Throwing Shaders at Language Models - Evaluating Creative Code Generation

by Jan Kels @ TaCoS
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About me

- **Jan.Kels@hhu.de**
- 8th semester CL at HHU
- Interested in LLMs
- English/German
- 🤗 @Vipitis

Outline for this talk

- **A:** background
  - “creative” code?
  - code generation
  - evaluation methods
- **B:** my work so far
  - a Dataset
  - an evaluation task
  - it’s results
  - the models
- **C:** things to come
  - improvements
  - a Bachelor Thesis?
- Questions/Discussion
- **[redacted]**
- Backup slides

A: some background

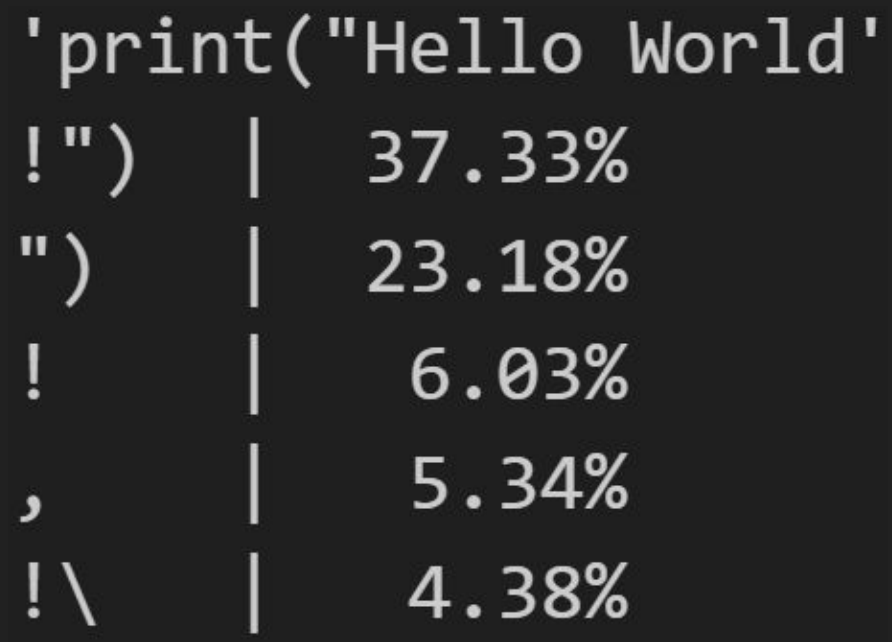
So we all understand what this is about

A1: what do we mean by creative code?

- “[...]a type of computer programming in which the goal is to create something *expressive* instead of something *functional.*”
- GLSL/WebGL: evaluate the color of every pixel, 60 times a second
- Some examples to show it best (backup 0)
  - https://www.shadertoy.com/view/fstyD4 (beautiful 2D example) (backup 1)
  - https://www.shadertoy.com/view/3lsSzf (3D stuff) (backup 2)
  - https://www.shadertoy.com/view/DdlcRf (my own creation) (backup 3)
- Very expressive, but requires some skill
- This website becomes the dataset we will see later

A2: what exactly is Code Generation?

- Decoder only models (GPT)
- learn the probability of the next token
- autoregressively generate more and more (when do they stop?)
- Code specific models exist: Codex(GPT3.5), santacoder, starcoder, InCoder, …
- Code completion is more accurate to what we are interested in



A3: How code generation is evaluated

According to Evtikhiev et al.(2023) there is 3 main kind:

- Metrics from machine translation: ROUGE-L, ChrF, …
- Metrics for code snippet comparison: CodeBLEU, RUBY, ….
- Metrics that run and unit tests: HumanEval, APPS, MBPP, … (*pass@k*)

```
def concatenate(strings):
    """
    Concatenate list of strings into a single string
    """
    <model generation here>
```

1. `return " ".join(strings)`
2. `return "".join(strings)`
3. `out = "".join(strings)`
   `return out`

- There now is an evaluation harness
  https://github.com/bigcode-project/bigcode-evaluation-harness

B: my project

From Deep Learning class

B1: Datasets you can use right now

- “Shadertoys” ~ 44k passes with code, title, author, description, source url, https://hf.co/datasets/Vipitis/Shadertoys
  < 14000 downloads - but I don’t know what for.
- “Shadertoys-fine” ~ 270k functions, https://hf.co/datasets/Vipitis/Shadertoys-fine

- Common train/test
- No deduplication
- License tagging is an issue - as long as you care

B2: a Return Completion task

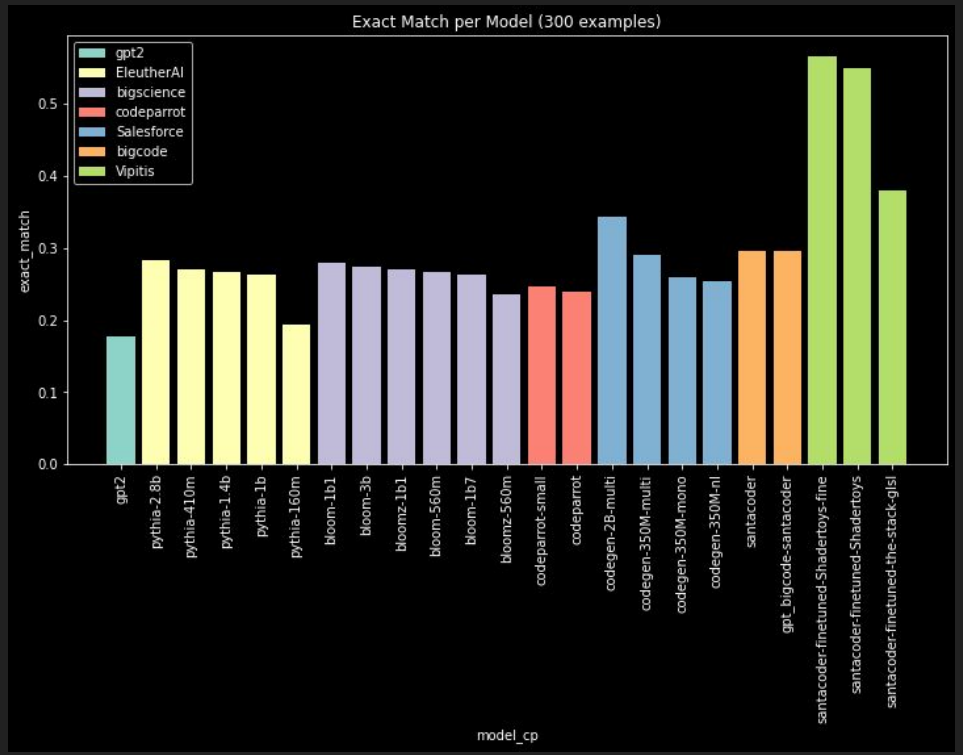
```
float noise(vec3 p) //Thx to Las^Mercury
{
        vec3 i = floor(p);
        vec4 a = dot(i, vec3(1., 57., 21.)) + vec4(0., 57., 21., 78.);
        vec3 f = cos((p-i)*acos(-1.))*(-.5)+.5;
        a = mix(sin(cos(a)*a),sin(cos(1.+a)*(1.+a)), f.x);
        a.xy = mix(a.xz, a.yw, f.y);
        return <model generation here>;
}
```

- Greedy decoding
- exact_match
- https://hf.co/spaces/Vipitis/ShaderEval

- gpt2 `mix`
- bloom-560m/codeparrot `a`
- santacoder-finetuned `mix(a.x, a.y, f.z)`
- StarCoder `sin(dot(a, vec2(12.9898, 78.233)))*43758.5453`
- StarCoderPlus `mix(mix(a.x, a.y, f.z), a.z, f.w)`
- Copilot chat `dot(a, vec4(1.0/vec3(1.0, 57.0, 113.0), 0.0))`

B2: the results

- “Proof of concept”
- Code models do better
- Fine tuned models overfit
- Larger models do better
- A bunch of issues with this task basis for “further research”



B3: fine tuned models on Shadercode

Santacoder (1B) finetuned for 1000 steps (~8hours) on three different datasets

- The Stack dedup, GLSL subset
- Shadertoys
- Shadertoys-fine

All available on https://hf.co/Vipitis

Work in progress demo space https://hf.co/spaces/Vipitis/ShaderCoder

Models might be horribly overfitted, don’t rely on them directly

C: future plans

Your feedback needed

C1: expand on the idea (ideas)

- Improve the dataset: deduplication, function parsing, without comments, licenses, thumbnails
- Expand the dataset: TwiGL, scraping, (any more?)
- Improve metrics for ReturnCompletion task: CodeBLEU, (more metrics?)
- Adding more tasks to become an evaluation suite:
  - Semantic match (same image generated)
  - CLIP match with title
  - further ideas?
- Provide them all in the BigCode Evaluation harness

C2: how to bachelor thesis?

- Any supervisors here that are interested?
- Relaxed timeframe: done in March 2024
- Literature recommendation?
- Formulate a “research question”!
- Present the work at a conference (any suggestions?)
- Is this even related to (formal) linguistics?
- Writing 30 000 words about it?
- Funding for hardware?

THANK YOU!

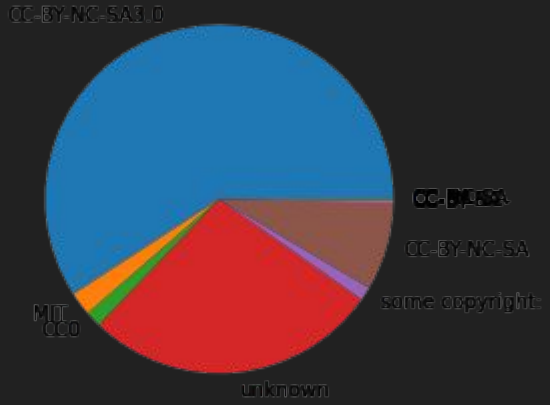
Any questions?

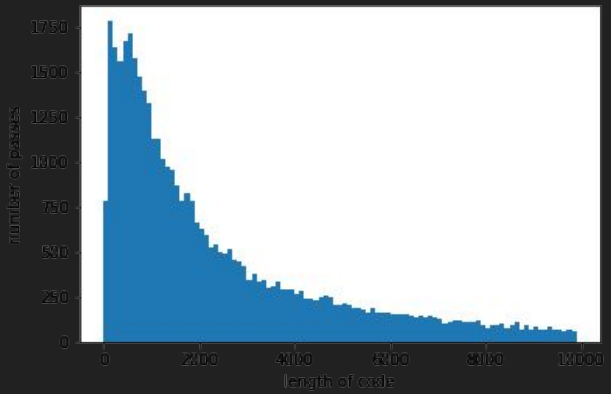
References/Sources

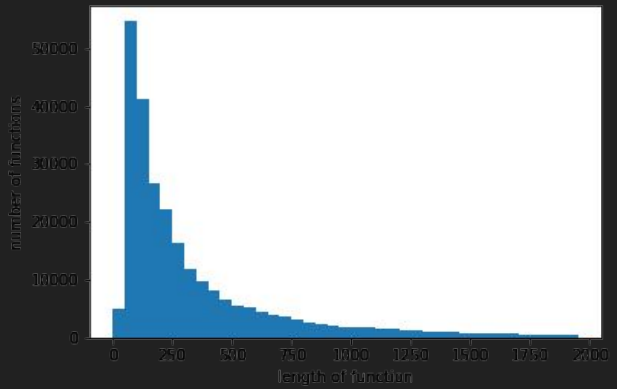
- https://commons.wikimedia.org/wiki/File:Michelangelo_-_Creation_of_Adam_(cropped).jpg
- https://en.wikipedia.org/wiki/Creative_coding
- Evtikhiev, M., Bogomolov, E., Sokolov, Y., & Bryksin, T. (2023). Out of the bleu: how should we assess quality of the code generation models?. Journal of Systems and Software, 203, 111741.
- https://huggingface.co/datasets/openai_humaneval/viewer/openai_humaneval/test?row=28
- https://www.shadertoy.com/view/ttlfWM

BONUS SLIDE (1/n)

Some metrics on the dataset:







BONUS SLIDE (2/n)

Shader Showdown video clip, ideas to turn this into a democratic exhibition with audience input/music guidance.

BONUS SLIDE (3/n)

How bad my time management was for the project so far

Deep Learning in NLP Ideen

1. (kein NLP) reinforcement learning um Mirror's Edge iOS zu spielen (overfitting Problem?) An Speedruns angelegt. Framework via Visual Studio und Hyper V auf dem Laptop müsste gelöst werden für TAS
2. Transformer für Shadertoy, angelegt an Copilot und so. Es soll wohl 50k shadertoys geben, kann man die als Korpus bekommen? Erstes Ziel Syntax der funktioniert.
3. betting related?
4. Neurolinguistische Methoden auf Transformer anwenden (könnte ne super Präsentation werden), ich habe aber keinen Kurs Neurolinguistik gemacht ... Sowas wie halbe Eingabe Vektoren löschen und Schlaganfall zu simulieren. Man bräuchte pretrained Models wie GPT-2/3. Eventuell was für später. "Drop out?"
5. Code golfing (mit phyton), sowas wie Text Zusammenfassung, aber eher mit harten regeln.
6. Meine eigenen Schulunterlagen als Korpus. Habe keinen Scanner, OCR eventuell als Problem?
7. Discord chatbot für Fragen? Bräuchte das CLI um Text zu extrahieren, Copyright wird fraglich
8. Image inpainting for highlight recovery using raw photography?

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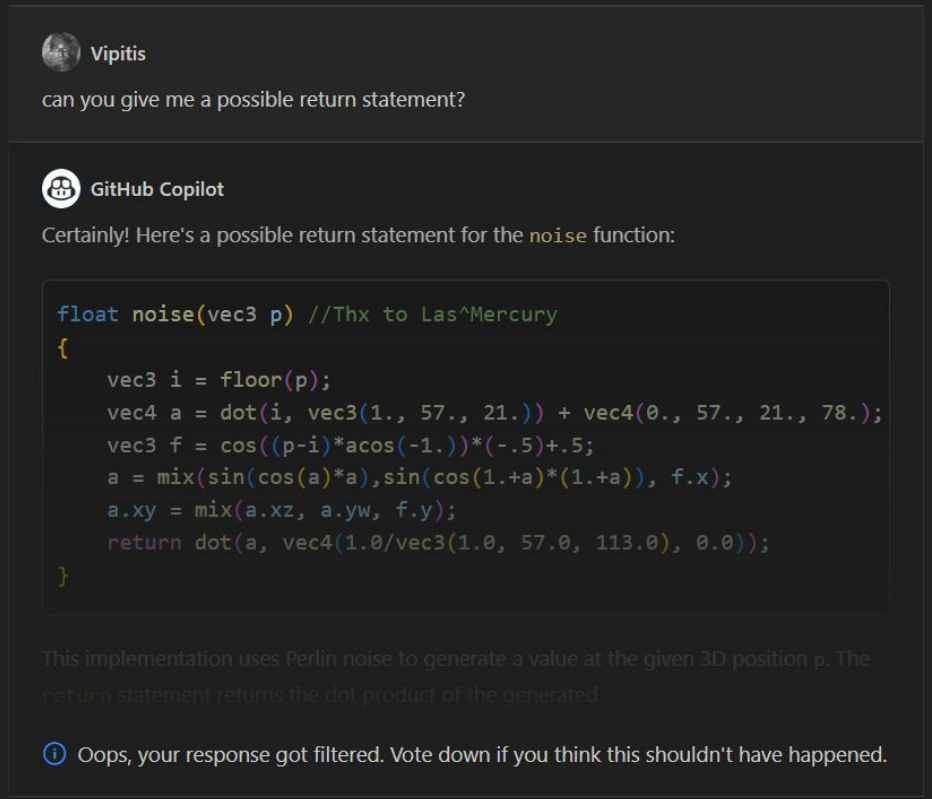
Created 8 Nov 2021
Close

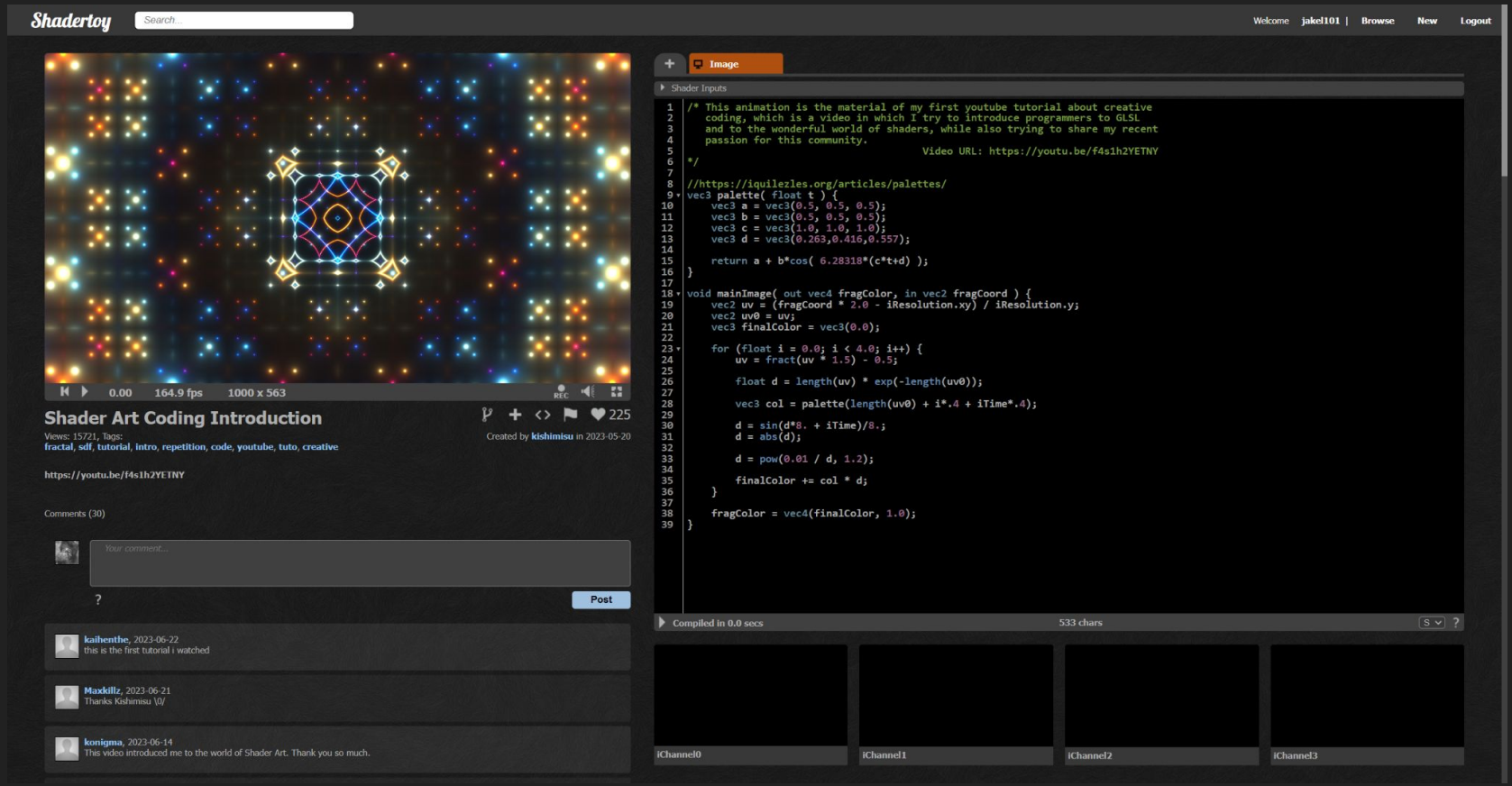
Prüfungsform	Modul	Prüfungs-/ Abgabedatum	Status
Hausarbeit	AP CL5: Morphologische und syntaktische Sprachverarbeitung (Hausarbeit oder Studienarbeit oder Projektarbeit)	05.08.2023	angemeldet

BONUS SLIDE (4/n)

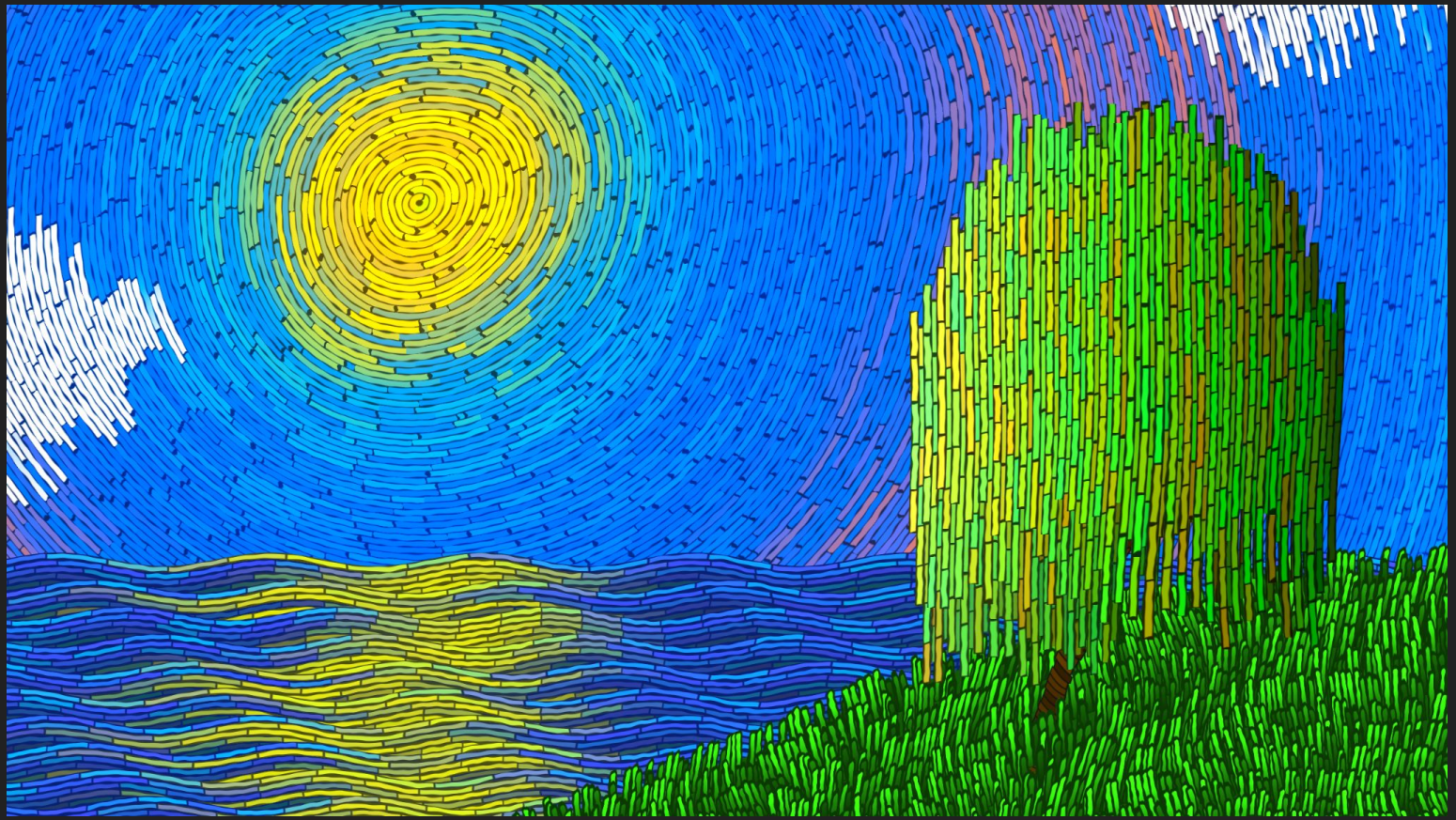
- I had to politely ask them to give me a possible return statement
- Has never happened to me before
- I could still copy and paste their suggestion
- It’s syntactically correct, and seems to be pragmatically alright.



BACKUP SLIDE 0 Shadertoy.com



BACKUP SLIDE 1 https://www.shadertoy.com/view/fstyD4



BACKUP SLIDE 2 https://www.shadertoy.com/view/3lsSzf

BACKUP SLIDE 3 https://www.shadertoy.com/view/DdlcRf