r2knowle_a3q3

March 1, 2023

1 A3-Q3: Time of Death

[2]:
```
import numpy as np
from scipy.integrate import solve_ivp
import matplotlib.pyplot as plt
import math
from copy import deepcopy

def MyOde(f, tspan, y0, h):
    t = tspan[0]
    y = deepcopy(y0)

    tlst = []
    ylst = []

    while (t < tspan[1]):
        normalEulers = y + h*f(t,y);
        newTime = t+h;
        RumeEulers = y + (h/2) * (f(t,y) + f(newTime, normalEulers))


        tlst.append(newTime)
        ylst.append(RumeEulers)

        y = RumeEulers;
        t = newTime;


    return np.array(tlst), np.array(ylst)
```

1.1 (a) Dynamics Function

[3]:
```
# === YOUR CODE HERE ===
def AmbTemp(t):
    if (t >= 7.5 and t <= 19):
        return 22;
    if (t >= 21 or t <= 7):
```

```
        return 16;
    if (t <= 7.5):
        timeLeft = 7.5-t;
        return 22 - (timeLeft/0.5)*6
    else:
        timeLeft = 21 - t;
        return 16 + (timeLeft/2)*6;


def de(t, z):
    '''
    z1 = A
    z2 = B
    z3 = T
    '''

    A = z[0];
    B = z[1];
    T = z[2];


    if (29 <= T and T <= 45):
        newA = (0.0008*(T - 29)**2) * (1-math.exp((0.08)*(T-45))) * A * (30 - A)
    else:
        newA = 0;

    if (17 <= T and T <= 32):
        newB = (0.001*(T - 17)**2) * (1-math.exp((0.05)*(T-32))) * B * (20 - B)
    else:
        newB = 0;

    part1 = -0.1 * (T - AmbTemp(t))
    part2 = (A + B)/100
    newC = part1 + part2


    return np.array([newA, newB, newC])
```

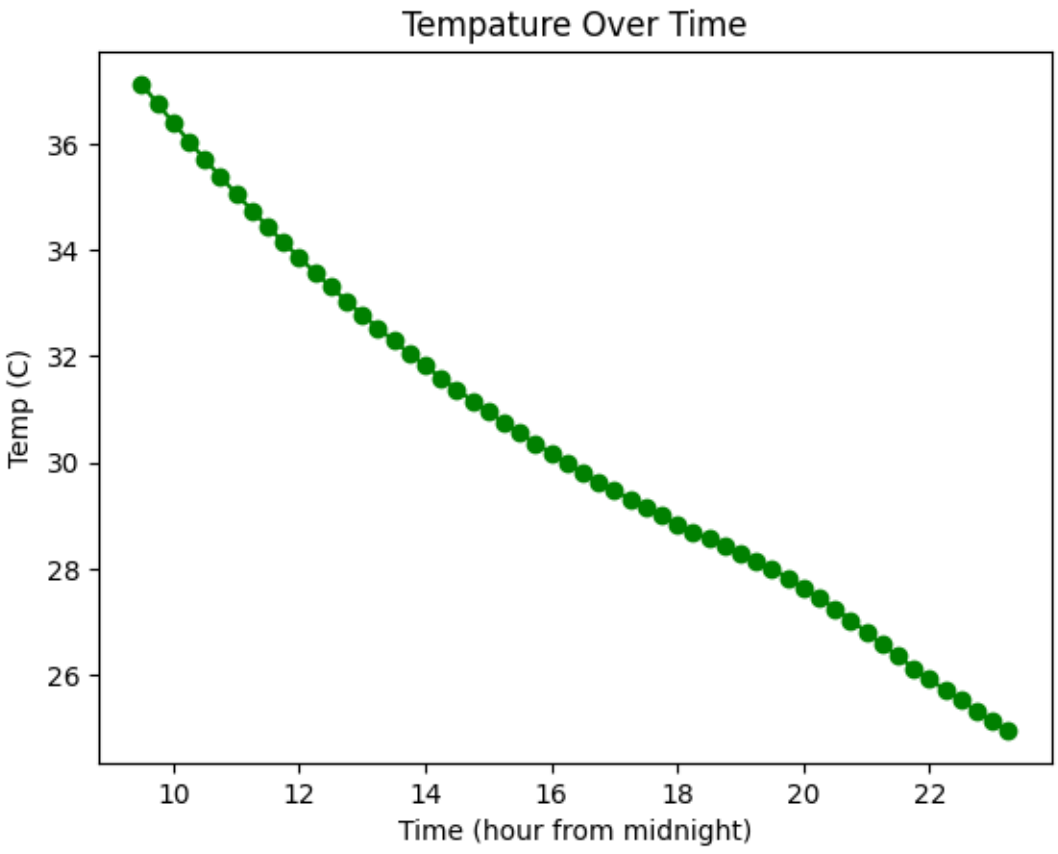
1.2 (b) Run the simulation

[4]:
```
# === YOUR CODE HERE ===
timeStart = 9.25
tspan = [timeStart, 23.25]
yStart = np.array([1, 1, 37.5])

t,y  = MyOde(de, tspan, yStart, 0.25)
print(y[-1])
```

```
[ 6.54034875 11.9558738  24.95932436]
```

[5]:
```
# Plot temperature, and display final state
plt.plot(t, y[:,2], 'go-');

plt.title('Tempature Over Time')
plt.xlabel('Time (hour from midnight)')
plt.ylabel('Temp (C)')
```

[5]:
```
Text(0, 0.5, 'Temp (C)')
```



1.3 (c) Prime Suspect

YOUR ANSWER HERE

[6]:
```
It looks like the murder happens between 9am and 11am. We know this as at 9am,
the amount of bacteria B is too high and at 11am its too low. Therefore the most
likely suspect is James Carver, as he doesnt have an alibi for this time.
```

```
  Cell In[6], line 1
    It looks like the murder happens between 9am and 11am. We know this as at␣
 ↪9am,

SyntaxError: invalid decimal literal
```

[ ]:

[ ]: