Computer graphics is everywhere

Computer graphics as a field
Definitions, examples

Computer graphics as a course
Topics, assignments, learning

Rendering
“The screen is a window through which one sees a virtual world.”
Definitions, examples
“The screen is a window through which one sees a virtual world. The challenge is to make that world look real, act real, sound real, feel real.”

Sutherland, 1965
“The purpose of computing is insight, not numbers.”
Hamming, 1962
“If mathematics is queen of the sciences, computer graphics is the royal interpreter.”

F. P. Brooks, Jr., 1962
COMPUTER GRAPHICS AS A COURSE

Topics, assignments, learning
You will learn how to represent geometry, motion, and appearance in complex 3D scenes

Systems
  Implementation, programming, system design

Computational Methods
  Rendering, animation, modeling

Big Ideas
  Sampling, integration, optimization
Computer-graphics systems can display images of things we see, measure, and imagine.
But, they do not make it easy to do so: they require expertise and many cumbersome steps.
Drawing a human shape, for example, may require drawing hundred or more points.

Ngo et al. 2000
Higher level abstractions allow anyone to create graphics as easily as they write text or edit images.
Physically based simulation generates realistic shapes, motions, and images automatically.
Nature can be difficult to command
“The screen is a window through which one sees a virtual world.” [Sutherland 1965]
Ray tracing casts a ray from the eye through each pixel in the screen.
This practice goes back to Albrecht Durer in the 16th century.
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Nature does it the other way: photons go from the light to the eye
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Abelardo Morell
Ray tracing also traces secondary rays toward light, reflection, and refraction.
The rays traced in the direction of the light determine whether a point is in shadow.
The rays traced in the direction of reflection accumulate contributions in mirror direction.
The rays traced in the direction of refraction accumulate contributions from transmission.
Computational models of refraction have revolutionized lens design.
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Figure 11.50 An example of the kind of lens design information available via computer techniques. (Photos courtesy Optical Research Associates.)

From Hecht's Optics
Recursive ray tracing accumulates secondary, tertiary, and other indirect effects
Cast a ray from the eye through each pixel
Cast random rays from the visible point
Accumulate radiance contribution
Cast a ray from the eye through each pixel
Cast random rays from the visible point
Recurse
Cast a ray from the eye through each pixel
Cast random rays from the visible point
Recurse
Systematically sample primary light
Trace only one secondary ray per recursion
But send many primary rays per pixel
10 paths/pixel
10 paths/pixel
100 paths/pixel
Without explicit light sampling

1 path per pixel

With explicit light sampling

4 path per pixel
Fixed random sequence
We see the structure in the error
Vintage path tracing by Kajyia