# CALIFORNIA STATE SCIENCE FAIR
# 2011 PROJECT SUMMARY

**Name(s)**

**Christine Chang**

**Project Number**

31446

**Project Title**

## Beethoven Reborn: A Novel Approach Employing Markov Model to Synthesize Music in Great Composers' Styles

**Abstract**

**Objectives/Goals**

The objective of this project is to use computers to learn music from great composers and generate new compositions that contain desirable characteristics as in the original music.

**Methods/Materials**

(I) Learning Phase: Implement Sequitur Algorithm to convert an original song from a sequence of notes to a sequence of motifs and learn the characteristics of the song, including motifs and motif's frequencies and the transition between consecutive motifs.

(II) Composing Phase: Build a Markov table based on the information learned during the learning phase. Each (key, successor) pair maps to an entry in the Markov table. The computer program composes new music based on this Markov table. It randomly picks an initial key from the Markov table and randomly picks one of the successors, according to the learned probability distribution from the original song. The newly picked successor becomes the new key. This process continues until the number of motifs in the new song equals to the number of motifs in the original song. Composition techniques are applied to promote variations: with a tunable probability, the computer program elevates or lowers a motif by an octave, and it doubles or halves the duration of all notes in a motif.

**Results**

The combination of Sequitur Algorithm and Markov Model works effectively in learning original music and then in generating new music. Some of the computer synthesized songs sound beautiful, and most songs sound acceptable.

**Conclusions/Discussion**

Sequitur Algorithm is chosen to extract hierarchical information from songs. The hierarchical information is organized into a Markov table. New music is created based on the Markov table. Compositional techniques are applied to promote variations. A Java program is written to implement the algorithm. The program works efficiently and effectively generates beautiful new music with traces of the original music. Future research includes more intelligence in learning phase, for example, in the recognition and generation of transposition of any music interval, the processing of multi-notes and multi-parts, and the generation of more developed music structure.

This approach of combining Sequitur Algorithm with Markov Model could be a powerful research method for applications such as text analysis and synthesis, genome scanning, or other applications that requires extracting and analyzing hierarchical information.

**Summary Statement**

This project identifies Sequitur Algorithm and Markov Model to be an excellent combination for computers to effectively learn the characteristics of input music and then to compose beautiful new music based on learned information.

**Help Received**