Faculty of Mathematics and Physics
Charles University in Prague
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Graphics for Games

Lab 09.3 – UE4 – Distance Field Techniques (DFSS, DFAO)

Resources
Links 1

- [Signed Distance Field techniques explained](#)
  - This presentation contains slides from this

- [Quick incomplete overview](#)

- [SDF construction](#)
  - One way to do it

Signed (Mesh) Distance Field
Motivation

Raycasting is essential for many techniques, as we integrate visibility over angles.

=> We would like to have real-time sampling method for this… ideally lowering the number of raycast required.

Mesh distance field is a mesh approximation that speeds up (approximate) mesh raycasting + checking how far the ray missed the mesh; fully 3D technique.
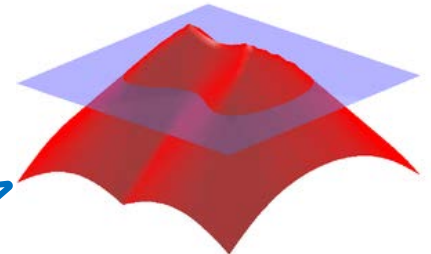
Signed Distance Field ~ 3D Signed Distance Function

In a nutshell, a function that gives you the distance to the nearest boundary point of the mesh for any given point within the space.

Once it's value is >=0, you know you're on the boundary / within the mesh.

Distance function visualization of the blue plane below

Our mesh

Signed Distance Field ~ 3D Signed Distance Function

If Ω is a subset of a [metric space](#), X,
with metric, d, then the
signed distance function, f, is defined by

$$f(x) = \begin{cases} d(x, \partial\Omega) & \text{if } x \in \Omega \\ -d(x, \partial\Omega) & \text{if } x \in \Omega^c \end{cases}$$
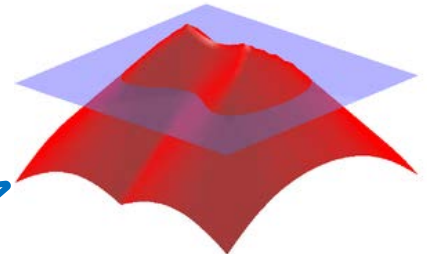
where $\partial\Omega$ denotes the boundary of Ω. For any $x \in X$,

$$d(x, \partial\Omega) := \inf_{y \in \partial\Omega} d(x, y)$$

where *inf* denotes the infimum.

Distance function visualization of the blue plane below

Our mesh X

2. We have SDF available for the 2D space

3. Computed for those "meshes"

8. Until boundary is hit

6. And perform another query here

5. Thus we can skip portion of space with ray

7. Recursion

1. Raycasting from this point and direction

4. So we know the distance to the nearest "mesh" boundary
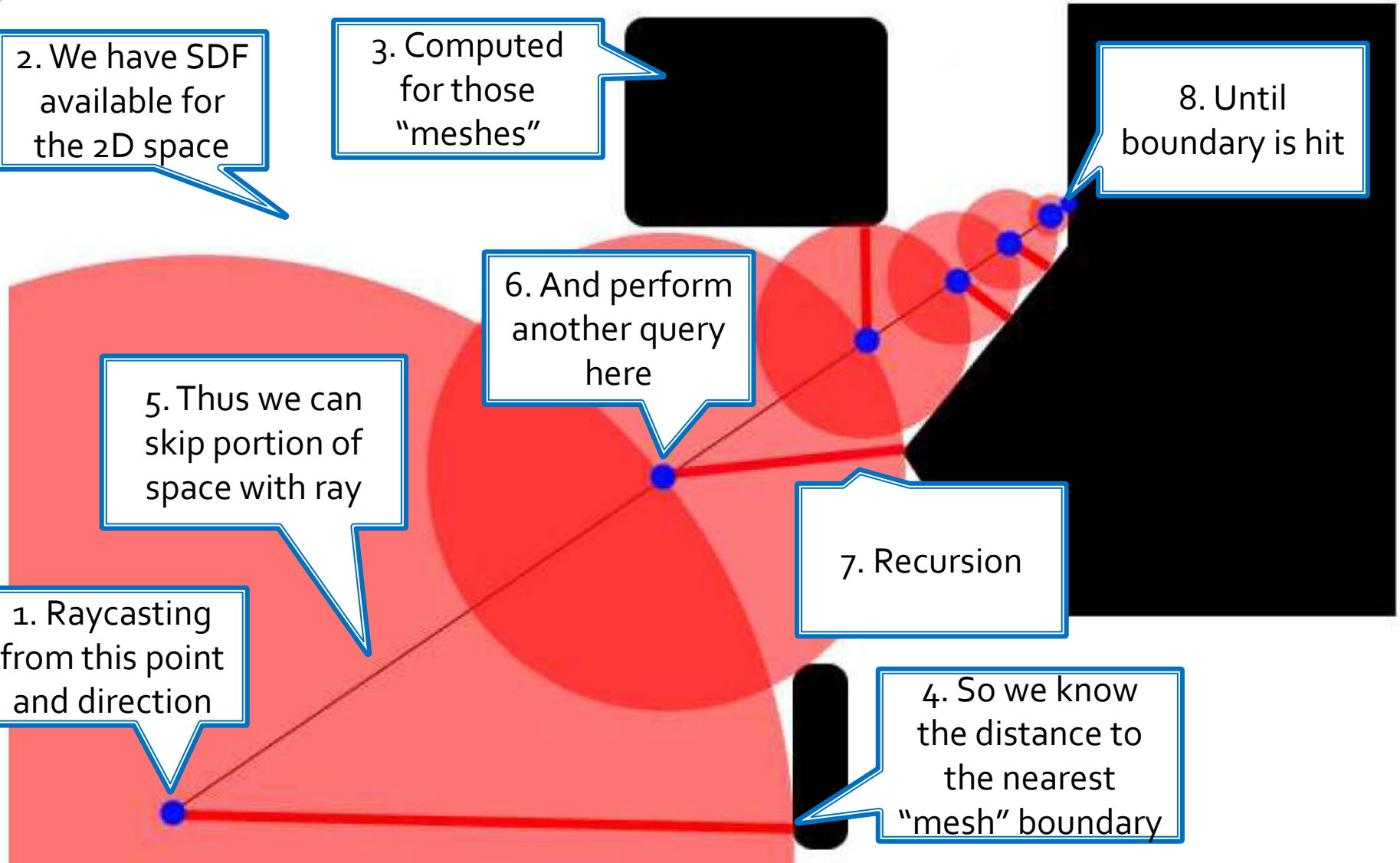
Distance Aided Ray Marching
Detour to Raytracers

- Do not define the scene via meshes, define space SDF! SDF may contain nearest boundary point albedo / normals.

=> Easy way to apply complex transformations the mesh; NVScene s. 30-44

Distance Aided Ray Marching

Detour to Raytracers

```
float twistedColumn( vec3 p )
{
    vec3 q = rotateY(p, p.y*1.7);
    return distanceToColumn(q);
}
```

```
float dist = distanceToColumn(p);
```

Signed Distance Field
Real-time Application

- Distance Field Ambient Occlusion
  - View independent, robust to occluded objects

- Distance Field Soft Shadows

- Accurate SDF takes a lot of computation time / space
  - $\Rightarrow$ Octree (GPU friendly) approximation

Distance Field Ambient Occlusion
UE4

- [Distance Field Ambient Occlusion](#)

- [Example video](#)

- Theory in [NVScene](#) s. 47-54
  - Be sure to visit!

- [Tim Hobson on DFAO](#), step by step
  - Be sure to visit!

- [How to enable in UE4](#)

Distance Field Soft Shadows
UE4

- Distance Field Soft Shadows

- Example video

- Theory in NVScene s. 55

- Tim Hobson on DFSS, step by step
  - Be sure to visit!

Distance Field AO / SS
UE4 – More links

- [Tom Looman on DF](#) AO / SS in UE4

- [UE4 SIGRAPH 2015 Presentation](#) on DF AO/SS