Percy Bell
Dec 9th 2019
CSCI3702

Mind, Body and Music: A study of Cognitive Musicology and Artificial Intelligence

Music has been a fundamental part of many if not all human civilizations and cultures. Each developing, without help from other civilizations, their own instruments, styles and music. Musicology is the study of music and has ties to many fields, anthropology, psychology, linguistics, mathematics, and now, with developments in cognitive science and artificial intelligence it can be applied to those as well. Much of cognitive musicology seems to focus on writing AI musical helpers for musicians, AI's who write their own music, or studying the cognitive reasoning behind how people compose, perform, and listen to music. This new mix of cognitive musicology and artificial intelligence provides a new way of looking at the philosophical question of how the mind and body work together. Gilbert Ryle in his book: *The Concept of Mind*, plays with the idea of whether or not the mind is a product of the body or is another kind of machine that works in tandem with the machine of the body. This is the idea of the dualist Cartesian mind where mind and body are separate and the mind inhabits a realm of its own which operates by separate principles as that of the physical world. Ryle actually argues against the idea of Cartesianism. The new applications of cognitive musicology to artificial intelligence support his claims about Cartesianism. We can see looking at computers that the software is a creation of the hardware not a separate entity of its own. If music is an inherently human creation and the existence of musical intelligence is human in nature, then as computers get better and better at working out musicological problems, and gain musical intelligence themselves, Cartesianism is proved incorrect. Musical intelligence must be a product of the physical body and thus so must the human mind.

Cartesians believe that the mind and body exist separately. The body existing in the physical world and the mind existing somewhere else entirely. The body in this case acts as the mind's connection to the physical world. Ryle describes this fairly well in his book: "Discartes found in himself two conflicting motives. As a man of scientific genius he could not but endorse the claims of mechanics, yet as a religious and moral man he could not accept [...], the discouraging rider to those claims, namely that human nature differs only in degree of complexity from clockwork. The mental could not just be a variety of the mechanical" (Ryle 8). The idea is that, there is nothing in the mechanical systems of the body that can explain the way the mind itself works. The mind is non-spatial, a "piece of non-clockwork" among the clockwork. It has been thought of as a "ghost attached to a machine" where the ghost itself is simply a kind of spectral machine which operates by its own laws.

Computers themselves are a direct contradiction of Cartesian theory. If the software of a computer is to the hardware as the mind of a human is to the body, then either software is the ghost in the machine, or humans are simply a more complex example of clockwork. Looking at the way software functions within a computer, we can see that the software is in fact a product of the hardware construction. The CPU completes calculations, data is moved in and out of physical registers, electronic signals are sent across wires, and all of this translates to the mind of the machine. So the ghost is not a ghost at all. We can prove this fact through examination of the machine, however, this examination becomes much more difficult when applied to the human mind. If the hardware of the mind is thought of as the synapses and tissue and sensors which

comprise the brain it is much harder to examine and prove that what the mind thinks and does is simply a product of physical manipulations within the brain itself. Human brains are much more complex in hardware than a computer. While we can not yet prove Cartesian theory wrong simply from looking at the workings of our brains, we can prove it wrong by showing the ability of computers. If a computer can perform a task which is traditionally human in nature it shows that no "ghost in the machine" is necessary. For this we can use music as an example.

Musicology in the cognitive sciences often measures an individual's thought process around music. Whether the task being studied is composing, playing, or listening to music. Intelligence in this situation, measures the ability of an individual to perform a task. As Ryle states in his book: "When we speak of intellect or better yet intellectual powers and performances of persons, we are referring primarily to that special class of operations which constitute theorizing. The goal of these operations is the knowledge of true propositions or facts. Mathematics and the established natural sciences are the model accomplishments of human intellects" (15). So, from this, having intelligence is to have a knowledge of something and act on that knowledge to prove intelligence. This however, is a simplified form of the measurement we need. Howard Gardner, in his book *Mind's New Science: A History of the Cognitive Revolution*, proposes splitting the idea of intelligence into separate parts depending on the discipline involved. One of these kinds of intelligence that he proposes is musical intelligence (Gardner 1985). Musical intelligence is measured by an individual's ability to listen to, perform, and to compose music.

The task of performing music proposes an interesting idea to the concept of mind vs body. In order to play music, three things called dimensions are required: task environment, competence, and performance. These three must always work together. "To accomplish any musical task whatsoever, one is required to activate all three dimensions: first, knowledge about one's tools and materials (task environment), second, declarative knowledge about the domain (competence), and third, procedural knowledge regarding the use of knowledge under factual constraints (performance)" (Laske 1988). In other words, say someone hands you a violin and a sheet of music and asks you to play it. In order to do this you must first know that using the bow on the violin strings will cause it to play notes (task environment). You must then understand how to use the bow and violin to play specific notes (competence), and finally, you must know how to join those notes together to play the specific musical piece (performance). This means that in order to accomplish the task of musical intelligence, an entity is required to meet all three dimensions at once (Laske1988).

It is in fact possible for a computer program to do this. Knowledge can be stored as data in a computer. The more difficult of the three musical dimensions is competence but as Laske postulates: AI can exchange competence with knowledge in a memory bank. This then becomes two different kinds of memory storage: knowledge stored of current musical states and separate knowledge stored of rules about what to play when. So, things such as: If we are in X part, then play Y thing. In order to play music an AI would knowledge of how to make the sound of a note. Something which computers easily have the power to do already. This covers the task environment. With a memory of musical knowledge as previously described the computer gains competence at how to actually play those notes. And with another data bank of knowledge on how those notes connect together the computer can easily gain performance. In this way, telling a computer to play a particular piece of music would be a fairly easy task. This shows that a computer can have the performance aspect of musical intelligence.

One of the important parts of musicology as a cognitive science is listening or information processing. For a human, this has to do with how we take in auditory information from music and process this into patterns, notes and interpretations of emotions based off of our own knowledge. This is more difficult currently for a computer as without the complexity of a human brain for storing and analyzing data. For a computer, in order to replicate this, one can create a network of information. As the computer comes into contact with new information, this information is tested against its current network. This can cause the network to change if the new information reveals new relations behind network data, contradicts network data, or is not already in the network. This seems like a very human way to take in new data. When a person learns new information, the same thing happens but on a more complex level. The old information on the subject is updated which changes the way that we interpret further information on the subject. The network built is called a Dynamic Hierarchical Network (DHN) as proposed by Marc Leman. The network described is built on a list of logical statements. New information is also set in terms of logic. This information is then checked against the current list in the network. This check can add new relationships between existing logic or if it contradicts existing logic cause a change in the network (Leman 1986). This network could be applied to a multitude of different subjects, but if applied to listening to music would allow a computer to make interpretations and recognise patterns within the music based on an ever-growing network of knowledge. The more music it listens to better it is able to adapt and understand. This would allow a computer to show a depth of intelligence concerning listening to music.

The third piece of musical intelligence is composition. Being able to compose a piece of music is an important part of cognitive musicology. Much of the current research on the subject using artificial intelligence is working on creating an AI which helps composers create music. In order to do this the AI has to be able to compose music in its own right. This involves an understanding of musical theory which can link back to both performance and listening abilities along with the mathematics behind music theory. It is possible to teach an AI to write music and this has been done numerous times, such AI's becoming more and more complex over time. Some software even exists for example: AIVA aka Artificial intelligence virtual artist, which is an AI that has created numerous musical pieces and is now marketed as software to assist composers in writing their own music. Listening to some of the music it has created it has a surreal sound but clearly follows many compositional rules and patterns of music writing. An interesting study also used the idea of multi-agent systems with the goal of also creating an AI to help composers with musical writing. This system involved many different AI's working on the same area of music at the same time but each with their own individual tasks. For example, one AI might look for areas in the track with very little musical activity and add it. Whereas another AI might look for areas to declutter (Dahlsted 2006). These examples show that for an AI, composing music is simply a matter of learning musical theory and rules and then applying that knowledge to composing using heuristics to determine how "good" or "bad" the music might sound.

If musical intelligence is based on an entity's ability to compose, listen to, and play music, then it is a very real and possible thing for an artificial intelligence to produce. AI's can be shown or theorized to have these abilities based on knowledge and software that already exists. An AI with the same musical intelligence as a human could easily one day be produced based on these concepts, many of which are just simplifications on the ways in which humans deal with musical theory. This supports the idea that machines and humans differ only by levels of complexity. If a computer can be shown to have musical intelligence then the idea of software

and hardware being mind and body is true. Software is a creation produced from the abilities of the hardware and the signals it produces. The same can then be said of the mind. It is created from the signals and complexity of the body and not an intangible thing of its own. It is however, difficult to tell if just because an AI has the musical knowledge and the ability to use it if it actually understands the concept. For example, an AI can understand how to play a C chord or a G minor scale but does it really understand what a chord or a scale even are? This could be an argument for the idea of Cartesian mind where humans have the ability to understand things at a deeper level than computers because their mind is more than just what exists physically. However, it could also be just another example of a complexity difference between the human brain and the hardware of a computer. A person may think they understand what a chord is but what does that mean exactly? Isn't the definition of that just data stored within the brain and the data to understand that data just more knowledge stored further down? It seems that understanding things at such a deep level is another example of how complex the human brain is compared to any known model of computational knowledge. Thus, this is further proof that the mind and body are not Cartesian.

In conclusion, the idea of a separation between mind and body is an old concept often described as a "ghost in the machine." Breaking this argument down is essential in human understanding of how the mind works and in the creation of artificial intelligence. If the idea of Cartesianism were to be true, then it would imply that human consciousness or mind is something that can never be fabricated or artificially created. If the mind exists in a different form from that of our physical bodies and is governed by its own separate laws then it would be impossible for something physical to create it. This means that any form of artificial intelligence created could never, no matter how complicated or intelligent, surpass the human mind. While currently AI's are in early stages of development showing the downfalls of Cartesianism points to the possibilities that AI's might one day match or more likely surpass us. Using cognitive musicology as a method of proving this is important. Intelligence is often thought of as more of a logical or mathematical interpretation of the mind's abilities. Music however, while having connections to math and logic, is also based largely on culture and emotion which are intrinsic parts of human existence. If many different forms of intelligence exist which conform to different standards of ability then for an AI to surpass human intelligence it must also gain attributes which would normally considered human. If technology is to make progress in the future we must get used to the fact that the only difference between us and clockwork is in fact complexity.

Bibliography:

- Ariza, C. (2009). The Interrogator as Critic: The Turing Test and the Evaluation of Generative Music Systems. *Computer Music Journal, 33*(2), 48-70. Retrieved from http://www.jstor.org.colorado.idm.oclc.org/stable/40301027
- AIVA Technologies (2016-2018) AIVA. Retreived from: https://www.aiva.ai/
- Dahlstedt, P., & McBurney, P. (2006). Musical Agents: Toward Computer-Aided Music Composition Using Autonomous Software Agents. *Leonardo, 39*(5), 469-470. Retrieved from www.jstor.org/stable/20206298
- Gardner, H. *Mind's New Science: A History of the Cognitive Revolution* (1985): Basic Books, New York, NY
- Laske, O. (1988). Introduction to Cognitive Musicology. *Computer Music Journal, 12*(1), 43-57. doi:10.2307/3679836

- Leman, M. (1986). THE USE OF LOGIC AS A DESIGN TOOL IN COGNITIVE MUSICOLOGY. *Logique Et Analyse, 29*(116), nouvelle sÉrie, 495-499. Retrieved from www.jstor.org/stable/44093331
- Ryle, G. The Concept of Mind (1949): University of Chicago Press, Chicago, IL