CS368 MATLAB Programming

Lecture 3

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Matrix Operations, Multiplication Again

Quiz

Matrix Operations, Division

Quiz

Curves

Math

- 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.

Function Curves

Math

- 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

Math

- To plot $(f_x(t), f_y(t))$ from $t = t_1$ to t_n, find $t_1 < t_2 < t_3 < ... < t_n$ and use lines to connect the following points,

$$(f_x(t_1), f_y(t_1)), (f_x(t_2), f_y(t_2)), (f_x(t_3), f_y(t_3)), ..., (f_x(t_n), f_y(t_n)).$$

Curve Discretization

Math

- $t_1, t_2, t_3, ..., t_n$ 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.
- *plot(x, y)* plots line segments connecting $(x_1, y_1), (x_2, y_2), ..., (x_n, y_n)$.

1. For example, define *x = 0:0.01:1* and use *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 *plot(fx(t), fy(t))* to plot $(f_x(t), f_y(t))$ between 0 and 1 with a partition of size 100.

Line Specs

Code

- *plot(x, y, s)* s 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 ...

- *plot(x1, y1, s1, x2, y2, s2, ...)* plots multiple lines in the same figure.

Curve Plotting, Square

Quiz

Curve Plotting, Circle

Quiz

Curve Plotting, Aliasing

Quiz

Plotting Features

Code

- 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 $c_1, c_2, \ldots$).
- *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.
- *plot3(x, y, z, s)* plots the lines in 3D connecting $(x_1, y_1, z_1), (x_2, y_2, z_2), ..., (x_n, y_n, z_n)$, with specs s.

Surfaces

Math

- 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.
- *contour(x, y, z, n)* plots n contours of the surface, and *contour3(x, y, z, n)* plots them in 3D.
- *mesh(x, y, z)* plots the surface mesh.
- *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] = meshgrid(u, v)* creates *x = repmat(u, [length(v), 1])* and *y = repmat(v', [1, length(u)])*. The matrices x, y then can be used to plot the surface $z = f(x, y)$ using *surf(x, y, f(x, y))*.
- *[x, y, z] = sphere()* and *[x, y, z] = cylinder()* create meshes of a unit sphere and a unit cylinder. The surface then can be plotted using *surf(x, y, z)*.

Other Plots

Code

- Under "PLOTS" tab, many other plots can be created based on a matrix.

Script

Code

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

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