

# Top-down Ground Proof Procedure

Idea: search backward from a query to determine if it is a logical consequence of  $KB$ .

An **answer clause** is of the form:

$$yes \leftarrow a_1 \wedge a_2 \wedge \dots \wedge a_m$$

The **SLD Resolution** of this answer clause on atom  $a_i$  with the clause:

$$a_i \leftarrow b_1 \wedge \dots \wedge b_p$$

is the answer clause

$$yes \leftarrow a_1 \wedge \dots \wedge a_{i-1} \wedge b_1 \wedge \dots \wedge b_p \wedge a_{i+1} \wedge \dots \wedge a_m.$$

- An **answer** is an answer clause with  $m = 0$ . That is, it is the answer clause  $\text{yes} \leftarrow$ .
- A **derivation** of query “ $?q_1 \wedge \dots \wedge q_k$ ” from  $KB$  is a sequence of answer clauses  $\gamma_0, \gamma_1, \dots, \gamma_n$  such that
  - ▶  $\gamma_0$  is the answer clause  $\text{yes} \leftarrow q_1 \wedge \dots \wedge q_k$ ,
  - ▶  $\gamma_i$  is obtained by resolving  $\gamma_{i-1}$  with a clause in  $KB$ , and
  - ▶  $\gamma_n$  is an answer.

To solve the query  $?q_1 \wedge \dots \wedge q_k$ :

$ac := \text{"yes} \leftarrow q_1 \wedge \dots \wedge q_k\text{"}$

**repeat**

**select** atom  $a_i$  from the body of  $ac$ ;

**choose** clause  $C$  from  $KB$  with  $a_i$  as head;

    replace  $a_i$  in the body of  $ac$  by the body of  $C$

**until**  $ac$  is an answer.

# Nondeterministic Choice

- **Don't-care nondeterminism** If one selection doesn't lead to a solution, there is no point trying other alternatives. **select**
- **Don't-know nondeterminism** If one choice doesn't lead to a solution, other choices may. **choose**

## Example: successful derivation

$a \leftarrow b \wedge c.$

$c \leftarrow e.$

$f \leftarrow j \wedge e.$

$a \leftarrow e \wedge f.$

$d \leftarrow k.$

$f \leftarrow c.$

$b \leftarrow f \wedge k.$

$e.$

$j \leftarrow c.$

Query: ?a

$\gamma_0 : \text{yes} \leftarrow a$

$\gamma_1 : \text{yes} \leftarrow e \wedge f$

$\gamma_2 : \text{yes} \leftarrow f$

$\gamma_3 : \text{yes} \leftarrow c$

$\gamma_4 : \text{yes} \leftarrow e$

$\gamma_5 : \text{yes} \leftarrow$

## Example: failing derivation

$a \leftarrow b \wedge c.$

$c \leftarrow e.$

$f \leftarrow j \wedge e.$

$a \leftarrow e \wedge f.$

$d \leftarrow k.$

$f \leftarrow c.$

$b \leftarrow f \wedge k.$

$e.$

$j \leftarrow c.$

Query: ?a

$\gamma_0 : \text{yes} \leftarrow a$

$\gamma_1 : \text{yes} \leftarrow b \wedge c$

$\gamma_2 : \text{yes} \leftarrow f \wedge k \wedge c$

$\gamma_3 : \text{yes} \leftarrow c \wedge k \wedge c$

$\gamma_4 : \text{yes} \leftarrow e \wedge k \wedge c$

$\gamma_5 : \text{yes} \leftarrow k \wedge c$

# Search Graph for SLD Resolution

$a \leftarrow b \wedge c.$	$a \leftarrow g.$
$a \leftarrow h.$	$b \leftarrow j.$
$b \leftarrow k.$	$d \leftarrow m.$
$d \leftarrow p.$	$f \leftarrow m.$
$f \leftarrow p.$	$g \leftarrow m.$
$g \leftarrow f.$	$k \leftarrow m.$
$h \leftarrow m.$	$p.$
$?a \wedge d$	

