CS368 MATLAB Programming

Lecture 3

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Based on lecture slides by Michael O’Neill and Beck Hasti

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Matrix Operations, Multiplication Again

Quiz
Matrix Operations, Division

Quiz
A curve can be the graph of a function described by $y = f(x)$, or the trace of a moving point, in which the movement of the point is described by its position $(f_x(t), f_y(t))$ at time $t$.

A curve is plotted using a large number of line segments.
To plot $y = f(x)$ from $x = x_1$ to $x = x_n$, find $x_1 < x_2 < x_3 < ... < x_n$ and use lines to connect the following points,

$$(x_1, f(x_1)), (x_2, f(x_2)), (x_3, f(x_3)), ..., (x_n, f(x_n)).$$
Parametric Curves

To plot \((f_x(t), f_y(t))\) from \(t = t_1\) to \(t_n\), find \(t_1 < t_2 < t_3 < \ldots < t_n\) and use lines to connect the following points,
\[(f_x(t_1), f_y(t_1)), (f_x(t_2), f_y(t_2)), (f_x(t_3), f_y(t_3)), \ldots, (f_x(t_n), f_y(t_n)).\]
Curve Discretization

Math

- $t_1, t_2, t_3, \ldots, t_n$ is a partition of the domain $t \in [t_1, t_n]$.

1. The partition is usually uniform, meaning $t_i = t_{i-1} + \delta$ with $\delta = \frac{t_n - t_1}{n}$ and some large $n$.

2. $t_i$ can also be sampled randomly. More details in a later lecture.

3. $t_i$ can also be chosen according to how fast the function is changing.

4. $t_i$ can also be chosen so that the lengths of the line segments are the same.
Curve Plotting

Code

- Suppose $x, y$ are vectors of length $n$.
  - $\text{plot}(x, y)$ plots line segments connecting $(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$.

1. For example, define $x = 0:0.01:1$ and use $\text{plot}(x, f(x))$ to plot $f(x)$ between 0 and 1 with a partition of size 100.

2. Another example, define $t = 0:0.01:1$ and use $\text{plot}(fx(t), fy(t))$ to plot $(fx(t), fy(t))$ between 0 and 1 with a partition of size 100.
Line Specs

Code

- \textit{plot}(x, y, s)\ s \textit{specifies the style, marker, and color of the lines.}

1. Line style: ‘—’ solid, ‘——’ dashed, ‘:’ dotted, ‘—.’ dash-dotted.

2. Marker: ‘o’ circle, ‘.’ dot, ‘x’ cross, ‘s’ square, ‘d’ diamond ...

3. Color: ‘r’ red, ‘g’ green, ‘b’ blue, ‘k’ black, ‘w’ white ...

- \textit{plot}(x_1, y_1, s_1, x_2, y_2, s_2, \ldots) \ plots multiple lines in the same figure.
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**Curve Plotting, Square Quiz**

Curve Plotting, Circle

Quiz
Curve Plotting, Aliasing

Quiz
Texts can be added to the plot. More details about text manipulation in the next lecture.

- `title(t)` adds title t.
- `xlabel(t)` adds x-axis label t.
- `ylabel(t)` adds y-axis label t.
- `legend(c1, c2, ...)` adds legend (names of the curves c1, c2, ...).
- `text(x, y, t)` adds text t at position (x, y).
- `axis([x0, x1, y0, y1])` changes the range of the axes to \( x \in [x_0, x_1] \) and \( y \in [y_0, y_1] \).
3D Curve Plotting

Code

- Suppose \( x, y, z \) are vectors of length \( n \).
- \( \text{plot3}(x, y, z, s) \) plots the lines in 3D connecting \((x_1, y_1, z_1), (x_2, y_2, z_2), \ldots, (x_n, y_n, z_n)\), with specs \( s \).
A surface can be a graph of a function described by $z = f(x, y)$, or the trace of a moving point, in which the movement of the point is described by its position $(f_x(s, t), f_y(s, t), f_z(s, t))$.

A surface is plotted using a large number of faces, usually triangles, but in MATLAB, four sided polygons.
Surface Plotting

Code

- Suppose $x, y, z$ are matrices representing points on the surface.
- $\text{contour}(x, y, z, n)$ plots $n$ contours of the surface, and $\text{contour3}(x, y, z, n)$ plots them in 3D.
- $\text{mesh}(x, y, z)$ plots the surface mesh.
- $\text{surf}(x, y, z)$ plots the surface.
- If $x$ and $y$ are omitted, the $x$ and $y$ coordinates are assumed to be the column and row indices of the elements in $z$. 
Surface Plotting, Pyramid Quiz
Surface Plotting, Plane

Quiz
Surface Plotting, Grid

Quiz
Surface Plotting, Bowl Quiz
**Mesh Grid Shortcut**

**Code**

- \([x, y] = \text{meshgrid}(u, v)\) creates \(x = \text{repmat}(u, [\text{length}(v), 1])\) and \(y = \text{repmat}(v', [1, \text{length}(u)])\). The matrices \(x, y\) then can be used to plot the surface \(z = f(x, y)\) using \(\text{surf}(x, y, f(x, y))\).

- \([x, y, z] = \text{sphere}()\) and \([x, y, z] = \text{cylinder}()\) create meshes of a unit sphere and a unit cylinder. The surface then can be plotted using \(\text{surf}(x, y, z)\).
Under "PLOTS" tab, many other plots can be created based on a matrix.
.m files are MATLAB scripts and can be used to store a list of commands or the definition of a function. More details in the next lecture.

The script and its output can be published as a PDF file or an HTML web page.
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