AIOps Challenge

2023 CCF国际AIOps挑战赛决赛
暨“大模型时代的AIOps”研讨会

基于建行云龙舟运维平台的稳定性工具和多维监控系统故障识别和故障分类

南开大学/王潇霏

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南開大學 Nankai University

01 团队介绍

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Parallel and Distributed Software Technology Lab | Nankai-Baidu Joint Laboratory

南開大學 Nankai University

- **参赛人员**

王文蕊（硕士研究生）

王潇霏（博士研究生）

张家茗（硕士研究生）

- **参赛单位**

南开大学（并行与分布式软件技术研究室）

- **指导老师**

王　刚（教授、博导）

刘晓光（教授、博导）

02 赛题解析 | 故障识别是故障根因定位和故障分类的基础

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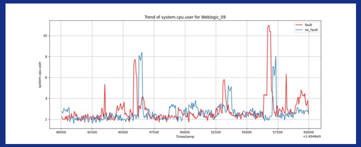
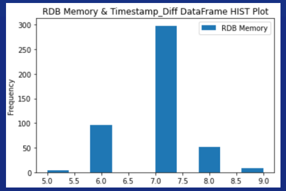
● 数据分析

timestamp	cmdb_id	kpi_name	value	device
1694707260	ES_01	system. cpu. guest	0	
1694707260	Weblogic_48	system. net. packets_out. error	0	eth0
1694707260	ES_03	system. mem. free	4430	
1694707260	Weblogic_48	system. os. nofile. current	4192	
1694707260	ES_03	system. mem. cached	7604	
1694707260	Weblogic_48	system. os. nofile. max	3247490	
1694707260	Weblogic_48	system. os. nofile. used_pct	0. 129	
1694707260	Weblogic_48	system. processes. gc. InfoCount. FGC	1	
1694707260	ES_03	system. mem. buffered	8	
1694707260	ES_03	system. load. norm. 5	0. 01	
1694707260	Weblogic_48	system. processes. gc. InfoPercent. E	25. 92	
1694707260	ES_03	system. load. norm. 15	0. 01	
1694707260	ES_03	system. load. norm. 1	0. 01	
1694707260	ES_03	system. mem. pct_usage	24. 95	
1694707260	Weblogic_48	system. processes. gc. InfoPercent. 0	5. 46	
1694707260	Weblogic_48	system. processes. gc. count	1	
1694707260	ES_03	system. load. 15	0. 05	
1694707260	ES_03	system. load. 1	0. 04	

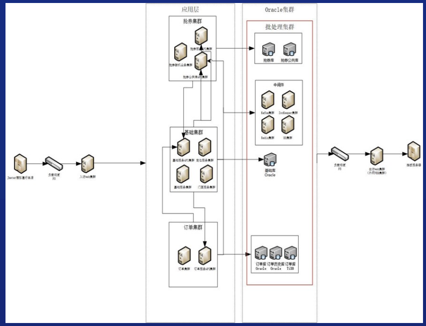


Monitor数据

```
4474:S 1694534438 * 10000 changes in 60 seconds. Saving...
4474:S 1694534438 * Background saving started by pid 18761
18761:C 1694534438 * DB saved on disk
18761:C 1694534438 * RDB: 7 MB of memory used by copy-on-write
4474:S 1694534438 * Background saving terminated with success
4474:S 1694534504 * 10000 changes in 60 seconds. Saving...
4474:S 1694534504 * Background saving started by pid 19023
19023:C 1694534505 * DB saved on disk
19023:C 1694534505 * RDB: 7 MB of memory used by copy-on-write
4474:S 1694534505 * Background saving terminated with success
4474:S 1694534579 * 10000 changes in 60 seconds. Saving...
4474:S 1694534579 * Background saving started by pid 19305
19305:C 1694534579 * DB saved on disk
19305:C 1694534579 * RDB: 7 MB of memory used by copy-on-write
```



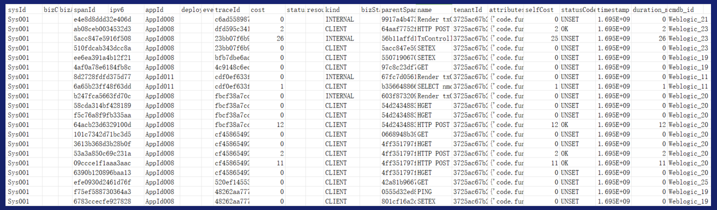
Log数据



部署架构图

tran_code	timestamp	amount	bus_success_rate	sys_success_rate	avg_rsp_time	stall_amount	avg_proc_time	stall_rate	apdex
A0018	1694620800	206	100	100	10	0	10	0	100
A0005	1694620800	202	100	100	2	0	2	0	100
A0004	1694620800	204	100	100	10	0	4	0	100
A0010	1694620800	99	100	100	27	0	8	0	100
A0007	1694620800	23	100	100	2	0	2	0	100
A0001	1694620800	50	100	100	4	0	2	0	100
A0022	1694620800	158	100	100	1	0	1	0	100
A0023	1694620800	2	100	100	33	0	33	0	100
A0017	1694620800	205	100	100	3	0	3	0	100
A0014	1694620800	201	100	100	2	0	2	0	100
A0008	1694620800	400	100	100	2	0	2	0	100
P0002	1694620800	149	100	100	2	0	2	0	100
P0015	1694620800	205	100	100	1	0	1	0	100
P0005	1694620800	17	100	100	1	0	1	0	100
P0008	1694620800	1	100	100	2	0	2	0	100
P0013	1694620800	14	100	100	1	0	1	0	100

TC数据



Apptracing数据

异常检测

如何借助Monitor和Log数据高效识别异常信息并进行分类?

根因定位

结合TC和Apptracing数据进行故障根因定位?

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02 赛题解析 | 多维数据的复杂性是高效识别故障并进行分类的难点

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难点1

- 数据量大，数据高维稀疏，数据类型差异大。

应对措施

- 特征筛选，特征转换等方式降低数据维度。
- 不同类型的数据采取不用的处理方式。
- 通过数据拆分降低数据稀疏程度。
- 查看数据分布，采用分布一致的数据进行建模。

难点2

- 单指标故障识别容易受数据波动影响。

应对措施

- 方案针对多指标联合识别。

基于建行云龙舟运维平台的稳定性工具和多维监控系统故障识别和故障分类

数据集
Monitor数据 Log数据

难点3

- 损耗性硬件故障的发生并不属于突发事件。

应对措施

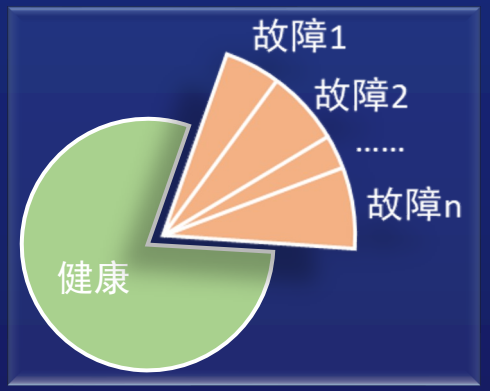
- 方案设置时间窗口进行故障识别。

难点4

- 同类型故障区分难度较大。

应对措施

- 借助聚类方法进行故障分类。



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03 方案介绍 | 基于LLM，采用ID²进行故障检测和故障多分类

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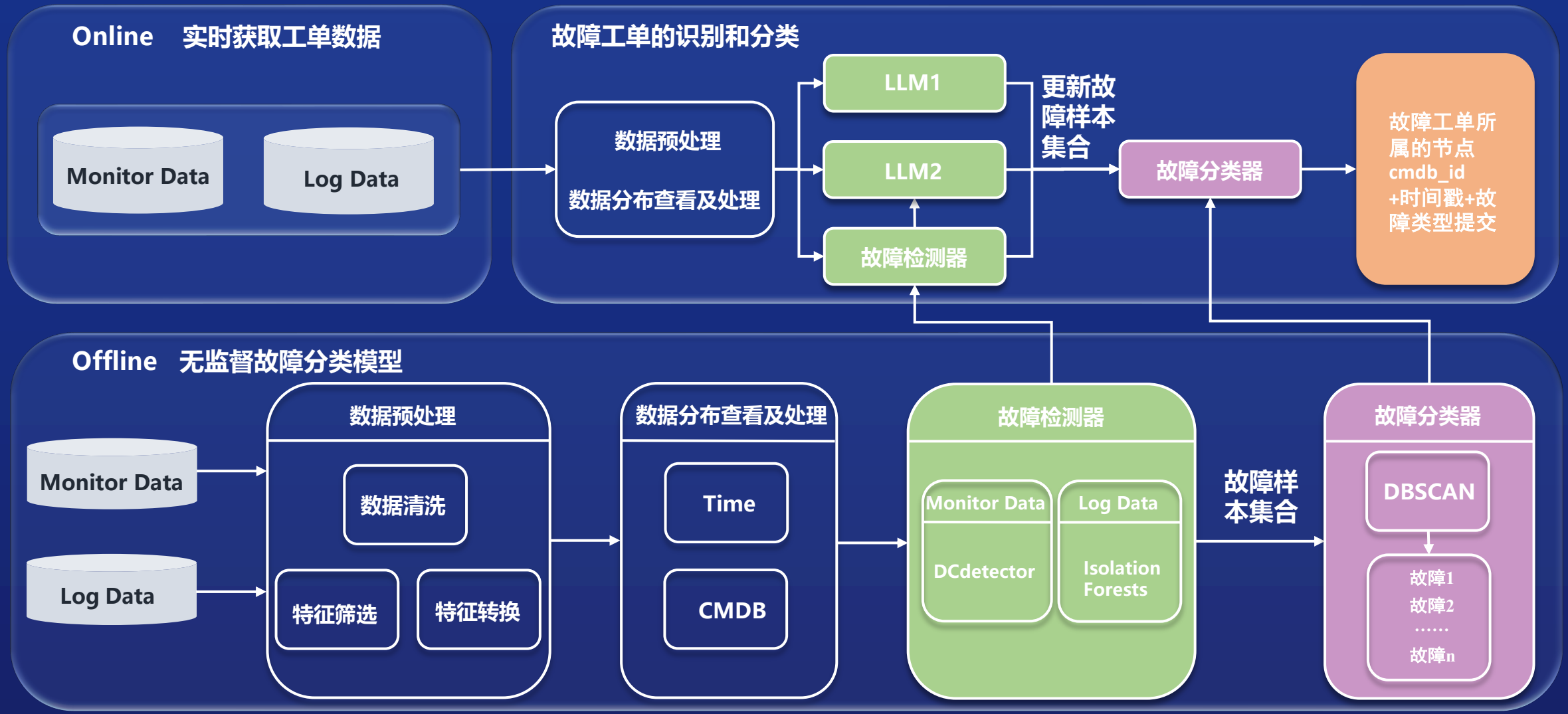

ID²_LLM（Isolation Forests_DCdetector_DBSCAN_LLM）总体框架图

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03 方案介绍 | 通过数据筛选和归一化操作保证数据质量

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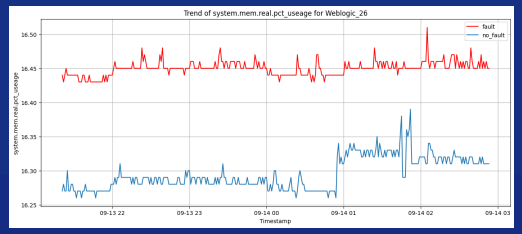
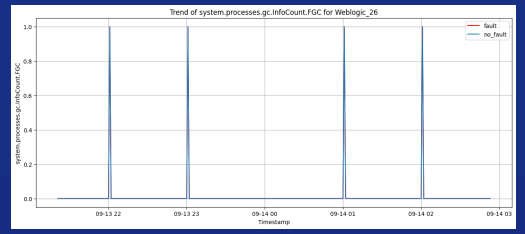
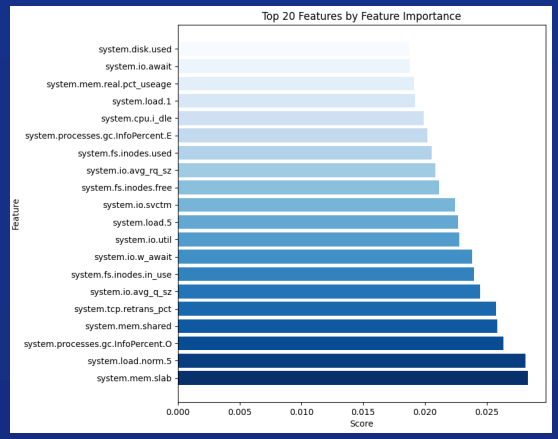
数据分析

- 特征对于异常数据识别的敏感性不同。

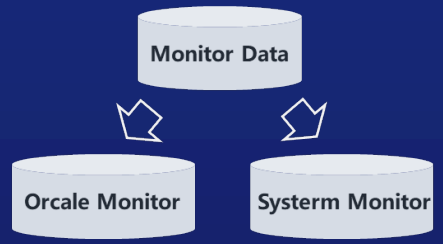


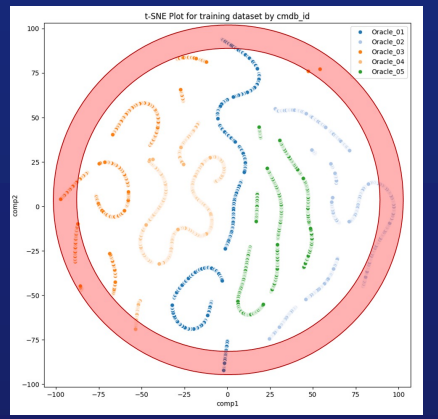


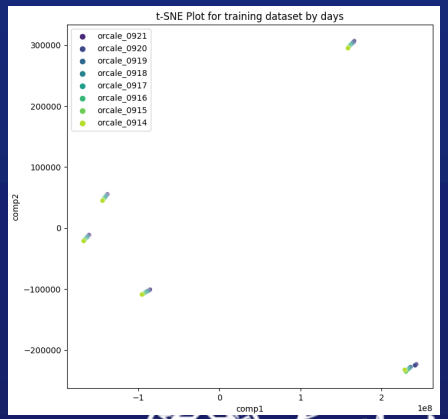


数据筛选

- 数据拆分：将Monitor数据进行拆分，降低数据稀疏性。
- 数据筛选：分别以Time和CMDB为单位筛掉分布不一致的数据。







按列归一化

- 指标值按列归一化：指标值之间具有数量级的差异。

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03 方案介绍 | 通过筛选和构造操作提取有助于建模的特征

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特征筛选

- 去除冗余特征：针对常量指标。

```
4474:S 1694534438 * 10000 changes in 60 seconds. Saving...
4474:S 1694534438 * Background saving started by pid 18761
18761:C 1694534438 * DB saved on disk
18761:C 1694534438 * RDB: 7 MB of memory used by copy-on-write
4474:S 1694534438 * Background saving terminated with success
4474:S 1694534504 * 10000 changes in 60 seconds. Saving...
4474:S 1694534504 * Background saving started by pid 19023
19023:C 1694534505 * DB saved on disk
19023:C 1694534505 * RDB: 7 MB of memory used by copy-on-write
4474:S 1694534505 * Background saving terminated with success
4474:S 1694534579 * 10000 changes in 60 seconds. Saving...
4474:S 1694534579 * Background saving started by pid 19305
19305:C 1694534579 * DB saved on disk
19305:C 1694534579 * RDB: 7 MB of memory used by copy-on-write
```

Timestamp	Ten Thousand Changes Times	Growth Times	RDB Times
1694534450	1	0	1
1694534612	2	0	2
1694534773	3	0	3
1694534884	3	1	3
1694534985	4	1	4

特征构造

- 正则匹配：利用正则表达式解析Log数据。
- 特征构造：基于统计学的方法构造差分特征。

Timestamp	AOF Rewrite Memory Times	AOF Diff Memory Times	AOF Flush Memory Times	Timestamp_Diff
1694534450	0	0	0	0.0
1694534612	0	0	0	162.0
1694534773	0	0	0	161.0
1694534884	1	1	1	111.0
1694534985	1	1	1	101.0

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03 方案介绍 | offline故障识别和故障分类

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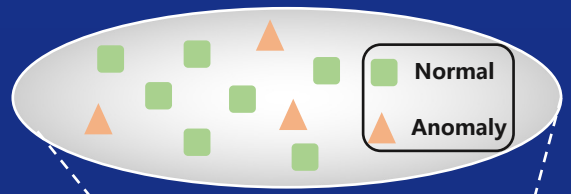

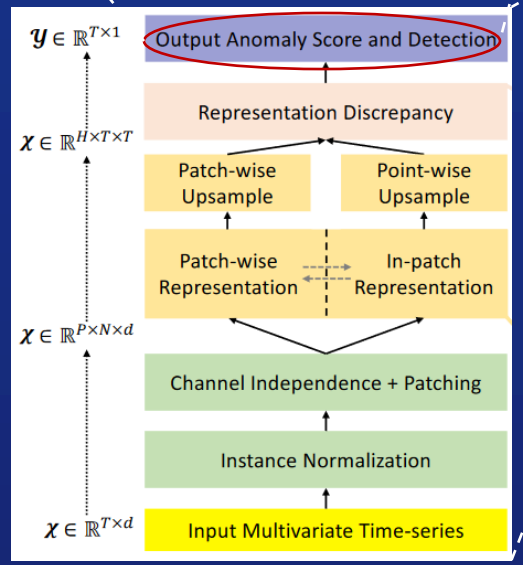

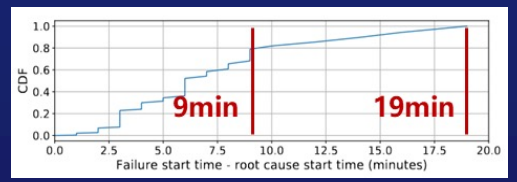

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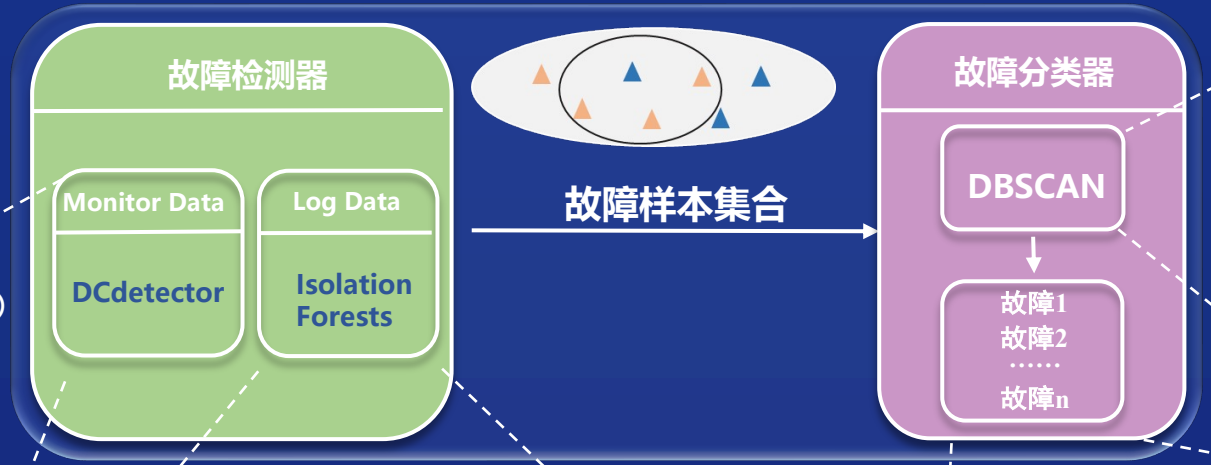

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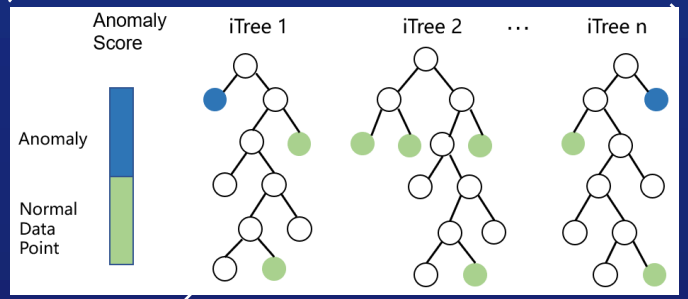

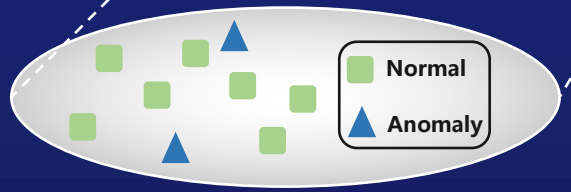

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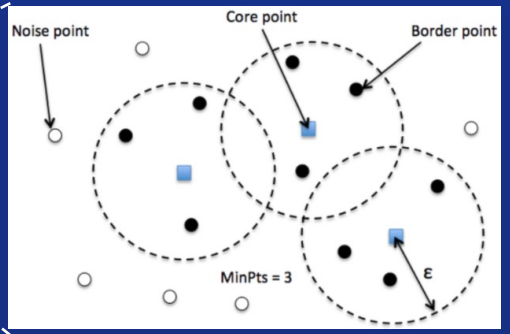

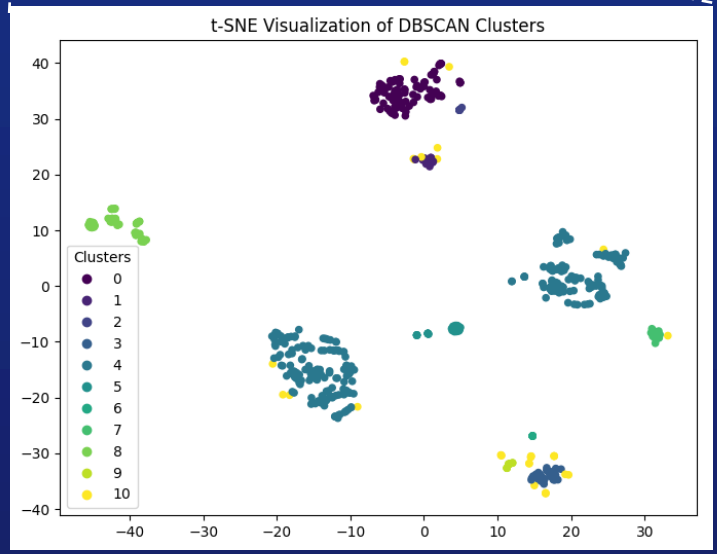

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03 方案介绍 | online故障识别和故障分类

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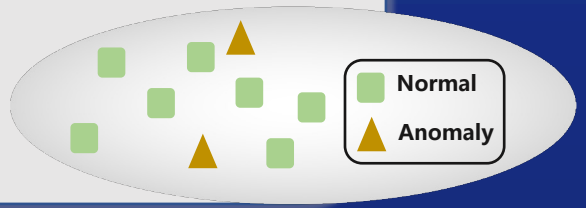
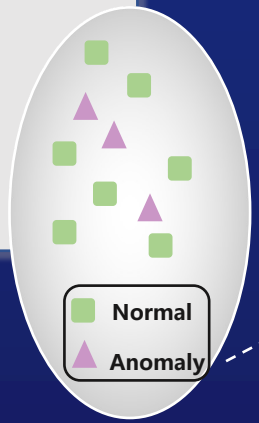
<|im_start|>system
You are a helpful assistant.<|im_end|>
<|im_start|>user
You are an experienced operations engineer. You will receive some server data and find patterns in the data to determine whether the server is damaged and provide the reasons. You can only diagnose the status of the server, and should not diagnose other hardware such as the RAM and CPU. You should output them in the required format as JSON.
-- A MALFUNCTION NODE EXAMPLE
{malfunctional example}
-- A FUNCTIONAL NODE DATA EXAMPLE
{functional example}
-- OUTPUT REQUIREMENT
{format_instructions}
-- OP DATA:
{disk_data}
-- YOUR JSON RESPONSE:
<|im_end|>
<|im_start|>assistant

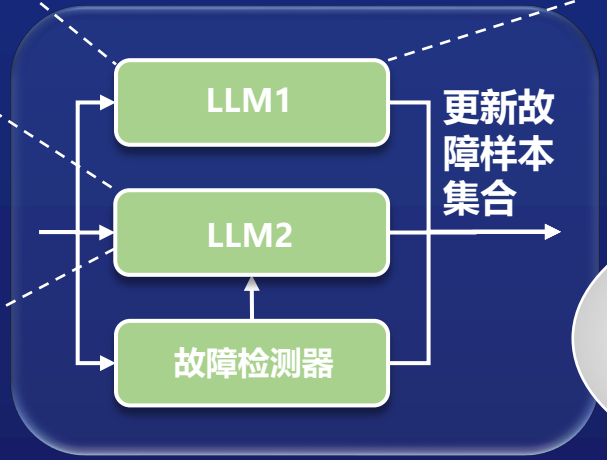
<|im_start|>system
You are a helpful assistant.<|im_end|>
<|im_start|>user
You are an experienced operations engineer. You will receive some server data and find patterns in the data to determine whether the server is damaged and provide the reasons. You can only diagnose the status of the server, and should not diagnose other hardware such as the RAM and CPU. You should output them in the required format as JSON.
-- OUTPUT REQUIREMENT
{format_instructions}
-- NODE DATA:
{disk_data}
-- YOUR JSON RESPONSE:
<|im_end|>
<|im_start|>assistant

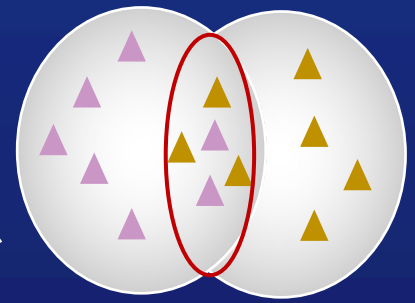


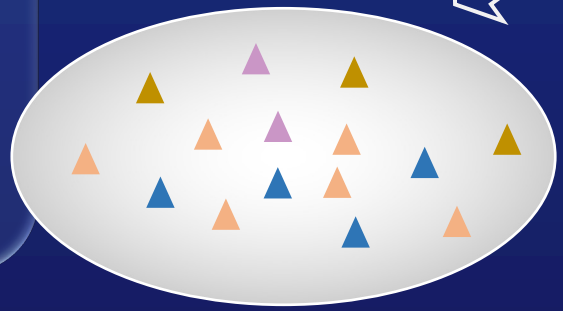
④

⑤









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03 方案介绍 | 总结

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方案的创新性和实用性

数据

- 本方案使用的Monitor和Log数据相对易于获取，则思路更容易被其他生产商借鉴去进行故障的识别和分类。
- 本方案对考虑了数据分布对模型性能的影响，该思路为后续故障预测类任务提供了新的方向。

模型

- 本方案故障检测和分类均为无监督算法，完全节省了人工标注数据的成本。
- 本方案在测试阶段借助了大模型的优势更新故障样本集合，实现了智能化的故障检测。
- 本方案的DCdetector创新性维护了一个故障检测窗口，考虑了硬件故障发生不属于突发事件，可做到提前预测。
- 本方案针对不同业务场景、不同数据只需要微调便可快读适应。

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04 未来展望

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改进思路

数据

- 数据处理及特征工程阶段存在人工干预，并未完全实现自动化。

模型

- 故障检测阶段各对象之间独立完成，后续可以考虑将对象之间的动态拓扑关系融入该阶段。
- 故障分类模型后续可进一步定位故障根因。
- 大模型后续可尝试prompt tuning。

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THANKS