

# In-class assignment #8

PHY-905-003  
Computational Astrophysics and Astrostatistics  
Spring 2023

**Instructions:** We're going to re-use the code for your pre-class assignment, where you used the shooting method to solve a boundary value problem. Given the equation:

$$\nabla^2 u = -\pi^2(u - 3) \quad (1)$$

whose analytic solution has the form

$$u(x) = \cos(\pi x) + 2 \sin(\pi x) + 3, \quad (2)$$

Show that you can calculate the solution using the shooting method on the interval  $[0, 1]$  for the initial conditions  $u(0) = 4$ ,  $u'(1) = -2\pi$  as well as the initial conditions  $u(1) = 2$ ,  $u'(0) = 2\pi$ . Can you write a general version of the shooting method code that can take in any arbitrary pair of  $u(x)$  and  $u'(x)$  values at the boundaries (one on each side of the interval - either  $u$  or  $u'$  on each side, and could be  $u$  on both sides,  $u'$  on both sides, or a mixed pair of  $u$  and  $u'$ ) and get the correct solution? Test it by coming up with a few different few different expressions for  $u$  and verify that it works correctly. Can you find any analytic expressions for  $u$  that are unsolvable with the shooting method?

**What to turn in:** Turn in `ANSWERS.md`, any source code you wrote, any plots you created (and the scripts you used to create them). **Do not** turn in object files or executables!