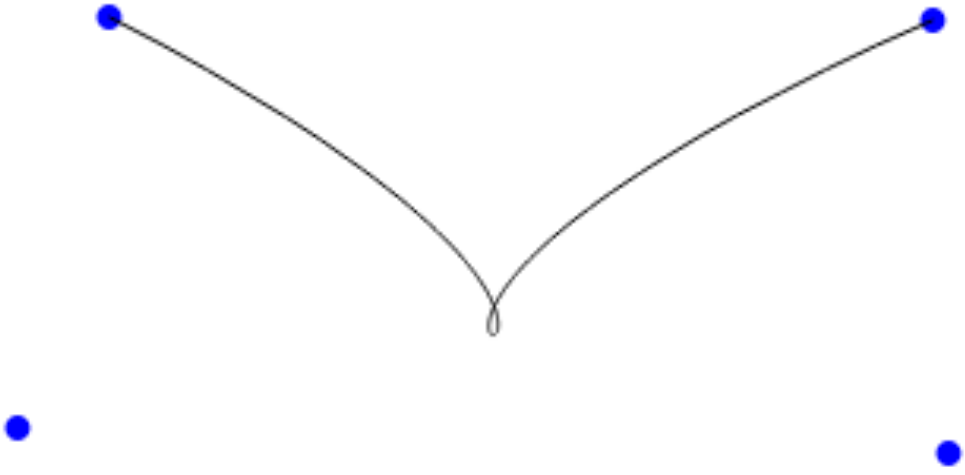


Computer Graphics

Lecture 31

Spline lab wrap-up

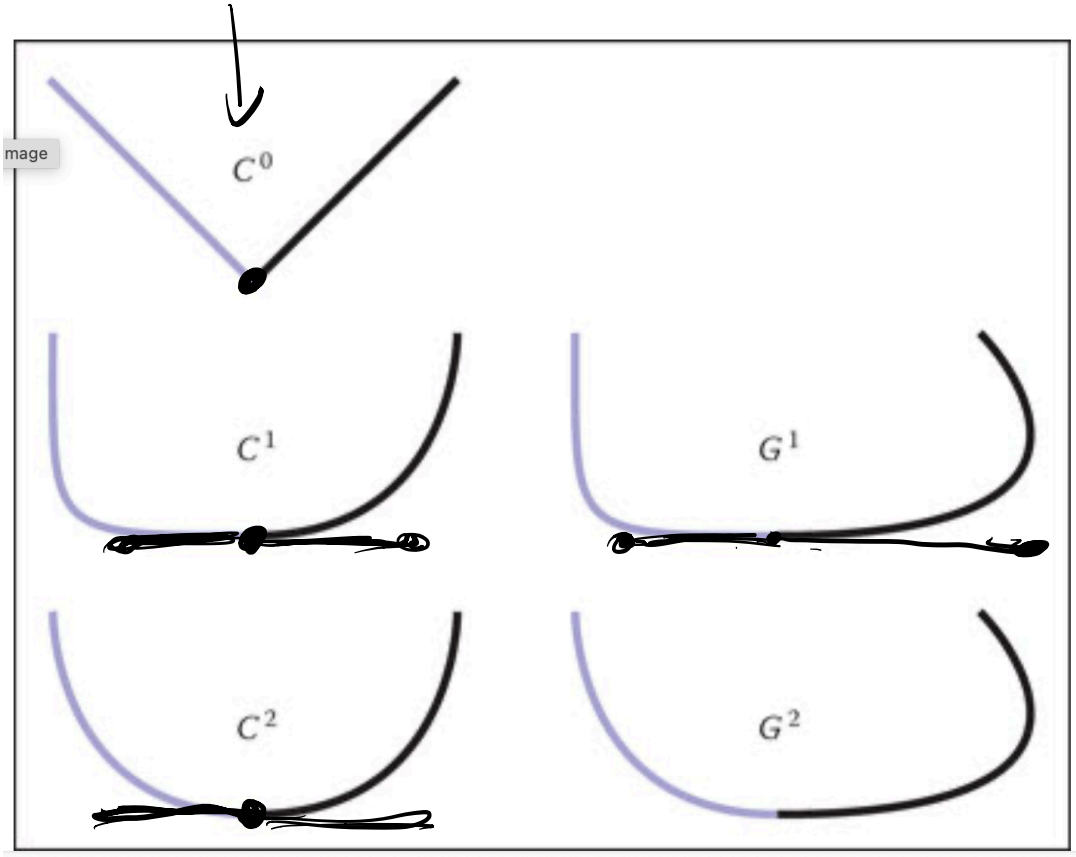
A little more on curves

Animation (if time)

Joining Segments

- http://math.hws.edu/eck/cs424/notes2013/canvas/bezier.html

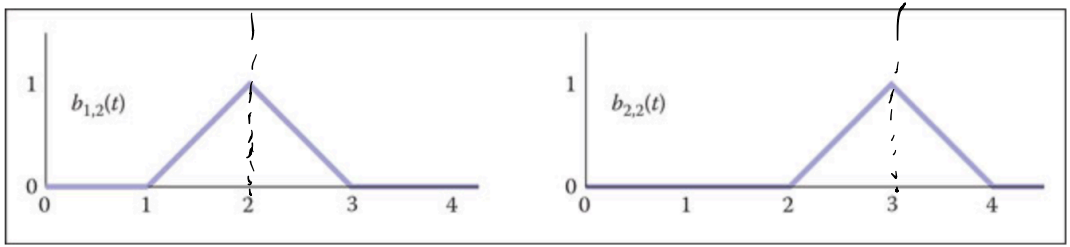
Curve Properties: Continuity



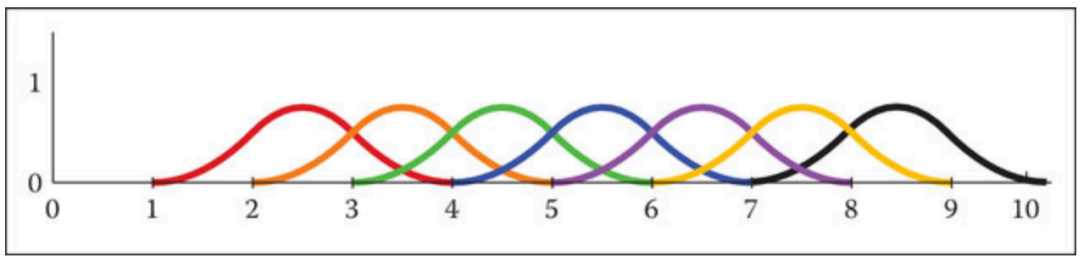
B-Splines

- Offer arbitrary continuity
- The basis polynomials are splines themselves!

k: polynomial order of "bump"

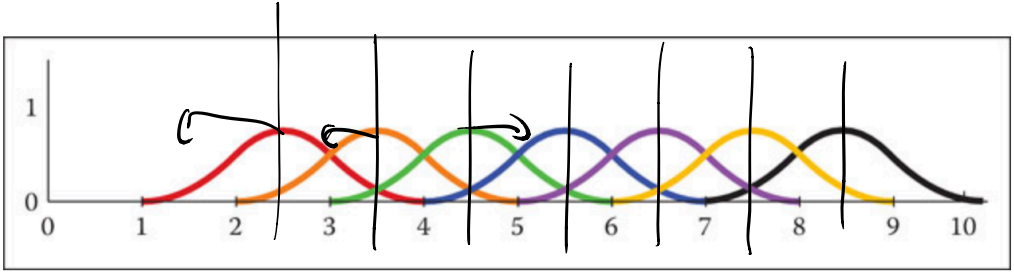


k = 1



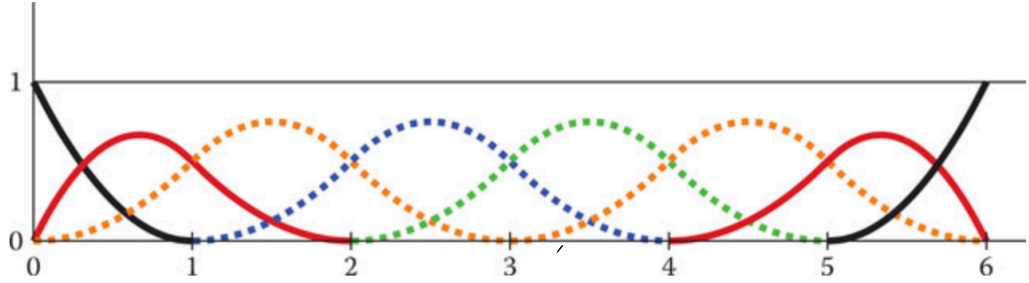
k = 3

Uniform B-Splines

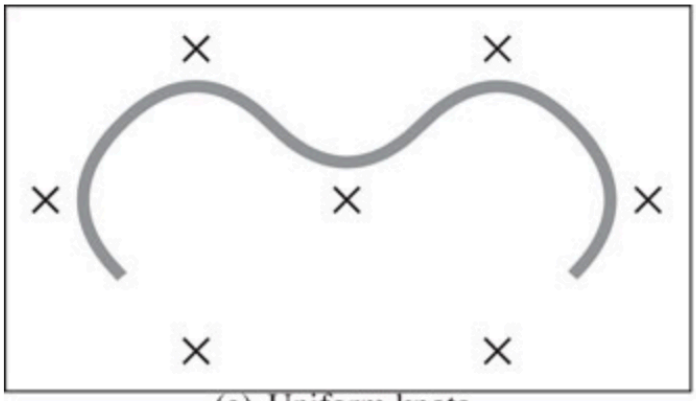


uniform B-spline: "bumps" (knots) evenly spaced

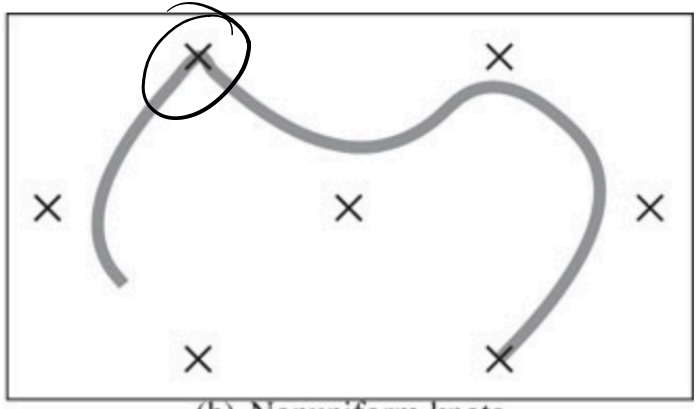
Non-Uniform B-Splines



non-uniform B-spline: "bumps" (knots) are not evenly spaced



(a) Uniform knots



(b) Nonuniform knots

Non-Uniform **Rational** B-Splines: NURBS

- B-spline bases are polynomials - can't represent conic sections e.g., a circle:
  - $x^2 + y^2 = 0$
- Rational B-splines - use a **ratio** of two polynomials.
  - Numerator and denominator are both B-splines

Curves are great, but.

https://youtu.be/AcFwH161XtM?t=68

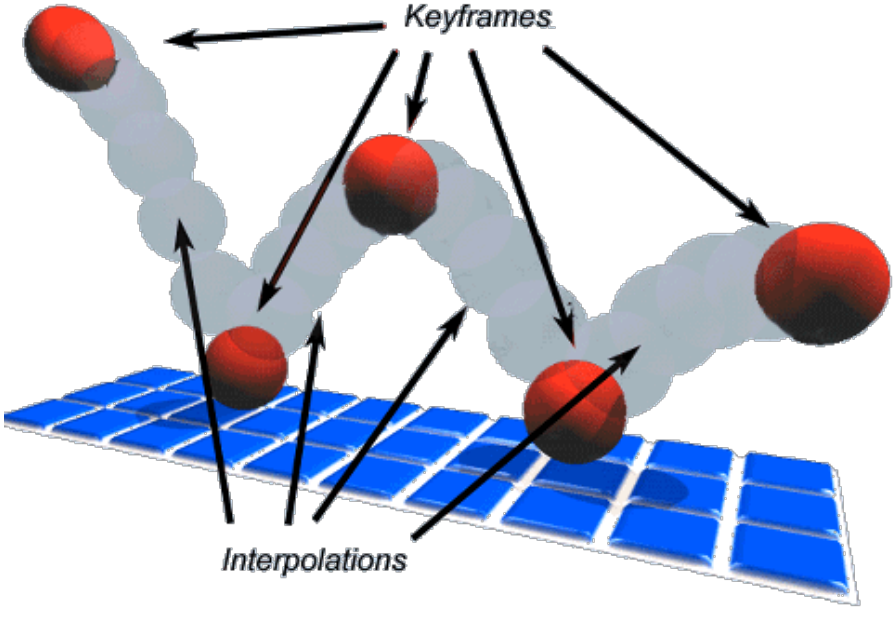
https://youtu.be/Zkx1aKv2z8o?t=1080

Animation

- Time-varying scene/model.
  That's pretty much it.
- Big challenges:
  - tedium
  - realism

Animation - Tedium

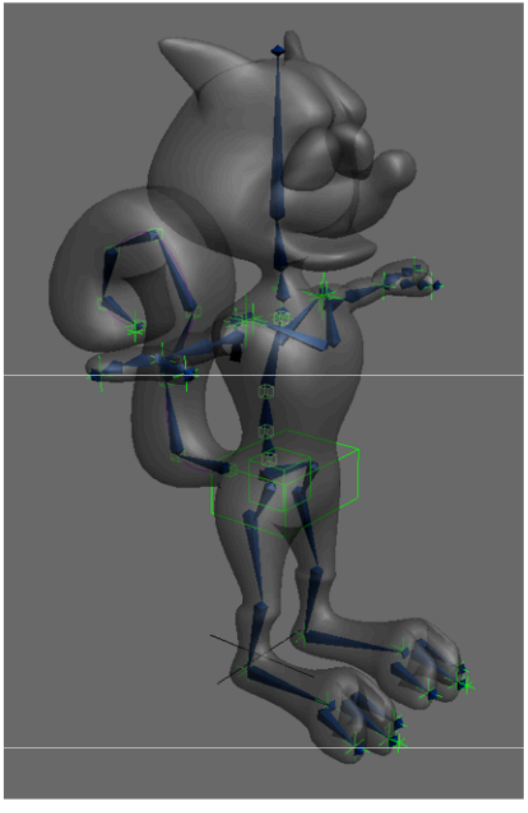
- **Keyframing** + interpolation



Linear interpolation? **Spline** interpolation?

Animation - Tedium

- **Rigging**

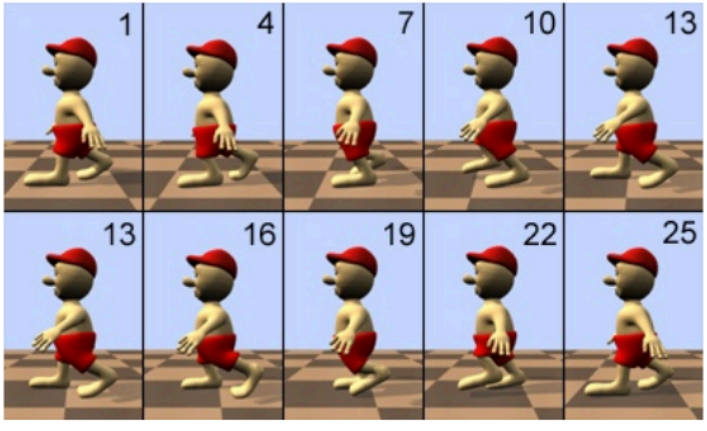


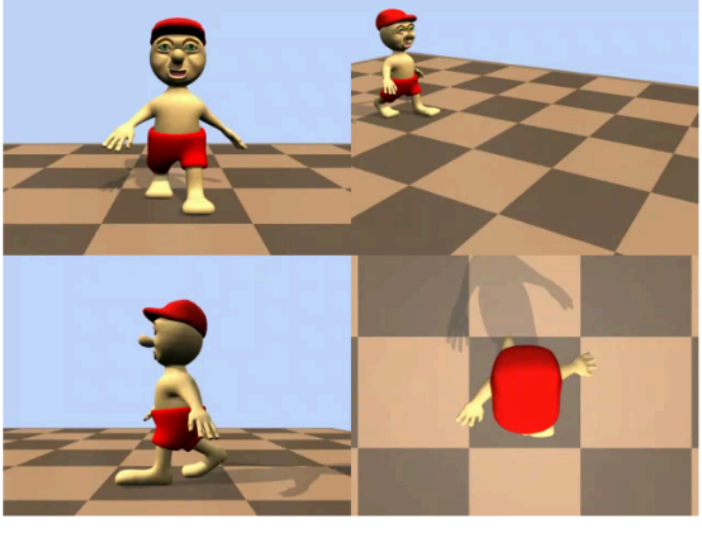
- Surface is deformed by a set of *bones*
- Bones are in turn controlled by a smaller set of *controls*
- The controls are useful, intuitive DOFs for an animator to use

Modeling DOF != Animation DOF

Animation - Tedium

Walk cycle

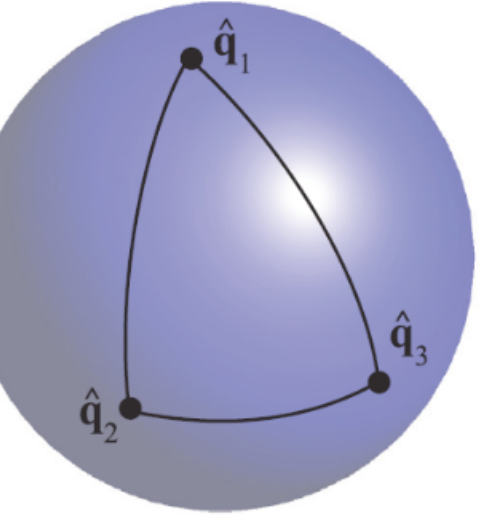




[Christopher Lutz http://www.animationsnippets.com]

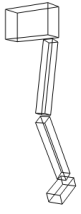
Interpolating Rotations

- Representation matters a lot - linear interpolation of rotation matrices are not rotation matrices.



- Quaternions are one answer
  - 4D vectors that make spherical interpolation nicer

Animation - Tedium



Forward Kinematics

Inverse Kinematics

Animation - Realism

- Tron (1982)
- Tron Legacy (2010)
- How to Train Your Dragon 2 (2014)

Animation - Realism

Motion capture

- A method for creating complex motion quickly: measure it from the real world

Animation - Realism

Motion capture in movies

[*The Two Towers* | New Line Productions]

Animation - Realism

Motion capture in games

Animation - Realism

- Motion capture technologies:

Magnetic

Mechanical

Optical