Introduction to Databases

How Do RDBMS Work? Managing DBs Using IDEs

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Questions

sli.do

#csharp-db

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Data Management

When Do We Need a Database?

Storage vs. Management (1)

- Conventional Data Storage
  - Notes
  - Receipts

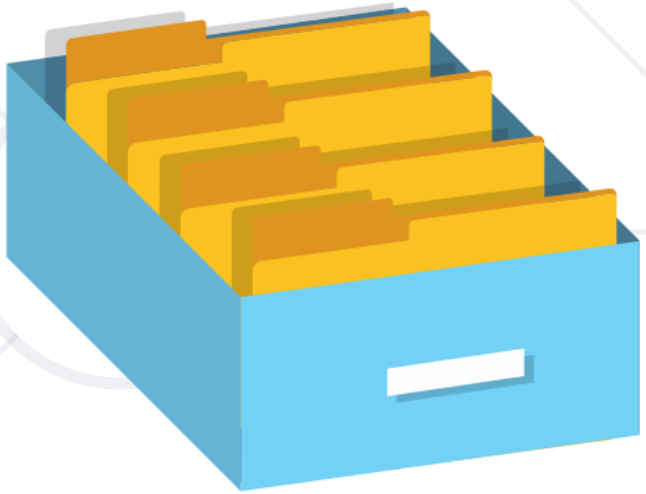
Storage vs. Management (2)

- We can group related pieces of data into separate columns

Order#	Date	Customer	Product	S/N	Unit Price	Qty	Total
315	07/16/2016	David Rivers	Oil Pump	OP147-0623	69.90	1	69.90

Storage vs. Management (3)

- Storing data is **not** the primary reason to use a Database
- Flat storage **eventually** runs into **issues** with
  - Size
  - Ease of updating
  - Searching
  - Concurrency
  - Security
  - Consistency



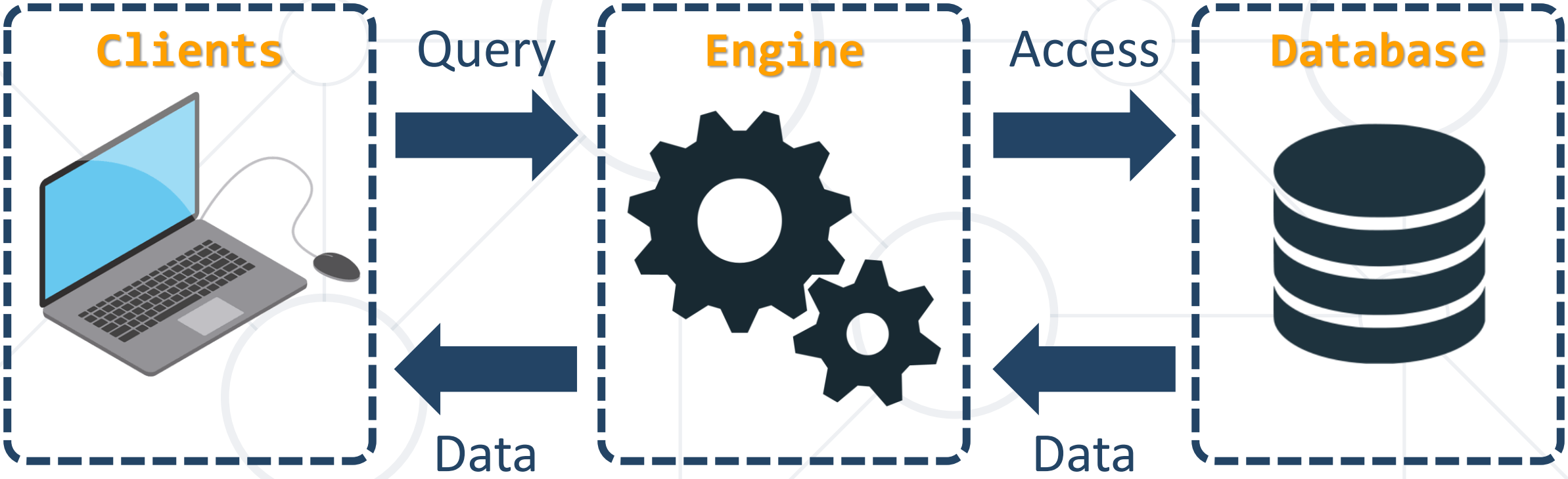
Databases and RDBMS

- A database is an **organized** collection of information
  - It imposes **rules** on the contained data
  - Relational storage first proposed by **Edgar Codd** in 1970
- A **R**elational **D**ata **B**ase **M**anagement **S**ystem provides tools to **manage** the database
  - It **parses requests** from the user and takes the **appropriate** action
  - The user doesn't have direct access to the stored data

Database Engines

Database Engine Flow

- SQL Server uses the Client-Server Model



Download Clients & Servers

- Download **SQL Server Express** Edition from Microsoft

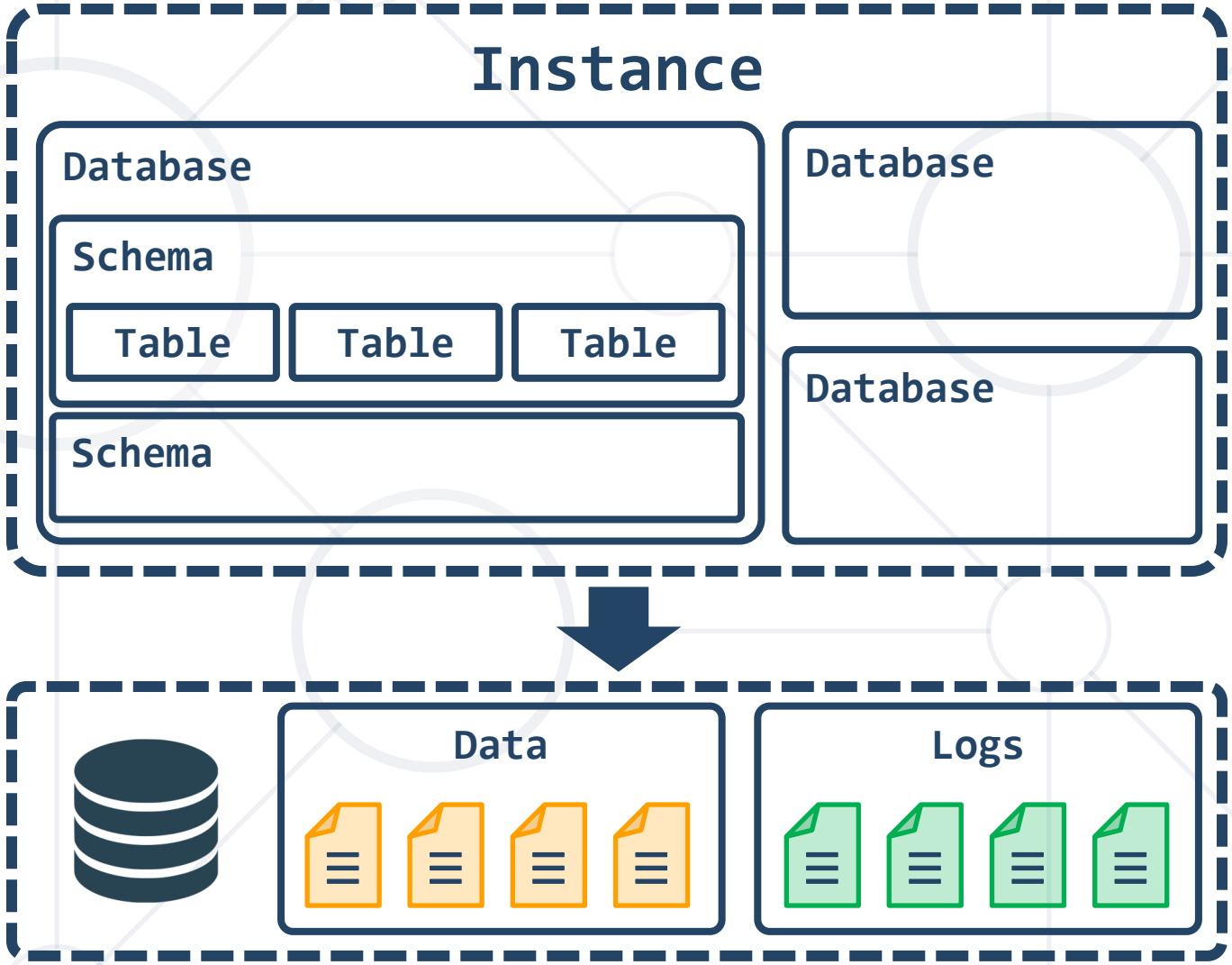
https://go.microsoft.com/fwlink/?linkid=866662

- Download SQL Server **Management Studio** separately

https://aka.ms/ssmsfullsetup

SQL Server Architecture

- Logical Storage
  - Instance
  - Database
  - Schema
  - Table
- Physical Storage
  - Data Files and Log files
  - Data Pages



Database Table Elements

- The table is the main **building block** of any database

Column

CustomerID	FirstName	Birthdate	CityID
1	Brigitte	03/12/1975	101
2	August	27/05/1968	102
3	Benjamin	15/10/1988	103
4	Denis	07/01/1993	104

Row

Cell

- Each **row** is called a **record** or **entity**
- Columns (**fields**) define the **type** of data they contain

Structured Query Language

- To communicate with the Engine we use **SQL**
  - **Declarative** language
- Logically divided in four sections
  - **Data Definition** – describe the structure of our data
  - **Data Manipulation** – store and retrieve data
  - **Data Control** – define who can access the data
  - **Transaction Control** – bundle operations and allow rollback

Data Types in SQL Server

Data Types in SQL Server (1)

- Numeric
  - `BIT` (1-bit), `TINYINT` (8-bit), `SMALLINT` (16-bit)
  - `INT` (32-bit), `BIGINT` (64-bit)
  - `FLOAT`, `REAL`, `DECIMAL(precision, scale)`
- Textual
  - `CHAR(size)` – fixed size string
  - `VARCHAR(size)` – variable size string
  - `NCHAR(size)` – Unicode fixed size string
  - `NVARCHAR(size)` – Unicode variable size string

Size of Textual Characters

```
DECLARE @VarcharVar VARCHAR(5) = 'Test';
DECLARE @NVarcharVar NVARCHAR(5) = 'Test';
DECLARE @CharVar CHAR(5) = 'Test';
DECLARE @NCharVar NCHAR(5) = 'Test';

SELECT DATALENGTH(@VarcharVar),
       DATALENGTH(@NVarcharVar),
       DATALENGTH(@CharVar),
       DATALENGTH(@NCharVar)
```

Data Types in SQL Server (2)

- Binary data
  - `BINARY(size)` – fixed length sequence of bits
  - `VARBINARY(size)` – a sequence of bits, 1-8000 bytes or `MAX` (2GB)
- Date and time
  - `DATE` – date in range 0001-01-01 through 9999-12-31
  - `DATETIME` – date and time with precision of 1/300 sec
  - `DATETIME2` – type that has a larger date range
  - `SMALLDATETIME` – date and time (1 minute precision)
  - `TIME` – defines a time of a day (no time zone)
  - `DATETIMEOFFSET` – date and time that has time zone

Date and Time in SQL Server

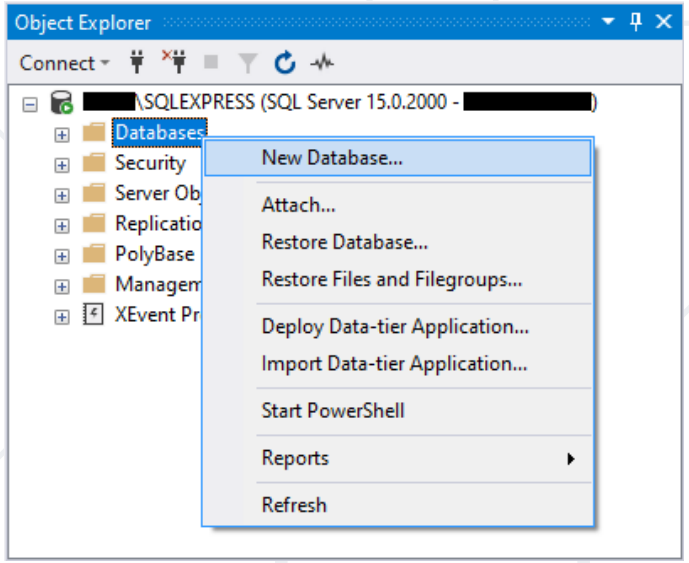
DATA TYPE	❶ RANGE OF VALUES	❷ ACCURACY	❸ STORAGE SPACE
SMALLDATETIME	01/01/1900 to 06/06/2079	1 minute	4 bytes
DATETIME	01/01/1753 to 12/31/9999	0.00333 seconds	8 bytes
DATETIME2	01/01/0001 to 12/31/9999	100 nanoseconds	6 to 8 bytes
DATETIMEOFFSET	01/01/0001 to 12/31/9999	100 nanoseconds	8 to 10 bytes
DATE	01/01/0001 to 12/31/9999	1 day	3 bytes
TIME	00:00:00.0000000 to 23:59:59.9999999	100 nanoseconds	3 to 5 bytes

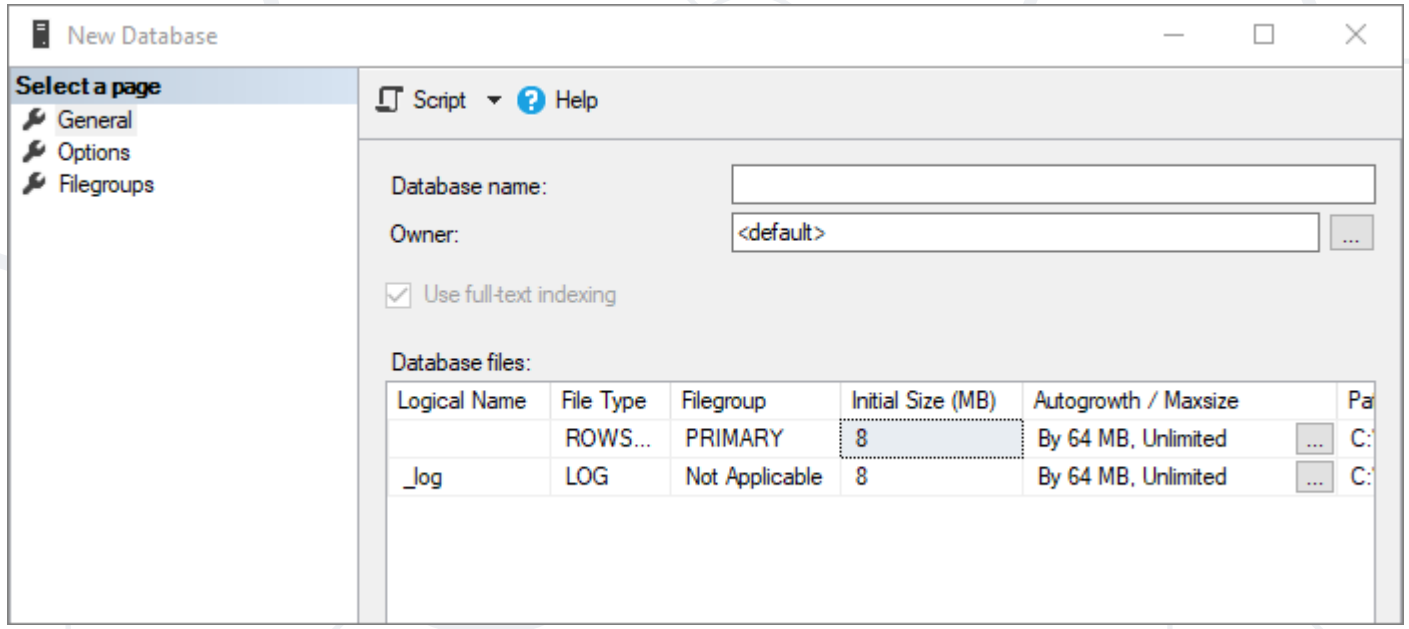
Database Modelling

Data Definition Using SSMS

Creating a New Database

- Select **New Database** from the **context menu** under "**Databases**"

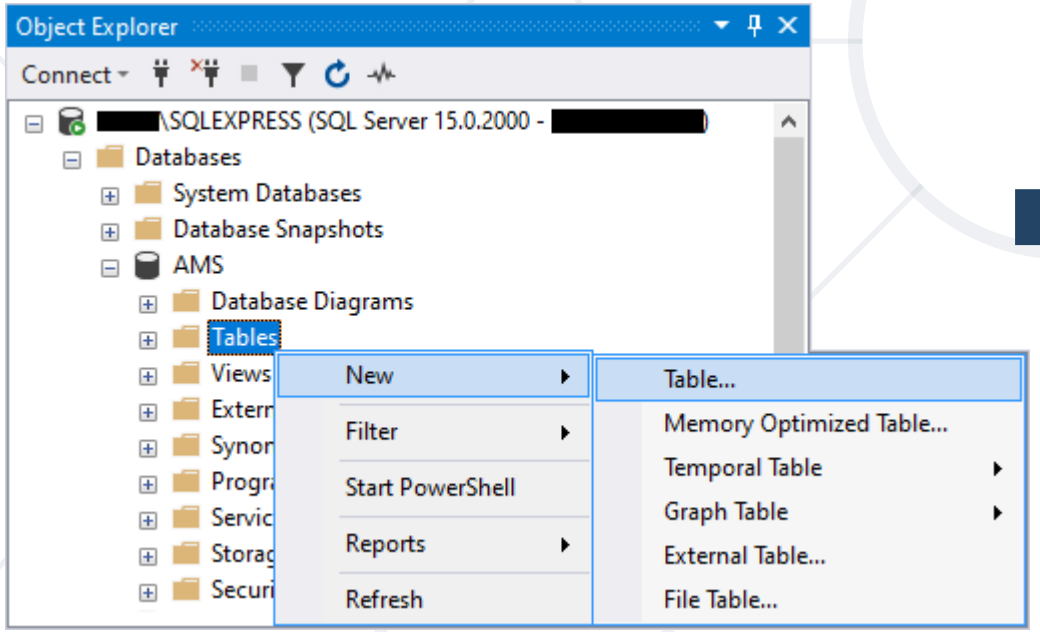




- You may need to **Refresh [F5]** to see the results

Creating Tables (1)

- Right-click from the **context menu** under "**New**" inside the desired database → "**`Table`**"

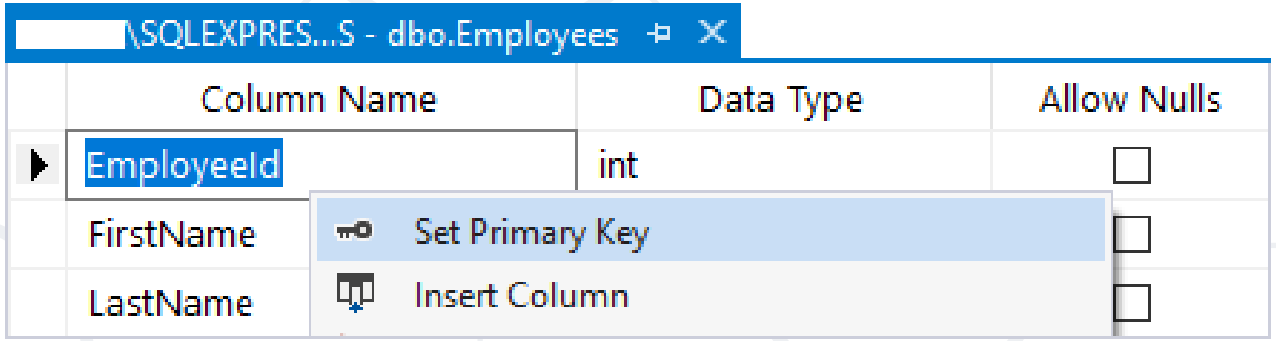


Column Name	Data Type	Allow Nulls
EmployeeId	int	☐
FirstName	nvarchar(50)	☐
LastName	nvarchar(50)	☐

- Table name can be set from its **`Properties [F4]`** or when it is **saved**

Creating Tables (2)

- A **Primary Key** is used to uniquely identify and index records
- Setting **primary key** on a column:

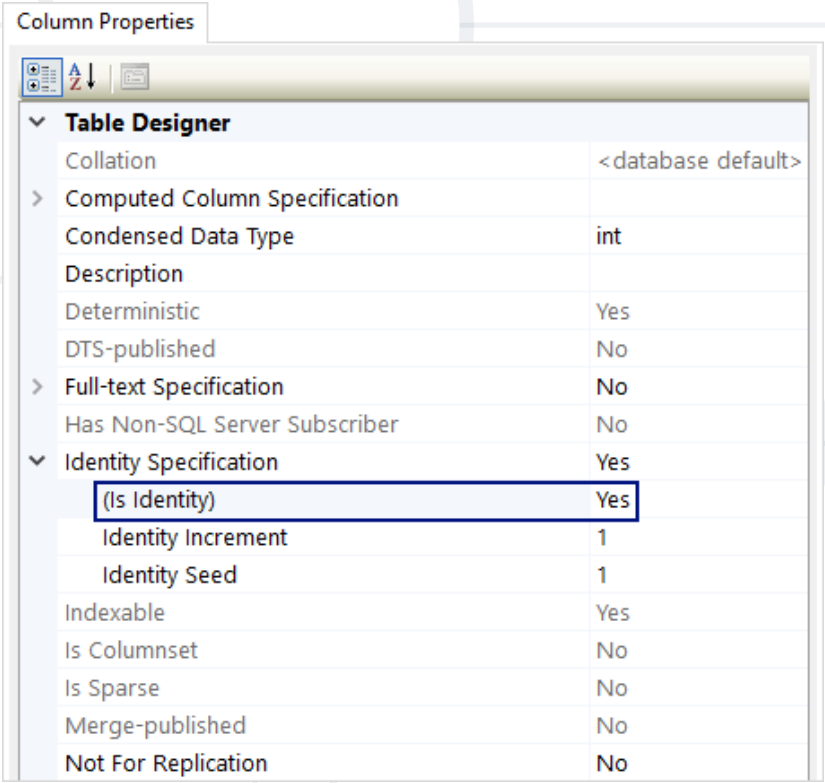


Creating Tables (3)

- **Identity** – The value in the column is automatically incremented when a new record is added
  - These values cannot be assigned manually
  - **Identity Seed** – the initial number (1 by default)
  - **Identity Increment** – how much each consecutive value is incremented

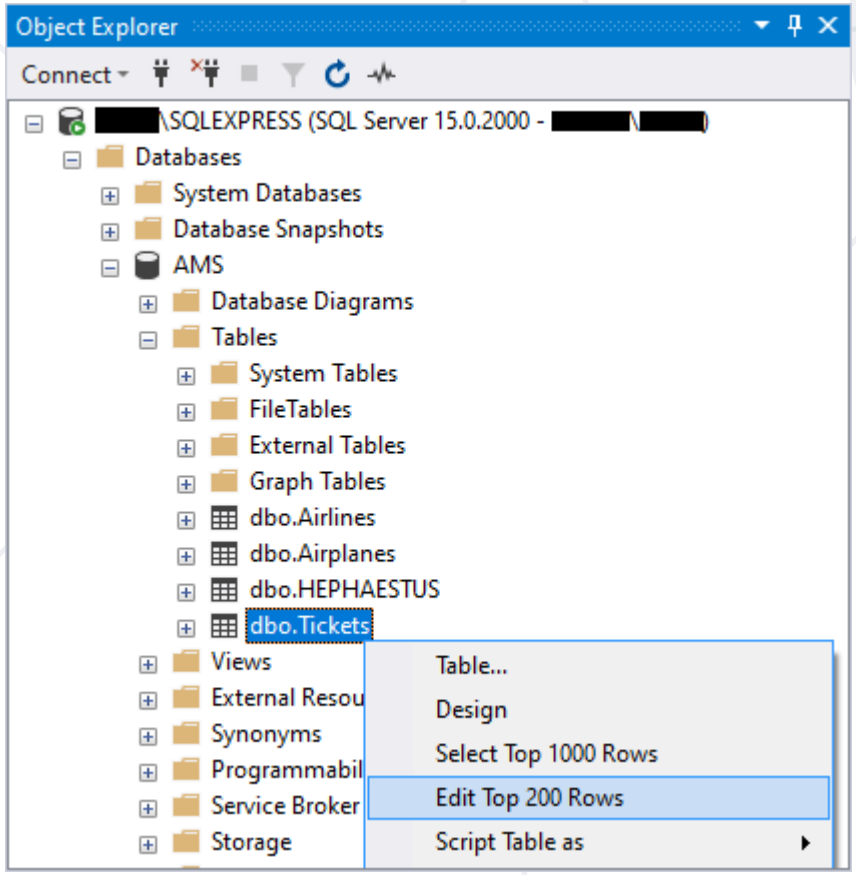
Creating Tables (4)

- Setting an identity through the "**Column Properties**" window:



Storing and Retrieving Data (1)

- We can **add**, **modify** and **read** records with Management Studio
- To insert or edit a record, click **`Edit`** from the context menu



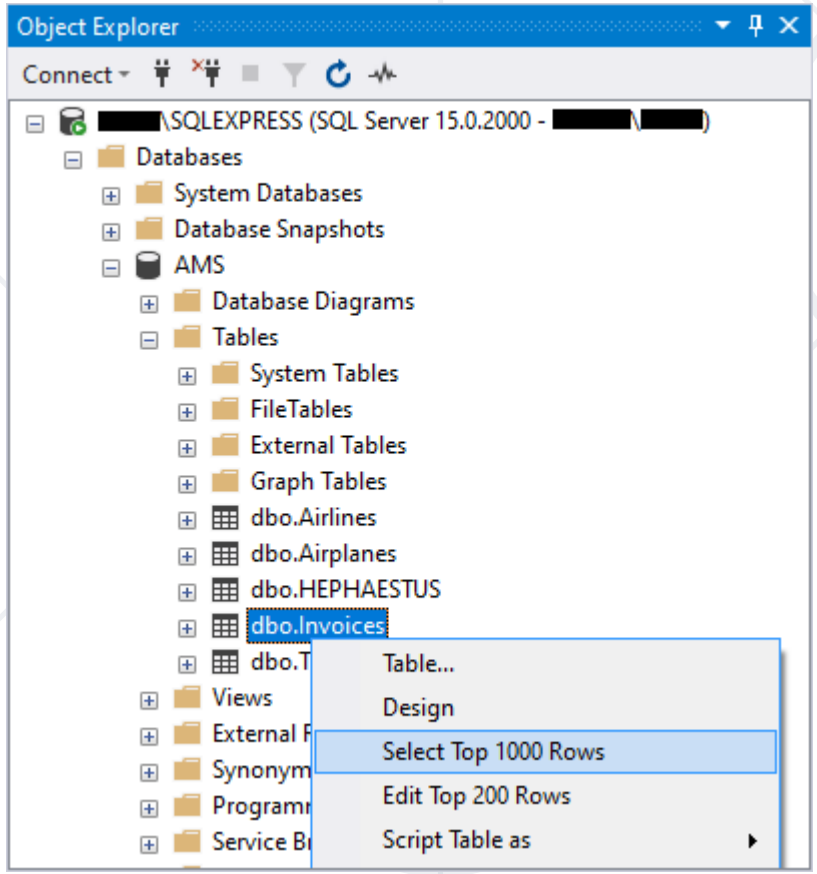
[redacted]\SQLEXPRESS.AMS - dbo.Tickets

	TicketId	Price	Class	Seat	CustomerId
	1	4500.00	First	233-A	3
	2	2669.85	Second	123-D	1
	3	1800.75	Second	12-Z	2
	4	616.02	Third	45-Q	2
	5	840.00	Third	201-R	4
	6	3150	Second	13-T	1
	7	5500.00	First	98-O	2
	8	100.00	First	1	1
▶*	NULL	NULL	NULL	NULL	NULL

Enter data at the end to add a new row

Storing and Retrieving Data (2)

- To retrieve records, click **`Select`** from the context menu

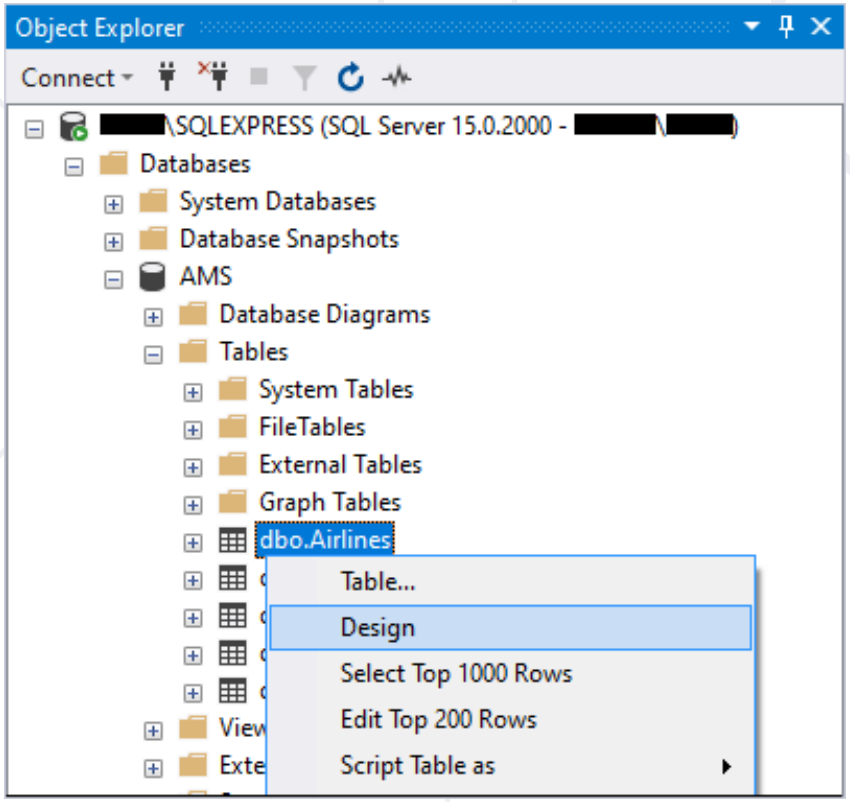


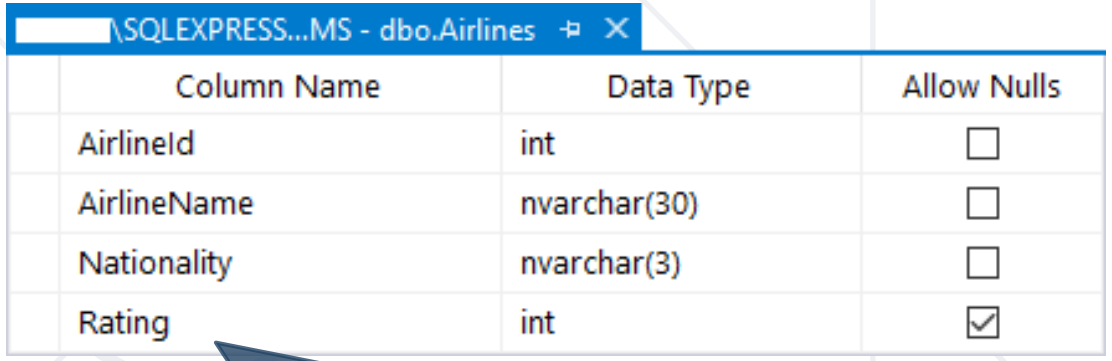
InvoiceId	CustomerId	InvoiceDate	BillingAddress	BillingCountry
1	1	2022-12-01	Theodor Heuss Strasse 34	Germany
2	4	2022-12-15	Ullevalsveien 14	Norway
3	8	2023-01-03	Gretrystraat 63	Belgium
4	23	2023-01-11	69 Salem Stree	United States
5	14	2023-01-06	8210 111 ST NW	United States
6	37	2023-01-19	Berger Strasse 10	Germany
7	38	2023-02-01	Barbarossastrasse 19	Germany
8	40	2023-02-01	8, Rue Hanovre	France
9	42	2023-02-02	9, Place Louis Barthou	France
10	46	2023-02-03	3 Chatham Street	Ireland
11	52	2023-02-06	202 Hoxton Street	United Kingdom
12	1	2023-02-11	Theodor Heuss Strasse 34	Germany

- The received information can be customized with **SQL queries**

Altering Tables

- You can change the properties of a table after its creation
- Select **Design** from the table's context menu





Column Name	Data Type	Allow Nulls
AirlineId	int	☐
AirlineName	nvarchar(30)	☐
Nationality	nvarchar(3)	☐
Rating	int	☑

Changes cannot conflict with existing rules!

Basic SQL Queries

Data Definition Using T-SQL

SQL Queries

- We can communicate with the database engine using SQL
- Queries provide greater **control** and **flexibility**
- To create a database using SQL:

Database name

```
CREATE DATABASE Employees
```

- SQL keywords are traditionally **capitalized**

Table Creation in SQL

Table name

```
CREATE TABLE People
(
  Id INT NOT NULL,
  Email VARCHAR(50) NOT NULL,
  FirstName VARCHAR(50),
  LastName VARCHAR(50)
)
```

Custom attributes

Column name

Data type

Retrieve Records in SQL

- To get all records from a table

```
SELECT * FROM Employees
```

- You can limit the number of rows and number of columns

Number of records

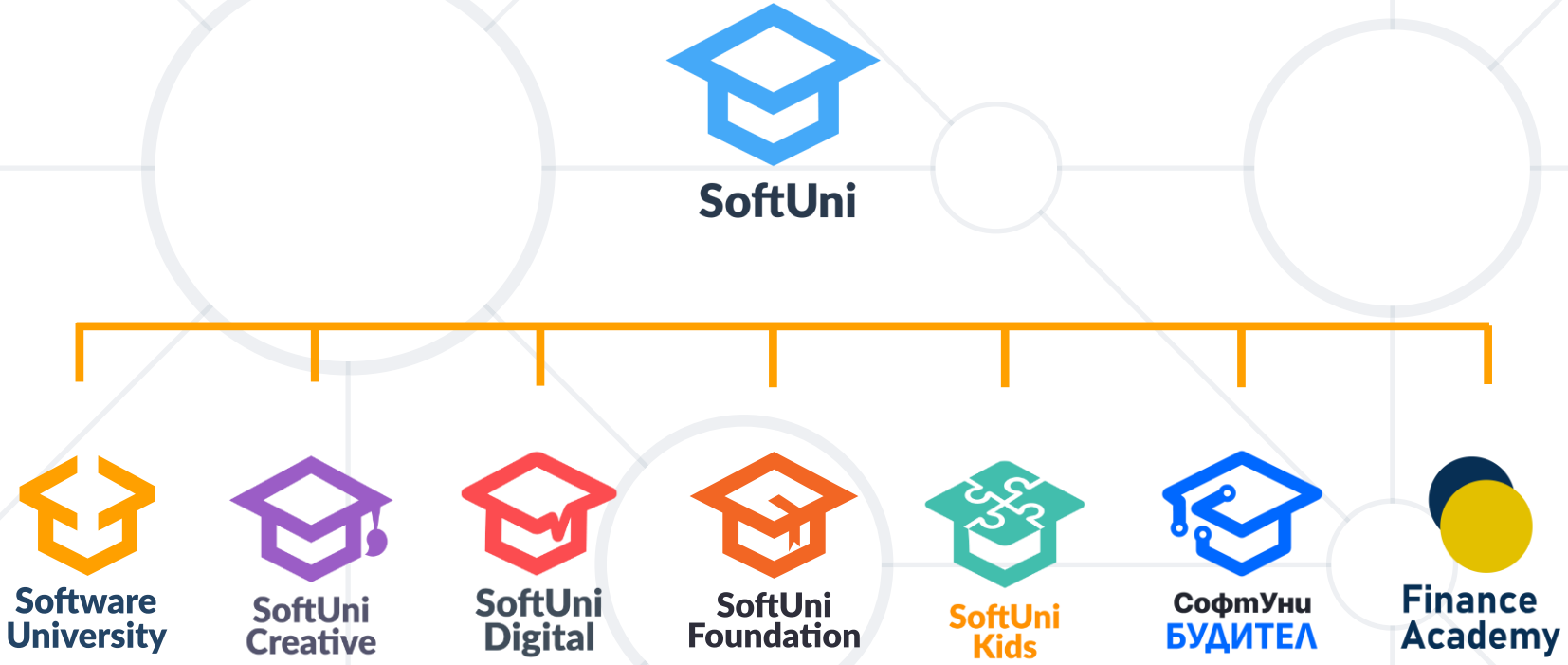
List of columns

```
SELECT TOP (5) FirstName, LastName
FROM Employees
```

Summary

- RDBMS stores and manages data
- Table relations reduce repetition and complexity
- Table columns have **fixed types**
- We can use Management Studio to **create** and **customize** tables
- SQL provides **greater control** over actions

Questions?



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