

**NUEN 647**  
**Uncertainty Quantification for Nuclear Engineering**  
**Assignment 1**

Due on Tuesday, October 4, 2016

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Complete the exercises in the Chapter 2 notes. Be sure to include discussion of results where appropriate. You may use any tools that are appropriate to solving the problem.

## Problem 1

Show that the transformation in equation 1 results in a standard normal random variable by computing the mean and variance of  $z$ .

$$z = \frac{x - \mu}{\sigma} \quad (1)$$

An important special case of the expectation value is the mean which is the expected value of  $x$ . It is often denoted as  $\mu$ ,

$$\mu = E[x] = \int_{-\infty}^{\infty} x f(x) dx$$

where  $x$  is a realization of a random sample and  $f(x)$  is the probability density function (PDF) for the random variable. For a normal distribution,

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

For the sake of the transformation, the value of  $z$  substitutes for  $x$ , the realization of a random sample (not the PDF because we are transforming that distribution). Therefore, the mean for  $z$  is:

$$\mu_z = \int_{-\infty}^{\infty} \frac{x - \mu}{\sigma} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx$$

If  $u = (x - \mu)^2$  and  $\frac{du}{2} = (x - \mu)dx$  (note that the limits change from  $(-\infty, \infty)$  to  $(\infty, \infty)$  - but that seems fishy to me so I will change it back after integration).

$$\begin{aligned} \mu_z &= \int_{-\infty}^{\infty} \frac{1}{2\sigma^2\sqrt{2\pi}} e^{-\frac{u}{2\sigma^2}} du = \left| \frac{-1}{\sqrt{2\pi}} e^{-\frac{u}{2\sigma^2}} \right|_{-\infty}^{\infty} \\ \mu_z &= \left| \frac{-1}{\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \right|_{-\infty}^{\infty} = \frac{-1}{\sqrt{2\pi}} (e^{-\infty} - e^{-\infty}) = 0 \end{aligned}$$

The variance

## Problem 2

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Example Figure

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This is an example citation [1].

## References

- [1] E. T. Tatro, S. Heffler, S. Shumaker-Armstrong, B. Soontornniyomkij, M. Yang, A. Yermanos, N. Wren, D. J. Moore, and C. L. Achim. Modulation of bk channel by microrna-9 in neurons after exposure to hiv and methamphetamine. *J Neuroimmune Pharmacol*, 2013. Tatro, Erick T Heffler, Shannon Shumaker-Armstrong, Stephanie Soontornniyomkij, Benchawanna Yang, Michael Yermanos, Alex Wren, Nina Moore, David J Achim, Cristian L R03 DA031591/DA/NIDA NIH HHS/United States U19 AI096113/AI/NIAID NIH HHS/United States Journal article Journal of neuroimmune pharmacology : the official journal of the Society on NeuroImmune Pharmacology J Neuroimmune Pharmacol. 2013 Mar 19.