Generating Concurrent Musical Accompaniment using Artificial Intelligence
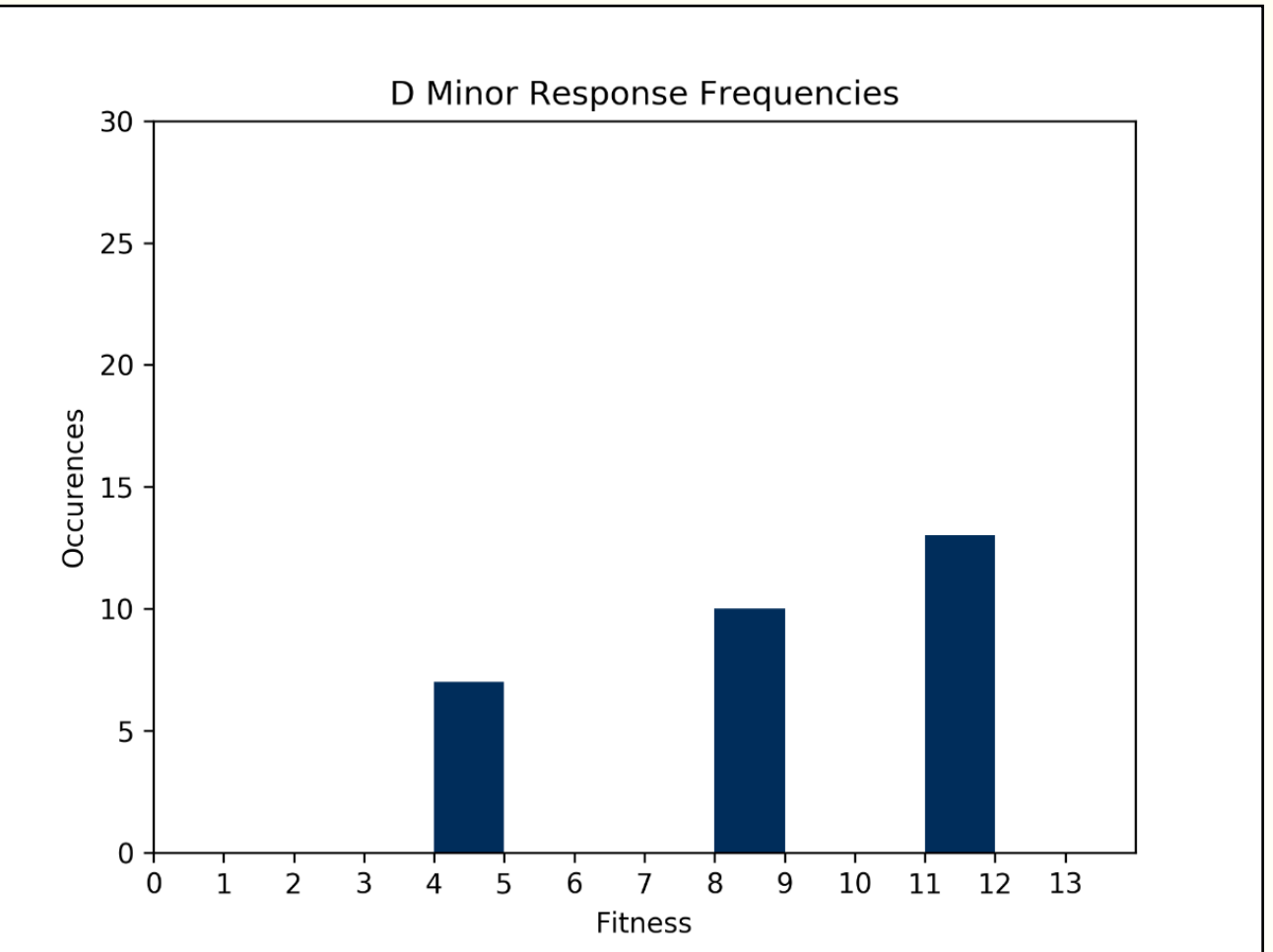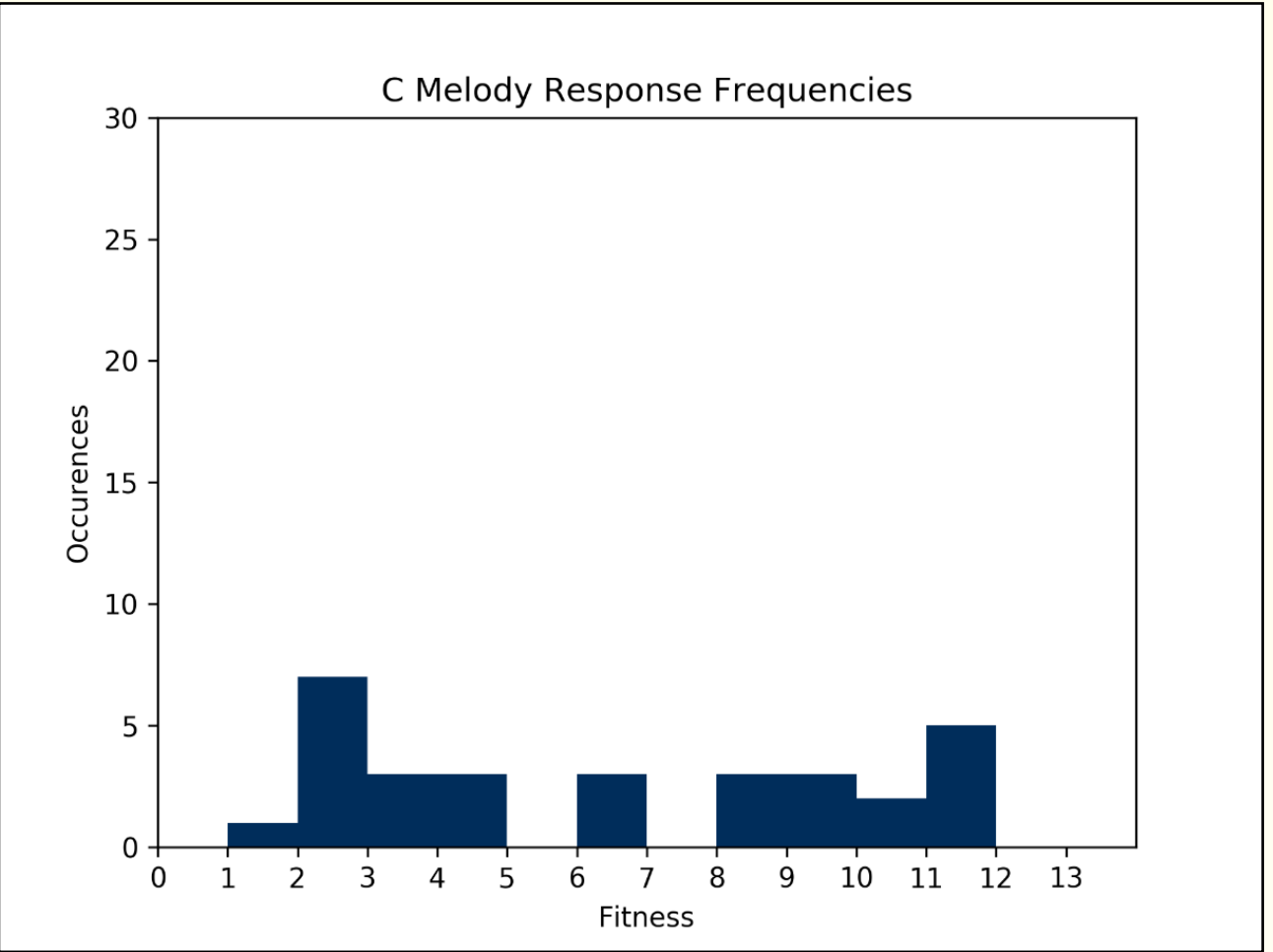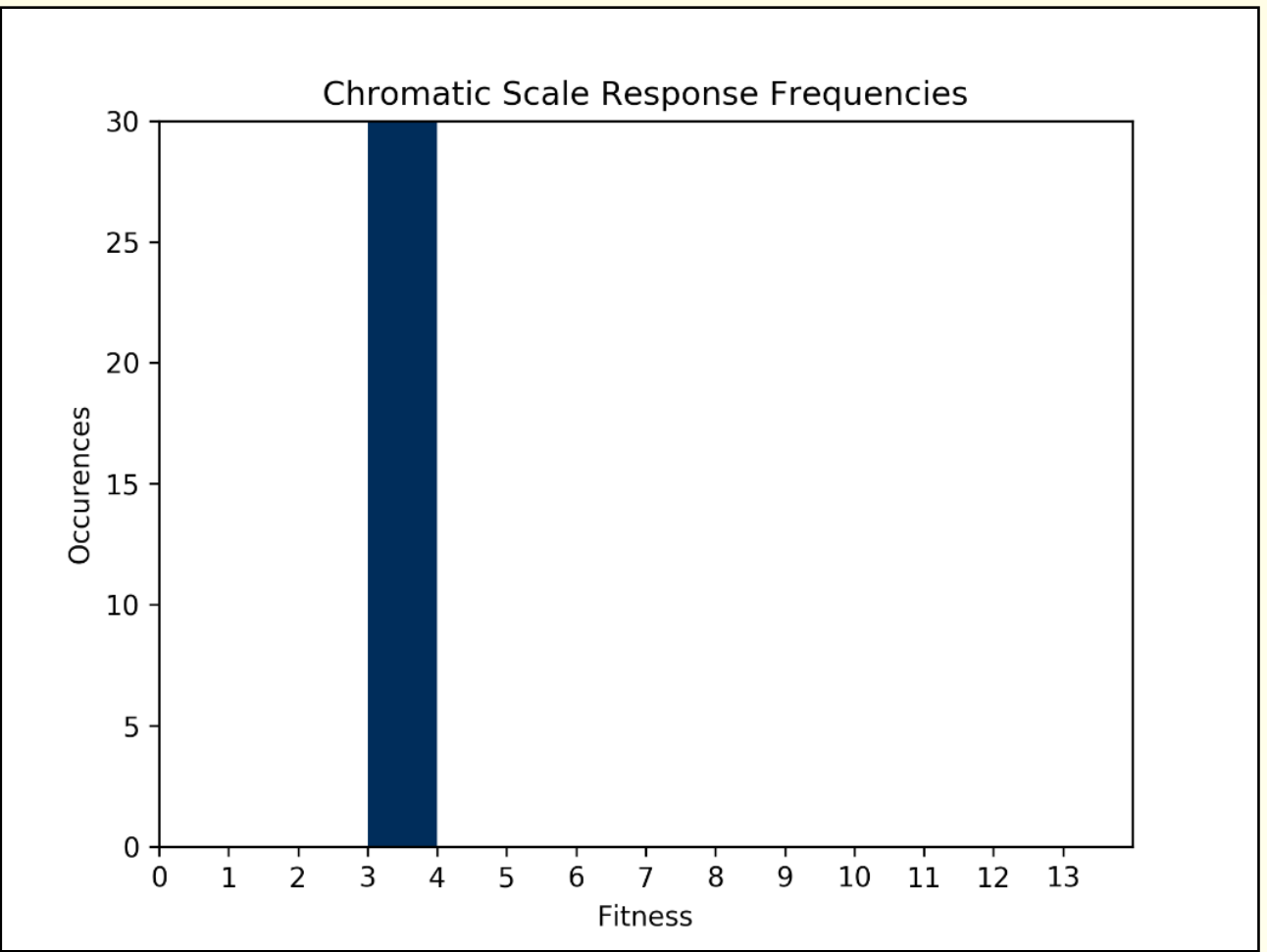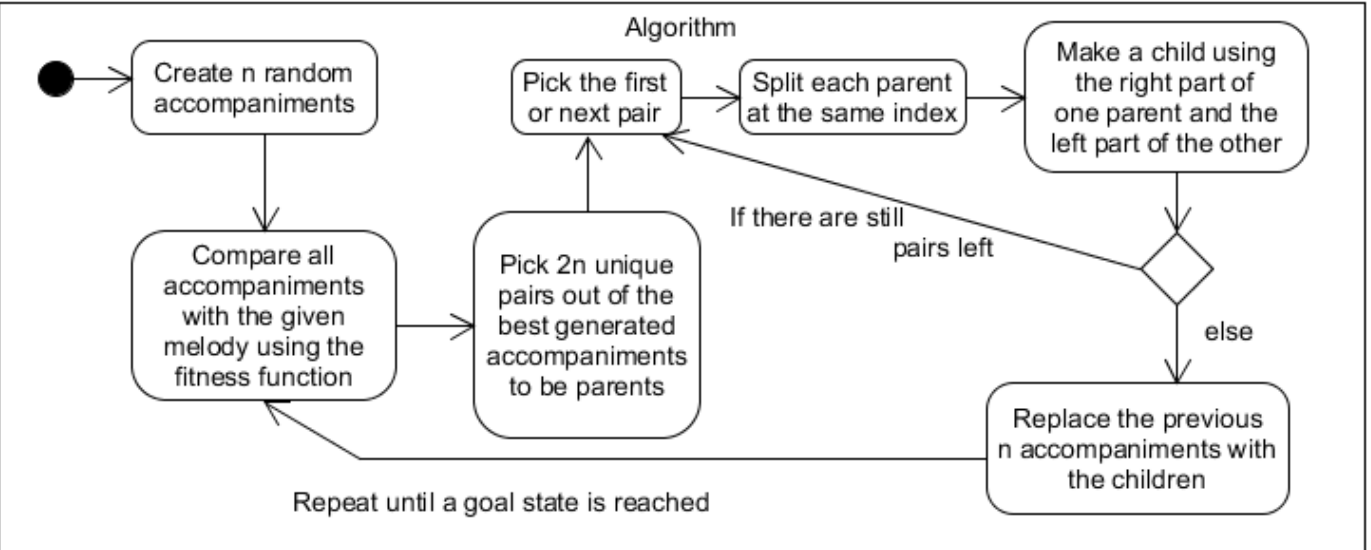
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Introduction

- Driving Question: Can an algorithm be used to create real-time musical accompaniment?
- Artificial Intelligence may provide possible solutions.
- Goal: Create an AI agent that responds to real-time musical input with real-time musical output
- This agent, GenegleBot, plays accompaniment in real time while also following the most recently established pattern when no input is present.
- We approach this problem with a genetic algorithm:
  - an AI Technique for searching for solutions to problems inspired by evolutionary processes

Methods

- Input & output are captured and transmitted as MIDI control messages to/from a keyboard
- We represent user input with a *queue* data structure of finite size
  - A histogram, $\vec{y}$, is computed from the queue
- The Genetic Algorithm is comprised of *individuals*: possible histograms that will be ranked based on their similarity to $\vec{y}$.
  - Ranking is based on a fitness function: $Fit(\vec{v})$
- The algorithm relies on a control message for determining the tempo of the performance:
- A hardware/software clock source is polled for: **0xF8, 0xFA,** and, **0xFC** messages to determine tempo events, and messages are masked with **0xF0** and masked with **0x90** to determine when notes are input. Note data is extracted from the next byte of the control message.
- At each generation of the genetic algorithm, the "best" individual (a histogram) is selected, which will be sampled for output notes.

Algorithm

Chromatic Scale Response Frequencies

C Melody Response Frequencies


D Minor Response Frequencies

Results

- Exploring the performance of this approach to the problem revealed that the algorithm's effectiveness relies on the monotony of the user input. Using a population size of 144 individuals with 3 generations of the genetic algorithm each time an individual is chosen for sampling notes, the fitness of each chosen individual occurred with frequencies shown in the above histograms. For a chromatic scale as input, no individual ever exceeded a fitness of 3. When input consisted of a slightly monotonic melody in C, there was more variance in the distribution of individuals' fitness. Finally, an input of an extremely monotonous D minor arpeggio resulted in many more highly fit individuals being produced.

Methods continued…

- An example of the relationship between the *queue* and its associated histogram is shown below. Note that the advantage of using a queue is that this allows only the most recent part of a performance to be considered by the genetic algorithm.

GenegleBot at a Glance

Histogram for user input queue, $(A_4, A_2, C_4, E_4, A_3)$
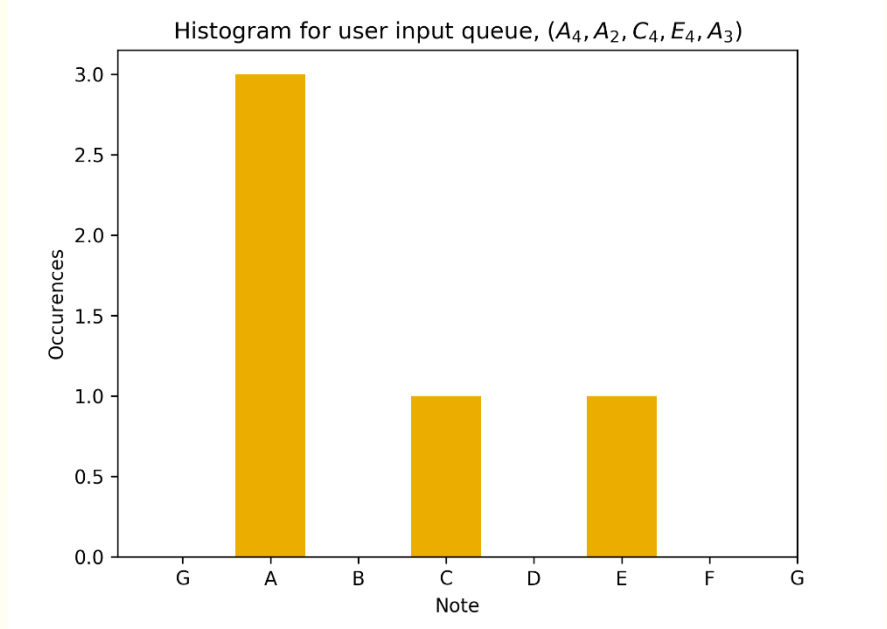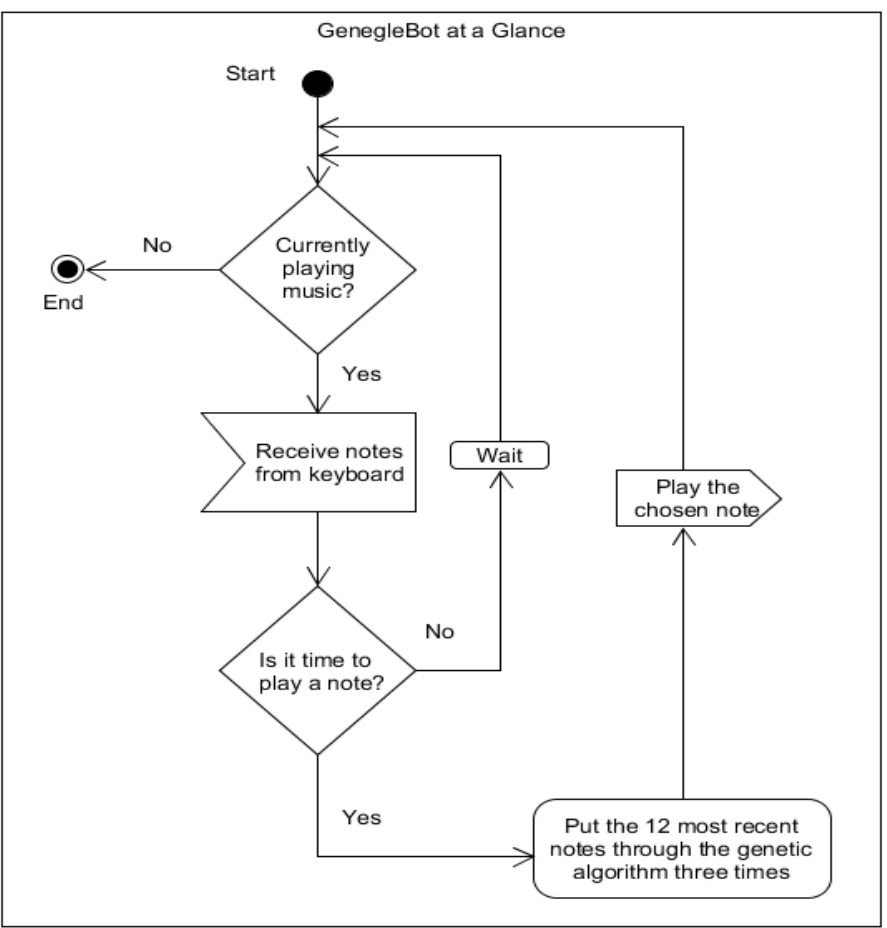
$$Fit(\vec{v}) = \vec{v} \cdot \vec{y}$$

$$= \sum_{i=1}^{m} \vec{v}_i \vec{y}_i$$

Discussion

- Most software for generating musical accompaniment will generate an accompaniment for a prerecorded piece.
- This AI is rare in that it generates accompaniment in real time.
  - These techniques are a possible candidate for creating music software that will be helpful for any musician in need of an agent to play an extra part to a song.
- This genetic algorithm has still more potential if it is adapted to respond intelligently to rhythm.

References
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