Cheat Sheet: Advanced Multimodal Applications

Package/Method	Description	Code Example
| Basic image querying | Create a simple function to send an image to a vision model and get a response to a general question about the image. | ```python
def generate_model_response(encoded_image, user_query,
                            assistant_prompt="You are a helpful assistant. Answer the following user query in 1 or 2 sentences: "):
    """Send image and query to model and get response."""
    messages = [
        {
            "role": "user",
            "content": [
                {
                    "type": "text",
                    "text": assistant_prompt + user_query
                },
                {
                    "type": "image_url",
                    "image_url": {
                        "url": "data:image/jpeg;base64," + encoded_image,
                    }
                }
            ]
        }
    ]
    response = model.chat(messages=messages)
    return response['choices'][0]['message']['content']

# Example usage:
user_query = "Describe the photo"
response = generate_model_response(encoded_images[0], user_query)
print("Description:", response)
``` |
| Basic object detection | Use the vision model to detect and count objects in images by asking specific questions. | ```python
// Detection examples for various use cases
image = encoded_images[1] // Select second image

// Count objects
result = generate_model_response(
    image,
    "How many cars are in this image?"
)
print("Cars detected:", result)

// Examine details
result = generate_model_response(
    image,
    "What color is the woman's jacket in this image?"
)
print("Clothing analysis:", result)

// Read text from images
result = generate_model_response(
    encoded_images[3], # Nutrition label image
    "How much sodium is in this product?"
)
print("Sodium content:", result)
``` |
| Creating messages for vision model | Format a request with both text and image data to send to the multimodal model. | ```python
def create_vision_message(prompt, encoded_image):
    messages = [
        {
            "role": "user",
            "content": [
                {
                    "type": "text",
                    "text": prompt
                },
                {
                    "type": "image_url",
                    "image_url": {
                        "url": "data:image/jpeg;base64," + encoded_image,
                    }
                }
            ]
        }
    ]
    return messages
``` |
| Environment setup | Create and activate a virtual environment, then install necessary packages for multimodal applications. | ```bash
python3.11 -m venv venv
source venv/bin/activate
pip install ibm-watsonx-ai==1.1.20 image==1.5.33 flask requests==2.32.0
pip install torch torchvision scikit-learn pillow gradio
``` |
| Fashion analysis prompting | Specialized prompting for fashion analysis with structured output for retail applications. | ```python
def generate_fashion_response(user_image_base64, matched_row, all_items,
                              similarity_score, threshold=0.8):
    """Generate fashion-specific analysis with product details."""
    # Generate list of items with prices and links
    items_list = []
    for _, row in all_items.iterrows():
        item_str = f"{row['Item Name']} (${row['Price']}): {row['Link']})"
        item_list.append(item_str)
    # Join with proper formatting
    items_description = "\n".join([f"- {item}" for item in items_list])
    if similarity_score >= threshold:
        # Prompt for exact matches
        assistant_prompt = f"""
You're conducting a professional retail catalog analysis.
Focus exclusively on professional fashion analysis.
ITEM DETAILS (always include this section):
{items_description}
Please:
1. Identify and describe clothing items objectively (colors, patterns, materials)
2. Categorize the overall style (business, casual, etc.)
3. Include the ITEM DETAILS section at the end
Use formal, clinical language for a professional catalog.
"""
    else:
        # Prompt for similar but not exact matches
        assistant_prompt = f"""
You're conducting a professional retail catalog analysis.
Focus exclusively on professional fashion analysis.
SIMILAR ITEMS (always include this section):
{items_description}
Please:
1. Note these are similar but not exact items
2. Identify clothing elements objectively
3. Include the SIMILAR ITEMS section at the end
Use formal, clinical language for a professional catalog.
"""
    # Generate and return response
    return generate_model_response(user_image_base64,
                                   "Analyze this outfit",
                                   assistant_prompt)
``` |
| Flask integration for vision AI web app | Basic Flask setup to create a web application with vision AI capabilities. | ```python
from flask import Flask, render_template, request
app = Flask(__name__)
@app.route("/", methods=["GET", "POST"])
def index():
    if request.method == "POST":
        # Retrieve user inputs
        user_query = request.form.get("user_query")
        uploaded_file = request.files.get("file")
        if uploaded_file:
            # Process the uploaded image
            encoded_image = input_image_setup(uploaded_file)
            # Generate the model's response
            response = generate_model_response(encoded_image, user_query, assistant_prompt)
            # Render the result
            return render_template("index.html", user_query=user_query, response=response)
    return render_template("index.html")

if __name__ == "__main__":
    app.run(debug=True)
``` |
| Image encoding from URLs | Load and encode multiple images from URLs to base64 format for batch processing with vision models. | ```python
import requests
import base64

// Define image URLs
url_image_1 = 'https://example.com/image1.jpg'
url_image_2 = 'https://example.com/image2.jpg'
image_urls = [url_image_1, url_image_2]

// Encode all images
encoded_images = []
for url in image_urls:
    encoded_images.append(
        base64.b64encode(
            requests.get(url).content
        ).decode("utf-8")
    )
``` |
| Image encoding from uploads | Convert an uploaded image file to base64 format for inclusion in a request to a vision model. | ```python
import base64
from PIL import Image
from io import import BytesIO

def input_image_setup(uploaded_file):
    if uploaded_file is not None:
        # Read file into bytes
        bytes_data = uploaded_file.read()
        # Encode image to base64 string
        encoded_image = base64.b64encode(bytes_data).decode("utf-8")
        return encoded_image
    else:
        raise FileNotFoundError("No file uploaded")
``` |
| Nutrition analysis prompt | Detailed prompt template for analyzing food images with structured output focusing on nutritional content. | ```python
def generate_nutrition_response(encoded_image, user_query):
    """Generate detailed nutrition analysis response."""
    assistant_prompt = """
You are an expert nutritionist. Your task is to analyze the
food items displayed in the image and provide a detailed
nutritional assessment using the following format:
1. **Identification**: List each identified food item clearly,
   one per line.
2. **Portion Size & Calorie Estimation**: For each identified
   food item, specify the portion size and provide an
   estimated number of calories. Use bullet points with
   the following structure:
   * **[Food Item]**: [Portion Size], [Number of Calories] calories
   Example:
   * **Salmon**: 6 ounces, 250 calories
   * **Asparagus**: 3 spears, 25 calories
3. **Total Calories**: Provide the total number of calories
   for all food items.
   Example:
   Total Calories: 235 calories
4. **Nutrient Breakdown**: Include a breakdown of key nutrients
   such as **Protein**, **Carbohydrates**, **Fats**, **Vitamins**,
   and **Minerals**. Use bullet points for each nutrient.
   Example:
   * **Protein**: Salmon (6g), Asparagus (3g) = 38g total
   * **Carbohydrates**: Asparagus (5g) = 5g total
5. **Health Evaluation**: Evaluate the healthiness of the
   meal in one paragraph.
6. **Disclaimer**: Include the following exact text:
   The nutritional information and calorie estimates provided
   are approximate and are based on general food data.
   Actual values may vary depending on factors such as
   portion size, specific ingredients, preparation methods,
   and individual variations. For precise dietary advice or
   medical guidance, consult a qualified nutritionist or
   healthcare provider.
"""
    return generate_model_response(encoded_image, user_query, assistant_prompt)
``` |

| **Similarity matching** | Find the closest matching image in a dataset based on cosine similarity of vector embeddings. | ```python
from sklearn.metrics.pairwise import cosine_similarity

def find_closest_match(user_vector, dataset):
    """Find closest match based on cosine similarity."""
    try:
        # Stack all vectors from dataset
        dataset_vectors = np.vstack(dataset['embedding'].dropna().values)
        # Calculate similarities
        similarities = cosine_similarity(user_vector.reshape(1, -1), dataset_vectors)
        # Find highest similarity index
        closest_index = np.argmax(similarities)
        similarity_score = similarities[0][closest_index]
        # Get corresponding dataset row
        closest_row = dataset.iloc[closest_index]
        return closest_row, similarity_score
    except Exception as e:
        print(f"Error finding closest match: {e}")
        return None, None
``` |
| **Vector embeddings for images** | Convert images to vector embeddings for similarity matching using a pre-trained ResNet50 model. | ```python
import torch
import torchvision.transforms as transforms
from torchvision.models import resnet50
import numpy as np

class ImageProcessor:
    def __init__(self, image_size=(224, 224),
                 norm_mean=[0.485, 0.456, 0.406],
                 norm_std=[0.229, 0.224, 0.225]):
        self.device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
        self.model = resnet50(pretrained=True).to(self.device)
        self.model.eval()  // Set model to evaluation mode
        # Image preprocessing pipeline
        self.preprocess = transforms.Compose([
            transforms.Resize(image_size),
            transforms.ToTensor(),
            transforms.Normalize(mean=norm_mean, std=norm_std),
        ])
    def encode_image(self, image_input, is_url=True):
        try:
            if is_url:
                # Fetch image from URL
                response = requests.get(image_input)
                image = Image.open(BytesIO(response.content)).convert("RGB")
            else:
                # Load from local file
                image = Image.open(image_input).convert("RGB")
            # Convert image to Base64
            buffered = BytesIO()
            image.save(buffered, format="JPEG")
            base64_string = base64.b64encode(buffered.getvalue()).decode("utf-8")
            # Get feature vector using ResNet50
            input_tensor = self.preprocess(image).unsqueeze(0).to(self.device)
            with torch.no_grad():
                features = self.model(input_tensor)
            # Convert to NumPy array
            feature_vector = features.cpu().numpy().flatten()
            return {"base64": base64_string, "vector": feature_vector}
        except Exception as e:
            print(f"Error encoding image: {e}")
            return {"base64": None, "vector": None}
``` |
| **Vision model initialization** | Set up credentials and initialize the Llama 3.2 Vision Instruct model through watsonx.ai. | ```python
from ibm_watsonx_ai import Credentials
from ibm_watsonx_ai import APIClient
from ibm_watsonx_ai.foundation_models import ModelInference
from ibm_watsonx_ai.foundation_models.schema import TextChatParameters

credentials = Credentials(
    url = "https://us-south.ml.cloud.ibm.com",
    # api_key = "YOUR_API_KEY" # Optional in lab environments
)
client = APIClient(credentials)

model_id = "meta-llama/llama-3-2-90b-vision-instruct"
project_id = "skills-network"
params = TextChatParameters(
    temperature=0.2,
    top_p=0.6,
    max_tokens=2000
)

model = ModelInference(
    model_id=model_id,
    credentials=credentials,
    project_id=project_id,
    params=params
)
``` |

Author

Hailey Quach