Lab1 Qeustion 1 (b)

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1 Pseudo code

1.1 Main function with Euler-Cromer method

```
def Euler_Cromer(x_0, y_0, vx_0, vy_0, d_t, t):

    steps = t / d_t     #calculate total number of steps
    x = [None]*steps    #initialize arrays
    y = [None]*steps
    vx = [None]*steps
    vy = [None]*steps
    x[0] = x_0          #take initial values
    y[0] = y_0
    vx[0] = vx_0
    vy[0] = vy_0
    for i in range(0, steps-1):     #Euler Cromer method
        x[i+1] = x[i] + vx[i] * d_t
        vx[i+1] = vx[i] - G * M_s * x[i+1] * d_t / r**3
    for i in range(0, steps-1):
        y[i+1] = y[i] + vy[i] * d_t
        vy[i+1] = vy[i] - G * M_s * y[i+1] * d_t / r**3

return x, y, vx, vy
```

1.2 Plot

```
result = Euler_Cromer(x_0, y_0, vx_0, vy_0, d_t, t)
x = result[0]
y = result[1]
vx = result[2]
vy = result[3]

new_plot()
plot(x, vx, color = 'red')
plot(y, vy, color = 'blue')

new_plot()
plot(x, y)
```

2 Explanation

2.1 Euler-Cromer function

In the first part of the pseudo code, I defined the function `Euler_Cormer` to take initial values of x, y, v_x, v_y as `x_0, y_0, vx_0, vy_0` respectively. Also, the function takes the total time interval as `t` and the time interval of each step as `d_t` to calculate the total number of steps as `steps`.
Then the function initializes four arrays `x, y, vx, vy` with length of `steps` to store the results. The first element of each array is set as the initial value which is taken by the function.
Then the function calculates the values step by step using Euler Cromer method with for loops.
The difference between Euler Cromer method and regular Euler method is that, when calculating v_{i+1}, Euler Cromer method uses x_{i+1} while regular Euler method uses x_i.
So, in my code, I calculate `x[i+1]` first and use its value to calculate `vx[i+1]`.
The function returns four arrays `x, y, vx, vy` which contains the simulation results.

2.2 Plot

The plot part is very straight forward. It runs the simulation with `Euler_Cormer` function, and plots the desired result.