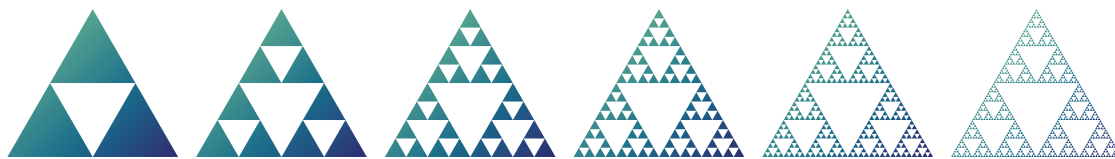## Sierpinski Triangle (L-system)

Sierpinski Triangle (cetz)
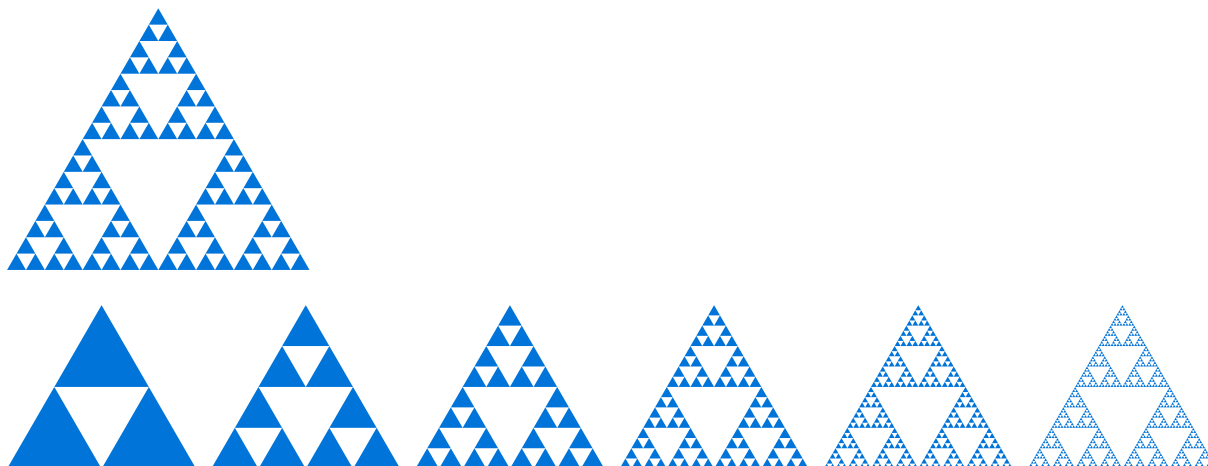

Figure 1:   *Figure 2:*   *Figure 3:*   *Figure 4:*   *Figure 5:*   *Figure 6:*

Sierpinski Triangle (Harlow's method)

$$k(i, j) = {}^{i}C_{\left(\frac{1-j}{2}\right)}$$

k is odd $\rightarrow$ black

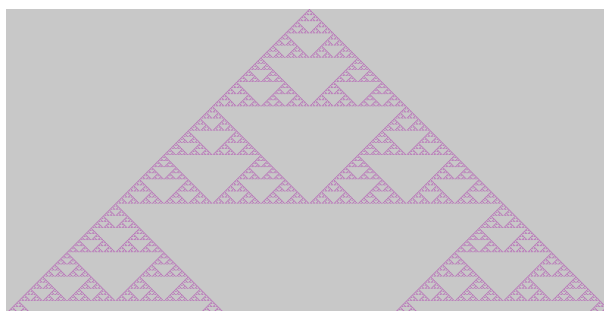k is even $\rightarrow$ white

Figure 7: Point test

Figure 8: Harlow's method

Optimization

A binomial coefficient is odd iff it has no factor of 2

The exponent of 2 in ${}^{n}C_{r}$ equals the number of carries when adding $r + (n - r)$ in binary

No carries $\Longleftrightarrow$ coefficient is odd

So:

Any carry $\rightarrow$ even

No carry $\rightarrow$ odd

The point test in Figure 7 can be greatly simplified to

$$\text{odd} = ((r\ \&\ (n - r)) == 0);$$

Figure 9: Point test (fast)