



TutorBot Final Presentation/Demo

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Problem to Solve:

In previous semesters, we set out to help electrical engineering students solve signal processing algorithms in Javascript. To do that, we created a tool called TutorJS. We also created a Chatbot that took information from the course discussion and textbook.

By combining both of these projects, we were able to have students use the capabilities of the chatbot inside of the TutorJS application to assist them in their learning when they had questions.

We set out to make the Chatbot accessible in TutorJS creating this semester's project: **TutorBot!**



Front-end Semester Goals:

- Create a chat bot to help users of TutorJS get direct help from the automated responses set in place by the TutorJS team
- This chat bot should help users be able to figure out code errors or get help with TutorJS if needed
- UI/Implementation was our top priority this semester
- We accomplished the task of coming up with the chatbot system, designing the UI for it, and implementing it into the TutorJS system

Research



LOCATIONS GIFT CARDS CAREERS MEMBERSHIP

SCHEDULE APPOINTMENT



MESSAGE ▾ SKIN CARE ▾ STRETCH ▾

MEMBERSHIP

A BETTER YOU STARTS TODAY.

A membership with a Message Envy franchised location means access to monthly services at lower rates, family benefits and discounts on additional services.

FIND A LOCATION

Message Envy
Typically replies instantly

Hello Ashley and Welcome to Message Envy. I'm your virtual assistant.

I am here to help you with whatever you need.

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To find local pricing and the most convenient location, send us your location pin so we can search around your area or choose a

Type a message...

15:38

Cheapflights > Manage

Cf Cheapflights 454k people like this, including Matthias Meyer Travel agent

15:38

Get Started

Flights from ny to Paris

OK, I've set New York, US as your departure location. You can change this later by typing "help". The average cheapest return flight to Paris leaving 13 Feb 2017 and returning 20 Feb 2017 is 499 USD. Easy huh...

[Book now](#)

[Search other dates](#)

[Help](#)

Type a message...

15:39

Cheapflights > Manage

Below:

Less than 100 USD

100 - 160 USD

Above 160 USD

Above 160 USD

Here are the best hotels in London available for your dates and price range.

[Book now](#)

Park Plaza Westminster Bridge London from 178 USD per night

Strand from 11

[Book now](#)

Type a message...



Tech stack



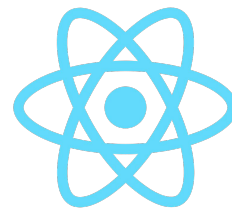
figma

Design the UI flow and look

storybook



Create components for styling and functionality



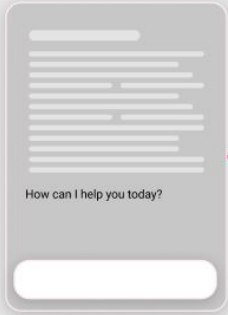
react

Integrated into TutorJS

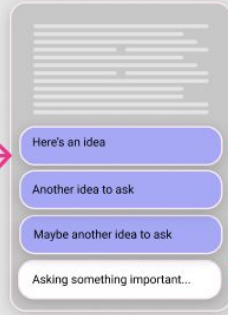
Chat-Bot Flow

User starts a new problem chat.

Welcome message, how can I help you?

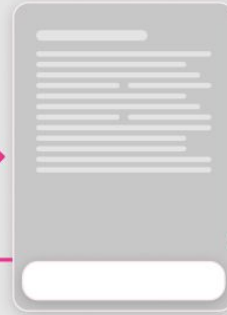


Give 3 keyword questions to ask.



Student asks question.

Display the answer, if the answer has a link or image, display that too



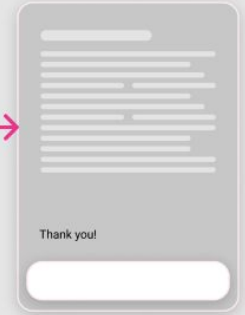
answer is given to student.

Display buttons if that answered their question



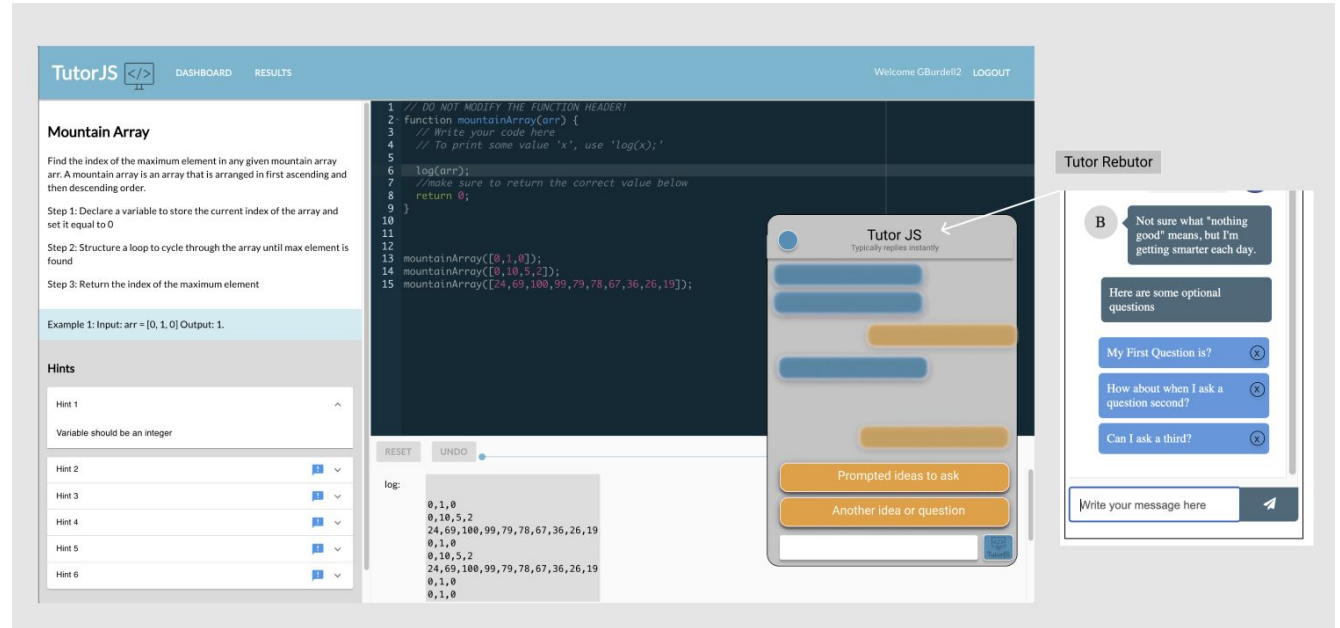
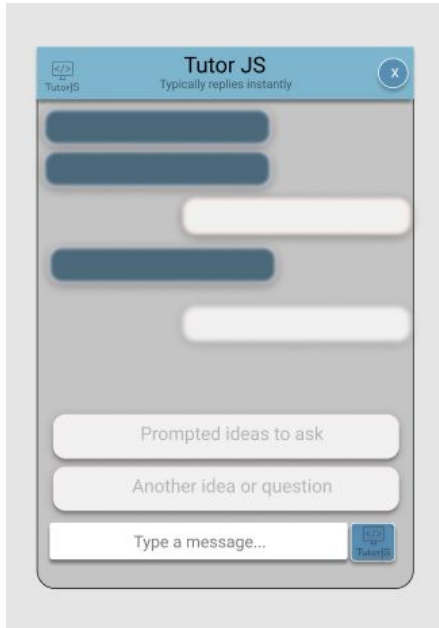
Haven't answered my question, next answer is given up to x

Chatbot lets you know they will update to let other students know that answered helped and to ask another question to them if they need



User's chat will stay there until a new problem is started.

Chat-Bot Prototypes



Current Chat-Bot UI

3 // write your code here
4 // To print some value 'x' to the log below, use 'log(x);' and press test
5
6
7 // make sure to return the correct value below
8 return 0;
9 }
10
11
12
13 mountainArray([0,1,0]);
14 mountainArray([0,10,5,2]);
15 mountainArray([24,69,100,99,79,78,67,36,26,19]);

RESET UNDO

log:

TUTORBOT

Hello from the TutorBot!
How can I help you with this problem?

Let's do some work maybe/

This is the textbook answer

collapse content

I could not get an answer for that question.
Did you check your spelling?

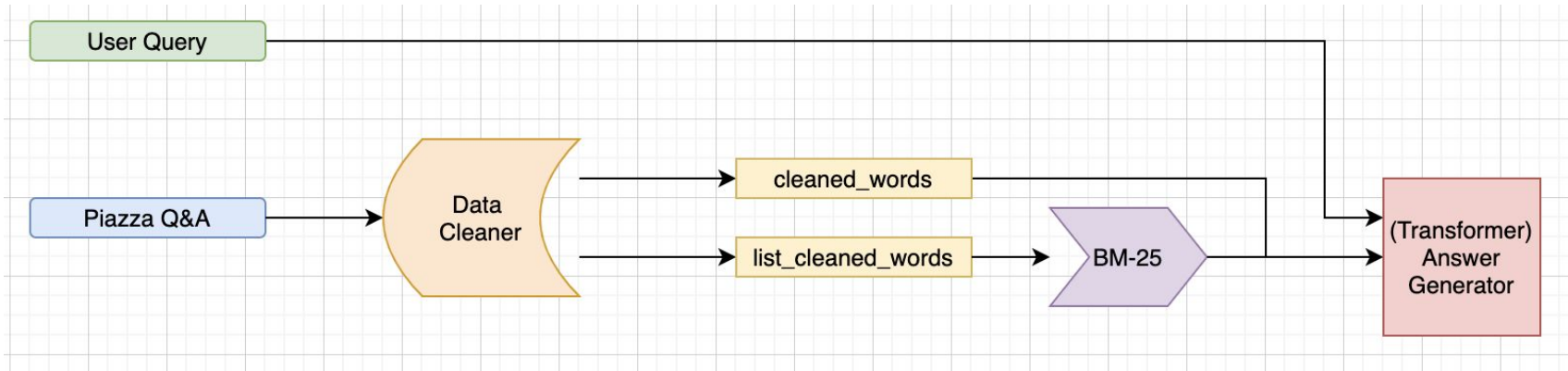
Write your message here



Backend Project Goals

- Improve the Chat-Bot's model to make it more efficient and effective
- Create an API to allow the Chatbot to communicate with the TutorJS React app
- Integrate human-readable error messages into TutorJS, and have the Chatbot help explain error messages

Chatbot Flowchart



Data Cleaning



Original: `<p>First-difference filter has the following input-output relationship:</p>`
`<p>$$y[n]=x[n]-x[n-1]$$</p>` `<p></p>` `<p>Its impulse response $$h[n]$$ is obtained when ...`

BM25 Algorithm

1. Remove HTML code
2. Remove stop words (commonly used words such as is, for, the, etc.)
3. Lowercase all words
4. Remove special characters
5. Remove Stemming (fixed => fix)
6. Remove punctuations
7. Normalization (he's => he is)
8. Tokenization (splitting sentences into list of words)

Output: [first, difference, filter, follow, input, output, relationship, etc.]

Transformer

1. Remove HTML code

Output: First-difference filter has the following input-output relationship: `$$y[n]=x[n]-x[n-1]$$` Its impulse response `$$h[n]$$` is obtained ...

BM25 (Search Engine)

- Behave similarly to a search engine
- Find top-n relevant document
- Works on the concept of TF/IDF

Question: What is a first-difference filter?

=> ['first', 'difference', 'filter']

	Score	content	list_clean_content
0	14.063737	<p>I don't understand how a first differen...	[first, difference, filter, not, understand, f...
1	12.287543	<p>What is difference between graph of first d...	[summer, 2016, final, 6, difference, graph, fi...
2	10.820964	<p>What's the difference visually between ...	[difference, visually, iir, lowpass, filter, a...
3	8.773553	<p>since, for filter #8, it is a high pass fil...	[lab, hw, since, filter, 8, high, pass, filter...
4	8.132891	<p>What is the difference between the notch fi...	[iir, nulling, filter, difference, notch, fiit...
5	7.383832	<p>When I try to run my xn through my first di...	[lab, 7, hw, 4, 2, b, try, run, xn, first, dif...
6	6.763801	<p>Could someone explain the difference betwee...	[hw, 6, could, someone, explain, difference, d...
7	6.763801	<p>Could someone explain the difference betwee...	[difference, spectrum, spectrogram, could, some...
8	6.568319	<p>Which difference equation does the matlab c...	[spring, 2018, final, 3c, difference, equation...
9	6.287750	What is the difference between C-to-D and A-to-D?	[terminology, difference, c]

Note: only useful columns are kept to showcase

Transformer (Answer Generator)

- Extract the answer from the top-n relevant documents
 - `clean_content_transformer` column
- Have a softmax score:
 - maximum value of 1
 - compare current answer to other answers
- Current pre-trained model: `ahotrod/electra_large_discriminator_squad2_512`

Question: What is a first-difference filter?

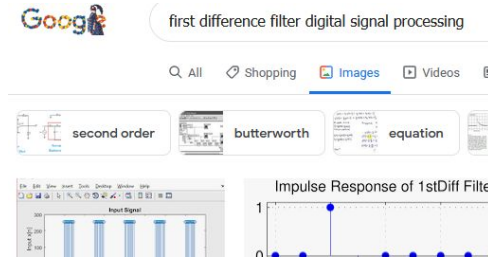
	<code>clean_question</code>	<code>clean_content_transformer</code>	<code>answer</code>	<code>softmax</code>
1496	First Difference Filters: I don't understand h...	First-difference filter has the following inpu... $y[n] = x[n] - x[n-1]$		1
225	Terminology: What is the difference between C-...	An A-to-D does two things to a continuous-time...	None	0
438	Spring 2018 Final 3c: Which difference equatio...	The \$\$\$'s come first. So $y_n = \text{filter}([1, 1], \dots$	None	0
1985	What's the difference visually between a IIR I...	The difference between an IIR and FIR lowpass ...	None	0
2169	Summer 2016 Final #6: What is difference betwe...	The role of filter E is nullifying the term wi...	None	0
4193	Difference between spectrum and spectrogram: Co...	A spectrum is a sketch you draw that in theory...	None	0
4439	Lab 7 HW 4.2 b: When I try to run my x_n throug...	<code>uint8</code> is a data type. You must first convert i...	None	0
4440	Lab 7 HW 4.2 b: When I try to run my x_n throug...	try using <code>conv</code> instead of <code>firfilt</code>	None	0
4659	LAB HW: since, for filter #8, it is a high pas...	You can do either method of either BPF with fi...	None	0
6087	HW 6: Could someone explain the difference bet...	For continuous periodic signal $x(t)$, its p...	None	0
6307	IIR Nulling Filters: What is the difference be...	I'm not sure about the $(1-z^{-1})(1+z^{-1})$...	None	0

Note: only useful columns are kept to showcase

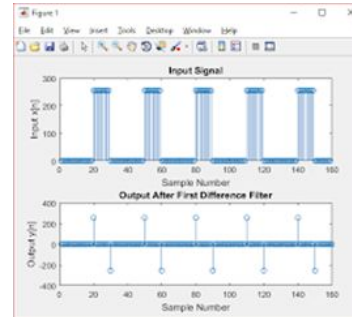
Web Scraping

- Use Selenium package
- Get top-n Google Image results
- Add “digital signal processing” at the end to improve search result
- Attempt to get the URL of the full resolution image first
 - If it does not load for 3 seconds, get the thumbnail image URL instead

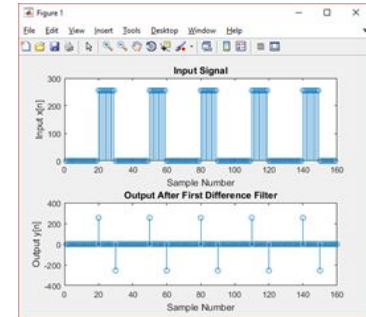
Question: What is a first-difference filter?



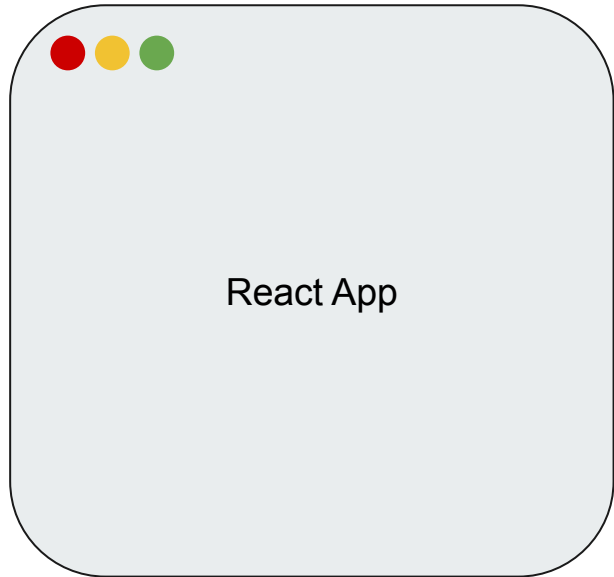
Thumbnail image



Full resolution image



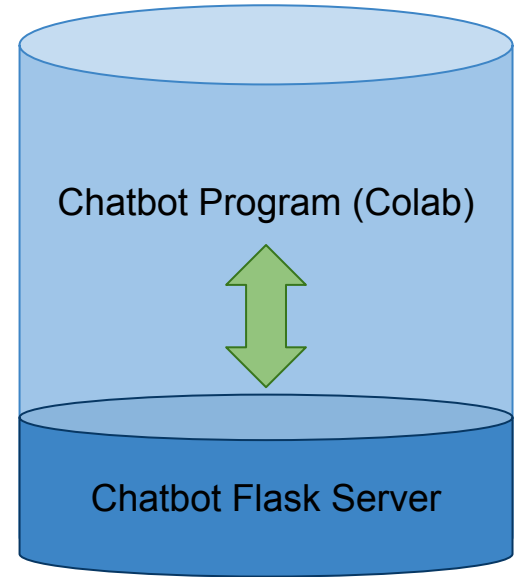
So how does this connect back to the React app?



No connection
between React app
and remote Colab
server



Use the Flask server
to send and receive
HTTP requests



API Endpoints

<http://cc4e-34-73-219-82.ngrok.io/get-list?msg=What is a first-filter difference?>

$$y[n] = x[n] - x[n-1]$$

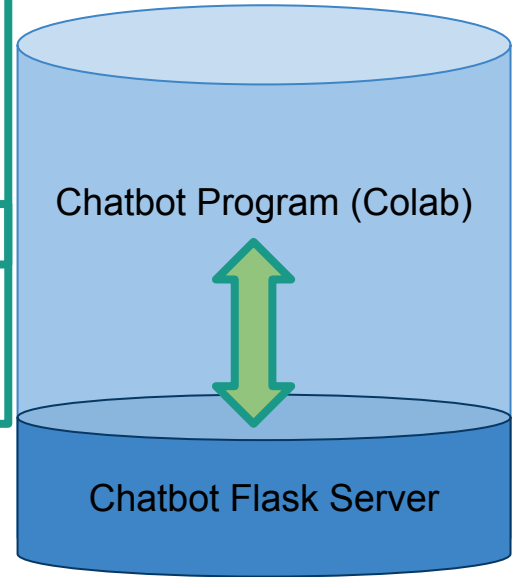
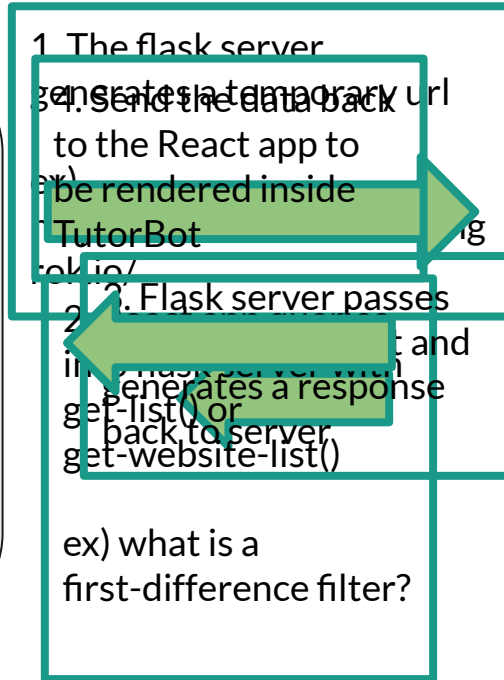
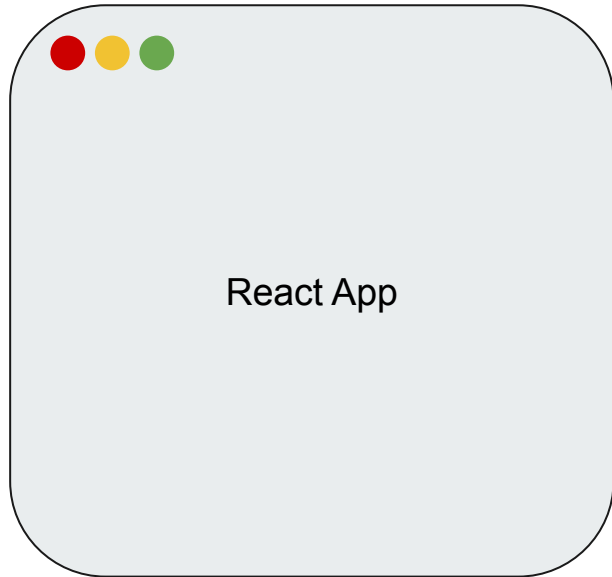
<http://cc4e-34-73-219-82.ngrok.io/get-website-list?msg=What is a first-filter difference?>

<https://d2vlcm61l7u1fs.cloudfront.net/media%2F95a%2F95aa15be-4ac1-454c-8140-c4d86ca37f2e%2FphpvQmXt4.png>,
http://dspfirst.gatech.edu/chapters/05fir/demos/tinvprop/graphics/impResp_1stDiff.png,
https://images.slideplayer.com/24/7050026/slides/slide_2.jpg

<http://cc4e-34-73-219-82.ngrok.io/get-qa?msg=What is a first-filter difference?>

```
{
  "answer": "First-difference filter has the following input-output relationship:  $y[n] = x[n] - x[n-1]$ . In MATLAB, its filter coefficient is  $[1, -1]$ .",
  "extracted_answer": "$ $ y [ n ] = x [ n ] - x [ n - 1 ] $ $",
  "question": "First Difference Filters: I don't understand how a first difference filter works. I know that  $y[n] = x[n] - x[n-1]$  and  $h[n]$  are correct, but I don't understand how the output signal is obtained."
},
{
  "answer": "The difference between an IIR and FIR lowpass filter can be best understood by comparing their frequency responses. FIR is represented by a finite number of coefficients, hence the peak response of an FIR filter would have sharper and well defined peaks.",
  "extracted_answer": null,
  "question": "What's the difference visually between a IIR lowpass filter and an FIR lowpass filter?"
},
```


Step by Step Procedure



Rendering in TutorBot

Custom ChatbotAnswer.js component with answer from chatbot server and images

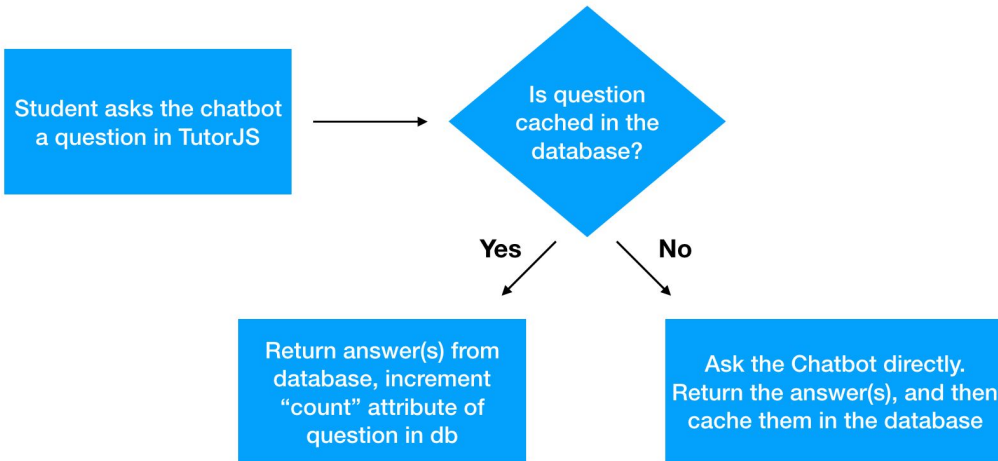
TutorBot component template from react-chatbot-kit library

Buttons to navigate between the various responses

The screenshot shows the TutorBot chat interface. At the top, the header reads "TutorBot". A message bubble labeled "B" contains the text "This is the textbook answer". Below this is a content block titled "collapse content" which displays a diagram titled "Digital Signal Processing". The diagram illustrates the flow of an analog signal through an Analog-to-Digital Converter (ADC) to produce incoming samples (0x00, 0x1A, 0x12, 0xAF, etc.), and then through a Digital-to-Analog Converter (DAC) to produce outgoing samples (0x00, 0x23, 0xCF, 0x78, etc.) after being processed by a microprocessor. The diagram includes two graphs: one for the analog signal and one for the digital waveform. At the bottom of the content block are two sets of navigation buttons: "<-- other answers -->" and "<-- other images -->". The chat input area at the bottom contains the text "Write your message here" and a send button with a paper plane icon. A small "open/close" button is located at the very bottom left of the interface.

Database Cache

TutorBot API Flowchart



```
_id: ObjectId("61ab9309d656c75cd19f5603")
question: "what is a first-difference filter?"
✓ answer: Array
  ✓ 0: Object
    _id: ObjectId("61ab9309d656c75cd19f5604")
    answer: "First-difference filter has the following input-
    extracted_answer: "$ $ y [ n ] = x [ n ] - x [ n - 1 ] $"
    question: "First Difference Filters: I don't understand h
  > 1: Object
  > 2: Object
  > 3: Object
  > 4: Object
count: 3
__v: 0
```



Human Readable Error Messages Implementation

- Updated human readable error messages from last semester to be more intuitive based on further research
- Implemented basic functionality within Chatbot

TutorBot

What is an ArithmeticException?

B Here is what I know:

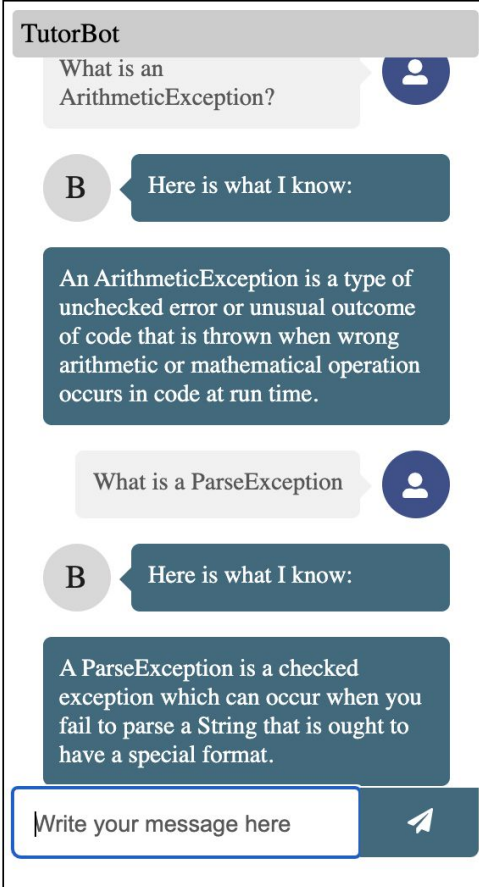
An ArithmeticException is a type of unchecked error or unusual outcome of code that is thrown when wrong arithmetic or mathematical operation occurs in code at run time.

What is a ParseException?

B Here is what I know:

A ParseException is a checked exception which can occur when you fail to parse a String that is ought to have a special format.

Write your message here



Plans for Future Semesters



- Create a pipeline
 - Able to add more json file down the line
 - Make the Chatbot easily callable
- Add “use_gpu” parameter
 - cuDF for DataFrame
 - PyTorch GPU for the Transformer (extracting answers)
- AWS integration
 - Permanent query url
 - Faster processing
- Analyze chatbot cache data
 - Collect more data points in the cache
 - Analyze the data to understand what students get stuck on
- Make more intuitive human readable error messages that Chatbot outputs
 - Use the stacktrace from console to give more personalized human readable error messages

Demo