SIGGRAPH2011

High-Quality Spatio-Temporal Rendering using Semi-Analytical Visibility

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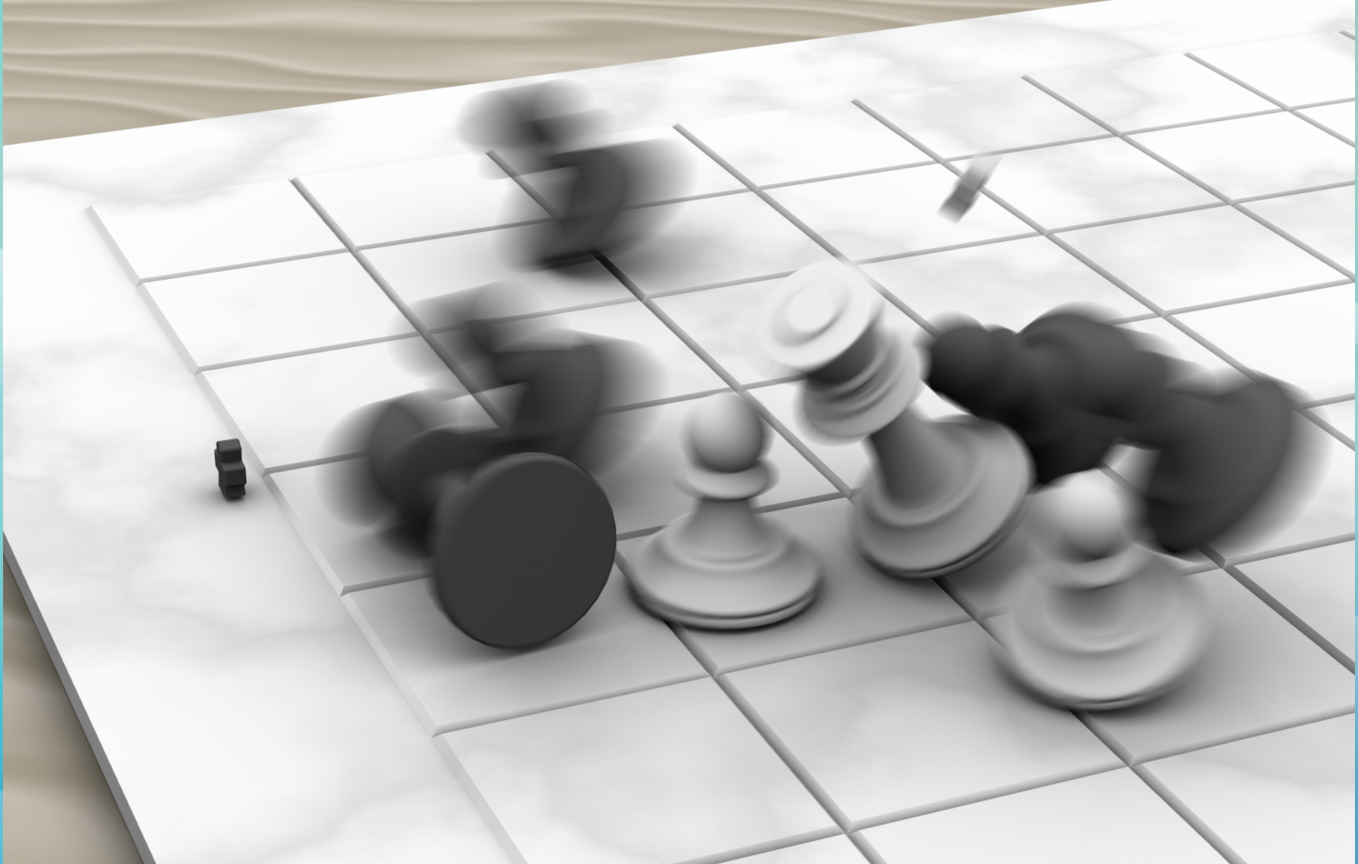

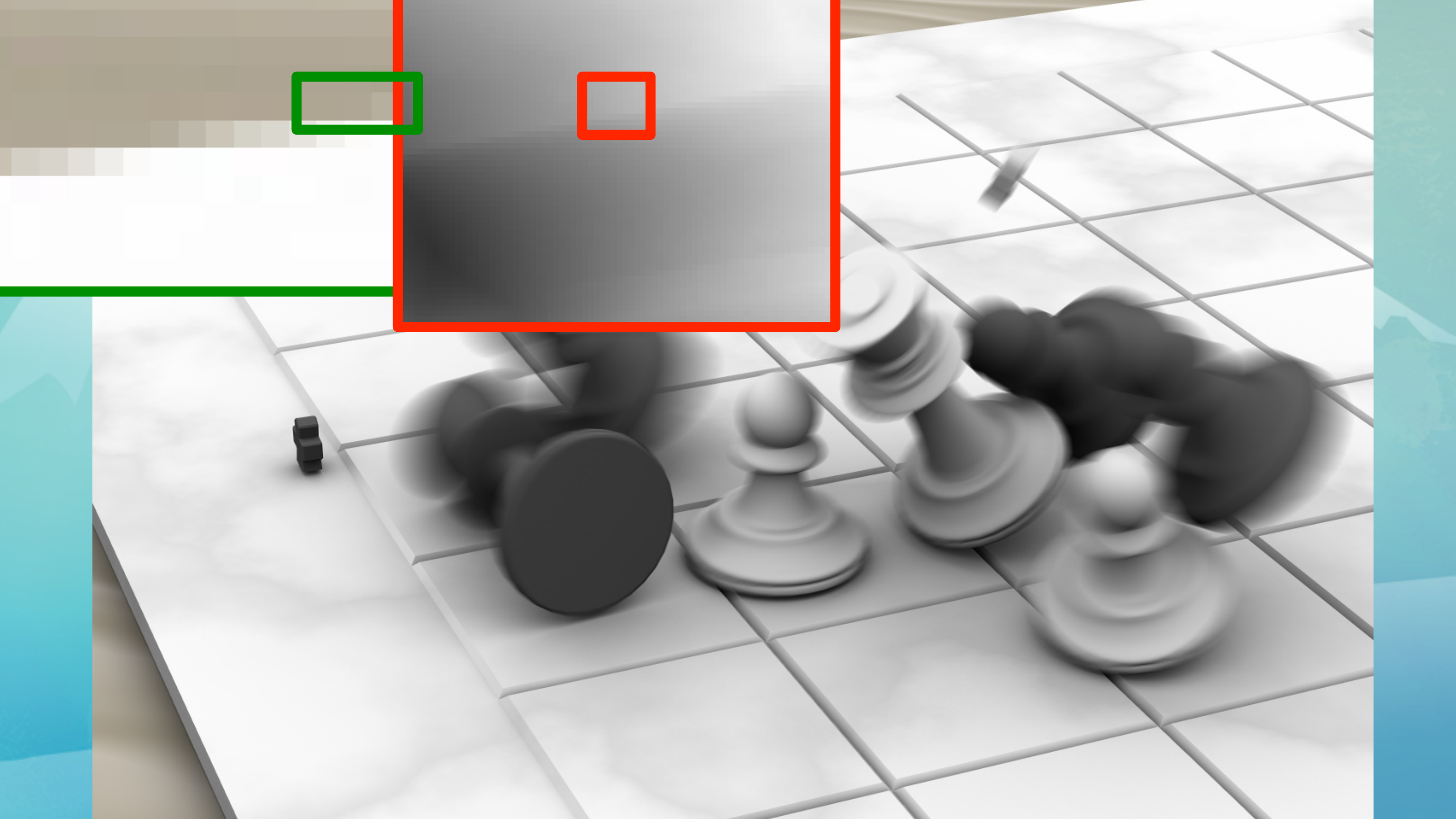

Overview

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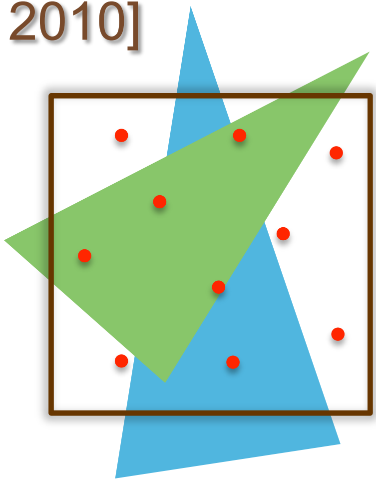
- Previous work
- Line sampling, approximation of LTD-space
- Visibility Engine
- Ambient Occlusion
- Results
- Future Work

Previous work

- Stochastic sampling
  - [Cook et al. 85], [Akenine-Möller et al. 2007], [Fatahalian et al. 2009], [McGuire et al. 2010]
- Decoupled shading and reuse
  - [Ragan-Kelley et al. 2011] [Burns et al. 2010]



Previous work

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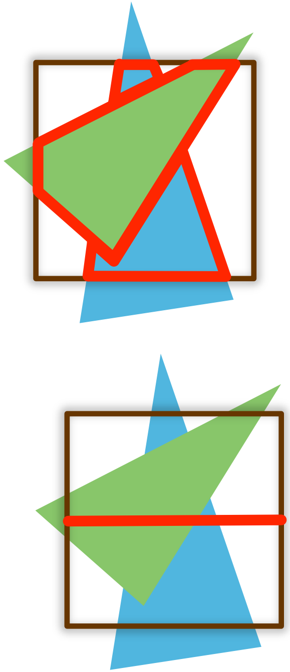
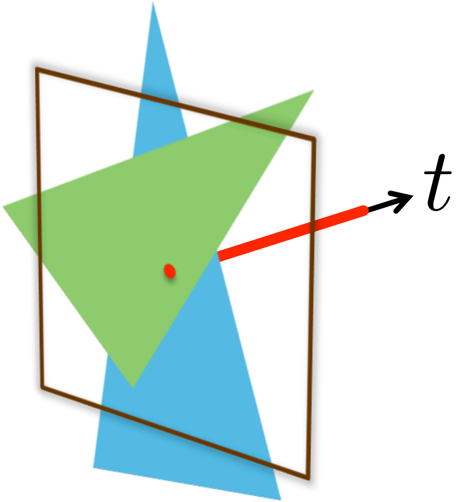
- 2D visibility
  - [Catmull 1978]
    [Grant 1985]
- 1D visibility
  - [Jones and Perry 2000]



Previous work

- Single sample visibility, continuous time
  - [Korein and Badler 1983]
    [Sung et al. 2002]
    [Gribel at al. 2010]



Our algorithm

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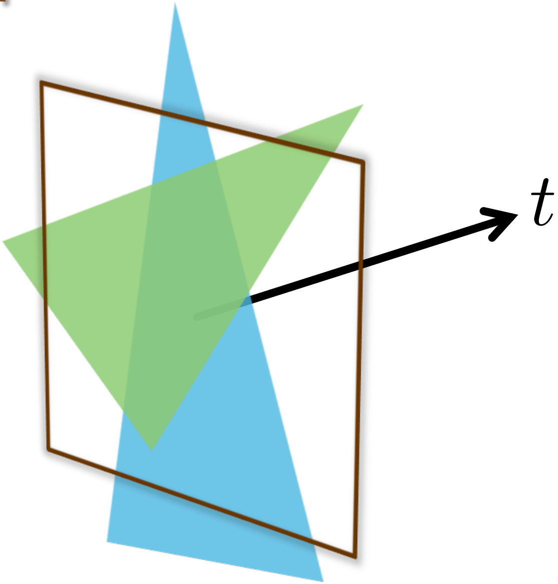
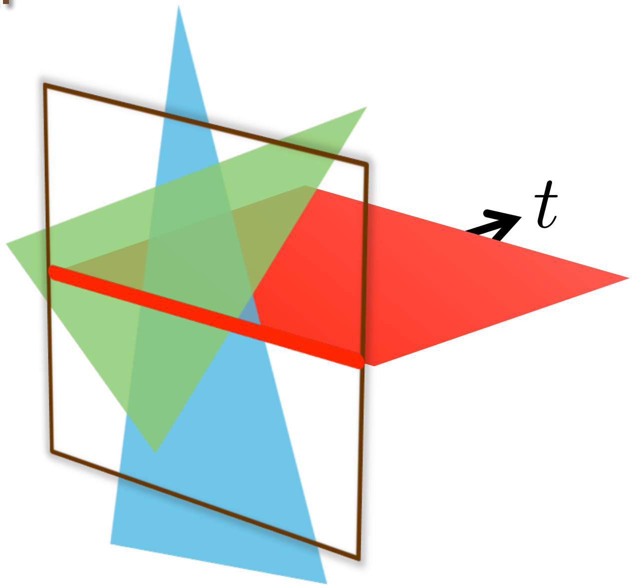
- Treat time and one spatial dimension as continua

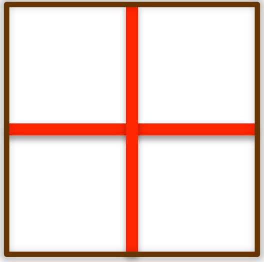


Our algorithm

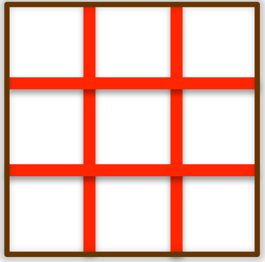
- Treat time and one spatial dimension as continua



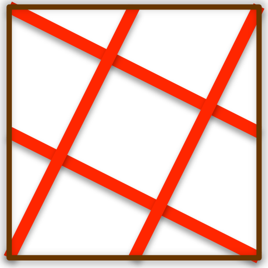
Line sample patterns



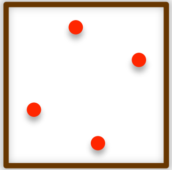
1H1V



2H2V



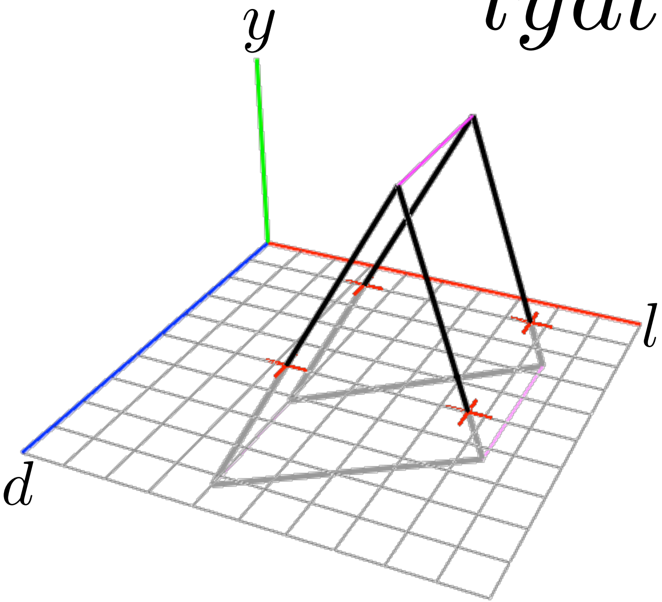
RGLS

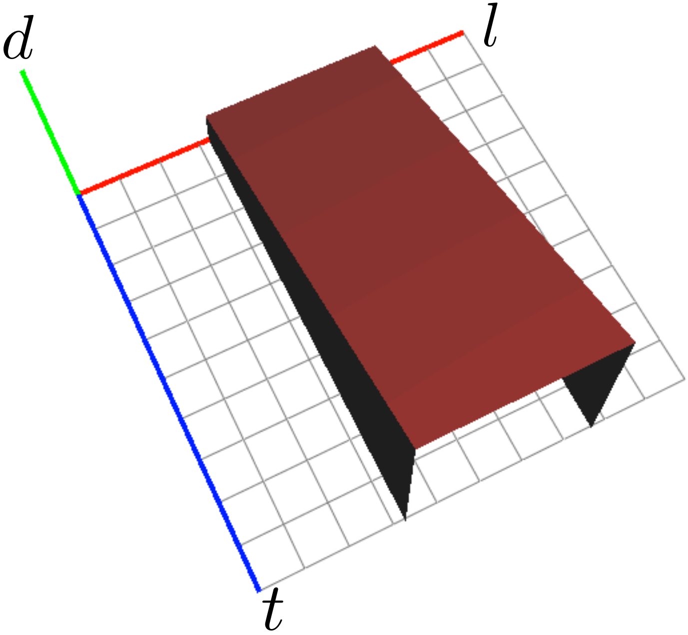


RGSS

[Jones & Perry 2000]

$$lydt \longmapsto ltd$$





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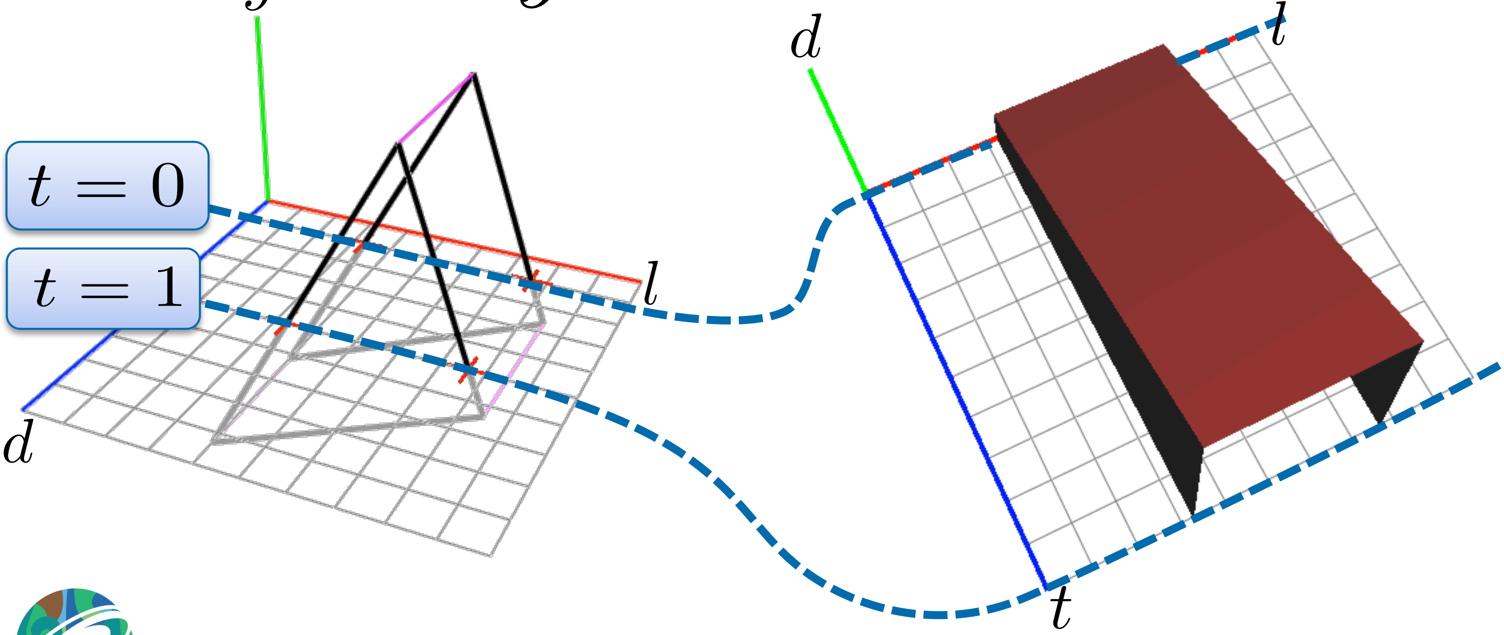
$$lydt \longmapsto ltd$$



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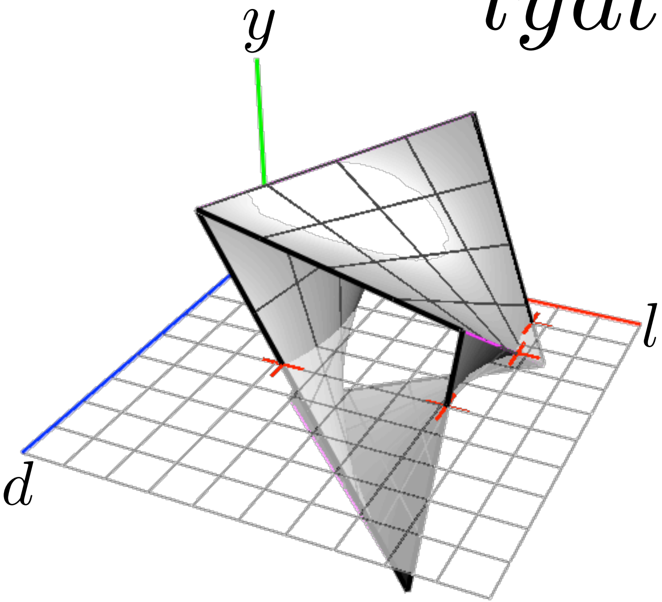
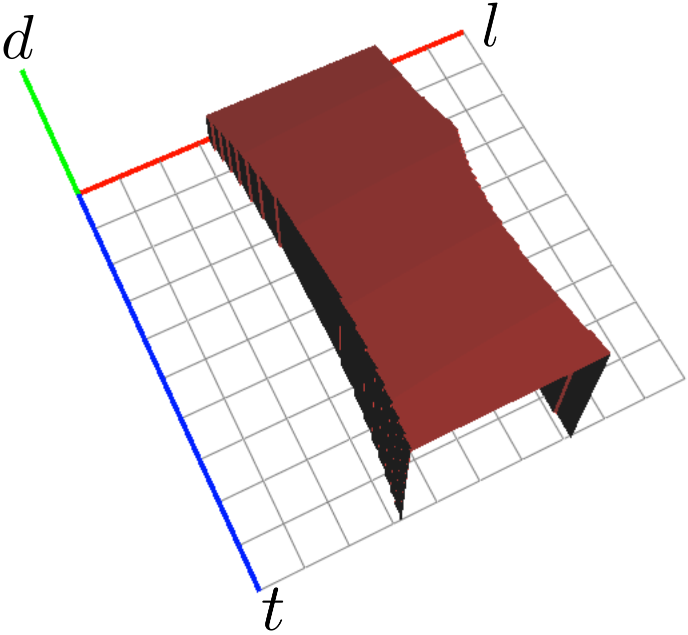
$$lydt \longmapsto ltd$$





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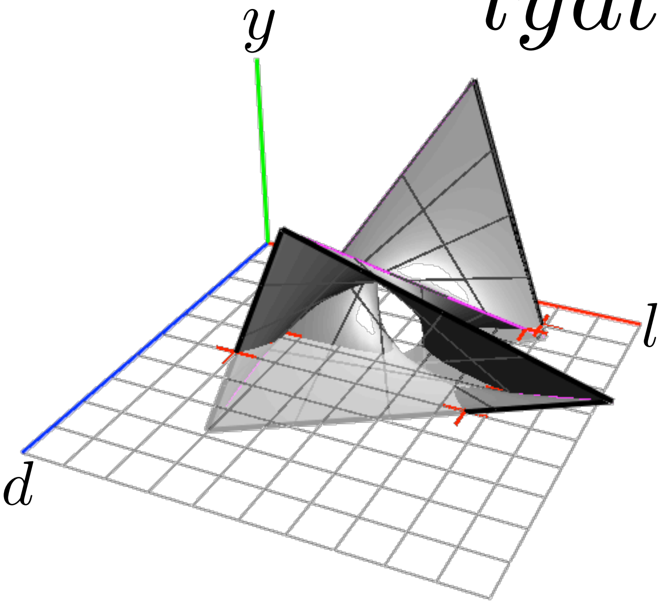
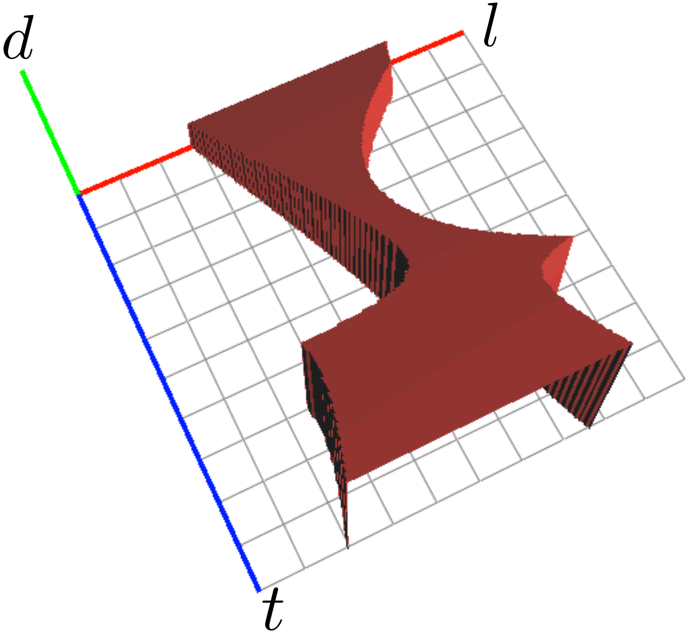
$$lydt \longmapsto ltd$$





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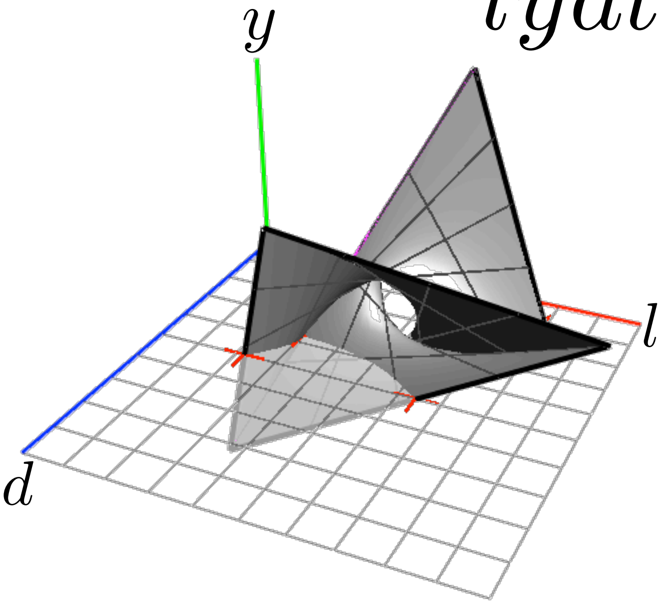
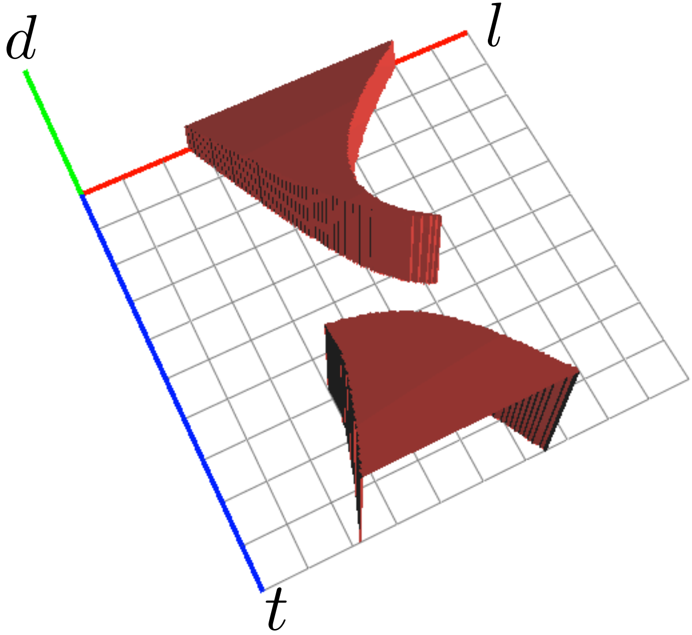
$$lydt \longmapsto ltd$$





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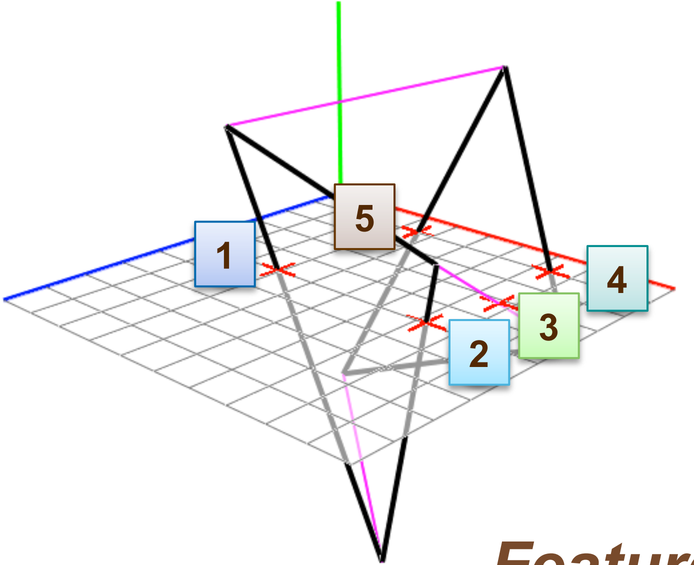
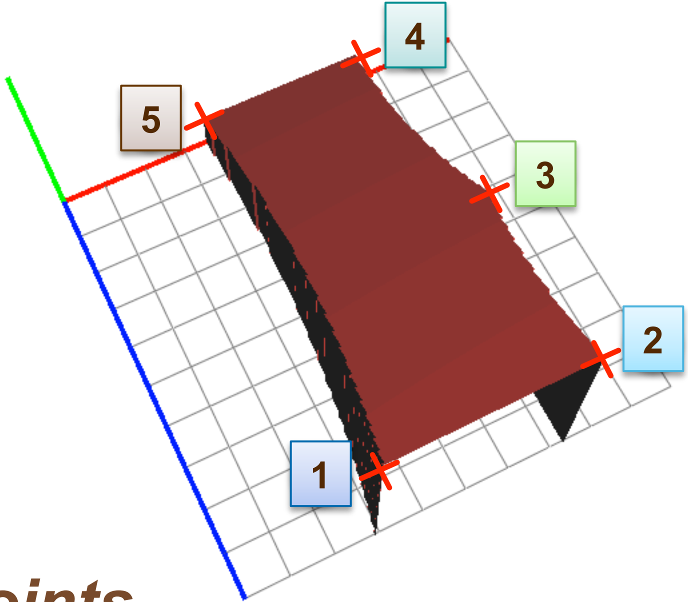
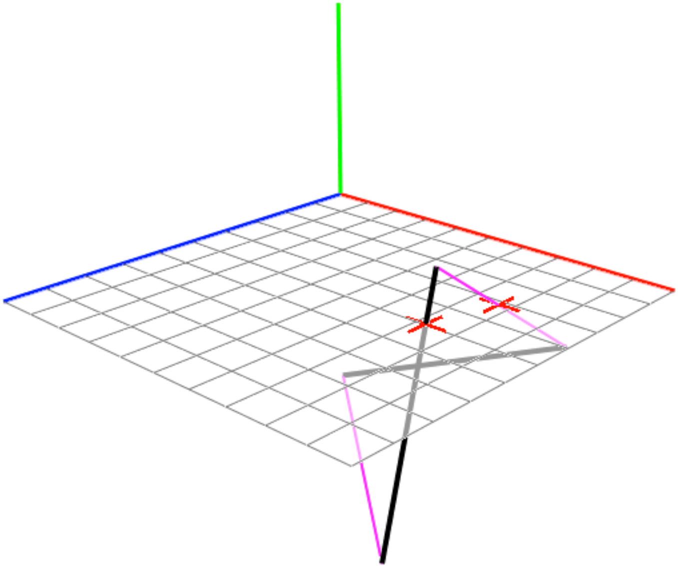
Approximation

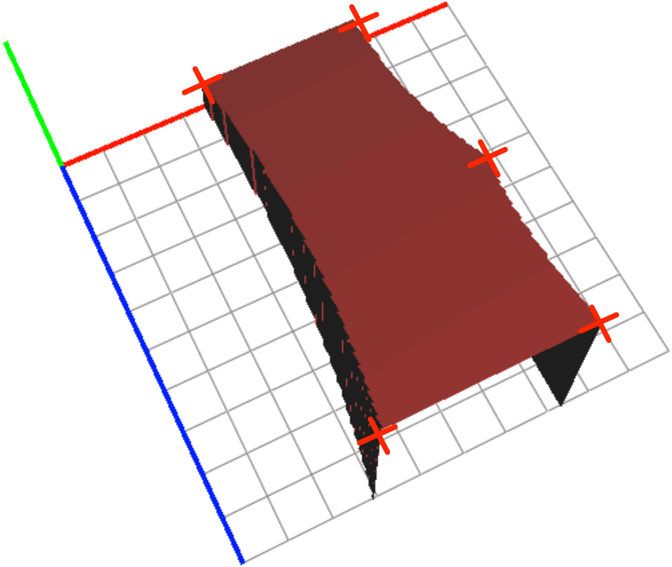




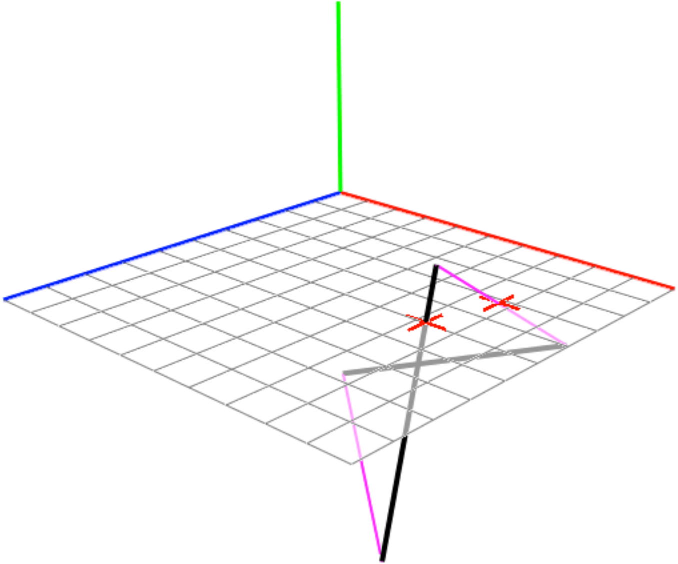
Feature points

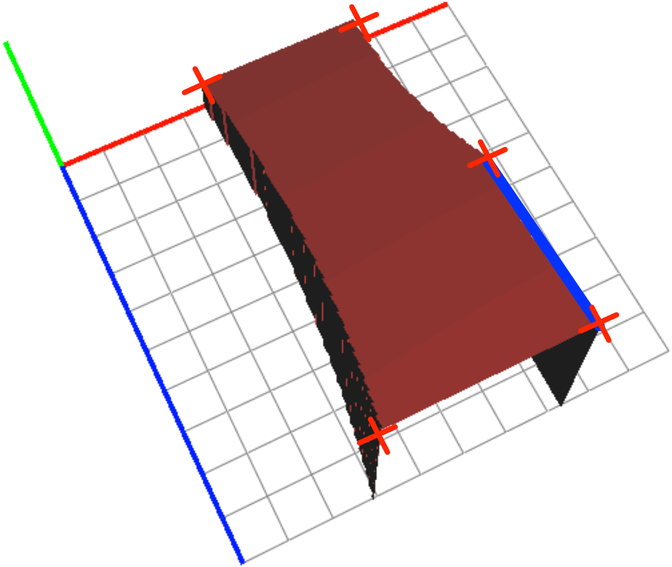
Approximation



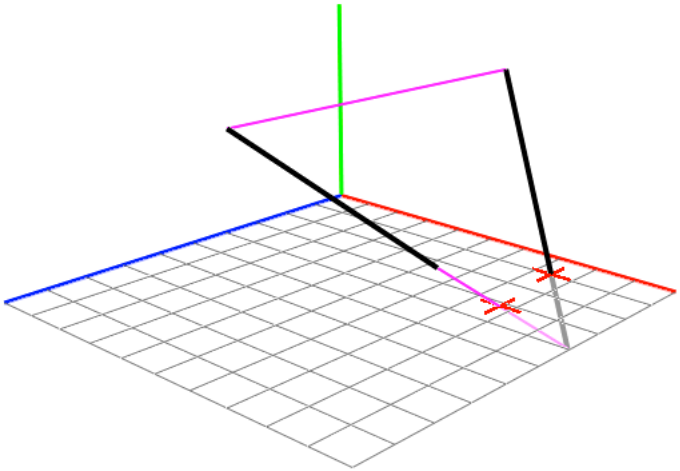


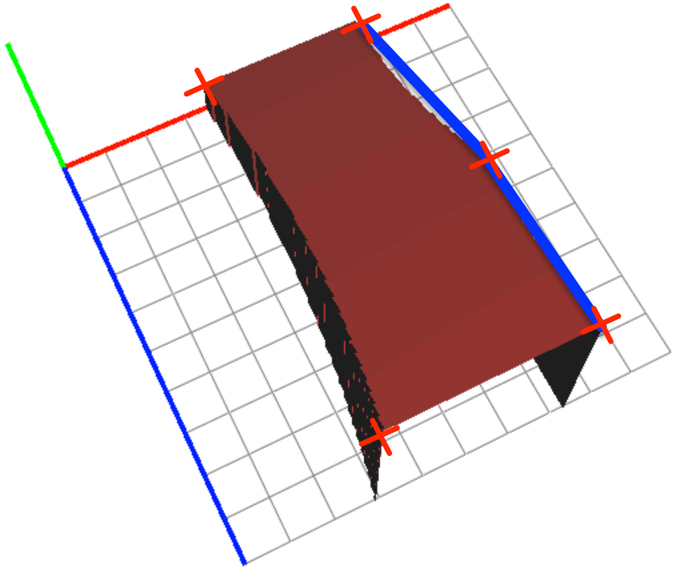
Approximation



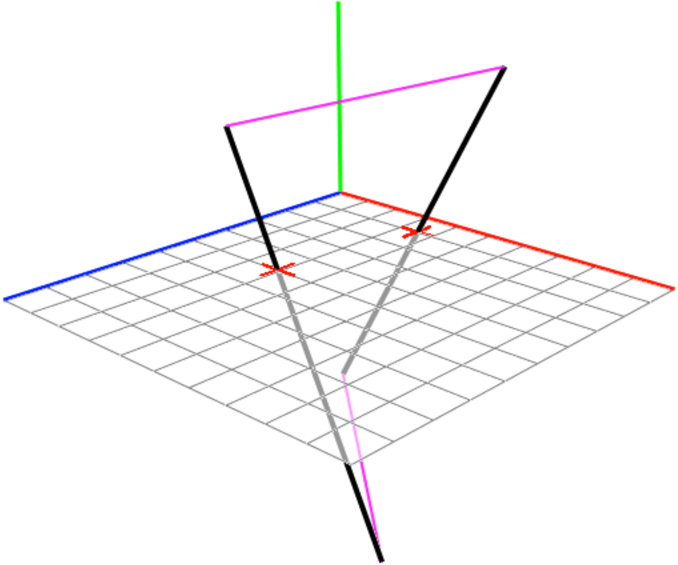


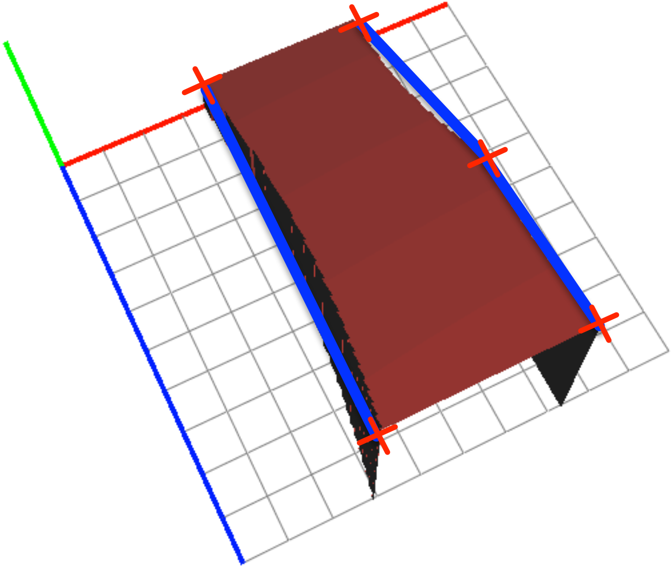
Approximation



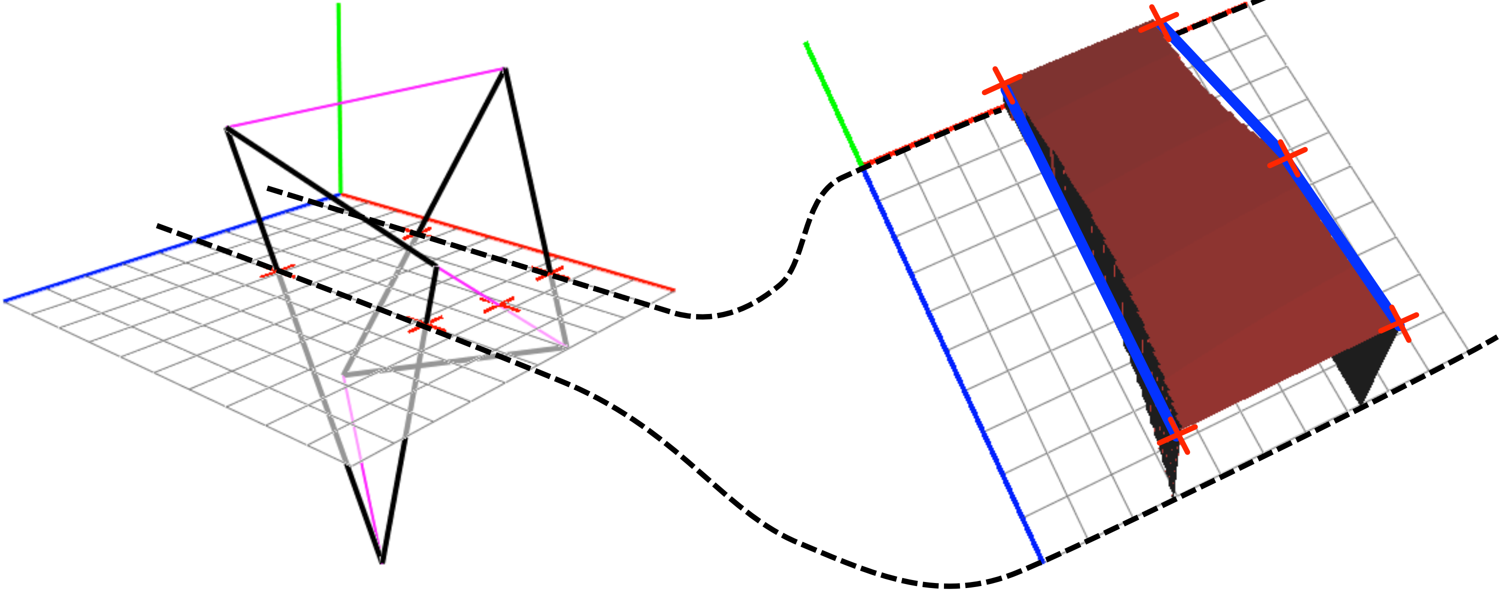


Approximation

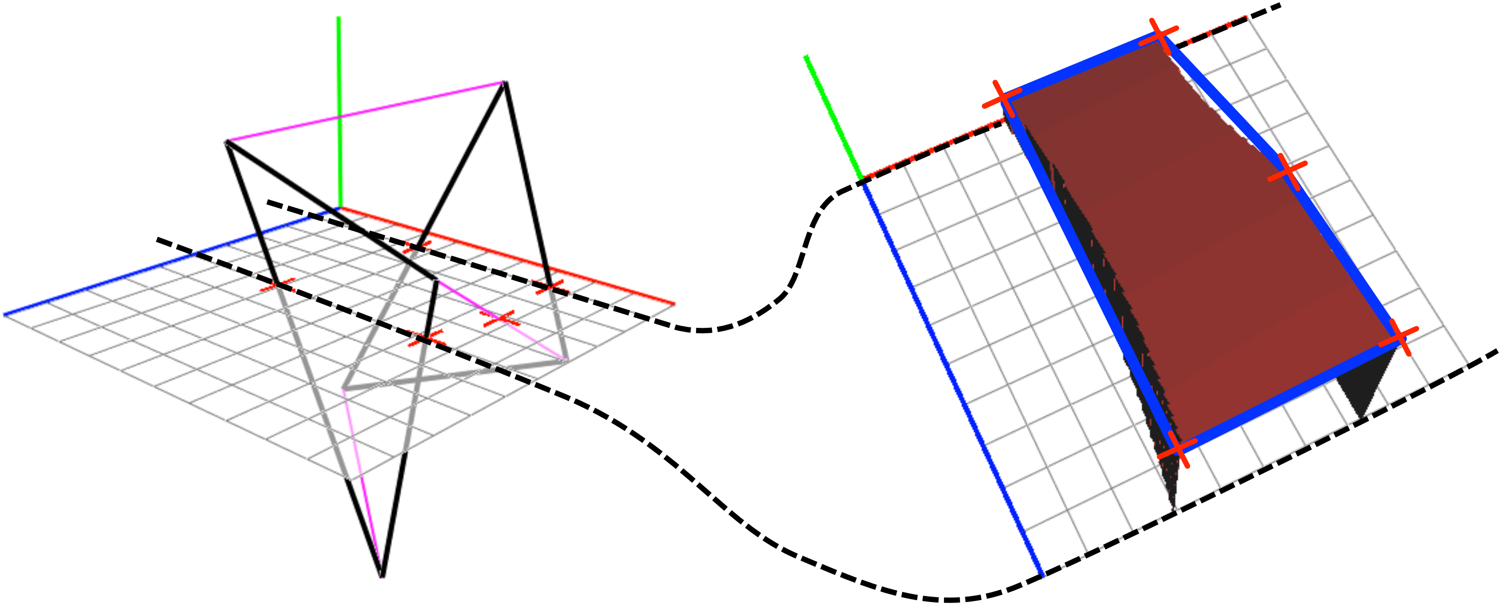




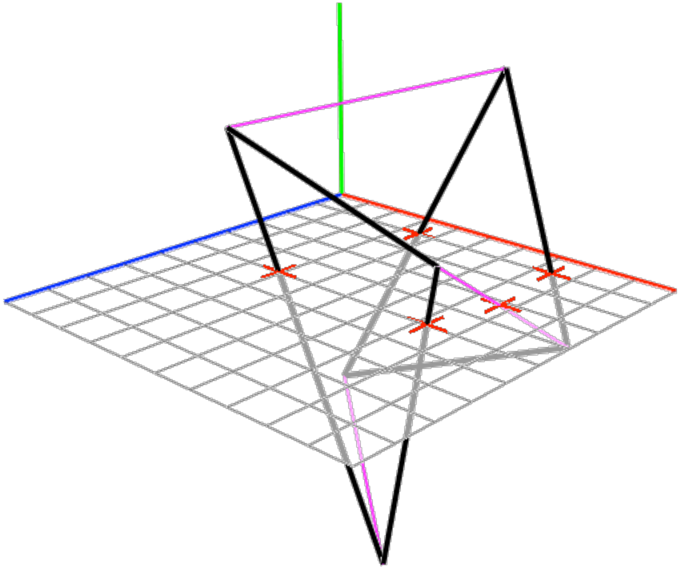
Approximation

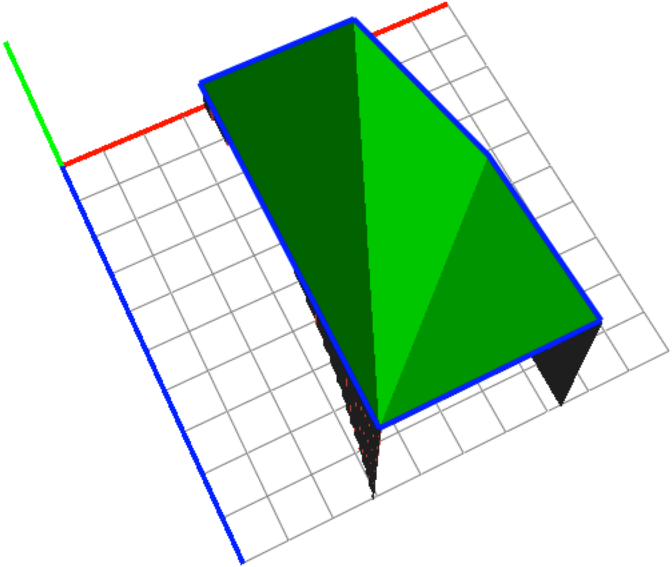


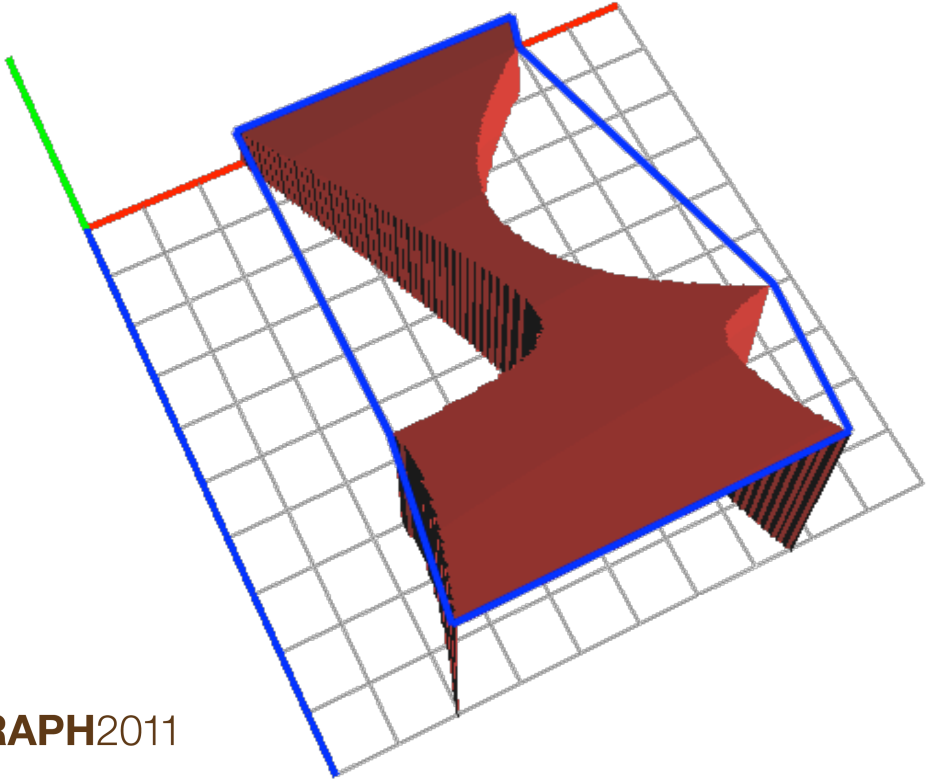
Approximation



Approximation







Approximation refinement

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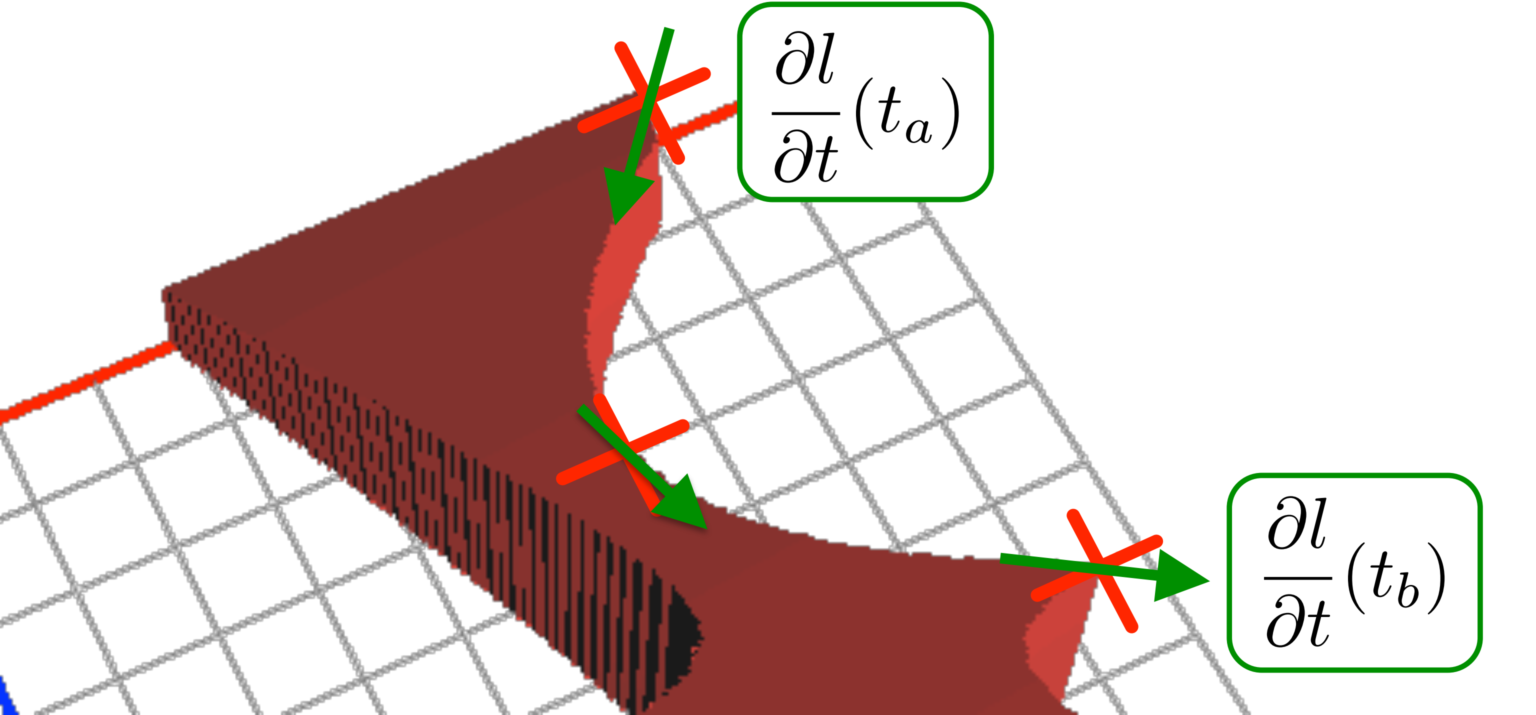

Approximation refinement

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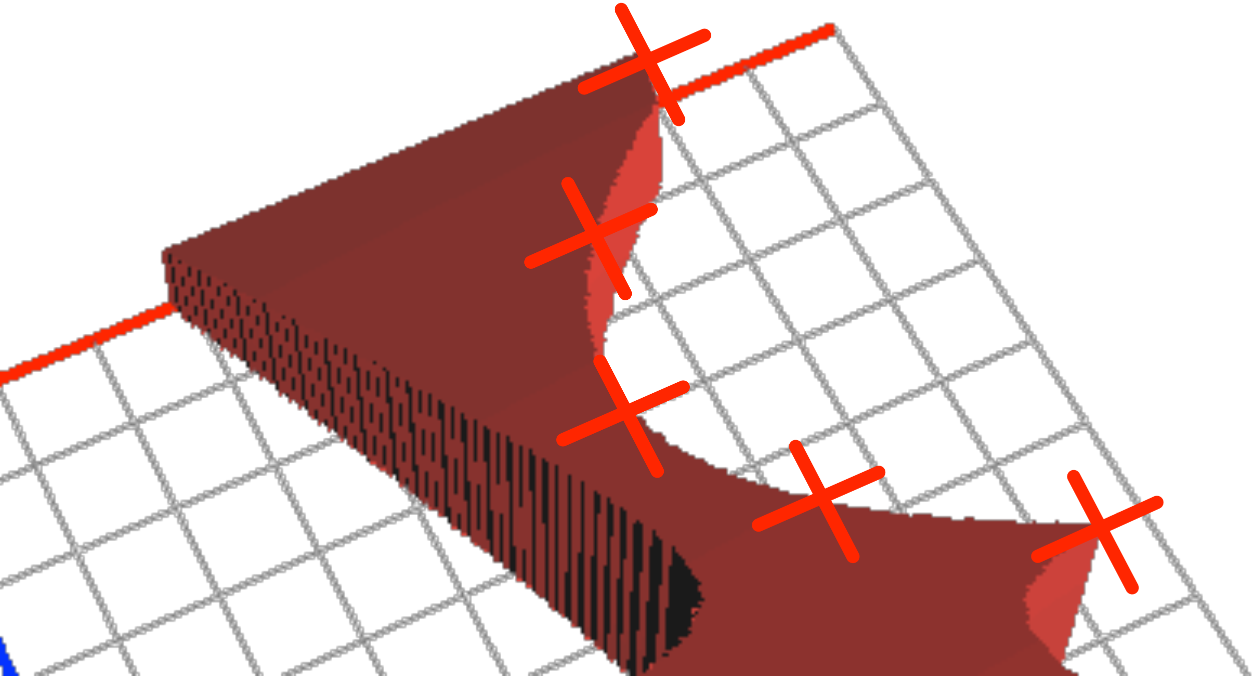

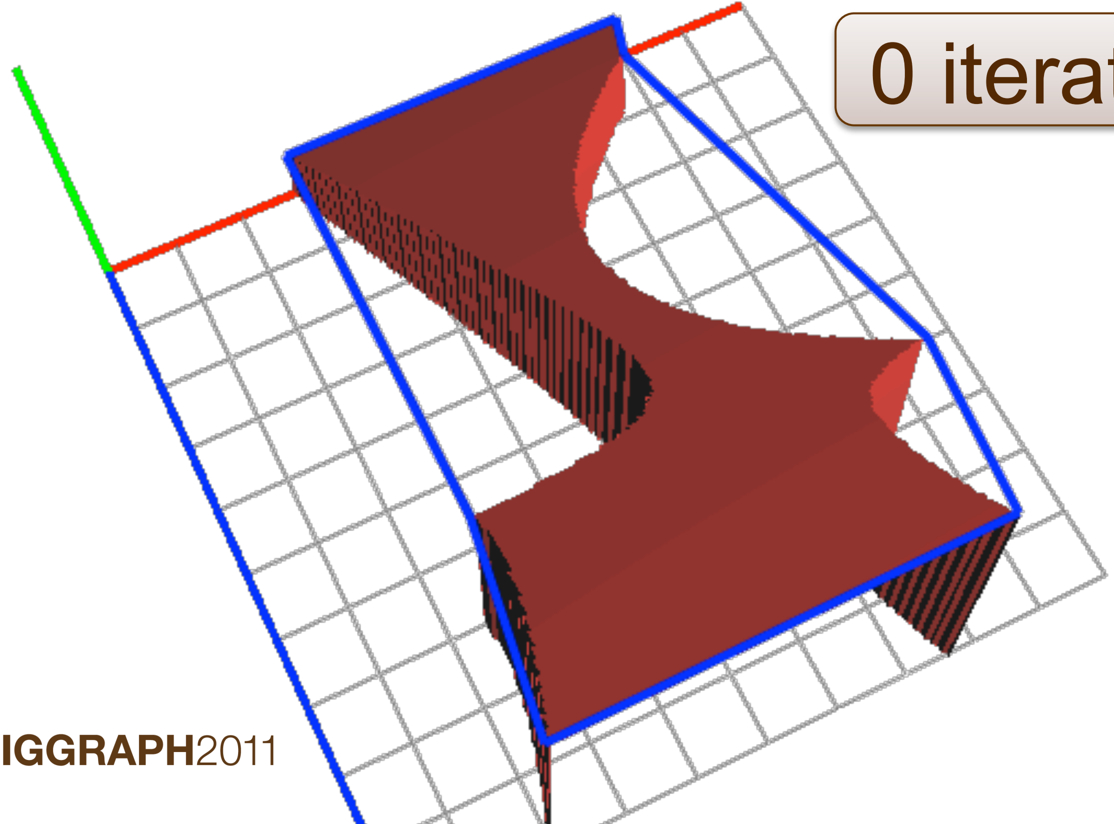

0 iterations

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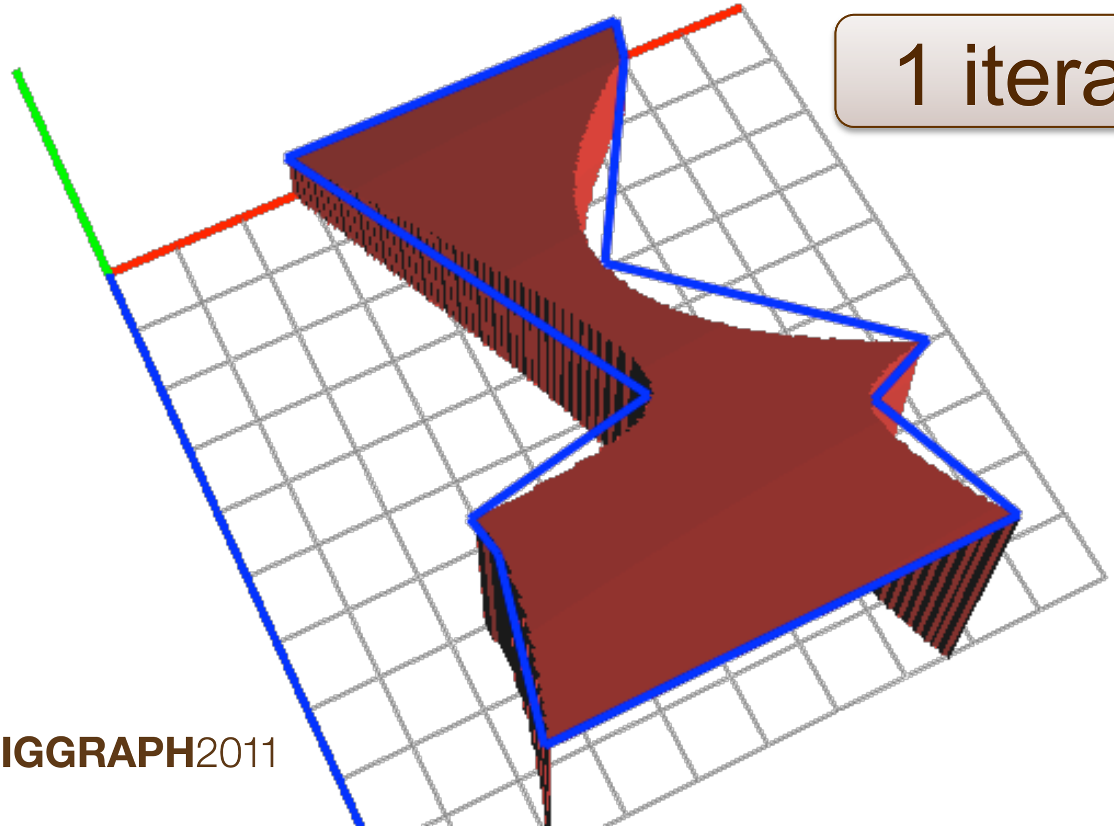
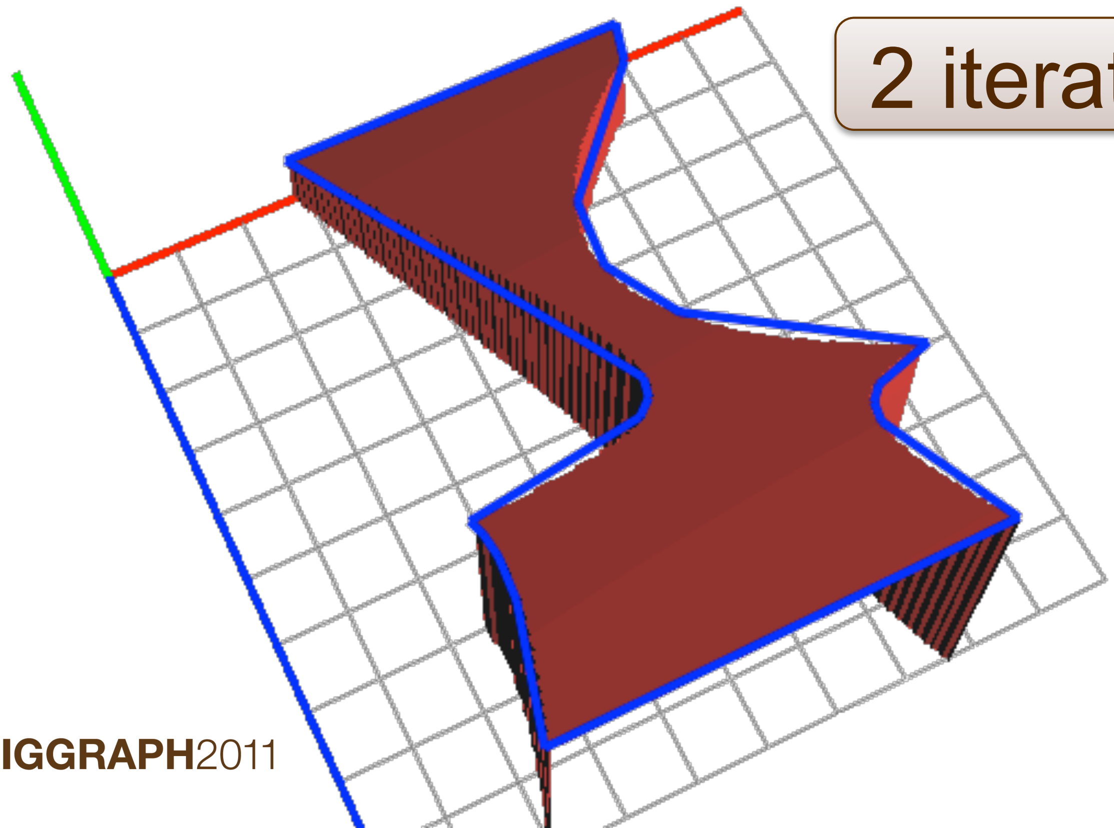
1 iteration





2 iterations

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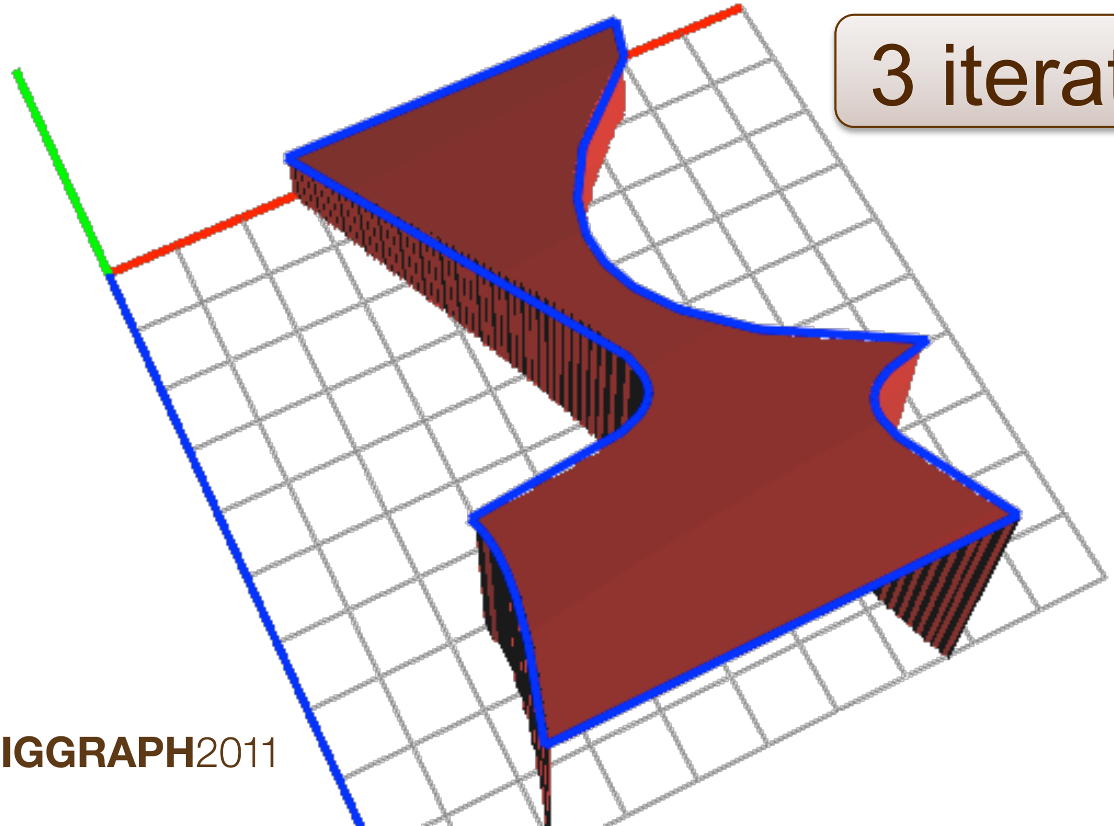
3 iterations



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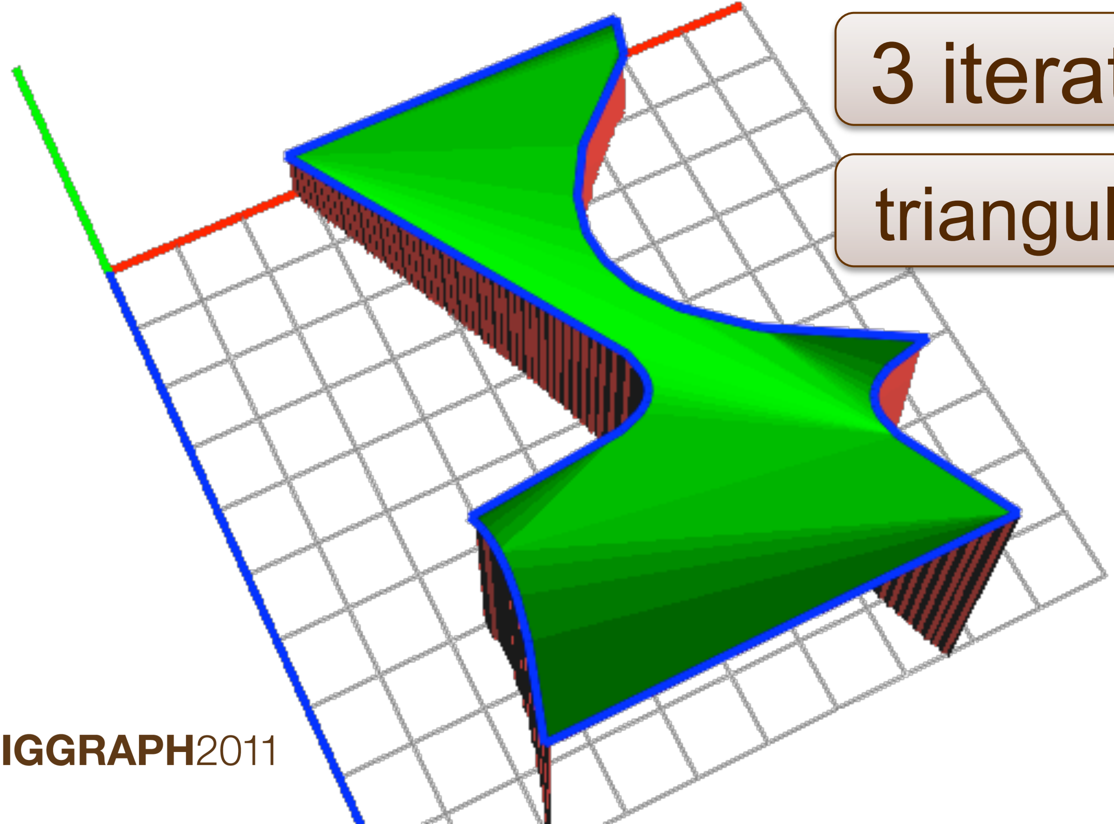

3 iterations

triangulation

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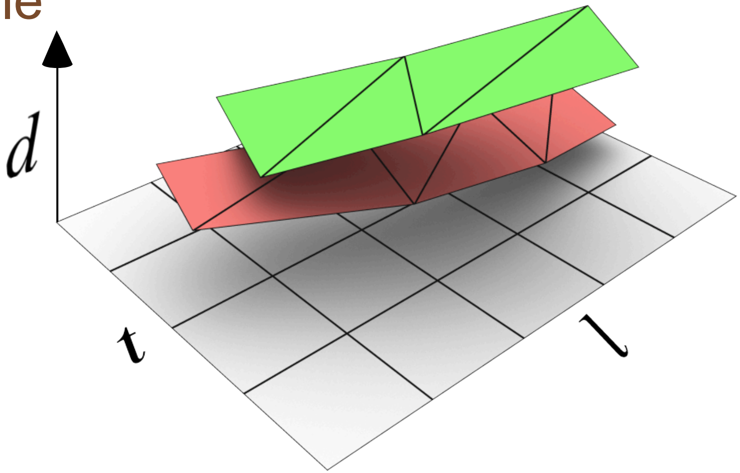
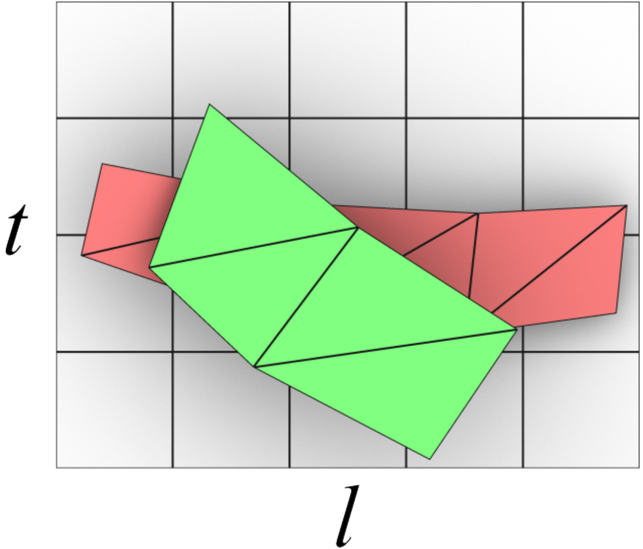
Visibility Engine

- Resolves visibility between triangles in *ltd*-space
- Calculates the color contributed to each pixel overlapping the line sample
- Stages:
  1. Binning
  2. Depth sorting
  3. Pixel integration



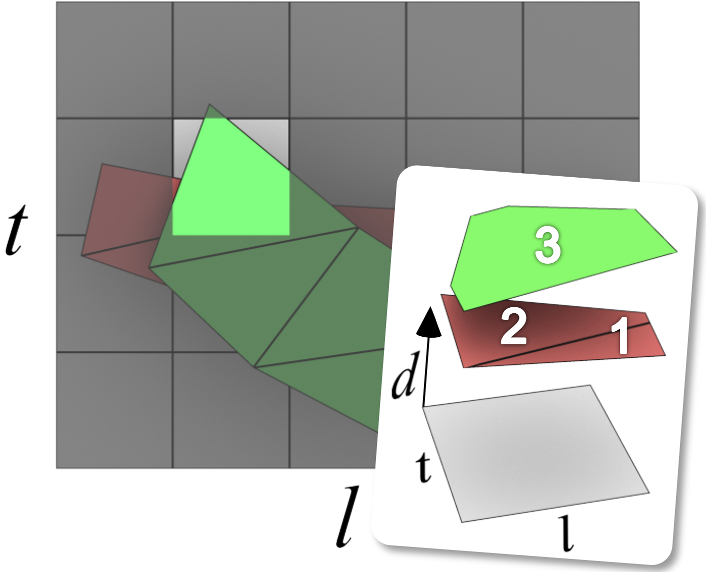
Stage 1: Binning

- Split *lt*-space into a uniform grid (*m* by *n*)
- Conservatively rasterize triangles to *lt*-cells
- Following stages: Process a single cell at a time!



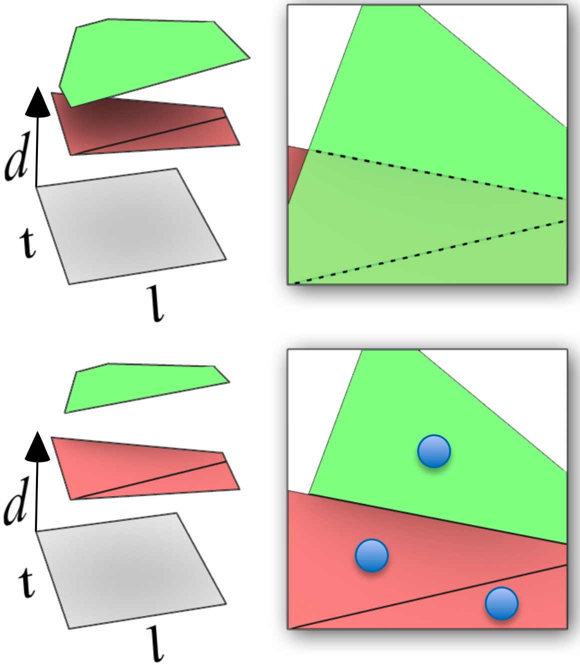
Stage 2: Depth sorting

- Clip binned triangles to cell boundaries
- Split polygons against each other (if necessary)
  - Using a BSP-tree
- Sort according to depth

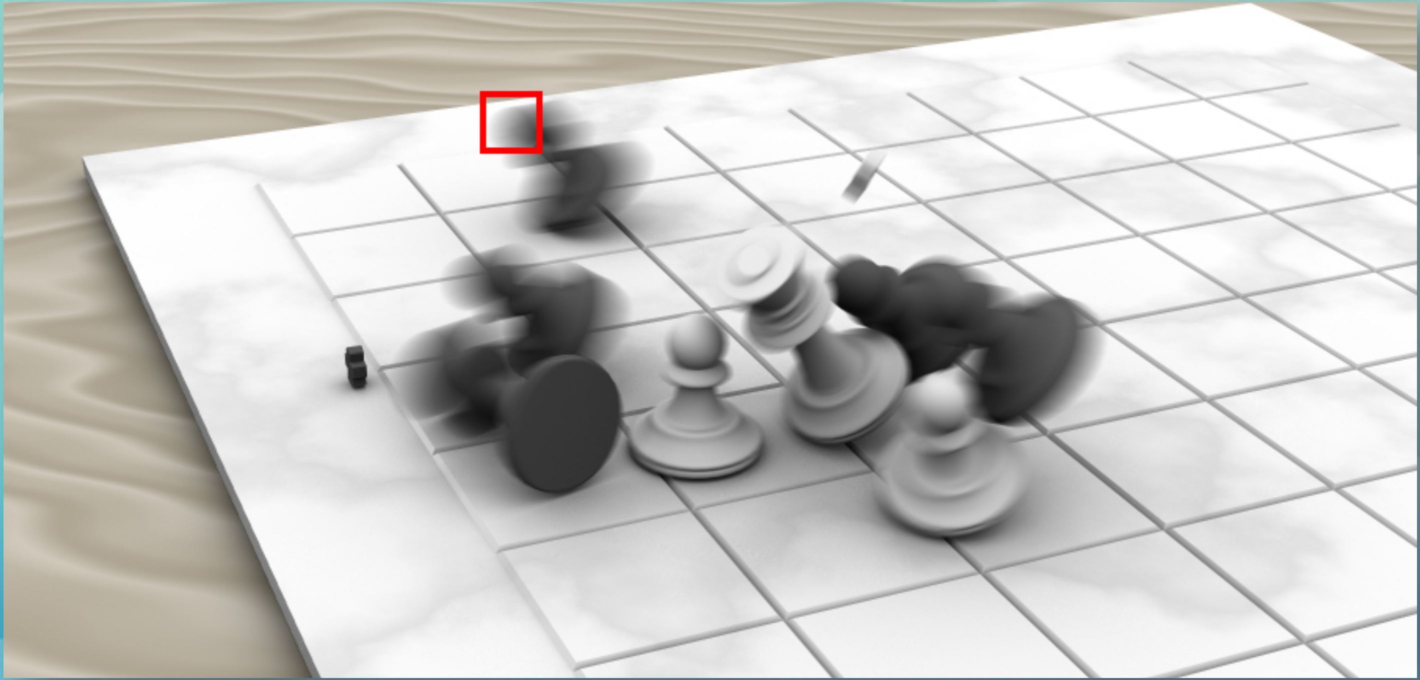


Stage 3: Pixel integration

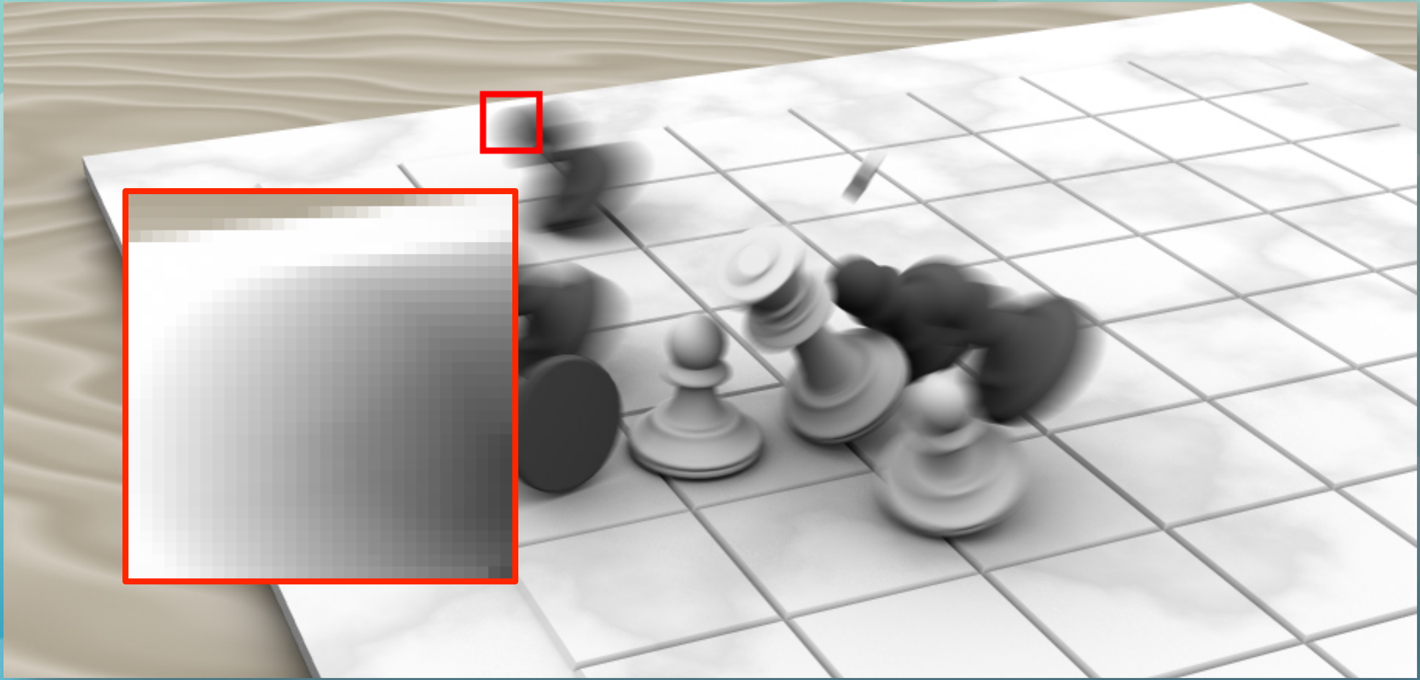
- Hidden surface removal [Catmull 1978]
- Shading
  - Sample each visible polygon at its barycenter
- Integration
  - Sum area weighted colors



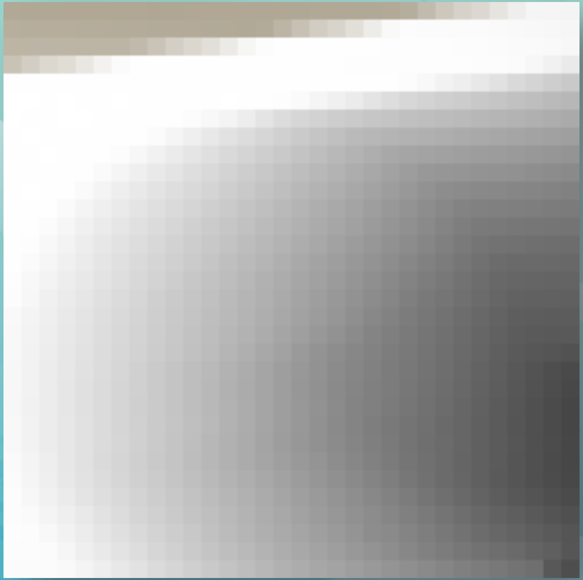
Chess ($n = 1$)



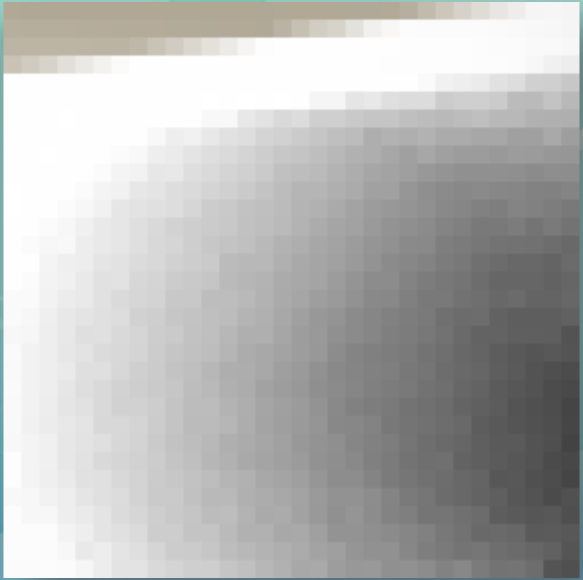
Chess ($n = 1$)



Chess (12 cores using 24 threads)

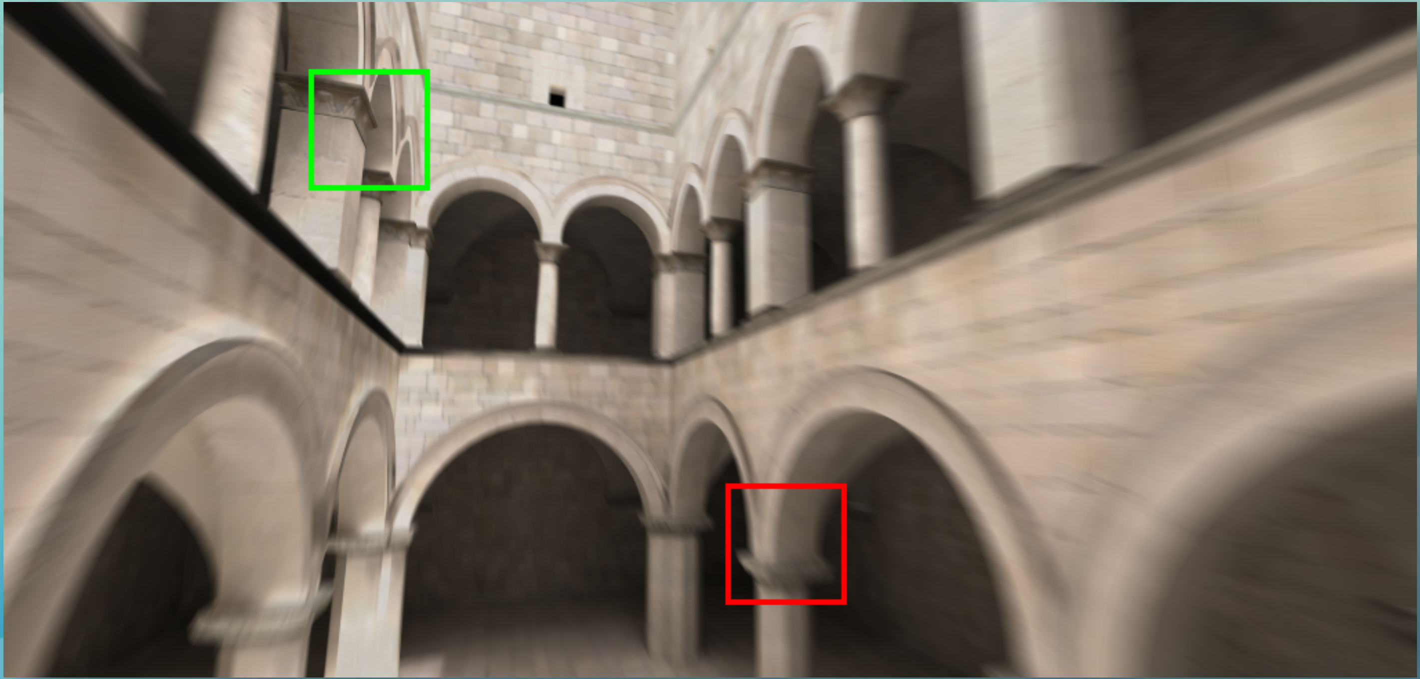


Our: 3.6 s

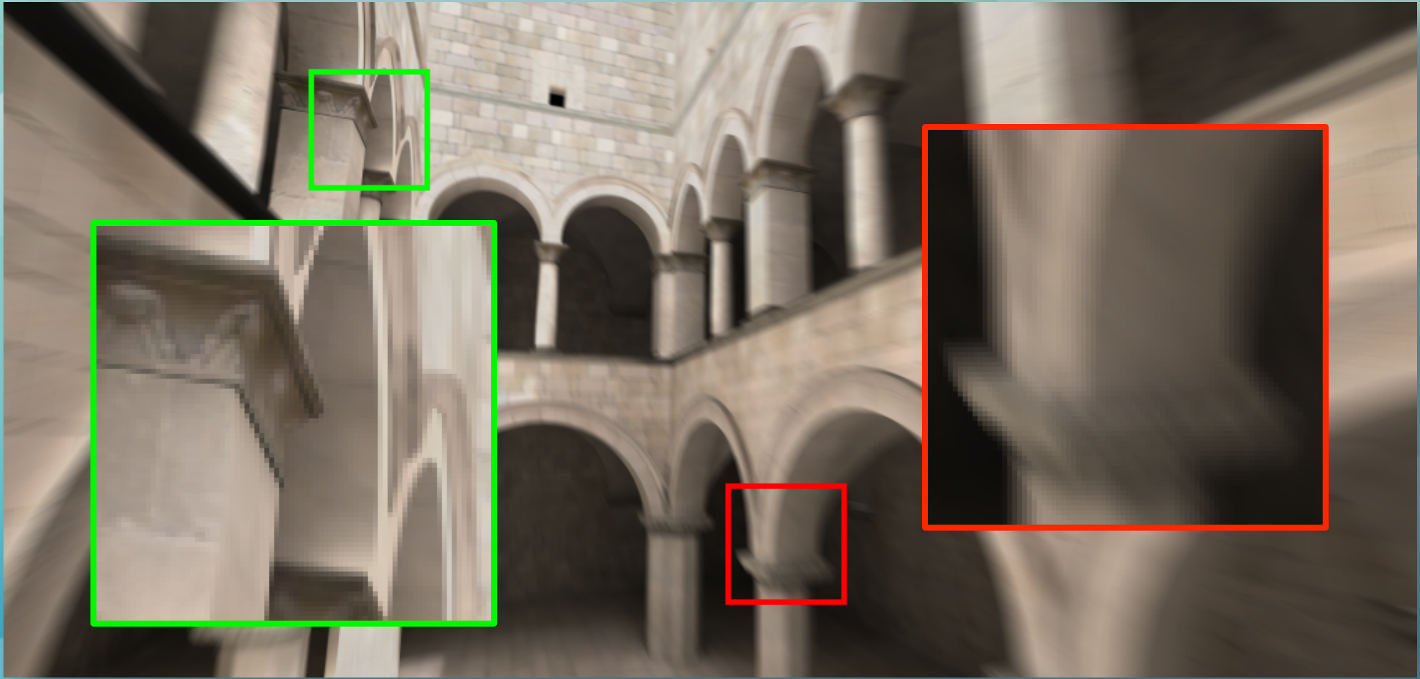


49 samples: 3.8 s

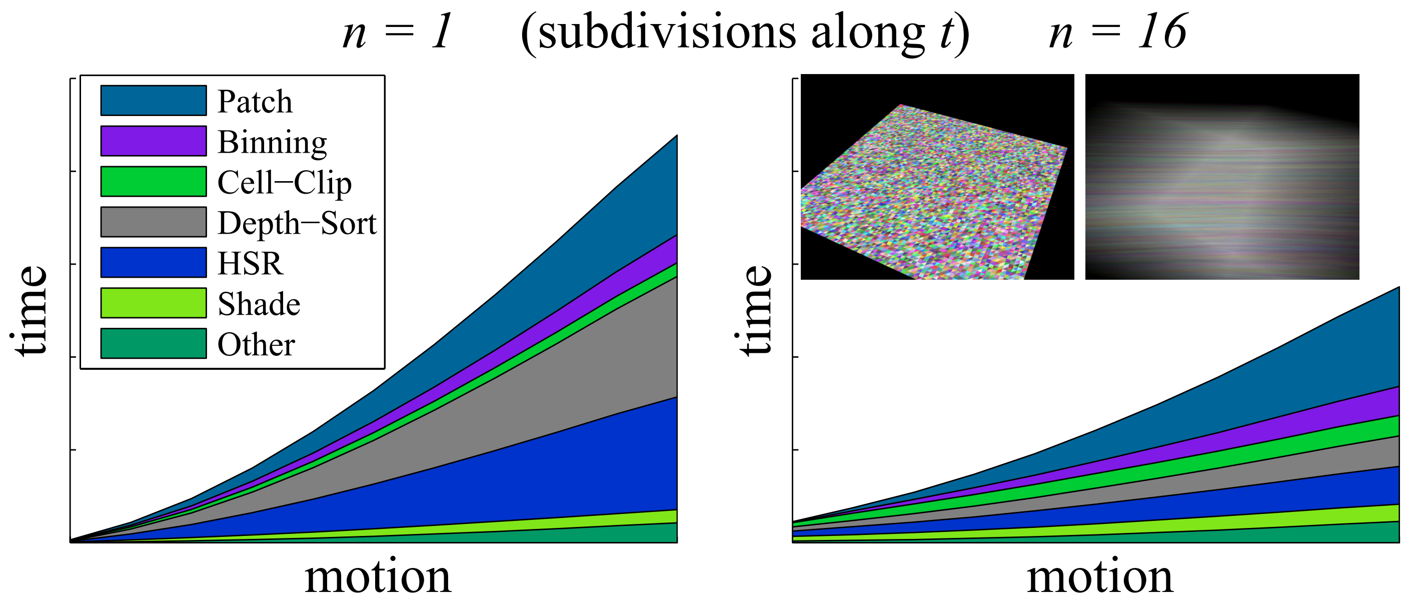
Sponza ($n = 16$)



Sponza ($n = 16$)



Performance with increasing motion

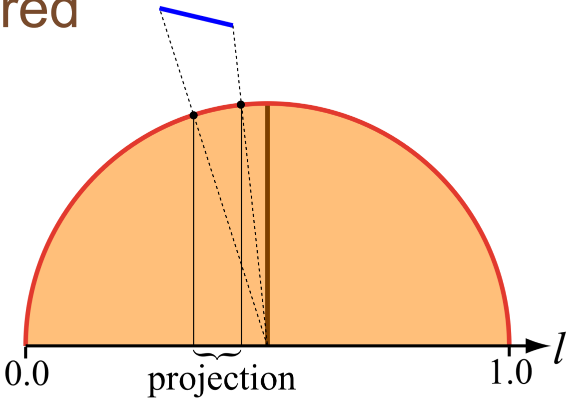


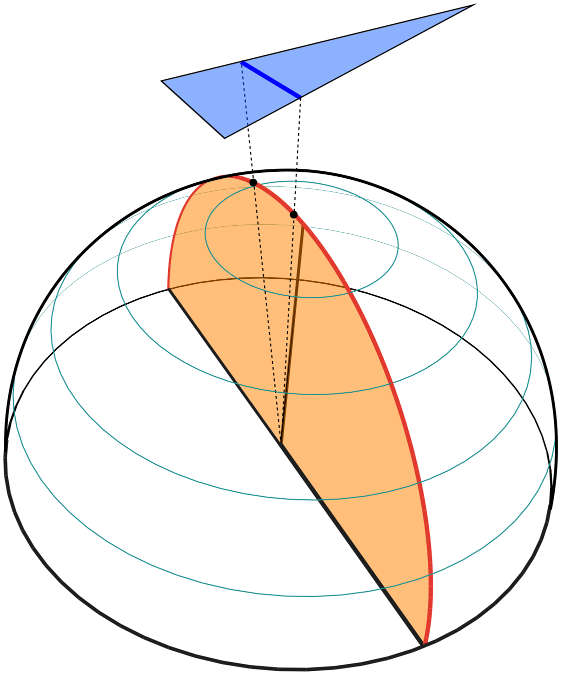
Ambient occlusion

- Our algorithm can be used to render ambient occlusion as well
- Common approximation of global illumination

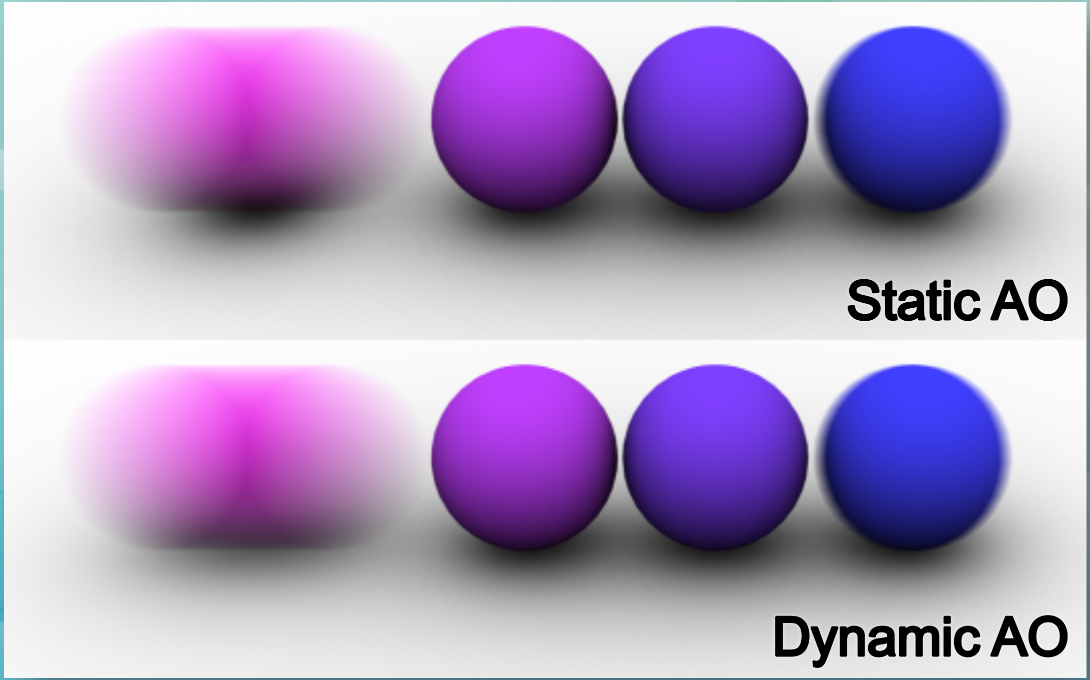
Ambient occlusion

- Line samples instead of rays
- Both static and motion blurred





Ambient occlusion



Ambient occlusion

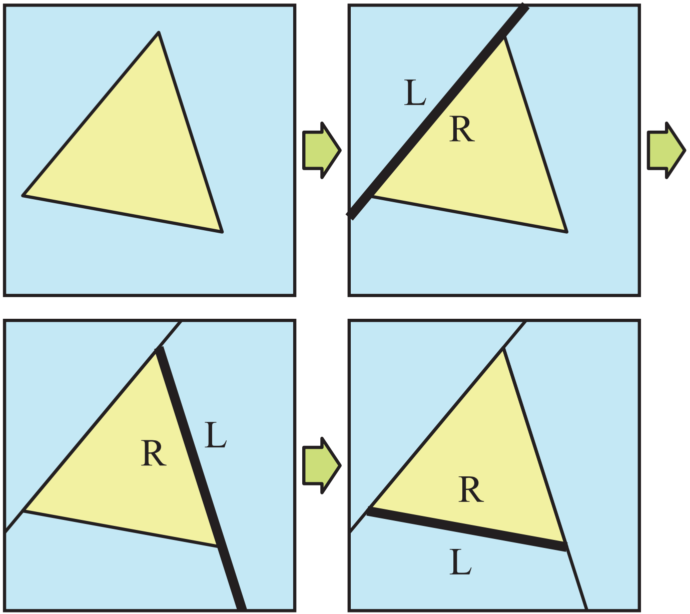
Future work

- Line sampling patterns
- Adaptive splitting of *lt*-space
- Depth of field
- Higher dimensional problems
- Rigorous ambient occlusion evaluation

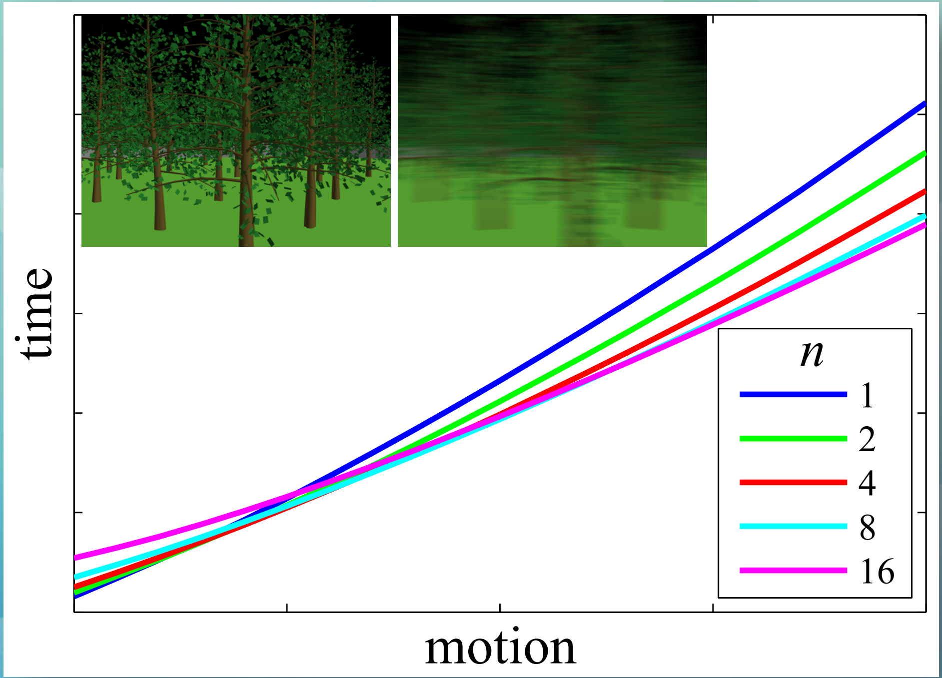
Thanks for listening!

Hidden surface removal [Catmull78]

- Insert polygons into tree in order
- Split against first edge
  - Left part is added to the sub tree of that edge
  - Right part is split against the next edge (or thrown away at last edge)



Performance with increasing motion



Near-z clipping

- Establish coordinate basis for the line sample in view space
- Transform moving triangles into this basis and generate *ltd*-triangles
- Clip against $z = z_{near}$
- Project into viewport space and map along line

Depth approximation error

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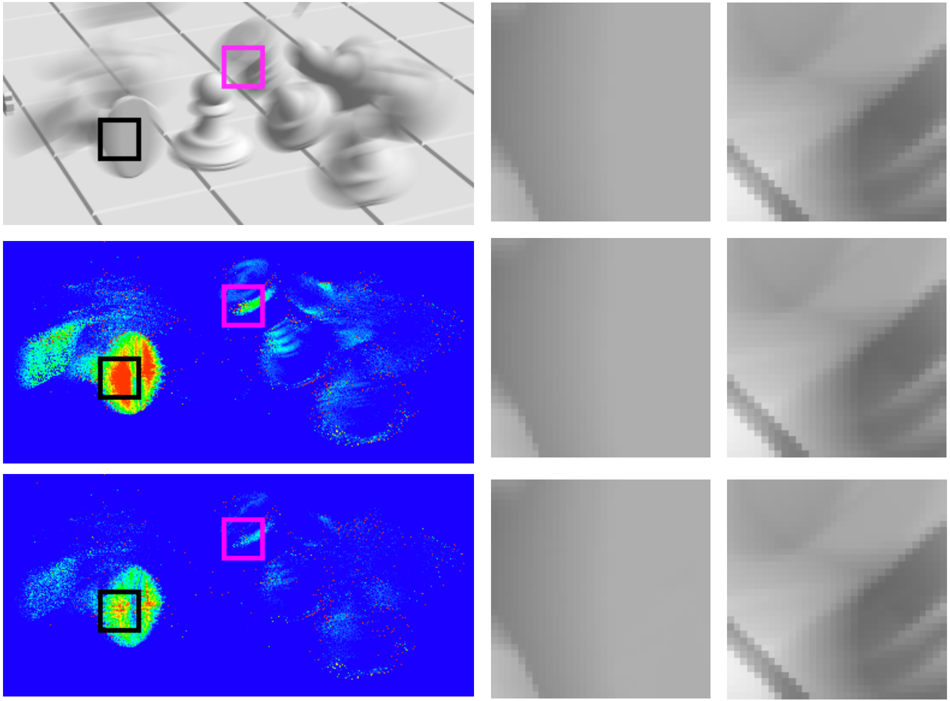
GT

0 iterations

3 iterations



Refinement iterations

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