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数据风云 十年变迁

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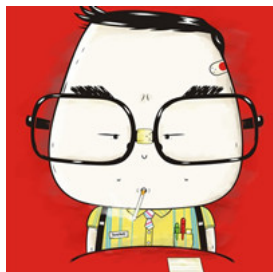
DATABASE TECHNOLOGY CONFERENCE CHINA 2019



Oracle SQL优化三板斧

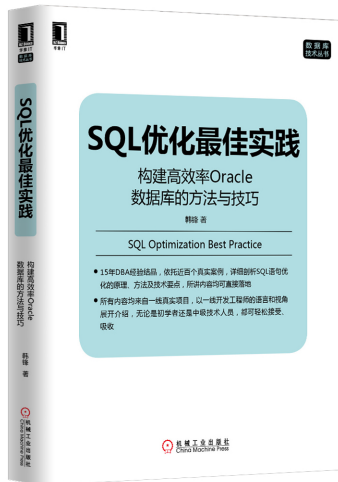
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- ITPUB论坛数据库管理版版主
- Oracle ACED、OCM
- 著有书籍《Oracle DBA实战攻略》

推荐3本Oracle SQL优化的书籍



数据库的主要作用是什么？

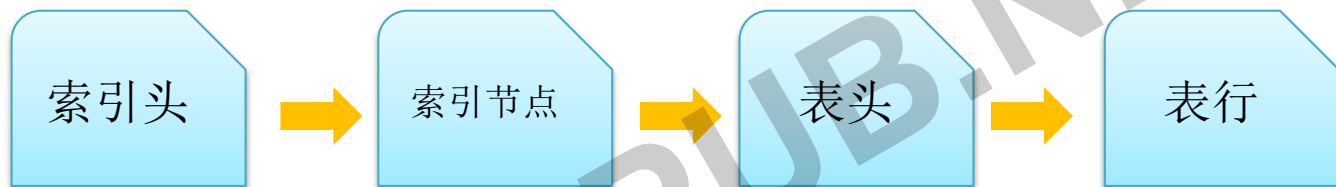
存储和读取数据



SQL优化的核心思想：如何快速地定位想要的数据库？

减少数据集、提高处理效率

逻辑读（logic reads）是衡量数据库读取效率的重要指标



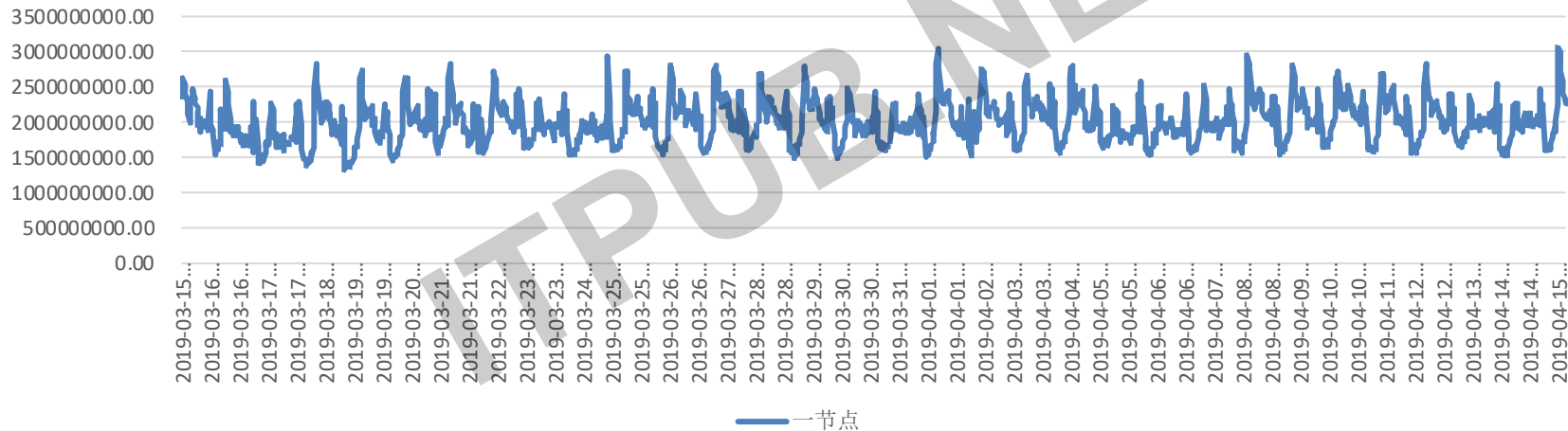
读取和存储的比例（OLTP系统）：8/2原则

Load Profile

	Per Second	Per Transaction	Per Exec	Per Call
DB Time(s):	192.3	0.0	0.01	0.00
DB CPU(s):	16.9	0.0	0.00	0.00
Redo size (bytes):	31,596,960.9	6,869.4		
Logical read (blocks):	2,398,187.8	521.4		
Block changes:	127,393.5	27.7		
Physical read (blocks):	1,413.2	0.3		
Physical write (blocks):	10,474.3	2.3		
Read IO requests:	1,389.0	0.3		
Write IO requests:	7,565.6	1.6		
Read IO (MB):	11.0	0.0		
Write IO (MB):	81.8	0.0		
Global Cache blocks received:	27.7	0.0		
Global Cache blocks served:	130.8	0.0		
User calls:	44,387.2	9.7		
Parses (SQL):	15,680.0	3.4		
Hard parses (SQL):	10.8	0.0		
SQL Work Area (MB):	13.9	0.0		
Logons:	1.4	0.0		
Executes (SQL):	29,164.4	6.3		
Rollbacks:	80.8	0.0		
Transactions:	4,599.7			

宏观：从逻辑读总次数及单次时间波动发现数据库性能变化

近一个月一节点logic reads



微观：从每次执行所耗逻辑读次数观察SQL执行计划优劣

Stat Name	Statement Total	Per Execution	% Snap Total
Elapsed Time (ms)	524,221,464	118.43	4.10
CPU Time (ms)	2,509,209	0.57	0.11
Executions	4,426,378		
Buffer Gets	143,501,009	32.42	0.04
Disk Reads	376,845	0.09	0.01
Parse Calls	3,967	0.00	0.00
Rows	6,595,844	1.49	
User I/O Wait Time (ms)	5,331,686		
Cluster Wait Time (ms)	0		
Application Wait Time (ms)	514,344,706		
Concurrency Wait Time (ms)	0		
Invalidations	0		
Version Count	16,605		
Sharable Mem(KB)	624,240		

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Execution Plan

Id	Operation	Name	Rows	Bytes	Cost (%CPU)	Time	Pstart	Pstop
0	UPDATE STATEMENT				4 (100)			
1	UPDATE	T_ORD_ORDER						
2	FILTER							
3	PARTITION RANGE ITERATOR		1	173	4 (0)	00:00:01	KEY	KEY
4	TABLE ACCESS BY LOCAL INDEX ROWID	T_ORD_ORDER	1	173	4 (0)	00:00:01	KEY	KEY
5	INDEX RANGE SCAN	IDX_ORDER_WAYBILL_NO	1		3 (0)	00:00:01	KEY	KEY

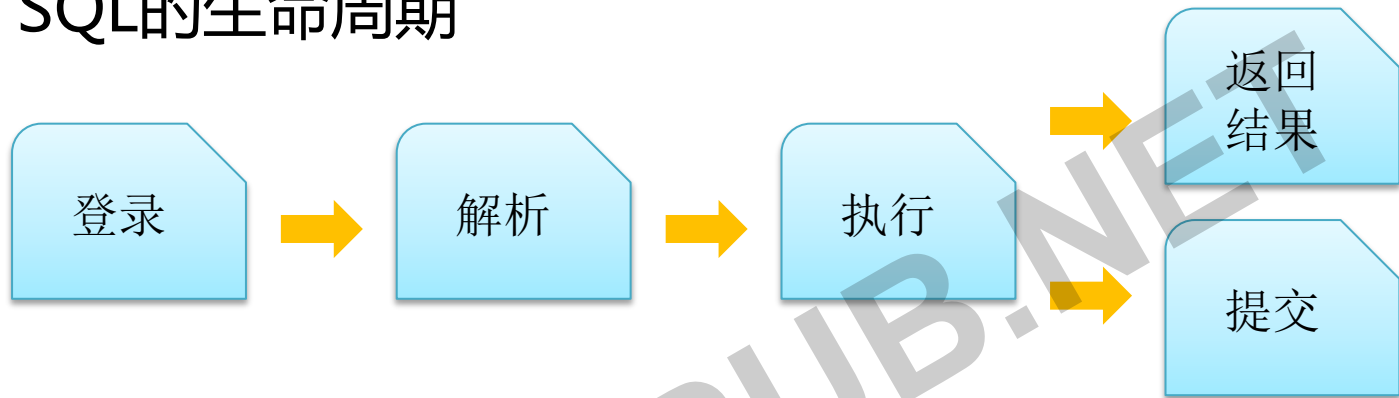
Stat Name	Statement Total	Per Execution	% Snap Total
Elapsed Time (ms)	171,700,342	29,210.67	1.34
CPU Time (ms)	49,751,461	8,464.01	2.26
Executions	5,878		
Buffer Gets	5,146,869,996	875,615.86	1.54
Disk Reads	299,246	50.91	0.00
Parse Calls	16	0.00	0.00
Rows	5,883	1.00	
User I/O Wait Time (ms)	639,041		
Cluster Wait Time (ms)	0		
Application Wait Time (ms)	0		
Concurrency Wait Time (ms)	0		
Invalidations	0		
Version Count	129		
Sharable Mem(KB)	2,890		

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Execution Plan

Id	Operation	Name	Rows	Bytes	Cost (%CPU)	Time	Pstart	Pstop
0	UPDATE STATEMENT				4 (100)			
1	UPDATE	T_ORD_ORDER						
2	FILTER							
3	PARTITION RANGE ITERATOR		1	189	4 (0)	00:00:01	KEY	KEY
4	TABLE ACCESS BY LOCAL INDEX ROWID	T_ORD_ORDER	1	189	4 (0)	00:00:01	KEY	KEY
5	INDEX RANGE SCAN	IDX_ORDER_CREATE_TIME	1		3 (0)	00:00:01	KEY	KEY

SQL的生命周期



SQL的生命周期：登录故障案例

Top 10 Foreground Events by Total Wait Time

Event	Waits	Total Wait Time (sec)	Wait Avg(ms)	% DB time	Wait Class
library cache lock	267	20.8K	77955	90.6	Concurrency
DB CPU		2461.5		10.7	
SQL*Net message from dblink	865	12.7	15	.1	Network
SQL*Net break/reset to client	86,784	6.2	0	.0	Application
enq: TX - row lock contention	1	4.9	4917	.0	Application
library cache: mutex X	39,504	3.3	0	.0	Concurrency
direct path read	13,473	3.1	0	.0	User I/O
log file sync	3,127	2.8	1	.0	Commit
gc cr block 2-way	5,270	2.7	1	.0	Cluster

解决办法：

SQL> alter system set
event= '28401 trace name
context off' scope=spfile ;

Time Model Statistics

- Total time in database user-calls (DB Time): 22976.5s
- Statistics including the word "background" measure background process time, and so do not contribute to the DB time statistic
- Ordered by % of DB time desc, Statistic name

Statistic Name	Time (s)	% of DB Time
connection management call elapsed time	21,138.95	92.00
DB CPU	2,461.48	10.71
sql execute elapsed time	1,495.73	6.51
PL/SQL execution elapsed time	78.49	0.34
parse time elapsed	58.31	0.25

Top Call Types

Call Type	Count	% Activity	Avg Active Sessions
LOGON	1,717	92.21	28.62
FETCH	75	4.03	1.25
V8 Bundled Exec	28	1.50	0.47

SQL的生命周期：解析故障案例

	Snap Id	Snap Time	Sessions	Cursors/Session
Begin Snap:	15476	11-Nov-18 07:00:52	1927	2.3
End Snap:	15477	11-Nov-18 08:00:06	2195	2.3
Elapsed:		59:24 (mins)		
DB Time:		1,057.24 (mins)		

Report Summary

Load Profile

	Per Second	Per Transaction	Per Exec	Per Call
DB Time(s):	17.9	33.3	0.00	0.00
DB CPU(s):	12.2	22.8	0.00	0.00
Redo size (bytes):	28,447.2	53,101.3		
Logical read (blocks):	314,839.1	587,697.7		
Block changes:	139.7	260.7		
Physical read (blocks):	0.0	0.1		
Physical write (blocks):	14.5	27.1		
Read IO requests:	0.0	0.1		
Write IO requests:	11.3	21.0		
Read IO (MB):	0.0	0.0		
Write IO (MB):	0.1	0.2		
User calls:	218,257.6	407,412.8		
Parses (SQL):	92,243.6	172,187.4		
Hard parses (SQL):	0.2	0.3		
SQL Work Area (MB):	3.9	7.3		
Logons:	0.9	1.7		
Executes (SQL):	92,252.1	172,203.4		
Rollbacks:	0.1	0.1		
Transactions:	0.5			

Top 10 Foreground Events by Total Wait Time

Event	Waits	Total Wait Time (sec)	Wait Avg(ms)	% DB time	Wait Class
DB CPU		43.4K		68.4	
latch: row cache objects	2,584,005	12.1K	5	19.1	Concurrency
library cache: mutex X	2,704,960	7350.9	3	11.6	Concurrency
cursor: pin S	425,110	2489.8	6	3.9	Concurrency
SQL*Net message to client	447,801,000	589.9	0	9	Network
latch: shared pool	1,599	36.3	23	.1	Concurrency
wait list latch free	10,395	11.2	1	.0	Other
latch free	54,460	10.6	0	.0	Other
resmgr:internal state change	49	4.9	101	.0	Concurrency
log file sync	4,063	.9	0	.0	Commit

Parse Calls	Executions	% Total Parses	SQL Id	SQL Module	SQL Text
127,155,836	127,908,946	38.79	05h5rkntrmbjm	JDBC Thin Client	SELECT T.ID, T.CODE, T.ORIG_OR...
59,141,747	59,236,822	18.04	8n52vk682swvm	JDBC Thin Client	SELECT T.ID, T.CODE, T.ORIG_OR...
34,087,833	34,122,085	10.40	09bjrvnq6vqtm	JDBC Thin Client	SELECT T.ID, T.CODE, T.DEST_OR...
28,098,739	28,122,510	8.57	dkswduuzrzyun	JDBC Thin Client	SELECT T.ID, T.CODE, T.ORIG_OR...
20,966,094	20,979,644	6.40	4qpfqcbmsm0f0	JDBC Thin Client	SELECT T.ID, T.CODE, T.ORIG_AR...
16,023,430	16,024,477	4.89	fqb3x3wmv4jhkv	JDBC Thin Client	SELECT T.ID, T.CODE, T.DEST_OR...
12,419,083	12,420,854	3.79	3gv9xg9pc5vp6	JDBC Thin Client	SELECT T.ID, T.CODE, T.ORIG_OR...
9,218,495	9,219,986	2.81	5n29h12y27w02	JDBC Thin Client	SELECT T.ID, T.CODE, T.ORIG_AR...
4,371,001	4,371,166	1.33	g6t0wwk38ycd0	JDBC Thin Client	SELECT ID, TRANSIT_RULE, SEQ, ...
2,502,730	2,503,241	0.76	bn59r7dcjcjfm	JDBC Thin Client	SELECT A.CODE FROM YTRUT.T_RUT...

SQL的生命周期：解析故障常见原因

内存
不足

内存
抖动

内存
碎片

高并发

大SQL

high
version
count

DDL

硬解析

bug

SQL的生命周期：执行，占SQL性能故障80%以上

Top 5 Timed Events

Event	Waits	Time(s)	Avg Wait(ms)	% Total Call Time	Wait Class
CPU time		1,554		68.5	
latch: cache buffers chains	456	116	255	5.1	Concurrency
latch: library cache	414	104	250	4.6	Concurrency
SQL*Net more data to client	490,438	100	0	4.4	Network
log file sync	6,369	93	15	4.1	Commit

Time Model Statistics

- Total time in database user-calls (DB Time): 2269.2s
- Statistics including the word "background" measure background process time, and so do not contribute to the DB time statistic
- Ordered by % or DB time desc, Statistic name

Statistic Name	Time (s)	% of DB Time
sql execute elapsed time	1,814.92	79.98
DB CPU	1,554.21	68.49
parse time elapsed	181.76	8.01

SQL ordered by Gets

- Resources reported for PL/SQL code includes the resources used by all SQL statements called by the code.
- Total Buffer Gets: 214,509,539
- Captured SQL account for 89.1% of Total

Buffer Gets	Executions	Gets per Exec	%Total	CPU Time (s)	Elapsed Time (s)	SQL Id	SQL Module	SQL Text
99,333,569	634	156,677.55	46.31	335.20	333.03	7qaqzc2fah98p	yfxt.exe	SELECT MS_CF01.CFHM, MS_CF01....
52,788,117	383	137,827.98	24.61	207.42	205.24	c89y8tcj4chqu	yfxt.exe	SELECT MS_CF01.CFHM, MS_CF01....
5,869,830	64	91,716.09	2.74	56.67	59.14	0nnm20wm7p74y	mzgl.exe	SELECT YB_TZYB_TRADESTATUS.SE...
5,342,842	107	49,933.10	2.49	35.65	56.58	0cvn020fz66kn	pb90.exe	SELECT count (ZY_BQYZ.ZYH) F...
4,476,988	89	50,303.24	2.09	18.53	23.23	40rmbm2mztknh	yfxt.exe	SELECT MS_CF01.CFHM, MS_CF01....
3,421,205	82	41,722.01	1.59	15.48	18.48	2hut94wu5j73x	yfxt.exe	SELECT MS_CF01.CFHM, MS_CF01....
2,419,497	58	41,715.47	1.13	10.14	10.06	70aatmbcrcmb3	yfxt.exe	SELECT MS_CF01.CFHM, MS_CF01....
1,668,722	40	41,718.05	0.78	7.33	7.30	2m0yyhvpvfta60	yfxt.exe	SELECT MS_CF01.CFHM, MS_CF01....
1,668,671	40	41,716.78	0.78	7.49	7.42	dpy9wv9t9z4ab	yfxt.exe	SELECT MS_CF01.CFHM, MS_CF01....
1,409,940	26	54,228.46	0.66	46.27	50.10	2u1y4bgv4xzzc	pb90.exe	SELECT MS_BRDA.MZHM, MS_BRDA....

SQL ID: 7qaqzc2fah98p

- 1st Capture and Last Capture Snap IDs refer to Snapshot IDs within the snapshot range
- SELECT MS_CF01.CFHM, MS_CF01.BRXM, MS_CF01...

#	Plan Hash Value	Total Elapsed Time(ms)	Executions	1st Capture Snap ID	Last Capture Snap ID
1	1042977941	498,727	349	13416	13416
2	2889805364	0	0	13416	13416

SQL的生命周期：执行故障常见原因

执行计划
变异

内存
不足

存储性能
下降

数据块
读/读冲突

数据块
读/写冲突

数据块
写/写冲突

死锁

表规模
变大

bug

SQL的生命周期：提交故障案例

Top 10 Foreground Events by Total Wait Time

Event	Waits	Total Wait Time (sec)	Wait Avg(ms)	% DB time	Wait Class
log file sync	3,495,239	65.5K	19	81.7	Commit
DB CPU		6136		7.7	
latch: enqueue hash chains	308,952	2047.6	7	2.6	Other
latch: ges resource hash list	195,728	1328.6	7	1.7	Other
library cache: mutex X	181,799	813	4	1.0	Concurrency
db file scattered read	361,629	608.2	2	.8	User I/O
db file sequential read	342,592	584.6	2	.7	User I/O
gc current grant 2-way	586,596	453.2	1	.6	Cluster
cursor: pin S	100,051	324.8	3	.4	Concurrency
latch: cache buffers chains	55,689	324.7	6	.4	Concurrency

Background Wait Events

- ordered by wait time desc, waits desc (idle events last)
- Only events with Total Wait Time (s) >= .001 are shown
- %Timeouts: value of 0 indicates value was < .5%. Value of null is truly 0

Event	Waits	%Time outs	Total Wait Time (s)	Avg wait (ms)	Waits /txn	% bg time
db file parallel write	108,313	0	329	3	0.02	46.91
log file parallel write	26,671	0	214	8	0.01	30.50
LGWR wait for redo copy	7,864	0	11	1	0.00	1.51
gcs log flush sync	2,857	4	6	2	0.00	0.80
latch: redo allocation	906	0	3	4	0.00	0.50
latch: cache buffers chains	55,689	0	324.7	6	0.00	0.43

Key Instance Activity Stats

- Ordered by statistic name

Statistic	Total	per Second	per Trans
db block changes	158,441,366	511,318.90	31.75
execute count	103,089,032	332,686.92	20.66
gc cr block receive time	3	0.01	0.00
gc cr blocks received	40	0.13	0.00
gc current block receive time	17	0.05	0.00
gc current blocks received	160	0.52	0.00
logons cumulative	187	0.60	0.00
opened cursors cumulative	104,417,091	336,972.81	20.93
parse count (total)	2,139,550	6,904.71	0.43
parse time elapsed	488	1.57	0.00
physical reads	2,032,011	6,557.67	0.41
physical writes	941,671	3,038.94	0.19
redo size	27,025,606,724	87,216,513.88	5,416.10
session cursor cache hits	6,102,760	19,694.71	1.22
session logical reads	512,346,852	1,653,435.82	102.68
user calls	3,832,928	12,369.55	0.77
user commits	4,981,375	16,075.80	1.00
user rollbacks	8,489	27.40	0.00
workarea executions - optimal	994	3.21	0.00

SQL的生命周期：提交故障常见原因

提交频繁

RAC节点
SCN同步

存储性能
下降

enq: CF -
contention

SQL的生命周期：结果返回故障案例

Top 5 Timed Events

Event	Waits	Time(s)	Avg Wait(ms)	% Total Call Time	Wait Class
SQL*Net more data to client	288,684	1,554	5	65.4	Network
CPU time		558		23.5	
db file sequential read	65,111	155	2	6.5	User I/O
enq: TX - row lock contention	32	87	2,717	3.7	Application
db file scattered read	43,772	39	1	1.6	User I/O

Wait Class

- s - second
- cs - centisecond - 100th of a second
- ms - millisecond - 1000th of a second
- us - microsecond - 1000000th of a second
- ordered by wait time desc, waits desc

Wait Class	Waits	%Time -outs	Total Wait Time (s)	Avg wait (ms)	Waits /txn
Network	4,102,398	0.00	1,563	0	212.00
User I/O	109,127	0.00	194	2	5.64
Application	6,404	0.39	90	14	0.33
System I/O	40,981	0.00	20	0	2.12
Commit	16,939	0.00	12	1	0.88
Concurrency	153	0.00	0	3	0.01
Configuration	7	0.00	0	10	0.00
Other	398	0.00	0	0	0.02

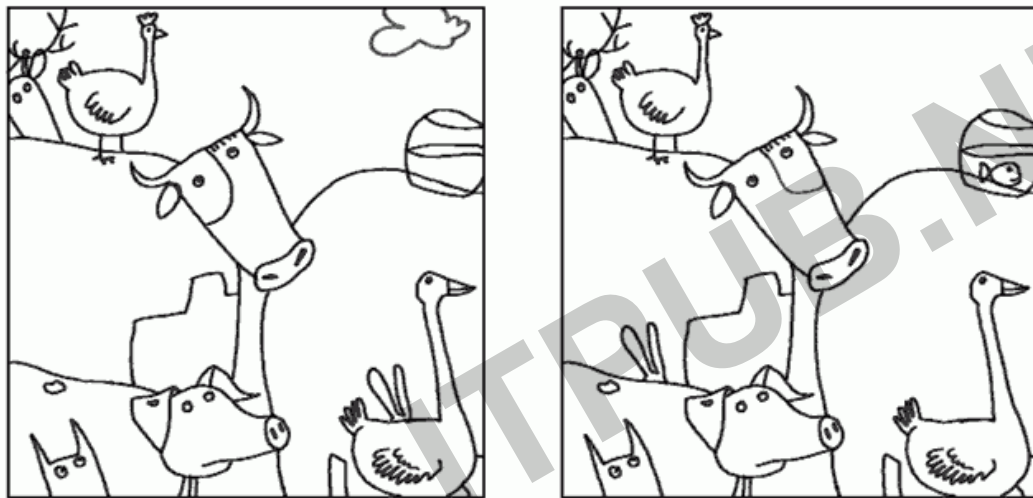
SQL的生命周期：结果返回故障常见原因

网络故障

arraysize

执行计划
异常

监控变化、重视变更是SQL优化的核心思想



高度紧张的时刻，找变化是相当痛苦的！

DTCC 2019

第十届中国数据库技术大会

DATABASE TECHNOLOGY CONFERENCE CHINA 2019



数据风云 **十年** 变迁

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