INTRO TO AI EXAM 1 REVIEW

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Spring 2023

Exam 1

- In-class this Thursday, February 16
  Room: DARRIN 324
  Time: 10am – 11:50am
- No collaboration, OPEN offline book / notes, no electronics ~~(except a calculator)~~
- Topics:
  - *Lectures (1-4): AI Search (BFS, DFS, UCS, A*)*
  - *Lectures (5-6): Adversarial Search (Mini-max, $\alpha - \beta$, Expecti-max, limited-depth)*
    - NO Constraint Satisfaction Problems (CSP)
  - ~~*Lectures (7-9): Probability and Bayesian Networks*~~

*Revised since Recitation

Topic 1: AI Search
What is it? Examples?

- Automated methods for searching a state space in a principled way
- Example (Uninformed Search): Fair division of resources

Find an allocation that satisfies a given Fairness criterion.

	a	b	c	d	e
Agent 1	3	5	1	3	2
Agent 2	1	1	2	2	5
Agent 3	5	4	1	2	3

Search space: n^m *for* m *goods and* n *agents*

Topic 1: AI Search
What is it? Examples?

- Automated methods for searching a state space in a principled way
- Example (Uninformed Search): Fair division of resources
- Example (Informed Search): Website design

Image: adobe.com

Topic 1: AI Search

Key Terms

Definitions

- States
- Successor Function
- Start state, Goal state
- State Space Graph
- Search Tree
- Fringe

- True Cost
- Admissible Heuristic
- Consistent Heuristic

Algorithms

- BFS
- DFS
- UCS
- Greedy
- A*

A* UCS pqueue

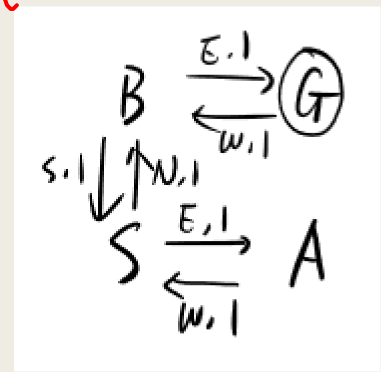
DFS stack

BFS queue

Topic 1: AI Search

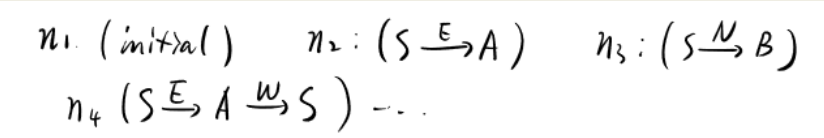
Key Terms

State Space Graph – (Unknown) world map

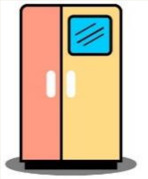


Search Tree –Internal representation (1) where visited, (2) how to get there

- Each node has unique label {state, history, successors}



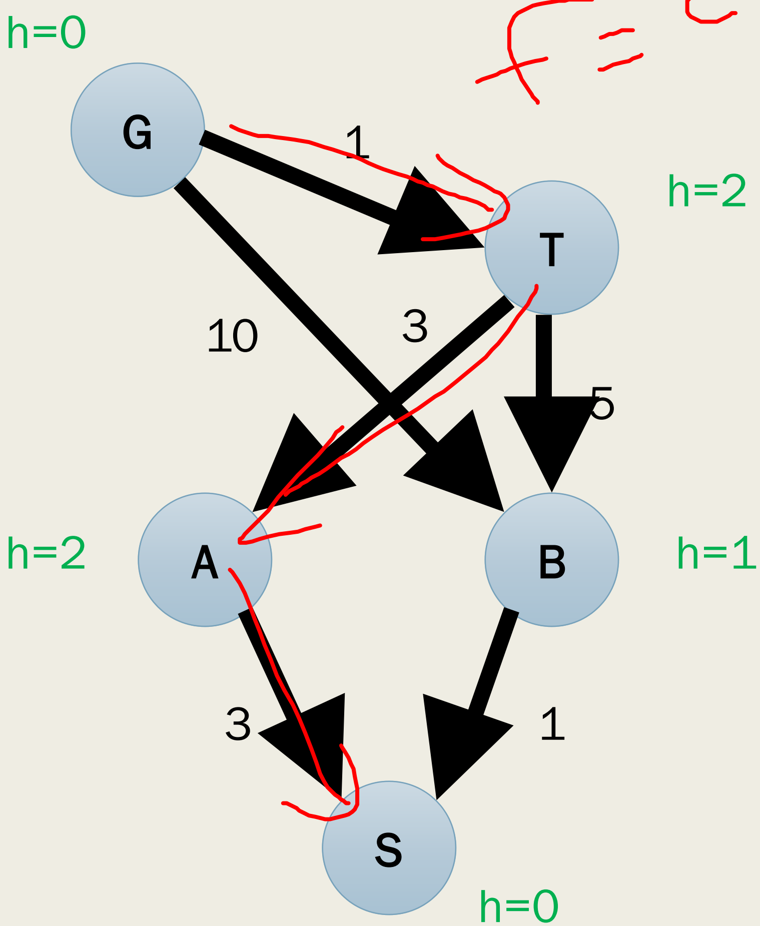
Fringe – set of nodes to search next



Topic 1: AI Search

Algorithm: A*

$f = c + h$



How to get there:

~~(T, 3)~~ ~~(A, 6)~~

(B, 11) (B, 7)

(S, 7)

7

Topic 1: AI Search

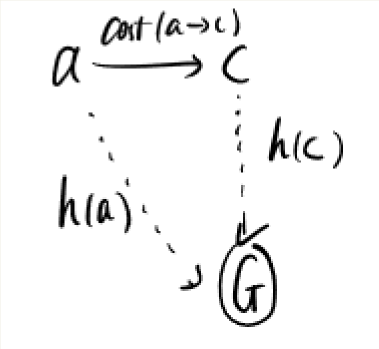
Algorithm: A*

Admissible Heuristic

- $h(s) \leq h^*(s)$ where $h^*(s)$ is minimal cost from s to nearest goal
- Easiest: $h(s) = 0$. Best $h(s) = h^*(s)$

Consistent Heuristic

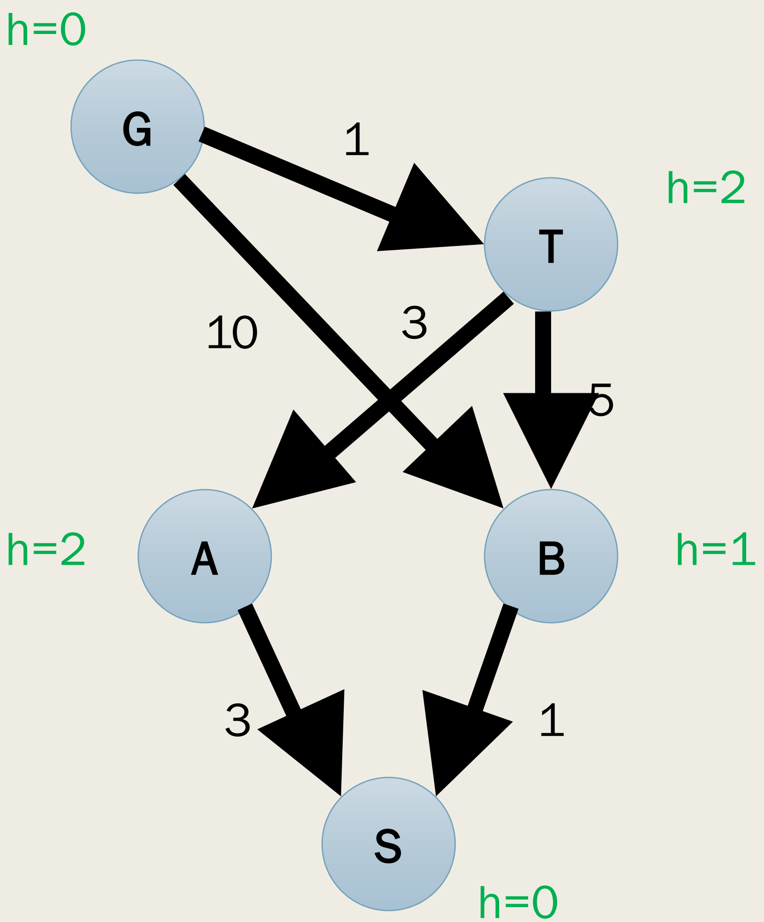
- $f = c + h$ never decreases along a path
- $cost(a \rightarrow c) + h(c) \geq h(a)$



Theorem: Consistency => Admissible and A* is correct

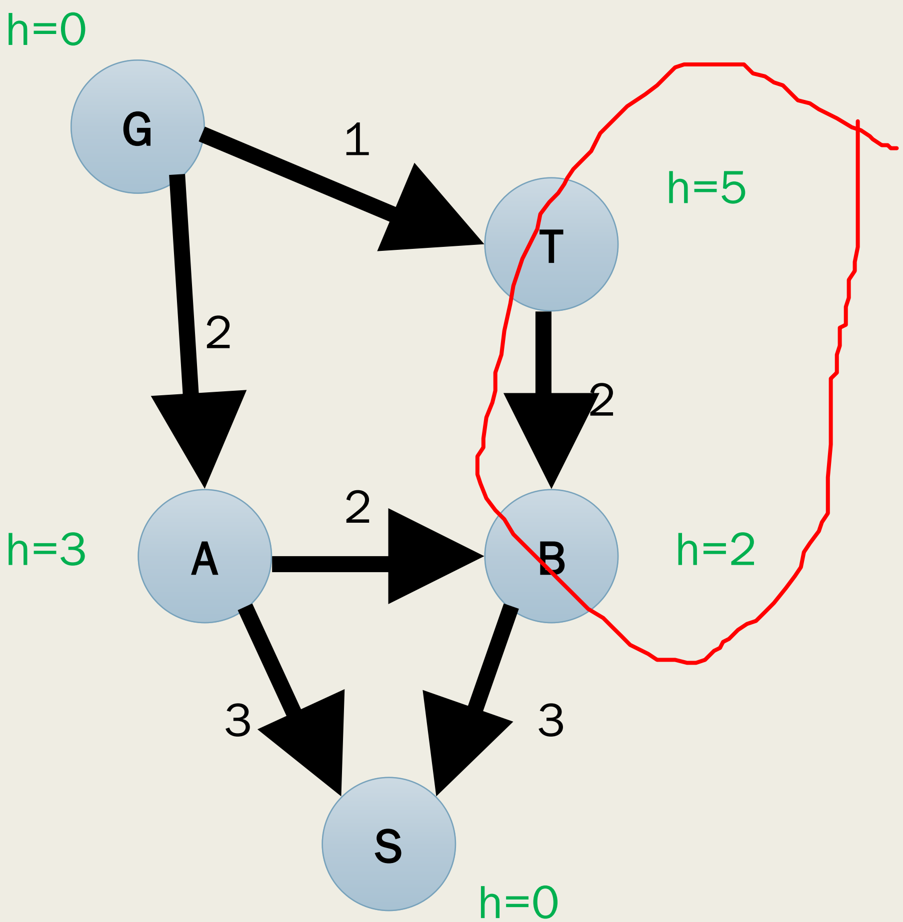
Topic 1: AI Search

Is this heuristic consistent?



Topic 1: AI Search

Is this heuristic consistent?



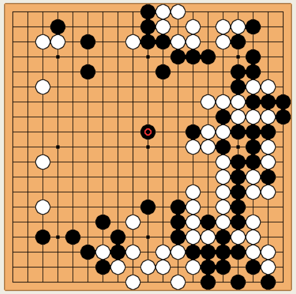
No, because
$h(T) > h(B) + cost(T \rightarrow B)$

Topic 2: Adversarial Search

What is it? Examples? What is Minimax?

Topic 2: Adversarial Search
Algorithm: Minimax

- (Zero-sum) game play with adversarial agents

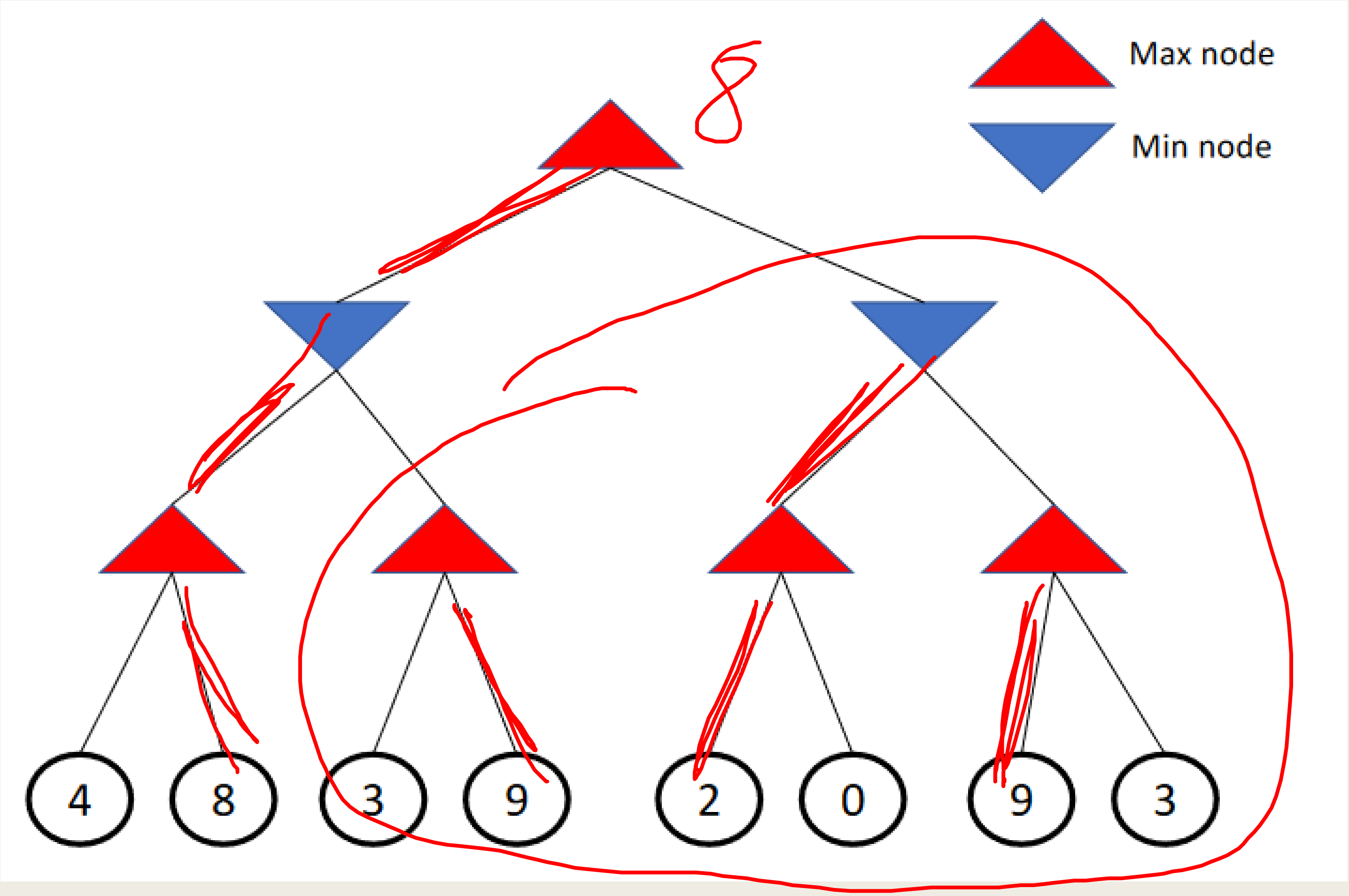


- Backward Induction – you know the opponent wants to minimize your score

Images: chess.com, senseis.xmp.net

Topic 2: Adversarial Search

Algorithm: Minimax



Topic 2: Adversarial Search

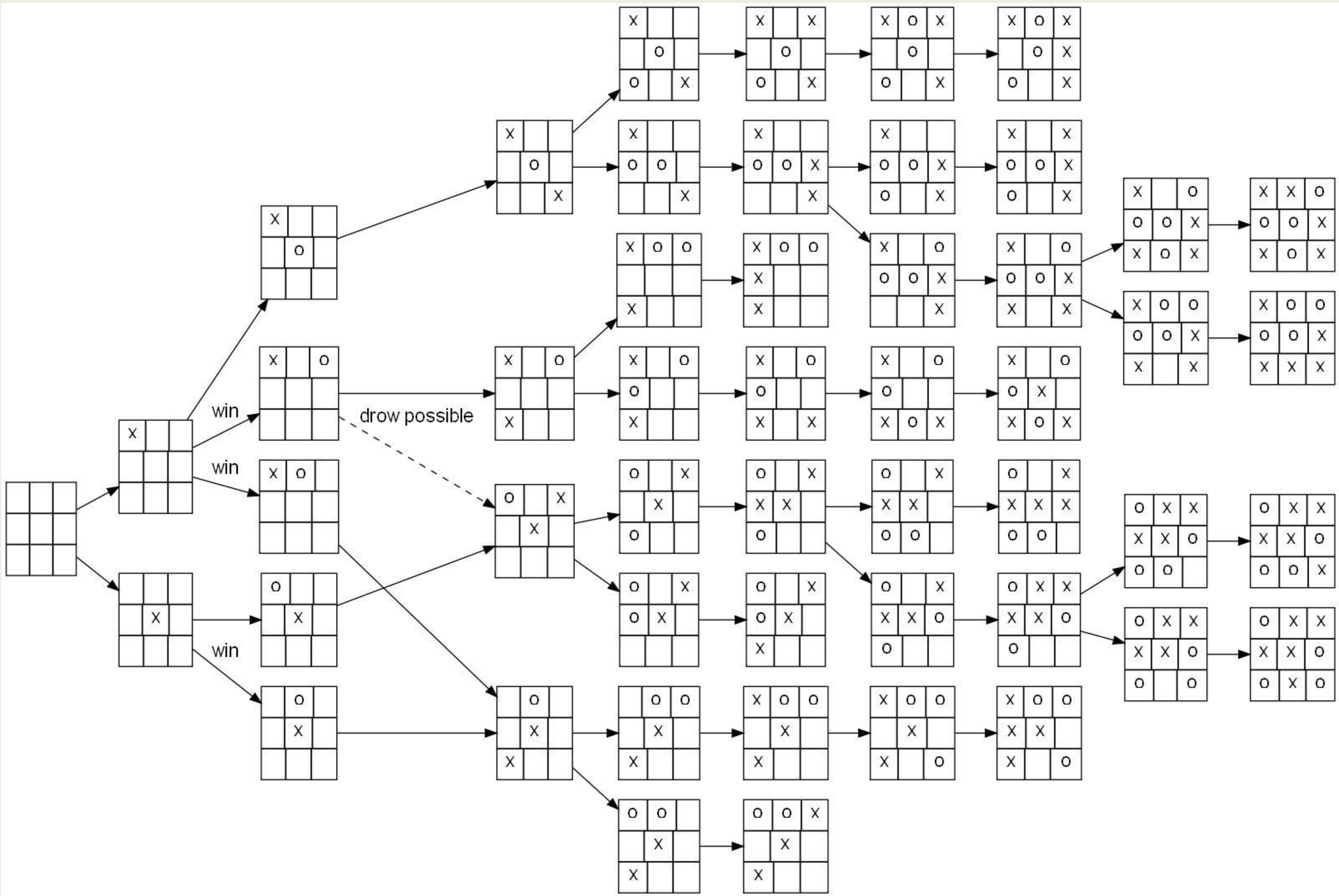


Image: wikepedia.com

Topic 2: Adversarial Search

Algorithm: $\alpha - \beta$ Search. What is it?

- Main idea: prune branches that cannot influence final decision
- What is α: highest value that a MAX node would choose up to this point
- What is β: lowest value that a MIN node would choose up to this point

Topic 2: Adversarial Search

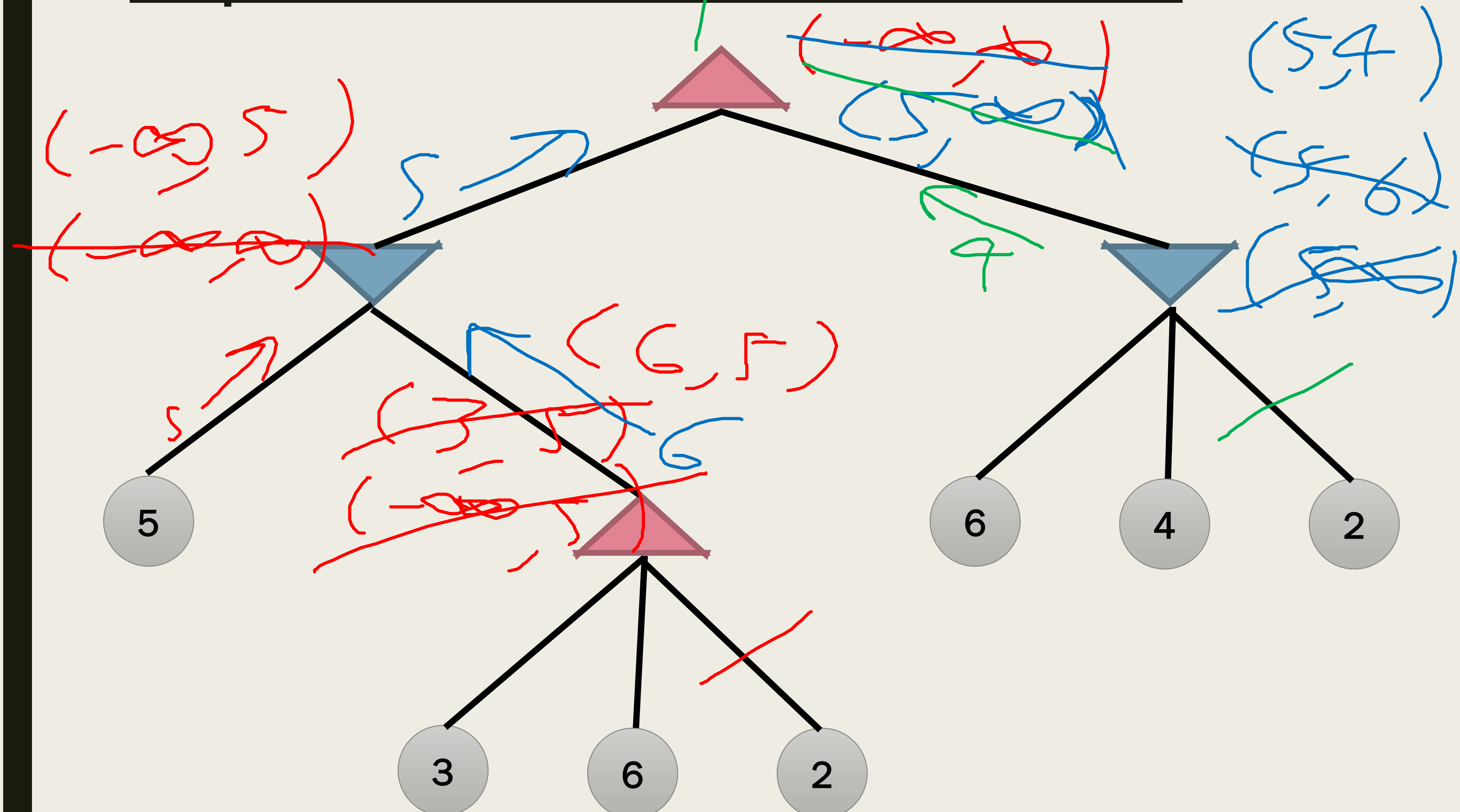
Algorithm: $\alpha - \beta$ Search. What is it?

- Main idea: prune branches that cannot influence final decision
- What is α: highest value that a MAX node would choose up to this point
- What is β: lowest value that a MIN node would choose up to this point

Process:

1. Copy (α, β) from parent
2. Update α at MAX (or β at MIN) when child returns
3. If $\alpha \geq \beta$.
   a) *Prune and return α if MAX (or β if MIN)*
   b) *Otherwise return maximin value*

Topic 2: Adversarial Search



Topic 3: Probability
Why do we care?

1. Mathematical convenience – internally consistent
2. Allows us to reason about the world from available information
3. Parameter estimation – MLE
4. ~~It's on your exam~~

*Revised since Recitation

Topic 3: Probability

Key Terms

Definitions

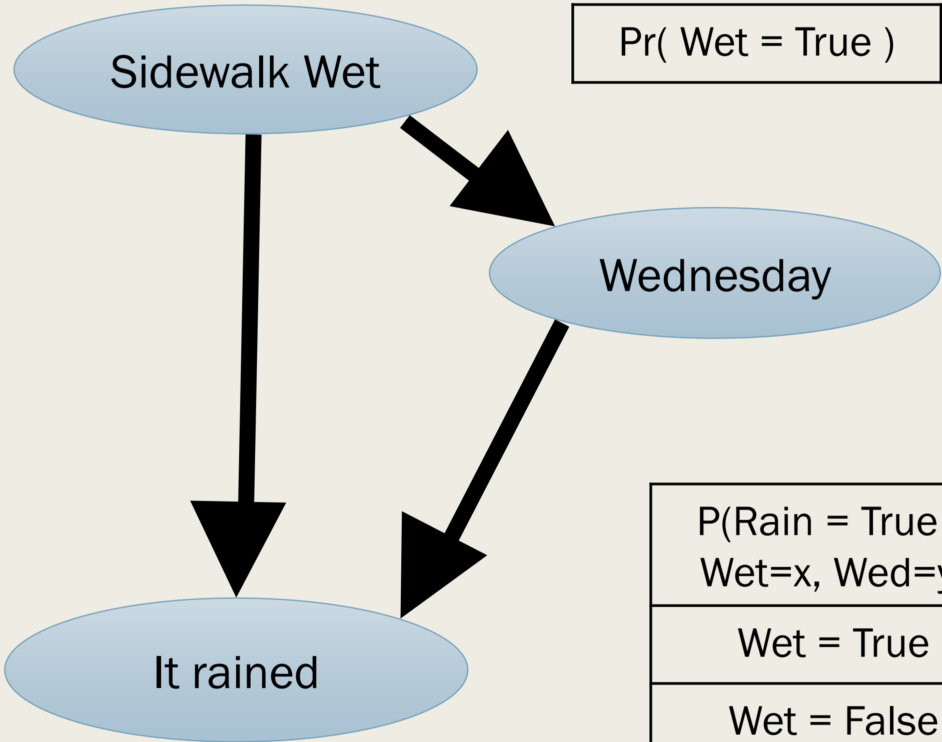
- Random variable
- Probability Distribution
- Marginal Probability
- Conditional Probability
- Chain Rule
- Bayesian Network
- Conditional Probability Table

Algorithms

- Compute storage space in BN
- Conditional dependence in BN
- Variable Elimination

Topic 3: Probability
Key Terms

Bayesian Network and Conditional Probability Table



Pr(Wet = True)	0.6

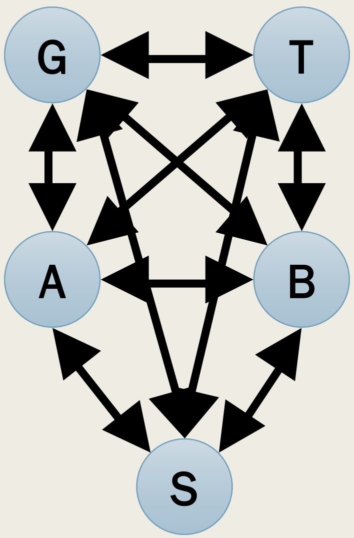
Pr (Wed = True | Wet = x)	
Wet = True	1/7
Wet = False	1/7

P(Rain = True | Wet=x, Wed=y)	Wed = True	Wed = False
Wet = True	0.1	0.8
Wet = False	0.01	0.01

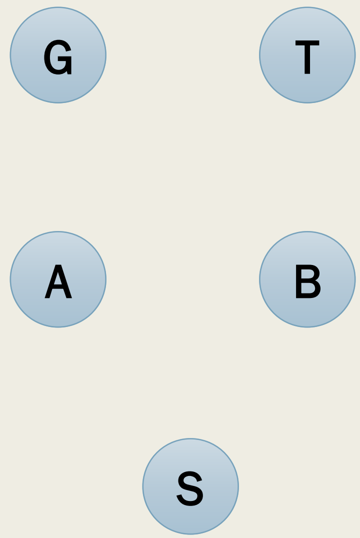
Topic 3: Probability

How many variables?

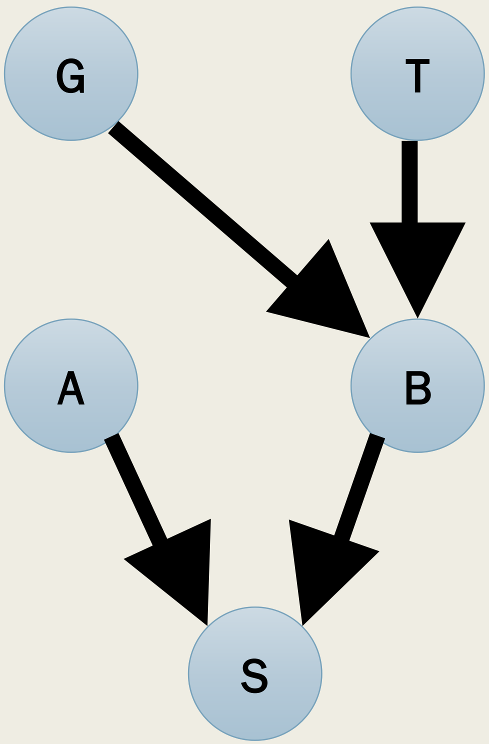
$|D_X| = 10$



$10^5 - 1$



9^5

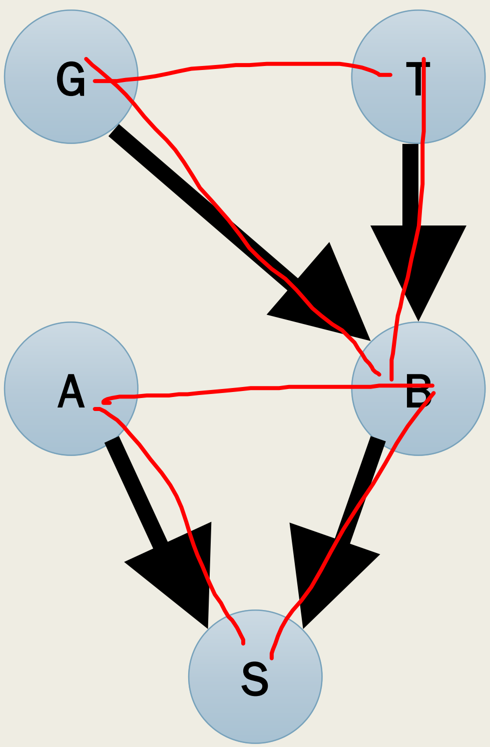


$9^3(9 \times 10^2)^2$

*Revised since Recitation

Topic 3: Probability

Is $G \perp S \mid B$?



1 Ancestral

2 Moralize

3 Disorient

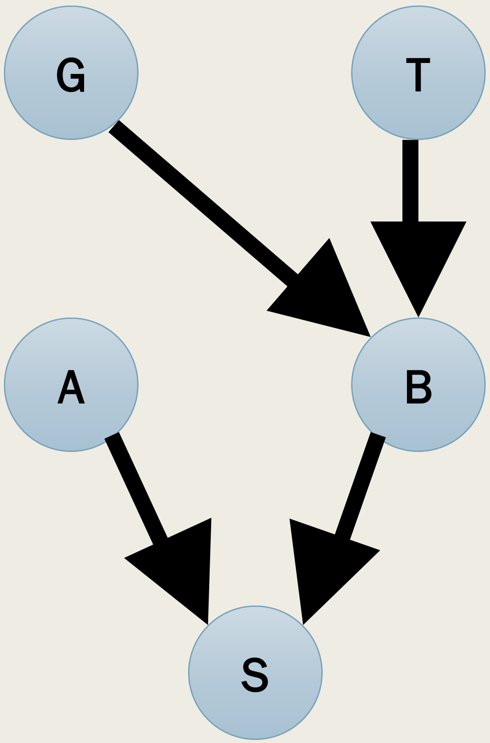
4 Remove Given

5 If $\exists$ path

$\Leftrightarrow$ not CI

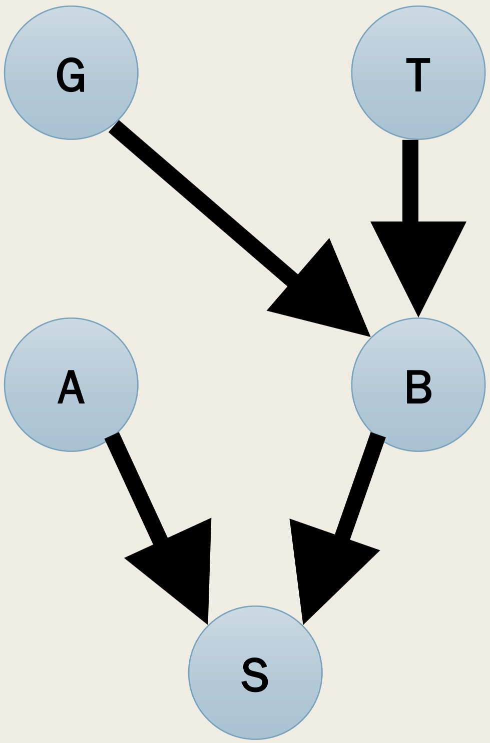
Topic 3: Probability

Is $G \perp S \mid B$?



Topic 3: Probability

Is $G \perp T \mid B$?

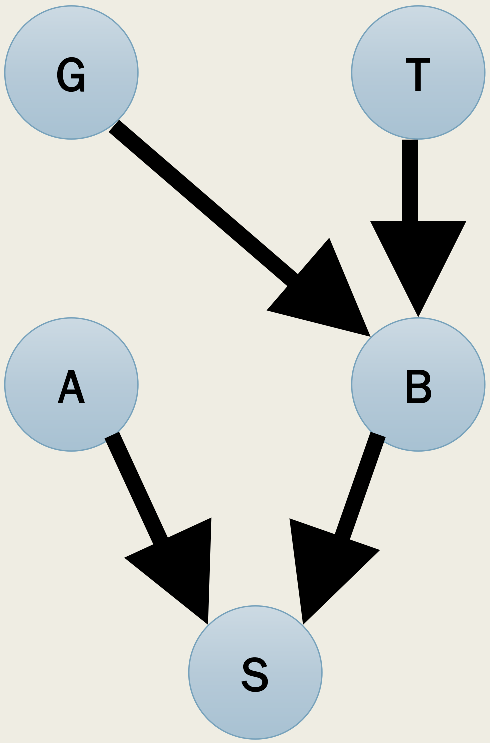


G — T

NO

Topic 3: Probability

Variable Elimination: $P(+g, +s)$?



1 Free variables

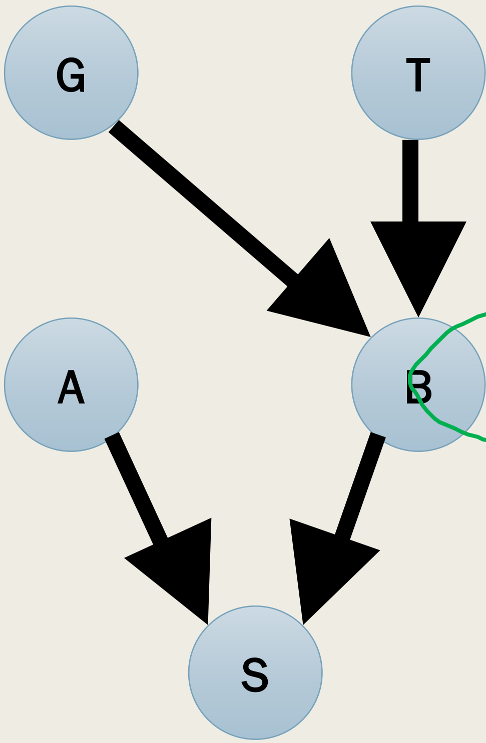
2 Write down marginal prob

3 Move left

4. DP

Topic 3: Probability

Variable Elimination: $P(+g, +s)$?



$$P = \sum_A \sum_T \sum_B P(A, T, B, +g, +s)$$

$$P(B \mid +G, T)\, P(A)\, P(+G)\, P(T)\, P(+S \mid A, B)$$

$$f_1(T, B) \quad f_2(B)$$

Good Luck

Get some sleep!