AI Search for Relaxing Music with Skin Conductance

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1 Background

Music has the power to cause intense emotions in the listener [], and the power to utterly relax them []. Its power in manipulating emotions has led to widespread use in therapy, a field known as musical therapy [].

The songs used in musical therapy are usually created specifically for that purpose, based on a general understanding of what causes a song to be relaxing []. This neglects the fact that people often have different preferences in music, and react differently to the same songs [].

We can improve on this by implementing a system that dynamically searches for songs that an individual finds relaxing. To measure how relaxed the listener is, we can use the Galvanic Skin Response, also known as Skin Conductance, which measures the activity in the central nervous system []. When a person is relaxed, there is very little activity in the central nervous system, and when they are experiencing intense emotion, positive or negative, the central nervous system is very stressed and active, which causes subsconcious sweating []. We can measure this by testing the skin's conductance. When the skin is highly conductive, we know the listener is sweating more, and therefore experiencing more intense emotion [].

1.1 Proposed Model

Using the Spotify API, we can represent a song as a 14-dimensional vector which describes its important qualities, including *danceability*, *energy*, and *key* [**?**, **?**].

2 Terms

GSR: Galvanic Skin Response, a measure of the subconscious sweating in the hands, which correlates to the sympathetic nervous system being excited.

3 Proposed Method

- Spotify API can give you a song as a 14-dimensional vector.
- We therefore have a 14-dimensional space, full of points, where each point represents a song
- We can map a fitness landscape over that space, where each point's fitness is determined by playing the song to a listener and measuring their change in GSR.
- AI search techniques will determine which point in the space to check next.
- Since it is rare that the point chosen in the space will match up to a song's point, we need to do nearest-neighbour search for the closest song.
- The AI Search will repeatedly choose points to test, trying to maximise the Fitness Function.

4 Themes

4.1 Approximate Search

Most AI Search problems are impractical to get an optimal solution because they have exponential time complexity. This problem has a linear time complexity in the number of songs, but our issue is that even that is too long. We want an approximate solution in far less than O(n) time.

4.2 AI Search

AI search is used to intelligently search a space of options to find the one that maximises or minimises some fitness function.

4.3 Music as Vectors

Echonest analyses music and turns it into vectors
Spotify bought them, it's now part of their API

4.4 Galvanic Skin Response

4.5 Nearest Neighbour Search

The AI search algorithm will just output a point in the space it wants to explore next. That point probably won't line up with an actual song. We need to find the song that is nearest to a point in a 14-dimensional space, and we need to do it quickly. We might just be able to do a linear search, as there aren't that many songs in our set, around 1 million songs. If this proves to be a slow point,

we can use space partitioning, or even an approximation method such as Greedy search in proximity neighborhood graphs.