Computer Graphics & Vision – Demetri Terzopoulos

* Computer Graphics (CG)
  + Forward math problem: computational models -> image & videos
  + Synthesis
* Computer Vision (CV)
  + Backward
  + Analysis
* History
  + Ph. D from MIT (1960s) – Sutherland: sketchpad, Roberts: machine perception of 3D solids
  + Independent fields (CG, CV) -> synergizing
    - Interdisciplinary: physics, entertainment, biology, AI
* Image/Video: array of pixels (1+ num)
  + Objects in reality (static & dynamic)
  + Illumination (light sources) – reflect
  + Imaging device (eyes, camera, sensors)
  + Stimulation of reflection of lights
* Applications (entertainment, VR, industry, robotics, inspection, imaging in medicine, military, remote sensing) -> portrayal of the living systems (world)
* CG
  + Research: modeling, animation, rendering
  + CRT -> Plasma -> LCD -> OLED
  + Exotic: immerse, head-mounted, autostereoscopic, holographic, volumetric
  + Moves: character, special effect
    - Double: digit composition – facial replacement
    - Cartoon (nonphotic realistic rendering)
  + Games: interactivity, artificial life
  + Computer-aided Design: industry – precision, engineering visualization
    - Stimulation: aerodynamics – lift/drag according to the shapes
  + Visualization: molecular – biology/chemistry, weather, architecture
* Graphical user interfaces
  + 3D, digital art, genetics analysis (binominal)
* Elements of CG (Pipeline)
  + Modeling -> Animation -> Rendering
    - Graphics chips – Nvidia
  + Integrated GPU – highly pipeline architecture -> deep learning (AI)
  + Modeling: primitives, attributes, 3D transformation
    - Visibility: stimulating light propagation
  + Animation: keyframe, motion capture, behavioral
* Model: objects – geometrically on a comp (maps: texture, etc.)
  + Altering – transformation
* Model: scanning shapes, procedural modeling (plants)
* Rendering: How camera + light reflection words
  + 3D cameras in a scene (A scene within a scene)
  + Visual surfaces (and hidden ones) – view focus point
  + Reflectance modeling – material science: diff property of solids
  + Information – Maps (different details)
* Animation: keyframe, motion capture
  + Markless motion capture, fluid stimulation (air and liquid)
  + Facial capture: virtual celebrity
  + Modeling facial anatomy
  + Algorithm for masses
* CV
  + Image processing, pattern recognition, visual perception
  + IU: human intelligence (inverse problem)
  + Change in perceptions (human neural)
  + Image segmentation, reconstruction, recognition
  + Image analysis – Adobe Illustrator/ Photoshop
  + Medical: retinal angiogram segmentation (eyes -> hypertension)
    - Detection of health condition
* CG
  + Modeling, animation, rendering
  + Construct specific models -> representing motions -> stimulate real world
  + Evolution: screens -> hands-on devices
    - Movies – CGI (characters, special effect, cloning) -> digital compositing -> cartoons (draw from 3D models -> converting to 2D characters)
    - Games – interaction, artificial life, 1st person driving/shooting
  + CAD: precision & engineering modeling -> stimulation
  + Visualization: scientific, architectural usage, GUI, 3D interface (AR/VR)
  + Pipeline (elements of CG)
  + Structure of CPU with integrated GPU -> mostly GPU (50% +)
  + Modeling: 3D points -> curves -> … -geometric transformation
    - Color: light refraction -> visibility (interface)
    - Changing/ transforming models via matrix, scanning, plant (pattern)
  + Animation: keyframe animation, motion capture – procedural (physics, behavior-based animations) ~ capture the movement of actors
  + Rendering: virtual camera + geometric shape/ reflectance -> illumination (where the light source comes from)
    - Camera model – tuning in 3D -> visible surfaces onto display
      * Image plane -> camera direction
      * Reflectance modeling
    - Subsurface scattering: translucency effect – (nVIDA)
    - Non-photorealistic effect
    - Information simplification: maps, keyframe, motion capture
* Markless capturing
* Animation: physical stimulation – fluid dynamics
* Modeling, virtual celebrity, facial anatomy -> realistic layers of faces
* Behavior stimulation – mass numbers of people or animals
  + Virtual reality – artificial life
* Problems
  + Model, render, animate real image
* Computer Vision
  + Image processing, pattern recognition, visual perception
    - Inverse – harder to solve
  + Related to how we perceive objects -> biased according to the environment
* Vision
  + Edge region, image segmentation, visual reconstruction, object tracking/ recognition
  + EX
    - Retinal
    - Cartographic modeling – rivers, buildings
    - Auto image retrieval – specific wording (large database)
    - Self-driving cars
    - Robots: visual
    - Motion tracking – heart
    - Images -> modeling (diff angles)
  + Deep learning in CV – convolutional neural nets (CNNs)
    - Image recognition
  + Virtual biomimetic robotics
  + Computational models
  + Artificial fish – perception + action + result
  + Medical: medical image segmentation
* CS 174A, B, C + grad
* Linear alg, C/C++, OpenGL, JS
* Creative – art + science + engineering