```sql
-------------------------------------------------------------------------
-- Scalar Subqueries
-------------------------------------------------------------------------

-- Order with the maximum order ID


USE TSQLV4;

DECLARE @maxid AS INT = (SELECT MAX(orderid)
                                FROM Sales.Orders);

SELECT orderid, orderdate, empid, custid
FROM Sales.Orders
WHERE orderid = @maxid;
GO

SELECT orderid, orderdate, empid, custid
FROM Sales.Orders
WHERE orderid = (SELECT MAX(O.orderid)
                 FROM Sales.Orders AS O);

-- PREDICATE: view table of orderid, orderdate, empid, and custid for just the max/highest order ID

USE Northwinds2022TSQLV7;

DECLARE @maxid AS INT = (SELECT MAX(orderid)
                                FROM Sales.[Order]);

SELECT orderid, orderdate, EmployeeId, CustomerId
FROM Sales.[Order]
WHERE orderid = @maxid;
GO

SELECT orderid, orderdate, EmployeeId, CustomerId
FROM Sales.[Order]
WHERE orderid = (SELECT MAX(O.orderid)
                 FROM Sales.[Order] AS O);
```

Results   Messages

	orderid	orderdate	empid	custid
1	11077	2016-05-06	1	65

	orderid	orderdate	empid	custid
1	11077	2016-05-06	1	65

	orderid	orderdate	EmployeeId	CustomerId
1	11077	2016-05-06	1	65

	orderid	orderdate	EmployeeId	CustomerId
1	11077	2016-05-06	1	65

```sql
52    -- Scalar subquery expected to return one value
53
54    USE TSQLV4;
55
56    SELECT orderid
57    FROM Sales.Orders
58    WHERE empid =
59      (SELECT E.empid
60       FROM HR.Employees AS E
61       WHERE E.lastname LIKE N'C%');
62    GO
63
64    -- BUG Subquery returned more than 1 value
65
66    -- SELECT orderid
67    -- FROM Sales.Orders
68    -- WHERE empid =
69    --   (SELECT E.empid
70    --    FROM HR.Employees AS E
71    --    WHERE E.lastname LIKE N'D%');
72    -- GO
73
74    SELECT orderid
75    FROM Sales.Orders
76    WHERE empid =
77      (SELECT E.empid
78       FROM HR.Employees AS E
79       WHERE E.lastname LIKE N'A%');
80
81    -- PREDICATE: orders placed by employees whose last name starts with the letter C
82
83    USE Northwinds2022TSQLV7;
84
85    SELECT orderid
86    FROM Sales.[Order]
87    WHERE EmployeeId =
88      (SELECT E.EmployeeId
89       FROM HumanResources.Employee AS E
90       WHERE E.EmployeeLastName LIKE N'C%');
91    GO
92
93    -- PREDICATE: orders placed by employees whose last name starts with the letter D
94    -- BUG Subquery returned more than 1 value
95
96    -- SELECT orderid
97    -- FROM Sales.[Order]
98    -- WHERE EmployeeId =
99    --   (SELECT E.EmployeeId
100   --    FROM HumanResources.Employee AS E
101   --    WHERE E.EmployeeLastName LIKE N'D%');
102   -- GO
103
104   -- PREDICATE: orders placed by employees whose last name starts with the letter A
105
106   SELECT orderid
107   FROM Sales.[Order]
108   WHERE EmployeeId =
109     (SELECT E.EmployeeId
110      FROM HumanResources.Employee AS E
111      WHERE E.EmployeeLastName LIKE N'A%');
112
```

Results   Messages

	orderid
1	10262
2	10268
3	10276
4	10278
5	10279
6	10286
7	10287
8	10290
9	10301
10	10305

orderid

	orderid
1	10262
2	10268
3	10276
4	10278
5	10279
6	10286
7	10287
8	10290
9	10301
10	10305

orderid

```
154    USE TSQLV4;
155
156    SELECT orderid
157    FROM Sales.Orders
158    WHERE empid IN
159      (SELECT E.empid
160       FROM HR.Employees AS E
161       WHERE E.lastname LIKE N'D%');
162
163
164    USE Northwinds2022TSQLV7;
165
166    -- Predicate: orders placed by employees with a last name starting with D
167
168    SELECT orderid
169    FROM Sales.[Order]
170    WHERE EmployeeId IN
171      (SELECT E.EmployeeId
172       FROM HumanResources.Employee AS E
173       WHERE E.EmployeeLastName LIKE N'D%');
174
```

Results Messages

	orderid
1	10258
2	10270
3	10275
4	10285
5	10292
6	10293
7	10304
8	10306
9	10311
10	10314
11	10316
12	10325
13	10340
14	10351
15	10357

	orderid
1	10255
2	10258
3	10263
4	10270
5	10275
6	10285
7	10292
8	10293
9	10304
10	10306
11	10311
12	10314
13	10316
14	10324
15	10325

```sql
USE TSQLV4;

SELECT O.orderid
FROM HR.Employees AS E
  INNER JOIN Sales.Orders AS O
    ON E.empid = O.empid
WHERE E.lastname LIKE N'D%';


-- Predicate: orders placed by employees with a last name starting with D
USE Northwinds2022TSQLV7;

SELECT O.orderid
FROM HumanResources.Employee AS E
  INNER JOIN Sales.[Order] AS O
    ON E.EmployeeId = O.EmployeeId
WHERE E.EmployeeLastName LIKE N'D%';
```

	orderid
1	10258
2	10270
3	10275
4	10285
5	10292
6	10293
7	10304
8	10306
9	10311
10	10314
11	10316
12	10325

	orderid
1	10255
2	10258
3	10263
4	10270
5	10275
6	10285
7	10292
8	10293
9	10304
10	10306
11	10311
12	10314

```sql
USE TSQLV4;

-- Orders placed by US customers
SELECT custid, orderid, orderdate, empid
FROM Sales.Orders
WHERE custid IN
  (SELECT C.custid
   FROM Sales.Customers AS C
   WHERE C.country = N'USA');


-- Predicate: Orders placed by US customers
USE Northwinds2022TSQLV7;

SELECT CustomerId, orderid, orderdate, EmployeeId
FROM Sales.[Order]
WHERE CustomerId IN
  (SELECT C.CustomerId
   FROM Sales.Customer AS C
   WHERE C.CustomerCountry = N'USA');
```

	custid	orderid	orderdate	empid
1	65	10262	2014-07-22	8
2	89	10269	2014-07-31	5
3	75	10271	2014-08-01	6
4	65	10272	2014-08-02	6
5	65	10294	2014-08-30	4
6	55	10305	2014-09-13	8
7	48	10307	2014-09-17	2
8	77	10310	2014-09-20	8
9	65	10314	2014-09-25	1
10	65	10316	2014-09-27	1
11	48	10317	2014-09-30	6
12	71	10324	2014-10-08	9

	CustomerId	orderid	orderdate	EmployeeId
1	65	10262	2014-07-22	8
2	89	10269	2014-07-31	5
3	75	10271	2014-08-01	6
4	65	10272	2014-08-02	6
5	65	10294	2014-08-30	4
6	55	10305	2014-09-13	8
7	48	10307	2014-09-17	2
8	77	10310	2014-09-20	8
9	65	10314	2014-09-25	1
10	65	10316	2014-09-27	1
11	48	10317	2014-09-30	6

```sql
207    USE TSQLV4;
208
209    -- Customers who placed no orders
210    SELECT custid, companyname
211    FROM Sales.Customers
212    WHERE custid NOT IN
213      (SELECT O.custid
214       FROM Sales.Orders AS O);
215
216    -- Predicate: Customers who placed no orders
217    USE Northwinds2022TSQLV7;
218
219    SELECT CustomerId, CustomerCompanyName
220    FROM Sales.Customer
221    WHERE CustomerId NOT IN
222      (SELECT O.CustomerId
223       FROM Sales.[Order] AS O);
224
225
226
```

Results   Messages

	custid	companyname
1	22	Customer DTDMN
2	57	Customer WVAXS

	CustomerId	CustomerCompanyName
1	22	Customer DTDMN
2	57	Customer WVAXS

```sql
USe TSQLV4;

-- Missing order IDs
USE TSQLV4;
DROP TABLE IF EXISTS dbo.Orders;
CREATE TABLE dbo.Orders(orderid INT NOT NULL CONSTRAINT PK_Orders PRIMARY KEY);

INSERT INTO dbo.Orders(orderid)
  SELECT orderid
  FROM Sales.Orders
  WHERE orderid % 2 = 0;

SELECT n
FROM dbo.Nums
WHERE n BETWEEN (SELECT MIN(O.orderid) FROM dbo.Orders AS O)
            AND (SELECT MAX(O.orderid) FROM dbo.Orders AS O)
  AND n NOT IN (SELECT O.orderid FROM dbo.Orders AS O);

-- CLeanup
-- DROP TABLE IF EXISTS dbo.Orders;

-- Predicate: Missing order IDs
USE Northwinds2022TSQLV7;
DROP TABLE IF EXISTS dbo.Orders;
CREATE TABLE dbo.Orders(orderid INT NOT NULL CONSTRAINT PK_Orders PRIMARY KEY);

INSERT INTO dbo.Orders(orderid)
  SELECT orderid
  FROM Sales.[Order]
  WHERE orderid % 2 = 0;

SELECT n
FROM dbo.Nums
WHERE n BETWEEN (SELECT MIN(O.orderid) FROM dbo.Orders AS O)
            AND (SELECT MAX(O.orderid) FROM dbo.Orders AS O)
  AND n NOT IN (SELECT O.orderid FROM dbo.Orders AS O);

-- Cleanup
-- DROP TABLE IF EXISTS dbo.Orders;
```

Results Messages

	n
1	10249
2	10251
3	10253
4	10255
5	10257
6	10259
7	10261
8	10263
9	10265
10	10267
11	10269
12	10271
13	10273
14	10275
15	10277

	n
1	10249
2	10251
3	10253
4	10255
5	10257
6	10259
7	10261
8	10263
9	10265
10	10267
11	10269
12	10271
13	10273
14	10275
15	10277

	custid	orderid	orderdate	empid
1	91	11044	2016-04-23	4
2	90	11005	2016-04-07	2
3	89	11066	2016-05-01	7
4	88	10935	2016-03-09	4
5	87	11025	2016-04-15	6
6	86	11046	2016-04-23	8
7	85	10739	2015-11-12	3
8	84	10850	2016-01-23	1
9	83	10994	2016-04-02	2
10	82	10822	2016-01-08	6

	(No column name)
1	10739

	orderid	custid	val	pct
1	10643	1	814.50	19.06
2	10692	1	878.00	20.55
3	10702	1	330.00	7.72
4	10835	1	845.80	19.79
5	10952	1	471.20	11.03
6	11011	1	933.50	21.85
7	10308	2	88.80	6.33
8	10625	2	479.75	34.20
9	10759	2	320.00	22.81
10	10926	2	514.40	36.67

	CustomerId	orderid	orderdate	EmployeeId
1	91	11044	2016-04-23	4
2	90	11005	2016-04-07	2
3	89	11066	2016-05-01	7
4	88	10935	2016-03-09	4
5	87	11025	2016-04-15	6
6	86	11046	2016-04-23	8
7	85	10739	2015-11-12	3
8	84	10850	2016-01-23	1
9	83	10994	2016-04-02	2
10	82	10822	2016-01-08	6

	(No column name)
1	10739

```sql
USE TSQLV4;
-- Customers from Spain who placed orders
SELECT custid, companyname
FROM Sales.Customers AS C
WHERE country = N'Spain'
  AND EXISTS
    (SELECT * FROM Sales.Orders AS O
     WHERE O.custid = C.custid);

-- Customers from Spain who didn't place Orders
SELECT custid, companyname
FROM Sales.Customers AS C
WHERE country = N'Spain'
  AND NOT EXISTS
    (SELECT * FROM Sales.Orders AS O
     WHERE O.custid = C.custid);


USE Northwinds2022TSQLV7;
-- Predicate: Customers from Spain who placed orders
SELECT CustomerId, CustomerCompanyName
FROM Sales.Customer AS C
WHERE CustomerCountry = N'Spain'
  AND EXISTS
    (SELECT * FROM Sales.[Order] AS O
     WHERE O.CustomerId = C.CustomerId);

-- Predicate: Customers from Spain who didn't place Orders
SELECT CustomerId, CustomerCompanyName
FROM Sales.Customer AS C
WHERE CustomerCountry = N'Spain'
  AND NOT EXISTS
    (SELECT * FROM Sales.[Order] AS O
     WHERE O.CustomerId = C.CustomerId);


-----------------------------------------------------------------------
```

	custid	companyname
1	8	Customer QUHWH
2	29	Customer MDLWA
3	30	Customer KSLQF
4	69	Customer SIUIH

	custid	companyname
1	22	Customer DTDMN

	CustomerId	CustomerCompanyName
1	8	Customer QUHWH
2	29	Customer MDLWA
3	30	Customer KSLQF
4	69	Customer SIUIH

	CustomerId	CustomerCompanyName
1	22	Customer DTDMN

```
341   ------------------------------------------------------------------------
342   -- Returning "Previous" or "Next" Value
343   ------------------------------------------------------------------------
344
345   USE TSQLV4;
346
347   SELECT orderid, orderdate, empid, custid,
348     (SELECT MAX(O2.orderid)
349      FROM Sales.Orders AS O2
350      WHERE O2.orderid < O1.orderid) AS prevorderid
351   FROM Sales.Orders AS O1;
352
353   SELECT orderid, orderdate, empid, custid,
354     (SELECT MIN(O2.orderid)
355      FROM Sales.Orders AS O2
356      WHERE O2.orderid > O1.orderid) AS nextorderid
357   FROM Sales.Orders AS O1;
358
359
360   USE Northwinds2022TSQLV7;
361   Go
362
363   -- Predicate: for each order, information about the current order and also the previous order ID
364   SELECT orderid, orderdate, EmployeeId, CustomerId,
365     (SELECT MAX(O2.orderid)
366      FROM Sales.[Order] AS O2
367      WHERE O2.orderid < O1.orderid) AS prevorderid
368   FROM Sales.[Order] AS O1;
369
370   -- Predicate: for each order, information about the current order and also the next order ID
371
372   SELECT orderid, orderdate, EmployeeId, CustomerId,
373     (SELECT MIN(O2.orderid)
374      FROM Sales.[Order] AS O2
375      WHERE O2.orderid > O1.orderid) AS nextorderid
376   FROM Sales.[Order] AS O1;
377
```

	orderid	orderdate	empid	custid	prevorderid
1	10248	2014-07-04	5	85	NULL
2	10249	2014-07-05	6	79	10248
3	10250	2014-07-08	4	34	10249
4	10251	2014-07-08	3	84	10250
5	10252	2014-07-09	4	76	10251
6	10253	2014-07-10	3	34	10252
7	10254	2014-07-11	5	14	10253
8	10255	2014-07-12	9	68	10254
9	10256	2014-07-15	3	88	10255
10	10257	2014-07-16	4	35	10256

	orderid	orderdate	empid	custid	nextorderid
1	10248	2014-07-04	5	85	10249
2	10249	2014-07-05	6	79	10250
3	10250	2014-07-08	4	34	10251
4	10251	2014-07-08	3	84	10252
5	10252	2014-07-09	4	76	10253
6	10253	2014-07-10	3	34	10254
7	10254	2014-07-11	5	14	10255
8	10255	2014-07-12	9	68	10256
9	10256	2014-07-15	3	88	10257
10	10257	2014-07-16	4	35	10258

	orderid	orderdate	EmployeeId	CustomerId	prevorderid
1	10248	2014-07-04	5	85	NULL
2	10249	2014-07-05	6	79	10248
3	10250	2014-07-08	4	34	10249
4	10251	2014-07-08	3	84	10250
5	10252	2014-07-09	4	76	10251
6	10253	2014-07-10	3	34	10252
7	10254	2014-07-11	5	14	10253
8	10255	2014-07-12	9	68	10254
9	10256	2014-07-15	3	88	10255
10	10257	2014-07-16	4	35	10256

	orderid	orderdate	EmployeeId	CustomerId	nextorderid
1	10248	2014-07-04	5	85	10249
2	10249	2014-07-05	6	79	10250
3	10250	2014-07-08	4	34	10251
4	10251	2014-07-08	3	84	10252
5	10252	2014-07-09	4	76	10253
6	10253	2014-07-10	3	34	10254
7	10254	2014-07-11	5	14	10255
8	10255	2014-07-12	9	68	10256
9	10256	2014-07-15	3	88	10257
10	10257	2014-07-16	4	35	10258

```sql
--------------------------------------------------------------------------
-- Running Aggregates
--------------------------------------------------------------------------

USE TSQLV4;
GO

SELECT orderyear, qty
FROM Sales.OrderTotalsByYear;

SELECT orderyear, qty,
  (SELECT SUM(O2.qty)
    FROM Sales.OrderTotalsByYear AS O2
    WHERE O2.orderyear <= O1.orderyear) AS runqty
FROM Sales.OrderTotalsByYear AS O1
ORDER BY orderyear;

-- USE Northwinds2022TSQLV7;
-- GO

-- SELECT orderyear, qty
-- FROM Sales.OrderTotalsByYear;

-- SELECT orderyear, qty,
--    (SELECT SUM(O2.qty)
--     FROM Sales.OrderTotalsByYear AS O2
--     WHERE O2.orderyear <= O1.orderyear) AS runqty
-- FROM Sales.OrderTotalsByYear AS O1
-- ORDER BY orderyear;
```

Results   Messages

	orderyear	qty
1	2016	16247
2	2014	9581
3	2015	25489

	orderyear	qty	runqty
1	2014	9581	9581
2	2015	25489	35070
3	2016	16247	51317

```sql
WHERE NOT EXISTS
  (SELECT *
   FROM Sales.Orders AS O
   WHERE O.custid = C.custid);

-- Cleanup
DELETE FROM Sales.Orders WHERE custid IS NULL;
GO


USE Northwinds2022TSQLV7;
GO
-- Predicate: customers who did not place any orders

SELECT CustomerId, CustomerCompanyName
FROM Sales.Customer
WHERE CustomerId NOT IN(SELECT O.CustomerId
                       FROM Sales.[Order] AS O);

-- Predicate: Add a row to the Orders table with a NULL custid
INSERT INTO Sales.[Order]
  (CustomerId, EmployeeId, orderdate, RequiredDate, ShipToDate, shipperid,
   freight, ShipToName, ShipToAddress, ShipToCity, ShipToRegion,
   ShipToPostalCode, ShipToCountry)
  VALUES(NULL, 1, '20160212', '20160212',
         '20160212', 1, 123.00, N'abc', N'abc', N'abc',
         N'abc', N'abc', N'abc');

--Predicate: returns an empty set because we're asking to return customerIds that are not in the Sales.Order table
SELECT CustomerId, CustomerCompanyName
FROM Sales.Customer
WHERE CustomerId NOT IN(SELECT O.CustomerId
                       FROM Sales.[Order] AS O);

-- Predicate: Exclude NULLs explicitly/return customerIDs that are not in the Sales.Order table ie have not placed an order
SELECT CustomerId, CustomerCompanyName
FROM Sales.Customer
WHERE CustomerId NOT IN(SELECT O.CustomerId
                       FROM Sales.[Order] AS O
                       WHERE O.CustomerId IS NOT NULL);

-- Predicate: Using NOT EXISTS to return customers that have not placed an order
SELECT CustomerId, CustomerCompanyName
FROM Sales.Customer AS C
WHERE NOT EXISTS
  (SELECT *
   FROM Sales.[Order] AS O
   WHERE O.CustomerId = C.CustomerId);

-- Cleanup
DELETE FROM Sales.[Order] WHERE CustomerId IS NULL;
GO
```

	custid	companyname
1	22	Customer DTDMN
2	57	Customer WVAXS

custid	companyname

	custid	companyname
1	22	Customer DTDMN
2	57	Customer WVAXS

	custid	companyname
1	22	Customer DTDMN
2	57	Customer WVAXS

	CustomerId	CustomerCompanyName
1	22	Customer DTDMN
2	57	Customer WVAXS

CustomerId	CustomerCompan…

	CustomerId	CustomerCompanyName
1	22	Customer DTDMN
2	57	Customer WVAXS

	CustomerId	CustomerCompanyName
1	22	Customer DTDMN
2	57	Customer WVAXS

```
560   -- Create and populate table Sales.MyShippers
561   USE Northwinds2022TSQLV7;
562
563   DROP TABLE IF EXISTS Sales.MyShippers;
564
565   CREATE TABLE Sales.MyShippers
566   (
567     shipper_id   INT          NOT NULL,
568     companyname NVARCHAR(40) NOT NULL,
569     phone       NVARCHAR(24) NOT NULL,
570     CONSTRAINT PK_MyShippers PRIMARY KEY(shipper_id)
571   );
572
573   INSERT INTO Sales.MyShippers(shipper_id, companyname, phone)
574     VALUES(1, N'Shipper GVSUA', N'(503) 555-0137'),
575           (2, N'Shipper ETYNR', N'(425) 555-0136'),
576           (3, N'Shipper ZHISN', N'(415) 555-0138');
577   GO
578
579   -- Shippers who shipped orders to customer 43
580
581   -- -- Bug
582   -- SELECT shipper_id, companyname
583   -- FROM Sales.MyShippers
584   -- WHERE shipper_id IN
585   --   (SELECT shipper_id
586   --    FROM Sales.[Order]
587   --    WHERE CustomerId = 43);
588   -- GO
589
590   -- -- The safe way using aliases, bug identified
591   -- SELECT shipper_id, companyname
592   -- FROM Sales.MyShippers
593   -- WHERE shipper_id IN
594   --   (SELECT O.shipper_id
595   --    FROM Sales.[Order] AS O
596   --    WHERE O.CustomerId = 43);
597   -- GO
598
599   -- Bug corrected
600   SELECT shipper_id, companyname
601   FROM Sales.MyShippers
602   WHERE shipper_id IN
603     (SELECT O.shipperid
604      FROM Sales.[Order] AS O
605      WHERE O.CustomerId = 43);
606
607   -- Cleanup
608   DROP TABLE IF EXISTS Sales.MyShippers;
609
```

Results   Messages

	shipper_id ∨	companyname ∨
1	2	Shipper ETYNR
2	3	Shipper ZHISN