Drain3 log与模板匹配的实现

```python
import os
import json
import re
from log_parser import parse_log_line

import matplotlib.pyplot as plt
from skimage import io
import seaborn as sns
import warnings
import numpy as np
import warnings
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt
import warnings
from pylab import mpl, plt
import matplotlib.patches as mpatches

# best font and style settings for notebook
warnings.filterwarnings('ignore')
sns.set_style("white")
mpl.rcParams['font.family'] = 'MiSans'

# 设置日志主目录
log_root_path = r".\2025_5_8_log_all"
log_extensions = (".log", ".txt", ".out")
all_log_files = []

# 扫描所有日志文件路径
for root, dirs, files in os.walk(log_root_path):
    for file in files:
        if file.lower().endswith(log_extensions):
            full_path = os.path.join(root, file)
            all_log_files.append(full_path)
```

```python
print(f"共找到 {len(all_log_files)} 个日志文件")
# print(all_log_files)

# 收集所有解析后的日志
parsed_logs = []

for path in all_log_files:
    with open(path, 'r', encoding='utf-8', errors='ignore') as f:
        for line in f:
            parsed = parse_log_line(line, source_file=path)
            if parsed:
                parsed_logs.append(parsed)

print(f"成功解析出 {len(parsed_logs)} 条日志记录")
```

```
共找到 24 个日志文件
成功解析出 362034 条日志记录
```

单条log案例

```python
parsed_logs[100]
```

```
{'source_file': '.\\2025_5_8_log_all\\dm日志及错误编码\\dm_RAC0_202504.log',
 'timestamp': '00:00:54',
 'level': 'INFO',
 'content': '2025-04-30 00:00:54.621 [INFO] database P0000009826 T0000000000000011334  ckpt2_log_adjust:
full_status: 160, ptx_reserved: 16'}
```

```python
len(parsed_logs)
```

```
362034
```

```python
import re
from drain3 import TemplateMiner
from drain3.file_persistence import FilePersistence
from drain3.template_miner_config import TemplateMinerConfig
import logging
from collections import defaultdict
import pandas as pd

# ✅ Step 1: 日志设置
logging.basicConfig(level=logging.INFO, format="%(message)s")

# ✅ Step 2: 自定义参数配置
from drain3.template_miner_config import TemplateMinerConfig

config = TemplateMinerConfig()
config.load("drain3.ini")  # 如果没有文件会自动加载内置默认配置
config.drain_sim_th = 0.7  # 提高相似度容忍
config.drain_max_depth = 5  # 增加树深
config.drain_max_children = 100  # 增加匹配宽度

# ✅ Step 3: 初始化 Drain 模板挖掘器
persistence = FilePersistence("drain3_state.json")
template_miner = TemplateMiner(persistence, config)


# ✅ Step 4: 日志预处理函数
def preprocess_log(log: str) -> str:
    log = re.sub(r"\d{4}-\d{2}-\d{2}( \d{2}:\d{2}:\d{2}(\.\d+)?)?", "<DATE>", log)
    log = re.sub(r"P\d{10}", "<P_ID>", log)
    log = re.sub(r"T\d{16}", "<T_ID>", log)
    log = re.sub(r"full_status:\s*\d+", "full_status: <STATUS>", log)
    log = re.sub(r"ptx_reserved:\s*\d+", "ptx_reserved: <RESERVED>", log)
    return log


# ✅ Step 5: 批量处理前1000条日志
results = []
template_stats = defaultdict(list)

for idx, log_item in enumerate(parsed_logs[:5000]):
    log_content_raw = log_item.get('content', '').strip()
    if not log_content_raw:
        continue

    log_content = preprocess_log(log_content_raw)

    result = template_miner.add_log_message(log_content)

    if result is not None:
        template = result.get('template_mined')
        variables = result.get('parameter_list', [])

        if template:
            results.append({
                'log_id': idx,
                'template': template,
                'variables': variables,
                'original': log_content_raw
            })
            template_stats[template].append(idx)

# ✅ Step 6: 打印示例结果
print("\n🔍 示例模板匹配结果 (前5条):")
for r in results[:5]:
    print(f"\n[Log ID] {r['log_id']}")
    print("Original :", r['original'])
    print("Template :", r['template'])
    print("Variables:", r['variables'])
```

```
config file not found: drain3.ini
Starting Drain3 template miner
Checking for saved state
Restored 2184 clusters built from 365782 messages
```

```
🔍 示例模板匹配结果 (前5条):

[Log ID] 0
Original : 2025-04-30 00:00:01.319 [WARNING] database P0000009826 T0000000000000034013
socket_err_should_retry errno:38
Template : <DATE> [WARNING] database <P_ID> <*> socket_err_should_retry <*>
Variables: []

[Log ID] 1
Original : 2025-04-30 00:00:03.926 [INFO] database P0000009826 T0000000000000011404  checkpoint requested by
CKPT_DIRTY_PAGES, rlog free space[21399052288], used space[75776000]
Template : <DATE> [INFO] database <P_ID> <*> checkpoint requested by <*> rlog free <*> used <*>
Variables: []

[Log ID] 2
Original : 2025-04-30 00:00:03.926 [INFO] database P0000009826 T0000000000000011404  checkpoint generate by
dirty_pages[10946] > ckpt_dirty_pages[10000]
Template : <DATE> [INFO] database <P_ID> <*> checkpoint generate by <*> > <*>
Variables: []

[Log ID] 3
Original : 2025-04-30 00:00:03.926 [INFO] database P0000009826 T0000000000000011334  checkpoint begin,
used_space[75776000], free_space[21399052288]...
Template : <DATE> [INFO] database <P_ID> <T_ID>334 checkpoint begin, <*> <*>
Variables: []

[Log ID] 4
Original : 2025-04-30 00:00:07.718 [WARNING] database P0000009826 T0000000000000033207
socket_err_should_retry errno:38
Template : <DATE> [WARNING] database <P_ID> <*> socket_err_should_retry <*>
```

```
Variables: []
```

```
len(results)
```

```
5000
```

```
# ✅ Step 7: 模板统计
print("\n📊 模板汇总统计:")
template_df = []
for template, ids in sorted(template_stats.items(), key=lambda x: -len(x[1]))[:3]:
    print(f"\nTemplate : {template}")
    print(f"Count    : {len(ids)}")
    print(f"Log IDs  : {ids[:5]}{'...' if len(ids) > 5 else ''}")

for template, ids in sorted(template_stats.items(), key=lambda x: -len(x[1]))[:]:
    template_df.append([template, len(ids), ids])
```

```
📊 模板汇总统计:

Template : <DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_request_far_ep_flush dest_seq:1 <*>
Count    : 1023
Log IDs  : [7, 8, 14, 15, 21]...

Template : <DATE> [INFO] database <P_ID> <*> checkpoint requested by <*> rlog free <*> used <*>
Count    : 545
Log IDs  : [1, 12, 19, 26, 34]...

Template : <DATE> [INFO] database <P_ID> <T_ID>334 checkpoint begin, <*> <*>
Count    : 545
Log IDs  : [3, 13, 20, 28, 36]...
```

```
template_df = pd.DataFrame(template_df, columns=['模板', '与模板匹配的log数量', '与模板log id的列表'])
template_df['累计'] = template_df['与模板匹配的log数量'].cumsum()
template_df['累计百分比'] = template_df['累计'] / len(results)
template_df
```

	模板	与模板匹配的log数量	与模板log id的列表	累计	累计百分比
0	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	1023	[7, 8, 14, 15, 21, 22, 29, 30, 37, 38, 45, 46,...	1023	0.2046
1	<DATE> [INFO] database <P_ID> <*> checkpoint r...	545	[1, 12, 19, 26, 34, 42, 50, 59, 70, 79, 95, 10...	1568	0.3136
2	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	545	[3, 13, 20, 28, 36, 43, 52, 61, 72, 81, 97, 10...	2113	0.4226

	模板	与模板匹配的log数量	与模板log id的列表	累计	累计百分比
3	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	544	[11, 18, 25, 33, 41, 49, 58, 66, 78, 88, 102, ...	2657	0.5314
4	<DATE> [INFO] database <P_ID> <*> ckpt2_log_ad...	506	[9, 16, 23, 31, 39, 47, 56, 64, 76, 86, 100, 1...	3163	0.6326
...	...	...	...	...	...
524	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	1	[4962]	4996	0.9992
525	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	1	[4969]	4997	0.9994
526	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	1	[4976]	4998	0.9996
527	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	1	[4985]	4999	0.9998
528	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	1	[4995]	5000	1.0000

529 rows × 5 columns

```python
import matplotlib.pyplot as plt

# 设置样式统一颜色与字体
plt.rcParams.update({'font.size': 11, 'axes.titlesize': 15, 'axes.labelsize': 12})

# ✅ 设置只显示前 N 个模板
N = 15
top_templates = template_df.sort_values(by='与模板匹配的log数量', ascending=False).head(N)
```

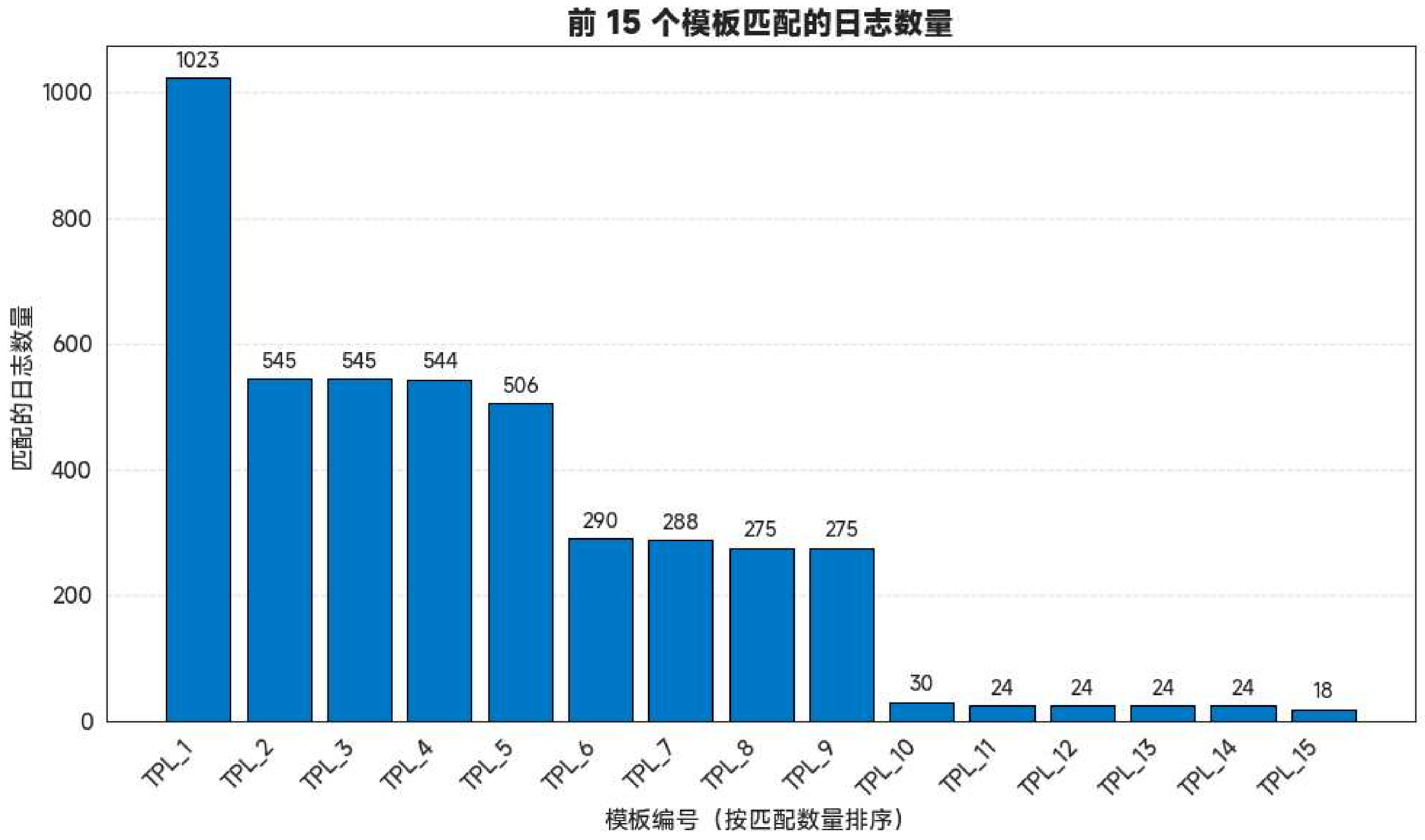
```python
plt.figure(figsize=(10, 6))
bars = plt.bar(
    range(N),
    top_templates['与模板匹配的log数量'],
    color='#007acc',
    edgecolor='black',
    linewidth=0.8
)

# ✅ 模板索引（编号）作为 x 轴
x_labels = [f'TPL_{i + 1}' for i in range(N)]
plt.xticks(range(N), x_labels, rotation=45, ha='right')

plt.ylabel("匹配的日志数量")
plt.xlabel("模板编号（按匹配数量排序）")
plt.title(f"前 {N} 个模板匹配的日志数量", fontweight='bold')

# ✅ 添加柱顶数字
for i, count in enumerate(top_templates['与模板匹配的log数量']):
    plt.text(i, count + max(top_templates['与模板匹配的log数量']) * 0.01,
             str(count), ha='center', va='bottom', fontsize=10)

plt.grid(axis='y', linestyle='--', alpha=0.4)
plt.tight_layout()
plt.show()
```



```
plt.figure(figsize=(10, 6))
template_df['累计百分比'].plot(kind='line', marker='o', color='#007acc', linewidth=2, markersize=6)

plt.title("模板累计覆盖率", fontweight='bold')
plt.xlabel("模板编号（索引）")
plt.ylabel("累计百分比")
```

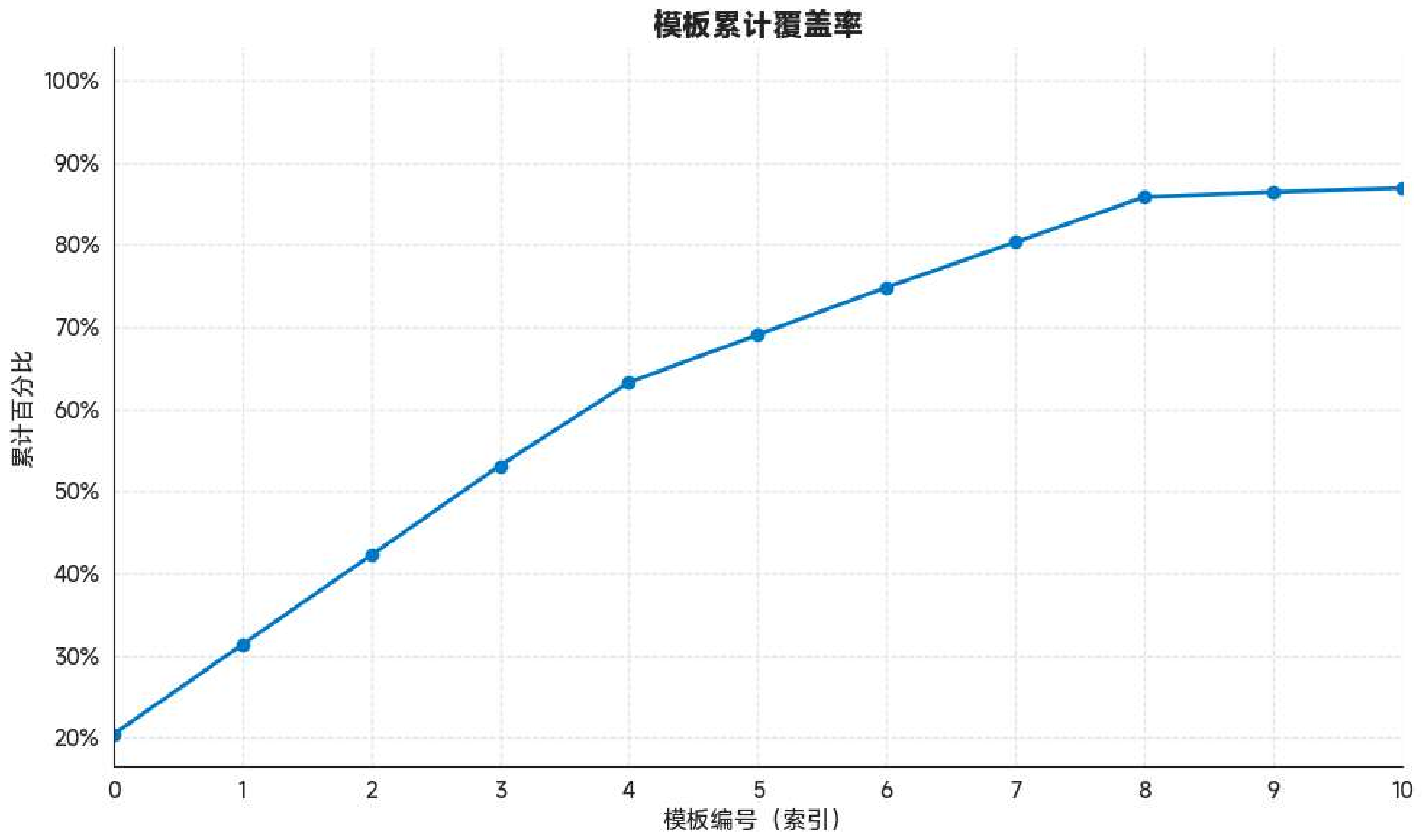
```
# ✅ 设置连续 x 轴刻度 & 限制范围
plt.xticks(range(11))
plt.xlim(0, 10)

# ✅ 百分比显示格式
from matplotlib.ticker import FuncFormatter

plt.gca().yaxis.set_major_formatter(FuncFormatter(lambda y, _: f'{y:.0%}'))

# ✅ 去掉边框，统一风格
for spine in ['top', 'right']:
    plt.gca().spines[spine].set_visible(False)

plt.grid(True, linestyle='--', alpha=0.4)
plt.tight_layout()
plt.show()
```



```
# ✅ Step 8: 导出 CSV（可选）
df = pd.DataFrame(results)
```

```
df
```

	log_id	template	variables	original
0	0	<DATE> [WARNING] database <P_ID> <*> socket_er...	[]	2025-04-30 00:00:01.319 [WARNING] database P00...
1	1	<DATE> [INFO] database <P_ID> <*> checkpoint r...	[]	2025-04-30 00:00:03.926 [INFO] database P00000...
2	2	<DATE> [INFO] database <P_ID> <*> checkpoint g...	[]	2025-04-30 00:00:03.926 [INFO] database P00000...
3	3	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	[]	2025-04-30 00:00:03.926 [INFO] database P00000...
4	4	<DATE> [WARNING] database <P_ID> <*> socket_er...	[]	2025-04-30 00:00:07.718 [WARNING] database P00...
...	...	...	...	...
4995	4995	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	[]	2025-04-30 00:26:29.630 [INFO] database P00000...
4996	4996	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	[]	2025-04-30 00:26:29.631 [INFO] database P00000...
4997	4997	<DATE> [INFO] database <P_ID> <*> checkpoint r...	[]	2025-04-30 00:26:29.631 [INFO] database P00000...
4998	4998	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	[]	2025-04-30 00:26:29.631 [INFO] database P00000...
4999	4999	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	[]	2025-04-30 00:26:29.773 [INFO] database P00000...

5000 rows × 4 columns

正则类型匹配，提取变量

```python
import re

template = "<DATE> [WARNING] database <P_ID> <*> socket_err_should_retry <*>"
original = "2025-04-30   00:00:01.319 [WARNING] database P0000009826 T0000000000000034013 
socket_err_should_retry errno:38"


def extract_variables_from_template(template, original):
    # Step 1: Replace <xxx> and <*> with a temporary placeholder for variables
    # We use a unique placeholder that won't conflict with literal characters
    temp_placeholder = "__VAR_PLACEHOLDER__"
    normalized = re.sub(r'<[^>]+>', temp_placeholder, template)

    # Step 2: Escape the entire normalized string for regex
    # This turns literal characters into their escaped form (e.g., [ into \[)
    pattern = re.escape(normalized)

    # Step 3: Convert our temporary placeholder back to the regex capturing group
    # Ensure this happens *after* re.escape, so we target the escaped placeholder
    pattern = pattern.replace(re.escape(temp_placeholder), r'(.+?)')

    # Step 4: Replace single escaped spaces with \s+ for multiple spaces
    pattern = pattern.replace(r'\ ', r'\s+')

    # # Debugging: Print the final pattern to inspect it
    # print(f"Generated Regex Pattern: {pattern}")

    match = re.match(pattern, original)
    return list(match.groups()) if match else []


# Test
variables = extract_variables_from_template(template, original)
print("✅ Extracted variables:", variables)
# 应用到整个 DataFrame 中
```

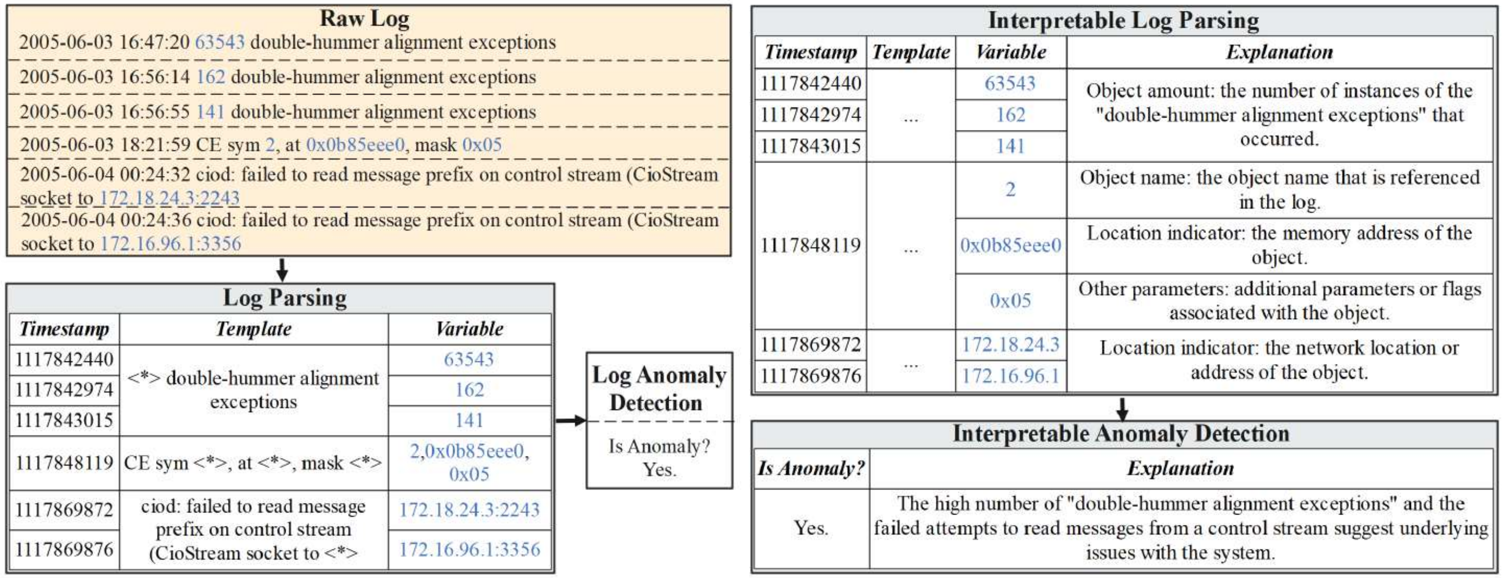
```python
df['variables'] = df.apply(lambda row: extract_variables_from_template(row['template'], row['original']),
axis=1)
df
```

```
✅ Extracted variables: ['2025-04-30   00:00:01.319', 'P0000009826', 'T0000000000000034013', 'e']
```

	log_id	template	variables	original
0	0	<DATE> [WARNING] database <P_ID> <*> socket_er...	[2025-04-30 00:00:01.319, P0000009826, T000000...	2025-04-30 00:00:01.319 [WARNING] database P00...
1	1	<DATE> [INFO] database <P_ID> <*> checkpoint r...	[2025-04-30 00:00:03.926, P0000009826, T000000...	2025-04-30 00:00:03.926 [INFO] database P00000...
2	2	<DATE> [INFO] database <P_ID> <*> checkpoint g...	[2025-04-30 00:00:03.926, P0000009826, T000000...	2025-04-30 00:00:03.926 [INFO] database P00000...
3	3	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	[2025-04-30 00:00:03.926, P0000009826, T000000...	2025-04-30 00:00:03.926 [INFO] database P00000...
4	4	<DATE> [WARNING] database <P_ID> <*> socket_er...	[2025-04-30 00:00:07.718, P0000009826, T000000...	2025-04-30 00:00:07.718 [WARNING] database P00...
...	...	...	...	...
4995	4995	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	[2025-04-30 00:26:29.630, P0000009826, T000000...	2025-04-30 00:26:29.630 [INFO] database P00000...
4996	4996	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	[2025-04-30 00:26:29.631, P0000009826, T000000...	2025-04-30 00:26:29.631 [INFO] database P00000...
4997	4997	<DATE> [INFO] database <P_ID> <*> checkpoint r...	[2025-04-30 00:26:29.631, P0000009826, T000000...	2025-04-30 00:26:29.631 [INFO] database P00000...

	log_id	template	variables	original
4998	4998	<DATE> [INFO] database <P_ID> <T_ID>334 checkp...	[2025-04-30 00:26:29.631, P0000009826, T000000...	2025-04-30 00:26:29.631 [INFO] database P00000...
4999	4999	<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_...	[2025-04-30 00:26:29.773, P0000009826, T000000...	2025-04-30 00:26:29.773 [INFO] database P00000...

5000 rows × 4 columns



Raw Log

```
2005-06-03 16:47:20 63543 double-hummer alignment exceptions
2005-06-03 16:56:14 162 double-hummer alignment exceptions
2005-06-03 16:56:55 141 double-hummer alignment exceptions
2005-06-03 18:21:59 CE sym 2, at 0x0b85eee0, mask 0x05
2005-06-04 00:24:32 ciod: failed to read message prefix on control stream (CioStream socket to 172.18.24.3:2243
2005-06-04 00:24:36 ciod: failed to read message prefix on control stream (CioStream socket to 172.16.96.1:3356
```

Log Parsing

Timestamp	*Template*	*Variable*
1117842440	<*> double-hummer alignment exceptions	63543
1117842974		162
1117843015		141
1117848119	CE sym <*>, at <*>, mask <*>	2,0x0b85eee0, 0x05
1117869872	ciod: failed to read message prefix on control stream (CioStream socket to <*>	172.18.24.3:2243
1117869876		172.16.96.1:3356

Log Anomaly Detection

Is Anomaly? Yes.

(a) Existing workflow of automated log analysis

Interpretable Log Parsing

Timestamp	*Template*	*Variable*	*Explanation*
1117842440	...	63543	Object amount: the number of instances of the "double-hummer alignment exceptions" that occurred.
1117842974		162	
1117843015		141	
1117848119	...	2	Object name: the object name that is referenced in the log.
		0x0b85eee0	Location indicator: the memory address of the object.
		0x05	Other parameters: additional parameters or flags associated with the object.
1117869872	...	172.18.24.3	Location indicator: the network location or address of the object.
1117869876		172.16.96.1	

Interpretable Anomaly Detection

Is Anomaly?	*Explanation*
Yes.	The high number of "double-hummer alignment exceptions" and the failed attempts to read messages from a control stream suggest underlying issues with the system.

(b) Interpretable log analysis

```
row = df.iloc[2000]

print("🧩 模板 Template:")
print(row["template"])
print("\n📦 提取出的变量 Variables:")
print(row["variables"] if row["variables"] else "（无）")
print("\n📝 原始日志 Original Log:")
print(row["original"])
```

```
🧩 模板 Template:
<DATE> [INFO] database <P_ID> <T_ID>334 ckpt2_request_far_ep_flush dest_seq:1 <*>

📦 提取出的变量 Variables:
['2025-04-30 00:09:33.386', 'P0000009826', 'T0000000000000011', 'b']

📝 原始日志 Original Log:
2025-04-30 00:09:33.386 [INFO] database P0000009826 T0000000000000011334  ckpt2_request_far_ep_flush
dest_seq:1 begin
```

```
df.to_csv(f"drain3_parsed_logs_{len(results)}.csv", index=False)
print(f"\n✅ 解析结果已保存至:drain3_parsed_logs_{len(results)}.csv")
```

```
✅ 解析结果已保存至:drain3_parsed_logs_5000.csv
```

```
!jupyter nbconvert --to html log_parsing_drain.ipynb
!jupyter nbconvert --to markdown log_parsing_drain.ipynb
```