CS 188 Discussion 3:

Constraint Satisfaction Problems (CSPs)

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Slides inspired by Sashrika Pandey and Regina Wang

Administrivia

- Project 2 due last Friday, Sep 22
- Homework 3 due next Tuesday, Sep 19
- We have office hours pretty much all day every weekday (12-7), come to Soda 341B!
- Reminder: Need extensions? We will give you extensions!

Today’s Topics

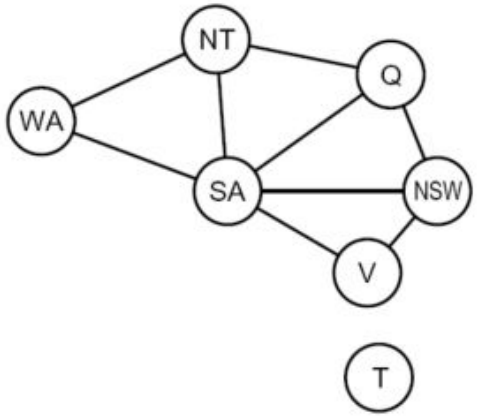
- Constraint Satisfaction Problems (CSPs)
  - Constraint graphs
  - Backtracking search
  - Forward checking

Constraint Satisfaction Problem

- **CSPs:**
  - Special subset of search problems
  - State defined by variables $\mathbf{X_1, \ldots, X_n}$ from domain **D** (sometimes $D_1, \ldots, D_n$)
  - Goal test is set of constraints on variables
- **Constraints:**
  - **Unary:** a single variable in the CSP, used to prune domain of the variable
  - **Binary:** involve 2 variables, represented as line on CSP graph
  - **Higher-order:** involve 3+ variables
  - **Implicit vs Explicit:** explicit constraints explicitly list out possible variable arrangements, we'll see an example on the next slide

CSP Example: Map Coloring

- Constraint: No adjacent states can be the same color
- Implicit: WA ≠ NT (bordering edges)
- Explicit: (WA, NT) ∈ {(red, green), (red, blue), …}

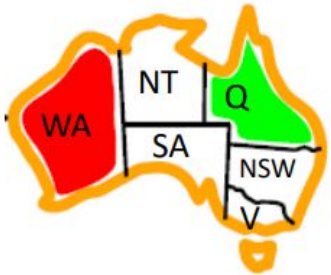


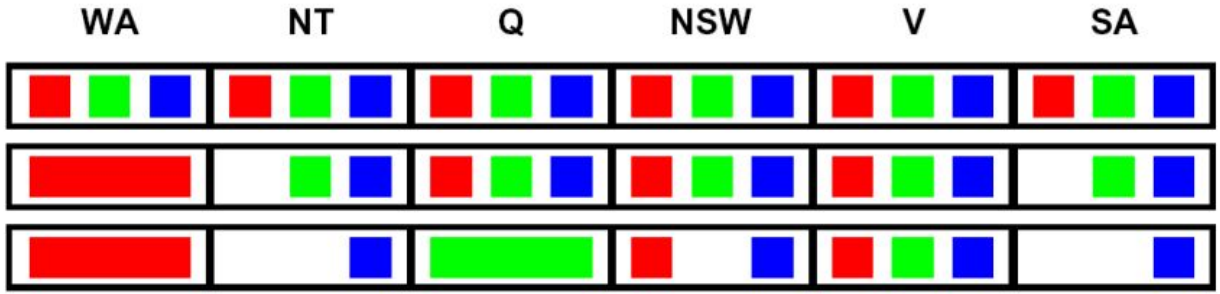
Backtracking Search

- Optimization on DFS
- Fix ordering of variables & select values in this order
- When selecting new value for variable, don’t conflict with previous assignments!
    - If this isn’t possible, then **backtrack** - return to previous variable and change its value

Forward Checking

- **Filtering:** Keep track of domains for unassigned variables and cross off bad options
- **Forward checking:** Cross off values that violate a constraint when added to the existing assignment
    - Run after every variable assignment



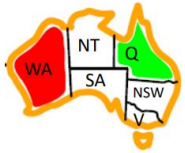


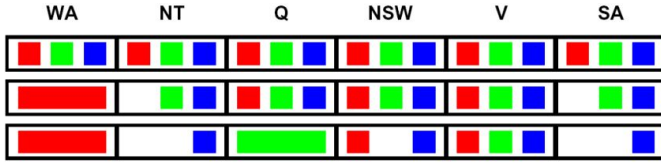
Ordering

- **Minimum Remaining Values (MRV):**
  - Choose variable to assign next with least remaining possible values in its domain
- **Least Constraining Value (LRV):**
  - Given a variable, choose the least constraining value to assign to it
  - Choose value for variable that rules out the fewest options for other variables

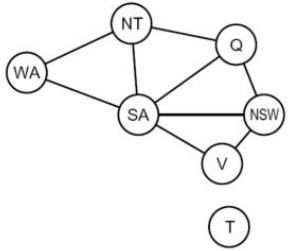
Worksheet

Summary





- **CSPs:**
  - Special subset of search problems
  - State defined by variables $\mathbf{X_1, ..., X_n}$ from domain **D** (sometimes $D_1, ..., D_n$)
  - Goal test is set of constraints on variables
- **Implicit vs Explicit:** explicit constraints explicitly list out possible variable arrangements
- **Backtracking Search:**
  - Assign variables in order, preserving constraints, until not possible - then backtrack



- **Forward Checking**
  - Cross off values that violate a constraint when added to the existing assignment
  - Run after each variable assignment
- **Minimum Remaining Values (MRV):**
  - Choose variable to assign next with least remaining possible values in its domain
- **Least Constraining Value (LRV):**
  - Given a variable, choose the least constraining value to assign to it
  - Choose value for variable that rules out the fewest options for other variables

Thank you for attending!

Attendance link:

- https://tinyurl.com/cs188fa23

Week No: 3

Remember my name is Kenny

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