1. In this problem we study the standard map numerically. This map, which describes
the time evolution of the kicked rotor, is given by

\[ J_{n+1} = (\epsilon \sin \phi_n + J_n) \mod 2\pi, \]
\[ \phi_{n+1} = (\phi_n + J_{n+1}) \mod 2\pi. \]  

Define both \( \phi_k \) and \( J_k \) on the interval \([0, 2\pi]\). If the variables are outside the interval
subtract a multiple of \( 2\pi \). As we did in the lecture we call the map \((\phi_{n+1}, J_{n+1}) \equiv Z_\epsilon(\phi_n, J_n)\).

- Show a 3d plot of \( Z_{\epsilon=0.75}(\phi, J) \).
- Use as initial conditions 20 equally spaced values of \( J \) and a randomly chosen
value of \( \phi \) on \([0, 2\pi]\). Iterate the map 500 times for each choice of the initial
conditions. Make plots of the iterants for \( \epsilon = 0.1, 0.5, 1.0, 2.0, 4.0, 8.0 \). The
figures should be similar to the ones shown during the lecture.
- Take \( \epsilon = 1 \) and study the evolution of the distance between two initial conditions
that are \( 10^{-8} \) apart. Compare the evolution for an initial condition in the regular
domain (the iterated points are on a curve) and an initial condition in the chaotic
domain (the iterated points scatter). Show graphs of the time evolution of the
distance between the two trajectories. Also show the iterants of the map in both
cases. Take for example 100 iterations.

Literature: p. 455 of Saletan and Jose, Classical Dynamics or p. 259 of Sussman and
Wisdom, Structure and Interpretation of Classical Mechanics.