Problem 1

1.a.

```
Transition probability matrix:
[[ 0.5   0.5   0.  ]
 [ 0.25  0.5   0.25]
 [ 0.    0.5   0.5 ]]
Transition probabilities after 2 steps
[[ 0.375  0.5    0.125]
 [ 0.25   0.5    0.25 ]
 [ 0.125  0.5    0.375]]
Transition probabilities after 5 steps
[[ 0.26562  0.5      0.23438]
 [ 0.25     0.5      0.25   ]
 [ 0.23438  0.5      0.26562]]
Transition probabilities after 10 steps
[[ 0.25049  0.5      0.24951]
 [ 0.25     0.5      0.25   ]
 [ 0.24951  0.5      0.25049]]
Transition probabilities after 25 steps
[[ 0.25  0.5   0.25]
 [ 0.25  0.5   0.25]
 [ 0.25  0.5   0.25]]
```

1.b.

```
Transition probability matrix with absorbing states:
[[ 1.    0.    0.  ]
 [ 0.25  0.5   0.25]
 [ 0.    0.    1.  ]]
Transition probabilities after 2 steps
[[ 1.     0.     0.   ]
 [ 0.375  0.25   0.375]
 [ 0.     0.     1.   ]]
Transition probabilities after 5 steps
[[ 1.       0.       0.     ]
 [ 0.48438  0.03125  0.48438]
 [ 0.       0.       1.     ]]
Transition probabilities after 10 steps
[[ 1.       0.       0.     ]
 [ 0.49951  0.00098  0.49951]
 [ 0.       0.       1.     ]]
Transition probabilities after 25 steps
[[ 1.   0.   0. ]
 [ 0.5  0.   0.5]
 [ 0.   0.   1. ]]
```

If a rat starts in room B it will end up in room A with probability .5 and room C with probability .5.

1.c.

After 84 iterations the rat has is in Room A with probability over 95% regardless of starting state. By 125th iteration that probability is over 99% regardless of starting state. In the limit, the rat will always end up in room A.

```
Transition probability matrix:
```

```
[[ 1.    0.    0.    0.    0.  ]
 [ 0.25  0.5   0.25  0.    0.  ]
 [ 0.    0.25  0.5   0.25  0.  ]
 [ 0.    0.    0.25  0.5   0.25]
 [ 0.    0.    0.    0.5   0.5 ]]

Transition probabilities after 84 iterations:
[[ 1.       0.       0.       0.       0.     ]
 [ 0.98153  0.00281  0.0052   0.00679  0.00367]
 [ 0.96587  0.0052   0.0096   0.01255  0.00679]
 [ 0.9554   0.00679  0.01255  0.01639  0.00887]
 [ 0.95173  0.00735  0.01358  0.01774  0.0096 ]]
Transition probabilities after 125 iterations:
[[ 1.       0.       0.       0.       0.     ]
 [ 0.99624  0.00057  0.00106  0.00138  0.00075]
 [ 0.99305  0.00106  0.00196  0.00256  0.00138]
 [ 0.99091  0.00138  0.00256  0.00334  0.00181]
 [ 0.99017  0.0015   0.00277  0.00361  0.00196]]
```

Problem 2.

a.

```
Transition probability matrix:
                    0         1
0             0.876158  0.123842
1             0.428688  0.571312
```

b.

```
                           Logit Regression Results
==============================================================================
Dep. Variable:                  union   No. Observations:                21766
Model:                          Logit   Df Residuals:                    21758
Method:                           MLE   Df Model:                            7
Date:                Sat, 25 Oct 2014   Pseudo R-squ.:                  0.1847
Time:                        17:27:04   Log-Likelihood:                -9462.5
converged:                       True   LL-Null:                       -11606.
LLR p-value:                     0.000
===============================================================================
                  coef    std err          z      P>|z|      [95.0% Conf. Int.]
-------------------------------------------------------------------------------
Intercept      -2.2960      0.385     -5.959      0.000        -3.051    -1.541
prior_union     2.1210      0.038     56.117      0.000         2.047     2.195
year           -0.0114      0.007     -1.700      0.089        -0.024     0.002
age             0.0237      0.006      3.846      0.000         0.012     0.036
grade           0.0464      0.008      5.911      0.000         0.031     0.062
south          -0.6630      0.042    -15.734      0.000        -0.746    -0.580
black           0.5797      0.043     13.404      0.000         0.495     0.664
smsa            0.0476      0.043      1.099      0.272        -0.037     0.132
===============================================================================
```

c., d., e.

Parts c. and d. do not ask for output. Steps shown in code file.

```
Markov transition matrix using the logistic model:
0.87142  0.12858
0.46298  0.53702
```

f.

```
Steady state distribution:
0.78264  0.21736
```

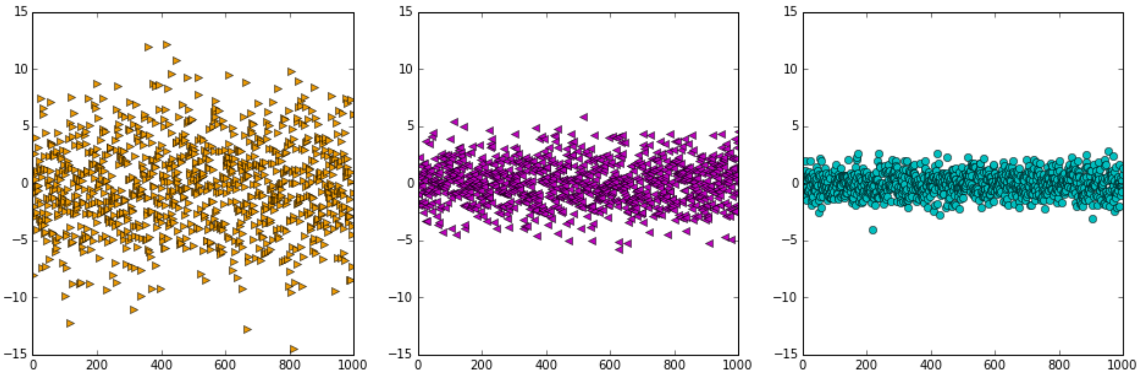
```
0.78264  0.21736
```

Data are probably available to compare the model's prediction to real outcomes. During a short search I could not find a summary of NLSW data that came from the same or similar source as the data we are given. Unsummarized NLSW data are available up to year 2003, but I wasn't confident I could aggregate and meaningfully summarize them to check prediction error.

Problem 3.

3.a.

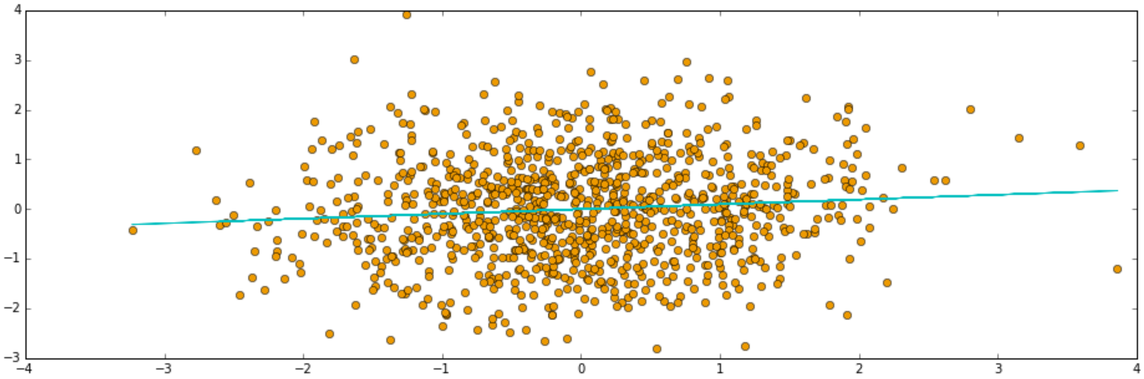
The three plots below are of random normal vectors with variances 4, 2, and 1.



3.b.

For this exercise I thought it would be fun to get a very low P-value, so I did not set seed and ran the code until I got the OLS with a P-value below 0.05. Naturally, it occurs about 5% of the time, so it didn't take long.

```
                            OLS Regression Results                            
==============================================================================
Dep. Variable:                      y   R-squared:                       0.008
Model:                            OLS   Adj. R-squared:                  0.007
Method:                 Least Squares   F-statistic:                     8.435
Date:                Sat, 25 Oct 2014   Prob (F-statistic):            0.00376
Time:                        18:33:53   Log-Likelihood:                -1460.1
No. Observations:                1000   AIC:                             2924.
Df Residuals:                     998   BIC:                             2934.
Df Model:                           1                                         
==============================================================================
                 coef    std err          t      P>|t|      [95.0% Conf. Int.]
------------------------------------------------------------------------------
const         -0.0014      0.033     -0.042      0.967        -0.066     0.063
x1             0.0960      0.033      2.904      0.004         0.031     0.161
==============================================================================
Omnibus:                        2.243   Durbin-Watson:                   2.051
Prob(Omnibus):                  0.326   Jarque-Bera (JB):                2.315
Skew:                           0.105   Prob(JB):                        0.314
Kurtosis:                       2.894   Cond. No.                         1.02
==============================================================================
```



3.c.

Since all of the OLS conditions are met, the slope coefficients have a t-distribution. The histogram is consistent with a t-distribution.