

Problem Set #3

Due

Note, you are submitting all your problems as Jupyter notebooks, so make your code, figures and text readable in a single file.

1) Consider the following differential system:

$$\frac{dy(t)}{dt} + \frac{y(t)}{4} = x(t)$$

and assume

$$x(t) = \cos(3t) ; y(0) = -1$$

Numerically solve this equation (and plot the results for both $x(t)$ and $y(t)$). Hint: define two functions $x(t)$, return $\text{np.cos}(3*t)$, and $f(t,y,c)$, return $x(t)-y/4$. Use the `solve_ivp` such that:

```
sol = solve_ivp(lambda t, y: f(t, y, c), [tspan[0], tspan[-1]], yinit, t_eval=tspan, rtol = 1e-5)
```

2) Imagine a box having 50% dark chocolates and 50% white chocolates. Half of the dark chocolate is wrapped in gold paper and another half in silver paper. All the white chocolates are wrapped in silver paper. A kid picked chocolate from the box, wrapped in silver paper. What is the probability that the picked one is dark chocolate?

3) There are three boxes, each containing 2 balls. One box contains 2 blue balls, one box contains 2 red balls, one box contains 1 blue ball and 1 red ball. You pick a box at random and take a ball out (without looking in the box). The ball is blue, what is the probability that the other ball is red? Write a simulation to deduce this probability.

4) Build a simulation gas station using `simpy`. Basically you have a simple refueling station. Cars arrive at random intervals between 30 and 300 secs. They all have 50 liter tanks, filled with varying levels from 5 to 25 liters. The station refuels at 3 liters/sec from a tank of 200 liters. When the main tank is near empty (at 25%), a tanker truck is called (it takes 300 secs to arrive and fill the tank).

Now the problem is this:

- 1) You sell fuel for 1.00 dollars per liter.
- 2) You buy the fuel for 0.98 dollars per liter.
- 3) You employ four attendants at 15 dollars per hour.

Run the simulation for 8 hour days, many times. Answer these questions:

- 1) Make a histogram of your profits per day.
- 2) What is your mean profit?
- 3) What percentage of days did you lose money?
- 4) At what rate can you cut your employees salary to guarantee a profit for 99% of the time?

PHYS510 problem: Redo the coin toss scenario with a posterior observation of 0,0,0,0,1,0,0,0,0,1.