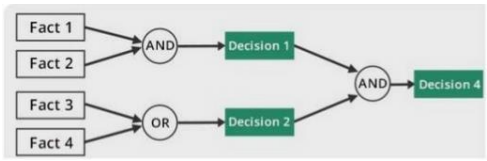
Forward Chaining

Forward Chaining

- data driven
- Starts with facts and apply rules
- Inference rules



Mechanism

- Take fact and match with all antecedents of a rule
- If matched then rule is triggered
- When triggered, it is fired to add conclusion to facts database

Example 1

R1: IF hot AND smoky THEN ADD fire
R2:IF alarm_beeps THEN ADD smoky
R3:If fire THEN ADD switch_on_sprinklers

F1:alarm_beeps[Given]
F2:hot[Given]

Example 1 contd..

R1: IF hot AND smoky THEN ADD fire
R2:IF alarm_beeps THEN ADD smoky
R3:If fire THEN ADD switch_on_sprinklers

F1:alarm_beeps[Given]
F2:hot[Given]
F3: smoky [from F1 by R2]
F4: fire [from F2, F3 by R1]
F5: switch_on_sprinklers [from F4 by R3]

Suppose we have developed the following rules for our weather forecasting system,

Rule I

If we suspect temperature is less than 20°
AND there is humidity in the air
Then there are chances of rain

Rule II

If Sun is behind the clouds
AND air is very cool.
Then we suspect temperature is less than 20°.

Rule III **If** air is very heavy
Then there is humidity in the air.

- Facts Given
  a) Sun is behind the clouds.
  b) Air is very heavy and cool.

Problem: Using Forward chaining try to conclude that there are chances of rain.

First pass

Rule, premise	Status	Working Memory
1, 1 we suspect temperature is less than 20°	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool.

First pass

Rule, premise	Status	Working Memory
1, 1 we suspect temperature is less than 20°	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool.
1, 2 there is humidity in the air	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool.

First pass

Rule, premise	Status	Working Memory
1, 1 we suspect temperature is less than 20°	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool.
1, 2 there is humidity in the air	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool.
2, 1 Sun is behind the clouds	True	a) Sun is behind the clouds. b) Air is very heavy and cool.

First pass

Rule, premise	Status	Working Memory
1, 1 we suspect temperature is less than 20°	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool.
1, 2 there is humidity in the air	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool.
2, 1 Sun is behind the clouds	True	a) Sun is behind the clouds. b) Air is very heavy and cool.
2.2 air is very cool.	True, fire rule	a) Sun is behind the clouds. b) Air is very heavy and cool. c) We suspect temperature is less than 20°

First pass

Rule, premise	Status	Working Memory
1, 1 we suspect temperature is less than 20°	True	a) Sun is behind the clouds. b) Air is very heavy and cool. c) We suspect temperature is less than 20°
1, 2 there is humidity in the air	Unknown	a) Sun is behind the clouds. b) Air is very heavy and cool. c) We suspect temperature is less than 20°
3, 1 air is very heavy	True, fire rule	a) Sun is behind the clouds. b) Air is very heavy and cool. c) We suspect temperature is less than 20° d) there is humidity in the air

Second pass

Rule, premise	Status	Working Memory
1, 1 we suspect temperature is less than 20°	True	a) Sun is behind the clouds. b) Air is very heavy and cool. c) We suspect temperature is less than 20° d) there is humidity in the air
1, 2 there is humidity in the air	True, fire rule	a) Sun is behind the clouds. b) Air is very heavy and cool. c) We suspect temperature is less than 20° d) there is humidity in the air **e) there are chances of rain**

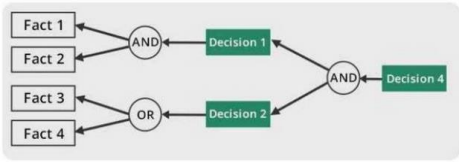
So we have deduced there are chances of rain.

Thank you !!!

Backward Chaining

Backward Chaining

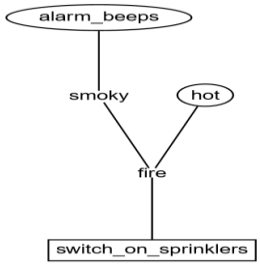
- Backward Chaining
  - goal driven
  - Starts with something and looks for rules to find out



Example 1

R1: IF hot AND smoky THEN fire
R2: IF alarm_beeps THEN smoky
R3: If fire THEN switch_on_sprinklers
Facts:
F1:hot
F2:alarm_beeps
Goal:
Should I switch sprinklers on?

Backward Chaining



Example 2

Rule I
If we suspect temperature is less than 20°
AND there is humidity in the air
Then there are chances of rain

Rule II
If Sun is behind the clouds
AND air is very cool.
Then we suspect temperature is less than 20°.

Rule III **If** air is very heavy
Then there is humidity in the air.

- Given
  a) Sun is behind the clouds.
  b) Air is very heavy and cool.
  - Problem: Using Backward chaining try to conclude that there are chances of rain.

Step	Description	Working Memory
1	Goal "There are chances of rain." Not in Working Memory.	

Rule I
If we suspect temperature is less than 20°
AND there is humidity in the air
Then there are chances of rain

Rule II
If Sun is behind the clouds
AND air is very cool.
Then we suspect temperature is less than 20°.

Rule III **If** air is very heavy
Then there is humidity in the air.

Step	Description	Working Memory
1	Goal "There are chances of rain." Not in Working Memory.	
2	Find rules with our goal "There are chances of rain" in conclusion: It is in Rule 1.	

Rule I
If we suspect temperature is less than 20°
AND there is humidity in the air
Then there are chances of rain

Rule II
If Sun is behind the clouds
AND air is very cool.
Then we suspect temperature is less than 20°.

Rule III **If** air is very heavy
Then there is humidity in the air.

Step	Description	Working Memory
1	Goal "There are chances of rain." Not in Working Memory.	
2	Find rules with our goal "There are chances of rain" in conclusion: It is in Rule 1.	
3	Now see if Rule 1, premise 1 is known "we suspect temperature is less than 20^{0}".	

Step	Description	Working Memory
1	Goal "There are chances of rain." Not in Working Memory.	
2	Find rules with our goal "There are chances of rain" in conclusion: It is in Rule 1.	
3	Now see if Rule 1, premise 1 is known "we suspect temperature is less than 20^{0}".	
4	This is conclusion of rule 2. So going to Rule 2. The premise 1 of rule 2 is "Sun is behind the clouds".	

Rule I
If we suspect temperature is less than 20°
AND there is humidity in the air
Then there are chances of rain

Rule II
If Sun is behind the clouds
AND air is very cool.
Then we suspect temperature is less than 20°.

Rule III **If** air is very heavy
Then there is humidity in the air.

Step	Description	Working Memory
1	Goal "There are chances of rain." Not in Working Memory.	
2	Find rules with our goal "There are chances of rain" in conclusion: It is in Rule 1.	
3	Now see if Rule 1, premise 1 is known "we suspect temperature is less than 20^{0}".	
4	This is conclusion of rule 2. So going to Rule 2. The premise 1 of rule 2 is "Sun is behind the clouds".	
5	This is primitive. We ask from user Response: Yes	Sun is behind the clouds.

6	See if Rule 2, premise 2 is known "Air is very cool".	

6	See if Rule 2, premise 2 is known "Air is very cool".	
7	This is also primitive. We ask its Response: Yes. Both conditions of Rule 2 are met so Fire rule 2	Sun is behind the clouds. Air is very cool. **We suspect temperature is less than 20^{0}.**

6	See if Rule 2, premise 2 is known "Air is very cool".	
7	This is also primitive. We ask its Response: Yes. Both conditions of Rule 2 are met so Fire rule 2	Sun is behind the clouds. Air is very cool. **We suspect temperature is less than 20^{0}.**
8	So Rule 1 premise 1 is in working memory, coming to Rule 1, premise 2 "There is humidity in the air"	Sun is behind the clouds. Air is very cool. **We suspect temperature is less than 20^{0}.**

Rule I
If we suspect temperature is less than 20°
AND there is humidity in the air
Then there are chances of rain

Rule II
If Sun is behind the clouds
AND air is very cool.
Then we suspect temperature is less than 20°.

Rule III **If** air is very heavy
Then there is humidity in the air.

Rule I
If we suspect temperature is less than 20°
AND there is humidity in the air
Then there are chances of rain

Rule II
If Sun is behind the clouds
AND air is very cool.
Then we suspect temperature is less than 20°.

Rule III **If** air is very heavy
Then there is humidity in the air.

6	See if Rule 2, premise 2 is known "Air is very cool".	
7	This is also primitive. We ask its Response: Yes. Both conditions of Rule 2 are met so Fire rule 2	Sun is behind the clouds. Air is very cool. **We suspect temperature is less than 20^0.**
8	So Rule 1 premise 1 is in working memory, coming to Rule 1, premise 2 "There is humidity in the air"	Sun is behind the clouds. Air is very cool. **We suspect temperature is less than 20^0.**
9	This is conclusion of Rule 3. So see if Rule 3, premise 1 is known "Air is very heavy".	Sun is behind the clouds. Air is very cool. **We suspect temperature is less than 20^0.**

10	This is primitive so asking from user Response: Yes. Fire rule	Sun is behind the clouds. Air is very cool. We suspect temperature is less than 20^0. **There is humidity in the air.**
11	Now Rule 1 premise 1 and 2 both are in working memory so fire Rule 1.	Sun is behind the clouds. Air is very cool. Air is very heavy. We suspect temperature is less than 20^0. There is humidity in the air. **There are chances of rain.**

How do we select

- Forward chaining or Backward chaining

Forward vs Backward reasoning

- **Number of start and goal states(same branching factor)**
  - **Forward chaining reasoning -> Smaller to Larger set of states**
- **Branching factor in each direction(Backward)**
  - **Proving the theorem {Few axiom, more theorems}**
  - **theorem to axioms**

Forward vs Backward reasoning

- **Need to justify reasoning.(Backward)**
  - **Advice for diagnostic program for infectious disease (MYCIN)**
- **Triggers for problem solving.**
  - **Combination of forward and backward reasoning. – Bidirectional search**
  - **If the number of nodes increases rapidly.**
    - **May fail**

Forward vs Backward reasoning

- **Problem solving**
- **Forward rule – Knowledge about.**
  - **How to respond to input configuration?**
- **Backward rule - Knowledge about.**
  - **How to achieve particular goal**

Thank You !