AIFA: CSP

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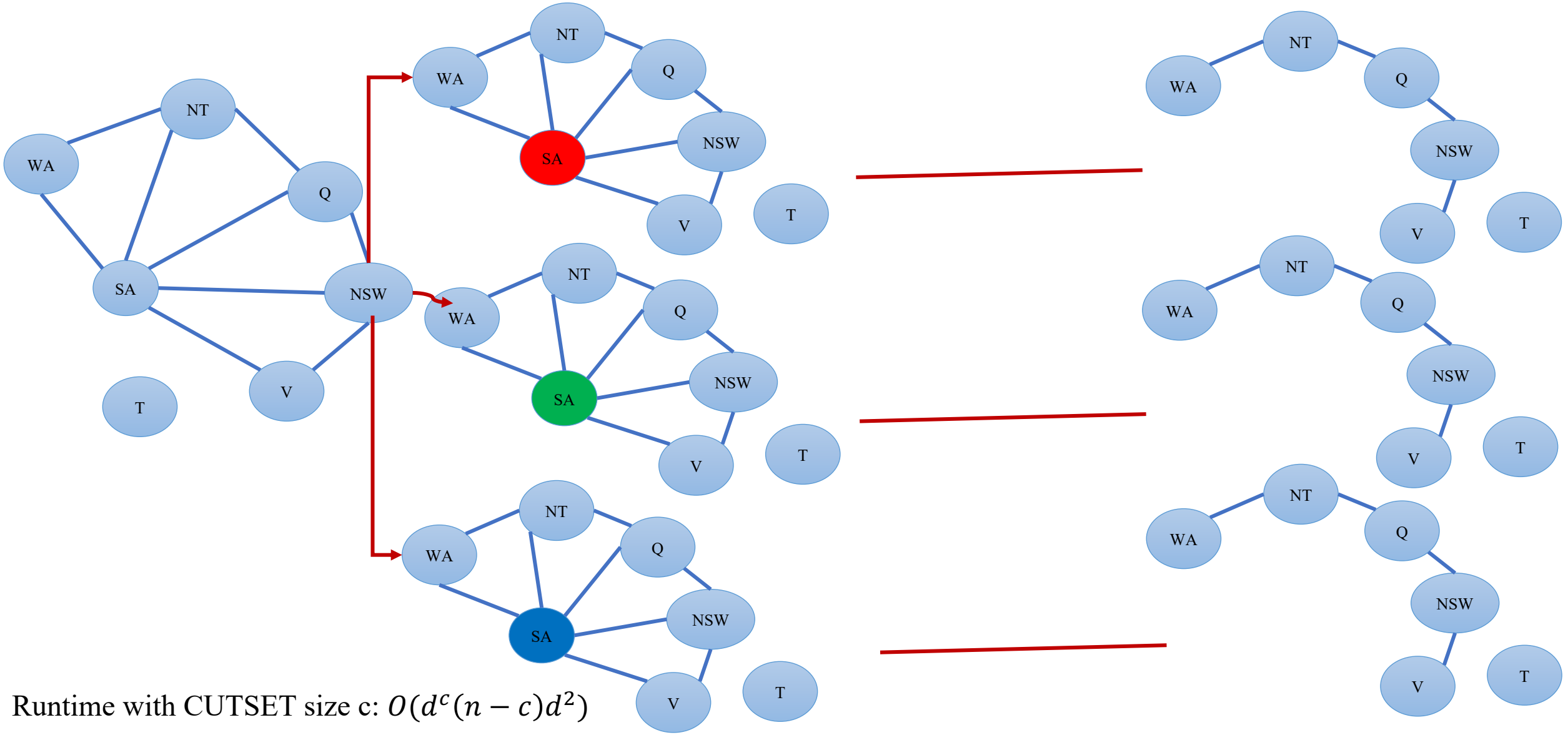
CUTSET Conditioning

Choose a CUTSET

Instantiate CUTSET

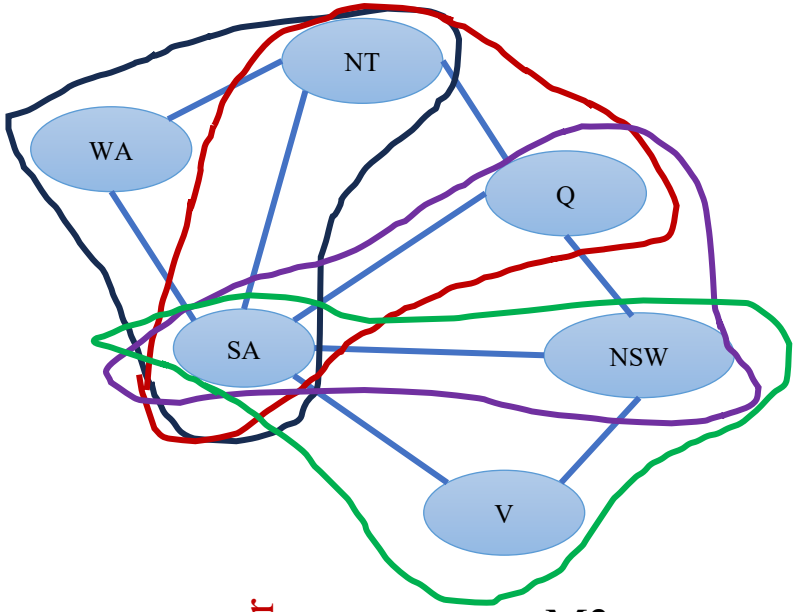
Compute Residual

Solve Residual TreeCSP

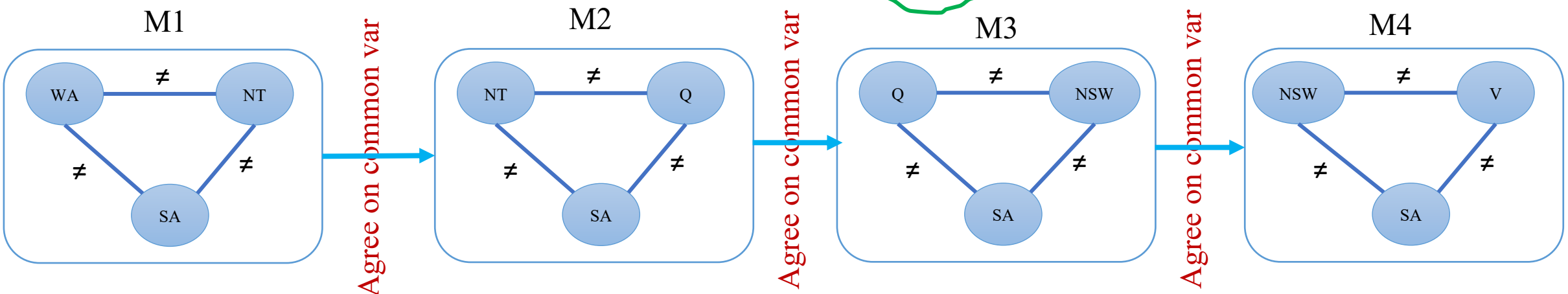


Runtime with CUTSET size c: $O(d^c(n-c)d^2)$

Tree Decomposing



Meta Constraint Graph



WA=R, NT=G, SA=B

Agree: $(M1, M2) \in \{\big((WA = G, NT = G, SA = G), (NT = G, Q = B, SA = G)\big), \dots\}$

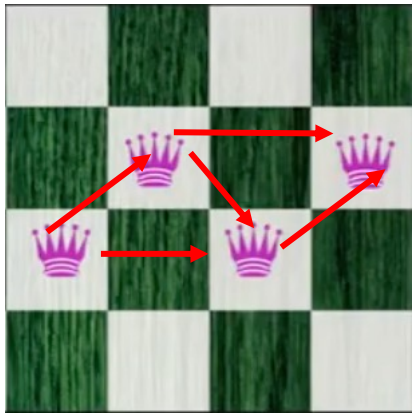
Iterative Improvement

- Start with a complete assignment with unsatisfied constraints

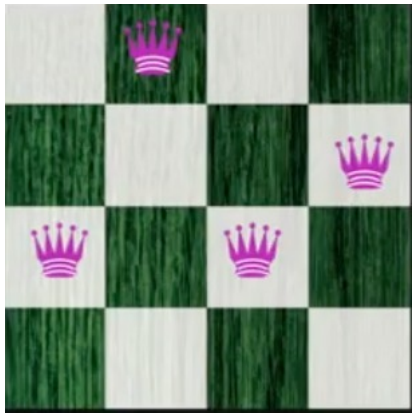
- Iteratively change solution
  - Reassign variable values
  - No data structure like stack maintained

- Algorithm
  - Variable selection: randomly select any conflicting variable
  - Value selection: min-conflict heuristics
    - Choose a value that violates the fewest constraints
    - (hill climb with h(n)=total number of constraints violated)

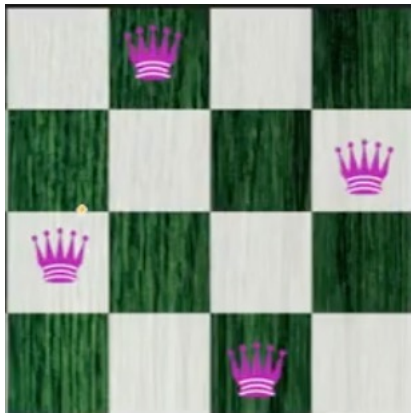
Iterative Improvement: 4 Queen Problem



h=5



h=2

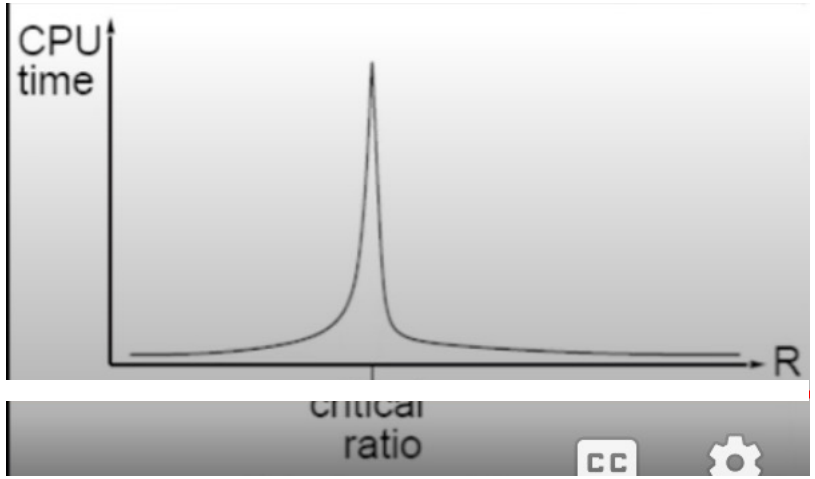


h=0

Min Conflict Heuristics

- Can solve N-queen problem for arbitrary n (~10M) with high probability in constant time
- Similar performance on random CSPs except for a narrow range

- $R = \frac{|Constraint\ Set|}{|Variable\ Set|}$



Comparison

Problem	Backtracking	BT+MRV	Forward Checking	FC + MRV	Min-Conflicts
N-Queens	>40,000K	13,500K	>40,000K	817K	4K

Summary

- CSP: Special instance of search problem
  - Generic (i.e., Problem Agnostic)
- Basic Algorithm: Backtracking
- Speedup: Ordering, Filtering, Problem Structure
- Iterative min-conflict (more practical)

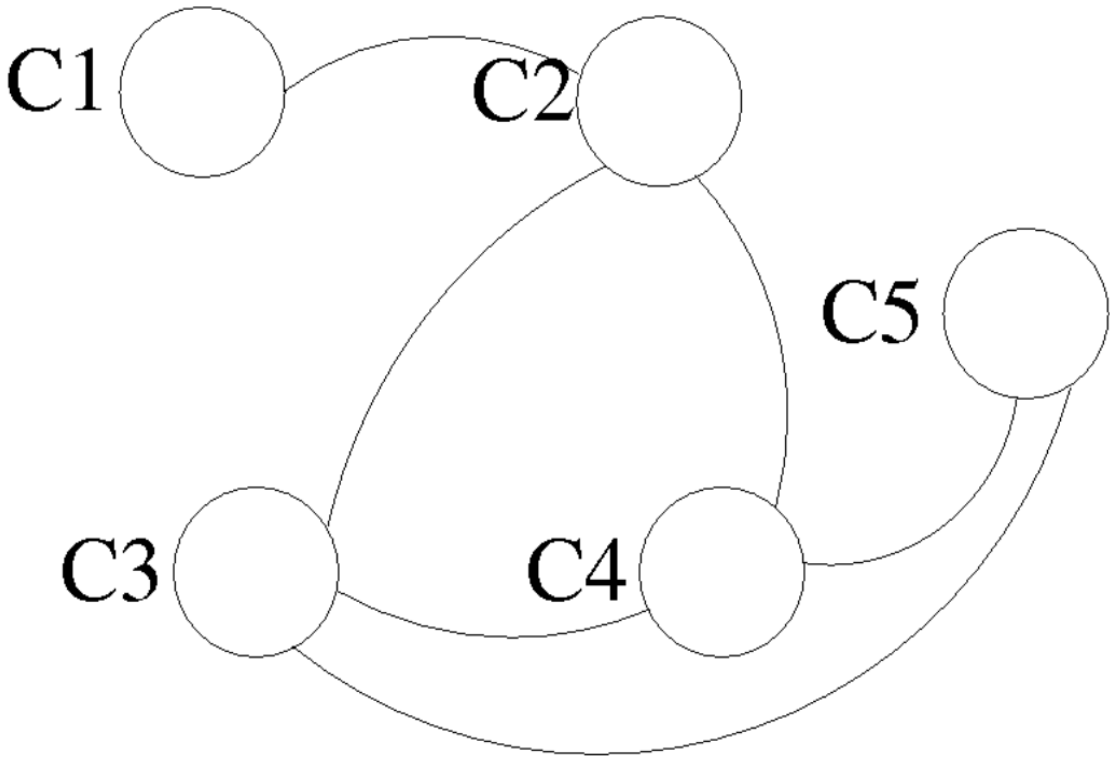
1) You are in charge of scheduling for computer science classes that meet Mondays, Wednesdays and Fridays. There are 5 classes that meet on these days and 3 professors who will be teaching these classes. You are constrained by the fact that each professor can only teach one class at a time.

- The classes are:
- Class 1 - Programming: meets from 8:00-9:00am
- Class 2 - Artificial Intelligence: meets from 8:30-9:30am
- Class 3 - Natural Language Processing: meets from 9:00-10:00am
- Class 4 – Information Retrieval: meets from 9:00-10:00am
- Class 5 - Machine Learning: meets from 9:30-10:30am
- The professors are:
- Professor A, who is available to teach Classes 3 and 4.
- Professor B, who is available to teach Classes 2, 3, 4, and 5.
- Professor C, who is available to teach Classes 1, 2, 3, 4, 5.

C1	C
C2	B,C
C3	A,B,C
C4	A,B,C
C5	B,C

(b). Draw the constraint graph associated with your CSP [2]

- Class 1 - Programming: meets from 8:00-9:00am
- Class 2 - Artificial Intelligence: meets from 8:30-9:30am
- Class 3 - Natural Language Processing: meets from 9:00-10:00am
- Class 4 – Information Retrieval: meets from 9:00-10:00am
- Class 5 - Machine Learning: meets from 9:30-10:30am



(c). Search for a solution using basic backtracking. Only check whether any new assignment violates no constraint with previous assignments. As a tie breaker assign a class to a professor based on alphabetical order. **Continue up to the first time you try and fail to assign any value for Class 5.**

SL No.	Var assigned or dequeued	List all values eliminated from neighbouring variables	Backtrack?
1			
2			
3			
4			
5			
6			
7			