# Statistical Models of the Brain—Homework 3

Consider a neuron whose firing rate is of $20\,Hz$ (20 spikes per second).

1. Let the interspike intervals present an exponential distribution.
   (a) Simulate one spike train 30 seconds long.
   *Hint*: use function `generateSpikeTrain` with `param = 20`.
      i. Compute the coefficient of variation of the interspike intervals.
      *Hint:* recall the definition: $cv_{ISI} = \frac{std(ISI)}{mean(ISI)}$.
      ii. Plot the ISI histogram.
      *Hint*: use function `hist`
      iii. Use a *pp*-plot to evaluate the goodness of fit of the generated ISIs to an exponential distribution.
      *Hint*: use function `ppPlot`.

   (b) With the same parameters as above, simulate 30 spike trains one second long. And repeat parts (i), (ii), (iii) above. In this case, pool all the ISIs across all the spike trains. Note that the correct way of *pooling* across spike trians is to pool together all the spike times, sort them, and obtain the ISI of this aggregated sorted set of spike times.

2. Let the interspike intervals present a Gamma distribution with shape parameter 1 and rate parameter 20. *Hint*: use function `generateSpikeTrain` with `param = [1 20]` and `distribution = 'gamma'`.
   (a) Simulate one spike train 30 seconds long: compute $cv_{ISI}$, plot ISI histogram, use *pp*-plot to evaluate goodness of fit to an exponential distribution.
   (b) Simulate 30 spike trains one second long: pool the spike trains, compute pooled ISIs and repeat the exercise.

3. Let the interspike intervals present a Gamma distribution with shape parameter 3 and rate parameter 60. Note that this combination of parameters preserves the desired firing rate.
   (a) Repeat the exercise: generate one spike train 30 seconds long, compute $CV$, plot ISI histogram and use *pp*-plot as a goodness of fit.
   (b) Do the same for 30 spike trains 1 second long.

4. Let the interspike intervals present an Inverse Gaussian distribution with parameters $(1/\mu, \lambda) = (20, 1)$. Note the desired firing rate is preserved.
   Do as before.
   *Hint*: use function `generateSpikeTrain` with `param = [20 1]` and `distribution = 'inversegaussian'`.

5. Consider all your results. Briefly summarize your findings. (E.g., in which cases are the distributions of the ISIs close to an exponential distribution? Why? What is the value of the CV in each case?) ALSO: this homework should have come much earlier in the course. Please jog your memory and write at least one sentence about what you think the purpose of this homework was—-i.e., how it connects to the readings (*Hint:* Shadlen and Newsome).

You are given the following scripts:

- `generateSpikeTrain`: it generates spike trains of a specific length by generating ISIs acording to a user given distribution and parameters

- `ppPlot`: generates a pp-plot comparing the given observations to a specified theoretical distribution.
- `printCellString`: given a cell vector of strings, it displays it on screen.
- `runExperim`: generates the required plots and statistics for this problem.
- `solutionsSpikeTrainGeneration`: shows how to use the given scripts to solve the problem. Note that the only thing you have to do is to change some parameters and run portions of this script.