CS148: Introduction to Computer Graphics and Imaging

Typography

**Topics**

Piecewise polynomial curves

**Fonts**

- Types of fonts
- Font properties
- Unicode
- Font metrics
- Box and glue model for layout
Polynomial Interpolation

3 constraints = degree 2

Polynomial Interpolation

4 constraints = degree 3
Polynomial Interpolation

5 constraints = degree 4

Underconstrained / Overfitting

5 constraints = degree 10
Curve may oscillate wildly
Overconstrained / Least-Squares

5 constraints = degree 2
Curve does not interpolate points
Instead it approximates the points

Curves in Region of Overlap Different

2 4-point interpolations
Piecewise Polynomial Interpolation

Different curves in each interval
Match values and slopes at endpoints

Describe Glyphs with Paths
John Warnock
Founder of Adobe
Glyphs
Linear and curved pieces
Smooth and kinked corners

abcdefg
Cubic Bezier Curve

Continuity between 2 Bezier Curves

Tangent of the 1st curve is equal to the tangent of the 2nd curve
Continuity between 2 Bezier Curves

4th point of the 1st curve is the same as the 1st point of the 2nd curve

Typography
References

The TExbook
DONALD E. KNUTH

PostScript
LANGUAGE REFERENCE
Adobe Systems Incorporated

References

Elements
TYPO-X
GRAPHIC
STYLE

The Non-Designer's Type Book
Second Edition
Insights and techniques for creating professional-level type

Robert Bringhurst
Robin Williams

CS148 Lecture 9
Pat Hanrahan, Fall 2011
“Because I had dropped out and didn’t have to take the normal classes, I decided to take a calligraphy class to learn how to do this. I learned about serif and sans serif typefaces, about varying the amount of space between different letter combinations, about what makes great typography great. It was beautiful, historical, artistically subtle in a way that science can’t capture, and I found it fascinating.”

Types of Type

(From R. Williams, Non-Designers Design Book)
**Oldstyle (Renaissance)**

- Serif (pronounced "sairif," not "suh reef")
- Diagonal stress
- Serifs on lowercase letters are slanted
- Moderate thick/thin transition in the strokes

Oldstyle

Goudy Palatino Times
Baskerville Garamond

CS148 Lecture 9 Pat Hanrahan, Fall 2011
Modern

Vertical stress
Serifs on lowercase letters are thin and horizontal

Radical thick/thin transition in the strokes

Bodoni, Times Bold, Onyx
Fenice, Ultra, Walbaum

Slab Serif

Serifs on lowercase letters are horizontal and thick (slabs)
Vertical stress
Very little or no thick/thin transition, or contrast, in the strokes

Clarendon, Memphis
Memphis Extra Bold
New Century Schoolbook
Childhood

I was born of very humble heritage. My mother and father had no degrees. Strange as it may seem, they only followed good common sense in rearing their family. My mother’s maiden name carried a Von before it and I believe this was a sign of some royal ancestor.

My grandfather Klinger had a grocery store and saloon, quite an enterprise in the 1800’s. My mother, with the rest of her family, arose early each morning to count and bag potatoes and from that I probably inherited the ability to count and bag coins at the dairy.
Styles

Roman

“I” changed

Italic

Oblique
Weights

Light
Regular
Semibold
Bold

Stretch

Condensed
Regular
Expanded
Properties

A case of cast metal type pieces and typeset matter in a composing stick

Typographical Size

Units
Points (pt)
Traditional: $72 \text{ pt} = 0.996 \text{ in}$
Adobe: $72 \text{ pt} \equiv 1 \text{ in}$
Picas (pc)
$12 \text{ pt} = 1 \text{ pc}$

Point or body size
Em (size of "M" - Body Size x Body Size)
En (size of "M" / 2)
Pixel Size is Not Equal to Point Size

Using pixels as the unit of size ...

Problem: the size of the character depends on the size and resolution of the display

- Early displays: 72 ppi (pixels per inch)
- Newer displays: 96 ppi
- iPhone retinal display: 960/3.5" = 363 ppi

Operating systems (and browsers) make assumptions about the ppi (bad)

- Mac: 72 ppi -> 1 px ~ 1pt
- Windows: 96 ppi

Font Metrics

```
ascent  ascender height

cap height

mean line  median

baseline

descent  descender height
```

Point size of font ~ ascender + descender
Glyph Metrics (STFont)

Need to store width or advance ...

Freetype Glyph Metrics (STFont)

Different x-heights

Times Caslon

The bigger the x-height the larger the font seems

Small fonts designed for the screen (like Tahoma & Verdana) have large x-heights. They are also stretched and have fairly uniform letter spacing.
Leading

The distance from the baseline of one line of type to another is called line spacing. It is also called leading, in reference to the strip of lead used to separate lines of metal type. The default setting in most layout and imaging software is slightly greater than the cap height of the letters. Expanding this distance creates a text block with a lighter, more-open color. As line spacing increases further, the lines of type become independent linear elements rather than parts of an overall texture.

10/11 Scala
10-px type with
15 px line spacing

This is called “set solid.” When lines are set this closely together, the ascenders and descenders begin to touch, an uncomfortable effect.

10/12 Scala
10-px type with
16 px line spacing

In most page layout programs, the default line spacing (leading) is 120%, or slightly greater than the cap height.

10/13 Scala
10-px type with
14 px line spacing

This column is set with wider line spacing (leading) than the standard default.

10/14 Scala
10-px type with
15 px line spacing

As the spacing becomes more extreme, the block of text begins to read as separate lines rather than a shade of grey.

Kerning

AV Wa
No kerning

AV Wa
Kerning applied
Ligatures

ff fi fl ffi ffl

ff fi fl ffi ffl

Combining Marks

á á̈ á̑ á̌ á̒ á̓ acute grave tildemacron breve circumflex

â â̈ â̑ â̌ â̒ â̓ overdot diacriticumlaut ring doubleacute caron

ć cédilla ogonek
Unicode and Font Formats

Unicode [unicode.org]

“Unicode provides a unique code for every character, no matter what the platform, no matter what the program, no matter what the language”

Characters distinguished by charcodes
Initial version encodes 65K (16-bit) characters
Organized as 256 code pages
  - http://unicode.org/charts
Encodings represent charcodes as numbers
  - ASCII, UTF-8, UTF-16, ISO-8859-1, ...

<?xml version="1.0" encoding="utf-8">
Font Definition (OpenType/TrueType)

Encoding
- Number representation → character code
- For example, utf-8 is a variable byte encoding

Character map
- Character code → glyph

Glyphs
- Bitmap
- Outline

Glyph metrics
- Baseline, advance

Box and Glue Model
Box and Glue Model

Box: Width

11 9 9 11 9 9 7 9

Don Knuth

2+1 2+1 6+6 2+1 2+1 2+1 2+1

Glue: Space + Stretch

Box and Glue Model

Stretch by 12

11 9 9 11 9 9 7 9

Don Knuth

3 3 12 3 3 3 3
Box and Glue Example

5 Results

In this section, we start by demonstrating the efficiency of the scattering equations for solving rendering problems. We then demonstrate the use of the 3D scattering and adding equations to render complex surfaces and show applications of the 3D scattering equation in accurate rendering of surfaces, accounting for light that enters the surface some distance from where it exists.

5.1 Accuracy and efficiency

We tested our implementation's accuracy against a model that corresponds to the standard problem in astrophysics. This model is specified by the atmosphere's optical thickness, albedo, and phase function. The resulting scattering functions have been computed and tabulated by many authors. We compared our results to tables from Bellman et al. [BK86], which have results computed by using Gaussian quadrature to generate a system of differential equations which were then solved via the Runge-Kutta method.

For a set of roughly forty randomly-selected albedos, thicknesses, and pairs of angles, we found excellent agreement with the

Things to Remember

Glyph outlines are modeled using piecewise curves

Typography

- Types of type
- Style, weight, stretch
- Character encoding is different than glyph index
- Font metrics
- Layout, box and glue model