

The background features a complex network of nodes and lines. The nodes are represented by small circles, some of which are highlighted with a glowing effect. The lines are thin and connect the nodes, creating a web-like structure. The overall color palette is dark, with shades of blue and green, giving it a technical or digital feel.

Signal Processing Quest Game

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Quest Game Purpose

- **Motivation:**

- Develop an interactive web application to learn Signal Processing in an adaptive manner

Quest Game Goals

Goals:

- Design a game with a timer-based challenge system to allow for the users to earn points by navigating through a quest like map
- Integrate ChatGPT to generate personalized feedback and hints, and additional practice questions.

Intended Audience

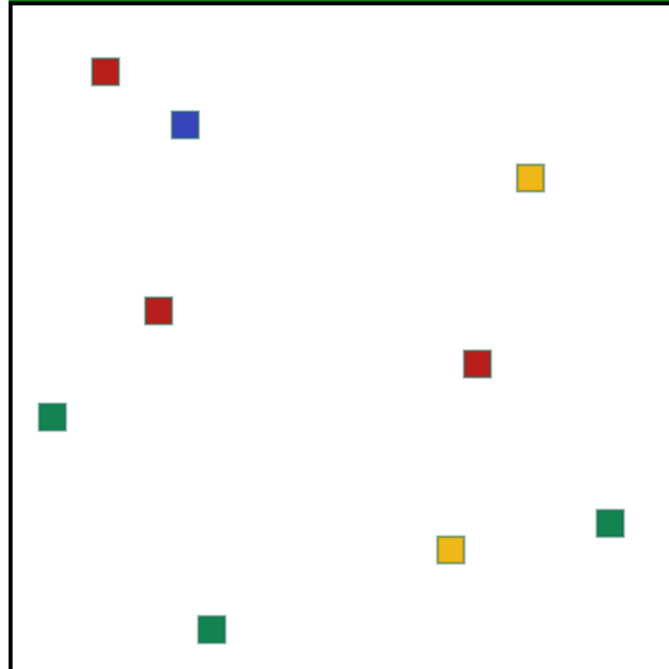
- Students taking Signal Processing can learn in a new incentivized game format
- Often times students learn better when they are in a more fun and gamified environment

Desired Product

Quest Game

Current Score: 0

Time left: 54



The signal

$x[n] = 7 \cos(0.2\pi n + \frac{\pi}{3})$ can also be written in the following form $x[n] = \Re\{X e^{j0.2\pi n}\}$ where \Re denotes the real operator.

How would you define the complex amplitude X in MATLAB notation?

- ;
- $X = 7 * e^{(\pi/3)}$;
 - $X = 7 * e^{(j * \pi/3)}$;
 - $X = 7 * \exp(\pi/3)$;
 - $X = 7 * \exp(j * \pi/3)$;
 - $X = 7 * \exp(j * 0.2 * \pi)$;

Hint: Recall that the complex amplitude of a complex exponential signal is the magnitude of the phasor representing the signal. In this case, the phasor can be represented by $e^{j\frac{\pi}{3}}$, which has a magnitude of 1. Therefore, to find the complex amplitude X , you can simply multiply the amplitude of the cosine signal by $e^{j\frac{\pi}{3}}$.

Generate hint

Ask ChatGPT

Submit answer

Past Questions:

Review by clicking question:

Question ID: 982

Question ID:


An abstract network diagram on a black background. It features numerous nodes, represented by small white circles with a central dot, connected by thin lines. The lines are colored in shades of blue and green, creating a complex web of connections. The nodes are scattered across the frame, with a higher density of connections on the right side. The overall effect is that of a dynamic, interconnected system.

Backend Features

Data Preparation

- MySQL database containing questions with unique ids, question types, category, difficulty.
- Connected using mysql.connector with Flask
- Wrote Python scripts to query and preprocess the data

questions

id	qtype	title	question	answers	category	status
1	MC	DTMF Signal Generation 1	Given: $\text{fs} = 11025$; $t = (\dots)$	7	Lab	publish
2	M	Polynomial Factors 1.013	Use MATLAB to factor both of these polynomial...	5	Z	edit
3	MC	Negative Frequency	The meaning of "negative frequency" in a Fouri...	4	Lab	publish
4	MC	Putting tones together 2	We are given the following MATLAB code: $\text{PR} \dots$	5	Chapter4	publish
5	C	D/A Conversion - find duration (1)	$\text{tt} = 0:(1/11025):\text{a}0; \text{xx} \dots$	1	PreLab04	publish
6	MC	LTI system	The discrete-time system defined by the followin...	4	Chapter7-Mod5	publish
7	MC	Basic Sound 1	A student wishes to generate a 3 kHz tone in M...	9	PreLab10	publish
8	M	Convolve with Impulses 1	The  href="SPFIRST/SP1F...	7	Chapter4-ECE2026	publish
9	C	D/A Conversion - find frequency (2)	$\text{tt} = 0:(1/11025):\text{a}$;	1	PreLab04	publish
10	MC	lowpass filter	Definition: A \dots	1	chapter7DM-def	edit
11	S	BPF Design (4)	Write a single line of the simplest possible MAT...	2	Code	edit
12	S	Column_extraction (1)	A student has imported a 2D Matrix into MATLA...	1	Code	edit
13	MC	ZD	In signal processing, the purpose of the \dots	1	chapter7DM-def	edit
14	C	Beat Periods	The following plot was generated by the followin...	1	PreLab04-fix-min	publish
15	MC	Find with Filter Coefficients (3)	Given a set of FIR filter coefficients contained in...	20	PreLab06-choices	edit
16	MC	FIR:complex BPF	Given an 8-point complex bandpass FIR filter, w...	5	Chapter7-limbo	edit
17	C	Find $x(0)$ from phase	If a sinusoid has a Frequency equal to \dots	1	PreLab02	publish
18	MC	Spectrum of Aliasing Movie	The DSP-First CD contains several movies in C...	5	Sampling	edit
19	MC	FIR:FR	Given the impulse response of a LTI system: \dots	4	Chapter6-Mod5	publish
20	C	Length of Convolution Output	Given two vectors: bb contain...	1	Lab	edit

questions_difficulty

id	q_id	difficulty	difficulty2	difficultySTD	difficultyDrop_N
1777	4	4.9797	3.9153	3.8187	3.8341
1778	5	6.2013	6.6403	5.5157	5.9177
1779	6	6.4406	4.3405	5.1685	5.2184
1780	7	NULL	NULL	NULL	NULL
1781	8	5.7368	4.3302	5.3363	1.7790
1782	9	6.2761	5.7325	5.5764	6.0385
1783	16	NULL	NULL	NULL	NULL
1784	17	5.7879	5.8557	4.9408	5.6376
1785	19	4.8791	5.4414	3.6045	3.4064
1786	23	5.1777	5.0033	5.0107	4.9922
1787	25	6.3889	4.7978	NULL	4.7650
1788	26	5.1255	NULL	4.5664	2.2349
1789	27	5.0039	1.2099	2.3259	2.2415

ChatGPT Integration

- Integrated an open-source ChatGPT clone into our backend.
- Goals
 - Provide feedback wrong answers
 - Generate hints
 - Ask open-ended questions about the problem
 - Generate problems
- Problems:
 - Text generation takes too long -> cache results in JSON
 - Raw data from database does not work well -> preprocessing using regex and BeautifulSoup

Developer API

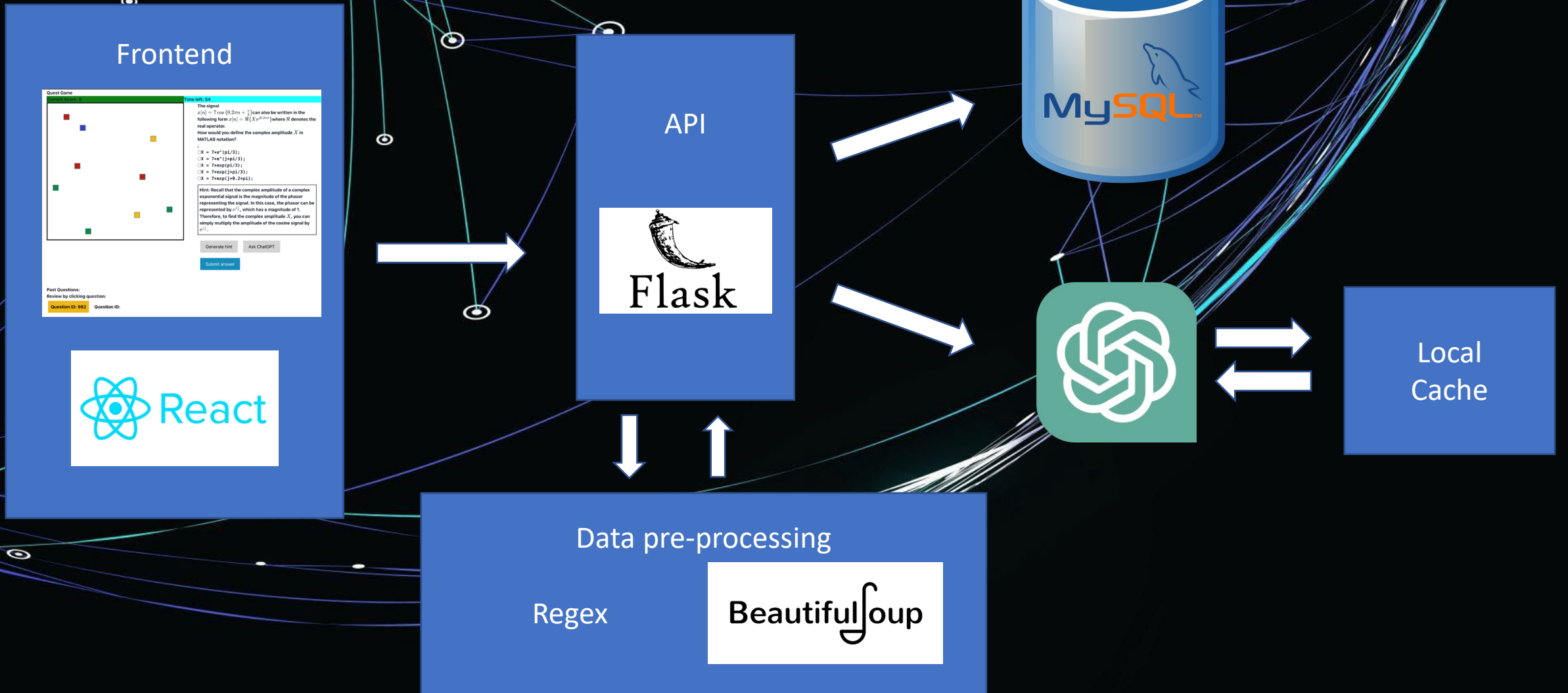
Basic example

```
from revChatGPT.V3 import Chatbot
chatbot = Chatbot(api_key="<api_key>")
chatbot.ask("Hello world")
```

Streaming example

```
from revChatGPT.V3 import Chatbot
chatbot = Chatbot(api_key="<api_key>")
for data in chatbot.ask_stream("Hello world"):
    print(data, end="", flush=True)
```


Backend Diagram



API Endpoints

- Extract Question
 - Retrieve the question, choices, difficulty, for a specific id from the database
 - Preprocess the raw data (close tags, replace tags for MATLAB, surround LaTeX with \$)
 - Sends a JSON object with all the information as the response
- Generate Hint
 - Feeds the ChatGPT API the question, choices, and asks it to generate a hint.
 - Custom rules for formatting generated text
 - Prompt: "Generate a hint for this question: [question]. [rules]"
- Generate Feedback
 - Generates explanations for why each choice is correct or wrong.
 - Prompt: "...Explain why the following choices are right or wrong, start each choice on a new line: [choices]"



Question Generation

An intended feature using ChatGPT API

- Main feature
 - Feeds ChatGPT API with the current question and prompt to generate new questions similar to the one the user is working on with answers following the questions
 - Formatting remains the same as ChatGPT replies with the same format as the input so LaTeX wrappers are included in the replies
 - Prompt: "Give a question that is similar to the following followed by the answer:"
- Due to the lack of accuracy and consistency of the answers given by the GPT-3.5 model, this feature is put on hold until a more reliable GPT model is released

Target Question:

Determine the **Magnitude** of the complex number Z obtained from the following sum: $Z = xe^{-j0.5\pi} + ye^{j2\pi}$

- Give a **numerical answer with two decimal digits, not a formula.**

Generated Question

1) What is the conjugate of the complex number Z given by $Z = ae^{j3\pi} + ce^{-jd\pi}$
Answer: The conjugate of the complex number Z is given by $Z^* = ae^{-j3\pi} + ce^{jd\pi}$

2) What is the **angle** of the complex number Z obtained from the following sum:
 $Z = 3e^{-j0.5\pi} + 4e^{j3\pi}$

- Give a **numerical answer with two decimal digits, not a formula.**

Answer: To determine the angle of Z , we need to find the argument of the complex number.

$$(Z) = (3e^{-j0.5\pi} + 4e^{j3\pi}) = (3e^{-j0.5\pi}) + (4e^{j3\pi}) \quad (\text{niiono}) = -0.5\pi + 3\pi = 2.5\pi$$

Therefore, the angle of Z is 2.5π or approximately 7.85 radians (rounded to two decimal places)

3) What is the **angle** of the complex number Z obtained from the following sum: $Z = 2e^{j\frac{\pi}{4}} + 2e^{-j\frac{\pi}{4}}$

- Give a **numerical answer with two decimal digits, not a formula.**

Answer: The given complex number Z can be expressed in rectangular form as follows:

$$Z = 2e^{j\frac{\pi}{4}} + 2e^{-j\frac{\pi}{4}} = 2(\cos \frac{\pi}{4} + j \sin \frac{\pi}{4}) + 2(\cos \frac{-\pi}{4} + j \sin \frac{-\pi}{4}) = 2\sqrt{2}j \text{ Therefore, the angle of } Z \text{ is } 90 \text{ degrees or equivalently, } 1.57 \text{ radians.}$$

4) What is the imaginary part of the complex number Z obtained from the following sum: $Z = xe^{(-j0.5\pi)} + ye^{(j2\pi)}$ Give a numerical answer with two decimal digits, not a formula.

Answer: The imaginary part of Z is $[x\sin(-y\pi) + y\sin(x\pi)]$ with numerical value depending on the given values of x and y .

Examples

Target Question:

Determine the **Magnitude** of the complex number Z obtained from the following sum: $Z = xe^{-j0.5\pi} + ye^{jx\pi}$

- Give a **numerical answer with two decimal digits, not a formula**.

Generated Question

1) What is the conjugate of the complex number Z given by $Z = ae^{jb\pi}; +; ce^{-jd\pi}$

Answer: The conjugate of the complex number Z is given by $Z^* = ae^{-jb\pi}; +; ce^{jd\pi}$

2) What is the **angle** of the complex number Z obtained from the following sum:

$$Z = 3e^{-j0.5\pi}; +; 4e^{j3\pi}$$

- Give a **numerical answer with two decimal digits, not a formula**.

Answer: To determine the angle of Z , we need to find the argument of the complex number.

$$\angle(Z) = \angle(3e^{-j0.5\pi} + 4e^{j3\pi}) = \angle(3e^{-j0.5\pi}) + \angle(4e^{j3\pi}) \quad (\text{niiono}) = -0.5\pi + 3\pi = 2.5\pi$$

Therefore, the angle of Z is 2.5π or approximately 7.85 radians (rounded to two decimal places)

An abstract network diagram on a black background. It features numerous nodes, represented by small white circles with a central dot, connected by thin, glowing lines in shades of blue and cyan. The connections form a complex web, with some nodes having multiple links. The overall structure is dynamic and interconnected, suggesting a network or data flow.

Frontend Features

Frontend Diagram

```
graph LR; Score[Score component] --- Timer[Timer component]; Score --- GameBoard[GameBoard component]; GameBoard --- ReviewSection[ReviewSection component]; GameBoard --- Question[Question component]; Timer --- Question; ReviewSection --- Question;
```

The diagram illustrates the relationships between five frontend components: Score component, Timer component, GameBoard component, Question component, and ReviewSection component. The components are arranged in two columns. The Score component is at the top left, the Timer component is at the top right, the GameBoard component is in the middle left, the Question component is in the middle right, and the ReviewSection component is at the bottom left. Lines connect the Score component to the Timer component and the GameBoard component. The GameBoard component is connected to the ReviewSection component, the Question component, and the Timer component. The ReviewSection component is connected to the Question component.

Score component

Timer component

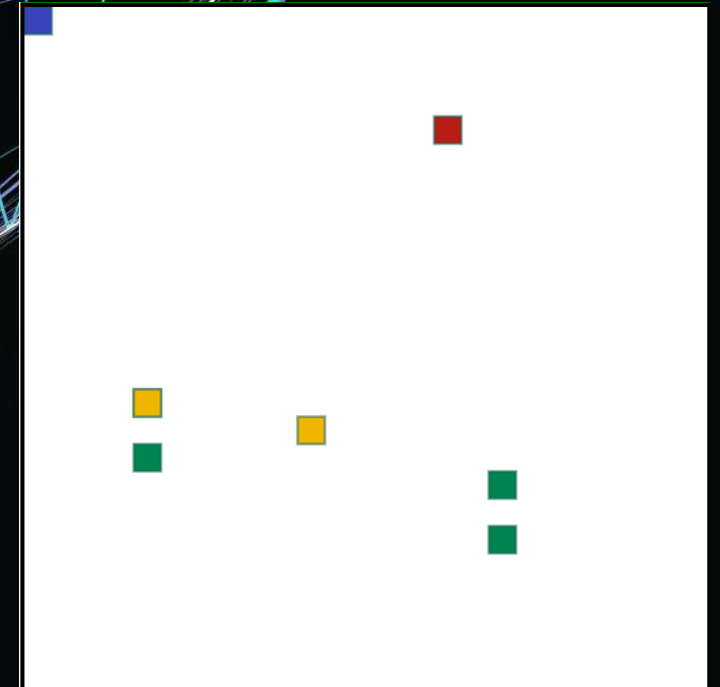
GameBoard component

Question component

ReviewSection component

Gameboard component

- Consists of user details and game logics
- User
 - • Blue square
 - Use global state management in redux to store user's current coordinates
 - 'w', 'a', 's', 'd' keys update current coordinates
- Questions
 - Color represents difficulty
 - Harder difficulty provides more time



Game Board Questions

- Stored in array of objects containing information about question's position on the canvas
- The canvas only draws questions that haven't been reached
- When the user reaches a question, the visited array is updated

Quest Game

Current Score: 0

Time left: 106

If the continuous-time signal $x(t) = \cos(2\pi(4200)t)$ is sampled with a sampling frequency of 8000 Hz, which of the following signals would yield a sampled signal that has the *same discrete-time frequency* ($\hat{\omega}$) if also sampled at 8000 Hz?

Pick the best answer;

$\cos(2\pi(4200)t + \frac{\pi}{2})$

$\cos(2\pi(3800)t)$

$\cos(2\pi(11800)t)$

All of the above.

None of the above.

Generate hint

Ask ChatGPT

Submit answer

Score Component

- The current score is stored as an interface in the redux's section of the code
- Each time the user answers the question correctly, the score is updated.
- Currently the score increments by a constant value of 10

Timer Component

- Timer was intended to be created based on previous performance on a given question but currently there due to a lack of data currently creating timer based on question difficulty
- Timer currently counts down from when the user steps on the question
 - Easy question: 45 seconds
 - Medium questions: 75 seconds
 - Hard questions: 110 seconds

Review Section

- Shows previously answered questions, colored by difficulty
- Only displays questions with 'reached' attribute
- Used conditional CSS styling based on value of enum DIFFICULTY

Past Questions:

Review by clicking question:

Question ID: 1081

Question ID: 7

Question ID: 1073

A network diagram on a dark background. It features several nodes, represented by small white circles with a central dot, connected by thin, light blue lines. The nodes are arranged in a roughly circular pattern, with some lines crossing each other. The overall appearance is that of a complex, interconnected network or graph.

Demo

Further Advancements

- Create student profiles to store performance information and collect data
 - Store movement information
 - Track what questions the student is good / bad at
 - Use data for further personalization (question difficulty, category, etc.)
- Be able to keep track of time and rather than question timer being based on question difficulty allow it to be based on previous performance on that question