Introduction to File and Database Management

Relational Algebra and SQL Expressions

Goals:

- Formulate queries (stated in English language) to their equivalent relational algebra expressions.

- Translate relational algebra expressions into equivalent SQL statement

Schema of Relations

- product(maker, model, type)

MAKER	MODEL	TYPE
A	1001	PC
A	1002	PC
A	1003	PC
B	1004	PC

A snapshot

Schema of Relations

- pc(<u>model</u>, speed, ram, HD, price)

MODEL	SPEED	RAM	HD	PRICE
1001	133	16	1.6	1595
1002	120	16	1.6	1399
1003	166	24	2.5	1899
1004	166	32	2.5	1999

A snapshot

Schema of Relations

- laptop(<u>model</u>, speed, ram, HD, price)

MODEL	SPEED	RAM	HD	PRICE
2001	100	20	1.1	1999
2002	117	12	0.7	2499
2003	117	32	1	3599
2004	133	16	1.1	3499

A snapshot

Schema of Relations

- printer(model, color, type, price)

MODEL	COLOR	TYPE	PRICE
3001	True	Ink-jet	275
3002	True	Ink-jet	269
3003	False	Laser	829
3004	False	Laser	879

A snapshot

QUERY

- List the model for PCs that are faster than 150Mhz?

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- List the model for PCs that are faster than 150Mhz?

$$\pi_{model}\left(\sigma_{speed>150}\left(pc\right)\right)$$

QUERY

- List the model for PCs that are faster than 150Mhz?

$$\pi_{model}\left(\sigma_{speed>150}\left(pc\right)\right)$$

```
SELECT model
FROM pc
WHERE speed > 150;
```

QUERY

- Which models of laser printers print in color?

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- Which models of laser printers print in color?

$$\pi_{model}\left(\sigma_{color='true'\ and\ type='laser'}(printer)\right)$$

QUERY

- Which <u>models</u> of <u>laser printers</u> print in <u>color</u>?

$$\pi_{model}\left(\sigma_{color='true'\ and\ type='laser'}(printer)\right)$$

```
SELECT model
 FROM printer
 WHERE(color = 'true' and type='laser');
```

QUERY

- List prices & models of all pc,laptop,printers.

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- List prices & models of all pc,laptop,printers.

$$\pi_{model,\,price}(pc)$$

$$\cup$$

$$\pi_{model,\,price}(laptop)$$

$$\cup$$

$$\pi_{model,\,price}(printer)$$

Union

```
SELECT model, price FROM pc
UNION
SELECT model, price FROM laptop
UNION
SELECT model, price FROM printer;
```

QUERY

- List makers that make laptops but not PCs.

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- List makers that make laptops but not PCs.

$$\pi_{maker}(\sigma_{type='laptop'}(product)) - \pi_{maker}(\sigma_{type='pc'}(product))$$

QUERY

- List makers that make laptops but not PCs.

$$\pi_{maker}(\sigma_{type='laptop'}(product)) - \pi_{maker}(\sigma_{type='pc'}(product))$$

```
SELECT maker FROM product WHERE type = 'laptop'
EXCEPT
SELECT maker FROM product WHERE type = 'pc';
```

QUERY

- Which speeds are common in PCs and laptops.

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- Which speeds are common in PCs and laptops.

$$\pi_{speed}(pc) \quad \cap \quad \pi_{speed}(laptop)$$

QUERY

- Which speeds are common in PCs and laptops.

$$\pi_{speed}(pc) \cap \pi_{speed}(laptop)$$

$$A \cap B = A - (A - B)$$

$$\pi_{speed}(pc) - (\pi_{speed}(pc) - \pi_{speed}(laptop))$$

Intersection Using difference

QUERY

- Which speeds are common in PCs and laptops.

$$\pi_{speed}(pc) \quad \cap \quad \pi_{speed}(laptop)$$

```
SELECT speed FROM pc
  INTERSECT
SELECT speed FROM laptop;
```

QUERY

- List makers and prices for makers that produce pc.

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- List makers and prices for makers that produce pc.

$$\pi_{maker,\,price}(product \bowtie pc)$$

```
SELECT maker, price
FROM product, pc
WHERE product.model = pc.model;
```

QUERY

- Which makers produce laptops with a hard disk of at least 1G?

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- Which makers produce laptops with a hard disk of at least 1G?

$$\pi_{maker}\left(product \bowtie \left(\sigma_{hd \geq 1}(laptop) \right) \right)$$

```
SELECT maker
FROM product, laptop
WHERE hd>=1 and product.model = laptop.model;
```

QUERY

- List makers that make at least 2 different models.

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

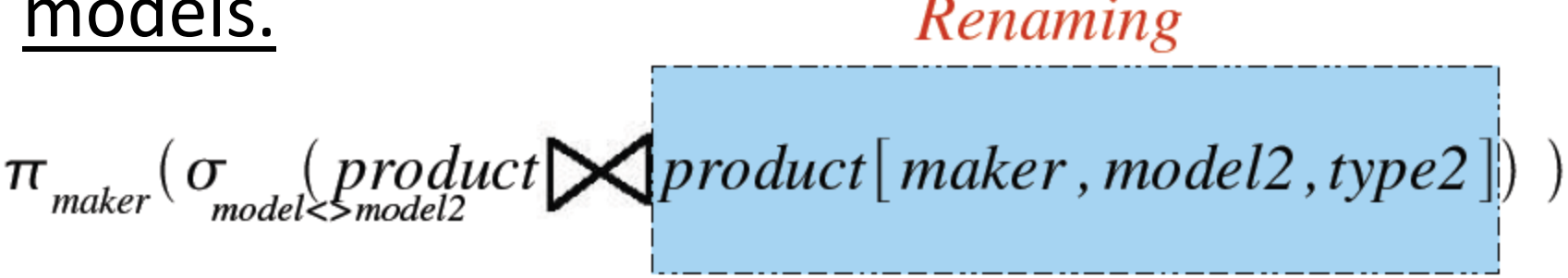
- List makers that make at least 2 different models.

Renaming

$$\pi_{maker}\left(\sigma_{model<>model2}\left(product \bowtie product[maker, model2, type2]\right)\right)$$

QUERY

- List makers that make at least 2 different models.




```
SELECT p1.maker
FROM product p1, product p2
WHERE p1.maker = p2.maker
 and p1.model <>p2.model;
```

QUERY

- Find all laptop models that are more expensive than the most expensive PC.

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- Find all laptop models that are more expensive than the most expensive PC.

$$\pi_{model}(\sigma_{price>\pi_{max(price)}(pc)}(laptop))$$

QUERY

- Find all laptop models that are more expensive than the most expensive PC.

$$\pi_{model}(\sigma_{price>\pi_{max(price)}(pc)}(laptop))$$

```
SELECT laptop.model
FROM laptop
WHERE laptop.price >
        (SELECT MAX(pc.price) FROM pc );
```

QUERY

- Find the CPU speed and HD size for all PCs and laptops with no duplicate rows in the output.

Given:

product(maker,model,type)

pc(model,speed,ram,HD,price)

laptop(model,speed,ram,HD,price)

printer(model,color,type,price)

QUERY

- Find the CPU speed and HD size for all PCs and laptops with no duplicate rows in the output.

$$\pi_{speed,hd}(laptop) \bigcup \pi_{speed,hd}(pc)$$

QUERY

- Find the CPU speed and HD size for all PCs and laptops with no duplicate rows in the output.

$$\pi_{speed,hd}(laptop) \bigcup \pi_{speed,hd}(pc)$$

```
SELECT laptop.speed, laptop.hd FROM laptop
UNION
SELECT pc.speed, pc.hd FROM pc;
```