

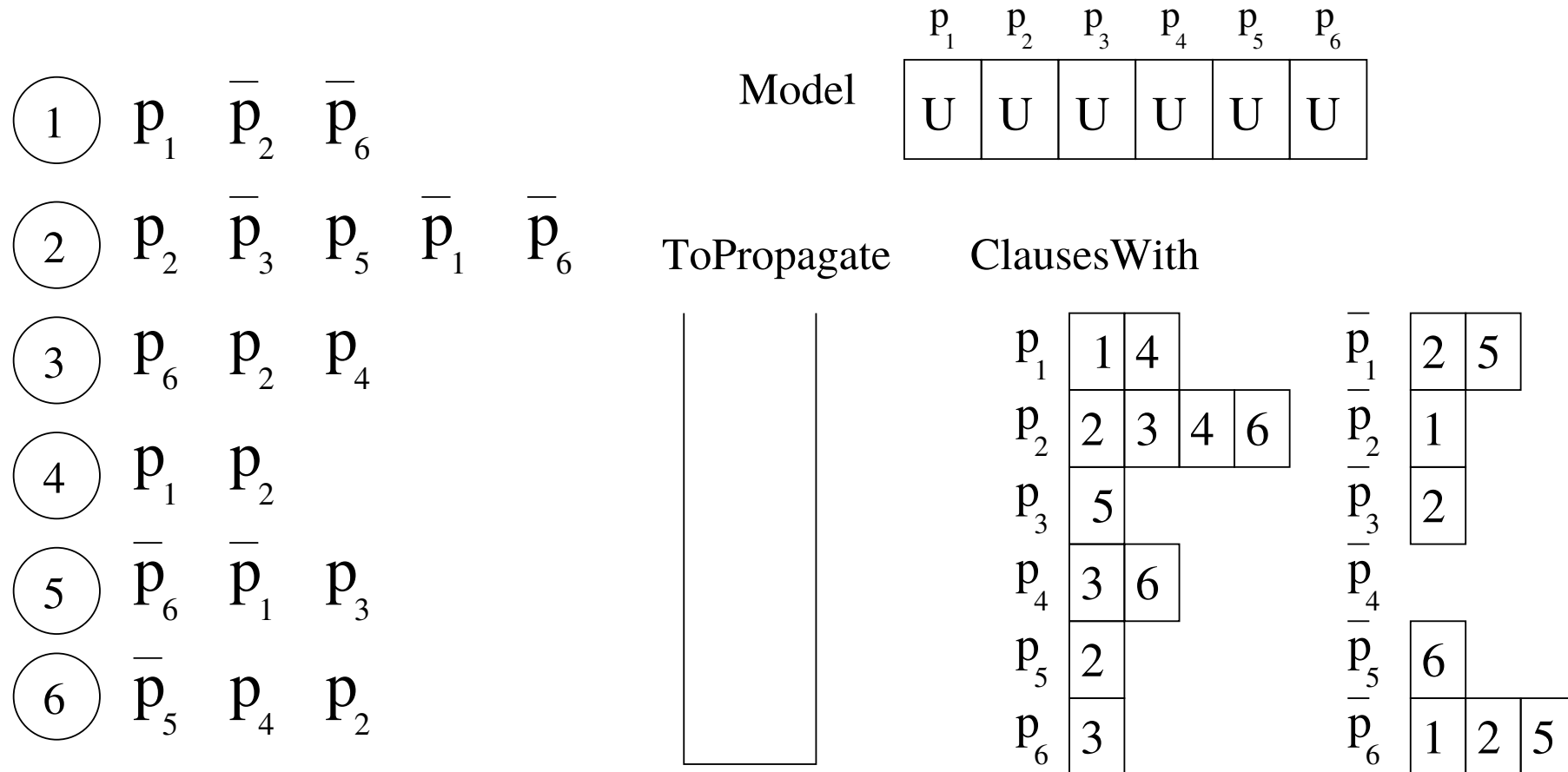
Performance of SAT Solvers

- The most important tasks that a SAT solver performs are:
 - ◆ Choose which variable to **Decide** on
 - ◆ Apply **unit propagation** exhaustively
 - ◆ **Analyze conflicts**
- When profiling a state-of-the-art SAT solver we get:
 - ◆ Variable selection ($\approx 10\%$)
 - ◆ Unit propagation application ($\approx 80\%$)
 - ◆ Conflict analysis ($\approx 10\%$)
- Hence, the most important thing to **optimize** is **unit propagation**, aka BCP (Boolean Constraint Propagation)

BCP with Occur Lists

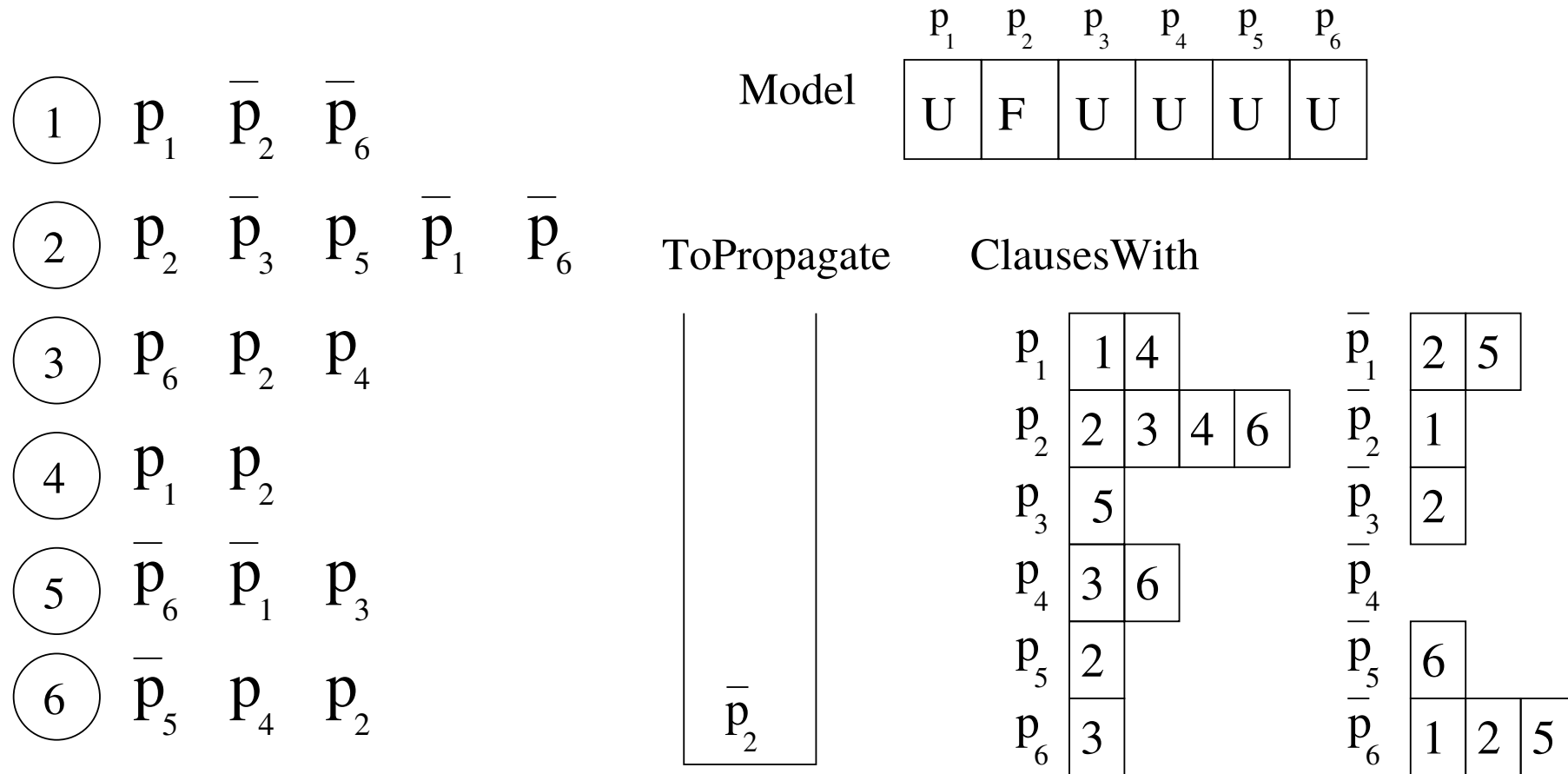
- BCP only has to detect **propagating** or **conflicting clauses**
- There is **no need** to detect that all **clauses** are **true**
- Instead of traversing the whole clause set again and again:
 - ◆ For each literal, store the clauses where it appears in **occur lists**
 - ◆ Every time a new lit l is added to the assignment, only clauses containing \bar{l} need to be visited
- Let's see how it would work with an **example**

BCP with Occur Lists



Current assignment: \emptyset

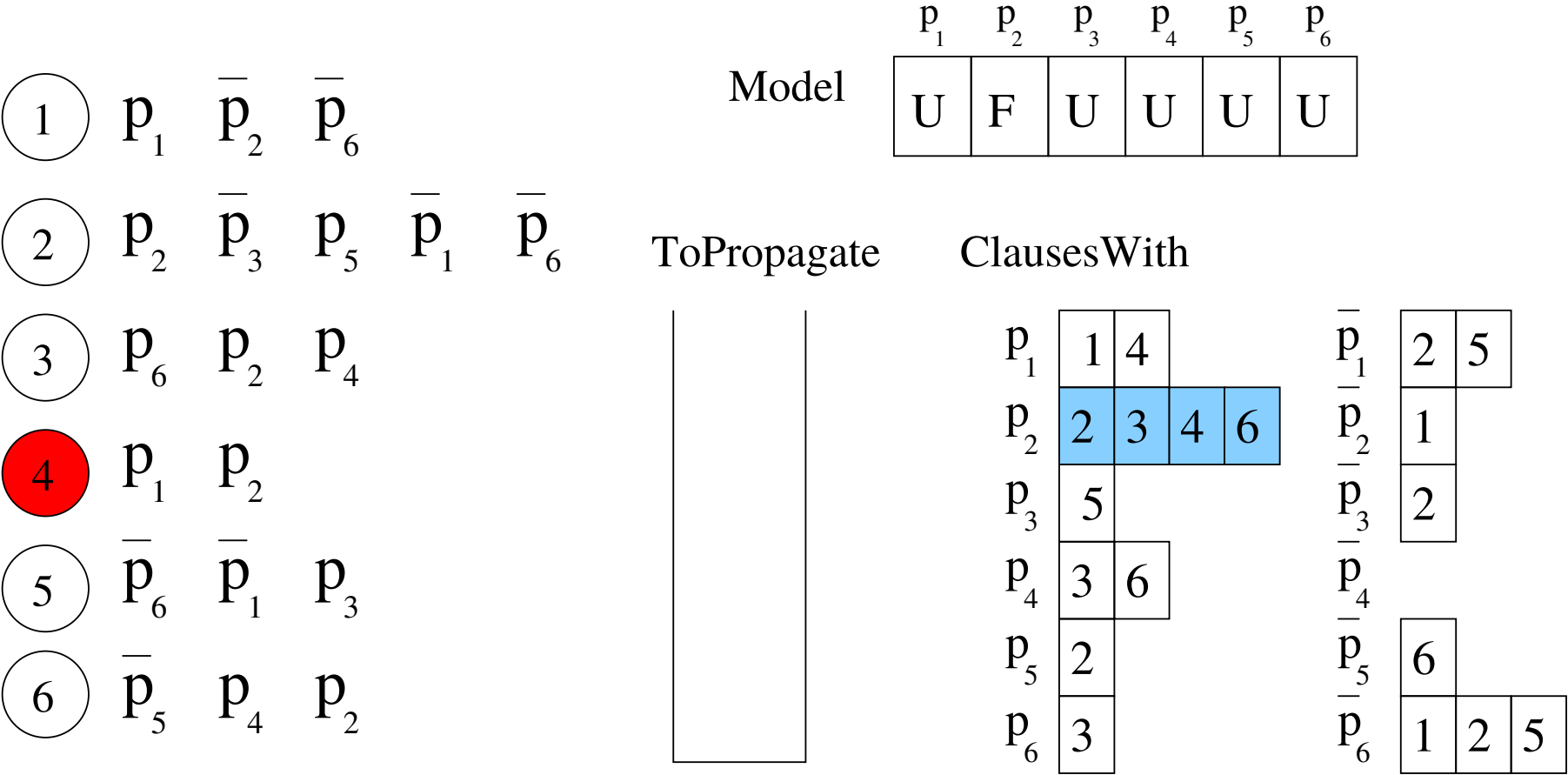
BCP with Occur Lists



Current assignment: \bar{p}_2^d

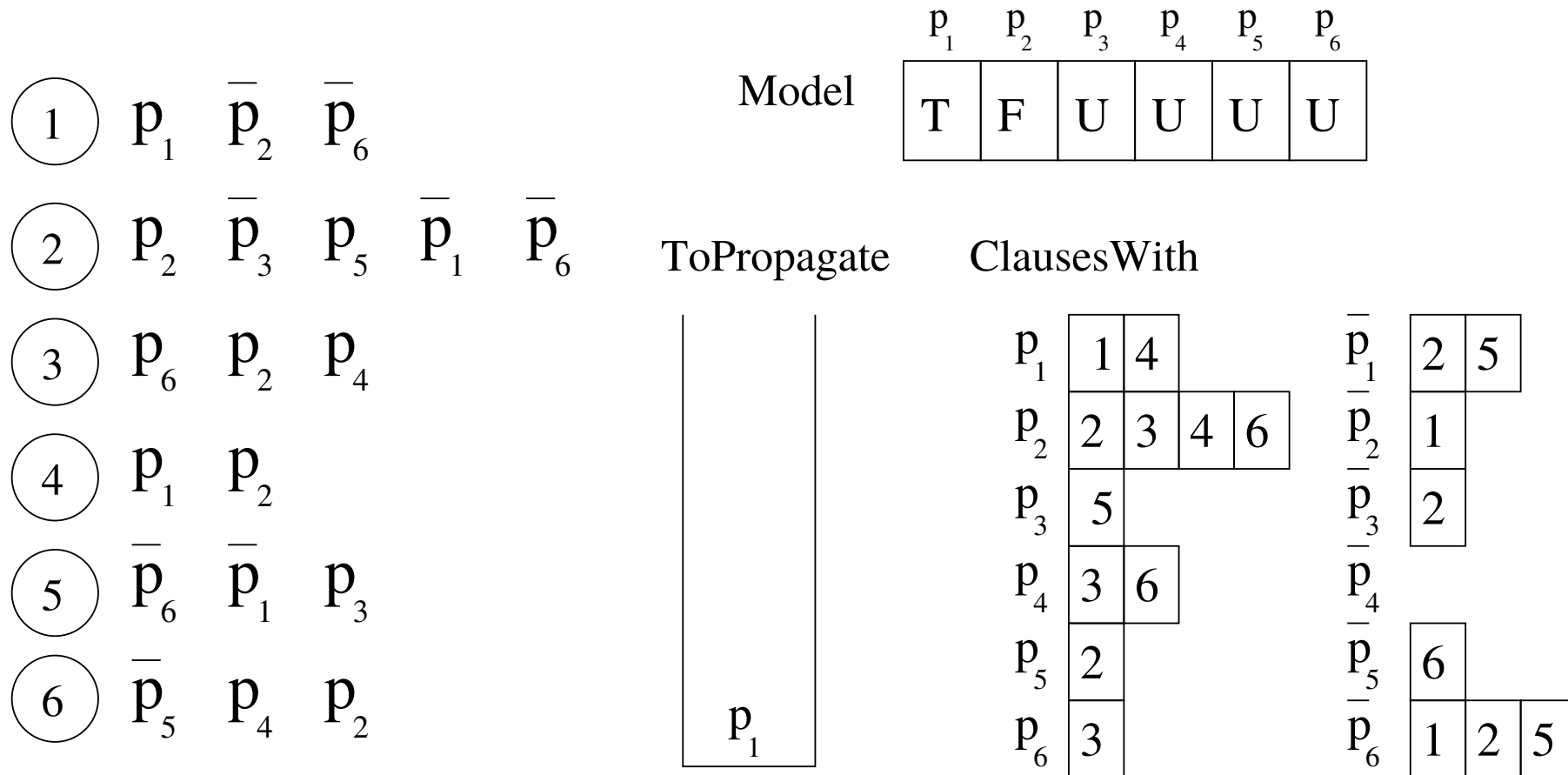
Now, we propagate \bar{p}_2 visiting ClausesWith[p_2]

BCP with Occur Lists



Current assignment: \bar{p}_2^d
 Literal p_1 has to be added to the assignment

BCP with Occur Lists



Current assignment: $\bar{p}_2^d p_1$

Now, we propagate p_1 visiting ClausesWith $[\bar{p}_1]$

BCP with Occur Lists

1 p_1 \bar{p}_2 \bar{p}_6

2 p_2 \bar{p}_3 p_5 \bar{p}_1 \bar{p}_6

3 p_6 p_2 p_4

4 p_1 p_2

5 \bar{p}_6 \bar{p}_1 p_3

6 \bar{p}_5 p_4 p_2

Model

p_1	p_2	p_3	p_4	p_5	p_6
T	F	U	U	U	U

ToPropagate

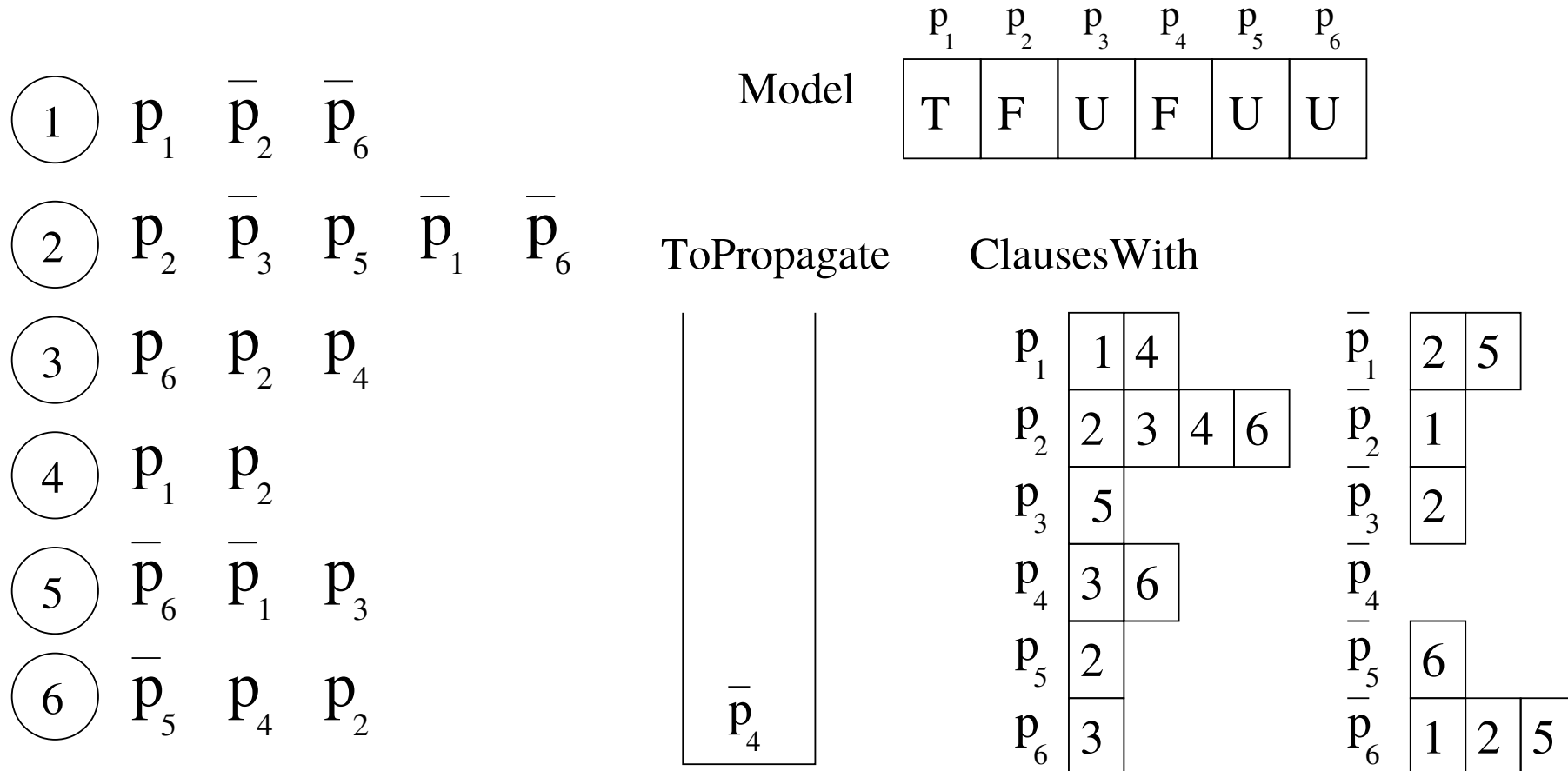
ClausesWith

p_1	1	4			
p_2	2	3	4	6	
p_3	5				
p_4	3	6			
p_5	2				
p_6	3				

\bar{p}_1	2	5	
\bar{p}_2	1		
\bar{p}_3	2		
\bar{p}_4			
\bar{p}_5	6		
\bar{p}_6	1	2	5

Current assignment: $\bar{p}_2^d p_1$
 No lit is propagated, we have to decide

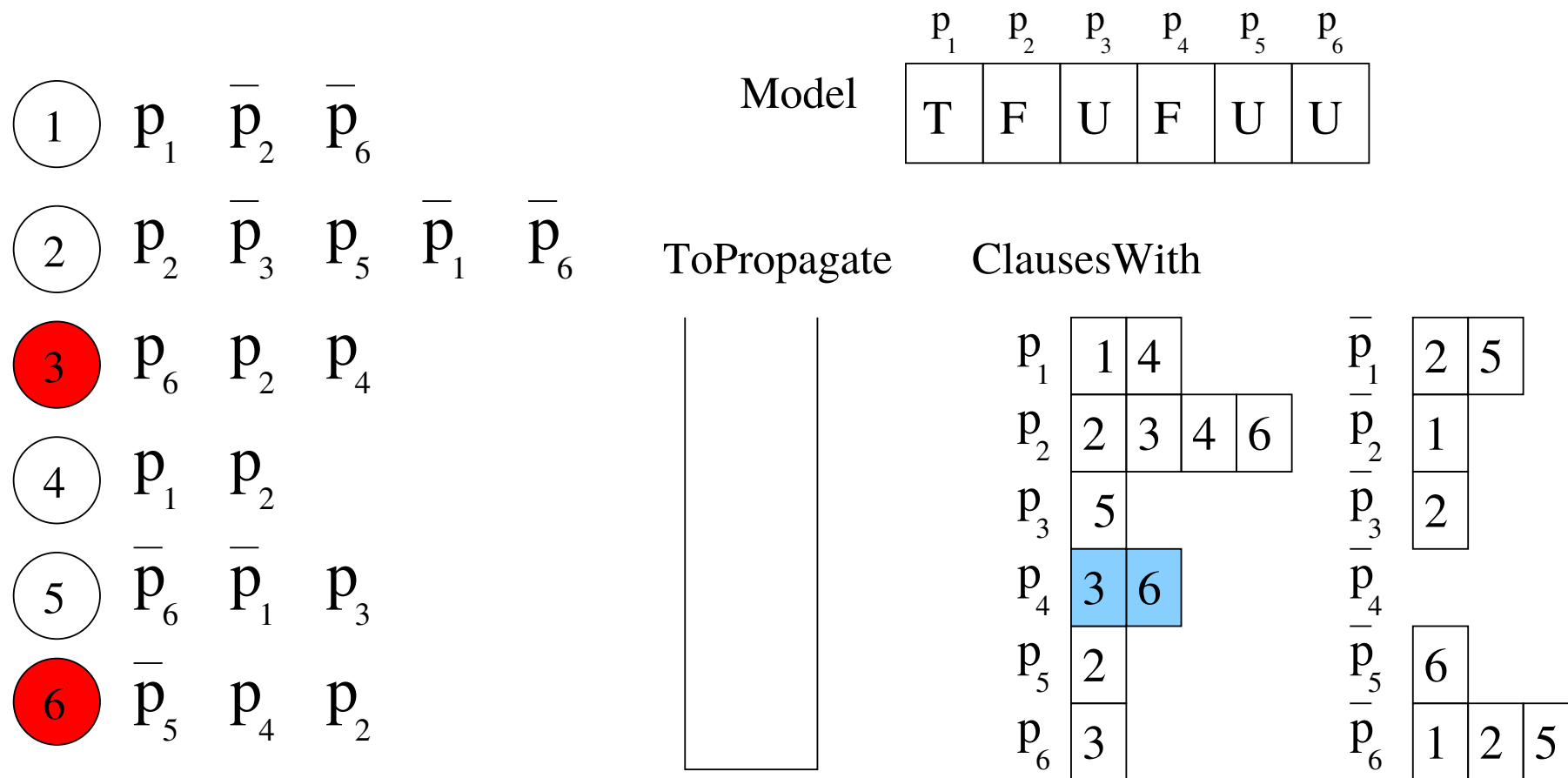
BCP with Occur Lists



Current assignment: $\bar{p}_2^d p_1 \bar{p}_4^d$

Now, we propagate \bar{p}_4 visiting ClausesWith[p_4]

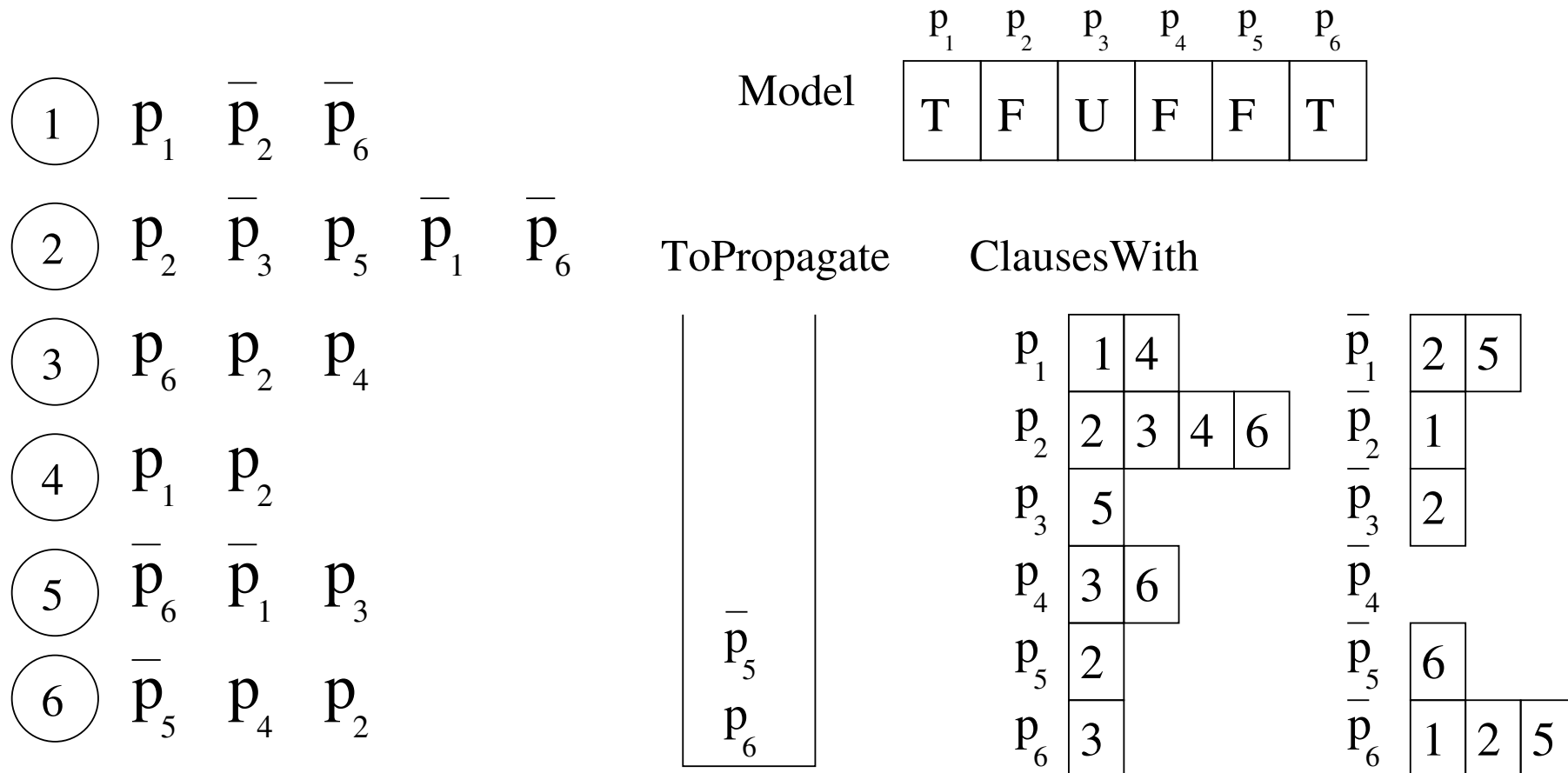
BCP with Occur Lists



Current assignment: $\bar{p}_2^d p_1 \bar{p}_4^d$

Literals p_6, \bar{p}_5 have to be added to the assignment

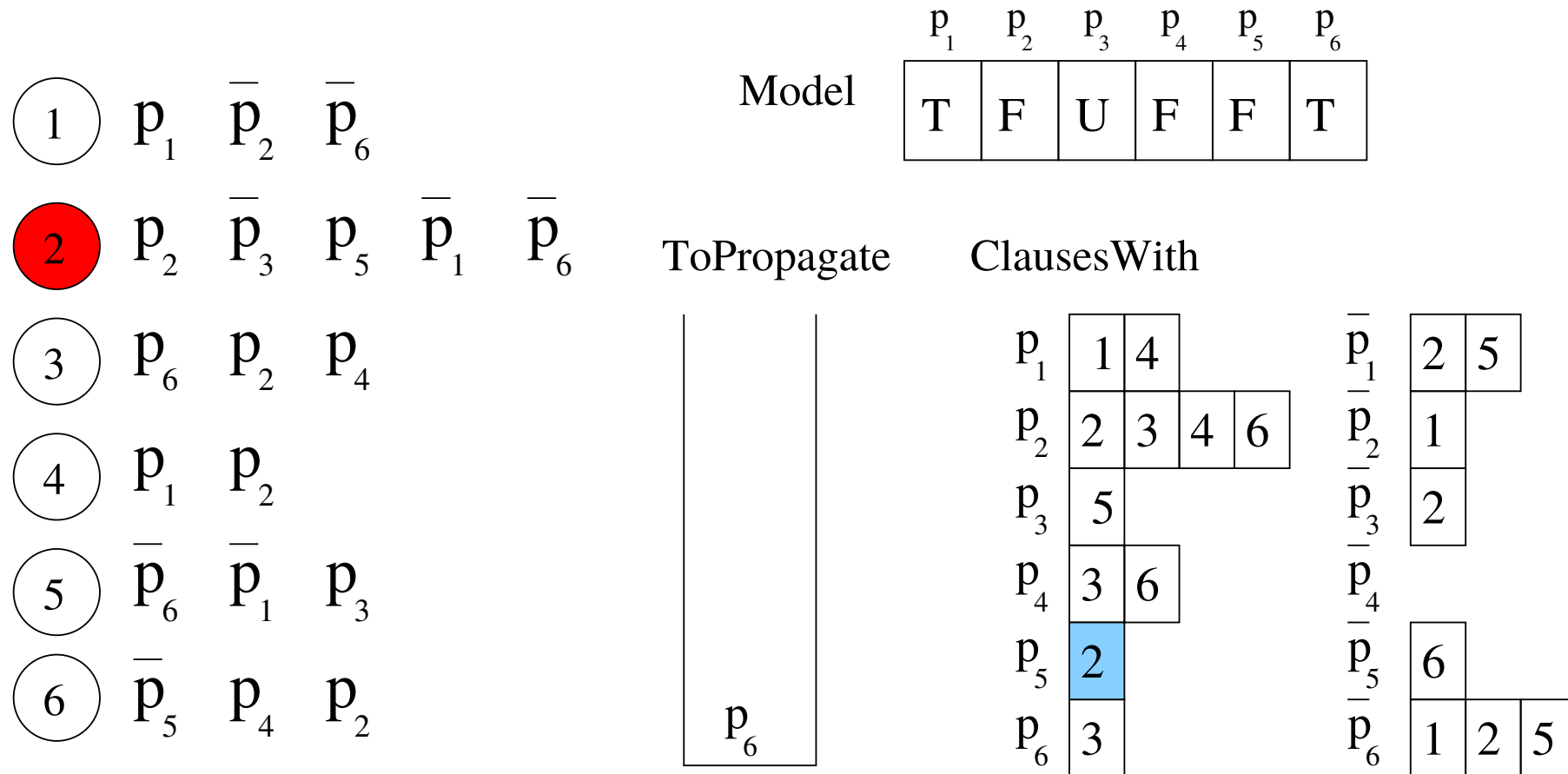
BCP with Occur Lists



Current assignment: $\bar{p}_2^d p_1 \bar{p}_4^d p_6 \bar{p}_5$

Now, we propagate \bar{p}_5 visiting ClausesWith[p_5]

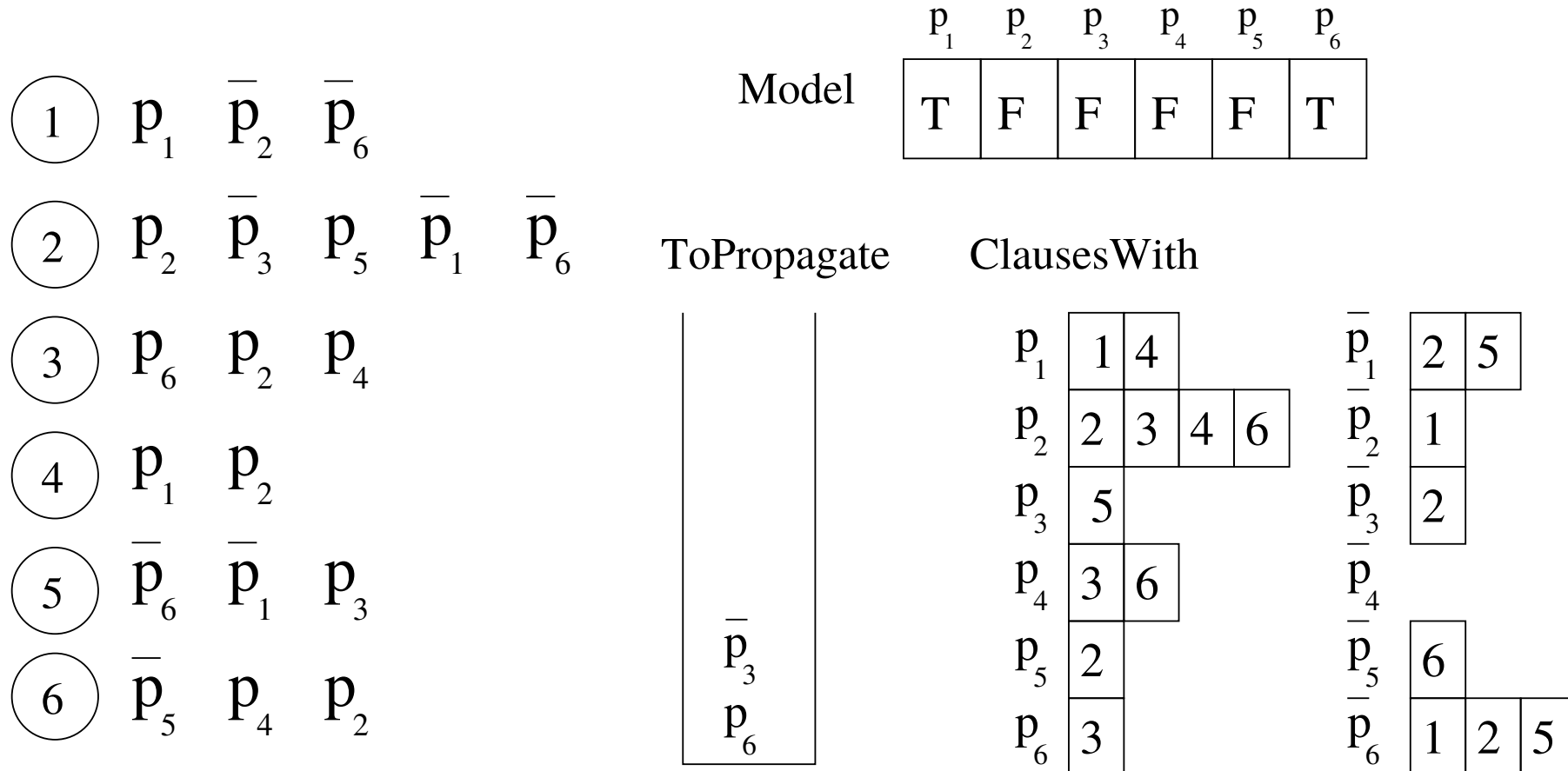
BCP with Occur Lists



Current assignment: $\bar{p}_2^d p_1 \bar{p}_4^d p_6 \bar{p}_5$

Literal \bar{p}_3 has to be added to the assignment

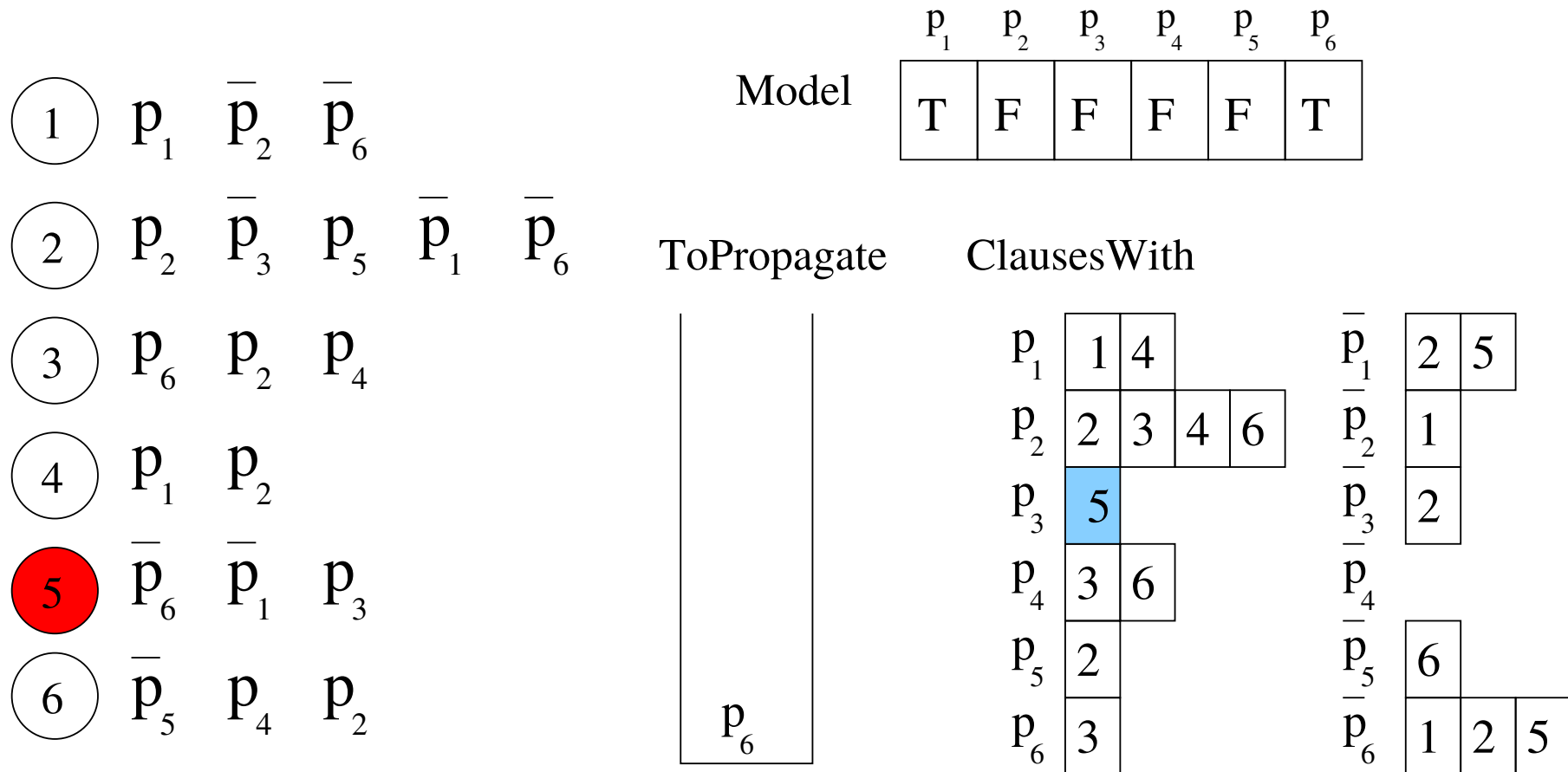
BCP with Occur Lists



Current assignment: $\bar{p}_2^d p_1 \bar{p}_4^d p_6 \bar{p}_5 \bar{p}_3$

Now, we propagate \bar{p}_3 visiting ClausesWith[p_3]

BCP with Occur Lists



Current assignment: $\bar{p}_2^d p_1 \bar{p}_4^d p_6 \bar{p}_5 \bar{p}_3$
 Clause 5 indicates a conflict. Backtrack/backjump is called.