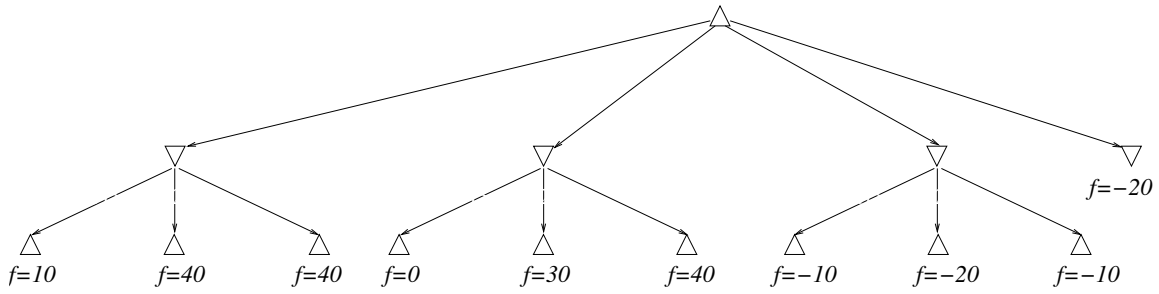
Computation, Information, and Intelligence (ENGRI/CS/INFO/COGST 172), Spring 2007
2/5/07: **Lecture aid — Pruning; wrap-up of problem solving**

Topics: (alpha-beta) pruning; Kasparov vs. Deep Blue vs. popular understandings of problem solving and "true" intelligence.
Announcements:

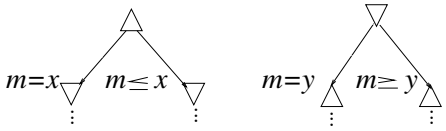
- Due to an all-Engineering faculty meeting, Prof. Lee's office hours this Tuesday (2/6) will be 3-3:30 instead of a full hour.
- When you turn in Homework One on Wednesday, there will be separate piles for each of the four parts. Therefore, remember to keep the different parts separate. Also, note that TAs will be picking up the homeworks at the beginning of class in order to begin grading them. Thus, your homework must be in by (the stated deadline of) the beginning of lecture.

I. Sample truncated game tree $\triangle$ and ∇ indicate player 1's and player 2's turn to move, respectively.[1]



II. Notation for pruning : Circle those leaf-node ((labels') (pseudo-)minimax values that are consulted. Use hash marks to indicate pruning sites, i.e., nodes below which we don't bother searching. Write current constraints by nodes, and cross out out-dated constraints.

III. Self-test Make sure you see why pruning occurs in each of the two situations below. $\triangle$ and ∇ indicate player 1's and player 2's turn to move, respectively. Next to each node is an indication of our current knowledge about its (pseudo-)minimax value m; x and y stand for numbers.



[1] This very sensible notation, which visually clarifies whether the player whose turn it is prefers high or low evaluation-function scores, is borrowed from Russell and Norvig (2003).

(OVER)

IV. Selected highlights in the history of computer chess

1845: Babbage discusses getting a machine to play chess.
late 1800's: Torres y Quevados builds a machine for three-piece (king and rook vs. king) endings.
1950's: Turing and Shannon (founders of computer science and information theory, respectively) propose searching path trees, elementary programs.
1957: Bernstein writes first program for full game.
1958: first documented human defeat (human taught rules just before the game).
The interim: Programmers and humans both confidently predict ultimate victory for their "sides". Slow but steady progress in program development.
1988: Deep Thought defeats a human grandmaster in a match game, but world champion Kasparov defeats it easily.
1996: Kasparov vs. Deep Blue. Kasparov loses the first game, but wins the six-game match.
1997: Deep Blue wins the rematch, and subsequently is retired.
2006: Kramnik defeated by a program that "in its basic form retails at $\pounds 36.50$" (Moss, *The Guardian* 12/8/2006)

V. Some opinions on computer chess-playing

1. Chess is the Drosophila [fruit fly] of artificial intelligence. — Alexander Kronrod, 1965.

2. The Brain's Last Stand. — *Newsweek*'s May 5, 1997 cover on the Kasparov/Deep Blue rematch.

3. Deep Blue [had] ingenious counterattacks .... I.B.M.'s master plotter played the strongest purely positional game ever produced by computer....Deep Blue's defensive power was once more extraordinary: with great virtuosity, it fought through .... Deep Blue [engaged in] original play in the opening .... Deep Blue played as though virtuosity in difficult endgames was second nature. No one had foreseen its scintillating method of certifying the draw. – Robert Byrne (Grandmaster and NYT chess columnist), *New York Times*, May 13, 1997.

4. The truth of the matter is that Deep Blue isn't so smart. It does not for a moment function in the manner of a human brain. It is just a brute-force computational device. Deep Blue is unaware that it is playing the game of chess. It is unconscious, unaware, literally thoughtless. It is not even stupid....[2]

   Machines aren't nearly as flexible and crafty as humans.
   [Computers] never learn....
   Deep Blue plays chess better ... but only because human beings have carefully programmed Deep Blue to play chess. Left on its own, Deep Blue wouldn't even know to come in out of the rain. — Joel Achenbach, *Washington Post*, May 10, 1997.

5. The "skin-of-an-onion" analogy is also helpful. In considering the functions of the mind or the brain we find certain operations which we can explain in purely mechanical terms. This we say does not correspond to the real mind: it is a sort of skin which we must strip off if we are to find the real mind. But then in what remains we find a further skin to be stripped off, and so on. Proceeding in this way do we ever come to the "real" mind, or do we eventually come to the skin which has nothing in it? — Alan M. Turing, "Computing machinery and intelligence". *Mind* (59), pp. 433–460, 1950.

[2] Colby Cosh remarked that "the media exuded a hysterical self-reassurance" ("Computer Bytes Man", *Alberta Report*, 1996).