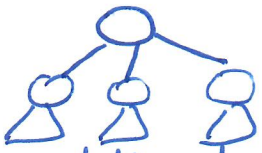
CS5811
Sep. 21, 2020
Monday (1)

Reminders

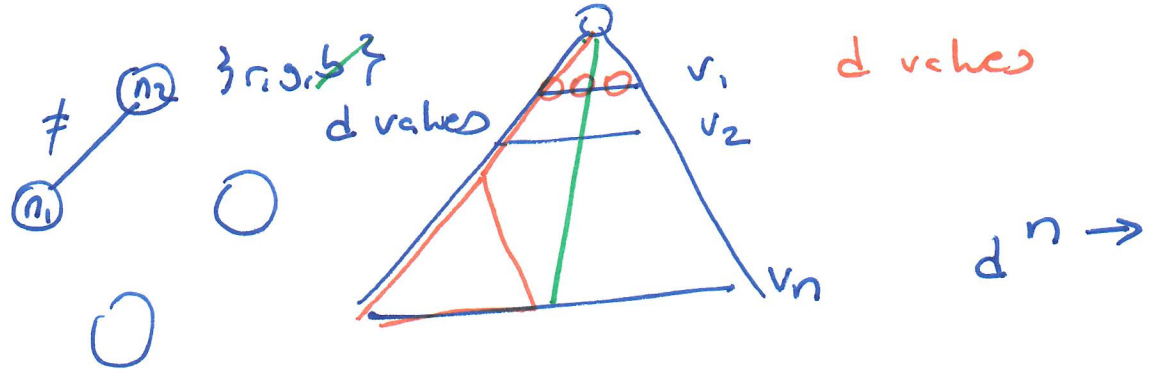
- Attendance is required and will be graded
- Please keep the video on during class.
  Brief time outs are OK.
- Please keep the microphone muted. You may unmute any time to add a comment or ask a question.
  Interrupting me is OK.

Previous classes

- Constraint satisfaction problems (CSPs): search problems defined in terms of variables, domains of variables, and constraints over variables.
- Use backtracking search (recursive implementation of depth-first search)



- Define heuristics to
  - move the path containing the solution to the left
  - detect failures early (prune the path)
- The search tree grows dynamically as before
- The constraints are static, they do not change during the search
- Binary constraints are represented using a constraint graph.



Heuristics

cost

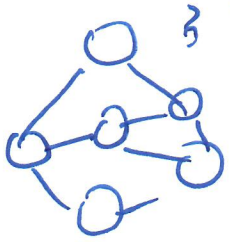
- which variable? choose a variable

  most constrained | fewest values possible | n

  most constraining | most constraints to other variables | n

  d values in each domain

  n variables → remaining values possible



  for each variable: n

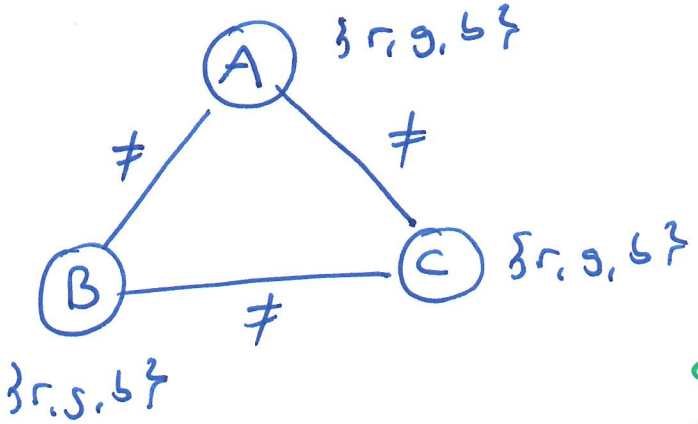
  ~~fewest values~~ # of values

- choose value | rules out the fewest values from other variables | d^2

  for each value d

  for each value of the other variable d | d^2

- forward checking | keep track of remaining values for the other variables



check arcs (directed arcs)

$V_1 \rightarrow V_2$

for each value of V_1 we need to find a value for V_2 that is legal

arc is consistent

A	B
B	A
A	C
C	A
B	C
C	B

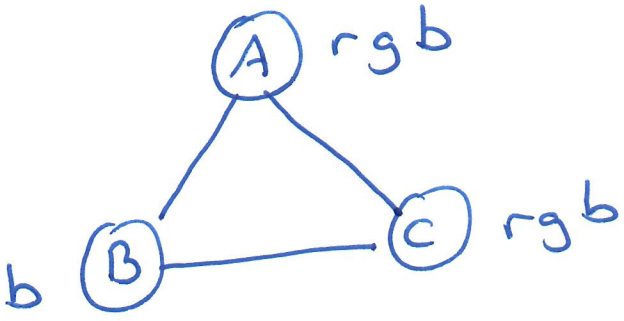
only A can lose values

list of arcs to be checked (queue)

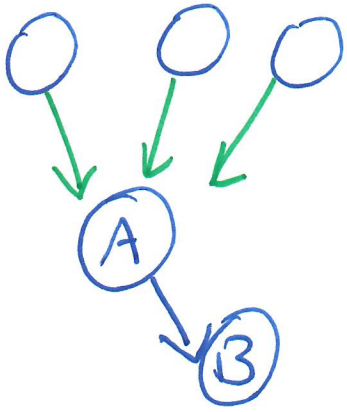
A → B

r	g	b
g	b	✓
r	b	✓
r	g	✓

possible values exist



A B
B A
A C
C A
B C
C B



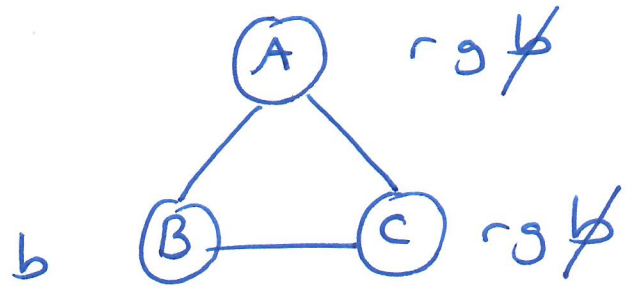
A → B

r	b	✓
g	b	✓
~~b~~	b	X

for A

{r, g, b} → {r, g}

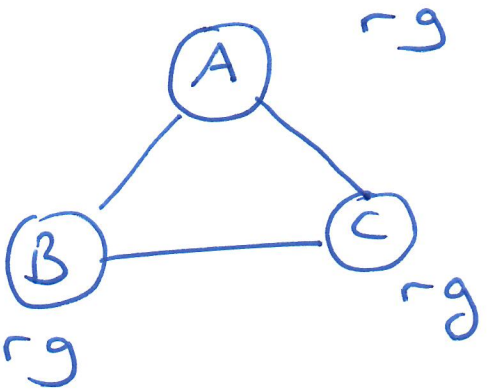
re insert all arcs coming into A.



b

two possible solutions

we need to continue expanding the search tree



is the graph arc consistent?

No ///

Yes // but the future is not bright.

idk

A	B	
r	g	✓
g	r	✓
~~g~~		

$V_x \rightarrow$ ~~N/A~~

arc consistent

time complexity

for each arc n^2

check each value of V_x d

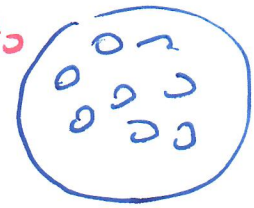
$V_x \rightarrow V_y$ is there a value in V_y d $n^2 d^2$

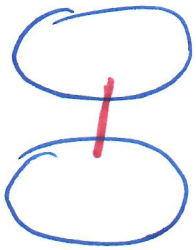
how many times can each arc be inserted into the queue d times

$n^2 d^3$

Problem structure

separate into subproblems





$n = 80 \quad d = 2$

$d^n = 2^{80}$

10 M nodes / second

4 billion years

$n = 20$

4 2^{20} 0.4 seconds

tree structured problems