Unbounded Grids Homework (Using Python)

Computational Methods in Astronomy 2
2020.10.07
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1. Implement Program 3 and produce a plot similar to Output 3

```
import numpy as np
import matplotlib.pyplot as plt

h, xmax = np.power(1/2, range(0,7)), 10 # Set h, xmax / h is interval in each x(2^0,2^1,2^2,2^3,2^4
error_sq, error_hat = [], []

fig, ax = plt.subplots(nrows=3,ncols=1,sharex=True,sharey=True,figsize=(16,8))

for z in range(len(h)):
  h0 = h[z]
  x = np.arange(-xmax,xmax +1,h0)
  xx = np.arange(-xmax-h0/20,xmax+h0/20 +h0/20,h0/20)

  def v(number): # Set Function : 1.Delta Func, 2.Square Func, 3.Hat Func
    if number == 1:
      v = (x == 0)
    elif number == 2:
      v = (abs(x) <= 3)
    elif number == 3:
      v = ((abs(x) <= 3) - abs(x)/3)
      v[v < 0] = 0
    else:
      print("Nothing")
    return v

  for i in range(0,3):
    p = np.zeros_like(xx)
```

Set 3x1 Figure

h = [1, ½, ¼, 1/8 …..]
h[0] = 1 and Set h0

In Matlab

```
case 1, v = (x==0);                % delta function
case 2, v = (abs(x)<=3);           % square wave
case 3, v = max(0,1-abs(x)/3);     % hat function
```

In Matlab

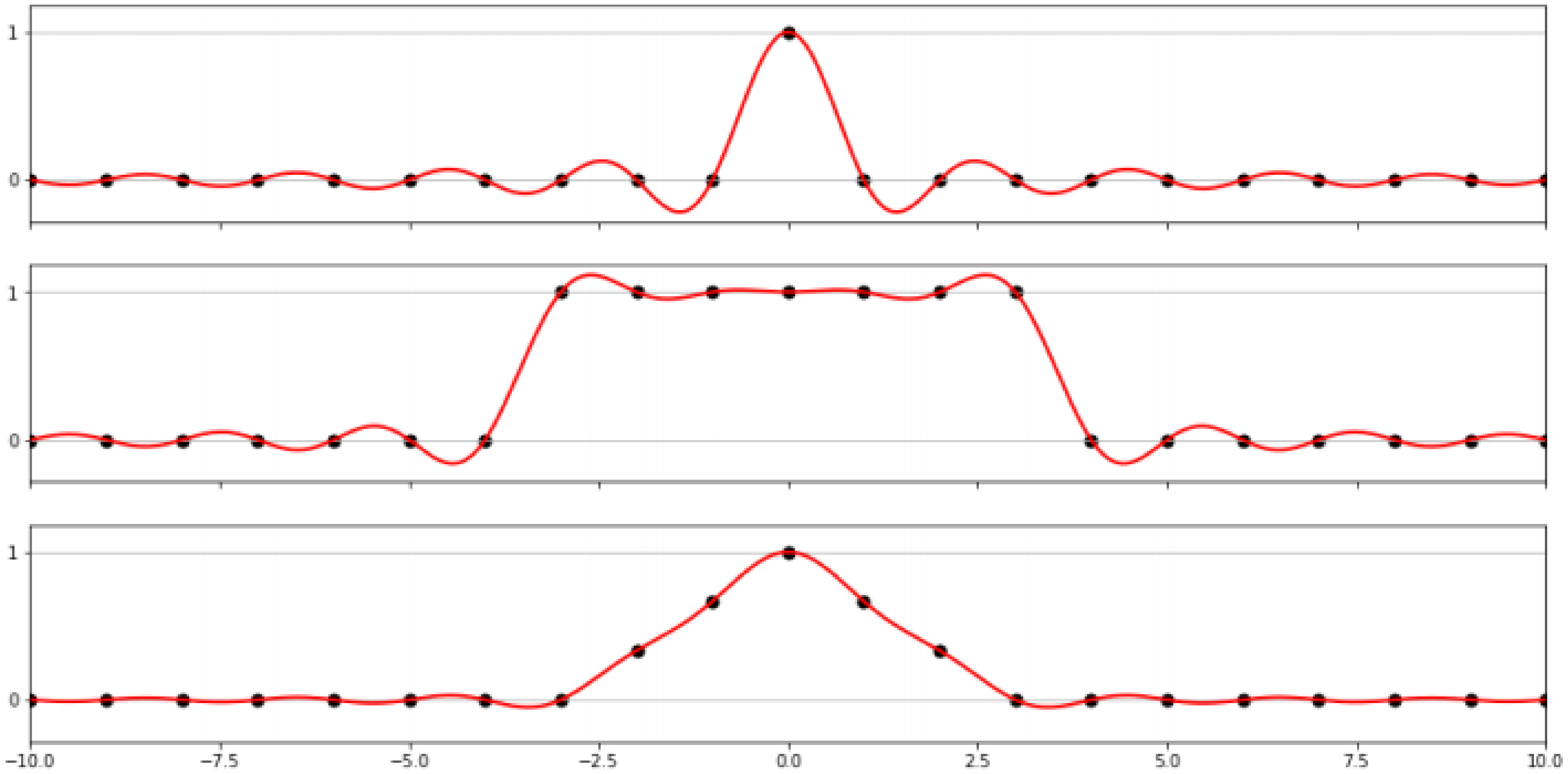
```
p = zeros(size(xx));
```

```python
  for j in range(1,len(x)):
    p = p + v(i+1)[j]*np.sin(np.pi*(xx-x[j])/h0) / (np.pi*(xx-x[j])/h0)

  if z == 0: # If h is 1(2^0), Plot graph
    ax[i].plot(xx,p,linewidth=2,color='red')
    ax[i].scatter(x,v(i+1),color='black',s=50)
    plt.yticks([0,1])
    ax[i].grid(axis='y')
  else:
    pass

plt.xlim(-xmax,xmax)

def vxx(number): # Set Function : 2.Square Func, 3.Hat Func / Same to v
  if number == 2:
    vxx = (abs(xx) <= 3)
  elif number == 3:
    vxx = ((abs(xx) <= 3) - abs(xx)/3)
    vxx[vxx < 0] = 0
  else:
    print("Nothing")
  return vxx

error_2 = max(abs(p - vxx(2))) # Calculate error and Append to list
error_3 = max(abs(p - vxx(3)))
error_sq.append(error_2)
error_hat.append(error_3)
```

```matlab
for i = 1:length(x),
  p = p + v(i)*sin(pi*(xx-x(i))/h)./(pi*(xx-x(i))/h);
```

In Matlab

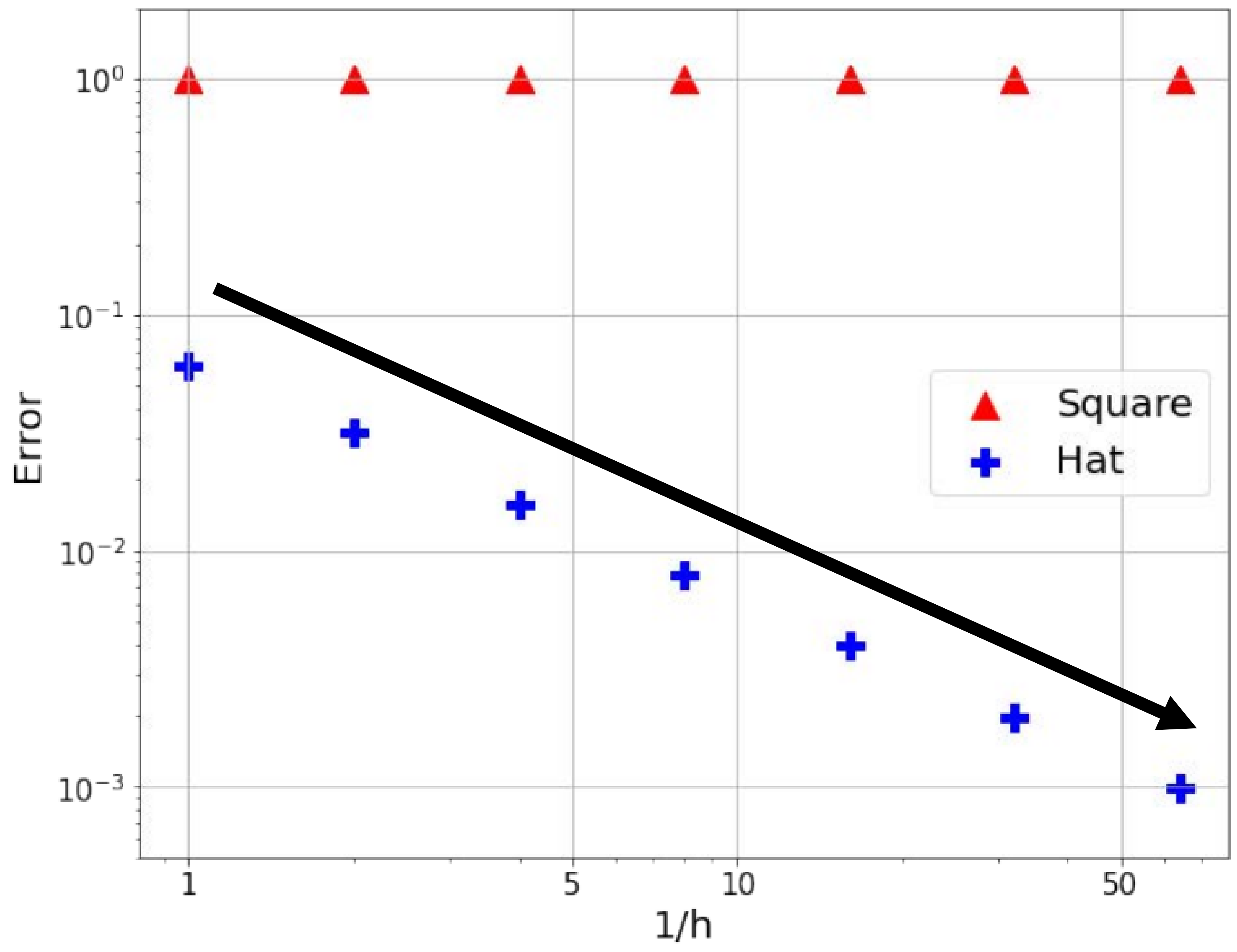
Find max error value in list



1
0
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

2. (Exercise 2.7) Modify Program 3 to determine the maximum error over $\mathbb{R}$ in the sinc function interpolants of the square wave and the hat function, and to produce a log-log plot of these two error maxima as a functions of h. (Good choices for h are $2^{-2}, 2^{-4}, 2^{-5}, 2^{-6}$.)

```
plt.figure(figsize=(10,8)) # Plot error's graph
plt.scatter(1/h,error_sq,marker='^',s=200,color='red',label='Square')
plt.scatter(1/h,error_hat,marker='P',s=200,color='blue',label='Hat')
plt.ylim(5*10**(-4),2)
plt.yscale('log')
plt.xscale('log')
plt.xticks([1,5,10,50],map(str,[1,5,10,50]),fontsize=15)
plt.yticks(fontsize=15)
plt.legend(loc='right',fontsize=20)
plt.xlabel('1/h',fontsize=20)
plt.ylabel('Error',fontsize=20)
plt.grid()
```


10^0
10^{-1}
10^{-2}
10^{-3}
Error
1
5
10
50
1/h
Square
Hat