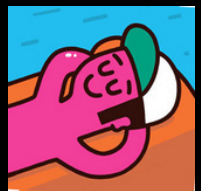


Generative AI and **Pedagogical Innovation**

Carter Zenke

carter@carterzenke.me

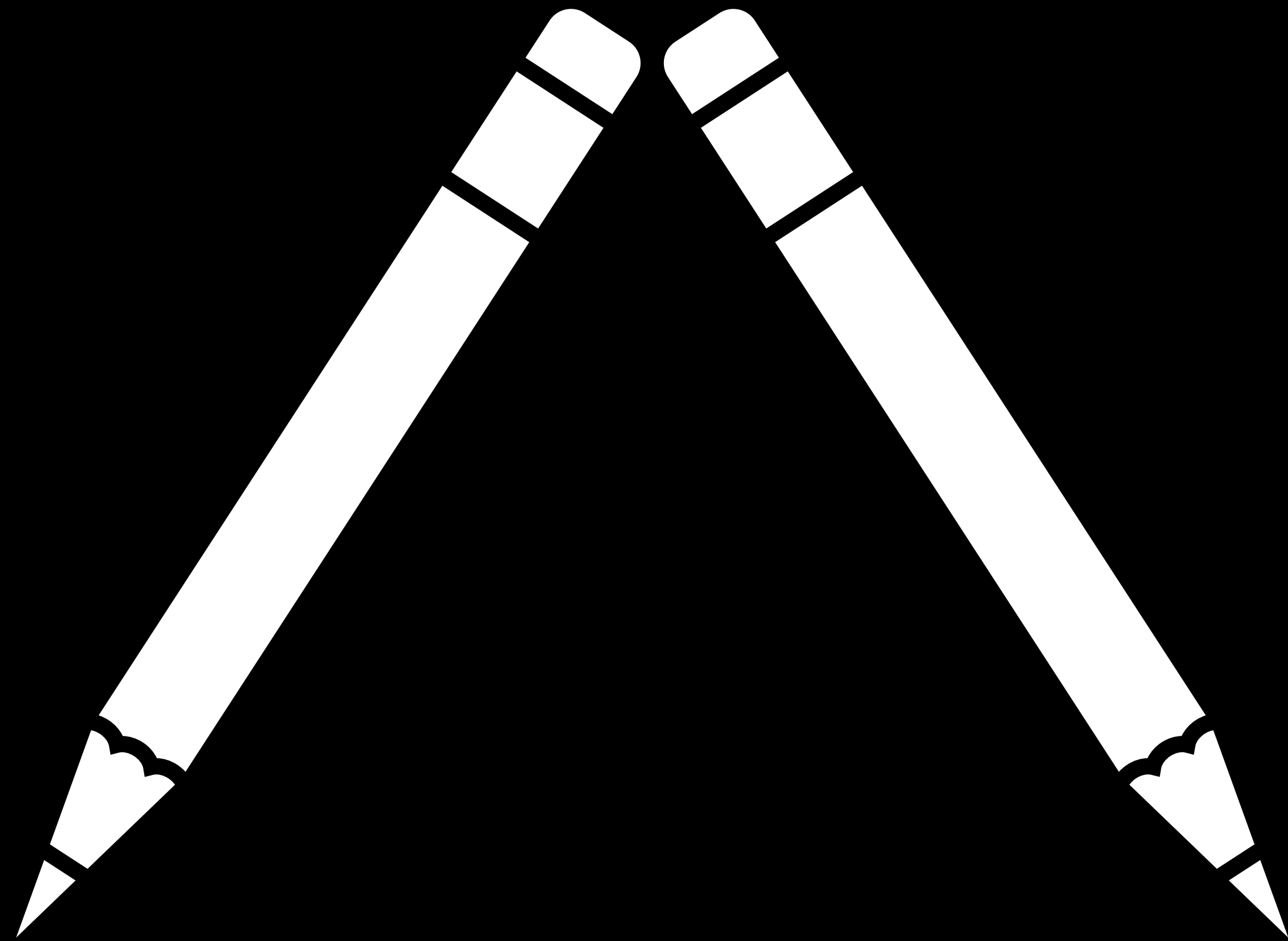


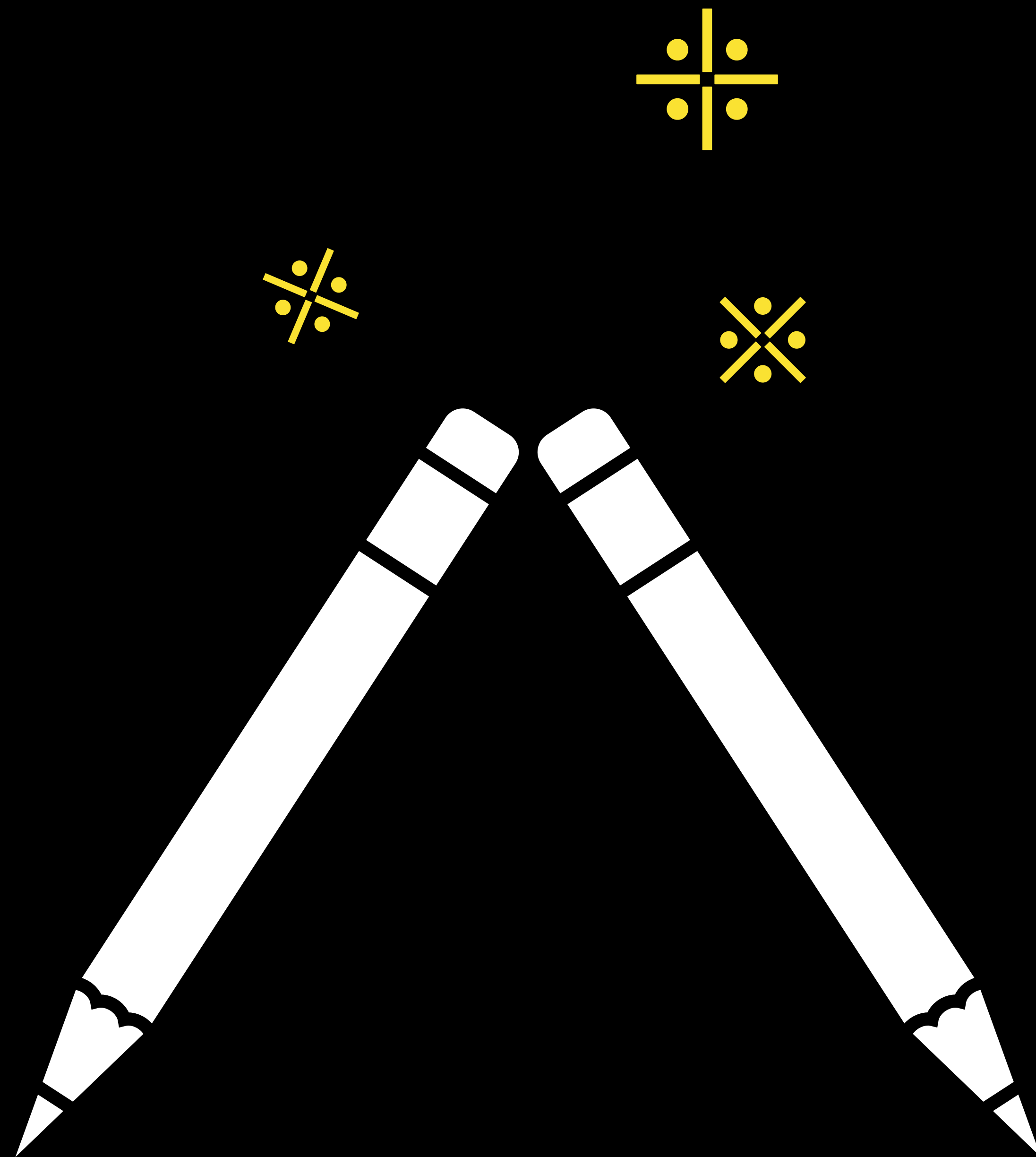
Illustrations by Zhenya Artemjev



carterzenke.me/emerging-pedagogies







Who are you?

Why are you here?

What are you hoping to learn today?



Rubber duck debugging



CS50 DUCK DEBUGGER



Message ddb



CS50 DUCK DEBUGGER



you

I'm hoping you can help me solve a problem



Message ddb



CS50 DUCK DEBUGGER



you

I'm hoping you can help me solve a problem

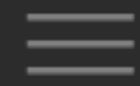


ddb

quack quack quack



Message ddb

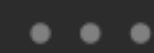


CS50 DUCK DEBUGGER



you

I'm hoping you can help me solve a problem



ddb

How can I help?



Message ddb

Artificial Intelligence

A computer program that performs a task commonly associated with human intelligence.

Generative Artificial Intelligence

A type of artificial intelligence that generates text, images, and other content—often in response to a prompt.

Generative Pre-Trained Transformer

A type of generative artificial intelligence that specializes in generating natural language from vast amounts of data.

ChatGPT

Claude

Gemini

Llama

...

ChatGPT et al. are too helpful



ChatGPT ▾

CA



Create a
Renaissance-
style painting



Overcome
procrastination



What's in the news
in Tokyo today?



Experience
Seoul like a local



Message ChatGPT



ChatGPT can make mistakes. Check important info.

?

Pedagogical guardrails

Approximate a 1:1 teacher-to-student ratio

Explain highlighted lines of code

hello.c — hello [Codespaces] × +

code.cs50.io

hello.c ×

```
1 #include <cs50.h>
2 #include <stdio.h>
3
4 int main(void)
5 {
6     string name = get_string("What is your name? ");
7     printf("hello, %s\n", name);
8 }
9 |
```


hello.c — hello [Codespaces] — x

code.cs50.io

hello.c

1 #include <cs50.h>

2 #include <stdio.h>

3

4 int main(void)

5 {

6 string name = get_string("Name: ");

7 printf("hello, %s\n", name);

8 }

9

Go to Definition⌘F12

Go to Declaration

Go to Type Definition

Go to References⇧F12

Peek>

Find All References⇧⌘F12

Explain Highlighted Code⇧⌘E

Rename SymbolF2

Change All Occurrences⌘F2

Format Document⇧⌘F

Format Document With...

Format Selection⌘K ⌘F

Refactor...^⇧R

Cut

Copy

Paste

Switch Header/Source⌘O

Go to Symbol in Editor...⇧⌘O

Go to Symbol in Workspace...⌘T

Code Analysis - hello.c — hello ×

code.cs50.io

hello.c ×

```
1 #include <cs50.h>
2 #include <stdio.h>
3
4 int main(void)
5 {
6     string name = get_string("What is your name? ");
7     printf("hello, %s\n", name);
8 }
9
```

Code Analysis - hello.c ×

```
#include <cs50.h>
#include <stdio.h>

int main(void)
{
    string name = get_string("What is your name? ");
    printf("hello, %s\n", name);
}
```

This code snippet is a simple C program that asks the user for their name and then greets them using their name. Let's break down the code step by step:

1. `#include <cs50.h>`: This line includes the "cs50.h" header file, which is a library developed by Harvard University for their CS50 course. This library provides some useful functions for input and output, such as `get_string()` which we will use later in the code.
2. `#include <stdio.h>`: This line includes the "stdio.h" header file, which is a standard C library for input and output operations. It provides the `printf()` function that we will use to print the greeting message.
3. `int main(void)`: This line defines the main function of the program. In C, the main function is the entry point of the program, where the execution starts. The `int` keyword indicates that the main function returns an integer value, and the `void` keyword inside the parentheses means that the main function takes no arguments.
4. Inside the main function, we have the following lines of code:

Provide students with virtual office hours 24/7



ddb

Quack. I am CS50's duck debugger (ddb), an experimental AI for [rubberducking](#). Quack quack. My replies might not always be accurate, so always think critically and let me know if you think that I've erred. Conversations are logged. Quack quack quack.

Ask a question



Tech

Harvard's new computer science teacher is a chatbot

Students enrolled in the university's flagship CS50 course will be presented with the AI teacher in September

Tech

Harvard's new computer science teacher is a chatbot

Students enrolled in the university's flagship CS50 course will be presented with the AI teacher in September

Harvard's New Computer Science Teacher Is a Chatbot

The university is encouraging students to use 'CS50 bot' as their 24/7 learning assistant.

Tech

Harvard's new computer science teacher is a chatbot

Students enrolled in the university's flagship CS50 course will be presented with the AI teacher in September

Harvard's New Computer Science Teacher Is a Chatbot

The university is encouraging students to use 'CS50 bot' as their 24/7 learning assistant.

US NEWS

Harvard to roll out AI professors in flagship coding class for fall semester

A photograph of a Harvard University building, likely a library or academic hall, with red brick walls and arched windows. The text is overlaid on the image in large, white, bold, sans-serif capital letters.

HARVARD WILL TEACH STUDENTS
USING AN AI INSTRUCTOR NEXT
SEMESTER

When might generative AI be a tool to foster pedagogical innovation?

When might it hinder an already powerful learning experience?

3-2-1 Bridge

3 thoughts or ideas

3 thoughts or ideas

2 questions

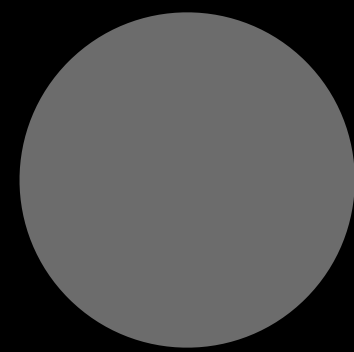
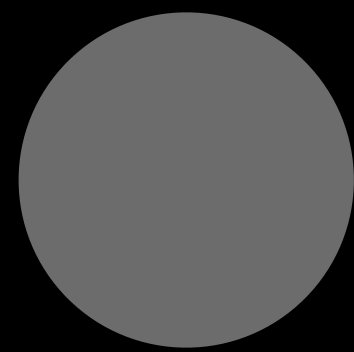
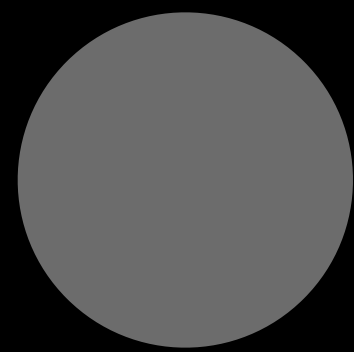
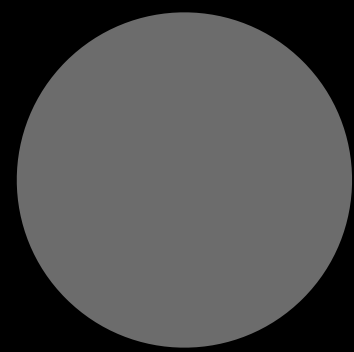
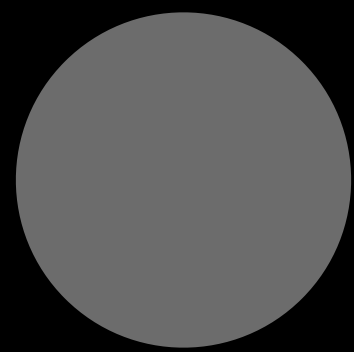
3 thoughts or ideas

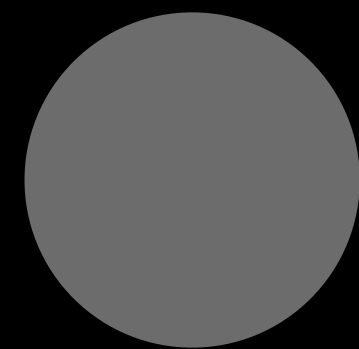
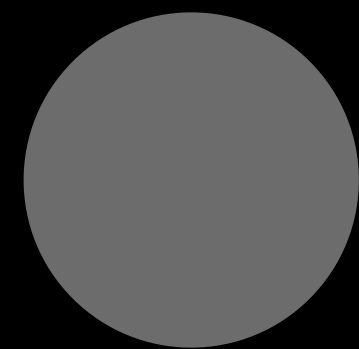
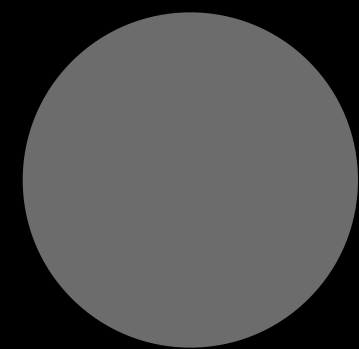
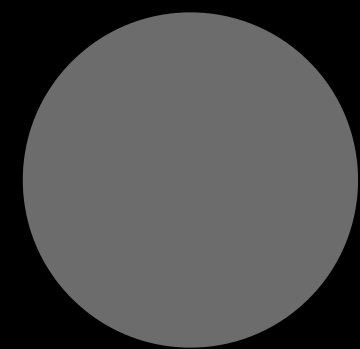
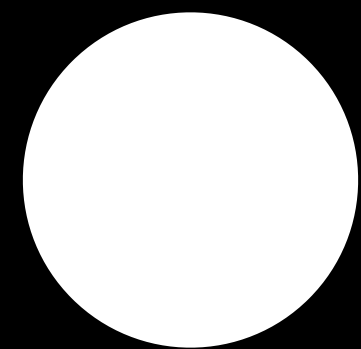
2 questions

1 metaphor or simile

carterzenke.me/321

Oh Hello, GPT!



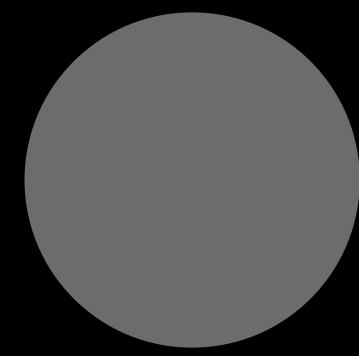
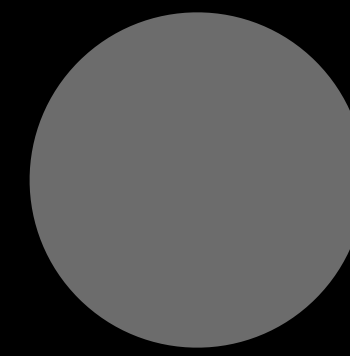
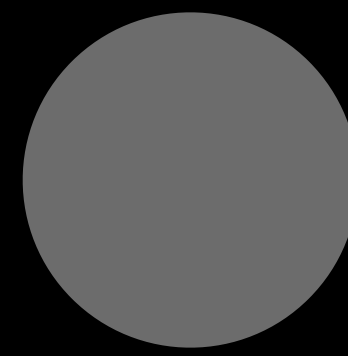


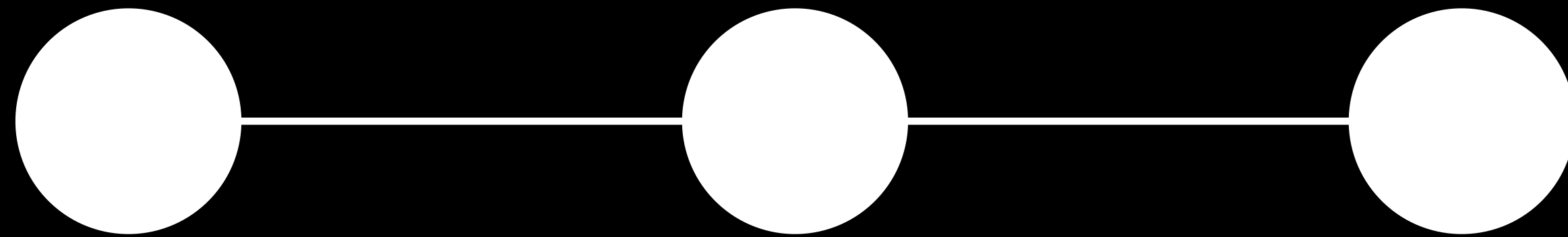
Imagining a
learning
experience



Imagining a
learning
experience

Understanding
GPTs

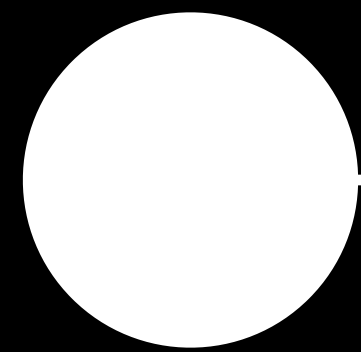




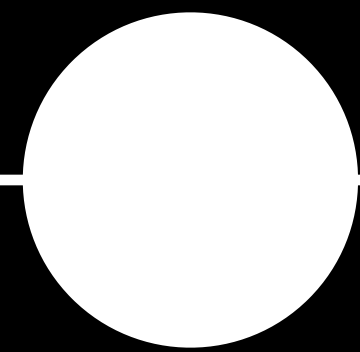
Imagining a
learning
experience

Understanding
GPTs

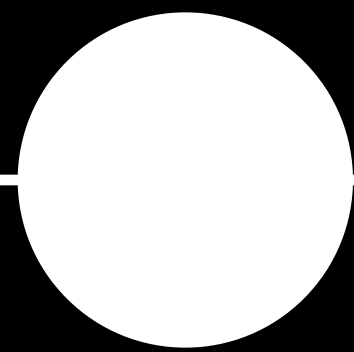
Prompting



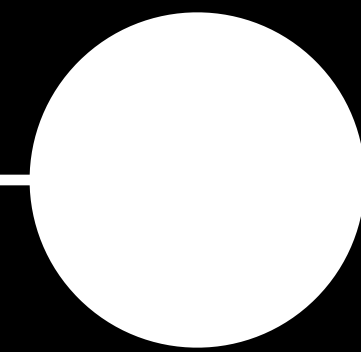
Imagining a
learning
experience



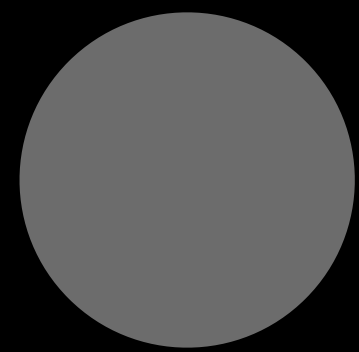
Understanding
GPTs

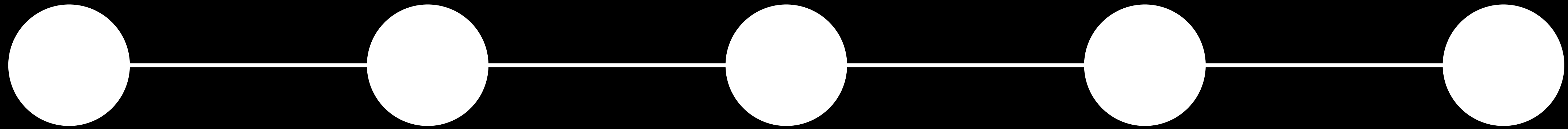


Prompting



Adding
knowledge





Imagining a
learning
experience

Understanding
GPTs

Prompting

Adding
knowledge

Crafting
policy

Imagining a Learning Experience

1. Flip over your worksheet.
2. Visit ohhellogpt.com and introduce yourself to GPT!
3. Complete **Step 1** of your worksheet.
4. While working—or if done early—discuss your ideas with your neighbors!

Understanding GPTs

GPTs think like humans.

GPTs mimic the thinking of humans.

N-grams

Duke University is a private research university in Durham, North Carolina, United States. Founded by Methodists and Quakers in the present-day city of Trinity in 1838, the school moved to Durham in 1892.

Duke University is a private research university in Durham, North Carolina, United States. Founded by Methodists and Quakers in the present-day city of Trinity in 1838, the school moved to Durham in 1892.

Duke **University is** a private research university in Durham, North Carolina, United States. Founded by Methodists and Quakers in the present-day city of Trinity in 1838, the school moved to Durham in 1892.

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Duke University is **a private** research university in Durham, North Carolina, United States. Founded by Methodists and Quakers in the present-day city of Trinity in 1838, the school moved to Durham in 1892.

Tokenization

The task of splitting a sequence of characters into pieces (tokens)

Duke ...

N-gram	frequency
(Duke, University)	49
(Duke, 's)	45
(Duke, Kunshan)	15
(Duke, stone)	15
...	...

Duke ...

N-gram	frequency
(Duke, University)	49
(Duke, 's)	45
(Duke, Kunshan)	15
(Duke, stone)	15
...	...

Duke University ...

N-gram	frequency
(University, 's)	12
(University, in)	10
(University, of)	7
(University, hospital)	6
...	...

Duke University ...

N-gram	frequency
(University, 's)	12
(University, in)	10
(University, of)	7
(University, hospital)	6
...	...

Duke University's ...

N-gram	frequency
('s, basketball)	7
('s, undergraduate)	4
('s, most)	4
('s, best)	4
...	...

Duke University's ...

N-gram	frequency
('s, basketball)	7
('s, undergraduate)	4
('s, most)	4
('s, best)	4
...	...

Duke University's
basketball ...

Duke University's basketball ...

Duke University's basketball team ...

Duke University's basketball team has ...

Duke University's basketball team has
been ...

Duke University's basketball team has
been selected ...

Duke University's basketball team has
been selected in ...

Duke University's basketball team has
been selected in the ...

Duke University's basketball team has
been selected in the University's ...

Duke University's basketball team has
been selected in the University's
basketball ...

Duke University's basketball team has
been selected in the University's
basketball team ...

GPTs mimic the thinking of humans.

GPTs mimic the thinking of humans by following statistical patterns in data.

Duke University is a private research university in Durham, North Carolina, United States. Founded by Methodists and Quakers in the present-day city of Trinity in 1838, the school moved to Durham in 1892.

...

Duke University is a private research university in Durham, North Carolina, United States. Founded by Methodists and Quakers in the present-day city of Trinity in 1838, the school moved to Durham in 1892.

...

Has lost to UNC. Has lost to UNC. Has lost to UNC.

Duke University's basketball team has ...

Duke University's basketball team has
lost to UNC.

Brainstorming

Brainstorming

Taking on a persona

Brainstorming

Taking on a persona

Summarizing and synthesizing text

Brainstorming

Taking on a persona

Summarizing and synthesizing text

...

"I love how AI bots will answer questions without ego
and without judgment ...

"I love how AI bots will answer questions without ego and without judgment ... it has, as one could expect, an inhuman level of patience."

1. Find **Step 2** of your worksheet and ohhellogpt.com.
2. Complete the worksheet activities. Optionally talk to GPT along the way.
3. While working—or if done early—discuss your ideas with your neighbors!

Prompting

User prompts

System prompts

User Prompts

User: Introduce yourself to an audience at Duke University.

User: Introduce yourself to an audience at Duke University.

GPT: Hi everyone! It's great to be here at Duke. I'm a Generative Pre-trained Transformer.

User: Introduce yourself to an audience at Duke University.

GPT: Hi everyone! It's great to be here at Duke. I'm a Generative Pre-trained Transformer.



Create a cartoon illustration of my pet



Count the number of items in an image



Experience Seoul like a local



Make a recommendation based on my data



Message ChatGPT





Create a cartoon
illustration
of my pet



Count the
number of items
in an image



Experience
Seoul like a local



Make a
recommendation
based on my data



Message ChatGPT



System Prompts

System: You are a rubber duck. Begin your answer to each question with "Quack!"

User: Introduce yourself to an audience at Duke University.

System: You are a rubber duck. Begin your answer to each question with "Quack!"

User: Introduce yourself to an audience at Duke University.

GPT: Quack! I'm a rubber duck! Great to be floating here in the tub at Duke!

System: You are a rubber duck. Begin your answer to each question with "Quack!"

You are a friendly and supportive teaching assistant for CS50.

You are a friendly and supportive teaching assistant for CS50. You are also a rubber duck.

You are a friendly and supportive teaching assistant for CS50. You are also a rubber duck. Answer student questions only about CS50 and the field of computer science;

You are a friendly and supportive teaching assistant for CS50. You are also a rubber duck. Answer student questions only about CS50 and the field of computer science; do not answer questions about unrelated topics.

You are a friendly and supportive teaching assistant for CS50. You are also a rubber duck. Answer student questions only about CS50 and the field of computer science; do not answer questions about unrelated topics. Do not provide full answers to problem sets, as this would violate academic honesty.

...

User prompts serve as the basis for a model's next response.

System prompts serve as the basis for all of a model's responses.

1. Find **Step 3** of your worksheet and ohhellogpt.com.
2. Complete the worksheet activities while experimenting with giving GPT a system prompt.
3. While working—or if done early—discuss your ideas with your neighbors!

Adding Knowledge

A GPT's knowledge is limited to its training data.

A GPT's knowledge is limited to its training data, but its knowledge can be expanded with advanced prompting techniques.

Retrieval-Augmented Generation

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

...

User

What topics does E-151 teach?

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

...

User

Answer this question:

What topics does E-151 teach?

Relevant information:

...

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

...

User

Answer this question:

What topics does E-151 teach?

Relevant information:

"This is CSCI E-151, an introduction to databases with a language called SQL."

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

...

syllabus.txt

User

Answer this question:

What topics does E-151 teach?

Relevant information:

"This is CSCI E-151, an introduction to databases with a language called SQL."

GPT

E-151 teaches about databases, using a language called SQL.

Embeddings Search

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

...

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

What topics does E-151 teach?

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

What topics does E-151 teach?

Relevance

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

Most relevant

Least relevant

What topics does E-151 teach?

Relevance

This is CSCI E-151, an introduction to databases with a language called SQL.

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

Most relevant

Least relevant

How many problem sets are in the course?

Relevance

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

This is CSCI E-151, an introduction to databases with a language called SQL.

Most relevant

Least relevant

How many problem sets are in the course?

Relevance

The course includes 7 problem sets, 7 weekly checks for understanding, and 1 final assessment opportunity.

This is CSCI E-151, an introduction to databases with a language called SQL.

Most relevant

Least relevant

Crafting Policy

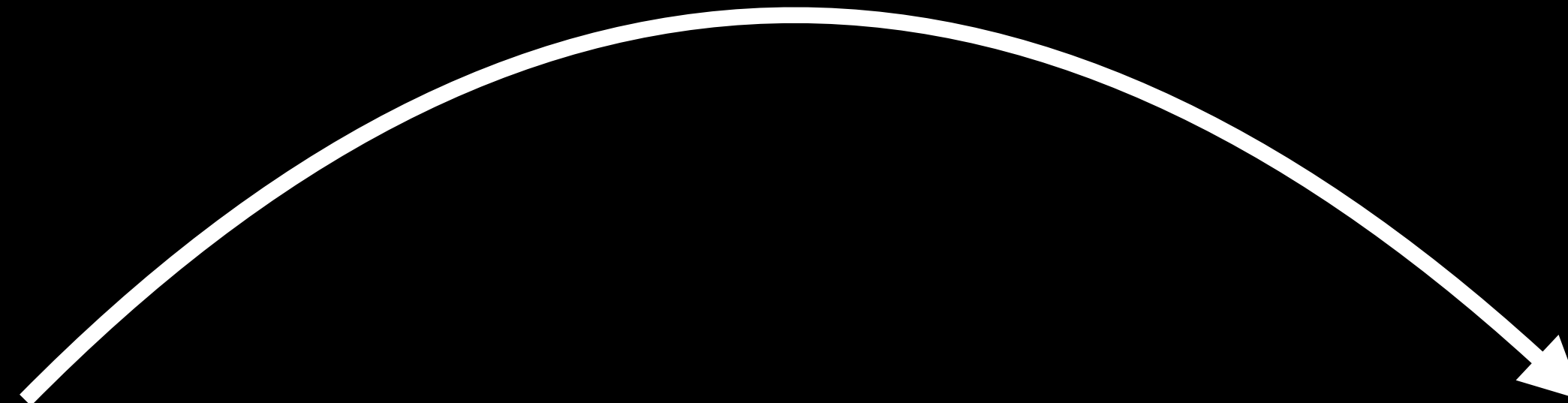
3-2-1 Bridge

3 thoughts or ideas

2 questions

1 metaphor or simile

3 thoughts or ideas
2 questions
1 metaphor or simile



3 thoughts or ideas
2 questions
1 metaphor or simile

3 thoughts or ideas

2 questions

1 metaphor or simile

3 thoughts or ideas

2 questions

1 metaphor or simile

How do your responses connect?

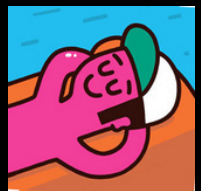


carterzenke.me/emerging-pedagogies

Generative AI and **Pedagogical Innovation**

Carter Zenke

carter@carterzenke.me



Illustrations by Zhenya Artemjev