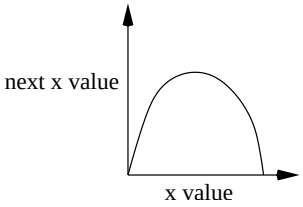
A very little bit about Time Series Analysis

- Given a time series, can we tell if it is chaotic (deterministic) or stochastic (produced by a non-deterministic process)? Yes
- The idea is to invert the procedure we used to generate orbits of the logistic function—use the orbits (i.e., the data) to generate the function!



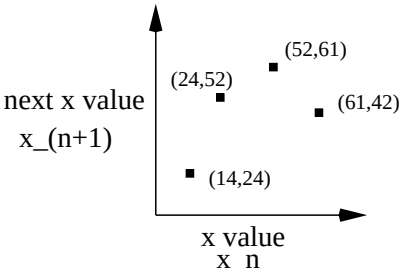
- We used a function like this to determine x_{n+1}, the next x value, given x_n, the current x value.

Real Data

- Suppose we have some real data:

```
x_1 = 14
x_2 = 24
x_3 = 52
x_4 = 61
x_5 = 42
```

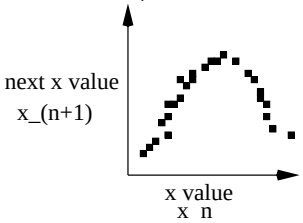
- Plot it as follows:



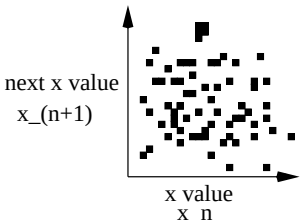
- The idea is that we're plotting x_{n+1} vs. x_n.
- Do this for lots and lots of data.

Determinism vs. Stochasticity

- If the data is deterministic, the plot will look like this:



- For a given x_n there is just one x_{n+1}.
- If the data is from a non-deterministic source, the plot will look like this:



- For a given x_n there can be many x_{n+1}'s.

Time Series Conclusion

- This sort of approach is a powerful and successful technique for analyzing experimental data.
- There's **much, much** more to it than this, however.
- For more, see, e.g.,
  - Kantz and Schreiber, *Nonlinear Time Series Analysis*. Cambridge. 1999.
  - Abarbanel. *Analysis of Observed Chaotic Data*. Springer-Verlag. 1996.
  - Bradley, Time-series analysis. `www.cs.colorado.edu/~lizb/papers/ida-chapter.html`. 1998.