

Transfer Learning with GPT-2 for Lyric Generation

**Original
Lyrics**

You know I hate to see the sun Sinking to the west Cos I
know my whole life's Gonna be one solid mess

Prediction

You know I hate to see the sun Sinking to the west Cos I
know my baby won't be happy He don't want to go around
wondering why

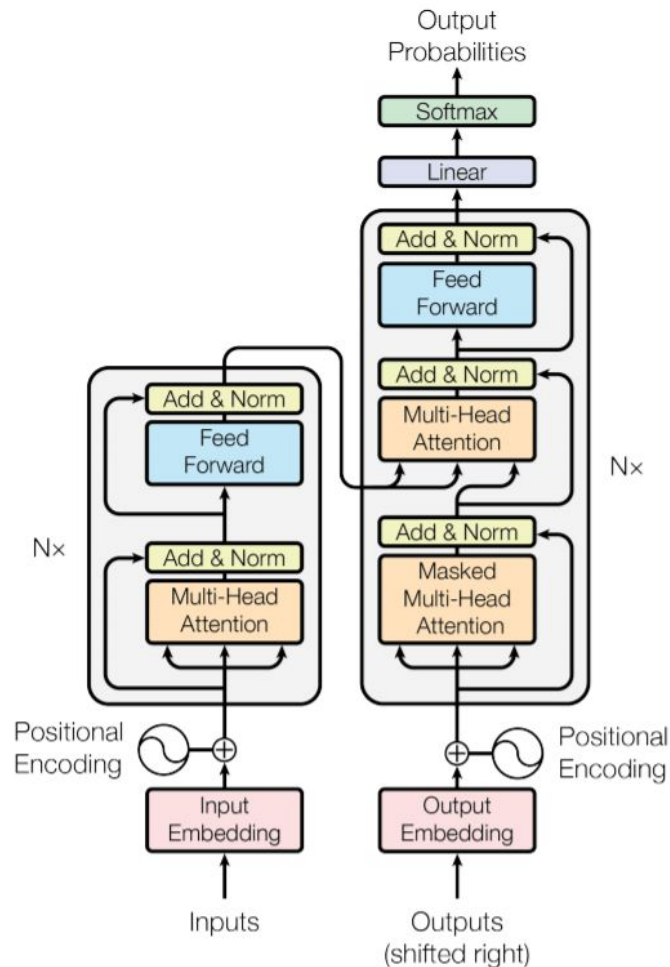
What is GPT-2?

Large language model that learned a variety of NLP tasks by training on over 8 million documents of text

The largest model, contains 1.5 billion parameters, and outperformed 7 out of 8 SOTA models



Transformer Architecture



Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł. & Polosukhin, I. (2017). Attention is all you need. *Advances in Neural Information Processing Systems* (p./pp. 5998--6008),

Research Objective

Can we fine-tune GPT-2 to
learn and emulate the
musical style of The Beatles?

The Beatles Lyrics



Play "Eleanor Rigby"

on Amazon Music Unlimited (ad)



"Eleanor Rigby"

Ah, look at all the lonely people
Ah, look at all the lonely people

Eleanor Rigby picks up the rice in the church where a wedding has been
Lives in a dream
Waits at the window, wearing the face that she keeps in a jar by the door
Who is it for?

All the lonely people
Where do they all come from?
All the lonely people
Where do they all belong?

Father McKenzie writing the words of a sermon that no one will hear
No one comes near
Look at him working, darning his socks in the night when there's nobody there
What does he care?

All the lonely people
Where do they all come from?
All the lonely people
Where do they all belong?

Ah, look at all the lonely people
Ah, look at all the lonely people

Key Components

Dataset

- **297** unique Beatles songs, scraped from www.azlyrics.com
- **55,665** tokens in total
- 10% test set
- Preprocessing steps:
 - filter out speeches
 - remove duplicate songs
 - tokenization

sea of green And we lived beneath the waves In our yellow submarine We all live in a yellow submarine We all live in a yellow submarine Yellow submarine, yellow submarine Many more of them live next door And the band begins to play We all live in a yellow submarine We all live in a yellow submarine Yellow submarine, yellow submarine Full speed ahead! Full speed it is, Sergeant! Cut the cable, drop the cable! Aye-aye, sea of blue live a life of ease (a life of ease) Everyone of us (everyone of us) has all we need of blue) and sea of green (sea of green) In our yellow (in our yellow) submarine (in our yellow submarine Yellow submarine, yellow submarine We all live in a yellow submarine Yellow submarine We all live in a yellow submarine Yellow submarine, yellow submarine We all live in a yellow submarine She said, "I know what it's like to be dead. I know what it's like to be dead... making me feel like I've never been born I said, "Who put all those things in your head? I'm mad. And you're making me feel like I've never been born." She said, "You don't understand what I said." I said, "No, no, no, you're wrong. When I was a boy everything was right." I said, "Even though you know what you know, I know that I'm ready to leave 'Cause you're making me feel like I've never been born." She said, "I know what it's like to be dead. I know what it's like to be dead..." Good day sunshine, good day sunshine, good day sunshine I need to know what you know, I know that I'm ready to leave 'Cause you're making me feel like I've got something I can laugh about I feel good in a special way I'm in love and it's a good day sunshine, good day sunshine We take a walk, the sun is shining down Burns my face Good day sunshine, good day sunshine Then we'd lie beneath the shady tree Good day sunshine feels good, she knows she's looking fine I'm so proud to know that she is mine. Good day sunshine Good day sunshine, good day sunshine, good day sunshine Good day sunshine Good day sunshine Good day... You tell me that you've got everything you want And your heart is broken you don't get me You say you've seen Seven Wonders and your bird is green But you can't see your prized possessions start to weigh you down Look in my direction, I'll be 'round You're broken will it bring you down You may be awoken, I'll be 'round, I'll be 'round You're sound there is And your bird can swing But you can't hear me, you can't hear me R. Doctor Robert Day or night he'll be there any time at all, Doctor Robert Doctor Robert helps you to understand He does everything he can, Doctor Robert If you're down he'll help you drink from his special cup, Doctor Robert Doctor Robert, he's a man you must believe in to succeed like Doctor Robert Well, well, well, you're feeling fine Well, well, well, your friend works for the national health, Doctor Robert Don't pay money just to see you

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Model & Fine-tuning

- HuggingFace Transformers library
- GPT-2-medium (345M parameters)
- EC2 instance with 1 GPU (g4dn.2xl)
- Fine-tuned on the training set over 20 epochs

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Evaluation

- Evaluated finetuned model against a naive model on test set:
 - Auto-completion of lyrics
 - Part-of-speech analysis
 - Count frequencies of most common words
 - Empirical evaluation

Results: Auto-completion

Assess the model's ability to “complete” a set of lyrics, given the first few words of a song, and evaluate using a BLEU score (1=identical sequences)

- Input: 50 tokens of each test song
- Output: 200 generated tokens

Results: Auto-completion

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- Output: 200 generated tokens

Tuned Model: 0.402

Naive Model: 0.039

	input	lyrics_end	naive_prediction_end	tuned_prediction_end
0	Don't let me down, don't let me down Don't let...	let me down Don't let me down, don't let me do...	let me down I love you (more and louder) I lov...	let me down Don't let me down, don't let me do...
1	I get high when I see you go by My oh my When ...	is all But it's so hard loving you Is it right...	all I can do Why is there not more love in you...	is all But it's so hard loving you Is it right...
2	[All too much!] It's all too much It's all too...	Everywhere, it's what you make For us to take,...	seems to be gone forever Now I'm just another ...	Everywhere, it's what you make For us to take,...
3	I love you, 'cause you tell me things I want t...	the reason why If I cry, it's not because I'm ...	And never ever forget that I'm my own mother O...	I Would give everything I've got For a little ...
4	Is there anybody going to listen to my story A...	so hard to leave her She will turn to me and s...	to forget. Ah, girl when I think of all the ti...	so hard to leave her She will turn to me and s...

Results: Auto-completion

Original Lyrics Remember to let her into your heart Then you can start to make it better Hey, Jude, don't be afraid You were made to go out and get her The minute you let her under your skin Then you begin to make it better

Tuned Model Prediction Remember to let her into your heart Then you can start to make it better Hey, Jude, don't be afraid You were made to go out and get her The minute you let her under your skin Then you begin to make it better

BLEU score: 0.49

Naive Model Prediction Remember to let her into your heart Then you can start to make some of your dreams come true I'll just be leaving right now but when I get home I know you are waiting for me I just won't leave you for an hour

BLEU score: ~0.0

Results: Auto-completion

Original
Lyrics

You'll let me be your man And please, say to me You'll let me hold your hand You'll let me hold your hand I wanna hold your hand And when I touch you I feel happy Inside It's such a feeling that my love I can't hide I can't hide I can't hide

Tuned
Model
Prediction

You'll let me be your man And please, say to me You'll let me hold your hand You'll let me hold your hand I wanna hold your hand And when I touch you I feel happy Inside It's such a feeling that my love I can't hide I can't hide

BLEU score: 0.94

Naive Model
Prediction

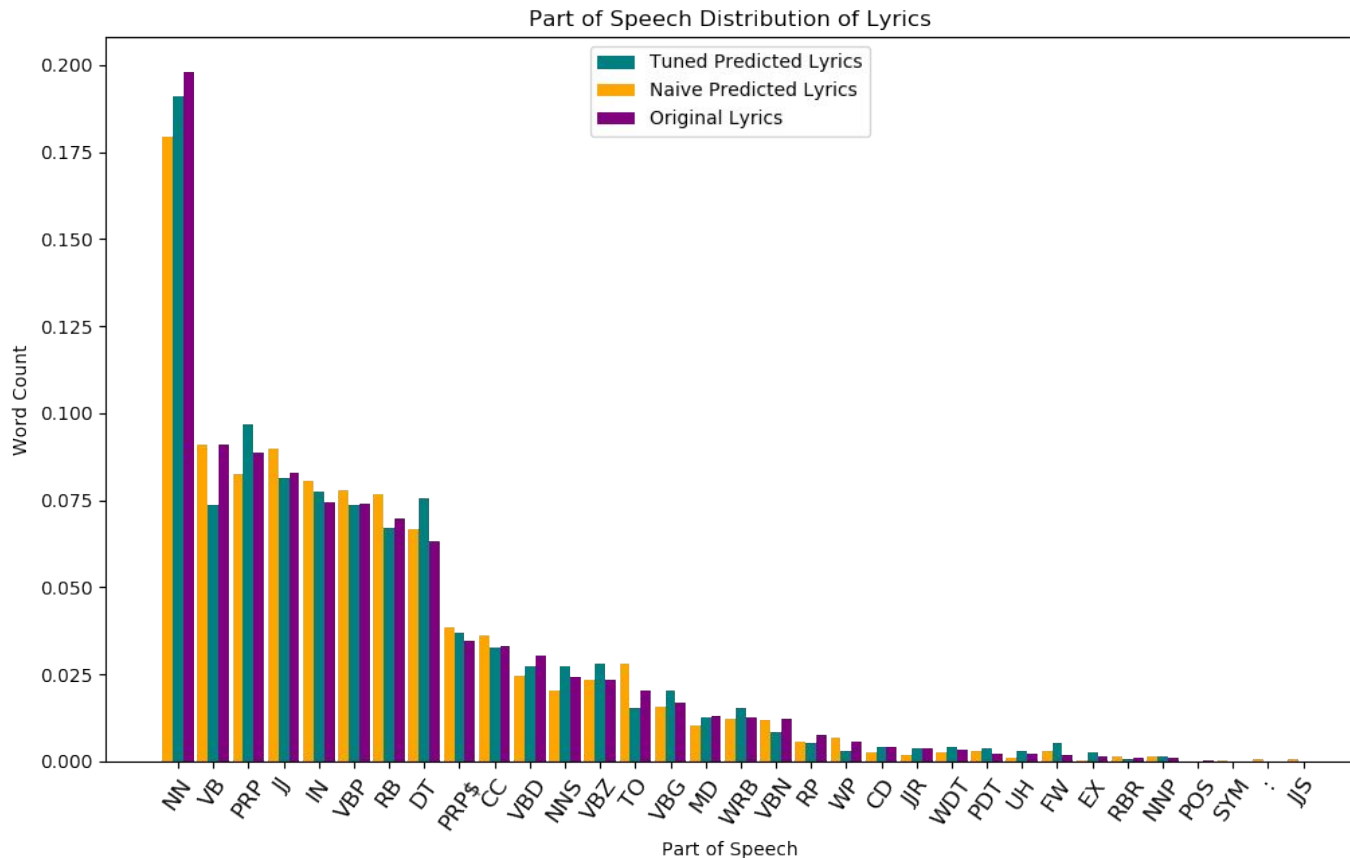
You'll let me be your man And please, say to me You'll let me hold your hand Oh please, say to me Oh please you'll let me hold your hand Oh please I want to love you (Hook 3) I want to love you Oh how I wanna cry Oh how I wanna weep

BLEU score: 0.07

Results: Part of Speech

Analyze the part-of-speech frequency distribution of original vs. generated lyrics

We observe a similar POS distribution between the three

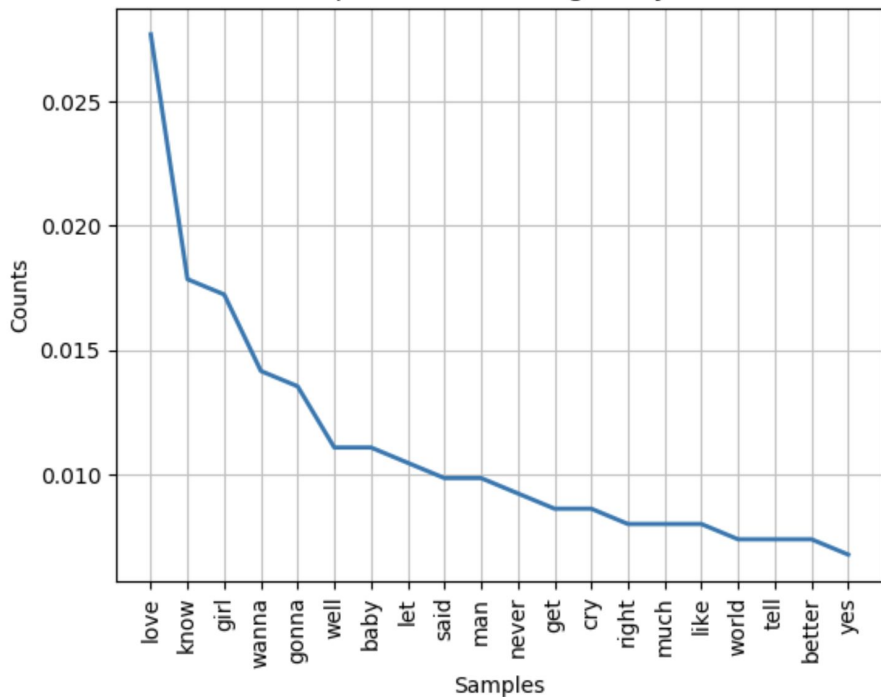


Results: Frequent Word Counts

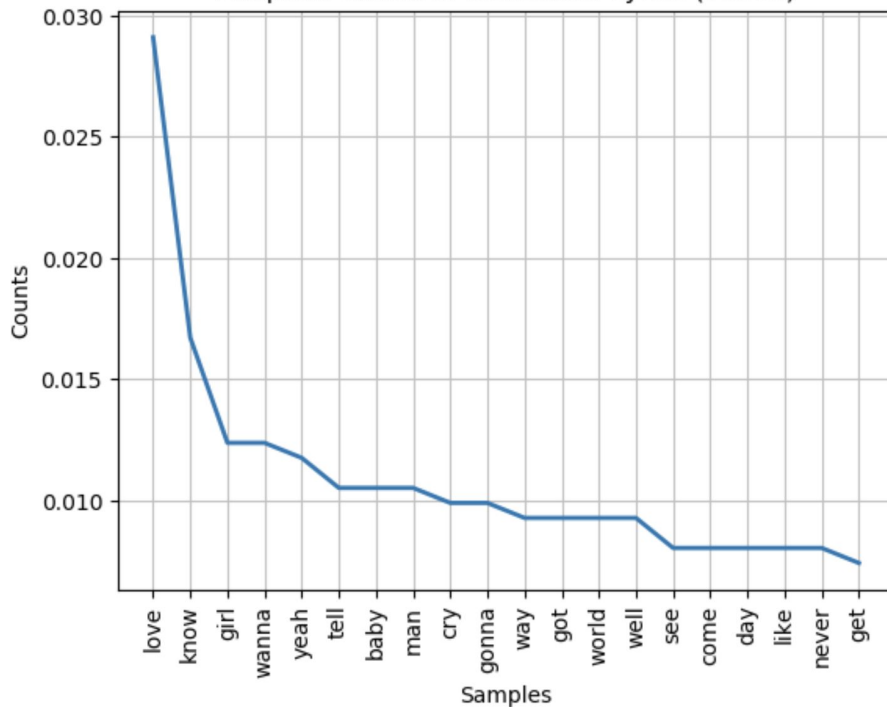
Inspect the most frequent words in original vs. **finetuned**-model generated lyrics

- We observe 63% coverage

Frequent Words in Original Lyrics



Frequent Words in Generated Lyrics (Tuned)

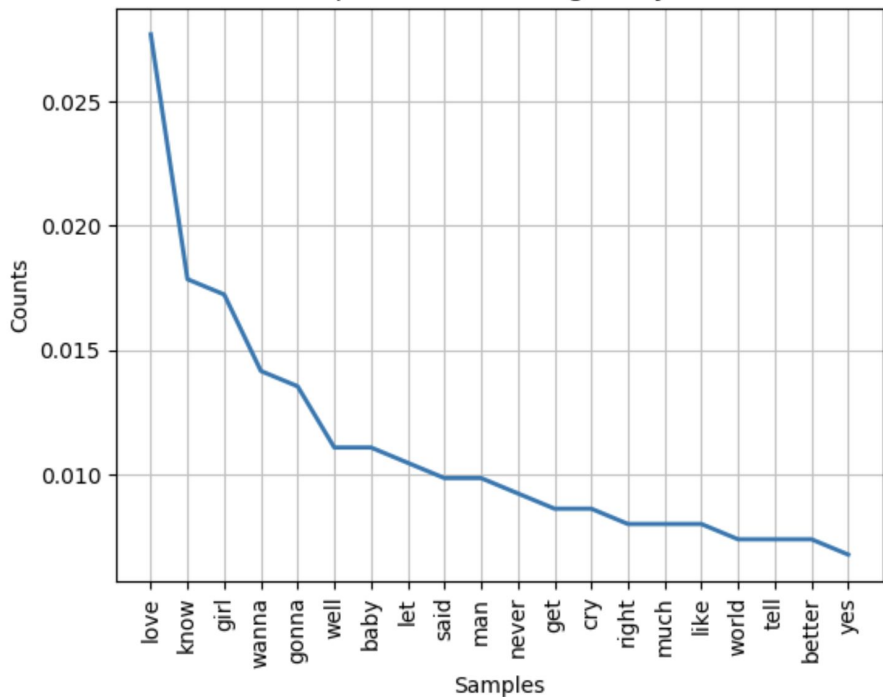


Results: Frequent Word Counts

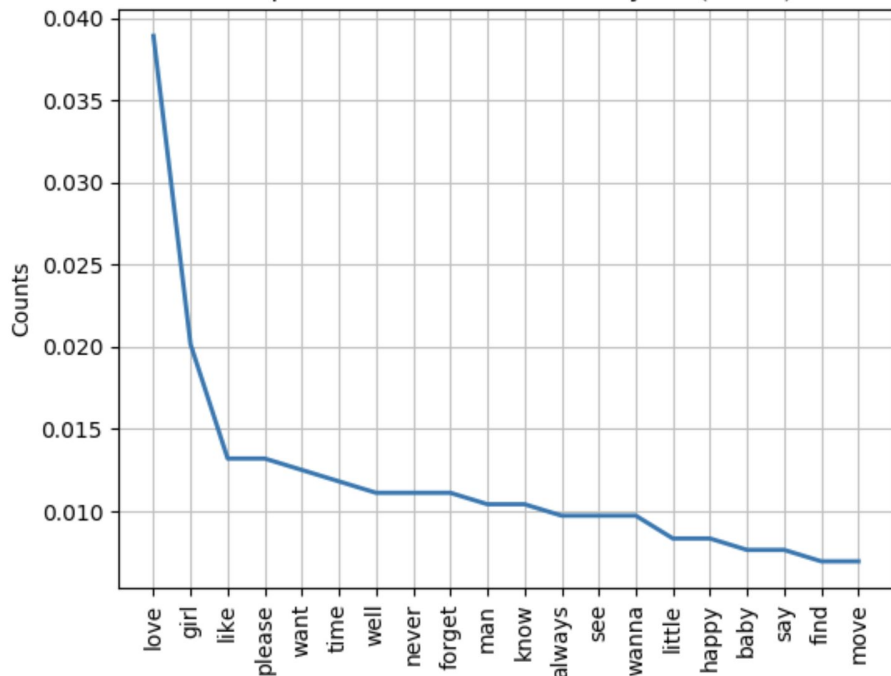
Inspect the most frequent words in original vs. **naive**-model generated lyrics

- We observe 53% coverage

Frequent Words in Original Lyrics



Frequent Words in Generated Lyrics (Naive)



Results: Free-form Lyric Generation

Empirically evaluate naive-model generated lyrics at different **Temperatures**

Temperature: **0.5**

I am going to make sure that the people who have been affected by this are given the opportunity to have their voices heard."

Results: Free-form Lyric Generation

Empirically evaluate naive-model generated lyrics at different **Temperatures**

Temperature: **0.5**

I am going to make sure that the people who have been affected by this are given the opportunity to have their voices heard."

Temperature: **1.2**

I am going crazy!" said Mrs Fyler again. Mrs Marston's head rose as soon as the door unlocked but it was quickly locked tight again, even more tightly. - excerpt from a novel

Results: Free-form Lyric Generation

Empirically evaluate naive-model generated lyrics at different **Temperatures**

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Temperature: **1.2**

I am going crazy!" said Mrs Fyler again. Mrs Marston's head rose as soon as the door unlocked but it was quickly locked tight again, even more tightly. - excerpt from a novel

Temperature: **3.0**

I am going," is really quite simple: just do not eat at your current or your former job after four, what we'd consider good hygiene days." -- Bill O'Sheff - quote

Results: Free-form Lyric Generation

Empirically evaluate tuned-model generated lyrics at different Temperatures

Temperature: 0.5

I am going to get you, I am going to get you in the end Yes I am going to get you in the end Oh
yeah, oh yeah I think about you night and day I need you and it's true When I think about you, I can
say I'm never, never, never, never blue - lyrics from "I'll Get You"

Results: Free-form Lyric Generation

Empirically evaluate tuned-model generated lyrics at different Temperatures

Temperature: 0.5

I am going to get you, I am going to get you in the end Yes I am going to get you in the end Oh
yeah, oh yeah I think about you night and day I need you and it's true When I think about you, I can
say I'm never, never, never, never blue - lyrics from "I'll Get You"

Temperature: 1.2

I am going to be sad) Because you told me, oh You told me, oh You didn't need me anymore Well
you know that I love only you You've tried to leave me But you didn't realize That before too long
I'd change my mind and I'd be with you - lyrics from "Oh Darling!"

Results: Free-form Lyric Generation

Empirically evaluate tuned-model generated lyrics at different Temperatures

Temperature: 0.5

I am going to get you, I am going to get you in the end Yes I am going to get you in the end Oh yeah, oh yeah I think about you night and day I need you and it's true When I think about you, I can say I'm never, never, never, never blue - lyrics from "I'll Get You"

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I am going to be sad) Because you told me, oh You told me, oh You didn't need me anymore Well you know that I love only you You've tried to leave me But you didn't realize That before too long I'd change my mind and I'd be with you - lyrics from "Oh Darling!"

Temperature: 3.0

I am going to find her, oh I have found her"] Ooh, what shall I do when he no longer likes me I wonder what to do I can't stop my heart but it can't be mad Cos when a girl says she loves you, you take it easy - these are new lyrics

Takeaways

Finetuning helps the model specialize to a given task

Data Leakage - It is possible that the underlying model was pretrained on song lyrics

The model can serve varying use cases (autocompletion vs free-text) depending on prediction Temperature

Further evaluation can be done to compare rhythm & syllable counts, and sentiment between original and generated lyrics



References

Radford, A., Wu, J., Child, R., Luan, D., Amodei, D., & Sutskever, I. (2019). Language models are unsupervised multitask learners. *OpenAI blog*, 1(8), 9.

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł. & Polosukhin, I. (2017). Attention is all you need. *Advances in Neural Information Processing Systems* (p./pp. 5998--6008), .