TA2: Handwritten Text Recognition and NLP Processing in Native Language

Steps to Follow:

1. **Capture or upload** an image of a handwritten page written in your mother tongue.
2. **Preprocess the image** to improve clarity (e.g., convert to grayscale, resize, denoise).
3. **Use OCR** to extract text from the image (e.g., Transformer based OCR with language pack for your language).
4. **Normalize** the extracted text (remove noise, unwanted characters, fix encoding issues).
5. **Tokenize** the text using an appropriate NLP tokenizer for your language.
6. **Marathi Named Entity Recognition (NER)**, Perform Named Entity Recognition on the extracted Marathi text to identify entities such as names of people, places, organizations, dates, etc.
7. **Performing NLP task**, such as:
   - Language detection
   - Translation
8. **Display the final output** in a readable format (console, notebook cell, or GUI).
9. **Sentiment Analysis:**
   Analyze the sentiment (positive, negative, or neutral) of the text extracted through OCR to understand the emotional tone of the content.
10. **Summarization** of the extracted text

Step 0: Install & Import Required Libraries

```
# Install All Required Python Libraries

!pip install gdown
!pip install indic-nlp-library
!pip install pytesseract
!pip install opencv-python-headless
!pip install googletrans==4.0.0-rc1
!pip install deep-translator
!pip install langdetect

# Update and Install All Required Libraries and Tools

!sudo apt-get update
!sudo apt-get upgrade
!sudo apt-get install -y tesseract-ocr
!sudo apt-get install -y tesseract-ocr-mar
!git clone https://github.com/anoopkunchukuttan/indic_nlp_resources.git
```

Show hidden output

```
# Import All Required Libraries

import gdown
from google.colab import files
from PIL import Image
import numpy as np
import cv2
import torch
import pytesseract
import re
import pandas as pd
import matplotlib.pyplot as plt
from deep_translator import GoogleTranslator
from indicnlp.tokenize.indic_tokenize import trivial_tokenize
from langdetect import detect

import os
os.environ["HF_TOKEN"] = "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"

# !huggingface-cli clear-cache

from huggingface_hub import login
login(token=os.environ["HF_TOKEN"])
```

```
Note: Environment variable`HF_TOKEN` is set and is the current active token independently from the token you've just configured.
WARNING:huggingface_hub._login:Note: Environment variable`HF_TOKEN` is set and is the current active token independently from the token you've just configured.
```

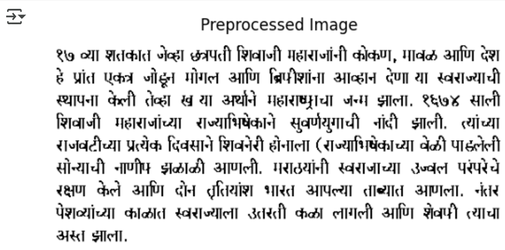
Step 1: Upload Image

```
# Option for the user to try dynamic upload quickly
user_choice = input("Would you like to skip static image and upload a dynamic image? (y/n) [default: n]: ").strip().lower()

if user_choice == 'y':
    print("Proceeding with dynamic image upload...")
    # Dynamic Image Uploads
    uploaded = files.upload()  # Upload image from user
    filename = list(uploaded.keys())[0]  # Get the name of the uploaded file

    # Open image with PIL
    img_pil = Image.open(filename)
    img_pil.show()

else:
    # Static Image Uploads
    file_id = '1z526YFcKb2g8HftFLPhH9Gg25I-jNtHh'  # Extract the file ID from the shared link
    url = f'https://drive.google.com/uc?export=download&id={file_id}'

    try:
        # Try downloading the static image using gdown
        gdown.download(url, 'marathi.gif', quiet=False)

        # Open the image with PIL
        img_pil = Image.open('marathi.gif')
        img_pil.show()

    except Exception as e:
        # If static image download fails, handle with dynamic image upload
        print(f"Static image download failed with error: {e}")
        print("Proceeding with dynamic image upload...")

        # Dynamic Image Uploads
        uploaded = files.upload()  # Upload image from user
        filename = list(uploaded.keys())[0]  # Get the name of the uploaded file

        # Open image with PIL
        img_pil = Image.open(filename)
        img_pil.show()
```

```
Would you like to skip static image and upload a dynamic image? (y/n) [default: n]: n
Downloading...
From: https://drive.google.com/uc?export=download&id=1z526YFcKb2g8HftFLPhH9Gg25I-jNtHh
To: /content/marathi.gif
100%|██████████| 7.23k/7.23k [00:00<00:00, 16.3MB/s]
```

Step 2: Preprocess Image

```
# Convert PIL to OpenCV format
img_cv = cv2.cvtColor(np.array(img_pil), cv2.COLOR_RGB2BGR)

# Preprocess image
gray = cv2.cvtColor(img_cv, cv2.COLOR_BGR2GRAY)
blurred = cv2.GaussianBlur(gray, (3, 3), 0)
_, thresh = cv2.threshold(blurred, 0, 255, cv2.THRESH_BINARY + cv2.THRESH_OTSU)

#Show the preprocessed image
plt.imshow(thresh, cmap='gray')
plt.title("Preprocessed Image")
plt.axis('off')
plt.show()
```



Step 3: Transformer based OCR Extraction

TrOCR

```
from transformers import TrOCRProcessor, VisionEncoderDecoderModel

# Load the pre-trained TrOCR model and processor
processor = TrOCRProcessor.from_pretrained("microsoft/trocr-base-handwritten")
model = VisionEncoderDecoderModel.from_pretrained("microsoft/trocr-base-handwritten")
model.eval()  # inference mode only

# Optional: use GPU if available
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
model.to(device)

# Step 1: Load or convert the image
# If using OpenCV image (NumPy array), convert to PIL
if isinstance(img_pil, np.ndarray):
    img_pil_ = Image.fromarray(img_pil)

# Step 2: Preprocess (resize and RGB)
img_pil_ = img_pil.convert("RGB")
img_pil_ = img_pil_.resize((384, 384))

# Step 3: Feature extraction
pixel_values = processor(images=img_pil_, return_tensors="pt").pixel_values.to(device)

# Step 4: Generate text from image
with torch.no_grad():
```

```
    generated_ids = model.generate(pixel_values)
    generated_text = processor.batch_decode(generated_ids, skip_special_tokens=True)[0]

print("\n📝 OCR Text with TrOCR:\n", generated_text)
```

```
preprocessor_config.json: 100%  224/224 [00:00<00:00, 18.7kB/s]
Using a slow image processor as `use_fast` is unset and a slow processor was saved with this model. `use_fast=True` will be the default behavior in v4.52, even if the model was saved with a slow processor. This will result in minor differences in outputs. You'll still be able to use a slow processor with `use_fast=False`.
tokenizer_config.json: 100%  1.12k/1.12k [00:00<00:00, 103kB/s]
vocab.json: 100%  899k/899k [00:00<00:00, 2.05MB/s]
merges.txt: 100%  456k/456k [00:00<00:00, 2.11MB/s]
special_tokens_map.json: 100%  772/772 [00:00<00:00, 77.0kB/s]
config.json: 100%  4.17k/4.17k [00:00<00:00, 282kB/s]
model.safetensors: 100%  1.33G/1.33G [00:07<00:00, 129MB/s]
Config of the encoder: <class 'transformers.models.vit.modeling_vit.ViTModel'> is overwritten by shared encoder config: ViTConfig {
  "attention_probs_dropout_prob": 0.0,
  "encoder_stride": 16,
  "hidden_act": "gelu",
  "hidden_dropout_prob": 0.0,
  "hidden_size": 768,
  "image_size": 384,
  "initializer_range": 0.02,
  "intermediate_size": 3072,
  "layer_norm_eps": 1e-12,
  "model_type": "vit",
  "num_attention_heads": 12,
  "num_channels": 3,
  "num_hidden_layers": 12,
  "patch_size": 16,
  "pooler_act": "tanh",
  "pooler_output_size": 768,
  "qkv_bias": false,
  "torch_dtype": "float32",
  "transformers_version": "4.51.1"
}

Config of the decoder: <class 'transformers.models.trocr.modeling_trocr.TrOCRForCausalLM'> is overwritten by shared decoder config: TrOCRConfig {
  "activation_dropout": 0.0,
  "activation_function": "gelu",
  "add_cross_attention": true,
  "attention_dropout": 0.0,
  "bos_token_id": 0,
  "classifier_dropout": 0.0,
  "cross_attention_hidden_size": 768,
  "d_model": 1024,
  "decoder_attention_heads": 16,
  "decoder_ffn_dim": 4096,
  "decoder_layerdrop": 0.0,
  "decoder_layers": 12,
  "decoder_start_token_id": 2,
  "dropout": 0.1,
  "eos_token_id": 2,
  "init_std": 0.02,
  "is_decoder": true,
  "layernorm_embedding": true,
  "max_position_embeddings": 512,
  "model_type": "trocr",
  "pad_token_id": 1,
  "scale_embedding": false,
  "torch_dtype": "float32",
  "transformers_version": "4.51.1",
  "use_cache": false,
  "use_learned_position_embeddings": true,
  "vocab_size": 50265
}

Some weights of VisionEncoderDecoderModel were not initialized from the model checkpoint at microsoft/trocr-base-handwritten and are newly initialized: ['encoder.pooler.dense.bias', 'encoder.pooler.dense.weight']
You should probably TRAIN this model on a down-stream task to be able to use it for predictions and inference.
generation_config.json: 100%  190/190 [00:00<00:00, 11.0kB/s]

📝 OCR Text with TrOCR:
 1957 58
```

Abhi964/MahaPhrase_mahaBERTv2_Finetuning

```
# Use pytesseract for raw text
ocr_text = pytesseract.image_to_string(thresh, lang="mar")

# Run through l3cube-pune/marathi-bert-v2 for context-aware prediction
from transformers import pipeline
ocr_model = pipeline("text-classification", model="Abhi964/MahaPhrase_mahaBERTv2_Finetuning", tokenizer="Abhi964/MahaPhrase_mahaBERTv2_Finetuning")
ocr_result = ocr_model(ocr_text)

print("\n📜 OCR Text:\n", ocr_text)
print("\n🔍 MahaBERT Inference:\n", ocr_result)
```

```
config.json: 100%  728/728 [00:00<00:00, 76.2kB/s]
model.safetensors: 100%  950M/950M [01:23<00:00, 10.5MB/s]
tokenizer_config.json: 100%  1.30k/1.30k [00:00<00:00, 122kB/s]
vocab.txt: 100%  3.16M/3.16M [00:00<00:00, 7.07MB/s]
tokenizer.json: 100%  6.41M/6.41M [00:00<00:00, 7.34MB/s]
special_tokens_map.json: 100%  695/695 [00:00<00:00, 76.4kB/s]
Device set to use cuda:0

📜 OCR Text:
 १७ व्या शतकात जेव्हा छत्रपती शिवाजी महाराजांनी कोकण, मावळ आणि देश
हे प्रांत एकज जोडून मोगल आणि ब्रिपीशांना आव्हान देणा या स्वराज्याची
स्थापना केली तेव्हा ख या अर्थाने महाराष्यराचा जन्म झाला. ९६७४ साली
शिवाजी महाराजांच्या राज्याभिषेकाने सुवर्णयुगाची नांदी झाली. त्यांच्या
राजबटीच्या प्रत्येक दिवसाने शिवनेरी होनाला (राज्याभिषेकाच्या वेळी पाडलेली
सोन्याची नाणीप् झळाळी आणली. मराठयांनी स्वराजाच्या उग्जल परंपरेचे
रक्षण केले आणि दोन तृतियांश भारत आपल्या ताब्यात आणला. नंतर
पेशव्यांच्या काळात स्वराज्याला उत्तरती कळा लागली आणि शेबपी त्याचा
अस्त झाला.


🔍 MahaBERT Inference:
 [{'label': 'LABEL_0', 'score': 0.969126284122467}]
```

Step 4: Normalize Text

```
# Normalize the OCR output
normalized_text = re.sub(r'[^\u0900-\u097F\s]', '', ocr_text)
normalized_text = re.sub(r'\s+', ' ', normalized_text).strip()
print("\nNormalized Marathi Text:\n", normalized_text)
```

```
Normalized Marathi Text:
 १७ व्या शतकात जेव्हा छत्रपती शिवाजी महाराजांनी कोकण मावळ आणि देश हे प्रांत एकज जोडून मोगल आणि ब्रिपीशांना आव्हान देणा या स्वराज्याची स्थापना केली तेव्हा ख या अर्थाने महाराष्यराचा जन्म झाला ९६७४ साली शिवाजी महाराजांच्या राज्याभिषेकाने सुवर्णयुगाची नांदी झाली त्यांच्या राजबटीच्या प्रत्येक दिवसाने शिवनेरी होनाला राज्याभिषेकाच्या वेळी पाडलेली सोन्याची नाणीप झळाळी आणली मराठयांनी स्वराजाच्या उग्जल परंपरेचे रक्षण केले आणि दो
```

Step 5: Tokenization

```
# Tokenization

# Simple whitespace tokenizer
tokens_simple = normalized_text.split()
print("\nTokenized Words (Simple Split):\n", tokens_simple)

# Advanced Indic NLP tokenizer
tokens_advanced = trivial_tokenize(normalized_text, lang='mar')
print("\nTokenized Words (Indic NLP):\n", tokens_advanced)

tokens = tokens_advanced
```

```
Tokenized Words (Simple Split):
 ['१७', 'व्या', 'शतकात', 'जेव्हा', 'छत्रपती', 'शिवाजी', 'महाराजांनी', 'कोकण', 'मावळ', 'आणि', 'देश', 'हे', 'प्रांत', 'एकज', 'जोडून', 'मोगल', 'आणि', 'ब्रिपीशांना', 'आव्हान', 'देणा', 'या', 'स्वराज्याची', 'स्थापना', 'केली', 'तेव्हा', 'ख', 'या', 'अर्थाने', 'महाराष्यराचा', 'जन्म', 'झाला', '९६७४', 'साली', 'शिवाजी', 'महाराजांच्या', 'राज्याभिषेकाने', 'सुवर्णयुगाची', 'नांदी', 'झाली', 'त्यांच्या', 'राज

Tokenized Words (Indic NLP):
 ['१७', 'व्या', 'शतकात', 'जेव्हा', 'छत्रपती', 'शिवाजी', 'महाराजांनी', 'कोकण', 'मावळ', 'आणि', 'देश', 'हे', 'प्रांत', 'एकज', 'जोडून', 'मोगल', 'आणि', 'ब्रिपीशांना', 'आव्हान', 'देणा', 'या', 'स्वराज्याची', 'स्थापना', 'केली', 'तेव्हा', 'ख', 'या', 'अर्थाने', 'महाराष्यराचा', 'जन्म', 'झाला', '९६७४', 'साली', 'शिवाजी', 'महाराजांच्या', 'राज्याभिषेकाने', 'सुवर्णयुगाची', 'नांदी', 'झाली', 'त्यांच्या', 'राज
```

Step 6: Name Entity Recognition

```
# NER Marathi

# Use a pipeline as a high-level helper
from transformers import pipeline
pipe = pipeline("token-classification", model="l3cube-pune/marathi-mixed-ner-iob")

ner_results = pipe(normalized_text)
print("\nNER Results:\n", ner_results)
```

```
Device set to use cuda:0

NER Results:
 [{'entity': 'B-NEM', 'score': np.float32(0.9490038), 'index': 1, 'word': '१७', 'start': 0, 'end': 2}, {'entity': 'B-NED', 'score': np.float32(0.9949727), 'index': 5, 'word': 'छत्रपती', 'start': 21, 'end': 28}, {'entity': 'B-NEP', 'score': np.float32(0.99822646), 'index': 6, 'word': 'शिवाजी', 'start': 29, 'end': 35}, {'entity': 'B-NED', 'score
```

Step 7: Language Detection and Translation

Language Detection

```
# Detect language
detected_language_code = detect(normalized_text)

# Map language code to full name (optional, for readability)
language_map = {
    'mr': 'Marathi',
    'en': 'English',
    # Add more mappings as needed
}
detected_language = language_map.get(detected_language_code, detected_language_code)

# Print result
print(f"Detected language: {detected_language}")
```

```
Detected language: Marathi
```

Translation

```
# Convert Marathi numbers to English numbers in text and tokens
devanagari_to_english_digits = {
    '०': '0', '१': '1', '२': '2', '३': '3', '४': '4',
    '५': '5', '६': '6', '७': '7', '८': '8', '९': '9'
}
```

```
def convert_devanagari_numbers(text):
    return re.sub(r'[\u0966-\u096F]+', lambda m: ''.join(devanagari_to_english_digits.get(ch, ch) for ch in m.group()), text)
```

```
# Translate full text
normalized_with_english_digits = convert_devanagari_numbers(normalized_text)
translation_text = GoogleTranslator(source='mr', target='en').translate(normalized_with_english_digits)
print("\nEnglish Translated Text:\n", translation_text)
```

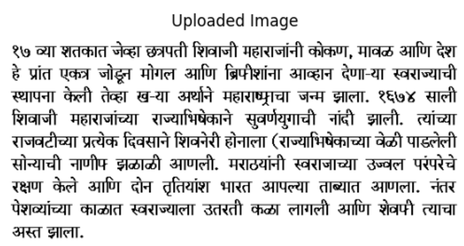
```
English Translated Text:
 In the 17th century, when Chhatrapati Shivaji Maharaj established the Konkan Maval and the country to challenge the Mughals and the British, Maharashtra was born in 9674 Shivaji Maharaj's coronation of the golden age. Protecting the tradition and two -thirds of India were taken into custody, after the Peshwa's time, Swarajya was responding
```

```
# Translate individual tokens
translated_tokens = []
for token in tokens:
    if re.fullmatch(r'[\u0966-\u096F]+', token):
        translated_tokens.append(convert_devanagari_numbers(token))
    else:
        try:
            translated = GoogleTranslator(source='mr', target='en').translate(token)
            translated_tokens.append(translated)
        except:
            translated_tokens.append(token)

print("\nTranslated Tokens:\n", translated_tokens)
```

```
Translated Tokens:
 ['17', 'Th', 'Centuries', 'When', 'Chhatrapati', 'Shivaji', 'By the Maharaja', 'Konkan', 'Maval', 'And', 'Country', 'This', 'Province', 'Unity', 'By connecting', 'Mogal', 'And', 'To the brippens', 'Challenge', 'Consecutive', 'These', 'State', 'Establishment', 'Kelly', 'When', 'Eclectic', 'These', 'In a sense', 'Maharashtra', 'Birth', 'Beca
```

Step 8: Final Output

```
# Display the image
plt.imshow(img_pil)
plt.axis('off')
plt.title("Uploaded Image")
plt.show()

# Final Output
print("\nFinal Output Summary:\n")
print("Original Marathi OCR Text:\n", normalized_text) # OCR Marathi Text
print("\nMarathi to English Translation:\n", translation_text) # English Translated Text
print("\nTokens in Marathi:\n", tokens) # Marathi Tokens
print("\nTranslated Tokens in English:\n", translated_tokens) # English Tokens
```




```
Final Output Summary:

Original Marathi OCR Text:
 १७ व्या शतकात जेव्हा छत्रपती शिवाजी महाराजांनी कोकण मावळ आणि देश हे प्रांत एकज जोडून मोगल आणि ब्रिपीशांना आव्हान देणा या स्वराज्याची स्थापना केली तेव्हा ख या अर्थाने महाराष्यराचा जन्म झाला ९६७४ साली शिवाजी महाराजांच्या राज्याभिषेकाने सुवर्णयुगाची नांदी झाली त्यांच्या राजबटीच्या प्रत्येक दिवसाने शिवनेरी होनाला राज्याभिषेकाच्या वेळी पाडलेली सोन्याची नाणीप झळाळी आणली मराठयांनी स्वराजाच्या उग्जल परंपरेचे रक्षण केले आणि दो

Marathi to English Translation:
 In the 17th century, when Chhatrapati Shivaji Maharaj established the Konkan Maval and the country to challenge the Mughals and the British, Maharashtra was born in 9674 Shivaji Maharaj's coronation of the golden age. Protecting the tradition and two -thirds of India were taken into custody, after the Peshwa's time, Swarajya was responding

Tokens in Marathi:
 ['१७', 'व्या', 'शतकात', 'जेव्हा', 'छत्रपती', 'शिवाजी', 'महाराजांनी', 'कोकण', 'मावळ', 'आणि', 'देश', 'हे', 'प्रांत', 'एकज', 'जोडून', 'मोगल', 'आणि', 'ब्रिपीशांना', 'आव्हान', 'देणा', 'या', 'स्वराज्याची', 'स्थापना', 'केली', 'तेव्हा', 'ख', 'या', 'अर्थाने', 'महाराष्यराचा', 'जन्म', 'झाला', '९६७४', 'साली', 'शिवाजी', 'महाराजांच्या', 'राज्याभिषेकाने', 'सुवर्णयुगाची', 'नांदी', 'झाली', 'त्यांच्या', 'राज

Translated Tokens in English:
 ['17', 'Th', 'Centuries', 'When', 'Chhatrapati', 'Shivaji', 'By the Maharaja', 'Konkan', 'Maval', 'And', 'Country', 'This', 'Province', 'Unity', 'By connecting', 'Mogal', 'And', 'To the brippens', 'Challenge', 'Consecutive', 'These', 'State', 'Establishment', 'Kelly', 'When', 'Eclectic', 'These', 'In a sense', 'Maharashtra', 'Birth', 'Beca
```

```
# Show tokens in tabular format
df = pd.DataFrame({'Marathi': tokens, 'English': translated_tokens})
df
```

	Marathi	English
0	१७	17
1	व्या	Th
2	शतकात	Centuries
3	जेव्हा	When
4	छत्रपती	Chhatrapati
...	...	...
72	आणि	And
73	शेबपी	Shabby
74	त्याचा	Its
75	अस्त	Weed
76	झाला	Became

77 rows × 2 columns

Step 9: Sentiment Analysis

```
# Sentiment Analysis

from transformers import pipeline

try:
    # Try Marathi sentiment analysis model (if available)
    sentiment_pipeline = pipeline("sentiment-analysis", model="l3cube-pune/MarathiSentiment")
    sentiment_result = sentiment_pipeline(normalized_text)
    print("\nMarathi Sentiment Analysis Result:\n", sentiment_result)

except:
    print("\nMarathi sentiment model failed or not available. Falling back to English sentiment analysis.")

    try:
        # Fallback: Use English-translated text and English sentiment model
        en_sentiment_pipeline = pipeline("sentiment-analysis")
        sentiment_result = en_sentiment_pipeline(translation_text)
        print("\nEnglish Sentiment Analysis Result:\n", sentiment_result)

    except Exception as e:
        print("\nSentiment analysis failed due to:", str(e))
```

```
Device set to use cuda:0

Marathi Sentiment Analysis Result:
 [{'label': 'Neutral', 'score': 0.983304500579834}]
```

Step 10: Summarize the Marathi and English text

```
# Summarization using transformers pipeline
summarizer_mar = pipeline("summarization", model="Existance/mT5_multilingual_XLSum-marathi-summarization")
summarizer_en = pipeline("summarization", model="Falconsai/text_summarization")

try:
    marathi_summary = summarizer_mar(normalized_text, max_length=130, min_length=30, do_sample=False)
    print("\nMarathi Text Summary:\n", marathi_summary[0]["summary_text"])
except Exception as e:
    print(f"\nError summarizing Marathi text: {e}")

try:
    english_summary = summarizer_en(translation_text, max_length=130, min_length=30, do_sample=False)
    print("\nEnglish Text Summary:\n", english_summary[0]["summary_text"])
except Exception as e:
    print(f"\nError summarizing English text: {e}")
```

```
Device set to use cuda:0
Device set to use cuda:0
Your max_length is set to 130, but your input_length is only 105. Since this is a summarization task, where outputs shorter than the input are typically wanted, you might consider decreasing max_length manually, e.g. summarizer('...', max_length=52)

Marathi Text Summary:
 मराठयांनी स्वराजाच्या उग्जल परंपरेचे रक्षण केले आणि दोन तृतियांश भारत आपल्या ताब्यात आणला नंतर पेशव्यांच्या काळात स्वराज्याला उत्तरती कळा लागली आता शेबपी त्याचा अस्त झाला

English Text Summary:
 Chhatrapati Shivaji Maharaj established the Konkan Maval and the country to challenge the Mughals and the British in the 17th century . Protecting the tradition and two -thirds of India were taken into custody . Swarajya was responding and Sheeppi was dissolved .
```