CMPSCI 105: Lecture #8 Graphics

PART 1: Graphics File Formats

Common Graphics Files

- **`.BMP`**
- **`.JPG`** / **`.JPEG`**
- **`.GIF`**
- **`.PNG`**
- **`.SVG`**
- One of these things is not like the others…

`.BMP`

- Bitmap (Native to Microsoft Windows)
- Uncompressed, all pixels stored
- Four color modes:
  - 24-Bit (16,777,216 colors) 3 bytes/pixel
  - 256 Color 1 byte/"pixel"
  - 16 Color ½ byte/"pixel"
  - 2 Color (Monochrome) 1 bit/"pixel"
  - First stores colors directly, last three use a Palette
- Not a good choice for the Web due to size

`.JPG` / `.JPEG`

- Joint Photographic Experts Group (pronounced "J-Peg")
- 16,777,216 possible colors (24-bit color)
- Compressed, uses "lossy" compression
  - Converting a **`.BMP`** to **`.JPG`** changes some pixels
  - Increases overall compression by doing so
  - Changes won't be noticed in "noisy" images
- Great for photographs
- Terrible for text, cartoons, line art

`.GIF`

- Graphics Interchange Format (CompuServe 1987, 1989), pronounced "JIFF"
- Up to 256 maximum colors, but uses a palette
- Compressed, uses "lossless" compression
- Supports transparency, simple loop animations
- OK but not great for photographs
- Great for text, cartoons, line art
- Patent entanglements diminished use 1995-2010

.PNG

- Portable Network Graphics (1996, pronounced "P-N-G")
- "Zillions" of colors: supports up to 48-bit color
- Supports both lossy & lossless compression
- Supports transparency (no animations, sorry)
- Great for photographs, text, cartoons, line art
- Free from patent entanglements
- Increasing support by graphics packages

What's Common About These?

- All formats so far (**.BMP**, **.JPG**, **.GIF**, **.PNG**) are pixel-based formats.
- Creatable by painting programs:
  - Windows Paint (comes with Windows)
  - Mac Paintbrush (free download)
  - Photoshop (not free)
- Painting new object over old changes the old
- Scaling up shows a bad case of "jaggies"

.SVG

- Scalable Vector Graphics
- NOT a pixel based graphics format
- IS a vector based graphics format
- Objects have separate existence from images
- Created by drawing programs, not painting
- Looks good when scaled up or down in size
- Text Coding similar to HTML (actually XML)
- Not all browsers fully support **.SVG** (e.g., I.E.)

PART 2: Bézier Curves

Bézier Curves

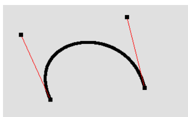
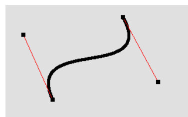
- A Bézier Curve (named after Pierre Bézier) is:
- A Piecewise,
- Parametric,
- Cubic,
- Polynomial.

Polynomial

- A simple polynomial is an equation, with:
- An independent variable,
- A series of terms based on powers of that variable,
- Simple numeric coefficients for those terms (no sines and cosines, no calculus, no fancy stuff, just numbers).
- $f(x) = \ldots + \mathbf{a}x^4 + \mathbf{b}x^3 + \mathbf{c}x^2 + \mathbf{d}x + \mathbf{e}$

Cubic

- Maximum power of any term is 3.
- $f(x) = \boldsymbol{a}x^3 + \boldsymbol{b}x^2 + \boldsymbol{c}x + \boldsymbol{d}$
- For Bézier curves this means that there are at most two changes in direction.

Parametric

- y is not a function of x, locking graph to the coordinate axes, but…
- …both x and y (and z if we go to 3 dimensions) are now functions of a new independent variable, the parameter, often called t,
- For Bézier curves this means that the curve can be oriented anywhere in the plane or in space – and is not locked to the coordinate axes.

Parametric (continued)

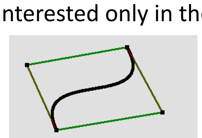
- $x(t) = \boldsymbol{a}_x t^3 + \boldsymbol{b}_x t^2 + \boldsymbol{c}_x t + \boldsymbol{d}_x$
- $y(t) = \boldsymbol{a}_y t^3 + \boldsymbol{b}_y t^2 + \boldsymbol{c}_y t + \boldsymbol{d}_y$
- $z(t) = \boldsymbol{a}_z t^3 + \boldsymbol{b}_z t^2 + \boldsymbol{c}_z t + \boldsymbol{d}_z$
- You can extend this method to even higher dimensions, even if you can't visualize the results!

Piecewise

- If you want a complicated shape, you have to stick a bunch of Bézier curves end-to-end, but…
- …you have to be careful to get one curve to flow smoothly into the next!

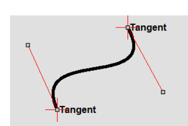
Points

- Four points define a Bézier Curve
  - Two end points and two control points,
  - Each end point associated with one control point.
- The curve goes off infinitely in each direction, but we are interested only in the <u>convex hull</u>:



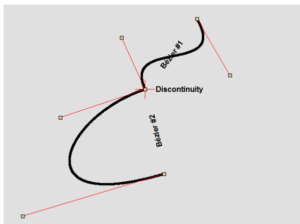
Control Lines

- Each end point and its associated control point form a control line, where…
- …the Bézier curve is tangent to each control line at the end point



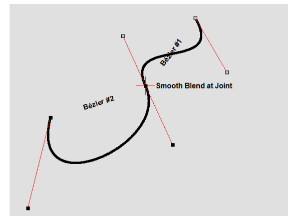
Joining Two Bézier Curves

- But control lines aren't the same:



Joining Two Bézier Curves

- But control lines ARE the same:



Summary

- When joining two Bézier curves end-to-end, make sure that the:
  - Second control point of the first curve,
  - The common end points, and
  - The first control point of the second curve…
- …are all in a straight line…
- …and the first curve will blend smoothly into the second!