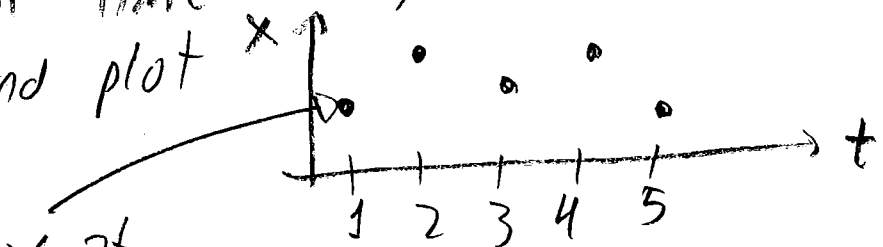
Chaos - complicated behavior from simple sources.

sensitivity to initial conditions - "Even the tiniest change can alter the future in ways you can't imagine"
A. Simpson

butterfly effect: the flapping of a butterfly's wings in Texas can cause a tornado in Kansas.
This is incorrect: a loss of our ability to predict the future is the effect of chaos.

Methods of presenting data

time series - measure some variable, x, at times $t=1$, $t=2$, $t=3$, $t=4$, ... and plot



x at $t=1$

histograms - divide the range of x-values into bins and count the number of times each bin is visited

return maps

Given the sequential measurements

$x_1, x_2, x_3, x_4, \ldots$

↑ x at time $t = 1$

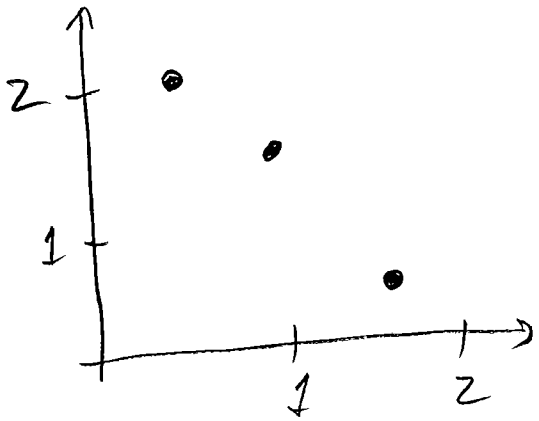
plot the points $(x_1, x_2), (x_2, x_3), (x_3, x_4), \ldots$

If $x_1 = 1$, $x_2 = 1.5$, $x_3 = .5$, $x_4 = 2, \ldots$

$(x_1, x_2) = (1, 1.5)$

$(x_2, x_3) = (1.5, .5)$

$(x_3, x_4) = (.5, 2)$



If each x_i is the result of applying a function (logistic map, tent map, or something else) to x_{i-1}, then the points of the return map will lie on the graph of the function.

Today: driven IFS plots ← detecting forbidden combinations

Kelly maps ← detecting repeating patterns