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| xxxxxxJeton  Mesurexxx | **J1** | **J2** | **J3** | **J4** | **J5** | **J6** | **J7** | **J8** | **J9** | **J10** | **J11** | **J12** | **J13** | **J14** | **J15** | **J16** |
| M1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| M2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| M3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| M4 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| M5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **2** | 1 | 1 | 1 | 1 | 1 | 1 |
| M6 | 1 | **2** | 1 | 1 | 1 | **2** | 1 | 1 | 1 | **2** | 1 | **2** | 1 | 1 | 1 | 1 |
| M7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| M8 | 1 | **2** | X | x | X | X | X | X | X | X | X | X | X | X | X | X |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| xxxxxxJeton  Mesurexxx | **J1** | **J2** | **J3** | **J4** | **J5** | **J6** | **J7** | **J8** | **J9** | **J10** | **J11** | **J12** | **J13** | **J14** | **J15** | **J16** |
| M1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| M2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| M3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| M4 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| M5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| M6 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| M7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| M8 | 1 | 2 | X | x | X | X | X | X | X | X | X | X | X | X | X | X |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| M1 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **1** | **1** | **1** | **1** | **1** | **1** |
| M2 | **1** | **2** | **1** | **1** | **1** | **2** | **1** | **1** | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| M3 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **1** | **1** | **1** | **1** | **1** | **1** |
| M4 | **1** | **2** | **1** | **1** | **1** | **2** | **1** | **1** | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| M5 | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **1** | **1** | **1** | **1** |
| M6 | **1** | **2** | **1** | **1** | **1** | **2** | **1** | **1** | **1** | **2** | **1** | **2** | **1** | **1** | **1** | **1** |
| M7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| M8 | **1** | **2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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| M1 | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **2** | | **1** | | **1** | | **1** | | **1** | | **1** | **1** |
| M2 | | **1** | | **2** | | **1** | | **1** | | **1** | | **2** | | **1** | | **1** | | 1 | | 2 | | 1 | | 2 | | 1 | | 1 | | 1 | 1 |
| M3 | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **0** | | **2** | | **1** | | **1** | | **1** | | **1** | | **1** | **1** |
| M4 | | **1** | | **2** | | **1** | | **1** | | **1** | | **2** | | **1** | | **1** | | 1 | | 1 | | 1 | | 2 | | 1 | | 1 | | 1 | 1 |
| M5 | | **1** | | **1** | | **1** | | **1** | | **1** | | **1** | | **1** | | **1** | | **1** | | **2** | | **1** | | **1** | | **1** | | **1** | | **1** | **1** |
| M6 | | **1** | | **2** | | **1** | | **1** | | **1** | | **2** | | **1** | | **1** | | **1** | | **2** | | **1** | | **2** | | **1** | | **1** | | **1** | **1** |
| M7 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 2 | | 1 | | 2 | | 1 | | 1 | | 1 | 1 |
| M8 | | **1** | | **2** | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |
| xxxxxJeton  Mesurexxx | **J1** | | **J2** | | **J3** | | **J4** | | **J5** | | **J6** | | **J7** | | **J8** | | **J9** | | **J10** | | **J11** | | **J12** | | **J13** | | **J14** | | **J15** | | **J16** |
| M1 | 0 | | 0 | | 2 | | 1 | | 2 | | 1 | | 2 | | 1 | | 1 | | 1 | | 2 | | 1 | | 1 | | 1 | | 1 | | 1 |
| M2 | 1 | | 1 | | 2 | | 1 | | 2 | | 1 | | 2 | | 1 | | 1 | | 1 | | 2 | | 1 | | 2 | | 1 | | 2 | | 1 |
| M3 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| M4 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 2 | | 1 | | 1 | | 1 | | 1 | | 1 |
| M5 | 0 | | 0 | | 2 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 2 | | 1 |
| M6 | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 |
| M7 | 1 | | 1 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |
| M8 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 |

Marginales M3 : J1, J2, J3 = [1., 0., 0.]

**Domaine du jeton: 32**

{0 <6.586566865924795E-4>, 1 <0.4518108849303363>, 2 <0.5475304583830712>}

CPBP Marginals: tensor([0.0007, 0.4518, 0.5475])

CMT rhythm\_out: tensor([[0.0007, 0.4518, 0.5475]], grad\_fn=<SoftmaxBackward0>)

===

**Domaine du jeton: 2**

{0 <0.8178584174932724>, 1 <6.784927640621734E-5>, 2 <0.1820737332303214>}

Token 2

CPBP Marginals: tensor([8.1786e-01, 6.7849e-05, 1.8207e-01])

CMT rhythm\_out: tensor([[8.1786e-01, 6.7849e-05, 1.8207e-01]], grad\_fn=<SoftmaxBackward0>)

**Domaine du jeton: 34**

{0 <1.0>}

sample RHYTHM token: Token 34

CPBP Marginals: tensor([1., 0., 0.])

CMT rhythm\_out: tensor([[1.8453e-06, 1.3459e-03, 9.9865e-01]], grad\_fn=<SoftmaxBackward0>)

['0.0', '0.0', '2.0', '0.0', '2.0', '1.0', '2.0', '1.0', '0.0', '2.0', '2.0', '0.0', '1.0', '2.0', '1.0', '2.0',

'1.0', '1.0', '2.0', '2.0', '0.0', '2.0', '0.0', '0.0', '1.0', '0.0', '0.0', '2.0', '2.0', '1.0', '2.0', '2.0',

'0.0', '0.0', '2.0', '0.0', '2.0', '1.0', '2.0', '1.0', '0.0', '2.0', '2.0', '0.0', '1.0', '2.0', '1.0', '2.0',

'1.0', '1.0', '2.0', '2.0', '0.0', '2.0', '0.0', '0.0', '1.0', '1.0', '2.0', '0.0', '1.0', '1.0', '1.0', '0.0',

'0.0', '0.0', '1.0', '1.0', '2.0', '2.0', '1.0', '2.0', '0.0', '0.0', '1.0', '2.0', '1.0', '0.0', '2.0', '2.0',

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'1.0', '0.0', '2.0', '0.0', '0. 0', '1.0', '2.0', '2.0', '1.0', '1.0', '1.0', '0.0', '0.0', '2.0', '2.0', '2.0']

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[0, 0, 2, 1, 2, 1, 2, 1, 1, 1, 2, 1, 1, 1, 1, 1,

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1, 1, 2, 1, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]

Mesure 1-2, mesure 3-4

Mesure 2, mesure 4

Mesure 2 : silences

['49.0', '49.0', '21.0', '48.0', '19.0', '48.0', '21.0', '48.0', '48.0', '48.0', '14.0', '48.0', '48.0', '48.0', '12.0', '14.0',

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'18.0', '48.0', '14.0', '48.0', '48.0', '48.0', '48.0', '48.0', '48.0', '48.0', '48.0', '48.0', '16.0', '48.0', '19.0', '48.0']

**Version 1**

You're familiar with AI that generates images and text. But what about music? Could a 'MusicGPT' be on the verge of gracing our concert halls ? That’s what my thesis is about.

I started taking piano lessons at an early age, and I remember that in between those tedious technical exercises I would play around on my piano, starting on an exercise and adding some notes or changing the rhythm and finding a melody that appealed to me. And while the melodies would be fun to play or to experiment with, there was always something missing, something more fundamental.

Let me ask you a question. What does the music of Taylor Swift, Mozart, Drake and Chopin all have in common? The same thing all music styles have in common. They all possess an organization: patterns repeated throughout a song that give music its sense, its direction and its meaning.

While it's certainly true that the patterns used by Taylor Swift greatly vary in nature to those used by Mozart, they all possess the characteristics of having melodies and rhythms that are repeated throughout their songs. This is an essential aspect for music that needs consistent elements for listeners to grasp on to. It’s what makes music understandable, it’s what makes it memorable.

So just like it would be most confusing that each chapter in a novel always be devoted to a different plot, successful music composition also relies on a sense consistency.

And so where does AI stand in all of this? Well in my research I realized that AI in music generation was rather just like me as a child playing around with my piano, finding fragments of melodies that sound nice. AI's current music creations often miss the cohesive structure that gives music its narrative, just like a novel without a unifying plot. It can create melodies that imitate a specific style but will lack the ability to organize them.

And that is the problem that I am tackling in my thesis. I analyze songs from a certain music style and find the patterns repeated within it. I then look at these patterns: when are they repeated? How often? How long do they last?

I then pass this knowledge to the AI to better guide it when it’s in the process of creating a melody. And where my approach particularly differs from previous ones is that I don't pay attention to the nature of these patterns and force the AI to follow them. Instead, I try to help it make more informed choices with the knowledge I gathered while it still maintains its same ability for creativity.

So, are we ready for MusicGPT? Perhaps not quite yet. But we’re laying the groundwork for a future where AI could play an essential role in music composition.

--

This fundamental aspect of music — its inherent structure and repeating patterns — is exactly what AI has struggled to replicate.

AI's current music creations often miss the cohesive structure that gives music its narrative, much like a novel without a unifying plot.

Just like a novel is organized in chapters, chapters divided in paragraphs, music also follows a structure, taking form in patterns repeated throughout a piece.

Version 2

You're familiar with AI that generates images and text. But what about music? Could a 'MusicGPT' be on the verge of gracing our concert halls?

I started taking piano lessons at an early age and I remember often diverging from those tedious technical exercises, changing notes and rhythms to find a melody that appealed to me. But despite the fun of experimenting, there was always something missing, something more fundamental. And you know what? In my research, I realized that AI was actually no different than me as a child playing around on my piano. It could produce fragments of melodies and mimic musical styles, but something essential was missing.

Consider this: What unites Taylor Swift, Mozart, Drake and Chopin? The same thing that unites all music genres. They all possess an organization: repeating patterns that grant music its direction and its meaning.

And while Taylor Swift’s musical patterns greatly differ in nature to those of Mozart, they all possess the characteristics of having melodies and rhythms that are repeated throughout their songs. Music needs consistent elements for listeners to grasp on to. It’s what makes it memorable. Would you remember the chorus of *Cruel Summer* if it weren’t repeated so many times?

So just like a coherent novel doesn’t switch plots every chapter, successful music composition also relies on a sense of consistency.

That’s precisely the flaw in current music generated by AI. Its creations often miss the cohesive structure that gives music its narrative, just like a novel without a unifying plot. It can create melodies that impeccably imitate a specific style but will lack the ability to organize them.

And that’s the problem that I’m tackling in my thesis. I analyze songs from a certain music style and find the patterns repeated within them. I then look at these patterns: when are they repeated? How often? How long do they last?

I then pass on this knowledge to the AI to better guide it when it’s creating a melody. And most importantly, I don't force the AI to follow the nature of these patterns. Would an author of a novel want to follow the exact same plot of an existing book? No. Instead, I help the AI make more informed choices with the knowledge I gathered while it still maintains its creativity.

So, are we ready for a MusicGPT concert? Perhaps not quite yet. But I’m confident that with this approach, we’re moving one step closer.

we’ll be able to expand the limits of AI’s potential.

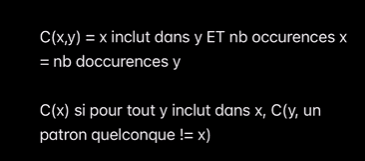
But I’m confident that with this approach, we’ll be able to expand the limits and potential of AI generated music.

we are not just creating a new tool for composers; we are expanding the boundaries of what music can be.

It’s what makes music understandable, it’s what makes it memorable.

Would an author of a novel want to follow the exact same plot of an existing book? No.

My name is Liliane-Caroline Demers and I am finishing my Master's in Computer Engineering under the supervision of Professor Gilles Pesant. My Master’s project is focused on generating music with long-term structure by combining machine learning and constraint programming. I have a strong musical background both in piano and musical theory. When I learned that Professor Gilles Pesant was working on applications in music, I jumped at the opportunity to combine my computer engineering skills with my musical knowledge!



Une image contenant capture d’écran, ligne, Parallèle, Tracé

Description générée automatiquement