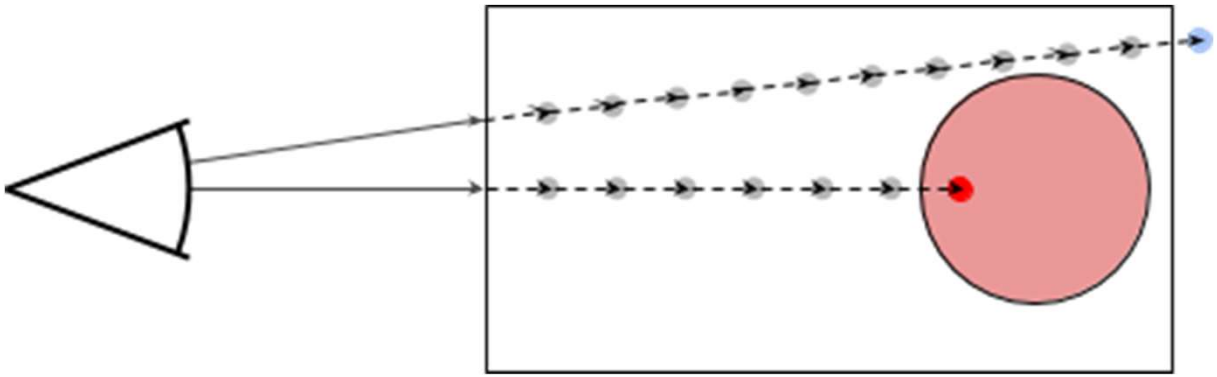
Raymarching

Raymarching

- Step along a ray until hit or max distance



Height Field

- Surfaces that can be described by a function

$$y = f(x, z)$$

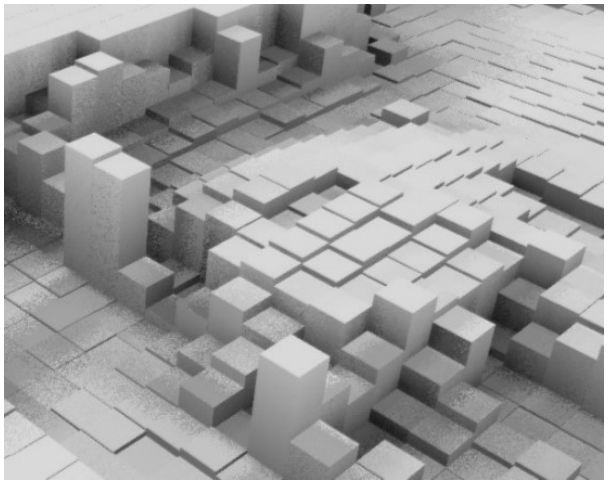
- Examples: terrain, measurements sampled on a plane, 2D scalar field

1	2	1	2	2	1
2	1	2	1	10	1
3	1	2	6	9	0
4	1	2	5	0	0
5	1	2	3	0	0
6	1	2	2	1	0

Height Field

- Grid that stores a height at each position

1	2	1	2	2	1
2	1	2	1	10	1
3	1	2	6	9	0
4	1	2	5	0	0
5	1	2	3	0	0
6	1	2	2	1	0

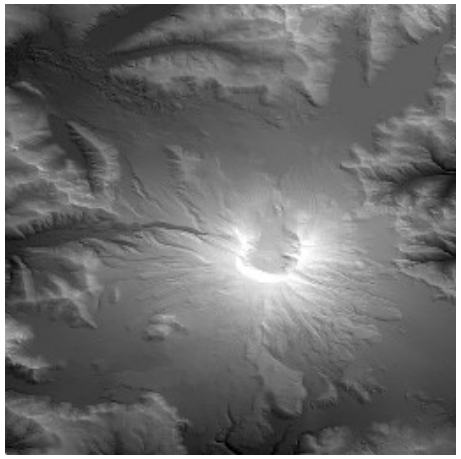


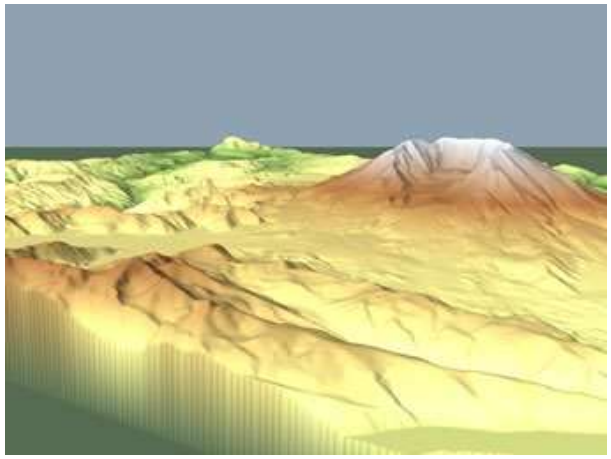
Height Field

- Can use mathematical function to create grid values

Height Field

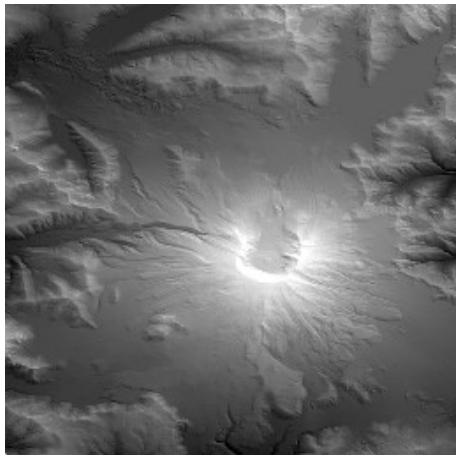
- Can use texture to store grid





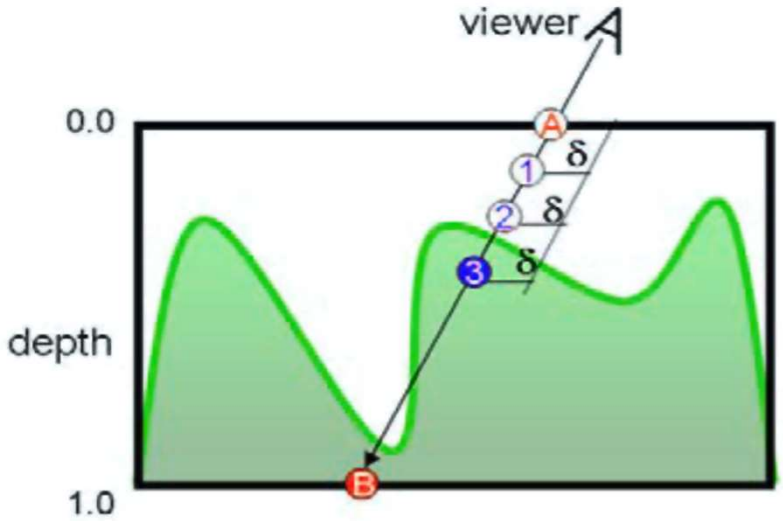
Height Field

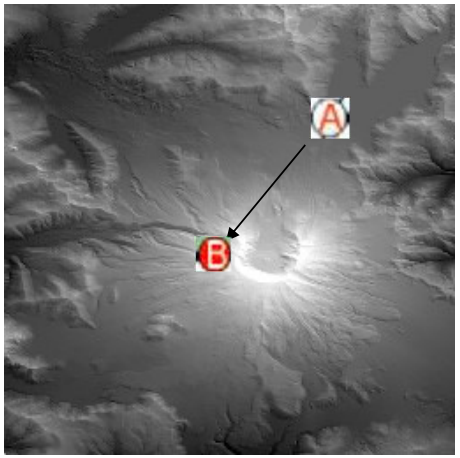
- Can render with different methods



Raymarching Height Field

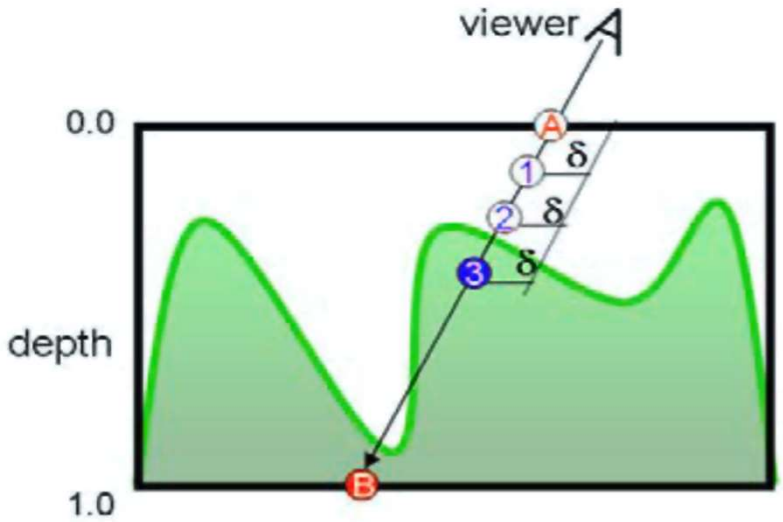
- Step with small increments along ray



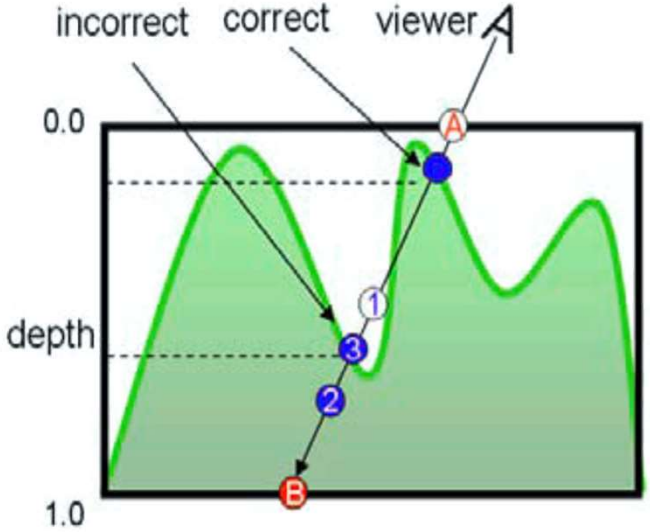


Raymarching Height Field

- Step with small increments along ray

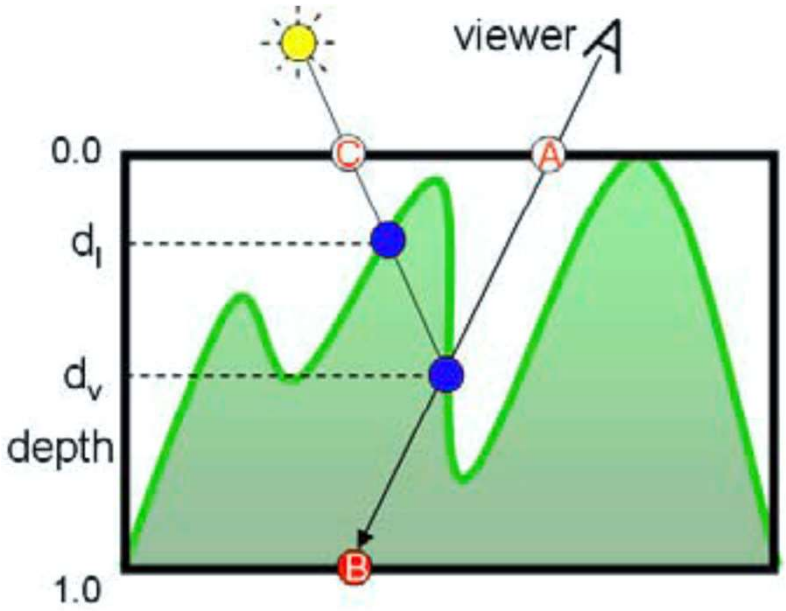


- Interval bisection



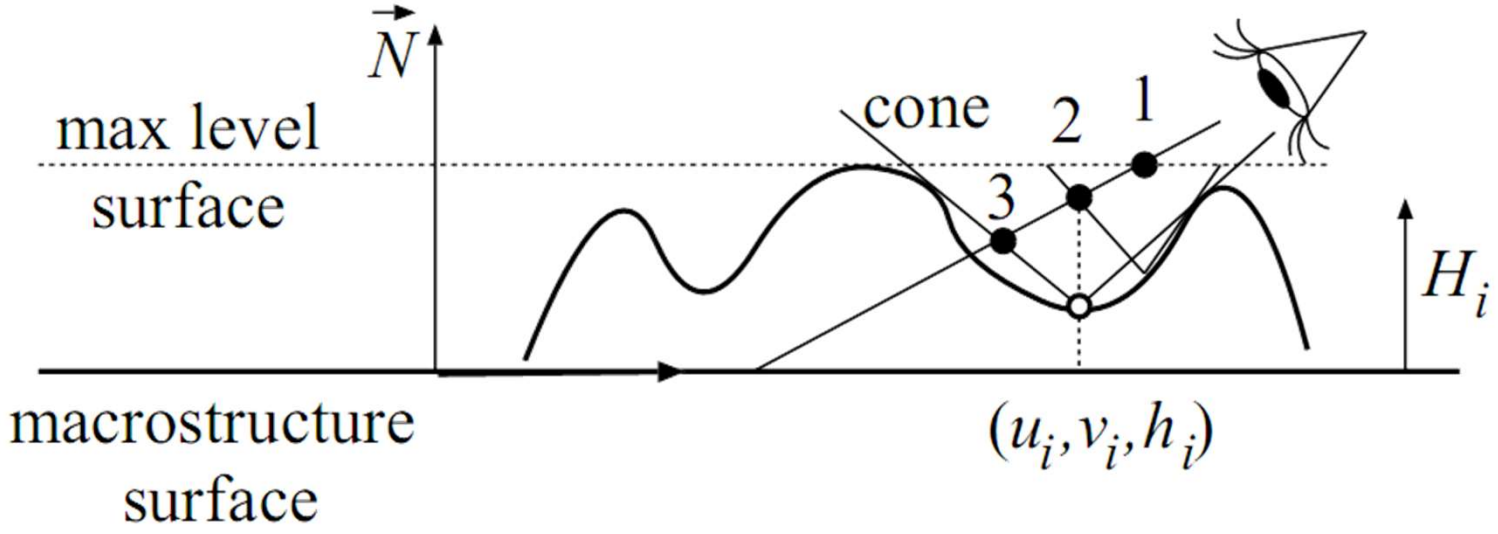
Shadowing

- Send shadow feeler ray



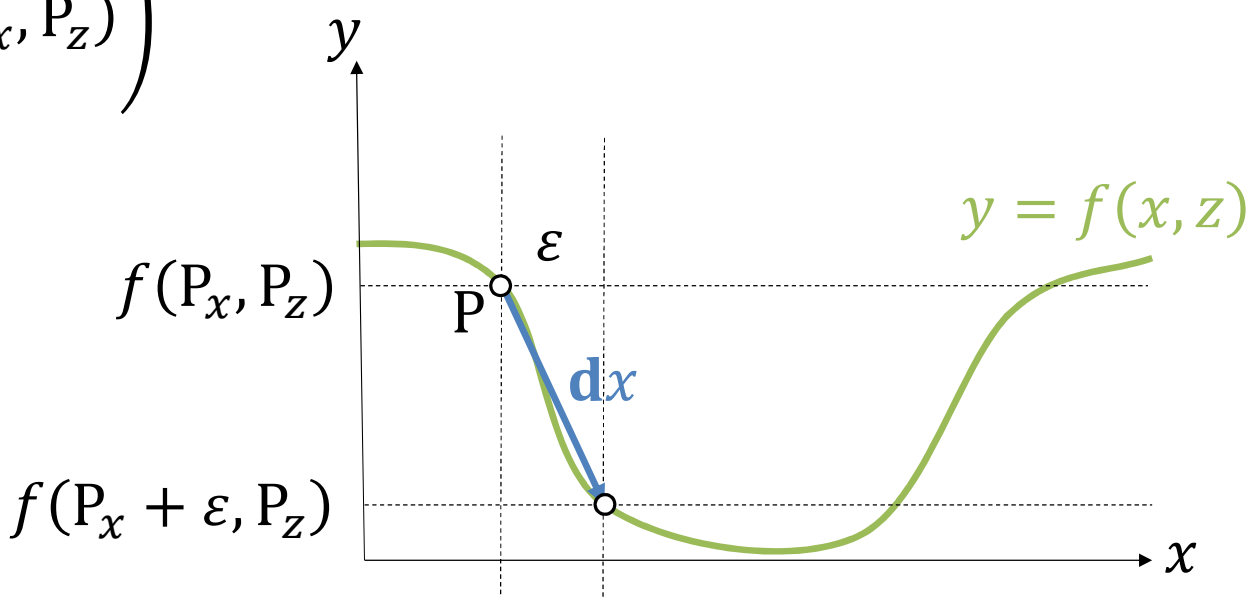
Accelerating Heightfield Rendering

- Help texture
  - Each texel stores cone of empty space above
  - Only store opening angle (1 additional value per texel)



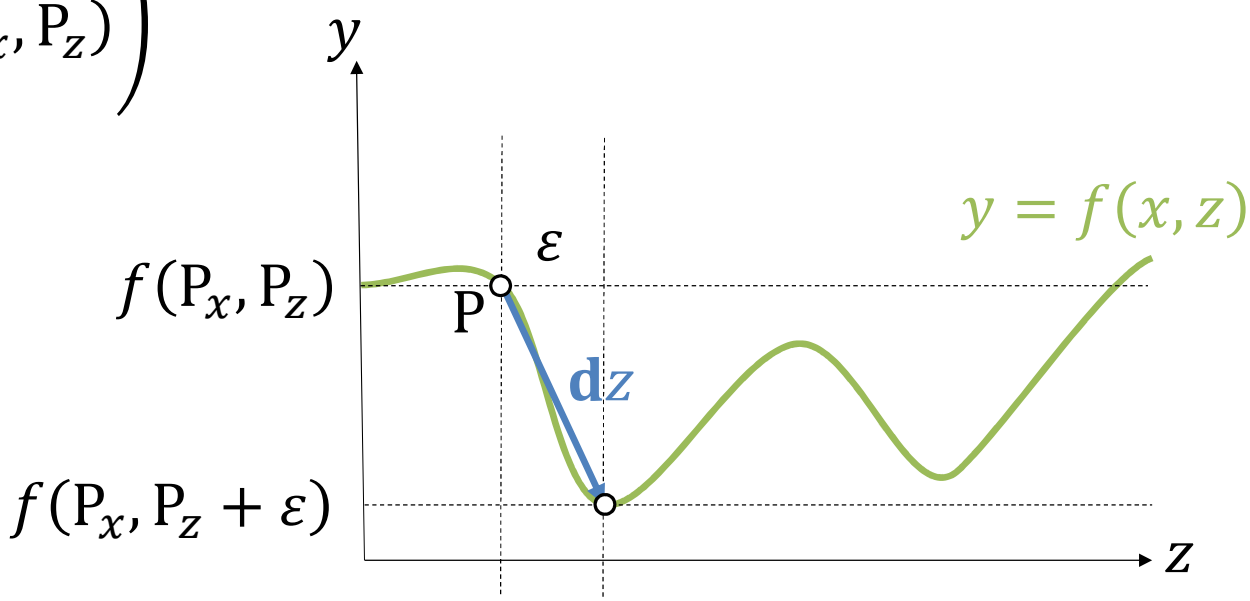
Calculating Height Field Normals

- $\mathbf{d}x = \begin{pmatrix} \varepsilon \\ f(\mathrm{P}_x + \varepsilon, \mathrm{P}_z) - f(\mathrm{P}_x, \mathrm{P}_z) \\ 0 \end{pmatrix}$



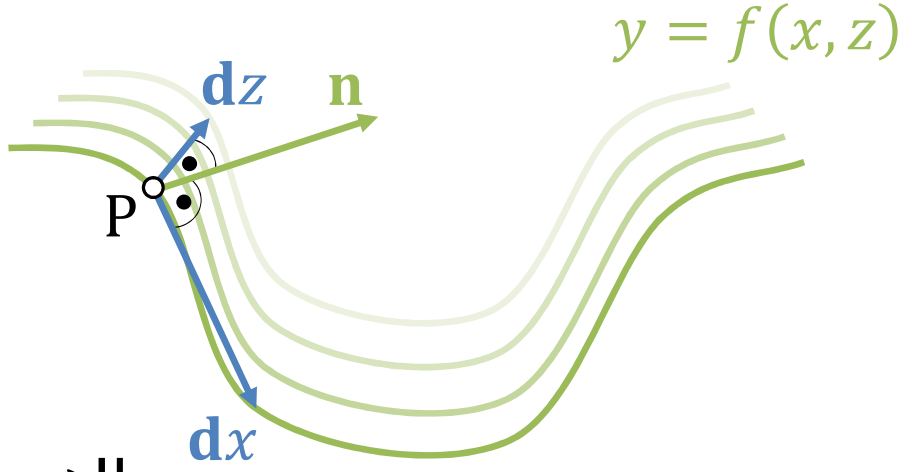
Calculating Height Field Normals

- $\mathbf{d}z = \begin{pmatrix} 0 \\ f(\mathrm{P}_x, \mathrm{P}_z + \varepsilon) - f(\mathrm{P}_x, \mathrm{P}_z) \\ \varepsilon \end{pmatrix}$



Calculating Height Field Normals

- $\mathbf{d}x = \begin{pmatrix} \varepsilon \\ f(\mathrm{P}_x + \varepsilon, \mathrm{P}_z) - f(\mathrm{P}_x, \mathrm{P}_z) \\ 0 \end{pmatrix}$
- $\mathbf{d}z = \begin{pmatrix} 0 \\ f(\mathrm{P}_x, \mathrm{P}_z + \varepsilon) - f(\mathrm{P}_x, \mathrm{P}_z) \\ \varepsilon \end{pmatrix}$



- $\mathbf{n} = \|\mathbf{d}z \times \mathbf{d}x\| = \left\| \begin{matrix} f(\mathrm{P}_x, \mathrm{P}_z) - f(\mathrm{P}_x + \varepsilon, \mathrm{P}_z) \\ \varepsilon \\ f(\mathrm{P}_x, \mathrm{P}_z) - f(\mathrm{P}_x, \mathrm{P}_z + \varepsilon) \end{matrix} \right\|$