Search cutoff and stochastic games

Note Title

Boardgames are available in majors' room: Othello + Clue!

1 Search cutoff

Our previous algorithms (minimax and $\alpha-\beta$) had:

if (terminal state) return utility

We now replace this with:

if (should cutoff) return evaluation

Example of cutoff test: ← ask for input on this

if (depth ≥ MAX_DEPTH or evaluation < BAD_SCORE)
return true;

Example of evaluation: See qu 5.9 in the textbook, where

$$Eval(s) = (3X_2(s) + X_1(s)) - (3O_2(s) - O_1(s))$$

for tic-tac-toe.

do 5.9(b)-(e) in class or as exercise

How about for Othello?
Could try

$$Eval(s) = score + c_1 \times NumCorners + c_2 \times NumEdges + ???$$

(2) Stochastic Games

Review of <u>expected value</u> from basic probability:

Given some numerical outcomes and probabilities for those outcomes, the <u>expected value</u> is the sum of prob × outcome.

e.g. • one dice:

	1	2	3	4	5	6
prob	1/6	1/6	-	-	-	1/6

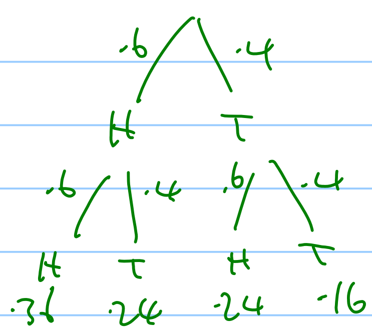
$$\text{exp. val.} = \left(\tfrac{1}{6}\times 1\right) + \left(\tfrac{1}{6}\times 2\right) + \ldots + \left(\tfrac{1}{6}\times 6\right) = 3.5$$

• two dice:

2	3	4	....	11	12
1/36	2/36	3/36	...	2/36	1/36

$$\text{exp. val.} = \left(\tfrac{1}{36}\times 2\right) + \left(\tfrac{2}{36}\times 3\right) + \ldots \left(\tfrac{1}{36}\times 12\right) = 7$$

Exercise: 2 biased coins. Chance of heads is 0.6 for each. Both are flipped, you win \$3 for each head showing. What are your expected winnings?



num heads	0	1	2
prob	.16	.48	.36
outcome	0	3	6

$$\text{exp. val.} = 0\times .16 + 3\times .48 + 6\times .36$$
$$= 3.6$$

Solving a stochastic game:

(1) Use chance nodes (as well as MAX, MIN)

(2) Use minimax, but compute expected value of minimax at chance nodes

e.g. Russell slide 26. Try it with biased coin.

(3) Can cut off and evaluate if desired.

Notes:
- complexity is horrible: $O(b^m n^m)$ — number of distinct chance outcomes
- pruning like α-β is possible but tricky — see homework exercise 5.16.
- can instead evaluate using Monte Carlo simulation.

(3) State of the art for AI in games

- See textbook section 5.7
  - understand why computers are great at some games and not others
- Check out the paper "Checkers is solved" cited on the resources web page (optional)