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Gull Alpha Power of the Chen Type

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Abstract
In they introduced the Chen distribution, and in they extended the distribution to include its "normalized version". In this paper, we introduce a variant of the Gull Alpha Power distribution by modifying Chen-G of and show the new family is good in fitting real life data.

Keywords: Chen distribution, Chen-G distribution, Gull alpha power distribution.

Introduction to the New Family

In 2000, the following distribution was introduced in [1] as the Chen distribution, $\mathbf{F(t)} = \mathbf{1 - e}^{\lambda\left(1-e^{t\beta}\right)}$, where λ,β,t>0. The two parameter Chen distribution has the ability to model bathtub shaped failure rate functions; it however lacks a scale parameter. The normalized version was introduced in [2] with the following CDF,

$$\mathrm{F(x)} = \int_0^{G(\chi)} \mathrm{f(t)dt} = \mathrm{A[1\ {-e}^{\lambda}(1{-e}^{G(x)B}\ )]}$$

Where λ,β > 0, x 2R and $A = \dfrac{1}{1-e^{\lambda(1-e)}}$ is a normalizing constant. Based on the structure of the Gull Alpha Power CDF [3] $\dfrac{\alpha^{F}(y)}{\alpha^{F(y)}}$ for α >1, we modify Chen-G [2] to introduce the following.

Definition
A random variable J will be called Gull Alpha Power distributed with respect to Chen if its CDF is given by

$$\mathrm{F}(\mathrm{x};\ \mathrm{a},\ \mathrm{b},\ \xi) = \frac{\left(e^{(1-e)^{a}}+1\right)G(x;\xi)}{e^{a\left(1-e^{G(x;\xi)b}\right)+1}}$$

Where a,b>0, G is some baseline distribution with parameter vector ξ, and $\chi \in \mathbb{R}$. The new distribution is a good fit to real life data as shown in the next section.

Practical Illustration

We assume the baseline distribution is Normal with the following CDF $\mathrm{G}(\mathrm{x};\xi) = \dfrac{1}{2}erfc\dfrac{c-x}{\sqrt{2d}}$ where erfc is the complementary error function. Thus, from the above definition, we have the following.

Proposition
The CDF of the Gull Alpha Power Normal distribution of the Chen Type is given by

$$\mathrm{F}(\mathrm{x};\ \mathrm{a},\ \mathrm{b},\ \mathrm{c},\ \mathrm{d}) = \frac{\left(e^{(1-e)a}+1\right)erfc\left(\dfrac{c-x}{\sqrt{2b}}\right)}{2\left(e^{a\left((1-e)^{2-b}{}_{erfc\left(\frac{c-x}{\sqrt{2}}\right)^{b}}\right)}+1\right)}$$

Obviously, the PDF can be obtained by differentiating the CDF above.

Notation
We write J ~ GAPANC(c,d,a,b) if J is a Gull Alpha Power Normal random variable of the Chen type

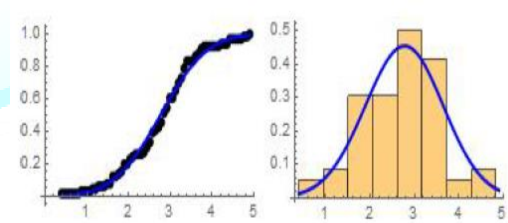

Figure 1: The CDF and PDF of GAPANC (2.71318, 0.884185, 0.160665, 0.457947) fitted to the empirical distribution and histogram of the lifetime of 50 devices data [4].

Open Problem

It is an open problem to obtain properties and applications of this new class of statistical distributions. The author invites readers to tackle this open problem.

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