Synthetic Landscapes

A presentation for the course
“Wissenschaftliche Arbeitstechniken und Präsentation”

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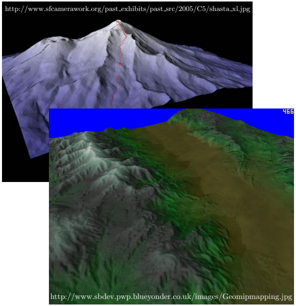
http://www.fnbpawhuska.com/images/contents/contents_bkg.jpg

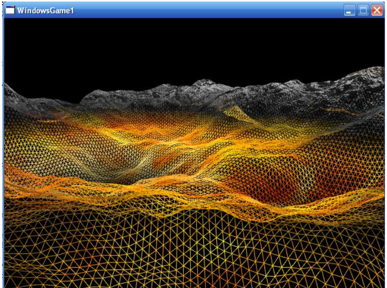
Outline

http://www.squeeky-kleen.co.uk/images/Fotolia_3673319_XS.jpg

- Artistic landscape painting captures minute details in a scene and mimics moods and environments.
- Realism and liveliness remain the merits for computer-generated landscapes.



- For real-time landscape generations, elements can be stored as production rules, parameters, and seeds and can be visualized using fractal and procedural algorithms on run.



http://i9.photobucket.com/albums/a59/craigory666/heightMapTerrain.jpg

Outline

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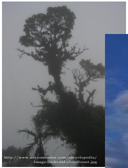
Formless Monsters

- Nature is complex when it comes to modelling.
- Euclidean geometry is not sufficient to model natural landscapes
- A cloud, a shoreline, a mount or a bark of tree is not a sphere, a cube, a cone, or a straight line that can be produced by some unfussy parameters.



- Benoit Mandelbrot, being the first mathematician to give new theoretical basis for study of such "formless" patterns, writes in his book:

  > *"... Responding to this challenge, I conceived and developed a new geometry of nature and implemented its use in a number of diverse fields. It describes many of the irregular and fragmented patterns around us, and leads to full-fledged theories, by identifying a family of shapes I call* ***fractals****. ..."*
  >
  > *[Mandelbrot, 1982]*

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Declarative Techniques

- Explicitly define position and properties of every object.
- Used for real world geographical systems where data is available for every object.
- Huge amount of data but no generation algorithms needed.
- Full control over the appearence of landscape.
- Exact definition of objects.
- Bad storage requirements.
- Too much work required for definition of the landscape.

Procedural Techniques

- Designs are codified into algorithms which generate patterns.
- Varying and realistic objects can be generated.
- Perfect when the landscape does not need to match any real-world location.
- Small memory footprint and disk storage space.
- Very less work required from the designer.
- The main focus of this presentation.

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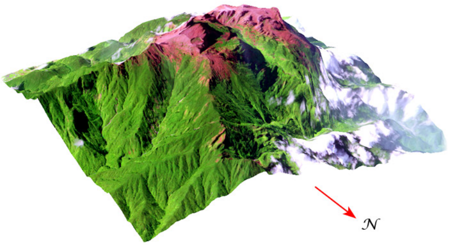
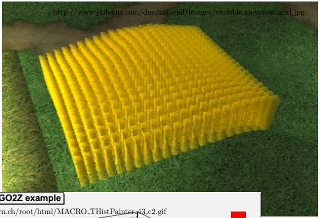
Landscape Generation

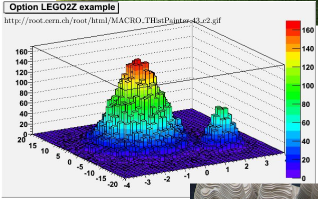
- We need to be able to:
  - represent a landscape digitally.
    - A simple implementation is **height maps**.
  - generate a grid with height values, if no real world data is available.
    - **Resursive Subdivision** defines a discrete grid and generate points.



http://www.crisp.nus.edu.sg/coverages/nature/images/MK_20070216_terrain.jpg

Height Maps

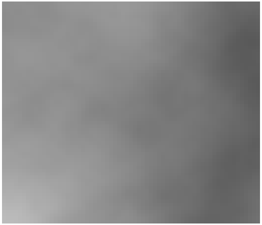




- A computer representation of landscape.
- A matrix of heights mapping locations to heights.

Height Maps (cont'd)

- A grayscale image is a good example of a height map.
- The pixel intensities can be treated as height values for each grid point.
- The following images represent a grayscale image height map and the corresponding smooth landscape generated from it.



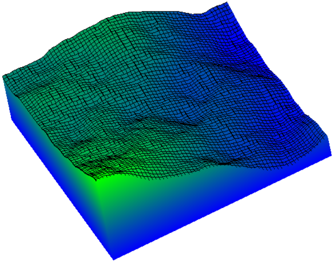


Image credit: [Macklem, 2003]

Recursive Subdivision Methods

- The landscape is defined by subdivision into smaller parts.
- Edge grid points define a square.
- The square is subdivided into four smaller squares and new grid points are generated.
- A random offset, proportional to the current edge-length, is added to the generated vertices.
- The process continues until the desired resolution is achieved.

Triangular-Edge Subdivision

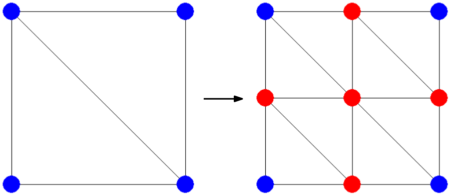


Image credit: [Macklem, 2003]

- Logically divide each square into two triangles.
- The midpoint of each triangle's edge is randomly offseted resulting in four small squares.
- Subdivision is repeated until the desired resolution is achieved.

Diamond-Square Subdivision

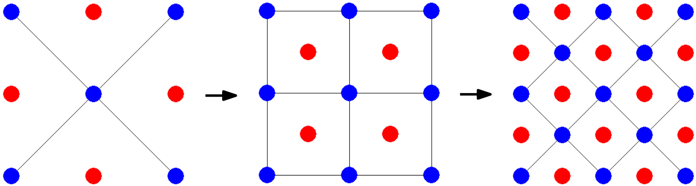
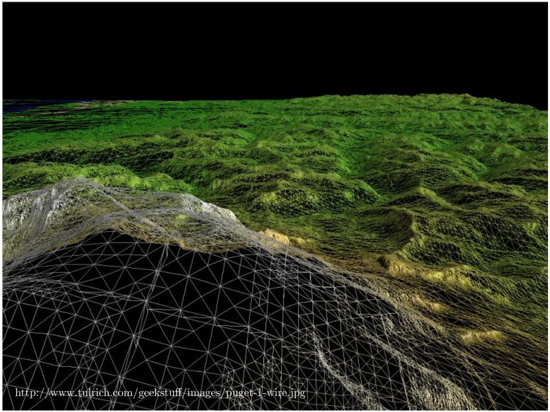


Image credit: [Macklem, 2003]

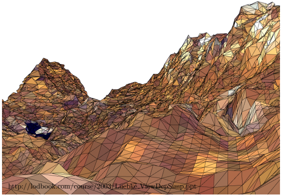
- Calculate the midpoint by averaging the four corner of the surrounding square or diamond.
- Randomly offset the midpoint.
- Repeat the subdivision until the desired resolution is achieved.



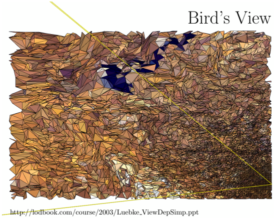
- The amount of detail to be displayed (texture size, amount of geometry, etc.).

- Three basic frameworks [D. Luebke and Huebner, a]:
  - Discrete LoD
    - Create LoDs for each object separately.
    - At run-time, pick each object's LOD according to object distance or similar criterion.
  - Continuous LoD
    - Create a data structure from which the desired level of detail can be extracted at run time.
  - View-dependent LoD
    - Use current view parameters to select best representation for the current view.
    - Single objects may thus span several levels of detail.

From View Point



Bird's View



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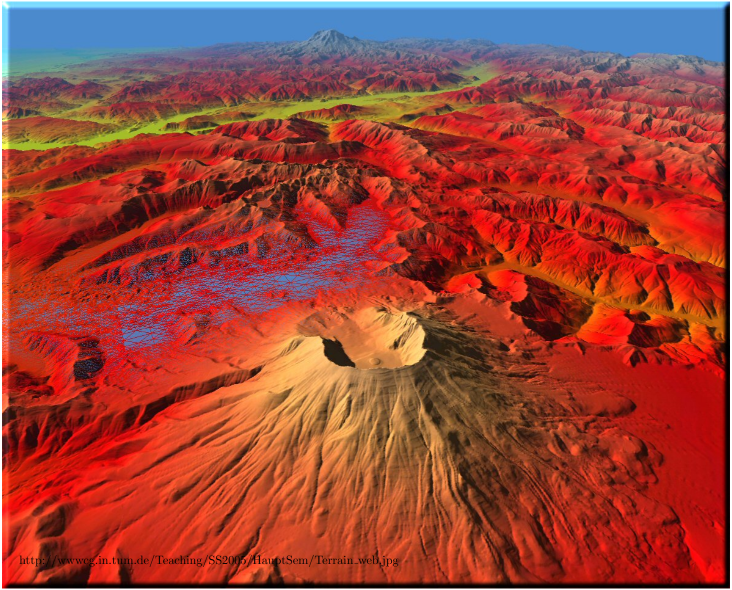
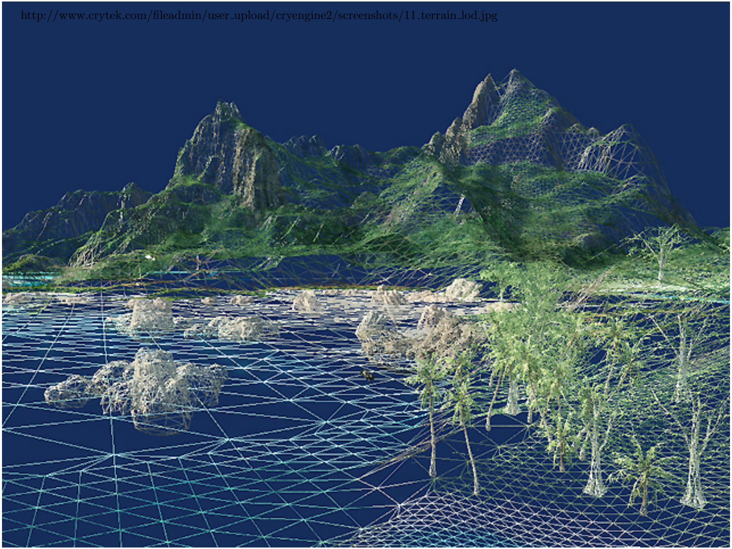
Some Examples




http://www.crytek.com/fileadmin/user_upload/cryengine2/screenshots/11_terrain_lod.jpg

Some Examples (cont'd)

http://hlfallout.filecloud.com/img/sized/00/00/41/00004118.jpg

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Thank you very much for your attention.