Group 17: Assignment 2(Linear Growth Model)

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Question:

> Consider a linear growth model with individual birth and death rate equal to (8.12n +2.43) per hour and (9.04n) per hour respectively. Initial value is five natives.

1. Simulate the system for 20 mins.
2. Plot the distribution of linear growth model.
3. Estimate the time until extinction.

Setting Given values:

```
%Setting initial state(population)
ni=5
```

```
ni = 5
```

```
n=ni
```

```
n = 5
```

```
%Setting birth rate per min
bn=((8.12*n)+2.43)/60;
%Setting death rate per min
dn=(9.04*n)/60;
fprintf("Initial Birth and Death rate(per min) are %f, %f respectively \n",bn,dn)
```

```
Initial Birth and Death rate(per min) are 0.717167, 0.753333 respectively
```

Simulating system for 20min:

```
disp("Now simulating given system for 20min.")
```

```
Now simulating given system for 20min.
```

```
para=bn+dn;
time_total=0;
holdtime=0;
Pm=[5];%Data variables for plotting
Tm=[0];%same
while (time_total+holdtime)<=20
    u=rand; %Random variable for hold time
    v=rand; %Random variable to simulate birth or death
    holdtime=(-1/para)*log(u);
    time_total=time_total+holdtime;
    fprintf("Time established in simulation is %f min",time_total)
    Pinc=bn/(bn+dn);
    Pdec=dn/(bn+dn);
```

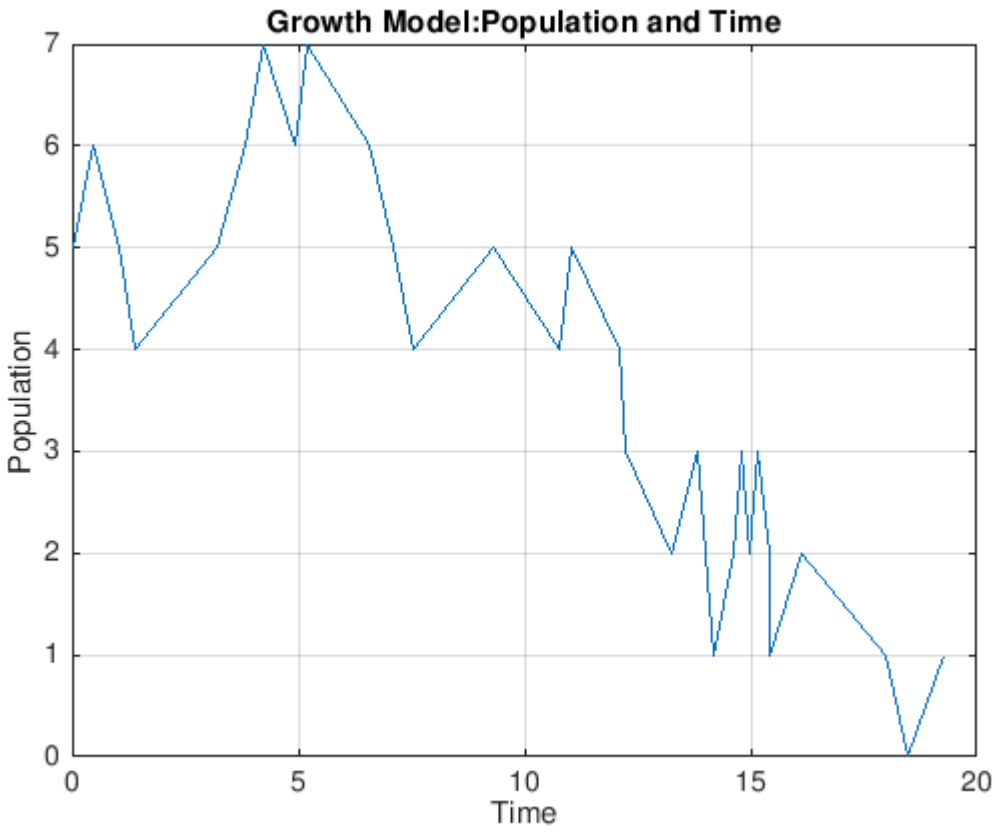
```
    if v<Pinc
        n=n+1;%updating n
    else
        n=n-1;%updating n
    end
    fprintf("Current Population is %i inhabitant(s)",n)
    %Now updating changed birth/death rates
    bn=((8.12*n)+2.43)/60;
    dn=(9.04*n)/60;
    %Collecting Data points:
    Tm=[Tm,time_total];
    Pm=[Pm,n];
    if time_total+holdtime>=20
        fprintf("Final Population after 20min is %i inhabitant(s) \n \n \n",n)
    end
end
```

```
Time established in simulation is 0.463731 min
Current Population is 6 inhabitant(s)
Time established in simulation is 1.048719 min
Current Population is 5 inhabitant(s)
Time established in simulation is 1.372603 min
Current Population is 4 inhabitant(s)
Time established in simulation is 3.213163 min
Current Population is 5 inhabitant(s)
Time established in simulation is 3.834243 min
Current Population is 6 inhabitant(s)
Time established in simulation is 4.218917 min
Current Population is 7 inhabitant(s)
Time established in simulation is 4.919977 min
Current Population is 6 inhabitant(s)
Time established in simulation is 5.190665 min
Current Population is 7 inhabitant(s)
Time established in simulation is 6.589019 min
Current Population is 6 inhabitant(s)
Time established in simulation is 7.121163 min
Current Population is 5 inhabitant(s)
Time established in simulation is 7.564617 min
Current Population is 4 inhabitant(s)
Time established in simulation is 9.306832 min
Current Population is 5 inhabitant(s)
Time established in simulation is 10.757355 min
Current Population is 4 inhabitant(s)
Time established in simulation is 11.023300 min
Current Population is 5 inhabitant(s)
Time established in simulation is 12.085905 min
Current Population is 4 inhabitant(s)
Time established in simulation is 12.234826 min
Current Population is 3 inhabitant(s)
Time established in simulation is 13.256682 min
Current Population is 2 inhabitant(s)
Time established in simulation is 13.828555 min
Current Population is 3 inhabitant(s)
Time established in simulation is 13.995674 min
Current Population is 2 inhabitant(s)
Time established in simulation is 14.202136 min
Current Population is 1 inhabitant(s)
Time established in simulation is 14.639984 min
Current Population is 2 inhabitant(s)
Time established in simulation is 14.794644 min
Current Population is 3 inhabitant(s)
Time established in simulation is 14.988974 min
```

```
Current Population is 2 inhabitant(s)
Time established in simulation is 15.158014 min
Current Population is 3 inhabitant(s)
Time established in simulation is 15.433064 min
Current Population is 2 inhabitant(s)
Time established in simulation is 15.433141 min
Current Population is 1 inhabitant(s)
Time established in simulation is 16.147281 min
Current Population is 2 inhabitant(s)
Time established in simulation is 17.999406 min
Current Population is 1 inhabitant(s)
Time established in simulation is 18.489888 min
Current Population is 0 inhabitant(s)
Time established in simulation is 19.290480 min
Current Population is 1 inhabitant(s)
Final Population after 20min is 1 inhabitant(s)
```

Plotting Distribution of Linear growth model

```
plot(Tm,Pm)
title('Growth Model:Population and Time')
xlabel('Time')
ylabel('Population')
grid on
```



Estimating time until extinction(independent of previous calculations and graph)

```
%Resetting Parameters to initial value
disp("Now computing time unto extinction.")
```

```
Now computing time unto extinction(independent of previous calculations and graph).
```

```
n=ni;
bn=((8.12*n)+2.43)/60;
dn=(9.04*n)/60;
para=bn+dn;
time_total=0;
holdtime=0;
while n>0 %loop for extinction
    u=rand; %Random variable for hold time
    v=rand; %Random variable to simulate birth or death
    holdtime=(-1/para)*log(u);
    time_total=time_total+holdtime;
    fprintf("Time established in simulation is %f min",time_total)
    Pinc=bn/(bn+dn);
    Pdec=dn/(bn+dn);
    if v<Pinc
        n=n+1;%updating n
    else
        n=n-1;%updating n
    end
    fprintf("Current Population is %i inhabitant(s)",n)
    %Now updating changed birth/death rates
    bn=((8.12*n)+2.43)/60;
    dn=(9.04*n)/60;
    if n==0
        fprintf("Time until extinction is %f min",time_total)
    end
end
```

```
Time established in simulation is 0.028512 min
Current Population is 4 inhabitant(s)
Time established in simulation is 0.436623 min
Current Population is 5 inhabitant(s)
Time established in simulation is 0.966378 min
Current Population is 4 inhabitant(s)
Time established in simulation is 1.033357 min
Current Population is 3 inhabitant(s)
Time established in simulation is 2.536278 min
Current Population is 2 inhabitant(s)
Time established in simulation is 3.088064 min
Current Population is 1 inhabitant(s)
Time established in simulation is 4.177986 min
Current Population is 0 inhabitant(s)
Time until extinction is 4.177986 min
```