Mathematica Problems on Recurrence Relations (RR) and Cellular Automata (CA)

1. A particle moves horizontally to the right. For $n \in \mathbf{Z}^+$, the distance the particle travels in the $(n+1)$st second is equal to 4 times the distance it travels during the nth second. If $x_n, n \geq 0$, denotes the position of the particle at the start of the $(n+1)$st second, find a recurrence relation for x_n, where $x_0 = 1$ and $x_1 = 3$. Solve it on the computer. Plot with command DiscretePlot the first 10 values of x_n (and logarithm for higher values).**OP**

2. Check if you, like in the logistic map, can see a couple of period doublings for $g(x) = a\sin(\pi x)$. Starting value is still between 0 and 1 and a lies also between zero and one. Make an estimate of Feigenbaums constant from your observations. The program will protest somewhat when you use the command Solve but you can trust the output.

3. Run rule 225 for a seed of length 1000. All cells are white initially except for a black cell at position 10. Iterate 1000 times and present the figure. Write 225 in base 2, using for example the command BaseForm, and try to understand the rule in detail.

4. Run the rule 90016 starting with a wall, that is a square of black cells. Take for example a 100 times 100 grid and put the wall at rows and columns 10 and 90. Iterate 1,2,3,.. 10,100, 500 times. What happens? Express 90016 in base 2, using BaseForm, and describe in words the rule, when will birth and survival happen? Note ;; can be used in the construction of the seed. $seed[[10;;90,1]] = 1$ gives the value 1 to all elements in the column 1 from row 10 to row 90. **OP**