現代控制理論HW1

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1.題目

設計出自己的linear state equation，x\_dot = Ax。利用不同的 A，產生五種type的state portrait，針對每種type，必須畫出所有初始值 X0 = [cosθ, sinθ]^T   
(only for node, saddle point and star)

2. 執行結果截圖

Phase Portrait的部分都畫出8種初始值 X0 = [cosθ, sinθ]^1000，θ分別為：

0,π/4, π/2, 3π/4, π, 5π/4, 3π/2, 7π/4。

|  |  |
| --- | --- |
| star | A=[] |
| Time Series | time_star.jpg |
| Phase Portrait | E_star.jpg |
| 備註 |  |

|  |  |
| --- | --- |
| node | A=[] |
| Time Series | time_node.jpg |
| Phase Portrait | E_node.jpg |
| 備註 |  |

|  |  |
| --- | --- |
| saddle | A=[] |
| Time Series | time_saddle.jpg |
| Phase Portrait | E_saddle.jpg |
| 備註 | 畫Phase Portrait的時候只疊代100次，否則衰減的那個變數相對於遞增的那個幾乎看不出變化。 |

|  |  |
| --- | --- |
| center | A=[] |
| Time Series | time_center.jpg |
| Phase Portrait | E_center.jpg |
| 備註 |  |

|  |  |
| --- | --- |
| focus | A=[] |
| Time Series | time_focus.jpg |
| Phase Portrait | E_focus.jpg |
| 備註 |  |

3.程式碼

(1)函式 使用Euler Method近似：

function xNew=Euler(x,delta,A)

xDot=[0 0]';

xNew=xDot;

xDot(1)=A(1,1)\*x(1)+A(1,2)\*x(2);

xDot(2)=A(2,1)\*x(1)+A(2,2)\*x(2);

% fprintf('xDot=%f %f\n', xDot(1),xDot(1));

xNew(1)=x(1)+xDot(1)\*delta;

xNew(2)=x(2)+xDot(2)\*delta;

% fprintf('xNew=%f %f\n', xNew(1),xNew(1));

return;

(2)函式 使用Runge Kutta Method近似：

function xNew=RungeKutta(x\_0,delta,A)

k1=[0 0]';k2=k1;k3=k1;k4=k1;tmp=k1;xNew=k1;

k1(1)=A(1,1)\*x\_0(1)+A(1,2)\*x\_0(2);

k1(2)=A(2,1)\*x\_0(1)+A(2,2)\*x\_0(2);

tmp(1)=x\_0(1)+k1(1)\*(delta/2);

tmp(2)=x\_0(2)+k1(2)\*(delta/2);

k2(1)=A(1,1)\*tmp(1)+A(1,2)\*tmp(2);

k2(2)=A(2,1)\*tmp(1)+A(2,2)\*tmp(2);

tmp(1)=x\_0(1)+k2(1)\*(delta/2);

tmp(2)=x\_0(2)+k2(2)\*(delta/2);

k3(1)=A(1,1)\*tmp(1)+A(1,2)\*tmp(2);

k3(2)=A(2,1)\*tmp(1)+A(2,2)\*tmp(2);

tmp(1)=x\_0(1)+k3(1)\*(delta);

tmp(2)=x\_0(2)+k3(2)\*(delta);

k4(1)=A(1,1)\*tmp(1)+A(1,2)\*tmp(2);

k4(2)=A(2,1)\*tmp(1)+A(2,2)\*tmp(2);

xNew(1)=x\_0(1)+delta\*(k1(1)+2\*k2(1)+2\*k3(1)+k4(1))/6;

xNew(2)=x\_0(2)+delta\*(k1(2)+2\*k2(2)+2\*k3(2)+k4(2))/6;

return;

(3)畫Phase Portrait

clear;clc;

% A=[-2 0;0 -2];%star

% A=[-2 0;0 -3];%node

A=[-2 0;0 3];%saddle

% A=[0 2;-2 0];%center

% A=[-2 1;-1 -2]%focus

num=8;theta=0; %total of the different kind of initial condition

datasize=100;

for j=1:8

theta=j\*(2\*pi/num);

x1array(1)=real(datasize\*exp(1i\*theta));

x2array(1)=imag(datasize\*exp(1i\*theta));

for i=1:(datasize-1)

x(1)=x1array(i); x(2)=x2array(i);

xNext=RungeKutta(x,0.01,A);

x1array(i+1)=xNext(1);

x2array(i+1)=xNext(2);

end

xlabel('x(1)');

ylabel('x(2)');

plot(x1array,x2array);

hold on;

end

(4)畫Time Series

clear;clc;

% A=[-2 0;0 -2];%star

% A=[-2 0;0 -3];%node

% A=[-2 0;0 3];%saddle

% A=[0 2;-2 0];%center

A=[-2 1;-1 -2]%focus

datasize=1000;

x1array(1)=1000;

x2array(1)=1000;

for i=1:(datasize-1)

x(1)=x1array(i); x(2)=x2array(i);

xNext=RungeKutta(x,0.01,A);

x1array(i+1)=xNext(1);

x2array(i+1)=xNext(2);

end

plot(x1array,'r');

hold on;

plot(x2array,'b');

legend('x1','x2');

title({'time series';'A=[-2 1;-1 -2] x\_0=[1000 1000]'});