Göllner (see Fig. 6). While the musicologist is the most frequent taught musical profession, the composer gets less and less important. The last teacher Theodor Göllner even had no student with the composer as musical profession. Thus, the change from composition to composition science that already started with Sandberger compared to Rheinberger, steadily continued with Sandberger's successors.

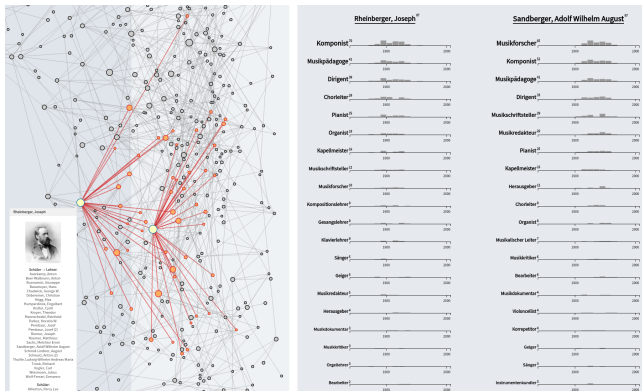


Figure 5: Comparing the students of Joseph Rheinberger and Adolf Wilhelm August Sandberger.



Figure 6: Temporal change of teaching in Munich.

## Conclusion

Through close collaboration with computer scientists and musicologists implementing a user-centered design approach, we developed a visualization that allows for the dynamic, interactive exploration of the social network of musicians, focusing primarily on teacher-student relationships. In contrast to out-of-the-box tools like Gephi, we took the research questions of the collaborating musicologists into account when designing the graph and the user interface. Although detailed information about individual relation periods between musicians as well as the taught musical professions are not included in the underlying database, the provided interface facilitates a novel view on the social network of musicians, which allows to draw conclusions on the question of the transfer of musical knowledge.

The value of our [system](#) for users of the BMLO is not only that social networks are visualized for the first

time, but also that the graph may be filtered in accordance with the way that specific research questions can be investigated. Next to teacher-student relationships, familial or labor relationships also create valuable networks to be explored. Furthermore, it is possible to analyze sub-networks concerning musical professions, and to combine relationship types with musical professions. For example, when combining teacher-student relationships with the musical profession *instrumentalist* (see Fig. 7), Wolfgang Amadeus Mozart shows up at the beginning of the instrument playing knowledge transfer.

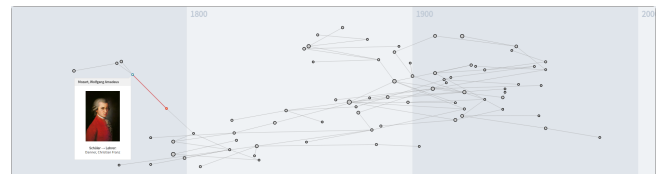


Figure 7: Teaching instrumentalists.

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