## 4   Sierpinski (7 marks)

In this question, we are interested in drawing the Sierpinski triangle. The Sierpinski triangle is a fractal that is generated by recursively subdividing an equilateral triangle into smaller equilateral triangles. The Sierpinski triangle is named after the Polish mathematician Wacław Sierpiński.

We will explain how Sierpinski triangle is generated first before we explain how to draw it.

- A Sierpinski triangle of level 0 is just an equilateral triangle.

- To generate a Sierpinski triangle of level n, divide the Sierpinski triangle of level $n - 1$ into four smaller congruent equilateral triangles and remove the middle triangle.

The figure below shows the Siperpinski triangle of Levels 0, 1, 2, and 3.
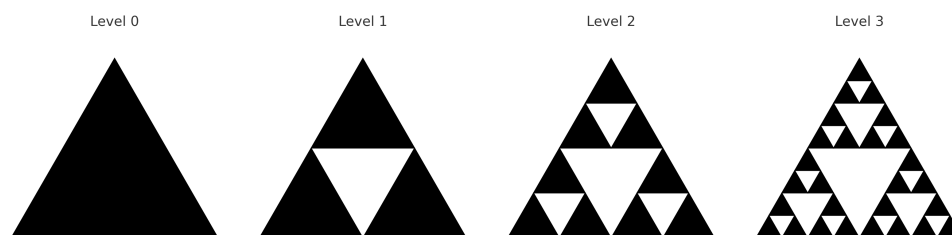
In this question, we will draw the Sierpinski triangle of Level i on the screen using #s and white spaces. The triangle must have exactly 2^i rows. Each row must have exactly $2^{i+1} - 1$ characters (including white spaces but excluding a new line). On each row, the sequence of characters representing the triangle must be centralized, padded by white spaces on both sides. We use #s for areas of the triangle that have not been removed and white spaces for areas that have been removed.

For example, the Sierpinski triangle of level 0 is just a single #.

```
#
```

The Sierpinski triangle of level 1 is shown below:

```
 #
# #
```

The Sierpinski triangle of level 2 is shown below

```
   #
  # #
 #   #
# # # #
```

The main program `sierpinski-main.c` has been given to you. This file contains the `main` method as well as the following two methods:

- `power_of_two` computes the power of two. Given an integer i, the function returns 2^i.

- `print_spaces` that prints spaces to the standard output. Given an integer n, the function prints n spaces to the screen (without a newline at the end)

You need to complete the function `draw_sierpinski` in the file `sierpinski.c`. The function takes two parameters, the level i of the Sierpinski triangle and the row number r of the triangle, and it should print the r-th row of the Sierpinski triangle of level i to the standard output. The function should not print a new line at the end of the row.

Special Constraints

You are required to solve this problem using only recursive functions. No loops are allowed inside sierpinski.c. Solutions that contain a loop (for any purpose) will receive 0 for the question.

You are not allowed to modify sierepinski-main.c.

The output of your program must match the test cases exactly, including the spaces and new lines.

Sample Runs

```
echu21@pe101:~$./sierpinski
3
        #
       # #
      #   #
     # # # #
    #       #
   # #     # #
  #   #   #   #
 # # # # # # # #
```

```
echu21@pe101:~$./sierpinski
4
                #
               # #
              #   #
             # # # #
            #       #
           # #     # #
          #   #   #   #
         # # # # # # # #
        #               #
       # #             # #
      #   #           #   #
     # # # #         # # # #
    #       #       #       #
   # #     # #     # #     # #
  #   #   #   #   #   #   #   #
 # # # # # # # # # # # # # # # #
```

Tips

White spaces are not visible. To help you debug, you can pipe the output through a Unix tool called sed. For example,

```
echu21@pe101:~$./sierpinski | sed 's/ /./g'
2
...#...
..#.#..
.#...#.
#.#.#.#
```