

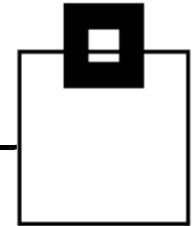
# Access Path Recovery for Db2 11 + 12 using **RUNSTATS Rescue** Still important in an AI/ML world?

Roy Boxwell, SEG



## RUNSTATS Rescue – Why?

---



A fact of life is:

Access Paths change...

Sometimes they get better...

Sometimes they don't!

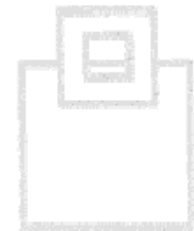


Why does that happen? The classic reasons are:

Statistics changes

Index changes

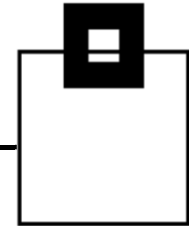
Any other reason... (APAR, Version, Rainy day etc.)



Wouldn't it be great if you could „turn back time“ – To get the last „good“ statistics and then be rescued from your bad access path!



# RUNSTATS Rescue – Why?



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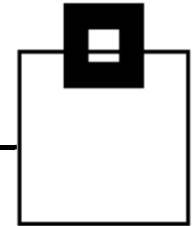


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## RUNSTATS Rescue – Db2 Help?

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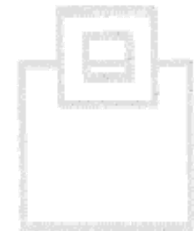
What does Db2 offer when this situation occurs?

For Static SQL – Plan Stability and BIND QUERY

Original Package

Previous Package

Current Package



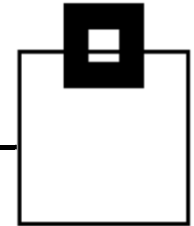
Does Plan Management work all the time?

With Schema changes it fails... (View, Index etc.)



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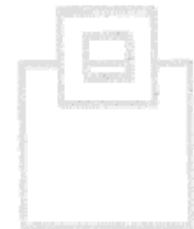
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104.8% of people  
do not understand  
percentages

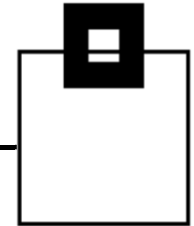


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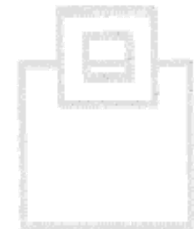


For Dynamic SQL you get:

Dynamic SQL – BIND QUERY



However BIND QUERY has one major limitation:



“Ensure that object names and SQL keywords in the statement text are specified by uppercase characters, especially for dynamic SQL statements.”

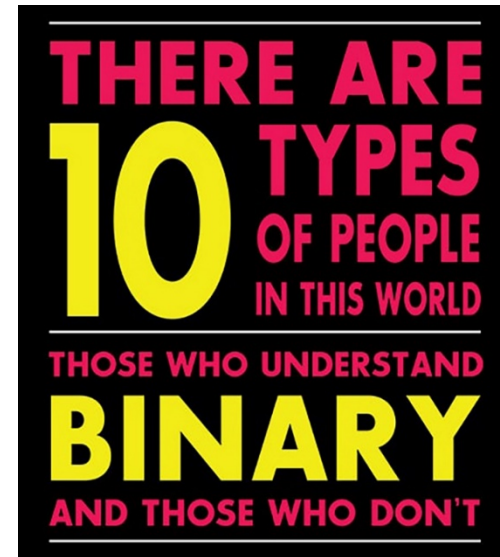


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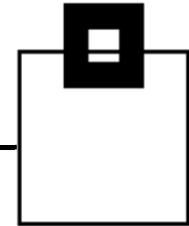
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# RUNSTATS Rescue – Db2 Help?



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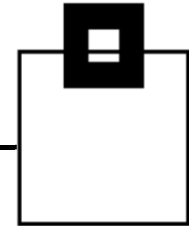
## IBM Analytics **Dynamic Plan Stability**

- DB2 12 plan – base infrastructure
  - Opaque parameter CACHEDYN\_STABILIZATION
  - Capture
    - Command with / without monitoring
    - Global variable
  - FREE
  - EXPLAIN (current, invalid)
  - Invalidation
  - LASTUSED (identify stale statements)
  - Instrumentation (query hash, explain, cache + catalog hit ratio)
  - APPLCOMPAT is part of matching criteria
- Key DB2 12 limitations
  - ! – Temporal stabilization not currently included
  - REBIND support not included
    - No PLANMGMT/SWITCH/APREUSE



How many SQLs are “worth” locking down? Top 10, 20?

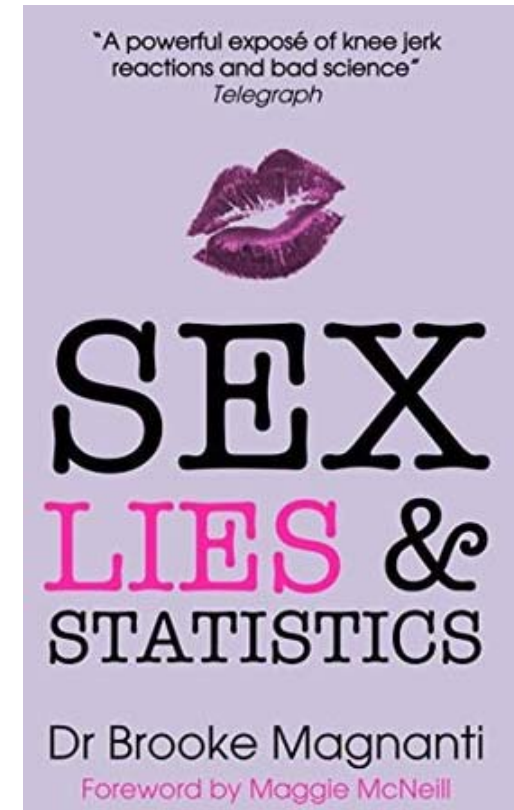
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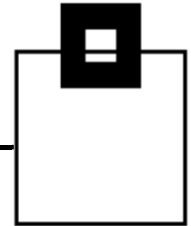


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## RUNSTATS AI/ML – Db2 Help?

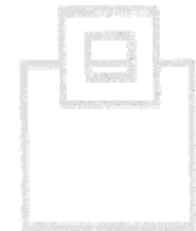
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Well, as you are all aware, AI and ML should come and rescue us from bad access paths as well.



How?



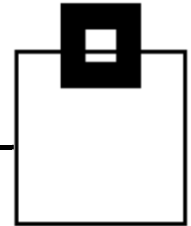
The problem is the well known outlier problem. The AI/ML learns on 1000's of SQLs that all run “nominally”.



When your application gets a deviant or outlier access path that the AI/ML has not seen before how will it react? Launch all nukes? Ignore it and hope to learn more for next time... or something completely different?

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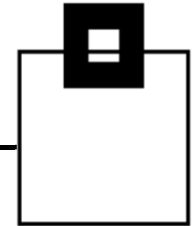
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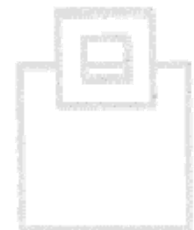
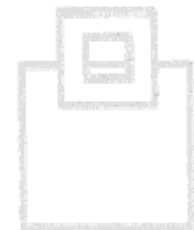


## RUNSTATS Rescue at a glance

---

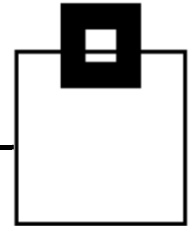


- Keeps a stats repository and allows to consistently restore statistics
- Quick and easy to use
- Supports dynamic SQL out-of-the-box
- Supports static SQL where Plan Management fails:
  - BINDs resulting from modified programs
  - Schema changes – VIEW changes etc.
- Verifies RUNSTATs as the reason for performance degradations
- Cross checks affected objects
- Add-on to Impact Expert or stand-alone to recover from bad RUNSTATS
- In future slides shortened to be **RR**



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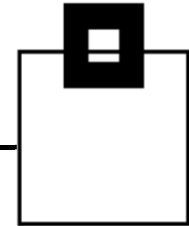


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# RUNSTATS Rescue procedure

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**Schedule RR-batch job to maintain a history of optimizer relevant statistics (using a GDG).**

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  - Rescue the stats



# RUNSTATS Rescue – Embedded or Stand-alone

ImpactExpert for DB2 z/OS ----- Main Menu ----- Version 6.10  
Command ==> \_\_\_\_\_ DB2: QB1A

Primary cmd: END, S(ettings), C(leanup), F(ilter Jobs), H(istory), A(bout), FAQ  
Line cmd: S(elect), I(nfo), F(ilter Jobs)

Scenario	Base / Recent	Dyn Expl	Migr. Rules	Convert Qual.	DRDA	VOX
REBIND Analysis	Catalog	YES	N	-	-	-
Pre-BIND Local	Catalog / DBRM	YES	-	-	-	-
Post-BIND Local	History / Catalog	NO	-	-	-	-
Pre-BIND Prod-Baseline	Export / DBRM (*)	YES	-	N	N	N
Post-BIND Prod-Baseline	Export / Catalog (*)	NO	-	N	N	-
Early Precheck Static	Export (*)	YES	Y	N	N	N
Early Precheck Dynamic	Export (*)	YES	Y	N	-	N
DSC Protection	Export (*)	YES	-	N	-	-
Dynamic SQL	DynStmtCache	YES	-	-	-	-
Static and dynamic SQL	Trace	YES	-	-	-	-
Local APAR Check Static	Catalog	-	-	-	-	-
Local APAR Check Dynamic	DynStmtCache	-	-	-	-	-
S RUNSTATS Rescue	Plan_table	-	-	-	-	-
Plan_table compare	Plan_table	-	-	-	-	-
DBRM reconstruct	Catalog	-	-	-	-	-

NOTE (\*): Use export/import function to update product internal copy tables.

**Start  
RUNSTATS  
Rescue  
from the  
main menu**



## S Setup RUNSTATS Rescue

# Use the first option to directly access the RR setup

NO !

# RUNSTATS Rescue – setup

ImpactExpert for DB2 z/OS ----- RUNSTATS Rescue Settings ----- Setting 1 from 4  
Command ==> \_\_\_\_\_ Scroll ==> CSR  
DB2: QB1A

Primary cmd: END, CAN(cel), F(ilter), T(ext on/off), L(ocate) setting  
Line cmd: S(elect), R(eset to DEFAULT)

Profile: HEINRIC Creator . .: HEINRIC  
Description: Default profile for IQA

Category Setting	Value	Valid Input
-----		
BIX RUNSTATS Rescue		
USE GDG FILES	<u>Y</u>	Y/N
GDG NAME	<u>SETEST..</u>	CHAR(35)
VSAM PREFIX FOR RUNSTATS RESCUE	<u>SETEST..</u>	CHAR(33)
SHOW CATALOG BROWSER	<u>Y</u>	Y/N
-----		

**A GDG is  
perfect for a  
stats history**

# RR generates the job to maintain the repository

```
Creator . .: HEINRIC
```

Description: Default profile for IQA

## Setting

Value

Valid Input

## BIX RUNSTATS Rescue

! Command ==>

```
! Primary cmd: END
```

## ! Setup RUNSTATS Rescue

```
! S Extract statistics from production DB2 catalog
```

## ! Prepare RUNSTATS Rescue - Dynamic

```
! Prepare RUNSTATS Rescue - Static
```

```
! Generate RUNSTATS Rescue batch job
```

```
! RUNSTATS Rescue Autonomic ACTIVE
```

# RUNSTATS Rescue – statistics repository

```
ImpactExpert for DB2 z/OS ----- RUNSTATS Rescue Settings ----- Setting 1 from 4
+-----+
! ImpactExpert for DB2 z/OS ----- Jobcard ----- !
! Command ==> _____ !
! !
! The following jobcard is used. Type in your changes. !
! !
! //&JOBNAME JOB ( ),CLASS=A,NOTIFY=&SYSUID !
! // * !
! // * !
! // * !
! // * !
! // * !
! // * !
! // * !
! // * !
! // * !
! // * !
! !
! STEP ACCT : _____ !
! !
+-----+
```

**Verify your  
jobcard to  
maintain the  
statistics  
repository**

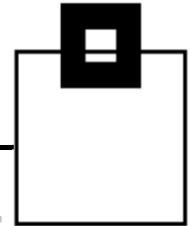
# RUNSTATS Rescue – statistics repository

```
ImpactExpert for DB2 z/OS ----- Change Data -----
EDIT      SYS16200.T134620.RA000.HEINRIC.R0118781      Columns 00001 00072
Command ==> _____ Scroll ==> CSR
000125 </PROD-SIM>
000126 //REPRO2      EXEC PGM=IDCAMS,COND=(0,LT)
000127 //SYSPRINT      DD SYSOUT=*
000128 //SYSIN          DD *
000129     REPRO INFILE(IN)      OUTFILE(OUT)
000130 //IN              DD DISP=SHR,
000131 //                  DSN=SETEST.BIX-RR.CATSTTS.STATS
000132 //OUT             DD DISP=(,CATLG),SPACE=(CYL,(50,10
000133 //                  DCB=(RECFM=VB,LRECL=8500),
000134 //                  DSN=SETEST.BIX-RR.STATS(+1)
000135 //BIX6RSCG        EXEC PGM=BIX6RSCG,
000136 //                  PARM=('QB1A,IOAP06QB,IOA061QB,Y,N')
000137 //STEPLIB          DD DISP=SHR,DSN=SE.PRODUCT.DTECB-IOA0610.QB1A.LOAD
000138 //                  DD DISP=SHR,DSN=SE.CATSTTS.STATS
000139 //                  DD DISP=SHR,DSN=DSNB10.SDSNEXIT.QB1A
000140 //                  DD DISP=SHR,DSN=SE.CATSTTS.STATS
000141 //BIXGDG           DD DISP=SHR,DSN=*.REPRO2.OUT
000142 //BIXPROT          DD SYSOUT=*
000143 //BIXINPUT         DD *
000144 //SYSOUT           DD SYSOUT=*
000145 //ERRORLOG         DD SYSOUT=*
000146 //SEDYNSQL         DD SYSOUT=*
000147 //
***** Bottom of Data *****
```

Using a CDC is a simple way  
to keep n generations of  
statistics. In z/OS 2.2 limit  
raised from 255 -> 999

# RUNSTATS Rescue procedure

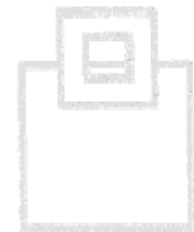
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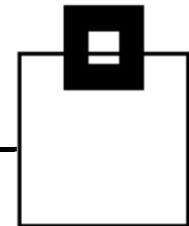
# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- RUNSTATS Rescue Settings ----- Setting 1 from 4
Command ==>                                                                    Scroll ==> CSR
                                                                    DB2: QB1A

Primary cmd: END, CAN(cel), F(filter), T(ext on/off), L(ocate) setting
Line      cmd: S(elect), R(eset to DEFAULT)

Profile: HEINRIC      Creator . .: HEINRIC
                        Description: Default profile for IQA

  Category
    Setting                                Value      Valid Input
-----
BIX RUNSTATS Rescue
+-----+
! ----- RUNSTATS Rescue ----- !
! Command ==> _____ !
! Primary cmd: END !
! !
! - Setup RUNSTATS Rescue !
! - Extract statistics from production DB2 log !
! S Prepare RUNSTATS Rescue - Dynamic ! -----
! - Prepare RUNSTATS Rescue - Static !
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! !
! RUNSTATS Rescue Autonomic ACTIVE !
! !
+-----+
```



# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- RUNSTATS Rescue Settings ----- Setting 1 from 4
C +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
! ----- Prepare RUNSTATS Rescue - Dynamic ----- ! DB2: QB1A
P !
L ! PLAN_TABLE OWNER : HEINRIC
!
P ! EXPLAIN QUERYNO : _____
! or
! TIMESTAMP FROM : 2014-01-01-00.00.00
! TIMESTAMP TO : 2016-12-31-00.00.00
!
! If QUERYNO is left blank the range of TIMESTAMPS
! will be used to identify the EXPLAIN data.
!
!
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
VSAM PREFIX FOR RUNSTATS RESCUE SETEST... CHAR(15)
SHOW CATALOG BROWSER Y
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

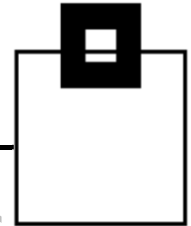
```

**To map a STMT  
against table(s) to  
associated table-  
/indexspaces  
explain data is key**



# RUNSTATS Rescue procedure

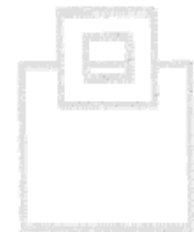
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# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- Tables of Explained SQL ----- Table 1 from 4
Command ==> _____ Scroll ==> CSR
MODE: _____ DB2: QB1A
Primary cmd: END, CAN(cel), Z(oom), L(ocate) creator
Line cmd: C(olumns), D(atabase), I(ndexes), L(CoLdist), P(artitions),
          T(ablespace), Z(oom)
```

Creator	+	Name	+	Database	Tablespace	Statstime	+
IQA061QB		IQATI004		IQAD06QB	IQASI004	2016-07-18-13.51.33	
IQA061QB		IQATI006		IQAD06QB	IQASI006	2016-07-18-13.51.29	
IQA061QB		IQATI007		IQAD06QB	IQASI007	2016-07-18-13.51.27	
IQA061QB		IQATI009		IQAD06QB	IQASI009	2016-07-18-13.51.22	

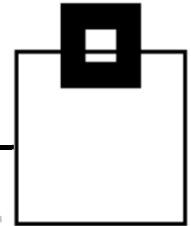
**If desired:**

**The determined spaces are shown**

```
VSAM PREFIX FOR RUNSTATS RESCUE SETEST.. CHAN
SHOW CATALOG BROWSER Y Y/N
```

# RUNSTATS Rescue procedure

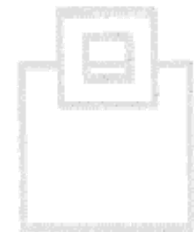
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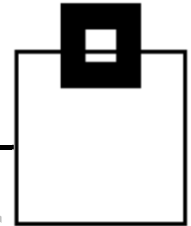
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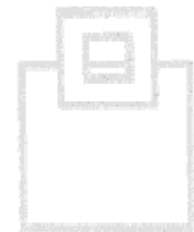
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# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- LINE 00000001 COL 001 080
Command ==>
Press END to continue
```

**RR transparently  
shows which object  
was RUNSTATED**

```
-----
Timestamp of GDG generation : 2016-07-18-13.49.25.570000
Dataset of GDG generation : SETEST.BIX-RR.
Specified search timestamp : 2016-07-18-13.50.00.000000
Determined minimum statstime: 2016-07-18-13.51.22.065344
Determined maximum statstime: 2016-07-18-13.51.33.036285
Determined maximum create TS: 2016-06-27-13.40.17.365875
-----
```

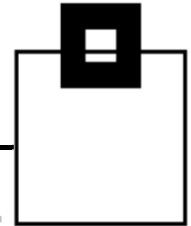
```
Queryno : 11111 EXPLAIN_TIME : 2016-07-18-12.48.24.460000
```

Tablespace IQAD06QB.IQASI009	Statstime : 2016-07-18-13.51.22.065344
Table IQA061QB.IQATI009	Statstime : 2016-07-18-13.51.22.065344
	Created : 2016-06-27-13.40.17.146617
- Index IQA061QB.IQAXI0091	Statstime : 2016-07-18-13.51.22.065344
Indexspace: IQAD06QB.IQAXI009	Created : 2016-06-27-13.40.17.365875

```
+-----+
! RSCU002B Either object(s) with statstime greater than the specified time !
! found or recreated object(s) with created timestamp greater than the    ! --
! specified time found.                                                    !
+-----+
```

# RUNSTATS Rescue procedure

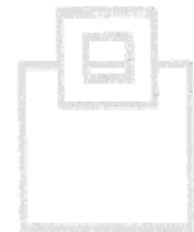
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  - Rescue the stats



# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- LINE 00000001 COL 001 080
C +-----+
P ! ----- Confirm GDG Generation ----- ! DB2: QB1A
!
- ! S Use file SETEST.BIX-RR.STATS.G0002V00 ! -----
T ! of 2016-07-18-13.49.25.570000 !
D !
S ! _ Select GDG generation from list !
D !
D !
D +-----+
-----
```

```
Queryno :      11111          EXPLAIN_TIME : 2016-07-18-13.49.24.460000
Tablespace IQAD06QB.IQASI009      Statstime : 2016-07-18-13.51.22.065344
Table IQA061QB.IQATI009          Statstime : 2016-07-18-13.51.22.065344
                                   Created   : 2016-06-27-13.40.17.146617
- Index IQA061QB.IQAXI0091        Statstime : 2016-07-18-13.51.22.065344
  Indexspace: IQAD06QB.IQAXI009   Created   : 2016-06-27-13.40.17.146617
-----
```

```
Queryno :      2773          EXPLAIN_TIME : 2016-07-18-13.51.22.260000
Tablespace IQAD06QB.IQASI009      Statstime : 2016-07-18-13.51.22.065344
Table IQA061QB.IQATI009          Statstime : 2016-07-18-13.51.22.065344
                                   Created   : 2016-06-27-13.40.17.146617
```

**RR automatically  
selects the right  
stats for fallback,  
but an override  
option is available  
as well**

# RUNSTATS Rescue – dynamic SQL

ImpactExpert for DB2 z/OS ----- LINE 00000001 COL 001 080

```
+-----+
! ImpactExpert for DB2 z/OS ----- Jobcard ----- !
! Command ==> _____ !
! !
! The following jobcard is used. Type in your changes. !
! !
! //&JOBNAME JOB ( ),CLASS=A,NOTIFY=&SYSUID !
! //* !
! //* !
! //* !
! //* !
! //* !
! //* !
! //* !
! //* !
! //* !
! !
! STEP ACCT : _____ !
! !
+-----+
```

**Verify your  
jobcard for  
statistics  
restore**

Queryno : 2773 EXPLAIN\_TIME : 2016-07-18-12.51.12.260000

Tablespace IQAD06QB.IQASI009 Statstime : 2016-07-18-13.51.22.065344

Table IQA061QB.IQATI009 Statstime : 2016-07-18-13.51.22.065344

Created : 2016-06-27-13.40.17.146617

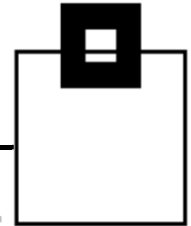
# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- Change Data -----
EDIT      SYS16200.T134620.RA000.HEINRIC.R0118781      Columns 00001 00072
Command ==> _____ Scroll ==> CSR
000106 //          DD DISP=SHR,DSN=CEE.SCEERUN
000107 //          DD DISP=SHR,DSN=DSNB10.SDSNEXIT.QB1A
000108 //          DD DISP=SHR,DSN=DSNB10.SDSNLOAD
000109 //SYSOUT      DD SYSOUT=*
000110 //ERRORLOG DD SYSOUT=*
000111 //BIXINPUT DD DISP=OLD,DSN=*.REPRO.IN1
000112 //PDB2OUT DD SYSOUT=*,RECFM=FBA
000113 //PDB2RUNI DD DISP=OLD,DSN=SETEST.BIX-RR.STATS.GDG
000114 //PDB2RUNO DD DISP=OLD,DSN=SETEST.BIX-RR.CATSTTS.RESCUE
000115 //PDB2IN DD *
000116 <PROD-SIM>
000117     <DB2-SYSTEM ALIAS-CREATOR="IQAD06QB"
000118                 CATALOG-CREATOR="SYSIBM"
000119                 GTT-IX-BPOOL="BP0"
000120     >
000121     </DB2-SYSTEM>
000122 </PROD-SIM>
000123 //PDB2TSIN DD *
000124 IQAD06QB.IQASI004
000125 IQAD06QB.IQASI006
000126 IQAD06QB.IQASI007
000127 IQAD06QB.IQASI009
000128 //
***** Bottom of Data *****
```

**Extract job is  
tailored for  
execution**

# RUNSTATS Rescue procedure

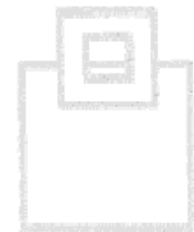
---



Schedule RR-batch job to maintain a history of optimizer relevant statistics (using a GDG).

If a (dynamic) SQL statement performs badly:

- Point RR to the STMT
  - RR shows the associated tablespaces/indexspaces for stats recovery
- Specify since when it degraded
  - RR checks if a RUNSTATS was executed since then and shows the details per object
  - RR verifies potential object (re-) creation within the timeframe
- RR generates jobs to
  - Extract the stats from its repository
  - **Rescue the stats**



# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- LINE 00000001 COL 001 080
Command ==>                               Scroll ==> PAGE
Press END to continue                      DB2: QB1A
```

```
-----
Timestamp of GDG generation : 2016-07-18-13.49.23.570000
Dataset of GDG generation : SETEST.BIX-RR.STTTS.G0002V00
Specified search timestamp : 2016-07-18-13.50.17.000000
Determined minimum statstime: 2016-07-18-13.51.22.065344
Determined maximum statstime: 2016-07-18-13.51.22.065344
Determined maximum create TS: 2016-06-27-13.40.17.365875
-----
```

**RR not only  
Rescues but also  
invalidates the bad  
access path from  
the DSC**

```
Qu ! ----- RUNSTATS Rescue ----- ! .48.24.460000
```

```
! Command ==> _____ !
```

```
Ta ! Primary cmd: END ! .51.22.065344
```

```
Ta ! ! .51.22.065344
```

```
! - Setup RUNSTATS Rescue ! .40.17.146617
```

```
- ! - Extract statistics from production DB2 catalog ! .51.22.065344
```

```
! - Prepare RUNSTATS Rescue - Dynamic ! .40.17.365875
```

```
! - Prepare RUNSTATS Rescue - Static !
```

```
-- ! S Generate RUNSTATS Rescue batch job ! -----
```

```
! !
```

```
Qu ! RUNSTATS Rescue Autonomic ACTIVE ! .51.12.260000
```

```
! !
```

```
Ta ! ! .51.22.065344
```

```
Ta +-----+ .51.22.065344
```

```
Created : 2016-06-27-13.40.17.146617
```

# RUNSTATS Rescue – dynamic SQL

```
ImpactExpert for DB2 z/OS ----- Change Data -----
EDIT      SYS16200.T134620.RA000.HEINRIC.R0118781      Columns 00001 00072
Command ==>                                         Scroll  CSR
000067 ALIAS-CREATOR=IQA061QB
000068 //PDB2OUT DD SYSOUT=*,RECFM=FBA
000069 //PDB2RUNS DD DISP=SHR,DSN=SETEST.BIX-RR.CATSTTS.RESCUE
000070 //*-----
000071 //RUNSTATS EXEC PGM=DSNUTILB,REGION=S2M,
000072 // PARM='QB1A,RSCURUNS'
000073 //STEPLIB DD DISP=SHR,DSN=DSNB10.SDSNEXIT.QB1A
000074 // DD DISP=SHR,DSN=DSNB10.SDSNEXIT.QB1A
000075 //SYSPRINT DD SYSOUT=*
000076 //SYSIN DD *
000077 RUNSTATS TABLESPACE IQAD06QB.IQASI004
000078 UPDATE NONE REPORT NO
000079
000080 RUNSTATS TABLESPACE IQAD06QB.IQASI006
000081 UPDATE NONE REPORT NO
000082
000083 RUNSTATS TABLESPACE IQAD06QB.IQASI007
000084 UPDATE NONE REPORT NO
000085
000086 RUNSTATS TABLESPACE IQAD06QB.IQASI009
000087 UPDATE NONE REPORT NO
000088
000089 //
***** Bottom of Data *****
```

**Runstats Rescue**

**DSC invalidation by  
UPDATE NONE**

## RUNSTATS Rescue – static SQL

- Basically the same as dynamic but the starting data requirement is a package and/or a statement id
- From this basis the rest of RR is the same as dynamic apart from the final recover step where RR generates a REBIND instead of a RUNSTATS of course!



## RUNSTATS Rescue summary I

- When you have 1000's of partitions on a multi tera-byte database - Without a tool you have no chance to react effectively!
- Buys much-needed time during critical events
- Cost-effective and time-saving
- Identifies whether or not RUNSTATS was guilty (ZPARM, SQL New Release, or Bufferpool etc.)



## RUNSTATS Rescue summary II

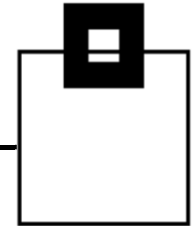
---

- Complements IBM-Plan Management where it does not work (any changed object e.g. views, dynamic SQL)
- Saves statistics and recovers back to them using a simple, guided semi-automatic process
- Helps to automate a rescue process
- Guarantees stable Access Paths for Dynamic as well as Static SQL in Db2 11 & 12 and not just for your “Top 10 or 20”

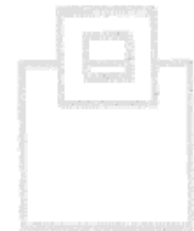


# RUNSTATS Rescue – REWE

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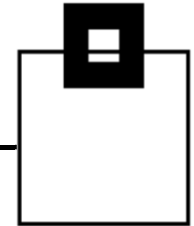


REWE Success stories ... Coming soon...

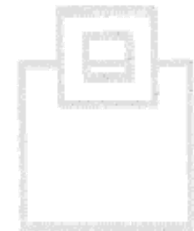


## RUNSTATS Rescue – DATEV

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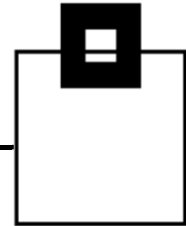


DATEV Success stories ... Coming soon...



# Give and Take Program, Germany 2020

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## What we **GIVE**:

- 1) 90 days free trial – even in production
- 2) Two webinars covering installation and all pre-reqs
- 3) Two days – free of charge – onsite support
- 4) Offer of two days – free of charge – for potential realization of customer requests and enhancements



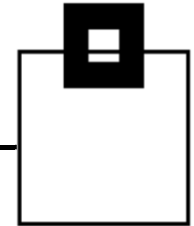
## What we **TAKE**:

- 1) Your Real World Experiences
- 2) Your permission to use the gathered data in our presentations (Anonymous or, if you allow it, with your customer name)



# Give and Take Program, Germany 2020

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The 2020 Program offers:

January – March (1Q): Db2 11 + 12 Audit + SIEM (Security Information Event Management) with optional framework Eclipse or ZOWE

April – June (2Q): Access Path Recovery

July – September (3Q): Space Assurance – K-no-w your limits

October – December (4Q):  **Zowe** and SQL Workload Performance for Db2 11 + 12

# Questions???

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Many thanks for your attention and now....

