Lab 11:
Interpolations

11.1 Background

For this assignment, you will be solving some interpolation problems in Chapters 15 and 16 of the Chapra book. In each case you will be making a plot containing the original data as well as one or more interpolations of that data. In some cases, you will also use those interpolations to make specific estimates of variable values. Be sure to read the assignment carefully - in many cases, you will be using the *data* from the book but may not be performing the specific tasks listed there.

11.2 Resources

The additional resources required for this assignment include:

- Books: Chapra
- Pratt Pundit Pages: None yet. Send Dr. G suggestions!

11.3 Getting Started

1. Log into one of the PCs in the lab using your NET ID. Be sure it is set to log on to acpub.
2. Start a browser and point it to `http://pundit.pratt.duke.edu/wiki/Lab:B209`. Check out the `Using the PCs to Run MATLAB Remotely` section for how to get connected and make sure the connection is working.
3. Once connected to a machine you believe will also display graphics, switch into your `EGR53` directory and create a `lab11` directory inside it:
   ```
   cd␣EGR53
   mkdir␣lab11
   ```
4. Switch to your ∼`/EGR53/lab11` directory:
   ```
   cd␣lab11
   ```
5. Copy all relevant files from Dr. G's public `lab11` directory:
   ```
   cp␣-i␣~mrg/public/EGR53/lab11/*␣.
   ```
   Do not forget the space and the "." at the end.
6. Open MATLAB by typing `matlab␣&` at the prompt that appears in your terminal window. It will take MATLAB a few seconds to start up.

11.4 Assignment

11.4.1 Based on Chapra 15.9, p. 356

Using the data from this problem, first create a graph showing the experimental values as black asterisks. Generate 1000 interpolated values for the voltage using three different kinds of interpolation - nearest neighbor, piecewise linear, and 5th order polynomial - and add these to the graph. Be sure to use different line styles for each of the models and include a legend. Then, determine the estimates for the voltage across the resistor when the current is 1.5 A for each of the models and present them in your report.

11.4.2 Based on Chapra 15.12, pp. 356-357

Using the data from this problem, you are going to generate some interpolated surfaces as well as predictions for oxygen concentration at a particular chloride concentration and temperature. You can use the code:

```
[cmodel, Tmodel] = meshgrid(...
     linspace(min(c(:)), max(c(:)), 20),
     linspace(min(T(:)), max(T(:)), 20));
```

to generate two 2-D model grids on which to base the interpolation. Using the `interp2` function, create models for the oxygen concentration using nearest neighbor, piecewise linear, and cubic spline interpolation. Graph each of these independently using the `surfc` command and use the commands `colormap gray;` and `view([145 15]);` to better visualize the information. Then generate estimates for the oxygen concentration when the chloride concentration is 10 g/L and the temperature is 18 °C as given in the problem. You should end up with three graphs. Note - one of the files you copied, `TableP15p12.mat`, already has the `c`, `T`, and `OC` matrices in it. Your script should load that file.

11.4.3 Based on Chapra 15.20, p. 358

Using the data from this problem, first create a graph showing the experimental values as black asterisks. Generate 100 interpolated values for the entropy using two different kinds of interpolation - piecewise linear and 2nd order polynomial - and add these to the graph. Be sure to use two different line styles for each of the four models and include a legend.

Next, make the predictions for v=0.108 m^3/kg using each interpolation method. For the third part of the problem - inverse interpolation - you will be effectively solving a root-finding problem where:

$$s(v) = 6.6 \qquad \longrightarrow \qquad s(v) - 6.6 = 0$$

In this case, you will only need to do the inverse interpolation on the quadratic interpolation. First, determine the coefficients of the interpolation itself, re-write the equation as a root-finding problem, and use whatever root-finding technique you want to determine the appropriate values of v.

11.4.4 Based on Chapra 16.12, p. 387

Using the function from this problem, first create a graph showing the five analytical values as black asterisks. Generate 100 interpolated values for the function using four different kinds of interpolation - piecewise linear, piecewise cubic, cubic spline, and 4th order polynomial - and add these to the graph. Be sure to use different line styles for each of the four models and include a legend.

11.4.5 Based on Chapra 16.13, p. 387

Using the function from this problem, first create a graph showing the eight analytical values as black asterisks. Generate 100 interpolated values for the function using four different kinds of interpolation - cubic spline with not-a-knot conditions, cubic spline with derivative conditions setting the derivative to 0 at the endpoints, cubic spline with derivative conditions setting the derivative to +5 at the first and last points, and cubic spline with derivative conditions setting the derivative to +5 at the first point and -5 at the last point. Be sure to use different line styles for each of the four models and include a legend.