Bab 5
Penutup

5.1 Kesimpulan

Penelitian yang telah dilakukan memberikan kontribusi dalam memahami pengaruh *delay* yang diberikan terhadap solusi persamaan diferensial logistik. Kontribusi utama dalam penelitian ini adalah sebagai berikut:

1. Solusi persamaan logistik dengan *delay* bergantung pada panjang interval *delay* dan fungsi *delay* yang diberikan.

2. Panjang interval *delay* yang relatif kecil berpengaruh pada solusi yakni pada titik kesetimbangan $y = 1$ didekati secara berfluktuasi.

3. Panjang interval *delay* yang relatif besar menyebabkan solusi tidak menuju pada titik kesetimbangan $y = 1$, namun berfluktuasi dengan tingkat fluktuasi hampir sama.

5.2 Saran

Berikut ini beberapa masalah terbuka pada skripsi ini yang masih bisa dikembangkan untuk penelitian selanjutnya.

- Menganalisis secara matematika perilaku solusi persamaan logistik dengan *delay* dilihat dari panjang interval yang diberikan, misalnya hubungan antara panjang interval *delay* dengan amplitudo solusinya atau frekuensi solusinya.
- Menganalisis secara matematika perilaku solusi persamaan logistik dengan *delay* dilihat dari jenis fungsi *delay* yang diberikan, misalnya hubungan antara jenis *delay* dengan amplitudo solusinya atau frekuensi solusinya.
- Menentukan panjang periode fluktuasi solusi.
- Mencari batas panjang interval untuk menentukan, apakah solusinya menuju kesetimbangan $y = 1$ atau tidak.

5.3 Lampiran

- Code program matlab Gambar 4.1

```
clc
close all
clear all
dl=2;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=-xdl+xdl+1.9;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');
    axis([-dl 50 -0.1 3])
    %axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.2

```
clc
close all
clear all
dl=2;%logistik menuju stabil, delay berfluktuasi dan menuju no
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=-xdl+xdl+.1;%.8*heaviside(xdl+dl+.2)-.7*heaviside(xdl+dl/2
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');
    axis([-dl 50 -0.1 3])
    %axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

● Code program matlab Gambar 4.3

```
clc
close all
clear all
```

```
dl=2;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.5+0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:40000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');
    axis([-dl 80 -0.1 3])
    %axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.4

```
clc
close all
clear all
dl=2;
alpa=1;
n=50;
```

```
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=.4+0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:40000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');
    axis([-dl 50 -0.1 3])
    %axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.5

```
clc
close all
clear all
dl=2;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=-xdl+1.8;
```

```
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');
    axis([-dl 50 -0.1 3])
    %axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.6

```
clc
close all
clear all
dl=2;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=-.4*xdl+.1;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
```

```
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');
    axis([-dl 50 -0.1 3])
    %axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.7

```
clc
close all
clear all
dl=.5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.5+xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
```

```
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');

    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.8

```
clc
close all
clear all
dl=1.5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.5+xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
```

```
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

● Code program matlab Gambar 4.9

```
clc
close all
clear all
dl=1.5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.5+xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:200000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
```

```
axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
        pause(.001)
        y0=y;g0=g;h0=h;f0=f;
    end
```

• Code program matlab Gambar 4.10

```
clc
close all
clear all
dl=2;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.5+xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:200000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);]
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

• Code program matlab Gambar 4.11

```
clc
```

```
close all
clear all
dl=.5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.5-xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0   0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
     axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.12

```
clc
close all
clear all
dl=.5;
alpa=1;
n=50;
dt=dl/n;
```

```
xdl=linspace(-dl,0,n+1);
ydl=1.4+0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');
     axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

• Code program matlab Gambar 4.13

```
clc
close all
clear all
dl=1;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.4+0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
```

```
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.14

```
clc
close all
clear all
dl=1.5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.4+0.2*xdl; %fungsi delay
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
```

```
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    %plot([(k-1)*dt,k*dt],[f0,f],'-y');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    %plot([(k-1)*dt,k*dt],[h0,h],'-c');

    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.2

```
clc
close all
clear all
dl=2;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.4+0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);%y'=y(t)[1-y(t-a)]
    h=h0+alpa*hdl(k)*dt*(1-h0);%h'=h(t-b)[1-h(t)]
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;%g'=g(t)[1-g(t)]
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));%f'=f(t-b)[1-f(t-a)]
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
```

```
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

• Code program matlab Gambar 4.15

```
clc
close all
clear all
dl=3;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.4+0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
```

```
end
```

- Code program matlab Gambar 4.16

```
clc
close all
clear all
dl=5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.4+0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.17

```
clc
close all
clear all
dl=.5;
```

```
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=1.4-0.2*xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.18

```
clc
close all
clear all
dl=.5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=.4+xdl-xdl;
hdl=ydl;fdl=ydl;
```

```
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.19

```
clc
close all
clear all
dl=1.5;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=.4+xdl-xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
```

```
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
    plot([(k-1)*dt,k*dt],[y0,y],'-k');
    plot([(k-1)*dt,k*dt],[g0,g],'-r');
    axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
    pause(.001)
    y0=y;g0=g;h0=h;f0=f;
end
```

- Code program matlab Gambar 4.20

```
clc
close all
clear all
dl=3;
alpa=1;
n=50;
dt=dl/n;
xdl=linspace(-dl,0,n+1);
ydl=.4+xdl-xdl;
hdl=ydl;fdl=ydl;
plot(xdl,ydl,'k');
y0=ydl(n+1);g0=y0;h0=y0;f0=y0;
for k=1:20000;
    hold on
    y=y0*(1+alpa*dt)-alpa*dt*y0*ydl(k);
    h=h0+alpa*hdl(k)*dt*(1-h0);
    g=g0*(1+alpa*dt)-alpa*dt*g0^2;
    f=f0+alpa*fdl(k)*dt*(1-fdl(k));
    ydl(n+k+1)=y;hdl(n+k+1)=h;fdl(n+k+1)=f;
    line([0  0],[-0.1 2],'Color','k')
    plot([(k-1)*dt,1.1*dt*k],[1,1],'-g');
    plot([(k-1)*dt,1.1*dt*k],[0,0],'-k');
```

```
plot([(k-1)*dt,k*dt],[y0,y],'-k');
plot([(k-1)*dt,k*dt],[g0,g],'-r');
 axis([-dl 1.02*dt*k+.01 -0.1 max(ydl)+.1])
pause(.001)
y0=y;g0=g;h0=h;f0=f;
end
```