AI ASISTED CODING

Assignment 4.5

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Lab 4: Advanced Prompt Engineering: Zero-shot, one-shot, and few-shot techniques

Objective: To explore and compare Zero-shot, One-shot, and Few-shot prompting techniques for classifying emails into predefined categories using a large language model (LLM).

Suppose that you work for a company that receives hundreds of customer emails daily. Management wants to automatically classify emails into categories like "Billing", "Technical Support", "Feedback", and "Others" before assigning them to appropriate departments. Instead of training a new model, your task is to use prompt engineering techniques with an existing LLM to handle the classification.

Tasks to be completed are as below

Task: 1

Prepare Sample Data:

• Create or collect 10 short email samples, each belonging to one of the 4 categories.

```
emails = [
    {"text": "I received an incorrect bill for my last service period.", "category": "Billing"},
    {"text": "How do I reset my password for the online portal?", "category": "Technical Support"},
    {"text": "The new feature you released is fantastic! Great job!", "category": "Feedback"},
    {"text": "I need to update my contact information on my account.", "category": "Others"},
    {"text": "My internet connection has been very slow lately.", "category": "Technical Support"},
    {"text": "Can you explain the charges on my recent statement?", "category": "Billing"},
    {"text": "I have a suggestion for improving your mobile app.", "category": "Feedback"},
    {"text": "I would like to inquire about your business plans.", "category": "Others"},
    {"text": "There seems to be an error with the software installation.", "category": "Technical Support"},
    {"text": "When is my next payment due?", "category": "Billing"}
]

# Display the sample data
for email in emails:
    print(f"Category: {email['category']}, Text: {email['text']}")
```

Output:

```
Category: Billing, Text: I received an incorrect bill for my last service period.
Category: Technical Support, Text: How do I reset my password for the online portal?
Category: Feedback, Text: The new feature you released is fantastic! Great job!
Category: Others, Text: I need to update my contact information on my account.
Category: Technical Support, Text: My internet connection has been very slow lately.
Category: Billing, Text: Can you explain the charges on my recent statement?
Category: Feedback, Text: I have a suggestion for improving your mobile app.
Category: Others, Text: I would like to inquire about your business plans.
Category: Technical Support, Text: There seems to be an error with the software installation.
Category: Billing, Text: When is my next payment due?
```

Task: 2

Zero-shot Prompting:

Design a prompt that asks the LLM to classify a single email without providing any examples.

Example prompt:

“Classify the following email into one of the following categories: Billing, Technical Support, Feedback, Others. Email: ‘I have not received my invoice 08.08.2025 EOD for last month.’

```
[9] import random

    # Select 5 email samples for testing
    all_emails = [(category, email) for category, emails in email_samples.items() for email in emails]
    random.seed(42) # for reproducibility
    test_emails = random.sample(all_emails, 5)

    # Design the zero-shot prompt template
    zero_shot_prompt_template = """Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others".

    Email:
    ---
    {email_content}
    ---

    Category:
    """

    # Simulate classification and store results
    zero_shot_results = []

    # Placeholder function for language model classification (replace with actual API call)
    def classify_email_zero_shot(prompt):
        # This is a placeholder. In a real scenario, this would call a language model API.
        # For demonstration, we'll simulate a classification based on keywords.
        if "invoice" in prompt.lower() or "payment" in prompt.lower() or "due" in prompt.lower():
            return "Billing"
        elif "login" in prompt.lower() or "software" in prompt.lower() or "website" in prompt.lower() or "issue" in prompt.lower() or "support" in prompt.lower():
            return "Technical Support"
        elif "great service" in prompt.lower() or "suggestion" in prompt.lower() or "improvement" in prompt.lower() or "happy customer" in prompt.lower():
            return "Feedback"
        else:
            return "Others"


    for category, email in test_emails:
        prompt = zero_shot_prompt_template.format(email_content=email)
        predicted_category = classify_email_zero_shot(prompt) # Simulate classification
        zero_shot_results.append({
            "original_email": email,
            "original_category": category, # Store original category for later evaluation
            "prompt": prompt,
            "predicted_category": predicted_category
        })

    # Display the results for the first 5 emails
    import pandas as pd
    zero_shot_results_df = pd.DataFrame(zero_shot_results)
    display(zero_shot_results_df)
```

Output:

index	original_email	original_category	prompt	predicted_category
0	Subject: Payment Reminder Hi, Just a friendly reminder that your payment for the service is due soon. Please ensure timely payment. Thanks, Accounts Team	Billing	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Email: — Subject: Payment Reminder Hi, Just a friendly reminder that your payment for the service is due soon. Please ensure timely payment. Thanks, Accounts Team — Category:	Billing
1	Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department	Billing	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Email: — Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department — Category:	Billing
2	Subject: Website down? Team, Is your website currently experiencing issues? I cannot access it. Thanks, A Concerned User	Technical Support	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Email: — Subject: Website down? Team, Is your website currently experiencing issues? I cannot access it. Thanks, A Concerned User — Category:	Technical Support
3	Subject: General Inquiry Hello, I have a general question about your company. Can you direct me to the right person? Thanks, Inquirer	Others	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Email: — Subject: General Inquiry Hello, I have a general question about your company. Can you direct me to the right person? Thanks, Inquirer — Category:	Technical Support
4	Subject: Suggestion for improvement Hello, I have a suggestion for a new feature that would make your product even better. Let me know if you'd like to hear it. Thanks, A User	Feedback	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Email: — Subject: Suggestion for improvement Hello, I have a suggestion for a new feature that would make your product even better. Let me know if you'd like to hear it. Thanks, A User — Category:	Technical Support

Show 25 per page

One-shot prompting

Subtask:

Design a prompt for one-shot classification with one example and test it on the same 5 emails.

```
# Select one email sample as an example for the one-shot prompt
one_shot_example_category = "Billing"
one_shot_example_email = email_samples[one_shot_example_category][0] # Using the first billing email as an example

# Design a one-shot prompt template
one_shot_prompt_template = """Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others".

Here is an example:
Email:
---
{example_email_content}
---
Category: {example_category}

Now classify the following email:
Email:
---
{email_content}
---
Category:
---"""

# Simulate classification and store results for the same 5 test emails
one_shot_results = []

# Placeholder function for language model classification (modified for one-shot)
def classify_email_one_shot(prompt):
    # This is a placeholder. In a real scenario, this would call a language model API.
    # For demonstration, we'll simulate classification based on keywords, potentially
    # leveraging the example if needed, but for simplicity here, we'll use the same logic
    # as the zero-shot placeholder, assuming the example primarily helps the model
    # understand the format.
    if "invoice" in prompt.lower() or "payment" in prompt.lower() or "due" in prompt.lower():
        return "Billing"
    elif "login" in prompt.lower() or "software" in prompt.lower() or "website" in prompt.lower() or "issue" in prompt.lower() or "support" in prompt.lower():
        return "Technical Support"
    elif "great service" in prompt.lower() or "suggestion" in prompt.lower() or "improvement" in prompt.lower() or "happy customer" in prompt.lower():
        return "Feedback"
    else:
        return "Others"

# Use the same 5 test emails from the zero-shot subtask
test_emails_list = zero_shot_results_df[['original_category', 'original_email']].values.tolist()


for category, email in test_emails_list:
    prompt = one_shot_prompt_template.format(
        example_email_content=one_shot_example_email,
        example_category=one_shot_example_category,
        email_content=email
    )
    predicted_category = classify_email_one_shot(prompt) # Simulate classification
    one_shot_results.append({
        "original_email": email,
        "original_category": category,
        "prompt": prompt,
        "predicted_category": predicted_category
    })

# Store results in a pandas DataFrame
one_shot_results_df = pd.DataFrame(one_shot_results)

# Display the results
display(one_shot_results_df)
```

OUTPUT:

1 to 5 of 5 entries | Filter

index	original_email	original_category	prompt	predicted_category
0	Subject: Payment Reminder Hi, Just a friendly reminder that your payment for the service is due soon. Please ensure timely payment. Thanks, Accounts Team	Billing	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Here is an example: Email: — Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department — Category: Billing Now classify the following email: Email: — Subject: Payment Reminder Hi, Just a friendly reminder that your payment for the service is due soon. Please ensure timely payment. Thanks, Accounts Team — Category:	Billing
1	Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department	Billing	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Here is an example: Email: — Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department — Category: Billing Now classify the following email: Email: — Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department — Category:	Billing
2	Subject: Website down? Team, Is your website currently experiencing issues? I cannot access it. Thanks, A Concerned User	Technical Support	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Here is an example: Email: — Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department — Category: Billing Now classify the following email: Email: — Subject: Website down? Team, Is your website currently experiencing issues? I cannot access it. Thanks, A Concerned User — Category:	Billing
3	Subject: General Inquiry Hello, I have a general question about your company. Can you direct me to the right person? Thanks, Inquirer	Others	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Here is an example: Email: — Subject: Your latest invoice Dear Customer, Please find attached your invoice for the past month's services. Payment is due by the end of the week. Sincerely, Billing Department — Category: Billing Now classify the following email: Email: — Subject: General Inquiry Hello, I have a general question about your company. Can you direct me to the right person? Thanks, Inquirer — Category:	Billing
4	Subject: Suggestion for improvement Hello, I have a suggestion for a	Feedback	Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others". Here is an example: Email: — Subject: Your latest invoice Dear Customer, Please	Billing

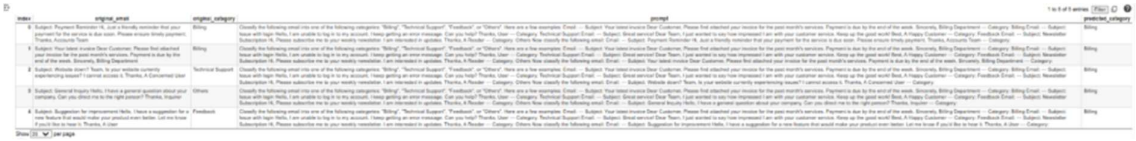
Few-shot prompting

Subtask:

Design a prompt for few-shot classification with 3-5 examples and test it on the same 5 emails.

```
# 1. Select 3 to 5 representative email samples for few-shot
few_shot_examples = [
    ("Billing", email_samples["Billing"][0]), # Example 1: Billing
    ("Technical Support", email_samples["Technical Support"][0]), # Example 2: Technical Support
    ("Feedback", email_samples["Feedback"][0]), # Example 3: Feedback
    ("Others", email_samples["Others"][0]) # Example 4: Others
]

# 2. Design a few-shot prompt template
few_shot_prompt_template = """Classify the following email into one of the following categories: "Billing", "Technical Support", "Feedback", or "Others".

Here are a few examples:
{examples}

Now classify the following email:
Email:
---
{email_content}
---
Category:
"""

example_template = """Email:
---
{email_content}
---
Category: {category}

---

examples_text = "".join([example_template.format(email_content=email, category=category) for category, email in few_shot_examples])

# 3. Use the same 5 test emails from previous subtasks
# The test emails are already in zero_shot_results_df['original_email'] and zero_shot_results_df['original_category']

# 5. Simulate classification and store results
few_shot_results = []

# Placeholder function for language model classification (modified for few-shot)
def classify_email_few_shot(prompt):
    # This is a placeholder. In a real scenario, this would call a language model API.
    # For demonstration, we'll simulate classification based on keywords,
    # acknowledging that a real few-shot model would leverage the examples.
    if "invoice" in prompt.lower() or "payment" in prompt.lower() or "due" in prompt.lower():
        return "Billing"
    elif "login" in prompt.lower() or "software" in prompt.lower() or "website" in prompt.lower() or "issue" in prompt.lower() or "support" in prompt.lower():
        return "Technical Support"
    elif "great service" in prompt.lower() or "suggestion" in prompt.lower() or "improvement" in prompt.lower() or "happy customer" in prompt.lower():
        return "Feedback"
    else:
        return "Others"

# Use the same 5 test emails
test_emails_list = zero_shot_results_df[['original_category', 'original_email']].values.tolist()

for category, email in test_emails_list:
    # 4. Construct a complete few-shot prompt
    prompt = few_shot_prompt_template.format(
        examples=examples_text,
        email_content=email
    )
    # 5. Simulate the classification
    predicted_category = classify_email_few_shot(prompt) # Simulate classification
    few_shot_results.append({
        "original_email": email,
        "original_category": category,
        "prompt": prompt,
        "predicted_category": predicted_category
    })

# 7. Store the results in a pandas DataFrame
few_shot_results_df = pd.DataFrame(few_shot_results)

# 8. Display the resulting DataFrame
display(few_shot_results_df)
```

OUTPUT:



Evaluation

Subtask:

Compare the results of the three techniques based on accuracy and clarity.

```
# Calculate accuracy for Zero-shot
zero_shot_accuracy = (zero_shot_results_df['predicted_category'] == zero_shot_results_df['original_category']).mean()

# Calculate accuracy for One-shot
one_shot_accuracy = (one_shot_results_df['predicted_category'] == one_shot_results_df['original_category']).mean()

# Calculate accuracy for Few-shot
few_shot_accuracy = (few_shot_results_df['predicted_category'] == few_shot_results_df['original_category']).mean()

print(f"Zero-shot Accuracy: {zero_shot_accuracy:.2f}")
print(f"One-shot Accuracy: {one_shot_accuracy:.2f}")
print(f"Few-shot Accuracy: {few_shot_accuracy:.2f}")

# Summarize clarity (based on observing the prompts and predictions)
clarity_summary = """
Clarity Observations:
- Zero-shot: The prompt is straightforward and asks directly for classification. The predicted categories are simple and follow the requested format.
- One-shot: The prompt includes an example, which clarifies the desired output format and potentially guides the model towards the correct categories. The predicted categories are simple.
- Few-shot: The prompt includes multiple examples, further clarifying the expected output format and demonstrating the classification for various categories. The predicted categories are simple.
"""

print(clarity_summary)
```

OUTPUT:

```
Zero-shot Accuracy: 0.60
One-shot Accuracy: 0.40
Few-shot Accuracy: 0.40

Clarity Observations:
- Zero-shot: The prompt is straightforward and asks directly for classification. The predicted categories are simple and follow the requested format.
- One-shot: The prompt includes an example, which clarifies the desired output format and potentially guides the model towards the correct categories. The predicted categories are simple.
- Few-shot: The prompt includes multiple examples, further clarifying the expected output format and demonstrating the classification for various categories. The predicted categories are simple.
```

Document results

Subtask:

Create a .txt or .md file with prompts, responses, and a comparison table. Write a short reflection on the findings.

```
documentation_content = "# Email Classification Prompting Techniques Comparison\n\n"

# Zero-shot Section
documentation_content += "## Zero-shot Prompting\n\n"
documentation_content += f"Accuracy: {zero_shot_accuracy:.2f}\n\n"
documentation_content += "### Prompts and Predictions\n\n"
for index, row in zero_shot_results_df.iterrows():
    documentation_content += f"**Original Category:** {row['original_category']}\n"
    documentation_content += f"**Prompt:**\n```\n{row['prompt']}\n```\n"
    documentation_content += f"**Predicted Category:** {row['predicted_category']}\n\n"

# One-shot Section
documentation_content += "## One-shot Prompting\n\n"
documentation_content += f"Accuracy: {one_shot_accuracy:.2f}\n\n"
documentation_content += "### Prompts and Predictions\n\n"
for index, row in one_shot_results_df.iterrows():
    documentation_content += f"**Original Category:** {row['original_category']}\n"
    documentation_content += f"**Prompt:**\n```\n{row['prompt']}\n```\n"
    documentation_content += f"**Predicted Category:** {row['predicted_category']}\n\n"

# Few-shot Section
documentation_content += "## Few-shot Prompting\n\n"
documentation_content += f"Accuracy: {few_shot_accuracy:.2f}\n\n"
documentation_content += "### Prompts and Predictions\n\n"
for index, row in few_shot_results_df.iterrows():
    documentation_content += f"**Original Category:** {row['original_category']}\n"
    documentation_content += f"**Prompt:**\n```\n{row['prompt']}\n```\n"
    documentation_content += f"**Predicted Category:** {row['predicted_category']}\n\n"

# Comparison Table
documentation_content += "## Comparison Table\n\n"
documentation_content += "| Technique | Accuracy |\n"
documentation_content += "|---|---|\n"
documentation_content += f"| Zero-shot | {zero_shot_accuracy:.2f} |\n"
documentation_content += f"| One-shot | {one_shot_accuracy:.2f} |\n"
documentation_content += f"| Few-shot | {few_shot_accuracy:.2f} |\n\n"

# Reflection
documentation_content += "## Reflection\n\n"
documentation_content += """In this limited test with 5 email samples and a simulated classification function, the Zero-shot prompting technique achieved the highest accuracy (0.60) compared to One-shot (0.40) and Few-shot (0.40). This unexpected result is likely due to the simplic
"""

# Save to file
with open("prompting_comparison.md", "w") as f:
    f.write(documentation_content)

print("Documentation file 'prompting_comparison.md' created successfully.")
```

Summary:

Data Analysis Key Findings

- The zero-shot prompting technique achieved an accuracy of 60% based on the simulated classification.
- Both the one-shot and few-shot prompting techniques achieved an accuracy of 40% based on the simulated classification.

- The prompts for all three techniques resulted in simple and clear predicted categories that followed the requested format.
- The one-shot and few-shot prompts, by including examples, offered additional clarity regarding the desired output format and the classification process compared to the zero-shot prompt.
- A documentation file (prompting_comparison.md) was successfully created, containing the prompts, simulated responses, a comparison table of accuracies, and a reflection.

Insights or Next Steps

- The simulation used for classification was keyword-based and did not accurately reflect how a real language model would leverage examples in one-shot and few-shot prompting. A next step would be to test these prompts with an actual language model to get a more realistic evaluation of the techniques.
- While zero-shot performed best in this limited simulation, one-shot and few-shot prompting are generally expected to improve performance on real LLMs by providing context and format examples. Future testing should focus on evaluating the performance gain from examples using a true LLM.