



Why is my SQL slow

Bob Carlin Consulting Member of Technical Staff Oracle Real-World Performance



Why is My SQL Slow ?





Problem Query

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Real-World Demos • Settings Window • Layout • Axis • Command • Login	Logged in as john.zimmerman logout
	SQL Monitor Report
Pagani Zonda 50,000,000 Porsche Carrera GT 50,000,000 Radical SR8 50,000,000 Rossion 01 50,000,000 Tesla Roadster 50,000,000 Ultima GTR 50,000,000 27 rows selected. Elapsed: 00:00:03.90 COUNT(*) 1,200,020,001 Elapsed: BYTES 64,483,229,696	Two SQL Statements SLA: 5 seconds Query 1 SELECT COUNT (pl.text) "Ferraris", COUNT (pl.text) "Ferraris", SUM(DECODE (pl.text, NULL, 1, 0)) "Other Ferraris" FROM (SELECT owner id, "Ferraris" "Ferraris" FROM carguys WHERE make = 'Ferrari') pl, (SELECT owner id, "Ferrari 458s' "Ferrari 458s" FROM carguys WHERE country = 'Italy' AND model = '458 Italia') p2
fonitored SQL Executions	WHERE p1.owner_id = p2.owner_id(+);
ID* Description Status Duration	Query 2
Table has 1.2B rows and is 64 GB.	<pre>SELECT COUNT(pl.text) "Combos 1", COUNT(p2.text) "Combos 2", SUM(DECODE(p2.text,NULL,1,0)) Diff FROM (SELECT owner_id, 'Citroens and Minis' "Citroens and Minis" FROM carguys WHERE make IN('Ferrari','Citroen','Mini')) p1, (SELECT owner_id, 'Mini Coopers' "Mini Coopers" FROM carguys WHERE country = 'England' AND make IN('Citroen','Mini')</pre>
	AND model IN ('Cooper')) p2 WHERE pl.owner_id = p2.owner_id(+)

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04,403,223,030	-) p2 WHERE p1.owner id = p2.owner id(+);
onitored SQL Executions	× •	WIERD DI.OWHEI_IG = D2.OWHEL_IG(),
ID Description	.atus Duration	Query 2
Query 1 consists of two subqueries. The first subquery finds all of the Ferraris.		<pre>SELECT COUNT(p1.text) "Combos 1", COUNT(p2.text) "Combos 2", STM(DECODE(p2.text,NULL,1,0)) Diff FROM (SELECT owner_id, 'Citroens and Minis' "Citroens and Minis" FROM carguys WHERE make IN ('Ferrari', 'Citroen', 'Mini')) p1, (SELECT owner_id, 'Mini Coopers' "Mini Coopers" FROM carguys WHERE country = 'England' AND make IN ('Citroen', 'Mini') AND model IN ('Cooper')) p2 WHERE p1.owner_id = p2.owner_id(+)</pre>

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itored SOL Executions		*) p2 WHERE p1.owner_id = p2.owner_id(+);
1 The second sul all of the Ferrar		Duration	<pre>Query 2 SELECT SUBJECT COUNT(pl.text) "Combos 1", COUNT(pl.text) "Combos 2", SUM(DECODE(pl.text,NULL,1,0)) Diff FROM (SELECT owner_id,</pre>



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	SQL Monitor Report
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Monitored SOL Executions) p2 WHERE p1.owner_id = p2.owner_id(+);
Duration Duration Duration Duration	<pre>Query 2 SELECT COUNT(p1.text) "Combos 1", COUNT(p2.text) "Combos 2", SUM(DECODE(p2.text,NULL,1,0)) Diff FROM (SELECT owner_id,</pre>

Problem Query

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Elapsed: 00:00:03.90

64,483,229,696

Monitored SQL Executions ID ^

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COUNT(*) 1.200.020.001 Elapsed: 00:00:03.67

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rld Demos • Settings Window • Layout • Axis • Command • Login	Logged in as john.zimmerman logou
Zonda 50,000,000	SQL Monitor Report SQL
Query 2 is the same but has different predicate values.	Two SQL Statements SLA: 5 seconds Query 1 SELECT COUNT (pl.text) "Ferraris", COUNT (p2.text) "Ferrari 458s", SUM (DECODE (p2.text, NULL,1,0)) "Other Ferraris"
d: 00:00:03.90 COUNT(*) 1,200,020,001 d: 00:00:03.67 BYTES 64,483,229,696	<pre>FROM (SELECT owner_id,</pre>
QL Executions Description Status	WHERE pl.owner_id = p2.owner_id(+); Query 2 SELECT COUNT(pl.text) "Combos 1", COUNT(p2.text) "Combos 2", SUM(DECODE(p2.text,NUL,1,0)) Diff
	<pre>FROM (SELECT owner_id,</pre>

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. Output		SQL Monit	or Report										
<pre>2 count(p1.text) "Ferraris", 3 count(p2.text) "Ferrari 458s",</pre>	^	More on OT ORAC Active Re	:LE Enterprise Manager								(English	
4 sum(decode(p2.text, null, 1, 0		Monitor	red SQL Execution Details	c 🕜									
6) "Other Ferraris"			-	• •									
7 from (select owner_id,		Overview SOL 10 0mv/h9/0wtza7 0 Time & Walt Statistics IO Statistics											
8 'Ferraris' as text 9 from carguys		Bacellal 88-rs 0 r											
9 from carguys 10 where make = 'Ferrari') p1,			ion Started Thu Sep 12, 201			se Time	.0s	18.		Buffer Gets			
11 (select owner id,			fresh Time Thu Sep 12, 201 recution ID 16777216	3 10:31:34 AM		L&Java 0.0s		10.		IO Bytes	-	215G	
12 'Ferrari 458s' as text			User CARS2			tivity %		100					
13 from carguys			Fetch Calls 1		- Tuic /	concy to		100		enneranney	52.70		
14 where country = 'Italy'		Details											
15 and make = 'Ferrari'	E	🗔 Plan	Statistics	Activity	Netrics								
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2		88	E PX BLOCK ITERATOR	CARGUYS	190K			50M	62K	99	.64	2.05	
		25	TABLE ACCESS S	CARGUYS	46M			50M	62K	99	.26		
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1. Development Findings

- Baseline Performance for Query 1
- Query 1 exceeds target



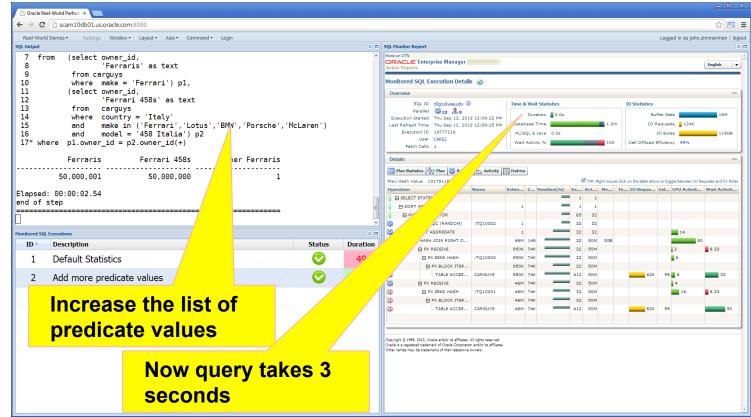
Initial Optimization Steps— More Predicate Values





More Predicate Values







More Predicate Values

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Ionitored SQL Execution Details 🥪									
Overview									-
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HASH JOIN RIGHT OUTER			46M	148K	32	50M 3GB			50
PX RECEIVE			950K	74K	32	50M		2	8.33
PX SEND HASH		:TQ10000	950K	74K	32	50M		— 6	
PX BLOCK ITERATOR			950K	74K	32	50M			
TABLE ACCESS STORAGE FULL		CARGUYS	950K	74K	412	50M		62K 99 8	33
PX RECEIVE PX SEND HASH		:TQ10001	46M 46M	74K	32	50M		4	8.33
		11010001	46M	74K	32	50M		16	6.33
PX BLOCK ITERATOR TABLE ACCESS STORAGE FULL		CARGUYS	46M	74K	412	50M		62K 99	50
·									

2. Development Findings

- Query runs faster just by changing the list of values in the select list
- Plan changed from a broadcast to a hash distribution due to the higher but inaccurate cardinality estimate
- Get correct plan with wrong cardinality estimate can lead to inconsistent plans and performance

Initial Optimization Steps— Increase Degree of Parallelism





Degree of Parallelism



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7 from (select owner_id, 8 'Ferraris' as text 9 from carguys		^		ACLE Enterprise Manager Reports							English		
9 from carguys 10 where make = 'Ferrari') p1,			Monitored SQL Execution Details 🥪										
11 (select owner_id,			Over	view							_		
12 'Ferrari 458s' as text 13 from carguys										IO Statistics			
13 from carguys 14 where country = 'Italy'			Parallel 00 128 28 8 Execution Stated Thu Sep 12, 2013 12:12:38 PM Duration				tion 2.0s Bu			Buffer Gets	16M		
15 and make = 'Ferrari'		Last Refr. In Time Thu Sep 12, 2013 12:12:40 PM Datab xecution ID 16777216 pL/S			Database Tim		2	1.5m IO	IO Requests 126K IO Bytes 119GB				
16 and model = '458 Italia') p2					PL/SQL & Ja	0.0s							
17* where pl.owner_id = p2.owner_id(+)				Fetch Calls 1		Wait Activit	_	1	.00 Cell Offload	d Efficiency 99%			
Ferraris Ferrari 458s Other Ferr	aris		Deta	ils							_		
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2 Add more predicate values		3	දිරි දිරි	- TABLE ACCES	CARGUYS			1,68 50M	63	K 99 9.09	44		
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Degree of Parallelism

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D PX RECEIVE			360K	18K	128	50M				9.09	3.7	
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3. Development Findings

- Changing DoP from 32 to 128 improves performance and meets the target; 4X more resources yields a 25X performance improvement
- Plan has changed from a broadcast distribution to a hash distribution due to DoP change
- DoP is a resource management technique, not a query tuning tool

Indexes









4. Development Findings—Indexes

- Indexes on columns:
 - owner_id
 - country
 - make
 - model
 - country, make, model



Indexes



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Real-World Demos • Settings Window • Layout • Axis • Command • Login SQL Output			SQL Monitor Report						Logged in as john	zimmerman log	
1,200,020,001		<u>^</u>	More on OTN ORACLE Enterprise Manage Active Reports	er						English 🗸	
Elapsed: 00:00:03.70 1 select /*+ MONITOR */ count(*) 2 from (select owner_id, 3 'Ferrari 458s' as text 4 from carguys 5 where country = 'Italy' 6 and make = 'Ferrari' 7* and model = '458 Italia') COUNT(*) 50,000,000 Elapsed: 00:00:00.52 end of step		Monitored SQL Execution Details Image: SQL 10 1y62/dampuel® (1) Image: SQL 10 1y62/dampuel® (1) Image: SQL 10 1y62/dampuel® (1) Image: SQL 10 100 Statistics Image: SQL 10 Image: SQL 10 100 Statistics Image: SQL 10 Image:						quests 415K 9 Bytes iciency 92%	gie between 10 Requests and 10 Rytes		
			PX SEND QC (RAND	:TQ10002	1	32	32				
Monitored SQL Executions			SORT AGGREGATE		1 46M 628K	32	32 50M 3GB		3.05		
ID Description	Status	n	D PX RECEIVE		46M 74K	32	50M			1.05	
1 Default Statistics		49	🚳 🗇 PX SEND HASH	:TQ10001	46M 74K		50M		3.82		
		-	TABLE AC	CARGUYS	46M 74K		50M 50M	62K	99 .76		
2 Add more predicate values		3	BUFFER SORT				50M 3GB		7.63		
3 Change DoP		2	D PX RECEIVE		44M 554K		50M		.76		
		-	PX SEND H		44M 554K		50M 50M	328K	7.63		
4 Indexes		160	-			1		25K	3.82	9.47	
⁵ Add indexes and query takes longer— 160 seconds!			Copyright () 1996, 2013, Oracle and/or to a Hill Copyright () 1996, 2013, Oracle and/or to a Hill Cocket is a registreed tablemark of Oracle Copy Other names may be tablemarks of their regist	oration and/or its affil							

Indexes

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More on OTN									English V		
Monitored SQL Execution Details 🥪											
Overview									-		
SQL ID 1y624ewpuqdf0 (i)	Time & Wait Statistics					IO Statistics					
Parallel 332 88 Execution Started Fri Sep 20, 2013 9:35:55 AM	Duration			2.7m		Buffer G	3ets		8,350K		
Last Refresh Time Fri Sep 20, 2013 9:38:36 AM	Database Time				4.1m	1m IO Requests 415K					
Execution ID 16777216 User CARS2	PL/SQL & Java 0.0s					IO By	ytes		64GB		
Fetch Calls 1	Wait Activity %				100	Cell Offload Efficie	ancy 92%				
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4. Development Findings—Indexes

- Not understanding the big/little data challenge
- Indexes are not efficient for operations on a large numbers of rows
- Full table scan is faster with predictable performance

To Index or Not



- Indexing is an OLTP technique for operations on a small number of rows
- A table scan may consume more resources but it will be predictable no matter how many rows are returned
- Indexes impact DML operations
- If I/O bandwidth went from 70MB/sec to 70GB/sec would you change your optimization/execution strategy?

- Index driven query retrieving 1,000,000 rows
 - Assume the index is cached and the data is not.
 - 1,000,000 random IOPS @ 5ms per I/O
 - This would require 5000 Seconds (or over 1 hour) to Execute
 - How much data could you scan in 5000 Seconds with a fully sized I/O system able to scan 25 GB/Sec ?
 - Over 100 TB !

Histograms





Histograms

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Histograms

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5. Development Findings

- Re-gathered stats to automatically create histograms
 - Frequency histograms on country, make and model columns
- No change in plan—query still exceeds target

Flash Temp





Flash Temp

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Flash Temp

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6. Development Findings

- Most of the wait time was spent performing IO on temp, so move temp to flash disks
- Improved performance but still does not meet target
- Not a good use of flash
- Incorrect use of tools/products

Manual Memory Parameters





Manual Memory Parameters

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Manual Memory Parameters

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Parallel 🖓 32 🚮 8	Duration 35.0s			Buffer G	iets		16M
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Execution ID 16777216	PL/SQL & Java 0.0s			IO By	rtes		119GB
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SORT AGGREGATE		1	1	1		.2	
PX COORDINATOR			65	32			3.85
D PX SEND QC (RANDOM)	:TQ10001	1	32	32			
SORT AGGREGATE		1 50M 148K	32	32 50M 64GB		.3	
B PX RECEIVE		360K 74K		600M 64GB		10	76
B PX SEND BROADCAST	:TQ10000	360K 74K		600M		12	15
8 P. PX BLOCK ITERATOR		360K 74K	32	50M			
TABLE ACCESS STORAGE FULL	CARGUYS	360K 74K	412	50M	62K	99 .2	
3 E-PX BLOCK ITERATOR		50M 74K	32	50M			
TABLE ACCESS STORAGE FULL	CARGUYS	50M 74K	412	50M	62K	99 .5	35
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Manual Memory Parameters



7. Development Findings

- Set sort_area_size and hash_area_size to 2G
- Eliminated temp usage but still did not meet target
- Memory is allocated per parallel server process, which can quickly exceed resources
- Moving to a solution before understanding the problem





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8	om (select owner_id, 'Ferraris' as text		^	More on OTN ORACLE Enterprise Manager Active Reports		E					English
9 10	from carguys			Monitored SQL Execution Deta	ils 🕢						
10	where make = 'Ferrari') p1, (select /*+ cardinality(carguys 50000000) */ owner_	id		Overview							
12	'Ferrari 458s' as text	10,		SQL ID fpt6wrqqmjdu9 (D	Time & Wait				IO Statistics	
13	from carguys			Parallel 332 28					t	Buffer Gets	164
14	where country = 'Italy'			Execution Started Thu Sep 12, 20		м	ation 3.0s		1.4m		16M
15	and make = 'Ferrari'			Last Refresh Time Thu Sep 12, 20 Execution ID 16777216	013 10:59:02 AN		Java 0.0s		1.4m	IO Requests 124K	119
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PX SEND QC (RANDOM)	:TQ10002	1	32	32		
🖏 🖻 SORT AGGREGATE		1	32	32	6.41	
🖏 🖻 HASH JOIN OUTER		50M 148K	32	50M 3GB		67
PX RECEIVE		50M 74K	32	50M	1.28	
D PX SEND HASH	:TQ10000	50M 74K	32	50M	6.41	
B PX BLOCK ITERATOR		50M 74K	32	50M		
TABLE ACCESS STORAGE FULL	CARGUYS	50M 74K	412	50M	62K 99 5.13	33
3 E PX RECEIVE		50M 74N	32	50M	2.56	
D PX SEND HASH	:TQ10001	50M 74K	32	50M	5.13	
B PX BLOCK ITER		50M 74K	32	50M		
35 TABLE ACCES	CARGUYS	50M 74K	412	50M	62K 99 6.41	63
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8. Cardinality Hint

- SQL Monitor showed poor cardinality estimates
- Cardinality hint gives optimizer the correct number of rows for the table scan
- Plan changed from a broadcast to hash distribution
- Query time now meets target
- Now temp is not an issue

Disable Broadcast Distribution





Disable Broadcast Distribution

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13	from carguys				SQLID dvkuxfxfcng0g 🛈 Parallel 🆓 32 🗸 8		Time & Wait St				I0 Statistics		
14	where country = 'Italy'				ution Started Fri Sep 20, 2013			on 3.0s				er Gets	16M
15 16	and make = 'Ferrari' and model = '458 Italia') p2				Refresh Time Fri Sep 20, 2013 Execution ID 16777216	10:15:16 AM	Database Tim PL/SQL & Jav			1.2m		quests a 124K	119
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Disable Broadcast Distribution

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Plan Hash Value 1317911832								𝗭 TIP: Right mouse click on the table a	lows to toggle between IO Requests and IO Bytes
Operation	Name	Estimated Rows	Cost Timeline(3s)	Executio	Actual Rows	Memory (M	Temp (Max) IO Requests	Cell Offlo CPU Activity %	Wait Activity %
B SELECT STATEMENT				1	1				
SORT AGGREGATE		1		1	1				
PX COORDINATOR				65	32				
PX SEND QC (RANDOM)	:TQ10002	1		32	32				
SORT AGGREGATE		1		32	32			12	
HASH JOIN RIGHT OUTER		50M	148K	32	50M	3GB			61
PX RECEIVE PX SEND HASH	:TQ10000	360K 360K	74K	32	50M 50M			5.08	17
B PX SEND RASH	1010000	360K	74K	32	50M			5.08	
TABLE ACCESS STORAGE FULL	CARGUYS	360K	74K	412	50M		62	K 99 5.08	33
86 PX RECEIVE		50M	74K	32	50M			5.08	
20 PX SEND HASH	:TQ10001	50M	74K	32	50M			5.08	
B PX BLOCK ITERATOR		50M	74K	32	50M				
TABLE ACCESS STORAGE FULL	2000VG	50M	74K	412	50M		62	K 99 🔜 6.78	50
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9. Development Findings

- Googling reveals a hidden parameter to disable broadcast distribution
- Plan and run times are similar to cardinality hint, meeting target
- Moving to a solution before understanding the problem

Second Query with Broadcast Distribution Disabled





Query 2: Broadcast Distribution Disable dworld performance

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9	from carguys			Mo	nitored SQL Execution Detai	s 🧹				
10	where make in ('Ferrari','Citroen','Mini')) p1,			0	verview					-
11 12	(select owner_id, 'Mini Coopers' as text				SQL ID 5p2v659suuhzp ()	Time & Wait Statist	ics	I0 Statistics	
13	from carguys				Parallel 🖓 32 🖁 8 Execution Started Fri Sep 20, 2013	10:17:25 AM	Duration	17.0s	Buffer Gets	16M
14	where make in ('Citroen','Mini')			L	ast Refresh Time Fri Sep 20, 2013	10:17:42 AM	Database Time 📕	47.38	IO Requests 124K	
15	and model in ('Cooper')) p2				Execution ID 16777216 User CARS2		PL/SQL & Java 0			119GB
16* whe	<pre>pl.owner_id = p2.owner_id(+)</pre>				Fetch Calls 1		Wait Activity %	100	Cell Offload Efficiency 99%	
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	150,010,001 100,000,000 50,010,001			Pla	an Hash Value 1317911832				click on the table allows to toggle between IO Requests a	
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end of s				0	E SELECT STATEMENT		1	1 1		
:======= 7				a 6	PX COORDINATOR		-	65 32		
1				- 83		:TQ10002	1	32 32		
Ionitored SQL I			۲		ASH JOIN RIGHT O		1 95M 148	32 32 32 150M 7MB	28	
ID ^	Description	Status	Duration	- 23	PX RECEIVE		849K 74K	32 10K	20	
3	Change DoP	\sim	2	^ (B)	PX SEND HASH	:TQ10000	849K 74K	32 10K		
4	Indexes	\bigcirc	160	88 8			849K 74K	32 10K		
7	Indexes		100	30 30 30		CARGUYS	849K 74K	412 10K 32 50M	62K 100 8	62
5	Stats with Histograms		51			:TQ10001	95M 74K	32 50M		
-	5			85			95M 74K	32 50M		
6	Flash Temp	\bigcirc	30	35	TABLE ACCES	CARGUYS	95M 74K	412 50M	62K 99 4	38
7	Manual memory allocation	\bigcirc	33							
8	Cardinality Hint	\bigcirc	3	Orac	vright () 1996, 2013, Oracle and/or its affiliates. Ie is a registered trademark of Oracle Corporati er names may be trademarks of their respective	on and/or its affiliate	5.			
9	Disable Broadcast Distribution	\bigcirc	3							
10	Query 2 Disable Broadcast Distribution	\bigcirc	17							
11										

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Query 2: Broadcast Distribution Disable dworld performance

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Overview												-
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Parallel 32 8 Execution Started Fri Sep 20, 2013 10:17:25 AM	Duration		17.0s					Buffer G	ets			16M
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Execution ID 16777216	PL/SQL & Java 0.0s							IO By	ies			119GB
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Details												-
🗐 Plan Statistics 🧞 Plan 🎆 Parallel 📐 Activity 🛛	Netrics											
Plan Hash Value 1317911832											IIP: Right mouse click on the table	allows to toggle between IO Requests and IO Bytes
Operation		Name	Estimated Rows	Cost	Timeline(17s)	Executio A	ctual Rows M	emory (M	Temp (Max)	IO Requests	Cell Offlo CPU Activity %	Wait Activity %
SELECT STATEMENT						1	1					
SORT AGGREGATE			1			1	1					
PX COORDINATOR						65	32					
A D PX SEND QC (RANDOM)		:TQ10002	1			32	32					
3 E SORT AGGREGATE			1			32	32					60
HASH JOIN RIGHT OUTER			95M	148K		32	150M	7MB			28	
B-PX RECEIVE			849K	74K	-	32	10K					
D PX SEND HASH		:TQ10000	849K	74K		32	10K					
PX BLOCK ITERATOR			849K	74K		32	10K					
TABLE ACCESS STORAGE FULL		CARGUYS	849K	74K		412	10K			62K	100 🔜 8	62
B PX RECEIVE			95M	74K		32	50M					
D PX SEND HASH		:TQ10001	95M	74K		32	50M					
PX BLOCK ITERATOR TABLE ACCESS STORAGE FULL			95M 95M	74K		32	50M					
TABLE ACCESS STORAGE FULL			95M	74K		412	50M			62K	99 📕 4	38
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Query 2: Broadcast Distribution Disable world PERFORMANCE

10. Development Findings

- Plan uses a hash distribution
- Exceeds target



Second Query with Broadcast Distribution Enabled





Query 2: Broadcast Distribution Enable

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QL Output					L Monitor Report					
6 7 fr 8) Diff 'om (select owner_id, 'Citroens and Minis' as text			C	re on OTN PRACLE: Enterprise Manager ctive Reports					English
9	from carguys			м	onitored SQL Execution Detail	s 🥑				
10	where make in ('Ferrari','Citroen','Mini')) p1,				Overview					-
11 12	(select owner_id, 'Mini Coopers' as text				SQL ID 8rprpsn2ybzug 🛈		Time & Wait Statistic	DS .	I0 Statistics	
13	from carguys				Parallel 👹 32 🖁 8 Execution Started Fri Sep 20, 2013	10:19:36 AM	Duration 🚪 2		Buffer Gets	16M
14	where make in ('Citroen','Mini')			l	Last Refresh Time Fri Sep 20, 2013 Execution ID 16777216	10:19:38 AM	Database Time	38.9s	IO Requests 12	
15 16* wh	and model in ('Cooper')) p2 mere p1.owner_id = p2.owner_id(+)				User CARS2		PL/SQL & Java 0.0	0s	IO Bytes	119GB
	,				Fetch Calls 1					
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					lan Hash Value 1048826780	Name	Estim C Timeline		lick on the table allows to toggle betw e IO Reque Cel CPU A	
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nd of	step				E SELECT STATEMENT E SORT AGGREGATE P PX COORDINATOR	iTQ10001		65 32		7.69
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onitored SQ	step	Status			BELECT STATEMENT BORT AGGREGATE FX COORDINATOR FX SEND QC (RANDOM) BORT AGGREGATE BHASH JOIN RIGHT O PX RECEIVE		1	65 32 32 32 32 32 32 150M 37MB 32 320K	23	73
onitored SQ ID^ 4	LExecutions Description Indexes	V	Duration 160		B SELECT STATEMENT B SORT AGOREGATE P X COORDINATOR B PX SEID QC (RANDOM) B SORT AGOREGATE C P X RECEIVE C P X RECEIVE C P X SEID BROADC E X BLOCK TTER		1 1 95M 148 849K 74K	65 32 32 32 32 32 32 32 32 150M 37MB	27	73
onitored SQ	L Executions Description		Duration		BELECT STATEMENT BORT ADDREGATE P.X.COORDINATOR P.X.SOORDINATOR SORT ADDREGATE MASH JOIN RIGHT C P.X.RECEVE D.X.SEIDE ROADC P.X.SEIDE ROADC D.X.SEIDE ROADC D.X.SEIDE ROADC		1 955M 148 849K 74K 849K 74K 849K 74K 849K 74K	65 32 32 32 32 32 32 1504 37MB 32 320K 32 320K 32 320K 412 10K	62K 100	73
onitored SQ ID^ 4 5	t Executions Description Indexes Stats with Histograms	V	Duration 160 51		BELECT STATEMENT BOK AGGREGATE FOR CONSINTOR PR SEND QC (RANDOM) BOK SORT AGGREGATE BASH JOUN RIGHT O PR RECEVE BR RECEVE	:TQ10000 CARGUYS	1 1 95M 148 849K 74K 849K 74K 849K 74K	65 32 32 32 32 32 32 1500 37MB 32 320K 32 320K 32 320K		73
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onitored SQ ID^ 4 5	t Executions Description Indexes Stats with Histograms	© ©	Duration 160 51		BELECT STATEMENT BOK AGGREGATE FOR CONSINTOR PR SEND QC (RANDOM) BOK SORT AGGREGATE BASH JOUN RIGHT O PR RECEVE BR RECEVE	:TQ10000 CARGUYS	1 1 9554 148 849K 74K 849K 74K 849K 74K 849K 74K	65 32 32 32 32 32 32 32 32 32 32 320 32 320K 32 320K 412 0K 32 50M	62K 100	73
onitored SQ ID^ 4 5 6	t Executions Description Indexes Stats with Histograms Flash Temp	V V V	Duration 160 51 30		BELECT STATEMENT BOK AGGREGATE FOR CONSINTOR PR SEND QC (RANDOM) BOK SORT AGGREGATE BASH JOUN RIGHT O PR RECEVE BR RECEVE	:TQ10000 CARGUYS CARGUYS	1 95M 148 8496 74K 8496 74K 8496 74K 8498 74K 95M 74K	65 32 32 32 32 32 32 32 32 32 32 320 32 320K 32 320K 412 0K 32 50M	62K 100	73
ind of onitored SQ ID^ 4 5 6 7	step		Duration 160 51 30 33		SELECT STATEMENT SOLUCT STATEMENT SOLUCT AGGREGATE SOLUCT S	:TQ10000 CARGUYS CARGUYS	1 95M 148 8496 74K 8496 74K 8496 74K 8498 74K 95M 74K	65 32 32 32 32 32 32 32 32 32 32 320 32 320K 32 320K 412 0K 32 50M	62K 100	73
nd of intored SQ ID ^ 4 5 6 7 8	step Description Indexes Stats with Histograms Flash Temp Manual memory allocation Cardinality Hint		Duration 160 51 30 33 3		SELECT STATEMENT SOLUCT STATEMENT SOLUCT AGGREGATE SOLUCT S	:TQ10000 CARGUYS CARGUYS	1 95M 148 8496 74K 8496 74K 8496 74K 8498 74K 95M 74K	65 32 32 32 32 32 32 32 32 32 32 320 32 320K 32 320K 412 0K 32 50M	62K 100	73
nd of ID 4 5 6 7 8 9	step Description Indexes Stats with Histograms Flash Temp Manual memory allocation Cardinality Hint Disable Broadcast Distribution		Duration 160 51 30 33 3 3 3		SELECT STATEMENT SOLUCT STATEMENT SOLUCT AGGREGATE SOLUCT S	:TQ10000 CARGUYS CARGUYS	1 95M 148 8496 74K 8496 74K 8496 74K 8498 74K 95M 74K	65 32 32 32 32 32 32 32 32 32 32 320 32 320K 32 320K 412 0K 32 50M	62K 100	73



Query 2: Broadcast Distribution Enable

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Overview												-
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Plan Hash Value 1048826780										OTTP: R	abt around click on the table allows to	to toggle between IO Requests and IO Bytes
Operation		Name	Estimated Rows	Cost Tir	meline(2s) Executio A	tual Rows	Memory (M	Temp (Max)	IO Requests		CPU Activity %	Wait Activity %
SELECT STATEMENT					1	1						
SORT AGGREGATE			1		1	1						
PX COORDINATOR					65	32						7.69
PX SEND QC (RANDOM)		:TQ10001	1		32	32						
SORT AGGREGATE			1		32	32						73
HASH JOIN RIGHT OUTER			95M	148K	32	150N					27	
B PX RECEIVE			849K	74K	32	3208						
PX SEND BROADCAST PX BLOCK ITERATOR		:TQ10000	849K 849K	74K	32	320k 10k						
TABLE ACCESS STORAGE FULL		CARGUYS	849K	746	412	104			62K	100		21
PX BLOCK ITERATOR		0110010	95M	74K	32	50M			02N	100		
TABLE ACCESS STORAGE FULL			95M	74K	412	50M			62K	99		62
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Query 2: Broadcast Distribution Enable

11. Development Findings

- Reset _parallel_broadcast_enabled
- Plan now uses a broadcast distribution
- Meets target
- Should not change system parameters to tune one query

Extended Stats





Extended Stats

Real-World Demos • Settings Window • Layout • Axis • Command • Login

where make = 'Ferrari') p1,

where country = 'Italy' and make = 'Ferrari'

'Ferraris' as text

and model = '458 Italia') p2

'Ferrari 458s' as text

Ferrari 458s

50,000,000

Other Ferraris

1

Status

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7 from (select owner_id,

50,000,001

Description

Flash Temp

Cardinality Hint

Extended Stats

Elapsed: 00:00:52.58 end of step

Monitored SQL Executions

ID ^

5

6

7

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9

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12 13

from carguys

(select owner_id,

 17^* where pl.owner id = p2.owner id(+) Ferraris

Stats with Histograms

Manual memory allocation

Query 2 Reset Parameter

Disable Broadcast Distribution

Query 2 Disable Broadcast Distribution

from carquys

SQL Output

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	Mon	itored SQL Executi	on Detaik														
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		SQL ID 3bcdva		Time & Wait Statistics							0 Statistics						
		Parallel 🖓 32 acution Started Thu S		Dur	ation 📱 54.0s					Bu	ffer Ge	ts	16M				
		t Refresh Time Thu S	Datat	ase.	Time			19.7	m	IO F	leques	ts 🚦 1,014K					
		Execution ID 16777	PL/S	QL &	Java 0.0s						IO Byte		221GB	11			
		User CARS2 Fetch Calls 1	Wait	Activi	ity %			100		Cell Offload I	Efficient	y 30%					
		Petch Calls 1				_	_							4			
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	Plan	Hash Value 2967640	732					6	TIP: R	ight mou	se click	on the table allov	is to tog	gle between IO	Requests and IO By	tes	
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	ý e	SELECT STATEMENT					_	1	1					.14			
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Ŧ	25	PX SEND QC (RA		:TQ10001	1			32	32								
≈ □	30 	SORT AGGREG			1			32	32					.41		-11	
uration	80 80	PX RECEIV			49M 323K	148		32	50M	36GB	52GE	890K		8.4	10	-11	
51 ^	201 255	PX RECEIV		:TQ10000	323K				1,600					8.4 16	1.7	11	
	839	-	CK ITER	11010000	323K			32	50M					10	1.7	- 11	
30	85	E VIEW			323K			412	50M					.41			
	85	TAE	BLE ACCE	CARGUYS	323K	74K		412	50M			62K		1.08	.68		
33	85	PX BLOCK	ITERATOR		49M	74K	-	32	50M								
	85	TABLE AC	CESS S	CARGUYS	49M	74K	-	412	50M			62K	99	.41	1.36		
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REAL-WORLD PERFORMANCE

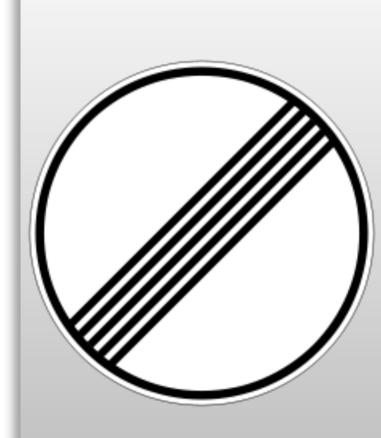
Extended Stats

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SQL Monitor Report									
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Monitored SQL Execution Details 🥥									
Overview									-
SQL ID 3bcdvzbk70cjj 🚺	Time & Wait Statistics					I0 Statistics			
Parallel 👹 32 🛄 8	Duration 5	4.0s				Buffer	Gets		16M
Execution Started Thu Sep 12, 2013 11:08:48 AM Last Refresh Time Thu Sep 12, 2013 11:09:42 AM	Database Time				19	.7m IO Reg	Jests 1,014K		
Execution ID 16777216	PL/SQL & Java 0.0s					IO	Bytes		221GB
User CARS2 Fetch Calls 1	Wait Activity %				10	D Cell Offload Effic	iency 30%		
Fetch Calls 1									
Details									-
🗐 Plan Statistics 💑 Plan 🔯 Parallel 📐 Activity 🛛	Metrics								
Plan Hash Value 2967640732								𝗭 TIP: Right mouse click on the table a	lows to toggle between IO Requests and IO Bytes
Operation	Na	me	Estimated Rows	Cost Timeline(54s)	Executio A	ctual Rows Memory (M	Temp (Max) IO Requests	Cell Offlo CPU Activity %	Wait Activity %
SELECT STATEMENT				-	1	1		.14	
SORT AGGREGATE			1		1	1			
PX COORDINATOR					65	32			
B PX SEND QC (RANDOM)	:T	Q10001	1		32	32			
SORT AGGREGATE HASH JOIN RIGHT OUTER			1 49M	148K	32	32 50M 36GB	5268	.41	73
B PX RECEIVE			323K	74K	32	1,600M	5235	8.4	10
B PX SEND BROADCAST	T	Q10000	323K	74K	32	1,600M		16	1.7
B PX BLOCK ITERATOR			323K	74K	32	50M			
3 LI VIEW			323K	74K	412	50M		.41	
TABLE ACCESS STORAGE FULL	0	RGUYS	323К	74K	412	50M	62K	99 🚪 1.08	.68
PX BLOCK ITERATOR			49M	74K	32	50M			
TABLE ACCESS STORAGE FULL	C/	RGUYS	49M	74K	412	50M	<mark>_</mark> 62K	99 🧧 .41	1.36
	ated co or car				t still h e	ave			

12. Development Findings

- High correlation between Country, Make and Model columns
- Created column group
- Query still exceeds target
- Still have poor cardinality estimate

Histogram on Column Group





Histogram on Column Group



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Real-World	l Demos • Settings Window • Layout • Axis • Command • Login									Logged in as john.	zimmerman
QL Output			× 🗆	SQL Monitor Report							
7 fr 8	'Ferraris' as text		^	More on OTN ORACLE: Enterprise Manager Active Reports							English
9 10	from carguys where make = 'Ferrari') p1,	Monitored SQL Execution Detail	s 🧭								
11	(select owner_id,		Overview								
12	'Ferrari 458s' as text			SQL ID 5mbrs6404upka 🛈)	Time & Wait Sta	atistics		I0 Statistics		
13 14	from carguys where country = 'Italy'			Parallel 🖓 32 🖁 8		Duration	n 📕 3.0s		Buff	er Gets	16M
15	and make = 'Ferrari'			Execution Started Thu Sep 12, 201 Last Refresh Time Thu Sep 12, 201				1.4m	IO Re	equests 🔒 124K	
16	and model = '458 Italia') p2			Execution ID 16777216		PL/SQL & Java	a 0.0s		IC	D Bytes	119
17* wh	ere pl.owner_id = p2.owner_id(+)			User CARS2 Fetch Calls 1		Wait Activity 9	/6	100	Cell Offload Ef	ficiency 99%	
	Ferraris Ferrari 458s Other Ferraris			Details							
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	50,000,001 50,000,000 1			Plan Hash Value 319619247				𝗭 TIP: Right mouse	click on the table allows	to toggle between IO R	lequests and I
lapsed	: 00:00:02.67			Operation	Name	Estim C Tim	veline(3s) Ex	Act Me	Te IO Reque 0	Cel CPU Activit	. Wait Act
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nd of	step										
	step ====================================		-	SORT AGGREGATE		1	1				
			H	B-SORT AGGREGATE D PX COORDINATOR D PX SEND QC (RANDOM)	;TQ10002	1	1 65	32			
			E •	PX COORDINATOR PX SEND QC (RANDOM)	:TQ10002	1	- 65	32 32 32		11	
]		Status		PX COORDINATOR PX SEND QC (RANDOM) SORT AGGREGATE AGGREGATE AGGREGATE	:TQ10002	1 1 46M 148	65 32 32 32	32 32 32 50M 3GB		11 60	
onitored 5QI	Executions Description		. □	PX COORDINATOR PX SEND QC (RANDOM) SORT AGGREGATE HASH JOIN OUTER PX RECEIVE		1 1 46M 148 46M 74K	65 32 32 32 32 32	32 32 32 50M 3GB 50M		60	
onitored SQI	Executions Description Flash Temp	V	Duration	PX COORDINATOR PX SEND QC (RANDOM) SORT AGGREGATE AGGREGATE AGGREGATE	:TQ10002	1 1 46M 148	65 32 32 32 32 32 32	32 32 32 50M 3GB		_	
onitored SQI	Executions Description		Duration	PX COORDINATOR PX SEND QC (RANDOM) PX SEND QC (RANDOM) PX SEND AGREGATE PX RECIVE PX RECIVE PX SEND HASH	:TQ10000	1 1 46M 148 46M 74K 46M 74K	65 32 32 32 32 32 32 32 32 32 32	32 32 32 50M 3GB 50M	62K	60	14
onitored SQL ID ^ 6 7	Executions Description Flash Temp Manual memory allocation	V	Duration 30 ^ 33	PX COORDINATOR PX SEID QC (ANIDOM) Sort Addreadate PX RECEIVE PX RECEIVE PX RECEIVE PX RECEIVE PX RECEIVE TABLE ACCS	1TQ10000 CARGUYS	1 1 460 460 460 460 74K 460 74K 460 74K 460 74K	65 32 32 32 32 32 32 32 32 412 32 412 32	32 32 50M 3GB 50M 50M 50M 50M	62K	60 4.76 99 1.59	14
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Histogram on Column Group

With a histogram on the column group we				
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now have a good		Time & Wait Statistics	Overview SQL ID 5mbrs6404upka (i)	
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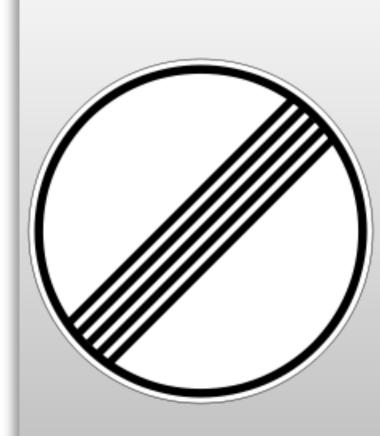
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13. Development Findings

- Re-gathered stats after running the query with the column groups
- Frequency Histogram on the column group
- Accurate cardinality estimates
- Optimizer now uses a hash distribution

Second Query with Histogram Column Group





Query 2: Histogram Column Group

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9 10	from carguys where make in ('Ferrari','Citroen','Mini')) p1,			Monitored SQL Execution Details	<i>></i>)						
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Query 2: Histogram Column Group

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14. Development Findings

- Accurate cardinality estimates
- Optimizer uses a broadcast distribution on second query

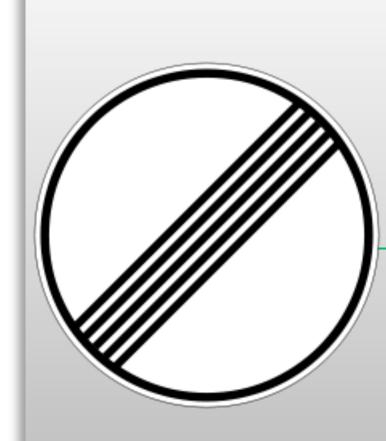


Now we have the correct solution!

- Both queries have good cardinality estimates
- Correct plans
- Meet targets



Auto Column Group Creation: Seed Column Usage





Auto Column Group Creation

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Auto Column Group Creation

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Auto Column Group Creation: Seed Column Usage

15. Development Findings

- Start with default statistics
- Execute dbms_stats.seed_col_usage to monitor column usage
- Run query

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Auto Column Group Creation: Create Extended Stats





Auto Column Group Creation

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14	Query 2 with Extended Stats	0	2	E	Other names may be trademarks of their respective owners.										
15	Seed Column Usage	\bigcirc	51												
16	Auto Column Groups		2												



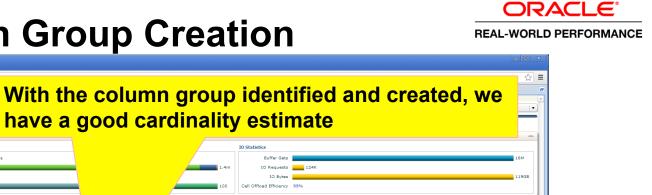
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Auto Column Group Creation



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Monitored SQL Execution Details 🏼

SQL Monitor Report

More on OTN

Overview Exe Last

Active Reports



Auto Column Group Creation: Create Extended Stats

16. Development Findings

- dbms_stats.report_col_usage shows column groups identified during Seed Column Usage
- dbms_stats.create_extended_stats creates column groups identified
- Automatically identifies usage of Country, Make and Model columns together and creates column group



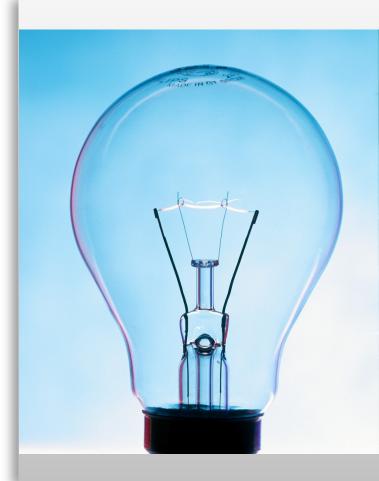
Auto Column Group Creation: Create Extended Stats

16. Development Findings

- Regather stats
- Automatically creates Histogram on the column group
- Query meets target



What Did We Learn ?





- Moving to a solution before determining the root cause
- Not understanding the big/little data problem
 - Incorrect use of indexes
- Incorrect use of the product
 - Use DoP to "tune" the query
 - Use of flash cache for TEMP
 - Manual Memory Parameters
- System wide changes to fix a single SQL
 - Disable broadcast distribution



Performance Improvement Techniques REAL-WORLD PERFORMANCE

Which one are you?

- A Hacker?
- Performance Engineer?





Performance Improvement Techniques REAL-WORLD PERFORMANCE

The Hacker

- Tuning by Google
- Tuning by pattern matching or word association
- Tuning by what worked well on another system
- Tuning by Folklore



Performance Improvement Techniques REAL-WORLD PERFORMANCE

The Performance Engineer

- Understands Performance is all about work done in a period of time and systematically learns where the time is spent before making any recommendations
- Tuning is seen as a never ending process to systematically locate where the time is spent and making changes that reduces where the time is spent most
- Able to clearly articulate the problem and recommend the appropriate solution

Hardware and Software

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