Principles of Complex Systems, Vols. 1 and 2
CSYS/MATH 6701, 6713, & a pretend number
University of Vermont, Fall 2025
"There is no Carol in HR"
Assignment 01

It's Always Sunny in Philadelphia: Sweet Dee has a Heart Attack, ??? S4E10
Episode links: IMDB, Fandom, TV Tropes.

Due: Wednesday, September 3, by 11:59 pm
https://pdodds.w3.uvm.edu/teaching/courses/2025-2026pocsverse/assignments/01/
Some useful reminders:
Deliverator: Prof. Peter Sheridan Dodds (contact through Teams)
Office: The Ether and/or Innovation, fourth floor
Office hours: See Teams calendar
Course website: https://pdodds.w3.uvm.edu/teaching/courses/2025-2026pocsverse
Overleaf: LaTeX templates and settings for all assignments are available at https://www.overleaf.com/read/tsxfwwmwdgxj.

Some guidelines:

1. Each student should submit their own assignment.
2. All parts are worth 3 points unless marked otherwise.
3. Please show all your work/workings/workingses clearly and list the names of others with whom you ~~conspired~~ collaborated.
4. We recommend that you write up your assignments in LaTeX (using the Overleaf template). However, if you are new to LaTeX or it is all proving too much, you may submit handwritten versions. Whatever you do, please only submit single PDFs.
5. For coding, we recommend you improve your skills with Python. And it's going to be a no for the catachrestic Excel. Please do not use any kind of AI thing unless directed. The (evil) Deliverator uses (evil) Matlab.
6. There is no need to include your code but you can if you are feeling especially proud.

Assignment submission:

Via **Brightspace** (which is not to be confused with the death vortex of the same name, just a weird coincidence). Again: One PDF document per assignment only.

Overall points: 15 points.

1. (3 for the plot, 3 for the exponent, 3 for a guess of the 'true' exponent, no points for the canoli but bring it)

   An amuse-bouche for scaling, to signal the flavors ahead:

   Please take in the following dataset from Bennett and Harvey's 1987 paper "Active and Resting Metabolism in Birds—Allometry, Phylogeny and Ecology" [1]:

   http://pdodds.w3.uvm.edu/pocsverse/data/bennett_harvey1987a_bird_metabolism_data.tsv

   The Deliverator typed the data into a text file from the appendices many years ago. Hopefully there aren't too many mistakes.

   The suffix .tsv = tab separated variables.

   [Self doubt intensifies.]

   A scan of a photocopy of the original paper is here.

   The three columns are:

   - Bird species name
   - Mass M in grams g
   - Resting metabolic rate P (or B) in Watts, W

   Plot the $log_{10}P$ as a function of $\log_{10} M$ to get a sense of things.

   (Base 10 is for heroes.)

   Take some time to make things look good.

   We strongly recommend Python.

   (The Deliverator accepts that Matlab wrong. But the power is real.)

   (a) Measure the exponent using linear regression.

   (b) Add the line of best fit to your plot, and submit this plot

   (c) Any idea of what the exponent might be theoretically?

   Side note: You are now part of a holy war. So that's fun.

2. (3 + 3)

   Some kitchen table preparation for for power-law size distributions:

Consider a random variable X with a probability distribution given by

$$P(x) = cx^{-\gamma}$$

where c is a normalization constant, and $0 < a \leq x \leq b$. (a and b are the lower and upper cutoffs respectively.) A Perishing Monk tells you to assume that $\gamma > 1$, that $a > 0$ always, and allow for the possibility that $b \to \infty$. And then the Monk disappears.

(a) Determine c.

(b) Why did the Perishing Monk tell us to assume $\gamma > 1$?
Think about what happens as $b \to \infty$.

References

[1] P. Bennett and P. Harvey. Active and resting metabolism in birds—allometry, phylogeny and ecology. J. Zool., 213:327–363, 1987. pdf