ECS 277 - Homework # 2

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May 14, 2018

We employed webGL to develop a dashboard for studying common techniques for scattered data point interpolation. These methods include using Hardy's method, Shepard's method, and k-Nearest Neighbors. The user is able to select from these methods and compare on a collection of datasets.

Running the Application

If running in a Chrome or Safari browser, cross-origin requests need to be enabled. The simplest way to do this is to run

```
python -m SimpleHTTPServer
```

while inside the directory containing `Index.html`. Then the app will be at `http://0.0.0.0:8000/`.

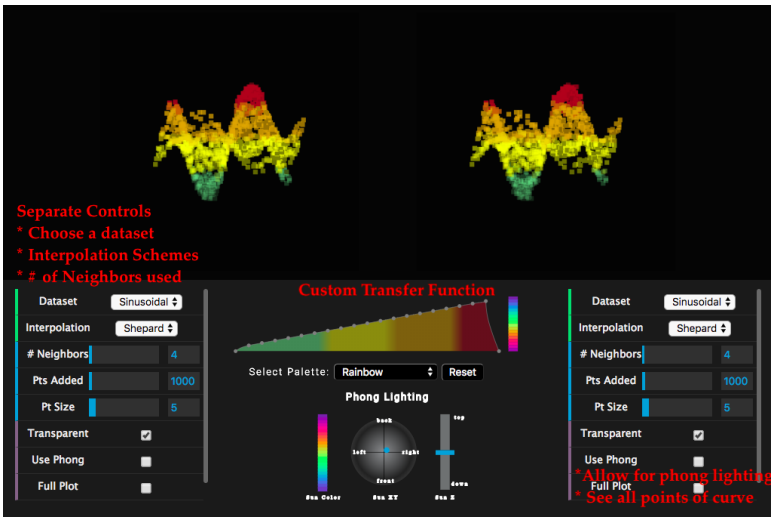

Figure 1: The dashboard for the Volume Rendering Comparison Tool. Here the user can select from a multitude of different controls for each visualization. Moreover, they have control over a shared transfer function or Phong lighting direction and intensity.

Controls

For each visualization there is a set of user-driven values that can be interacted with. These values allow the user to explore different techniques in scattered interpolation, and the two sets of controls allow for comparisons between two visualizations. Table 1 explains each control in detail.

Name	Range	Description
Dataset	Allows the user to choose from 4 datasets constructed by randomly removing points from analytic surfaces.	Sinusoidal, Gaussian, Wave, or Hourglass.†
Interpolation	Allows the user to select from one of 3 types of scattered interpolation schemes.	Hardy, Shepard, KNN *
# Neighbors	Controls how many neighbors will be used for interpolating a given point.	[2,50]
Pts Added	How many points will be added to the graph via interpolation (Randomly across a mesh grid).	[0, 20000]
Pt Size	Defines the side length of each point (square) in pixels.	[0,50]
Transparent	Controls the transparency of the visualization. If True, then low opacities will be completely transparent, else opacity is ignored.	True / False
Full Plots	If True, then the initial points will consist of every point across the mesh grid; not the scattered points.	True / False
Triangulation	If True, then a convex hull surrounding each point's neighbors is filled in via triangulation.	True / False
Use Phong	Should Phong lighting be applied to the curve?	True / False

Table 1. A table depicting the main controls available in the Scattered Interpolation dashboard. Each visualization has its own set of the above controls so the user can compare different values of each.

* Interpolation Schemes

Three interpolation schemes are provided for the user to compare. These schemes include Hardy's method, Shepard's method, and standard k-Nearest Neighbors averaging. Combining a specific interpolation scheme with a dataset allows the user to see which characteristics of a curve a given interpolation scheme works the best with. For example, the Wave function has an asymptote, which is only properly accounted for using Hardy's method. Each of these schemes is given below.

1. **Hardy's**:
$$H(\vec{x}) = \sum_{i}^{k} c_i \left(R^2 + d_i(\vec{x}, \vec{x}_i)^2\right)^{1/2}$$
2. **Shepard's**:
$$S(\vec{x}) = \frac{1}{\sum_i^k f(\vec{x}_i)^{-2}} \sum_{i}^{k} d(\vec{x}, \vec{x}_i)^2 f(\vec{x}_i)^{-2}$$
3. **k-NN**:
$$f(\vec{x}) = \frac{1}{k} \sum_{i}^{k} f(\vec{x}_i)$$

† Datasets

The datasets selected for this dashboard were constructed from analytic functions. This allowed for direct comparison with the scattered interpolation schemes and the fully constructed points from the mesh grid. The functions were chosen to provide many cases of different function slopes and curvature to compare the effects of this on the interpolation schemes. Moreover, the Wave function contains an asymptote at $x = y$. Figure 2 shows these surfaces and the following describes their analytic function values.

1. **Gaussian**:
$$F(x, y) = 2e^{-(x^2+y^2)}$$
2. **Sinusoidal**:
$$F(x, y) = \sin(4x)\cos(y)e^{-(x^2+y^2)/100}$$
3. **Hourglass**:
$$F(x, y)^2 = 3x^2 + 4y^2$$
4. **Wave**:
$$F(x, y) = \frac{x}{100y} + \frac{1}{2}\sin(3xy) + \cos(xy)e^{-(x^2+y^2)/100}$$

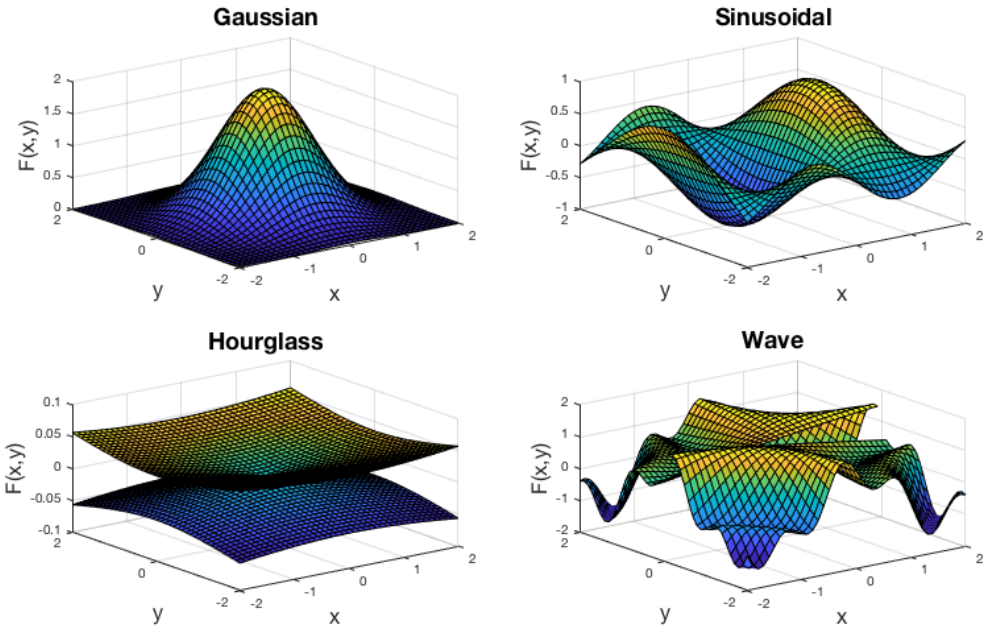

Figure 2: The different functions available in the dashboard. Each curve has unique 1st and 2nd derivative behavior to provide the best comparison.