1. Some people believe that ____________'s shoulder hit in game 2 of the Go match against ____________ marks the end of an era, because (circle answer)
   a) this unusual move caused the computer to fall behind, but it recovered and won the game.
   b) a strong human would never make this move, yet this move turned out to be strong.
   c) after this strong move, the human did not win another game in the match.
   d) the computer found the move quickly, and a thorough post-game analysis showed that all other moves were losing.

2. For this position, the number of misplaced tiles is _____, and a tile slide that decreases this quantity is (circle answer) up down left right.

3. show your work This is A*: shortest path from A to K, use straight-line distance heuristic. A’s neighbours are B,C,D. cost is current distance from A, and heur is ______________________________
   The next node selected will be _____, because

4. If this Go game ends now, the Tromp-Taylor score is _______ points for Black and _______ points for White. From this position, White has _______ legal moves and Black has _______ legal moves. If this game continues, the best move for White is to point _______. 
5. \( \alpha \beta \) search executes on this graph in the usual order (circle one):
   a) left-right reverse dfs  b) left-right bfs  c) top-down bfs  d) left-right dfs. After backing up to node _______ from node _______, \( \alpha \beta \) cuts off the branch from node _______ to _______ because it sees that the value of node _______ will not change the minimax value of the tree, which is _______.

6. Computers achieved superhuman strength in chess in 1997 and in Go in _______.
   This took longer for Go mainly because (circle one)
   a) computer scientists were studying the game of chess longer than they studied the game of Go.
   b) chess has an easily computed and relatively accurate heuristic evaluation
   c) chess simplifies as players are captured, so the end result can be computed with endgame databases
   d) computers can evaluate all endgame positions of the 8x8 chess board but not the 19x19 Go board

Right: for this nim(3 3 3) dp solver partial trace, give the missing data for the last 3 lines.

7. For nim(7 10 11), a winning move is to remove _______ stones from the pile with _______.

8. Left: label the root with the minimax value for Max, the first player, who tries to maximize her score. Leaf scores are for Max. Show your work. Right: 0 moves next. show the next 2 layers of the tic-tac-toe game tree, and give the minimax value: _______
1. answers in lecture prologue: AlphaGo, end of an era (this move was so unexpected, Michael Redmond did a triple take when he saw this move)

2. only tile 3 of tiles 1-8 is in the right place; after 8 slides R, D D L U L U. bfs always finds shortest solution, as does A* with not-overestimating heuristic. lucky bfs can be as fast as A*. A* not easier to implement.

3. priority is cost + heur, heur is st-line dist to K. whichever of current nodes under consideration has highest priority (so here, smallest sum, so C)


5. any form of minimax (including $\alpha\beta$) must proceed in bottom up fashion. here, consider left-right bfs.

Due to a typo in the labelling of the tree, this particular example has no $\alpha\beta$ cutoffs. So everyone received full marks for this part of the question. You still needed to answer the multiple choice, and find the minimax value.

Note: this example is t3.in in simple/alphabeta/; run `python3 alphabeta.py < t3.in` to see output.

dfs(a)
dfs(b)
  minimax(b) = 2
after backing up to a, can we cutoff?
  if all remaining nodes score 1,
    max’s best root move: to b
  if all remaining nodes score 3,
    max’s best root move: to c
*** so no cutoffs yet ***
dfs(c)
dfs(d)
  minimax(d) = 5
after backing up to c, can we cutoff?
  if all remaining nodes score 3,
    max best root move: c, then min best move: e
  if all remaining nodes score 6
    max best root move: c, then min best move: d
*** no cutoffs yet ***
dfs(e)
dfs(f)
  minimax(f) = 4
after backing up to e, can we cutoff?
if remaining node g has score 6,
  max best root move c, min best move d
if remaining node g has score 4,
  max best root move c, min best move g
*** no cutoffs yet ***
dfs(g)
  minimax(g) = 3
  in dfs(e), max’s best move is to f
  minimax(e) = 4
  in dfs(c), min’s best move is to e
  minimax(c) = 4
  in dfs(a), max’s best move is to c
  minimax(a) = 4

6. 2015 (if superhuman means stronger than some professional) or 2016 (if superhuman means stronger than (probably) all humans) best answer (4 marks): chess’s heuristic evaluation; next best answer (2 marks): chess simplifies (but not nearly enough to solve it with endgame databases, there is more that has to be done)

7. answer in webnotes (nim section)

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

leftmost column with 1-sum has a 1 in 7 row,

10 1 0 1 0  
so remove from 7-pile, must leave

11 1 0 1 1  
total of xorsum of other piles,  
so leave 1 0 1 0 +x 1 0 1 1 = 1,  
so remove 6 stones from 7-pile is only winning move

8. left: minimax value of left subtree 1, minimax value of right subtree 4, so minimax value at root is max(1, 6, 4) = 6

right: answer as in webnotes (ttt section). minimax value: win for O