Miscellaneous Graphics Concepts
(and how we can use them)

Key frames and Transformations
Animation: the briefest of histories

- **Hot 19’th Century Topic:**
  - Do all four feet of a galloping horse ever completely leave the ground at the same time?
  - No one could prove such an assertion true or false

- **Enter: Edweard Muybridge**
  - In 1878 Muybridge set up trip wires on a race course, each set to take a picture when a horse ran the course.
  - Besides discovering the answer, the pictures made for a cool animation (flip book style).
  - For more, see https://en.wikipedia.org/wiki/Eadweard_Muybridge
Animation: Cartoons and Walt Disney

- **Winsor McCay & Gertie the Dinosaur**
  - The first film to use key frame animation. Gertie is “brought to life” and given a personality of sorts
  - Major influence on animation pioneers, e.g. Walt Disney

- **Walt Disney paid...**
  - Keyframe animators to draw basic still images for his movies.
    - Two examples: Mickey Mouse standing up, Mickey sitting down
  - In-Between frame animators to draw additional stills
    - Mickey in the process of sitting down.
  - (You can guess which animators were paid more.)

- For more, see: https://www.youtube.com/watch?v=TGXC8gXOPoU
- And http://publicdomainreview.org/collections/gertie-the-dinosaur-1914/
Key Frames: Definition

• In animation, a key frame is a drawing that specifies a starting or ending point of a simple animation. Each pair of key frames specifies start and end points.

• In between frames simply provide the transition frames in between a pair of key frames.
  – A frame is a still image on a film reel.
  – Display each frame at a rate of 24+ frames per second: animation!
Interpolation

- In mathematics, interpolation is the method to describe a function $f(x)$ that passes through a set of discrete points.
  - Our interest is to retrieve new data points.

Linear interpolation allows us to create a set of data points on the simplest of equations, a line.
Key Frames and Linear Interpolation

• How do we get from point R to point S?
Key Frames and Linear Interpolation

- How do we get from point $R$ to point $S$?
  - Use linear interpolation:
Key Frames and Linear Interpolation

• How do we get from point $R$ to point $S$?
  – Use linear interpolation: $R \rightarrow R_1 \rightarrow R_2 \rightarrow R_3 \rightarrow S$
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• Let’s call points $R$, $S$ key frame points
  – And $R_1$, $R_2$, $R_3$ points: in-between frame points
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• Let’s call the diagram represented by “$R$” and “$S$” as key frames &
  – Diagrams represented by “$R_1$” “$R_2$” and “$R_3$” as in between frames
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Let’s display each frame at 24 fps to create an animation.
Key Frames and Interpolation: more...

• Linear Interpolation between one set of key frames is easy.
  – Linear Interpolation between multiple sets of key frames is more difficult. Why?
    • We are dealing with multiple sets of discrete (linear) functions and change can appear to be disjoint
    • There are other kinds of interpolation to ensure smooth transitions between pairs of keyframes.
    • For more: paulbourke.net/miscellaneous/interpolation/ or Professor Ellman

• We can interpolate more than just sets of vertices on the x/y cartesian plane
  – Like what? We should check in with Michael Jackson for an example. Really!
Key Frame Animation in Dr.Racket

- We can create two lists of vertices posns.
  - That represent a line drawing/polygon
    - In the form of key frames
- We can create a 1-1 mapping of
  - the list of posns in the first list and...
  - the list of posns in the second list.
    - And (manually) ensure the lists have the same length
- We can linearly interpolate “in-between” posns
  - To create a new list of posns
    - In the form of an in-between frame
- And, we can draw & display the diagram represented by each list
  - Using big-bang to create an animation where
    - The first shape transmogrifies into the last shape.

- Conceptually, this is what happened when we created the…
  “Incredible Shrinking Red Square”
  - The first key frame was a red square of size 100
  - The second key frame was a red square of size 1
  - Big-bang generated 98 other in-between frames for us (based on the computer’s millisecond clock).
Key Frame Animation in Dr.Racket

• With permission from Paul Bourke let’s look at:
  paulbourke.net/miscellaneous/interpolation/

  a snippet of plain C code will serve to describe the mathematics.

  double LinearInterpolate(
    double y1,double y2,
    double mu)
{
    return(y1*(1-mu)+y2*mu);
}

  The parameter mu defines where to estimate the value on
  the interpolated line, it is 0 at the first point and 1 and the
  second point. For interpolated values between the two points
  mu ranges between 0 and 1.
Key Frame Animation in Dr.Racket

• Let’s take a look at a new assignment
  – And associated starter code!