Assignment 7
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A synapse is a part of the neuron where the transmission of electrical signal from one neuron to another takes place. Vesicles of neurotransmitters that are released at the synaptic junction are also known as quanta. The release of quanta is stochastic and can be modeled by either binomial or Poisson distribution. Binomial model is appropriate if the number of release sites,N, and release probability, Pr, is known. And Poisson model can be used when the release probability is really small in relation to the number of release sites. Once the released quanta make it to the receptors across the synapse, they induce a miniature membrane potential with a gaussian voltage distribution. These miniature potentials than combine into a single postsynaptic membrane potential that will be propagated to the next neuron. This potential is the sum of the individual gaussian mini-potentials.

Figure 1 displays the results of a simulation of 100 instances where the quanta are released from N =10 release sites with probability of release Pr = 0.2. Here, we can see that the postsynaptic potential is most likely to have the value of 1mv with the maximum potential reaching up to around 6 mV.

Figure 1

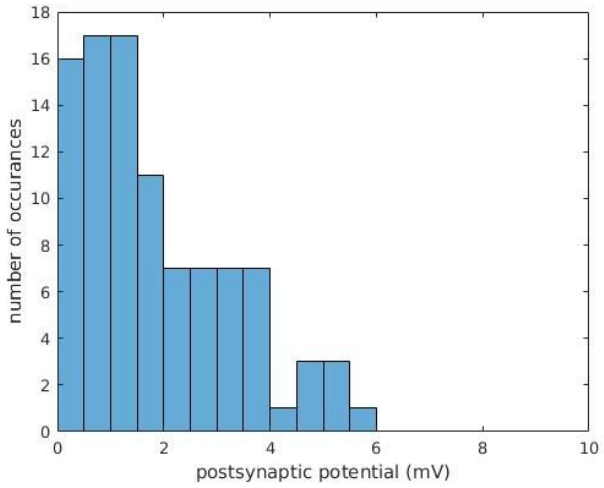

Figure 2 displays the results of such simulations for the release probabilities from Pr = 0.1 to 0.8. We can see that as the probability of release increases, so does the likeliest value of the postsynaptic membrane potential.

Figure 2

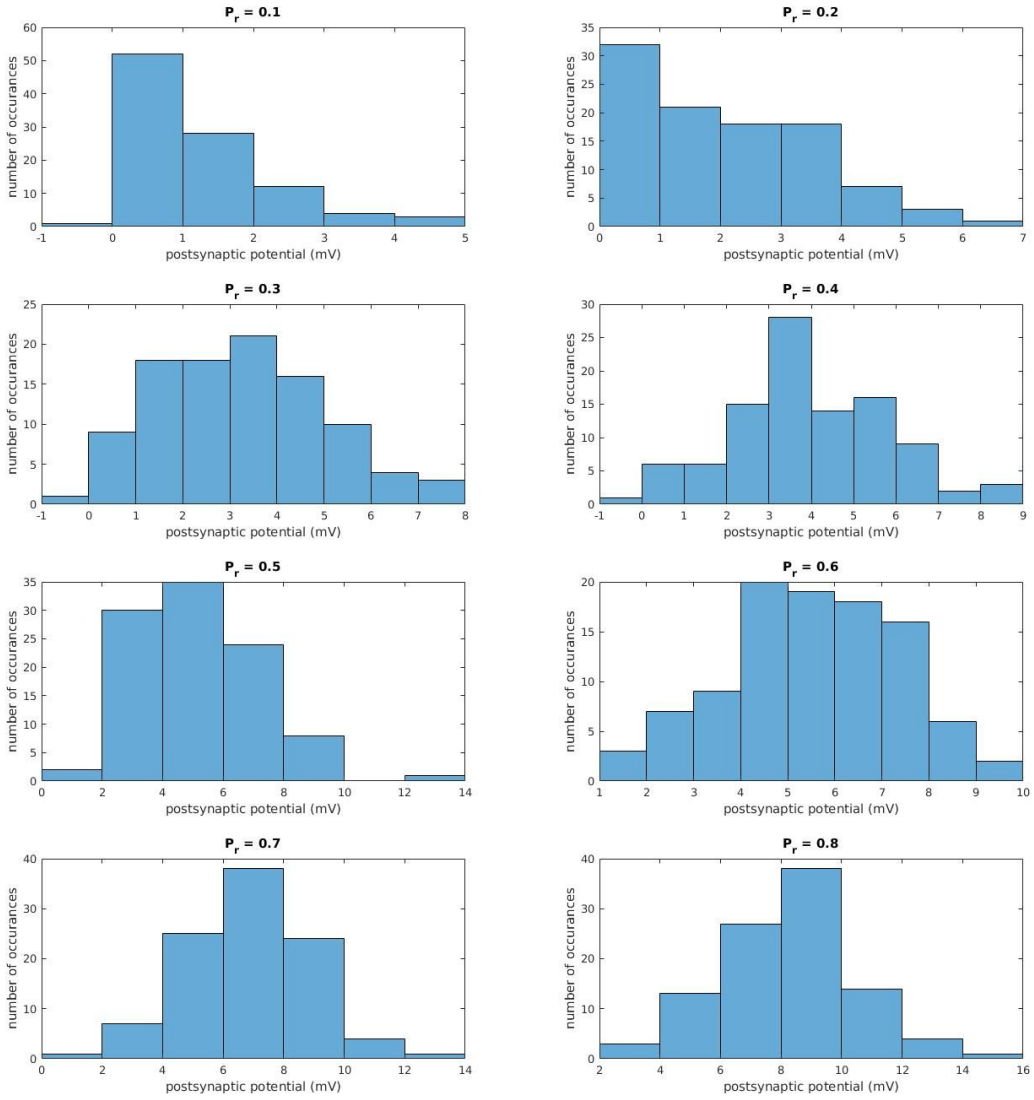
P_r = 0.1
P_r = 0.2
P_r = 0.3
P_r = 0.4
P_r = 0.5
P_r = 0.6
P_r = 0.7
P_r = 0.8
number of occurances
postsynaptic potential (mV)

Figure 3

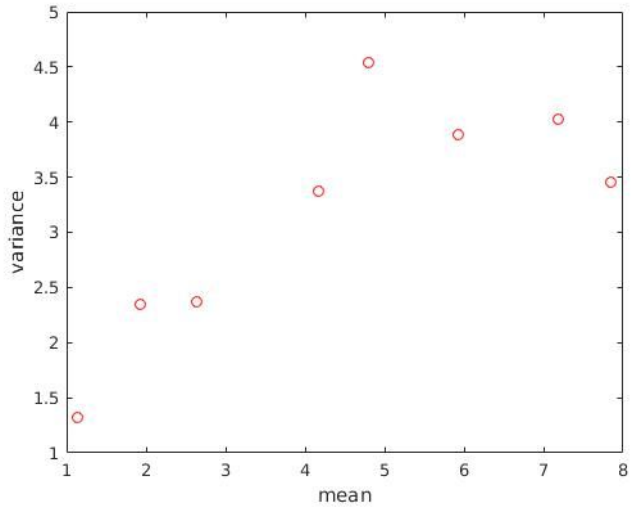

Figure 3 shows a plot of the estimated variance as a function of mean for the eight simulations in Figure 2. Each data point corresponds to a probability value. The distribution has a positive slope, which means that as mean value of the potential increases, the variance of the potential also increases. The variance vs mean function for the poisson model should look similar, also linear with a positive slope.