Break New Ground

高效SQL语句编写

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ORACLE CODE

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个人介绍

- 杨廷琨(yangtingkun)
  - Oracle ACE Director
  - ITPUB数据库管理区版主
  - ACOUG核心会员副总裁
  - 参与编写《Oracle数据库性能优化》、《Oracle DBA手记》、《Oracle DBA手记3》和《Oracle性能优化与诊断案例精选》
  - 十九年的DBA经验
  - 个人BLOG中积累了2500篇原创技术文章
  - 云和恩墨CTO

ORACLE ACE Director

ACOUG
All China Oracle User Group
中国 Oracle 用户组

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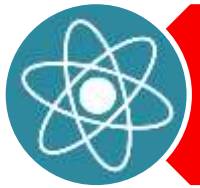
高效SQL的必要性

- SQL是世界上第二大的编程语言，超过50%的开发者使用SQL
- 80%的数据库问题是SQL引起的
- 80%的性能问题来自20%的SQL语句
- 高并发环境中，单条SQL语句可能导致整个数据库出现性能故障

合理运用新特性

数据集整体处理

设计SQL执行计划



严格过滤数据

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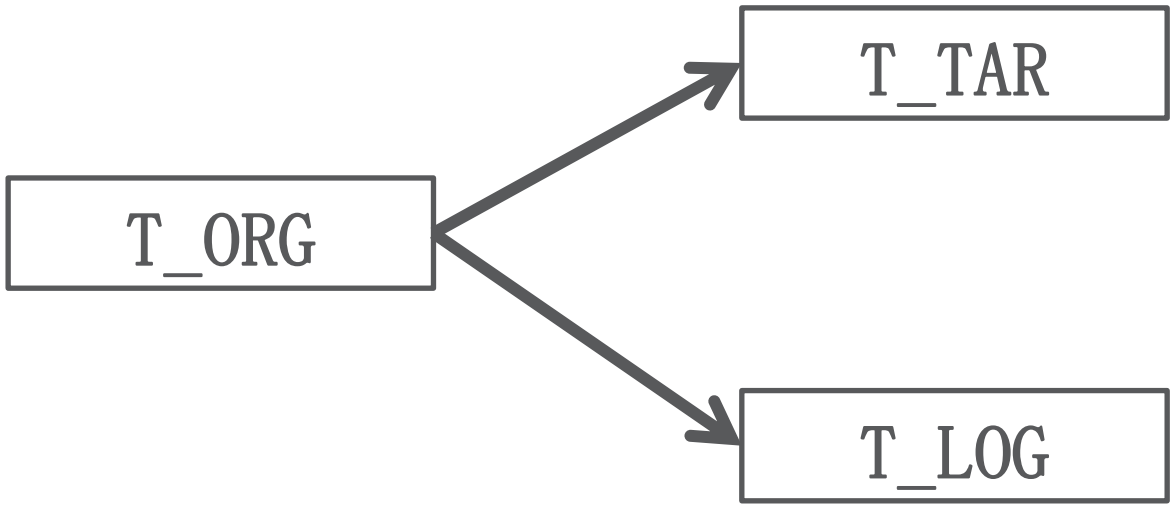
合理运用新特性

目标：从一张表取数据插入到另一张表中，此外需要为插入的目标表做一个应用级的日志表，也就是说在插入目标表的同时，还需要将相同的数据插入到日志表中。



合理运用新特性

方案:

- CREATE TRIGGER

```
CREATE OR REPLACE TRIGGER T_INSERT_TAR
AFTER INSERT ON T_TAR
FOR EACH ROW
BEGIN
INSERT INTO T_LOG (ID, NAME)
VALUES (:NEW.ID, :NEW.NAME);
END;
/
```

合理运用新特性

方案:

- CREATE TRIGGER
  - 太“重”
  - 实现与需求有差异
  - 增加后续维护成本
  - 触发器效率较低

合理运用新特性

方案:

- CREATE TRIGGER
- DOUBLE INSERT

```
INSERT INTO T_TAR SELECT * FROM T_ORG;
INSERT INTO T_LOG SELECT * FROM T_ORG;
```

合理运用新特性

方案:

- CREATE TRIGGER
- DOUBLE INSERT
  - 一致性
    - 锁
    - 串行事务
    - 临时表
    - AS OF查询
  - 原子性
    - 异常处理

合理运用新特性

方案:

- CREATE TRIGGER
- DOUBLE INSERT
- OPEN CURSOR

```
SQL> BEGIN
  2  FOR I IN (SELECT * FROM T_ORG) LOOP
  3  INSERT INTO T_TAR VALUES (I.ID, I.NAME);
  4  INSERT INTO T_LOG VALUES (I.ID, I.NAME);
  5  END LOOP;
  6  END;
  7  /

PL/SQL 过程已成功完成。
```

合理运用新特性

方案:

- CREATE TRIGGER
- DOUBLE INSERT
- OPEN CURSOR
  - 效率低

合理运用新特性

方案:

- CREATE TRIGGER
- DOUBLE INSERT
- OPEN CURSOR
- BULK INTO VARIABLE

合理运用新特性

```
SQL> DECLARE
  2  TYPE T_ID IS TABLE OF T_ORG.ID%TYPE;
  3  TYPE T_NAME IS TABLE OF T_ORG.NAME%TYPE;
  4  V_ID T_ID;
  5  V_NAME T_NAME;
  6  BEGIN
  7  SELECT ID, NAME BULK COLLECT INTO V_ID, V_NAME
  8  FROM T_ORG;
  9  FORALL I IN 1..V_ID.COUNT
 10  INSERT INTO T_TAR VALUES(V_ID(I), V_NAME(I));
 11  FORALL I IN 1..V_ID.COUNT
 12  INSERT INTO T_LOG VALUES(V_ID(I), V_NAME(I));
 13  END;
 14  /

PL/SQL 过程已成功完成。
```

合理运用新特性

方案:

- CREATE TRIGGER
- DOUBLE INSERT
- OPEN CURSOR
- BULK INTO VARIABLE
  - 复杂度高
  - 效率较低

合理运用新特性

方案:

- CREATE TRIGGER
- DOUBLE INSERT
- OPEN CURSOR
- BULK INTO VARIABLE
- INSERT ALL

```
SQL> INSERT ALL INTO T_TAR (ID, NAME)
  2  INTO T_LOG (ID, NAME)
  3  SELECT ID, NAME FROM T_ORG;
```

合理运用新特性

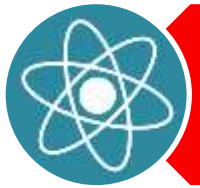
“新”特性：

- INSERT ALL/ANY　　插入多张表或限定条件插入
- MERGE　　合并UPDATE和INSERT语句
- WITH　　避免重复读取
- ANALYTIC FUNCTIONS　　行级计算避免自关联
- TOP-N　　分页语句
- PIVOT/UNPIVOT　　行列转换
- MODEL　　报表数组处理

合理运用新特性

数据集整体处理

设计SQL执行计划



严格过滤数据

数据集整体处理

判断表空间是否自动扩展:

```
SQL> select distinct tablespace_name, autoextensible
  2  from DBA_DATA_FILES
  3  where autoextensible = 'YES'
  4  union
  5  select distinct tablespace_name, autoextensible
  6  from DBA_DATA_FILES
  7  where autoextensible = 'NO'
  8  and tablespace_name not in
  9  (select distinct tablespace_name
 10  from DBA_DATA_FILES
 11  where autoextensible = 'YES');

TABLESPACE_NAME                AUT
------------------------------ ---
SYSAUX                         YES
SYSTEM                         YES
TEST                           NO
UNDOTBS1                       YES
USERS                          YES
```

数据集整体处理

```
SQL> select distinct tablespace_name, autoextensible
  2  from DBA_DATA_FILES
  3  where autoextensible = 'YES'
  4  union
  5  select distinct tablespace_name, autoextensible
  6  from DBA_DATA_FILES
  7  where autoextensible = 'NO'
  8  and tablespace_name not in
  9  (select distinct tablespace_name
 10  from DBA_DATA_FILES
 11  where autoextensible = 'YES');
```

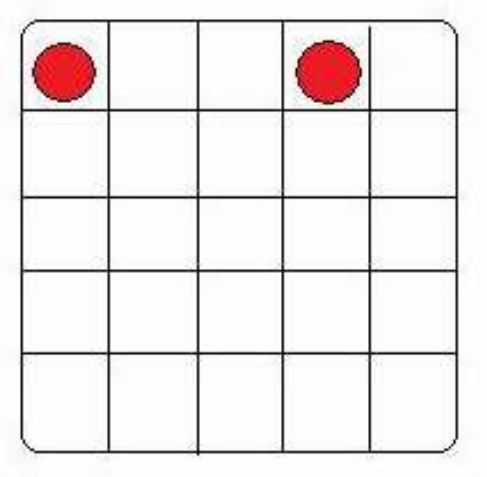
- 优点：思路清晰
- 缺点：效率低效，冗余严重
  - 三次扫描DBA_DATA_FILES视图
  - 包含三次DISTINCT操作
  - 包含UNION数据集操作
  - 包含NOT IN子查询

数据集整体处理

```
SQL> SELECT TABLESPACE_NAME, MAX(AUTOEXTENSIBLE)
  2  FROM DBA_DATA_FILES
  3  GROUP BY TABLESPACE_NAME;

TABLESPACE_NAME                MAX
------------------------------ ---
SYSAUX                         YES
UNDOTBS1                       YES
USERS                          YES
TEST                           NO
SYSTEM                         YES
```

数据集整体处理



问题：在5X5的方格棋盘中（如图），每行、列、斜线（斜线不仅仅包括对角线）最多可以放两个球，如何摆放才能放置最多的球，这样的摆法总共有几种？输出所有的摆法。

要求：用一句SQL实现。

输出格式：从方格棋盘第一行至第5行，每行从第一列到第5列依次输出，0表示不放球，1表示放球。例如：1001000000000000000000000。一行输出一个行号和一个解，按解所在的列字符串顺序从大到小排序。

数据集整体处理

```
SQL> with c as
  2    (select rownum - 1 c from dual connect by rownum <= 2),
  3  line_seed as
  4    (select c1.c || c2.c || c3.c || c4.c || c5.c line,
  5    c1.c c1, c2.c c2, c3.c c3, c4.c c4, c5.c c5
  6    from c c1, c c2, c c3, c c4, c c5
  7    where c1.c + c2.c + c3.c + c4.c + c5.c = 2
  8    order by 1 desc)
  9  select * from line_seed;
```

LINE	C1	C2	C3	C4	C5
11000	1	1	0	0	0
10100	1	0	1	0	0
10010	1	0	0	1	0
10001	1	0	0	0	1
01100	0	1	1	0	0
01010	0	1	0	1	0
01001	0	1	0	0	1
00110	0	0	1	1	0
00101	0	0	1	0	1
00011	0	0	0	1	1

数据集整体处理

```
with c as
(select rownum - 1 c from dual connect by rownum <= 2),
line_seed as
(select c1.c || c2.c || c3.c || c4.c || c5.c line, c1.c c1, c2.c c2, c3.c c3, c4.c c4, c5.c c5
from c c1, c c2, c c3, c c4, c c5
where c1.c + c2.c + c3.c + c4.c + c5.c = 2
order by 1 desc)
select rownum, line1.line || line2.line || line3.line || line4.line || line5.line result
from line_seed line1, line_seed line2, line_seed line3, line_seed line4, line_seed line5
where line1.c1 + line2.c1 + line3.c1 + line4.c1 + line5.c1 = 2
and line1.c2 + line2.c2 + line3.c2 + line4.c2 + line5.c2 = 2
and line1.c3 + line2.c3 + line3.c3 + line4.c3 + line5.c3 = 2
and line1.c4 + line2.c4 + line3.c4 + line4.c4 + line5.c4 = 2
and line1.c5 + line2.c5 + line3.c5 + line4.c5 + line5.c5 = 2
and line3.c1 + line4.c2 + line5.c3 <= 2
and line2.c1 + line3.c2 + line4.c3 + line5.c4 <= 2
and line1.c1 + line2.c2 + line3.c3 + line4.c4 + line5.c5 <= 2
and line1.c2 + line2.c3 + line3.c4 + line4.c5 <= 2
and line1.c3 + line2.c4 + line3.c5 <= 2
and line1.c3 + line2.c2 + line3.c1 <= 2
and line1.c4 + line2.c3 + line3.c2 + line4.c1 <= 2
and line1.c5 + line2.c4 + line3.c3 + line4.c2 + line5.c1 <= 2
and line2.c5 + line3.c4 + line4.c3 + line5.c2 <= 2
and line3.c5 + line4.c4 + line5.c3 <= 2;
```

数据集整体处理

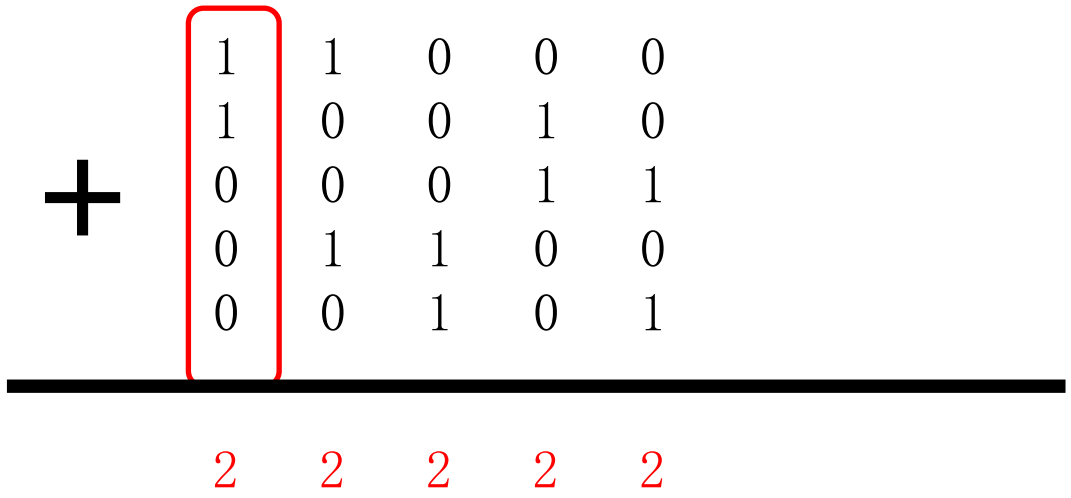
```
SQL> with c as
  2  (select rownum - 1 c from dual connect by rownum <= 2),
  3  lines as
  4  (select to_number(c1.c || c2.c || c3.c || c4.c || c5.c) line
  5  from c c1, c c2, c c3, c c4, c c5
  6  where c1.c + c2.c + c3.c + c4.c + c5.c = 2
  7  order by 1 desc)
  8  select ltrim(to_char(line1.line, '09999')) || chr(10)
  9    || ltrim(to_char(line2.line, '09999')) || chr(10)
 10    || ltrim(to_char(line3.line, '09999')) || chr(10)
 11    || ltrim(to_char(line4.line, '09999')) || chr(10)
 12    || ltrim(to_char(line5.line, '00009')) result
 13  from lines line1, lines line2, lines line3, lines line4, lines line5
 14  where line1.line + line2.line + line3.line + line4.line + line5.line = 22222
 15  and ltrim(to_char(line1.line + 10*line2.line + 100*line3.line + 1000*line4.line + 10000*line5.line), '012') is null
 16  and ltrim(to_char(10000*line1.line + 1000*line2.line + 100*line3.line + 10*line4.line + line5.line), '012') is null
 17  and rownum = 1;

RESULT
-----------------------------------
11000
10010
00011
01100
00101
```

数据集整体处理

```
 where line1.line + line2.line + line3.line + line4.line + line5.line = 22222
 and ltrim(to_char(line1.line + 10*line2.line + 100*line3.line + 1000*line4.line +
10000*line5.line), '012') is null
 and ltrim(to_char(10000*line1.line + 1000*line2.line + 100*line3.line + 10*line4.line
+ line5.line), '012') is null
```

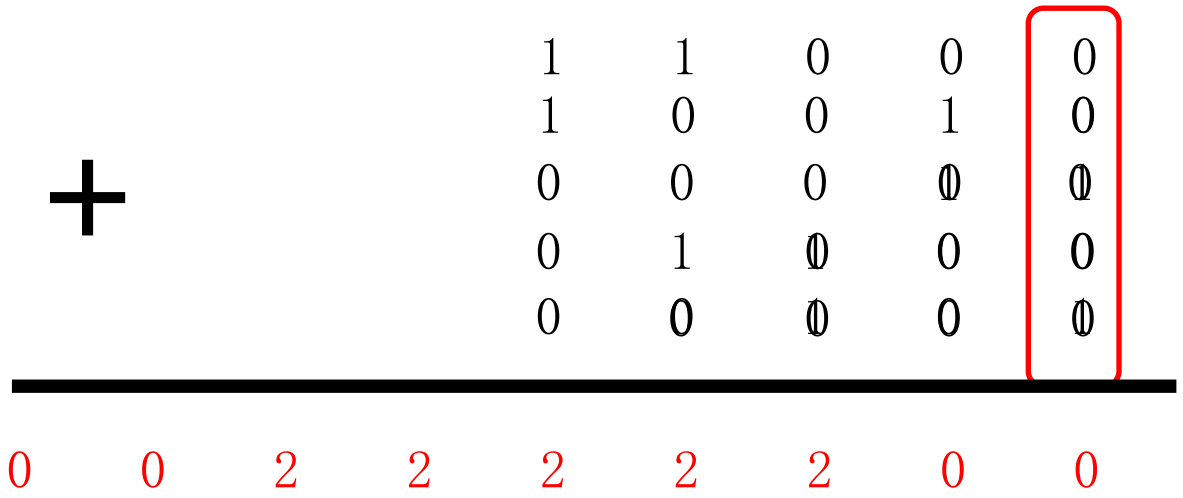
RESULT



数据集整体处理

```
 where line1.line + line2.line + line3.line + line4.line + line5.line = 22222
 and ltrim(to_char(line1.line + 10*line2.line + 100*line3.line + 1000*line4.line +
10000*line5.line), '012') is null
 and ltrim(to_char(10000*line1.line + 1000*line2.line + 100*line3.line + 10*line4.line +
line5.line), '012') is null
```

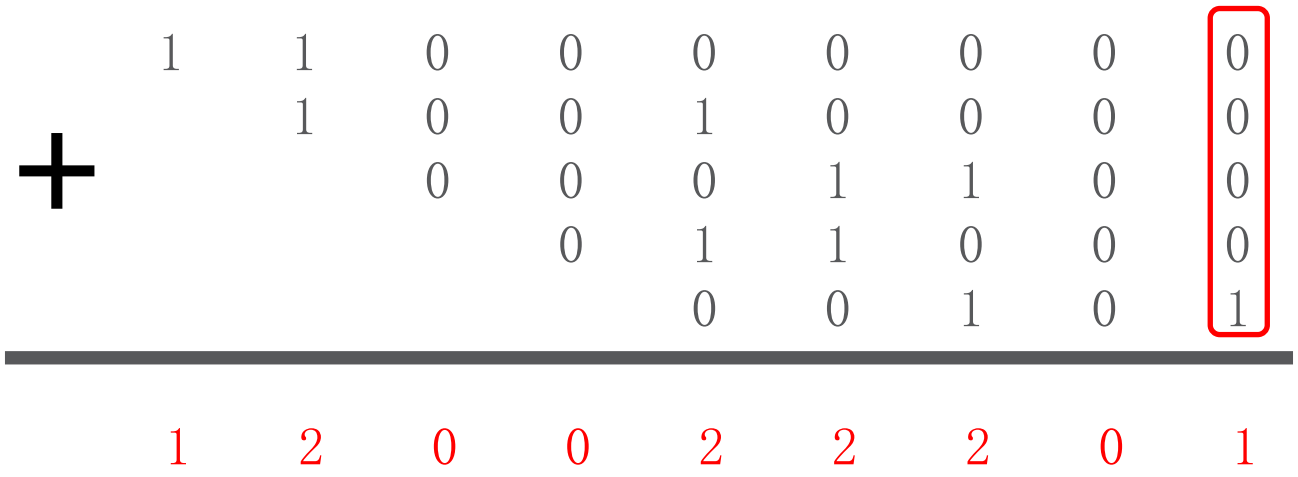
RESULT



数据集整体处理

```
 where line1.line + line2.line + line3.line + line4.line + line5.line = 22222
 and ltrim(to_char(line1.line + 10*line2.line + 100*line3.line + 1000*line4.line
+ 10000*line5.line), '012') is null
 and ltrim(to_char(10000*line1.line + 1000*line2.line + 100*line3.line +
10*line4.line + line5.line), '012') is null
```

RESULT



数据集整体处理

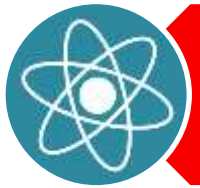
- Tom说过:
  - 如果可能你应该使用单条SQL语句来实现
  - 如果单条SQL语句无法实现，那么考虑使用PL/SQL
  - 如果PL/SQL无法实现，尝试使用Java存储过程

- 我们建议:
  - 能够用单条SQL处理的，就不要使用多条
  - 能够只扫描一次的，就不要扫描多次
  - 从整体上处理数据，避免单条处理逻辑

合理运用新特性

数据集整体处理

设计SQL执行计划



严格过滤数据

设计SQL执行计划

客户某SQL语句执行缓慢，消耗大量逻辑读：

```
SQL> EXPLAIN PLAN FOR
  2  SELECT VCM.POL_ID, TC.MOBILE, TC.FIRST_NAME PH_NAME,
  3     PKG_UTILS.F_GET_DESC('T_TITLE', DECODE(TC.GENDER,'M', '1', 'F', '2'), '211'),
  4     PKG_UTILS.F_GET_DESC('V_PRO_LIFE_3',
  5              (SELECT T.PROD_ID FROM T_CON_PROD T WHERE T.POL_ID = VCM.POL_ID AND T.MASTER_ID IS NULL), '211'),
  6     SUM(TPA.FEE_AMOUNT), VCM.POLICY_CODE, PKG_UTILS.F_GET_DESC('T_LIA_STAT',VCM.LIA_STATE, '211'),
  7     PKG_UTILS.F_GET_DESC('T_SAL_CHAN', VCM.CHANN_TYPE, '211'), VCM.CHANN_TYPE,TC.CUSTOMER_ID, TCO.ORGAN_CODE
  8  FROM V_CON_MAS VCM, T_CON_MAS TCM, T_AGENT TA, T_CUSTOMER TC,
  9     T_POH VPH,T_COM_ORG TCO, T_P_A TPA
 10  WHERE VCM.POL_ID = VPH.POL_ID
 11  AND VCM.SERVICE_AGENT = TA.AGENT_ID
 12  AND VCM.POL_ID = TCM.POL_ID
 13  AND VPH.PARTY_ID = TC.CUSTOMER_ID
 14  AND VCM.ORGAN_ID = TCO.ORGAN_ID
 15  AND VCM.POL_ID = TPA.POL_ID
 16  AND VCM.LIABILITY_STATE = 1
 17  AND TPA.FEE_TYPE IN (41, 569)
 18  AND TPA.FEE_STATUS <> 2
 19  AND (EXISTS (
 20     SELECT 1 FROM T_PO_CH T, T_CH TC WHERE T.MAS_C_ID = TC.CH_ID  AND TC.CH_ID = TPA.CH_ID AND T.SERV_ID = 3 ))
 21  AND TPA.DUE_TIME >= (TRUNC(:B1 ) + 7)
 22  AND TPA.DUE_TIME < (TRUNC(:B1 ) + 8)
 23  AND REGEXP_LIKE(TRIM(TC.MOBILE), '^\d{11}$')
 24  AND NOT EXISTS (
 25     SELECT 1 FROM T_DATA_EXT SDE, T_DATA TSD
 26     WHERE SDE.DATA_ID = TSD.DATA_ID AND SDE.RELAT_VALUE_1 = VCM.POL_ID AND TSD.SMS_ID = 12 AND SDE.RELAT_VALUE_2 = TO_CHAR(:B1 , 'yyyy-MM-dd'))
 27  GROUP BY VCM.POL_ID, TC.MOBILE, TC.FIRST_NAME, TC.GENDER, VCM.POLICY_CODE, VCM.LIABILITY_STATE, VCM.CHANNEL_TYPE, TC.CUSTOMER_ID, TCO.ORGAN_CODE;
```

设计SQL执行计划

Id	Operation	Name	Rows	Bytes	Cost (%CPU)
0	SELECT STATEMENT		356	53400	901K (1)
* 1	INDEX RANGE SCAN	IDX_CON_PROD__PRD_ID	1	12	1 (0)
2	HASH GROUP BY		356	53400	901K (1)
* 3	FILTER				
* 4	FILTER				
5	NESTED LOOPS		356	53400	84579 (2)
* 6	HASH JOIN		356	51264	84578 (2)
7	TABLE ACCESS FULL	T_C_O	143	2145	4 (0)
8	NESTED LOOPS SEMI		356	45924	84573 (2)
9	NESTED LOOPS		370	44030	84481 (2)
10	NESTED LOOPS		6067	539K	82962 (2)
11	NESTED LOOPS		6036	465K	81452 (2)
* 12	HASH JOIN		6037	430K	81451 (2)
* 13	TABLE ACCESS BY INDEX ROWID	T_P_A	4812	145K	596 (1)
* 14	INDEX RANGE SCAN	IDX_P_A__DUE	14477		10 (0)
15	VIEW	V_CON_MAS	877K	35M	80844 (2)
16	UNION-ALL				
* 17	TABLE ACCESS FULL	T_CON_MAS_LOG	877K	36M	80844 (2)
* 18	FILTER				
* 19	TABLE ACCESS FULL	T_CON_MAS	155K	6357K	21715 (1)
* 20	INDEX UNIQUE SCAN	PK_T_AGENT	1	6	1 (0)
21	TABLE ACCESS BY INDEX ROWID	T_POH	1	12	1 (0)
* 22	INDEX RANGE SCAN	IDX_POH_PO_ID	1		1 (0)
* 23	TABLE ACCESS BY INDEX ROWID	T_CUSTOMER	1	28	1 (0)
* 24	INDEX UNIQUE SCAN	PK_T_CUSTOMER	1		1 (0)
* 25	TABLE ACCESS BY INDEX ROWID	T_PO_CH	244K	2389K	1 (0)
* 26	INDEX RANGE SCAN	IDX_PO_CH__MAS_CH_ID	1		1 (0)
* 27	INDEX UNIQUE SCAN	PK_T_CON_MAS	1	6	1 (0)
28	NESTED LOOPS				
29	NESTED LOOPS		1	34	4591 (1)
30	TABLE ACCESS BY INDEX ROWID	T_DATA_EXT	1	25	4590 (1)
* 31	INDEX SKIP SCAN	IDX_DATA_EXT__RELAT_	1		4589 (1)
* 32	INDEX UNIQUE SCAN	PK_T_DATA	1		1 (0)
* 33	TABLE ACCESS BY INDEX ROWID	T_DATA	1	9	1 (0)

设计SQL执行计划

```
SQL> create table t_objects as select * from dba_objects;
表已创建。

SQL> create index ind_obj_id on t_objects(object_id);
索引已创建。

SQL> create table t_tab as select * from dba_tables;
表已创建。

SQL> create table t_ind as select * from dba_indexes;
表已创建。

SQL> create index ind_tab_name on t_tab(table_name);
索引已创建。

SQL> create index ind_ind_name on t_ind(index_name);
索引已创建。

SQL> create view v_seg as
  2  select owner, table_name, tablespace_name, blocks from t_tab where temporary = 'N'
  3  union all
  4  select owner, index_name, tablespace_name, num_rows from t_ind where status = 'N/A';
视图已创建。
```

设计SQL执行计划

```
SQL> select obj.owner, obj.object_name, created, v.blocks
  2  from t_objects obj, v_seg v
  3  where obj.object_id = 12345
  4  and obj.object_name = v.table_name;

未选定行

-----------------------------------------------------------------------------------------
| Id  | Operation                    | Name         | Rows  | Bytes | Cost  |
-----------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |              |     1 |   194 |    43 |
|*  1 |  HASH JOIN                   |              |     1 |   194 |    43 |
|   2 |   TABLE ACCESS BY INDEX ROWID| T_OBJECTS    |     1 |   115 |     2 |
|*  3 |    INDEX RANGE SCAN          | IND_OBJ_ID   |     1 |       |     1 |
|   4 |   VIEW                       | V_SEG        |  3340 |   257K|    40 |
|   5 |    UNION-ALL                 |              |       |       |       |
|*  6 |     TABLE ACCESS FULL        | T_TAB        |  1184 | 95904 |    15 |
|*  7 |     TABLE ACCESS FULL        | T_IND        |  2156 |   178K|    25 |
-----------------------------------------------------------------------------------------
```

设计SQL执行计划

```
SQL> select /*+ index(t_tab ind_tab_name) */ obj.owner, obj.object_name, created, v.blocks
  2  from t_objects obj, v_seg v
  3  where obj.object_id = 12345
  4  and obj.object_name = v.table_name;

未选定行

-----------------------------------------------------------------------------------------
| Id  | Operation                    | Name        | Rows  | Bytes | Cost  |
-----------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |             |     1 |   194 |    43 |
|*  1 |  HASH JOIN                   |             |     1 |   194 |    43 |
|   2 |   TABLE ACCESS BY INDEX ROWID| T_OBJECTS   |     1 |   115 |     2 |
|*  3 |    INDEX RANGE SCAN          | IND_OBJ_ID  |     1 |       |     1 |
|   4 |   VIEW                       | V_SEG       |  3340 |   257K|    40 |
|   5 |    UNION-ALL                 |             |       |       |       |
|*  6 |     TABLE ACCESS FULL        | T_TAB       |  1184 | 95904 |    15 |
|*  7 |     TABLE ACCESS FULL        | T_IND       |  2156 |   178K|    25 |
-----------------------------------------------------------------------------------------
```

设计SQL执行计划

```
SQL> select /*+ index(v.t_tab ind_tab_name) */ obj.owner, obj.object_name, created, v.blocks
  2  from t_objects obj, v_seg v
  3  where obj.object_id = 12345
  4  and obj.object_name = v.table_name;

未选定行

-----------------------------------------------------------------------------------------
| Id  | Operation                      | Name          | Rows  | Bytes | Cost  |
-----------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT               |               |     1 |   194 |  1210 |
|*  1 |  HASH JOIN                     |               |     1 |   194 |  1210 |
|   2 |   TABLE ACCESS BY INDEX ROWID  | T_OBJECTS     |     1 |   115 |     2 |
|*  3 |    INDEX RANGE SCAN            | IND_OBJ_ID    |     1 |       |     1 |
|   4 |   VIEW                         | V_SEG         |  3340 |   257K|  1207 |
|   5 |    UNION-ALL                   |               |       |       |       |
|*  6 |     TABLE ACCESS BY INDEX ROWID| T_TAB         |  1184 | 95904 |  1182 |
|   7 |      INDEX FULL SCAN           | IND_TAB_NAME  |  2367 |       |    11 |
|*  8 |     TABLE ACCESS FULL          | T_IND         |  2156 |   178K|    25 |
-----------------------------------------------------------------------------------------
```

设计SQL执行计划

```
SQL> select obj.owner, obj.object_name, created, v.blocks
  2  from t_objects obj,
  3  (select owner, table_name, tablespace_name, blocks from t_tab where temporary = 'N'
  4  union all
  5  select owner, index_name, tablespace_name, num_rows from t_ind where status = 'N/A') v
  6  where obj.object_id = 12345
  7  and obj.object_name = v.table_name;
```

未选定行

Id	Operation	Name	Rows	Bytes	Cost
0	SELECT STATEMENT		1	194	43
* 1	HASH JOIN		1	194	43
2	TABLE ACCESS BY INDEX ROWID	T_OBJECTS	1	115	2
* 3	INDEX RANGE SCAN	IND_OBJ_ID	1		1
4	VIEW		3340	257K	40
5	UNION-ALL				
* 6	TABLE ACCESS FULL	T_TAB	1184	95904	15
* 7	TABLE ACCESS FULL	T_IND	2156	178K	25

设计SQL执行计划

```
SQL> select /*+ index(v.t_tab ind_tab_name) */ obj.owner, obj.object_name, created, v.blocks
  2  from t_objects obj,
  3  (select owner, table_name, tablespace_name, blocks from t_tab where temporary = 'N'
  4  union all
  5  select owner, index_name, tablespace_name, num_rows from t_ind where status = 'N/A') v
  6  where obj.object_id = 12345
  7  and obj.object_name = v.table_name;
```

未选定行

Id	Operation	Name	Rows	Bytes	Cost
0	SELECT STATEMENT		1	194	1210
* 1	HASH JOIN		1	194	1210
2	TABLE ACCESS BY INDEX ROWID	T_OBJECTS	1	115	2
* 3	INDEX RANGE SCAN	IND_OBJ_ID	1		1
4	VIEW		3340	257K	1207
5	UNION-ALL				
* 6	TABLE ACCESS BY INDEX ROWID	T_TAB	1184	95904	1182
7	INDEX FULL SCAN	IND_TAB_NAME	2367		11
* 8	TABLE ACCESS FULL	T_IND	2156	178K	25

设计SQL执行计划

```
SQL> select /*+ index(t_tab ind_tab_name) */ obj.owner, obj.object_name, created, blocks
  2  from t_objects obj,
  3  (select owner, table_name, tablespace_name, blocks from t_tab where temporary = 'N'
  4  union all
  5  select owner, index_name, tablespace_name, num_rows from t_ind where status = 'N/A')
  6  where obj.object_id = 12345
  7  and obj.object_name = table_name;

未选定行

-----------------------------------------------------------------------------------
| Id  | Operation                     | Name        | Rows  | Bytes | Cost  |
-----------------------------------------------------------------------------------
|   0 | SELECT STATEMENT              |             |     1 |   194 |    43 |
|*  1 |  HASH JOIN                    |             |     1 |   194 |    43 |
|   2 |   TABLE ACCESS BY INDEX ROWID | T_OBJECTS   |     1 |   115 |     2 |
|*  3 |    INDEX RANGE SCAN           | IND_OBJ_ID  |     1 |       |     1 |
|   4 |   VIEW                        |             |  3340 |  257K |    40 |
|   5 |    UNION-ALL                  |             |       |       |       |
|*  6 |     TABLE ACCESS FULL         | T_TAB       |  1184 | 95904 |    15 |
|*  7 |     TABLE ACCESS FULL         | T_IND       |  2156 |  178K |    25 |
-----------------------------------------------------------------------------------
```

设计SQL执行计划

```
SQL> SELECT ID, OBJECT_ALIAS, DEPTH
  2  FROM V$SQL_PLAN
  3  WHERE SQL_ID IN
  4  (SELECT SQL_ID FROM V$SQL
  5  WHERE SQL_TEXT LIKE 'select /*+ index(t_tab ind_tab_name) */%')
  6  ORDER BY SQL_ID, ID;

        ID OBJECT_ALIAS                         DEPTH
---------- ------------------------------ ----------
         0                                         0
         1                                         1
         2 OBJ@SEL$1                               2
         3 OBJ@SEL$1                               3
         4 from$_subquery$_002@SEL$1               2
         5                                         3
         6 T_TAB@SEL$2                             4
         7 T_IND@SEL$3                             4

-------------------------------------------------------------------------------
| Id  | Operation                    | Name        | Rows  | Bytes | Cost  |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |             |     1 |   194 |    43 |
|*  1 |  HASH JOIN                   |             |     1 |   194 |    43 |
|   2 |   TABLE ACCESS BY INDEX ROWID| T_OBJECTS   |     1 |   115 |     2 |
|*  3 |    INDEX RANGE SCAN          | IND_OBJ_ID  |     1 |       |     1 |
|   4 |   VIEW                       |             |  3340 |  257K |    40 |
|   5 |    UNION-ALL                 |             |       |       |       |
|*  6 |     TABLE ACCESS FULL        | T_TAB       |  1184 | 95904 |    15 |
|*  7 |     TABLE ACCESS FULL        | T_IND       |  2156 |  178K |    25 |
-------------------------------------------------------------------------------
```

设计SQL执行计划

```
SQL> select /*+ index("from$_subquery$_002".t_tab ind_tab_name) */ obj.owner, obj.object_name, created, blocks
  2  from t_objects obj,
  3  (select owner, table_name, tablespace_name, blocks from t_tab where temporary = 'N'
  4  union all
  5  select owner, index_name, tablespace_name, num_rows from t_ind where status = 'N/A')
  6  where obj.object_id = 12345
  7  and obj.object_name = table_name;
```

未选定行

Id	Operation	Name	Rows	Bytes	Cost
0	SELECT STATEMENT		1	194	1210
* 1	HASH JOIN		1	194	1210
2	TABLE ACCESS BY INDEX ROWID	T_OBJECTS	1	115	2
* 3	INDEX RANGE SCAN	IND_OBJ_ID	1		1
4	VIEW		3340	257K	1207
5	UNION-ALL				
* 6	TABLE ACCESS BY INDEX ROWID	T_TAB	1184	95904	1182
7	INDEX FULL SCAN	IND_TAB_NAME	2367		11
* 8	TABLE ACCESS FULL	T_IND	2156	178K	25

设计SQL执行计划

```
SQL> select /*+ index(t_tab ind_tab_name) */ obj.owner, obj.object_name, created, blocks
  2  from t_objects obj,
  3  (select owner, table_name, tablespace_name, blocks from t_tab where temporary = 'N'
  4  union all
  5  select owner, index_name, tablespace_name, num_rows from t_ind where status = 'N/A')
  6  where obj.object_id = 12345
  7  and obj.object_name = table_name;
```

未选定行

Id	Operation	Name	Rows	Bytes	Cost
0	SELECT STATEMENT		1	194	43
* 1	HASH JOIN		1	194	43
2	TABLE ACCESS BY INDEX ROWID	T_OBJECTS	1	115	2
* 3	INDEX RANGE SCAN	IND_OBJ_ID	1		1
4	VIEW		3340	257K	40
5	UNION-ALL				
* 6	TABLE ACCESS FULL	T_TAB	1184	95904	15
* 7	TABLE ACCESS FULL	T_IND	2156	178K	25

设计SQL执行计划

```
SQL> select /*+ index(@v_1 t_tab ind_tab_name) */ obj.owner, obj.object_name, created, blocks
  2  from t_objects obj,
  3  (select /*+ qb_name(v_1) */ owner, table_name, tablespace_name, blocks from t_tab where temporary = 'N'
  4  union all
  5  select owner, index_name, tablespace_name, num_rows from t_ind where status = 'N/A')
  6  where obj.object_id = 12345
  7  and obj.object_name = table_name;

未选定行

-------------------------------------------------------------------------------------
| Id  | Operation                     | Name         | Rows  | Bytes | Cost  |
-------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT              |              |     1 |   123 |  1210 |
|*  1 |  HASH JOIN                    |              |     1 |   123 |  1210 |
|   2 |   TABLE ACCESS BY INDEX ROWID | T_OBJECTS    |     1 |    44 |     2 |
|*  3 |    INDEX RANGE SCAN           | IND_OBJ_ID   |     1 |       |     1 |
|   4 |   VIEW                        |              |  3340 |  257K |  1207 |
|   5 |    UNION-ALL                  |              |       |       |       |
|*  6 |     TABLE ACCESS BY INDEX ROWID| T_TAB       |  1184 | 28416 |  1182 |
|   7 |      INDEX FULL SCAN          | IND_TAB_NAME |  2367 |       |    11 |
|*  8 |     TABLE ACCESS FULL         | T_IND        |  2156 | 66836 |    25 |
-------------------------------------------------------------------------------------
```

设计SQL执行计划

```
SQL> select /*+ push_pred(v) */ obj.owner, obj.object_name, created, v.blocks
  2  from t_objects obj, v_seg v
  3  where obj.object_id = 12345
  4  and obj.object_name = v.table_name;

未选定行
```

Id	Operation	Name	Rows	Bytes	Cost (%CPU)
0	SELECT STATEMENT		1	78	6 (0)
1	NESTED LOOPS		1	78	6 (0)
2	TABLE ACCESS BY INDEX ROWID BATCHED	T_OBJECTS	1	44	2 (0)
* 3	INDEX RANGE SCAN	IND_OBJ_ID	1		1 (0)
4	VIEW	V_SEG	1	34	4 (0)
5	UNION ALL PUSHED PREDICATE				
* 6	TABLE ACCESS BY INDEX ROWID BATCHED	T_TAB	1	24	2 (0)
* 7	INDEX RANGE SCAN	IND_TAB_NAME	1		1 (0)
* 8	TABLE ACCESS BY INDEX ROWID BATCHED	T_IND	1	31	2 (0)
* 9	INDEX RANGE SCAN	IND_IND_NAME	1		1 (0)

设计SQL执行计划

```
SQL> alter session set "_optimizer_push_pred_cost_based"=false;

Session altered.
```

Id	Operation	Name	Rows	Bytes	Cost (%CPU)
0	SELECT STATEMENT		286	42900	659K (1)
* 1	INDEX RANGE SCAN	IDX_CON_PROD__PRD_ID	1	12	1 (0)
.					
.					
.					
* 12	TABLE ACCESS BY INDEX ROWID	T_P_A	4812	145K	596 (1)
* 13	INDEX RANGE SCAN	IDX_P_A__DUE	14477		10 (0)
* 14	VIEW	V_CON_MAS	1	42	1 (0)
15	UNION-ALL PARTITION				
* 16	TABLE ACCESS BY INDEX ROWID	T_CON_MAS_LOG	1	44	1 (0)
* 17	INDEX RANGE SCAN	IDX_CON_MAS_L__LAST_CM	1		1 (0)
* 18	FILTER				
* 19	TABLE ACCESS BY INDEX ROWID	T_CON_MAS	1	42	1 (0)
* 20	INDEX UNIQUE SCAN	PK_T_CON_MAS	1		1 (0)
21	NESTED LOOPS				
22	NESTED LOOPS		1	34	4591 (1)
.					
.					
.					
* 34	INDEX UNIQUE SCAN	PK_T_CON_MAS	1	6	1 (0)
* 35	INDEX UNIQUE SCAN	PK_T_COM_ORG	1		1 (0)
36	TABLE ACCESS BY INDEX ROWID	T_COM_ORG	1	15	1 (0)

设计SQL执行计划

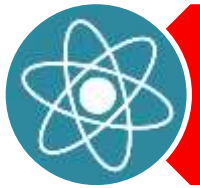
掌握HINT的重要性：

- 掌控SQL执行方式
- 理解执行计划的效率差异
- 分析定位问题的利器
- 规避bug或性能问题
- 强制数据库按照设计思路运行

合理运用新特性

数据集整体处理

设计SQL执行计划



严格过滤数据

严格过滤数据

如何用一条SQL计算100以内的质数

```
SQL> WITH T
  2  AS
  3  (SELECT ROWNUM RN FROM DUAL CONNECT BY LEVEL < 100)
  4  SELECT RN FROM T
  5  WHERE RN > 1
  6  MINUS
  7  SELECT A.RN * B.RN FROM T A, T B
  8  WHERE A.RN <= B.RN
  9  AND A.RN > 1
 10  AND B.RN > 1;

        RN
----------
         2
         3
         5
.
.
.
        97

已用时间:  00: 00: 00.07
```

严格过滤数据

```
SQL> WITH T
  2  AS
  3  (SELECT ROWNUM RN FROM DUAL CONNECT BY LEVEL < 10000)
  4  SELECT RN FROM T
  5  WHERE RN > 1
  6  MINUS
  7  SELECT A.RN * B.RN FROM T A, T B
  8  WHERE A.RN <= B.RN
  9  AND A.RN > 1
 10  AND B.RN > 1;

已选择 1229 行。

已用时间:  00: 01: 56.88

统计信息
----------------------------------------------------------
        521  recursive calls
       1702  db block gets
     180013  consistent gets
      65297  physical reads
        964  redo size
      22473  bytes sent via SQL*Net to client
       1442  bytes received via SQL*Net from client
         83  SQL*Net roundtrips to/from client
          2  sorts (memory)
          1  sorts (disk)
       1229  rows processed
```

严格过滤数据

```
SQL> WITH T
  2  AS
  3  (SELECT ROWNUM RN FROM DUAL CONNECT BY LEVEL < 10000)
  4  SELECT RN FROM T
  5  WHERE RN > 1
  6  MINUS
  7  SELECT A.RN * B.RN FROM T A, T B
  8  WHERE A.RN <= B.RN
  9  AND A.RN > 1
 10  AND A.RN <= 100
 11  AND B.RN > 1
 12  AND B.RN <= 5000;

已选择 1229 行。

已用时间:  00: 00: 00.62

统计信息
----------------------------------------------------------
         10  recursive calls
         23  db block gets
       1831  consistent gets
         16  physical reads
        624  redo size
      22473  bytes sent via SQL*Net to client
       1442  bytes received via SQL*Net from client
         83  SQL*Net roundtrips to/from client
          3  sorts (memory)
          0  sorts (disk)
       1229  rows processed
```

严格过滤数据

```
SQL> WITH T
  2  AS
  3  (SELECT ROWNUM * 2 + 1 RN FROM DUAL CONNECT BY LEVEL < 4999)
  4  SELECT 2 FROM DUAL
  5  UNION ALL
  6  (
  7   SELECT RN FROM T
  8   MINUS
  9   SELECT A.RN * B.RN FROM T A, T B
 10   WHERE A.RN <= B.RN
 11   AND A.RN <= 100
 12   AND B.RN <= 5000
 13  );

已选择 1229 行。

已用时间:  00: 00: 00.19

统计信息
----------------------------------------------------------
         10  recursive calls
         15  db block gets
        523  consistent gets
          8  physical reads
        624  redo size
      22472  bytes sent via SQL*Net to client
       1442  bytes received via SQL*Net from client
         83  SQL*Net roundtrips to/from client
          3  sorts (memory)
          0  sorts (disk)
       1229  rows processed
```

严格过滤数据

海盗分金问题：

有五个海盗，劫掠了100两金子，需要分赃。办法是抓阄，盗亦有道。

抓到第一个阄的人，可以先提出一个分配方案，如果他的方案被一半以上的人同意，就照他的方案分金子，否则，第一个人就要被杀掉。余下的人也照此办理。

我们的问题是：如果你是第一个人，你会提出怎样的分配方案?

为了分析问题更确定，我们假定每个人都是追求自己利益极大化的人。

严格过滤数据

一个人的分配原则：独占

```
SQL> WITH A AS
  2  (SELECT 100 - ROWNUM + 1 N FROM DUAL CONNECT BY ROWNUM <= 101),
  3  MAX_ONE AS
  4  (SELECT MAX(N) MAX1 FROM A)
  5  SELECT * FROM MAX_ONE;

      MAX1
----------
       100
```

严格过滤数据

最悲催的两个人分金方案：白忙

```
SQL> WITH A AS
  2  (SELECT 100 - ROWNUM + 1 N FROM DUAL CONNECT BY ROWNUM <= 101),
  3  MAX_ONE AS
  4  (SELECT MAX(N) MAX1 FROM A),
  5  MAX_TWO AS
  6  (SELECT /*+ LEADING (P2, P1) USE_NL(P1) */ P2.N MAX2, P1.N MAX1
  7  FROM A P1, A P2
  8  WHERE P1.N + P2.N = 100
  9  AND P1.N >= (SELECT MAX1 FROM MAX_ONE)
 10  AND ROWNUM = 1)
 11  SELECT * FROM MAX_TWO;

      MAX2       MAX1
---------- ----------
         0        100
```

严格过滤数据

三个人的分金方案：拉拢

```
SQL> WITH A AS
  2  (SELECT 100 - ROWNUM + 1 N FROM DUAL CONNECT BY ROWNUM <= 101),
  3  MAX_ONE AS
  4  (SELECT MAX(N) MAX1 FROM A),
  5  MAX_TWO AS
  6  (SELECT /*+ LEADING (P2, P1) USE_NL(P1) */ P2.N MAX2, P1.N MAX1
  7  FROM A P1, A P2
  8  WHERE P1.N + P2.N = 100
  9  AND P1.N >= (SELECT MAX1 FROM MAX_ONE)
 10  AND ROWNUM = 1),
 11  MAX_THREE AS
 12  (SELECT /*+ LEADING(P3, P2, P1) USE_NL(P1) */ P3.N MAX3, P2.N MAX2, P1.N MAX1
 13  FROM A P1, A P2, A P3, MAX_TWO
 14  WHERE P1.N + P2.N + P3.N = 100
 15  AND SIGN(P2.N - MAX2) + SIGN(P1.N - MAX1) >=0
 16  AND ROWNUM = 1)
 17  SELECT * FROM MAX_THREE;

      MAX3       MAX2       MAX1
---------- ---------- ----------
        99          1          0
```

严格过滤数据

四个人的分金方案：排挤

```
SQL> WITH A AS
  2  (SELECT 100 - ROWNUM + 1 N FROM DUAL CONNECT BY ROWNUM <= 101),
  3  MAX_ONE AS
  4  (SELECT MAX(N) MAX1 FROM A),
  5  MAX_TWO AS
  6  (SELECT /*+ LEADING (P2, P1) USE_NL(P1) */ P2.N MAX2, P1.N MAX1
  7  FROM A P1, A P2
  8  WHERE P1.N + P2.N = 100
  9  AND P1.N >= (SELECT MAX1 FROM MAX_ONE)
 10  AND ROWNUM = 1),
 11  MAX_THREE AS
 12  (SELECT /*+ LEADING(P3, P2, P1) USE_NL(P1) */ P3.N MAX3, P2.N MAX2, P1.N MAX1
 13  FROM A P1, A P2, A P3, MAX_TWO
 14  WHERE P1.N + P2.N + P3.N = 100
 15  AND SIGN(P2.N - MAX2) + SIGN(P1.N - MAX1) >=0
 16  AND ROWNUM = 1),
 17  MAX_FOUR AS
 18  (SELECT /*+ LEADING(P4, P3, P2, P1) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P4.N MAX4, P3.N MAX3, P2.N MAX2, P1.N MAX1
 19  FROM A P1, A P2, A P3, A P4, MAX_THREE
 20  WHERE P1.N + P2.N + P3.N + P4.N = 100
 21  AND SIGN(P3.N - MAX3) + SIGN(P2.N - MAX2) + SIGN(P1.N - MAX1) > 0
 22  AND ROWNUM = 1)
 23  SELECT * FROM MAX_FOUR;

      MAX4       MAX3       MAX2       MAX1
---------- ---------- ---------- ----------
        97          0          2          1
```

严格过滤数据

```
SQL> WITH A AS
  2  (SELECT 100 - ROWNUM + 1 N FROM DUAL CONNECT BY ROWNUM <= 101),
  3  MAX_ONE AS
  4  (SELECT MAX(N) MAX1 FROM A),
  5  MAX_TWO AS
  6  (SELECT /*+ LEADING (P2, P1) USE_NL(P1) */ P2.N MAX2, P1.N MAX1
  7  FROM A P1, A P2
  8  WHERE P1.N + P2.N = 100
  9  AND P1.N >= (SELECT MAX1 FROM MAX_ONE)
 10  AND ROWNUM = 1),
 11  MAX_THREE AS
 12  (SELECT /*+ LEADING(P3, P2, P1) USE_NL(P1) */ P3.N MAX3, P2.N MAX2, P1.N MAX1
 13  FROM A P1, A P2, A P3, MAX_TWO
 14  WHERE P1.N + P2.N + P3.N = 100
 15  AND SIGN(P2.N - MAX2) + SIGN(P1.N - MAX1) >=0
 16  AND ROWNUM = 1),
 17  MAX_FOUR AS
 18  (SELECT /*+ LEADING(P4, P3, P2, P1) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P4.N MAX4, P3.N MAX3, P2.N MAX2, P1.N MAX1
 19  FROM A P1, A P2, A P3, A P4, MAX_THREE
 20  WHERE P1.N + P2.N + P3.N + P4.N = 100
 21  AND SIGN(P3.N - MAX3) + SIGN(P2.N - MAX2) + SIGN(P1.N - MAX1) > 0
 22  AND ROWNUM = 1),
 23  FIVE AS
 24  (SELECT /*+ LEADING(P5, P4, P3, P2, P1) USE_NL(P4) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P5.N N5, P4.N N4, P3.N N3, P2.N N2, P1.N N1
 25  FROM A P1, A P2, A P3, A P4, A P5, MAX_FOUR
 26  WHERE P1.N + P2.N + P3.N + P4.N + P5.N = 100
 27  AND SIGN(P4.N - MAX4) + SIGN(P3.N - MAX3) + SIGN(P2.N - MAX2) + SIGN(P1.N - MAX1) >= 0
 28  AND ROWNUM = 1)
 29  SELECT * FROM FIVE;
        N5         N4         N3         N2         N1
---------- ---------- ---------- ---------- ----------
        97          0          1          0          2

已用时间:  00: 05: 51.49
```

严格过滤数据

```
SQL> WITH A AS
  2  (SELECT 100 - ROWNUM + 1 N, ROWNUM - 1 NA FROM DUAL CONNECT BY ROWNUM <= 101),
  3  MAX_ONE AS
  4  (SELECT MAX(N) MAX1 FROM A),
  5  MAX_TWO AS
  6  (SELECT /*+ LEADING(MAX_ONE, P2, P1) USE_NL(P2) USE_NL(P1) */ DECODE(P1.NA, MAX1, P2.N - 1, P2.N) MAX2, P1.NA MAX1
  7  FROM A P1, A P2, MAX_ONE
  8  WHERE P1.NA + P2.N = 100
  9  AND P1.NA >= MAX1
 10  AND ROWNUM = 1),
 11  MAX_THREE AS
 12  (SELECT /*+ LEADING(MAX_TWO, P3, P2, P1) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P3.N MAX3, P2.NA MAX2, P1.NA MAX1
 13  FROM A P1, A P2, A P3, MAX_TWO
 14  WHERE P1.NA + P2.NA + P3.N = 100
 15  AND P3.N + P2.NA <= 100
 16  AND CASE WHEN P2.NA > MAX2 THEN 1 ELSE -1 END + CASE WHEN P1.NA > MAX1 THEN 1 ELSE -1 END >= 0
 17  AND ROWNUM = 1),
 18  MAX_FOUR AS
 19  (SELECT /*+ LEADING(MAX_THREE, P4, P3, P2, P1) USE_NL(P4) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P4.N MAX4, P3.NA MAX3, P2.NA MAX2, P1.NA MAX1
 20  FROM A P1, A P2, A P3, A P4, MAX_THREE
 21  WHERE P1.NA + P2.NA + P3.NA + P4.N = 100
 22  AND P4.N + P3.NA <= 100
 23  AND P4.N + P3.NA + P2.NA <= 100
 24  AND CASE WHEN P3.NA > MAX3 THEN 1 ELSE -1 END + CASE WHEN P2.NA > MAX2 THEN 1 ELSE -1 END + CASE WHEN P1.NA > MAX1 THEN 1 ELSE -1 END > 0
 25  AND ROWNUM = 1),
 26  MAX_FIVE AS
 27  (SELECT /*+ LEADING(MAX_FOUR, P5, P4, P3, P2, P1) USE_NL(P5) USE_NL(P4) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P5.N N5, P4.NA N4, P3.NA N3, P2.NA N2, P1.NA N1
 28  FROM A P1, A P2, A P3, A P4, A P5, MAX_FOUR
 29  WHERE P1.NA + P2.NA + P3.NA + P4.NA + P5.N = 100
 30  AND P5.N + P4.NA <= 100
 31  AND P5.N + P4.NA + P3.NA <= 100
 32  AND P5.N + P4.NA + P3.NA + P2.NA <= 100
 33  AND CASE WHEN P4.NA > MAX4 THEN 1 ELSE -1 END + CASE WHEN P3.NA > MAX3 THEN 1 ELSE -1 END + CASE WHEN P2.NA > MAX2 THEN 1 ELSE -1 END + CASE WHEN P1.NA >
MAX1 THEN 1 ELSE -1 END >= 0
 34  AND ROWNUM = 1)
 35  SELECT * FROM MAX_FIVE;

        N5         N4         N3         N2         N1
---------- ---------- ---------- ---------- ----------
        97          0          1          0          2

已用时间:  00: 00: 00.03
```

严格过滤数据

```
SQL> WITH A AS
  2  (SELECT 100 - ROWNUM + 1 N, ROWNUM - 1 NA FROM DUAL CONNECT BY ROWNUM <= 101),
  3  MAX_ONE AS
  4  (SELECT MAX(N) MAX1 FROM A),
  5  MAX_TWO AS
  6  (SELECT /*+ LEADING(MAX_ONE, P2, P1) USE_NL(P2) USE_NL(P1) */ DECODE(P1.NA, MAX1, P2.N - 1, P2.N) MAX2, P1.NA MAX1
  7  FROM A P1, A P2, MAX_ONE
  8  WHERE P1.NA + P2.N = 100
  9  AND P1.NA >= MAX1
 10  AND ROWNUM = 1),
 11  MAX_THREE AS
 12  (SELECT /*+ LEADING(MAX_TWO, P3, P2, P1) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P3.N MAX3, P2.NA MAX2, P1.NA MAX1
 13  FROM A P1, A P2, A P3, MAX_TWO
 14  WHERE P1.NA + P2.NA + P3.N = 100
 15  AND P3.N + P2.NA <= 100
 16  AND CASE WHEN P2.NA > MAX2 THEN 1 ELSE -1 END + CASE WHEN P1.NA > MAX1 THEN 1 ELSE -1 END >= 0
 17  AND ROWNUM = 1),
 18  MAX_FOUR AS
 19  (SELECT /*+ LEADING(MAX_THREE, P4, P3, P2, P1) USE_NL(P4) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P4.N MAX4, P3.NA MAX3, P2.NA MAX2, P1.NA MAX1
 20  FROM A P1, A P2, A P3, A P4, MAX_THREE
 21  WHERE P1.NA + P2.NA + P3.NA + P4.N = 100
 22  AND P4.N + P3.NA <= 100
 23  AND P4.N + P3.NA + P2.NA <= 100
 24  AND CASE WHEN P3.NA > MAX3 THEN 1 ELSE -1 END + CASE WHEN P2.NA > MAX2 THEN 1 ELSE -1 END + CASE WHEN P1.NA > MAX1 THEN 1 ELSE -1 END > 0
 25  AND ROWNUM = 1),
 26  MAX_FIVE AS
 27  (SELECT /*+ LEADING(MAX_FOUR, P5, P4, P3, P2, P1) USE_NL(P5) USE_NL(P4) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P5.N N5, P4.NA N4, P3.NA N3, P2.NA N2, P1.NA N1
 28  FROM A P1, A P2, A P3, A P4, A P5, MAX_FOUR
 29  WHERE P1.NA + P2.NA + P3.NA + P4.NA + P5.N = 100
 30  AND P5.N + P4.NA <= 100
 31  AND P5.N + P4.NA + P3.NA <= 100
 32  AND P5.N + P4.NA + P3.NA + P2.NA <= 100
 33  AND CASE WHEN P4.NA > MAX4 THEN 1 ELSE -1 END + CASE WHEN P3.NA > MAX3 THEN 1 ELSE -1 END + CASE WHEN P2.NA > MAX2 THEN 1 ELSE -1 END + CASE WHEN P1.NA > MAX1 THEN 1 ELSE -1 END >= 0
 34  AND ROWNUM = 1),
 35  FIVE AS
 36  (SELECT /*+ LEADING(MAX_FOUR, MAX_FIVE, P5, P4, P3, P2, P1) USE_NL(MAX_FIVE) USE_NL(P5) USE_NL(P4) USE_NL(P3) USE_NL(P2) USE_NL(P1) */ P5.N N5, P4.NA N4, P3.NA N3, P2.NA N2, P1.NA N1
 37  FROM A P1, A P2, A P3, A P4, A P5, MAX_FOUR, MAX_FIVE
 38  WHERE P1.NA + P2.NA + P3.NA + P4.NA + P5.N = 100
 39  AND MAX_FIVE.N5 = P5.N
 40  AND P5.N + P4.NA <= 100
 41  AND P5.N + P4.NA + P3.NA <= 100
 42  AND P5.N + P4.NA + P3.NA + P2.NA <= 100
 43  AND CASE WHEN P4.NA > MAX_FOUR.MAX4 THEN 1 ELSE -1 END
 44      + CASE WHEN P3.NA > MAX_FOUR.MAX3 THEN 1 ELSE -1 END
 45      + CASE WHEN P2.NA > MAX_FOUR.MAX2 THEN 1 ELSE -1 END
 46      + CASE WHEN P1.NA > MAX_FOUR.MAX1 THEN 1 ELSE -1 END >= 0)
 47  SELECT * FROM FIVE;

        N5         N4         N3         N2         N1
---------- ---------- ---------- ---------- ----------
        97          0          1          0          2
        97          0          1          2          0

已用时间:  00: 00: 00.03
```

严格过滤数据

```
WITH A AS
.
.
.
FROM A P1, A P2, A P3, MAX_TWO
WHERE P1.NA + P2.NA + P3.N = 100
AND P3.N + P2.NA <= 100
.
.
.
WHERE P1.NA + P2.NA + P3.NA + P4.N = 100
AND P4.N + P3.NA <= 100
AND P4.N + P3.NA + P2.NA <= 100
.
.
.
WHERE P1.NA + P2.NA + P3.NA + P4.NA + P5.N = 100
AND P5.N + P4.NA <= 100
AND P5.N + P4.NA + P3.NA <= 100
AND P5.N + P4.NA + P3.NA + P2.NA <= 100
.
```

严格过滤数据

- 第一步结果集最小原则
- 能提前限制的条件不要放到后面
- 充分利用索引的ACCESS
- 不要忽略FILTER

总结

- 处理问题从整体上考虑，避免单条操作
- 第一步结果集最小原则，合理选择驱动表
- 利用新特性、分析函数避免重复多次的扫描，减少自关联
- 在每一个步骤上尽可能过滤掉无用数据
- 多写SQL：熟能生巧
- 多思考：算法为王
- 持之以恒：优化无止境

Q & A