

**Hierarchical Queries in Data
Warehouse Systems : Demystifying
The **CONNECTION BY** Example**

Paper 104

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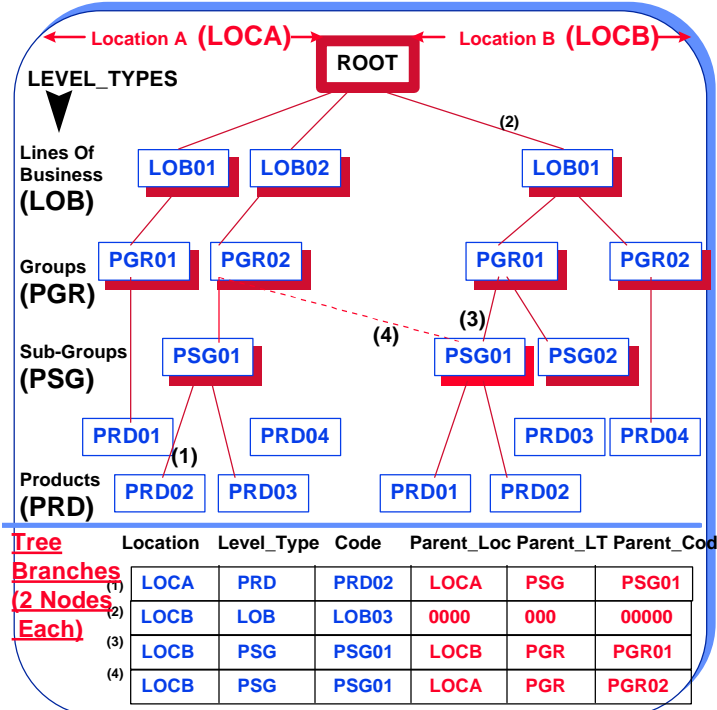
by
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Objectives

- **Understanding Hierarchical Structures**
- **Understanding “CONNECT BY”**
- **Using Hierarchical Queries -
Tips And Techniques**
- **Using Hierarchical Queries - Caution !**
- **The Challenge For Decision Support
Systems**
- **Using Hierarchical Results In
Dimension/Fact Tables**
- **Having The Cake And Eating It Too !**
- **Summary**

A Typical Hierarchy (Tree vs Network)

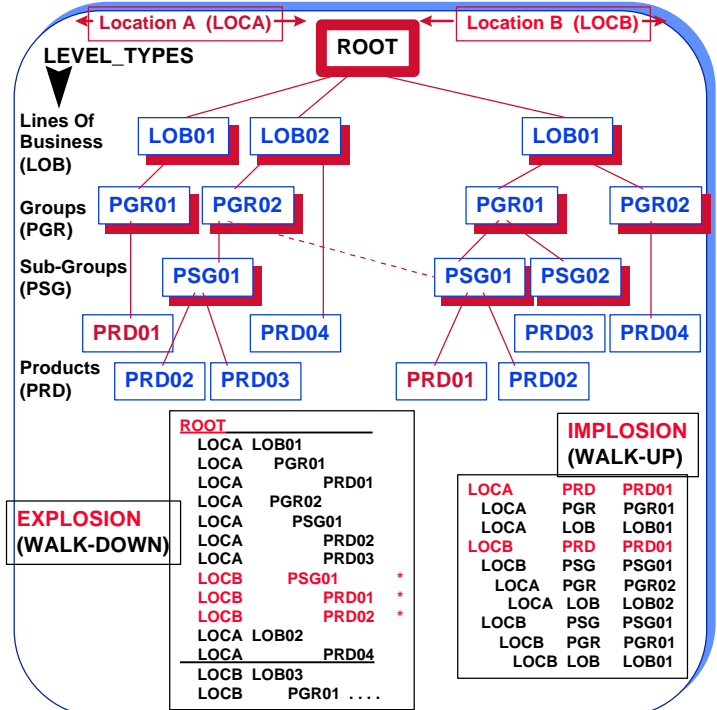


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Hierarchical Queries - What To Expect ?



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Base Table And Its Contents

TABLE : LOC_PROD_RU

Name	Null?	Type
LOC_CODE	NOT NULL	VARCHAR2(4) (P1)
LEVEL_TYPE	NOT NULL	VARCHAR2(3) (P2)
PROD_CODE	NOT NULL	VARCHAR2(5) (P3)
PARENT_LOC_CODE	NOT NULL	VARCHAR2(4) (P4)
PARENT_LEVEL_TYPE	NOT NULL	VARCHAR2(3) (P5)
PARENT_PROD_CODE	NOT NULL	VARCHAR2(5) (P6)
PROD_DESC		VARCHAR2(20)
ADD_DT	NOT NULL	DATE
UPDATE_DT	NOT NULL	DATE (P7)
EFF_START_DT	NOT NULL	DATE
EFF_END_DT		DATE

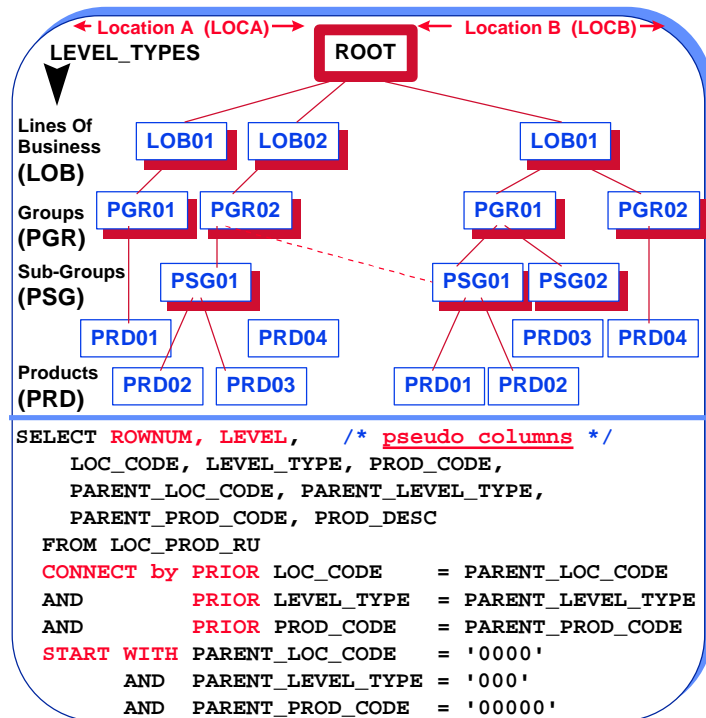
Base Table And Its Contents

```

LOC_ LEV PROD_ PARE PAR PAREN PROD_DESC EFF_START
-----
LOCB LOB LOB01 0000 000 00000 LOB LOB01 01-NOV-94
LOCB PGR PGR01 LOCB LOB LOB01 Group PGR01 At B 01-NOV-94
LOCB PGR PGR02 LOCB LOB LOB01 Group PGR02 At B 01-NOV-94
LOCB PSG PSG01 LOCB PGR PGR01 PSG01/B-Dual Report 01-NOV-94
LOCB PSG PSG02 LOCB PGR PGR01 Subgroup PSG02 At B 01-NOV-94
LOCB PRD PRD01 LOCB PSG PSG01 Product PRD01 At B 01-NOV-94
LOCB PRD PRD02 LOCB PSG PSG01 Product PRD02 At B 01-NOV-94
LOCB PRD PRD03 LOCB PSG PSG02 Product PRD03 At B 01-NOV-94
LOCB PRD PRD04 LOCB PGR PGR02 Product PRD04 At B 01-NOV-94
LOCA PRD PRD04 LOCA LOB LOB02 Product PRD04 At A 01-NOV-94
LOCA PRD PRD03 LOCA PSG PSG01 Product PRD03 At A 01-NOV-94
LOCA LOB LOB02 0000 000 00000 LOB LOB02 01-NOV-94
LOCA PGR PGR02 LOCA LOB LOB02 Group PGR02 At A 01-NOV-94
LOCA PRD PRD02 LOCA PSG PSG01 Product PRD02 At A 01-NOV-94
LOCA LOB LOB01 0000 000 00000 LOB LOB01 01-NOV-94
LOCA PGR PGR01 LOCA LOB LOB01 Group PGR01 At A 01-NOV-94
LOCA PSG PSG01 LOCA PGR PGR02 Subgroup PSG01 At A 01-NOV-94
LOCA PRD PRD01 LOCA PGR PGR01 Product PRD01 At A 01-NOV-94
LOCB PSG PSG01 LOCA PGR PGR02 PSG01/B-Dual Report 01-NOV-94

19 rows selected.
    
```

Hierarchical Query : A Basic "Connect By" Explosion (Multi-level Self-Join)



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"Connect By" Explosion (With One Primary Index)

```

SELECT ROWNUM, LPAD(' ',1*(LEVEL-1)) || LEVEL "LV_NO",
       LPAD(' ',2*(LEVEL-1)) || LOC_CODE || ' ' || LEVEL_TYPE ||
       ' ' || PROD_CODE || ' ' "PROD_IDENTIFIER",
       LPAD(' ',2*(LEVEL-1)) || PARENT_LOC_CODE || ' ' ||
       PARENT_LEVEL_TYPE || ' ' || PARENT_PROD_CODE ||
       ' ' "PARENT_IDENTIFIER", PROD_DESC FROM LOC_PROD_RU
CONNECT BY PRIOR LOC_CODE = PARENT_LOC_CODE
AND PRIOR LEVEL_TYPE = PARENT_LEVEL_TYPE
AND PRIOR PROD_CODE = PARENT_PROD_CODE
START WITH PARENT_LOC_CODE = '0000'
AND PARENT_LEVEL_TYPE='000' AND PARENT_PROD_CODE='00000'
    
```

RNUM	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER	PROD_DESC
1	1	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
2	2	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
3	3	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
4	4	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
5	4	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
6	3	LOCB PSG PSG02	LOCB PGR PGR01	Subgroup PSG02 At B
7	4	LOCB PRD PRD03	LOCB PSG PSG02	Product PRD03 At B
8	2	LOCB PGR PGR02	LOCB LOB LOB01	Group PGR02 At B
9	3	LOCB PRD PRD04	LOCB PGR PGR02	Product PRD04 At B
10	1	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
11	2	LOCA PRD PRD04	LOCA LOB LOB02	Product PRD04 At A
12	2	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
13	3	LOCA PSG PSG01	LOCA PGR PGR02	Subgroup PSG01 At A
14	4	LOCA PRD PRD03	LOCA PSG PSG01	Product PRD03 At A
15	4	LOCA PRD PRD02	LOCA PSG PSG01	Product PRD02 At A
16	3	LOCA PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
17	4	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
18	4	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
19	1	LOCA LOB LOB01	0000 000 00000	LOB LOB01 At A
20	2	LOCA PGR PGR01	LOCA LOB LOB01	Group PGR01 At A
21	3	LOCA PRD PRD01	LOCA PGR PGR01	Product PRD01 At A

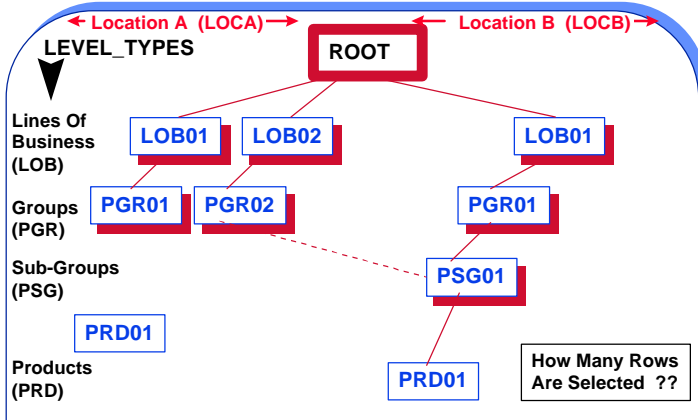
21 rows selected.

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“Connect By” Implosion



WALK UP THE TREE FROM LEAF NODES

```
CONNECT BY LOC_CODE = PRIOR PARENT_LOC_CODE
AND LEVEL_TYPE = PRIOR PARENT_LEVEL_TYPE
AND PROD_CODE = PRIOR PARENT_PROD_CODE
START WITH (LOC_CODE, LEVEL_TYPE, PROD_CODE) IN
(SELECT LOC_CODE, LEVEL_TYPE, PROD_CODE
FROM LOC_PROD_RU
WHERE LOC_CODE IN ('LOCA', 'LOCB')
AND LEVEL_TYPE = 'PRD'
AND PROD_CODE = 'PRD01')
```

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“Connect By” Implosion

```
SELECT ROWNUM, LPAD(' ',1*(LEVEL-1)) || LEVEL "LV_NO",
LPAD(' ',2*(LEVEL-1)) || LOC_CODE || ' ' || LEVEL_TYPE ||
' ' || PROD_CODE || ' ' "PROD_IDENTIFIER",
LPAD(' ',2*(LEVEL-1)) || PARENT_LOC_CODE || ' ' ||
PARENT_LEVEL_TYPE || ' ' || PARENT_PROD_CODE ||
' ' "PARENT_IDENTIFIER", PROD_DESC
FROM LOC_PROD_RU
CONNECT BY LOC_CODE = PRIOR PARENT_LOC_CODE
AND LEVEL_TYPE = PRIOR PARENT_LEVEL_TYPE
AND PROD_CODE = PRIOR PARENT_PROD_CODE
START WITH (LOC_CODE,LEVEL_TYPE,PROD_CODE) IN
(SELECT LOC_CODE, LEVEL_TYPE, PROD_CODE
FROM LOC_PROD_RU
WHERE LOC_CODE IN ('LOCA', 'LOCB')
AND LEVEL_TYPE='PRD'AND PROD_CODE = 'PRD01')
```

RNUM	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER	PROD_DESC
1	1	LOCA PRD PRD01	LOCA PGR PGR01	Product PRD01 At A
2	2	LOCA PGR PGR01	LOCA LOB LOB01	Group PGR01 At A
3	3	LOCA LOB LOB01	0000 000 00000	LOB LOB01 At A
4	1	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
5	2	LOCB PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
6	3	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
7	4	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
8	2	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
9	3	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
10	4	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B

10 rows selected.

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Controlling The Order Of Explosion ("Distinct" In Start With)

```

SELECT ROWNUM, LEVEL, LOC_CODE ||
' ' || LEVEL_TYPE || ' ' || PROD_CODE,
PARENT_LOC_CODE || ' ' || PARENT_LEVEL_TYPE ||
' ' || PARENT_PROD_CODE, PROD_DESC
FROM LOC_PROD_RU
CONNECT BY PRIOR LOC_CODE = PARENT_LOC_CODE
AND PRIOR LEVEL_TYPE = PARENT_LEVEL_TYPE
AND PRIOR PROD_CODE = PARENT_PROD_CODE
START WITH (LOC_CODE, LEVEL_TYPE, PROD_CODE) IN
(SELECT DISTINCT LOC_CODE, LEVEL_TYPE, PROD_CODE
FROM LOC_PROD_RU
WHERE PARENT_LOC_CODE = '0000' AND
PARENT_LEVEL_TYPE='000' AND PARENT_PROD_CODE='00000')

```

Controlling The Order Of Explosion ("Distinct" In Start With)

```

RNUM LV_NO PROD_IDENTIFIER      PARENT_IDENTIFIER      PROD_DESC
-----
1 1 LOCA LOB LOB01 0000 000 00000 LOB LOB01 At A
2 2      LOCA PGR PGR01      LOCA LOB LOB01      Group PGR01 At A
3 3      LOCA PRD PRD01      LOCA PGR PGR01      Product PRD01 At A
4 1 LOCA LOB LOB02 0000 000 00000 LOB LOB02 At A
5 2 LOCA PRD PRD04      LOCA LOB LOB02      Product PRD04 At A
6 2 LOCA PGR PGR02      LOCA LOB LOB02      Group PGR02 At A
7 3      LOCA PSG PSG01      LOCA PGR PGR02      Subgroup PSG01 At A
8 4      LOCA PRD PRD03      LOCA PSG PSG01      Product PRD03 At A
9 4      LOCA PRD PRD02      LOCA PSG PSG01      Product PRD02 At A
10 3      LOCB PSG PSG01      LOCA PGR PGR02      PSG01/B-Dual Report
11 4      LOCB PRD PRD01      LOCB PSG PSG01      Product PRD01 At B
12 4      LOCB PRD PRD02      LOCB PSG PSG01      Product PRD02 At B
13 1 LOCB LOB LOB01 0000 000 00000 LOB LOB01 At B
14 2      LOCB PGR PGR01      LOCB LOB LOB01      Group PGR01 At B
15 3      LOCB PSG PSG01      LOCB PGR PGR01      PSG01/B-Dual Report
16 4      LOCB PRD PRD01      LOCB PSG PSG01      Product PRD01 At B
17 4      LOCB PRD PRD02      LOCB PSG PSG01      Product PRD02 At B
18 3      LOCB PSG PSG02      LOCB PGR PGR01      Subgroup PSG02 At B
19 4      LOCB PRD PRD03      LOCB PSG PSG02      Product PRD03 At B
20 2      LOCB PGR PGR02      LOCB LOB LOB01      Group PGR02 At B
21 3      LOCB PRD PRD04      LOCB PGR PGR02      Product PRD04 At B
21 rows selected.

```

Controlling The Order Of Explosion (Index On Parent Columns)

TABLE : LOC_PROD_RU

Name	Null?	Type
LOC_CODE	NOT NULL	VARCHAR2(4) (P1) (U4)
LEVEL_TYPE	NOT NULL	VARCHAR2(3) (P2) (U5)
PROD_CODE	NOT NULL	VARCHAR2(5) (P3) (U6)
PARENT_LOC_CODE	NOT NULL	VARCHAR2(4) (P4) (U1)
PARENT_LEVEL_TYPE	NOT NULL	VARCHAR2(3) (P5) (U2)
PARENT_PROD_CODE	NOT NULL	VARCHAR2(5) (P6) (U3)
PROD_DESC		VARCHAR2(20)
ADD_DT	NOT NULL	DATE
UPDATE_DT	NOT NULL	DATE (P7) (U7)
EFF_START_DT	NOT NULL	DATE
EFF_END_DT		DATE

```
CONNECT by PRIOR LOC_CODE = PARENT_LOC_CODE
AND PRIOR LEVEL_TYPE = PARENT_LEVEL_TYPE
AND PRIOR PROD_CODE = PARENT_PROD_CODE
START WITH PARENT_LOC_CODE = '0000'
AND PARENT_LEVEL_TYPE = '000'
AND PARENT_PROD_CODE = '00000'
```

Controlling The Order Of Explosion (Index On Parent Columns)

```
SELECT ROWNUM, LPAD(' ',1*(LEVEL-1)) ||
LEVEL "LV_NO",
LPAD(' ',2*(LEVEL-1)) || LOC_CODE ||
' ' || LEVEL_TYPE ||
' ' || PROD_CODE || ' '
"PROD_IDENTIFIER",
LPAD(' ',2*(LEVEL-1)) || PARENT_LOC_CODE
|| ' ' || PARENT_LEVEL_TYPE || ' ' ||
PARENT_PROD_CODE ||
' ' "PARENT_IDENTIFIER", PROD_DESC
FROM LOC_PROD_RU
CONNECT by PRIOR LOC_CODE = PARENT_LOC_CODE
AND PRIOR LEVEL_TYPE = PARENT_LEVEL_TYPE
AND PRIOR PROD_CODE = PARENT_PROD_CODE
START WITH PARENT_LOC_CODE = '0000'
AND PARENT_LEVEL_TYPE='000'
AND PARENT_PROD_CODE='00000'
```

Controlling The Order Of Explosion (Index On Parent Columns)

```

RNUM LV_NO PROD_IDENTIFIER      PARENT_IDENTIFIER      PROD_DESC
-----
1 1  LOCA LOB LOB01  0000 000 00000  LOB LOB01 At A
2 2      LOCA PGR PGR01      LOCA LOB LOB01  Group PGR01 At A
3 3      LOCA PRD PRD01      LOCA PGR PGR01  Product PRD01 At A
4 1  LOCA LOB LOB02  0000 000 00000  LOB LOB02 At A
5 2      LOCA PGR PGR02      LOCA LOB LOB02  Group PGR02 At A
6 3      LOCA PSG PSG01      LOCA PGR PGR02  Subgroup PSG01 At A
7 4      LOCA PRD PRD02      LOCA PSG PSG01  Product PRD02 At A
8 4      LOCA PRD PRD03      LOCA PSG PSG01  Product PRD03 At A
9 3      LOCB PSG PSG01      LOCA PGR PGR02  PSG01/B-Dual Report
10 4      LOCB PRD PRD01      LOCB PSG PSG01  Product PRD01 At B
11 4      LOCB PRD PRD02      LOCB PSG PSG01  Product PRD02 At B
12 2      LOCA PRD PRD04      LOCA LOB LOB02  Product PRD04 At A
13 1  LOCB LOB LOB01  0000 000 00000  LOB LOB01 At B
14 2      LOCB PGR PGR01      LOCB LOB LOB01  Group PGR01 At B
15 3      LOCB PSG PSG01      LOCB PGR PGR01  PSG01/B-Dual Report
16 4      LOCB PRD PRD01      LOCB PSG PSG01  Product PRD01 At B
17 4      LOCB PRD PRD02      LOCB PSG PSG01  Product PRD02 At B
18 3      LOCB PSG PSG02      LOCB PGR PGR01  Subgroup PSG02 At B
19 4      LOCB PRD PRD03      LOCB PSG PSG02  Product PRD03 At B
20 2      LOCB PGR PGR02      LOCB LOB LOB01  Group PGR02 At B
21 3      LOCB PRD PRD04      LOCB PGR PGR02  Product PRD04 At B
21 rows selected.

```

Using Hierarchical Queries - Summary

- Every Row (Branch) Contains A Child Node And A Parent Node
- “Start With” Selects Initial Nodes From The Tree For Starting The “Walks”
- “Connect By” Walks The Tree For Each Selected Node (Recursive Joins)
- Tree Walks Can Start From Any Node
- Use “Prior” On The Child Side For Top-Down Walk (Explosion)
- Use “Prior” On The Parent Side For Bottom-Up Walk (Implosion)
- ROWNUM Gives The Tree-Ordering Of The Result Set
- LEVEL Gives The Depth Of Recursion - Beginning With 1

Using Hierarchical Queries - Tips & Techniques

- **Root Nodes - Do Not Appear As Children In Any Branches**

```
SELECT PARENT_COLUMNS MINUS  
SELECT CHILD_COLUMNS
```

- **Leaf Nodes - Do Not Appear As Parents In Any Branches**

```
SELECT CHILD_COLUMNS MINUS  
SELECT PARENT_COLUMNS
```

- **Orphan Branches - Unexpected Root Or Leaf Nodes**

```
SELECT ROOT_NODES <> '0000' UNION  
SELECT LEAF_NODES <> 'PRD'
```

- **List Of All Orphan Branches**

```
SELECT All_Columns FROM TABLE MINUS  
SELECT All_Columns FROM TABLE  
CONNECT BY ... (Walk Down)  
START WITH ... (Main Root Node)
```

- **Network vs Tree - Multiple Parents For A Child**

```
SELECT COLUMN_LIST FROM TABLE  
GROUP BY CHILD_COLUMNS  
HAVING COUNT(*) > 1
```

- **Circular References : Oracle Error**

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Using Hierarchical Queries - Caution !

- **WHERE Clause**

- ↳ Operates On Individual Rows And Not On All Connected Rows

- **Omitting "Start With" Causes All Nodes To be Used As Starting Points !!**

- **Use ROWNUM From Explosion To Sort By "Explosion" Order (Or Implosion)**

- **ORDERING BY "Other_Columns" Can Give Unexpected Results**

- **Tree SELECT Cannot Also Perform A Join**

- **Tree Select Cannot Select Data From A View Whose Query Performs A Join**

- **Use Views With Pre-Coded Tree Queries To Perform Joins (Static Explosion Only)**

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Using Hierarchical Queries - When Do You Need It ?

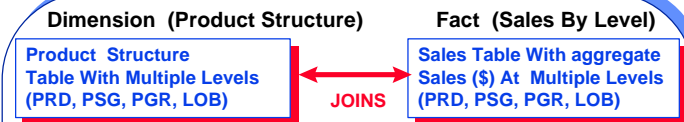
- Product Structure For Sales
- Product Structure For Finance
- Customer Structure
- Corporate Organizations
- Sales Territories
- Geographical Groupings
- Functional Groupings
- Family Tree
- Bill Of Materials
- Memberships
- Any “Pecking Order . . .”
- And More . . .

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Using Hierarchical Queries - The Challenge For Decision Support Systems



- All Sales For Group PGR01, Location A
 - ↳ Use Simple Join Between Tables
- Now, “Drill Down” To Give Sales For All Sub Components Of The Group PGR01
 - ↳ Needs “CONNECT BY” - No Joins Allowed !
- Options And Issues
 - ↳ Use Programmatic Interface For Recursive Joins
 - ↳ Use Temporary Tables For Intermediate Results
 - ↳ Split Dimension (Product Structure) Table Into Multiple Tables - One Per Level
 - ↳ Split Fact Table By Level (Data Volume Issue)
- Result
 - ↳ Less Flexibility
 - ↳ Explosion In Number Of Tables, Especially For Multiple Hierarchical Dimensions

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Using Hierarchical Queries - The Challenge For Decision Support Systems

The Key :

- Given A Starting Node, “Pull Out” All Rows Of The Sub_Trees From Dimension Tables Without Using A CONNECT BY, To Allow Joins To Fact Tables ! OR
- Get Results Of Tree Traversal Without Using “CONNECT BY”

The Magic Answer :

- Create “Pre-Exploded” Dimension Tables With Enough Intelligence To Simulate Results Of Tree Walks

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Storing Pre-Exploded Trees

→ Create A “Pre-Exploded” Table For The Product Structure Table To Store :

- ↳ The Results Of Walks Down The Tree Starting With Every Non-Leaf Node, Including Every Root Node (“DOWN” Rows)
- ↳ The Results Of Walks Up The Tree Starting With Every Non-Root Nodes, Including Every Leaf Node (“UP” Rows)
- ↳ Mark The Rows As “DOWN” Or “UP” Rows
- ↳ Add The “Originating Node” Details To Every Row Of The Corresponding Results
- ↳ Store The ROWNUM From Tree Walks To Preserve The Original Order Of Results
- ↳ Store LEVEL From Tree Walks

→ Use Simple SELECTs To Get Results

- ↳ Results Of Tree Walks Originating At Every Possible Node Are Stored In The Table
- ↳ Indexed By The “Originating Node”
- ↳ ORDER By “Stored Rownum” To Simulate Original Tree Walks

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Storing Pre-Exploded Tree - Table Definition

LOC_PROD_EXP

Name	Null?	Type
ROOT_LOC_CODE		NOT NULL VARCHAR2(4)
ROOT_LEVEL_TYPE		NOT NULL VARCHAR2(3)
ROOT_PROD_CODE		NOT NULL VARCHAR2(5)
LOC_CODE		NOT NULL VARCHAR2(4)
LEVEL_TYPE		NOT NULL VARCHAR2(3)
PROD_CODE		NOT NULL VARCHAR2(5)
PARENT_LOC_CODE		NOT NULL VARCHAR2(4)
PARENT_LEVEL_TYPE		NOT NULL VARCHAR2(3)
PARENT_PROD_CODE		NOT NULL VARCHAR2(5)
PROD_DESC		VARCHAR2(20)
ROWNO		NOT NULL NUMBER
LVLNO		NUMBER
DIRECTION		VARCHAR2(2)
ADD_DT		NOT NULL DATE
UPDATE_DT		NOT NULL DATE
EFF_START_DT		NOT NULL DATE
EFF_END_DT		DATE

Note : See Appendix for Code to Load LOC_PROD_EXP

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Storing Pre-Exploded Tree - Table Definition

```
SELECT DIRECTION "UD",
       ROOT_LOC_CODE, ROOT_LEVEL_TYPE,
       ROOT_PROD_CODE, ROWNUM,
       LPAD(' ',1*(LVLNO-1)) || LVLNO "LV_NO",
       LPAD(' ',2*(LVLNO-1)) || LOC_CODE ||
       ' ' || LEVEL_TYPE ||
       ' ' || PROD_CODE || ' ' "PROD_IDENTIFIER",
       LPAD(' ',2*(LVLNO-1)) || PARENT_LOC_CODE ||
       ' ' || PARENT_LEVEL_TYPE ||
       ' ' || PARENT_PROD_CODE ||
FROM LOC_PROD_EXP
ORDER BY 1, 2, 3, 4, 5
```

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Pre-Exploded Table (Part 1 of 3)

UD	ROOT	ROO	ROOT_	RNUM	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER	PROD_DESC
DN	0000	000	000000	1	1	LOCA LOB LOB01	0000 000 00000	LOB LOB01 At A
DN				2	2	LOCA PGR PGR01	LOCA LOB LOB01	Group PGR01 At A
DN				3	3	LOCA PRD PRD01	LOCA PGR PGR01	Product PRD01 At A
DN				4	1	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
DN				5	2	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
DN				6	3	LOCA PSG PSG01	LOCA PGR PGR02	Subgroup PSG01 At A
DN				7	4	LOCA PRD PRD02	LOCA PSG PSG01	Product PRD02 At A
DN				8	4	LOCA PRD PRD03	LOCA PSG PSG01	Product PRD03 At A
DN				9	3	LOCB PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
DN				10	4	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
DN				11	4	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
DN				12	2	LOCA PRD PRD04	LOCA LOB LOB02	Product PRD04 At A
DN				13	1	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
DN				14	2	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
DN				15	3	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
DN				16	4	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
DN				17	4	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
DN				18	3	LOCB PSG PSG02	LOCB PGR PGR01	Subgroup PSG02 At B
DN				19	4	LOCB PRD PRD03	LOCB PSG PSG02	Product PRD03 At B
DN				20	2	LOCB PGR PGR02	LOCB LOB LOB01	Group PGR02 At B
DN				21	3	LOCB PRD PRD04	LOCB PGR PGR02	Product PRD04 At B
DN	LOCA	LOB	LOB01	22	1	LOCA PGR PGR01	LOCA LOB LOB01	Group PGR01 At A
DN				23	2	LOCA PRD PRD01	LOCA PGR PGR01	Product PRD01 At A
DN		LOB02		24	1	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
DN				25	2	LOCA PRD PRD02	LOCA PGR PGR02	Product PRD02 At A
DN				26	3	LOCA PRD PRD02	LOCA PSG PSG01	Product PRD02 At A
DN				27	3	LOCA PRD PRD03	LOCA PSG PSG01	Product PRD03 At A
DN				28	2	LOCB PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
DN				29	3	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
DN				30	3	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
DN				31	1	LOCA PRD PRD04	LOCA LOB LOB02	Product PRD04 At A
DN		PGR01		32	1	LOCA PRD PRD01	LOCA PGR PGR01	Product PRD01 At A
DN		PGR02		33	1	LOCA PRD PRD01	LOCA PGR PGR02	Subgroup PSG01 At A
DN				34	2	LOCA PRD PRD02	LOCA PSG PSG01	Product PRD02 At A
DN				35	2	LOCA PRD PRD03	LOCA PSG PSG01	Product PRD03 At A
DN				36	1	LOCB PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
DN				37	2	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
DN	LOCA	PGR	PGR02	38	2	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
DN				39	1	LOCA PRD PRD02	LOCA PSG PSG01	Product PRD02 At A
DN				40	1	LOCA PRD PRD03	LOCA PSG PSG01	Product PRD03 At A

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Pre-Exploded Table (Part 2 of 3)

UD	ROOT	ROO	ROOT_	RNUM	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER	PROD_DESC
DN	LOCB	LOB	LOB01	41	1	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
DN				42	2	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
DN				43	3	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
DN				44	3	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
DN				45	2	LOCB PSG PSG02	LOCB PGR PGR01	Subgroup PSG02 At B
DN				46	3	LOCB PRD PRD03	LOCB PSG PSG02	Product PRD03 At B
DN				47	1	LOCB PGR PGR02	LOCB LOB LOB01	Group PGR02 At B
DN				48	2	LOCB PRD PRD04	LOCB PGR PGR02	Product PRD04 At B
DN		PGR01		49	1	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
DN				50	2	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
DN				51	2	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
DN				52	1	LOCB PSG PSG02	LOCB PGR PGR01	Subgroup PSG02 At B
DN				53	2	LOCB PRD PRD03	LOCB PSG PSG02	Product PRD03 At B
DN		PGR02		54	1	LOCB PRD PRD04	LOCB PGR PGR02	Product PRD04 At B
DN		PSG01		55	1	LOCB PRD PRD01	LOCB PSG PSG01	Product PRD01 At B
DN				56	1	LOCB PRD PRD02	LOCB PSG PSG01	Product PRD02 At B
DN		PGR02		57	1	LOCB PRD PRD03	LOCB PSG PSG02	Product PRD03 At B
UP	LOCA	LOB	LOB01	58	1	LOCA LOB LOB01	0000 000 00000	LOB LOB01 At A
UP		LOB02		59	1	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP		PGR01		60	1	LOCA PGR PGR01	LOCA LOB LOB01	Group PGR01 At A
UP				61	2	LOCA LOB LOB01	0000 000 00000	LOB LOB01 At A
UP		PGR02		62	1	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
UP				63	2	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP		PRD01		64	1	LOCA PRD PRD01	LOCA PGR PGR01	Product PRD01 At A
UP				65	2	LOCA PGR PGR01	LOCA LOB LOB01	Group PGR01 At A
UP				66	3	LOCA LOB LOB01	0000 000 00000	LOB LOB01 At A
UP		PRD02		67	1	LOCA PRD PRD02	LOCA PSG PSG01	Product PRD02 At A
UP				68	2	LOCA PSG PSG01	LOCA PGR PGR02	Subgroup PSG01 At A
UP				69	3	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
UP				70	4	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP		PRD03		71	1	LOCA PRD PRD03	LOCA PSG PSG01	Product PRD03 At A
UP				72	2	LOCA PSG PSG01	LOCA PGR PGR02	Subgroup PSG01 At A
UP				73	3	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
UP				74	4	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP	LOCA	PRD	PRD04	75	1	LOCA PRD PRD04	LOCA LOB LOB02	Product PRD04 At A
UP				76	2	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP		PSG01		77	1	LOCA PSG PSG01	LOCA PGR PGR02	Subgroup PSG01 At A
UP				78	2	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
UP				79	3	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A

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Pre-Exploded Table (Part 3 of 3)

UD	ROOT	ROO	ROOT_	RNUM	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER	PROD_DESC
UP	LOCB	LOB	LOB01	80	1	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP		PGR	PGR01	81	1	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
UP				82	2	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP				83	1	LOCB PGR PGR02	LOCB LOB LOB01	Group PGR02 At B
UP				84	2	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP		FRD	FRD01	85	1	LOCB FRD FRD01	LOCB PSG PSG01	Product FRD01 At B
UP				86	2	LOCB PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
UP				87	3	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
UP				88	4	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP				89	2	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
UP				90	3	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
UP				91	4	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP			PRD02	92	1	LOCB FRD PRD02	LOCB PSG PSG01	Product PRD02 At B
UP				93	2	LOCB PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
UP				94	3	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
UP				95	4	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP				96	2	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
UP				97	3	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
UP				98	4	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP			PRD03	99	1	LOCB FRD PRD03	LOCB PSG PSG02	Product PRD03 At B
UP				100	2	LOCB PSG PSG02	LOCB PGR PGR01	Subgroup PSG02 At B
UP				101	3	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
UP				102	4	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP			PRD04	103	1	LOCB FRD PRD04	LOCB PGR PGR02	Product PRD04 At B
UP				104	2	LOCB PGR PGR02	LOCB LOB LOB01	Group PGR02 At B
UP				105	3	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP			PSG01	106	1	LOCB PSG PSG01	LOCA PGR PGR02	PSG01/B-Dual Report
UP				107	2	LOCA PGR PGR02	LOCA LOB LOB02	Group PGR02 At A
UP				108	3	LOCA LOB LOB02	0000 000 00000	LOB LOB02 At A
UP				109	1	LOCB PSG PSG01	LOCB PGR PGR01	PSG01/B-Dual Report
UP				110	2	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
UP				111	3	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B
UP			LOCB PSG PSG02	112	1	LOCB PSG PSG02	LOCB PGR PGR01	Subgroup PSG02 At B
UP				113	2	LOCB PGR PGR01	LOCB LOB LOB01	Group PGR01 At B
UP				114	3	LOCB LOB LOB01	0000 000 00000	LOB LOB01 At B

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Sales Summary Table (Fact Table)

SALES_RU

Name	Null?	Type
CUST_CD	NOT NULL	VARCHAR2(10)
LOC_CODE	NOT NULL	VARCHAR2(4)
LEVEL_TYPE	NOT NULL	VARCHAR2(3)
PROD_CODE	NOT NULL	VARCHAR2(5)
SALES_DT	NOT NULL	DATE
SALES_AMT	NOT NULL	NUMBER(12,2)
SALES_REP_ID	NOT NULL	VARCHAR2(10)
ADD_DT	NOT NULL	DATE
UPDATE_DT		DATE

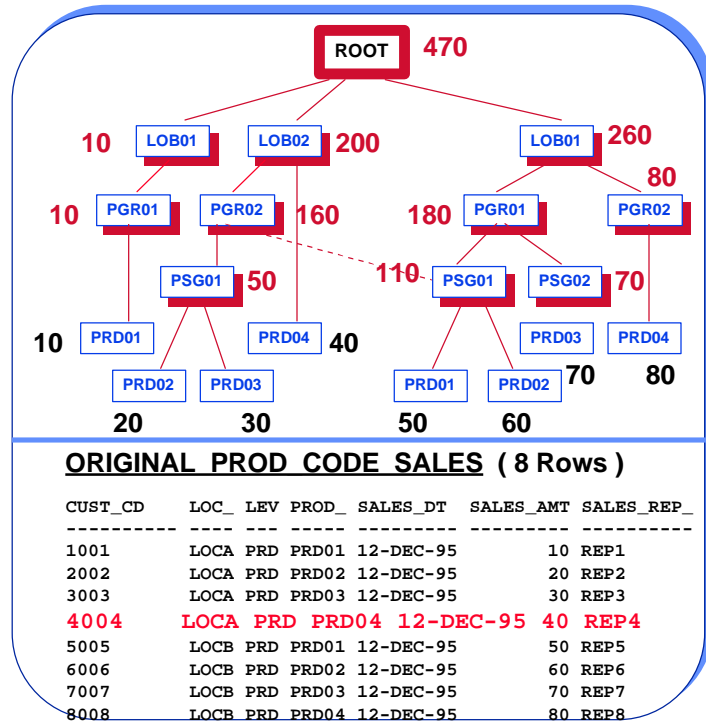
- Sales For All Rollup Levels Of Product Structure (Summarized)
- CUST_CD And SALES_REP_ID Are Not Included At Higher Levels Of Sales
- No Recursive Information In This Table (Parent Codes Could Be Added)

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Sales Data At Product And Summary Levels (In One Table)

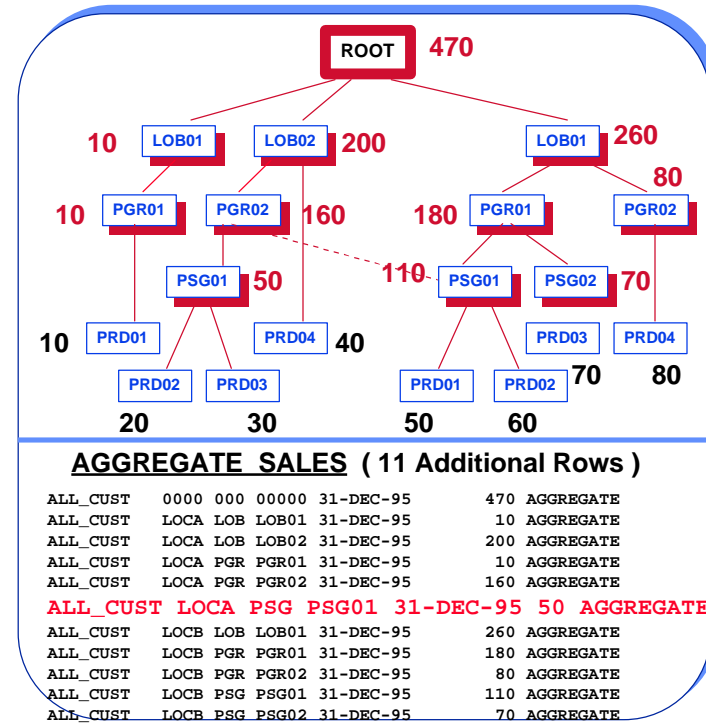


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Sales Data At Product And Summary Levels (In One Table)

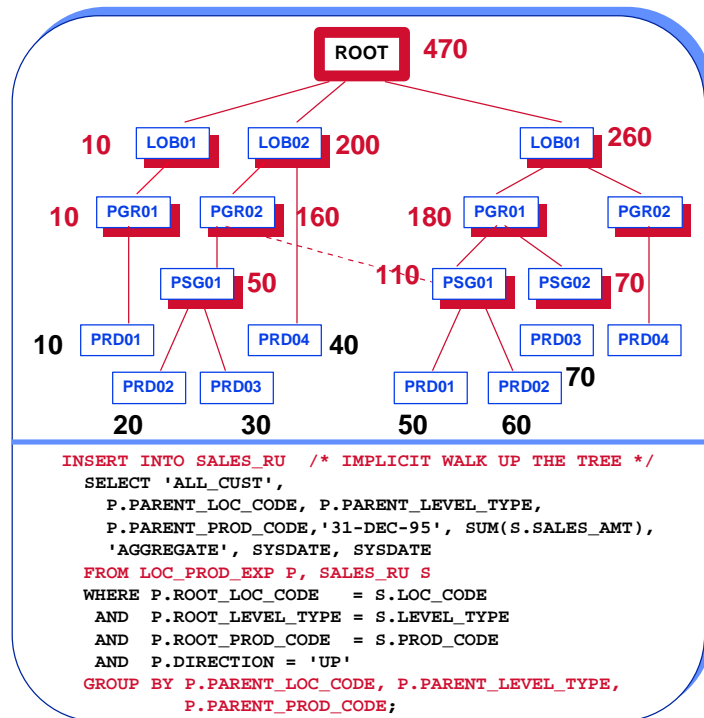


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Hierarchical Aggregation Of Sales Without Using "CONNECT BY"



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Hierarchical Access Of Sales Without Using "CONNECT BY"

Dimension Table : LOC_PROD_EXP
(Pre-Exploded Product Structure)

Fact Table : SALES_RU
(Pre-Aggregated Sales)

Product Structure
Table With Multiple
Levels (PRD, PSG,
PGR, LOB)

Sales Table With
Aggregate Sales (\$) At
Multiple Levels (PRD,
PSG, PGR, LOB)

← SIMPLE
JOINS →

```

SELECT DIRECTION "DN",
       S.LOC_CODE, S.LEVEL_TYPE, S.PROD_CODE, P.ROWNO,
       LPAD(' ',1*(LVLNO-1)) || LVLNO "LV_NO",
       LPAD(' ',2*(LVLNO-1)) || S.LOC_CODE || ' ' || S.LEVEL_TYPE
       || ' ' || S.PROD_CODE || ' ' "PROD_IDENTIFIER",
       LPAD(' ',2*(P.LVLNO-1)) || P.PARENT_LOC_CODE || ' ' ||
       P.PARENT_LEVEL_TYPE || ' ' || P.PARENT_PROD_CODE ||
       ' ' "PARENT_IDENTIFIER", S.SALES_AMT
FROM LOC_PROD_EXP P, SALES_RU S
WHERE P.ROOT_LOC_CODE = '0000'
AND P.ROOT_LEVEL_TYPE = '000'
AND P.ROOT_PROD_CODE = '00000'
AND P.DIRECTION = 'DN' /* ALL SUB-NODES */
AND P.LOC_CODE = S.LOC_CODE
AND P.LEVEL_TYPE = S.LEVEL_TYPE
AND P.PROD_CODE = S.PROD_CODE
ORDER BY P.ROWNO
  
```

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Hierarchical Access Of Sales Without Using "CONNECT BY"

Dimension Table : LOC_PROD_EXP
(Pre-Exploded Product Structure)

Product Structure
Table With Multiple
Levels (PRD, PSG,
PGR, LOB)

Fact Table : SALES_RU
(Pre-Aggregated Sales)

Sales Table With
Aggregate Sales (\$) At
Multiple Levels (PRD,
PSG, PGR, LOB)

SIMPLE
JOINS

UD	LOC_	LEV	PROD_	ROWNO	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER	SALES
DN	LOCA	LOB	LOB01	1	1	LOCA LOB LOB01	0000 000 00000	10
DN	LOCA	PGR	PGR01	2	2	LOCA PGR PGR01	LOCA LOB LOB01	10
DN	LOCA	PRD	PRD01	3	3	LOCA PRD PRD01	LOCA PGR PGR01	10
DN	LOCA	LOB	LOB02	4	1	LOCA LOB LOB02	0000 000 00000	200
DN	LOCA	PGR	PGR02	5	2	LOCA PGR PGR02	LOCA LOB LOB02	160
DN	LOCA	PSG	PSG01	6	3	LOCA PSG PSG01	LOCA PGR PGR02	50
DN	LOCA	PRD	PRD02	7	4	LOCA PRD PRD02	LOCA PSG PSG01	20
DN	LOCA	PRD	PRD03	8	4	LOCA PRD PRD03	LOCA PSG PSG01	30
DN	LOCB	PSG	PSG01	9	3	LOCB PSG PSG01	LOCA PGR PGR02	110
DN	LOCB	PRD	PRD01	10	4	LOCB PRD PRD01	LOCB PSG PSG01	50
DN	LOCB	PRD	PRD02	11	4	LOCB PRD PRD02	LOCB PSG PSG01	60
DN	LOCA	PRD	PRD04	12	2	LOCA PRD PRD04	LOCA LOB LOB02	40
DN	LOCB	LOB	LOB01	13	1	LOCB LOB LOB01	0000 000 00000	260
DN	LOCB	PGR	PGR01	14	2	LOCB PGR PGR01	LOCB LOB LOB01	180
DN	LOCB	PSG	PSG01	15	3	LOCB PSG PSG01	LOCB PGR PGR01	110
DN	LOCB	PRD	PRD01	16	4	LOCB PRD PRD01	LOCB PSG PSG01	50
DN	LOCB	PRD	PRD02	17	4	LOCB PRD PRD02	LOCB PSG PSG01	60
DN	LOCB	PSG	PSG02	18	3	LOCB PSG PSG02	LOCB PGR PGR01	70
DN	LOCB	PRD	PRD03	19	4	LOCB PRD PRD03	LOCB PSG PSG02	70
DN	LOCB	PGR	PGR02	20	2	LOCB PGR PGR02	LOCB LOB LOB01	80
DN	LOCB	PRD	PRD04	21	3	LOCB PRD PRD04	LOCB PGR PGR02	80

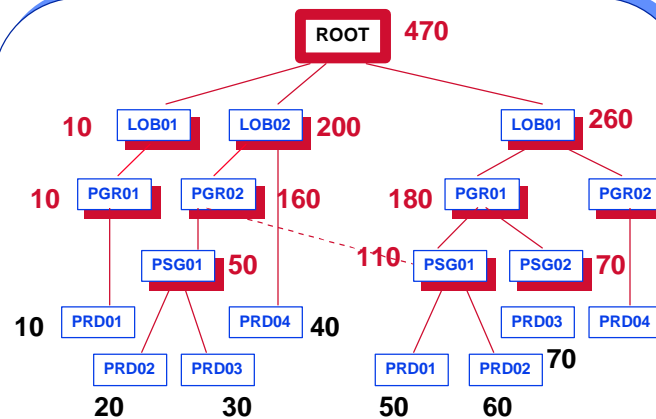
21 rows selected.

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Computing Aggregate Sales For Any Node (On-the-Fly)



```

1  SELECT SUM(SALES_AMT)
2  FROM LOC_PROD_EXP P, SALES_RU S
3  WHERE P.ROOT_LOC_CODE = 'LOCB'
4  AND P.ROOT_PROD_CODE = 'PGR01'
5  AND P.ROOT_LEVEL_TYPE = 'PGR'
6  AND P.LEVEL_TYPE = 'PRD'
7  AND P.LOC_CODE = S.LOC_CODE
8  AND P.LEVEL_TYPE = S.LEVEL_TYPE
9* AND P.PROD_CODE = S.PROD_CODE
SUM(SALES_AMT)
-----
180

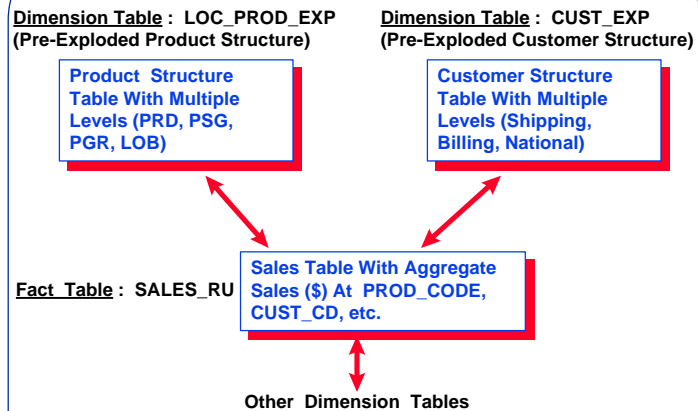
```

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Multidimensional Hierarchy



- Aggregation And Access Can Be Coded Without Using "CONNECT BYs"
- One Table Per Dimension (All Levels)
- Cartesian Products Across Dimensions (?)

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Other Techniques

- Extensions Using Self-Joins On Pre-Exploded Table (To Aggregate And Report On A Subtree In One Statement) - see Appendix for Example
- For Pure Tree Hierarchies, An Ancestor Column Can be Added To Every Row Containing A Concatenated List Of All Its Ancestor Nodes (Tree Walk Up)
 - ↳ Convenient For Extracting SubTrees
 - ↳ Does Not Work For Nodes With Multiple Parents
- Ancestor Codes For Different Nodes :
 - ↳ Root : ROOT
 - ↳ Groups : ROOT GRP
 - ↳ Sub Groups : ROOT GRP SUBGRP
 - ↳ Products : ROOT GRP SUBGRP PRD

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Summary

- **Hierarchy Occurs Naturally In The Real World**
- **Oracle Provides An Elegant Way To Store And Retrieve Hierarchical Information**
- **But Trying To Use Hierarchical Data With Other Tables, Especially In Decision Support, Is Akward And Often Not Practical**
- **This Presentation Has Provided**
 - ↳ **An Understanding Of Tree Queries**
 - ↳ **An Enhanced Way To Store Pre-Exploded Data From Hierarchies**
 - ↳ **Techniques To Utilize Hierarchical Data Within Decision Support Environments**
- **See Appendix for On-the-fly Aggregation**

Appendix

- **Original Table : LOC_PROD_RU**
- **Pre-Exploded Table : LOC_PROD_EXP**
- **Sales Table : SALES_RU**
- **Notes :**
 - ↳ **Additional Rows For Leaf Nodes Have Been Added To LOC_PROD_EXP (see new output)**
- **This Appendix Includes :**
 - ↳ **PL/SQL Script To Load LOC_PROD_EXP**
 - ↳ **Dump of LOC_PROD_EXP With The New Rows**
 - ↳ **A Script To Aggregate Sales “On The Fly” For All The Nodes In Any SubTree**
 - ↳ **Output Of The Script**

Populate LOC_PROD_EXP

```
1 truncate table loc_prod_exp;
2 declare
3   cursor nodelist is
4     select distinct parent_loc_code, parent_level_type, parent_prod_code
5     from loc_prod_ru;
6   cursor leaflist is
7     select distinct loc_code, level_type, prod_code
8     from loc_prod_ru;
9 begin
10  for nodelist_rec in nodelist loop
11    insert into loc_prod_exp      /* Explosion - Walk Down */
12    select
13      nodelist_rec.parent_loc_code,
14      nodelist_rec.parent_level_type,
15      nodelist_rec.parent_prod_code,
16      loc_code, level_type, prod_code,
17      parent_loc_code,
18      parent_level_type,
19      parent_prod_code,
20      prod_desc,
21      rownum, level, 'DN',
22      add_dt, update_dt, eff_start_dt, eff_end_dt
23    from loc_prod_ru
24    connect by prior loc_code = parent_loc_code
25    and        prior level_type = parent_level_type
26    and        prior prod_code = parent_prod_code
27    start with parent_loc_code = nodelist_rec.parent_loc_code
28    and        parent_level_type = nodelist_rec.parent_level_type
29    and        parent_prod_code = nodelist_rec.parent_prod_code;
30  end loop;
31  insert into loc_prod_exp      /* Add PRD Rows For Explosion */
32  select
33    loc_code, level_type, prod_code, loc_code, level_type, prod_code,
34    loc_code, level_type, prod_code, prod_desc, 0, 0, 'DN',
35    add_dt, update_dt, eff_start_dt, eff_end_dt
36  from loc_prod_ru
37  where level_type = 'PRD';
38  commit;
```

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Populate LOC_PROD_EXP

```
(CONTD. ...)
```

```
39  for leaflist_rec in leaflist loop  /* Implosion - Walk Up The Tree */
40    insert into loc_prod_exp
41    select
42      leaflist_rec.loc_code,
43      leaflist_rec.level_type,
44      leaflist_rec.prod_code,
45      loc_code, level_type, prod_code,
46      parent_loc_code,
47      parent_level_type,
48      parent_prod_code,
49      prod_desc,
50      rownum, level, 'UP',
51      add_dt, update_dt, eff_start_dt, eff_end_dt
52    from loc_prod_ru
53    connect by loc_code = prior parent_loc_code
54    and        level_type = prior parent_level_type
55    and        prod_code = prior parent_prod_code
56    start with loc_code = leaflist_rec.loc_code
57    and        level_type = leaflist_rec.level_type
58    and        prod_code = leaflist_rec.prod_code;
59  end loop;
60  commit;
61* end;
```

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Contents Of LOC_PROD_EXP (1 / 3)

UD	ROOT	ROO	ROOT_	ROWNO	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER
DN	0000	000	00000	1	1	LOCA LOB LOB01	0000 000 00000
DN				2	2	LOCA PGR PGR01	LOCA LOB LOB01
DN				3	3	LOCA PRD PRD01	LOCA PGR PGR01
DN				4	1	LOCA LOB LOB02	0000 000 00000
DN				5	2	LOCA PGR PGR02	LOCA LOB LOB02
DN				6	3	LOCA PSG PSG01	LOCA PGR PGR02
DN				7	4	LOCA PRD PRD02	LOCA PSG PSG01
DN				8	4	LOCA PRD PRD03	LOCA PSG PSG01
DN				9	3	LOCB PGR PGR01	LOCA PGR PGR02
DN				10	4	LOCB PRD PRD01	LOCB PGR PGR01
DN				11	4	LOCB PRD PRD02	LOCB PGR PGR01
DN				12	2	LOCA PRD PRD04	LOCA LOB LOB02
DN				13	1	LOCB LOB LOB01	0000 000 00000
DN				14	2	LOCB PGR PGR01	LOCB LOB LOB01
DN				15	3	LOCB PSG PSG01	LOCB PGR PGR01
DN				16	4	LOCB PRD PRD01	LOCB PSG PSG01
DN				17	4	LOCB PRD PRD02	LOCB PSG PSG01
DN				18	3	LOCB PSG PSG02	LOCB PGR PGR01
DN				19	4	LOCB PRD PRD03	LOCB PSG PSG02
DN				20	2	LOCB PGR PGR02	LOCB LOB LOB01
DN				21	3	LOCB PRD PRD04	LOCB PGR PGR02
DN	LOCA	LOB	LOB01	1	1	LOCA PGR PGR01	LOCA LOB LOB01
DN				2	2	LOCA PRD PRD01	LOCA PGR PGR01
DN		LOB02		1	1	LOCA PGR PGR02	LOCA LOB LOB02
DN				2	2	LOCA PSG PSG01	LOCA PGR PGR02
DN				3	3	LOCA PRD PRD02	LOCA PSG PSG01
DN				4	3	LOCA PRD PRD03	LOCA PSG PSG01
DN				5	2	LOCB PSG PSG01	LOCA PGR PGR02
DN				6	3	LOCB PRD PRD01	LOCB PGR PGR01
DN				7	3	LOCB PRD PRD02	LOCB PSG PSG01
DN				8	1	LOCA PRD PRD04	LOCA LOB LOB02
DN		PGR	PGR01	1	1	LOCA PRD PRD01	LOCA PGR PGR01
DN		PGR02		1	1	LOCA PSG PSG01	LOCA PGR PGR02
DN				2	2	LOCA PRD PRD02	LOCA PSG PSG01
DN				3	2	LOCA PRD PRD03	LOCA PSG PSG01
DN				4	1	LOCB PSG PSG01	LOCA PGR PGR02
DN				5	2	LOCB PRD PRD01	LOCB PGR PGR01
DN				6	2	LOCB PRD PRD02	LOCB PSG PSG01
DN		PRD	PRD01	0	0	LOCA PRD PRD01	LOCA PRD PRD01
DN		PRD02		0	0	LOCA PRD PRD02	LOCA PRD PRD02
DN		PRD03		0	0	LOCA PRD PRD03	LOCA PRD PRD03
DN		PRD04		0	0	LOCA PRD PRD04	LOCA PRD PRD04

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Contents Of LOC_PROD_EXP (2 / 3)

UD	ROOT	ROO	ROOT_	ROWNO	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER
DN	LOCA	PSG	PSG01	1	1	LOCA PRD PRD02	LOCA PSG PSG01
DN				2	1	LOCA PRD PRD03	LOCA PSG PSG01
DN	LOCB	LOB	LOB01	1	1	LOCB PGR PGR01	LOCB LOB LOB01
DN				2	2	LOCB PSG PSG01	LOCB PGR PGR01
DN				3	3	LOCB PRD PRD01	LOCB PSG PSG01
DN				4	3	LOCB PRD PRD02	LOCB PSG PSG01
DN				5	2	LOCB PSG PSG02	LOCB PGR PGR01
DN				6	3	LOCB PRD PRD03	LOCB PSG PSG02
DN				7	1	LOCB PGR PGR02	LOCB LOB LOB01
DN				8	2	LOCB PRD PRD04	LOCB PGR PGR02
DN		PGR	PGR01	1	1	LOCB PSG PSG01	LOCB PGR PGR01
DN				2	2	LOCB PRD PRD01	LOCB PSG PSG01
DN				3	2	LOCB PRD PRD02	LOCB PSG PSG01
DN				4	1	LOCB PSG PSG02	LOCB PGR PGR01
DN				5	2	LOCB PRD PRD03	LOCB PSG PSG02
DN				1	1	LOCB PRD PRD04	LOCB PGR PGR02
DN		PRD	PRD01	0	0	LOCB PRD PRD01	LOCB PRD PRD01
DN		PRD02		0	0	LOCB PRD PRD02	LOCB PRD PRD02
DN		PRD03		0	0	LOCB PRD PRD03	LOCB PRD PRD03
DN		PRD04		0	0	LOCB PRD PRD04	LOCB PRD PRD04
DN		PSG	PSG01	1	1	LOCB PRD PRD01	LOCB PSG PSG01
DN				2	1	LOCB PRD PRD02	LOCB PSG PSG01
DN				1	1	LOCB PRD PRD03	LOCB PSG PSG02
UP	LOCA	LOB	LOB01	1	1	LOCA LOB LOB01	0000 000 00000
UP			LOB02	1	1	LOCA LOB LOB02	0000 000 00000
UP		PGR	PGR01	1	1	LOCA PGR PGR01	LOCA LOB LOB01
UP				2	2	LOCA LOB LOB01	0000 000 00000
UP			PGR02	1	1	LOCA PGR PGR02	LOCA LOB LOB02
UP				2	2	LOCA LOB LOB02	0000 000 00000
UP		PRD	PRD01	1	1	LOCA PRD PRD01	LOCA PGR PGR01
UP				2	2	LOCA PGR PGR01	LOCA LOB LOB01
UP				3	3	LOCA LOB LOB01	0000 000 00000
UP			PRD02	1	1	LOCA PRD PRD02	LOCA PSG PSG01
UP				2	2	LOCA PSG PSG01	LOCA PGR PGR02
UP				3	3	LOCA PGR PGR02	LOCA LOB LOB02
UP				4	4	LOCA LOB LOB02	0000 000 00000
UP			PRD03	1	1	LOCA PRD PRD03	LOCA PSG PSG01
UP				2	2	LOCA PSG PSG01	LOCA PGR PGR02
UP				3	3	LOCA PGR PGR02	LOCA LOB LOB02
UP				4	4	LOCA LOB LOB02	0000 000 00000
UP			PRD04	1	1	LOCA PRD PRD04	LOCA LOB LOB02
UP				2	2	LOCA LOB LOB02	0000 000 00000

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Contents Of LOC_PROD_EXP (3 / 3)

UD	ROOT	ROO	ROOT_	ROWNO	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER
UP	LOCA	PSG	PSG01	1	1	LOCA PSG PSG01	LOCA PGR PGR02
UP				2	2	LOCA PGR PGR02	LOCA LOB LOB02
UP				3	3	LOCA LOB LOB02	0000 000 00000
UP	LOCB	LOB	LOB01	1	1	LOCB LOB LOB01	0000 000 00000
UP		PGR	PGR01	1	1	LOCB PGR PGR01	LOCB LOB LOB01
UP				2	2	LOCB LOB LOB01	0000 000 00000
UP			PGR02	1	1	LOCB PGR PGR02	LOCB LOB LOB01
UP				2	2	LOCB LOB LOB01	0000 000 00000
UP		PRD	PRD01	1	1	LOCB PRD PRD01	LOCB PSG PSG01
UP				2	2	LOCB PSG PSG01	LOCA PGR PGR02
UP				3	3	LOCA PGR PGR02	LOCA LOB LOB02
UP				4	4	LOCA LOB LOB02	0000 000 00000
UP				5	2	LOCB PSG PSG01	LOCB PGR PGR01
UP				6	3	LOCB PGR PGR01	LOCB LOB LOB01
UP				7	4	LOCB LOB LOB01	0000 000 00000
UP			PRD02	1	1	LOCB PRD PRD02	LOCB PSG PSG01
UP				2	2	LOCB PSG PSG01	LOCA PGR PGR02
UP				3	3	LOCA PGR PGR02	LOCA LOB LOB02
UP				4	4	LOCA LOB LOB02	0000 000 00000
UP				5	2	LOCB PSG PSG01	LOCB PGR PGR01
UP				6	3	LOCB PGR PGR01	LOCB LOB LOB01
UP				7	4	LOCB LOB LOB01	0000 000 00000
UP			PRD03	1	1	LOCB PRD PRD03	LOCB PSG PSG02
UP				2	2	LOCB PSG PSG02	LOCB PGR PGR01
UP				3	3	LOCB PGR PGR01	LOCB LOB LOB01
UP				4	4	LOCB LOB LOB01	0000 000 00000
UP			PRD04	1	1	LOCB PRD PRD04	LOCB PGR PGR02
UP				2	2	LOCB PGR PGR02	LOCB LOB LOB01
UP				3	3	LOCB LOB LOB01	0000 000 00000
UP			PSG	1	1	LOCB PSG PSG01	LOCA PGR PGR02
UP				2	2	LOCA PGR PGR02	LOCA LOB LOB02
UP				3	3	LOCA LOB LOB02	0000 000 00000
UP				4	1	LOCB PSG PSG01	LOCB PGR PGR01
UP				5	2	LOCB PGR PGR01	LOCB LOB LOB01
UP				6	3	LOCB LOB LOB01	0000 000 00000
UP			PSG02	1	1	LOCB PSG PSG02	LOCB PGR PGR01
UP				2	2	LOCB PGR PGR01	LOCB LOB LOB01
UP				3	3	LOCB LOB LOB01	0000 000 00000

122 rows selected.

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On The Fly Aggregation (Tree Query Output)

SQL To Aggregate All Nodes Starting With ROOT Node (000)

```

1 select P.direction "UD", P.ROWNO,
2     P.ROOT_LOC_CODE, P.ROOT_LEVEL_TYPE, P.ROOT_PROD_CODE,
3     lpad(' ',1*(P.lvlno-1)) || P.lvlno "LV_NO",
4     lpad(' ',2*(P.lvlno-1)) || P.loc_code || ' ' || P.level_type ||
5     ' ' || P.prod_code || ' ' "PROD_IDENTIFIER",
6     lpad(' ',2*(P.lvlno-1)) || P.parent_loc_code || ' ' || P.parent_level_type ||
7     ' ' || P.parent_prod_code || ' ' "PARENT_IDENTIFIER", SUM(S.SALES_AMT)
8 from loc_prod_exp P, SALES_RU S, loc_prod_exp PP
9 WHERE P.ROOT_LOC_CODE = '0000'
10 AND P.ROOT_LEVEL_TYPE = '000'
11 AND P.ROOT_PROD_CODE = '000000'
12 AND P.DIRECTION = 'DN'
13 AND P.LOC_CODE = PP.ROOT_LOC_CODE
14 AND P.LEVEL_TYPE = PP.ROOT_LEVEL_TYPE
15 AND P.PROD_CODE = PP.ROOT_PROD_CODE
16 AND PP.LEVEL_TYPE = 'PRD'
17 AND P.DIRECTION = PP.DIRECTION
18 AND PP.LOC_CODE = S.LOC_CODE
19 AND PP.LEVEL_TYPE = S.LEVEL_TYPE
20 AND PP.PROD_CODE = S.PROD_CODE
21 GROUP BY
22     P.direction, P.ROWNO,
23     P.ROOT_LOC_CODE, P.ROOT_LEVEL_TYPE, P.ROOT_PROD_CODE,
24     lpad(' ',1*(P.lvlno-1)) || P.lvlno,
25     lpad(' ',2*(P.lvlno-1)) || P.loc_code || ' ' || P.level_type ||
26     ' ' || P.prod_code || ' ',
27     lpad(' ',2*(P.lvlno-1)) || P.parent_loc_code || ' ' || P.parent_level_type ||
28     ' ' || P.parent_prod_code || ' '

```

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Results Of On The Fly Aggregation

COMPARE RESULTS WITH PRE-CALCULATED SUMMARIES

UD	ROWNO	ROOT	ROO	ROOT_	LV_NO	PROD_IDENTIFIER	PARENT_IDENTIFIER	S.SALES_AMT
DN	1	0000	000	000000	1	LOCA LOB LOB01	0000 000 00000	10
DN	2				2	LOCA PGR PGR01	LOCA LOB LOB01	10
DN	3				3	LOCA PRD PRD01	LOCA PGR PGR01	10
DN	4				1	LOCA LOB LOB02	0000 000 00000	200
DN	5				2	LOCA PGR PGR02	LOCA LOB LOB02	160
DN	6				3	LOCA PSG PSG01	LOCA PGR PGR02	50
DN	7				4	LOCA PRD PRD02	LOCA PSG PSG01	20
DN	8				4	LOCA PRD PRD03	LOCA PSG PSG01	30
DN	9				3	LOCB PSG PSG01	LOCA PGR PGR02	110
DN	10				4	LOCB PRD PRD01	LOCB PSG PSG01	50
DN	11				4	LOCB PRD PRD02	LOCB PSG PSG01	60
DN	12				2	LOCA PRD PRD04	LOCA LOB LOB02	40
DN	13				1	LOCB LOB LOB01	0000 000 00000	260
DN	14				2	LOCB PGR PGR01	LOCB LOB LOB01	180
DN	15				3	LOCB PSG PSG01	LOCB PGR PGR01	110
DN	16				4	LOCB PRD PRD01	LOCB PSG PSG01	50
DN	17				4	LOCB PRD PRD02	LOCB PSG PSG01	60
DN	18				3	LOCB PSG PSG02	LOCB PGR PGR01	70
DN	19				4	LOCB PRD PRD03	LOCB PSG PSG02	70
DN	20				2	LOCB PGR PGR02	LOCB LOB LOB01	80
DN	21				3	LOCB PRD PRD04	LOCB PGR PGR02	80

21 rows selected.

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Test Files

p trcrtab1.sql
 p trldtab1.sql
 p trqfull1.sql

 p trqexpa1.sql
 p trqexpb1.sql

 p trcrtab2.sql
 p trldtab2.sql
 p trexpa2.sql

 p trcrtab3.sql
 p trqexp4.sql
 p trqexp5.sql
 p trqexp6.sql

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