Problem 1  (Discrete Dynamical Systems)  10 Pts

A two-dimensional discrete linear dynamical system is given by two update equations of the form

\[ x(t + 1) = a_0 x(t) + a_1 y(t) + a_2 \]  \( (1) \)
\[ y(t + 1) = b_0 x(t) + b_1 y(t) + b_2 . \]  \( (2) \)

As an example, take

\[ x(t + 1) = 2x(t) + 1 \]  \( (3) \)
\[ y(t + 1) = 3y(t) + 2 . \]  \( (4) \)

Make a sketch of this system by starting at some random initial values, e.g. \( x(0) = 0, y(0) = 1 \), calculating the next time step according to the update equations and marking the points of the trajectory in a 2d-coordinate system (you can also connect points in time with arrows to make the order of the sequence more visible). You can also use this online grapher if you do not want to calculate the steps by hand:

https://www.desmos.com/calculator/vgxtfkfd3w

- Describe the shape of the solutions that you observe.
- Try to see how changing the coefficients in the equation affects these solutions.
Problem 2  (Graphs)  

The graph given in Fig. 1 shows an abstraction of a part of the Frankfurt public transport network. Evaluate:

1. coordination number $z$,
2. connection probability $p$,
3. network diameter $l$,
4. and clustering coefficient $C$.

Compare the network diameter and clustering coefficient with the values you would expect for a random graph with the same coordination number.

Figure 1: Graph with $N=16$ vertices