

ICS 321 Fall 2011

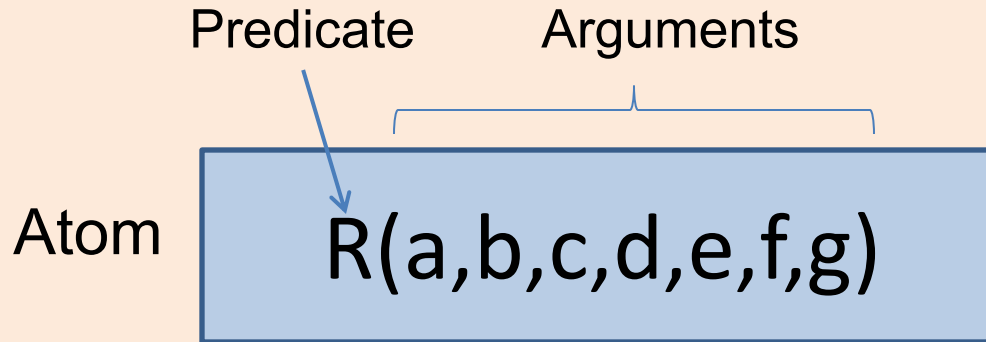
Algebraic and Logical Query Languages (ii)

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Datalog : Database Logic



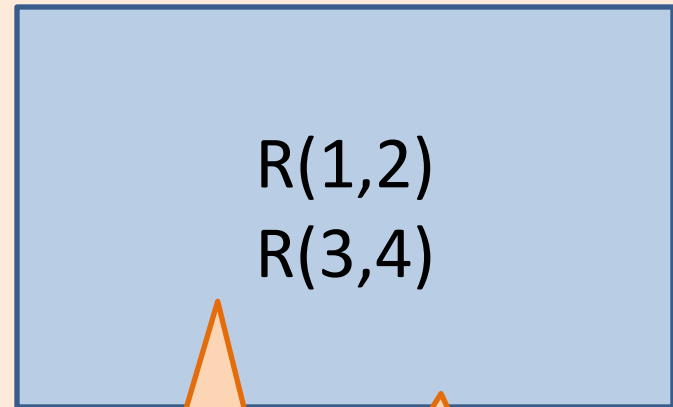
- A (relational) **atom**
 - Consists of a **predicate** and a list of **arguments**
 - Arguments can be **constants** or **variables**
 - Takes on Boolean value (true or false)
- A relation R can be represented as a predicate R
 - A tuple $\langle a,b,c,d,e,f,g \rangle$ is in R iff the atom $R(a,b,c,d,e,f,g)$ is true.

Example: tables in datalog

R

A	B
1	2
3	4

Datalog



True by default.

R(1,4) would
be false

Arithmetic Atoms

$$x < y$$
$$x+1 \geq y+4*z$$

Can contain
both constants
and variables.

Datalog Rules

head

“if” or ←

body

Shorthand
for AND

LongMovie(t,y) :- Movies(t,y,l,g,s,p) , l >=100

(t,y) is a tuple of LongMovie
IF (t,y,l,g,s,p) is a tuple of
Movies and length of movie is
at least 100

These two
“t,y” have to
match

These two
“l” have to
match

Aka “subgoal”
Can be preceded
by negation
operator “NOT”
or “~”

Anonymous variables

LongMovie(t,y) :- Movies(t,y,l,_,_,_) , l >=100

Safety Condition for Datalog Rules

Every **variable** that appears anywhere in the rule **must** appear in some **nonnegated, relational subgoal** of the body

- Without the safety condition, rules may be underspecified, resulting in an infinite relation (not allowed).
- Examples
 - $\text{LongMovie}(t,y) \text{ :- Movies}(t,y,l,_,_,_) , l \geq 100$
 - $P(x,y) \text{ :- } Q(x,z), \text{ NOT } R(w,x,z), x < y$

Alternative Interpretation: Consistency

Datalog

```
Q(1,2)
Q(1,3)
R(2,3)
R(3,1)
P(x,y) :- Q(x,z), R(z,y), NOT Q(x,y)
```

- For each consistent assignment of nonnegated, relational subgoal,
- Check the negated, relational subgoals and the arithmetic subgoals for consistency

Q(x,z)	R(z,y)	Consistent?	NOT Q(x,y)	Head
(1,2)	(2,3)	Yes	false	
(1,2)	(3,1)	No, z=2,3		
(1,3)	(2,3)	No, z=2,3		
(1,3)	(3,1)	Yes	true	P(1,1)

Intensional vs Extensional

Datalog

Q(1,2)

Q(1,3)

R(2,3)

R(3,1)

P(x,y) :- Q(x,z), R(z,y), NOT Q(x,y)

extensional

intensional

- **Extensional** predicates – relations stored in a database
- **Intensional** predicates – computed by applying one or more datalog rules

What about bag semantics ?

- Datalog still works if there are no negated, relational subgoals.
- Treat duplicates like non-duplicates

Datalog

```
R(1,2)
R(1,2)
S(2,3)
S(4,5)
S(4,5)
H(x,z) :- R(x,y), S(y,z)
```

R(x,y)	S(y,z)	Consistent?	Head
(1,2)	(2,3)	Yes	H(1,3)
(1,2)	(4,5)	No, y=2,4	
(1,2)	(4,5)	No, y=2,4	
...

Example 1

Datalog

Answer(x,y) :- A(x,y)

Answer(x,y) :- B(x,y)

Example 2

Datalog

Answer(x,y) :- A(x,y), B(x,y)

Example 3

Datalog

Answer(x,y) :- A(x,y), NOT B(x,y)

Example 4

Datalog

```
Answer(x,y) :- A(x,y), x > 10, y = 200
```

Example 5

Datalog

Answer(x) :- A(x,y)

Example 6

Datalog

Answer(w,x,y,z) :- A(w,x), B(y,z)

Example 7

Datalog

$\text{Answer}(w,x,y) :- A(w,x), B(x,y)$

Example 8

Datalog

Answer(w,x,z) :- A(w,x), B(y,z), x>y

Example 9

Datalog

```
Path(x,y) :- Edge(x,y)
Path(x,z) :- Edge(x,y), Edge(y,z)
```