Assignment A1a: Jupyter Notebooks

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1. Markdown and latex

1a.

$p(x|\mu, \sigma)$ is a function $f(x)$ that describes a normal distribution for a continuous random variable (X).

The function is almost always written as

$$p(x|\mu, \sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}},$$

and is used to represent a continuous random variable whose value and distribution are unknown.

1b.

For more than one continuous random variable (with a normal distribution where μ is the mean and σ is the standard deviation), $Ex_i,\ i = 1 \ldots N,$ $the joint probability distribution can be expressed as a product of the individual pdfs:$

$$\begin{aligned} p(x_{1:N}|\mu, \sigma) &= \prod_{i=1}^{N} p(x_i|\mu, \sigma) \\ &= \frac{1}{(2\pi\sigma)^{\frac{N}{2}}} e^{-\frac{1}{2\sigma^2}\sum_{i=1}^{N}(x_i-\mu)^2} \end{aligned}$$

$

--*To answer **1a** and **1b**, I referenced my probability textbook: Introduction to Probability by Anderson, Seppäläinen, and Valkó (Cambridge) pp. 90-91, 119-121*

2. Simple functions and plotting

In [ ]:

```
# Import Statements:
import numpy as np
import math
import matplotlib.pyplot as plt
```

Function g:

In [ ]:

```
# Gaussian pdf:
def g (x, mu = 0, sigma = 1.0):
    return (1 / math.sqrt(2*math.pi*(sigma**2)))*math.exp(-((x-mu)**2)/(2*(si
```

Plotting:

In [ ]:

```
def plot_g (x_1, mu = 0, sigma = 1.0):
    # Plotting pdf
    x = np.linspace(start=mu-4*sigma, stop=mu+4*sigma, num=100)
    p = []
    for x_ind in x:
        p.append(g(x_ind, mu=mu, sigma=sigma))
    plt.plot(x, p)
    plt.xlabel("x")
    plt.ylabel("Likelihood: p(x|mu, sigma)")
    plt.title("PDF of a Gaussian Distribution")

    # Plotting point x_1
    y_1 = g(x_1, mu=mu, sigma=sigma)
    plt.scatter(x_1, y_1)

    #Creating annotation:
    plt.annotate(text="{val}".format(val = round(y_1, 3)), xy=(x_1, y_1+ 0.01

    plt.show()
```

In [ ]:

```
plot_g(x_1 = 1, mu = 0, sigma=1.0)
```