CS368 MATLAB Programming
Lecture 3

Young Wu

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

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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 $x_1 < x_2 < x_3 < \ldots < x_n$ and use lines to connect the following points,

$$(x_1, f(x_1)), (x_2, f(x_2)), (x_3, f(x_3)), \ldots, (x_n, f(x_n)).$$
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

- $t_1, t_2, t_3, ..., t_n$ 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.
Suppose $x, y$ are vectors of length $n$.

- $\textit{plot}(x, y)$ 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 $\textit{plot}(x, f(x))$ 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 $\textit{plot}(fx(t), fy(t))$ to plot $(f_x(t), f_y(t))$ between 0 and 1 with a partition of size 100.
**Line Specs**

**Code**

- \( \text{plot}(x, y, s) \) 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 ...

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

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 *c*₁, *c*₂, ...).
- **text**(*x, y, t*) adds text *t* at position (*x, y*).
- **axis**(*[x₀, x₁, y₀, y₁]*) changes the range of the axes to *x* ∈ [*x₀, x₁*] and *y* ∈ [*y₀, y₁*].
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.
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 Quiz Questions

Quiz
[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).
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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