Question 1. Numerical Computations

We would like to study bifurcations. We will use the pitchfork bifurcation studied in class:

\[ \frac{dx}{dt} = h + rx - x^3 \]

Two plots to generate:

a) Let \( h = 0 \). Generate a 2D array, storing the values of \( \frac{dx}{dt} \) for a range of values for \( r \) and \( x \). Produce a plot of the critical points, clearly showing the bifurcation, using the \texttt{contour} command.

b) We would like to see the more complex dependence on \( r \) and \( h \). Generate a 3D array, storing the values of \( \frac{dx}{dt} \) for a range of values for \( r, h \) and \( x \). We’re looking for a surface in 3D, the complex folded shape at which \( \frac{dx}{dt} \) is zero. Produce a plot of this surface using \texttt{isosurface}. Ideally, rotate the plot (click on the rotate button and use the mouse) to make the fold more easily visualized.

Comment briefly on your observations.

Please submit MATLAB code at the end of the assignment.
Question 2. Reading and Commentary

Your choice . . . do one of the following three:

i. Read Chapter 1 from *A Short History of Progress* (link on home page):
   - Give a half-page summary of progress, particularly the phenomenon of *progress traps*
   - Give a half-page on your perspectives on the chapter

or

ii. Read Chapter 1 from *Critical transitions in nature and society* (link on home page):
   - Give a half-page on your perspectives on the chapter
   - Scheffer presents the examples of coral reefs, the Sahara desert, and societal shifts. Based on what Scheffer says, plus a bit of looking around online, give and briefly discuss (half page) further biological, climate, and societal examples of nonlinear behaviour and critical transitions.

or

iii. Read the Nature paper by Scheffer (link on home page):
   Give a one-page summary of the paper and its main points. Although you do not need to use equations, your discussion should be technical in nature.