

QUANTUM COMPUTER MUSIC



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Background :

The first uses of computers in music were for composition. The great majority of computer music pioneers were composers interested in inventing new music and/or innovative approaches to compose. They focused on developing algorithms to generate music.

Hence the term ‘algorithmic computer music’. Essentially, the art of algorithmic computer music consists

of :

- (a) harnessing algorithms to produce patterns of data and
- (b) developing ways to translate

These patterns into musical notes or synthesised sound.

<https://arxiv.org/pdf/2110.12408.pdf> [1]

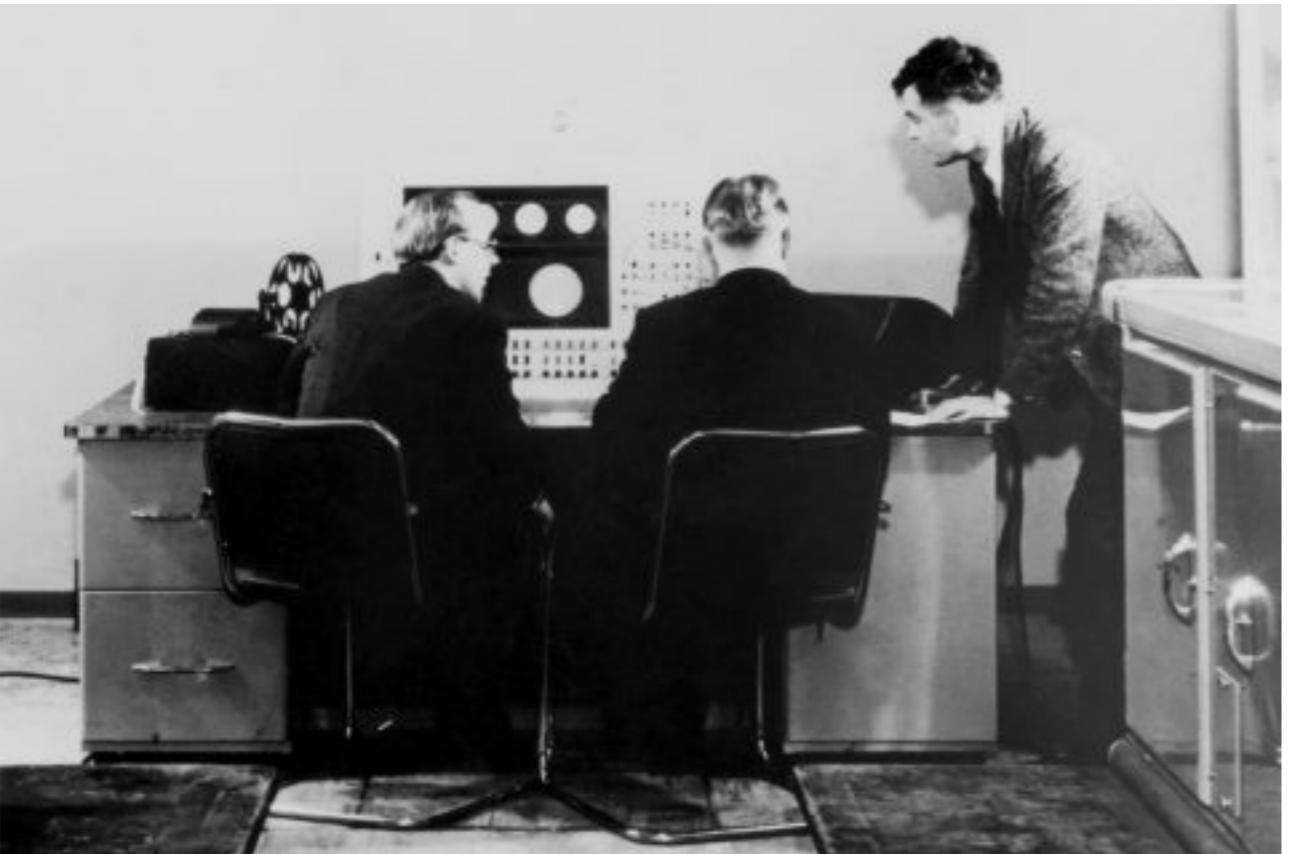
Nowadays, computing technology is omnipresent in almost every aspect of music. Therefore, forthcoming alternative computing technology, such as biocomputing and quantum computing will certainly have an impact in the way in which we create and distribute music in time to come. [1]

Our project is an introduction to the pioneering research into the exploration of emerging field of quantum computing technology in music.

<https://stoneyroads.com/2016/09/listen-to-the-first-recorded-piece-of-computer-generated-music/>

Here is the audio of the first ever music produced by using computer.

https://soundcloud.com/guardianaustralia/first-ever-recording-of-computer-music?utm_source=stoneyroads.com&utm_campaign=wtshare&utm_medium=widget&utm_content=https%253A%252F%252Fsoundcloud.com%252Fguardianaustralia%252Ffirst-ever-recording-of-computer-music

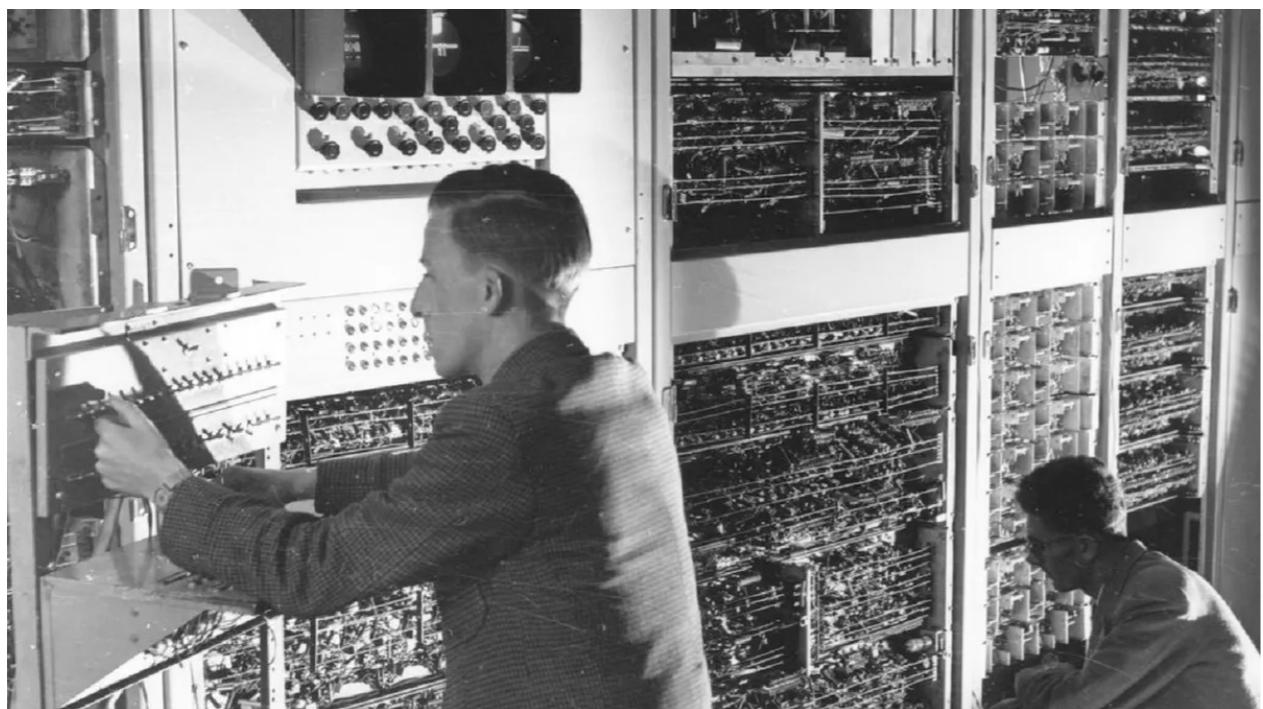


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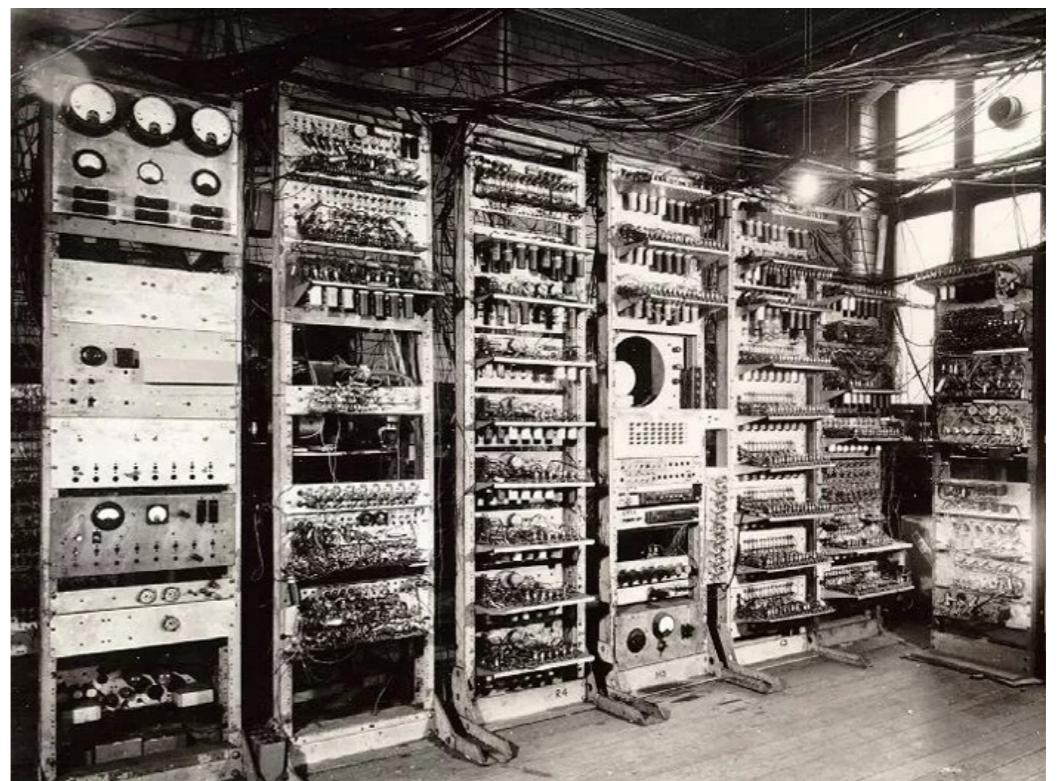


Visitors can have hands-on experience with music software on 1980s desktop computers at the exhibition

(<https://ajovomultja.hu/news/history-computer-music?language=en>)



CSIRAC was the first computer to play music in the 1950s



'The Baby' was the forerunner to the Ferranti Mark 1 that was used to make the first computer music recording.

<https://www.musicradar.com/news/tech/a-brief-history-of-computer-music-177299>

Current Work in Quantum Computer Music

Currently people around globe are working in the field of quantum music, some of the recent work in this field are given :

1. First Quantum Music Composition Unveiled

In 2015, this article suggested that we can think the seven notes in a quantum octave as independent event. They also suggested that an audience will hear the same sequence of notes but when a quantum musical state is observed, it will collapse into any one of the notes. The notes will be formed entirely random, but it will depend on the precise linear setup of the state

(<https://www.technologyreview.com/2015/04/15/168638/first-quantum-music-composition-unveiled/>)

2. Hear Musicians Jam With a Quantum Computer

In this article, Dr Alexis Kirke, Senior Research Fellow in the Interdisciplinary Centre for Computer Music Research at the University of Plymouth (UK), has been able to show that a human musician can communicate directly with a quantum computer via teleportation, through which a blend of live human and computer-generated sounds could come together to create an unique performance piece.



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First Quantum Music Composition Unveiled

Physicists have mapped out how to create quantum music, an experience that will be profoundly different for every member of the audience, they say.

By Emerging Technology from the arXiv

April 15, 2015

<https://www.technologynetworks.com/informatics/news/hear-musicians-jam-with-a-quantum-computer-336979>



3. QuTune Project

Currently QuTune is the leading team of scientists/researchers/musicians, which are working together to enhance the field of Quantum Music. They recently organised the 1st International Symposium on Quantum Computing and Musical Creativity. They have around 5 research papers published in this field and around 3 articles on the topic. Medium is an American online publishing platform, and that has published around 3 articles on Quantum Music. <https://iccmr-quantum.github.io>)

4. A QUANTUM NATURAL LANGUAGE PROCESSING APPROACH TO MUSICAL INTELLIGENCE

Quantum Natural Language Processing

In this project, researchers are trying to make an intelligent music system, where the system will know what to play in different occasions. A challenging task is to design generative systems with enough knowledge of musical structure and ability to manipulate said structure, so that given requests for mood, purpose, style, and so on, are appropriately met.

(<https://cambridgequantum.com/a-quantum-natural-language-processing-approach-to-musical-intelligence/>)

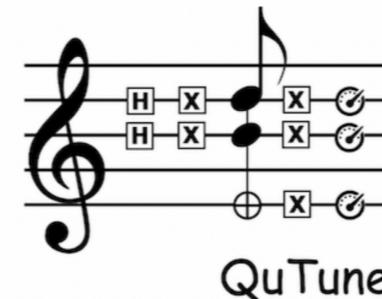
ISQCMC
1st International
Symposium on
Quantum Computing
and Musical Creativity

Nov 19-20, 2021

QuTune Project

Quantum Computer Music Resources

Cambridge Quantum



A QUANTUM NATURAL LANGUAGE
PROCESSING APPROACH TO
MUSICAL INTELLIGENCE
Quantum Natural Language
Processing

Our project

In our Quantum music project, we have used random walk on a cube to make a quantum circuit using jupyter notebook and python language and the outputs were converted to notes and rhythms by simply running the quantum circuit. The corresponding notes and rhythms were used to create midi tracks by converting the outcome to the musical notations, and now once we have our music notation, we can play our quantum computer music anywhere anytime. Simple steps that can be used to replicate our project,

- Preparation of the quantum circuit [1]

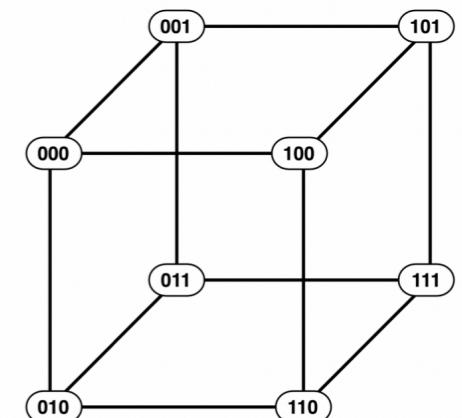


Figure 24: Cube representation of the quantum walk routes and nodes.

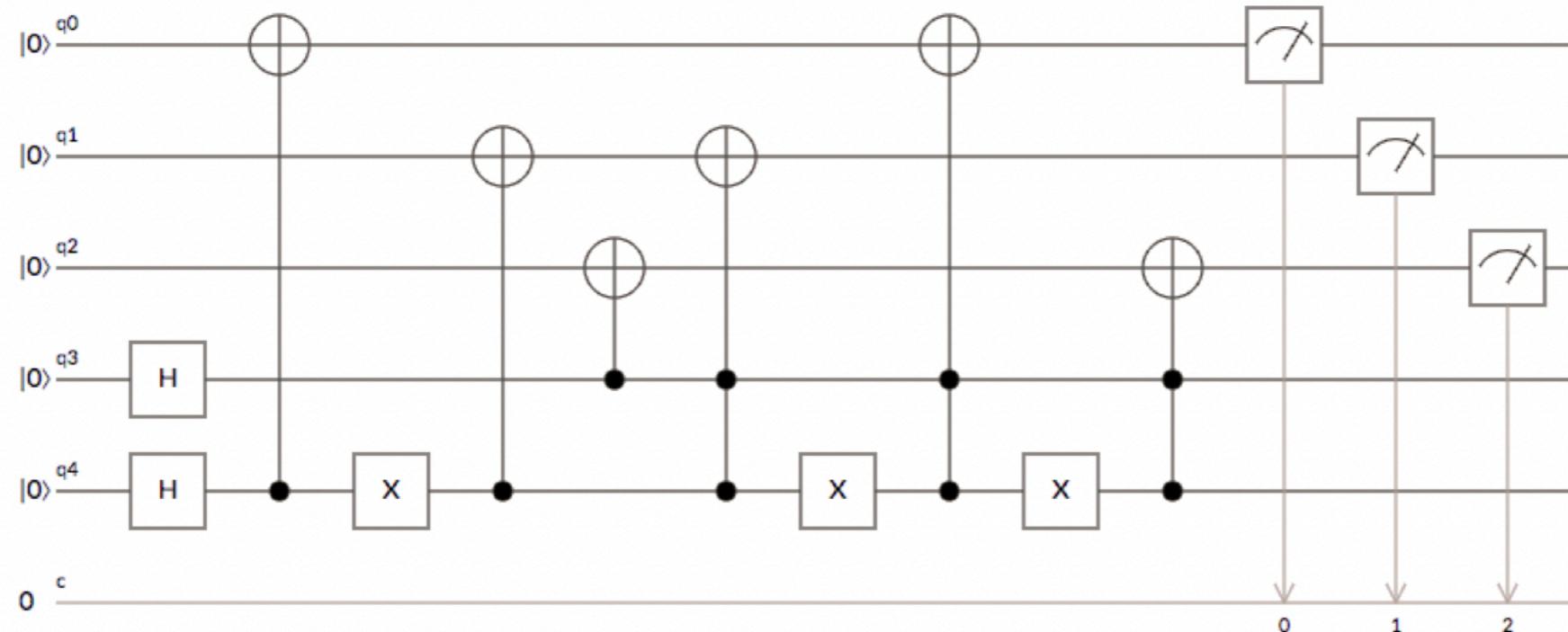


Figure 23: Quantum walk circuit. [1]

- Creation of two lists, one for the pitch and the other one for the rhythm

Step	Pitch	Rhythm	Step	Pitch	Rhythm
0	000	100	15	110	100
1	000	000	16	111	110
2	001	010	17	111	100
3	000	110	18	110	101
4	000	100	19	110	100
5	001	101	20	010	100
6	001	001	21	011	110
7	000	001	22	010	010
8	001	001	23	010	110
9	011	101	24	011	010
10	011	001	25	011	011
11	011	000	26	010	010
12	001	001	27	000	000
13	000	001	28	000	000
14	010	101	29	000	010

Table 4: Results from running the quantum walk algorithm 30 times.

- For each list quantum circuit was iterated several times always beginning in the state where it was measured in the previous step
- Conversion from binary outputs into notes (<https://www.dcode.fr/music-sheet>)
- Creation of MIDI file

Future of quantum music

The Sound of the Future:

Technology has changed music forever and will continue to do so as long as it remains the part of human life. Even the way pop music sounds has been altered by the noises that computers generate, giving rise to the “electronic” genre. Tech’s effect on music will reverberate through the industry, revolutionising the balance between artists and powerful music labels. This opens the door for more niche, experimental music to reach the world. With the help of computers, social media and even AI, almost anything is possible in tomorrow’s music scene. The impact of quantum computer will be revolutionary and it will change the way we produced music before.

Music Driven by AI and Algorithm Technology:

A.I. is the ability of a computer to not only retain and regurgitate certain information, but to evolve, learn, and create new ways of interpreting and reciting information. The best comparison for this technology is the brain – a mechanism that can not only learn about its environment, but can learn about itself, and in turn begin to learn in new ways an A.I. includes algorithms but also implements general reasoning, and self-correction or adaption mechanisms. Although A.I. is still in its initial stages, once it becomes fully developed, there is no telling how capable a technology it will become. AI/ML will bring quantum music to the new height, and improve our way of understanding of music.

Future tune:

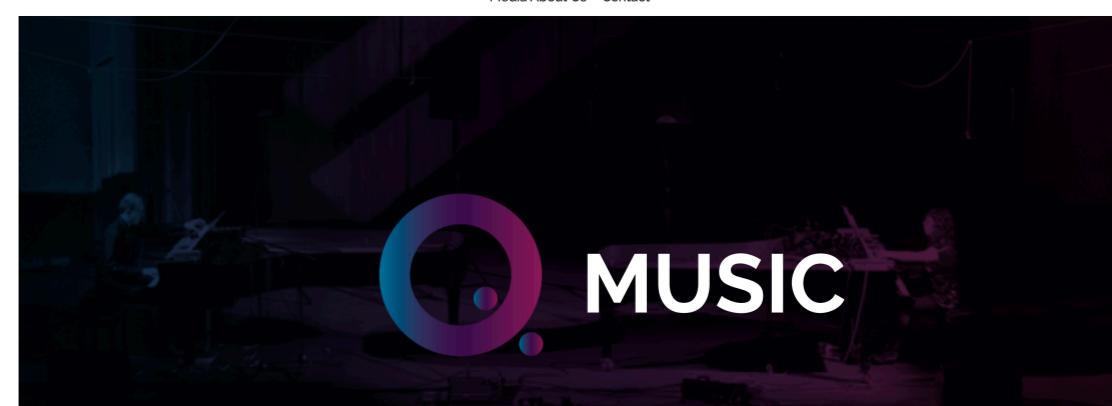
Quantum Computing will most certainly have an impact on the way in which we create and distribute music in time to come. The arrival of Quantum Computer Music is a natural progression for music technology. The main advantage being the potential speed increase of quantum algorithms. It introduces a way of utilising Grover's algorithm - which has been shown to provide a quadratic speed-up over its classical equivalent - in algorithmic rule-based music composition.

The system introduced - qgMuse - is simple but scalable. It lays some groundwork for new ways of addressing a significant problem in computer music research, unstructured random search for desired music features.

Projects like Quantum Music(<http://quantummusic.org>) are bringing scientists/researchers/musicians together to work on Quantum Music.

The quantum world challenges us to modify the way we perceive the world around us. We learn that our everyday world has an unexpected capacity for new kinds of behaviour and "self organisation" that we are only just beginning to fathom.

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