

Query Processing and Advanced Queries

Query Processing (1)

Example

Select B,D

From R,S

Where $R.A = \text{"c"} \wedge S.E = 2 \wedge R.C = S.C$

Example (cont.)

R	A	B	C	S	C	D	E
	a	1	10		10	x	2
	b	1	20		20	y	2
	c	2	10		30	z	2
	d	2	35		40	x	1
	e	3	45		50	y	3

Example (cont.)

R	A	B	C	S	C	D	E
	a	1	10		10	x	2
	b	1	20		20	y	2
	c	2	10		30	z	2
	d	2	35		40	x	1
	e	3	45		50	y	3

Answer

B	D
2	x

How Do We Execute Query?

One idea

- Do **Cartesian Product**
- Select tuples
- Do projection

One Idea

RXS	R.A	R.B	R.C	S.C	S.D	S.E
a	1	10	10	x	2	
a	1	10	20	y	2	
.						
.						
C	2	10	10	x	2	
.						
.						

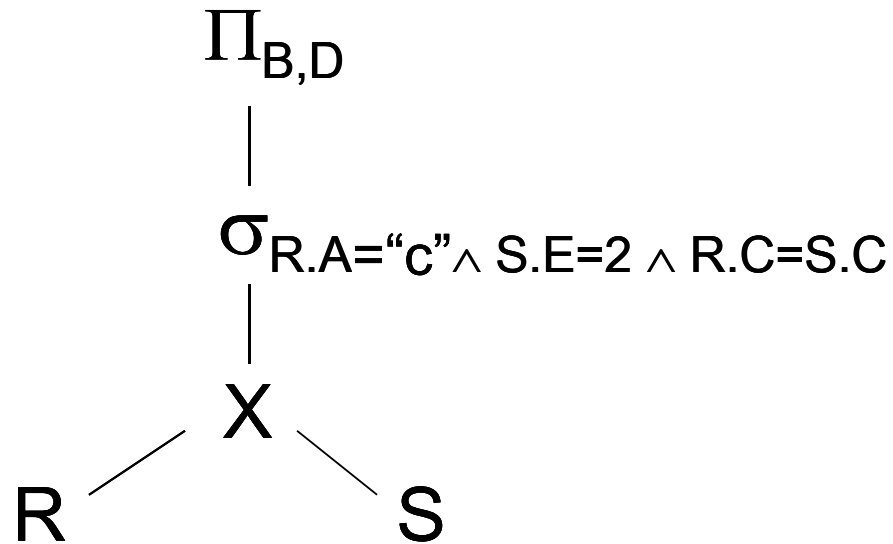
One Idea

RXS	R.A	R.B	R.C	S.C	S.D	S.E
	a	1	10	10	x	2
	a	1	10	20	y	2
	.					
	.					
Bingo! →	C	2	10	10	x	2
Got one...	.					
	.					

Relational Algebra

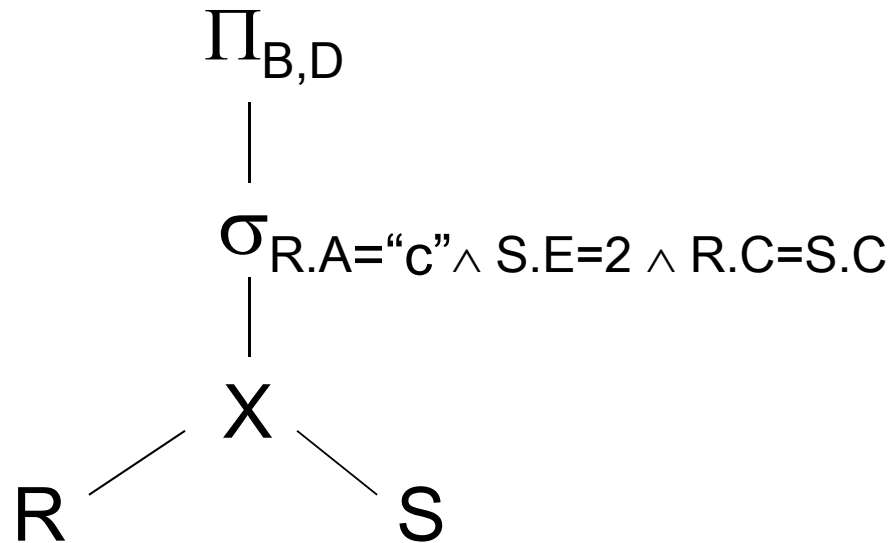
Ex: Plan I

can be used to describe plans...



Relational Algebra (cont.)

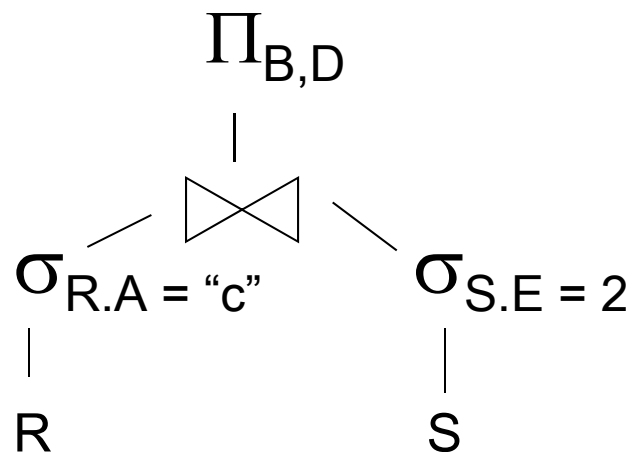
Ex: Plan I

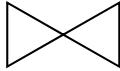


OR: $\Pi_{B,D} [\sigma_{R.A="c" \wedge S.E=2 \wedge R.C = S.C} (RXS)]$

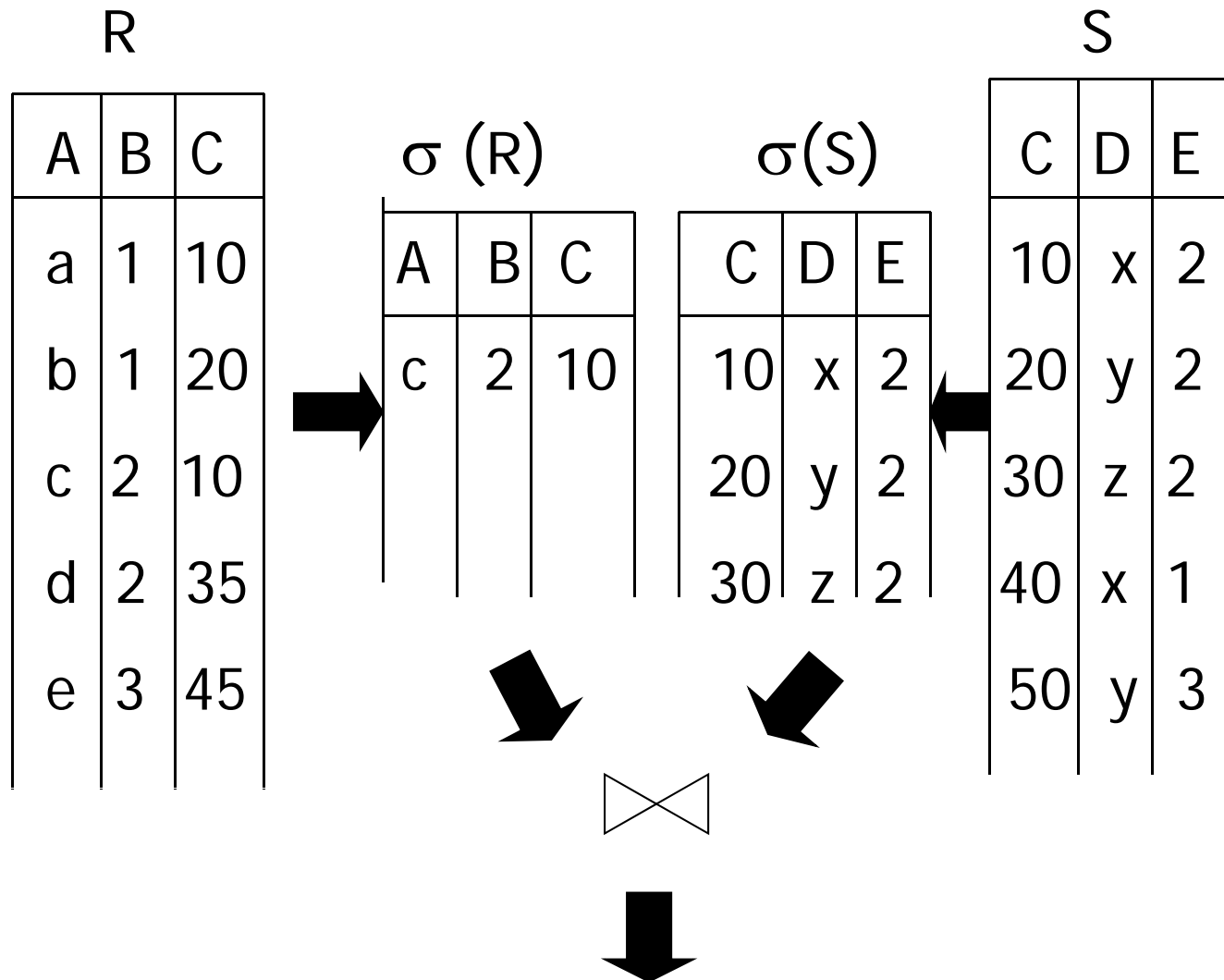
Another Idea (1)

Plan II




natural join

Another Idea (2)



Plan III (1)

Use R.A and S.C Indexes

(1) Use R.A index to select R tuples
with R.A = "c"

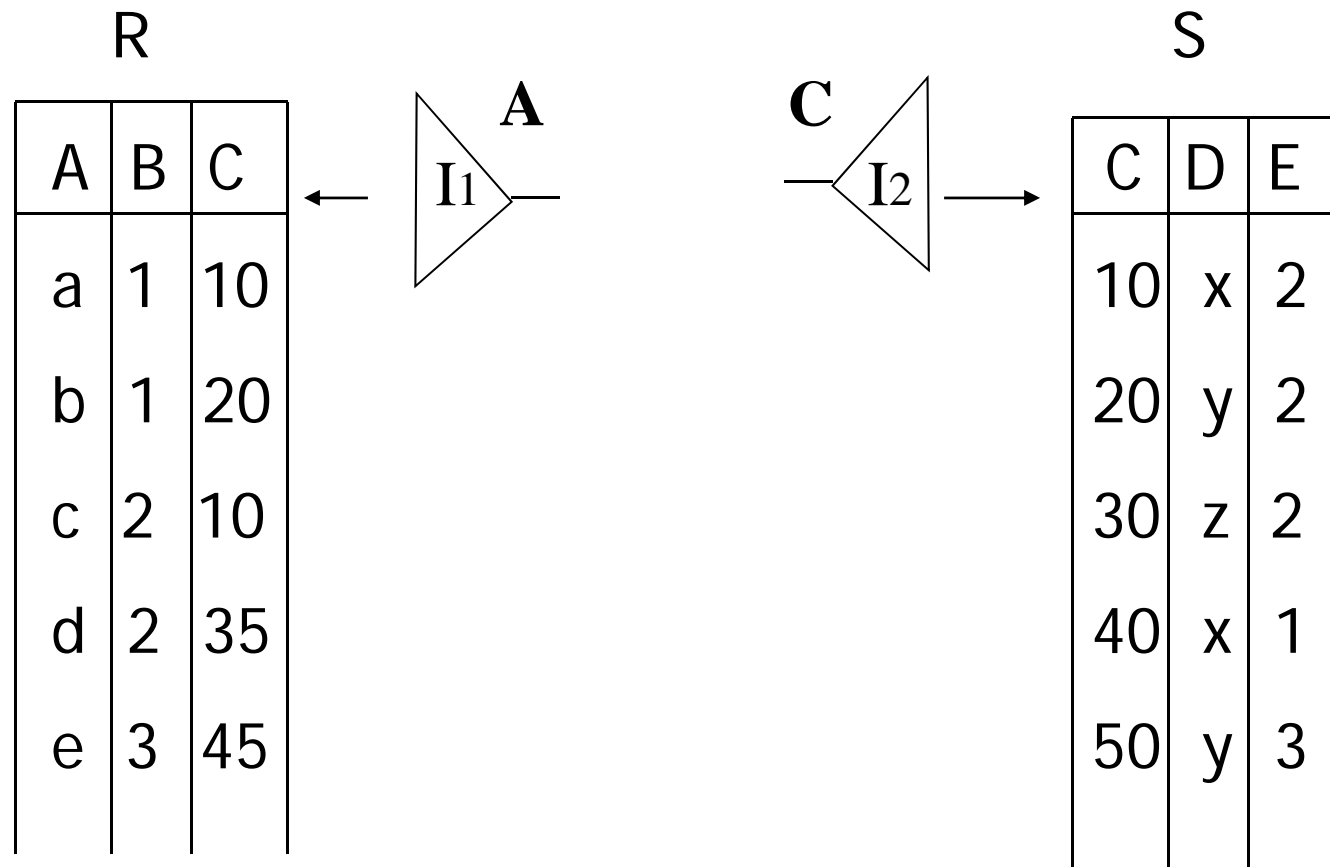
(2) For each R.C value found, use S.C
index to find matching tuples

Plan III (2)

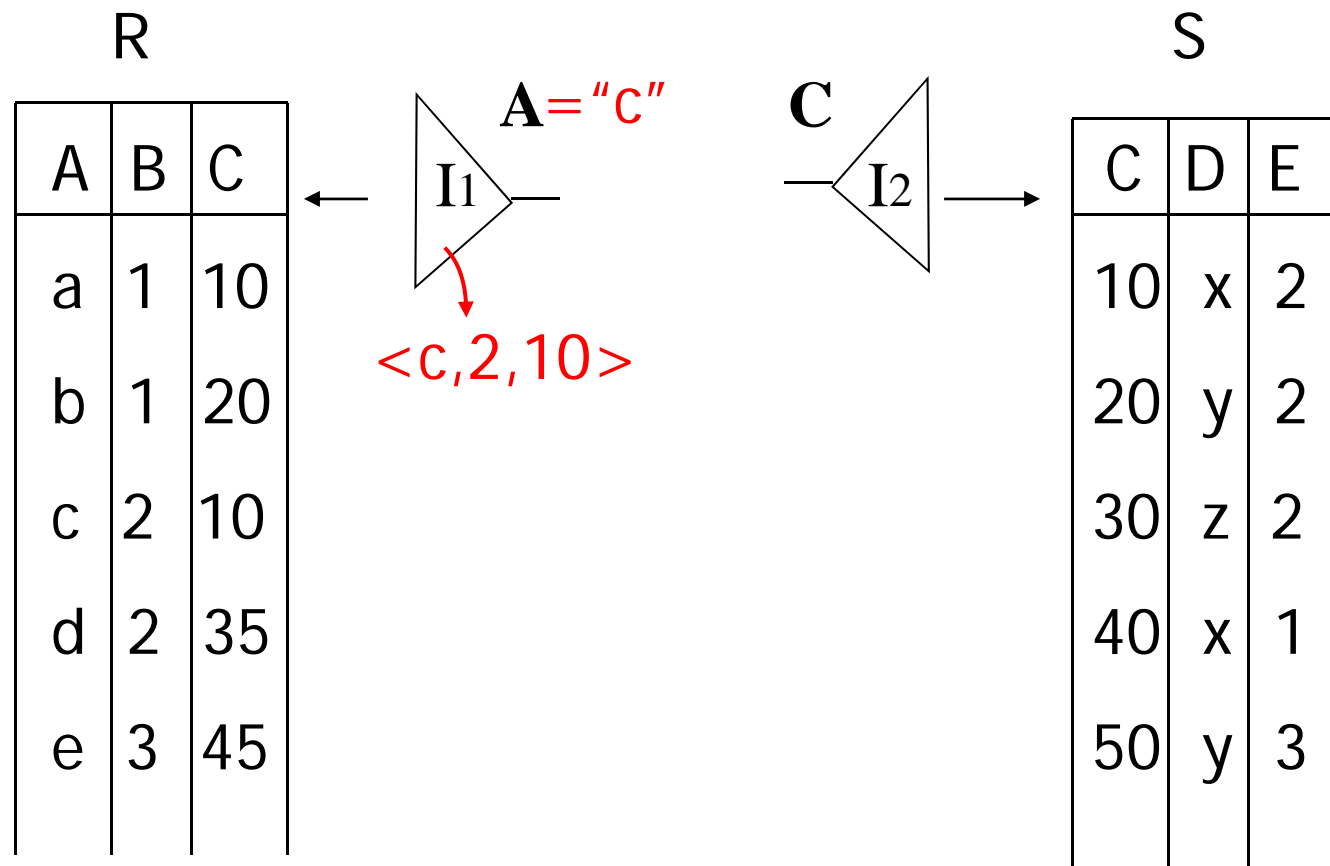
Use R.A and S.C Indexes

- (1) Use R.A index to select R tuples with R.A = "c"
- (2) For each R.C value found, use S.C index to find matching tuples
- (3) Eliminate S tuples S.E \neq 2
- (4) Join matching R,S tuples, project B,D attributes and place in result

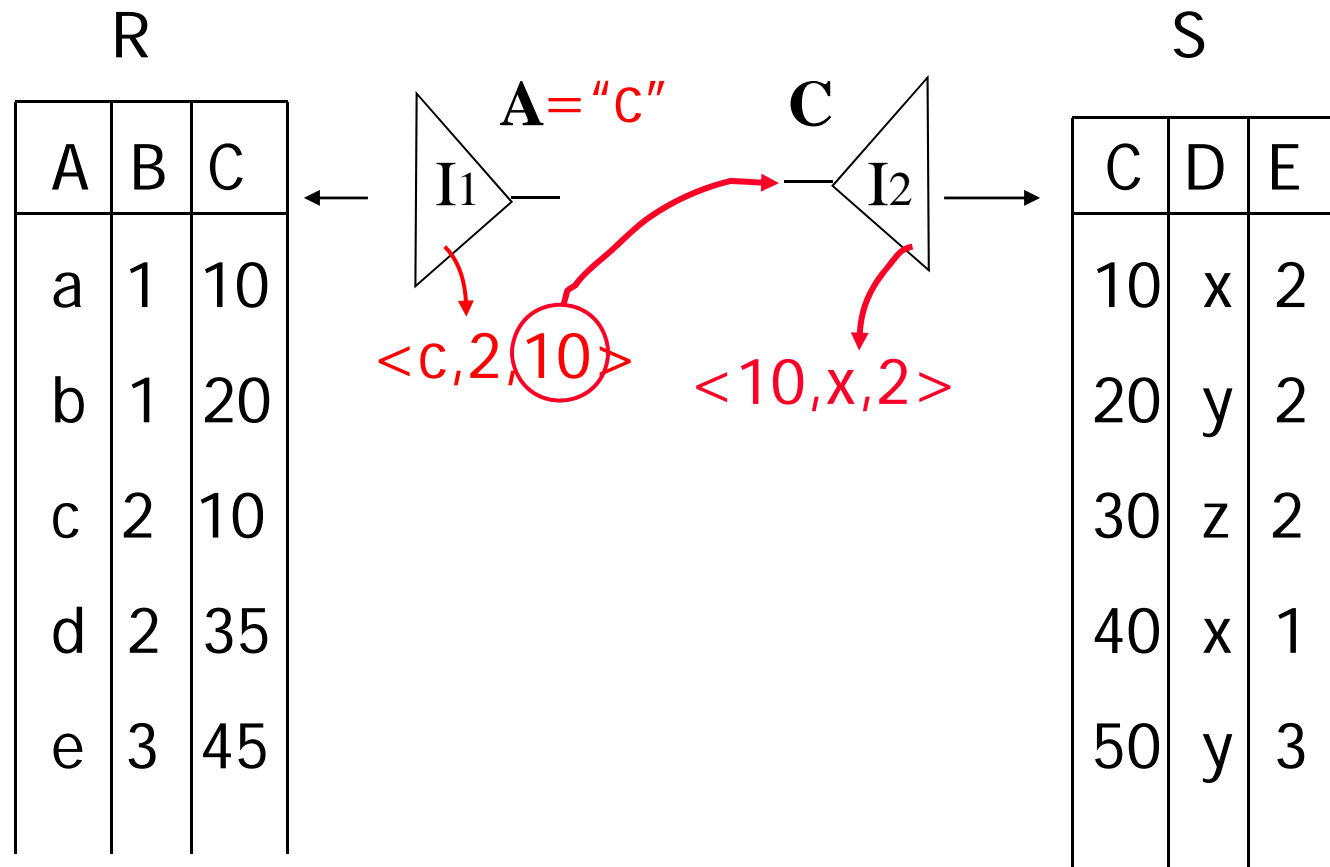
Plan III (3)



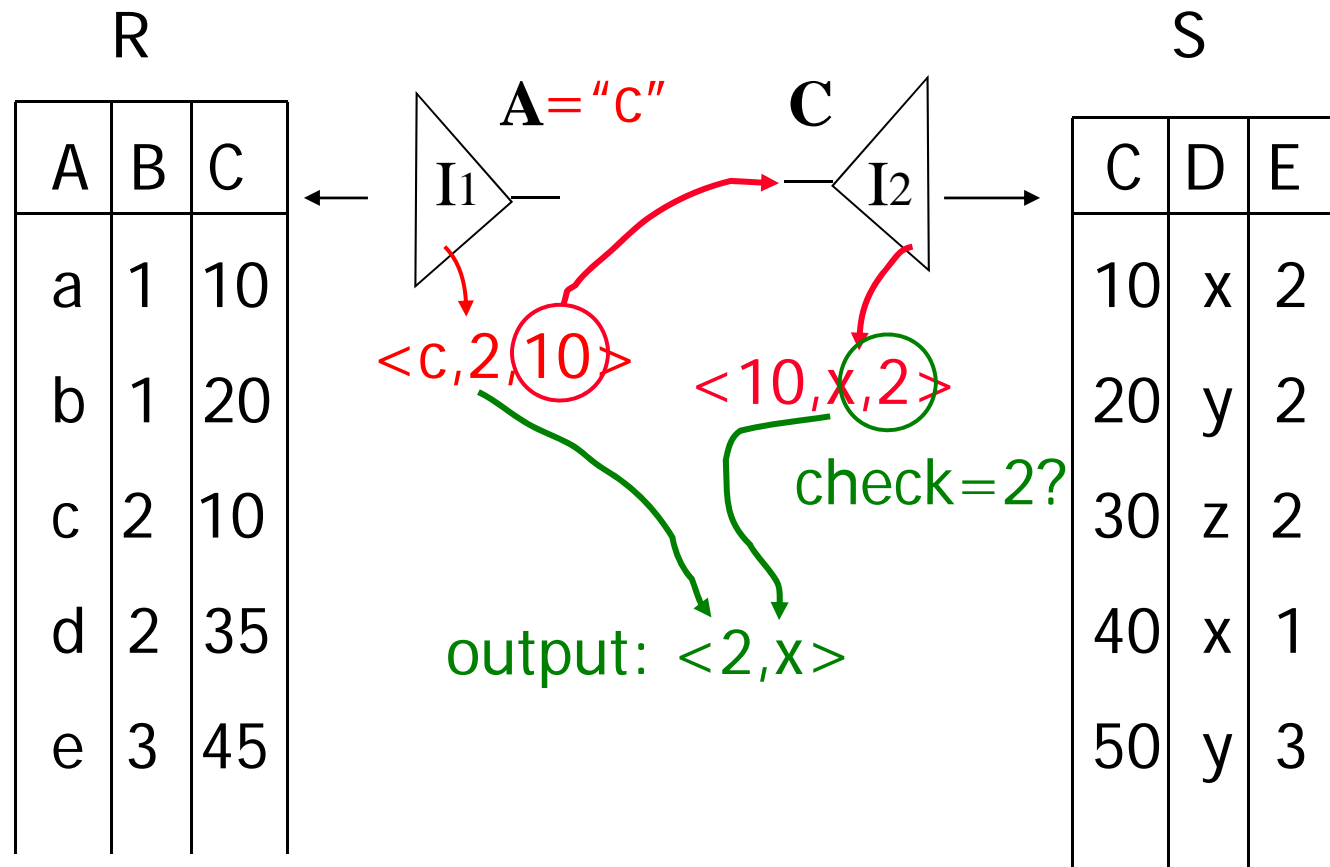
Plan III (4)



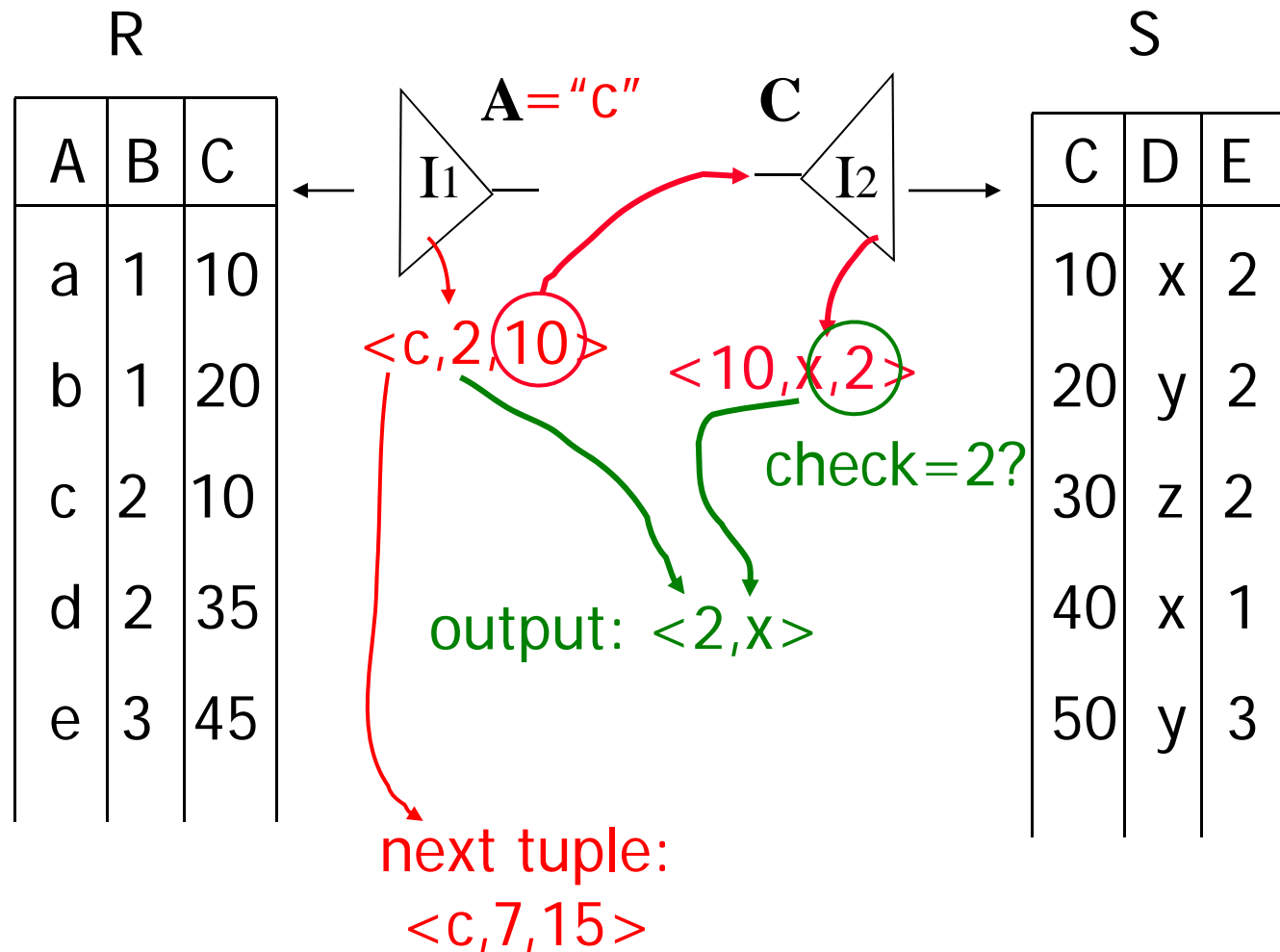
Plan III (5)



Plan III (6)



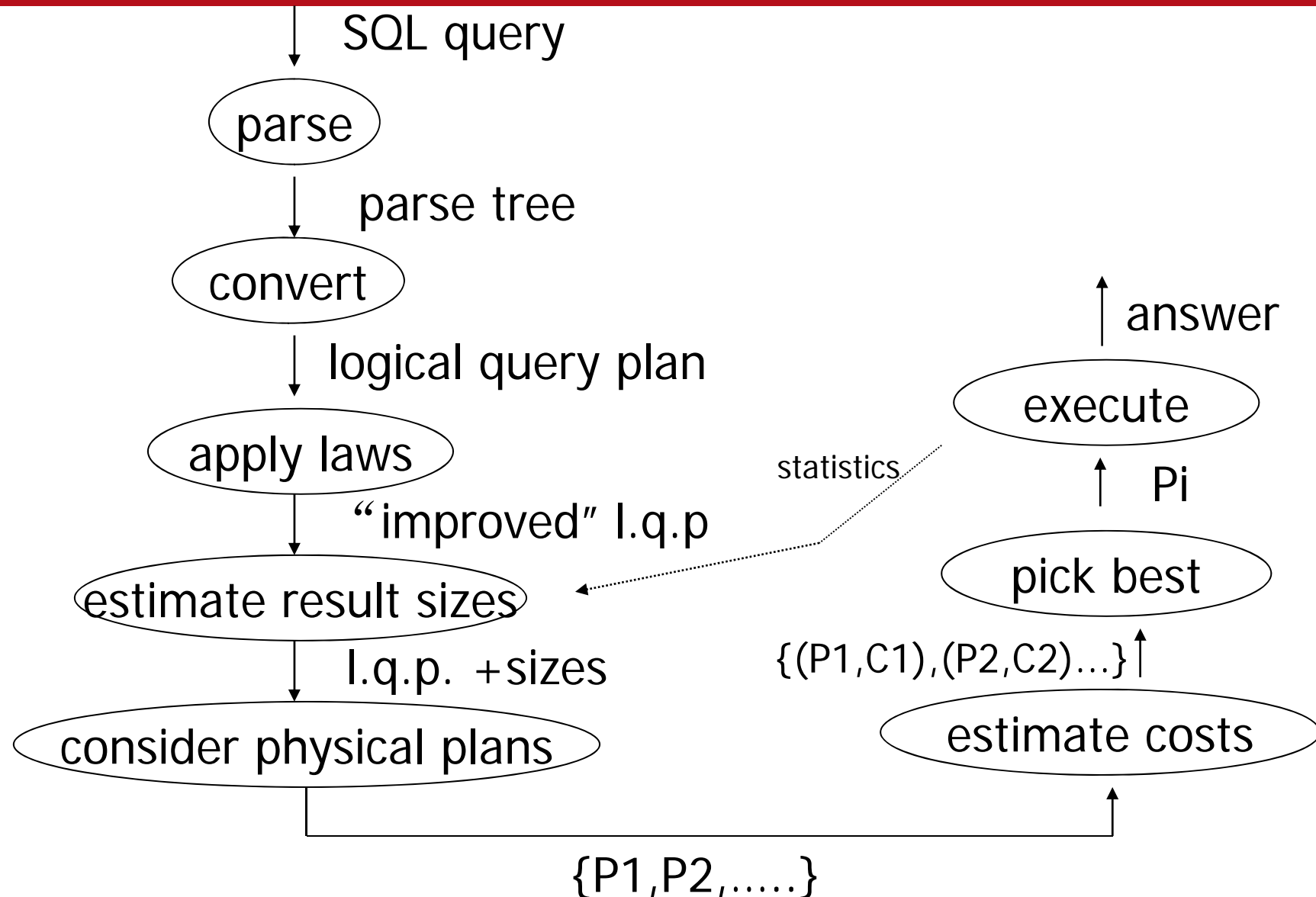
Plan III (7)



Overview of Query Processing

- The Query Processing translates an SQL query into a physical query plan, which can be executed, in three steps:
 - The query is parsed and represented as a *parse tree*.
 - The parse tree is converted into a relational algebra expression tree (*logical query plan*).
 - The logical query plan is refined into a *physical query plan*, which also specifies the algorithms used in each step and the way in which data is obtained.

Query Processing



Parsing

Parse Trees

- *Nodes* correspond to either atoms (terminal symbols) or syntactic categories (non-terminal symbols).
- An *atom* is a lexical element such as a keyword, name of an attribute or relation, constant, operator, parenthesis.
- A *syntactic category* denotes a family of query subparts that all play the same role within a query, e.g. Condition.
- Syntactic categories are enclosed in triangular brackets, e.g. <Condition>.

Example: SQL Query

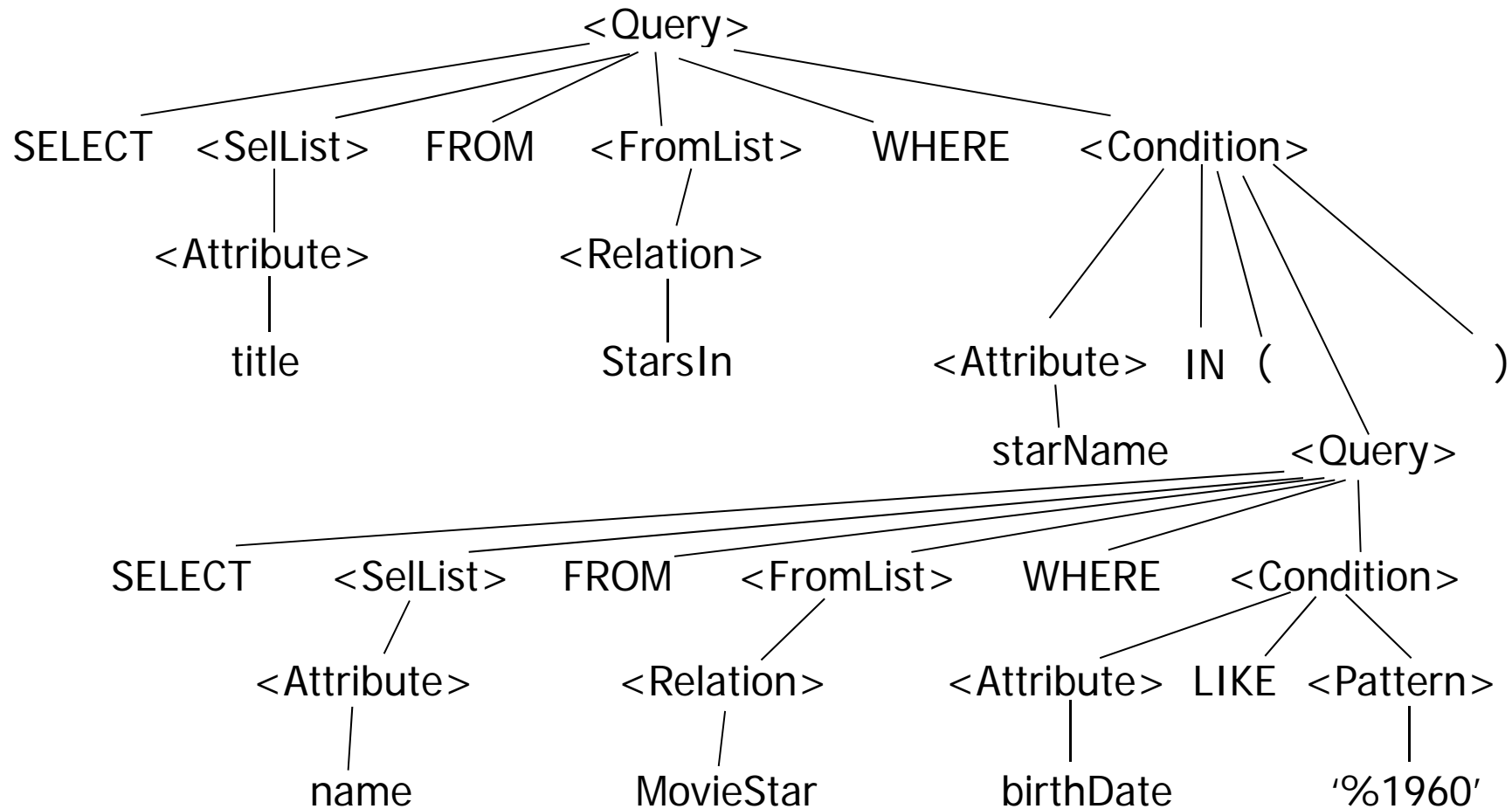
```
SELECT title
FROM StarsIn
WHERE starName IN (
    SELECT name
    FROM MovieStar
    WHERE birthdate LIKE '%1960'
);
```

(Find the movies with stars born in 1960)

StarsIn (movieTitle, movieYear, starName)

MovieStar (name, address, gender, birthdate)

Example: Parse Tree



Example: Generating Relational Algebra

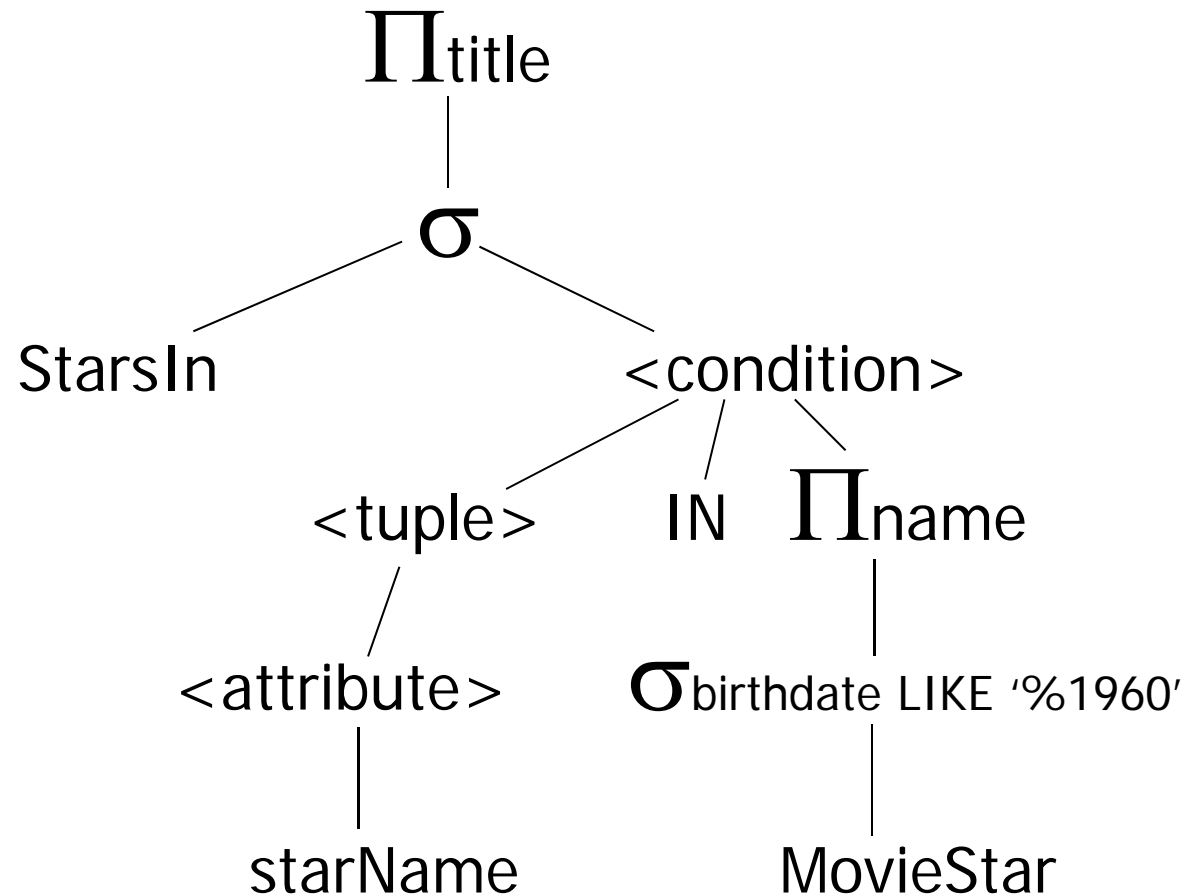


Fig. 7.15: An expression using a two-argument σ , midway between a parse tree and relational algebra

Example: Logical Query Plan

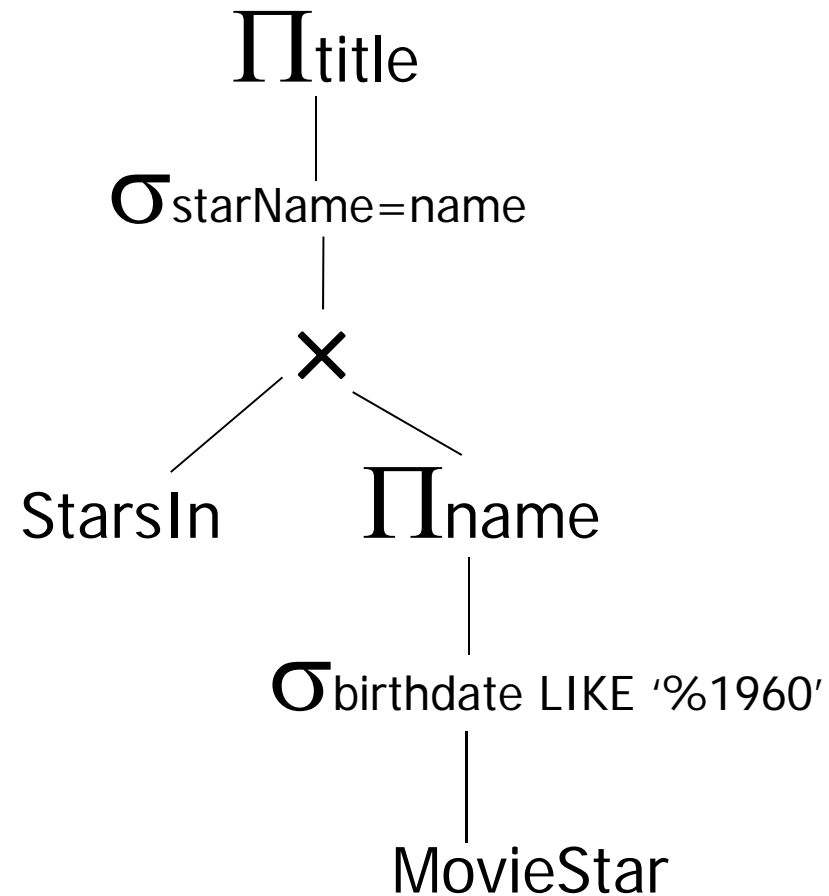
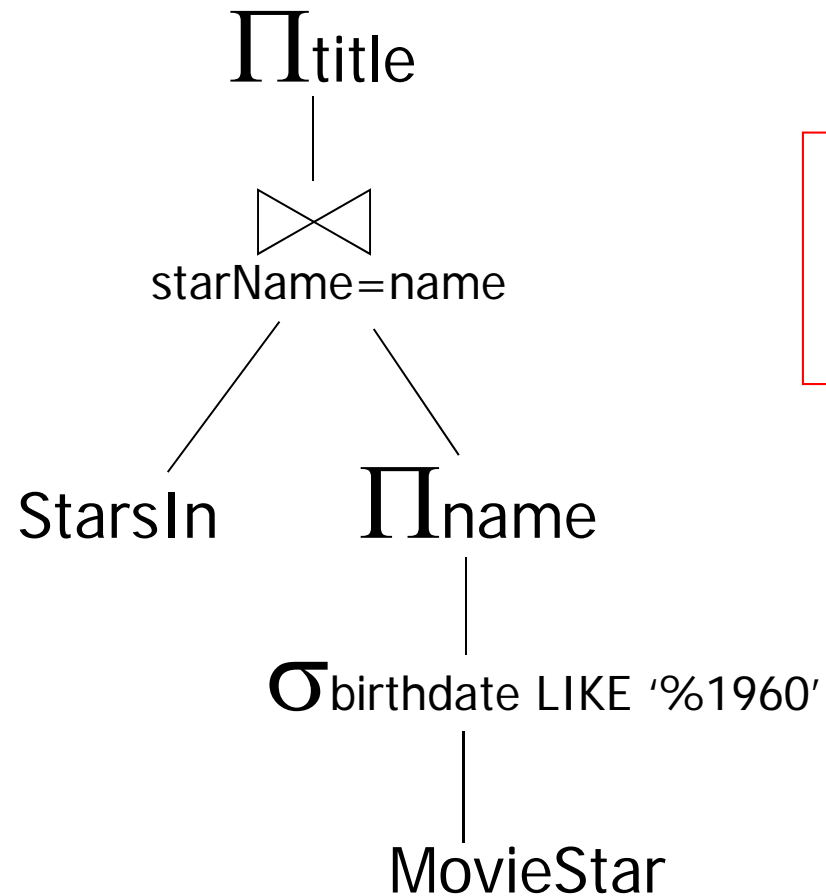


Fig. 7.18: Applying the rule for IN conditions

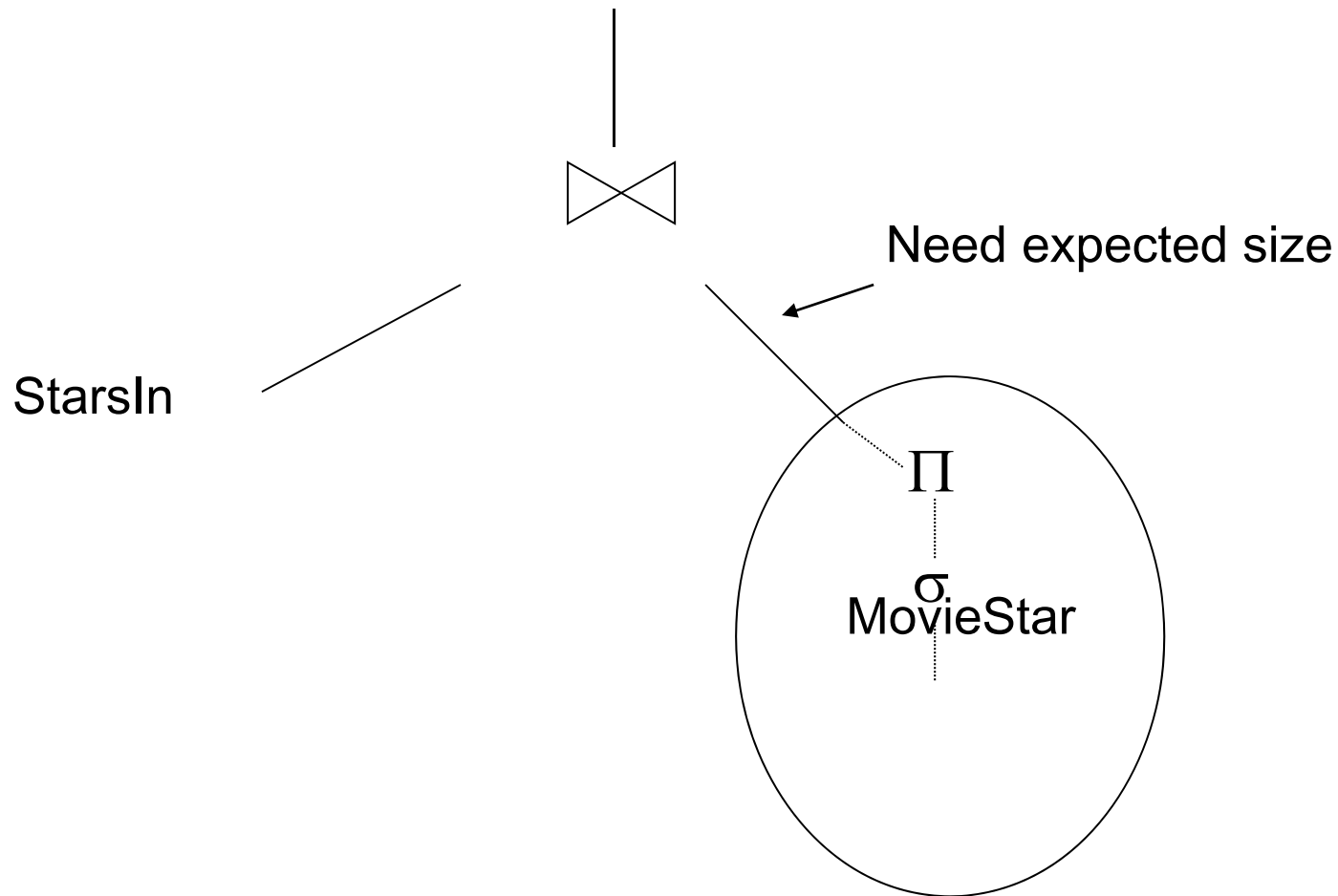
Example: Improved Logical Query Plan



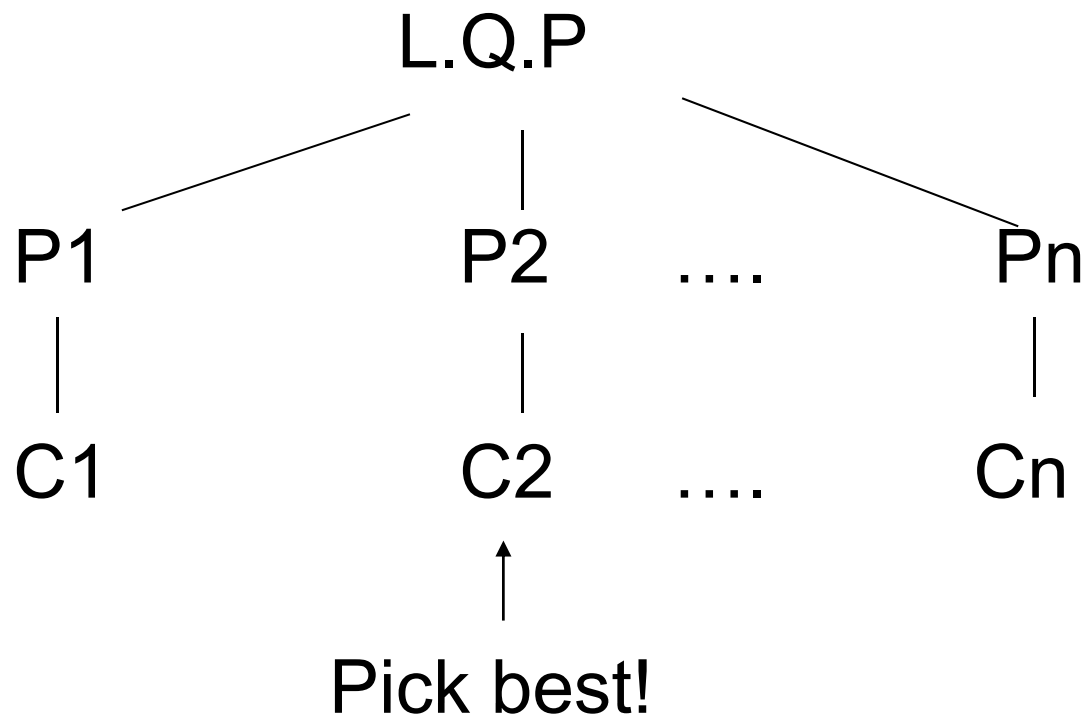
Question:
Push project to
StarsIn?

Fig. 7.20: An improvement on fig. 7.18.

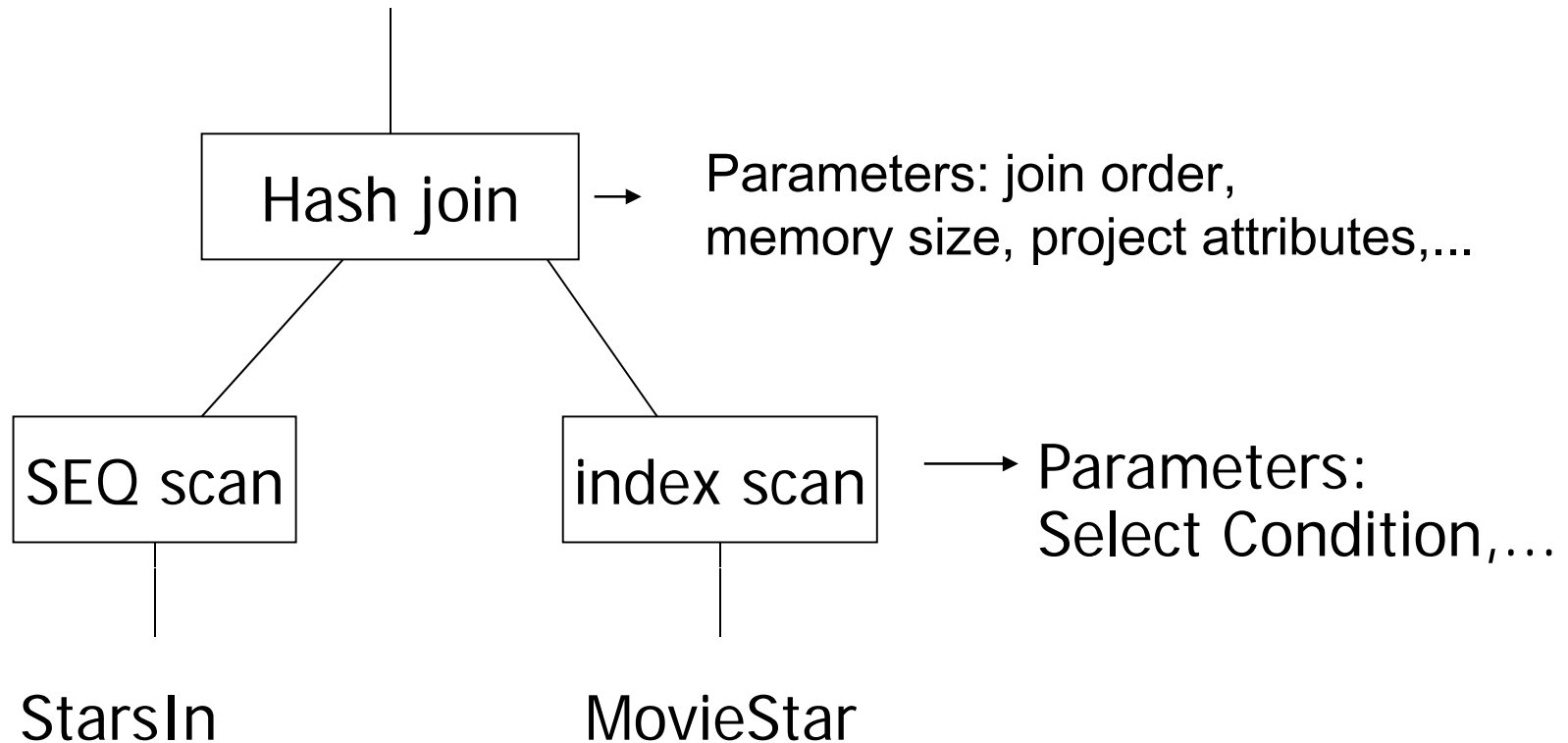
Example: Estimate Result Sizes



Example: Estimate costs



Example: One Physical Plan



Textbook Outline

Chapter 5 and 15

- 5 Algebra for queries [bags vs sets]
 - Select, project, join, [project list
a,a+b->x,...]
 - Duplicate elimination, grouping, sorting
- 15.1 Physical operators
 - Scan,sort, ...
- 15.2 - 15.6 Implementing operators +
estimating their cost

Textbook Outline (cont.)

Chapter 16

- 16.1 Parsing
- 16.2 Algebraic laws
- 16.3 Parse tree -> logical query plan
- 16.4 Estimating result sizes
- 16.5 Cost based optimization

Topics to Be Covered...

- Relational algebra level
- Detailed query plan level
 - Estimate Costs
 - without indexes
 - with indexes
 - Generate and compare plans