CS575 Design and Analysis of Algorithms

Spring 2025

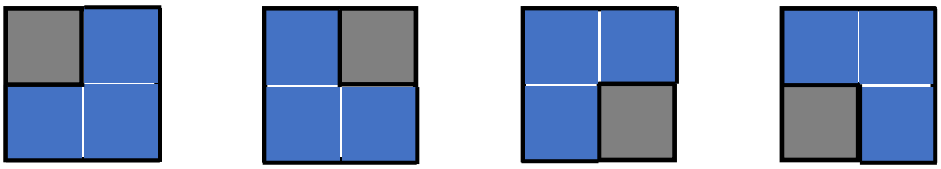
***Programming Assignment* 2**

Assigned: February 25, 2025
Due: Midnight Thursday, March 27, 2025

Remember to include the following statement at the end of your *readme.txt* with your signature. "I have done this assignment completely on my own. I have not copied it, nor have I given my solution to anyone else. I understand that if I am involved in plagiarism or cheating, I will have to sign an official form that I have cheated and that this form will be stored in my official university record. I also understand that I will receive a grade of 0 for the involved assignment for my first offense and that I will receive a grade of "F" for the course for any additional offense."

Assignment

Given a natural number n and a chess board with 2^n squares on each side (the length of the side is 2^n, called the board size) with a missing square in any location, you will use the divide and conquer approach to design and implement an algorithm (see the algorithm skeleton from the class slides) to cover the chess board (with a missing square) by an arrangement of trominoes (an L-shaped arrangement of three squares; see figure below) such that all trominoes are confined to the boundaries of the chess board, and no tromino overlaps another.



We will use x coordinate and y coordinate to record the location of the missing square. It is convenient to treat the origin (0, 0) as the lower left corner of the board. For instance, the coordinate of the missing square in the first figure above is (0, 1); the coordinate of the missing square in the second figure above is (1, 1).

You will make a function called tromino as below.

```
void tromino /* function to do tiling */
    ( int x_board,      /* x coordinate of board */
      int y_board,      /* y coordinate of board */
      int x_missing,    /* x coordinate of missing square */
      int y_missing,    /* y coordinate of missing square */
      int board_size ); /* size of board, which is a power of 2*/
```

The main program should call tromino(0, 0, x_missing, y_missing, board_size), which allows the user to input board_size by prompting the line "Please enter size of board as a power of 2 (0 to quit):" first, then to input coordinates of missing square for x_missing and y_missing by prompting the line "Please enter coordinates of missing square (separate by a space):". If the

board size from the user input is not a power of 2, please issue a message “The board size should be a power of 2” and prompt the same user input line “Please enter size of board as a power of 2 (0 to quit):”.

For the tromino function below,

```
void tromino /* function to do tiling */
    ( int x_board,      /* x coordinate of board */
      int y_board,      /* y coordinate of board */
      int x_missing,    /* x coordinate of missing square */
      int y_missing,    /* y coordinate of missing square */
      int board_size ) /* size of board, which is a power of 2*/
```

you will need to set up the base case for board_size = 2. What you need to do in the base case is to decide which L shape to be put in the three squares. Please print “LR” (Lower Right) in all three squares for the first L shape (see the figure above), print “LL” (Lower Left) for the second L shape (see the figure above), “UL” (Upper Left) for the third L shape (see the figure above), “UR” (Upper Right) for the fourth L shape (see the figure above).

You will do the following four recursive calls for the four half_size (board_size/2) subboards: upper left subboard, upper right subboard, lower left subboard, and lower right subboard.

```
/* tile the four subboards */
    tromino( x_board, y_board + half_size, x_upper_left, y_upper_left, half_size );
    tromino( x_board + half_size, y_board + half_size, x_upper_right, y_upper_right, half_size );
    tromino( x_board, y_board, x_lower_left, y_lower_left, half_size );
    tromino( x_board + half_size, y_board, x_lower_right, y_lower_right, half_size );
```

The main program should output the arrangement of trominoes at each coordinate location. For example, when board_size =2, x_missing = 0, and y_missing = 1 (the first figure above), the output should be as follows (please use “MS” to stand for the missing square).

```
MS    LR
LR    LR
```