Homework 2

Problem 1: Bayesian Inference

These are the data-set for the number of car accidents in the rush hour of a small city. You are assigned to predict the **number of car accidents in the rush hour of the day**. You need to find the full probability distribution of this quantity using Bayesian statistics and assuming a prior distribution over this parameter.

Also, make sure to clearly **state the assumptions** you are making at each step.

16	24	16	12	16	11	14	15	9	14	7

Table 1: The Number of Accident during rush hour

Tip: *You can/should make reasonable assumption about the data.*

Problem 2: zero-order Optimization

Consider the simple quadratic function

$$g(\vec{w}) = \vec{w}^T\vec{w}$$

whose minimum is always at the origin regardless of the input dimension N.

1. Create a range of these quadratics for input dimension $N = 1$ to $N = 100$, sample the input space of each $P = 100$ times randomly on the hypercube $[-1, 1] \times [-1, 1] \times \ldots \times [-1, 1]$ (this hypercube has N sides), and plot the minimum value attained for each quadratic against the input dimension N.
2. Repeat part (1) using $P = 100, P = 1000$, and $P = 10000$ samples, and plot all three curves in the same figure. What sort of trend can you see in this plot as N and P increase?

Tip: *You can use the package named Latin Hypercube Sampling with Multi-Dimensional Uniformity. Install it using* `pip install lhsmdu` *and produce sample from* $[0, 1]^N$ *using* `lhsmdu.sample(N, P)` *where* N *is the dimension and* P *is the number of samples*

Problem 3: first-order Optimization

A number of applications will find us employing a simple multi-input quadratic

$$g(\vec{w}) = a + \vec{b}^T\vec{w} + \vec{w}^T C\vec{w}$$

where the matrix $C = \frac{1}{\beta}I$. Here I is the $N \times N$ identity matrix, and $\beta > 0$ a positive scalar. a and $\vec{b}$ are constant scalar and vector respectively. Find all stationary points of g.