Animation

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Animation

- Changing images quickly
- Timing is critical
  - Fast movement makes object appear low weight
  - Slow movement = heavy
  - **Easing** in and out, acceleration and deceleration
  - Controlling timing
    - Frames and update speed
- Disney - the kings of animation
  - Principles of hand drawn animation still relevant
  - But there are some issues for **Dynamic Animation**

Principles of Animation

- Disney's principles

1. **Timing and Motion** - spacing actions to define the weight and size of objects and the personality of characters
2. **Squash and Stretch** - defining the rigidity and mass of an object by distorting its shape during an action
3. **Anticipation** - the preparation for an action
4. **Staging** - presenting an idea so that it is unmistakably clear
5. **Follow Through and Overlapping Action** - the termination of an action and establishing its relationship to the next action
6. **Straight Ahead Action and Pose-to-Pose Action** - The two contrasting approaches to the creation of movement

Principles of Animation

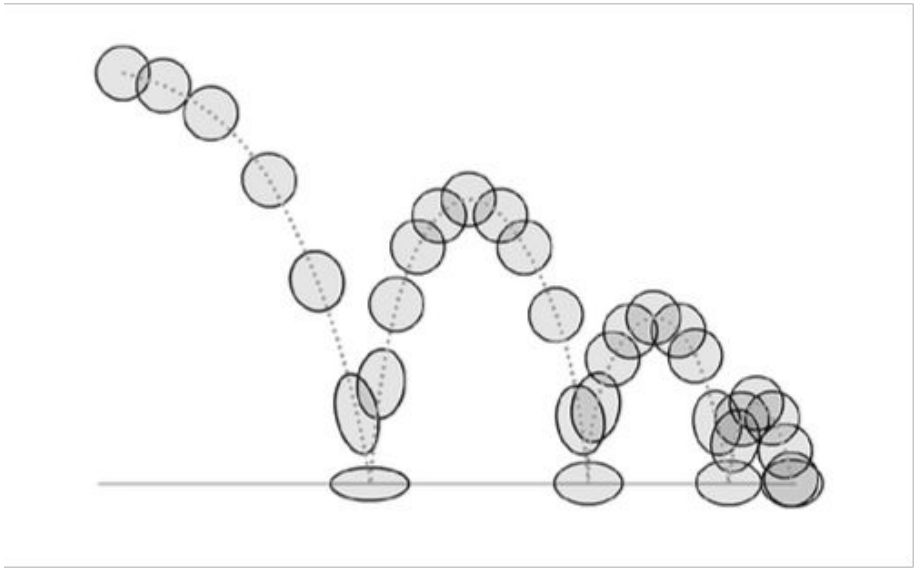
- Disney's principles cont.

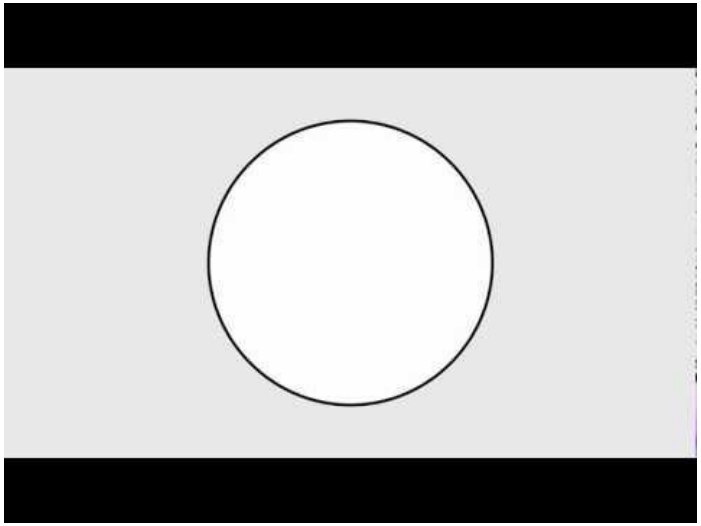
7. **Slow In and Out** - the spacing of the in-between frames to achieve subtlety of timing and movement
8. **Arcs** - the visual path of action for natural movement
9. **Exaggeration** - Accentuating the essence of an idea via the design and the action
10. **Secondary Action** - the action of an object resulting from another action
11. **Solid Drawing*** - has a 3D presence, less of an issue for us
12. **Appeal** - creating a design or an action that the audience enjoys watching

Squash and stretch

- Understanding Physics
  - But not always copying it
  - What **looks** right is more important than what **is** right

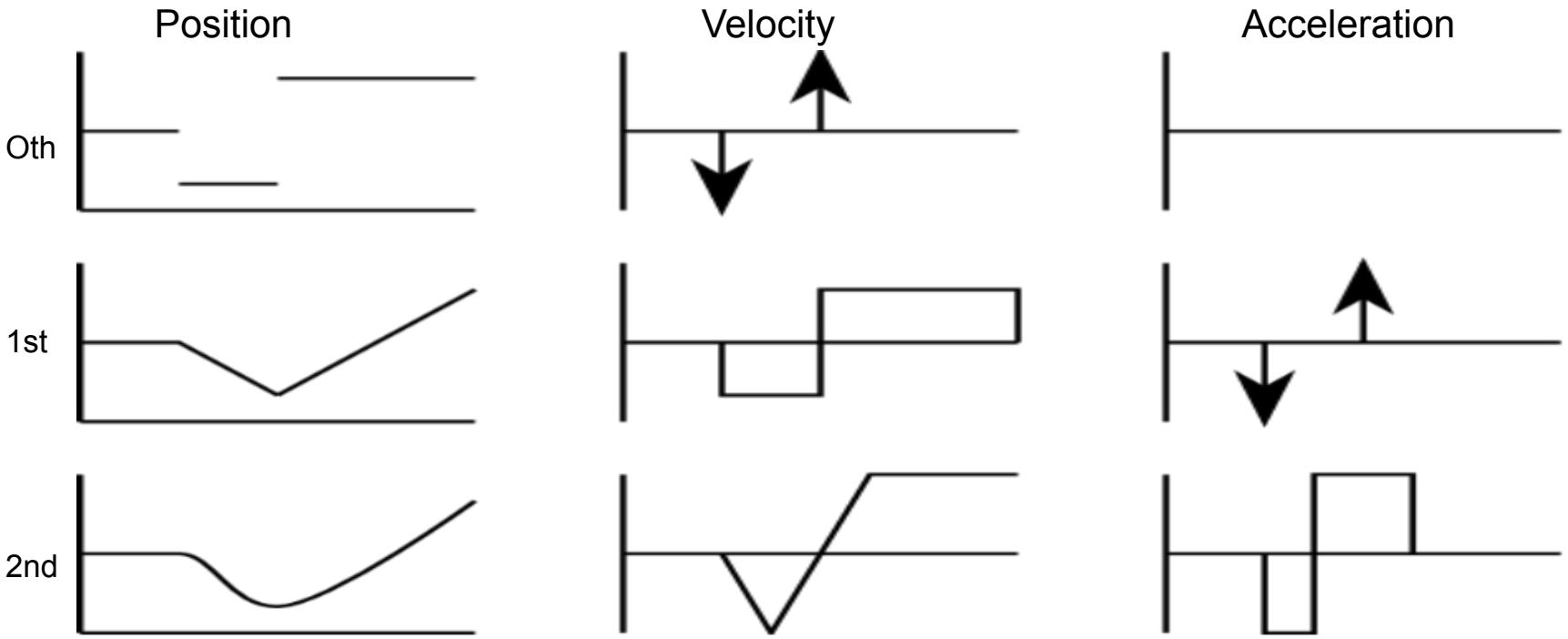
- Ball bouncing squash and stretch





Continuity

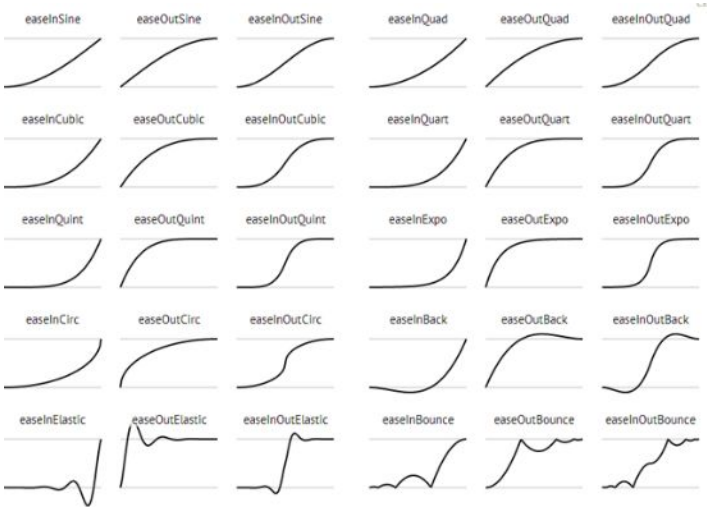
- Continuity
  - 0^{th} order, No continuity
  - 1^{st} order, Position continuity – infinite velocity
  - 2^{nd} order, Velocity continuity – infinite acceleration
  - 3^{rd} order, Acceleration continuity – infinite jerk

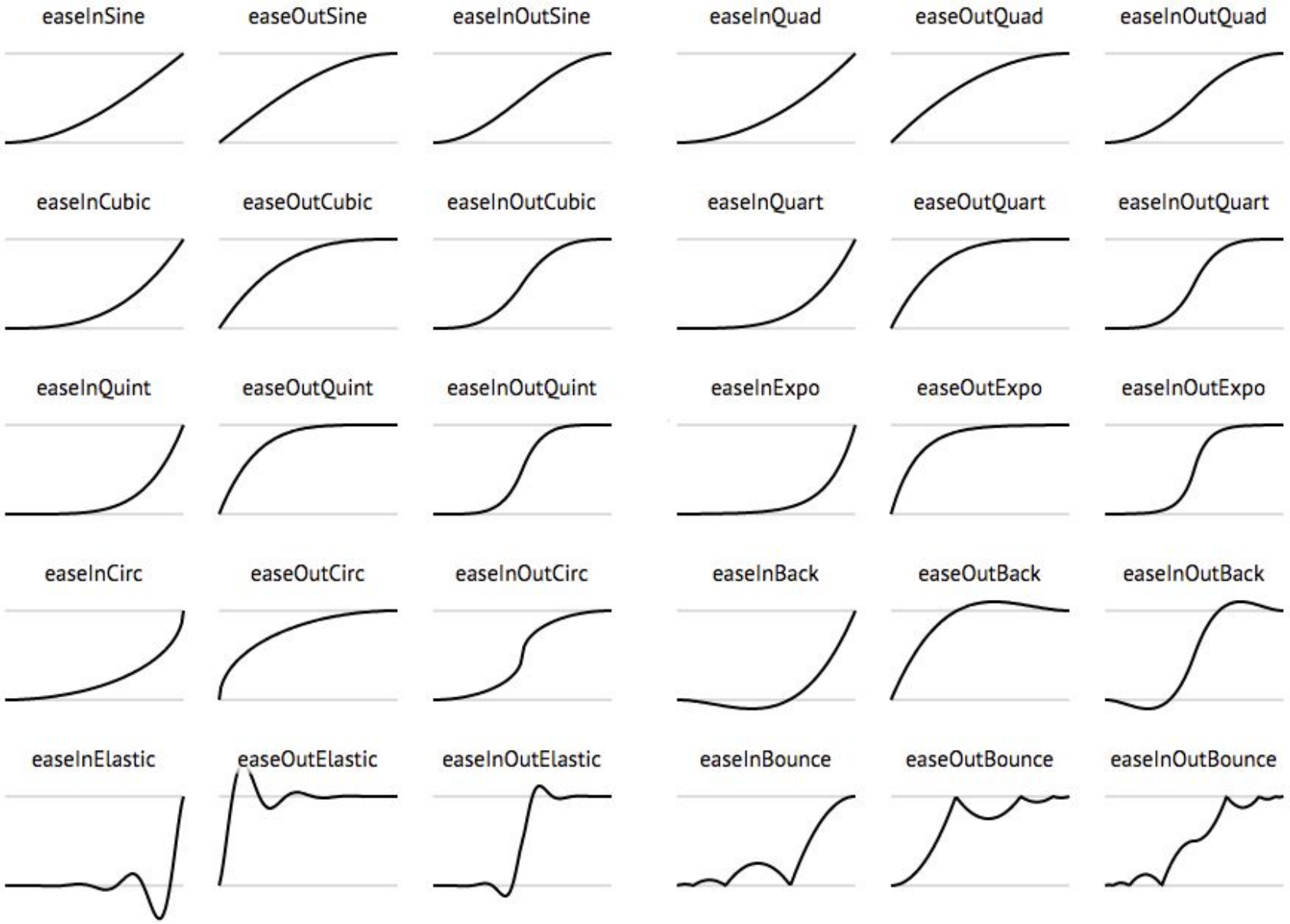


Easing

- Second order continuity
  - Acceleration and deceleration
  - Use curves rather than mathematical force calculation
  - Near continuous
- Looks much more realistic
  - Removes jerks
  - Simulates physical properties of the real world
  - Subtle changes affect the feel

https://easings.net/#

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easeInElastic
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2D APIs

- SDL2
  - Simple DirectMedia Layer
  - Provides a wrapper for native code
  - Code runs across platforms, Linux, Mac, Windows, …
  - API for keyboard, mouse, networking, time, …….
- Java 2D API
  - Provides a library for doing fast 2D calls
- Unity3D - has 2D mode
- Torque2D - MIT licence very open
- Spine - really nice tool for animation of 2D
- Construct2, Corona, Pixi.js ….. Many web based animation tools
- Flash is Dead finally - some use swf for UI

APIs

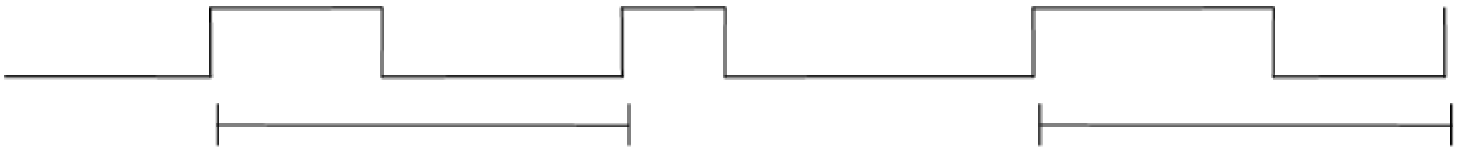
- Must provide
  - Placement - **Blitting**, X, Y and sometimes Z
- Should provide
  - Transparency
  - Masking - perhaps
  - Layers
  - Animation system
- May provide
  - Rotation
  - Scale
  - Lighting
  - Physics, Box2D now common

Films vs Games

- Animation control – Ballistic - Films
  - Directors and animators control characters
  - Know what is about to happen
  - Transitions planned – checked and changed
  - Viewing angle controlled
  - Emotional intent defined by story
- Animation control – Interactive - Games
  - Player changing direction/action
  - Transitions from any point in an animation to another
  - View direction could change
  - Player imposes agenda – leave expressions bland
  - Possible interactions with world extensive

Timing

- Controlling time
  - Fps – Frames per second
  - Frames of an animation – should be time related – should not go faster with faster frame rate
  - Picking an image to draw based on time
- Delta t
  - Time since last frame was drawn



- Without timing information animations change speed with cpu load

Timing and Animation

- Drawing each frame is to time consuming
  - Set FPS – 30
  - Describe the sequence of frames
  - <1,2,3,4,5,6> <1,2,1,3> <1,1,1,2,3,3,3,4,4,5,6,7,7>
- Transitions and keyframes
  - Set up important frames and how to transition
- Explicit timing information
  - Each frame is given a time delta from the last frame
  - Show frame closest to the current offset
- Ballistic vs interactive animation
  - Ballistic - once started runs to end
  - Interactive - can be interrupted

Transitions

- Character animations
  - Walking → Running → Standing → Hit by object
  - How to deal with breaking animation cycles
  - Often the task of AI
  - Some transitions can be handled
    - Walking frames mapped to running frame <1,1> <2,1> <3,2> <4,3>
    - When transitioning between states use mapping to alter animation
- Object animations
  - Interaction with the player
  - Physics important for understanding the nature of objects
  - Affordance – the natural association of an object and an action
  - Small subtle animations make a scene appear more alive.

Physics and Animation

- Single player
  - Slow game down if actions drops to below 10fps
  - One view on game
  - Animations focused on what the player can see
- Multiplayer games
  - External world clock
  - Lag is a killer
  - Multiple views on an action
  - Animations can be different so long as result is the same
- Physics of objects
  - Uses some and throws away others
    - Ballistic jump - out
    - Gravity - in

Kinematics

- Forward Kinematics
  - Calculate the rotations of the core out to extremities
  - Shoulder then elbow then wrist
  - Useful when modeling an action that is initiated by the player
- Inverse Kinematics
  - Goal directed
  - Work out the angles of the joints to reach a target
  - Complex math as there are lots of potential solutions
  - Find the BEST solution

3D Animation

3D animations deforming a mesh

- Mesh
  - The triangles that make up a model
- Skeleton
  - Used to control mesh
  - Bones form hierarchy
  - Mesh connects to bones

Animating Skeletons

Create the next position for the skeleton

Unreal

- Skeleton Editor - bones
- Skeletal Mesh Editor - view
- Animation Editor - sequence of action
- Anim blueprint editor - logic

- Physics can be used

Particle systems

Usually just cosmetics

Emitter - origin of particles
Lifetime - how long they stay active
Spread - curve editor in unreal

Level of Detail