CS365 project presentation

Automatic Music Generation for Indian Classical Music

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Presented by:
Sarika Mohapatra
Ankit Awasthi
Department of CSE
IIT Kanpur

Supervised by:
Prof. Amitabha Mukherjee
Department of CSE
IIT Kanpur
Introduction

- Algorithmic composition is the technique of using algorithms to create music
- Six major categories of compositional algorithm:

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- Some samples: Martin Dostál's GeneticDrummer System, Computer program Randomusic
- Some softwares: Jonathan N. Middleton’s Musical Algorithms, cgMusic, WolframTones based on 1-dimensional cellular automata
Background & Related Work

- Finites state models for Indian Classical Music have been investigated (Dipanjan Das and Monujit Choudhary, 2004, IIT Kharagpur)
- Interactive Genetic Algorithms have been used in the past
- Automatic fitness evaluators, Hybrid models. E.g, Biles et al (1996) used ANN as a fitness evaluator without much success
Problem Statement

- Explore the use of Markov Models and Genetic Algorithms for composition of Indian Classical Music
Music Representation

• Fundamental elements
  – Melody: the primary sequence of notes in a song
  – Harmony: the secondary series of a particular sequence of notes or chords
  – Rhythm: The percussive and/or non-melodic sounds within a song

• Melody consists of a series of musical sounds (notes) or silences (rests) with different lengths and stresses, arranged in succession in a particular rhythmic pattern, to form recognizable unit

• Example: A piano has 88 different notes

• Thus a melody is represented as a sequence of integers (each integer representing a single note, 0 for silence) with length of a note represented by a multiple of the minimum unit of time
Hidden Markov Models

Basic Algorithms:
• Given the parameters of a model, compute the probability of a particular output sequence
• Given the parameters of a model and a particular output sequence, find the state sequence that is most likely to have generated that output sequence
• Given an output sequence or a set of such sequences, find the most likely set of state transition and output probabilities
HMMs for Music Generation

- Train the HMM using music data (other natural data with some inherent pattern has been used too)
- Generate similar (but not same) sequences while varying the input to the HMM
- Get sequences for different features of the music data
- Put the features together using a compositional tool to generate audio
Genetic Algorithms

A typical genetic algorithm requires:
- a genetic representation of the solution domain
- a fitness function to evaluate the solution domain

Simple generational genetic algorithm pseudocode:
- Choose the initial population of individuals
- Evaluate the fitness of each individual in that population
- Repeat on this generation until termination: (time limit, sufficient fitness achieved, etc.)
- Select the best-fit individuals for reproduction
- Breed new individuals through crossover and mutation operations to give birth to offspring
- Evaluate the individual fitness of new individuals
- Replace least-fit population with new individuals
Genetic Programming

- Genetic programming techniques allow for a certain degree of relaxation of the constraints upon the search space imposed by GAs by genetically producing the functions themselves that will solve a given problem.

- GP applications allow genetically evolved functions to adapt to the search space, depending on which of these functions solves the given problem best.
Evolutionary Music Generation

Parameters

- Search Domain
- Knowledge and rule representation
- Fitness function
  - Distance metrics
  - Trained evaluators - neural networks etc.
- Functions in GP
Distance Metrics

Normalised Information Distance

- \( \text{NID}(x, y) = \frac{\max\{K(x|y), K(y|x)\}}{\max\{K(x), K(y)\}} \)

where \( K(x|y) \) is the conditional Kolmogorov complexity of string \( x \) given string \( y \), whose value is the length of the shortest program (for some universal machine) which, when run on input string \( y \) outputs string \( x \). \( K(x) \) is the degenerate case \( K(x|\lambda) \), where \( \lambda \) is the empty string.

But unfortunately, both the conditional and the unconditional complexities happen to be incomputable functions.

A computable estimate of the NID is the

Normalised Compression Distance (NCD)

- \( \text{NCD}(x, y) = \frac{\max\{C(xy) - C(x), C(yx) - C(y)\}}{\max\{C(x), C(y)\}} \)

where \( xy \) is the concatenation of strings \( x \) and \( y \), and \( C(x) \) denotes the length of the text \( x \) compressed by some compression algorithm which approximates \( K(x) \) from above.

HMMs, n-gram models
Evaluation of the Compositions

- Comparison of generated compositions with random compositions in a raga
- Creativity in the compositions (subjective)
- Evaluation by an expert
- Categorization by trained models
Review of Objectives

- A comparative study of which methods and parameters lead to better results
- Relevance of methods and parameters for Indian classical music
- Improvising on existing methods if possible
References


