CSE 167:
Introduction to Computer Graphics
Lecture #14: Procedural Modeling

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Announcements

- Project 6 due tomorrow
- Monday: Midterm discussion
- Next Thursday: Midterm #2
- Final project description released tomorrow evening

Lecture Overview

- Procedural Modeling
  - Concepts
  - Algorithms

3D Modeling

- Creating 3D objects/scenes and defining their appearance (texture, etc.)
- So far we created
  - Triangle meshes
  - Bezier patches
- Interactive modeling
  - Place vertices, control points manually
- For realistic scenes, need extremely complex models containing millions or billions of primitives
- Modeling everything manually is extremely tedious

Alternatives

- Data-driven modeling
  - Scan model geometry from real world examples
  - Use laser scanners or similar devices
  - Use photographs as textures
  - Archives of 3D models
    - http://www-graphics.stanford.edu/data/3Dscanrep/
    - Reader for PLY point file format: http://w3.impa.br/~diego/software/rply/
- Procedural modeling
  - Construct 3D models and/or textures algorithmically

Photograph Rendering

[Levoy et al.]

Procedural Modeling

- Wide variety of techniques for algorithmic model creation
- Used to create models too complex (or tedious) to build manually
  - Terrain, clouds
  - Plants, ecosystems
  - Buildings, cities

[Deussen et al.]

- Usually defined by a small set of data, or rules, that describes the overall properties of the model
  - Tree defined by branching properties and leaf shapes
- Model is constructed by an algorithm
  - Often includes randomness to add variety
  - E.g., a single tree pattern can be used to model an entire forest

Randomness

- Use some sort of randomness to make models more interesting, natural, less uniform
- *Pseudorandom* number generation algorithms
  - Produce a sequence of (apparently) random numbers based on some initial seed value
- Pseudorandom sequences are repeatable, as one can always reset the sequence
  - E.g., if a tree is built using pseudorandom numbers, then the entire tree can be rebuilt by resetting the seed value
  - If the seed value is changed, a different sequence of numbers will be generated, resulting in a (slightly) different tree

Recursion

- Repeatedly apply the same operation (set of operations) to an object
- Generate self-similar objects: fractals
  - Objects which look similar when viewed at different scales
- For example, the shape of a coastline may appear as a jagged line on a map
  - As we zoom in, we see that there is more and more detail at finer scales
  - We always see a jagged line no matter how close we look at the coastline