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Opinion

The Cot-X Family of Distributions with Application

Clement Boateng Ampadu*

Department of Biostatistics, USA

***Corresponding author:** Clement Boateng Ampadu, Department of Biostatistics, USA.

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Abstract

We modify the cotangent function into a new statistical distribution and show its applicability.

Keywords: Trigonometric functions; Statistical distributions; Breast cancer; Odds T-X Contents

Introduction

Statistical distributions arising from trigonometric functions have populated the literature, and for example, see [1-4]. On the other hand, the T-X(W) family of distributions appeared in [5], and in the special case the random variable T has support [0, ∞), and the weight function is given by $W(x)=\frac{x}{1-x}$., we get the so-called Odds T-X family of distributions with the following integral representation for its CDF

$$\int_0^{\frac{F(x)}{1-F(x)}} r(t)\,dt\ 0$$

where the random variable X has CDF F (x) and the random variable T has PDF r(t).

By these observations, this paper unfolds as follows. We introduce a so-called Cot-X family of distributions in Section 2, and in Section 3 we introduce a so called Cot Odds T-X family of distributions. Section 4 and Section 5, show applicability of the new families, and the last section is devoted to the conclusions.

The New Family

The CDF of Cot-X is defined as

$$G(x;\xi)=-\cot\left(\frac{1}{4}\pi\left(F(x;\xi)+2\right)\right)$$

where x ∈ R, the baseline distribution has CDF F (x; ξ) and PDF f(x; ξ). By differentiat-ing the CDF, the PDF of Cot-X is given as

$$g(x;\xi)=\frac{1}{4}\pi f(x;\xi)\csc^2\left(\frac{1}{4}\pi\left(F(x;\xi)+2\right)\right)$$

A New Variant of the Odds T-X Family of Distributions

Let T be a random variable with support [0, ∞), whose PDF and CDF are given by r(t; ξ) and R(t; ξ), respectively, with ξ being a vector of parameters in the distribution of T , and let X be a random variable with PDF f(x; β) and CDF F (x; β), where β is a vector of parameters in the distribution of X. We define the Cot Odds T-X family of distributions with the following integral for its CDF

$$k(x;\beta,\xi)=\frac{1}{4}\pi\int_0^{\frac{F(x;\beta)}{1-F(x;\beta)}} r(t;\xi)\csc^2\left(\frac{1}{4}\pi\left(R(t;\xi)+2\right)\right)dt,$$

$$x\in\mathbb{R}$$

Explicitly the CDF of the Cot Odds T-X family is given by

$$k(x;\beta,\xi)=-\cot\left(\frac{1}{4}\pi\left(R\left(\frac{F(x;\beta)}{1-F(x;\beta)};\xi\right)+2\right)\right)$$

and the PDF is given by

$$k(x;\beta,\xi)=\frac{1}{4}\pi\csc^2\left(\frac{1}{4}\pi\left(R\left(\frac{F(x;\beta)}{1-F(x;\beta)};\xi\right)+2\right)\right)r\left(\frac{F(x;\beta)}{1-F(x;\beta)};\xi\right)\frac{f(x;\beta)}{\left(F(x;\beta)-1\right)^2}$$

Practical Illustration of Cot-X

We assume X is a Dagum random variable with CDF

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

for x, a, b, c > 0. Now from Section 2 we have the following

Proposition 6.1. The CDF of Cot-Dagum is given by

$$G(x;a,b,c) = -\cot\left(\frac{1}{4}\pi\left(\left(\left(\frac{x}{c}\right)^{-b}+1\right)^{-a}+2\right)\right)$$

where x, a, b, c > 0

Remark 6.2. The PDF of Cot-Dagum can be obtained by differentiating the CDF. We write S ~ CD(a, b, c), if S is a Cot-Dagum random variable (Figure 1).

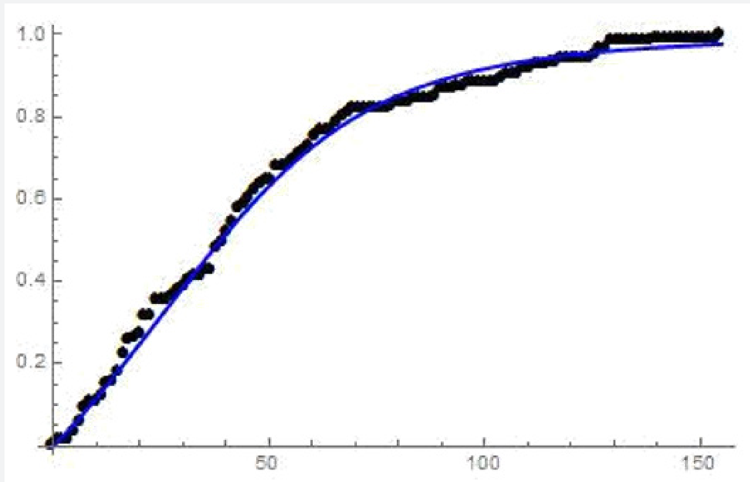

Figure 1: The CDF of CD(0.337462, 3.19503, 58.7951) fitted to the empirical distri-bution of the data on patients with breast cancer, Section 5.2 [6].

Practical Illustration of Cot Odds T-X

We assume T is a Frechet random variable with CDF

$$R(t;c,d) = e^{-\left(\frac{t}{d}\right)^{-c}}$$

for x, c, d > 0. We also assume that X is a Weibull random variable with CDF given by

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

for x, a, b > 0. Now from Section 3, we have the following

Proposition 7.1. The CDF of Cot Odds Frechet-Weibull is given by

$$K(x;a,b,c,d) = -\cot\left(\frac{1}{4}\pi\left(e^{-\left(\frac{e^{\left(\frac{x}{b}\right)^{a}}\left(1-e^{-\left(\frac{x}{b}\right)^{a}}\right)}{d}\right)^{-c}}+2\right)\right)$$

where x, a, b, c, d > 0

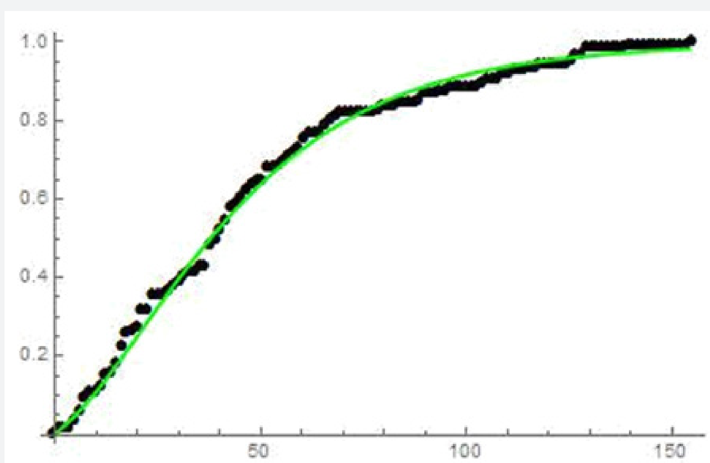

Figure 2: The CDF of COF W (0.73884, 1.47816, 0.192653, 2062.69) fitted to the em-pirical distribution of the data on patients with breast cancer, Section 5.2.

Remark 7.2. The PDF of Cot Odds Frechet-Weibull can be obtained by differentiating the CDF. We write J ~ COF W (a, b, c, d), if J is a Cot Odds Frechet-Weibull random variable (Figure 2).

Concluding Remarks

In the present paper we introduced the Cot-X and Cot Odds T-X family of distributions respectively and have shown fit to real-life data. The future interesting problem is to investigate some properties and application of these new classes of statistical distributions.

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Conflict of Interest

No conflict of interest.

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