Assignment 3

Questions 1-4 is a individual assignment and Questions 5 and 6 is a group assignment. Submit to prof4155@cs.dal.ca with subject line A3a for the individual part and A3b for the group part by Monday October 1, 4pm

1. Plot a histogram of random numbers drawn from the Chi-square distribution and the Trappenberg distribution. The Trappenberg distribution is given by

$$p(x) = \begin{cases} a_n || \sin(x) || & \text{for } 0 < x < n\pi/2 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

   for $n = 5$. What is the mean, variance, and skewness of these distributions?

2. Explain if the random variables X and Y are independent if their marginal distribution is $p(x) = x + 3log(x)$ and $p(y) = 3ylog(y)$, and the joined distributions is $p(x, y) = xylog(x) + 3ylog(xy)$.

3. (From Thrun, Burgard and Fox, Probabilistic Robotics) A robot uses a sensor that can measure ranges from $0m$ to $3m$. For simplicity, assume that the actual ranges are distributed uniformly in this interval. Unfortunately, the sensors can be faulty. When the sensor is faulty it constantly outputs a range below $1m$, regardless of the actual range in the sensor's measurement cone. We know that the prior probability for a sensor to be faulty is $p = 0.01$.
   Suppose the robot queries its sensors N times, and every single time the measurement value is below $1m$. What is the posterior probability of a sensor fault, for $N = 1, 2, ..., 10$. Formulate the corresponding probabilistic model.

4. Given are four Bernoulli distributed random variables X_1, X_2, X_3 and Y. The conditional probability of random variables X_i on Y is given by $p(x_i|y) = 0.2$ and $p(x_i|\neg y) = 0.6$, and all x_i are conditionally independent of each other given Y. The marginal probability of Y is $p(y) = 0.3$. What is the probability of Y given X_1 =true and X_2 =true and X_3 =false ?

5. Use the light sensor to measure distances to a surface and derive a sensor model for this sensor. Provide a parametric form of your model and include estimations of the parameters.

6. Derive a motion model for the tribot when driving the motors with different power parameters. Provide a parametric form of your model and include estimations of the parameters.