Artificial Intelligence, Spring 2018

Homework 3

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1 Problem Formulation

Please define the Go game's (19*19) states, actions, branching factor and transition model.
hint: follow the definition of 'brancing factor' on the textbook.

- **States:** The board size of the Go is 19×19, and each intersection can be "empty", "black", or "white", so there are $3^{19\times19}$ states in the board. Let e denote "empty", b denote black, and w denote "white".

  The states are $\{\{eee\cdots e\},\{bee\cdots e\},\{wee\cdots e\},\cdots,\{www\cdots w\}\}$.

- **Actions:** The actions are $PlayBlack$, $PlayWhite$, and $Pass$.

  There are two players in a Go game. Black player goes first. When it is their turn, a player may either pass (by announcing "pass" and performing no action) or play the color he/she own.

  Step 1. (Playing a stone) Placing a stone of their color on an empty intersection.

  Step 2. (Capture) Removing from the board any stones of their opponent's color that have no liberties.

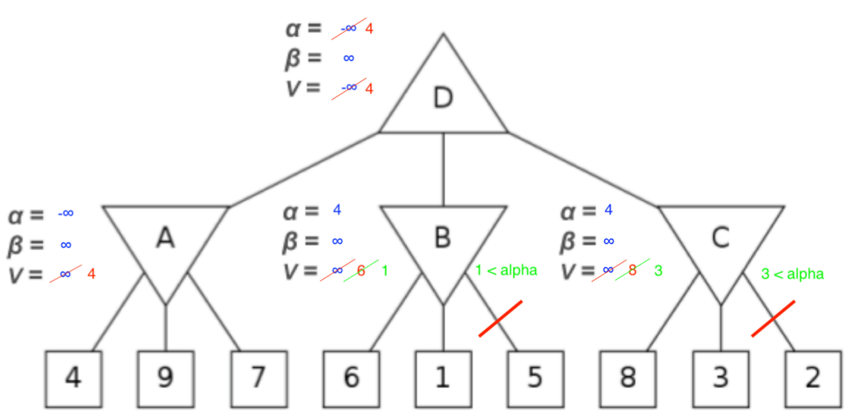
  Step 3. (Self-capture) Removing from the board any stones of their own color that have no liberties.

  Each action may remain the same state ($Pass$) or lead to a new state ($PlayBlack$ or $PlayWhite$).

- **Branching factor:**
  - All: $b = 19 \times 19$.
  - Average: $b = 250$.

- **Transition model:** Returns the board with the same state, or with a *black* or *white* stone added to the specified intersection.

2 Alpha-Beta Pruning



3 MDP

(a) What is the optimal value $V^*(A)$? Justify your answer briefly.

By MDP with $\gamma = 1$, we have the following table:

	+1	A			+10
$k=0$	0	0	0	0	0
$k=1$	1	0	0	0	10
$k=2$	1	1	0	10	10
$k=3$	1	1	10	10	10
$k=4$	1	10	10	10	10

$V^*(A) = 10$.

(b) What is the first iteration k for which $V_k(A)$ will be non-zero?

Because $V_2(A) = 1 \neq 0$, $k = 2$.

(c) What will $V_k(A)$ be when it is first non-zero?

$V_2(A) = 1$.

(d) After how many iterations k will we have $V_k(A) = V^*(A)$?

Because $V_4(A) = 10 = V^*(A)$, $k = 4$.

(e) If $\gamma = 0.5$, what is the optimal value $V^*(A)$? Justify your answer briefly.

	+1	A			+10
$k=0$	0	0	0	0	0
$k=1$	1	0	0	0	10
$k=2$	1	0.5	0	5	10
$k=3$	1	0.5	2.5	5	10
$k=4$	1	1.25	2.5	5	10

$V^*(A) = 1.25$.

(f) For what range of values γ of the discount will it be optimal to go *Right* from A?

$$\begin{aligned}\gamma^2 \cdot 1 &\leq \gamma^4 \cdot 10\\ \gamma^2 &\geq \frac{1}{10}\\ \gamma &\geq \frac{1}{\sqrt{10}}.\end{aligned}$$

(g) Let's assume that the $Left$ and $Right$ movement actions are now stochastic and failwith probability f. When an action fails, the agent stays in place. The $Exit$ action does not fail. If the failure probability is $f = 0.5$ and the discount $\gamma = 1$, what is the optimal value $V^*(A)$? Justify your answer briefly.

Since $\gamma = 1$, the failure doesn't affect the $V^*(A)$, the optimal value is still 10.