Linear Population Growth Model for Flour Beetles

Statement of Problem: The equations used to model the discrete population growth of the flour beetle are given on page 39 of the text, equation 1.5.

$$
\begin{aligned}
L_{t+1} &= bA_t \\
P_{t+1} &= L_t(1-\mu_L) \\
A_{t+1} &= P_t(1-\mu_P) + A_t(1-\mu_A)
\end{aligned}
$$

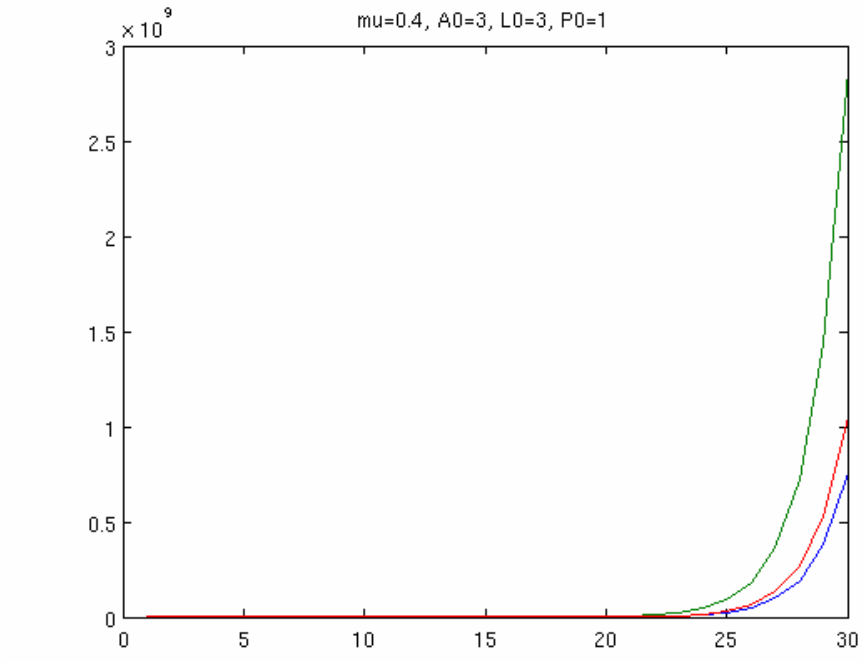
The parameter b is the birth rate of the species (number of Larvae produced each time unit from an Adult). The parameters μ_L, μ_P, μ_A measure the death rates of the Larvae, Pupae, and Adults, respectively.

We are asked to use Matlab to calculate the values for L, P, A for successive times given initial conditions.

Note: Make sure you provide a thorough explanation of any mathematical material, or modeling assumptions you have made.

Writeup: Because the model is linear, we expect exponential growth and/or decay to be present. Using the Matlab code (linear_beetle.m) listed in Appendix 1, we used the same values for b as for the nonlinear discrete model (equation 1.6 on page 40 of the text).

Case 1: Using initial conditions $L_0 = 3, P_0 = 1, A_0 = 3$ as well as $b = 7.48$, and integrating 30 time steps ($N = 30$), we get the following graph for the population



Note: Be sure to include lots of graphics. I have included one case study (for illustrative purposes) but five to ten cases would be appropriate in this instance.

References: Any references (books, papers, web links) would go here …

Note: Web links should be given in full URL format (ie http://X.Y.Z/xyz). Journal and book references should be complete, and in a consistent style.

Appendix 1 (Matlab Codes):

Listing for *linear_beetle.m* is given below

```
function linear_beetle(L0,A0,P0,N)
% Linear model for population growth
% Equations 1.5 on page 39 of text.
% The input arguments are initial conditions
% for L, A, P respectively

% Initialize static parameters ...
% to be those of the nonlinear model 1.6
b=7.48;
cea=0.009;
cel=0.012;
mul=0.267;
mup=0.0;
mua=0.4;
cpa=0.004;

% Create and initialize matrices ...
L=zeros(N,1);
P=zeros(N,1);
A=zeros(N,1);

% Set initial conditions ...
L(1)=L0;
A(1)=A0;
P(1)=P0;

% now, iteration N time steps ...
for i=1:N-1
  L(i+1)=b*A(i);
  P(i+1)=L(i)*(1-mul);
  A(i+1)=P(i)*(1-mup)+A(i)*(1-mua);
end;

% Make a plot of the three dependent variables ...
t=1:N;
plot(t,A(t),t,L(t),t,P(t));

% Give it an informative title ...
title(sprintf('mu=%0.5g, A0=%0.5g, L0=%0.5g,
P0=%0.5g',mua,A(1),L(1),P(1)));
```

Note: Matlab listings should be formatted and commented!