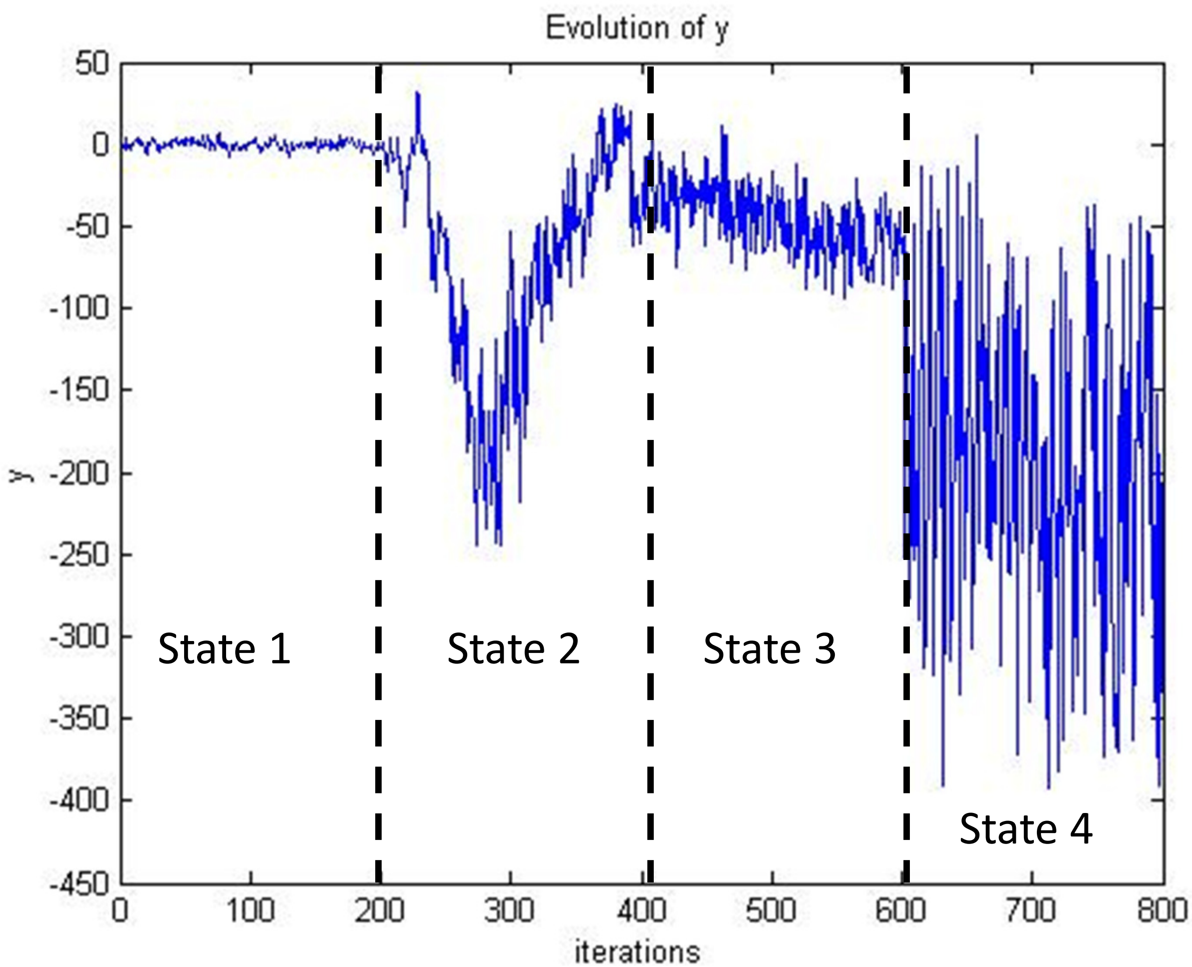
Kalman Filter Homework 2

- Generate a Kalman Filter for simulated data
- The equations are: $$\mathbf{x}^{(k+1)} = A\mathbf{x}^{(k)} + \boldsymbol{\varepsilon}_x^{(k)}$$ $$y^{(k)} = H\left(\mathbf{x}^{(k)} + \boldsymbol{\varepsilon}_s^{(k)}\right) + \varepsilon_y^{(k)}$$
- Note that the measurement has signal-dependent noise
- Assume that the system can fall under different "states". These states will be defined through different *A* and noises.
- The system transitions between different states. The transition times are specified.
- $H = [1\ 1]^T$

States

State	Iteration	$\varepsilon_x^{(k)}$	$\varepsilon_y^{(k)}$	$\varepsilon_s^{(k)}$	A
1	1-200	$N \sim (0, I)$	$N \sim (0,1)$	$N \sim (0, I)$	$\begin{bmatrix} .5 & 0 \\ 0 & .3 \end{bmatrix}$
2	200-400	$N \sim \left(0, \begin{bmatrix} 25 & 0 \\ 0 & 25 \end{bmatrix}\right)$	$N \sim (0,1)$	$N \sim (0, I)$	I
3	400-600	$N \sim (0, I)$	$N \sim (0,25)$	$N \sim (0, I)$	I
4	600-800	$N \sim (0, I)$	$N \sim (0,1)$	$N \sim \left(0, \begin{bmatrix} 25 & 0 \\ 0 & 25 \end{bmatrix}\right)$	I



Evolution of y
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
y
0
100
200
300
400
500
600
700
800
iterations
State 1
State 2
State 3
State 4

- *Task:*
  - *For each state, defined on the next slide, calculate the steady state that the Kalman Gain will converge to.*
  - *Write and implement a Kalman Filter. Note that the measurement noise is signal-dependent.*
    - *At each state transition, change your A matrix and noises appropriately*
    - *Your estimates of x and P at the end of each state will carry over into the next state.*
  - *Compare your final Kalman Gain at the end of each state with your analytically calculated value*
  - *Also compare the Kalman Gain* ***at each iteration*** *to the "gain" of an LMS algorithm (plot and compare these two gains)*