

MathWorks
**AUTOMOTIVE
CONFERENCE 2023**
India

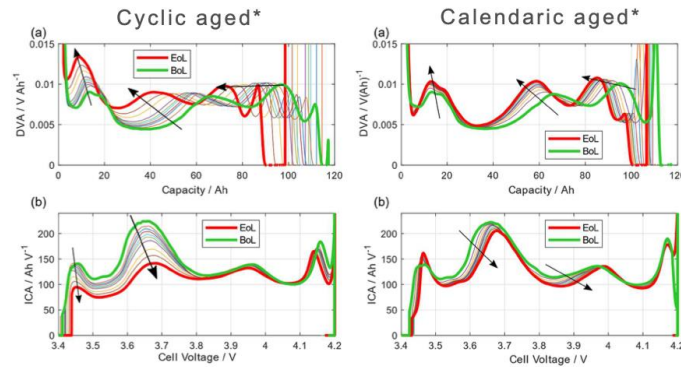
ChatGPT and Large Language Models with MATLAB

Prashant Rao, MathWorks



AI is making its way into all stages of bringing vehicles to market

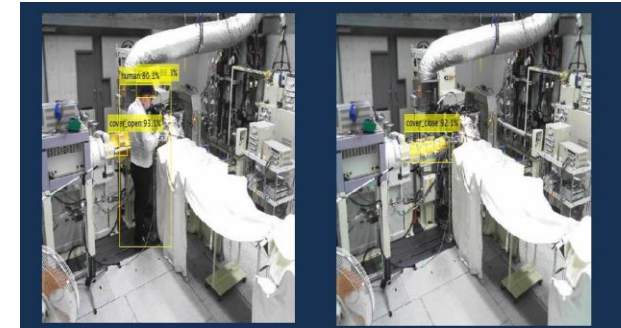
R&D



Gotion

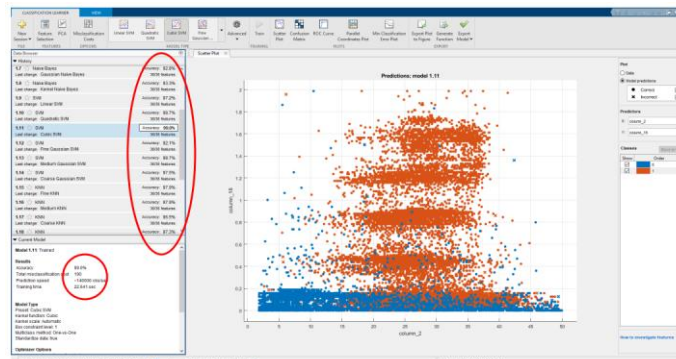
Battery SOH Estimation

Manufacturing



Toyota

Predictive maintenance of engine bench



PathPartner

Radar-based automotive packages



Daihatsu

Engine knock detection

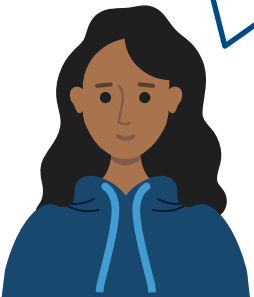
Disruptive AI technology: ChatGPT

How is it going to change R&D?

Example:

ChatGPT Integration in automotive

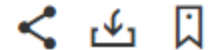
What activities can I do at the beach ... or in Bangalore traffic?



Mercedes-Benz tests ChatGPT in intelligent vehicle production

Stuttgart, July 06, 2023

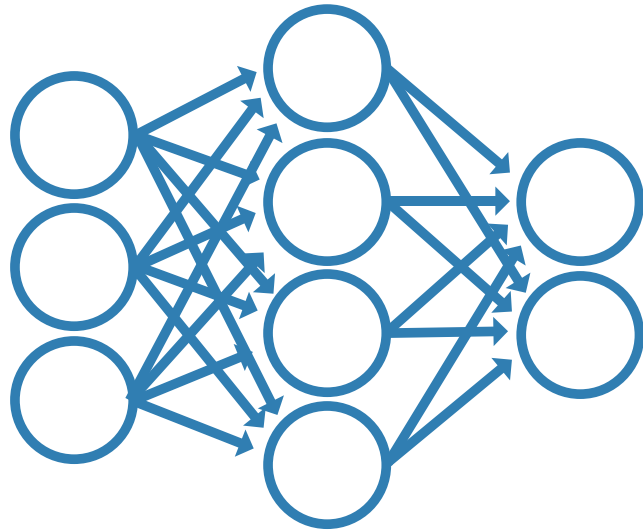
3 Pictures | 2 Documents



"... ChatGPT can additionally support Mercedes-Benz quality engineers in identifying faults by clustering data. For example, with the help of ChatGPT, complex evaluation and presentations of production-relevant data and quality management are significantly simplified for employees.... "

<https://media.mercedes-benz.com/article/dd57aac5-7911-48bb-b61a-7c3d54cdfdf>

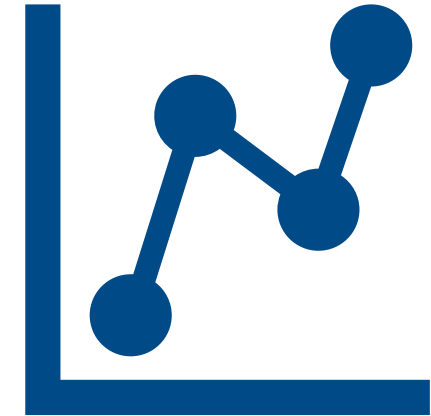
What are Large Language Models?



Large language models (or LLMs) are a type of artificial intelligence model



Trained on huge amounts of data



Networks with millions to trillions of parameters

But wait, what is it?



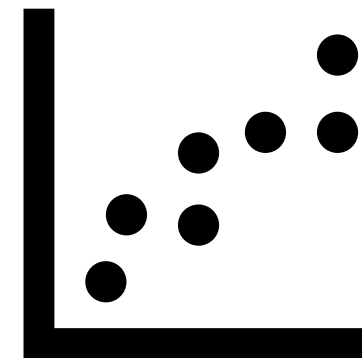
- It's an AI chatbot, developed by OpenAI
- Built on GPT-3.5 and GPT-4, focused on human alignment
- GPTs are generative pre-trained transformers, a type of *large language models*

LLMs generate output word by word

What is the next word?

Accelerating the pace of engineering and science
with tech plus research
of innovation and knowledge
then engineering or science

They do not understand text
in the way humans do.



They recognize patterns in the data
they were trained on.

Being trained on next word prediction results in impressive functionality

- **Grammar**

When I get home, I like to do some {reading, *banana*}

- **World Knowledge**

The capital of Brazil is {Brasília, *Buenos Aires*}

- **Sentiment Analysis**

That movie was very boring, it was quite {bad, *good*}

- **Math**

First grade arithmetic exam: $3 + 8 + 4 = \{15, 11\}$

- **Programming**

```
while (x<100)
    x = x * 3;
{end, for}
```

But some things cannot be learned in that way

- **Current world knowledge**

MathWorks is hosting the MATLAB Automotive Conference 2023.

The event will happen at ???

- **Long arithmetic**

$12698681629350158454873 + 632359246225445775100 = ???$

- **Predict the future**

The team that will win the 2023 Cricket World Cup is ???

There are still many limitations with Large Language Models

Models can hallucinate



How can I tokenize text in MATLAB?

If you need help with
your software, talk to us!

Function does not exist!



In MATLAB, you can tokenize text by using the `tokenize` function, which is available starting from MATLAB R2017a. The `tokenize` function splits a string into individual tokens based on a specified delimiter. Here's an example of how you can use it:

```
matlab Copy code  
  
str = 'Hello, how are you today?';  
delimiter = ' ,.?'; % Specify the characters to be treated as delimiters  
tokens = tokenize(str, delimiter);
```

Output is not always reliable



Translate the following code from MATLAB to C:

```
A = [1, 2; 3, 4];  
[eigVec, eigVal] = eig(A);
```

You will not have
this problem with
MATLAB Coder!

Code does not compile!



Here's the equivalent code in C:

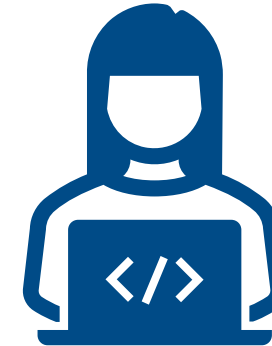
```
c Copy code  
  
#include <stdio.h>  
#include <stdlib.h>  
#include <math.h>  
  
void matrix_eig(double *A, int n, double *eigVec, double *eigVal);  
  
int main() {
```

What Large Language Models are great at...

Natural Language Understanding



Generating text and code



LLMs can help you solve specific problems

Generate Text

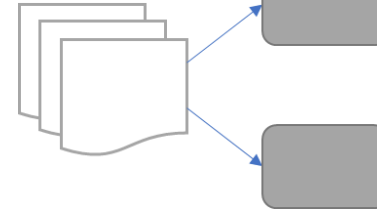


Write Code

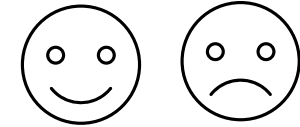


Document

Classify Text

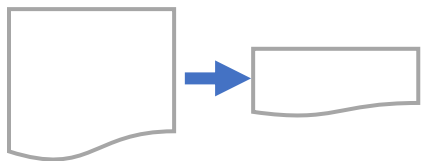


Classify Maintenance Documents

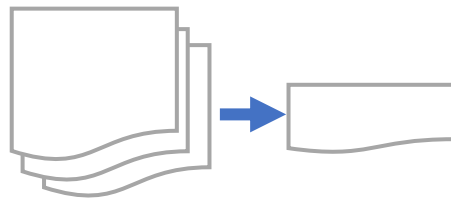


Analyze Sentiment

Summarize



One document

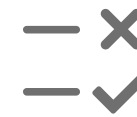


Multiple documents

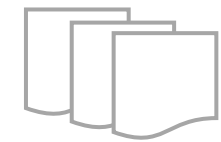
Retrieve Information



Scientific Discovery

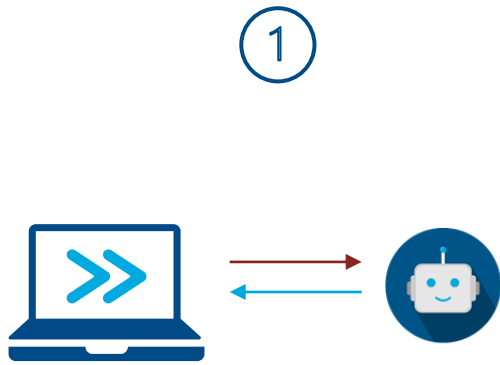


Requirements for design & engineering

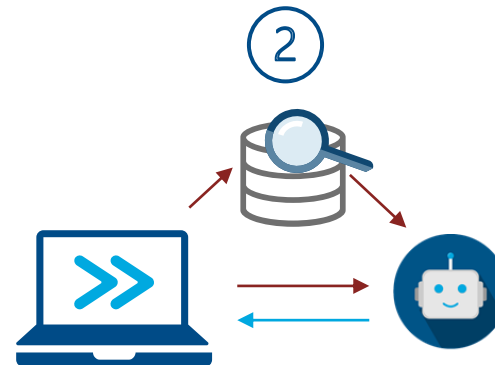


Knowledge from internal documents

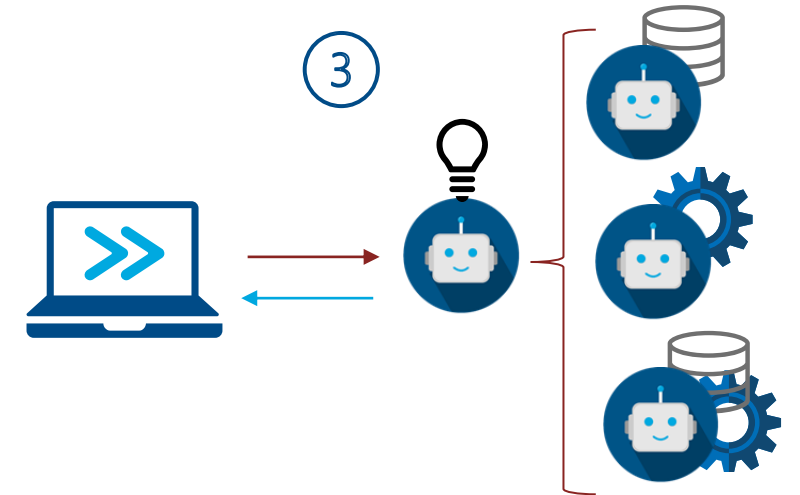
Approaches for leveraging LLMs



Prompt Engineering



Retrieval-Augmented Generation



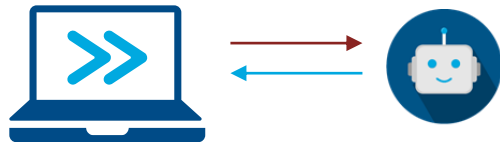
Fine-tuning

For some things it's just easier to use the chat interface...



Generate MATLAB code to compute the sine of values between 1 and 30. The code should be optimized and use vectorization. Let's think step-by-step.

Prompt engineering is the process of crafting and refining inputs to an AI model to guide its output.



Sure! Here's the MATLAB code that computes the sine of values between 1 and 30 using vectorization:

matlab

Copy code

```
% Define the range of values
startValue = 1;
endValue = 30;

% Generate the values within the range
x = startValue:endValue;

% Compute the sine of the values using vectorization
y = sin(x);

% Display the results
disp(y);
```

For other things, you might want to use ChatGPT programmatically



① Copy and paste each document individually into the chat interface.

② Ask ChatGPT for a summary

③ Copy and paste the result into another file



Summarize...

...



① Read each file inside MATLAB in a loop

② Request the ChatGPT API for a summary for each document

③ Automatically save each summary to a file

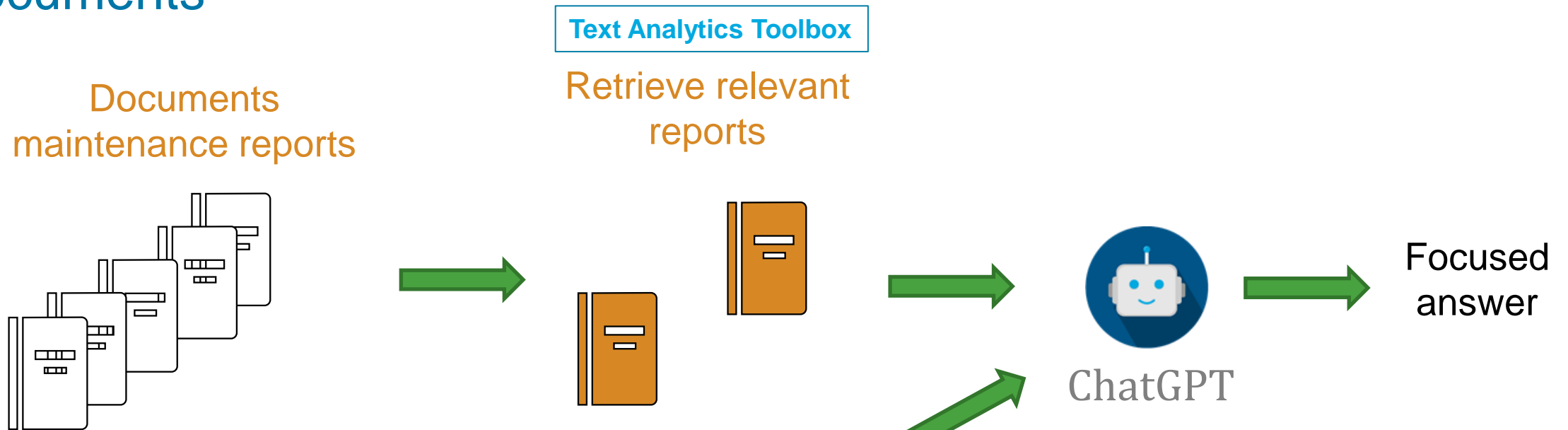


Design notes



If there is repetition, there is potential for automation via MATLAB

Retrieval-Augmented Generation (RAG) to ask questions about your documents

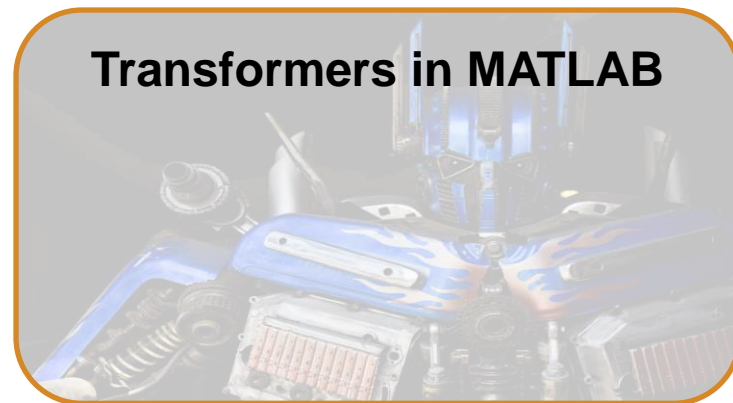


Query: Model XYZ had a faulty spark plug,
what should I do?

Use RAG when you
want to tailor the
model's output to
your own data!

Fine-tuning Large Language Models

For domain-specific text, you might want to fine-tune (adapt) a model to your own data.



R2020a

Fine-tuning a large model requires parameter efficient fine-tuning techniques.

AI Chat Playground

Playground

Hello! Whether you're checking out MATLAB for the first time or years, I'm here to answer your questions and provide coding tips

✓ Ran in R2023a

DF Deborah Ferreira

How can I compute the eigenvalues for a matrix?

AI



To compute eigenvalues for a matrix in MATLAB, you can use the `eig()` function. Here's an example code.

```
A = [1 2; 3 4];
eigenvalues = eig(A);
disp(eigenvalues);
```

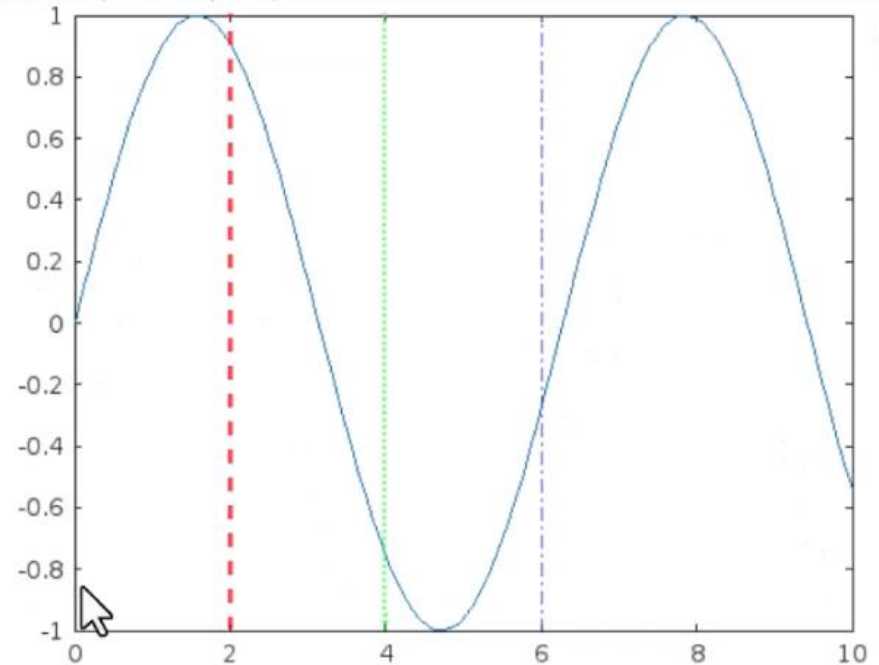
This will output the eigenvalues for matrix A. What happens when you try to compute eigenvalues for a non-square matrix?

How can you verify the correctness of your code?

Send a message...



Generated code and text might be inaccurate. Validate before use.



```
A = [1 2; 3 4];
eigenvalues = eig(A);
disp(eigenvalues);
```

```
-0.3723
 5.3723
```

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Thank you



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AI Chat Playground

