Readings:

Today: Flash animation handout
Next class: Chapter 17, esp. §17.1 – 17.2, Eberly

Reference: http://www.learning-maya.com

Today:
- Maya & Animation Preliminaries – Ross Tutorials
  - Maya interface: navigation, menus, tools, primitives

Next Class:
- Animations 2 – Rotations, Dynamics & Kinematics

Lecture Outline

- Reading for Last Class: §10.4, 12.7, Eberly
- Reading for Today: §11.1 – 11.6 Eberly 2nd Ed. (736), Flash handout
- Reading for Next Class: §17.1 – 17.2, Eberly 2nd Ed.

- Last Time: Curves & Surfaces
  - Piecewise polynomial curves (aka splines) and their properties
  - Hermite vs. Bézier curves: manipulation vs. display (rendering)
  - DeCasteljau’s algorithm: recursive linear interpolation
  - Other representations: Bernstein basis functions, matrix form
  - Bicubic surfaces
  - Bilinear interpolation

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**Review [2]: Linear Interpolation**

- Linear interpolation (Lerp) is a common technique for generating a new value that is somewhere in between two other values.
- A `linear` could be a number, vector, color, or even something more complex like an entire 3D object...
- Consider interpolating between two points a and b by some parameter t: $Lerp(t, a, b) = (1-t)a + tb$

**Review [3]: Hermite Curves**

- Polylines are linear (1st order polynomial) interpolations between points
- Green points P0 and P1: They determine the tangents at the join points:
  - $(1-t)P_0 + tP_1$ are called weighting functions of $P_0$ and $P_1$
- Splines are higher order polynomial interpolations between points
- Linear interpolation but with higher order weighting functions allowing better approximation/smoothness of curves.
- One representation: Hermite curve (interpolating spline):
  - Determined by two control points $P_0$ and $P_1$, an initial tangent vector $v_0$, and a final tangent vector $v_1$.
  - Equations:
    - $y(t) = (2t^3 - 3t^2 + 1)P_0 + (-2t^3 + 3t^2)P_1$
    - $(t^2 - 2t + 1)v_0 + (t^2 - 2t + 1)v_1$

**Review [4]: Bézier Curves**

- Bézier representation is similar to Hermite.
- 4 points instead of 2 points and 2 vectors $(P_1-P_0)$
- Initial position $P_0$, tangent vector is $P_1 - P_0$.
- Final position $P_3$, tangent vector is $P_3 - P_2$.
- This representation allows a spline to be stored as a list of vertices with some global parameters that describe the smoothness and continuity.
- Bézier splines are widely used (Adobe, Microsoft) for font definition.

**Review [5]: De Casteljau's Algorithm**

- Geometric Continuity: $G^i$
  - Guarantees that direction of $i$th order derivative equal
  - $G^0$: curves touch at join point
  - $G^1$: curves also share common tangent direction at join point
  - $G^2$: curves also share common center of curvature at join point
- Mathematical Continuity: $C^i$
  - Guarantees that direction, magnitude of $i$th order derivative equal
  - $C^0$: $G^i$ curves touch at join point
  - $C^1$: curves share common tangent direction / magnitude at join point
  - $C^2$: curves share second derivative at join point

**Review [6]: Bernstein Polynomials – Matrix Form**

- Bernstein polynomials can be represented in a matrix form.
- The Bernstein basis functions form a basis for the space of polynomials.
- $x = a_0 + a_1t + a_2t^2 + a_3t^3 + a_4t^4$
- The coefficients $a_0, a_1, a_2, a_3, a_4$ correspond to the values of the function at the end points of the interval.

**Review [7]: Gvs. C1 Continuity**

- Geometric Continuity: $G^i$
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Parametric Bicubic Surface: Generalization of Parametric Cubic Curve

From Curves to Surfaces
- Let one parameter (say $v$) be held at constant value
- Above will represent a curve
- Surface generated by sweeping all points on boundary curve, e.g., $P(u, 0)$, through cubic trajectories, defined using $v$, to boundary curve $P(u, 1)$

$$0 \leq u, v \leq 1$$

$$P(u, v) = [x(u, v), y(u, v), z(u, v)]$$

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Review [8]:
- Parametric Bicubic Surfaces
- Curves
  - Bézier: easier to scan convert (DeCasteljau)
  - Hermite: easier to control via GUI (tangent)
- Bicubic patches
  - Bilinear interpolation
  - Control patch aka Coons patch

Curves & Surfaces
- Acknowledgments - thanks to Eric McKenzie, Edinburgh, from whose Graphics Course some of these slides were adapted.

Acknowledgements: Maya Character Rigging

Aaron Ross
Founder, Digital Arts Guild
http://dr-yo.com
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- Examples Online

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Maya Character Rigging
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Character Modeling in Maya [4]: Driver

Character Modeling in Maya [5]: Blend Shape Deformation Setup

Character Modeling in Maya [6]: Inverse Kinematics (IK)

Character Modeling in Maya [7]: Controlling Deformation & Rotation

Cloth Modeling in Maya [1]: More Driven Keys & Blend Shape

Cloth Modeling in Maya [2]: Output
Summary

- Reading for Next Class: §17.1 – 17.2, Eberly 3rd
- Last Time: Curves & Surfaces
- Piecewise linear, quadratic, cubic curves and their properties
- Interpolation: subdivision (DeCasteljau’s algorithm)
- Bicubic surfaces & bilinear interpolation
  - Maya interface: navigation, menus, tools, primitives
  - GUI & objects (Ross 1); viewports, transforms, & hotkeys (Ross 2)
  - Nodes & attributes (Ross 3); UI, channel box & deformers (Ross 4)
  - Modeling, scene creation, materials (Ross 5)
- Previous Videos (#3): Morphing & Other Special Effects (SFX)
- Next Set of Videos (#4): Modeling & Simulation
- Next Class: Animations 2 – Rotations, Dynamics & Kinematics

Terminology

- Piecewise Polynomial Curves aka Splines
- Continuity: Geometric (G), Mathematical (C)
- Bicubic Surfaces including NURBS Surfaces
- Maya Software for 3-D Modeling & Animation
  - Shelves – groups of tools & action icons; compare palettes, toolbars
  - Hotkeys – key combos for common functions; compare macros
  - Viewports – scene views for editing: orthographic, perspective
  - Channel box – GUI for accessing position, rotation, scale, history
  - Deformers – tools for controlling complex vertex meshes
- Rigging Character Models: Defining Components of Articulated Figure
  - Joints – axis of rotation, angular degree(s) of freedom (DOFs)
  - Bones – attached to joints, rotate about joint axis