Artificial intelligence identifies the musical progression of the Beatles

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Music fans and critics know that the music of the Beatles underwent a dramatic transformation in just a few years, but until now there hasn't been a scientific way to measure the progression. That could change now that computer scientists at Lawrence Technological University have developed an artificial intelligence algorithm that can analyze and compare musical styles, enabling research into the musical progression of the Beatles.

Assistant Professor Lior Shamir and graduate student Joe George had previously developed audio analysis technology to study the vocal communication of whales, and they expanded the algorithm to analyze the albums of the Beatles and other well-known bands such as Queen, U2, ABBA and Tears for Fears. The study, published in the August issue of the journal *Pattern Recognition Letters*, demonstrates scientifically that the structure of the Beatles music changes progressively from one album to the next.

The algorithm works by first converting each song to a spectrogram – a visual representation of the audio content. That turns an audio analysis task into an image analysis problem, which is solved by applying comprehensive algorithms that turn each music spectrogram into a set of almost 3,000 numeric descriptors reflecting visual aspects such as textures, shapes and the statistical distribution of the pixels. Pattern recognition and statistical methods are then used to detect and quantify the similarities between different pieces of music.

In popular music, albums are widely considered milestones in the stylistic development of music artists, and these collections of songs provide a convenient unit for establishing measurements to quantify a band's progression.

LTU's study analyzed 11 songs from each of the 13 Beatles studio albums released in Great Britain, and quantified the similarities between each song and all the others in the study. The results for the individual songs were then used to compare the similarities between the albums.

The automatic placement of the albums by the algorithm was in agreement with the chronological order of the recording of each album, starting with the Beatles' first album, "Please, Please Me," and followed by the subsequent early albums, "With the Beatles," "Beatles for Sale" and "A Hard Day's Night."

The automatic association of these albums demonstrated that the computer algorithm determined that the songs on the first album, "Please, Please Me," were most like the group of songs on the second album, "With the Beatles," and least like the songs on the last album recorded, "Abbey Road."

The algorithm then placed the albums "Help!," and "Rubber Soul," followed by "Revolver," "Sergeant Pepper's Lonely Hearts Club Band," "Magical Mystery Tour," "Yellow Submarine," and "The Beatles" (The White Album).

"Let It Be" was the last album released by the Beatles, but the algorithm correctly identified those songs as having been recorded earlier than the songs on "Abbey Road."

"People who are not Beatles fans normally can't tell that 'Help!' was recorded before 'Rubber Soul,' but the algorithm can," Shamir said.

"This experiment demonstrates that artificial intelligence can identify the changes and progression in musical styles by 'listening' to popular music albums in a completely new way."

The computer algorithm was able to deduce the chronological order of the albums of the other groups in the study by analyzing the audio data alone – with one notable exception. Strong similarities were identified between two Tears for Fears albums released 15 years apart. That makes sense because "Seeds of Love," released in 1989, was the last album before the band's breakup, and "Everybody Loves a Happy Ending," released in 2004, was recorded after the band reunited. Those two albums had less in common with two solo albums released by Roland Orzabal, the group's principal songwriter, after the band split up in 1991.

In the case of "Queen," the computer not only sorted the albums by their chronological order, but also distinguished between albums before and after the album "Hot Space," which represented a major shift in Queen's musical style.

In this era of big data, such algorithms can assist in searching, browsing, and organizing large music databases, as well as identifying music that matches an individual listener's musical preferences.

In the case of the Beatles, Shamir believes this type of research will have historical significance. "The baby boomers loved the music of the Beatles, I love the Beatles, and now my daughters and their friends love the Beatles. Their music will live on for a very long time," Shamir said. "It is worthwhile to study what makes their music so distinctive, and computer science and big data can help."

Provided by Lawrence Technological University