Knowledge-based representations for Carnatic music

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Knowledge-based similarity measures for music

- Intonation analysis
- Building ontologies
- Similarity measures for navigation
Outline

• Current data structuring
• Knowledge representation for Carnatic music
• Ontologies for knowledge representation
• The raaga ontology
• Application scenarios
  – Similarity measures for navigation
  – Audio analysis
  – Web-data mining
• Future work
Current data structuring

- Relational databases
- Varied and incoherent vocabulary
- No place for semantics
- Complex adhoc linking processes
- Insights hidden under ‘joins’
Our goals

• Machine-ready descriptions
  – Semantically rich descriptions of entities
  – From music theory, relevant to current practice

• Linkedness
  – Linked, multimodal data repository
  – Coherent vocabulary
Our goals

• **Machine-ready descriptions**
  – Semantically rich descriptions of entities
  – From music theory, relevant to current practice

• **Linkedness**
  – Linked, multimodal data repository
  – Coherent vocabulary
Knowledge representation for Carnatic music

• Melody
  – Svara
  – Gamaka & Sequence
  – Classification schemes

• Rhythm
  – Metrical cycles
  – Sub structures

• Forms
  – Improvisatory
  – Compositional
Ontologies for knowledge representation (1)

- Existing vocabularies/ontologies/linked-data sources
- Ontology languages (RDFS, OWL …)
- Linked data infrastructure (URI, RDF …)
- Query languages and Reasoners
Ontologies for knowledge representation (2)

- Improved data structuring
- Bring MIR and music theory closer
- Knowledge sharing and communication
- Comparison and integration of different models of a concept
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Raaga: The melodic framework of Indian art music

- **Svaras**: a frequency region with a melodic context
- **Gamakas & Phrases/Sequences**

![Graphs showing pitch and time for Kampita, Jaaru, and Orikkai](image_url)
The raaga ontology :: Svaras

The raaga ontology :: Svaras

<?xml version="1.0"?>
<!DOCTYPE Ontology [
    <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
    <!ENTITY xml "http://www.w3.org/XML/1998/namespace" >
    <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
    <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
]>

...<Declaration>
    <Class IRI="#OWLClass_66eaf4cc_8842_4f1d_99e2_74e0d609c639"/>
</Declaration>

...<EquivalentClasses>
    <Class IRI="#OWLClass_66eaf4cc_8842_4f1d_99e2_74e0d609c639"/>
    <Class IRI="#R3"/>
</EquivalentClasses>
...
The raaga ontology :: Svaras
The raaga ontology :: Sequences (1)
The raaga ontology :: Sequences (2)
The raaga ontology :: Sequences (3)
The raaga ontology :: Classification schemes (1)

- Melakarta system
- Linear / Non-linear
- Varjya / Sampoorna
- Upanga / Bhashanga
The raaga ontology :: Classification schemes (2)

• SPARQL rules

```
CONSTRUCT { ?raaga a :vakraRaaga }
WHERE {

  {?raaga :hasArohana ?progression.
   ?progression ol:hasContents :Gandhara.
   ?progression ol:isFollowedBy ?subsequentProgression.
   ?subsequentProgression ol:hasContents :Rishaba. }

  UNION

  {?raaga :hasArohana ?progression.
   ?progression ol:hasContents :Gandhara.
   ?progression ol:isFollowedBy ?subsequentProgression1.
   ?progression ol:isFollowedBy ?subsequentProgression2.
   ?subsequentProgression1 ol:isFollowedBy ?subsequentProgression2
   ?subsequentProgression2 ol:hasContents :Gandhara.
   ?subsequentProgression2 ol:hasContents :Rishaba. }
}
```

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Application scenarios :: Similarity measures
Application scenarios :: Audio analysis

• **Intonation analysis**¹
  – Melodic context of svaras
  – Deduction of new facts by combining sources
  – Cross comparison / Evaluation

• **Motif detection**²
  – Supervised learning
  – Functional roles of svaras
  – Impact of structure of progression on motives

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Application scenarios :: Web-data mining

- Knowledge discovery from discussion forums
  - Natural language technologies
  - Bootstrap entity recognition based on Wikipedia information
  - Use concepts and relations in ontology

Lalgudi Jayaraman in his Melbourne concert (1994) played Garudagamana (Nagaswaravali) and then shifted to Hamsadhwani via greha bedham during kalpana swaram. He actually played a short passage of Vathapi to emphasise the greha bedham.

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Future work

- Similarity measures for navigation of music collections
- Learning ontologies from Wikipedia / discussion forums
- Ontologies for rhythm and forms
- Access to a multimodal knowledge-base
- Explore and compare alternative sequence representations
  - SPARQL property paths
  - RDF List
  - Other design patterns
Join us and Collaborate

https://github.com/gopalkoduri/ontologies