

The Vienna Philharmonic Orchestra's New Year's Concerts Building a FAIR Data Corpus for Musicology

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ABSTRACT

The Vienna Philharmonic Orchestra's New Year's Concert is an annual, live-broadcast New Year's Day staple for a vast international audience, with an alternating line-up of star conductors and an ever-changing repertoire that incorporates the same favourites – most notably, the *Blue Danube Waltz* and the *Radetzky March* – year after year. We are gathering, digitizing, and aligning the concert recordings of this series with audio features, score encodings, records of historical discourse, and other ephemera, interconnecting this multimodal music information and making it available as a digital corpus of linked open data following the principles of Findable, Accessible, Interoperable, and Reusable (FAIR) research data management. Here, we raise musicological research questions motivating our work; describe the approach to assembling our corpus and developing associated editorial and analytical tooling, building on and extending recently established semantic music information workflows; and, provide insight into ongoing digital musicology research incorporating this data. Our work is motivated both by the pursuit of our own research interests in musicology and performance science, but also by a desire to provide a useful and reusable dataset for the wider digital music research community, bringing publication practices between these fields into further dialogue.

CCS CONCEPTS

• Information systems Multimedia information systems;
Digital libraries and archives; • Applied computing Sound
and music computing.

KEYWORDS

Digital Libraries, Digital Musicology, Linked Open Data

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1 VIENNA'S NEW YEAR'S CONCERTS

The Vienna Philharmonic Orchestra's New Year's Concert is an annual classical music performance tradition significant to Austrian and European cultural heritage. From inauspicious origins as a mechanism of Nazi propaganda in 1939, it has grown into an international New Year's Day staple, reaching an audience of tens of millions in nearly 100 countries through its annual live broadcast [32]. The series is characterised by both homogeneity and heterogeneity: inseparable from the Vienna Philharmonic Orchestra, but subject to continuous evolution of its membership; presided over by a growing number of world-renowned conductors, sometimes retaining their position for many years, while at other times substituting in new personalities at every iteration; featuring a sizable variety of pieces and composers over the span of time, while also incorporating the same staples, year after year. These qualities combine to make the collected recordings, discourse and other ephemera associated with this concert series an appealing corpus ripe for analysis.

The quintessential New Year's Concert repertoire – waltzes, polkas, operetta overtures and marches by the Strauss family – offers over eighty years of performance material, opening up plentiful opportunities for music scholarship. For instance, how is this repertoire performed by the Vienna Philharmonic, and how does it change or remain the same over time? There are stylistic norms considered particular to the Viennese waltz style – including the relative timing (agogic) of the three waltz beats [1, 4]. Which norms remain constant, and which vary across performances? Can stylistic shifts be explained by historical factors, such as who conducted the orchestra or served as concertmaster? Can we track turning points in performance traditions – such as the transition from Clemens Krauss' decades-long tenure as conductor, to the orchestra being led by their principal violinist, Willi Boskovsky? Music Information Retrieval technologies deriving feature descriptions from digitized audio open up further affordances for research, allowing us to conduct large-scale, quantitative analyses over large performance collections. Much is made of the star guest conductors who have alternated annually since the 80s, but in what quantifiable ways do they impact the orchestra's performance? Is there a machine-audible 'Maazel', 'Karajan' or 'Harnoncourt' factor?

Although this signature repertoire is inextricably linked with the Vienna Philharmonic, other ensembles do perform it. Can we identify empirical differences in style or interpretation? What editions/score addenda can we trace? Is there a Viennese sound?

Further questions arise regarding concert programmes and corresponding recordings. While the *Radetzky March* and the *Blue*

Danube Waltz are annual staples, which other compositions are most frequently performed? Is the performance order consistent between printed programmes and CD track lists? Do they differ in length, order, editing or presentation?

Finally, this institution has been essential for the internalized and externalized constructs of *Wien, Stadt der Musik* and *Musikland Österreich* [13, 19, 21, 32]. The concerts have been broadcast since their inception and their recordings consistently top the charts; the series has an unusually broad reach which negotiates the space between ‘serious’ and ‘light’ music. Due to unbroken popularity, it has been consistently reviewed and discussed, from a variety of loci. Understood as a musical, cultural and political product, a pressing question for musicology is how its considerable cultural currency is negotiated through discourse.

2 BUILDING A FAIR DATA CORPUS

Signature Sound Vienna, a 3-year research project currently in its first year, is dedicated to digitally capturing, analysing, and interpreting the wealth of music information relating to the New Year’s Concert series, while facilitating reuse and reinterpretation of this information by the wider digital music research community. The project is informed by prior endeavours identifying trends in quantitative data extracted from sizable collections of music recordings [5, 8, 18, 24, 30] and builds on the advances of recent large-scale digital music research projects applying semantic workflows for music processing [27, 35] and analysis [3, 6, 16, 17, 23, 29]. These projects leverage aspects of music encoding, music information retrieval, and Semantic Web technologies to interconnect disparate, multimodal sources of musical meaning, while integrating expertise from music scholars, performers, and enthusiasts alongside algorithmic processing.

We aim to contribute to the current state of the art established in these projects through scholarly application and technical extensions in investigations spanning the history of the New Year’s Concert series, combining these varied but complementary technological approaches within applied and focused music scholarship. We are assembling a large corpus of music information relevant to these concerts, including scores, audio recordings and feature data characterising the audio signal, performance and catalogue metadata, and information drawn from the broader historical context. Aside from pursuing answers to the musicological questions posed in Section 1, the project is motivated by a focus on research data management, to allow the corpus we are producing to provide a viable basis for future research in digital musicology, music information retrieval, and performance science outside of the confines of our project. Such re-use is best facilitated by ensuring that data is created and processed using open technologies, interconnected with relevant authority records to serve in disambiguation and enrichment of the available information, and stored using widely used, inter-operable vocabularies. These considerations are formalised in the FAIR principles of Findable, Accessible, Interoperable, and Reusable research data management [36] – a collection of best practices originating in the natural sciences.

Though recent inroads have been made in this direction in digital musicology [11, 35], projects overly focused on data management considerations run the risk of delving deeply into data and library

science but losing their focus on doing *music* research [12]. To avert this risk, our project team comprises researchers with backgrounds in historical musicology and performance studies, alongside information science. Correspondingly, our layered digital musicology workflow (Figure 1) explicitly incorporates parallel processes of music informatics and musicology scholarship.

An important source of historical reference data for this undertaking is the archive of the *Gesellschaft der Musikfreunde in Wien* (“*Musikverein*” for short), the venue at which all performances in this series have taken place. We have developed custom scripts¹ to retrieve semi-structured text detailing the concerts, pieces, conductors, and key performers of these concerts from the archive’s website², and convert it to structured linked data available as a named graph through our triplestore³. To process this data, we have developed analytical tools for exploratory analysis and visualisation. As an example, Figure 2 displays the compositions most frequently performed across the concert series. We are continuously acquiring and digitizing a collection of source materials for our corpus on physical media, incorporating CDs, DVDs, and LPs relevant to the New Year’s Concerts. The acquisition of these recordings is far from trivial: while each performance was live-broadcast (via radio, and via television from 1959) [7], only recordings from 1987 onward are still readily available for purchase from music shops. Our search has thus expanded to flea markets and (physical and online) second-hand shops. In order to expand our corpus to incorporate other orchestras’ recordings of compositions frequently performed at the New Year’s Concerts (Figure 2), consultation of catalogs such as *Bielefelder Katalog Klassik*⁴ was particularly relevant. By searching for well-known Austrian and international orchestras of interest to the project as a basis for comparison and cross-referencing relevant works or their composers several novel recordings, some still available for purchase, were located. Our collection currently includes audio from 58 New Year’s Concerts (of which 39 are ‘complete’ concert recordings, the remainder being compilations) and 21 albums by other orchestras performing relevant repertoire.

During the digitization process, we label each release and track with discographic metadata using the MusicBrainz Picard Tagger [31]. Where corresponding records are not yet available, we generate and contribute them to the MusicBrainz collection using a dedicated account. We then obtain a structured description of the metadata associated with each release using Picard’s ‘Generate Cuesheet’ plugin, convert this to linked data using a custom Python script developed for our project⁵, and publish this information to another named graph within our triplestore.

Audio features derived from the digital audio signals are made publicly available, following a non-consumptive access approach to reproducible research on copyright-restricted materials [22]. We are further identifying and linking to publicly accessible copies of the corresponding audio signals on streaming services where available, to allow project-external researchers (and the wider public) to listen without circumventing copyright.

¹<https://github.com/Signature-Sound-Vienna/scrapers>

²<https://www.musikverein.at/konzertarchiv>

³ Available from <https://repo.mdw.ac.at/signature-sound-vienna/virtuoso/sparql>

⁴ Available from <http://www.bielekat.info/>

⁵ Available from <https://github.com/Signature-Sound-Vienna/cueToRdf>

Using open-source research software including the *Sync Toolbox* Python package [20], we generate fine-grained alignments between different renditions of each relevant composition, while extending previous work [33] to reconcile these alignments with music notation encoded using the Music Encoding Initiative's (MEI) XML-schema [10], which captures musical meaning in machine-interpretable form. The resulting audio-to-score alignments form the basis for distant and close listening analyses of our corpus (Section 3). Further, they provide a secondary means of generating accessible versions of all renditions in our corpus without violating copyright restrictions, as the alignments support creation of MIDI-auralisations of the pieces exhibiting salient performance features of each recorded rendition (e.g., tempo and dynamics). The resulting MIDI files may in turn be played back using digital acoustic instruments or standard MIDI synthesizers.

Arriving at the required music encodings involves a multiple-step process: first, print score images are processed using the commercial software PhotoScore by Neuraton for optical music recognition to obtain a rough digitized version, then corrected using widely-used music notation software including MuseScore and Sibelius. After that, scores are exported as uncompressed MusicXML files and converted to MEI using Verovio [25], or converted directly to MEI from Sibelius using the SibMEI plug-in⁶. Final corrections are then applied using an adapted version of the open-source *mei-friend* tool [9], originally a plug-in to the Atom text editor, which we have converted to a native Web-browser application, optimised for the encoding of orchestral music, and extended with GitHub integration, schema-informed autocompletion, and other new features as part of our research⁷.

All research outcomes and metadata describing their provenance are stored and exposed as linked open data, forming a layered digital library of music information [23]. Where appropriate, we are contributing the generated research outcomes to open platforms under public license, including MusicBrainz⁸ (discographic metadata), AcoustID⁹ (audio fingerprints), AcousticBrainz¹⁰ (audio features), GitHub (source code), and Zenodo (score encodings, MIDI-auralisations). These outcomes and other relevant Web sources (including concert recordings accessible on streaming platforms) are interlinked and described using linked open data served by our triplestore. This triplestore is also used to house musicological assertions (Section 3) in a form suitable for hypermedia publication that allow the scholarly argumentation to form a re-usable, re-interpretable part of the data corpus alongside the evidence it builds upon [15].

3 DIGITAL MUSICOLOGY SCHOLARSHIP

We are applying a combination of close- and distant-listening approaches in the scholarly investigation of our corpus. These build on the outcomes of the alignment process (Section 2), which provide us with scaffolding to undertake both quantitative comparison and qualitative interpretation across different renditions of each piece

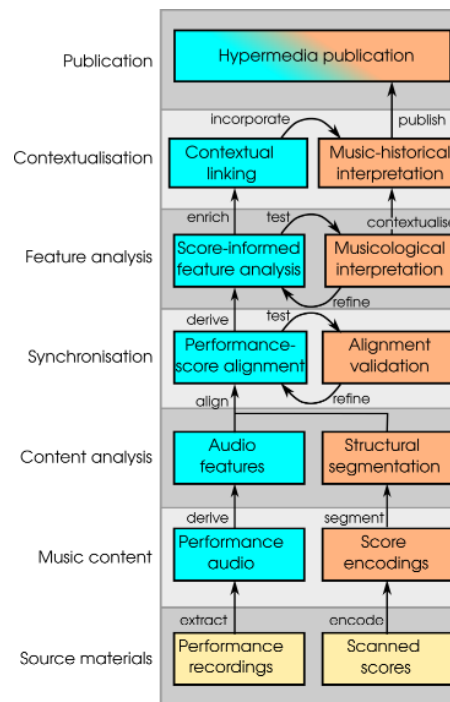


Figure 1: Layered digital musicology workflow. Yellow: source materials. Blue: largely quantitative music informatics processing of feature data. Orange: largely qualitative processes incorporating scholarly expertise interpreting music content and aggregated feature analysis outcomes.

at high granularity. While early results of the ‘off-the-shelf’ software driving our alignment process have been impressive, we are developing tooling to allow efficient manual verification and correction in order to arrive at the high level of alignment confidence necessary for scholarly analysis.

Our initial close-listening investigations have already raised specific questions around score alterations, addenda, and discrepancies which may prove specific to the orchestra or a particular conductor. For certain pieces, including the *Radetzky March* and the *Fledermaus Overture*, we have found significant diversions between the Vienna Philharmonic’s performance practices (in terms of scoring and instrumentation) and those of other orchestras or standard editions. In other cases, the Philharmonic plays certain tones or passages differently over time, or under specific conductors.

To facilitate further study of these and other aspects, including questions of tempo, acceleration rate, and length of fermate, we are developing further tools building on work in [33, 34] to enable targeted playback within and across different performance recordings, using the digital score as an interactive navigation platform which may be annotated and segmented to direct, constrain, and document the close-listening process.

The availability of structured metadata within our corpus via the triplestore allows for another avenue of musicological investigation: for instance, a combination of SPARQL queries comparing the order of performance in historical concert programmes with track listings

⁶<https://github.com/music-encoding/sibmei>

⁷Browser application available at <https://mei-friend.mdw.ac.at>

⁸<https://musicbrainz.org>

⁹<https://acoustid.org/>

¹⁰<https://acousticbrainz.org>

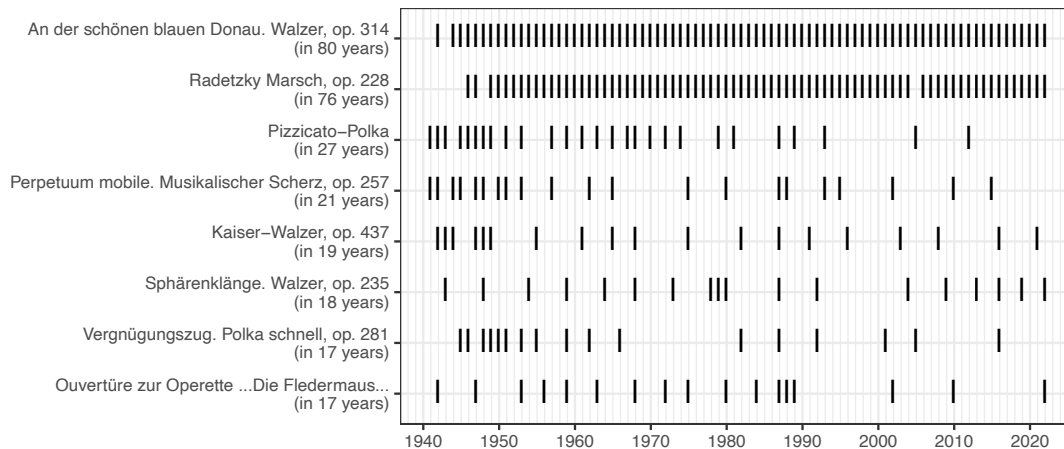


Figure 2: Most frequently performed compositions in the New Year's Concert series.

on our recordings¹¹ demonstrates frequent discrepancies, in terms of omission (where pieces were performed but are not available on the recording) and re-ordering – though the signature encores of *An der schönen blauen Donau* (*Blue Danube Waltz*) and the *Radetzky March* always¹² remain intact.

Concurrent with these initial analyses, we are locating and incorporating discourse and related ephemera pertaining to the New Year's concerts, the Philharmonic and their conductors into our corpus. This includes but is not limited to scholarship, images, press reviews, YouTube and social media commentary and articles in periodicals. We tag all discourse by category, location and date of origin, and the date of the performance or recording it references in preparation for basic sentiment and text analyses. These data and analyses will provide additional vantage points to illuminate shifts and discrepancies in how the New Year's Concert series, its related orchestra and its various conductors have been perceived over time.

Motivated by recent developments such as [14], we aim to create hypermedia publications tracing scholarly narratives through our data, while enabling readers to depart into their own explorations of the digital corpus. Beyond scholarly dissemination, this serves the secondary purpose of bringing the realms of digital humanities and more traditional musicological approaches into dialogue. Building on [15] and the artistic research multimedia publication platform, The Research Catalogue, an initiative spearheaded by the Society of Artistic Research [28] where multimedia expositions replace traditional text articles to present music and art research in multimedia, non-linear formats, [2, 26] an underlying desire is to modernise musicological publication. By adopting an open, transparent, and FAIR approach, our findings will not exist in a closed bubble, but provide both starting points for future scholarship, and an extensive music dataset that can be referenced, but also externally developed and refined.

¹¹<https://github.com/Signature-Sound-Vienna/cueToRdf/blob/main/compareProgrammeArchiveToTracks.rq>

¹²With an exception: the *Radetzky March* was not performed in 2005 in deference to the preceding year's catastrophic flooding events in South-East Asia.

4 LIMITATIONS AND OPEN QUESTIONS

The New Year's Concert series is a conglomeration of acoustic experiences. Some, such as the listening experience of in-situ audience members, are ephemeral and defy quantitative, data-driven study. The sound experienced in the *Musikverein* on January 1st differs from its corresponding recording; recording sound fundamentally alters it, introducing inherent constraints. The acoustic chain involved in transforming a live sound into a CD recording is extensive and contingent. Microphone placement, compression, recording technique and equipment choice alter timbre, balance, brightness, resonance and even perceived note length. They cannot yet be appropriately compared. This, particularly because the performance audio feed is processed by different teams annually for live radio, live television and CD recordings. Accepting these realities, we limit our analyses to the commercial products – the music recordings available for purchase – of the New Year's Concerts.

Beyond retrieving and processing historical information from the *Musikverein's* Web archive, we are seeking access to its physical archives alongside those of the Vienna Philharmonic Orchestra. This would allow us to draw stronger conclusions in terms of score addenda, conductor agency and the identification of specific instrumentalists. Thankfully, a wealth of tractable quantities can be differentiated including tone onset, instrumentation, phrasing, (relative) articulation, pitch, tempo, rhythm and agogic relationships between beats. In addition, extensive discourse regarding the New Year's Concert series and its signature orchestra is available in the public domain. By incorporating analyses of this discourse into our research, we will explore how the series shapes Austria's identity, culturally and politically, both internally and abroad.

We expect our results to aid scholarship within historical musicology, *Zeitgeschichte*, performance practice, *Kulturgeschichte*, music sociology, acoustics, popular music studies and institutional studies. The agile interaction between musicological concerns, source materials and data processing tools is envisioned as a blueprint for future, similarly interdisciplinary projects where field-specific scholarly insight and the ability to intelligently scour large data sets productively interact.

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