WHEN SCIENCE MEETS MUSIC: CREATING MELODIES FROM MOLECULES OF LIFE

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Dated: 30 October 2022
Keywords: Protein music, sequence-to-protein mapping,Amino acids, Musicality

INTRODUCTION

Understanding sophisticated science is not always simple, and those who believe science is a challenging subject may decide against studying it or going into the field as a profession.

In order to simplify complex scientific ideas into manageable chunks of information, science communication techniques are becoming more and more creative. By developing melodies based on the structure of proteins, Yu Zong Chen, a professor in the department of pharmacy at the National University of Singapore, and Peng Zhang, a postdoc at Rockefeller University, have perhaps advanced innovation. In Heliyon, their research has been published.

The language of love, according to poets and authors, is music. Scientists have proposed that music could serve as a molecular structure-specific language, or the language of chemistry.

"The most common forms of expression, dissemination, and perception for humans to understand themselves, the world, and events are through music and visual art. Most people think that science is complicated and difficult to understand. Proteins are the workhorses of life, therefore by musically representing one of life's fundamental components, the general people may hear what science sounds like and hear life at its most microscopic level "Chen spoke with Technology Networks.

HOW DO PROTEINS WORK?

The body depends heavily on proteins, which are big, complicated molecules. They carry out the majority of the work inside cells and are necessary for the regulation, construction, and operation of all the tissues and organs in the body.

HOW CAN WE MAKE MUSIC OUT OF PROTEINS?

It may sound challenging to translate protein structure into music, yet there are some similarities between how proteins are constructed and how music is created. Zhang said, "Protein structure is like a folded chain, and this chain is made up of little units called amino acids.

There are 20 distinct amino acids, and each one is given an alphabetical label. "These alphabetic letters can be used to represent a protein chain, which is similar to representing a string of musical notes in alphabetical notation," Zhang continued. In order to facilitate their function, protein chains fold and wave in specific ways. There are loops, turns, and ups and downs in these patterns. "The sound waves in a musical string have varying tempos, pitches higher and lower, and repetitions. The structural and chemical properties of amino acids can be converted into a series of musical qualities using algorithms."

This idea is not new, but previous attempts didn't concentrate on a specific music genre, resulting in an unsatisfactory audio experience. The current algorithms use a basic technique of linking amino acid features to fundamental music characteristics like note length and pitch, but this approach struggles to capture intricate musical elements like rhythm and harmony.

The protein-to-music algorithm involves four steps: creating distribution maps for musical and amino acid features, comparing these maps to find the best matches, and using the matched amino acid features to map to each musical feature.

Chen and his team concentrated on classical music in their research to facilitate the intricate mapping of various amino acid features to the robust characteristics of this genre.

Chen stated that classical music typically includes lighter, emotive, graceful, and homophonic melodies, and these strong features could be used as a useful guide for protein-to-music mapping. They specifically chose the Romantic period classical music, which has characteristics like chromaticism and chords and spans a broad range of piano keys. Chen also noted that music from this period is highly emotional, allowing them to test a wide variety of piano keys in their algorithm.

WHAT PROTEINS WERE SELECTED?

Out of the numerous proteins that exist in the human body, Chen and his colleagues chose 18 proteins that belong to two distinct groups. The first group comprises 11 proteins that are associated with emotion, cognition, sensation, and performance, which align with the lighter, more homophonic, and graceful qualities of classical music. The second group contains proteins that have diverse functions, such as photosynthesis, fluorescence, food proteins, and disease, representing various "aspects" and "states" of life.

The researchers analyzed four pieces of classical music from the Romantic period, specifically from the mid-1800s, which included Chopin's Fantasie-Impromptu and Franz Schubert's Wanderer Fantasy.

Chen explained that the resulting music was intricate, with noticeable variations in pitch, volume, and rhythm. Each protein produced a unique melody due to its distinct amino acid sequence, making no two pieces alike. The researchers observed that generating music in this manner could result in intriguing patterns. For instance, the music created from the oxytocin receptor contained repeating motifs due to certain smaller amino acid sequences in the protein. Moreover, some compositions sounded more chromatic than others, such as the music from the cellular tumor antigen p53, which had toccata-like phrases. Chen noted that the music from the M protein of the coronavirus, which shapes the viral envelope, covered a vast range of keys, particularly in the bass.

INSPIRING A GREATER UNDERSTANDING OF THE MOLECULES OF LIFE

The researchers aim to raise awareness and interest in the molecules of life through their musical creations. They hope that their work will inspire future research in this field. Chen acknowledged that their mapping algorithms were developed based on a limited selection of classical music pieces and the opinions of a small group of people. He believes that a more refined algorithm could be developed by incorporating a larger variety of music pieces and obtaining input from a more diverse group of individuals.

WHAT ARE THE POTENTIAL APPLICATIONS OR BENEFITS?

The meaning of music can vary greatly, and it fosters both engagement and imagination. Incorporating music into chemistry education can introduce innovative approaches for students to grasp complex concepts. Consider the possibility of experimenting with musical equipment or software to manipulate chemical structures.

In addition, the technique of molecular sonification provides a way for blind chemists and students to perceive the structures of molecules. By converting visual information into sound, it serves as a valuable tool for sensory substitution and allows individuals with visual impairments to experience the satisfaction of constructing atomic and molecular models.

Over the past few years, the use of AI models has become increasingly important in the creation and production of drugs and other chemical substances. Molecular sonification could play a role in enhancing these models, allowing for more rapid identification of desired chemicals. As an example, a recent protein-design study involved converting protein sequences into musical compositions and utilizing AI to correlate musical patterns with protein structures. This process led to the creation of new proteins by generating novel musical compositions and translating them back into protein sequences.

CONCLUSION

Molecular sonification is not limited to the field of chemistry; it also has potential applications for musicians and music researchers. Typically, machine-learning models require vast amounts of data to be trained effectively. By transforming molecules into musical compositions, molecular sonification provides an abundance of complex musical data that could be used to train AI models for music generation. It appears that the integration of music into AI, chemistry, and data visualization will play an increasingly significant role in the future. We can expect to see more developments in this area in the coming years.

Reference

1. Tay, Nicole Wan Ni et al. 2021. “Protein Music of Enhanced Musicality by Music Style Guided Exploration of Diverse Amino Acid Properties.” *Heliyon* 7(9): e07933. https://doi.org/10.1016/j.heliyon.2021.e07933.

2. Dunn, John, and Mary Anne Clark. 1999. “ Life Music: The Sonification of Proteins .” *Leonardo* 32(1): 25–32.