Student(sid, name, addr, age, GPA)

| sid | name | addr | age | GPA |
|---|---|---|---|---|
| 301 | John | 183 Westwood | 19 | 2.1 |
| 303 | Elaine | 301 Wilshire | 17 | 3.9 |
| 401 | James | 183 Westwood | 17 | 3.5 |
| 208 | Esther | 421 Wilshire | 20 | 3.1 |

Class(dept, cnum, sec, unit, title, instructor)

| dept | cnum | sec | unit | title | instructor |
|---|---|---|---|---|---|
| CS | 112 | 01 | 03 | Modeling | Dick Muntz |
| CS | 143 | 01 | 04 | DB Systems | Carlo Zaniolo |
| EE | 143 | 01 | 03 | Signal | Dick Muntz |
| ME | 183 | 02 | 05 | Mechanics | Susan Tracey |

Enroll(sid, dept, cnum, sec)

| sid | dept | cnum | sec |
|---|---|---|---|
| 301 | CS | 112 | 01 |
| 301 | CS | 143 | 01 |
| 303 | EE | 143 | 01 |
| 303 | CS | 112 | 01 |
| 401 | CS | 112 | 01 |

# Division

$R$: A table when all students take all CS courses

| sid | dept | cnum | sec |
|---|---|---|---|
| 301 | CS | 112 | 01 |
| 301 | CS | 143 | 01 |
| 303 | CS | 112 | 01 |
| 303 | CS | 143 | 01 |
| 401 | CS | 112 | 01 |
| 401 | CS | 143 | 01 |
| 208 | CS | 112 | 01 |
| 208 | CS | 143 | 01 |

$R -$ Enroll:

| sid | dept | cnum | sec |
|---|---|---|---|
| 303 | CS | 143 | 01 |
| 401 | CS | 143 | 01 |
| 208 | CS | 112 | 01 |
| 208 | CS | 143 | 01 |

# Division

$\pi_{sid}(R - \text{Enroll})$:

| sid |
|---|
| 303 |
| 401 |
| 208 |

$\pi_{sid}(\text{Student})$:

| sid |
|---|
| 301 |
| 303 |
| 401 |
| 208 |

$\pi_{sid}(\text{Student}) - \pi_{sid}(R - \text{Enroll})$:

| sid |
|---|
| 301 |

## Relational algebra: things to remember

- Data manipulation language (query language)
  - Relation $\longrightarrow$ algebra $\longrightarrow$ relation
- Relational algebra: set semantics, SQL: bag semantics
- Operators: $\sigma, \times, \bowtie, \rho, \cup, -, \cap, /$
- General suggestion: If difficult to write, consider its complement