CSE 505 HW2 Report Enbo Yu
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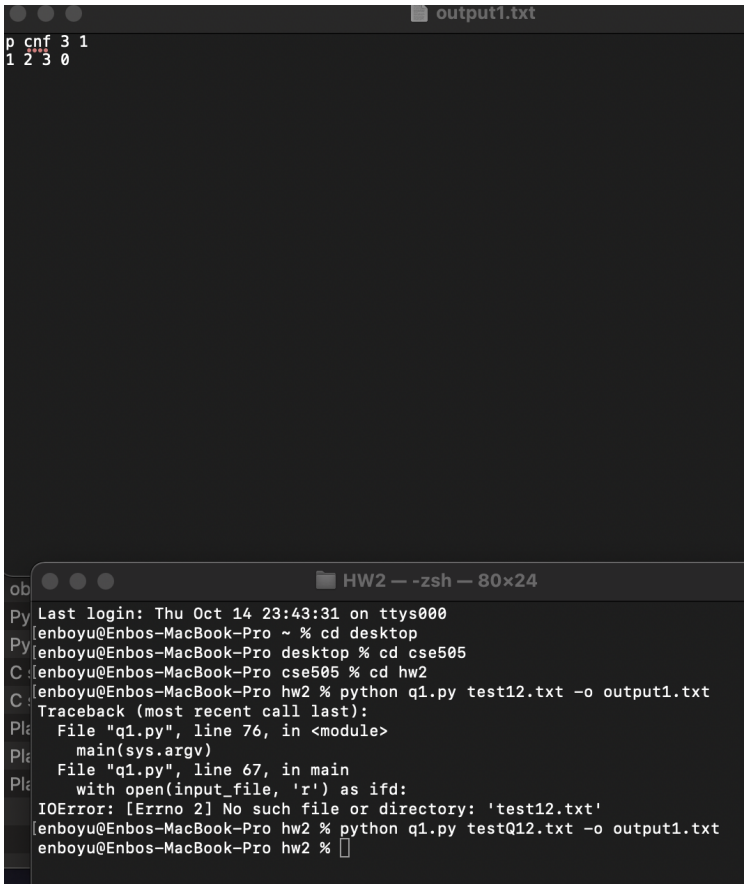
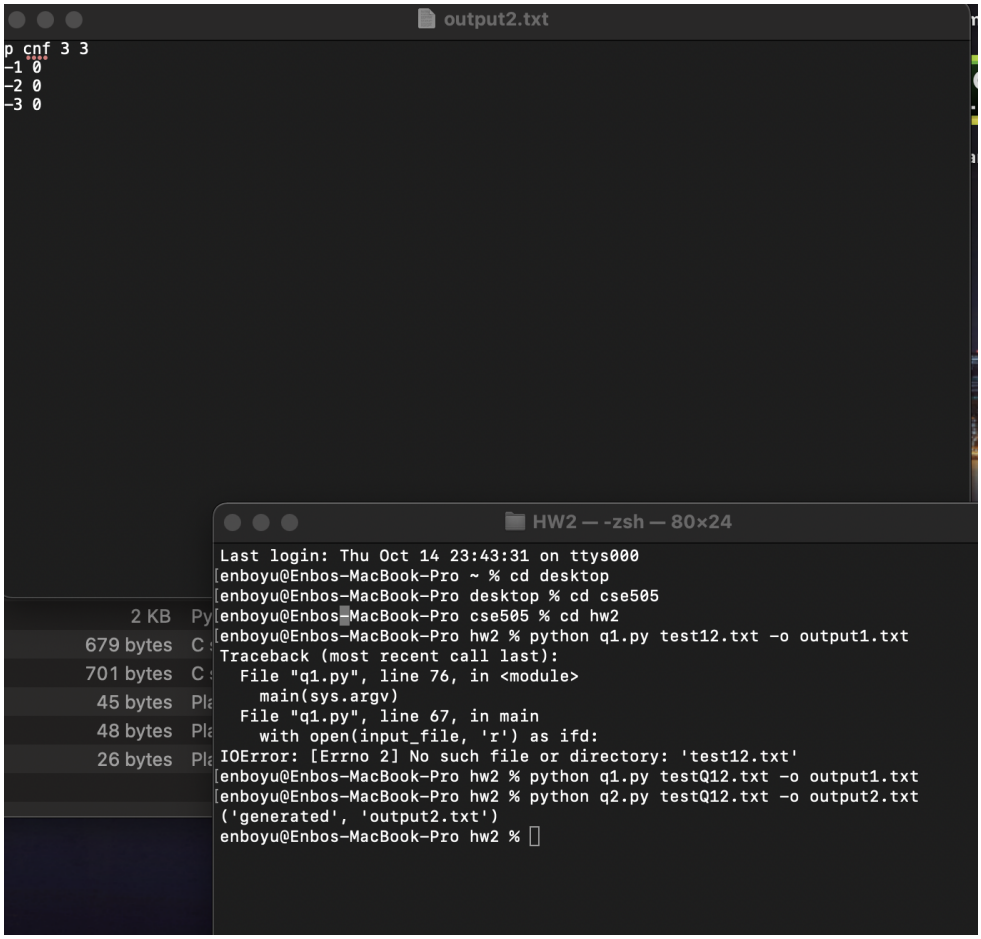
Q1:
p cnf n 1
p1 p2 ... pn 0
See Q1.py
Input:
p cnf 3 2
-1 2 0
-2 -3 1 0
Output:
p cnf 3 1
1 2 3 0
Q1Test:

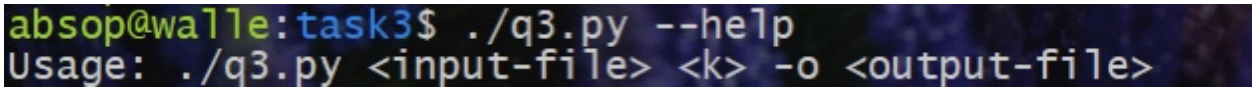


Q2:
p cnf n n -p1 0 -p2 0
...- p n 0
See Q2.py
Input:
p cnf 3 2

-1 2 0
-2 -3 1 0
Output:
p cnf 3 3
-1 0
-2 0
-3 0
Q2Test:



Q3:
p cnf n k
p1 p2 ... pk-1 pk 0 p2 p3 ... pk pk+1 0
...pn-k pn-k+1 ... pn-1 pn 0
Q3Test:



Q4:
see Q4.c Test: 368 12
23
34

45
56
61
25
36
Output: SATISFIABLE

Q5:

1.
For all steps s ∈ [0, K], integer num (s, i, j) ∈ [0, N × N − 1] denoting which number or label the tile contains at step s.
2.
For all space(i, j) : num (0, i, j) is the number of the (i, j) in the initial configuration. The empty tile is numbered as 0.
3.

Integers d i (s) , d j (s) ∈ {− 1, 0, 1 } , respectively denoting the vertical and horizontal movement of the empty tile during the transition from step s to step s + 1.
4.
For all steps s ∈ [0, K] , a Boolean goal (s) denoting whether the puzzle has been solved at step s or at an earlier step.
5.
Integersemptyi(s)∈[0,N−1]andemptyj (s)∈[0,N−1],respectivelydenotingthevertical and horizontal coordinates of the empty tile at step s.
6.
(num(s,i,j)=0)⇔(emptyi(s)=i∧emptyj (s)=j).Thissynchronizesthetwowaysof tracking the location of the empty tile.
7.
For all steps s ∈ [0, K] : (steps ≤ s) → (goal (s) = 1)
8
Forallstepss∈[0,max−1]:di (s)=0∨dj(s)=0.Thisenforcesthattheplayeronlymakes orthogonal moves.
9.
goal(s)=1⇔(di (s)=0∧dj(s)=0).Thisenforcesthatnomoremovesaremadeoncethe puzzle has been solved.
10.
(di (s)=0∧dj(s)=0)→(emptyi(s)=emptyi (s+1)∧emptyj(s)=
empty j (s + 1)) . This enforces that, if one has not moved, the empty tile should not have moved.
11.
Forthemoves(i,j)∈{(1,0),(−1,0),(0,1),(0,−1)}:(di (s)=
i∧dj (s)=j)→(emptyi (s)+i≥0∧emptyi (s)+i≤N∧emptyj (s)+j≥0∧emptyj (s) +j≤N∧emptyi (s)+i=emptyi (s+1)∧emptyj (s)+j=emptyj (s+1)).Thisenforcesthat the player only makes valid moves and that the empty tile actually moves.
12.

¬((emptyi (s)=i∧emptyj (s)=j)∨(emptyi (s+1)=i∧emptyj(s+1)=j))→(num(s, i, j) = num (s + 1, i, j)) .This enforces that, if the tile was not the empty tile during either one of the two steps, its contents should be unchanged.

13.

Forallstepss∈[1,K−1]:di (s−1)=1→di (s)!=−1,di (s−1)=−1→di (s)!=1,dj (s −1)=1→dj (s)!=−1,dj (s−1)=−1→dj (s)!=1.Thenumberofpossiblemovesatevery step reducing the size of the search space.

14.

See Q5.c

Test:

4 100

15 2 1 12

8 5 6 11

4 9 10 7

3 14 13 0

Output: SATISFIABLE