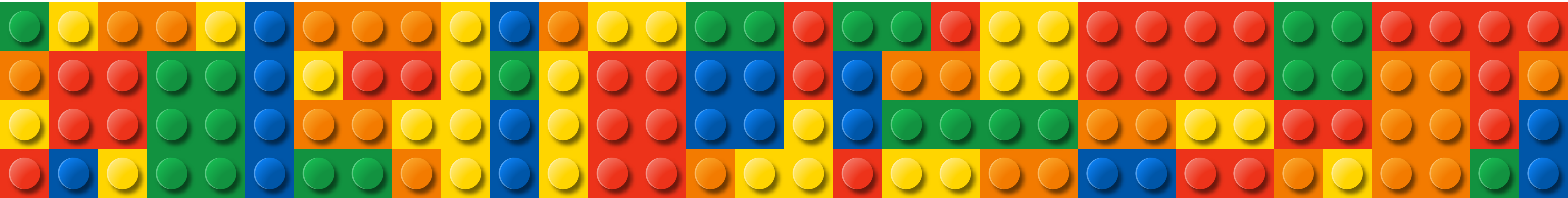
Building Better

SQL Server Databases



Who is this guy?

Eric Cobb

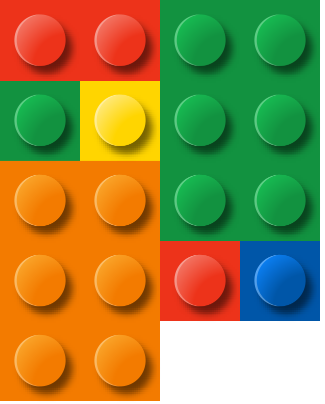
- Started in IT in 1999 as a "webmaster“
- Developer for 14 years
- Microsoft Certified Solutions Expert (MCSE)
  - Data Platform
  - Data Management and Analytics

Blog: http://www.sqlnuggets.com

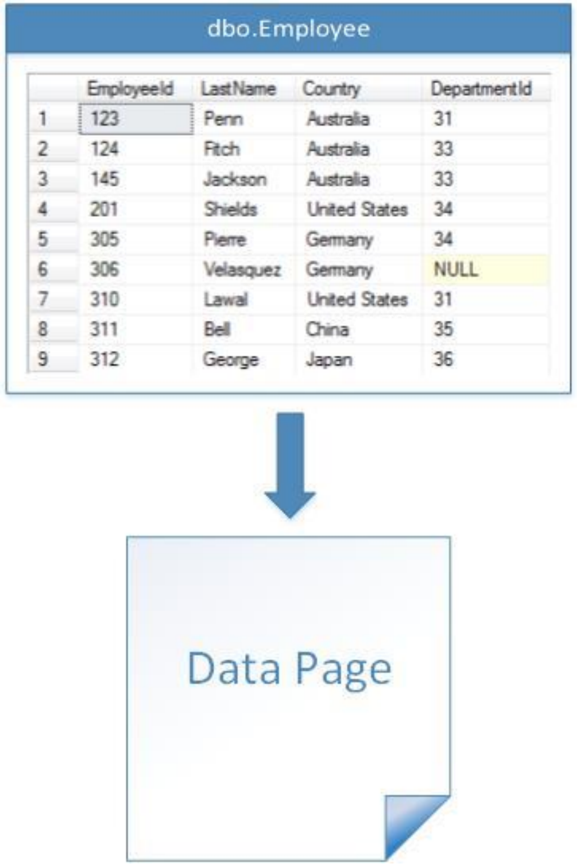
Twitter: @sqlnugg
@cfgears

A PEEK UNDER THE HOOD OF SQL SERVER

A BRIEF OVERVIEW OF HOW SQL SERVER STORES AND RETRIEVES DATA



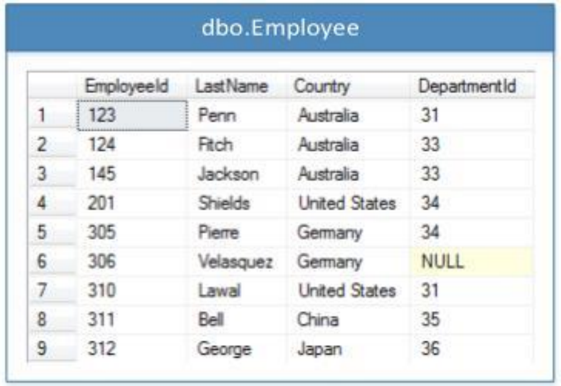
A Peek Under The Hood



dbo.Employee

	EmployeeId	LastName	Country	DepartmentId
1	123	Penn	Australia	31
2	124	Fitch	Australia	33
3	145	Jackson	Australia	33
4	201	Shields	United States	34
5	305	Pierre	Germany	34
6	306	Velasquez	Germany	NULL
7	310	Lawal	United States	31
8	311	Bell	China	35
9	312	George	Japan	36

A Peek Under The Hood



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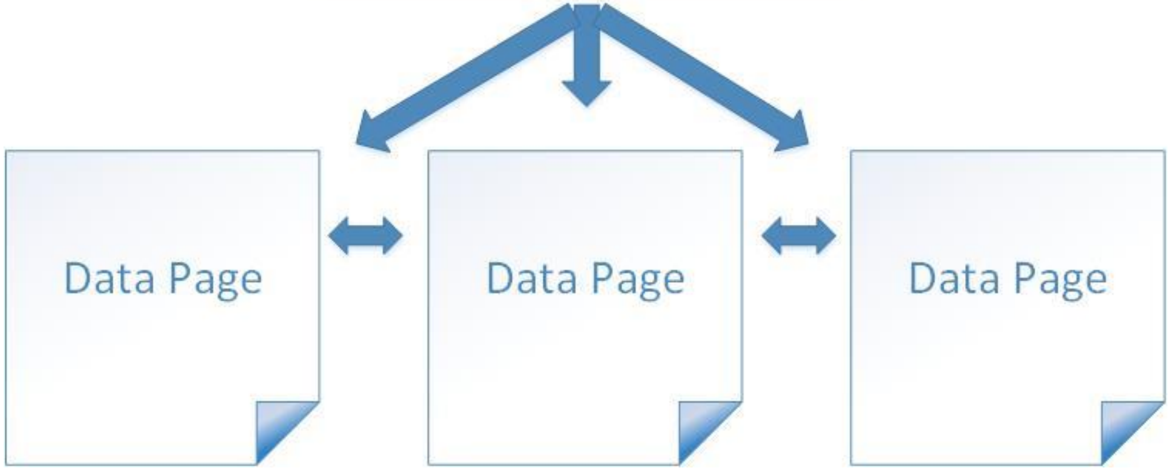
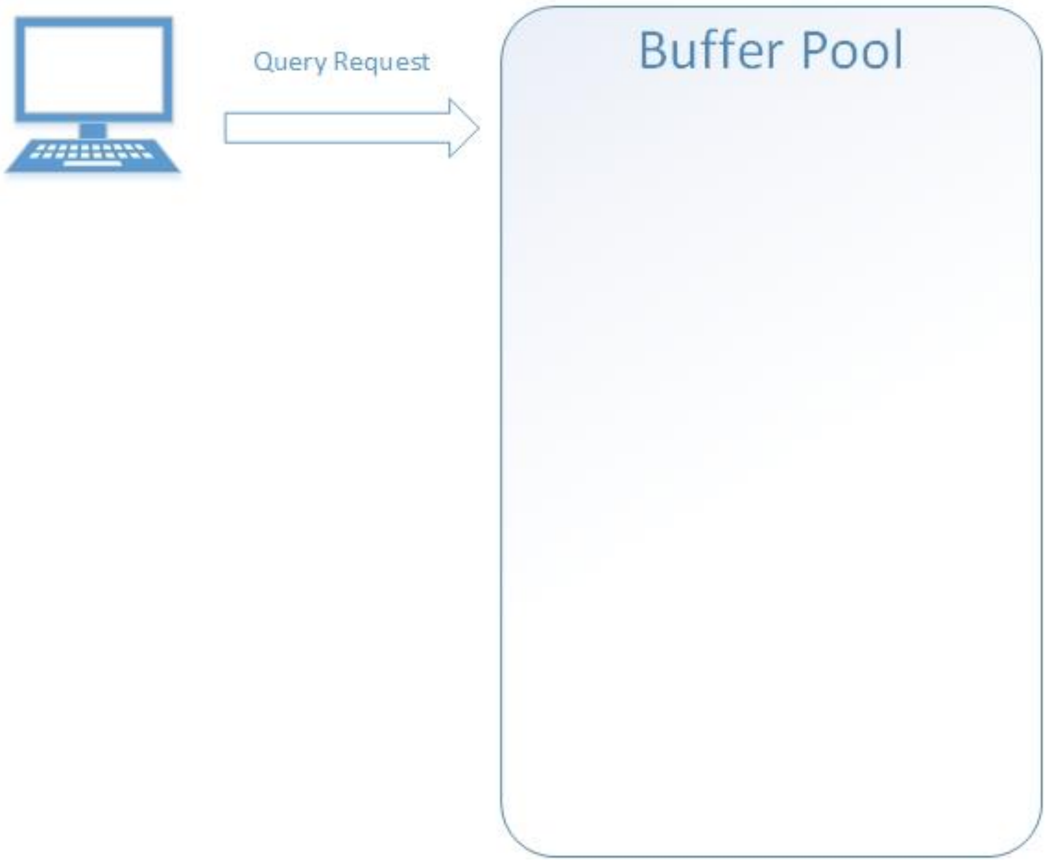
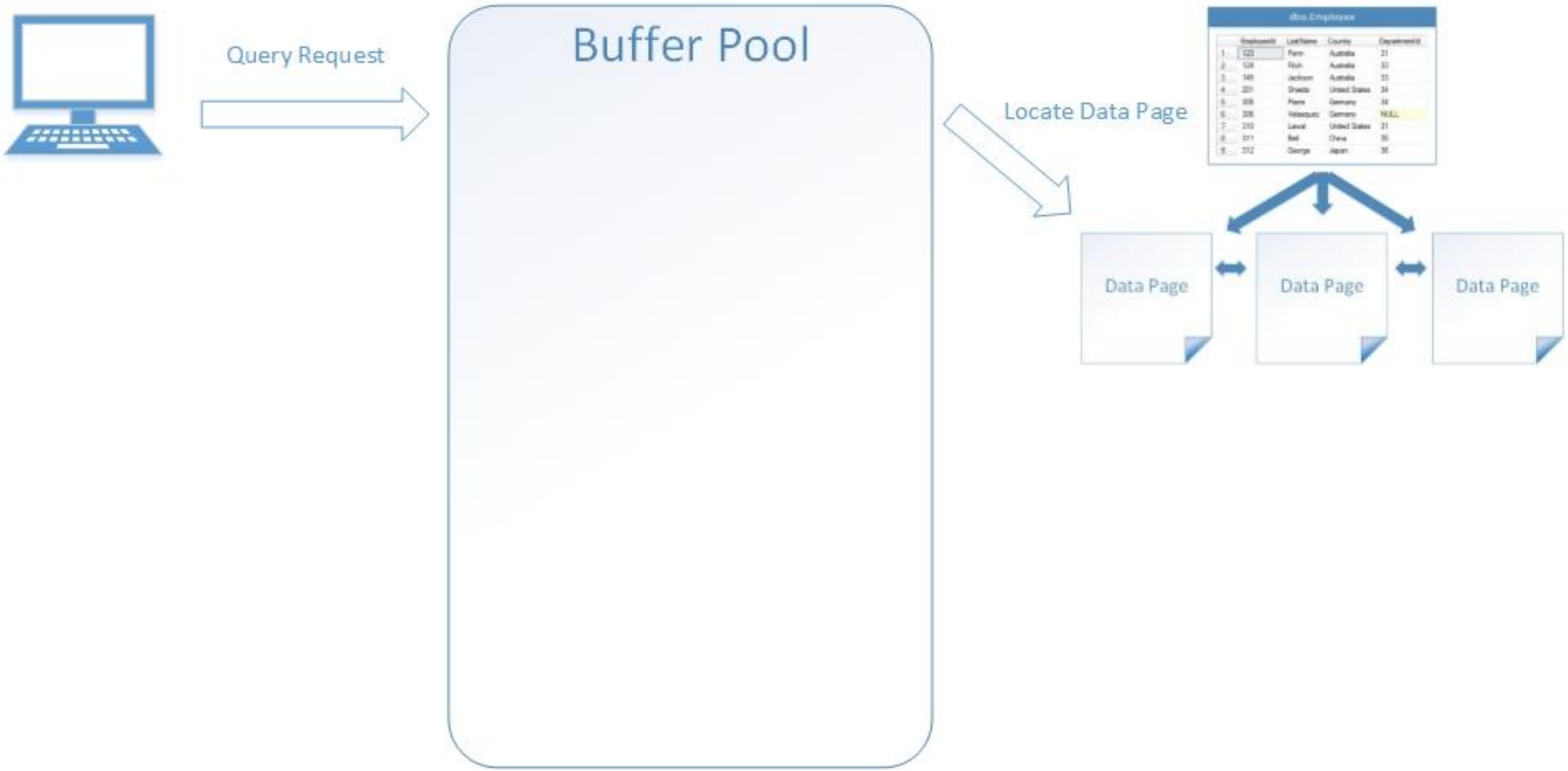


A Peek Under The Hood



A Peek Under The Hood



	EmployeeId	LastName	Country	DepartmentId
1	123	Penn	Australia	31
2	124	Rich	Australia	33
3	149	Jackson	Australia	33
4	201	Shields	United States	34
5	305	Pierre	Germany	34
6	306	Velasquez	Germany	NULL
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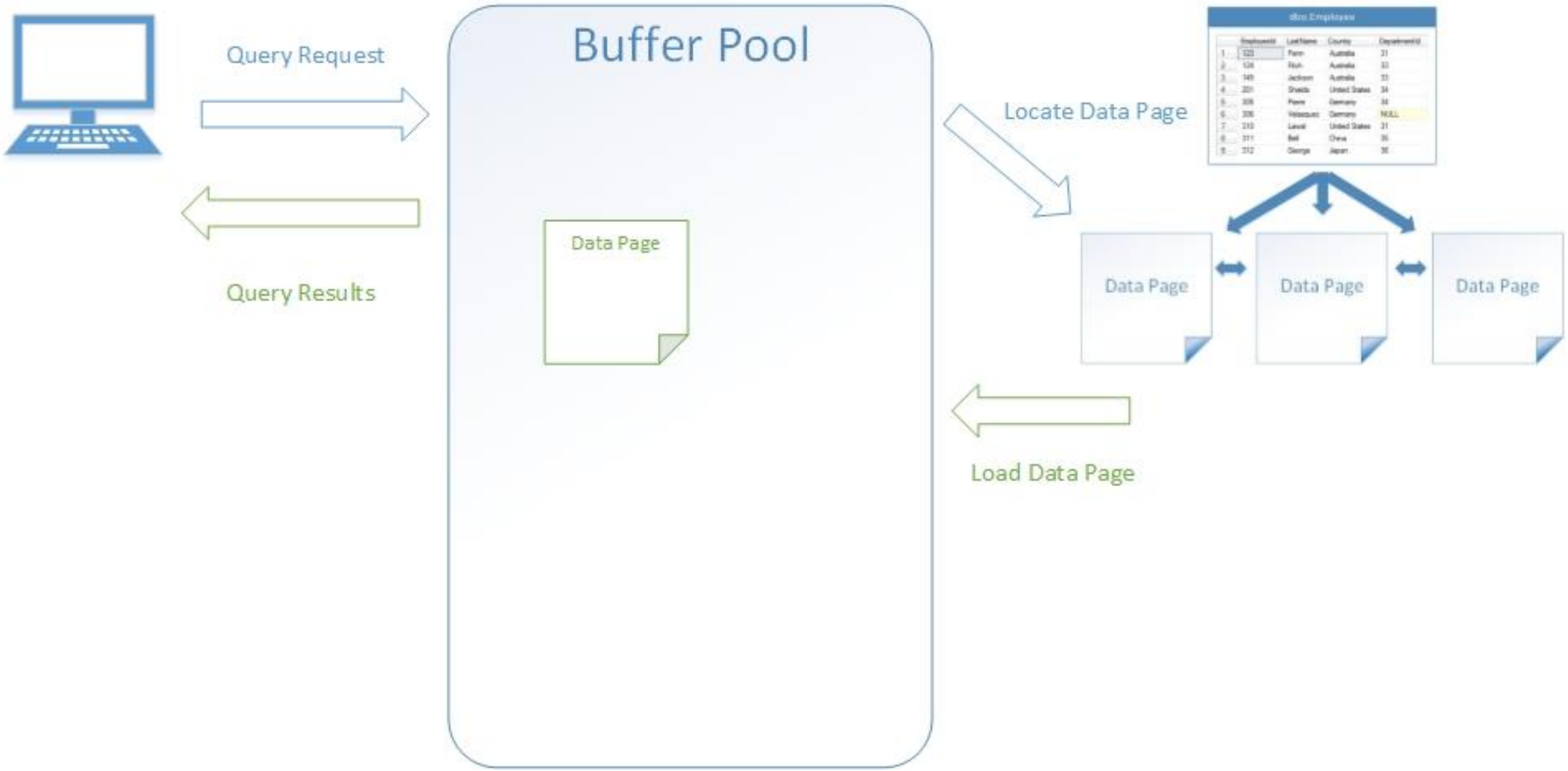
A Peek Under The Hood



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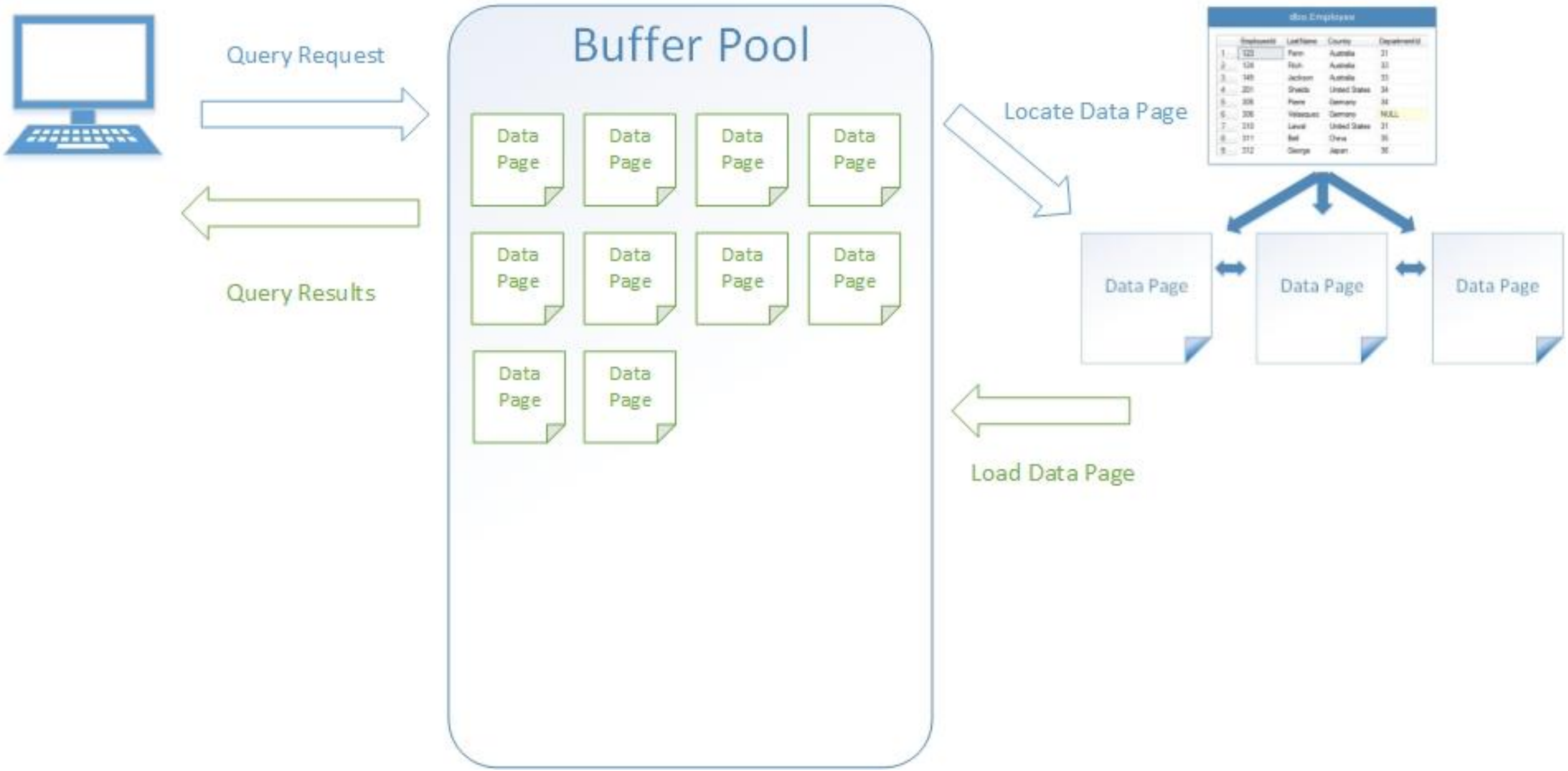
A Peek Under The Hood



dbo.Employee

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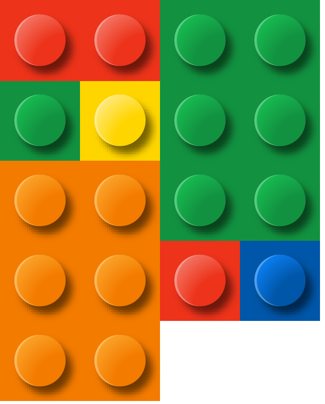
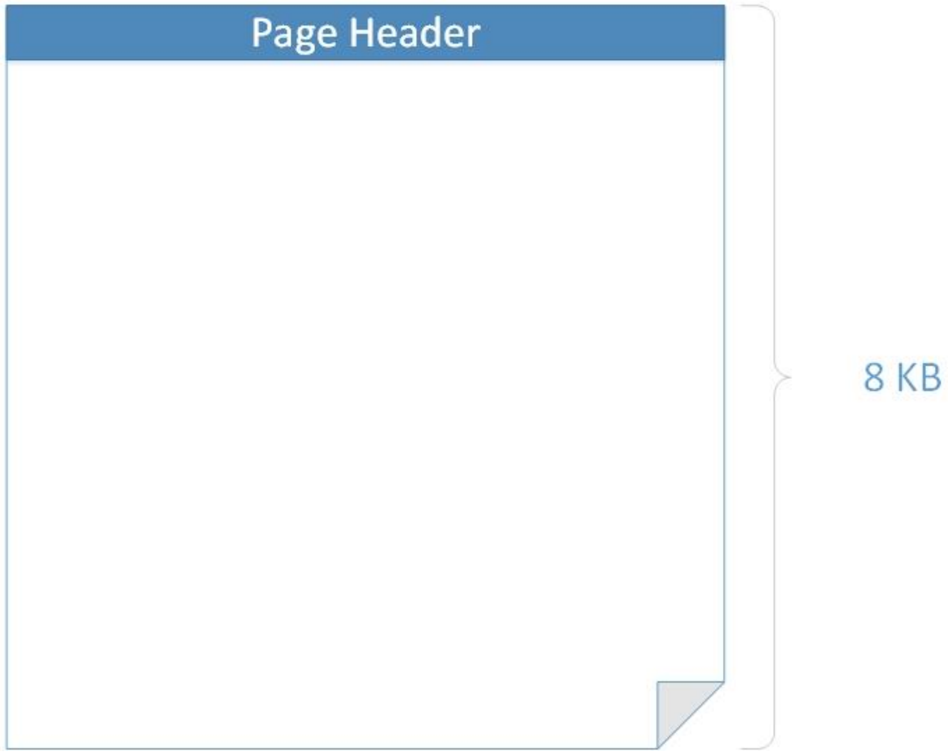


A Peek Under The Hood

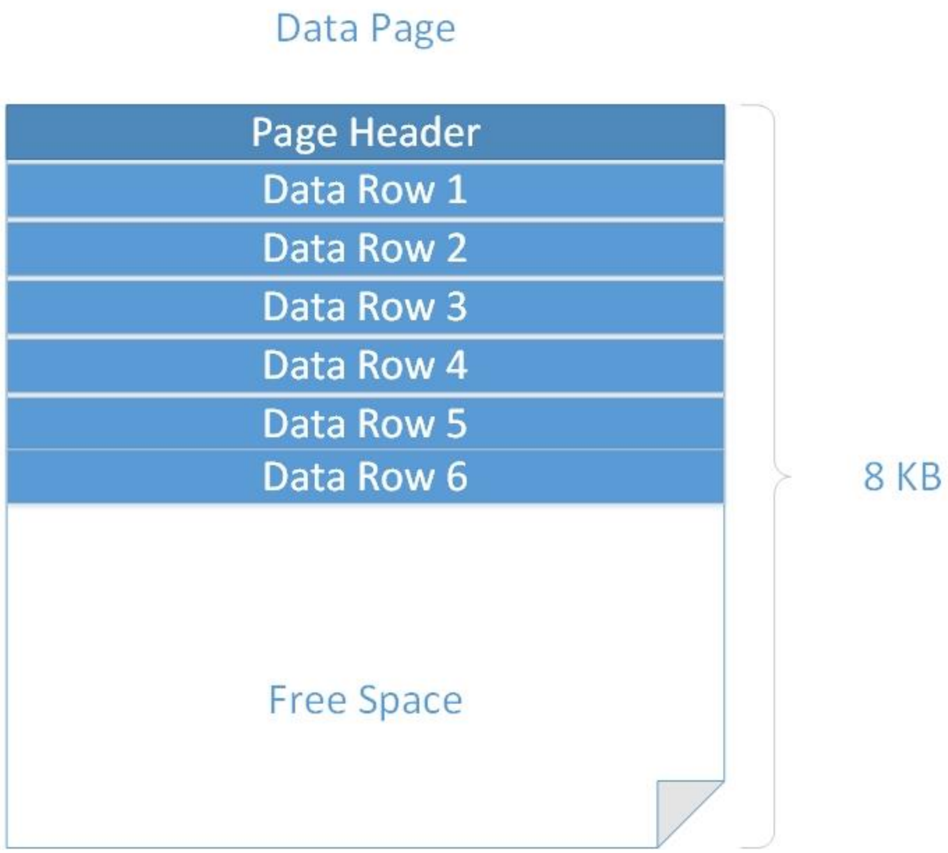
Storing Data in Pages

Data Page



A Peek Under The Hood

Storing Data in Pages



Data Page

Page Header

Data Row 1

Data Row 2

Data Row 3

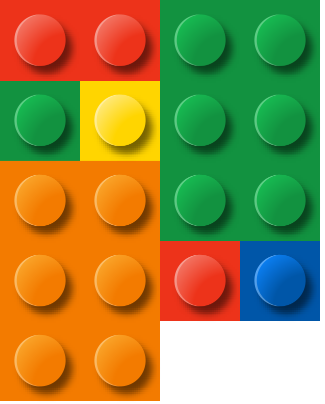
Data Row 4

Data Row 5

Data Row 6

Free Space

8 KB



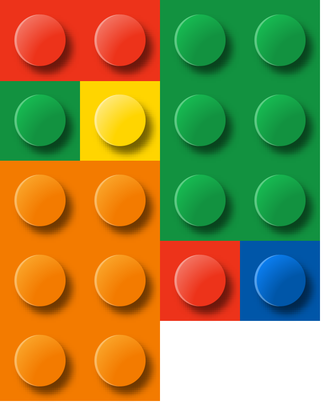
A Peek Under The Hood

Storing Data in Pages

How is the data stored in a Page?

- Unordered (Heap)
  - Query optimizer reads all the rows in the table (table scan), to find the rows that meet the criteria of a query
  - A table scan generates many disk I/O operations and can be resource intensive
  - Heaps should generally be avoided, although can be useful when inserting large amounts of data in ETL/Bulk processes

- Ordered (Clustered Index)
  - Tells SQL Server how to physically sort the records on disk
  - The most important index you can apply to a table
  - Data pages are ordered, for faster data retrieval
  - There is only ever 1 clustered index on a table



A Peek Under The Hood

Storing Data in Pages

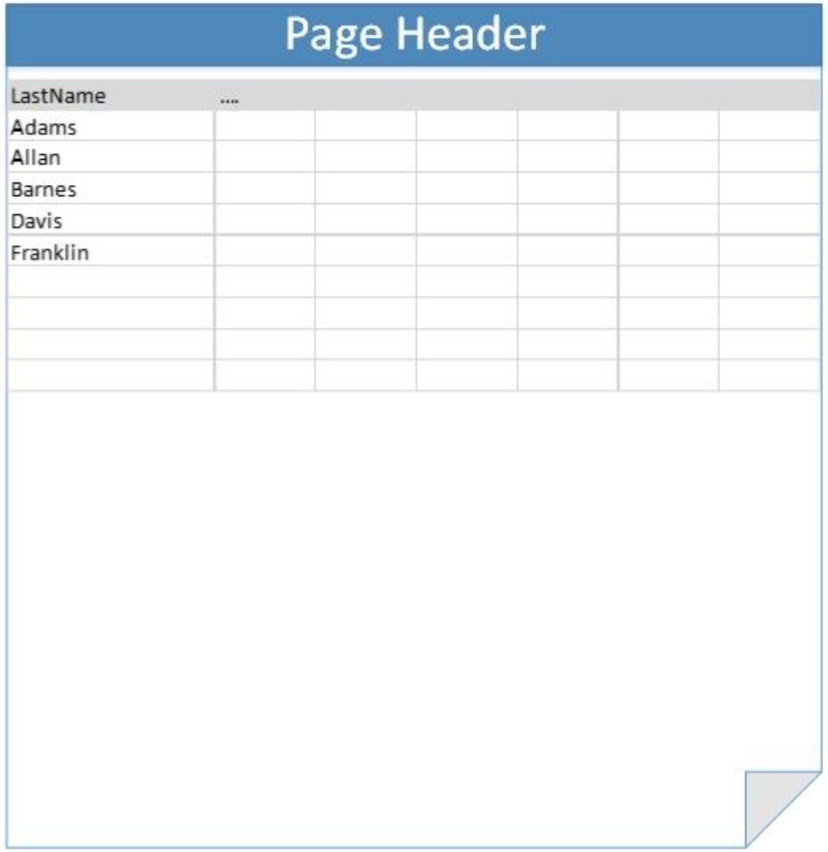
How do I create Clustered Indexes?

- Primary Key = Clustered Index (usually)
  - SQL Server automatically creates a clustered index on your Primary Key column if a clustered index does not already exist on the table
  - If you do not want the Primary Key to be your Clustered Index, you can create your Clustered Index on a different column

- Clustered Index (Primary Key) Tips:
  - Use a naturally occurring incremental value
  - Keep as small and narrow as possible (single columns are preferred)
  - Avoid using character data types for a Clustered Index

A Peek Under The Hood

Storing Data in Pages

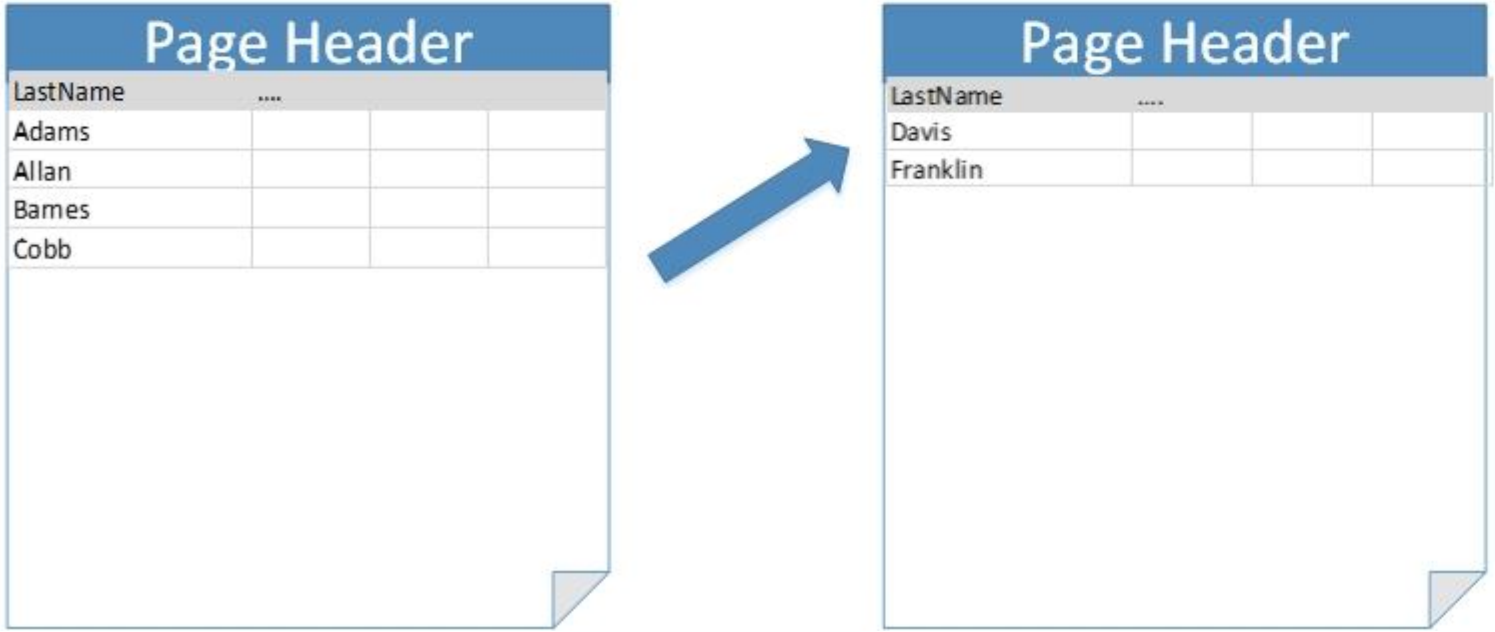


Page Header

LastName	....					
Adams						
Allan						
Barnes						
Davis						
Franklin						

A Peek Under The Hood

Page Splits



Page Header

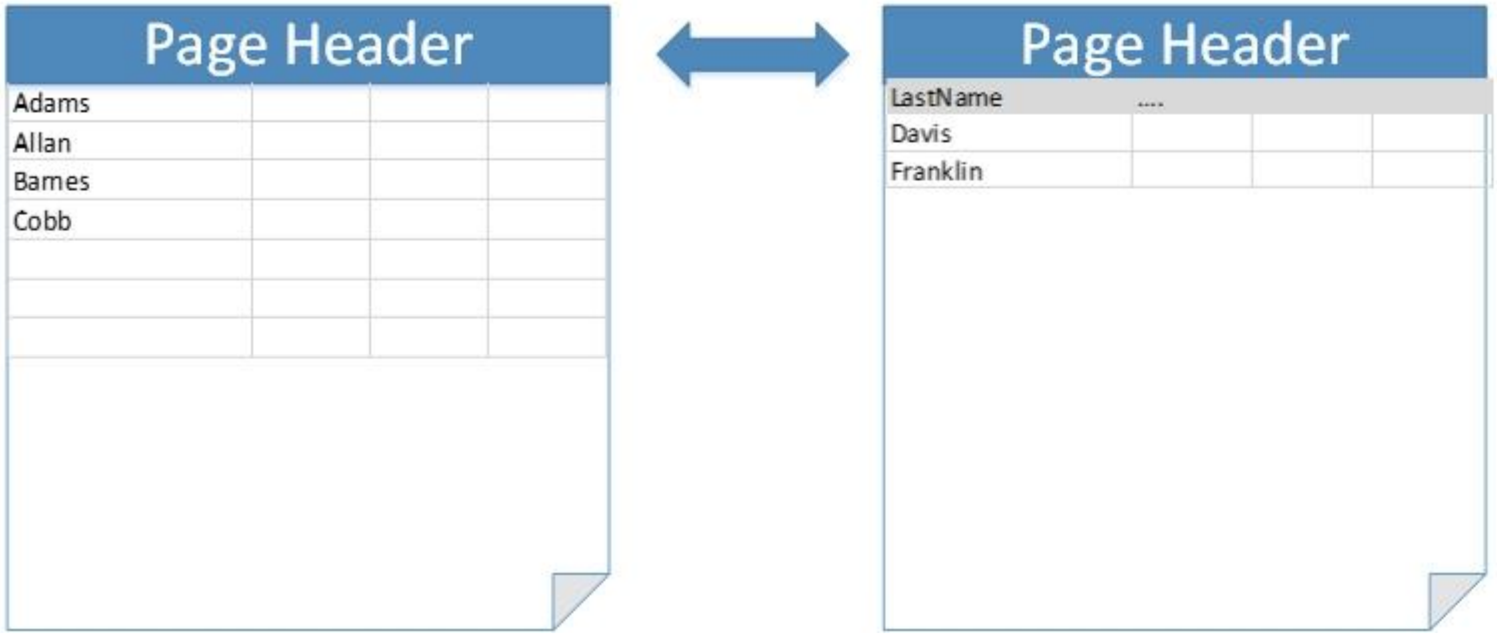
LastName	....		
Adams			
Allan			
Bames			
Cobb			

Page Header

LastName	....		
Davis			
Franklin			

A Peek Under The Hood

Page Splits



Page Header

Adams

Allan

Barnes

Cobb

Page Header

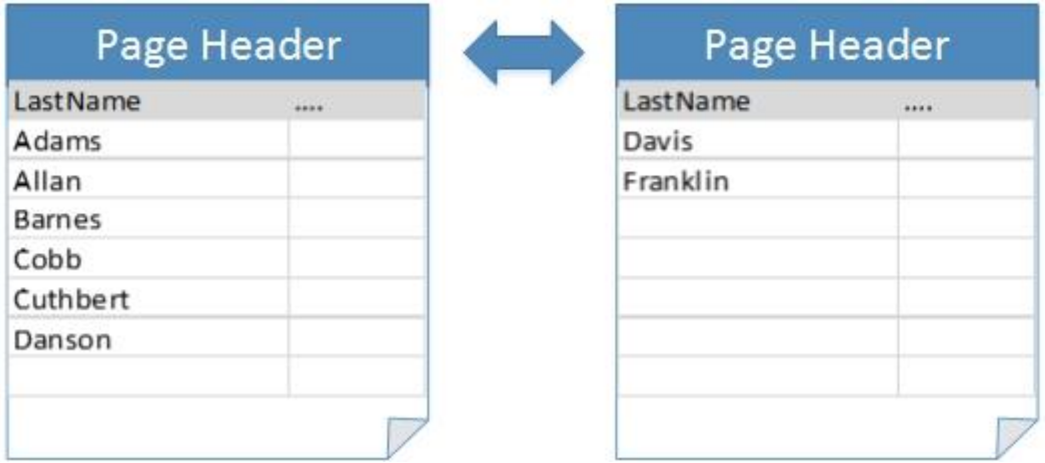
LastName ....

Davis

Franklin

A Peek Under The Hood

Page Splits



Page Header

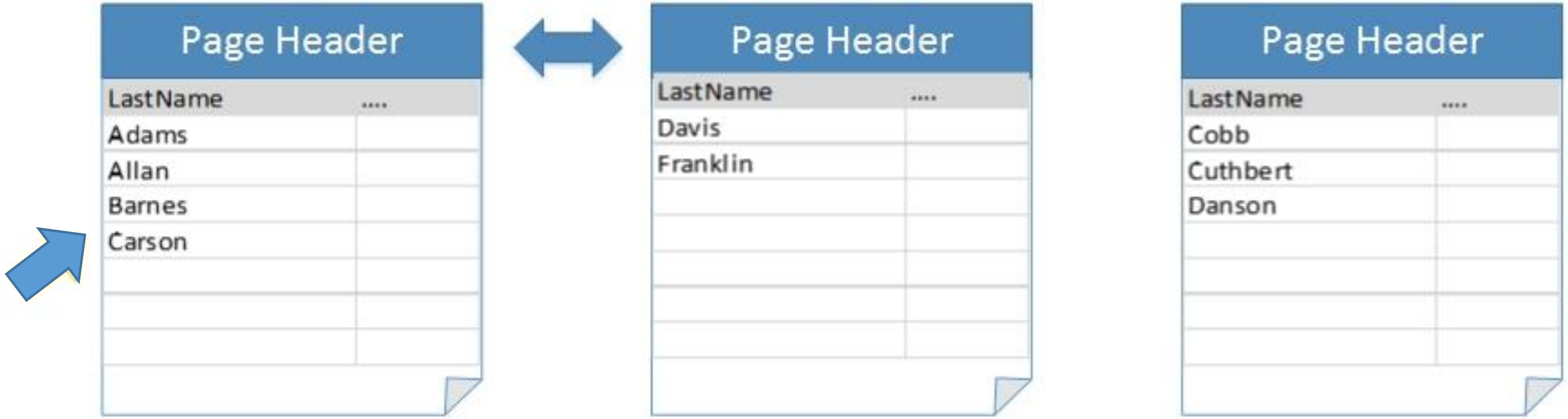
LastName	....
Adams	
Allan	
Barnes	
Cobb	
Cuthbert	
Danson	

Page Header

LastName	....
Davis	
Franklin	

A Peek Under The Hood

Page Splits



Page Header

LastName	....
Adams	
Allan	
Barnes	
Carson	

Page Header

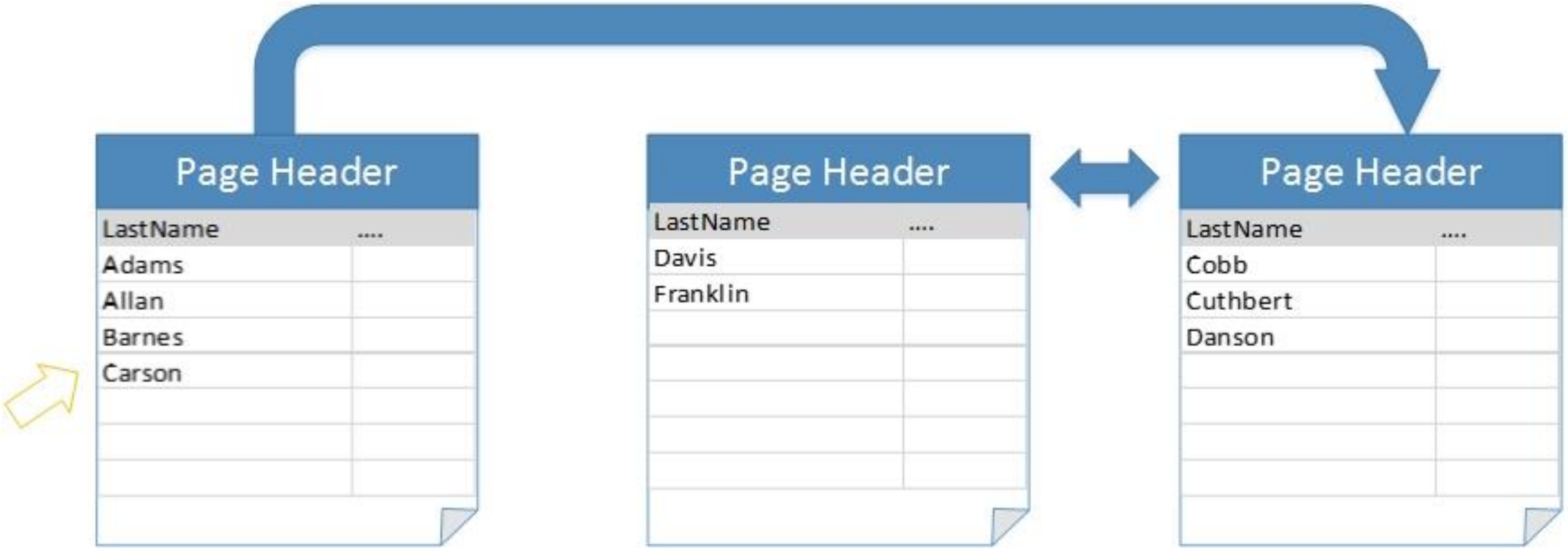
LastName	....
Davis	
Franklin	

Page Header

LastName	....
Cobb	
Cuthbert	
Danson	

A Peek Under The Hood

Page Splits



Page Header

LastName	....
Adams	
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Page Header

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Davis	
Franklin	

Page Header

LastName	....
Cobb	
Cuthbert	
Danson	

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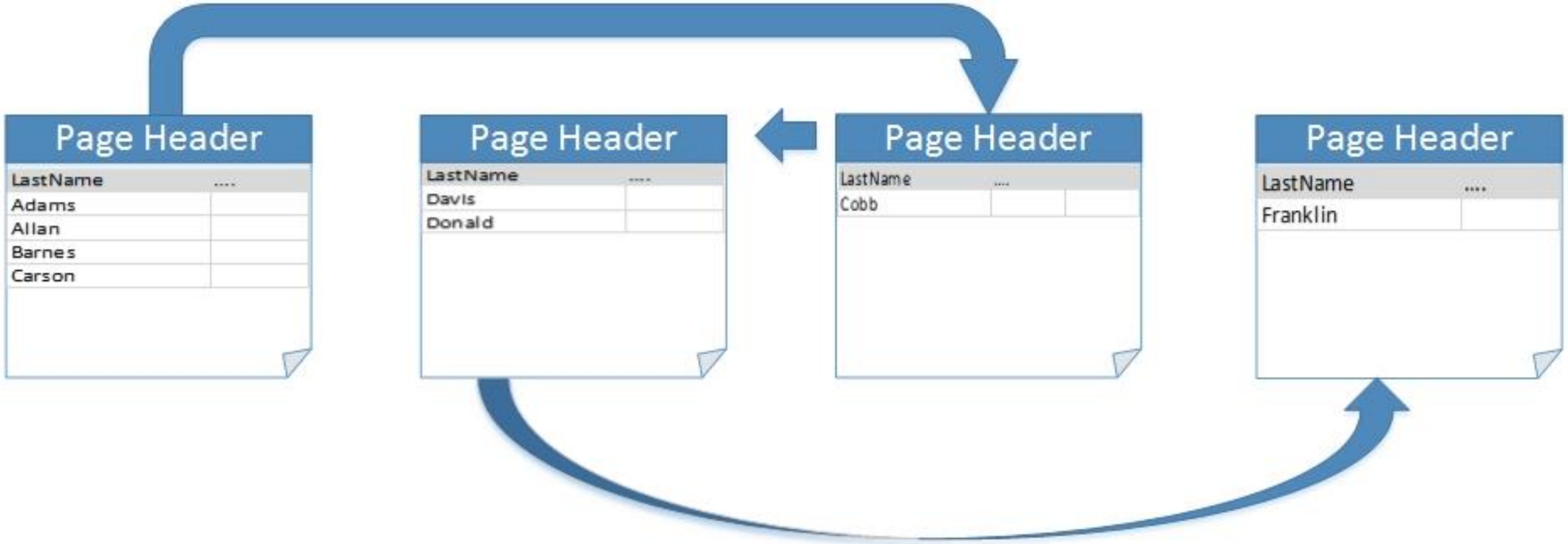
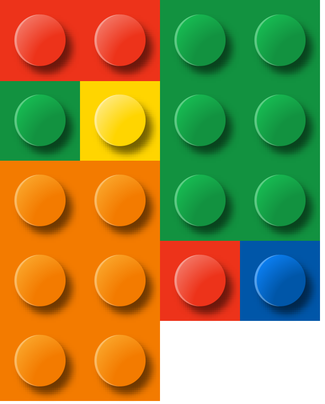




A Peek Under The Hood

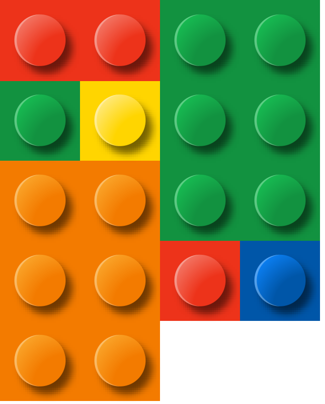
Page Splits

How can we avoid Page Splits?

- You can’t avoid them, but you can minimize them with good table designs
  - Choose a good Clustered Index (Primary Key) for your table
    - Should be unique, narrow, static, and incremental
    - Good Clustered Index examples:
      - A numeric IDENTITY column (smallint, int, bigint)
      - A composite key of date and identity – in that order (date, identity)
      - A pseudo sequential GUID (using the NEWSEQUENTIALID() function in SQL Server)
        - Not recommended, but the best you can do if you absolutely have to use a GUID
    - Clustered Indexes to avoid:
      - Unique Identifier (GUID) generated from an application or with SQL Server’s NEWID() function
      - Character columns (CHAR, VARCHAR, NVARCHAR, etc…)
      - Combination of multiple character columns (LastName, FirstName, MiddlieInitial)
      - Columns that undergo frequent changes

BUILDING BETTER TABLES

DESIGNING TABLES WITH EFFECIENCY IN MIND

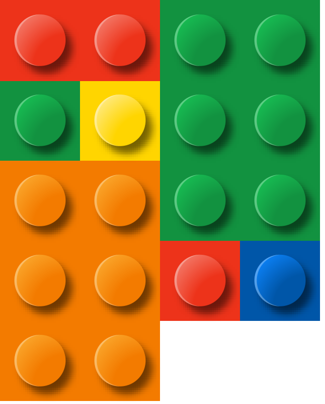


Building Better Tables

Using The Right Data Types

Data Types Are Important!

- Choose your table column data types wisely
  - They can affect the performance of your database as it grows
- Know your data, use the appropriate data type for the data you are storing
  - The more accurate your data type is, the more efficiently SQL Server can handle your data.
- Use the smallest data type possible (within reason)
  - The smaller the column, the less data you have to store and retrieve, which leads to faster queries
  - The longest city name in the U.S. is *Rancho Santa Margarita, California*; it’s 22 chars, don’t use VARCHAR(MAX)
  - The true name of Bangkok, Thailand is: *Krungthepmahanakhon Amonrattanakosin Mahintharayutthaya Mahadilokphop Noppharatratchathaniburirom Udomratchaniwetmahasathan Amonphimanawatansathit Sakkathattiyawitsanukamprasit*. (176 chars)



Building Better Tables

Using The Right Data Types

CHAR vs VARCHAR

- CHAR(*n*): Fixed-length string data, and the storage size is *n* bytes.
- VARCHAR(*n*): Variable-length string data, the storage size is the actual length of the data entered + 2 bytes.
- If you know the length of the string will always be the same, use CHAR to avoid the additional 2 bytes added to every VARCHAR record

NCHAR vs NVARCHAR

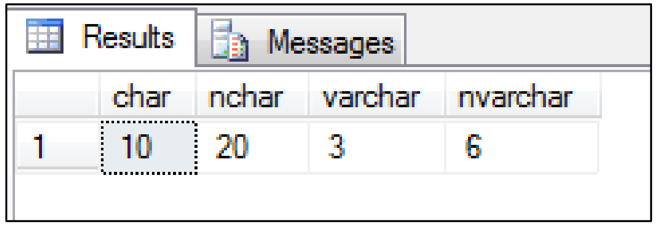
- If you have databases that support multiple languages, consider using the Unicode NCHAR or NVARCHAR data types to minimize character conversion issues
- Carefully evaluate whether you really need NCHAR or NVARCHAR
- NCHAR(*n*): Fixed-length Unicode string data, and the storage size is two times *n* bytes
- NVARCHAR(*n*): Variable-length Unicode string data, and the storage size, in bytes, is two times the actual length of data entered + 2 bytes

Building Better Tables

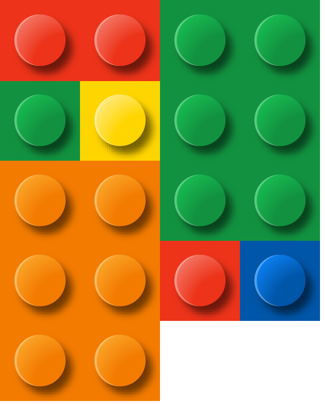
Using The Right Data Types

```sql
DECLARE
  @var1 CHAR(10) = 'abc',
  @var2 NCHAR(10) = 'abc',
  @var3 VARCHAR(10) = 'abc',
  @var4 NVARCHAR(10) = 'abc'

SELECT
  DATALENGTH(@var1) AS [char],
  DATALENGTH(@var2) AS [nchar],
  DATALENGTH(@var3) AS [varchar],
  DATALENGTH(@var4) AS [nvarchar]
```



	char	nchar	varchar	nvarchar
1	10	20	3	6



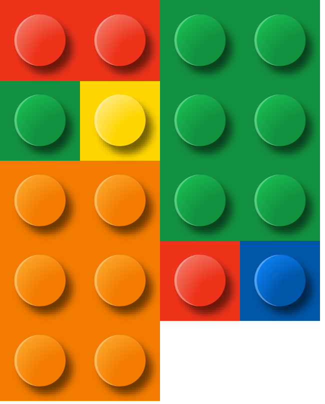
Building Better Tables

Using The Right Data Types

Numeric Data Types

Data Type	Range	Storage
BIGINT	-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807 (Quintillion)	8 Bytes
INT	-2,147,483,648 to 2,147,483,647 (Billion)	4 Bytes
SMALLINT	-32,768 to 32,767	2 Bytes
TINYINT	0 to 255	1 Byte

- Choose the appropriate Data Type for the range of numbers you will be storing



Building Better Tables

Using The Right Data Types

Date and Time Data Types

Data Type	Range	Storage
TIME	00:00:00.0000000 through 23:59:59.9999999	3 - 5 Bytes
DATE	0001-01-01 through 9999-12-31	3 Bytes
SMALLDATETIME	1900-01-01 through 2079-06-06	4 Bytes
DATETIME	1753-01-01 through 9999-12-31	8 Bytes

- Choose the appropriate Data Type for the range of dates you will be storing.

Building Better Tables

Using The Right Data Types

Why does this matter?

Performance

- Smaller data sets = faster queries
- Optimized data pages = optimized resource usage (Remember the Buffer Pool?)
    - Saving 32 bytes in 1 table saved 30.5GB when the table reached 1 Billion rows*
        - * Taken from Kimberly Tripp's Pluralsight Course: SQL Server: Why Physical Database Design Matters

Scalability

- Helps you build better, more scalable applications
    - Don't think in terms of 1 row of data, think about millions
- Scalable applications do not happen by accident

Time spent on proper database design is well worth it

- Minor changes can have a major impact
    - It can take more effort to rebuild an existing application than it does to originally design one correctly

T-SQL TIPS

A LOOK AT SOME T-SQL HABITS THAT CAN HURT QUERY PERFORMANCE

T-SQL Tips

NOLOCK

Allows a Dirty Read

- Does not issue locks to prevent other transactions from modifying data being read
- Allows other transactions to modify the data while you’re trying to read it
- Data returned to the SELECT statement may or may not actually exist in the database, and in some cases it may cause a query to return the same row multiple times or even skip rows

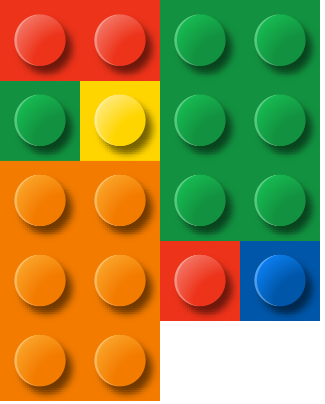
But NOLOCK makes my query faster!

- It makes your query faster because it is ignoring the safeguards put in place to ensure that your query is returning accurate data

When should I use NOLOCK?

- If your query doesn’t necessarily need to return precise figures, and can tolerate some inconsistencies
- If you are querying data that does not get modified often

If you need 100% accurate results from your query, do not use NOLOCK



T-SQL Tips

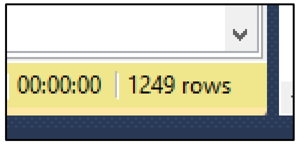
Stored Procedures

Do not name your stored procedures with the “sp_” prefix!

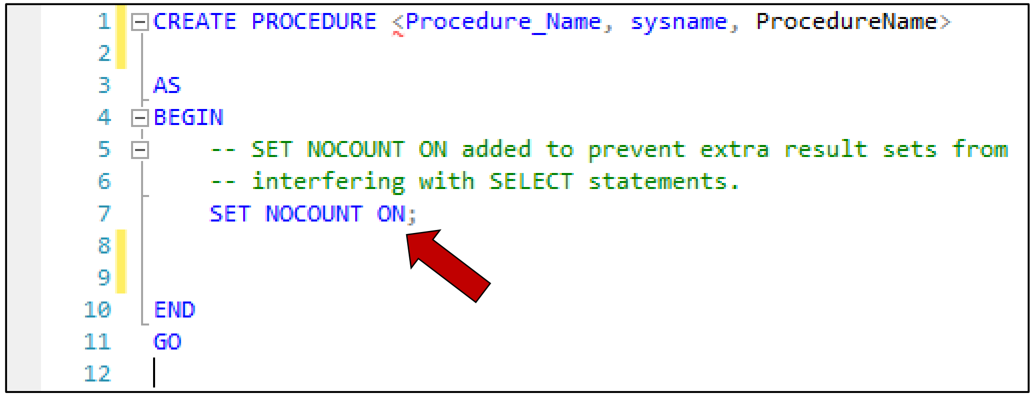
- This is reserved for system stored procedures
- SQL Server first checks the Master database for these procedures

Use SET NOCOUNT

- Can improve stored procedure performance
- Turns off the messages that SQL Server sends back to the client after each T-SQL statement is executed



```
00:00:00 | 1249 rows
```

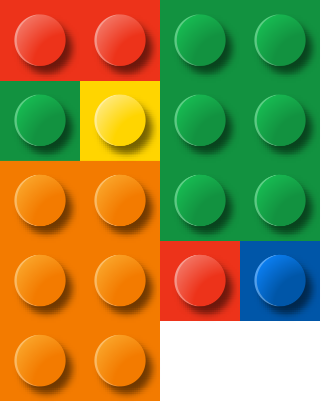


```
CREATE PROCEDURE <Procedure_Name, sysname, ProcedureName>

AS
BEGIN
    -- SET NOCOUNT ON added to prevent extra result sets from
    -- interfering with SELECT statements.
    SET NOCOUNT ON;


END
GO

```



T-SQL Tips

Why Is My Query Slow?

- Using ORDER BY or DISTINCT
  - Could be forcing SQL Server to write your results to TempDB (especially with large result sets)
  - Try to sort/filter the data in your application instead
- Using Scalar Functions in SELECT statements, WHERE clauses, or JOINS
  - Forces row-by-row operations; Forces single-threaded execution plan
- Cursors and Loops in your T-SQL statements
  - Forces row-by-row operations
- Use of SELECT *
  - Can cause the optimizer to ignore indexes on the table, forcing a full table scan
  - Returning unnecessary columns in large result sets takes more resources
- Data Type Mismatches (aka Implicit Conversions)
  - Variables used in WHERE clauses should match the data type of the columns they’re compared with
  - Columns used in JOIN conditions should have matching data types

Questions?

Thank You!

Eric Cobb

http://www.sqlnuggets.com