420-500: Programming Assignment 2

Read every page very carefully before you begin.

- Implement seven search algorithms to solve 8-puzzle: dfs, bfs, dls, ids, greedy, a-star, ida-star.
- 2. Test and compare time and space complexity for all cases.
- 3. Test and compare the effect of different heuristic functions (for the informed search algorithms).

This project is inspired by: http://www.cs.utexas.edu/users/novak/asg-8p.html.

Program 2: Required Material

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Use the exact filename as shown below (in **bold**).

- Program code (eight.lsp): put it in a single text file.
 - Ample indentation and documentation is required.
- Documentation (**README**): user manual plus results/analysis.
- Inputs and outputs (include in **README**; truncate output for search sessions that produce too much output):
 - **Easy:** ' (1 3 4 8 6 2 7 0 5)
 - Medium: ' (2 8 1 0 4 3 7 6 5)
 - Hard: ' (5 6 7 4 0 8 3 2 1)

Program 2: 8-Puzzle with Search

Input: a board configuration

' (1 3 4 8 6 2 7 0 5)

- Output: sequence of moves
 ' (UP RIGHT UP LEFT DOWN)
- Search methods to be implemented (use the exact function interface): dfs, bfs, dls, ids, greedy, a-star, ida-star.
- Use h₁ (number of tiles out-of-place), and h₂ (sum of manhattan distance) for those requiring heuristics (make the functions to take the function as an argument).
- This is an individual project.

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Program 2: Required Material (Cont'd)

Continued from the previous page

- For each run, report the time taken, the number of nodes visited. Except for IDA*, report the maximum length of the node list (or recursion depth) during the execution of the search.
- Compare the time and space complexity (from above) of various search methods using the Easy, Medium, and Hard case examples.
- For each method, comment on the strengths and weaknesses.
- Some search methods may fail to produce an answer. Analyze why it failed and report your findings.

Program 2: Function interface

Program 2 Tips (1)

• See

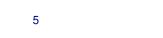
http://courses.cs.tamu.edu/choe/07fall/420/src/eight-interface.lsp

• Exactly follow the interfaces and function names.

Timing execution: use (time (your-function-to-run)) to get the execution time.

* (time (car '(x x)))
real time : 0.000 secs
run time : 0.000 secs
X

*



Program 2 Tips (2)

Checking for duplicate states

```
(defun dupe (state node-list)
  (dolist (node node-list nil)
      (if (equal state (first node))
            (return-from dupe T))))
```

(You may use a state-list to save space, rather than a node-list, or better yet, use somekind of hash function.)

Program 2: State Representation

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1	3	4
8	6	2
7		5

A node in the search tree has the following structure:

'((1 3 4 8 6 2 7 0 5);blank is stored as 0

h	;heuristic function value
depth	;depth from the root
path))	;list of moves from
	; the start

Program 2: Sorting

```
'((1 3 4 8 6 2 7 0 5);blank is stored as 0
h ;heuristic function value
depth ;depth from the root
path)) ;list of moves from
; the start
```

Sorting a node list, e.g. according to the heuristic:

```
(sort <node-list>
#'(lambda (x y) (< (second x) (second y)) )
)</pre>
```

lambda : read define-anonymous function

```
#'something = (function something)
cf.'something = (quote something)
```

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Lambda Expression

lambda expression can basically replace any occurrences of function names, i.e. it works like an anonymous function:

```
(defun mysqr (x) (* x x))
(mysqr '11)
; the above is the same as
```

```
((lambda (x) (* x x)) '11)
```

```
; some more examples
(defun myop (x op)
        (eval (list op (first x) (second x))))
```

(myop '(2 3) '*)

(myop '(2 3) '(lambda (x y) (* x y)))

Sorting: Alternatives

```
(defun sort-node-list (node-list)
  (sort node-list
   #'(lambda (x y) (< (second x) (second y)) )))</pre>
```

```
; the above is equivalent to :
  (defun sort-node-list (node-list)
    (sort node-list
      (function (lambda (x y) (< (second x) (second y)) )))</pre>
```

; the above is equivalent to : (defun compare-h (x y) (< (second x) (second y)))</pre>

```
(defun sort-node-list (node-list)
  (sort node-list #'compare-h))
```

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Sorting: Example

```
(setq test-node-list
    '((list1 10 0 0) (list2 87 0 0)
        (list 100 0 0) (list 5 1 0 0))
)
```

```
(defun sort-node-list (node-list)
  (sort node-list
    #'(lambda (x y) (< (second x) (second y)))
)
)</pre>
```

```
(sort-node-list test-node-list)
```

* You can use any combination of values to sort, and do ascending or descending sorts by changing the **lambda** function.

Program 2: Utility Routines

Source is available on the course web page: http://courses.cs.tamu.edu/choe/07fall/420/src/eight-util.lsp

- (apply-op <operator> <node>): return new node after applying operator on current node
- (print-tile <state>): prints out the board
- (print-answer <state> <path>): prints boards after each move in the path, starting from the state.
- (while <cond> <expr1> <expr2> ...): while loop macro.

See http://courses.cs.tamu.edu/choe/07fall/420/src/eight-util.txt for example runs.

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Program 2: Grading Criteria

- analysis, program comments, readability: 15%
- dfs, bfs, dls, and ids: 10% each
- greety, a-star, and ida-star: 15% each

Program 2: DFS working code

See http://courses.cs.tamu.edu/choe/07fall/420/src/dfs.lsp for a functioning DFS code.

Program 2: Other tips

For this assignment, it is highly recommended that you compile and run your program. See ROB, "Lisp: compiling".

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Program 2: Submission

- Turnin using CSNET turnin page.
- See the course web page for details.
- No late submission will be allowed.
- Only send plain ASCII text files. Do not send MS-Word documents or other formatted text.