3.1
1:
a): without the pruning rule, the BFS path-finding algorithm has a branching factor of 4 since at any given state it can also expand the state that is its predecessor, causing there to be a number of children = 4, namely the four directions, NEWS.
b): if the shortest path is of length k, then in 4k expansions the BFS will guarantee to find the shortest path without the pruning rule since in each state there are 4 options to expand, it will certainly reach the goal in less than or equal to 4k node expansions.
c): if the shortest path is of length k the maximum number of nodes to expand is k^2+2k.
d): the maximum number of nodes bidirectional search with BFS and the pruning rule has to expand to find a shortest path when k is odd is $(k+1)^2$, and when k is even it is k^2+2k.
e): The need for a finite search space is because the algorithm needs to find the path with the lowest cost, and the cost of the path can be negative.
2:
a. bi directional search graph is worse than BFS when there is a path from s to t that traverses only a few vertices but the route from s to t visits many vertices, i.e essentially asymmetric branching factors.
b. Bidirectional search is better than BFS if the paths all have uniform cost.
c. if the search space resembles a linked list, iterative deepening will visit the child of the root. In the second iteration, you will visit the root's child and its own child (depth = 2, visited 2 nodes). In the third iteration, you go to a depth of 3, visiting 3 nodes. Hence the total number of visits is $1 + 2 + ... + n = O(n^2)$ but normal DFS will take only linear $O(n)$ time.
d. DFS is better when the target is far away from the source node.
3.2:
Variables: $p_1, p_2, \ldots, p_n$: each represent a placement, or position of a small square piece on the chess board.
Domain: $\{(i, j) \mid 1 \leq i \leq W - w_1, 1 \leq j \leq H - h_1\}, \{(i, j) \mid 1 \leq i \leq W - w_2, 1 \leq j \leq H - h_2\}, \ldots, \{(i, j) \mid 1 \leq i \leq W - w_n, 1 \leq j \leq H - h_n\}$
Constraints: $p_i \neq p_j$ for any $1 \leq i, j \leq n$