

Animation Pipeline Keyframing Introduction

COMPUTER ANIMATION

15-497/15-861

Producing an Animation

- Film runs at 24 frames per second (fps)
 - That's 1440 pictures to create per minute
 - 1800 fpm for video (30fps)
- Productions issues:
 - Need to stay organized for efficiency and cost reasons
 - Need to create the frames systematically
- Artistic issues:
 - How to create the desired look and mood while conveying story?
 - Artistic vision has to be converted into a sequence of still frames
 - Not enough to get the stills right--must look right at full speed
 - » Hard to “see” the motion given the stills
 - » Hard to “see” the motion at the wrong frame rate

A lesson you will painfully learn in this class!

Traditional Animation: The Process

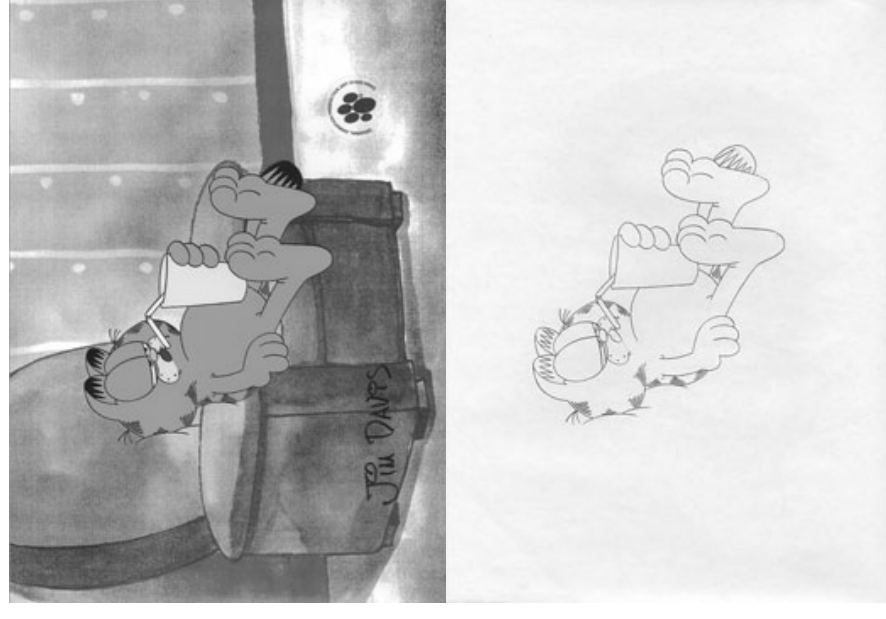
- Story board
 - Sequence of drawings with descriptions
 - Story-based description
- Key Frames
 - Draw a few important frames as line drawings
 - » For example, beginning of stride, end of stride
 - Motion-based description
- Inbetweens
 - Draw the rest of the frames
 - People who draw these don't get paid much
- Painting
 - Redraw onto acetate *Cels*, color them in
 - These people get paid even less



From <http://www.animationartgallery.com/>

Layered Motion

- It's often useful to have multiple layers of animation
 - How to make an object move in front of a background?
 - Use one layer for background, one for object
 - Can have multiple animators working simultaneously on different layers, avoid re-drawing and flickering
- Transparent acetate allows multiple *layers*
 - Draw each separately
 - Stack them together on a copy stand
 - Transfer onto film by taking a photograph of the stack



From <http://www.animationartgallery.com/>

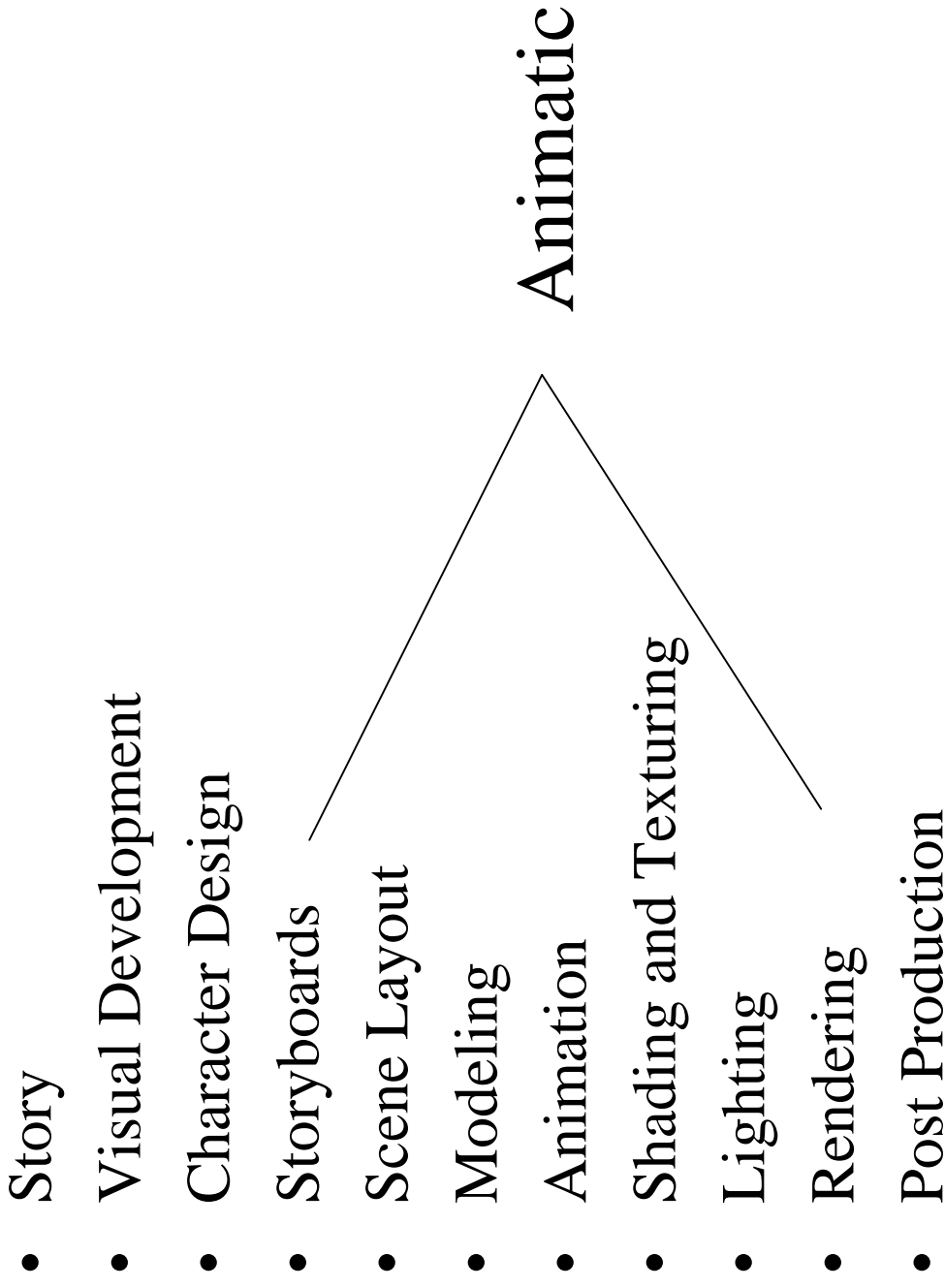
Computer-Assisted Animation

- Computerized Cel painting
 - Digitize the line drawing, color it using seed fill
 - Eliminates cel painters (low rung on totem pole)
 - Widely used in production (little hand painting any more)
 - e.g. *Lion King*
- Cartoon Inbetweening
 - Automatically interpolate between two drawings to produce inbetweens (morphing)
 - Hard to get right
 - » inbetweens often don't look natural
 - » what are the parameters to interpolate? Not clear...
 - » not used very often

True Computer Animation

- Generate the images by rendering a 3-D model
- Vary the parameters to produce the animation
- Brute force
 - Manually set the parameters for each and every frame
 - For an n parameter model: $1440n$ values per minute
- Computer keyframing
 - Lead animators create the important frames with 3-D computer models
 - Unpaid computers draw the inbetweens
 - The dominant production method

Digital Production Pipeline



Story

- Different types of stories
 - beginning/middle/end with conflict and resolution (drama)
 - » Red's Dream
 - sequences built around a situation
 - » Mickey Mouse
 - String of Gags
 - » Roadrunner
- Story is the most important part of any animation
 - 1 big, simple idea
 - the story you can tell in 2 sentences
 - Shorts are particularly hard to get right

Visual Development

- What look will your scenes have?
- Who are the characters and how do they look?
- Develop style
- Includes the creation of characters, environments (desert, swamp), props, etc.
- Involves painters, sculptors, illustrators, etc.

Lots of drawings pasted up on the wall!

Character Design

- After story come characters
- Consists mostly of drawings, or sculptures
 - body poses
 - facial expressions
 - key features from multiple points of view

Note the lack of computers at this stage!

Storyboards

- The film in outline form
 - specify the key scenes
 - specify the camera moves and edits
 - specify character gross motion
- Typically paper and pencil sketches on individual sheets taped on a wall

Still not very many computers...

Story Boarding (from “A Bug’s Life”)



What makes a good storyboard?

- Does the shot sequence
 - maintain continuity
 - not confuse the audience
 - contain variations in pacing
- Is the information clearly presented?
- Are the characters clearly portrayed?
- Is the story clear?
- Do you have the techniques necessary to pull it off?
- Can you do it with the time and \$ you have?

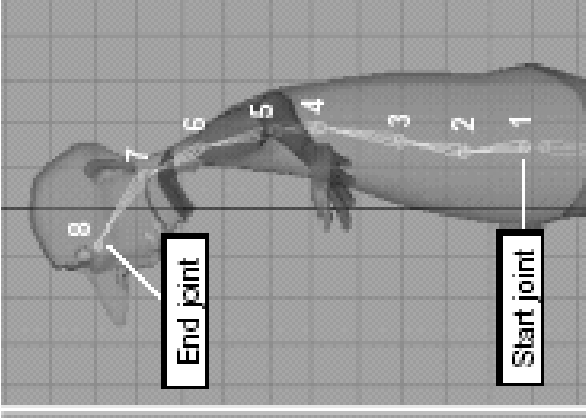
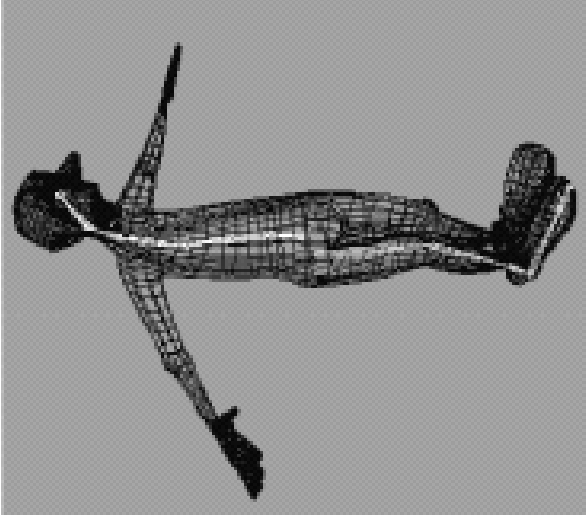
Scene Layout

Design the scenes

- for example, build the room with an understanding of the camera pan
- create colors
- create textures
- create props
- keep in mind camera and character motion within the scene
- use placeholder geometry and start to design camera moves

Modeling

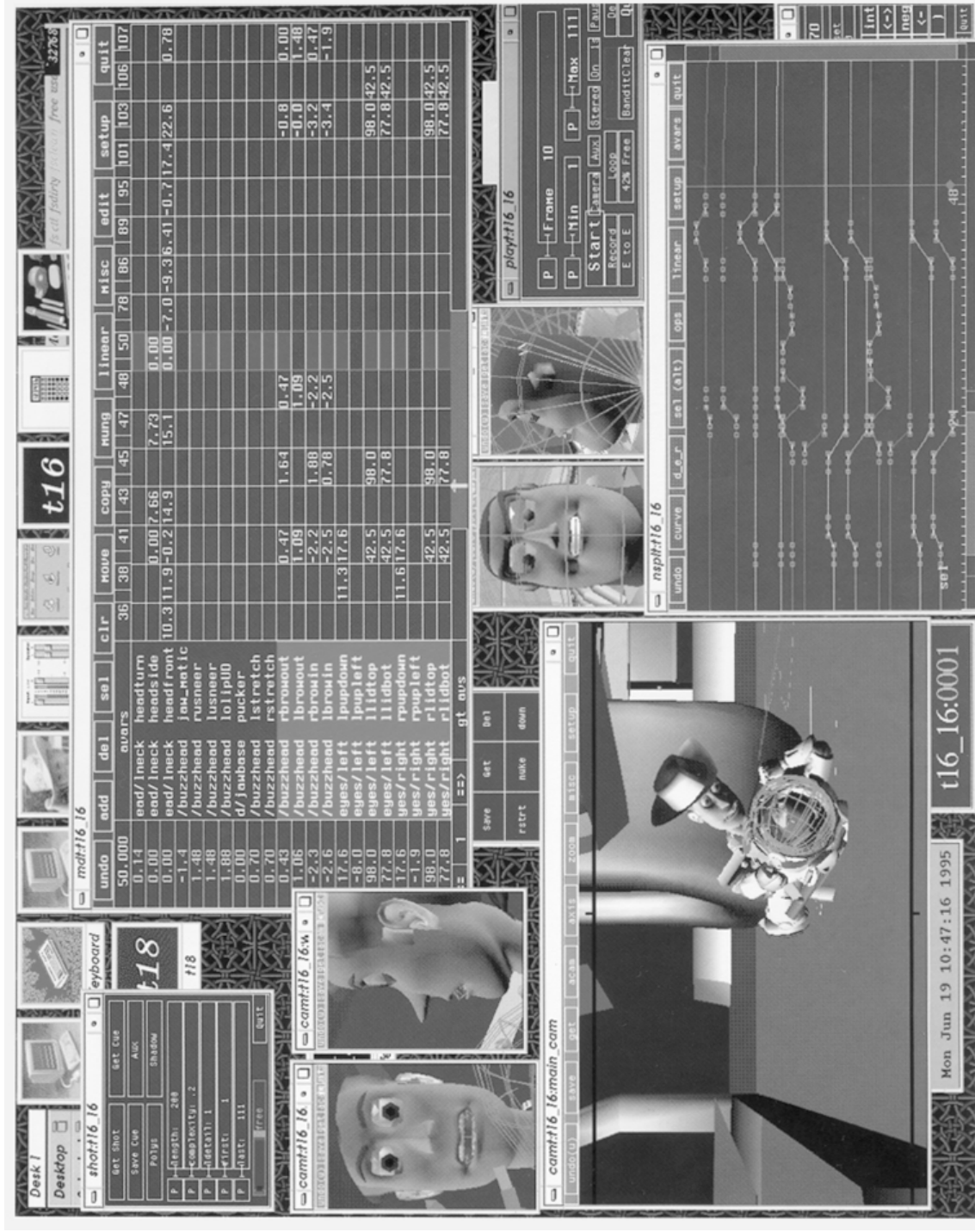
- Create geometric models of environment, props, characters
- Keep in mind the ultimate purpose of the model – feature film, game, etc.
- Set up internal skeleton and animation handles appropriately for that character's behaviors



Scene from Toy Story II



From the “Making of Toy Story”



Post Production

- Sound track sync
- Titles
- Cuts and effects (dissolves, fades, etc)

Rendering

- Frames can take hours to render
- 1800 frames for a single minute of animation
- Pixar has a HUGE renderfarm

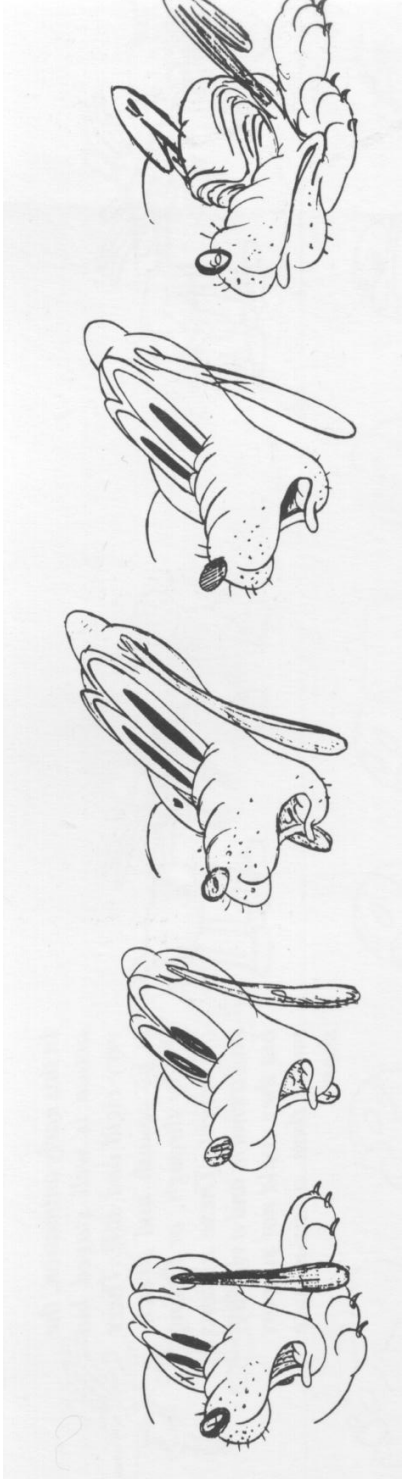
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What is a key?

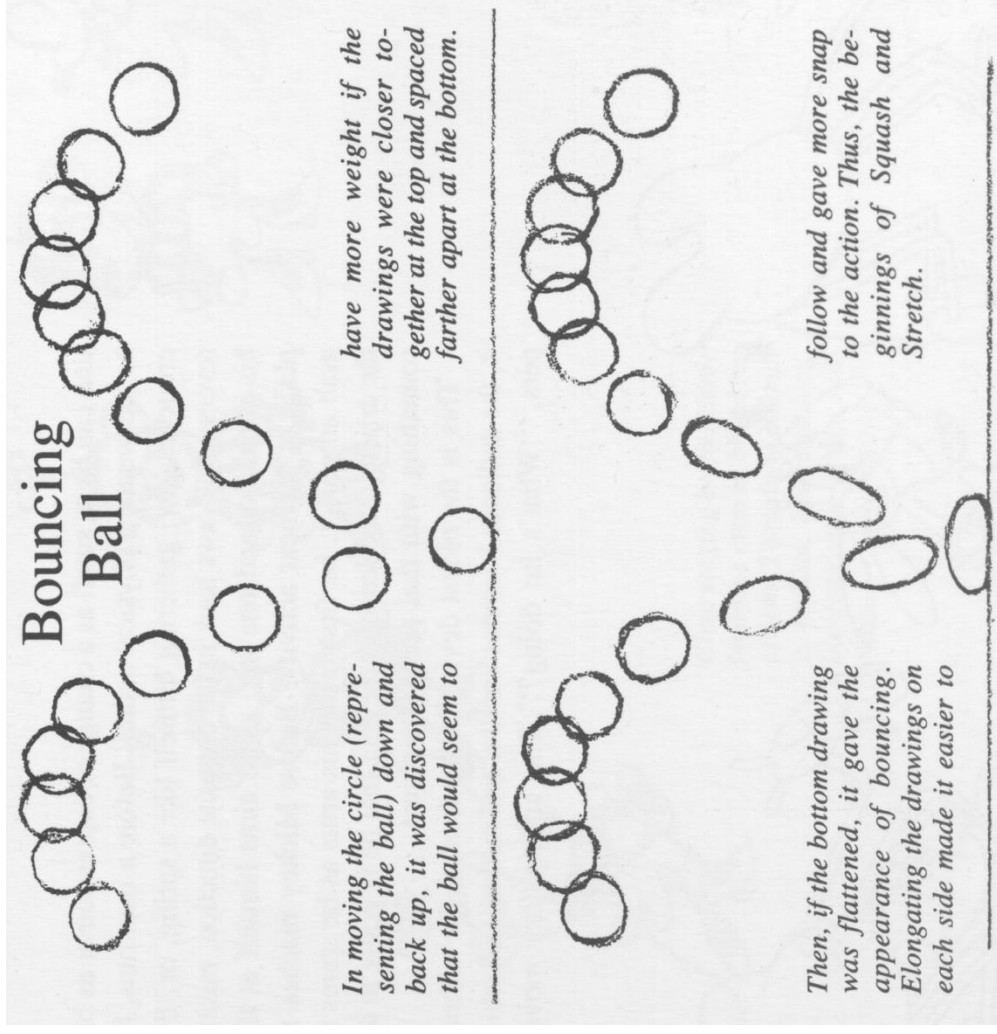
- Hard to interpolate hand-drawn images
 - Computers don't help much



- The situation is different in computer animation:
 - Each keyframe is defined by a bunch of parameters (state)
 - Sequence of keyframes = points in high-dimensional state space
- Computer inbetweening interpolates these points
- How? You guessed it: splines

What is a key?

- For a bouncing ball?
 - Position in 3D
 - Orientation?
 - Squishedness?



What is a key?

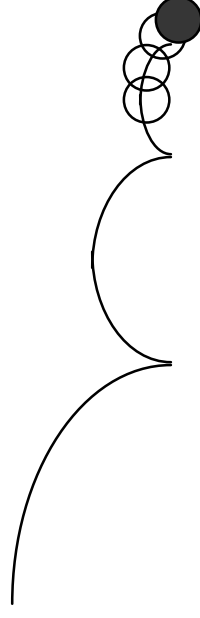
- For a monster?
 - Position and orientation in 3D
 - Joint angles of the hierarchy
 - Deformations?
 - Facial features
 - Hair/fur???
 - Clothing???



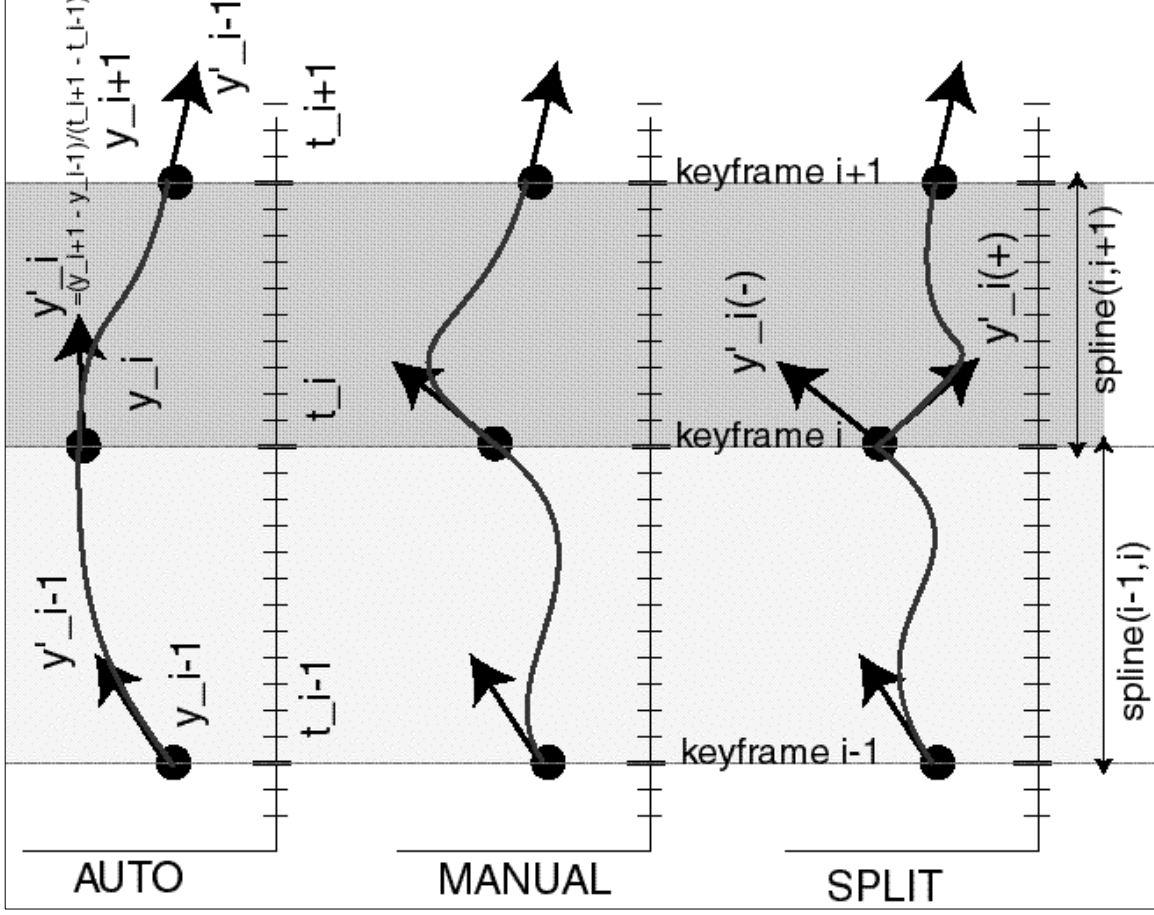
© 2001 Disney/Pixar

Splines for Interpolation

- Splines: non-uniform, C^1 is pretty good
- Velocity control is needed at the keyframes
- Classic example - a ball bouncing under gravity
 - zero vertical velocity at start
 - high downward velocity just before impact
 - lower upward velocity after
 - motion produced by fitting a smooth spline looks unnatural
- What kind of continuity/control do we need?

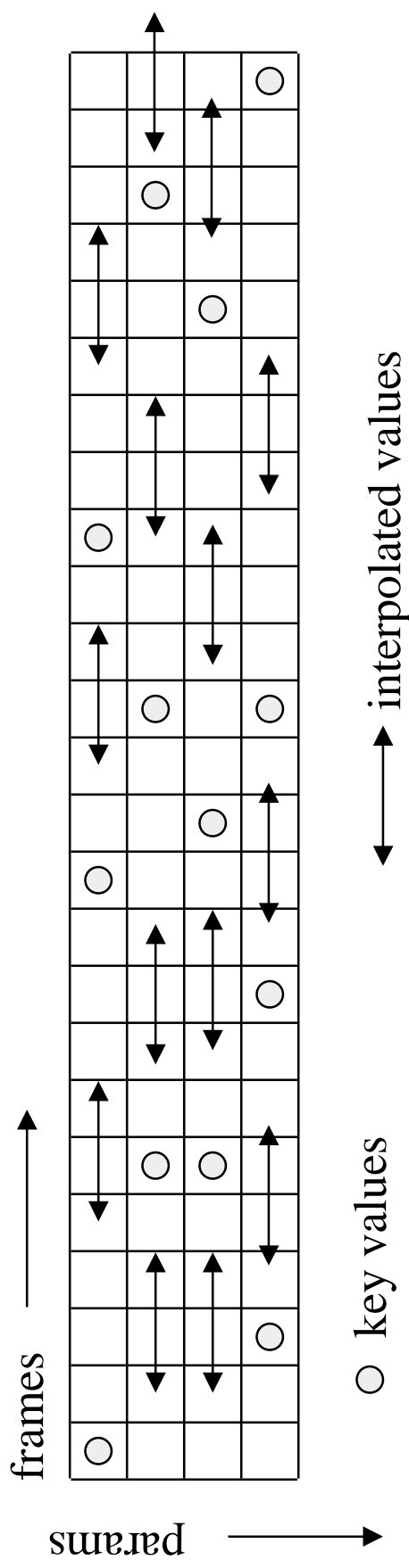


How Do You Interpolate Between Keys?



Keyframing Basics

- Despite the name, there aren't really keyframes, *per se*.
- For each variable, specify its value at the “important” frames.
- Not all variables need agree about which frames are important.
- Hence, *key values* rather than key frames
- Create path for each parameter by interpolating key values



Keyframing: Issues

- What should the key values be?
- When should the key values occur?
- How can the key values be specified?
- How are the key values interpolated?
- What kinds of BAD THINGS can occur from interpolation?
 - Invalid configurations (pass through walls)
 - Unnatural motions
 - » Painful twists/bends
 - » Going the “long way around”
 - Jerky motion

Keyframe Animation: Production Issues

- How to learn the craft?
 - apprentice to an animator
 - practice, practice, practice
- Pixar starts with animators, teaches them computers and starts with computer folks and teaches them some art
- Gives good control over motion
- Eliminates much of the labor of traditional animation
 - But still very labor-intensive
- Impractical for complex scenes with everything moving: grass in the wind, water, and crowd scenes, for example

Next Class

- Representation of joint angles
 - Euler angles
 - Quaternions
- Interpolation of quaternions

Very important for the first assignment!