Group 17: Assignment 2(Linear Growth Model)

Members: 1. Riddhesh Tiwaskar(2017B4A30537P)

2. Aman Gupta(2017B4A20835P)

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);
```

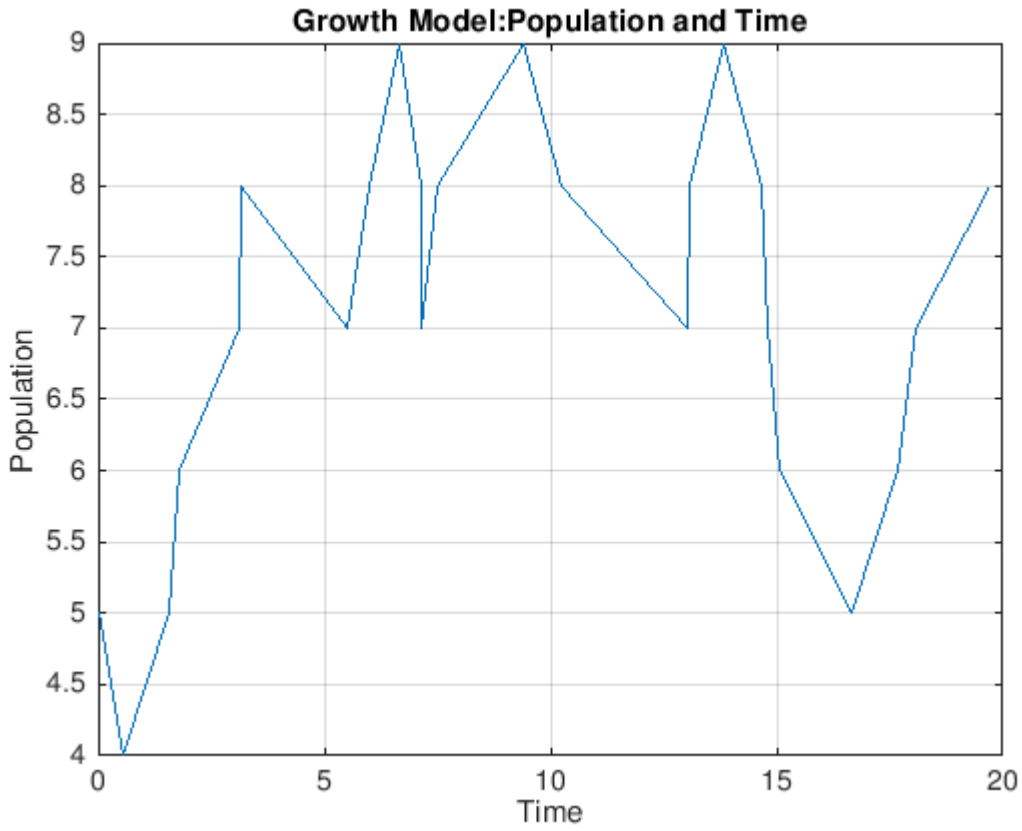
```
    if v<Pinc
        n=n+1;%updating n
    else
        n=n-1;%updating n
    end
    fprintf("Current Population is %i inhabitant(s)",n)
    %Now updating changed birth/death rates
    bn=((8.12*n)+2.43)/60;
    dn=(9.04*n)/60;
    %Collecting Data points:
    Tm=[Tm,time_total];
    Pm=[Pm,n];
    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 0.570855 min
Current Population is 4 inhabitant(s)
Time established in simulation is 1.549857 min
Current Population is 5 inhabitant(s)
Time established in simulation is 1.805847 min
Current Population is 6 inhabitant(s)
Time established in simulation is 3.099553 min
Current Population is 7 inhabitant(s)
Time established in simulation is 3.158325 min
Current Population is 8 inhabitant(s)
Time established in simulation is 5.493439 min
Current Population is 7 inhabitant(s)
Time established in simulation is 6.003266 min
Current Population is 8 inhabitant(s)
Time established in simulation is 6.637649 min
Current Population is 9 inhabitant(s)
Time established in simulation is 7.136158 min
Current Population is 8 inhabitant(s)
Time established in simulation is 7.168024 min
Current Population is 7 inhabitant(s)
Time established in simulation is 7.485544 min
Current Population is 8 inhabitant(s)
Time established in simulation is 9.415328 min
Current Population is 9 inhabitant(s)
Time established in simulation is 10.262227 min
Current Population is 8 inhabitant(s)
Time established in simulation is 13.042570 min
Current Population is 7 inhabitant(s)
Time established in simulation is 13.064276 min
Current Population is 8 inhabitant(s)
Time established in simulation is 13.836046 min
Current Population is 9 inhabitant(s)
Time established in simulation is 14.659820 min
Current Population is 8 inhabitant(s)
Time established in simulation is 14.810151 min
Current Population is 7 inhabitant(s)
Time established in simulation is 15.088383 min
Current Population is 6 inhabitant(s)
Time established in simulation is 16.672956 min
Current Population is 5 inhabitant(s)
Time established in simulation is 17.679972 min
Current Population is 6 inhabitant(s)
Time established in simulation is 18.061737 min
Current Population is 7 inhabitant(s)
Time established in simulation is 19.704514 min
```

```
Current Population is 8 inhabitant(s)
Final Population after 20min is 8 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.
```

```
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 0.381322 min
Current Population is 4 inhabitant(s)
Time established in simulation is 0.664472 min
Current Population is 5 inhabitant(s)
Time established in simulation is 0.925769 min
Current Population is 6 inhabitant(s)
Time established in simulation is 1.169786 min
Current Population is 5 inhabitant(s)
Time established in simulation is 1.645408 min
Current Population is 4 inhabitant(s)
Time established in simulation is 1.855333 min
Current Population is 5 inhabitant(s)
Time established in simulation is 2.287810 min
Current Population is 4 inhabitant(s)
Time established in simulation is 3.459108 min
Current Population is 3 inhabitant(s)
Time established in simulation is 4.458590 min
Current Population is 4 inhabitant(s)
Time established in simulation is 4.458659 min
Current Population is 5 inhabitant(s)
Time established in simulation is 4.560752 min
Current Population is 6 inhabitant(s)
Time established in simulation is 4.599933 min
Current Population is 7 inhabitant(s)
Time established in simulation is 4.610520 min
Current Population is 6 inhabitant(s)
Time established in simulation is 6.867559 min
Current Population is 5 inhabitant(s)
Time established in simulation is 8.845761 min
Current Population is 4 inhabitant(s)
Time established in simulation is 9.736282 min
Current Population is 5 inhabitant(s)
Time established in simulation is 10.894932 min
Current Population is 4 inhabitant(s)
Time established in simulation is 11.504351 min
Current Population is 3 inhabitant(s)
Time established in simulation is 11.554237 min
Current Population is 4 inhabitant(s)
Time established in simulation is 14.156870 min
Current Population is 3 inhabitant(s)
```

```
Time established in simulation is 14.339056 min
Current Population is 4 inhabitant(s)
Time established in simulation is 15.117319 min
Current Population is 3 inhabitant(s)
Time established in simulation is 16.096495 min
Current Population is 4 inhabitant(s)
Time established in simulation is 16.823396 min
Current Population is 5 inhabitant(s)
Time established in simulation is 16.999742 min
Current Population is 4 inhabitant(s)
Time established in simulation is 17.553825 min
Current Population is 3 inhabitant(s)
Time established in simulation is 18.325361 min
Current Population is 4 inhabitant(s)
Time established in simulation is 18.483251 min
Current Population is 3 inhabitant(s)
Time established in simulation is 20.906866 min
Current Population is 2 inhabitant(s)
Time established in simulation is 21.017110 min
Current Population is 1 inhabitant(s)
Time established in simulation is 21.373661 min
Current Population is 2 inhabitant(s)
Time established in simulation is 22.333707 min
Current Population is 1 inhabitant(s)
Time established in simulation is 22.609457 min
Current Population is 2 inhabitant(s)
Time established in simulation is 22.956818 min
Current Population is 3 inhabitant(s)
Time established in simulation is 23.486060 min
Current Population is 2 inhabitant(s)
Time established in simulation is 25.501159 min
Current Population is 3 inhabitant(s)
Time established in simulation is 25.571772 min
Current Population is 4 inhabitant(s)
Time established in simulation is 25.630780 min
Current Population is 3 inhabitant(s)
Time established in simulation is 26.330472 min
Current Population is 4 inhabitant(s)
Time established in simulation is 27.038319 min
Current Population is 5 inhabitant(s)
Time established in simulation is 27.085541 min
Current Population is 4 inhabitant(s)
Time established in simulation is 28.273201 min
Current Population is 3 inhabitant(s)
Time established in simulation is 28.947866 min
Current Population is 2 inhabitant(s)
Time established in simulation is 29.339572 min
Current Population is 3 inhabitant(s)
Time established in simulation is 30.130213 min
Current Population is 2 inhabitant(s)
Time established in simulation is 32.413925 min
Current Population is 1 inhabitant(s)
Time established in simulation is 32.847368 min
Current Population is 0 inhabitant(s)
Time until extinction is 32.847368 min
```