HW01, Problem 4 (Hint)

Problem

Recall that Cartesian coordinates (x, y, z) in $\mathbb{R}^3$ are related to spherical coordinates (ρ, ϕ, θ) by

$$x = \rho \sin\phi \cos\theta, \quad y = \rho \sin\phi \sin\theta, \quad z = \rho \cos\phi,$$

where $\phi \in [0, \pi]$ and $\theta \in [0, 2\pi)$. Write a script which takes Cartesian coordinates as inputs and converts them to spherical ones.

Hint

Make sure you begin by remembering/writing down the conversion formulas:

$$\begin{aligned} \rho &= \text{some function of } x, y, z \\ \theta &= \text{another function of } x, y, z \\ \phi &= \text{yet another function of } x, y, z \end{aligned}$$

A key point of this problem is how you manage to calculate θ in $[0, 2\pi)$. If you simply use either `theta=atan(y/x)` or `theta=atan2(y,x)`, your script will fail to convert properly points such as

$$(x, y, z) = (1, -1, 1) \quad \longrightarrow \quad (\rho, \phi, \theta) = (1.7320\ldots, 0.9553\ldots, 5.4977\ldots).$$

since `atan` outputs angles in $[-\pi/2, \pi/2]$ while `atan2` produces angles in $[-\pi, \pi]$. For more hints/references:

- Exercise 3 in *Relational and Logical Operations*
- In the Command Window, type `doc atan` and `doc atan2`.