Statistics tutorial 4 exercise 3

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1 task 3

1.1 task 3.a)

Gaussian error propagation of:

$$g = A\sin\theta + B\cos\theta \tag{1}$$

results in the following error on g:

$$\sigma_g = \sqrt{(\sin\theta)^2 \cdot \sigma_A^2 + (\cos\theta)^2 \cdot \sigma_B^2 + (A\cos\theta - B\sin\theta)^2 \cdot \sigma_\theta^2} \tag{2}$$

1.2 task 3.b)

Relative uncertainties are added quadratic-ally in error-propagation in multiplication AND division. Therefore all 3 functions f,g and h have the same relative uncertainty!

$$(\frac{\sigma_f}{f})^2 = (\frac{\sigma_x}{x})^2 + (\frac{\sigma_y}{y})^2 \tag{3}$$

$$(\frac{\sigma_g}{g})^2 = (\frac{\sigma_x}{x})^2 + (\frac{\sigma_y}{y})^2 \tag{4}$$

$$(\frac{\sigma_h}{h})^2 = (\frac{\sigma_x}{x})^2 + (\frac{\sigma_y}{y})^2 \tag{5}$$

Plugging in relative uncertainty for x of 3% and y of 4% results in relative uncertainties for all 3 functions f,g and h of 5%.

1.3 task 3.c)

With the following transformations one can calculate the uncertainties for the cartesian coordinates:

$$x = r \cdot \cos\phi \tag{6}$$

$$y = r \cdot \sin\phi \tag{7}$$

$$z = z \tag{8}$$

Therefore the uncertainties are:

$$\sigma_x = \sqrt{(\cos\phi \cdot \sigma_r)^2 + (-r\sin\phi \cdot \sigma_p hi)^2} = r\sin\phi \cdot \sigma_\phi \tag{9}$$

$$\sigma_y = r\cos\phi\sigma_\phi \tag{10}$$

$$\sigma_z = \sigma_z \tag{11}$$