

# SQL Saturday Haitian 2023

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Les structures de données  
@conseilit



Microsoft®  
**SQL Server®**



~ since 1997 : SQL 6.5 / WinNT4



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/in/christophelaporte



- Audit / Conseil
  - Infrastructure / Architecture
  - Virtualisation / Cloud
  - Haute disponibilité
  - Performance / Optimisation
  - Dépannage / Migrations
- Formations
- DBA-as-a-Service



conseilit@outlook.com





**SQL Saturday  
Haitian 2023**

**Merci à notre sponsor**



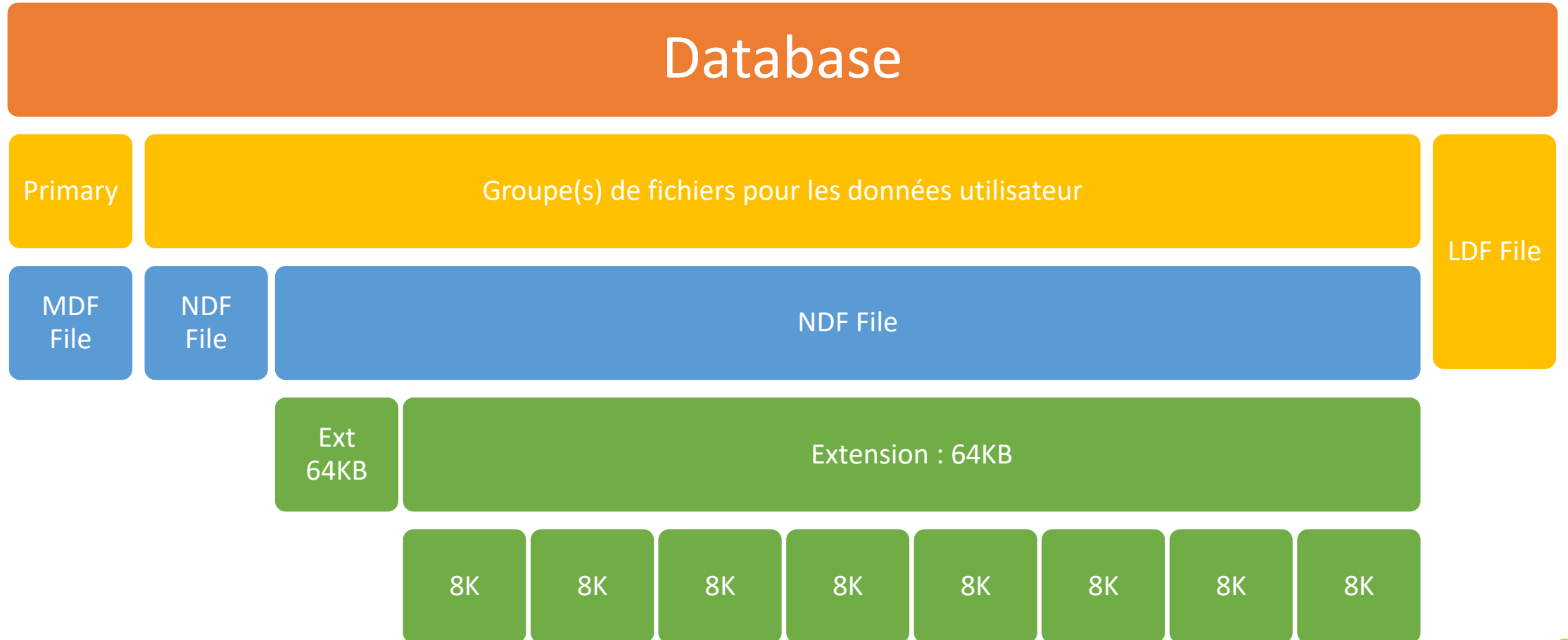
**Microsoft**

# Les structures de données

Row Store



# Anatomie d'une base de données



# Deux types d'extensions

MIXED\_PAGE\_ALLOCATION

TF 1118

## Mixed extent



Table2



Index1



Index2



Table2



Table3



Index3



Table2



Table3

## Uniform extent



Table1



Table1



Table1



Table1



Table1



Table1



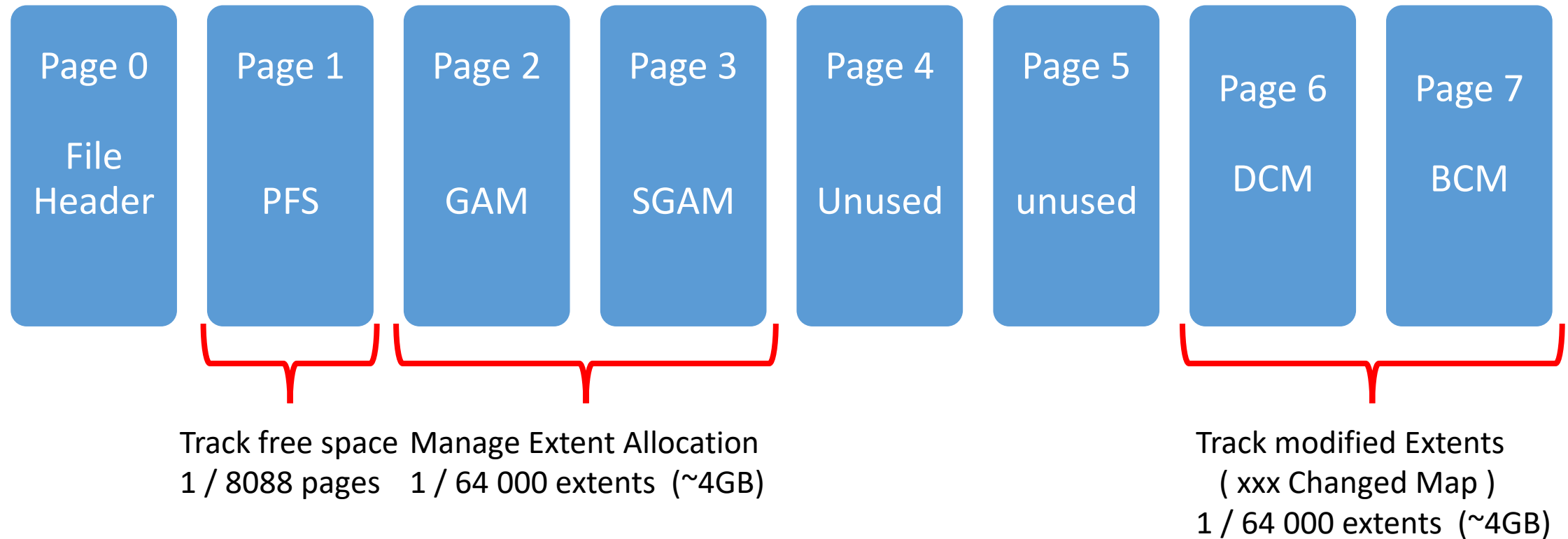
Table1



Table1

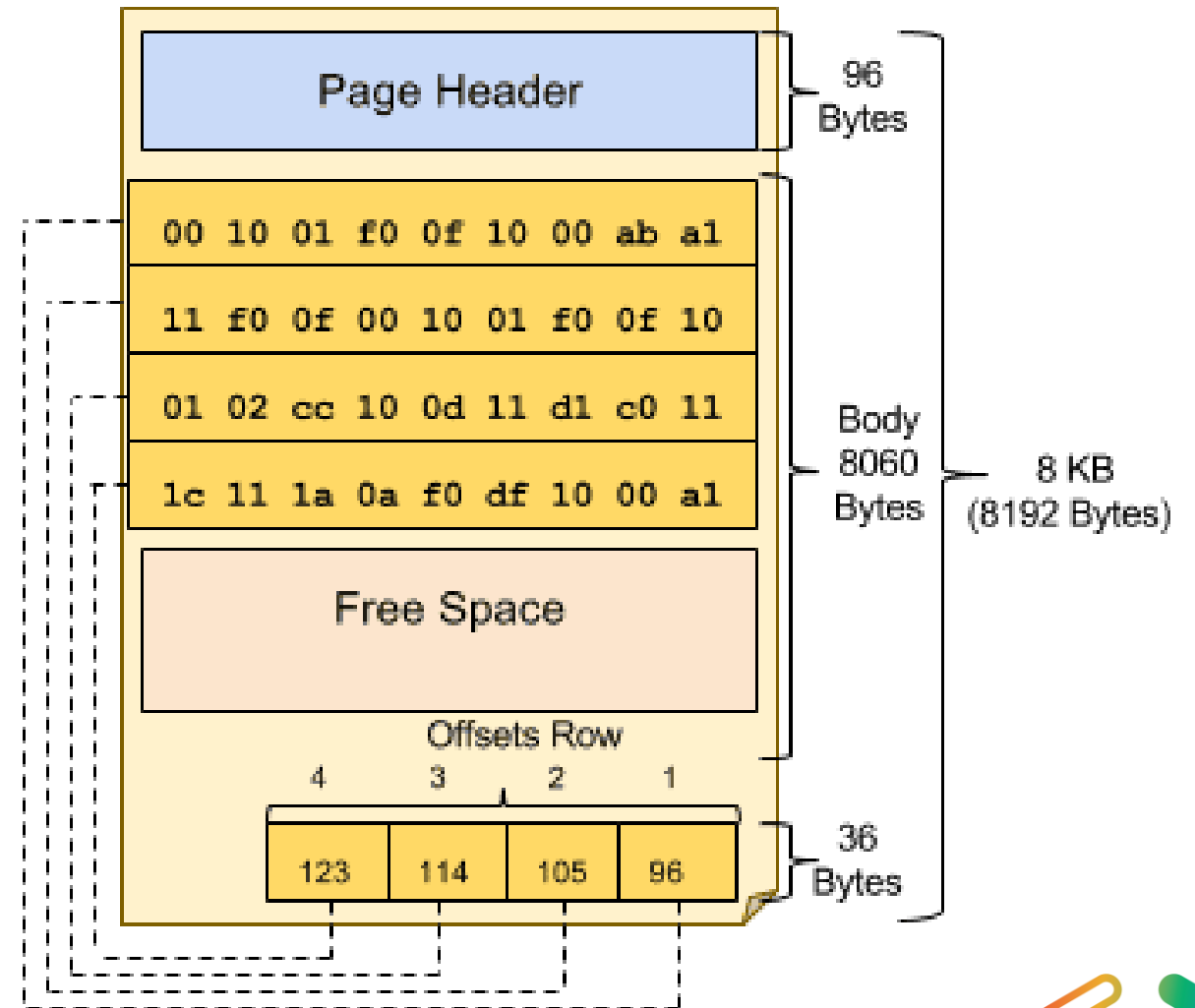


# 1ère Extension



# Pages de données

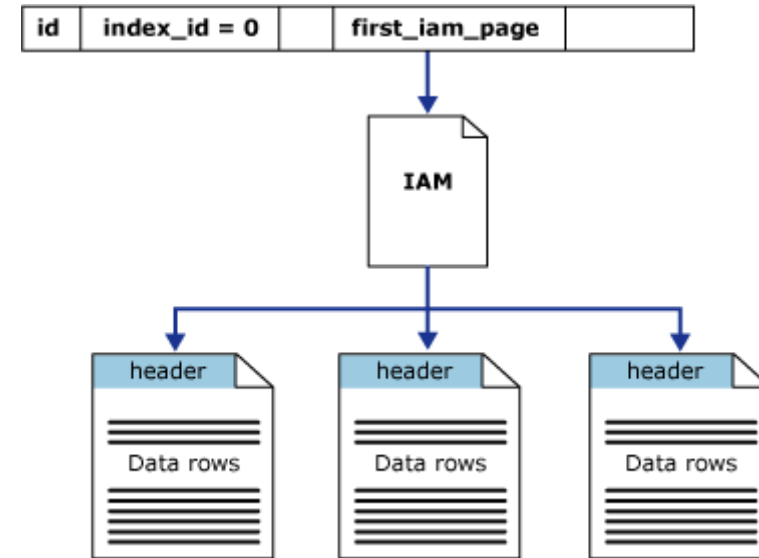
- Chaque page
  - Relative à un objet
- Un enregistrement
  - 8060 o maximum
  - Typages de données
  - LOB InRow / OffRow
- Une table
  - Liste chaînée de Data Pages





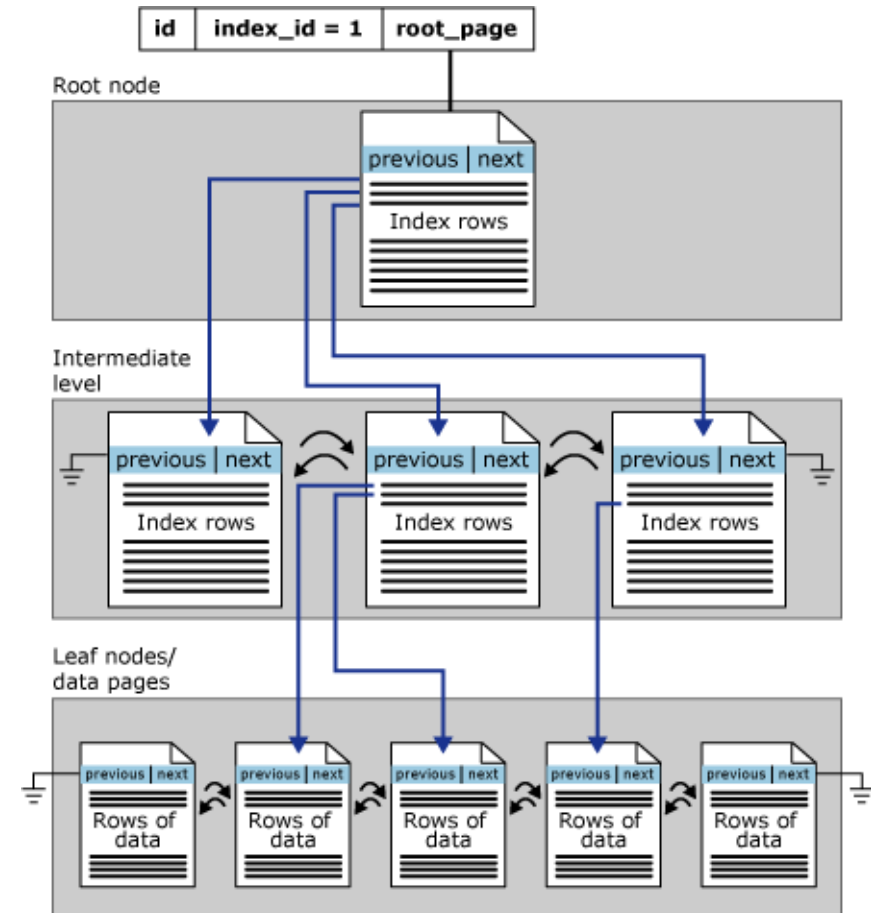
# Heap (Row Store)

- Enregistrements
  - Non ordonnés
- Avantages
  - Insert rapide
- Inconvénients
  - Forwarded records
  - Espace perdu (Del / Upd)



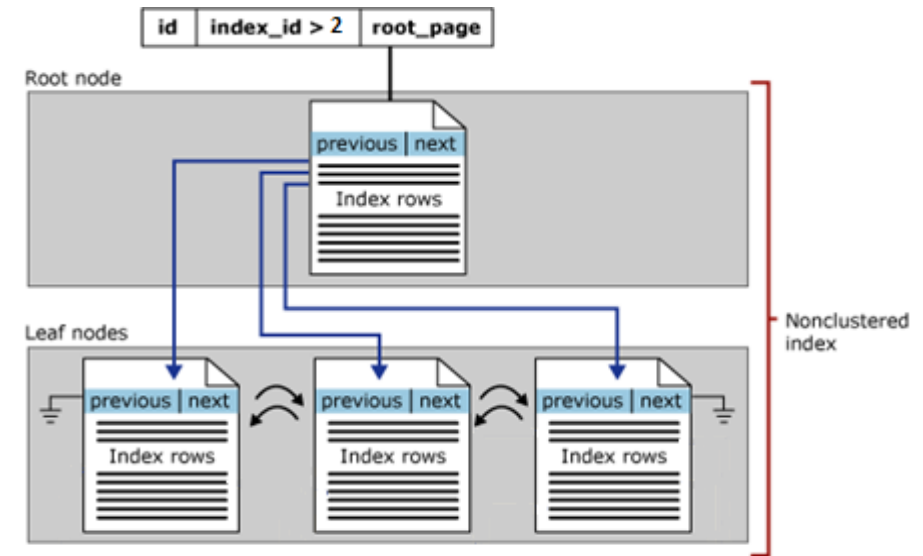
# Index Clustered (Row Store)

- Enregistrements
  - Ordonnés (inter pages)
  - Record size : 8060o
  - Key Size : 900o
- Avantages
  - Pages feuille : les données
  - Range Scan
- Inconvénients
  - Page split
  - Hot Page
  - Un seul (trouver le bon !)



# Index NonClustered (Row Store)

- Enregistrements
  - Ordonnés (inter pages)
  - Key Size : 1700o
- Options
  - Index avec colonne(s) incluse(s)
  - Index filtré
  - Index unique
- Avantages
  - Accélère la recherche de données
- Inconvénients
  - Page split
  - Hot Page (IU/IX Locks)
  - 999 au maximum (!!!)



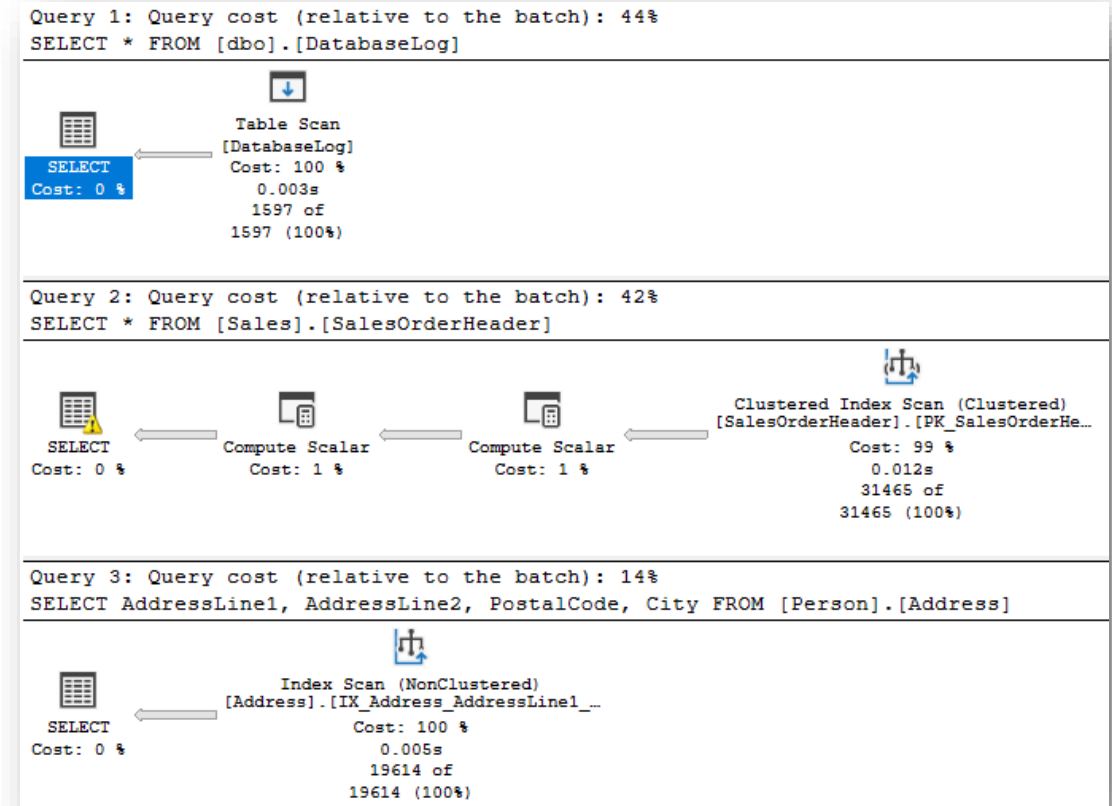
# Les opération

Scan, Seek & Lookup



# Scan

- Table Scan
- Cluster Index Scan
- NonClustered Index Scan

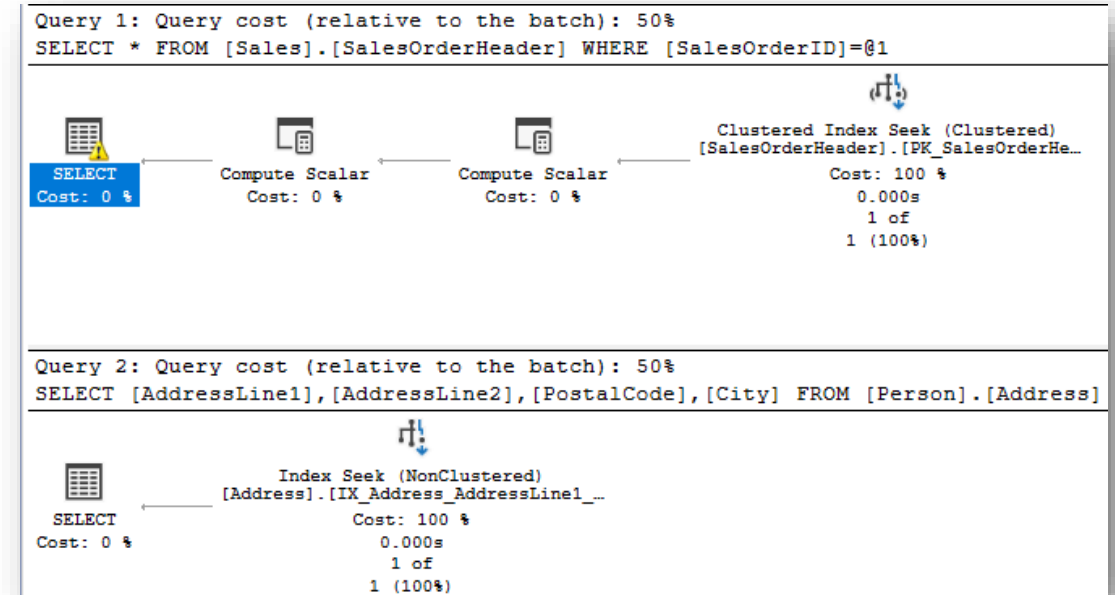


DatabaseName	SchemaName	TableName	index_name	object_id	index_id	user_scans	user_seeks	user_lookups	user_updates	last_user_scan	last_user_seek	last_user_lookup
AdventureWorks2017	dbo	DatabaseLog	NULL	901578250	0	1	0	0	0	2023-03-16 11:59:49.130	NULL	NULL
AdventureWorks2017	Sales	SalesOrderHeader	PK_SalesOrderHeader_SalesOrderID	1922105888	1	1	0	0	0	2023-03-16 11:59:49.290	NULL	NULL
AdventureWorks2017	Person	Address	IX_Address_AddressLine1_AddressLine2_City_StatePostalCode	1029578706	3	1	0	0	0	2023-03-16 11:59:49.597	NULL	NULL



# Seek

- Clustered Index Seek
- NonClustered Index Seek

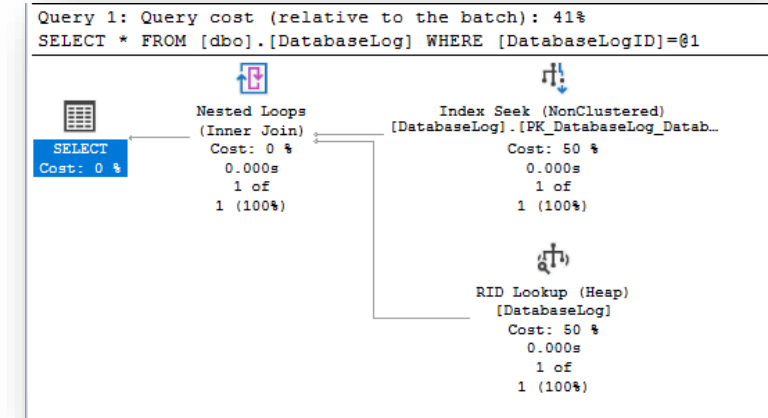
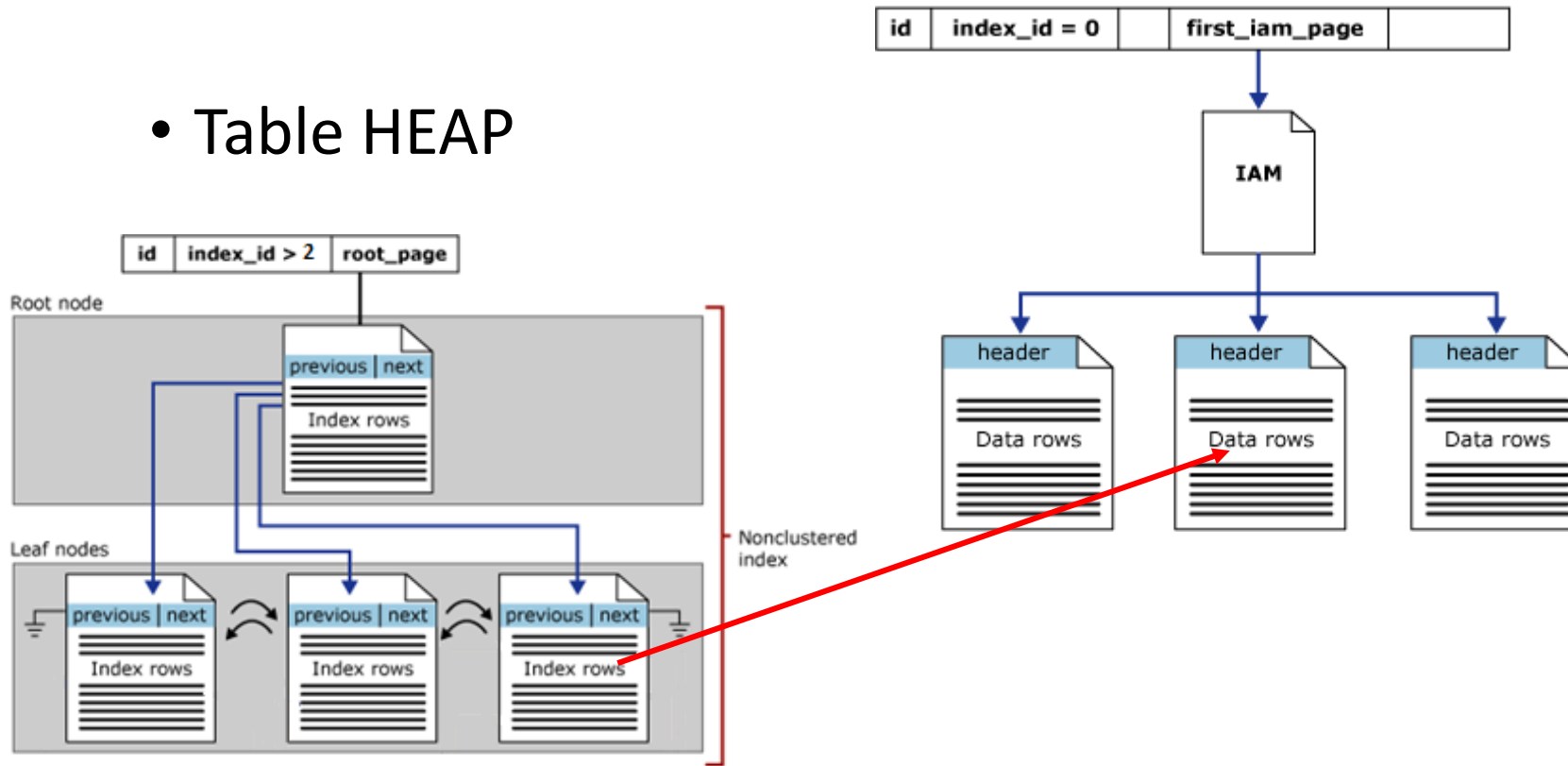


DatabaseName	SchemaName	TableName	index_name	object_id	index_id	user_scans	user_seeks	user_lookups	user_updates	last_user_scan	last_user_seek	last_user_lookup
AdventureWorks2017	Sales	SalesOrderHeader	PK_SalesOrderHeader_SalesOrderID	1922105888	1	1	1	0	0	2023-03-16 11:59:49.290	2023-03-16 12:04:00.593	NULL
AdventureWorks2017	Person	Address	IX_Address_AddressLine1_AddressLine2_City_StatePostalCode	1029578706	3	1	1	0	0	2023-03-16 11:59:49.597	2023-03-16 12:04:00.640	NULL



# Bookmark lookup – RID Lookup

- Table HEAP

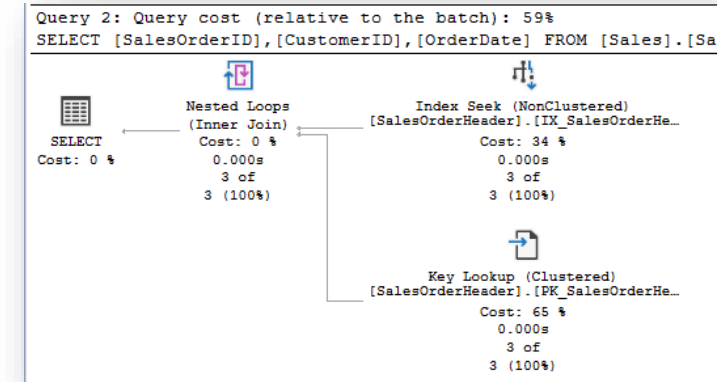
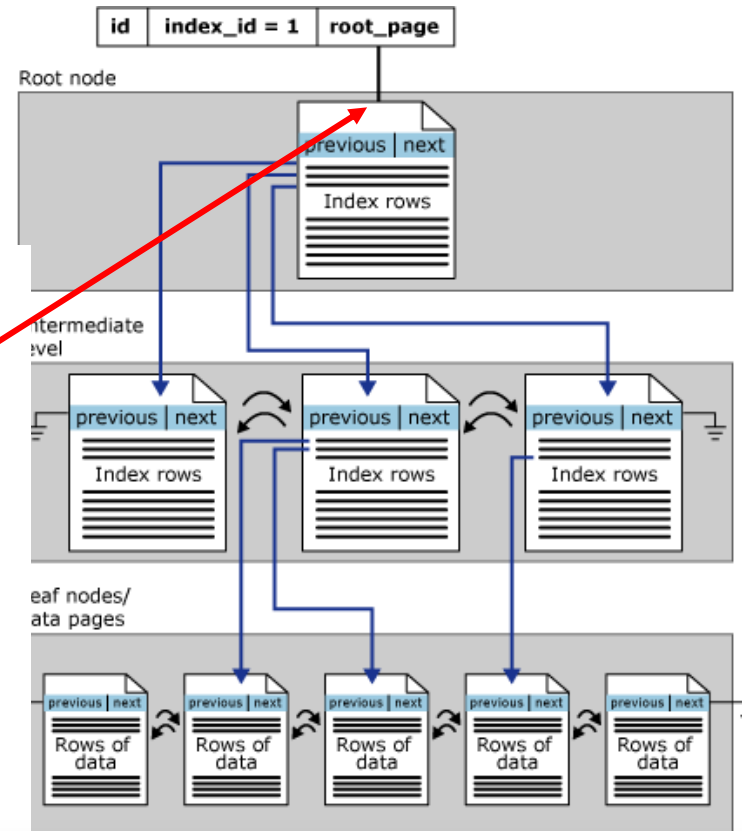
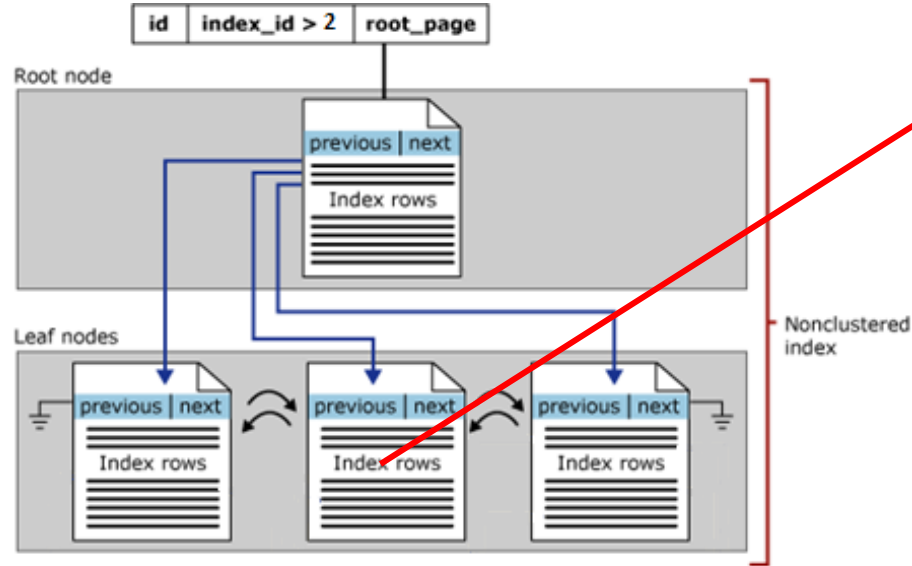


DatabaseName	SchemaName	TableName	index_name	object_id	index_id	user_scans	user_seeks	user_lookups	user_updates	last_user_scan	last_user_seek	last_user_lookup
AdventureWorks2017	dbo	DatabaseLog	PK_DatabaseLog_DatabaseLogID	901578250	2	0	1	0	0	NULL	2023-03-16 12:06:34.140	NULL
AdventureWorks2017	dbo	DatabaseLog	NULL	901578250	0	1	0	1	0	2023-03-16 11:59:49.130	NULL	2023-03-16 12:06:34.140



# Bookmark lookup – Key Lookup

- Index Cluster



DatabaseName	SchemaName	TableName	index_name	object_id	index_id	user_scans	user_seeks	user_lookups	user_updates	last_user_scan	last_user_seek	last_user_lookup
AdventureWorks2017	Sales	SalesOrderHeader	IX_SalesOrderHeader_CustomerID	1922105888	4	0	1	0	0	NULL	2023-03-16 12:10:53.713	NULL
AdventureWorks2017	Sales	SalesOrderHeader	PK_SalesOrderHeader_SalesOrderID	1922105888	1	1	1	1	0	2023-03-16 11:59:49.290	2023-03-16 12:04:00.593	2023-03-16 12:10:53.713





# Bonus – Key Lookup Deep Dive

Field	PageId	Row	Level	ChildField	ChildPageId	CustomerID (key)
1	7496	0	1	1	7256	NULL
1	7496	1	1	1	7257	11191
1	7496	2	1	1	7258	11330
1	7496	3	1	1	7259	11519
1	7496	4	1	1	7260	11736
1	7496	5	1	1	7261	11967
1	7496	6	1	1	7262	12211
1	7496	7	1	1	7263	12475
1	7496	8	1	1	7264	12763
1	7496	9	1	1	7265	13068

Field	PageId	Row	Level	CustomerID (key)	SalesOrderID (key)	KeyHashValue	Row Size
1	7256	0	0	11000	43793	(dc9ad24a8317)	12
1	7256	1	0	11000	51522	(4ec3187d6991)	12
1	7256	2	0	11000	57418	(d0df796d1d13)	12
1	7256	3	0	11001	43767	(acd94b335138)	12
1	7256	4	0	11001	51493	(1c0f95fcd8f2)	12
1	7256	5	0	11001	72773	(4e1ca1670056)	12
1	7256	6	0	11002	43736	(dfd038d85b9f)	12
1	7256	7	0	11002	51238	(888ee458692b)	12
1	7256	8	0	11002	53237	(5b740c7bbfb)	12
1	7256	9	0	11003	43701	(2547c24d9bdf)	12

Field	PageId	Row	Level	CustomerID (key)	SalesOrderID (key)	KeyHashValue	Row Size
1	7257	0	0	11191	70229	(c7f2d17302a4)	12
1	7257	1	0	11192	60704	(23b7a4f27e66)	12
1	7257	2	0	11192	67056	(db2028f3f42d)	12
1	7257	3	0	11193	53325	(ae7b4796322)	12
1	7257	4	0	11193	64476	(8a75be1a17bf)	12
1	7257	5	0	11194	54355	(c10b5a950ef3)	12
1	7257	6	0	11194	72599	(16785202e20e)	12
1	7257	7	0	11195	56195	(b9a6bf232bd5)	12
1	7257	8	0	11195	68921	(0cfe2667c8d5)	12
1	7257	9	0	11196	53786	(d4abeeb6cfd9)	12



# Bonus – Key Lookup Deep Dive

Field	PageId	Row	Level	ChildField	ChildPageId	CustomerID (key)
1	7496	0	1	1	7256	NULL
1	7496	1	1	1	7257	11191
1	7496	2	1	1	7258	11330
1	7496	3	1	1	7259	11519
1	7496	4	1	1	7260	11736
1	7496	5	1	1	7261	11967
1	7496	6	1	1	7262	12211
1	7496	7	1	1	7263	12475
1	7496	8	1	1	7264	12763
1	7496	9	1	1	7265	13068

Field	PageId	Row	Level	CustomerID (key)	SalesOrderID (key)	KeyHashValue	Row Size
1	7256	0	0	11000	43793	(dc9ad24a8317)	12
1	7256	1	0	11000	51522	(4ec3187d6991)	12
1	7256	2	0	11000	57418	(d0df796d1d13)	12
1	7256	3	0	11001	43767	(acd94b335138)	12
1	7256	4	0	11001	51493	(1c0f95fcd8f2)	12
1	7256	5	0	11001	72773	(4e1ca1670056)	12
1	7256	6	0	11002	43736	(dfd038d85b9f)	12
1	7256	7	0	11002	51238	(888ee458692b)	12
1	7256	8	0	11002	53237	(5b740c7bbfb)	12
1	7256	9	0	11003	43701	(2547c24d9bdf)	12

Field	PageId	Row	Level	CustomerID (key)	SalesOrderID (key)	KeyHashValue	Row Size
1	7257	0	0	11191	70229	(c72d17302a4)	12
1	7257	1	0	11192	60704	(23b7a4f27e66)	12
1	7257	2	0	11192	67056	(db2028f3f42d)	12
1	7257	3	0	11193	53325	(ae7b4796322)	12
1	7257	4	0	11193	64476	(8a75be1a17bf)	12
1	7257	5	0	11194	54355	(c10b5a950ef3)	12
1	7257	6	0	11194	72599	(16785202e20e)	12
1	7257	7	0	11195	56195	(b9a6bf232bd5)	12
1	7257	8	0	11195	68921	(0cfe2667c8d5)	12
1	7257	9	0	11196	53786	(d4abeeb6cfd9)	12



# Bonus – Key Lookup Deep Dive

Field	PageId	Row	Level	ChildField	ChildPageId	CustomerID (key)
1	7496	0	1	1	7256	NULL
1	7496	1	1	1	7257	11191
1	7496	2	1	1	7258	11330
1	7496	3	1	1	7259	11519
1	7496	4	1	1	7260	11756
1	7496	5	1	1	7261	11991
1	7496	6	1	1	7262	12211
1	7496	7	1	1	7263	12479
1	7496	8	1	1	7264	12763
1	7496	9	1	1	7265	13068

Field	PageId	Row	Level	CustomerID (key)	SalesOrderID (key)	KeyHash/Value	Row Size
1	7256	0	0	11000	43793	(d63ed04e8317)	12
1	7256	1	0	11000	51622	(4ec3187d6991)	12
1	7256	2	0	11000	57418	(d0df796d1d13)	12
1	7256	3	0	11001	43767	(ac0f9d319138)	12
1	7256	4	0	11001	51493	(1c09f99cd82)	12
1	7256	5	0	11001	72773	(de1ca1670056)	12
1	7256	6	0	11002	43736	(d82030c0569)	12
1	7256	7	0	11002	51238	(889ea458692b)	12
1	7256	8	0	11002	53237	(db74dc7bcbfd)	12
1	7256	9	0	11003	43701	(2547c3d49cdf)	12

Field	PageId	Row	Level	CustomerID (key)	SalesOrderID (key)	KeyHash/Value	Row Size
1	7257	0	0	11191	70229	(c792d177202a4)	12
1	7257	1	0	11192	60704	(23b7a9f27a66)	12
1	7257	2	0	11192	67056	(d82028f94d6)	12
1	7257	3	0	11193	53325	(ae7ba799c32d)	12
1	7257	4	0	11193	64476	(8a78ea1a17bf)	12
1	7257	5	0	11194	54355	(c10b5a005af3)	12
1	7257	6	0	11194	72599	(16785202a20e)	12
1	7257	7	0	11195	96195	(67a0df232a0f)	12
1	7257	8	0	11195	60921	(0a0c2957c0d0f)	12
1	7257	9	0	11196	53786	(d4abeb6fd4f8)	12



# Bonus – Key Lookup Deep Dive

Field	PageId	Row	Level	ChildField	ChildPageId	SalesOrderID (key)	KeyHashValue	Row Size
1	16416	0	2	1	3000	NULL	NULL	11
1	16416	1	2	1	2976	71190	NULL	11

Field	PageId	Row	Level	ChildField	ChildPageId	CustomerID (key)	SalesOrderID (key)	KeyHashValue	Row Size
1	7256	0	0	11000	43793	(0c3e034e317)	12		
1	7256	1	0	11000	51522	(4ec31876991)	12		
1	7256	2	0	11000	57418	(50af796d1d13)	12		
1	7256	3	0	11001	43787	(ac0f96320138)	12		
1	7256	4	0	11001	51493	(c09f99cd82)	12		
1	7256	5	0	11001	72773	(de1ca1670056)	12		
1	7256	6	0	11002	43736	(af2030359)	12		
1	7256	7	0	11002	51238	(889ea45892a)	12		
1	7256	8	0	11002	53237	(8b74d7b0a6)	12		
1	7256	9	0	11003	43701	(2547c34c9d)	12		

Field	PageId	Row	Level	ChildField	ChildPageId	CustomerID (key)	SalesOrderID (key)	KeyHashValue	Row Size
1	7496	0	1	1	7256	NULL			
1	7496	1	1	1	7257	11191			
1	7496	2	1	1	7258	11330			
1	7496	3	1	1	7259	11519			
1	7496	4	1	1	7260	11726			
1	7496	5	1	1	7261	11901			
1	7496	6	1	1	7262	12211			
1	7496	7	1	1	7263	12475			
1	7496	8	1	1	7264	12783			
1	7496	9	1	1	7265	13068			

Field	PageId	Row	Level	ChildField	ChildPageId	SalesOrderID (key)	KeyHashValue	Row Size
1	3000	0	1	1	16600	NULL	NULL	11
1	3000	1	1	1	16601	43700	NULL	11
1	3000	2	1	1	16602	43747	NULL	11
1	3000	3	1	1	16603	43794	NULL	11
1	3000	4	1	1	16604	43841	NULL	11
1	3000	5	1	1	16605	43882	NULL	11
1	3000	6	1	1	16606	43924	NULL	11
1	3000	7	1	1	16607	43971	NULL	11
1	3000	8	1	1	16608	44018	NULL	11
1	3000	9	1	1	16609	44065	NULL	11

Field	PageId	Row	Level	ChildField	ChildPageId	SalesOrderID (key)	KeyHashValue	Row Size
1	2976	0	1	1	16424	71190	NULL	11
1	2976	1	1	1	16425	71237	NULL	11
1	2976	2	1	1	16426	71284	NULL	11
1	2976	3	1	1	16427	71331	NULL	11
1	2976	4	1	1	16428	71378	NULL	11
1	2976	5	1	1	16429	71425	NULL	11
1	2976	6	1	1	16430	71472	NULL	11
1	2976	7	1	1	16431	71519	NULL	11
1	2976	8	1	1	16432	71566	NULL	11
1	2976	9	1	1	16433	71613	NULL	11

Slot 36 Column 1 Offset 0x4 Length 4 Length (physical) 4  
SalesOrderID = 43736

Slot 36 Column 2 Offset 0x8 Length 1 Length (physical) 1  
RevisionNumber = 8

Slot 36 Column 3 Offset 0x9 Length 8 Length (physical) 8  
OrderDate = 2011-06-09 00:00:00.000

Slot 36 Column 4 Offset 0x11 Length 8 Length (physical) 8  
DueDate = 2011-06-21 00:00:00.000



# Conclusion

- La modélisation physique a son importance
- /!\ Ne pas confondre
  - Clé primaire et Index Clustered
  - SQL Server / SSMS
    - Contrainte PK implémentée sous forme d'index cluster par défaut
  - MAIS
    - Gains de performance possibles à ne pas suivre cette règle ...
- La fragmentation
  - N'est pas forcément votre ennemie !
- L'optimiseur est basé sur le cout ...

