HEIGHT FIELD LIGHTING

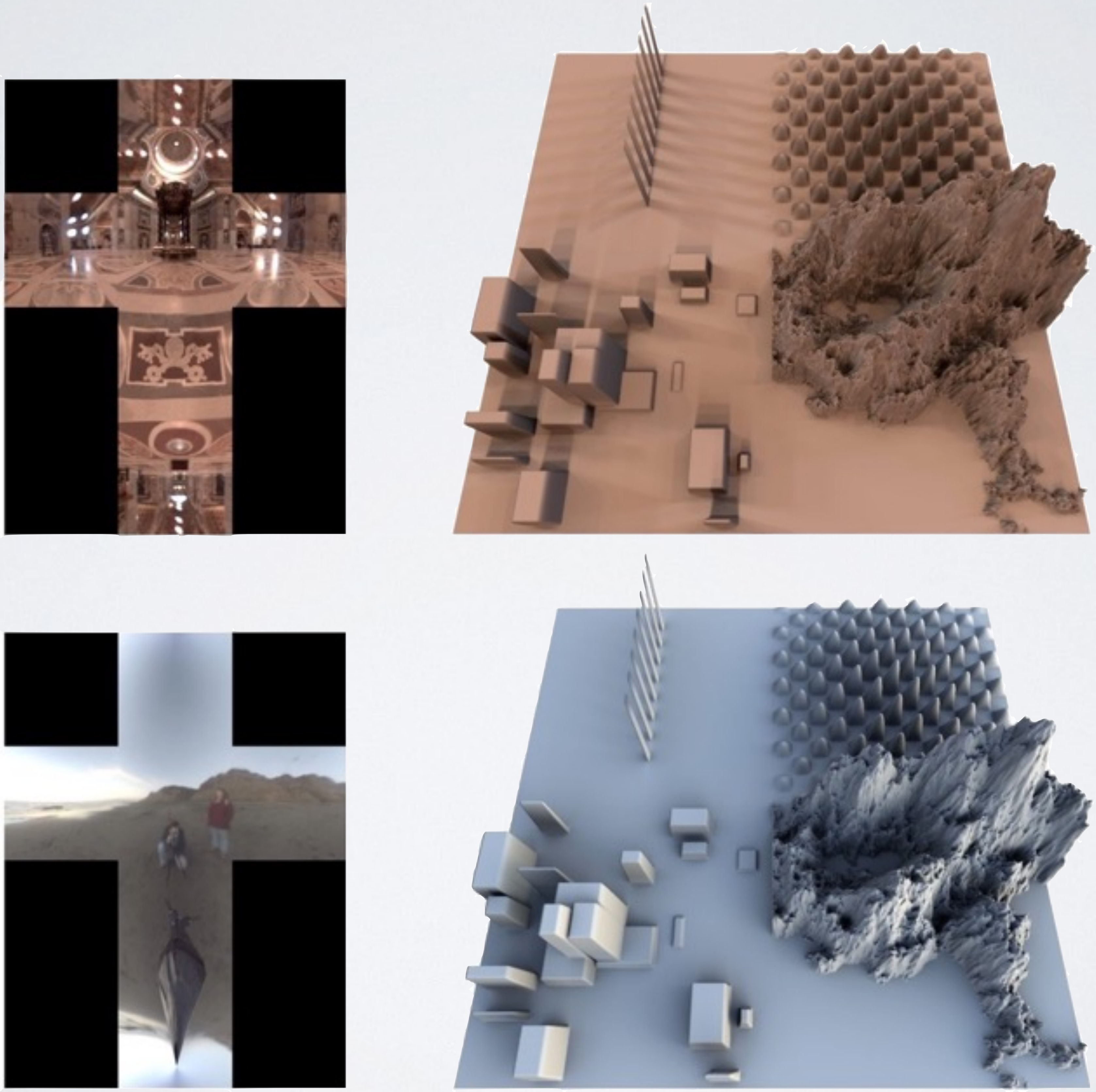
Ville Timonen 17.2.2010

Height field geometry

Environment lighting

Represented by e.g. cube maps

Directly lit height fields



The two core problems

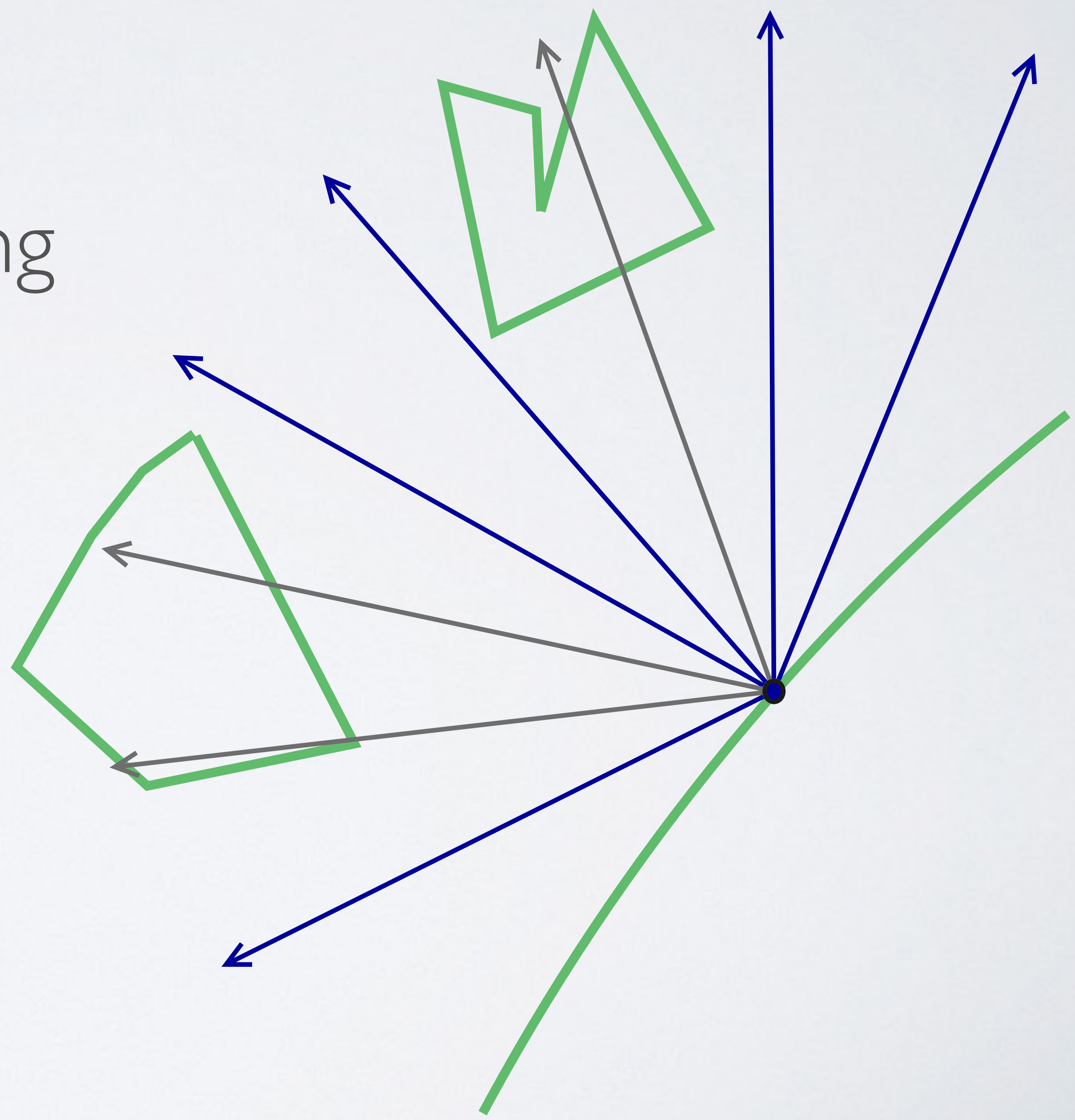
- Visibility of the light source (our focus)
- Integration of the incident light over visibility

Visibility problem

Direct lighting

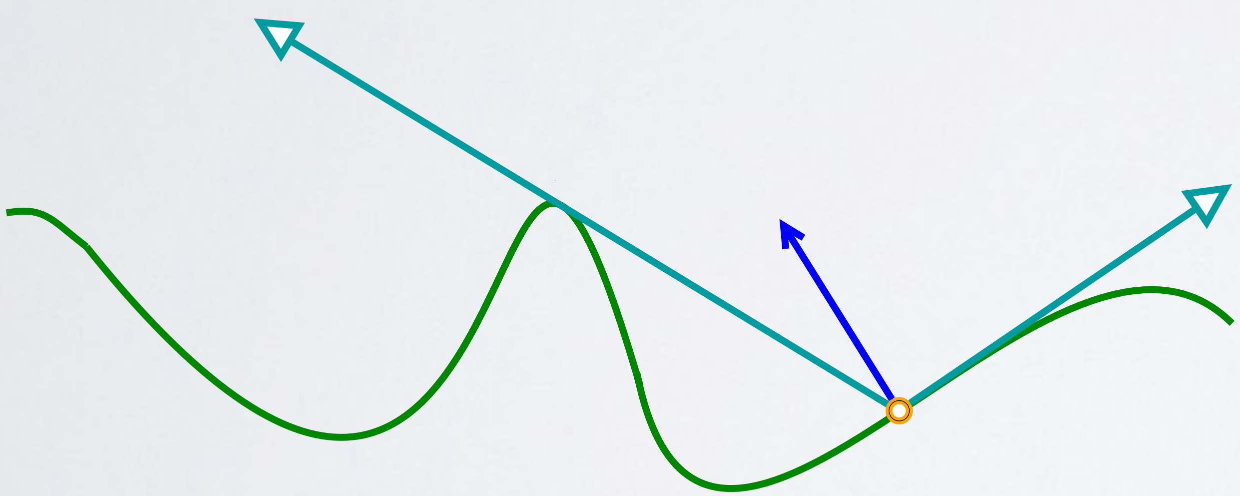
Generic geometry

Find the sky by ray tracing



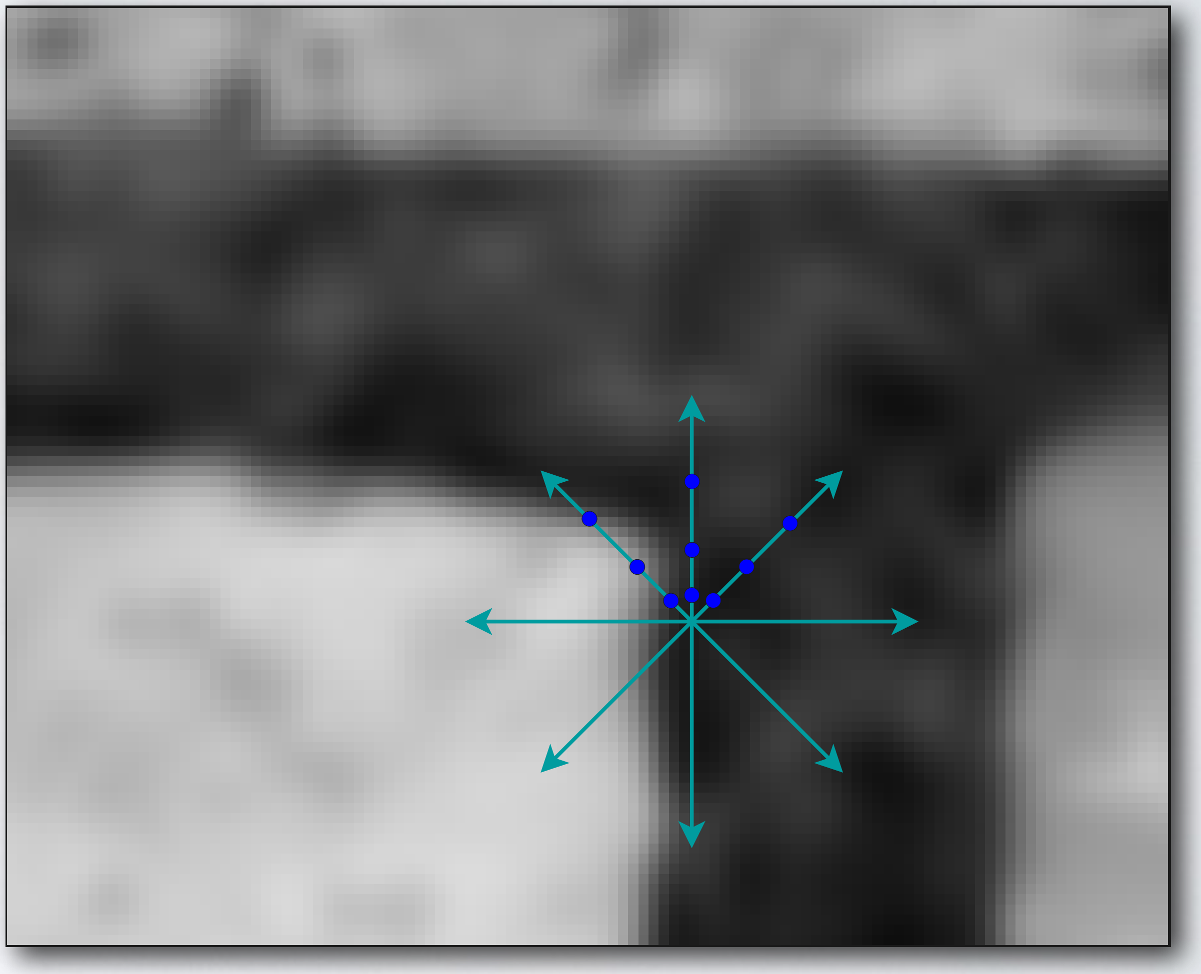
Visibility problem

Direct lighting



Find the horizon

Height field geometry



Computation complexity is $O(n^3)$

Previous state of the art

Eurographics Symposium on Rendering (2008)
Steve Marschner and Michael Wimmer (Guest Editors)

Fast Soft Self-Shadowing on Dynamic Height Fields

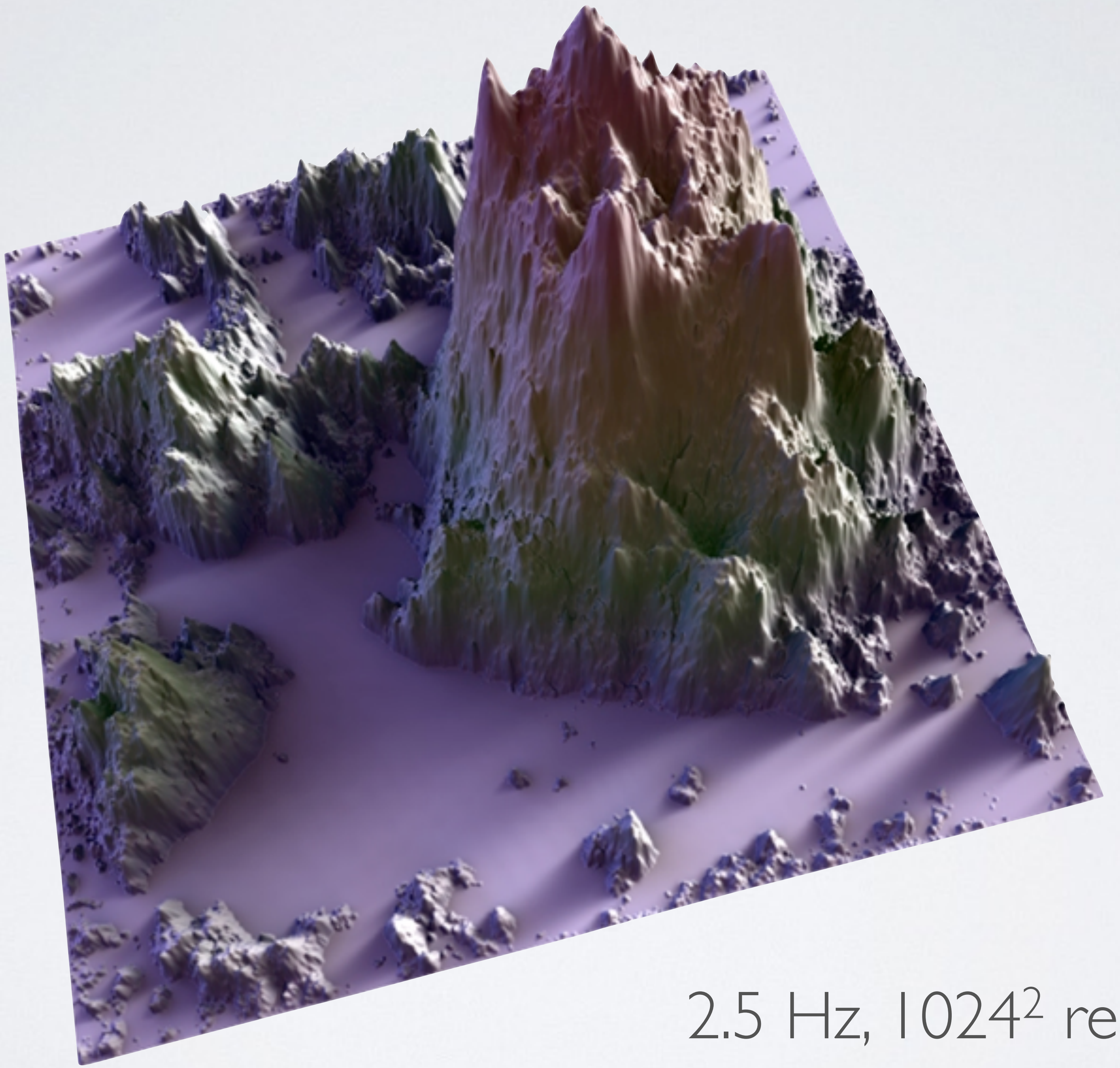
John Snyder[1] and Derek Nowrouzezahrai[2]

[1]Microsoft Research
[2]Dynamic Graphics Project, University of Toronto

Abstract

We present a new, real-time method for rendering soft shadows from large light sources or lighting environments on dynamic height fields. The method first computes a horizon map for a set of azimuthal directions. To reduce sampling, we compute a multi-resolution pyramid on the height field. Coarser pyramid levels are indexed as the distance from caster to receiver increases. For every receiver point and every azimuthal direction, a smooth func-

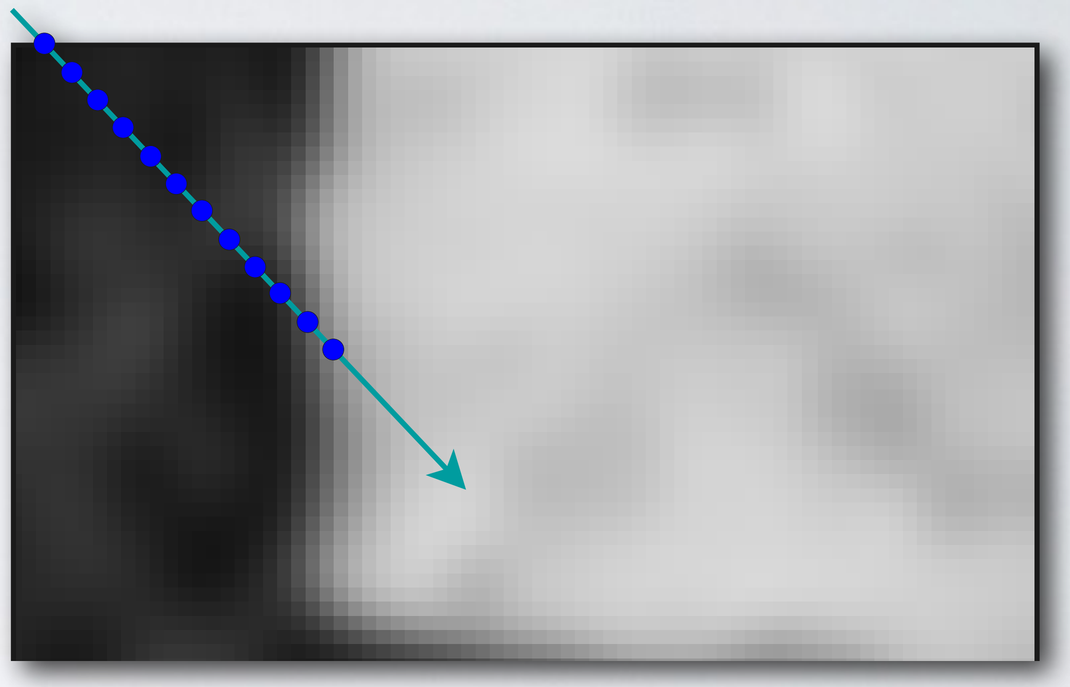
Previous state of the art



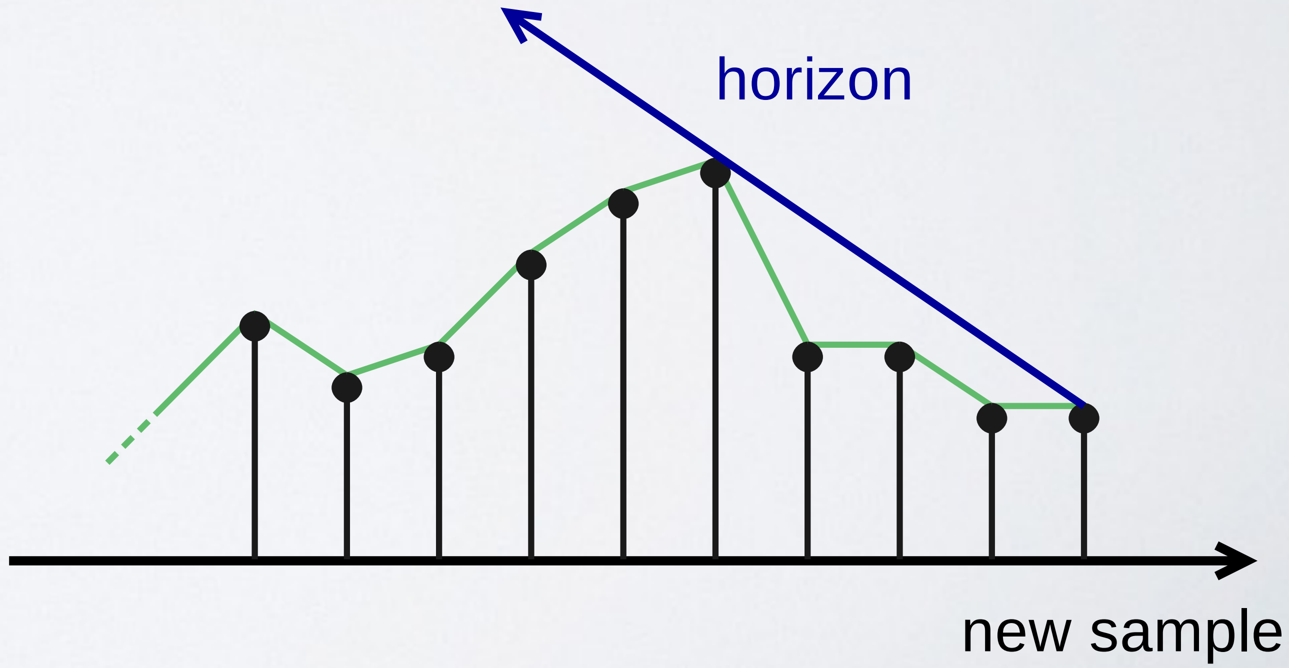
2.5 Hz, 1024^2 resolution
16 azimuthal directions, G80 hardware

There's a faster way

Process lines instead of elements

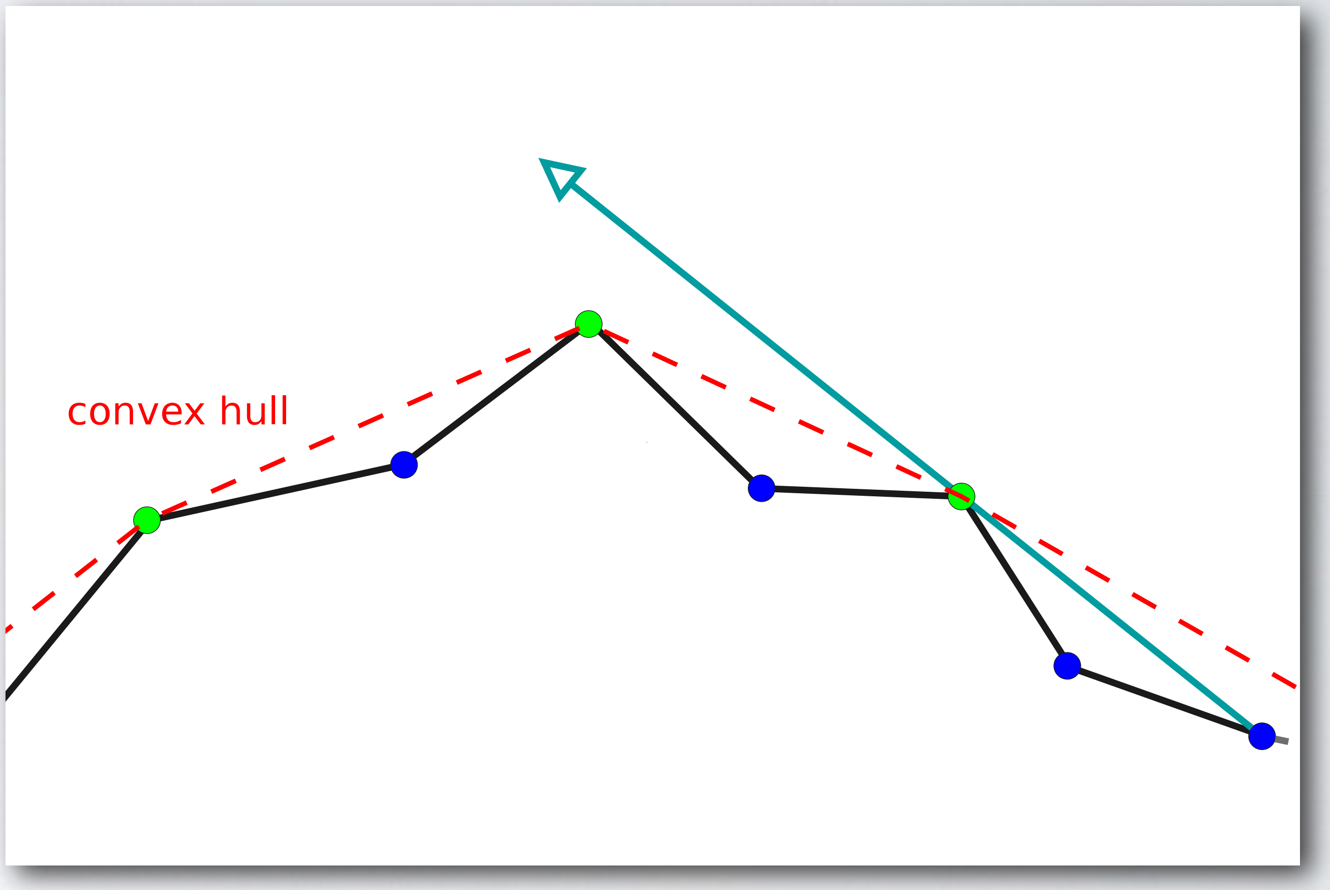


Extract horizon values from remembered data



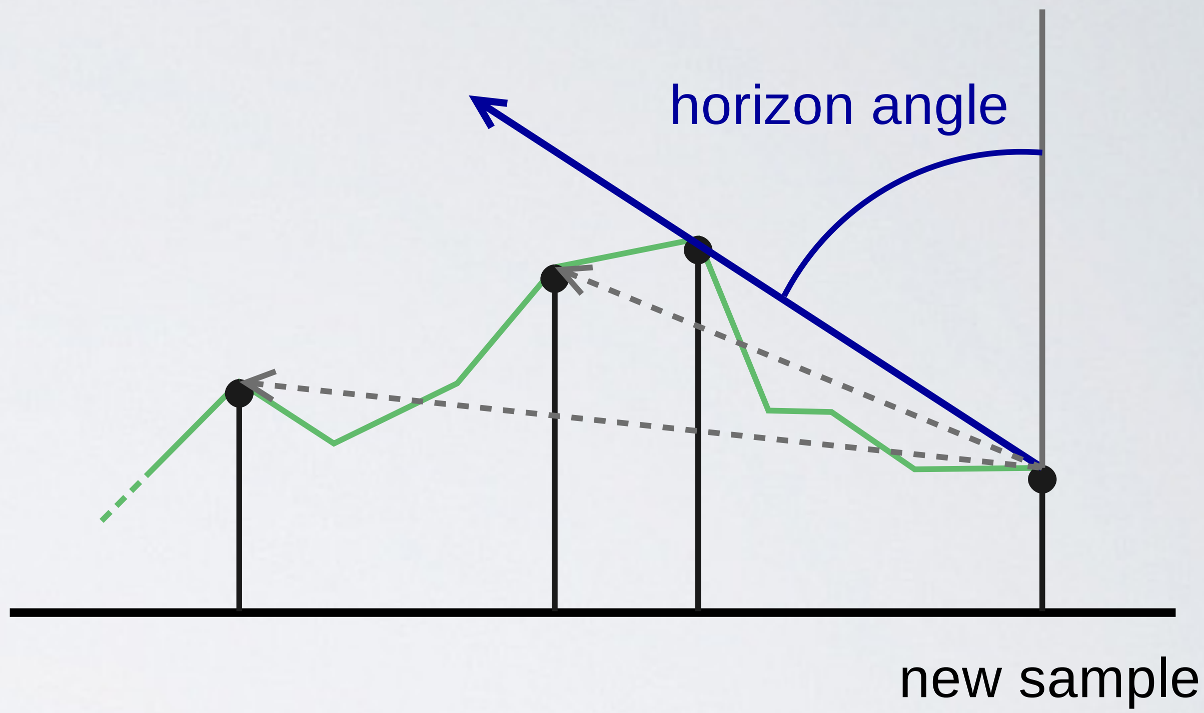
Extracting horizon

The dominant occluder comes from the convex hull subset



Convex hull

1 Add a new value
2 Retain convexity
3 Find dominant occluder

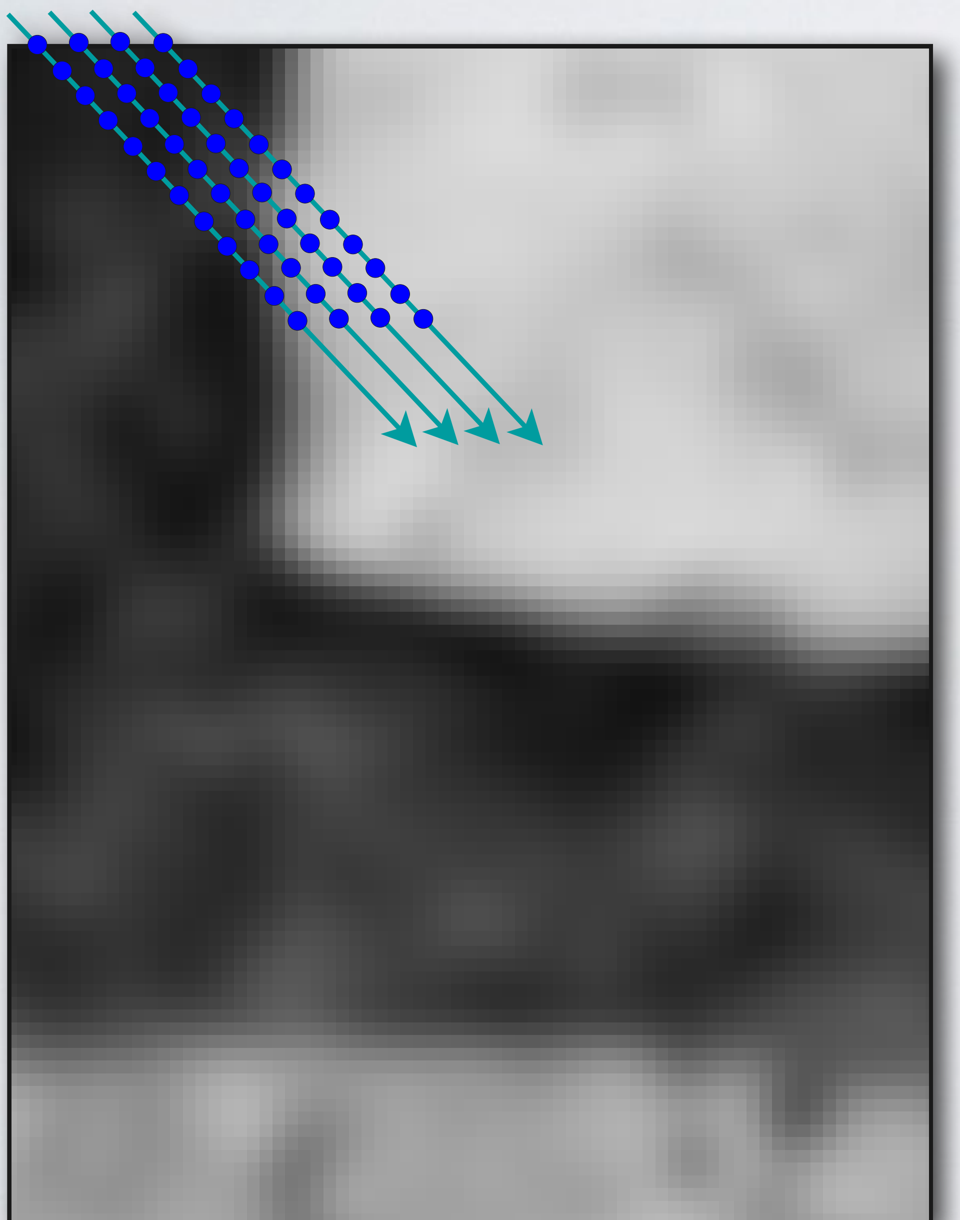


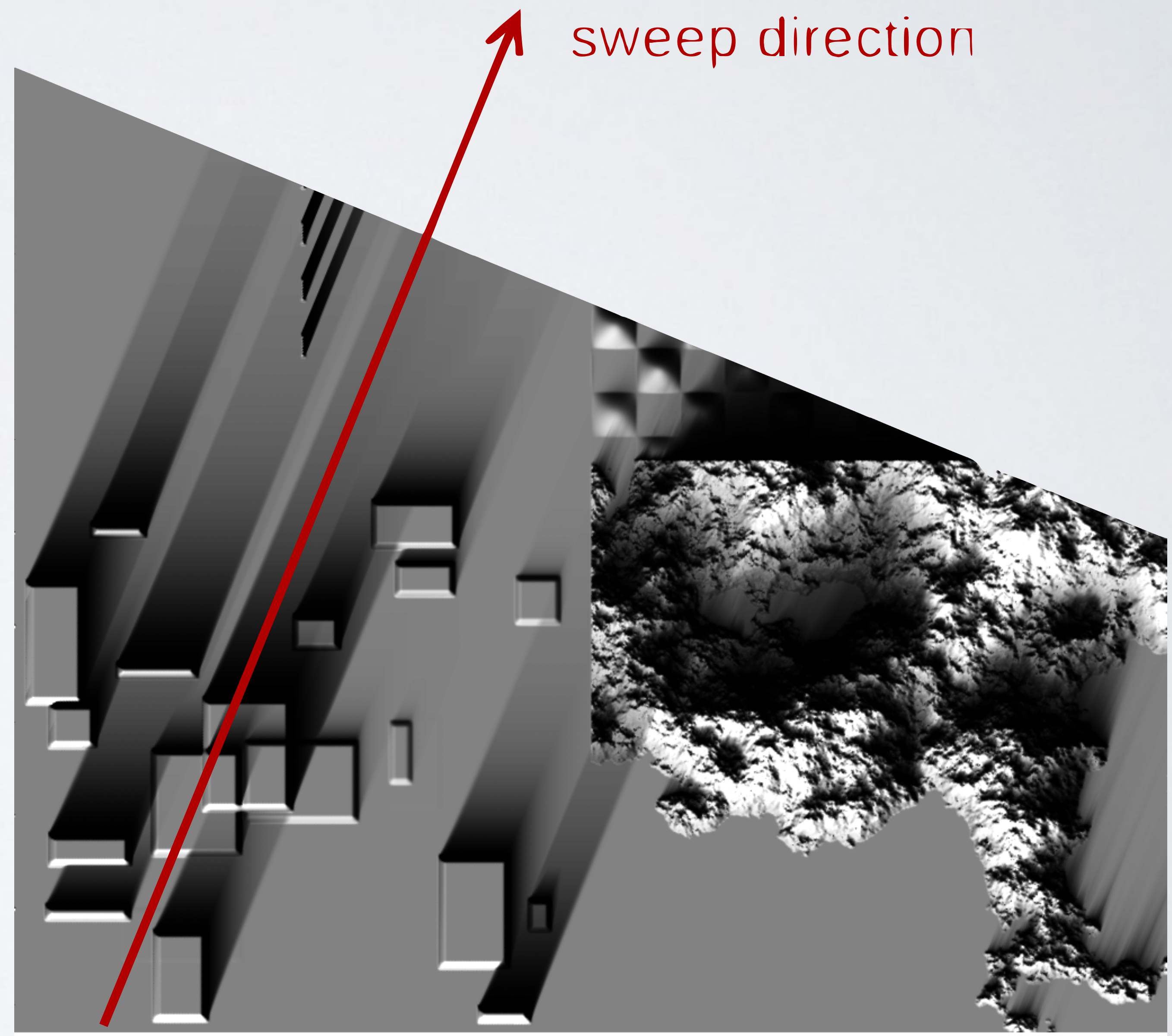
- Can be implemented as a stack
- Pop until the tail is convex
- The last element in the set is your occluder

Results in an O(*n*) op. for a line of *n* elems

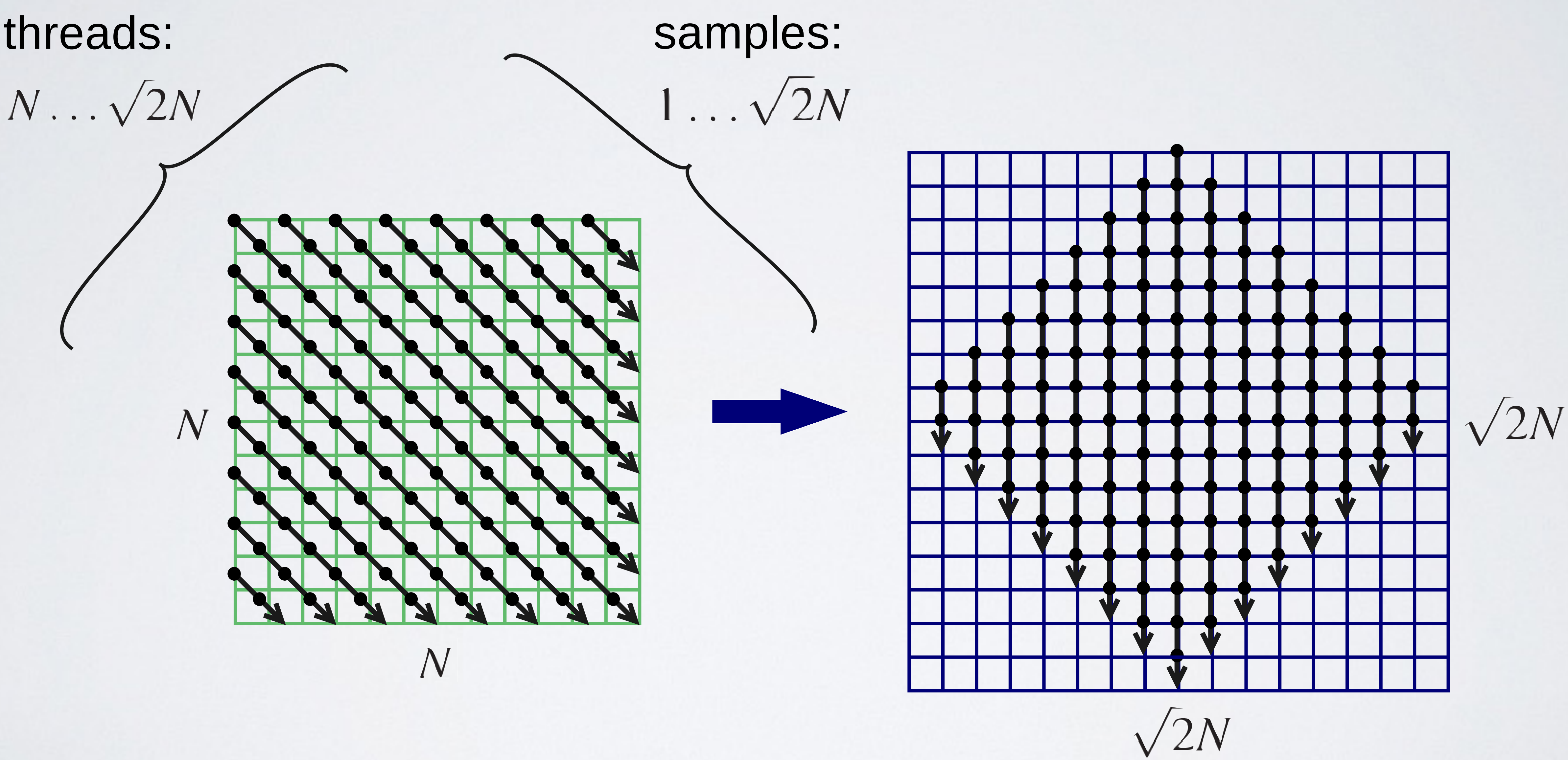
Spawn adjacent threads

Repeat for many directions



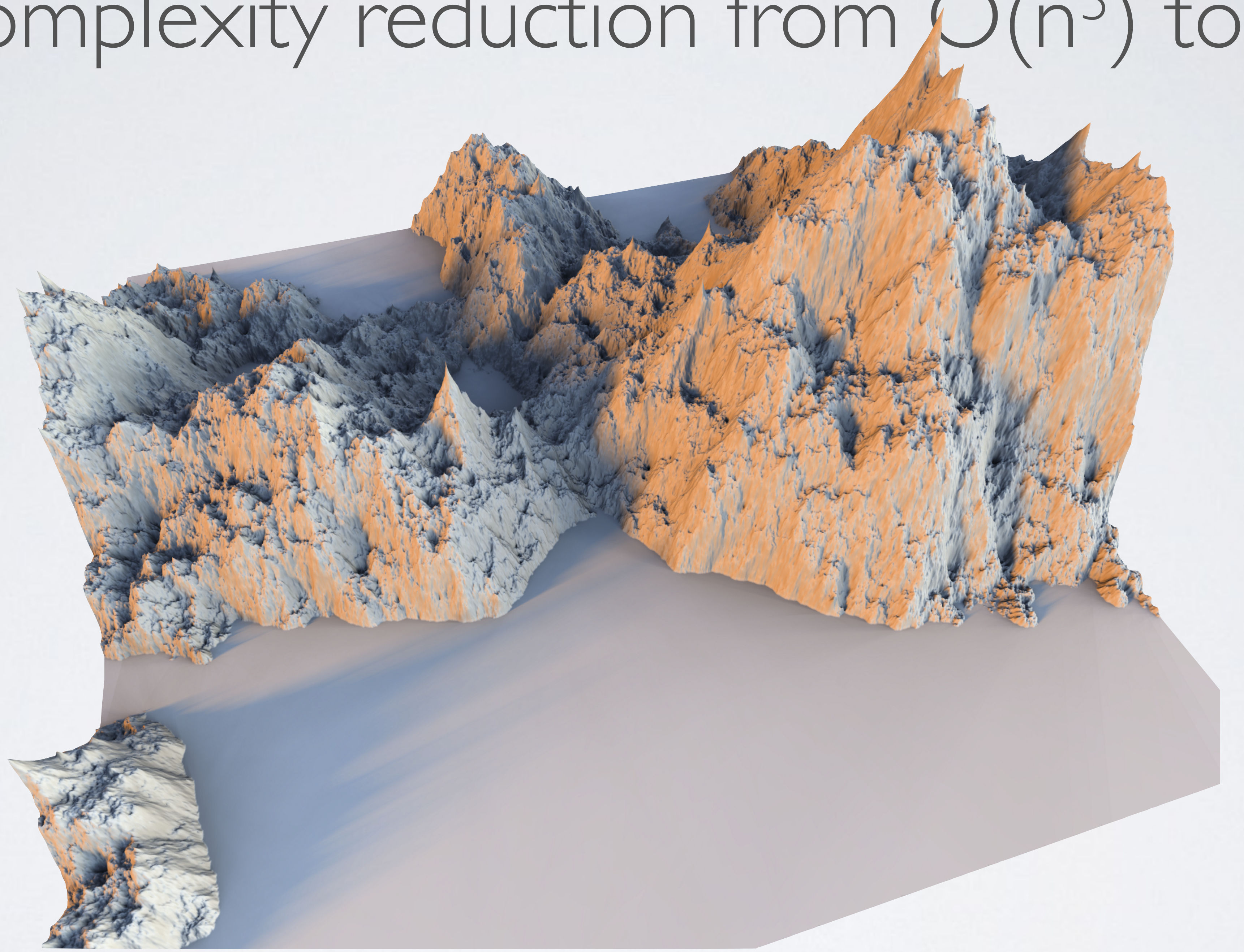


Texture reads, coalesced writes



Results

Time complexity reduction from $O(n^3)$ to $O(n^2)$



No geometry approximations
Soft and hard shadows

38 Hz (up from 2.5 Hz)

The new state of the art

EUROGRAPHICS 2010 / T. Akenine-Möller and M. Zwicker
(Guest Editors)

Volume 29 (2010), Number 2

Scalable Height Field Self-Shadowing

Ville Timonen and Jan Westerholm

Åbo Akademi University

Abstract

We present a new method suitable for general purpose graphics processing units to render self-shadows on dynamic height fields under dynamic light environments in real-time. Visibility for each point in the height field is determined as the exact horizon for a set of azimuthal directions in time linear in height field size and the number of directions. The surface is shaded using the horizon information and a high-resolution light environment extracted on-line from a high dynamic range cube map, allowing for detailed extended shadows. The desired

Current research: Indirect lighting

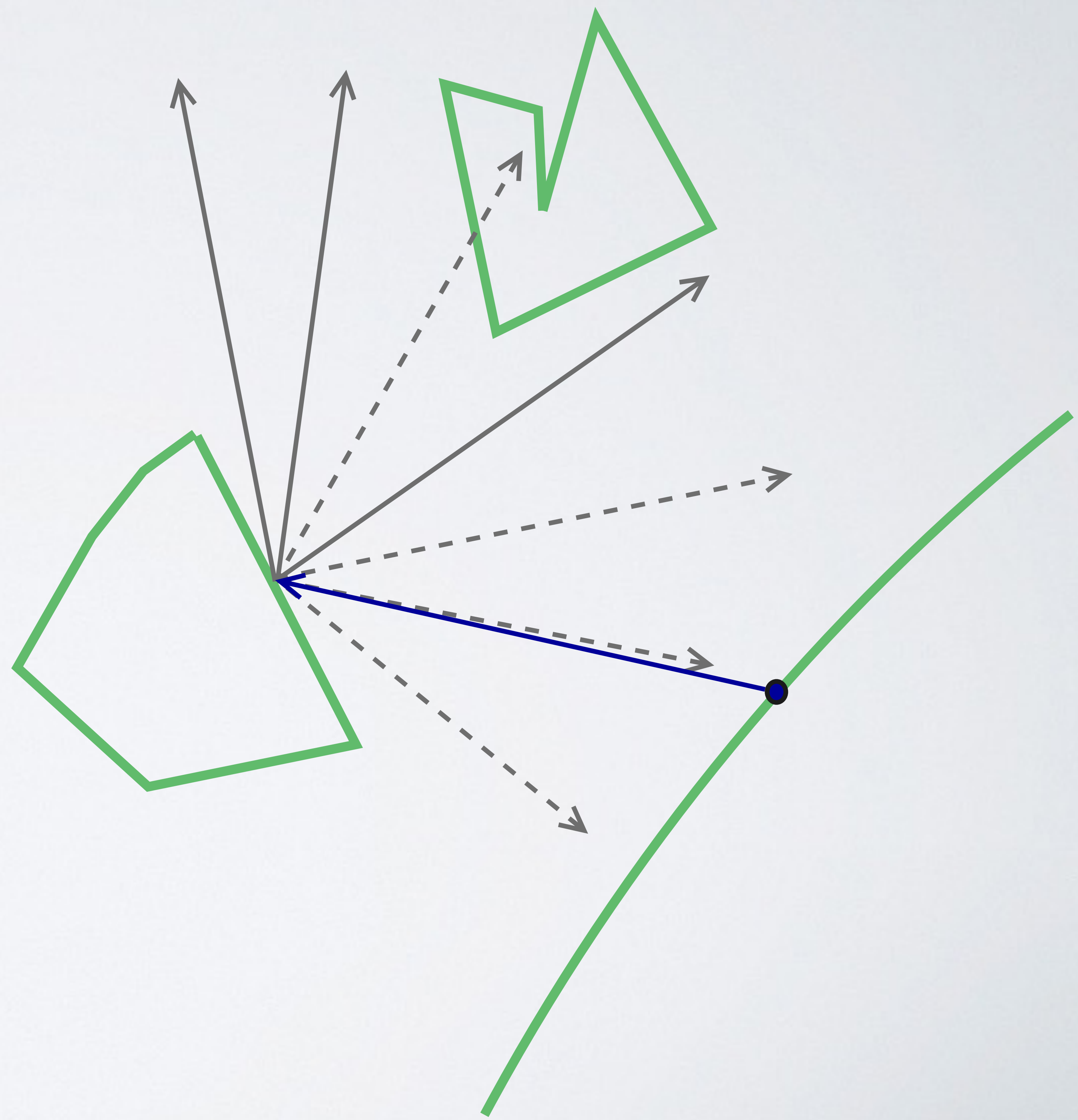
When light hits the surface, the surface becomes a light source itself, and further lights the surface.

The surface can also have its own output radiance: beacons, fires, building windows, embedded displays...

Visibility problem

Indirect lighting

Generic geometry



It is not enough
to just find the sky

Previous state of the art

Eurographics Symposium on Rendering 2009
Hendrik P. A. Lensch and Peter-Pike Sloan
(Guest Editors)

Volume 28 (2009), Number 4

Fast Global Illumination on Dynamic Height Fields

Derek Nowrouzezahrai
University of Toronto

John Snyder
Microsoft Research

Abstract

We present a real-time method for rendering global illumination effects from large area and environmental lights on dynamic height fields. In contrast to previous work, our method handles inter-reflections (indirect lighting) and non-diffuse surfaces. To reduce sampling, we construct one multi-resolution pyramid for height variation to compute direct shadows, and another pyramid for each indirect bounce of incident radiance to compute inter-reflections. The basic principle is to sample the points blocking direct light, or shedding indirect light, from coarser levels of the pyramid the farther away they are from a given receiver point. We unify the representation of visibility

Visibility problem

Indirect lighting

Height field geometry

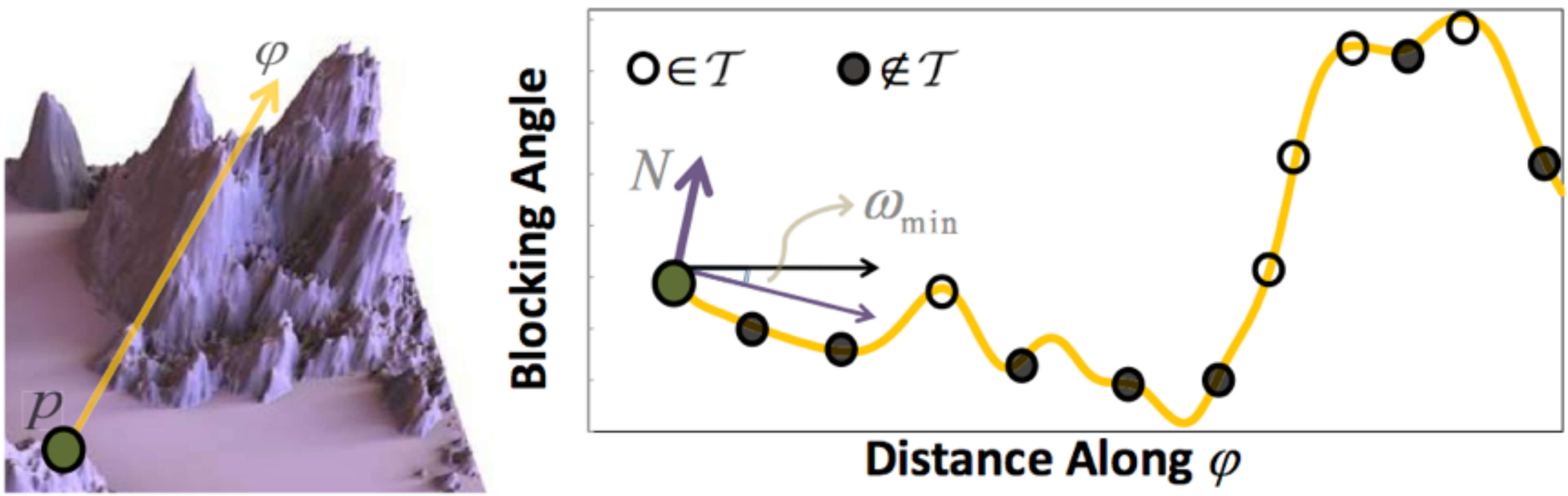


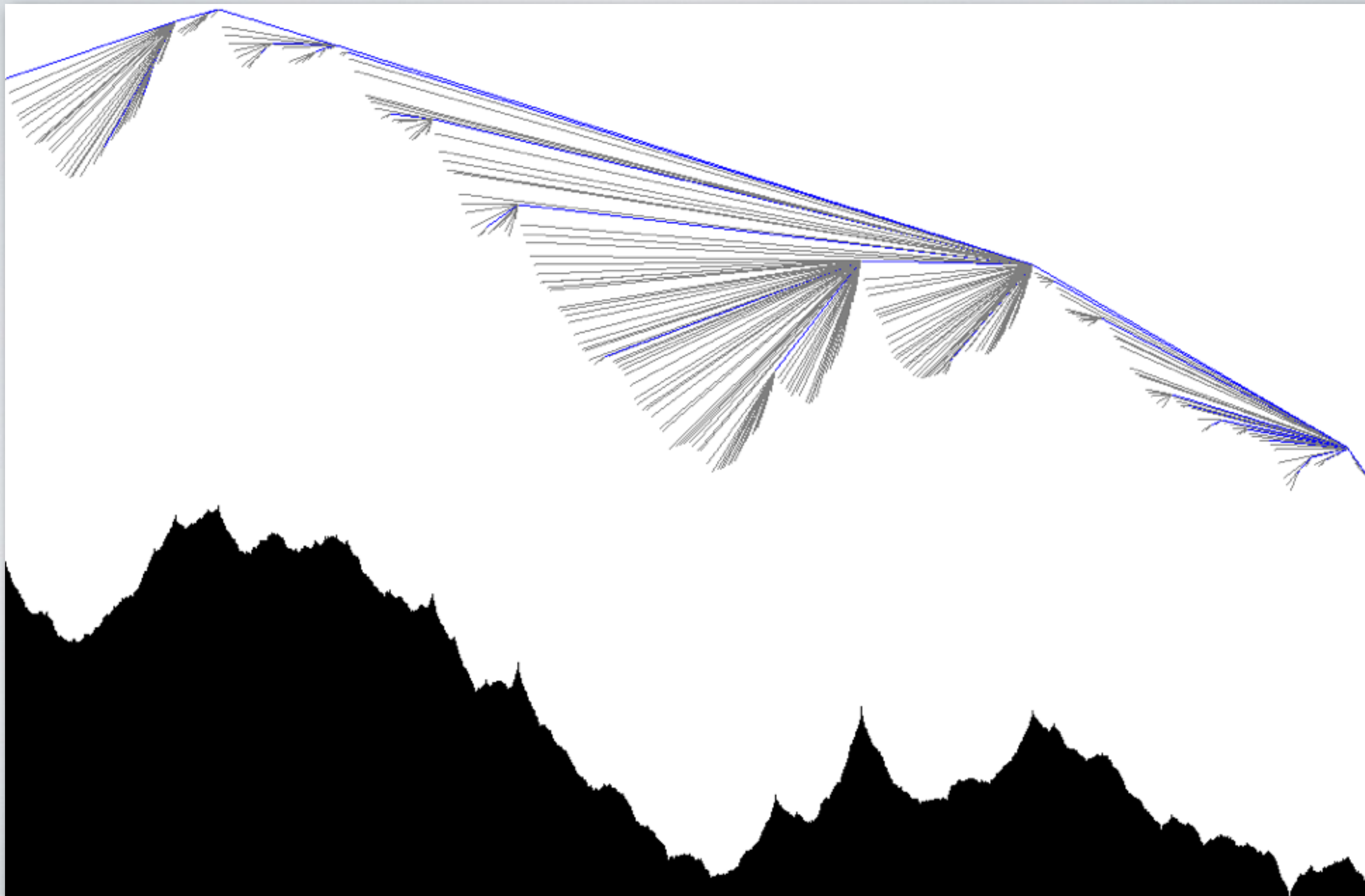
Figure 3: *Monotonically increasing blocking angles above ω_{min}, marked in white, form the casting set. Samples in black are not visible from the receiver p and thus excluded.*

How to improve?

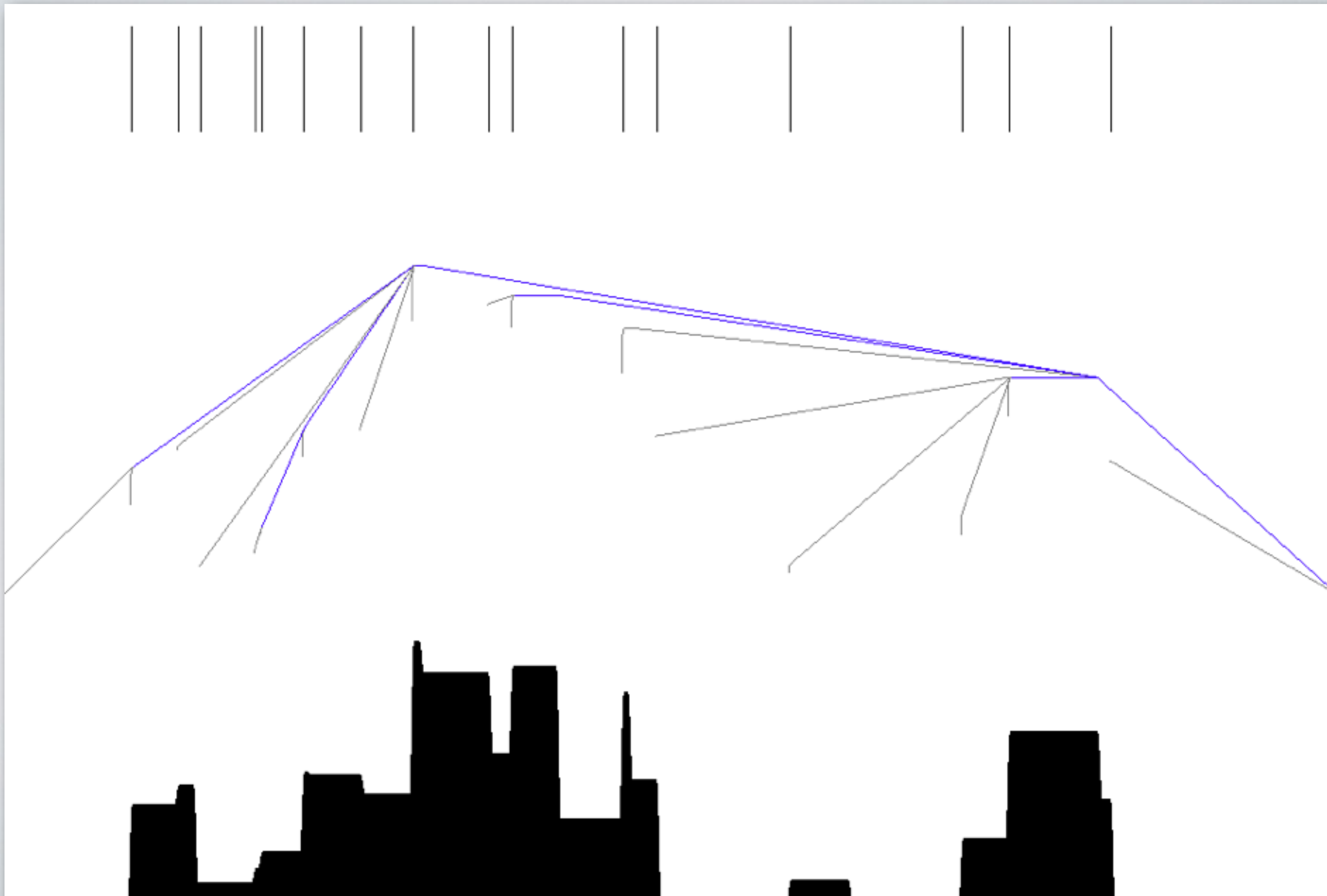
Series of concave + convex hulls

Bars represent boundaries

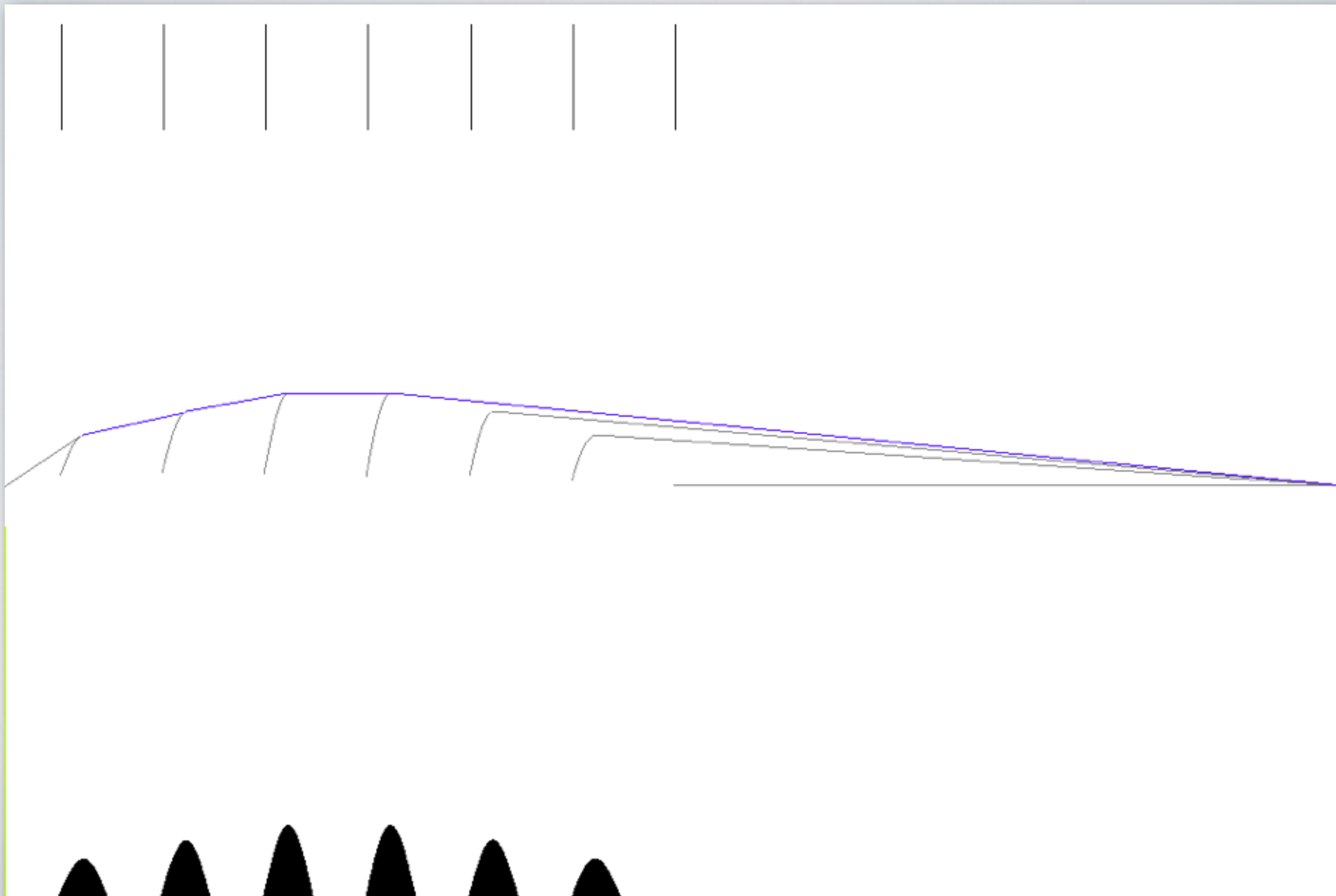
Tree of convex hulls



Tree of convex hulls

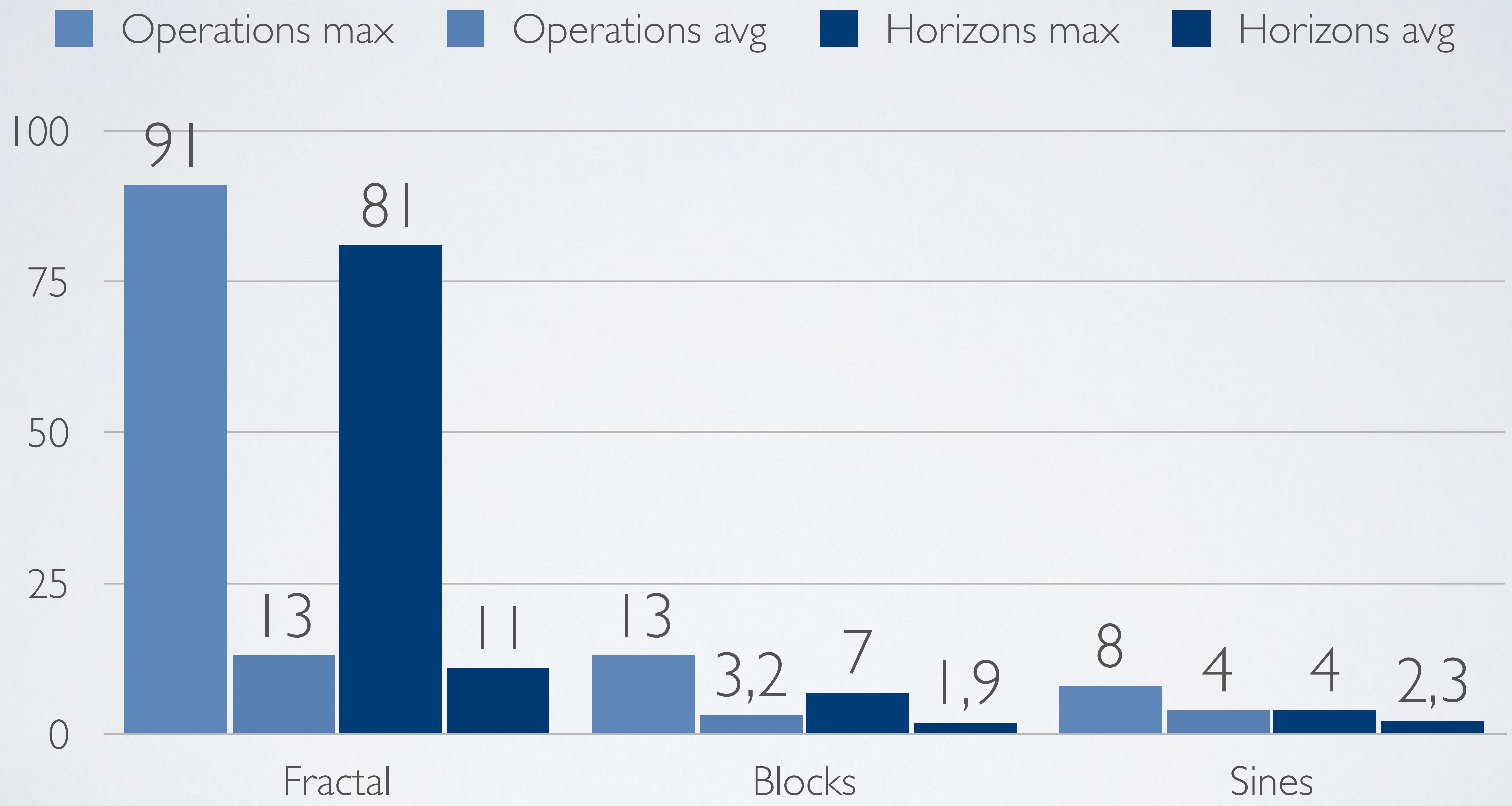


Tree of convex hulls



Statistics

Complexity will be roughly O(operations + horizons)



Improvement over O(N/2) = O(512)?

THE END