

# 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	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'
);
```

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 (
    '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 (
    '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

- Unrelated
- Case 1
- Case 2
- Correlated
- Universal

## Unrelated

### 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
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
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 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	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 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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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	Hatity	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
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
RebeccaG84	Aerified	2.0
RebeccaG84	Flexidy	1.1
StephenS86	Span	2.0
Tammy1998	Hatity	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' ));
```

Deborah84

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' ));
```

Deborah84

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 ));
```

Deborah84

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' ));
```

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 ));
```

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

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 ( -- 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 ));
```

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'
  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' ));
```

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 (      -- False (i.e., exist)
    SELECT d.customerid
    FROM downloads d
    WHERE d.customerid = 'JohnnyG89'
      AND d.name = 'Aerified'
      AND d.version = '1.0' ));
```

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' -- 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 ));
```

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 = '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' ));
```

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 (      -- False (i.e., exist)
    SELECT d.customerid
    FROM downloads d
    WHERE d.customerid = 'JohnnyG89'
    AND d.name = 'Aerified'
    AND d.version = '2.0' ));
```

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' -- 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 ));
```

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 = '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

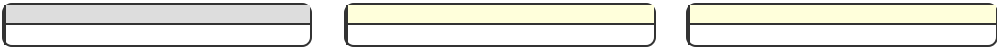
customerid	name	version
Deborah84	Aerified	1.0
Deborah84	Flexidy	1.0
Deborah84	Flexidy	2.0
JohnnyG89	Aerified	1.0
JohnnyG89	Aerified	2.0
Tammy1998	Aerified	1.0
Tammy1998	Flexidy	2.0
Tammy1998	Aerified	2.0

# 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 . . .
```

