Short Communication

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The Zeid-G Family of Distributions

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Abstract

In this short communication, the class of Zeid-G statistical distributions are introduced. A sub-model of this family is shown to be practically significant in fitting real-life data as well as simulated data. The researchers are asked to further develop the properties and applications of this new class.

Keywords: 1ΣαPT-Gfamilyofdistributions, Chen-G, Carbon Fibers Data

Introduction to the New Family

Firstly, we recall the following

Definition 1.1: [1] Let $\alpha \neq \frac{1}{e}, \alpha > \frac{1}{e}$ and $\xi > 0$ where α is the rate scale parameter and ξ is a vector of parameters in the baseline distribution all of whose entries are positive. A random variable Z is said to follow the $\left(\frac{1}{e}\right)^{\alpha}$ power transform family of distributions if the Cumulative Distribution Function (CDF) is given by

$$F(x;\alpha,\xi) = \frac{1-e^{-\alpha G(\chi;\xi)}}{1-e^{-\alpha}} \, x \in \mathbb{R},$$

where the baseline distribution has CDF $G(x;\xi)$.

Proposition 1.2: [1] The PDF of the $\left(\frac{1}{e}\right)^{\alpha}$ power transform family distribution is given by

$$f(x;\alpha,\xi) = \frac{1}{1-e^{-\alpha}}\left(\alpha g(x,\xi) e^{-\alpha G(x,\xi)}\right)$$

where $\alpha \neq \frac{1}{e}, \alpha > \frac{1}{e}$ and $\xi > 0$ and $G(x;\xi)$ is the baseline cumulative distribution with

probability density function $g(x;\xi)$

Remark 1.3: The parameter space for α have been relaxed to $\alpha \in R, \alpha \neq 0$. The relaxation has been employed in several papers, and for example, see [2]

Using this relaxation, we introduce the following, inspired by the structure of the Chen-G CDF [3]

Definition 1.4: A random variable Y wil bel called a Zeid random variable, if the CDF is given by Zeid-G, that is,

$$F(x;\alpha,\beta,\xi) = \frac{1-e^{-\alpha}\left\{1-e^{-\beta G(\chi;\xi)}\right\}}{1-e^{-\alpha\left\{1-e^{-\beta}\right\}}} \chi \in Supp(G),$$

Where the baseline distribution has CDF $G(x;\xi), \xi$ is a vector of parameters in the baseline CDF whose support depends on the chosen baseline CDF. $\alpha, \beta \in \mathbb{R},$ and $\alpha, \beta \neq 0$

Practical Illustration

Assume the baseline distribution is Normal with the following CDF

$$G(x;c,d) = \frac{1}{2} ercf\left(\frac{c-\chi}{\sqrt{2d}}\right)$$

where $x, c \in \mathbb{R}, d > 0,$ and $erfc(z) = 1 - erf(z) = 1 - \frac{2}{\sqrt{\pi}}\int_0^z e^{-t^2} dt.$ It follows from the Definition immediately above that we have the following

Proposition 2.1: The CDF of Zeid-Normal, for $x \in \mathbb{R}$, is given by

$$F(x;\alpha,\beta,c,d)=\frac{e^{\alpha\left(e^{-\frac{1}{2}\beta erfc\left(\frac{c-z}{\sqrt{2}d}\right)}\right)}-1}{e^{\alpha\left(e^{-\beta-1}\right)}-1}$$

where $\alpha,\beta\in\mathbb{R},\alpha,\beta\neq 0,c\in\mathbb{R},d>0,$ and

$$erfc(z)=1-erf(z)=1-\frac{2}{\sqrt{\pi}}\int_0^z e^{-t^2}dt.$$

Remark 2.2: We write $J\sim ZN(\alpha,\beta,c,d),$ if J is a Zeid random variable with the above

CDF

The new distribution is a good fit to real life data as well as simulated data, as illustrated below [4] (Figures 1 & 2)

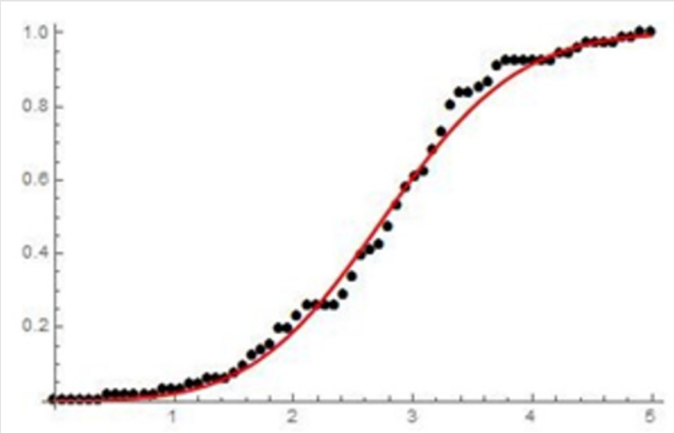

Figure 1: The cdf of ZN (1.6156, -0.474565, 2.89578, 0.897577) (red) fitted to the empirical distribution.

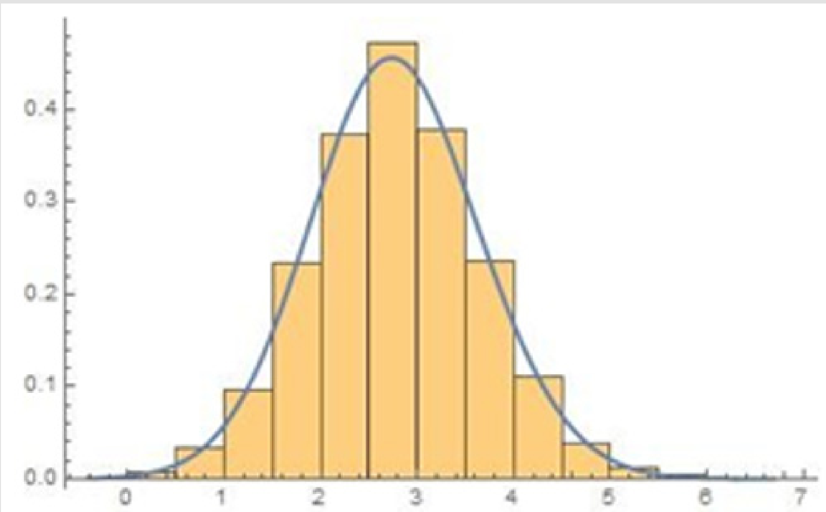

Figure 2: The pdf of ZN (-1.6156, -0.474565, 2.89578, 0.897577) (blue) fitted to the histogram of 10,000 random samples of ZN (-1.6156, -0.474565, 2.89578, 0.897577).

Concluding Remarks

In this paper, we introduced the Zeid-G family of distributions, and showed the Zeid-Normal distribution is a good fit to real life data as well as simulated data. We hope the researchers will further develop the properties and applications of the Zeid-G class of distributions.

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