Operational Statistics for SAR Imagery Course Assignment

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1 Different Statistical Distribution

In this course, we mainly learned about the distribution of statistical models of Synthetic Aperture Radar (SAR) imagery, such as Gamma distribution, K distribution, etc. At the same time, we also study to use different tools to plot these distribution.

1.1 Exponential Distribution

Firstly,we learned the exponential distribution.The distribution function is:

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

I plot the distribution with means 1/2,1 and 2(red,black,blue,resp.),then convert it to logarithmic coordinates.The plot is shown as Figure1:

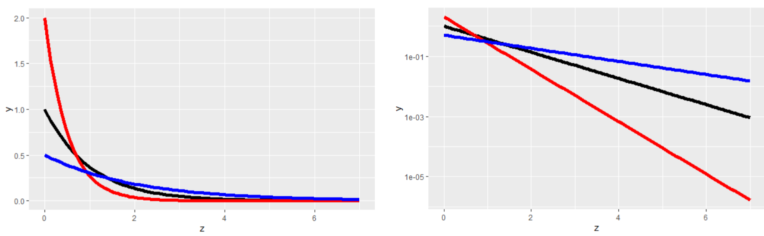

Figure 1: Exponential distribution of Cartesian coordinates(left) and logarithmic coordinates(right)

1.2 Gamma Distribution

Secondly,we learned the Gamma distribution.The distribution function is:

$$f_Z(z, L, \sigma^2) = \frac{L^L}{\sigma^{2L}\Gamma(L)} z^{L-1} exp\{-Lz/\sigma^2\} \tag{2}$$

where $\Gamma(v)$ is the Gamma function given by $\Gamma(v) = \int_{R_+} t^{v-1}e^{-t}dt$ I plot three cases of the Gamma distribution with uni-tary mean and shape parameters (Looks) equal to 1 (the Exponen-tial distribution), 3 and 8,then convert it to logarithmic coordinates.The plot is shown as Figure 2:

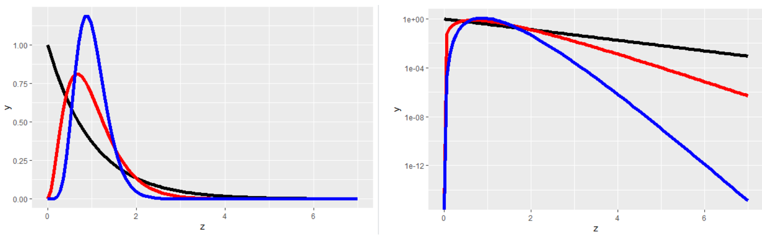

Figure 2: Gamma distribution of Cartesian coordinates(left) and logarithmic coordinates(right)

1.3 K Distribution

The K distribution function is:

$$f_Z(z, \alpha, \lambda, L) = \frac{2\lambda L}{\Gamma(\alpha)\Gamma(L)} \lambda L z^{\frac{\alpha+L}{2}-1} K_{\alpha-L}(2\sqrt{\lambda L z}) \tag{3}$$

where $\alpha > 0$ measures the roughness,$\lambda > 0$ is a scale parame-ter, and K_v is the modified Bessel function of order v . This special function is given by $K_v(z) = \int_0^\infty e^{-z}cosh(vt)dt$. I try to plot the K distributions with unitary mean ($\alpha \in 1, 3, 8$ in red, blue, black, resp.),then convert it to logarithmic coordinates.The plot is shown as Figure3:

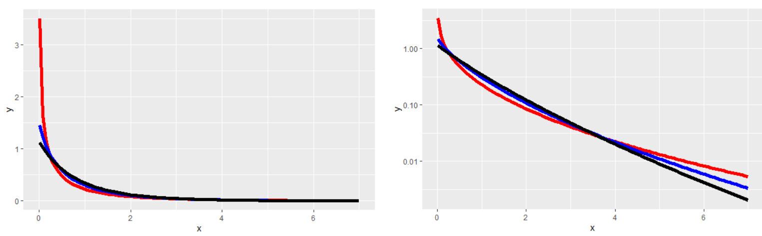

Figure 3: K distribution of Cartesian coordinates(left) and logarithmic coordinates(right)

1.4 G_0 Distribution

The G_0 distribution function is:

$$f_Z(z, \alpha, \gamma, L) = \frac{L^L \Gamma(L-\alpha)}{\gamma^\alpha \Gamma(L)\Gamma(-\alpha)} \frac{Z^{l-1}}{(\gamma + Lz)^{L-\alpha'}} \tag{4}$$

I try to plot the G_0 distributions with unitary mean ($\alpha \in -1.5, -3, -8$ in red, blue, black, resp.),then convert it to logarithmic coordinates.The plot is shown as Figure4:

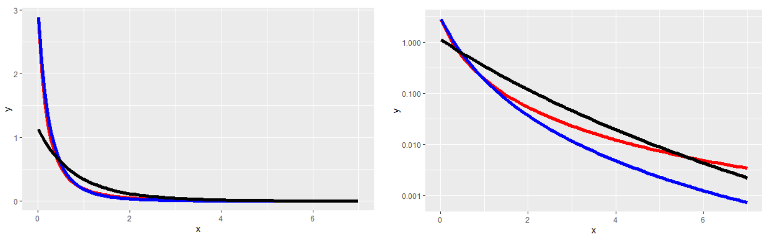

Figure 4: G_0 distribution of Cartesian coordinates(left) and logarithmic coordinates(right)

2 SAR Image Analysis

In this part, I selected a 70*154 size image from the given SAR images.The selected image is shown in figure5 : For the selected image, I first converted it to a grayscale image

Figure 5: The selected SAR image

and plotted the histogram.The histogram of this image is shown as figure6: According

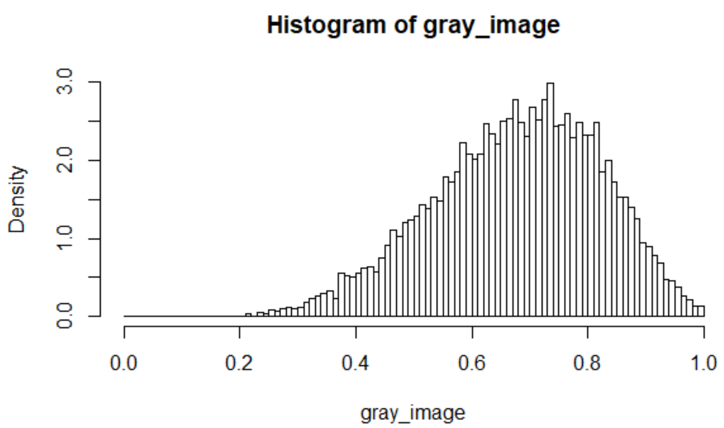

Figure 6: The histogram of selected SAR image

to the histogram I can observe that it Approximately obey the Gamma distribution.To confirm this idea, I tried to plot the Gamma distribution and adjusted the parameters to make the distribution line'shape better fit.After many different experiments, I finally chose the shape parameter being 4 and the scale parameter being 1/12, 1/11 and 1/10, respective.The final result is shown as figure7:

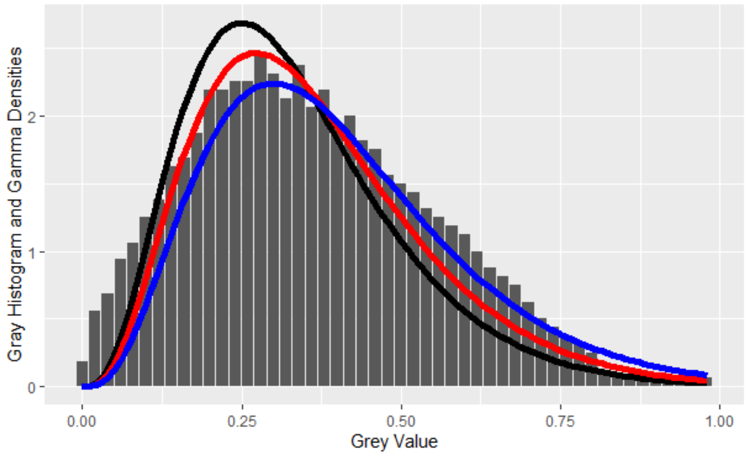

Figure 7: The final result