

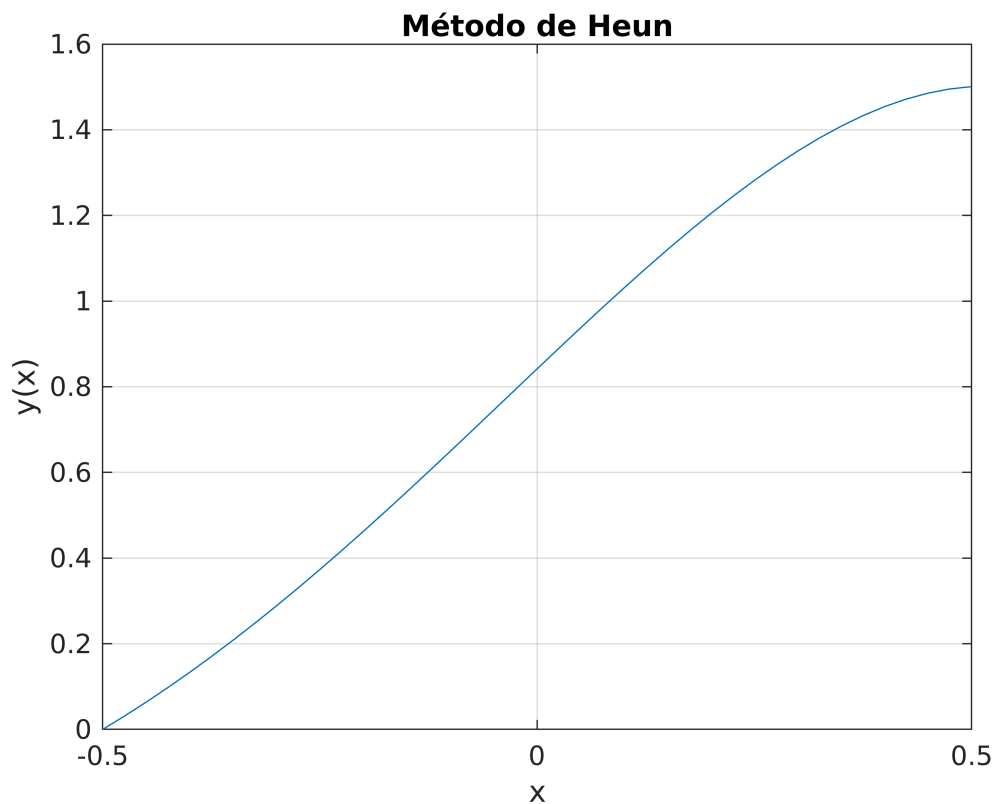
## Ejercicio 1

# HEUN

```
[x,y_p1, y_filter] = heun_vec('pv1', -1/2, 1/2, 40, [0, 2*exp(-1/2)], [-1/2, -1/4, -1,
```

```
x = 41x1
-0.5000
-0.4750
-0.4500
-0.4250
-0.4000
-0.3750
-0.3500
-0.3250
-0.3000
-0.2750
⋮
⋮
y_p1 = 41x2
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 = 7x2
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 = 7x2
  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('pvil', -1/2, 1/2, 40, [0, 2*exp(-1/2)])
```

```
x = 41x1
-0.5000
-0.4750
-0.4500
-0.4250
-0.4000
-0.3750
-0.3500
-0.3250
-0.3000
-0.2750
⋮
y_p2 = 41x2
  0      1.2131
```

```

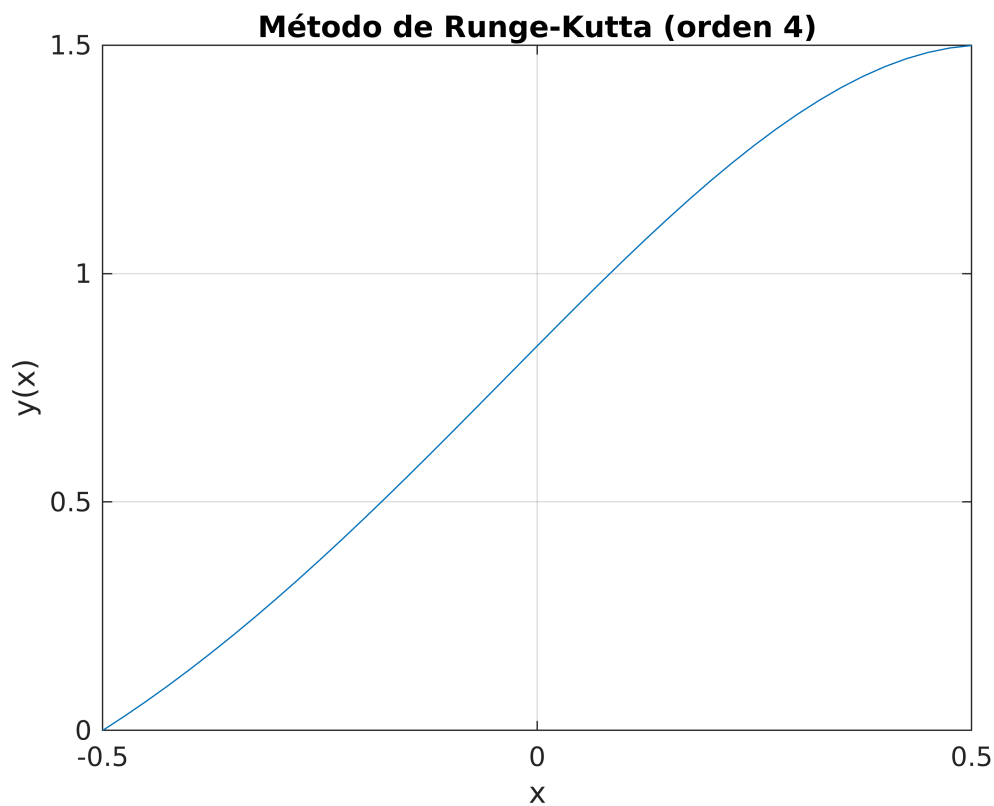
0.0311    1.2733
0.0637    1.3325
0.0977    1.3906
0.1332    1.4471
0.1700    1.5019
0.2082    1.5547
0.2478    1.6052
0.2885    1.6532
0.3304    1.6983
⋮

```

```

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 = 1x41
   -0.5000   -0.4750   -0.4500   -0.4250   -0.4000   -0.3750   -0.3500   -0.3250 ...

```

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

```

y = 41x3
    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 = 41x3
      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 = 41x3
      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 = 41x3
      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
:
:
:

```

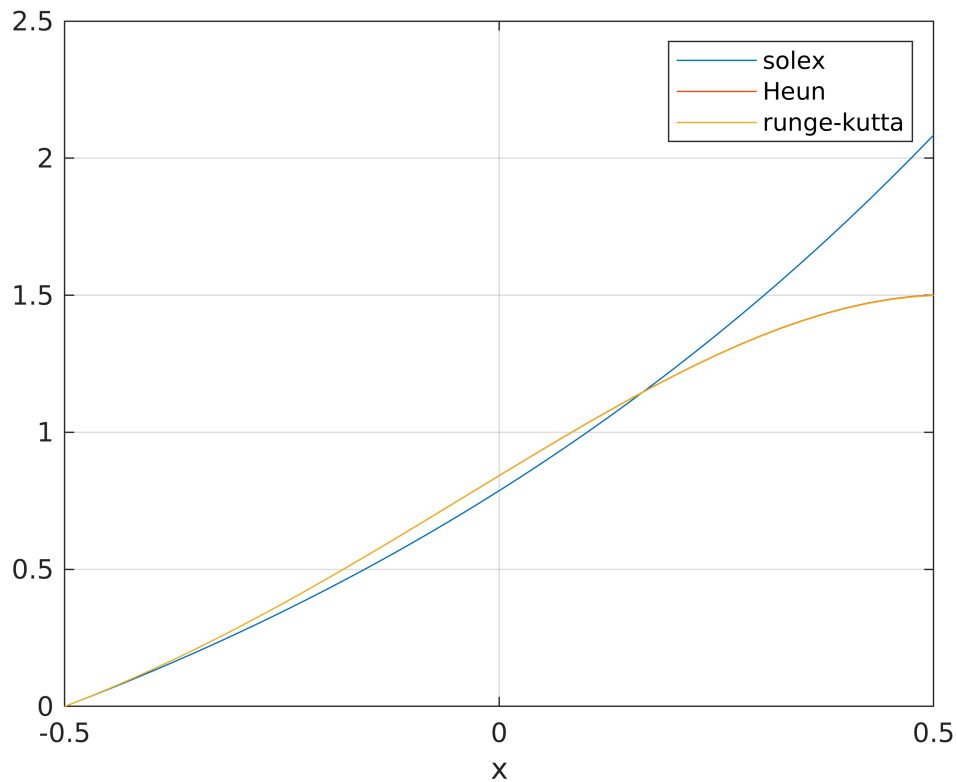
```
plot(x,y)
```

```

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('pvil', -1/2, 1/2, 40, [0, 2*exp(-1/2)], [-1/2, -1/4, -1/8, -1/16, -1/32, -1/64, -1/128, -1/256, -1/512, -1/1024, -1/2048, -1/4096, -1/8192, -1/16384, -1/32768, -1/65536, -1/131072, -1/262144, -1/524288, -1/1048576, -1/2097152, -1/4194304, -1/8388608, -1/16777216, -1/33554432, -1/67108864, -1/134217728, -1/268435456, -1/536870912, -1/1073741824, -1/2147483648, -1/4294967296, -1/8589934592, -1/17179869184, -1/34359738368, -1/68719476736, -1/137438953472, -1/274877906944, -1/549755813888, -1/1099511627776, -1/2199023255552, -1/4398046511104, -1/8796093022208, -1/17592186044416, -1/35184372088832, -1/70368744177664, -1/140737488355328, -1/281474976710656, -1/562949953421312, -1/1125899906842624, -1/2251799813685248, -1/4503599627370496, -1/9007199254740992, -1/18014398509481984, -1/36028797018963968, -1/72057594037927936, -1/144115188075855872, -1/288230376151711744, -1/576460752303423488, -1/1152921504606846976, -1/2305843009213693952, -1/4611686018427387904, -1/9223372036854775808, -1/18446744073709551616, -1/36893488147419103232, -1/73786976294838206464, -1/147573952589676412928, -1/295147905179352825856, -1/590295810358705651712, -1/1180591620717411303424, -1/2361183241434822606848, -1/4722366482869645213696, -1/9444732965739290427392, -1/18889465931478580854784, -1/37778931862957161709568, -1/75557863725914323419136, -1/151115727451828646838272, -1/302231454903657293676544, -1/604462909807314587353088, -1/1208925819614629174706176, -1/2417851639229258349412352, -1/4835703278458516698824704, -1/9671406556917033397649408, -1/19342813113834066795298816, -1/38685626227668133590597632, -1/77371252455336267181195264, -1/154742504910672534362390528, -1/309485009821345068724781056, -1/618970019642690137449562112, -1/1237940039285380274899124224, -1/2475880078570760549798248448, -1/4951760157141521099596496896, -1/9903520314283042199192993792, -1/19807040628566084398385987584, -1/39614081257132168796771975168, -1/79228162514264337593543950336, -1/158456325028528675187087900672, -1/316912650057057350374175801344, -1/633825300114114700748351602688, -1/1267650600228229401496703205376, -1/2535301200456458802993406410752, -1/5070602400912917605986812821504, -1/10141204801825835211973625643008, -1/20282409603651670423947251286016, -1/40564819207303340847894502572032, -1/81129638414606681695789005144064, -1/162259276829213363391578010288128, -1/324518553658426726783156020576256, -1/649037107316853453566312041152512, -1/1298074214633706907132624082305024, -1/2596148429267413814265248164610048, -1/5192296858534827628530496329220096, -1/10384593717069655257060992658440192, -1/20769187434139310514121985316880384, -1/41538374868278621028243970633760768, -1/83076749736557242056487941267521536, -1/166153499473114484112975882535043072, -1/332306998946228968225951765070086144, -1/664613997892457936451903530140172288, -1/1329227995784915872903807060280344576, -1/2658455991569831745807614120560689152, -1/5316911983139663491615228241121378304, -1/10633823966279326983230456482242756608, -1/21267647932558653966460912964485513216, -1/42535295865117307932921825928971026432, -1/85070591730234615865843651857942052864, -1/170141183460469231731687303715884105728, -1/340282366920938463463374607431768211456, -1/680564733841876926926749214863536422912, -1/1361129467683753853853498429727072845824, -1/2722258935367507707706996859454145691648, -1/5444517870735015415413993718908291383296, -1/10889035741470030830827987437816582766592, -1/21778071482940061661655974875633165533184, -1/43556142965880123323311949751266331066368, -1/87112285931760246646623899502532662132736, -1/174224571863520493293247799005065324265472, -1/348449143727040986586495598010130648530944, -1/696898287454081973172991196020261297061888, -1/1393796574908163946345982392040522594123776, -1/2787593149816327892691964784081045188247552, -1/5575186299632655785383929568162090376495104, -1/11150372599265311570767859136324180752990208, -1/22300745198530623141535718272648361505980416, -1/44601490397061246283071436545296723011960832, -1/89202980794122492566142873090593446023921664, -1/178405961588244985132285746181186892047843328, -1/356811923176489970264571492362373784095686656, -1/7136238463529799405291429847247475681913733
```

```
[x,y_heum, y_filter] = heun_vec('pvil', -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 = 21x1
```

```
0
0.1000
0.2000
0.3000
0.4000
0.5000
0.6000
0.7000
0.8000
0.9000
```

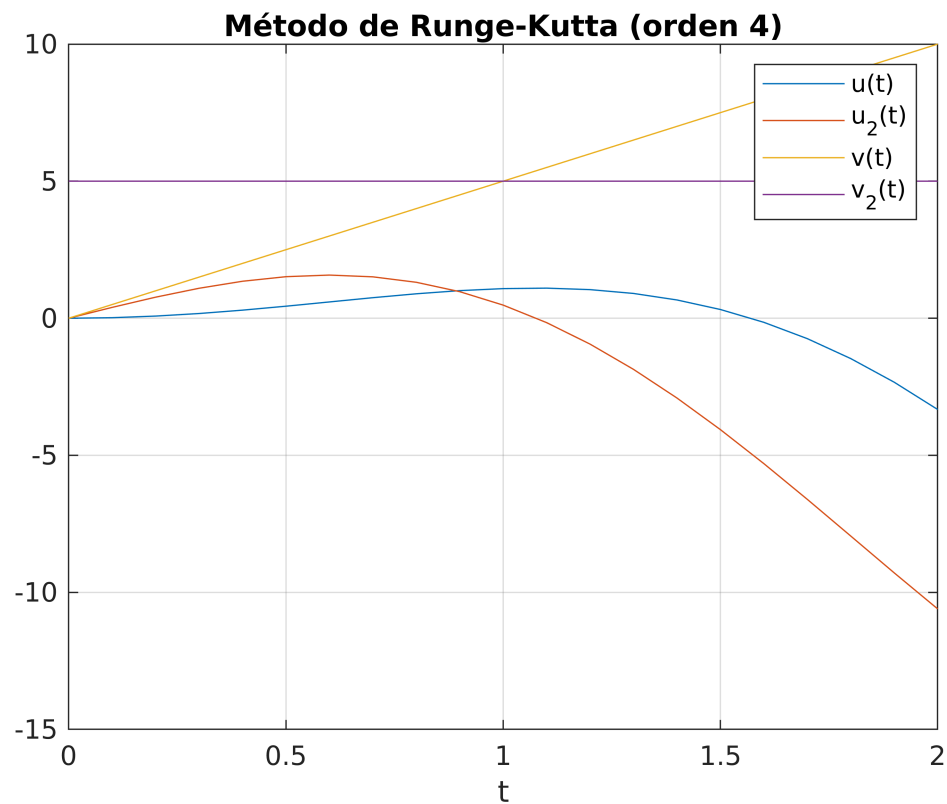
```
⋮
```

```
y = 21x4
```

```
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 = 101x1
    0
    0.2000
    0.4000
    0.6000
    0.8000
    1.0000
    1.2000
    1.4000
    1.6000
    1.8000
    ⋮
    ⋮
y = 101x4
1011 x
      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 = 101x4
1011 ×
    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])

```

