

# Database

## SQL

### Nested Simulation



# Simulation

## Uncorrelated

*Case 1*

*Case 2*

## Correlated

## Universal

## Uncorrelated

### Case 1

```
SELECT d.name  
FROM downloads d  
WHERE d.customerid IN (  
    SELECT c.customerid FROM customers c  
    WHERE c.country = 'Singapore'  
);
```

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

## Uncorrelated

*Case 1*

*Case 2*

## Correlated

## Universal

## Uncorrelated

### Case 1

```
SELECT d.name  
FROM downloads d  
WHERE d.customerid IN (  
    SELECT c.customerid FROM customers c  
    WHERE c.country = 'Singapore'  
);
```

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

## Uncorrelated

*Case 1*

*Case 2*

## Correlated

## Universal

## Uncorrelated

### Case 1

```
SELECT d.name  
FROM downloads d  
WHERE d.customerid IN (  
    'Deborah84',  
    'Tammy1998'  
);
```

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

## Uncorrelated

Case 1

Case 2

## Correlated

## Universal

## Uncorrelated

### Case 1

```
SELECT d.name  
FROM downloads d  
WHERE d.customerid IN (  
    'Deborah84',  
    'Tammy1998'  
);
```

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hatity	2.1

# Simulation

## Uncorrelated

Case 1

Case 2

Correlated

Universal

## Uncorrelated

### Case 1

```
SELECT d.name  
FROM downloads d  
WHERE d.customerid IN (  
    SELECT c.customerid FROM customers c  
    WHERE c.country = 'Singapore'  
)
```

name

Cookley

Fintone

Hativity

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

## Uncorrelated

Case 1

Case 2

Correlated

Universal

## Uncorrelated

### Case 2

```
SELECT d.name  
FROM downloads d  
WHERE d.customerid IN (  
    SELECT c.customerid FROM customers c  
    WHERE c.country = 'Singapore'  
)
```

name
Cookley
Cookley
Fintone
Hatity

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
Deborah84	Cookley	1.2
RebeccaG84	Aerified	2.0
StephenS86	Span	2.0
Tammy1998	Hatity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE d.customerid = c.customerid
    AND c.country = 'Singapore'
);
```

#### Idea

1. Loop through each row in **downloads**.
2. Substitute values obtained from this row.
3. Check if condition evaluates to TRUE.

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 1
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE d.customerid = c.customerid
        AND c.country = 'Singapore'
);
```

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hatity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 1
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE 'Deborah84' = c.customerid
    AND c.country = 'Singapore'
);
```

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 1
WHERE EXISTS ( -- True
    SELECT c.customerid
    FROM customers c
    WHERE 'Deborah84' = c.customerid
        AND c.country = 'Singapore'
);
```

Cookley

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 2
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE d.customerid = c.customerid
        AND c.country = 'Singapore'
);
```

Cookley

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
Case 1  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 2
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE 'Deborah84' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 2
WHERE EXISTS ( -- True
    SELECT c.customerid
    FROM customers c
    WHERE 'Deborah84' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
Case 1  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 3
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE d.customerid = c.customerid
        AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 3
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE 'RebeccaG84' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 3
WHERE EXISTS ( -- False
    SELECT c.customerid
    FROM customers c
    WHERE 'RebeccaG84' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 4
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE d.customerid = c.customerid
        AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 4
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE 'RebeccaG84' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 4
WHERE EXISTS ( -- False
    SELECT c.customerid
    FROM customers c
    WHERE 'RebeccaG84' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
Case 1  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 5
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE d.customerid = c.customerid
        AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 5
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE 'StephenS86' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 5
WHERE EXISTS ( -- False
    SELECT c.customerid
    FROM customers c
    WHERE 'StephenS86' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
Case 1  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 6
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE d.customerid = c.customerid
        AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 6
WHERE EXISTS (
    SELECT c.customerid
    FROM customers c
    WHERE 'Tammy1998' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley

Fintone

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
» Correlated  
*Case 1*  
Universal

## Correlated

### Case 1

```
SELECT d.name
FROM downloads d -- 6
WHERE EXISTS ( -- True
    SELECT c.customerid
    FROM customers c
    WHERE 'Tammy1998' = c.customerid
    AND c.country = 'Singapore'
);
```

Cookley
Fintone
Hativity

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore
RebeccaG84	Malaysia
StephenS86	Vietnam

downloads

customerid	name	version
Deborah84	Cookley	1.1
Deborah84	Fintone	1.0
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hativity	2.1

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
  FROM customers c
 WHERE NOT EXISTS (
   SELECT g.version
     FROM games g
    WHERE g.name = 'Aerified'
      AND NOT EXISTS (
        SELECT d.customerid
          FROM downloads d
         WHERE d.customerid = c.customerid
           AND d.name = g.name
           AND d.version = g.version ));
```

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = c.customerid
        AND d.name = g.name
        AND d.version = g.version
    ));

```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

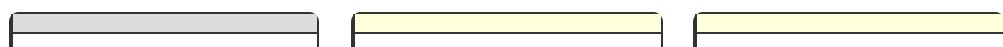
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

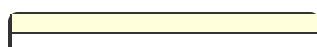
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = 'Aerified'
        AND d.version = '1.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

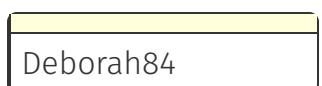
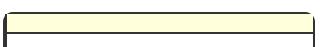
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = 'Aerified'
        AND d.version = '1.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

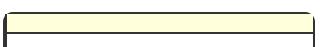
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
  FROM customers c
 WHERE NOT EXISTS (
    SELECT g.version
      FROM games g
     WHERE g.name = 'Aerified'
      AND NOT EXISTS (
        SELECT d.customerid
          FROM downloads d
         WHERE d.customerid = 'Deborah84'
          AND d.name = g.name
          AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

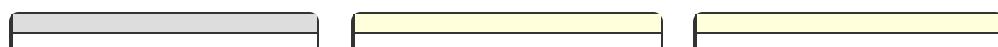
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- False
    AND NOT EXISTS ( -- don't care
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

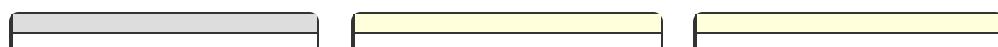
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

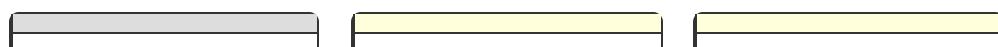
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = 'Aerified'
        AND d.version = '2.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

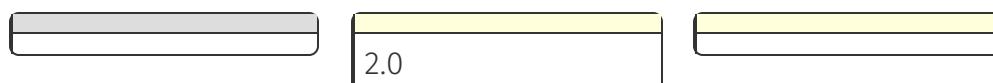
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- True (i.e., empty)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = 'Aerified'
        AND d.version = '2.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

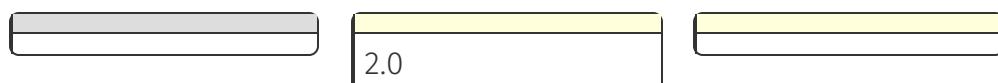
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Inserted (i.e., WHERE True)
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- True (i.e., empty)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

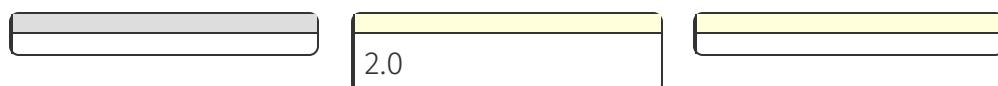
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

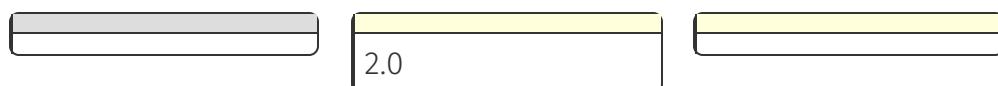
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- False
    AND NOT EXISTS ( -- don't care
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Deborah84'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

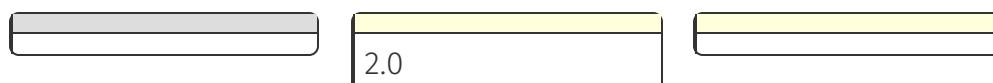
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
  FROM customers c
 WHERE NOT EXISTS ( -- False (i.e., exist)
    SELECT g.version
      FROM games g
     WHERE g.name = 'Aerified'
       AND NOT EXISTS (
          SELECT d.customerid
            FROM downloads d
           WHERE d.customerid = c.customerid
             AND d.name = g.name
             AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

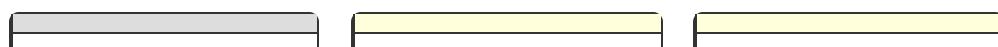
Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = c.customerid
        AND d.name = g.name
        AND d.version = g.version
    ));

```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

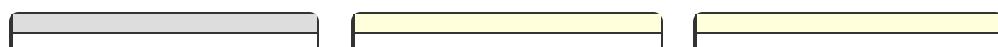
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

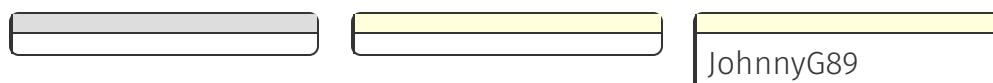
# Simulation

Uncorrelated  
Correlated  
» Universal  
Case 1

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = 'Aerified'
        AND d.version = '1.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

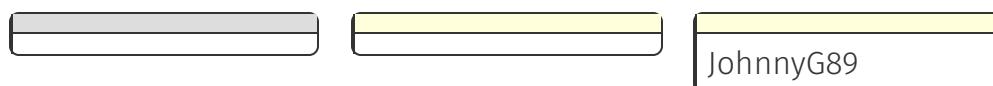
# Simulation

Uncorrelated  
Correlated  
» Universal  
Case 1

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
        AND NOT EXISTS ( -- False (i.e., exist)
            SELECT d.customerid
            FROM downloads d
            WHERE d.customerid = 'JohnnyG89'
                AND d.name = 'Aerified'
                AND d.version = '1.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

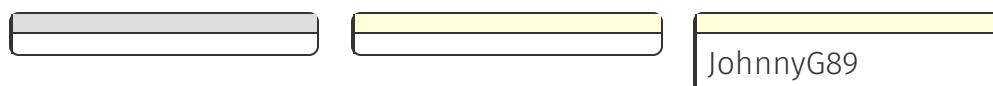
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

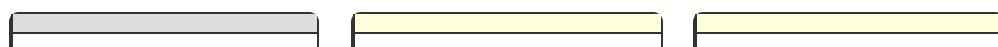
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- False
    AND NOT EXISTS ( -- don't care
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

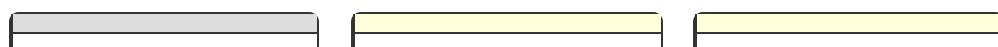
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

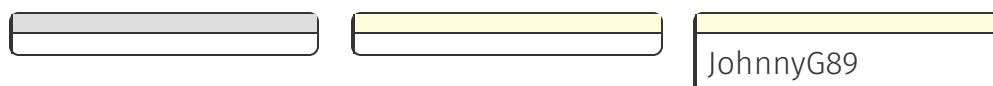
# Simulation

Uncorrelated  
Correlated  
» Universal  
Case 1

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = 'Aerified'
        AND d.version = '2.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

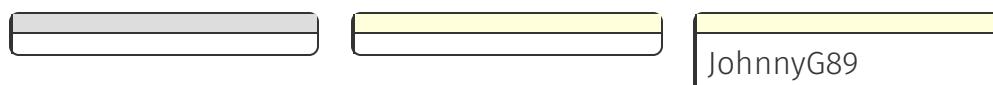
# Simulation

Uncorrelated  
Correlated  
» Universal  
Case 1

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = 'Aerified'
        AND d.version = '2.0' ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

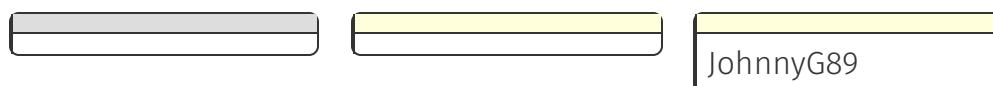
# Simulation

Uncorrelated  
Correlated  
» Universal  
Case 1

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

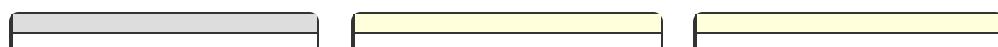
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

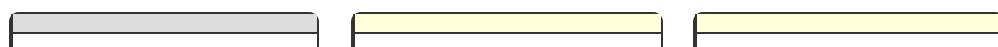
# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- False
    AND NOT EXISTS ( -- don't care
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'JohnnyG89'
        AND d.name = g.name
        AND d.version = g.version ));
```



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

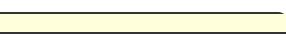
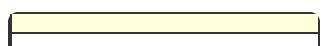
Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
  FROM customers c
 WHERE NOT EXISTS ( -- True (i.e., empty)
    SELECT g.version
      FROM games g
     WHERE g.name = 'Aerified'
       AND NOT EXISTS (
          SELECT d.customerid
            FROM downloads d
           WHERE d.customerid = c.customerid
             AND d.name = g.name
             AND d.version = g.version ));
```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

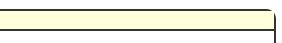
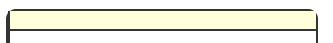
## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = c.customerid
        AND d.name = g.name
        AND d.version = g.version
    ));

```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
Case 1

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = 'Aerified'
        AND d.version = '1.0' ));
```

JohnnyG89

Tammy1998

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = 'Aerified'
        AND d.version = '1.0' ));
```

JohnnyG89

Tammy1998

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89

Tammy1998

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

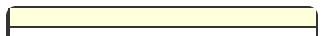
Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- False
    AND NOT EXISTS ( -- don't care
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

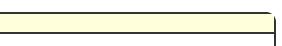
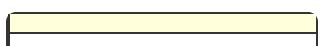
Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = 'Aerified'
        AND d.version = '2.0' ));
```

JohnnyG89

Tammy1998

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS (          -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = 'Aerified'
        AND d.version = '2.0' ));
```

JohnnyG89

Tammy1998

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- True
    AND NOT EXISTS ( -- False (i.e., exist)
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89

Tammy1998

customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version
    FROM games g
    WHERE g.name = 'Aerified'
    AND NOT EXISTS (
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
FROM customers c
WHERE NOT EXISTS (
    SELECT g.version -- Ignored (i.e., WHERE False)
    FROM games g
    WHERE g.name = 'Aerified' -- False
    AND NOT EXISTS ( -- don't care
        SELECT d.customerid
        FROM downloads d
        WHERE d.customerid = 'Tammy1998'
        AND d.name = g.name
        AND d.version = g.version ));
```

JohnnyG89



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# Simulation

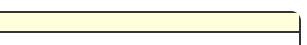
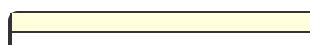
Uncorrelated  
Correlated  
» Universal  
*Case 1*

## Universal

### Case 1

```
SELECT c.customerid
  FROM customers c
 WHERE NOT EXISTS ( -- True (i.e., empty)
    SELECT g.version
      FROM games g
     WHERE g.name = 'Aerified'
       AND NOT EXISTS (
          SELECT d.customerid
            FROM downloads d
           WHERE d.customerid = c.customerid
             AND d.name = g.name
             AND d.version = g.version ));
```

JohnnyG89
Tammy1998



customers

customerid	country
Deborah84	Singapore
JohnnyG89	Malaysia
Tammy1998	Singapore

games

name	version
Aerified	1.0
Flexidy	1.0
Aerified	2.0
Flexidy	2.0

downloads

customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

```
postgres=# exit
```

```
Press any key to continue . . .
```

