COMP 696: Advanced Parallel Computing Note : Visualizing Results using Gnuplot on tuckoo

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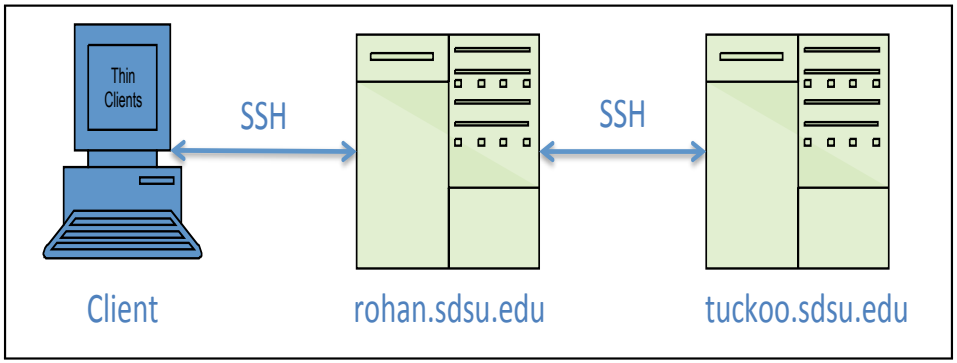
X11 forwarding to run Gnuplot on tuckoo

- Using X11 forwarding will allow you to vizualize data or run graphical applications, e.g.:
  - ncview to view NetCDF data files or
  - ParaProf performance analyzer
- see `http://www-rohan.sdsu.edu/faculty/mthomas/courses/f15/comp696/topics/tools/comp696-ssh-xterm.pdf`

Setting up X11 (xterm) using SSH Forwarding



- Launch *SSH* X11 terminal on your computer
- *SSH* onto rohan (OS X):

  %ssh −Y rohanUserName@rohan.sdsu.edu
- *SSH* from rohan to tuckoo:

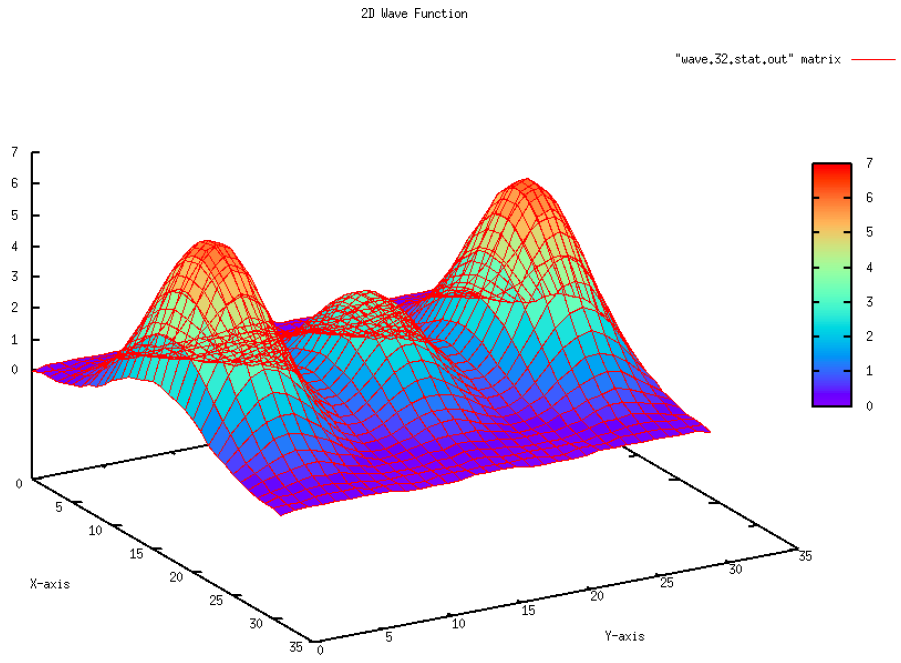
  %ssh −Y tuckooUserName@tuckoo.sdsu.edu
- Software required: some for of X11 window application
  - OSX: XQuartz X Window System
  - Windows: XMing or PuTTY (select Connection/SSH/X11)
- To Test, run the command *% xclock &*

Gnuplot: interactive commands

- run Gnuplot: [*mthomas*] % *gnuplot*
- Interactive commands:

```
set pm3d
set view 60, 60, 1, 1
set title "2D Wave Function"
set ylabel 'Y-axis'
set xlabel 'X-axis'
splot 'wave.32.stat.out' matrix with lines
set palette rgbformulae 22,13,-31
```

Gnuplot commands/script



"Wave" Generator using parallel MPI code, wave-dyn.c, running on tuckoo to caculate Airy Disk Function (N=32,f=0.5, g=0.25, s=4)

Gnuplot Refs

- http://lowrank.net/gnuplot/index-e.html
- http://gnuplot.sourceforge.net/demo/
- http://www.ma.utexas.edu/users/ktaliaferro/gnuplot_examples.html#3dpar
- http://www.cs.princeton.edu/courses/archive/fall99/cs323/precepts/plotting/gnuplot.html
- and many more

"Wave" Generator Using Matrix-Matrix Multiplication of Airy Disk Function

- For this assignment you will use *matrix-matrix* multiplication (not the Hadamard product, see above) to calculate a matrix product using the matrices defined by the Airy disc/Fraunhaufer Diffraction pattern described above:

  $$F(x,y) = f * cos^2(r) * e^{(-gr^2)}$$

  where (x, y) are cartesian coordinates, $r = \sqrt{x^2 + y^2}$, and f and g are constants that control the shape of the waves.
- This particular form allows us to factor the function into a matrix multiplication equation of the form:

  $$F(x,y) = A * B$$

  where:

  $$A = f * cos^2\left(\sqrt{x^2 + y^2}\right) \quad \text{and} \quad B = e^{-g\left(x^2+y^2\right)}$$

- Notes:
  1. (x, y) are the grid cartesian coordinates, and f and g are constants that control the shape of the waves.
  2. The results will differ from those obtained using Hadamard matrix multiplication.

Matlab code: Mat-Mult to generate Waves

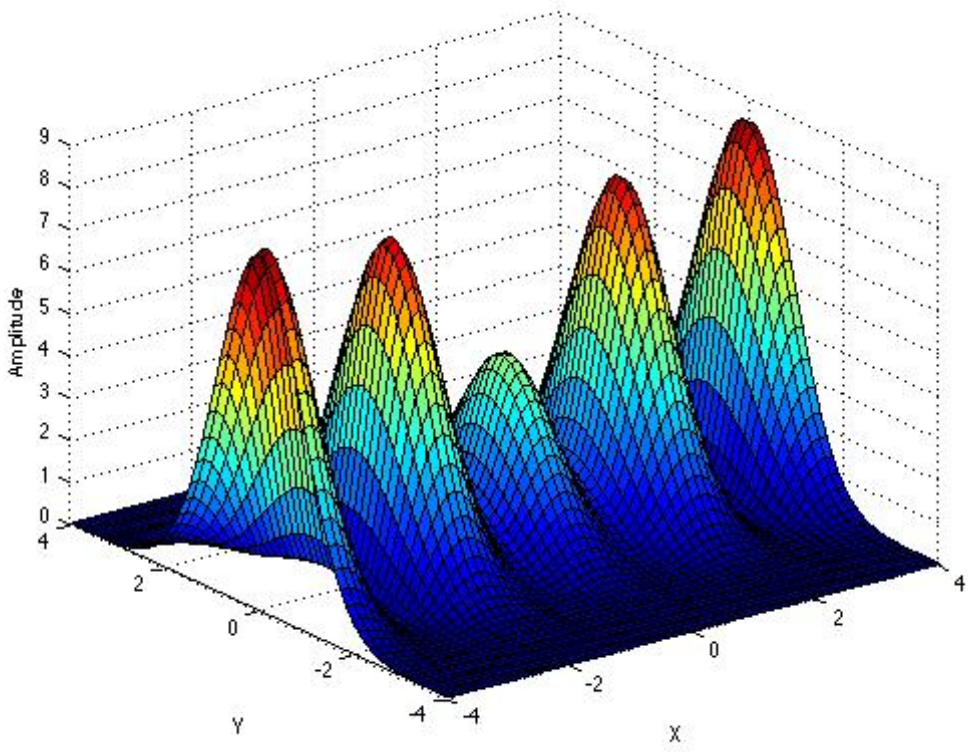
```
%
% Wave Function Test Case: Matlab code
%   Calculates modified bessel function
%       using mat-mat multiplication:  C=A.*B
%
%   By Mary Thomas (March, 2014)
%       updated: March, 2015
%       Created: March, 2014
%
%  scaling factors affect max amplitude
%  number of wavelengths
%
%
clear all;
ni=64;
fprintf('init wave function test case\n');
%%
% f: max amplitude
f=1.0;
f=0.5;
%f=.25;
%f=.1;

% g: inverse wavelength
g=.1;
g=0.25;
%g=.5;
%g=.75;
%g=1.;

% s:  number of wavelengths in hat ~ s+1
s=1;
%s=2;
%s=3;
s=4;
%s=6;
```

```
x = linspace(-s , s ,ni);
y = linspace(-s , s ,ni);

fprintf('init x,y\n');

%% serial matrix-matrix multiplication
%
C=zeros(ni,ni);
A=zeros(ni,ni);
B=zeros(ni,ni);

for i=1:ni
    for j=1:ni
        r(i,j)=sqrt(x(i)^2 + y(j)^2)*pi*f;  %convert to ra

        xpts(i,j) = x(i); % these are for plotting
        ypts(i,j) = y(j);

        A(i,j) = f*(cos(r(i,j)))^2;

        B(i,j) =  exp(-g*r(i,j)^2);
    end
end

fprintf('calc A,B ok\n');
%%
% using r(i,k) produces waves
for i=1:ni
    for j=1:ni
        for k=1:ni;
            C(i,j) = C(i,j) + A(i,k) * B(k,j);
        end
    end
end
fprintf('calc C ok\n');
```

Matlab code: Mat-Mult to generate Waves

```
%% plot 3D surface node mesh -- waves
figure;
surf(xpts,ypts,C);
title(['Bessel Waves -- Calc C(i,j)  Ni=',num2str(ni),', S=',num2str(s),',  F=',num2str(f),',  G=',num2str(g)]);
xlabel('X');ylabel('Y');zlabel('Amplitude');
grid on;

%% plot 3D surface node mesh -- waves
D=A*B;
figure;
surf(xpts,ypts,D);
%title(['Bessel Waves -- Calc D=A*B,  Ni=',num2str(ni),', S=',num2str(s),',  F=',num2str(f),',  G=',num2str(g)]);
xlabel('X');ylabel('Y');zlabel('Amplitude');
grid on;
```

"Wave" Function: Generated by Calculation of Airy Disk Function



"Wave" Generator Using Matlab code to calculate Matrix-Matrix Multiplication of Airy Disk Function