

# Text Summarization



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*Intern: Mohan Krishna G R*

*Group: 4*



# Introduction

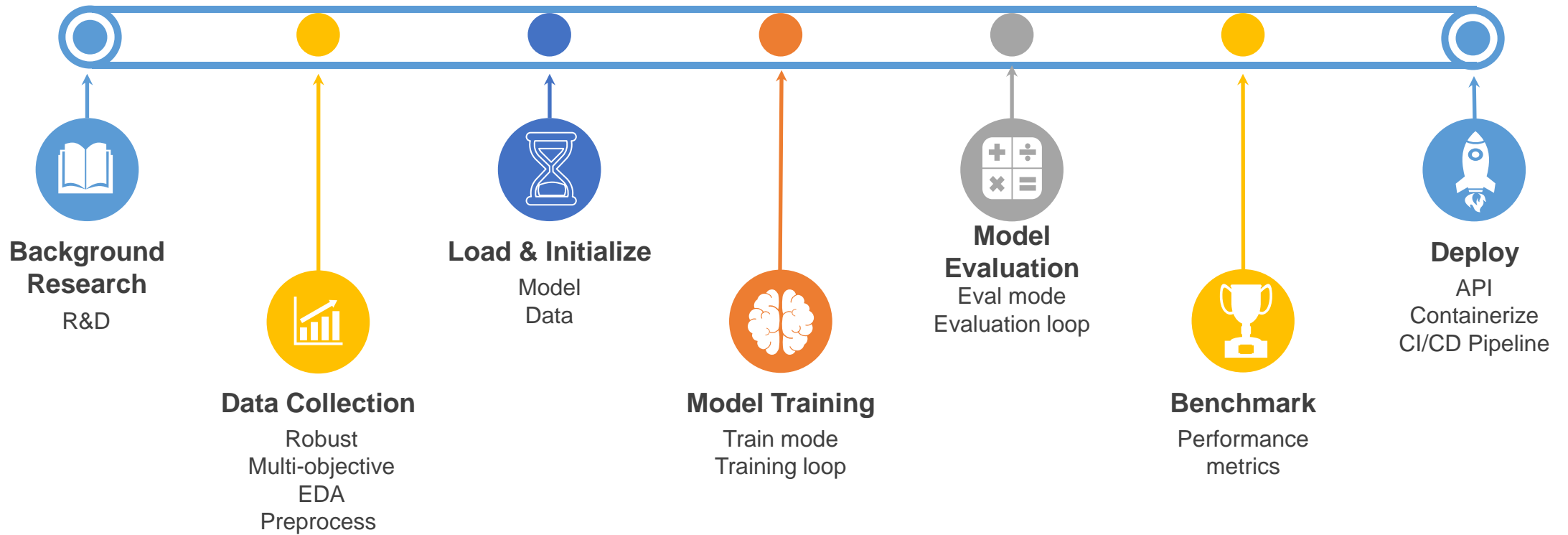
## Problem Statement & Planning

# Introduction

## Problem Statement

- Developing an automated text summarization system that can accurately and efficiently condense large bodies of text into concise summaries is essential for enhancing business operations.
- This project aims to deploy NLP techniques to create a robust text summarization tool capable of handling various types of documents across different domains.
- The system should deliver high-quality summaries that retain the core information and contextual meaning of the original text.

# INTENDED PLAN



# Background Research

## Literature Review & Findings

# Background Research

## Literature Review

S. No	Use-Case	Paper Title	Year	Method	Dataset	Results	Limitations
1	General text summarization	Text Summarization Using Deep Learning Techniques: A Review	2023	Deep Learning (Seq2Seq, Attention, Transformers)	CNN/Daily Mail, XSum	Improved performance in capturing semantic relationships, better coherence	Computationally expensive, requires large datasets

[1] Saiyyad, M.M.; Patil, N.N. "Text Summarization Using Deep Learning Techniques: A Review". Eng. Proc. 2023, 59, 194.

# Background Research

## Literature Review

S. No	Use-Case	Paper Title	Year	Method	Dataset	Results	Limitations
2.	Implementation of the Transformer architecture	Attention is all you need	2023	Transformer	WMT 2014 English-German, WMT 2014 English-French	Introduced the Transformer architecture, significantly improving the performance of text summarization tasks.	Requires large datasets and computational resources for training.

[2] A. Vaswani, L. Jones, N. Shazeer, N. Parmar, A. N. Gomez, J. Uszkoreit, Ł. Kaiser, and I. Polosukhin, "Attention Is All You Need," arXiv:1706.03762v7 [cs.CL], Aug. 2, 2023.

# Background Research

## Literature Review

S. No	Use-Case	Paper Title	Year	Method	Dataset	Results	Limitations
3.	Multi-document summarization	Surveying the Landscape of Text Summarization with Deep Learning	2023	Deep learning methods.  Various techniques like RBMs and fuzzy logic employed for summarization.	CNN/Daily Mail	Incorporating transfer learning enhances summary quality and reduces data demand.	Complex models, high computational resources

[3] G. Wang and W. Wu, "Surveying the Landscape of Text Summarization with Deep Learning: A Comprehensive Review," arXiv:2310.09411v1 [cs.CL], Oct. 13, 2023.



# Background Research

## Literature Review

S. No	U4se-Case	Paper Title	Year	Method	Dataset	Results	Limitations
4.	Abstractive summarization	Pegasus: Pre-training with gap-sentences for abstractive summarization	2020	Transformer (Pegasus)	XSum, CNN/Daily Mail, and Reddit TIFU	Significant improvements in abstractive summarization quality	Resource-intensive

[4] J. Zhang, Y. Zhao, M. Saleh, and P. J. Liu, "PEGASUS: Pre-training with Extracted Gap-sentences for Abstractive Summarization," arXiv:1912.08777v3 [cs.CL], Jul. 10, 2020.

# Background Research

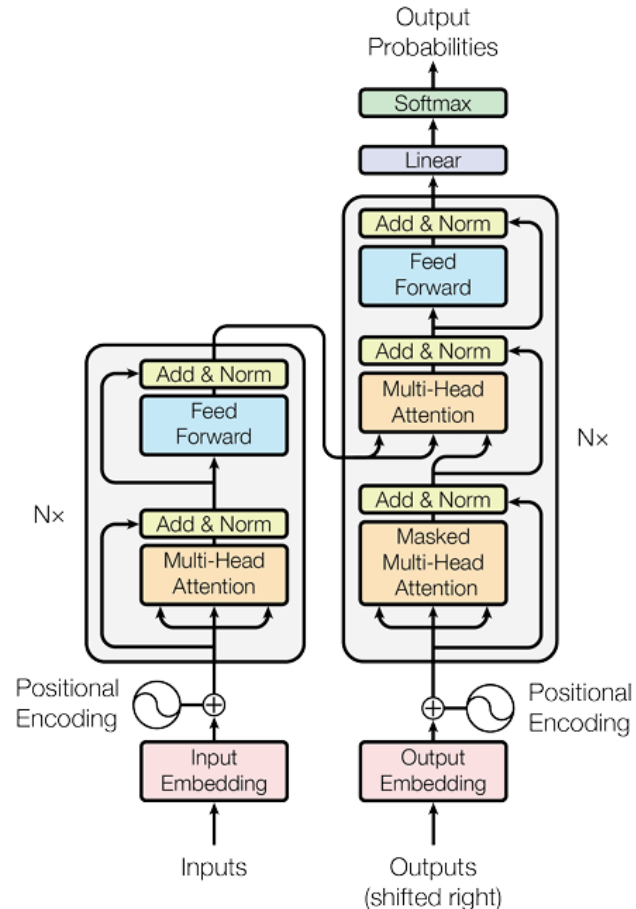
## Literature Review

S. No	Use-Case	Paper Title	Year	Method	Dataset	Results	Limitations
5.	Extractive summarization	Text Summarization with Pretrained Encoders	2019	Intersentence Transformer layers for summarization	CNN/Daily Mail, NYT, Xsum, DailyMail	BERT-based models outperformed other approaches in abstractive summarization.	High computational resources required

[5] Y. Liu and M. Lapata, "Text Summarization with Pretrained Encoders," arXiv:1908.08345v2 [cs.CL], Sep. 5, 2019.

# Research

## Selected Architecture



[2] Fig. :Transformer architecture:

- **Implementation methods:**

- *From Scratch*

- Build Model
  - NN
- Initialize normalized W&B
- Train model with extensive data
- Hence,
  - Computationally Intensive
  - Sub-Optimal usage of resources
  - Out-of-scope

- *Using Pre-trained model*

- Load Model & its parameters
- Re-Train with specific dataset
- Evaluate
- Hence,
  - Innovation can be done at intended tasks
  - Optimal utilization of resources

# Proposals

# Proposal Workflow

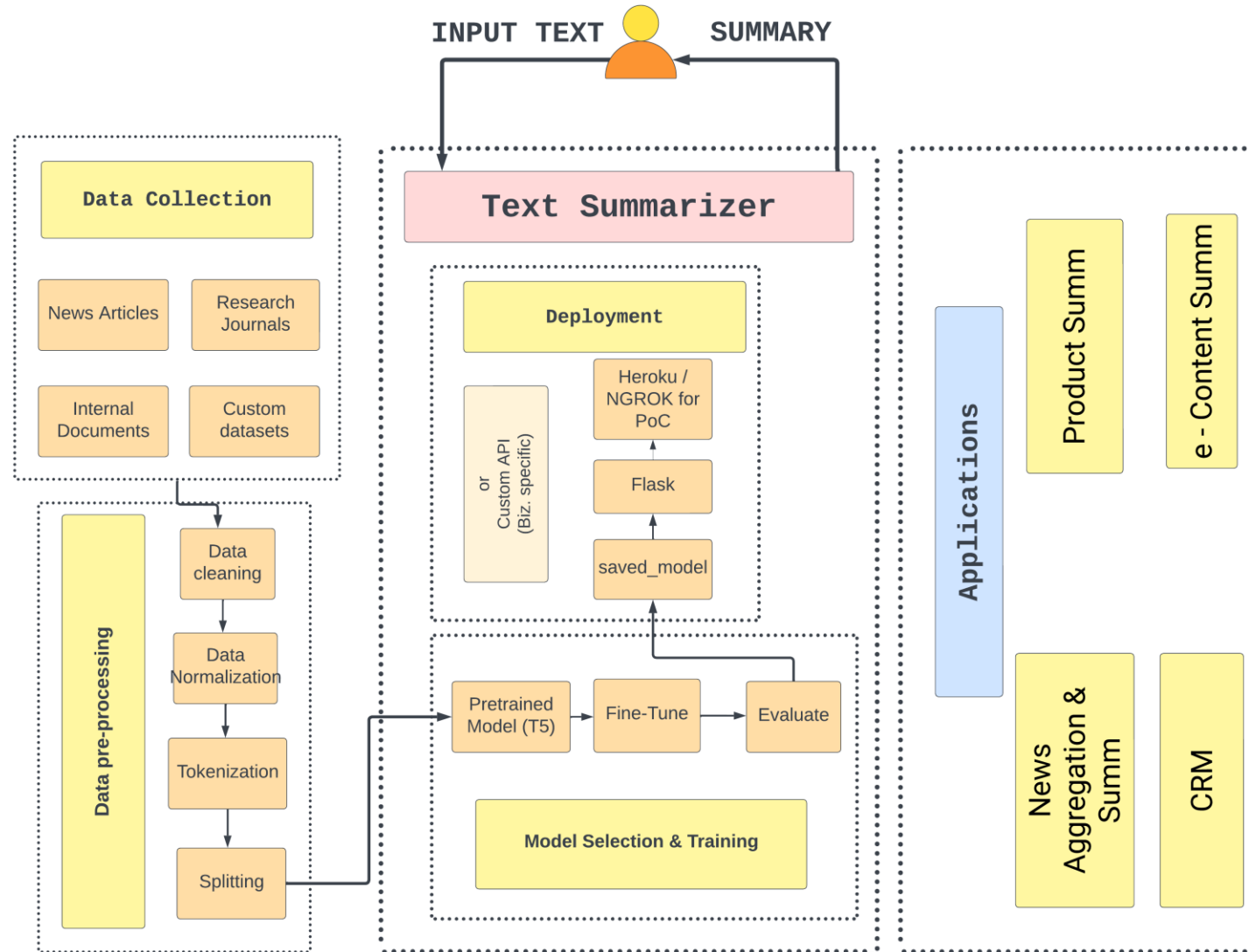


Fig. : Proposed Workflow

# Proposal

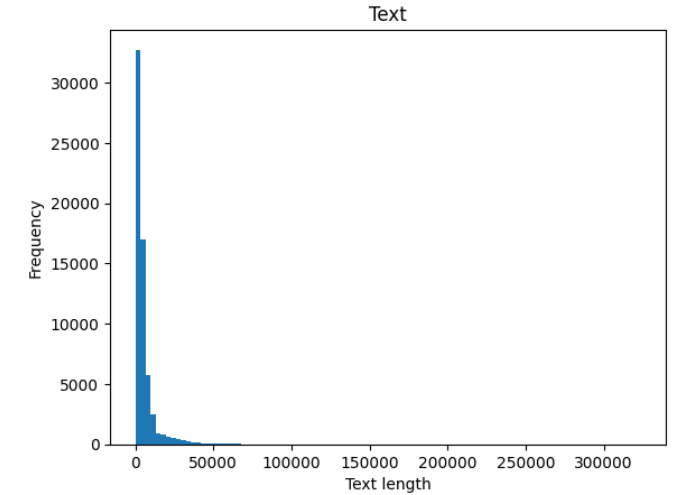
## Dataset

- Merged selective dataset from
  - CNN, Daily Mail : News,
  - BillSum: Legal,
  - ArXiv : Scientific
  - Dialoguesum : Conversations.
- Completed - data preprocessing
  - Removed
    - NULL records, punctation, stop-words
  - Lowercasing, lemmatization.

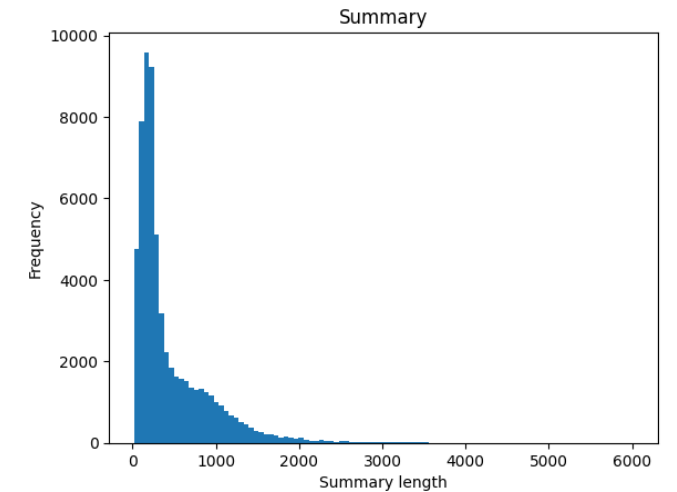
	text	summary
0	section 1 liability business entity providing ...	shield business entity civil liability relatin...
1	section 1 short title act may cited human righ...	human right information act requires certain f...
2	section 1 short title act may cited jackie rob...	jackie robinson commemorative coin act directs...
3	section 1 nonrecognition gain rollover small b...	amends internal revenue code provide temporari...
4	section 1 short title act may cited native ame...	native american energy act sec 3 amends energy...
...	...	...
62702	person1 excuse mr green manchester arent perso...	tan ling pick mr green easily recognized white...
62703	person1 mister ewing said show conference cent...	person1 person2 plan take underground together...
62704	person1 help today person2 would like rent car...	person2 rent small car 5 day help person1
62705	person1 look bit unhappy today whats person2 w...	person2s mom lost job person2 hope mom wont fe...
62706	person1 mom im flying visit uncle lee family n...	person1 asks person2s idea packing bag visitin...

62707 rows × 2 columns

```
count    62707.000000
mean      5211.270975
std       7794.860686
min        83.000000
25%      1275.000000
50%      3176.000000
75%      5684.500000
max     323742.000000
Name: text, dtype: float64
```



```
count    62707.000000
mean      448.081937
std       459.087443
min        16.000000
25%       154.000000
50%       255.000000
75%       618.000000
max     6014.000000
Name: summary, dtype: float64
```



\* In characters.

[https://drive.google.com/drive/folders/1yH89iZmARdc-R7QY6pwfE8tbOJI\\_n9K8?usp=sharing](https://drive.google.com/drive/folders/1yH89iZmARdc-R7QY6pwfE8tbOJI_n9K8?usp=sharing)  
[Infosys\\_Text-Summarization/src/data\\_preprocessing.ipynb](#) at main · MohanKrishnaGR/Infosys\_Text-Summarization (github.com)

# Proposal

## Model Training



Fig. : Fine-Tuning Overview

- Proposed implementation – Two – 2 Methods
  - Method 1 – Native PyTorch Method
  - Method 2 – Trainer Class Method

# Proposal

## Model Training (Method 1)



Hugging Face

PyTorch

- Load pre-trained transformer
  - Facebook's Bart Large
- OOP implementation of Dataset
  - Feature, Target
  - Tokenize
  - Padding, Truncate
  - Convert to Tensor
  - Pass to: DataLoader – with batch size
- Training Loop
  - Adam optimizer
  - Forward pass & compute loss
  - Backward pass
  - Update params – compute gradient
  - Update LR
  - Zero the gradients
  - Update total loss
- Only minimal train loss of 1.3280.
  - But, produced inconsistent results.
  - Cannot be pushed into production.
- Raises the need for optimized training and eval loop for Transformer.

```
import pandas as pd
from torch.utils.data import Dataset, DataLoader
from transformers import BartTokenizer

class SummarizationDataset(Dataset):
    def __init__(self, file_path, tokenizer, max_length=512):
        self.data = pd.read_csv(file_path)
        self.tokenizer = tokenizer
        self.max_length = max_length

    def __len__(self):
        return len(self.data)

    def __getitem__(self, idx):
        text = self.data.iloc[idx, 0]
        summary = self.data.iloc[idx, 1]

        inputs = self.tokenizer.encode_plus(
            text,
            max_length=self.max_length,
            padding='max_length',
            truncation=True,
            return_tensors='pt'
        )

        targets = self.tokenizer.encode_plus(
            summary,
            max_length=self.max_length,
            padding='max_length',
            truncation=True,
            return_tensors='pt'
        )

        return [inputs, targets]
```

Fig. : Screenshot



# Proposal

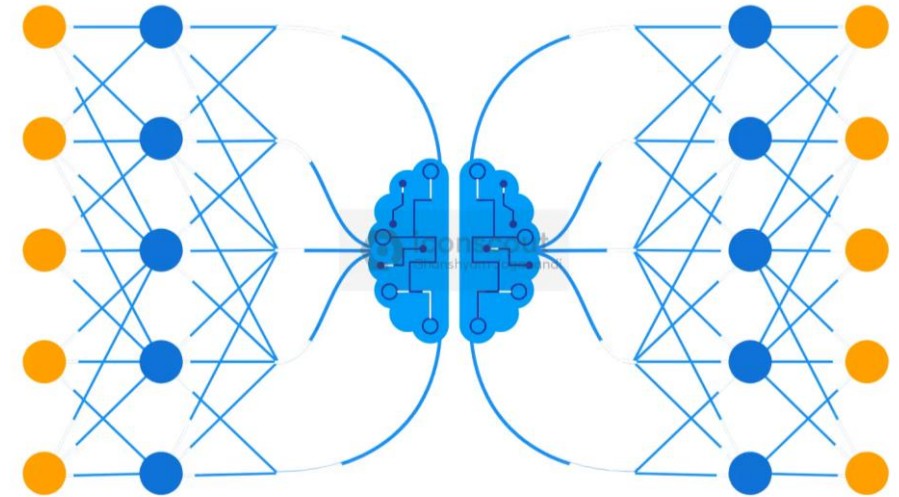
## Model Training (Method 2)

- Trainer Method
- Implemented in src/bart.ipynb.
- A function was implemented for the dataset, to convert text data into model inputs and targets.
- Trainer class from transformer package was utilized for training and evaluation. Tainer is a simple but feature-complete training and eval loop for PyTorch, optimized for transformers.
- The model was trained with whole dataset for 10 epochs for 26:24:22 (HH:MM:SS) in 125420 steps.
- Training Loss = 17.4700
- Considered the performance metrics of the models trained by the forementioned methods. After the due analysis, the model trained using 'Method 2' was selected.



Hugging Face

PyTorch



[Infosys\\_Text-Summarization/src/bart.ipynb at main · MohanKrishnaGR/Infosys\\_Text-Summarization \(github.com\)](#)

[https://drive.google.com/drive/folders/1tNdLI67UTc5es6VB\\_dml8b5gkRUWzupl?usp=drive\\_link](https://drive.google.com/drive/folders/1tNdLI67UTc5es6VB_dml8b5gkRUWzupl?usp=drive_link)

# Proposal

## Model Validation

- Performance metrics – **ROUGE** (Recall-Oriented Understudy for Gisting Evaluation)
  - Overlap between generated summary and reference summary.
  - Best suited : evaluating 'Text Summarization' tasks.
  - Other options : **BLEU**.
- ROUGE-N: Measures the overlap of n-grams (contiguous sequences of n items) between the candidate summary and the reference summaries.
  - **ROUGE-1:**
    - Overlap of unigrams (single words).
  - **ROUGE-2:**
    - Overlap of bigrams (two-word sequences).
  - **ROUGE-L:**
    - Measures the longest common subsequence (LCS) between the candidate and reference summaries.
  - **ROUGE-LSUM**
    - (LCS Summary) - variant of the ROUGE-L metric, specifically designed to evaluate the quality of summaries.
- Aimed to: implement custom evaluation function, using ROUGE based on model's inference.



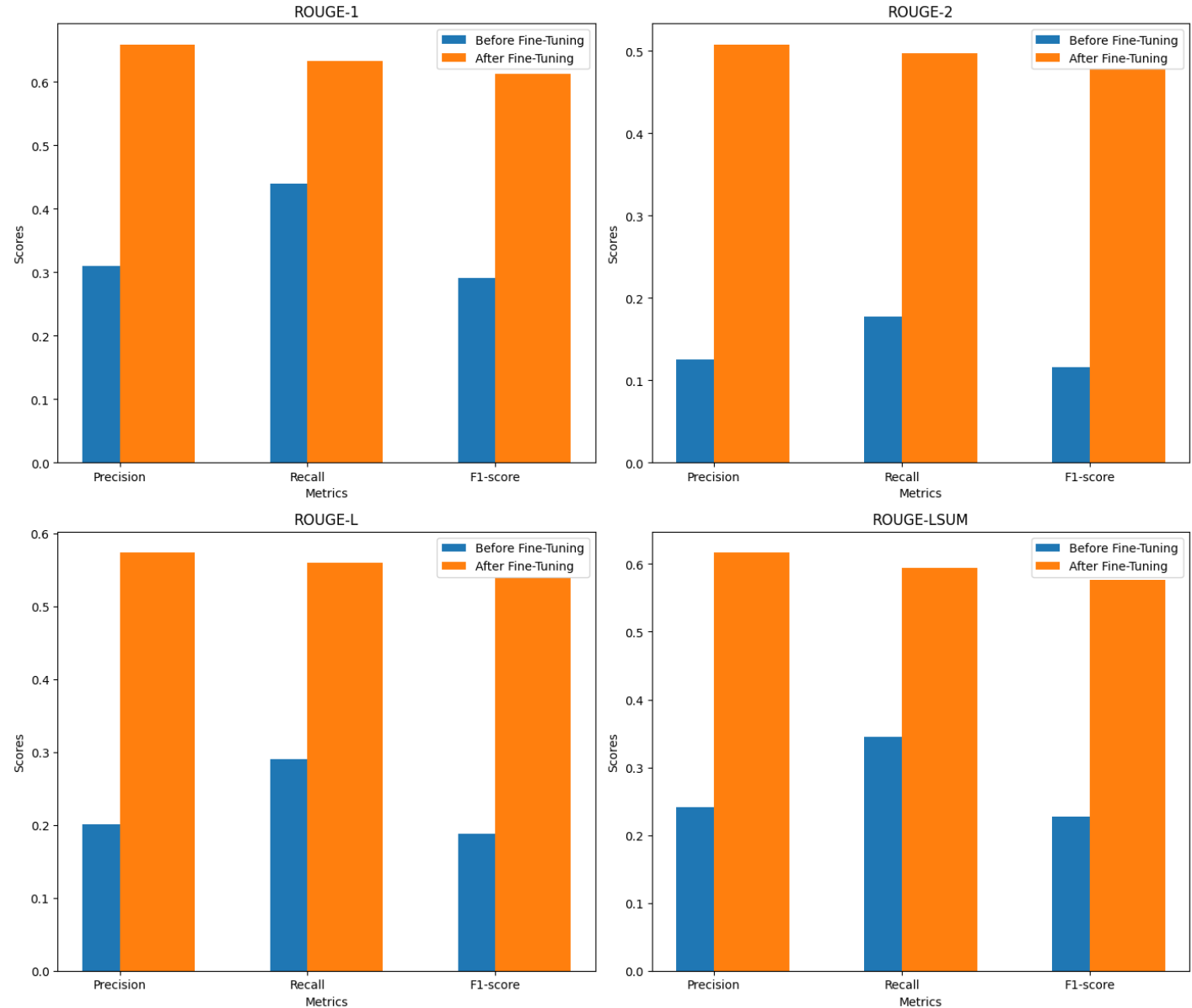
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[Infosys\\_Text-Summarization/src/roque.ipynb at main · MohanKrishnaGR/Infosys\\_Text-Summarization \(github.com\)](#)

# Proposal

## Comparative Analysis

- Analysis of the transformer's performance metrics before and after Fine-Tuning.
- The transformer model shows significant improvements across all ROUGE metrics after fine-tuning.
- The most substantial gains observed in ROUGE-2 scores. (F1-score=61.32)
- This indicates that the fine-tuning process has notably enhanced the model's ability to generate more accurate and relevant summaries.
- The model is now more proficient at generating summaries that are precise, comprehensive, and contextually accurate.
- Will act as a powerful tool for a variety of Business applications that require efficient and effective text summarization.



# Proposal Testing



**Infosys Springboard - Text Summarizer**

A simple and efficient text summarizer. Enter your text in the box below and get a concise summary.

Input text

At least 49 migrant workers, including around 40 Indian citizens, have died in a deadly fire that devastated a building in Kuwait's southern district of Al-Mangaf. The fire that broke out in the apartment building located in Kuwait's Al Ahmadi Governorate early on Wednesday also left more than a dozen injured, who were admitted to nearby hospitals, reported the Kuwait News Agency (KUNA). Prime Minister Narendra Modi and External Affairs Minister S. Jaishankar expressed shock over the incident, and Congress leader Rahul Gandhi expressed 'serious concern' about the condition of Indians in the Gulf region.

"My thoughts are with all those who have lost their near and dear ones. I pray that the injured recover at the earliest. The Indian Embassy in Kuwait is closely monitoring the situation and working with the authorities there to assist the affected," said Mr. Modi in a message. Mr. Modi held a review meeting on Wednesday evening about the condition of the affected Indians in Kuwait. He deputed Minister of State for External Affairs Kirti Vardhan Singh to oversee the help being rendered to the injured and to bring back the remains of the Indians who perished in the incident.

Indian ambassador to Kuwait Adarsh Swaika visited the Mubarak Al-Kabeer Hospital where 11 injured workers were admitted. "Ten of them are expected to be released today and one in hospital is reportedly stable," the Indian embassy said in a statement. The Government of Kuwait has not made any statement officially so far, but Interior Minister Sheikh Fahad Al-Yousuf Al-Sabah has ordered the police to arrest the owner of the building located in Al-Mangaf.

The incident has highlighted the poor living conditions of blue-collar Indian workers in the region.

Clear Submit

Summarized Text

Fire broke out in apartment building located in Kuwait's Al Ahmadi Governorate early on Wednesday. At least 49 migrant workers, including around 40 Indian citizens, have died in the blaze. The Indian embassy in Kuwait is monitoring the situation and working with the authorities there to assist the affected people.

Flag

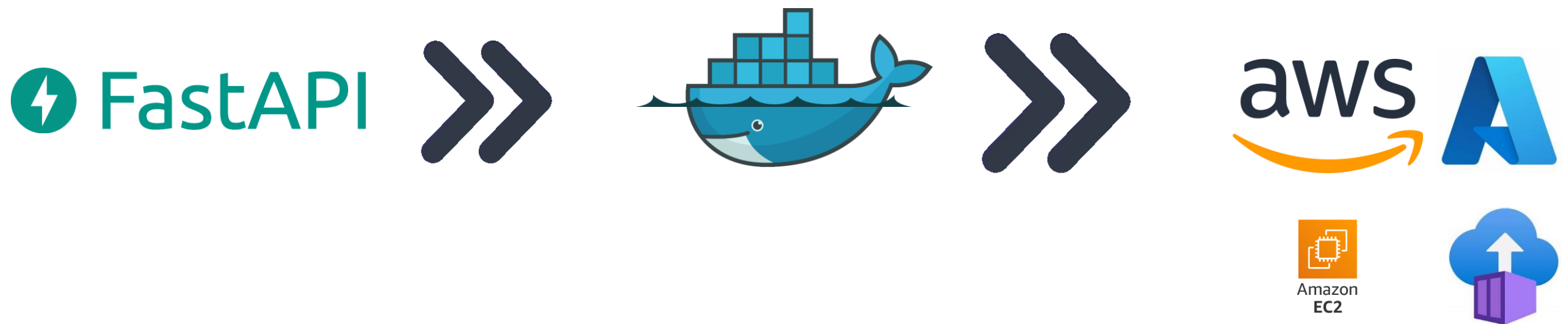
Powered by Infosys Springboard Intern. Let's connect, [LinkedIn](#).

- Simple interface for the Deep Learning model, developed using Gradio.
- Gradio is an open-source Python package that allows us to quickly build a demo - web-application for the trained models.
- Enables us to test and even deploy the trained model.

[Infosys\\_Text-Summarization/src/interface.ipynb](#) at main · MohanKrishnaGR/Infosys\_Text-Summarization (github.com)

# Proposal

## Deployment



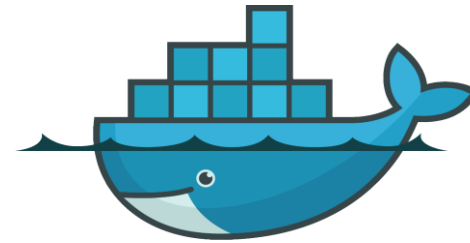
# Proposal

## Deployment



- Implemented extractor modules for text extraction from URL, PDF, docx.
- Defined the API endpoints. (FastAPI)
  - Accepts: Text, URL, Files (PDF, docx)
  - Returns:
    - Abstractive & Extractive Summary
- Utilized 'jQuery' for a dynamic webpage.

- Containerized the entire application along with the deep-learning models.
  - Built the image & Pushed into docker hub.



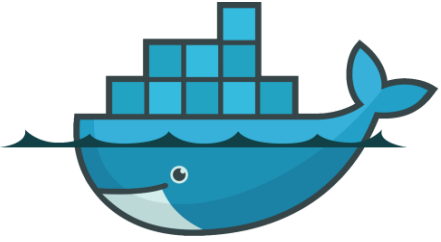
- Deployed the docker image using AWS EC2
- Integrated with GitHub actions – CI/CD pipeline
- Drawback = Less computation for free-tier plan (t2.micro)

- Deployed the docker image using Azure Container Instance
- Integrated with GitHub actions – CI/CD pipeline
- Advantage = 4 CPU cores for Free Trail



# Proposal

## Deployment - Ref. Links



- [mohankrishnagr/infosys text-summarization - Docker Image | Docker Hub](https://hub.docker.com/r/mohankrishnagr/infosys_text-summarization)



Amazon  
EC2



- [Text-Summarizer](#)
  - <http://54.168.82.95/>



- [Text-Summarizer](#)
  - <http://mohankrishnagr.centralindia.azurecontainer.io:8000/>
  - <http://20.219.203.134:8000/>

# Proposal

## Deployment - Result

The screenshot shows a web browser window with the address bar displaying "Not secure | mohankrishnagr.centralindia.azurecontainer.io:8000". The page features the "Infosys Springboard" logo at the top. Below the logo, the title "Text Summarizer" is centered. The interface includes three input methods: "Enter URL:" with a text box containing "https://example.com" and a "Summarize URL" button; "Upload File:" with a "Choose File" button and a "Summarize File" button; and "Enter Text:" with a text box containing a news snippet about an airport roof collapse and a "Summarize Text" button. The output section displays two summaries: an "Abstractive Summary" and an "Extractive Summary". At the bottom, a footer states "Text summarizer developed by Mohan Krishna G R, AI/ML Intern @ Infosys. Connect with me on LinkedIn." and includes social media icons for LinkedIn, GitHub, Email, and Discord.

Infosys Springboard

### Text Summarizer

Enter URL:  Summarize URL

Upload File:  No file chosen Summarize File

Enter Text:  Summarize Text

**Abstractive Summary:** Roof of the Indira Gandhi International Airport collapsed early Friday. A cabdriver was killed when a pillar holding up part of the roof fell onto his car. Eight others were taken to the hospital with injuries. More than 40 flights out of the airport were canceled at around 1 p.m.

**Extractive Summary:** airport official said collapse happened around 5 a.m. local time departure area terminal departure terminal suspended . part roof collapse india ' busiest airport heavy rain least one person killed part roof caved crushed vehicle indira gandhi airport new delhi , according official . " mallikarjun kharge , president opposition indian national congress party , wrote x. minister civil aviation , though , told reporter friday collapse happened older part airport , recently expanded section .

Text summarizer developed by Mohan Krishna G R, AI/ML Intern @ Infosys. Connect with me on [LinkedIn](#).

[in](#) [GH](#) [✉](#) [DS](#)

Fig. : Screenshot of the deployed application.