Introduction to Database Systems CSE 414

Lecture 4: SQL Joins and Aggregates

Announcements

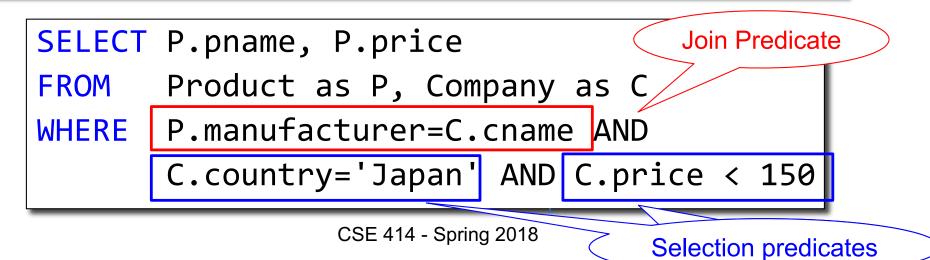
- WQ1 due on Tuesday
 - No late days allowed
- HW1 due on Tuesday
 - Submit using script in repo
- WQ2 and HW2 will be out tomorrow
 - Both are 1 week assignments
- Check website for up to date OHs

Product(<u>pname</u>, price, category, manufacturer)
Company(<u>cname</u>, country)

Joins in SQL

pname	price	category	manufacturer	cname	country
MultiTouch	199.99	gadget	Canon	GizmoWorks	USA
SingleTouch	49.99	photography	Canon	Canon	Japan
Gizom	50	gadget	GizmoWorks	Hitachi	Japan
SuperGizmo	250.00	gadget	GizmoWorks		-

Retrieve all Japanese products that cost < \$150



Product(pname, price, category, manufacturer)
Company(cname, country)

Joins in SQL

pname	price	category	manufacturer
MultiTouch	199.99	gadget	Canon
SingleTouch	49.99	photography	Canon
Gizom	50	gadget	GizmoWorks
SuperGizmo	250.00	gadget	GizmoWorks

cname	country	
GizmoWorks	USA	
Canon	Japan	
Hitachi	Japan	

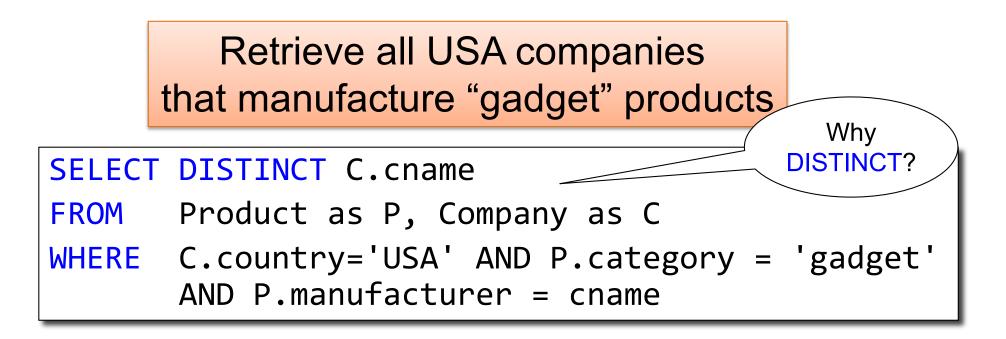
Retrieve all USA companies that manufacture "gadget" products

Product(<u>pname</u>, price, category, manufacturer)
Company(<u>cname</u>, country)

Joins in SQL

pname	price	category	manufacturer	
MultiTouch	199.99	gadget	Canon	
SingleTouch	49.99	photography	Canon	
Gizom	50	gadget	GizmoWorks	
SuperGizmo	250.00	gadget	GizmoWorks	

cname	country	
GizmoWorks	USA	
Canon	Japan	
Hitachi	Japan	



Product(pname, price, category, manufacturer)
Company(cname, country)

-- manufacturer is foreign key to Company

SELECT	DISTINCT cname
FROM	Product, Company
WHERE	country='USA' AND category = 'gadget' AND manufacturer = cname

SELECT DISTINCT cname

FROM Product, Company

WHERE country='USA' AND category = 'gadget' AND manufacturer = cname

Product

pname	category	manufacturer
Gizmo	gadget	GizmoWorks
Camera	Photo	Hitachi
OneClick	Photo	Hitachi

cname	country
GizmoWorks	USA
Canon	Japan
Hitachi	Japan

SELECT DISTINCT cname

FROM Product, Company

WHERE country='USA' AND category = 'gadget' AND manufacturer = cname

Product

pname	category	manufacturer	
Gizmo	gadget	GizmoWorks	
Camera	Photo	Hitachi	
OneClick	Photo	Hitachi	

cname	country
GizmoWorks	USA
Canon	Japan
Hitachi	Japan

SELECT DISTINCT cname FROM Product, Company WHERE country='USA' AND category = 'gadget' AND manufacturer = cname

Product

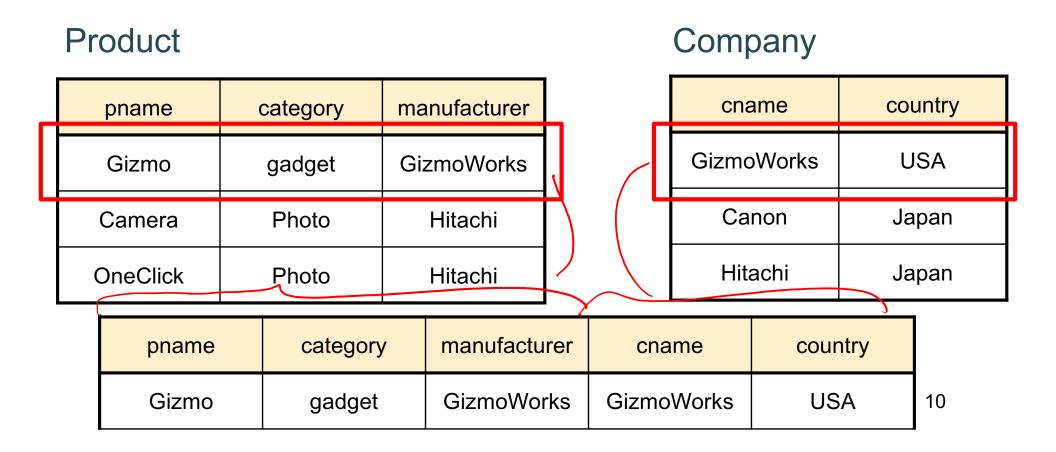
pname	category	manufacturer	
Gizmo	gadget	GizmoWorks	
Camera	Photo	Hitachi	
OneClick	Photo	Hitachi	

cname	country
GizmoWorks	USA
Canon	Japan
Hitachi	Japan

SELECT DISTINCT cname

FROM Product, Company

WHERE country='USA' AND category = 'gadget' AND manufacturer = cname



SELECT DISTINCT cname

FROM Product, Company

WHERE country='USA' AND category = 'gadget' AND manufacturer = cname

Product

pname	category	manufacturer
Gizmo gadget		GizmoWorks
Camera	Photo	Hitachi
OneClick	Photo	Hitachi

cname	country
GizmoWorks	USA
Canon	Japan
Hitachi	Japan

SELECT DISTINCT cname

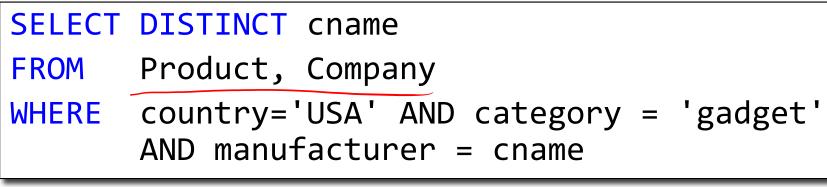
FROM Product, Company

WHERE country='USA' AND category = 'gadget' AND manufacturer = cname

Product

pname	category	manufacturer	
Gizmo gadget		GizmoWorks	
Camera	Photo	Hitachi	
OneClick	Photo	Hitachi	

cname	country
GizmoWorks	USA
Canon	Japan
Hitachi	Japan



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SELECT	DISTINCT cname
FROM	Product JOIN Company ON
	country = 'USA' AND category = 'gadget'
	AND manufacturer = cname

SELECT x1.a1, x2.a2, ... xm.am
FROM R1 as x1, R2 as x2, ... Rm as xm
WHERE Cond

typle in RI

for x1 in R1:

for x2 in R2:

for xm in Rm:

if Cond(x1, x2...):

output(x1.a1, x2.a2, ... xm.am)

This is called nested loop semantics since we are interpreting what a join means using a nested loop

Product(pname, price, category, manufacturer)
Company(cname, country)

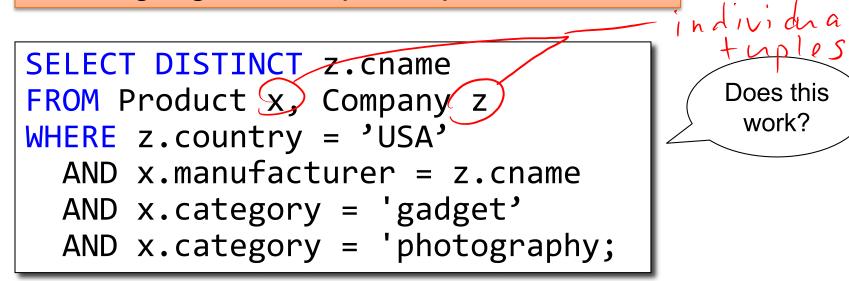
-- manufacturer is foreign key to Company

Find US companies that manufacture both 'gadgets' and 'photo' products

Product(pname, price, category, manufacturer)
Company(cname, country)

-- manufacturer is foreign key to Company

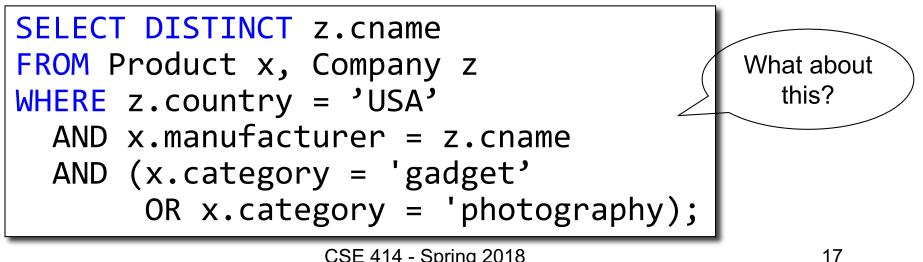
Find US companies that manufacture both 'gadgets' and 'photo' products



Product(pname, price, category, manufacturer) Company(cname, country)

-- manufacturer is foreign key to Company

Find US companies that manufacture both 'gadgets' and 'photo' products

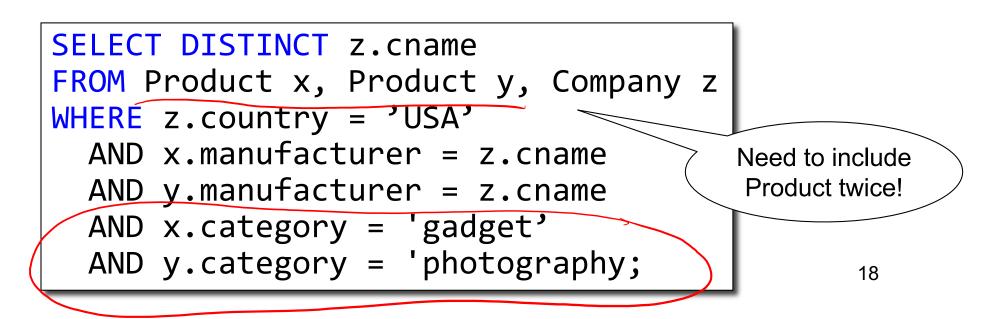


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Product(pname, price, category, manufacturer)
Company(cname, country)

-- manufacturer is foreign key to Company

Find US companies that manufacture both 'gadgets' and 'photo' products



Self-Joins and Tuple Variables

Find US companies that manufacture both 'gadgets' and 'photo' products

- Joining Product with Company is insufficient: need to join Product, with Product, and with Company
- When a relation occurs twice in the FROM clause we call it a self-join; in that case we must use tuple variables (aka table aliases) (why?)

SELECT DISTINCT z.cname
FROM Product x, Product y, Company z
WHERE z.country = 'USA'
AND x.category = 'gadget'
AND y.category = 'photo'
AND x.manufacturer = z.cname
AND y.manufacturer = z.cname;

Product

pname	category	manufacturer		
Gizmo	gadget	GizmoWorks		
SingleTouch	photo	Hitachi		
MultiTouch	Photo	GizmoWorks		

cname	country
GizmoWorks	USA
Hitachi	Japan

SELECT DISTINCT z.cname
FROM Product x, Product y, Company z
WHERE z.country = 'USA'
AND x.category = 'gadget'
AND y.category = 'photo'
AND x.manufacturer = z.cname
AND y.manufacturer = z.cname;

Product

X

pname	category	manufacturer	
Gizmo	gadget	GizmoWorks	
SingleTouch	ch photo Hitach		
MultiTouch	Photo	GizmoWorks	

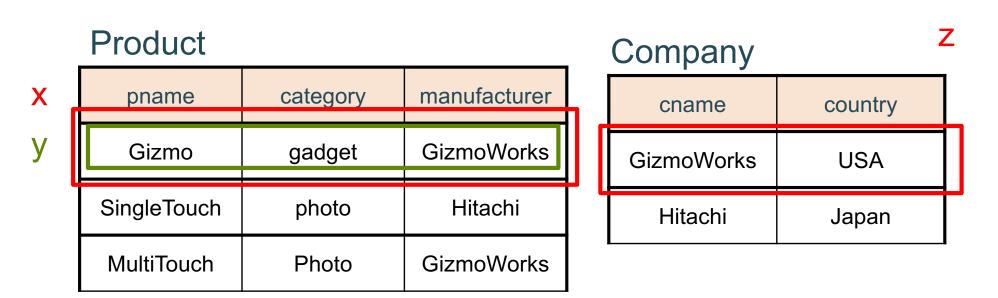
cname	country
GizmoWorks	USA
Hitachi	Japan

SELECT DISTINCT z.cname
FROM Product x, Product y, Company z
WHERE z.country = 'USA'
AND x.category = 'gadget'
AND y.category = 'photo'
AND x.manufacturer = z.cname
AND y.manufacturer = z.cname;

Product

x	pname	category	manufacturer	
у	Gizmo	gadget	GizmoWorks	
	SingleTouch	photo	Hitachi	
	MultiTouch	Photo	GizmoWorks	

cname	country
GizmoWorks	USA
Hitachi	Japan



SELECT DISTINCT z.cname
FROM Product x, Product y, Company z
WHERE z.country = 'USA'
AND x.category = 'gadget'
AND y.category = 'photo'
AND x.manufacturer = z.cname
AND y.manufacturer = z.cname;

Ζ Product Company X manufacturer category pname country cname У Gizmo gadget GizmoWorks GizmoWorks USA SingleTouch Hitachi photo Hitachi Japan **MultiTouch** GizmoWorks Photo

	Product			•	Company	:	Z
×	pname	category	manufacturer		cname	country	
	Gizmo	gadget	GizmoWorks		GizmoWorks	USA	Π
У	SingleTouch	photo	Hitachi	┍	Hitachi	Japan	Γ
	MultiTouch	Photo	GizmoWorks				J

SELECT DISTINCT z.cname
FROM Product x, Product y, Company z
WHERE z.country = 'USA'
AND x.category = 'gadget'
AND y.category = 'photo'
AND x.manufacturer = z.cname
AND y.manufacturer = z.cname;

Ζ Product Company manufacturer X category pname country cname Gizmo GizmoWorks gadget **GizmoWorks** USA У SingleTouch Hitachi photo Hitachi Japan **MultiTouch** GizmoWorks Photo

	Product		•	Company			
Х	pname	category	manufacturer		cname	country	
	Gizmo	gadget	GizmoWorks		GizmoWorks	USA	1
	SingleTouch	photo	Hitachi		Hitachi	Japan	ť
У	MultiTouch	Photo	GizmoWorks				4

	Product				Company				-		
Х	pname		catego	ory	manu	facturer	1	cname	countr	Ŋ	
	Gizmo		gadg	et	Gizm	GizmoWorks		GizmoWorks	USA]
	SingleTouc	ch	phot	0	Hi	Hitachi		Hitachi	Japar	l l	J
У	MultiTouc	h	Phot	0	Gizm	oWorks					
x.pnam	e x.category	x.m	anufacturer	y.pn	ame	y.category	<i>y</i>	y.manufacturer	z.cname	z.coui	ntry
Gizmo	gadget GizmoWorks		Multi	MultiTouch Ph			GizmoWorks	GizmoWorks	USA	A	

Product								Company				Z
Х	pname		catego	ory	manu	facturer	7	cname		country		1
	Gizmo		gadg	et	Gizm	oWorks] [GizmoWork	izmoWorks			1
	SingleTouc	ch	phot	0	Hi	Hitachi		Hitachi		Japar	1	
У	MultiTouc	h	Phot	0	Gizm	oWorks						_
x.pnam	e x.category	x.m	anufacturer	y.pn	ame	y.category	y	y.manufacturer		z.cname	Z.C	ountry
Gizmo	izmo gadget GizmoWorks MultiTouch		Photo		GizmoWorks		GizmoWorks	ι	JSA			

Joins in SQL

- The join we have just seen is sometimes called an inner join
 - Each row in the result must come from
 both tables in the join
- Sometimes we want to include rows from only one of the two table: outer join

Inner Join

Employee			Sales					
id	name		<u>employeeID</u>	productID				
1	Joe		1	344				
2	Jack		1	355				
3	Jill		2	544				

Retrieve employees and their sales

Inner Join

Employee			Sales					
id	name		<u>employeeID</u>	productID				
1	Joe		1	344				
2	Jack		1	355				
3	Jill		2	544				

Retrieve employees and their sales

SELECT *

FROM Employee E, Sales S
WHERE E.id = S.employeeID

Inner Join

Employee			Sales					
id	name		<u>employeeID</u>	productID				
1	Joe		1	344				
2	Jack		1	355				
3	Jill		2	544				

Retrieve employees and their sales

SELECT	*	id	name	empolyeeID	productID
FROM	Employee E, Sales S	1	Joe	1	344
WHERE	E.id = S.employeeID	1	Joe	1	355
		2	Jack	2	544

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Inner Join

	Employee			Sales			
	id name		e	employeeID		productID	
	1	Joe		1		344	
	2	Jack		1		355	
	3	Jill		2		544	
Retrieve employees and th				ir sal	es	r	Jill is nissing
SELE	CT *			id	name	empolyeeID	productID
FROM	Employ	vee E, Sales	S	1	Joe	1	344
WHERI		S.employee		1	Joe	1	355
				2	Jack	2	544

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Inner Join

	Employee			S	ales			
	id	name	E		mploye	<u>eeID</u>	productID	
	1 Joe			1			344	
	2 Jack		1	1		355		
	3	Jill		2			544	
Retrieve employees and t Alternat					r sal	es	r	Jill is nissing
SELE	CT *	synta		1	id	name	empolyeeID	productID
FROM	Employ	vee E			1	Joe	1	344
	INNER	JOIN			1	Joe	1	355
	Sales	S			2	Jack	2	544
((ON E.id =	<pre>S.employee</pre>	PIC	נ				36

Outer Join

	Employee			Sales			
	id	name	e	employeeID		productID	
	1	Joe	-	1		344	
	2	Jack	-			355	
	3	Jill		2		544	
Retr	ieve emp	loyees and	the	ir sal	es	Jill is presen	It
SELE	CT *			id	name	empolyeeID	productID
FROM	Employ	vee E		1	Joe	1	344
LEFT OUTER JOIN Sales S ON E.id = S.employeeI				1	Joe	1	355
				2	Jack	2	544
				3	Jill	NULL	NULL

Outer joins

Product(<u>name</u>, category)
Purchase(prodName, store)

-- prodName is foreign key

SELECT Product.name, Purchase.store
FROM Product LEFT OUTER JOIN Purchase ON
Product.name = Purchase.prodName

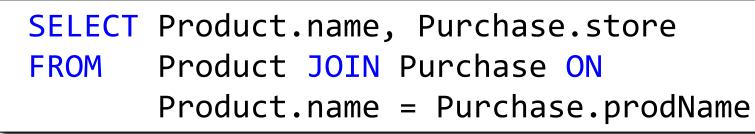
SELECT Product.name, Purchase.store FROM Product JOIN Purchase ON Product.name = Purchase.prodName

Product

Name	Category		
Gizmo	gadget		
Camera	Photo		
OneClick	Photo		

Purchase

ProdName	Store		
Gizmo	Wiz		
Camera	Ritz		
Camera	Wiz		

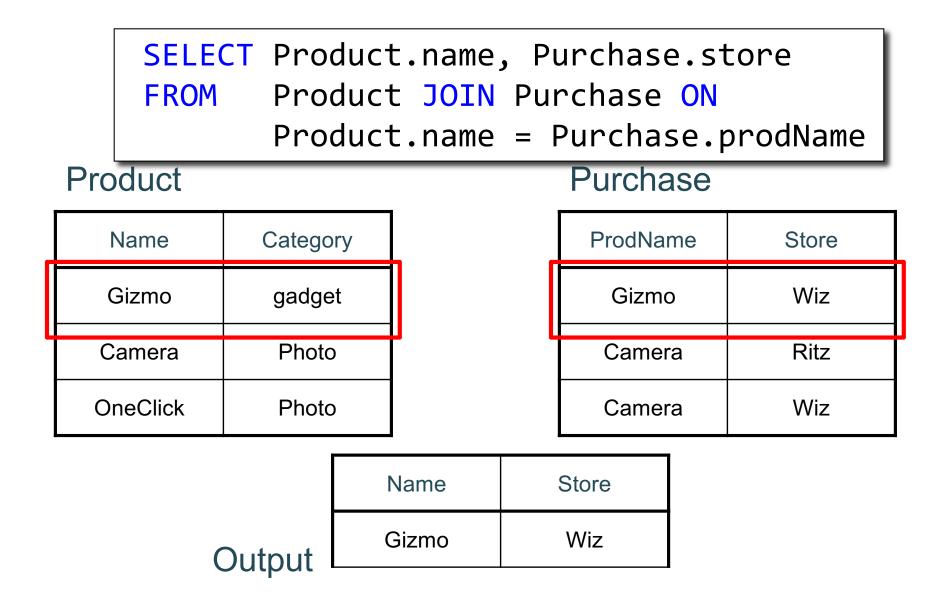


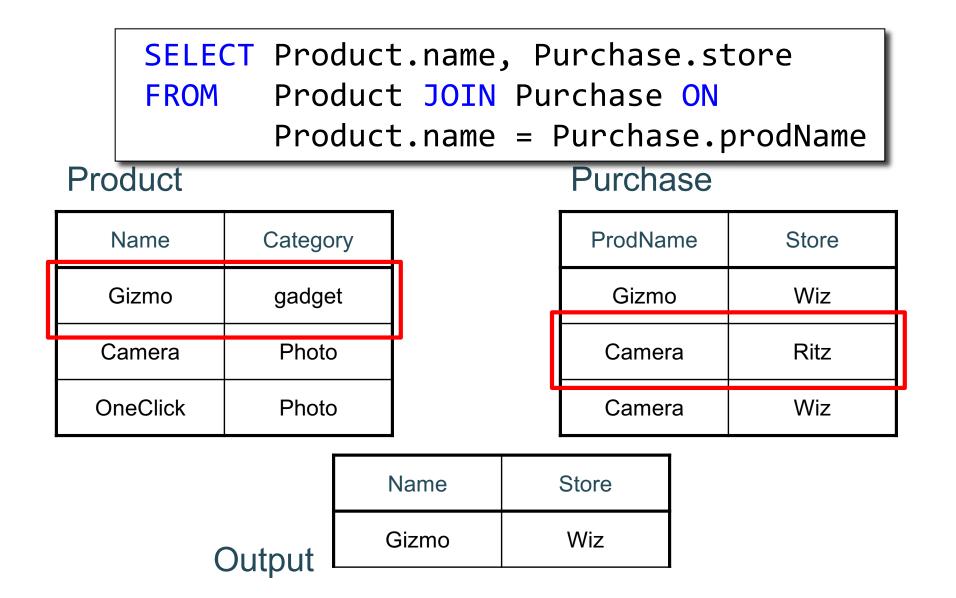
Product

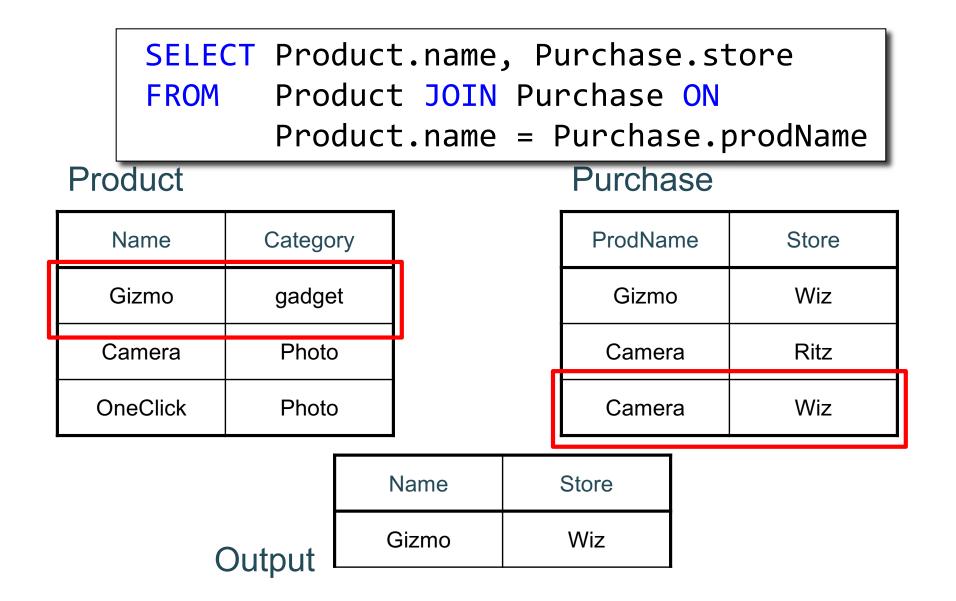
Name	Name Category		
Gizmo	gadget		
Camera	Photo		
OneClick	Photo		

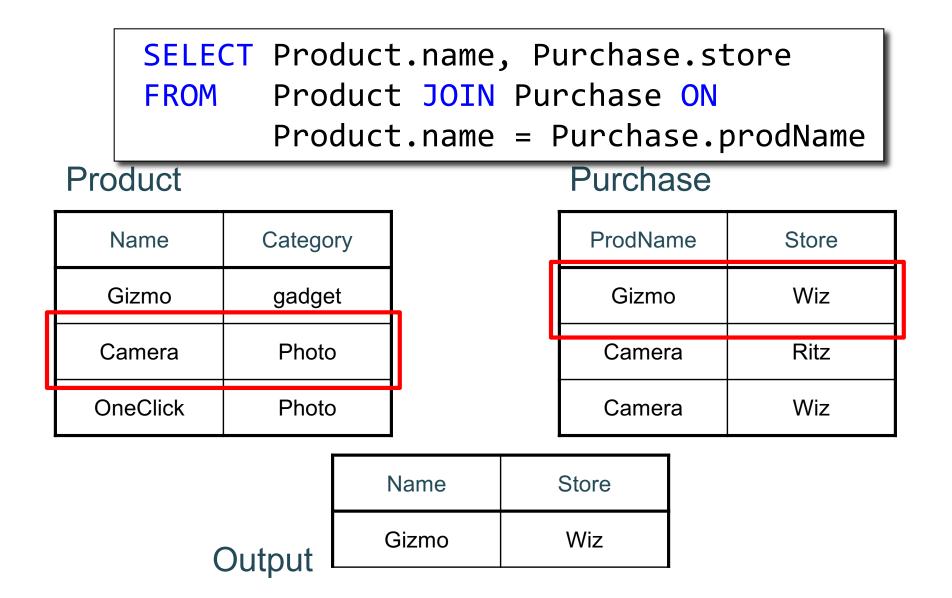
Purchase

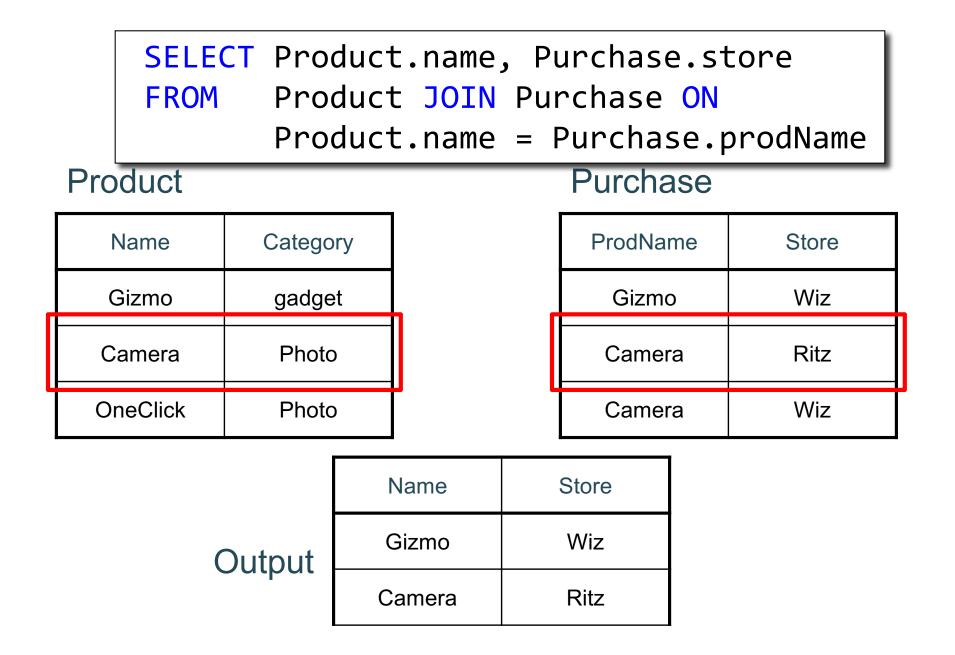
ProdName	Store		
Gizmo	Wiz		
Camera	Ritz		
Camera	Wiz		

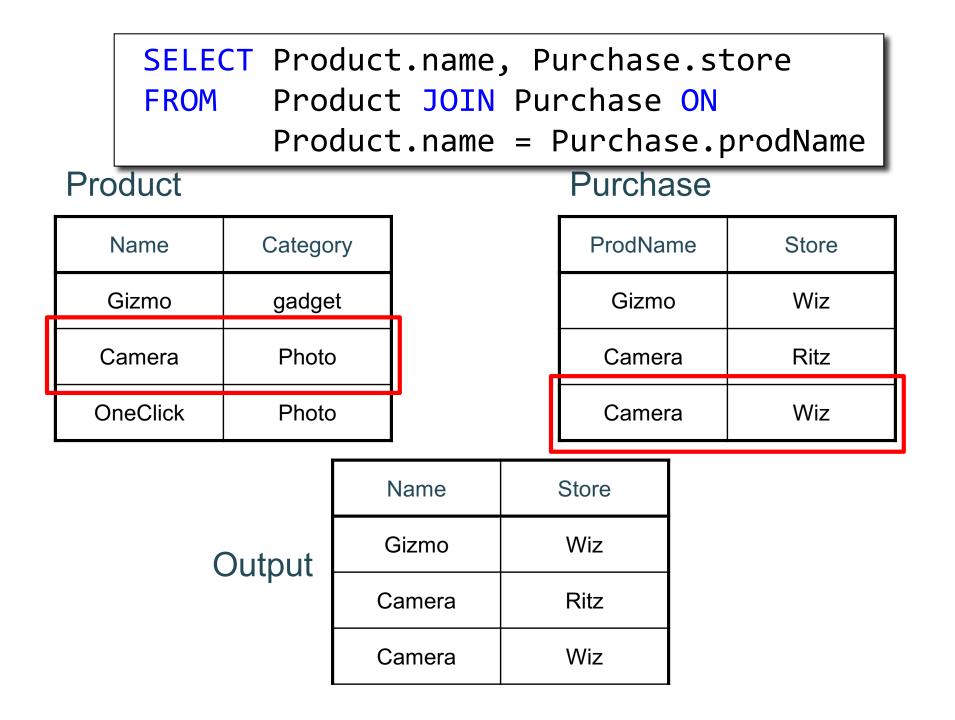


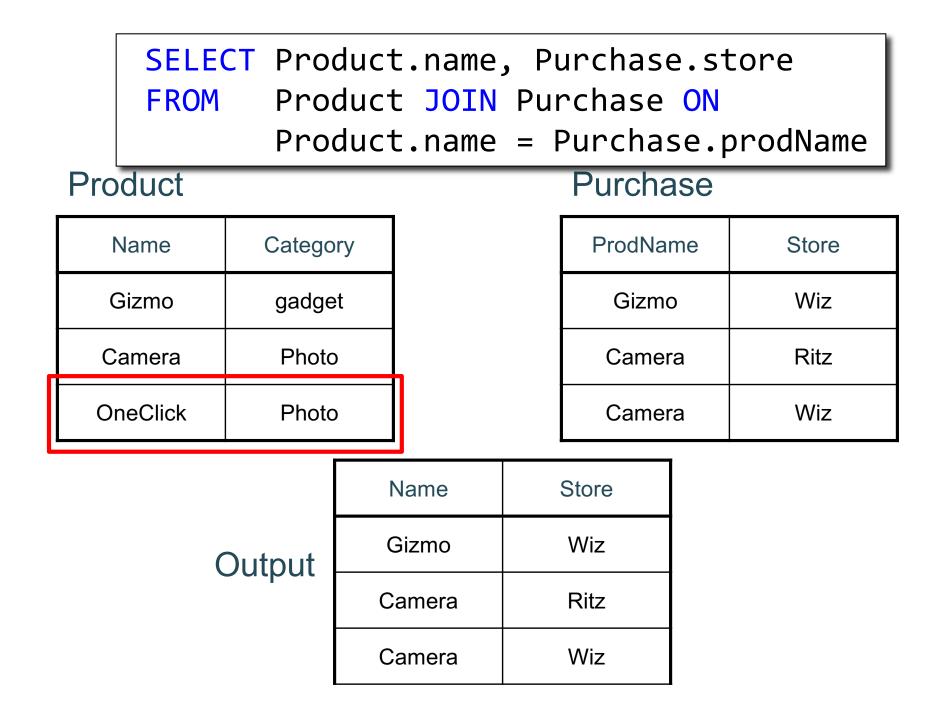


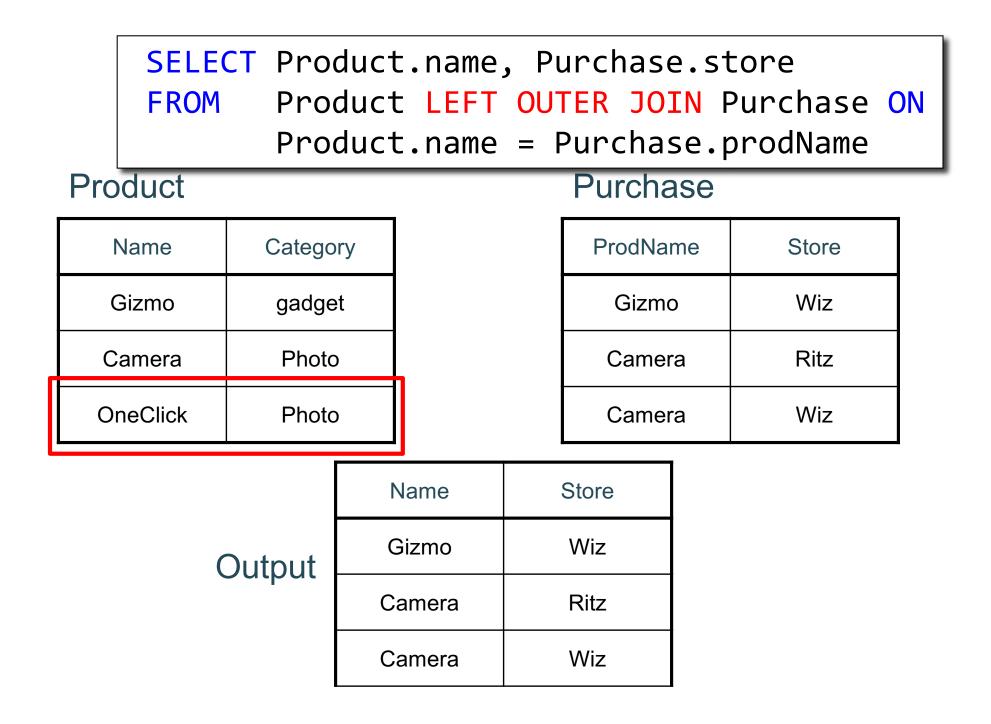


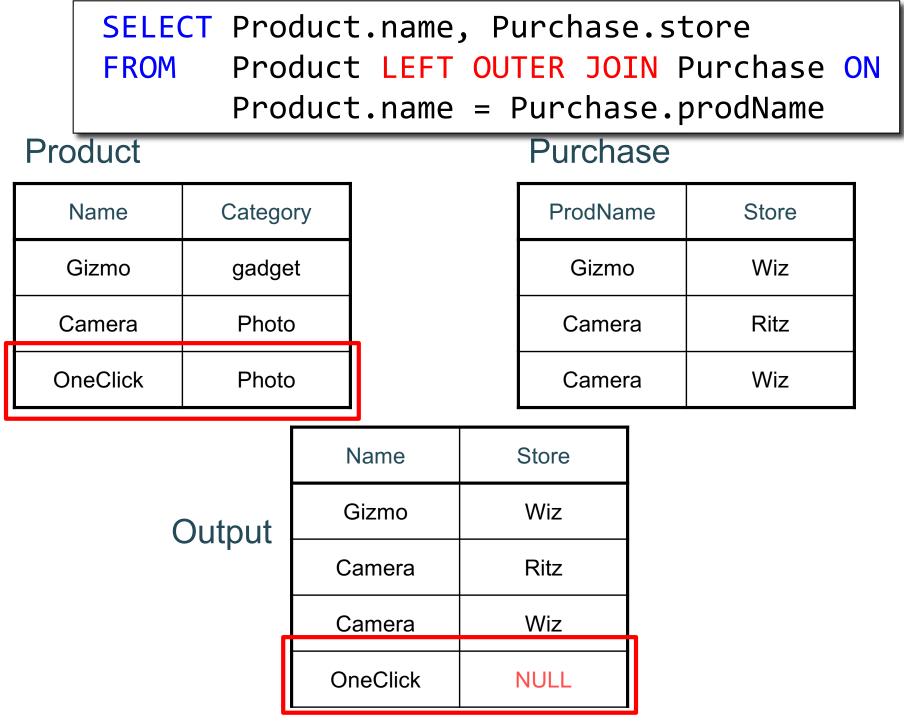












<pre>SELECT Product.name, Purchase.store FROM Product FULL OUTER JOIN Purchase ON Product.name = Purchase.prodName</pre>							
Product Purchase							
Name	Category			ProdName	Store		
Gizmo	gadget			Gizmo	Wiz		
Camera	Photo			Camera	Ritz		
OneClick	Photo			Camera	Wiz		
	Name	Store		Phone	Foo		
Output	Gizmo	Wiz)			
	Camera	Ritz					
	Camera	Wiz					
	OneClick	NULL					
	NULL	Foo	1	\langle		50	

Outer Joins

tableA (LEFT/RIGHT/FULL) OUTER JOIN tableB ON p

- Left outer join:
 - Include tuples from tableA even if no match
- Right outer join:
 - Include tuples from tableB even if no match
- Full outer join:
 - Include tuples from both even if no match
- In all cases:
 - Patch tuples without matches using NULL