Matiab 求解微分方程作业

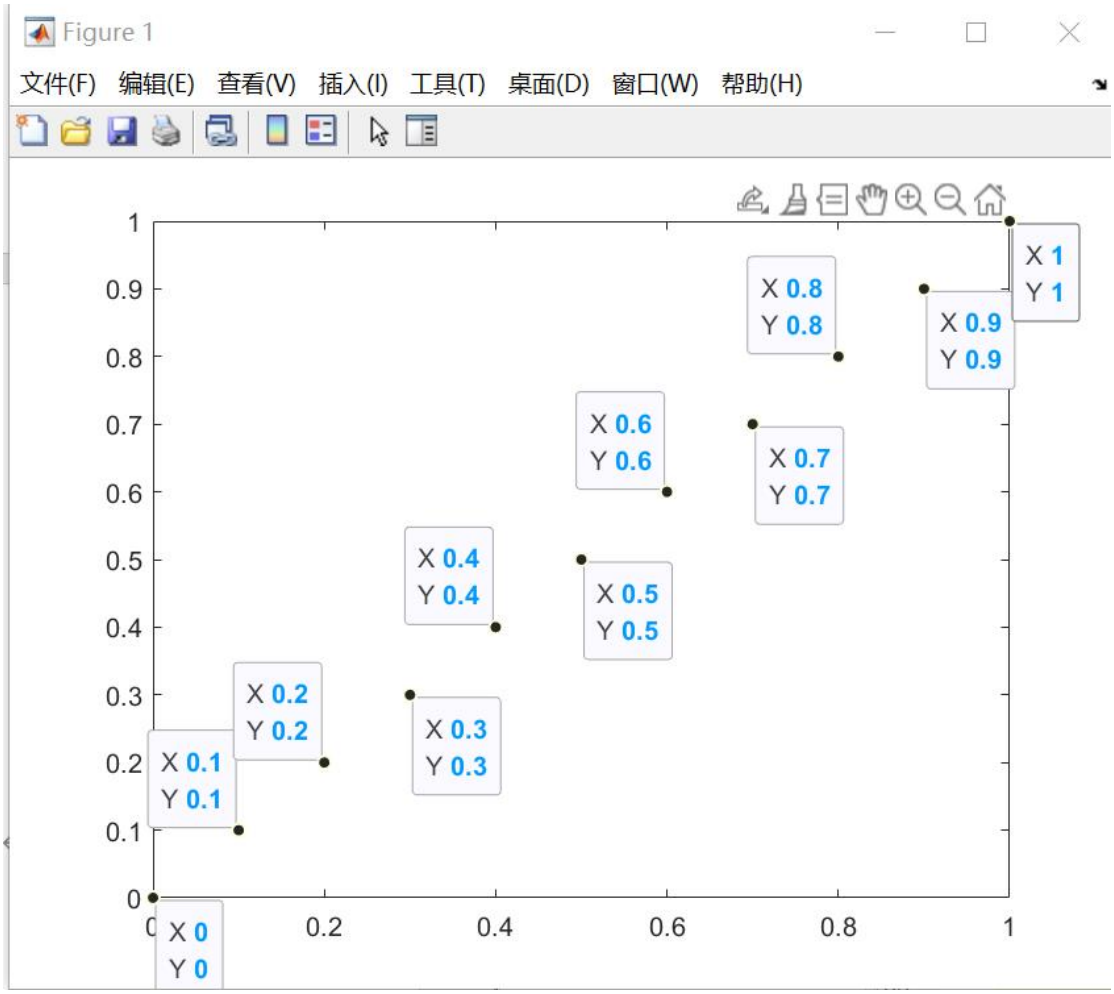
贾博方
222021321132005

Using the Runge-Kutta method

1. $dy/dt = 1 + t - y, \quad y(0) = 0; \quad (y(t) = t)$

```
clc,clear
set(0,'defaultfigurecolor','w')
x0 = 0;
xn = 1;
y0 = 0;
h = 0.1;
[x,y] = RungeKutta4(x0, xn, y0, h);
plot(x,y,'r.')
hold on

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;
for i = 1:n
   x(i+1) = x(i)+h;
```

```
    K1 = fun(x(i), y(i));
    K2 = fun(x(i)+h/2, y(i)+K1*h/2);
    K3 = fun(x(i)+h/2, y(i)+K2*h/2);
    K4 = fun(x(i)+h, y(i)+K3*h);
    y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
f = 1+x-y;
end
```



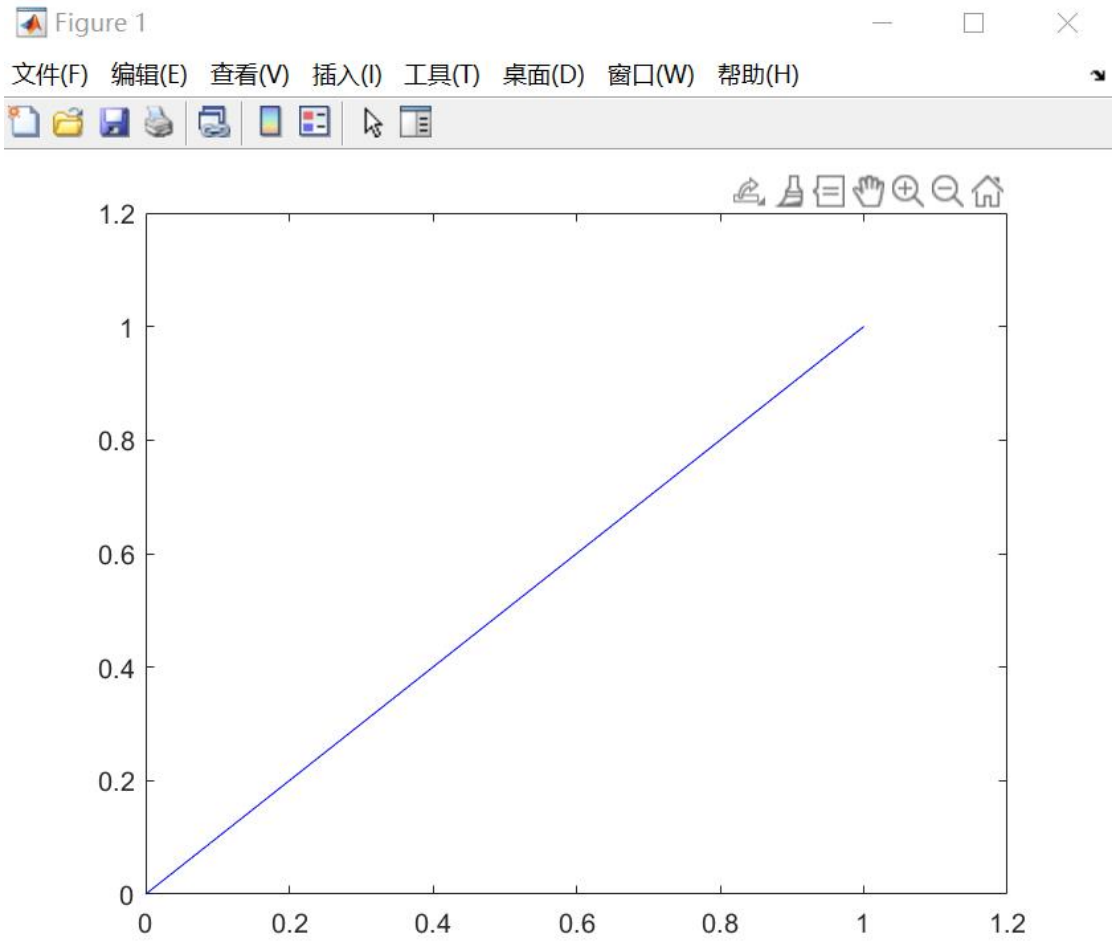

```
clc,clear

set(0,'defaultfigurecolor','w')

x0 = 0;

xn = 1;

y0 = 0;

m0 = 0;

mn = 1;

q0 = 0;

h = 0.1;

p = 0.025;
```

```
[x,y] = RungeKutta4(x0, xn, y0, h);

plot(x,y,'r')
hold on;
[m,q] = RungeKutta(m0, mn, q0, p);

plot(m,q,'b')
hold on;

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;

for i = 1:n
   x(i+1) = x(i)+h;
   K1 = gun(x(i), y(i));
   K2 = gun(x(i)+h/2, y(i)+K1*h/2);
   K3 = gun(x(i)+h/2, y(i)+K2*h/2);
   K4 = gun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
```

```
end

function [m,q] = RungeKutta(m0, mn, q0, p)
k = (mn-m0)/p;
m = zeros(k+1,1);
q = zeros(k+1,1);
m(1) = m0;
q(1) = q0;
for j = 1:k
   m(j+1) = m(j)+p;
   K1 = gun(m(j), q(j));
   K2 = gun(m(j)+p/2, q(j)+K1*p/2);
   K3 = gun(m(j)+p/2, q(j)+K2*p/2);
   K4 = gun(m(j)+p, q(j)+K3*p);
   q(j+1) = q(j)+p/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
f = 1+x-y;
end

function g = gun(m,q)
g = 1+m-q;
```

```
end
```

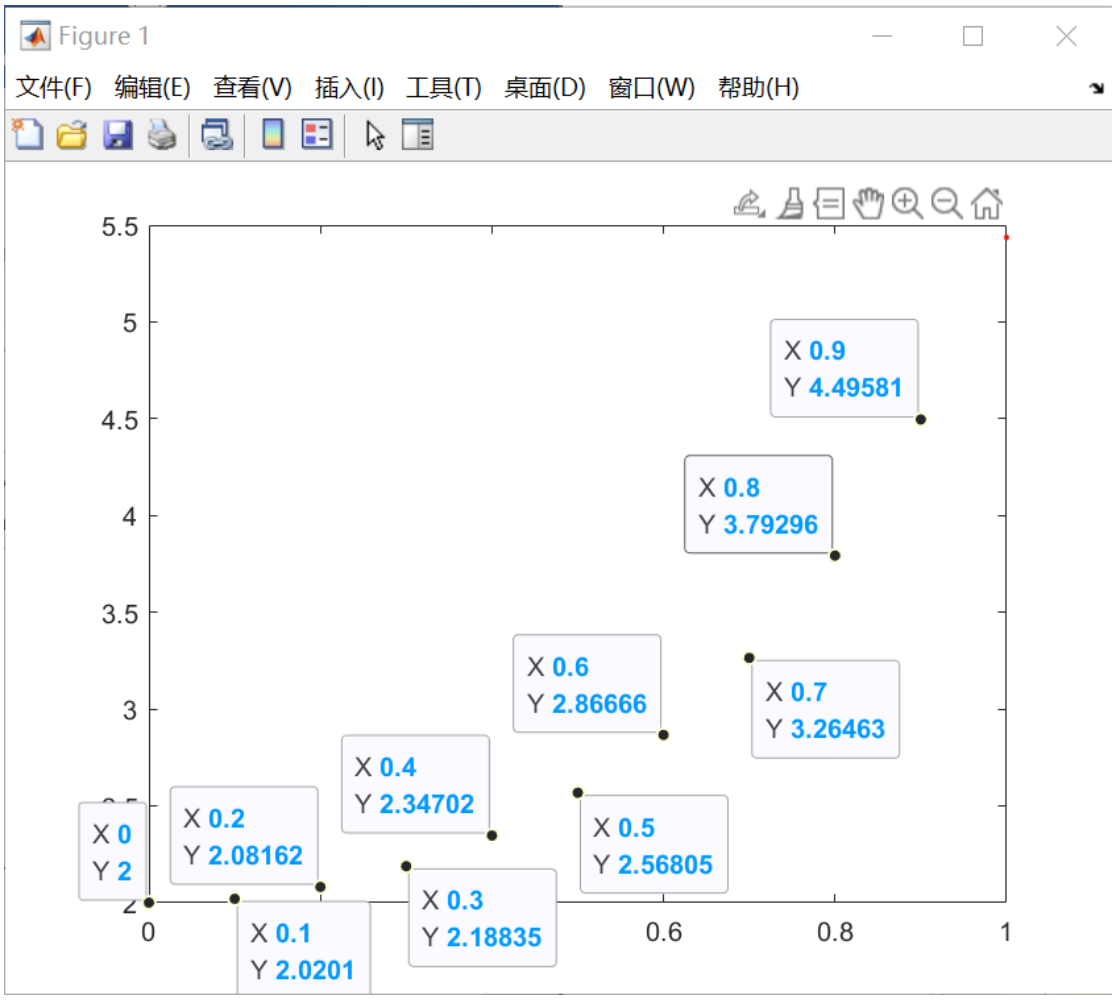
曲线重合



2. $dy/dt=2ty,\quad y(0)=2;\quad (y(t)=2e^{t^2})$

```
clc,clear

set(0,'defaultfigurecolor','w')

x0 = 0;

xn = 1;

y0 = 2;

h = 0.1;
```

```
[x,y] = RungeKutta4(x0, xn, y0, h);
plot(x,y,'r.')
hold on

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;
for i = 1:n
   x(i+1) = x(i)+h;
   K1 = fun(x(i), y(i));
   K2 = fun(x(i)+h/2, y(i)+K1*h/2);
   K3 = fun(x(i)+h/2, y(i)+K2*h/2);
   K4 = fun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
f = 2*x*y;
end
```

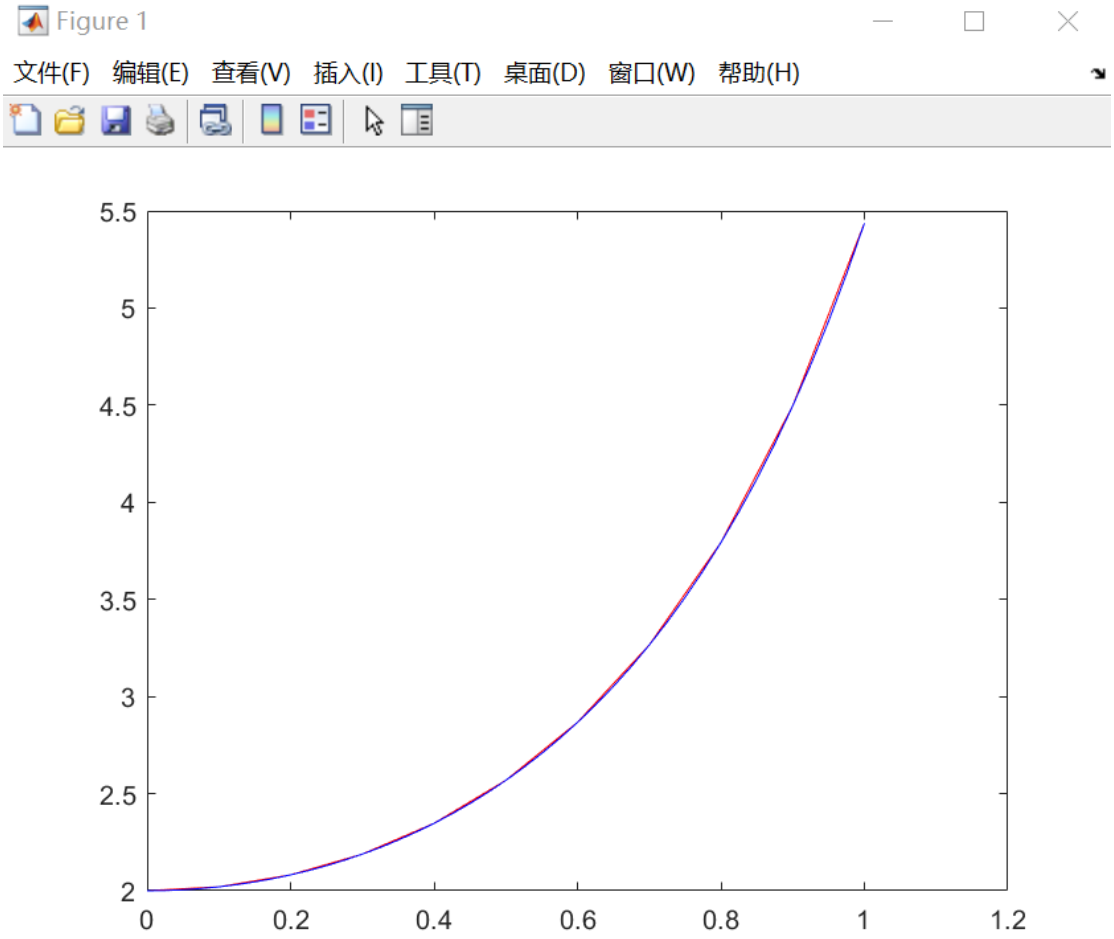



```
clc,clear

set(0,'defaultfigurecolor','w')

x0 = 0;

xn = 1;

y0 = 2;

m0 = 0;

mn = 1;

q0 = 2;

h = 0.1;
```

```
p = 0.025;
[x,y] = RungeKutta4(x0, xn, y0, h);

plot(x,y,'r')
hold on;
[m,q] = RungeKutta(m0, mn, q0, p);

plot(m,q,'b')
hold on;

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;

for i = 1:n
   x(i+1) = x(i)+h;
   K1 = gun(x(i), y(i));
   K2 = gun(x(i)+h/2, y(i)+K1*h/2);
   K3 = gun(x(i)+h/2, y(i)+K2*h/2);
   K4 = gun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
```

```
end
end

function [m,q] = RungeKutta(m0, mn, q0, p)
k = (mn-m0)/p;
m = zeros(k+1,1);
q = zeros(k+1,1);
m(1) = m0;
q(1) = q0;
for j = 1:k
   m(j+1) = m(j)+p;
   K1 = gun(m(j), q(j));
   K2 = gun(m(j)+p/2, q(j)+K1*p/2);
   K3 = gun(m(j)+p/2, q(j)+K2*p/2);
   K4 = gun(m(j)+p, q(j)+K3*p);
   q(j+1) = q(j)+p/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
f = 2*x*y;
end

function g = gun(m,q)
```

```
g = 2*m*q;
end
```

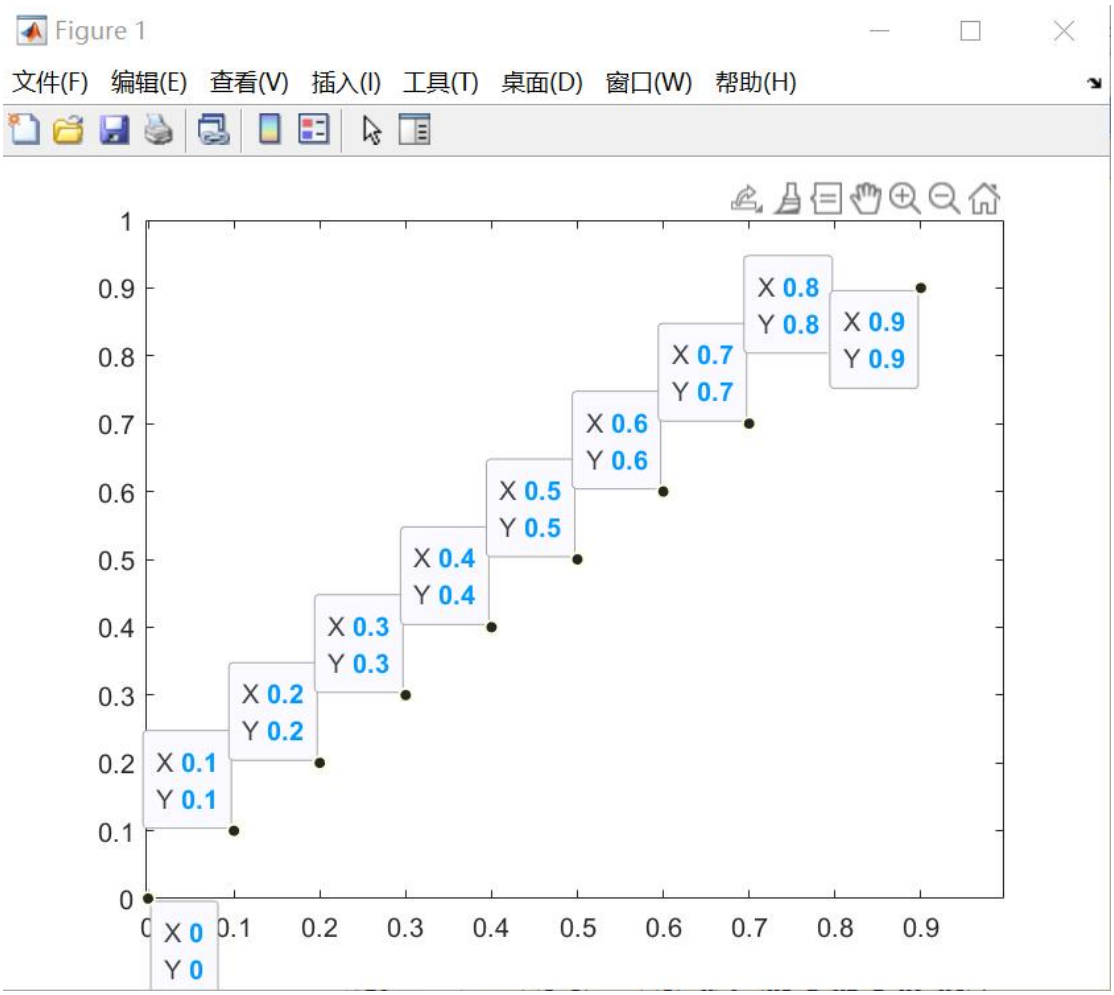


3. $dy/dt = 1 + y^2 - t^2, \quad y(0) = 0; \quad (y(t) = t)$

```
clc,clear
set(0,'defaultfigurecolor','w')
x0 = 0;
xn = 1;
y0 = 0;
```

```
h = 0.1;
[x,y] = RungeKutta4(x0, xn, y0, h);
plot(x,y,'r.')
hold on

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;
for i = 1:n
   x(i+1) = x(i)+h;
   K1 = fun(x(i), y(i));
   K2 = fun(x(i)+h/2, y(i)+K1*h/2);
   K3 = fun(x(i)+h/2, y(i)+K2*h/2);
   K4 = fun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
f = 1+y^2-x^2;
```

```
end
```



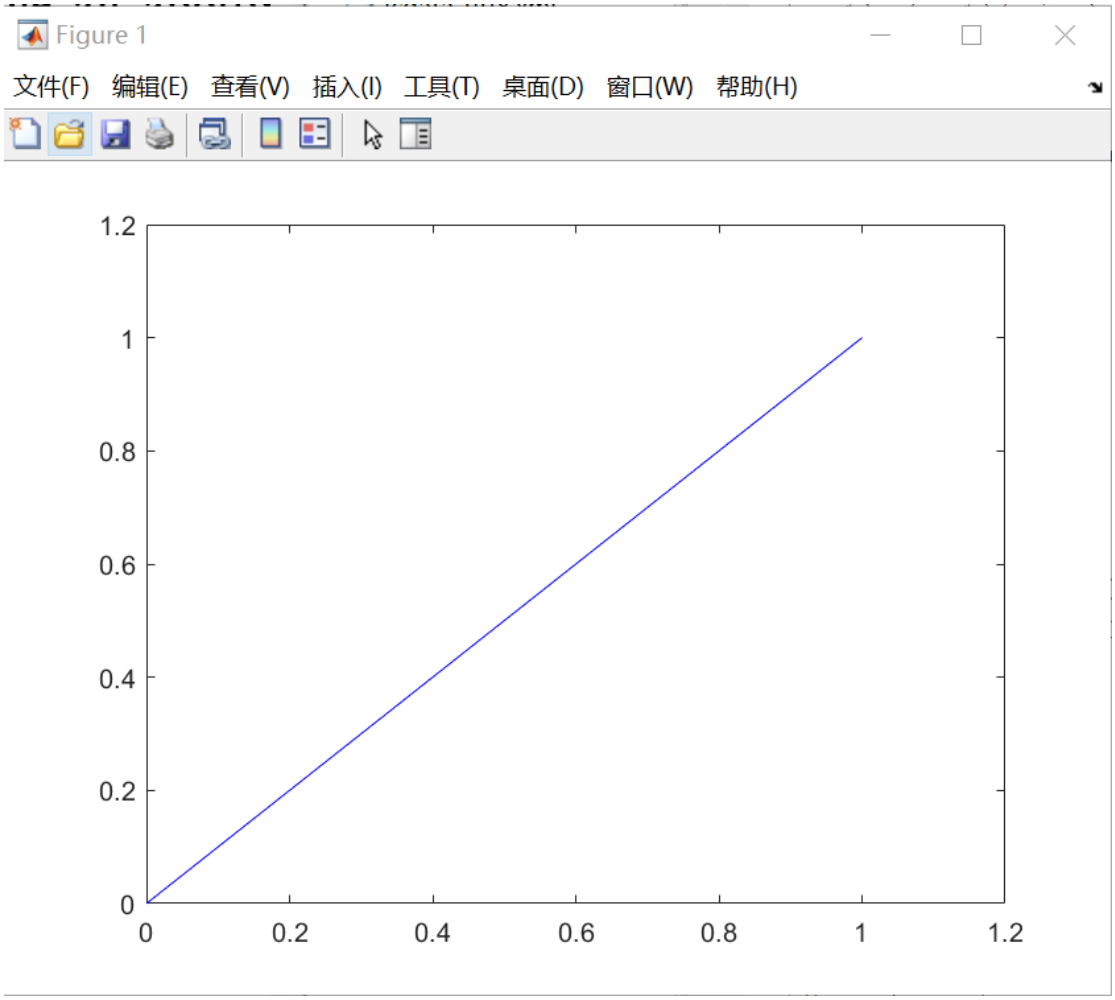

```
clc,clear
set(0,'defaultfigurecolor','w')
x0 = 0;
xn = 1;
y0 = 0;
m0 = 0;
mn = 1;
q0 = 0;
```

```
h = 0.1;
p = 0.025;
[x,y] = RungeKutta4(x0, xn, y0, h);

plot(x,y,'r')
hold on;
[m,q] = RungeKutta(m0, mn, q0, p);

plot(m,q,'b')
hold on;

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;


for i = 1:n
   x(i+1) = x(i)+h;
   K1 = gun(x(i), y(i));
   K2 = gun(x(i)+h/2, y(i)+K1*h/2);
   K3 = gun(x(i)+h/2, y(i)+K2*h/2);
   K4 = gun(x(i)+h, y(i)+K3*h);
```

```
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
end

function [m,q] = RungeKutta(m0, mn, q0, p)
k = (mn-m0)/p;
m = zeros(k+1,1);
q = zeros(k+1,1);
m(1) = m0;
q(1) = q0;
for j = 1:k
   m(j+1) = m(j)+p;
   K1 = gun(m(j), q(j));
   K2 = gun(m(j)+p/2, q(j)+K1*p/2);
   K3 = gun(m(j)+p/2, q(j)+K2*p/2);
   K4 = gun(m(j)+p, q(j)+K3*p);
   q(j+1) = q(j)+p/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
f = 1+y^2-x^2;
end
```

```
function g = gun(m,q)
g = 1+q^2-m^2;
end
```

曲线重合

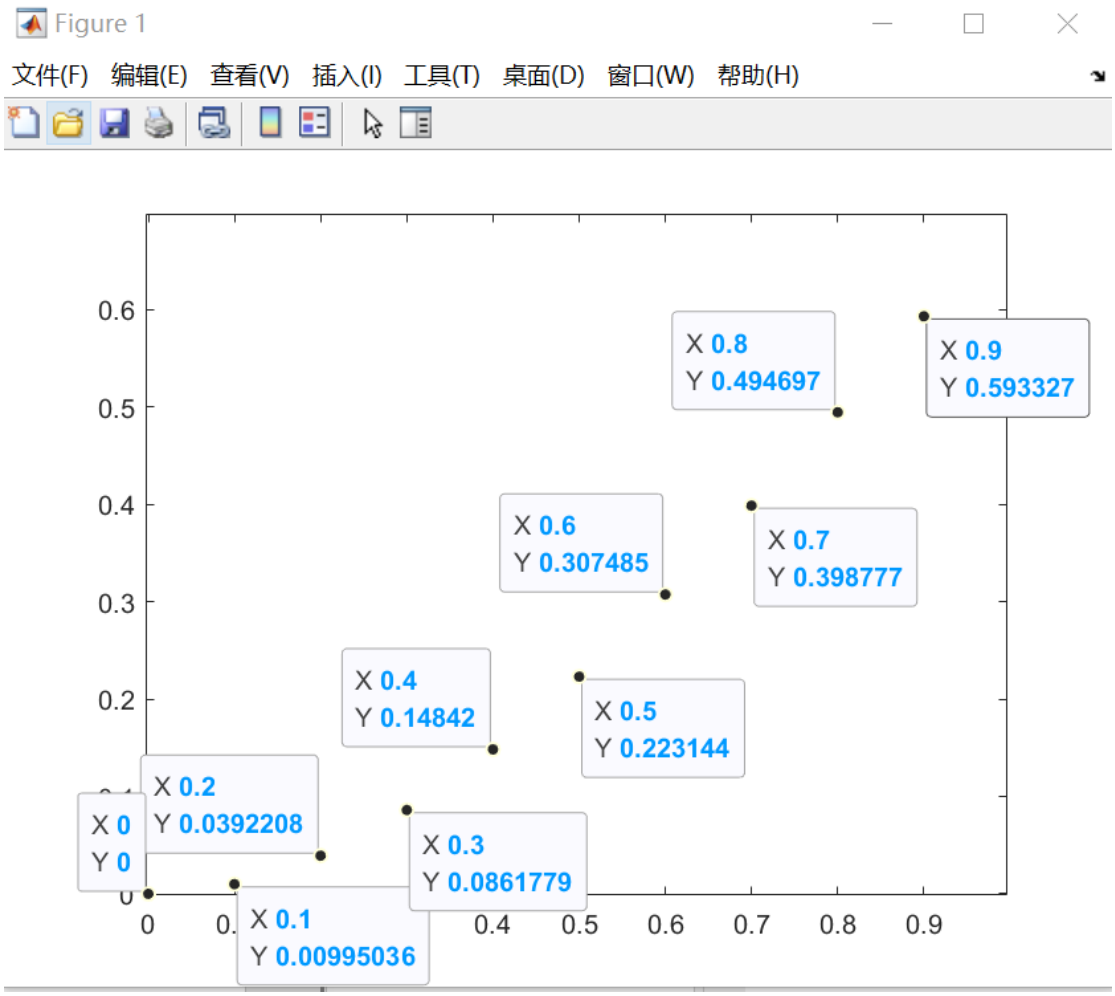


4. $dy/dt = te^{-y} + t/(1+t^2), \quad y(0)=0; \quad (y(t)=\ln(1+t^2))$

```
clc,clear
set(0,'defaultfigurecolor','w')
x0 = 0;
```

```
xn = 1;
y0 = 0;
h = 0.1;
[x,y] = RungeKutta4(x0, xn, y0, h);
plot(x,y,'r.')
hold on

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;
for i = 1:n
   x(i+1) = x(i)+h;
   K1 = fun(x(i), y(i));
   K2 = fun(x(i)+h/2, y(i)+K1*h/2);
   K3 = fun(x(i)+h/2, y(i)+K2*h/2);
   K4 = fun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
end
```

```
function f = fun(x,y)
f = x*exp(-y)+x/(1+x^2);
end
```

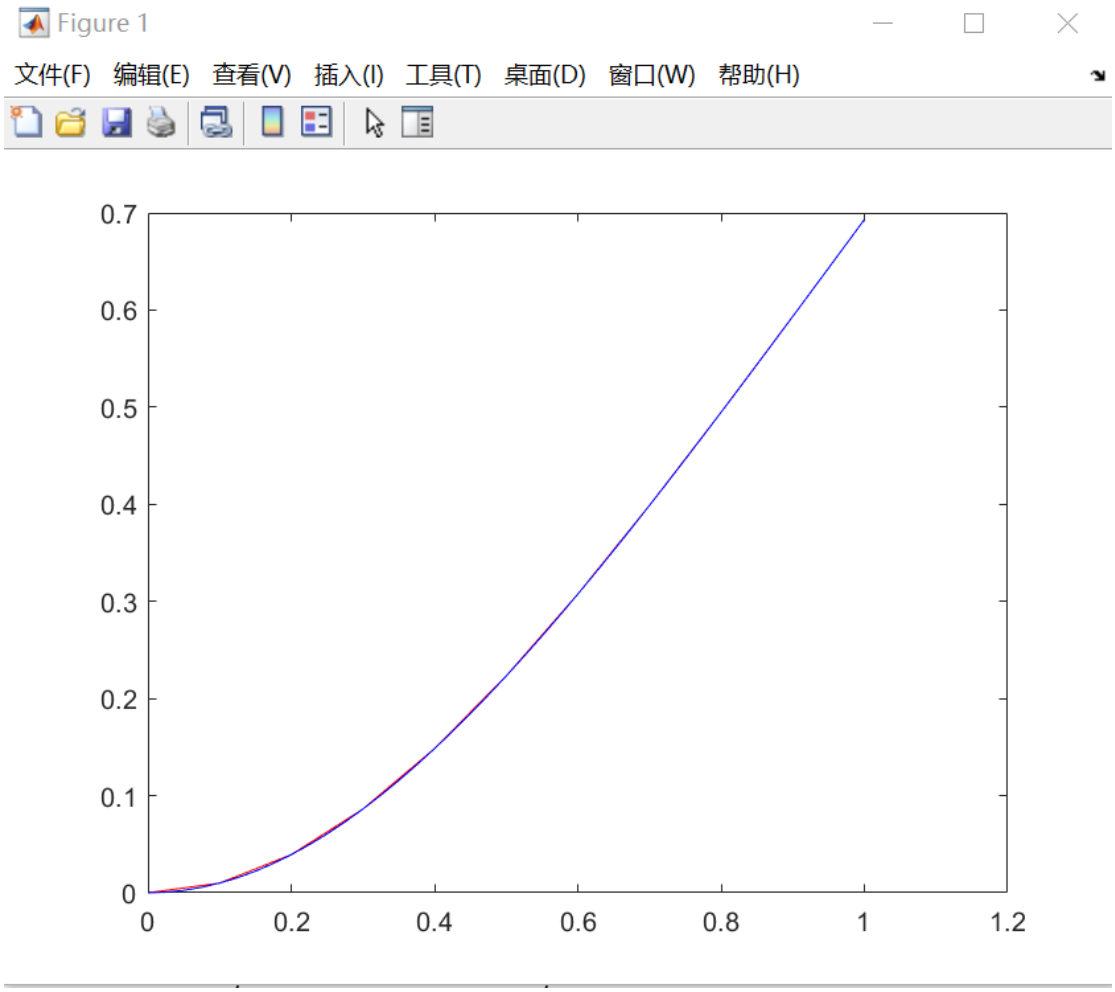



```
clc,clear
set(0,'defaultfigurecolor','w')
x0 = 0;
xn = 1;
y0 = 0;
m0 = 0;
```

```
mn = 1;
q0 = 0;
h = 0.1;
p = 0.025;
[x,y] = RungeKutta4(x0, xn, y0, h);

plot(x,y,'r')
hold on;
[m,q] = RungeKutta(m0, mn, q0, p);

plot(m,q,'b')
hold on;

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;

for i = 1:n
   x(i+1) = x(i)+h;
   K1 = gun(x(i), y(i));
   K2 = gun(x(i)+h/2, y(i)+K1*h/2);
```

```
   K3 = gun(x(i)+h/2, y(i)+K2*h/2);
   K4 = gun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
end

function [m,q] = RungeKutta(m0, mn, q0, p)
k = (mn-m0)/p;
m = zeros(k+1,1);
q = zeros(k+1,1);
m(1) = m0;
q(1) = q0;
for j = 1:k
   m(j+1) = m(j)+p;
   K1 = gun(m(j), q(j));
   K2 = gun(m(j)+p/2, q(j)+K1*p/2);
   K3 = gun(m(j)+p/2, q(j)+K2*p/2);
   K4 = gun(m(j)+p, q(j)+K3*p);
   q(j+1) = q(j)+p/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
```

```
f = x*exp(-y)+x/(1+x^2);
end

function g = gun(m,q)
g = m*exp(-q)+m/(1+m^2);
end
```

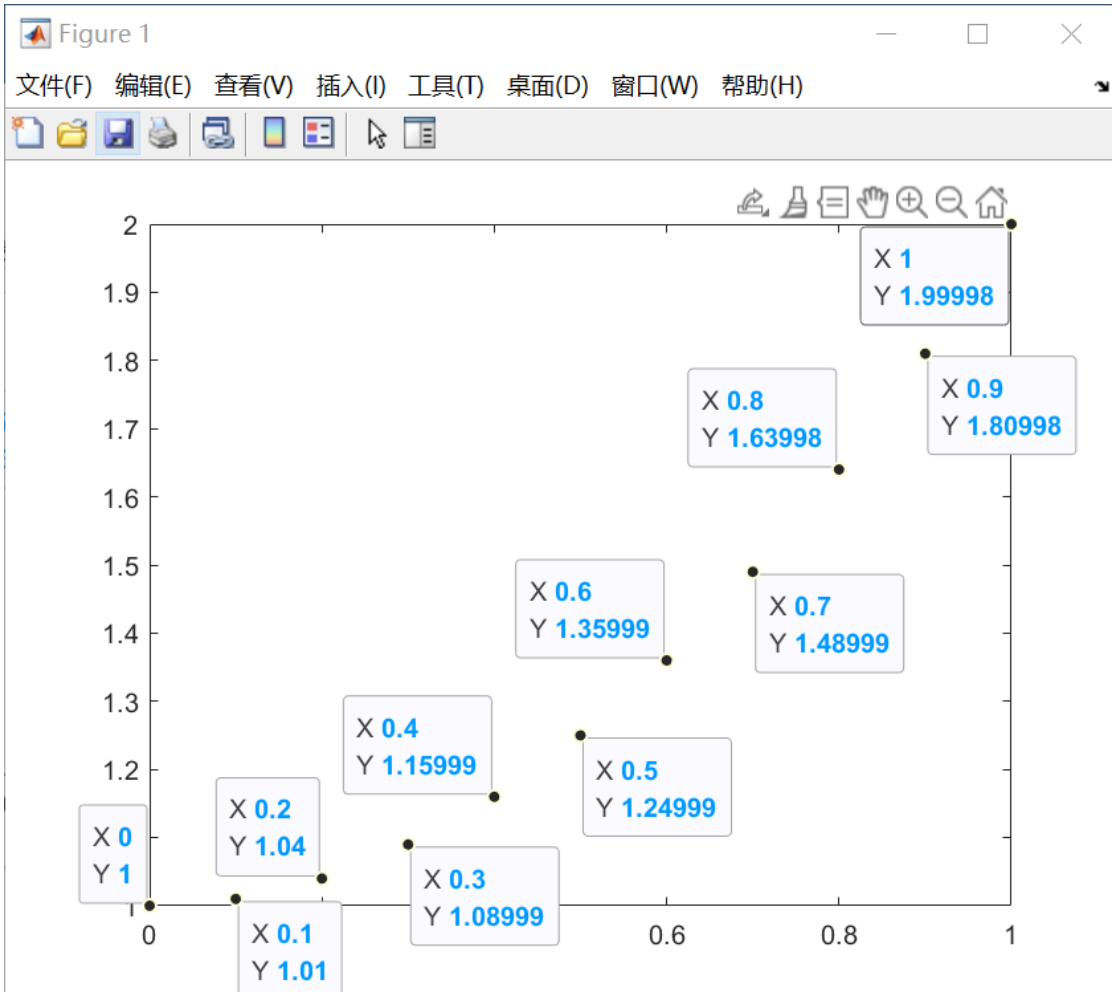


5. $dy/dt = -1+2t+y^2/((1+t^2)^2),\quad y(0)=1;\quad (y(t)=1+t^2)$

```
clc,clear
set(0,'defaultfigurecolor','w')
```

```
x0 = 0;
xn = 1;
y0 = 1;
h = 0.1;
[x,y] = RungeKutta4(x0, xn, y0, h);
plot(x,y,'r.')
hold on

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;
for i = 1:n
   x(i+1) = x(i)+h;
   K1 = fun(x(i), y(i));
   K2 = fun(x(i)+h/2, y(i)+K1*h/2);
   K3 = fun(x(i)+h/2, y(i)+K2*h/2);
   K4 = fun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
```

```
end

function f = fun(x,y)

f = -1+2*x+y^2/((1+x^2)^2);

end
```




```
clc,clear

set(0,'defaultfigurecolor','w')

x0 = 0;

xn = 1;

y0 = 1;

m0 = 0;
```

```
mn = 1;
q0 = 1;
h = 0.1;
p = 0.025;
[x,y] = RungeKutta4(x0, xn, y0, h);

plot(x,y,'r')
hold on;
[m,q] = RungeKutta(m0, mn, q0, p);

plot(m,q,'b')
hold on;

function [x,y] = RungeKutta4(x0, xn, y0, h)
n = (xn-x0)/h;
x = zeros(n+1,1);
y = zeros(n+1,1);
x(1) = x0;
y(1) = y0;

for i = 1:n
   x(i+1) = x(i)+h;
   K1 = gun(x(i), y(i));
   K2 = gun(x(i)+h/2, y(i)+K1*h/2);
```

```
   K3 = gun(x(i)+h/2, y(i)+K2*h/2);
   K4 = gun(x(i)+h, y(i)+K3*h);
   y(i+1) = y(i)+h/6*(K1+2*K2+2*K3+K4);
end
end

function [m,q] = RungeKutta(m0, mn, q0, p)
k = (mn-m0)/p;
m = zeros(k+1,1);
q = zeros(k+1,1);
m(1) = m0;
q(1) = q0;
for j = 1:k
   m(j+1) = m(j)+p;
   K1 = gun(m(j), q(j));
   K2 = gun(m(j)+p/2, q(j)+K1*p/2);
   K3 = gun(m(j)+p/2, q(j)+K2*p/2);
   K4 = gun(m(j)+p, q(j)+K3*p);
   q(j+1) = q(j)+p/6*(K1+2*K2+2*K3+K4);
end
end

function f = fun(x,y)
```

```
f = -1+2*x+y^2/((1+x^2)^2);
end

function g = gun(m,q)
g = -1+2*m+q^2/((1+m^2)^2);
end
```