

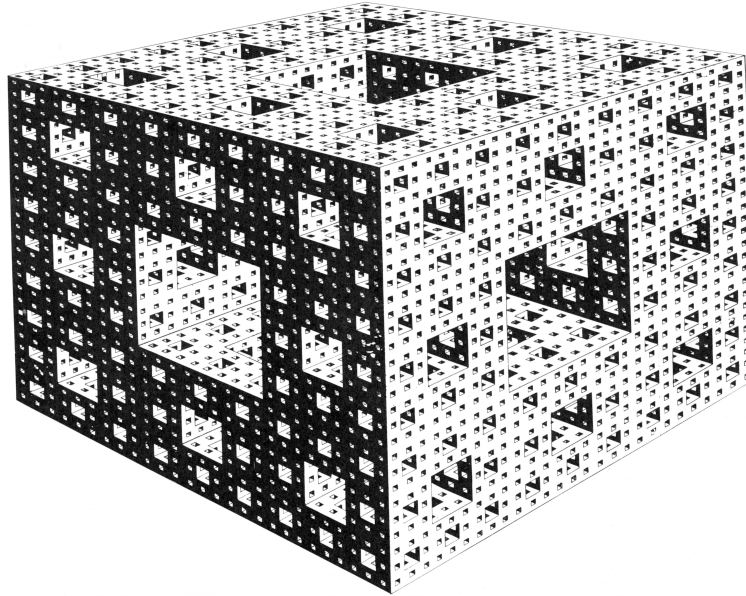
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EPS 109, Fall 2008  
Instructor: Burkhard Militzer

## Homework Assignment 2

**Due date: Monday Sept 15, 2008, midnight**

### (1) Characterize the Menger sponge:



- *Explain how this fractal was constructed. (Assume the object looks the same from all sides.)*
- *What is the Euclidean dimension  $E$ ?*
- *Calculate the fractal dimension and explain your reasoning.*
- *Just look **at one side** of the big cube. What is the dimension of the fractal it contains on the surface?*
- *Now look at the total surface of the fractal considering all faces. What is its fractal dimension? Explain your answers briefly.*
- *Optional: Since you cannot see how this fractal looks from the other side, it is possible that the constructor of this fractal “cheated”. What other fractal dimensions are consistent with the image shown above?*

(continued)

**(2) Mandelbrot and Julia sets:** Both fractals use the complex iteration formula

$$z_{n+1} = (z_n)^2 + c \quad . \quad (\#)$$

For Mandelbrot set, you always start with  $z_0=0$  and  $c$  is the parameter that you vary. The Mandelbrot set is defined as all point  $c$  in the complex plane, which the series (#) does not diverge.

For the Julia set, the roles of  $z_0$  and  $c$  are reversed. You vary the starting number,  $z_0=x_0+iy_0$ . The parameter  $c$  stays fixed at some complex number to be specified beforehand. The Julia set is defined as the set of complex points  $z_0$ , for which the series (#) does not diverge.

- Now start from the latest version of Mandelbrot program that you modified in Tuesday's computer lab. Reverse the roles of  $c$  and  $z_0$ . Fix  $c$  at  $-0.4+I*0.6$ . Investigate the interval  $-3<x_0<+3$  and  $-3<y_0<+3$  and locate the fractal region. Zoom in a little bit so that the fractal region fills the picture. Set  $Z(j,i)=n$  as explained in the lab handout. Insert your image in decent resolution here:
- Now zoom in deeper and deeper, insert your best image here and provide your  $x_0$  and  $y_0$  intervals. You may have to increase the maximum number of iterations. Please keep  $c$  at  $-0.4+I*0.6$  fixed.
- Now zoom out again and change  $c$  to  $0.85+I*0.22$ . Insert your picture here:
- Now explore the  $c$  parameter region on your own and insert your most beautiful picture here. Please specify  $c$  and the  $z_0$  interval.