

SQLServerFast.com

Execution Plan Video Training

Block 2: Reading data

Level: Basic

Chapter 2: Scan operators

Scan operators

Eight different scan operators

- Clustered Index Scan

- Columnstore Index Scan

- Constant Scan

- Deleted Scan

- Index Scan

- Inserted Scan

- Remote Scan

- Table Scan

Scan operators

Eight different scan operators

Read all data from their source

Scan vs seek?

Seek operators read only a specific subset of the data

For small subset, seek is faster than scan

Cost of enabling the seek might exceed savings

Scan operators read from start to finish

Or until parent operator stops asking for data

May be limited by Top, or by other operators

Scan operators

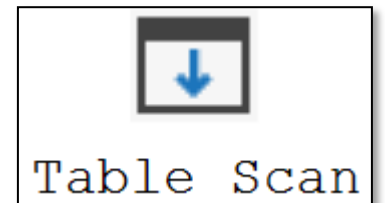
Table Scan

Reads (all) data from a heap table

Heap table: Table without clustered index

Should (generally) be avoided

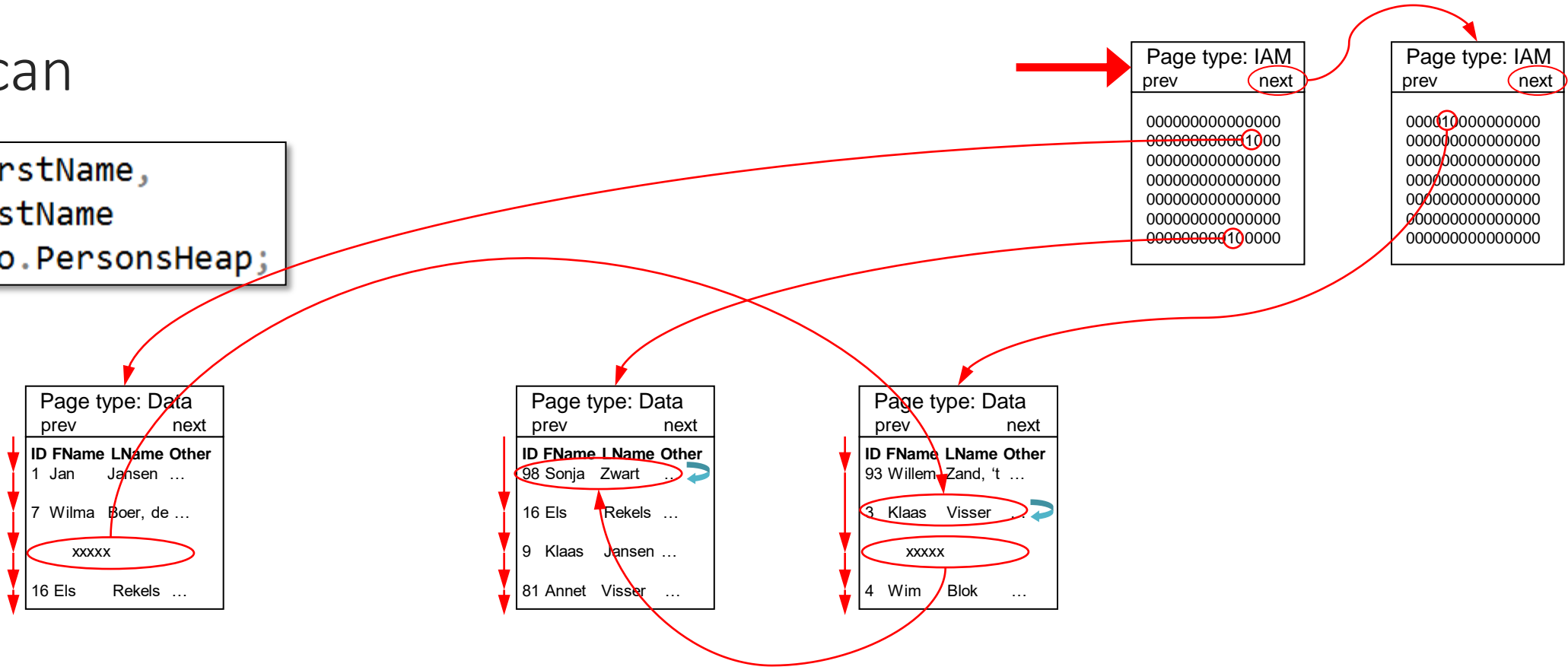
Choose a clustered index for all your tables



Scan operators

Table Scan

```
SELECT FirstName,  
        LastName  
FROM    dbo.PersonsHeap;
```



Scan operators

Table Scan

Properties (popup)

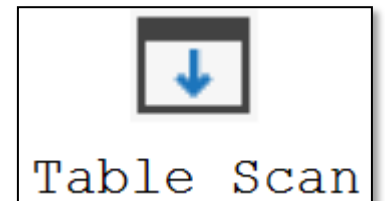
Actual and estimated row count

“Pushed down” predicate

Which table is scanned?

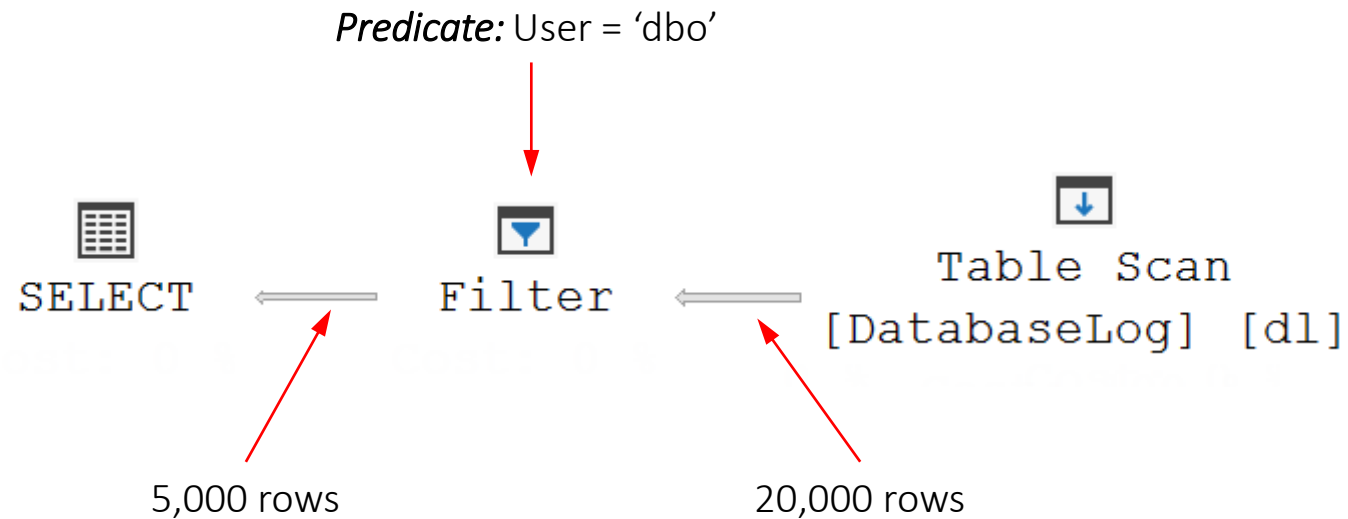
Data returned to caller

Table Scan	
Scan rows from a table.	
Physical Operation	Table Scan
Logical Operation	Table Scan
Actual Execution Mode	Row
Estimated Execution Mode	Row
Storage	RowStore
Number of Rows Read	1596
Actual Number of Rows for All Executions	1596
Actual Number of Batches	0
Estimated I/O Cost	0,581644
Estimated Operator Cost	0,583556 (100%)
Estimated CPU Cost	0,0019126
Estimated Subtree Cost	0,583556
Number of Executions	1
Estimated Number of Executions	1
Estimated Number of Rows Per Execution	1596
Estimated Number of Rows to be Read	1596
Estimated Row Size	285 B
Actual Rebinds	0
Actual Rewinds	0
Ordered	False
Node ID	0
Predicate	
[AdventureWorks2017].[dbo].[DatabaseLog].[DatabaseUser] as [dl].[DatabaseUser]=N'dbo'	
Object	
[AdventureWorks2017].[dbo].[DatabaseLog] [dl]	
Output List	
[AdventureWorks2017].[dbo].[DatabaseLog].PostTime; [AdventureWorks2017].[dbo].[DatabaseLog].Event; [AdventureWorks2017].[dbo].[DatabaseLog].Object	



Scan operators

Predicate pushdown



Scan operators

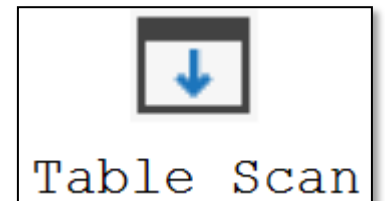
Table Scan

Properties (popup)

Number of rows the operator read
(includes rows read but not returned)

“Pushed down” predicate

Table Scan	
Scan rows from a table.	
Physical Operation	Table Scan
Logical Operation	Table Scan
Actual Execution Mode	Row
Estimated Execution Mode	Row
Storage	RowStore
Number of Rows Read	1596
Actual Number of Rows for All Executions	1596
Actual Number of Batches	0
Estimated I/O Cost	0,581644
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Estimated Number of Rows Per Execution	1596
Estimated Number of Rows to be Read	1596
Estimated Row Size	285 B
Actual Rebinds	0
Actual Rewinds	0
Ordered	False
Node ID	0
Predicate	[AdventureWorks2017].[dbo].[DatabaseLog].[DatabaseUser] as [dl].[DatabaseUser]=N'dbo'
Object	[AdventureWorks2017].[dbo].[DatabaseLog] [dl]
Output List	[AdventureWorks2017].[dbo].[DatabaseLog].PostTime; [AdventureWorks2017].[dbo].[DatabaseLog].Event; [AdventureWorks2017].[dbo].[DatabaseLog].Object



Scan operators

Table Scan

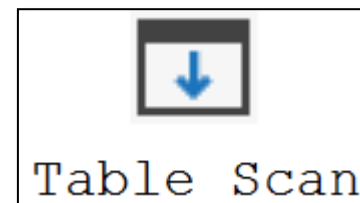
Properties (full list)

How many reads?

Actual I/O Statistics	
Actual Lob Logical Reads	0
Actual Lob Physical Reads	0
Actual Lob Read Aheads	0
Actual Logical Reads	782
Actual Physical Reads	0
Actual Read Aheads	0
Actual Scans	1

Total number of rows in the heap table
(at the time the query was last compiled)

Properties	
Table Scan	
Misc	
Actual Execution Mode	Row
Actual I/O Statistics	
Actual Number of Batches	0
Actual Number of Rows for A	1596
Actual Rebinds	0
Actual Rewinds	0
Actual Time Statistics	
Defined Values	[AdventureWorks2017].[dbo].[Dat
Description	Scan rows from a table.
Estimated CPU Cost	0,0019126
Estimated Execution Mode	Row
Estimated I/O Cost	0,581644
Estimated Number of Executi	1
Estimated Number of Rows P	1596
Estimated Number of Rows to	1596
Estimated Operator Cost	0,583556 (100%)
Estimated Rebinds	0
Estimated Rewinds	0
Estimated Row Size	285 B
Estimated Subtree Cost	0,583556
Forced Index	False
ForceScan	False
Logical Operation	Table Scan
Node ID	0
NoExpandHint	False
Number of Executions	1
Number of Rows Read	1596
Object	[AdventureWorks2017].[dbo].[Dat
Ordered	False
Output List	[AdventureWorks2017].[dbo].[Dat
Parallel	False
Physical Operation	Table Scan
Predicate	[AdventureWorks2017].[dbo].[Dat
Storage	Row Store
TableCardinality	1596
Actual Execution Mode	Actual Execution Mode



Scan operators

Index Scan

Sometimes called Nonclustered Index Scan for clarity

Reads (all) data from a nonclustered index

- On-disk rowstore

- Columnstore (different name and icon used)

- Memory-optimized (Bw-tree)

- Memory-optimized Hash



Index Scan (NonClustered)

Scan operators

Index Scan

Sometimes called Nonclustered Index Scan for clarity

Reads (all) data from a nonclustered index

Three processing modes

- Ordered forward

- Ordered backward

- Unordered

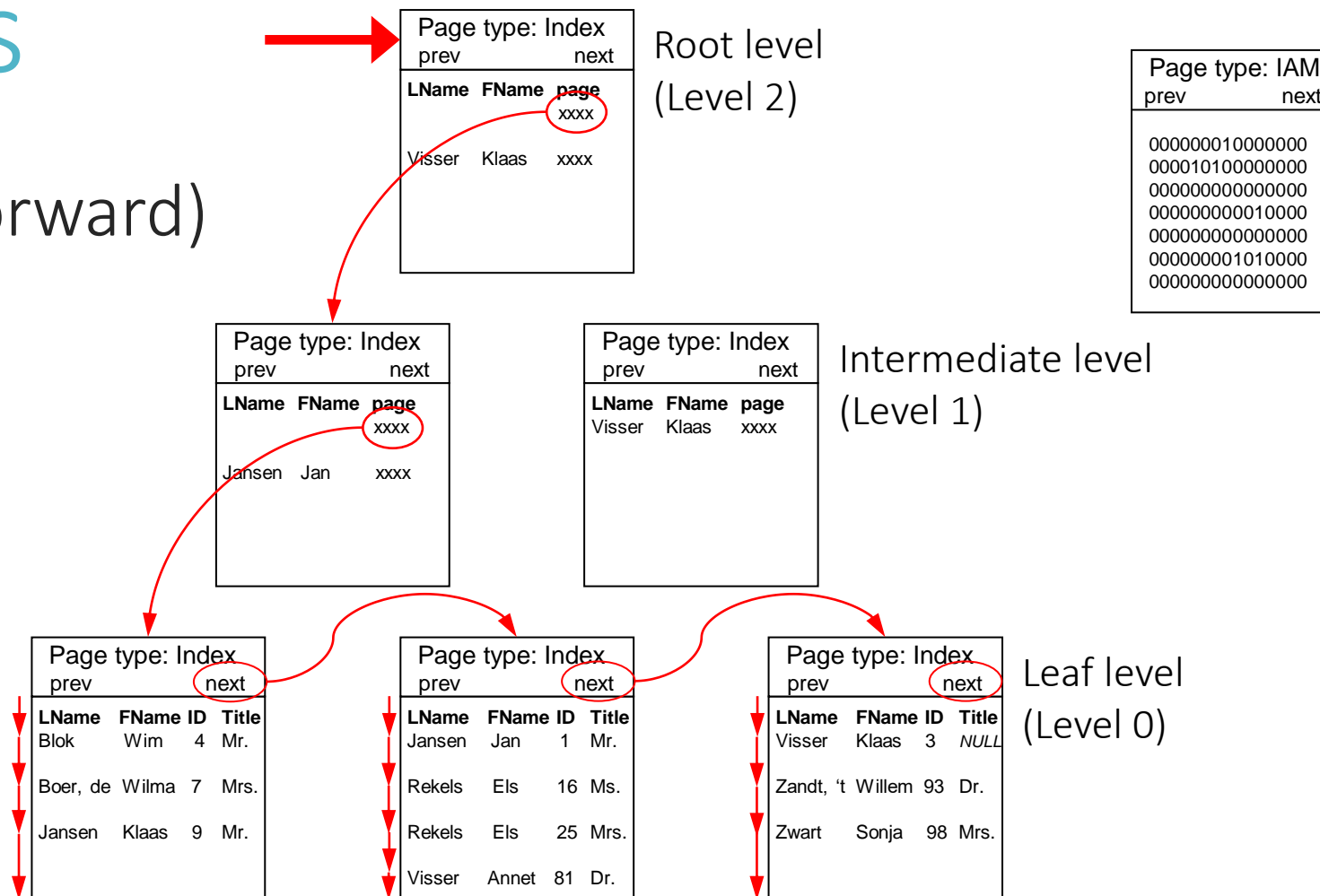


Index Scan (NonClustered)

Scan operators

Index Scan (ordered forward)

```
SELECT    Title,  
          FirstName,  
          LastName  
FROM      dbo.PersonsCluster  
ORDER BY  LastName;
```



Scan operators

Index Scan (ordered forward)

```
SELECT    Title,  
          FirstName,  
          LastName  
FROM      dbo.PersonsCluster  
ORDER BY  LastName;
```

Page type: Index			
prev	(lvl 2)	next	
LName	FName	page	
		xxxx	
Visser	Klaas	xxxx	

Page type: IAM	
prev	next
0000000100000000	
0000101000000000	
0000000000000000	
0000000000010000	
0000000000000000	
0000000010100000	
0000000000000000	

Page type: Index			
prev	(lvl 1)	next	
LName	FName	page	
		xxxx	
Jansen	Jan	xxxx	

Page type: Index			
prev	(lvl 1)	next	
LName	FName	page	
Visser	Klaas	xxxx	

Page type: Index				
prev	(lvl 0)	next		
LName	FName	ID	Title	
Blok	Wim	4	Mr.	
Boer, de	Wilma	7	Mrs.	
Jansen	Klaas	9	Mr.	

Page type: Index				
prev	(lvl 0)	next		
LName	FName	ID	Title	
Jansen	Jan	1	Mr.	
Rekels	Els	16	Ms.	
Rekels	Els	25	Mrs.	
Visser	Annet	81	Dr.	

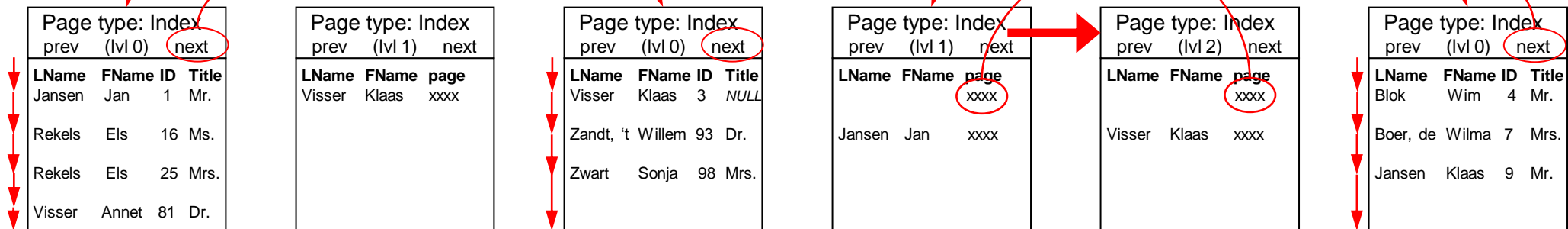
Page type: Index				
prev	(lvl 0)	next		
LName	FName	ID	Title	
Visser	Klaas	3	NULL	
Zandt, 't	Willem	93	Dr.	
Zwart	Sonja	98	Mrs.	

Scan operators

Index Scan (ordered forward)

```
SELECT  Title,  
        FirstName,  
        LastName  
FROM    dbo.PersonsCluster  
ORDER BY LastName;
```

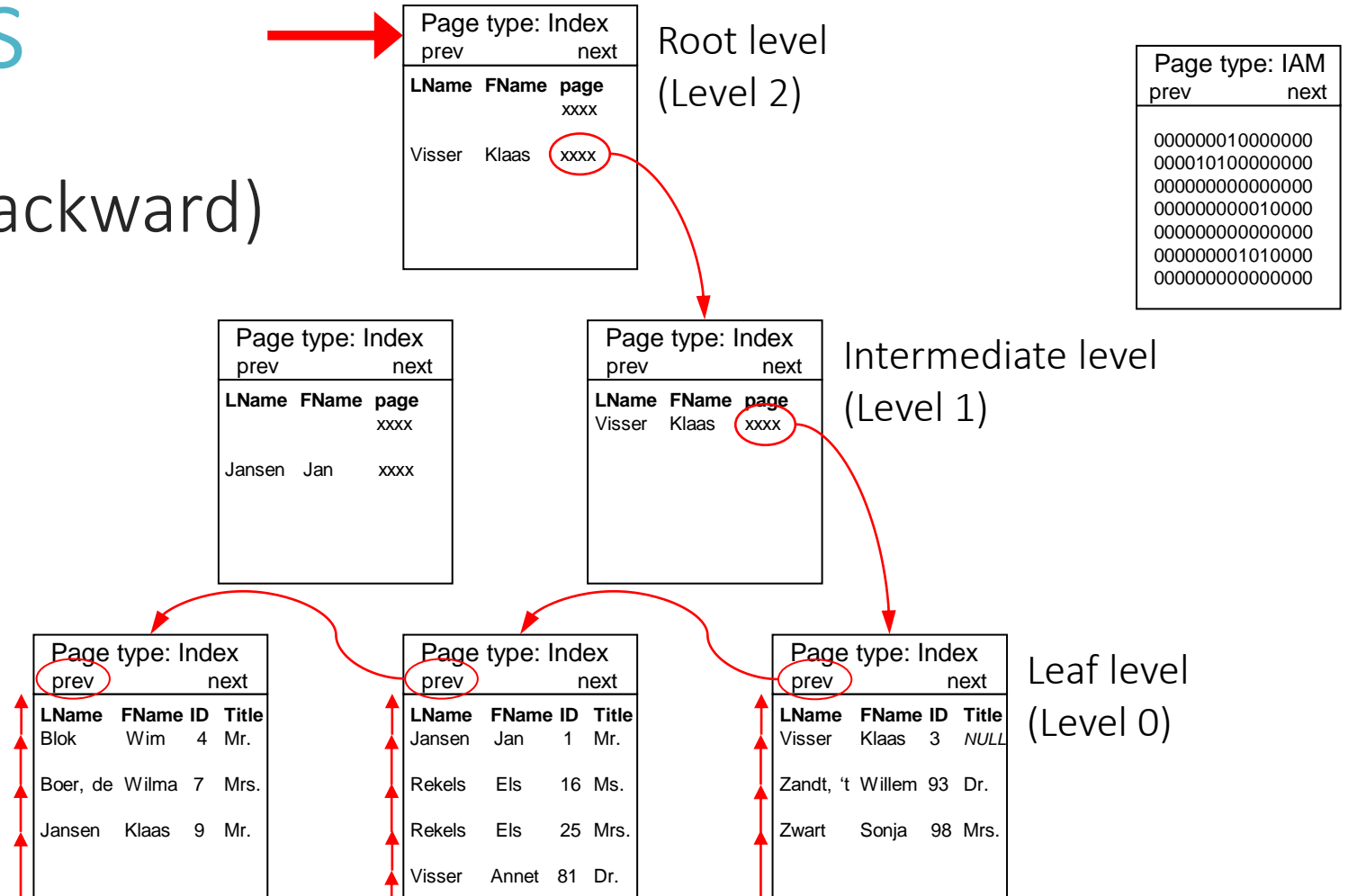
Page type: IAM	
prev	next
0000000100000000	
0000101000000000	
0000000000000000	
0000000000010000	
0000000000000000	
0000000010100000	
0000000000000000	



Scan operators

Index Scan (ordered backward)

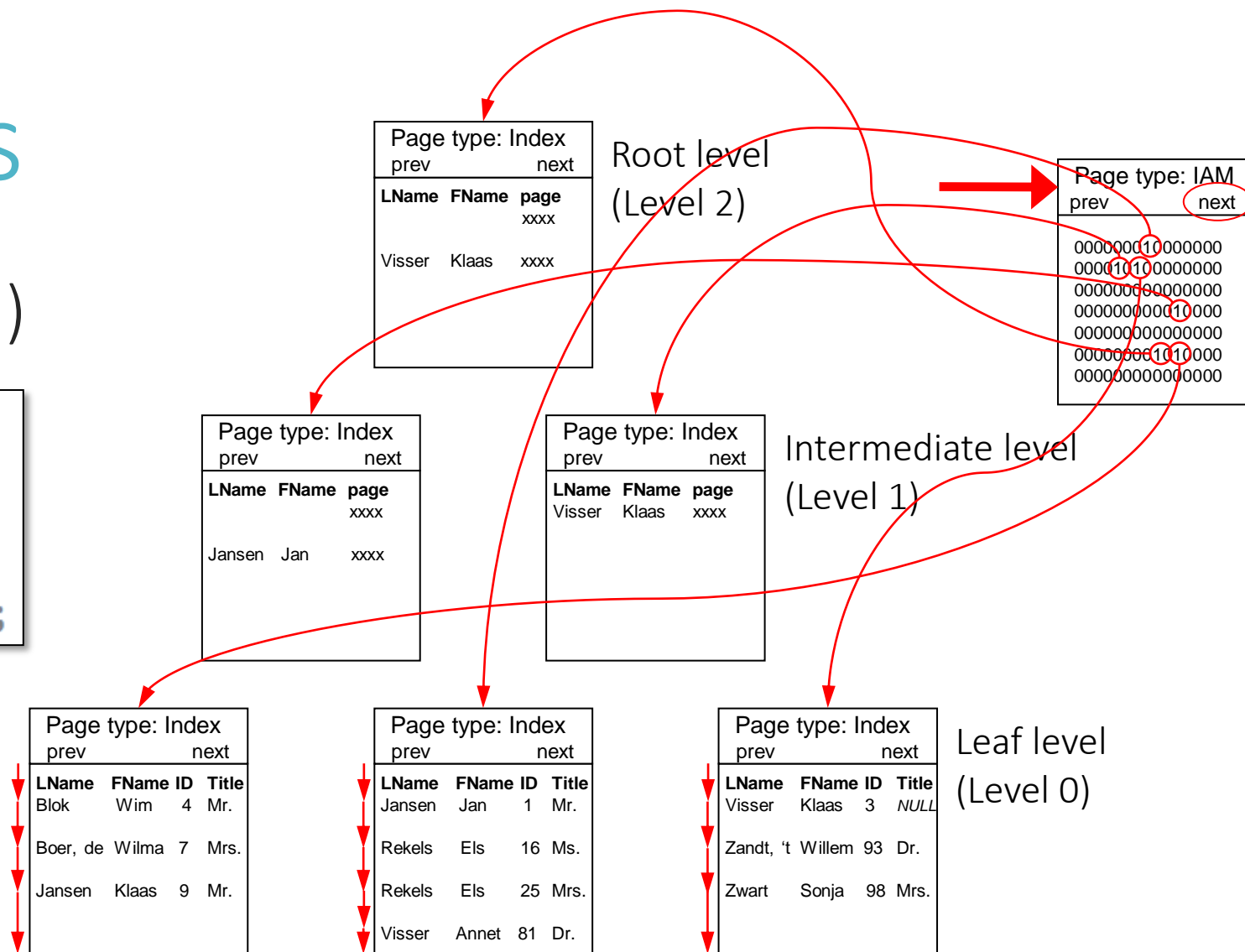
```
SELECT LastName,  
        FirstName  
FROM    dbo.PersonsCluster  
ORDER BY LastName DESC,  
        FirstName DESC;
```



Scan operators

Index Scan (unordered)

```
SELECT PersonID,  
       LastName,  
       FirstName  
FROM   dbo.PersonsCluster  
       WITH (TABLOCK);
```



Scan operators

Index Scan (unordered vs ordered)

Unordered scan touches all non-leaf pages

Just a tiny fraction of the total number of pages



Index Scan (NonClustered)

Scan operators

Index Scan (unordered vs ordered)

- Unordered scan touches all non-leaf pages

- Unordered scan is sequential (file allocation order)

 - Larger read-ahead I/O requests

 - Less head movement (spinning disk)



Index Scan (NonClustered)

Scan operators

Index Scan (unordered vs ordered)

Unordered scan touches all non-leaf pages

Unordered scan is sequential (file allocation order)

Determined by *Ordered* property

Set to True when ordered data is required

Set to False when order is irrelevant

Defers scan type choice to run time



Index Scan (NonClustered)

Scan operators

Index Scan (unordered vs ordered)

Unordered scan touches all non-leaf pages

Unordered scan is sequential (file allocation order)

Determined by *Ordered* property

Unordered scan is subject to concurrency problems

Only permitted when ...

- Table-level lock used

- Index is read only

- NOLOCK / READUNCOMMITTED



Index Scan (NonClustered)

Scan operators

Index Scan (unordered vs ordered)

- Unordered scan touches all non-leaf pages

- Unordered scan is sequential (file allocation order)

- Determined by *Ordered* property

- Unordered scan is subject to concurrency problems

- Unordered scan considered too expensive for less than 64 pages



Index Scan (NonClustered)

Scan operators

Index Scan

Properties (popup)

Ordered scan required?
(by optimizer)

Which index is scanned?

Index Scan (NonClustered)	
Scan a nonclustered index, entirely or only a range.	
Physical Operation	Index Scan
Logical Operation	Index Scan
Actual Execution Mode	Row
Estimated Execution Mode	Row
Storage	RowStore
Number of Rows Read	19972
Actual Number of Rows for All Executions	103
Actual Number of Batches	0
Estimated I/O Cost	0,080162
Estimated Operator Cost	0,102288 (91%)
Estimated CPU Cost	0,0221262
Estimated Subtree Cost	0,102288
Estimated Number of Executions	1
Number of Executions	1
Estimated Number of Rows Per Execution	109,003
Estimated Number of Rows to be Read	19972
Estimated Row Size	35 B
Actual Rebinds	0
Actual Rowinds	0
Ordered	True
Node ID	2
Predicate	
[AdventureWorks2017].[Person].[Person].[FirstName] as [p]. [FirstName]=N'Richard'	
Object	
[AdventureWorks2017].[Person].[Person]. [IX_Person_LastName_FirstName_MiddleName] [p]	
Output List	
[AdventureWorks2017].[Person].[Person].LastName	

Index Scan (NonClustered)

Scan operators

Index Scan

Properties (full list)

Were various hints
used in the query?

Indexed view with NOEXPAND hint

Order scan: forward or backward?

Properties	
Index Scan (NonClustered)	
Description	Scan a nonclustered index, er ^
Estimated CPU Cost	0,0221262
Estimated Execution Mode	Row
Estimated I/O Cost	0,080162
Estimated Number of Execu	1
Estimated Number of Rows	109,003
Estimated Number of Rows	19972
Estimated Operator Cost	0,102288 (91%)
Estimated Rebinds	0
Estimated Rewinds	0
Estimated Row Size	35 B
Estimated Subtree Cost	0,102288
Forced Index	False
ForceScan	False
ForceSeek	False
Logical Operation	Index Scan
Node ID	2
NoExpandHint	False
Number of Executions	1
Number of Rows Read	19972
Object	[AdventureWorks2017].[Perso
Ordered	True
Output List	[AdventureWorks2017].[Perso
Parallel	False
Physical Operation	Index Scan
Predicate	[AdventureWorks2017].[Perso
Scan Direction	BACKWARD
Storage	Rowstore
TableCardinality	19972
Actual Execution Mode	
Actual Execution Mode	

Scan operators

Clustered Index Scan

Actually same as (nonclustered) Index Scan

Reads (all) data from a ***clustered*** index

- On-disk rowstore

- Columnstore (different name and icon used)

- Memory-optimized (Bw-tree)

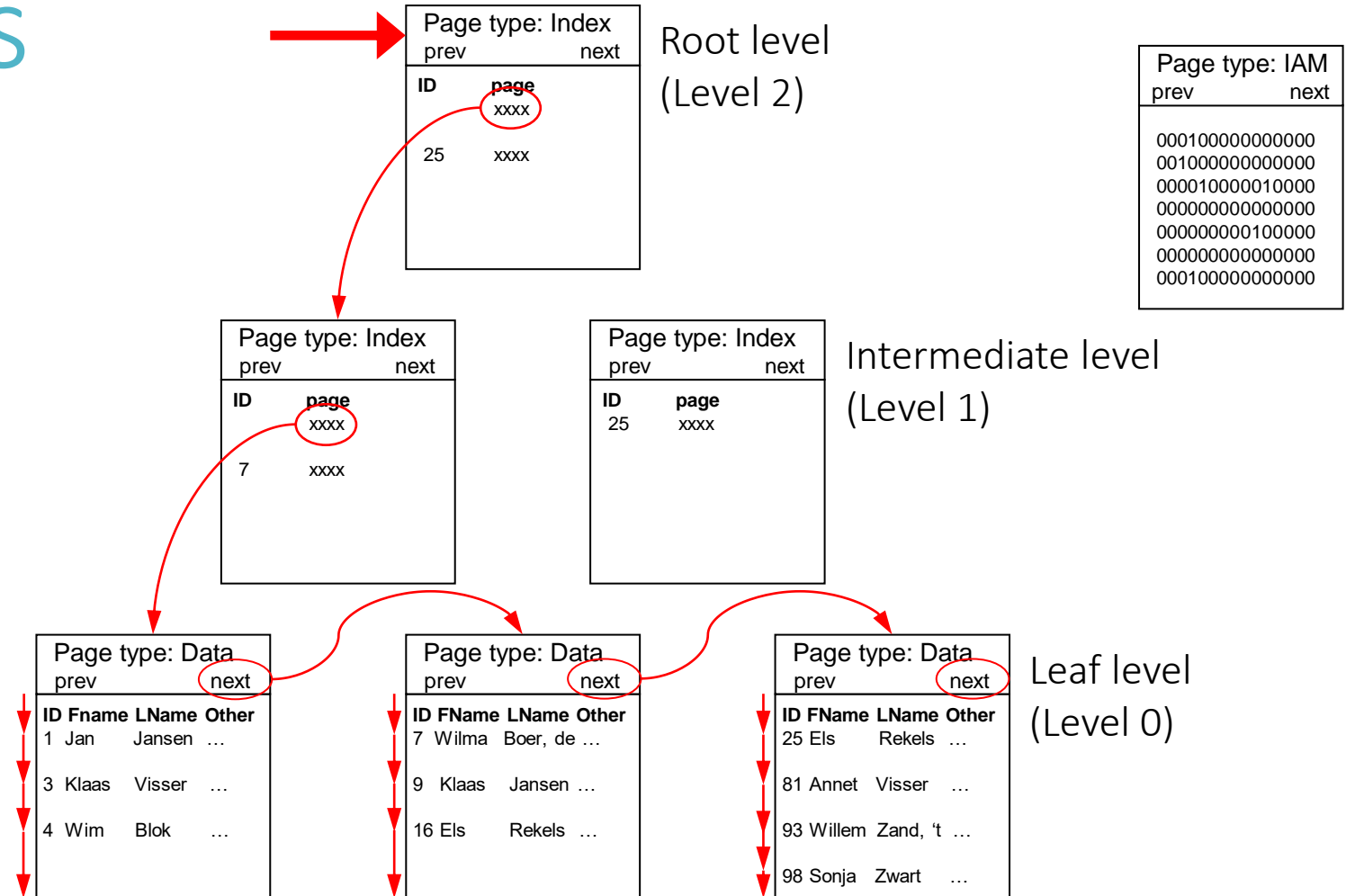
- Memory-optimized Hash



Clustered Index Scan (Clustered)

Scan operators

Clustered Index Scan
Ordered forward

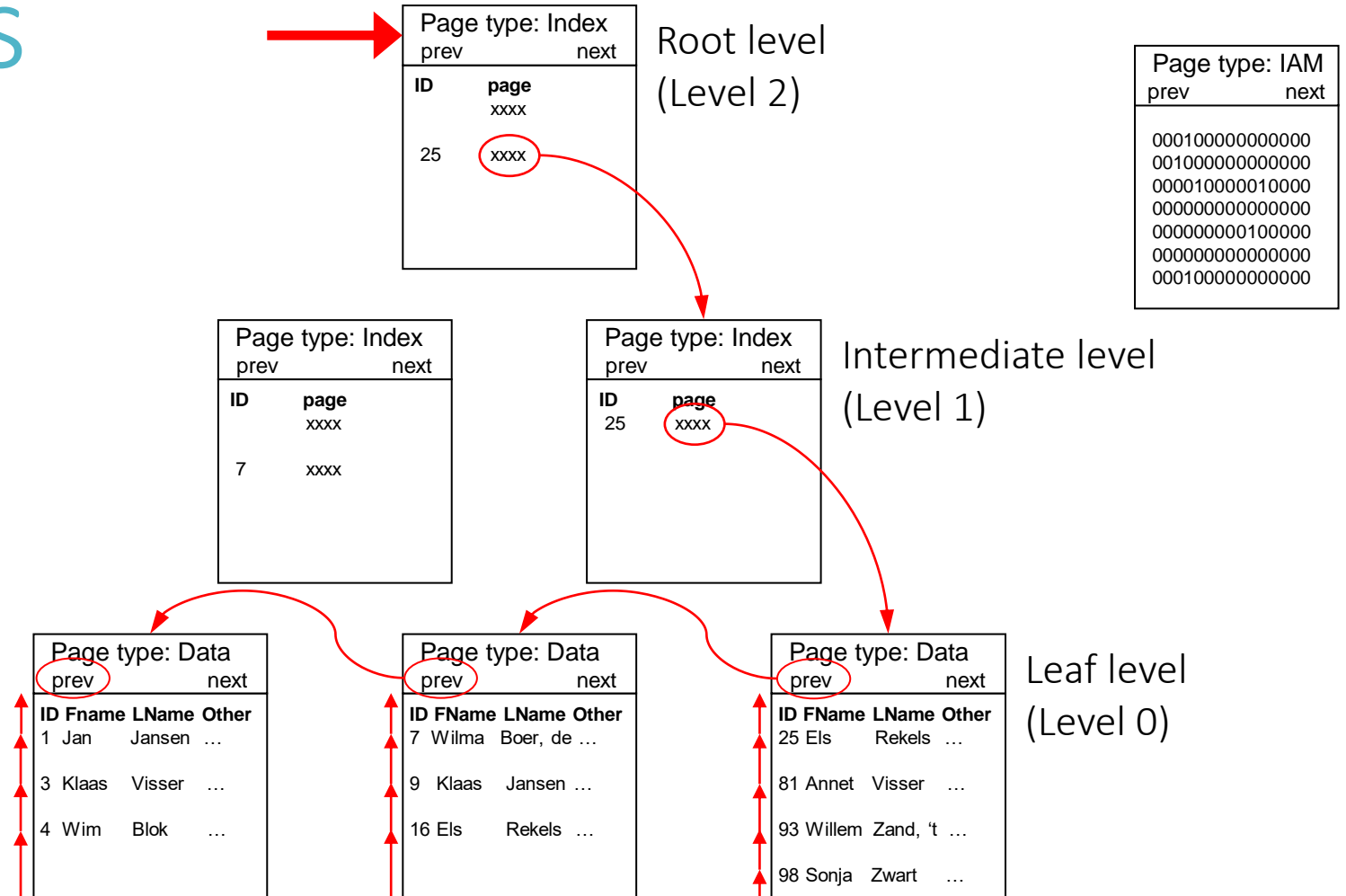


Scan operators

Clustered Index Scan

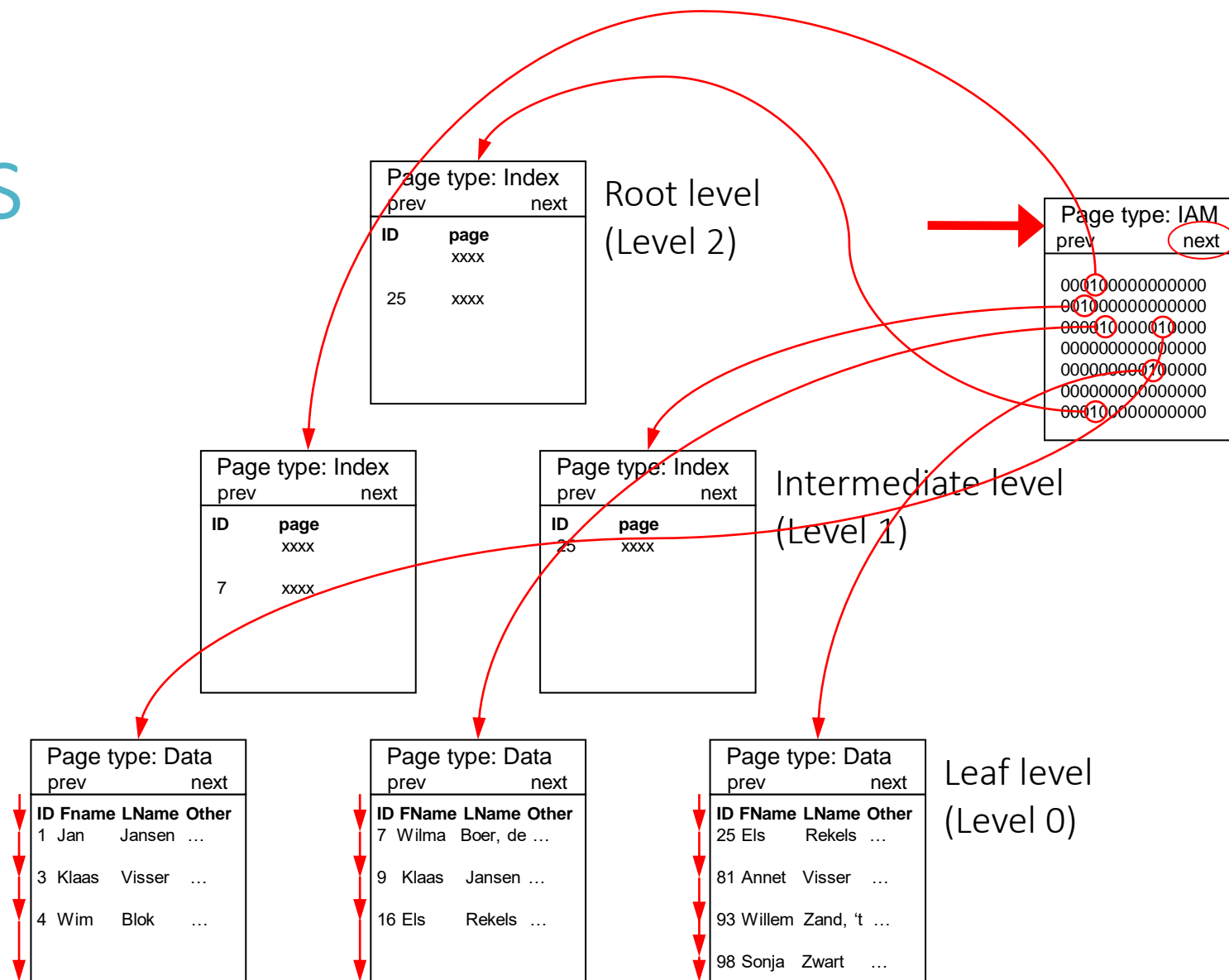
Ordered forward

Ordered backward



Scan operators

Clustered Index Scan
Ordered forward
Ordered backward
Unordered (IAM scan)



Scan operators

Clustered Index Scan

Actually same as (nonclustered) Index Scan

Reads (all) data from a ***clustered*** index

Can access ALL data

No need for Lookup to get additional data

Needs to read more pages



Clustered Index Scan (Clustered)

Summary

Scan operators

Table Scan

- IAM scan only

Index Scan / Clustered Index Scan

- Ordered scan or IAM scan

Predicate

- Pushed down to eliminate rows early

Next chapters

Chapter 3: Seek operators

- Index Seek

- Clustered Index Seek

Chapter 4: Lookup operators

Chapter 5: Special scans