

BasicProblems

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Strang Matrix Problem Use Julia's array and control flow syntax in order to define the NxN Strang matrix:

$$\begin{bmatrix} -2 & 1 & & & \\ 1 & -2 & 1 & & \\ & \ddots & \ddots & \ddots & \\ & & \ddots & \ddots & 1 \\ & & & 1 & -2 \end{bmatrix}$$

i.e. a matrix with -2 on the diagonal, 1 on the off-diagonals, and 0 elsewhere.

In [1]: *#### Prepare Data For Regression Problem*

```
X = rand(1000, 3)           # feature matrix
a0 = rand(3)                 # ground truths
y = X * a0 + 0.1 * randn(1000); # generate response

# Data For Regression Problem Part 2
X = rand(100);
y = 2X + 0.1 * randn(100);
```

Regression Problem Given an Nx3 array of data (`randn(N, 3)`) and a Nx1 array of outcomes, produce the data matrix X which appends a column of 1's to the front of the data matrix, and solve for the 4x1 array β via $\beta X = b$ using `qr`fact, or `\`, or [the definition of the OLS estimator](#). (Note: This is linear regression).

Compare your results to that of using `llsq` from `MultivariateStats.jl` (note: you need to go find the documentation to find out how to use this!). Compare your results to that of using ordinary least squares regression from `GLM.jl`.

Regression Problem Part 2 Using your OLS estimator or one of the aforementioned packages, solve for the regression line using the (X,y) data above. Plot the (X,y) scatter plot using `scatter!` from `Plots.jl`. Add the regression line using `abline!`. Add a title saying "Regression Plot on Fake Data", and label the x and y axis.

Logistic Map Problem The logistic difference equation is defined by the recursion

$$b_{n+1} = r * b_n(1 - b_n)$$

where b_n is the number of bunnies at time n . Starting with $b_0 = .25$, by around 400 iterations this will reach a steady state. This steady state (or steady periodic state) is dependent on r . Write a function which plots the steady state attractor. This is done as follows:

- 1) Solve for the steady state(s) for each given r (i.e. iterate the relation 400 times).
- 2) Calculate “every state” in the steady state attractor. This means, at steady state (after the first 400 iterations), save the next 150 values. Call this set of values $y_s(r)$.
- 3) Do steps (1) and (2) with $r \in (2.9, 4)$, $dr = .00005$. Plot r x-axis vs $y_s(r)$ =value seen in the attractor) using Plots.jl. Your result should be the [Logistic equation bifurcation diagram](#).