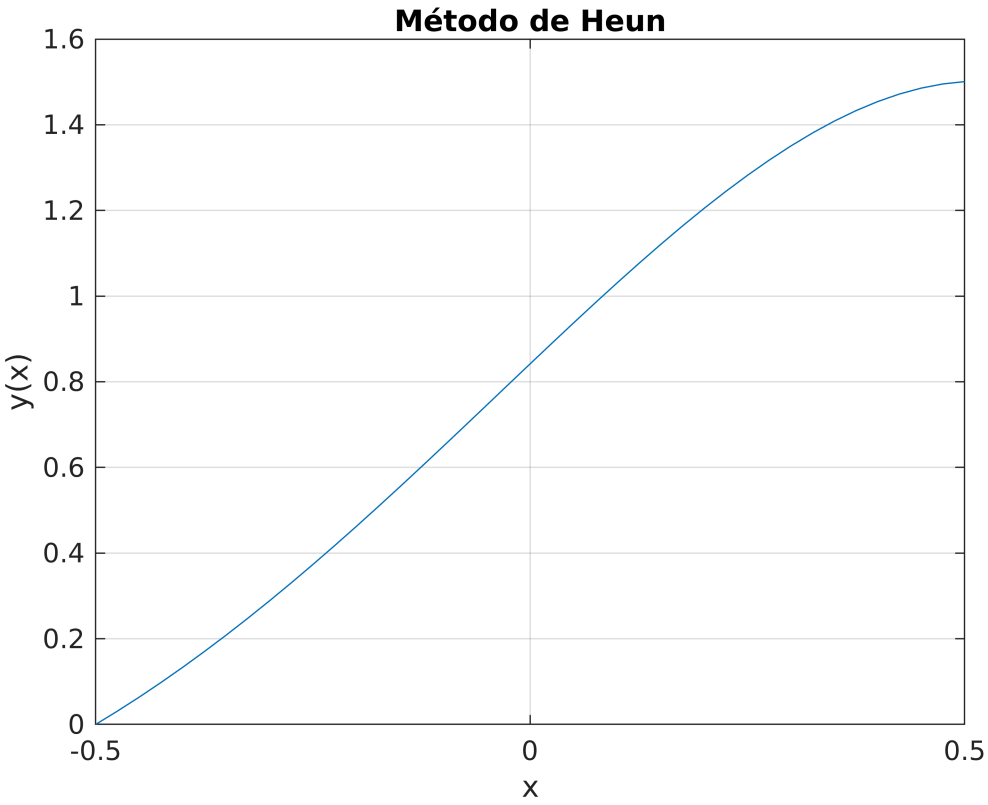
Ejercicio 1

HEUN

```
[x,y_p1, y_filter] = heun_vec('pvi1', -1/2, 1/2, 40, [0, 2*exp(-1/2)], [-1/2, -1/4, -1/
```

```
x = 41×1
   -0.5000
   -0.4750
   -0.4500
   -0.4250
   -0.4000
   -0.3750
   -0.3500
   -0.3250
   -0.3000
   -0.2750
      ⋮
y_p1 = 41×2
         0    1.2131
    0.0311    1.2733
    0.0637    1.3326
    0.0977    1.3907
    0.1332    1.4473
    0.1701    1.5021
    0.2083    1.5549
    0.2478    1.6055
    0.2886    1.6535
    0.3305    1.6987
      ⋮
y_filter = 7×2
         0    1.2131
    0.3735    1.7408
    0.6018    1.8937
    0.8420    1.9231
    1.0761    1.7910
    1.2819    1.4634
         0         0
```

```
plot(x,y_p1(:,1))
title("Método de Heun")
xlabel("x")
%legend("y(t)", "y_2(t)")
ylabel("y(x)")
grid on
```




```
y_filter
```

```
y_filter = 7×2
         0    1.2131
    0.3735    1.7408
    0.6018    1.8937
    0.8420    1.9231
    1.0761    1.7910
    1.2819    1.4634
         0         0
```

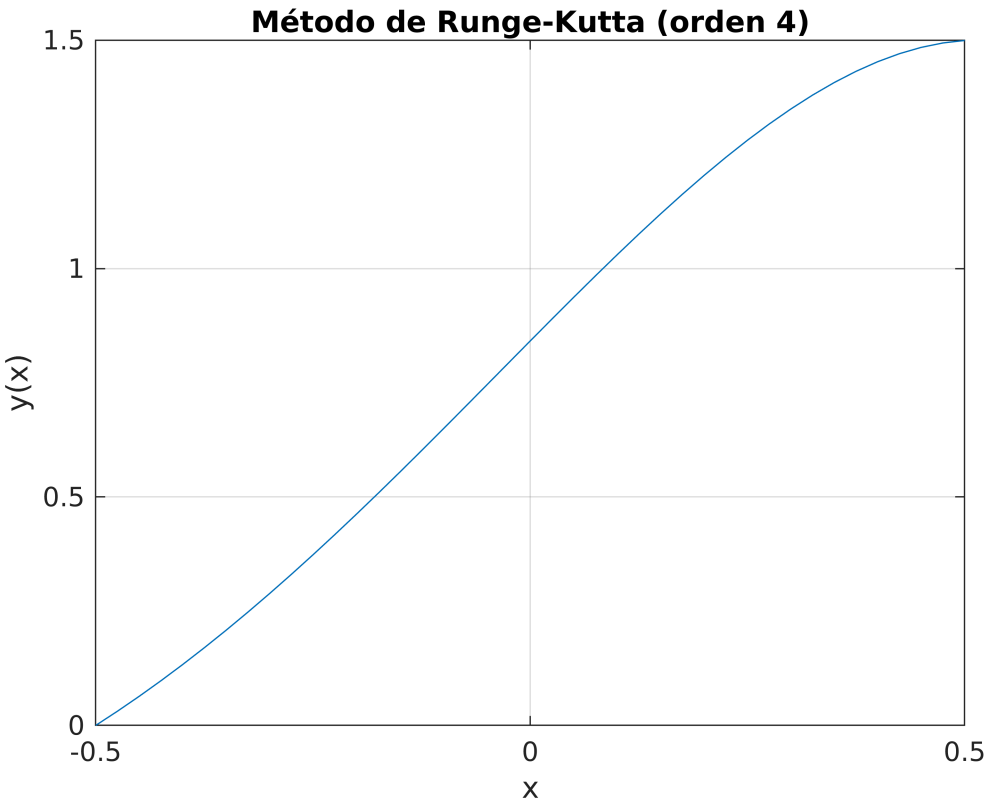
Runge-Kutta (orden 4)

```
[x, y_p2] = runge_kutta('pvi1', -1/2, 1/2, 40, [0, 2*exp(-1/2)])
```

```
x = 41×1
   -0.5000
   -0.4750
   -0.4500
   -0.4250
   -0.4000
   -0.3750
   -0.3500
   -0.3250
   -0.3000
   -0.2750
      ⋮
y_p2 = 41×2
         0    1.2131
```

```
    0.0311    1.2733
    0.0637    1.3325
    0.0977    1.3906
    0.1332    1.4471
    0.1700    1.5019
    0.2082    1.5547
    0.2478    1.6052
    0.2885    1.6532
    0.3304    1.6983
     ⋮
```

```
plot(x,y_p2(:,1))
title("Método de Runge-Kutta (orden 4)")
xlabel("x")
%legend("y(t)", "y_2(t)")
ylabel("y(x)")
grid on
```




```
x =-0.5:1/40:0.5
```

```
x = 1×41
   -0.5000   -0.4750   -0.4500   -0.4250   -0.4000   -0.3750   -0.3500   -0.3250 ···
```

```
y = zeros(41, 3)
```

```
y = 41×3
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0
```

```
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     ⋮
```

```
y(:,1)=2*exp(x) - 2*exp(-1/2)
```

```
y = 41×3
         0         0         0
    0.0307         0         0
    0.0622         0         0
    0.0945         0         0
    0.1276         0         0
    0.1615         0         0
    0.1963         0         0
    0.2320         0         0
    0.2686         0         0
    0.3061         0         0
     ⋮
```

```
y(:,2) = y_p1(:,1)
```

```
y = 41×3
         0         0         0
    0.0307    0.0311         0
    0.0622    0.0637         0
    0.0945    0.0977         0
    0.1276    0.1332         0
    0.1615    0.1701         0
    0.1963    0.2083         0
    0.2320    0.2478         0
    0.2686    0.2886         0
    0.3061    0.3305         0
     ⋮
```

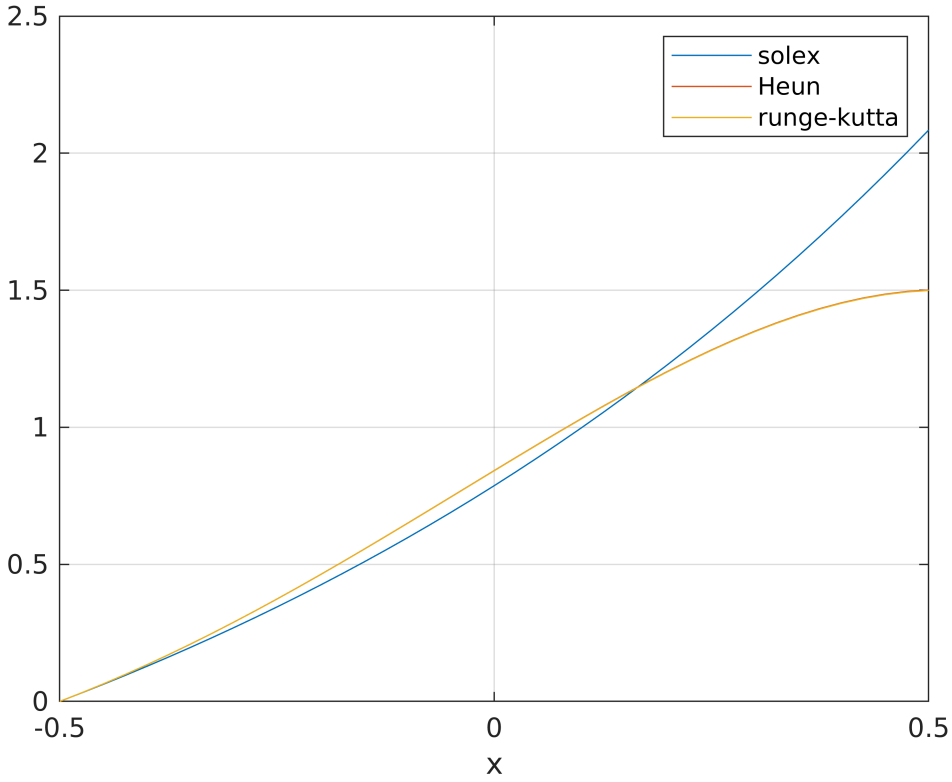
```
y(:,3) = y_p2(:,1)
```

```
y = 41×3
         0         0         0
    0.0307    0.0311    0.0311
    0.0622    0.0637    0.0637
    0.0945    0.0977    0.0977
    0.1276    0.1332    0.1332
    0.1615    0.1701    0.1700
    0.1963    0.2083    0.2082
    0.2320    0.2478    0.2478
    0.2686    0.2886    0.2885
    0.3061    0.3305    0.3304
     ⋮
```

```
plot(x,y)

xlabel("x")
legend("solex", "Heun", "runge-kutta")
%legend("u(t)", "v(t)")
```

```
grid on
```



Calculo del Error Heum

```
solex = 2*exp(x) - 2*exp(-1/2);

[x,y_heum, y_filter] = heun_vec('pvi1', -1/2, 1/2, 40, [0, 2*exp(-1/2)], [-1/2, -1/4, -
y_solex=2*exp(x) - 2*exp(-1/2);

error40 = max(abs(y_solex-y_heum(:,1)))
```

```
error40 = 0.5836
```

```
[x,y_heum, y_filter] = heun_vec('pvi1', -1/2, 1/2, 80, [0, 2*exp(-1/2)], [-1/2, -1/4, -
y_solex=2*exp(x) - 2*exp(-1/2);

error80 = max(abs(y_solex-y_heum(:,1)))
```

```
error80 = 0.5848
```

Orden del Error:

```
error = error40/error80
```

```
error = 0.9980
```

Calculo Error Runge-Kutta

```
solex = 2*exp(x) - 2*exp(-1/2);
```

```
[x, y_hat] = runge_kutta('pvi1', -1/2, 1/2, 40, [0, 2*exp(-1/2)]);
y_solex=2*exp(x) - 2*exp(-1/2);

error40 = max(abs(y_solex-y_hat(:,1)))
```

```
error40 = 0.5852
```

```
[x, y_hat] = runge_kutta('pvi1', -1/2, 1/2, 80, [0, 2*exp(-1/2)]);
y_solex=2*exp(x) - 2*exp(-1/2);

error80 = max(abs(y_solex-y_hat(:,1)))
```

```
error80 = 0.5852
```

Orden del error:

```
error = error40/error80
```

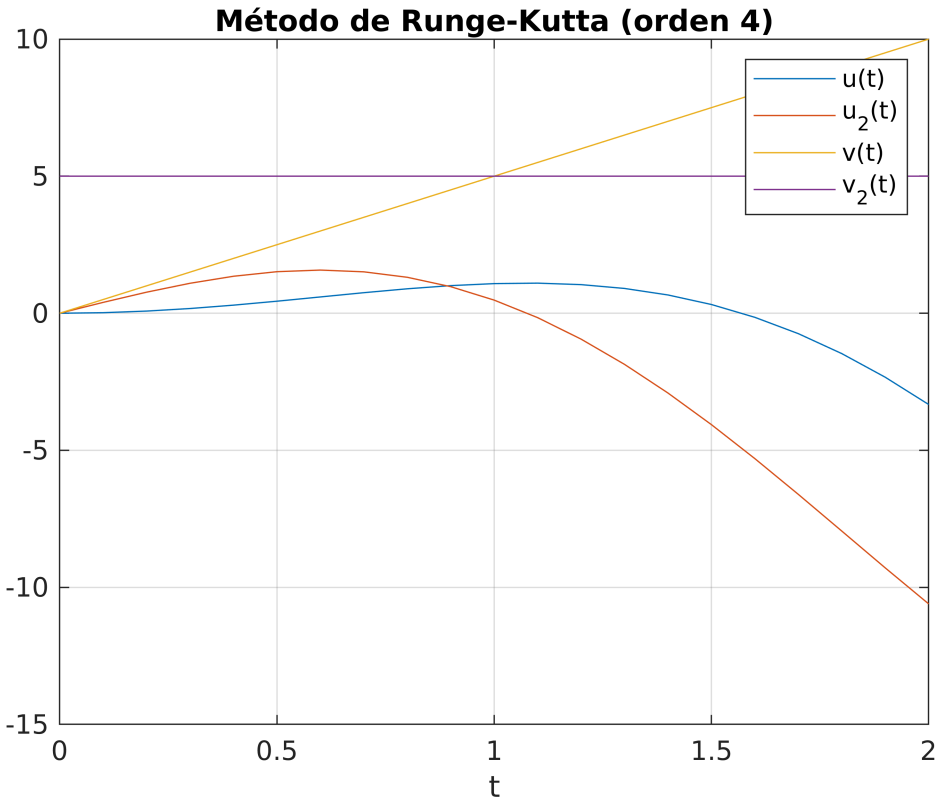
```
error = 1.0000
```

Ejercicio 2

```
[x, y] = runge_kutta('pvi2', 0, 2, 20, [0, 0, 0, 5])
```

```
x = 21×1
         0
    0.1000
    0.2000
    0.3000
    0.4000
    0.5000
    0.6000
    0.7000
    0.8000
    0.9000
     ⋮
y = 21×4
         0         0         0    5.0000
    0.0199    0.3960    0.5000    5.0000
    0.0784    0.7682    1.0000    5.0000
    0.1720    1.0932    1.5000    5.0000
    0.2947    1.3491    2.0000    5.0000
    0.4388    1.5155    2.5000    5.0000
    0.5942    1.5743    3.0000    5.0000
    0.7495    1.5102    3.5000    5.0000
    0.8918    1.3112    4.0000    5.0000
    1.0070    0.9688    4.5000    5.0000
     ⋮
```

```
plot(x,y)
title("Método de Runge-Kutta (orden 4)")
xlabel("t")
legend("u(t)", "u_2(t)", "v(t)", "v_2(t)")
%legend("u(t)", "v(t)")
grid on
```




```
[x, y] = runge_kutta('pvi2', 0, 20, 100, [0, 0, 0, 5])
```

```
x = 101×1
         0
    0.2000
    0.4000
    0.6000
    0.8000
    1.0000
    1.2000
    1.4000
    1.6000
    1.8000
     ⋮
y = 101×4
10^11 ×
         0         0         0    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000   -0.0000    0.0000    0.0000
    0.0000   -0.0000    0.0000    0.0000
   -0.0000   -0.0000    0.0000    0.0000
   -0.0000   -0.0000    0.0000    0.0000
     ⋮
```

```
y
```

```
y = 101×4
10^11 ×
         0         0         0    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000    0.0000    0.0000    0.0000
    0.0000   -0.0000    0.0000    0.0000
    0.0000   -0.0000    0.0000    0.0000
   -0.0000   -0.0000    0.0000    0.0000
   -0.0000   -0.0000    0.0000    0.0000
      ⋮
```

```
format short

%plot(x,y(:,[1,3]))
plot(x,y)
grid on
title("Método de Runge-Kutta (orden 4)")
xlabel("t")
legend("u(t)", "u_2(t)", "v(t)", "v_2(t)")
%legend("u(t)", "v(t)")
xlim([14 20])
ylim([-3000 2000])
```