



Universitat
Pompeu Fabra
Barcelona

MTG
Music Technology
Group



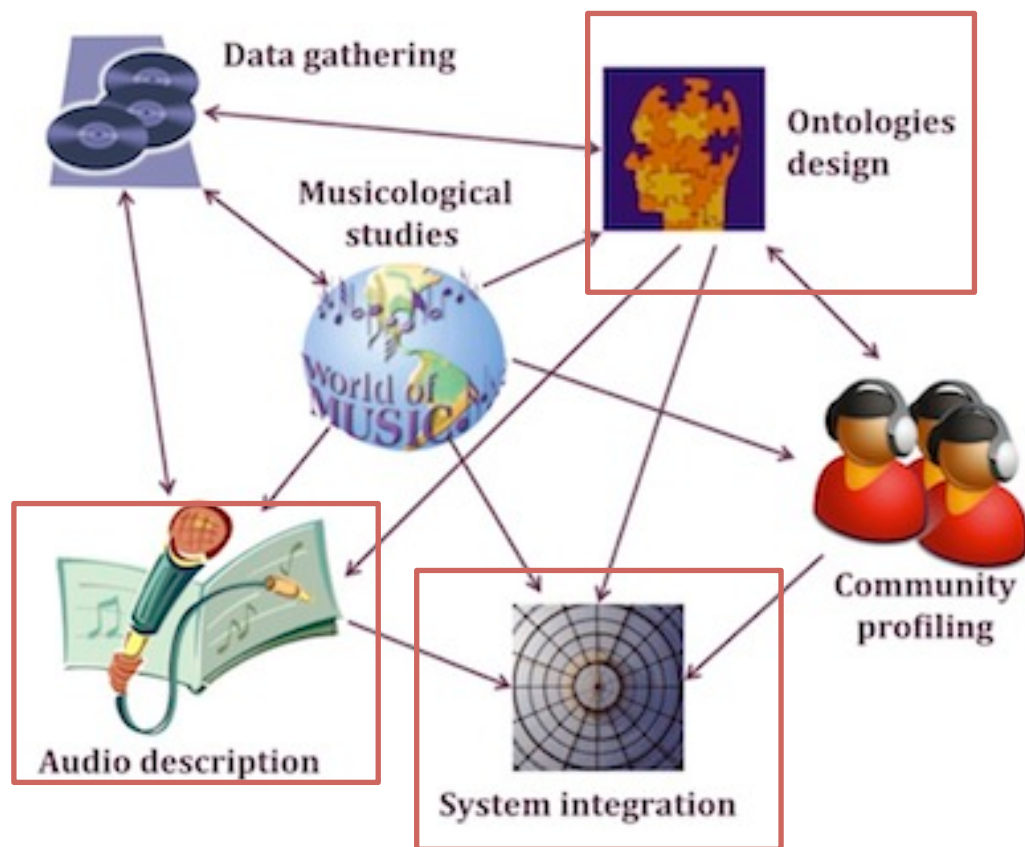
compmusic

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

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**
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- **Linkedness**
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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)

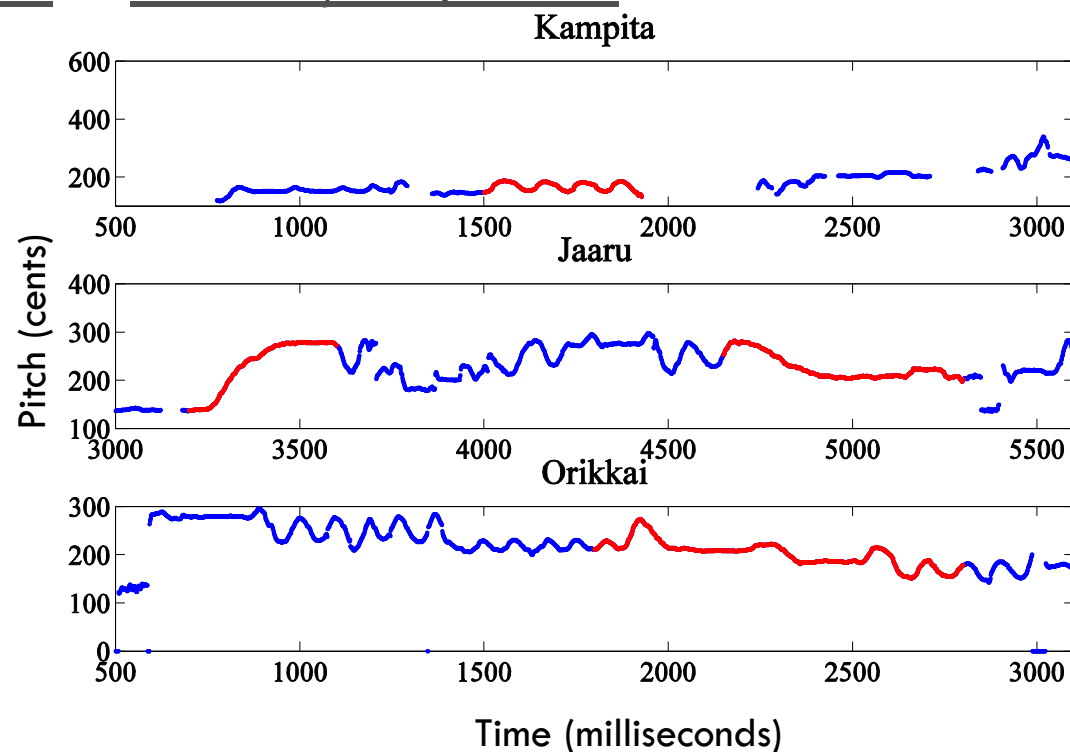
- Improved data structuring
- Bring MIR and music theory closer
- Knowledge sharing and communication
- Comparison and integration of different models of a concept

Outline

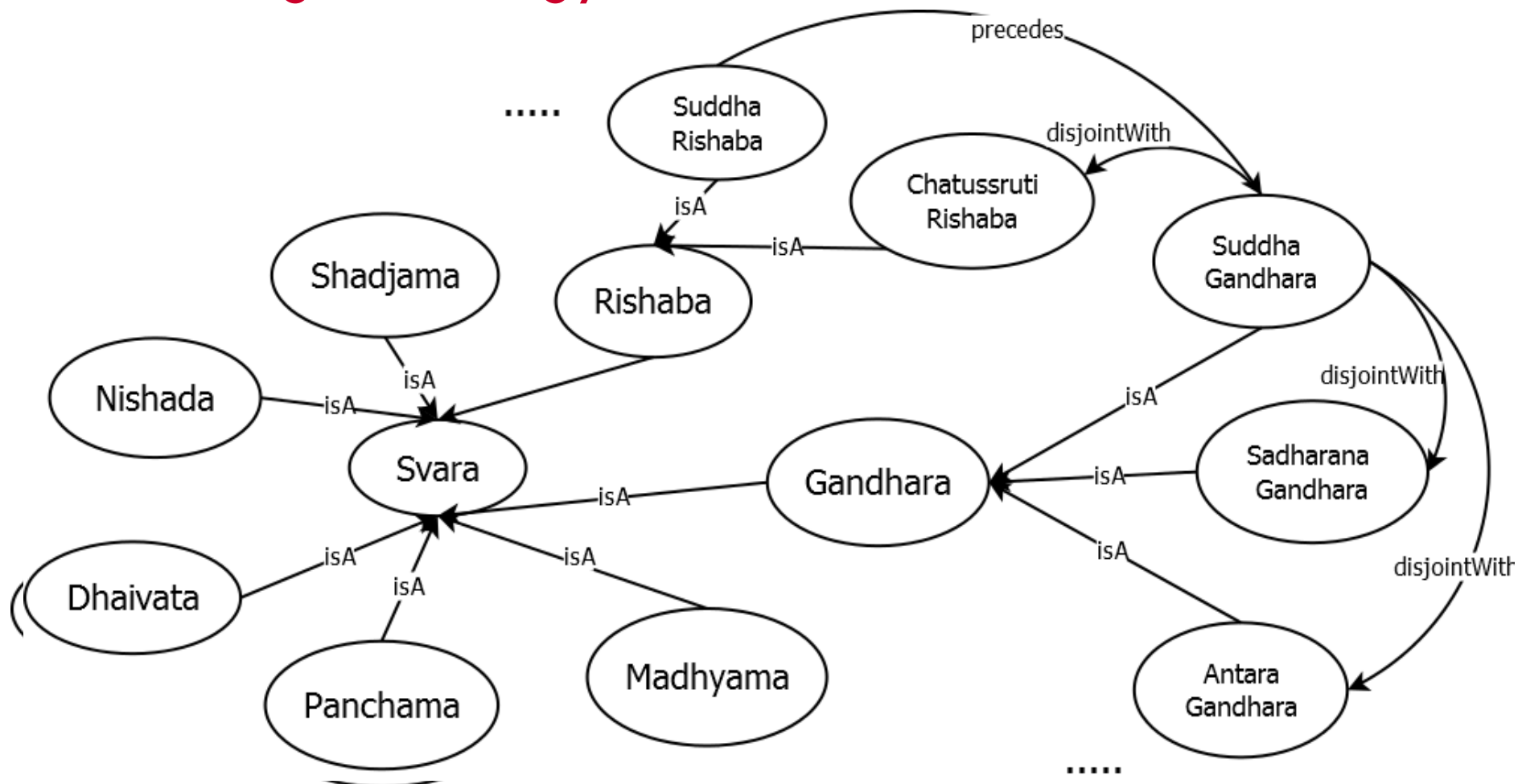
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Raaga: The melodic framework of Indian art music

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



The raaga ontology :: Svaras

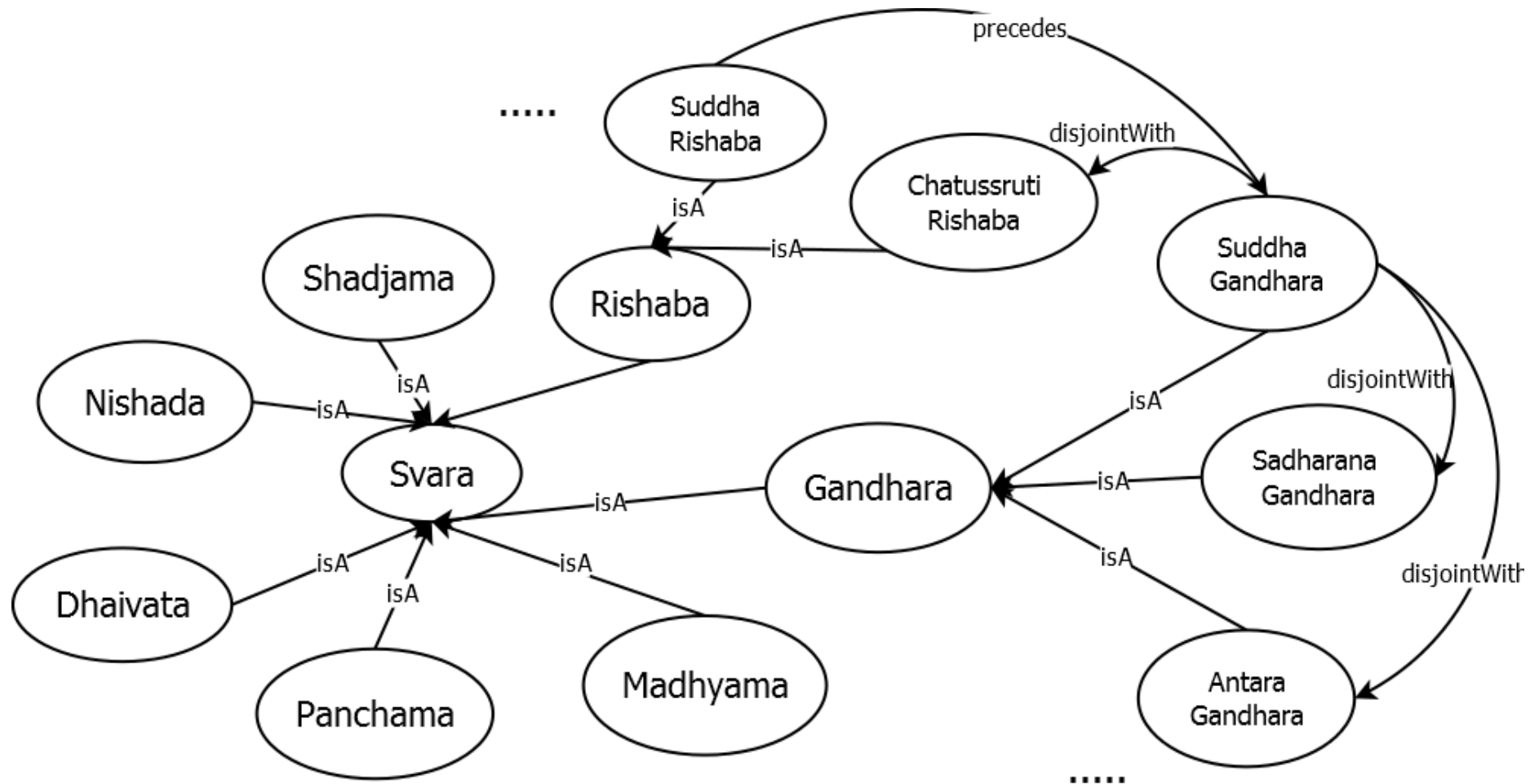


- Krishna, T. M., & Ishwar, V. (2012). Karṇāṭik Music: Svara, Gamaka, Phraseology And Rāga Identity. In *2nd CompMusic Workshop* (pp. 12–18).

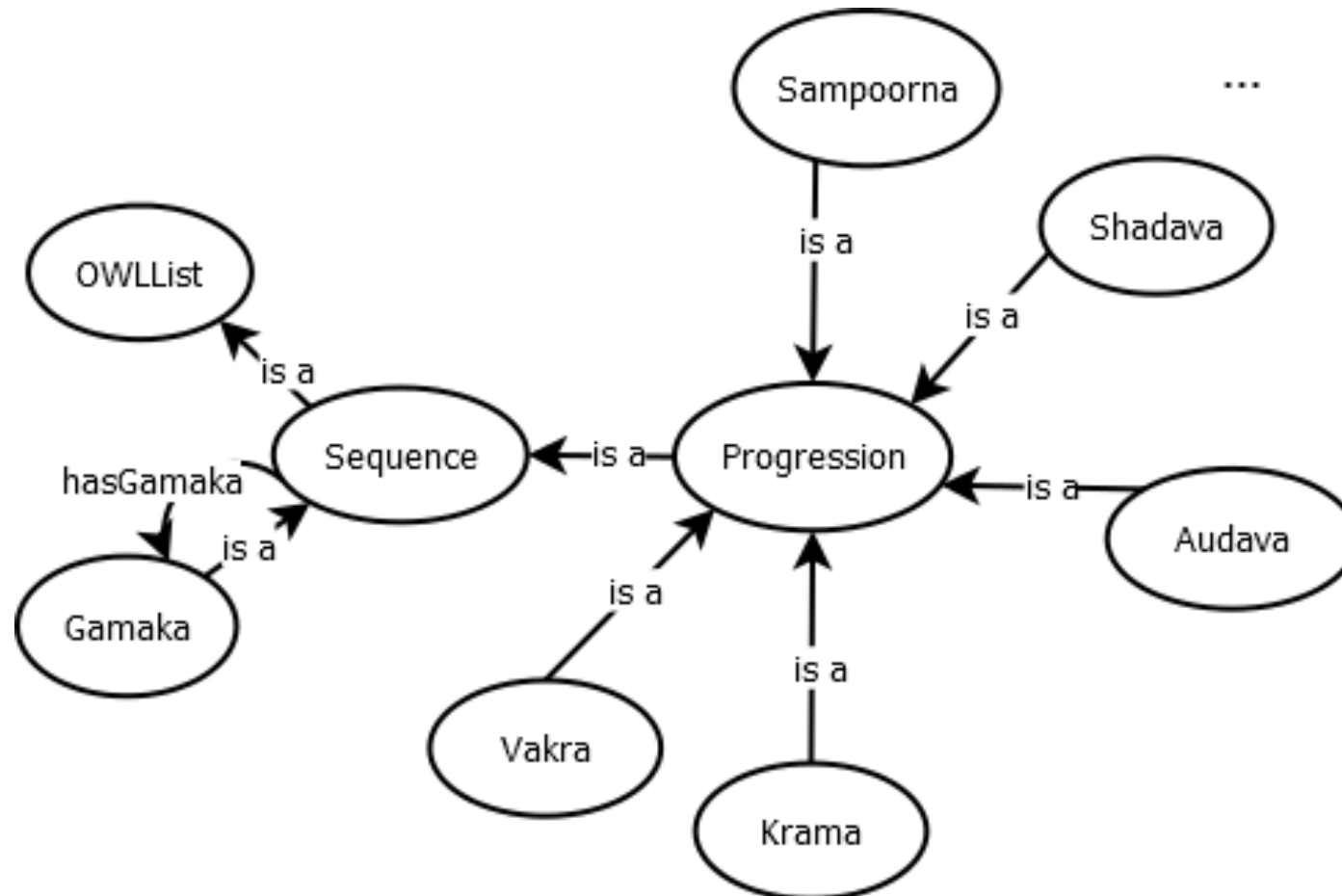
The raaga ontology :: Svaras

```
<?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>
...
```

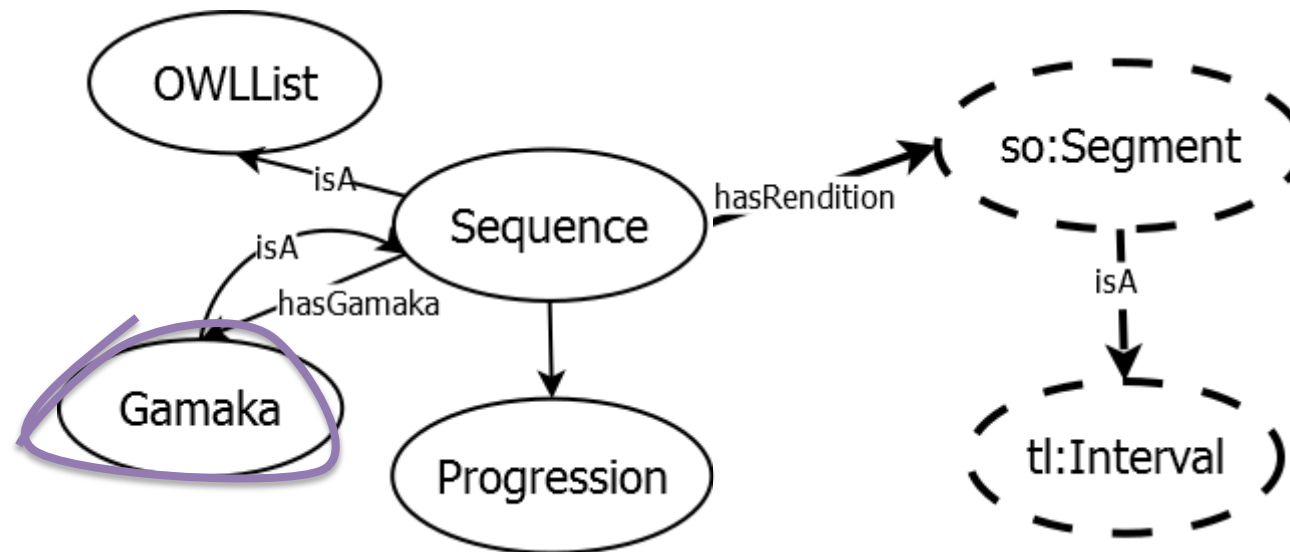
The raaga ontology :: Svaras



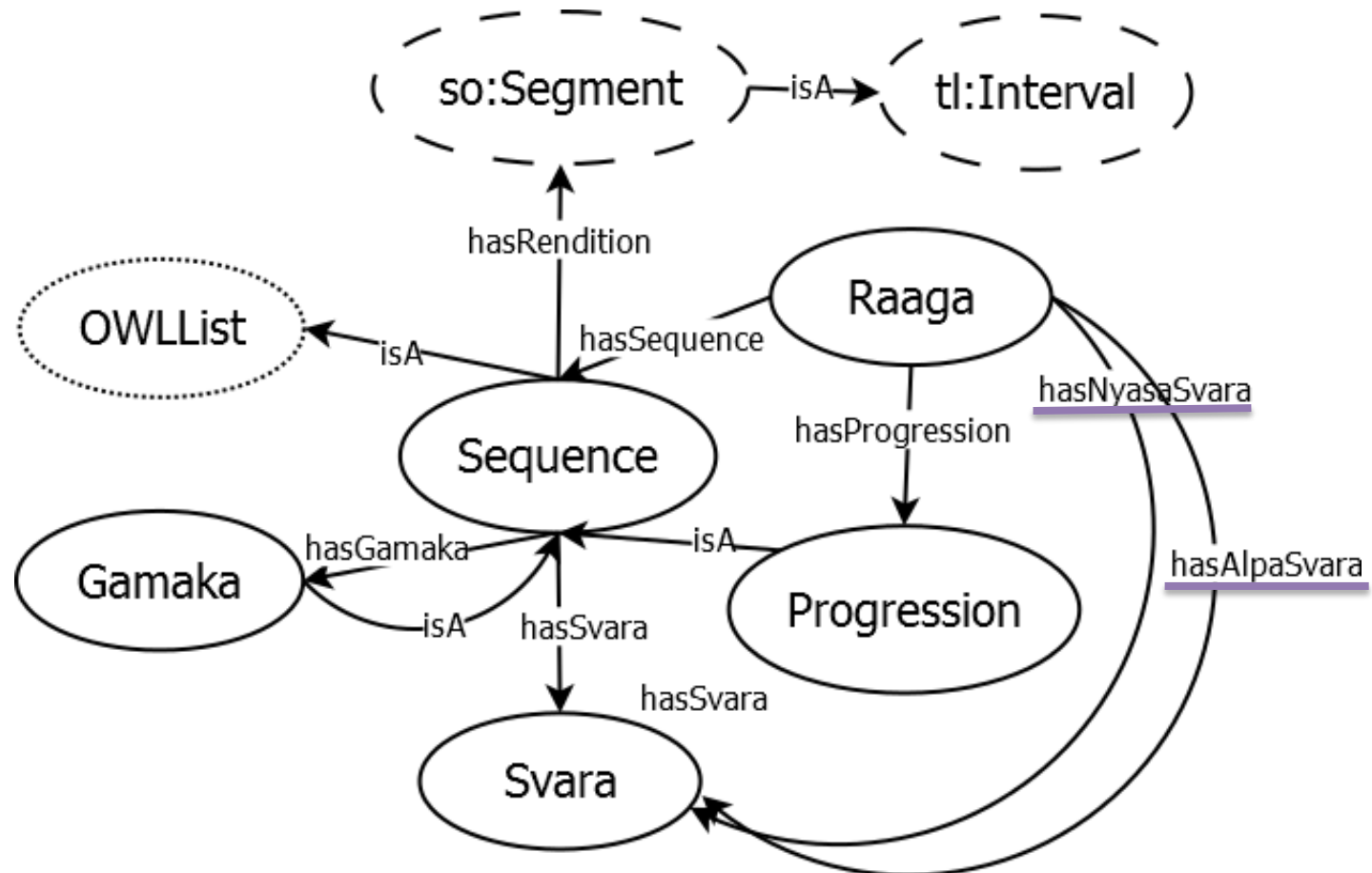
The raaga ontology :: Sequences (1)



The raaga ontology :: Sequences (2)

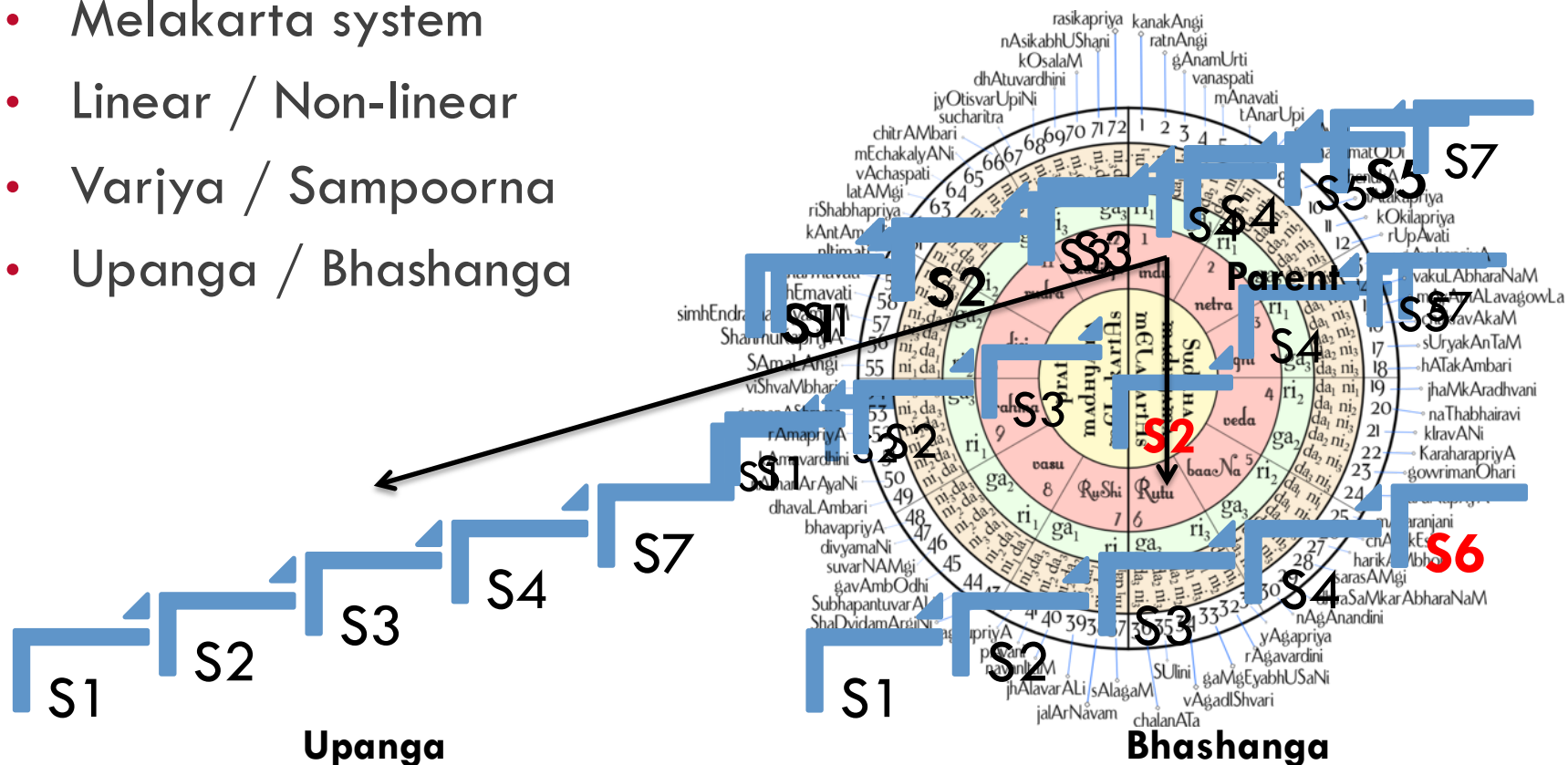


The raaga ontology :: Sequences (3)



The raaga ontology :: Classification schemes (1)

- Melakarta system
- Linear / Non-linear
- Varjya / Sampoorna
- Upanga / Bhashanga



The raaga ontology :: Classification schemes (2)

- SPARQL rules

```
1
2  CONSTRUCT {?raaga a :vakraRaaga}
3  WHERE {
4    {
5      ?raaga :hasArohana ?progression.
6      ?progression ol:hasContents :Gandhara.
7      ?progression ol:isFollowedBy ?subsequentProgression.
8      ?subsequentProgression ol:hasContents :Rishaba.
9    }
10   UNION
11   {
12     ?raaga :hasArohana ?progression.
13     ?progression ol:hasContents :Gandhara.
14     ?progression ol:isFollowedBy ?subsequentProgression1.
15     ?progression ol:isFollowedBy ?subsequentProgression2.
16     ?subsequentProgression1 ol:isFollowedBy ?subsequentProgression2
17     ?subsequentProgression2 ol:hasContents :Gandhara.
18     ?subsequentProgression2 ol:hasContents :Rishaba.
19   }
20 }
21 }
```

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Application scenarios :: Similarity measures



Select Music Style
▼ Carnatic










ABOUT Login

Raaga Abhogi

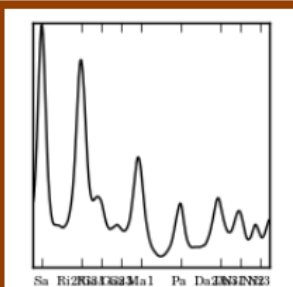




Sa Ri2/Ga1 Ma1 Pa Da2/Ni1

ARTISTS WHO PERFORM THIS RAAGA	COMPOSERS	COMPOSITIONS
 Sanjay Subrahmanyan	 Patnam Subramania Iyer	 Sabhapathiby Gopalakrishna Bharathi
 G. N. Balasubramaniam	 Papanasam Sivan	 Sri Lakshmi Varahamby Muthuswamy Dikshitar
 P. Unnikrishnan	 Gopalakrishna Bharathi	 Manasunilpaby Tyagaraja
 M. D. Ramanathan	 Vannadiil Pudiyaveettil Dhananjayan	 Sabhapathikkuby Gopalakrishna Bharathi
 Nithyasree Mahadevan		

Related raagas, based on pitch histogram similarity



Sa Ri2/Ga1 Ma1 Pa Da2/Ni1

Jayamanohari raaga



Sa Ri2/Ga1 Ma1 Pa Da2/Ni1

Abhang raaga



Sa Ri2/Ga1 Ma1 Pa Da2/Ni1

Karaharapriya raaga

Application scenarios :: Audio analysis




- Intonation analysis¹
 - Melodic context of svaras
 - Deduction of new facts by combining sources
 - Cross comparison / Evaluation
- Motif detection²
 - Supervised learning
 - Functional roles of svaras
 - Impact of structure of progression on motives

1. Koduri, G. K., Serrà, J., & Serra, X. Characterization of Intonation in Carnatic Music by Parametrizing Pitch Histograms (ISMIR, 2012)
2. Ross, J. C., & Rao, P. (2012). Detection Of Raga-Characteristic Phrases From Hindustani Classical Music Audio. In *2nd CompMusic Workshop* (pp. 133–138).

Application scenarios :: Web-data mining

- Knowledge discovery from discussion forums¹
 - 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.

-  Raaga
-  Relation between raagas
-  Musical form

1. Sordo, M., Serrà, J., Koduri, G. K., & Serra, X. (2012). Extracting Semantic Information from an Online Carnatic Music Forum. In *ISMIR*.

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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>