Abstract

Automatically describing different aspects of digital music content is crucial for organizing, searching and interrelating large volumes of music recordings. Melody is a fundamental facet in most music traditions, and therefore, is an indispensable component in this task . It is still a challenge to obtain a reliable melody representation from recorded polyphonic music and most melodic analyses primarily use symbolic representations of music, which only covers a particular view of music. The specific heterophonic characteristics in Indian art music (IAM) make it feasible to obtain a low-level melody representation from audio recordings using current state-of-the-art pitch estimation methods, which in turn enables to focus on the description of higher level melodic aspects of music performances. With its complex melodic framework and well-grounded theory, the description of IAM melody beyond pitch contours, offers a very interesting and challenging research topic. In this thesis we analyze melodies within their tonal context, identify melodic patterns and compare them both within and across music pieces, and finally, characterize the specific melodic context of IAM, the rāgas. All these analyses are done using data-driven methodologies on large curated music corpora.

The thesis starts by compiling and structuring representative music corpora of the two IAM traditions, Hindustani and Carnatic music, comprising quality audio recordings and the associated metadata. From the music recordings we extract low-level melody representations by using a state-of-the-art algorithm for extracting predominant pitch from polyphonic audio. To make this representation more musically meaningful we identify the tonic context of every recording, estimating the tonic by using a multipitch approach, which is then used to normalize the pitch contours. Another important element to describe melodies is the identification of the meaningful temporal units, for which we propose to detect occurrences of nyās svaras in Hindustani music, a landmark that demarcates musically salient melodic patterns.

Utilizing the melodic features mentioned above we extract musically significant melodic patterns. These recurring patterns are the building blocks of melodic structures in both improvisation and composition, and are thus, fundamental in the description of audio collections in IAM. We propose an unsupervised approach that employs timeseries analysis tools to discover melodic patterns in sizable music collections. Due to the challenges involved in quantitatively evaluating unsupervised approaches, we first carry out an in-depth supervised analysis of melodic similarity, which is a critical component in pattern discovery. We improve upon the best methodology for melodic similarity that we identified through an exhaustive evaluation of different procedures and parameter settings that are well known and widely used for this task. We improve melodic similarity by exploiting characteristics that are peculiar to melodies in

IAM. Computational pattern discovery often results in large quantities of musically irrelevant patterns. To identify and select musically significant patterns we exploit the relationships between the discovered patterns by performing a network analysis. Listening tests reveal that the discovered melodic patterns are musically interesting and significant.

Finally, we utilize the results of the analysis mentioned above; melody representations, melodic descriptors and discovered patterns to recognize rāgas in recorded performances of IAM. Rāga is a core musical concept in IAM, used in composition, performance, music organization, and pedagogy, and therefore, the most desired melodic description of a music recording. We propose two novel approaches that jointly capture the tonal and the temporal aspects of melody. Our first approach uses melodic patterns, the most prominent cues for raga identification by humans. We utilize the discovered melodic patterns and employ topic modeling techniques, wherein we regard a rāga rendition similar to a textual description of a topic. In our second approach we propose the time delayed melodic surface (TDMS), a novel feature based on delay coordinates that captures the melodic outline of a rāga. With these approaches we demonstrate unprecedented accuracies in rāga recognition on the largest datasets ever used for this task. Although our approach is guided by the characteristics of melodies in IAM and the task at hand, we believe our methodology can be easily extended to other melody dominant music traditions.

In this thesis we have built novel computational methods for melodic analysis of IAM, using which we can describe and interlink large amount of music recordings. In this process we have developed several tools and compiled data that can be used for a number of computational studies in IAM, specifically in characterization of ragas, compositions and artists. The technologies resulted from this research work are a part of several applications developed within the CompMusic project for a better description, enhanced listening experience, and pedagogy in IAM.