Motivation
Melodic concepts like vadi, samvadi, graha svara:
> Lack of objective definition hinders the cause of music information retrieval
> Absence of quantitative evidence for qualitative terms like ‘shine’ or ‘focus’
> Manual analyses introduce subjective biases, and are not easily reproducible

Lack of studies at the time-scale of a full raga performance:
> Some attention has been paid to phrase-level modeling, which is not adequate to appreciate how a musician plans the evolution of the melody over the time-scale of the concert
> Pitch histogram model is useful for intonation analysis, but timing information is crucial for exploring melodic structures

How ‘improvisatory’ are the improvisations?
> What is the universal structure that underlies melodic improvisation, and is this raga-specific?
> How much of this is artist-dependent?
> Can the gharana (lineage) be inferred from a concert audio?

Case study concert:
> Artist: Ajoy Chakraborty (male)
> Raga: Todi, Talas: Ektal, Laya: Vilambit (40 bpm)
> Svaras: S r g M P d N (7 svarasthanas)
> Artist: Ajoy Chakraborty (male)

Data processing
> A trained Hindustani musician annotated their svarasthanas and layas of bandish

Lack of studies at the time-scale of a full raga performance:
> The corpus amounts to 20 hours of data
> 67 unique compositions
> 40 eminent artists (male and female), 75 concerts from 10 widely used ragas

Knowledge hypotheses
K1: Evolution of melody in time
Irrespective of the raga and concert-duration, artists take the same time to explore the melody and arrive at the highest svara

K2: Transitional characteristics of nyas svaras
Artists ‘focus’ on a nyas svara for consecutive breath-phrases to establish that svara before moving on to the next svara

K3: Relationship between functional roles of svaras and their duration in melody
Any svara in a breath-phrase cannot be stretched arbitrarily long, the nyas svara decides how much variance other svaras can exhibit

K4: Duration and position of svaras in melody
The performance starts from a lower svara (graha) and reaches the focal svara (vadi) in course of the gradual development of the melody

K5: Presence of possible pulsatation in melody
There is an implicit pulsatation present in the alap of Hindustani music, this carries forward to the tempi of the bandish

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Music collection
> 75 concerts from 10 widely used ragas
> 40 eminent artists (male and female)
> 67 unique compositions
> Diverse in terms of number of svaras, their svarasthanas and layas of bandish
> A trained Hindustani-musician annotated the end of alap and vistar section
> The corpus amounts to 20 hours of data

MEC Feature Extraction
> A collection of heuristic features (slope-based, duration-based, jump-based, and level-based)
> Stp slope between the MEC value of initial frame and the first frame where MEC rises
> Cen centroid (salience of the bins as the weights is regarded) of each svara
> Pro proportion of duration spent on each svara
> Feature selection in Weka reveals:
  - Stp is a raga-independent feature
  - Cen is a raga-dependent feature
  - Pro for vad (vadi) svara is always higher

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Summary
> We outline the motivation and relevance of computational approaches for quantitatively studying the underlying musical concepts
> Musically relevant acoustic features, computed using existing MIR tools and techniques, are intuitive and easy-to-interpret by musicians/musologists
> We discover implicit relationships between svara and duration in the temporal evolution of a raga performance which is useful in the music pedagogy
> Statistical analyses on a larger representative corpus shows that the validated hypotheses are generalizable

Future work
> Use these findings for characterizing artist- and gharana-specific melodic aspects in Hindustani music
> Incorporate timbre and volume dynamics with melodic features to study use of alankars in alap performances
> Corroborate the findings to propose a system that could provide qualitative (musically valid) feedback to music learners and aid compositional tools