# Computer Assignment

B RAJA REDDY, EE13B1004

13-09-2015

## 1 Poisson Process

Poisson process depends on the arrival rate, number of samples in each second. The inter-arrival times follow an exponential distribution. The **rand** function generates uniform random numbers between 0 and 1. Now *floor(p + rand)* gives a success (value = 1) with probability p. The distribution of arrival times is shown below:

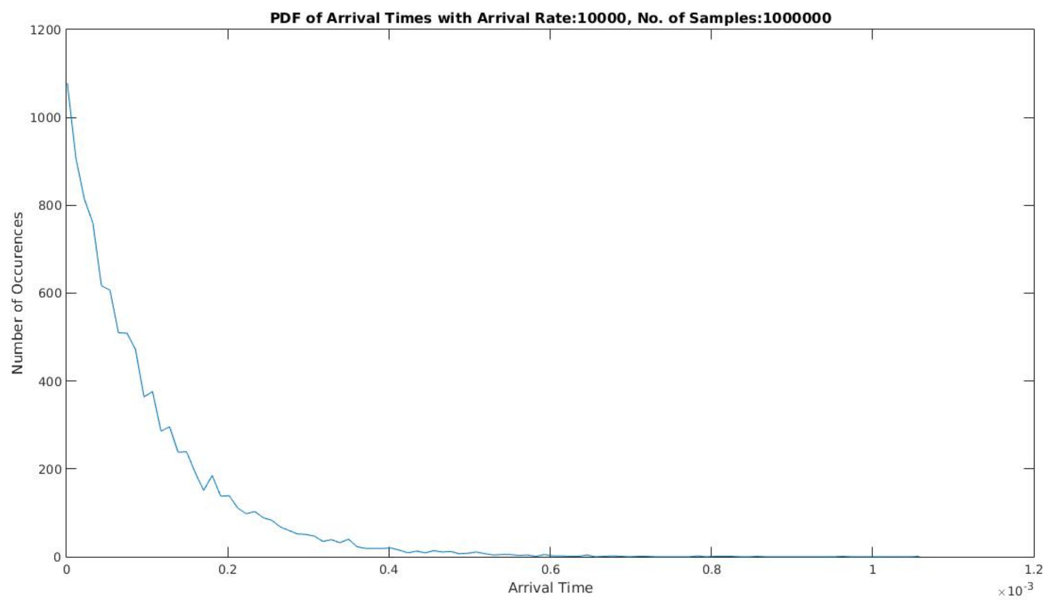


Figure 1: Distribution of Arrival times

## 2 Brownian Motion

Normal distribution decides the next step in the case of Brownian motion. The **randn** function in MATLAB has been used for the simulation of Brownian motion. Correlated Brownian Motion has been generated by using:

$$B_1(t) = W_1(t)$$
$$B_2(t) = \rho W_1(t) + \sqrt{1-\rho^2}W_2(t)$$

The following plot demonstrates Brownian motion:

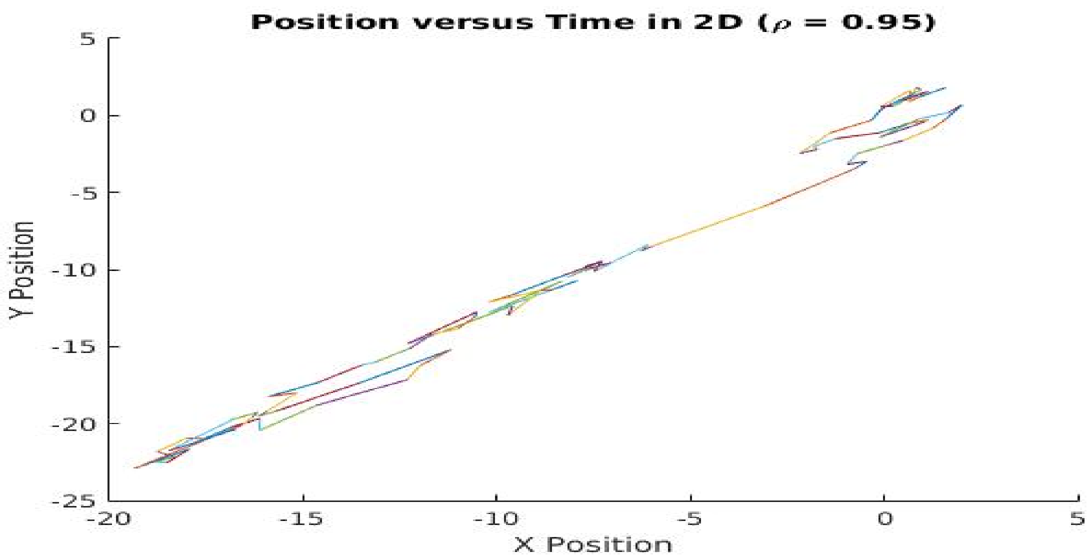


Figure 2: Brownian Motion with $\rho$ as 0.95

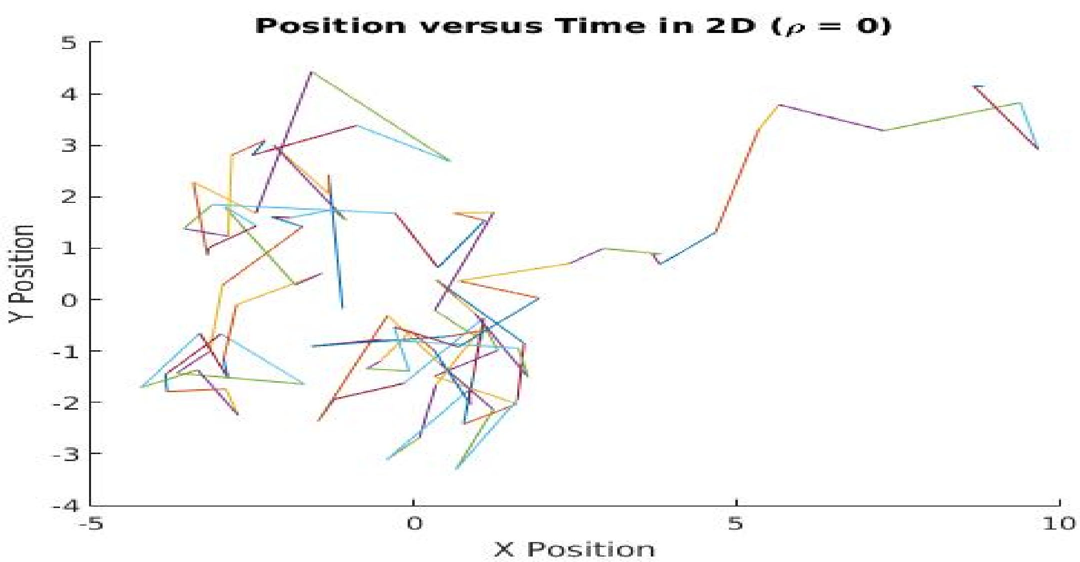


Figure 3: Brownian Motion with $\rho$ as 0

# 3 ECG Signal

I have obtained the ECG signal from the following `http://www.physionet.org/physiobank/database/mitdb/` . Now, the signal has been scaled between -1 and 1.

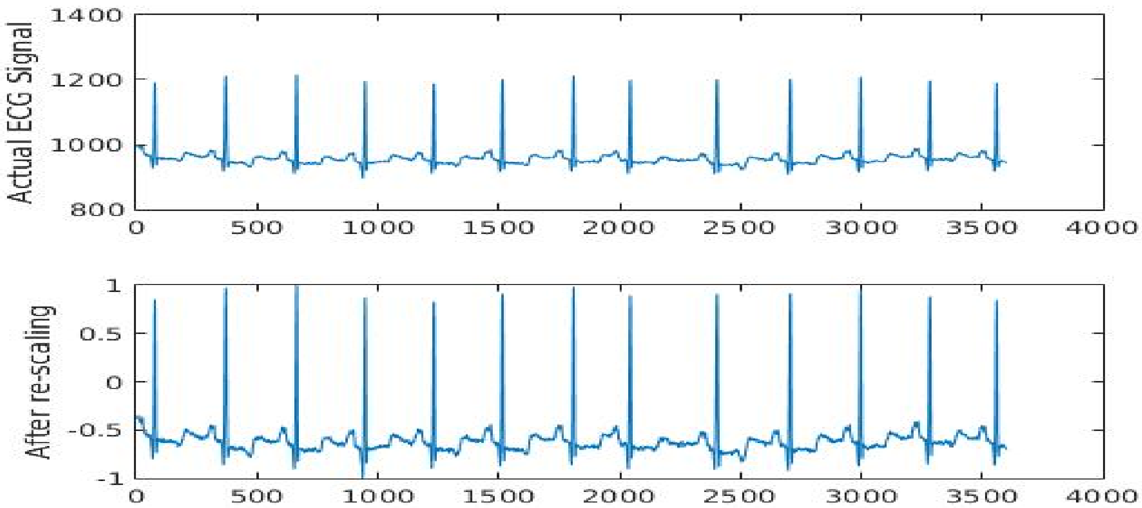


Figure 4: ECG Signal

### 3.1 Wiener filtering

Wiener filtering is now performed after the addition of Gaussian Noise. The function for Wiener filter has been obtained from the following `http://www.mit.edu/~gari/CODE/ECGtools/ecgBag/wienerFilter.m` . The results are shown below:

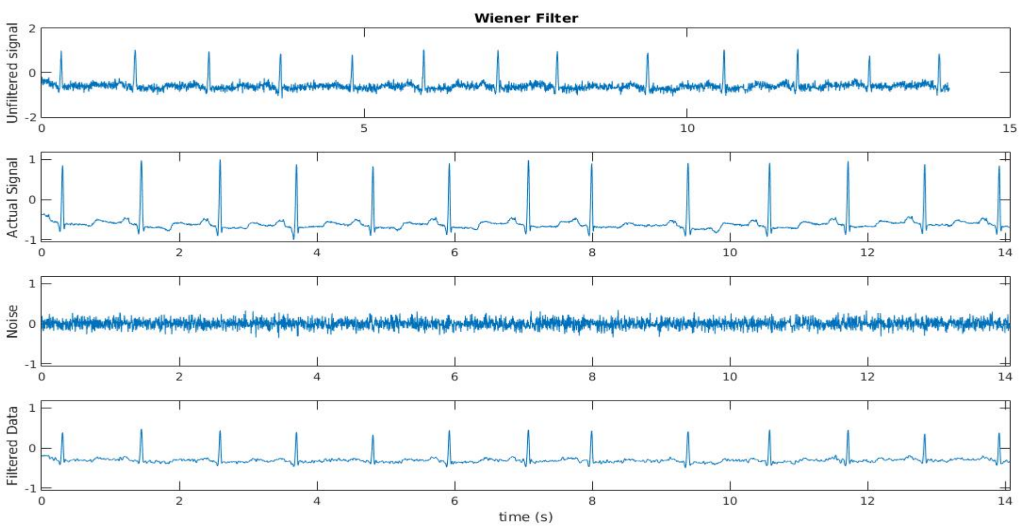


Figure 5: Wiener Filtering (Variance of Gaussian Noise is 0.1)

### 3.2 Median filtering

Median filtering is performed after the addition of Poisson Noise. MATLAB's inbuilt **medfilt1** has been used for this filtering. The results are shown below:

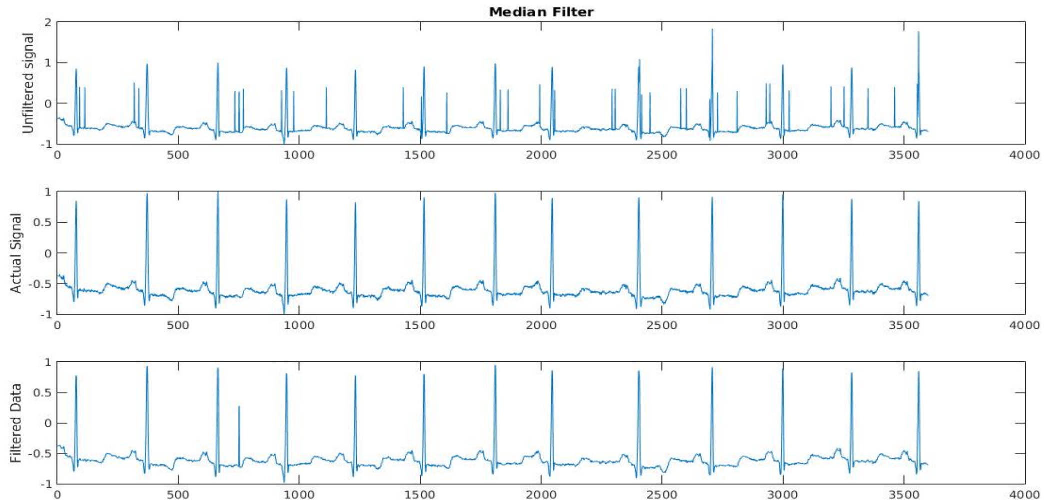


Figure 6: Median Filtering (p = 0.01)

### 3.3 Observations

In the case of Wiener filtering, Mean Squared Error (MSE) is computed for different variances. In the case of Median filtering, MSE is computed for different probabilities since probabilities resemble arrival rates.

| Case | Variance | MSE |
|---|---|---|
| 1 | 0.01 | 0.0998 |
| 2 | 0.10 | 0.1000 |
| 3 | 0.50 | 0.1101 |
| 4 | 1.00 | 0.1152 |
| 5 | 5.00 | 0.1585 |

Table 1: MSE vs Variance in Wiener Filtering

| Case | Probability | MSE |
|---|---|---|
| 1 | 0.01 | 0.0001 |
| 2 | 0.05 | 0.0050 |
| 3 | 0.10 | 0.0316 |
| 4 | 0.20 | 0.1080 |
| 5 | 0.30 | 0.2119 |

Table 2: MSE vs Probability in Median Filtering

- Wiener Filtering: MSE increases with increase in Variance. As variance increases points are generated more sparsely. Hence the Gaussian noise component increases there by leading to higher MSE.
- Median Filtering: MSE increases with increase in arrival rate. As arrival rate increases more number of arrivals occur. Hence the Poisson noise component increases there by leading to higher MSE.