



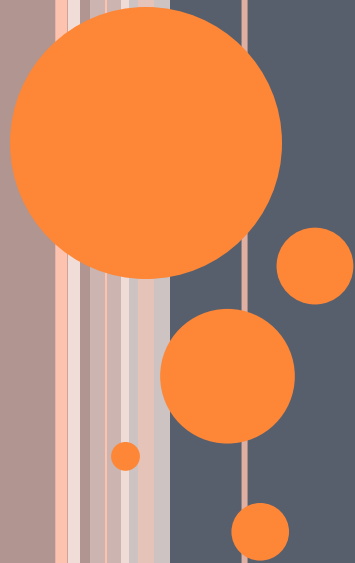
REVECTORIZATION-BASED ACCURATE SOFT SHADOW USING ADAPTIVE AREA LIGHT SOURCE SAMPLING

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AGENDA

- Introduction;
- Revectorization-Based Shadow Mapping;
- Revectorization-Based Accurate Soft Shadows;
- Results and Discussion;
- Conclusion and Future Work;



INTRODUCTION

CONTEXT

- Rendering Equation:

$$L(\mathbf{p} \rightarrow \Theta) = \int_{\mathcal{L}} f_r(\mathbf{p}, \vec{\mathbf{p}}\mathbf{l} \rightarrow \Theta) L_e(\mathbf{l} \rightarrow \vec{\mathbf{l}}\mathbf{p}) V(\mathbf{p}, \mathbf{l}) G(\mathbf{p}, \mathbf{l}) d\mathcal{L}_1$$

**Light Sources
Surface Area** ↑

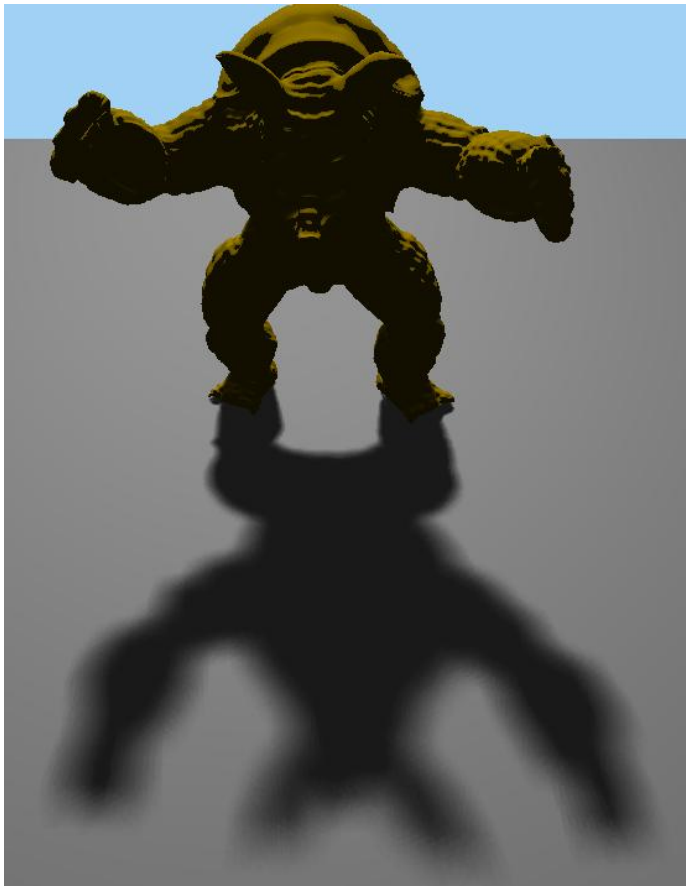
**Area Light
Source Sample** ↓

↑ **Visibility
Function**

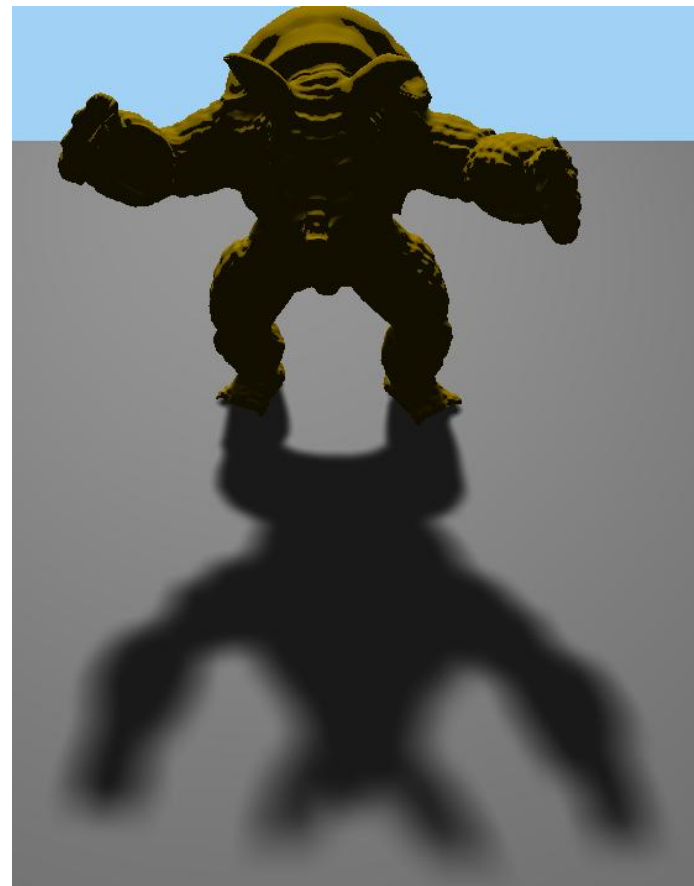
↑ **Shadow
Mapping**
[Williams1978]

CONTEXT

- Accurate Shadow Rendering:



288 samples – 370 ms



25 samples – 80 ms



REVECTORIZATION-BASED SHADOW MAPPING

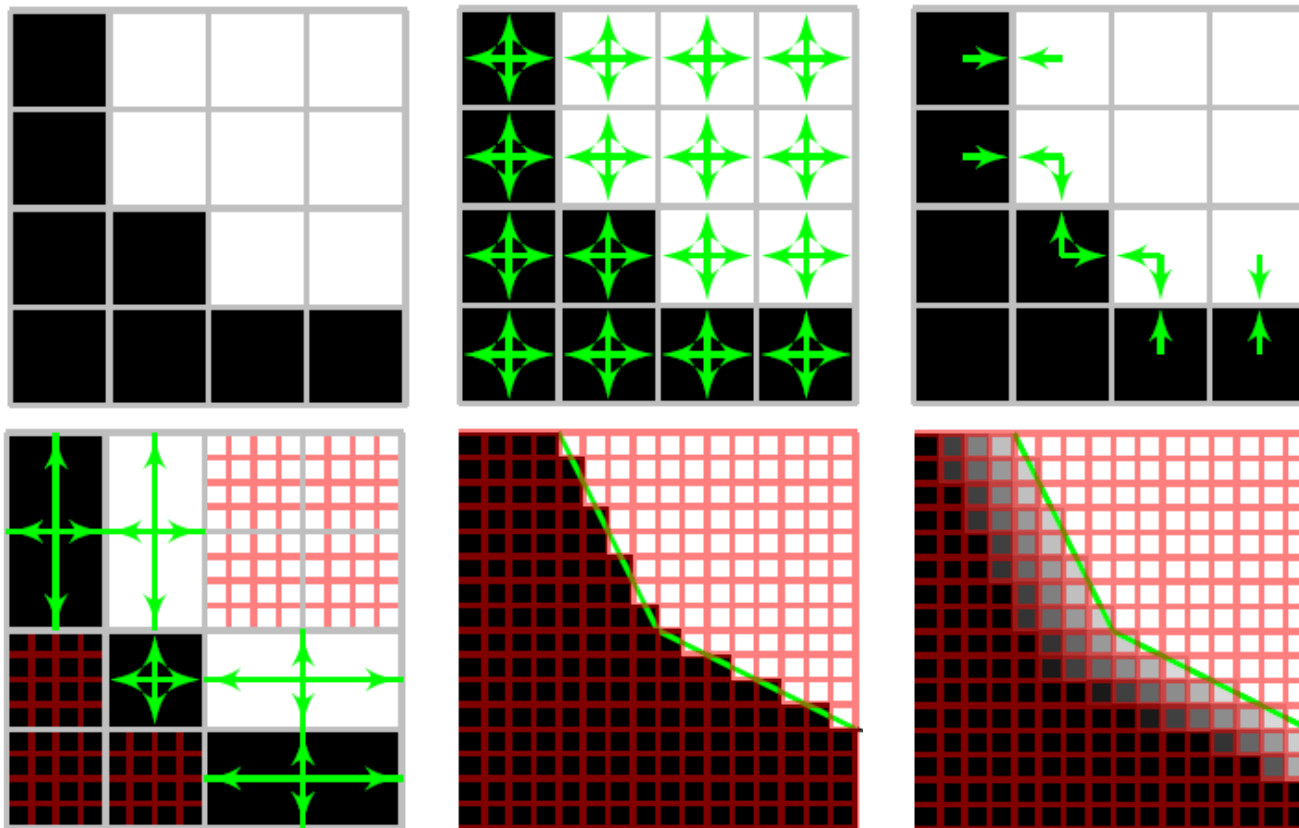
REVECTORIZATION-BASED SHADOW MAPPING

- Shadow Revectorization [Macedo2016]:



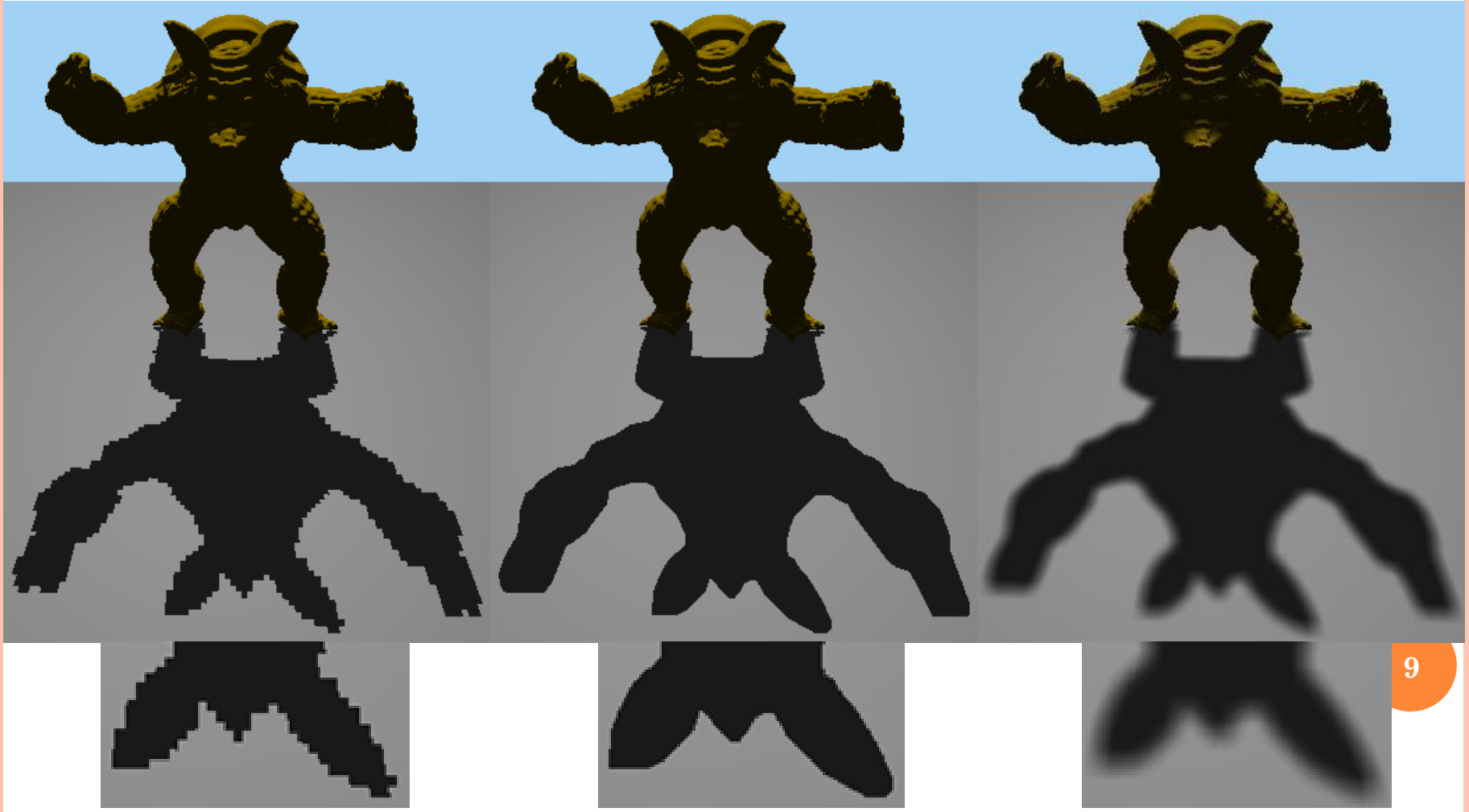
REVECTORIZATION-BASED SHADOW MAPPING

- Revectorization Pipeline [Macedo2016]:



REVECTORIZATION-BASED SHADOW MAPPING

- Visual Quality:

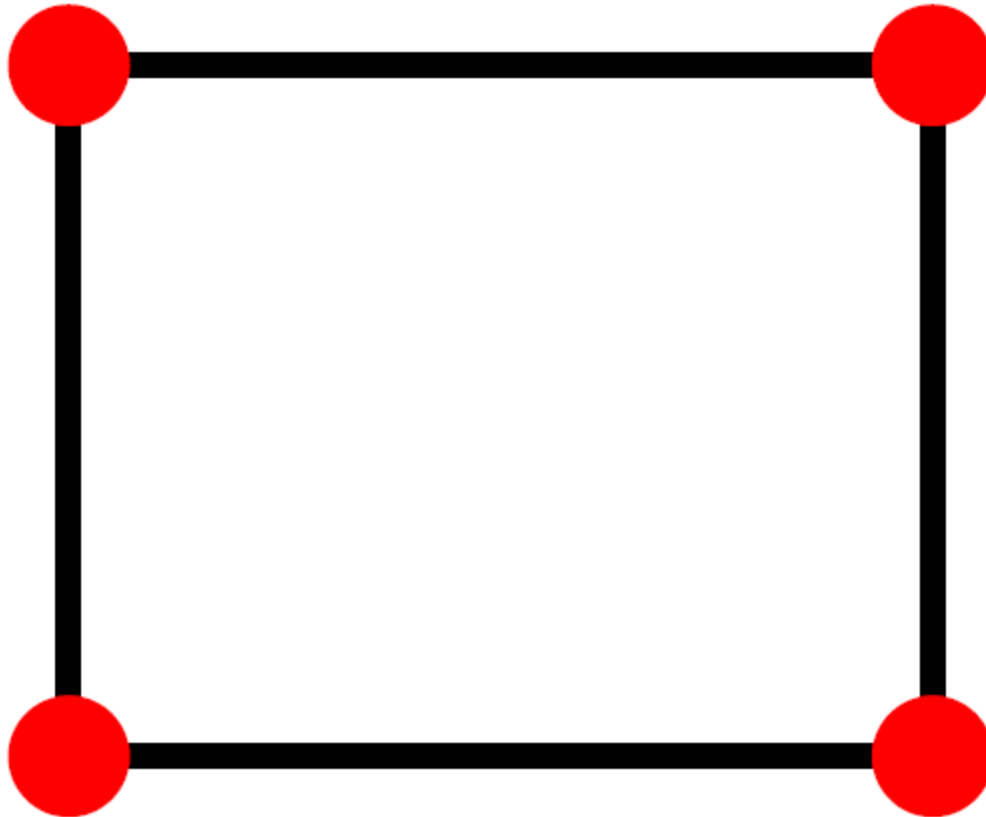




**REVECTORIZATION-BASED
ACCURATE SOFT SHADOWS**

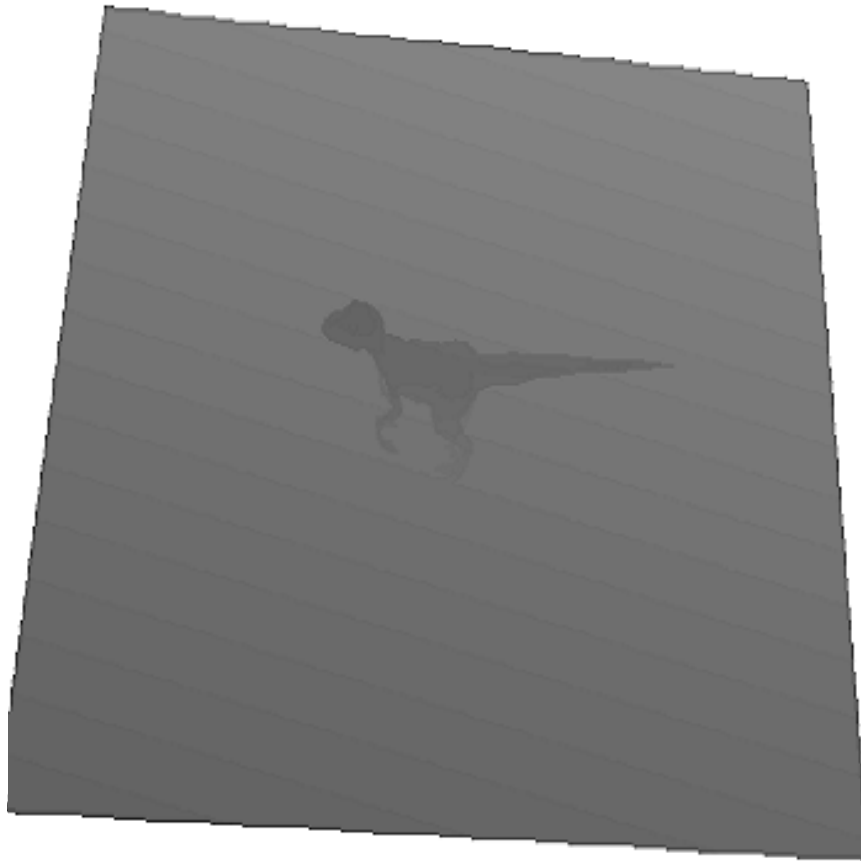
ALGORITHM

- Step 1 – Light Source Sampling:



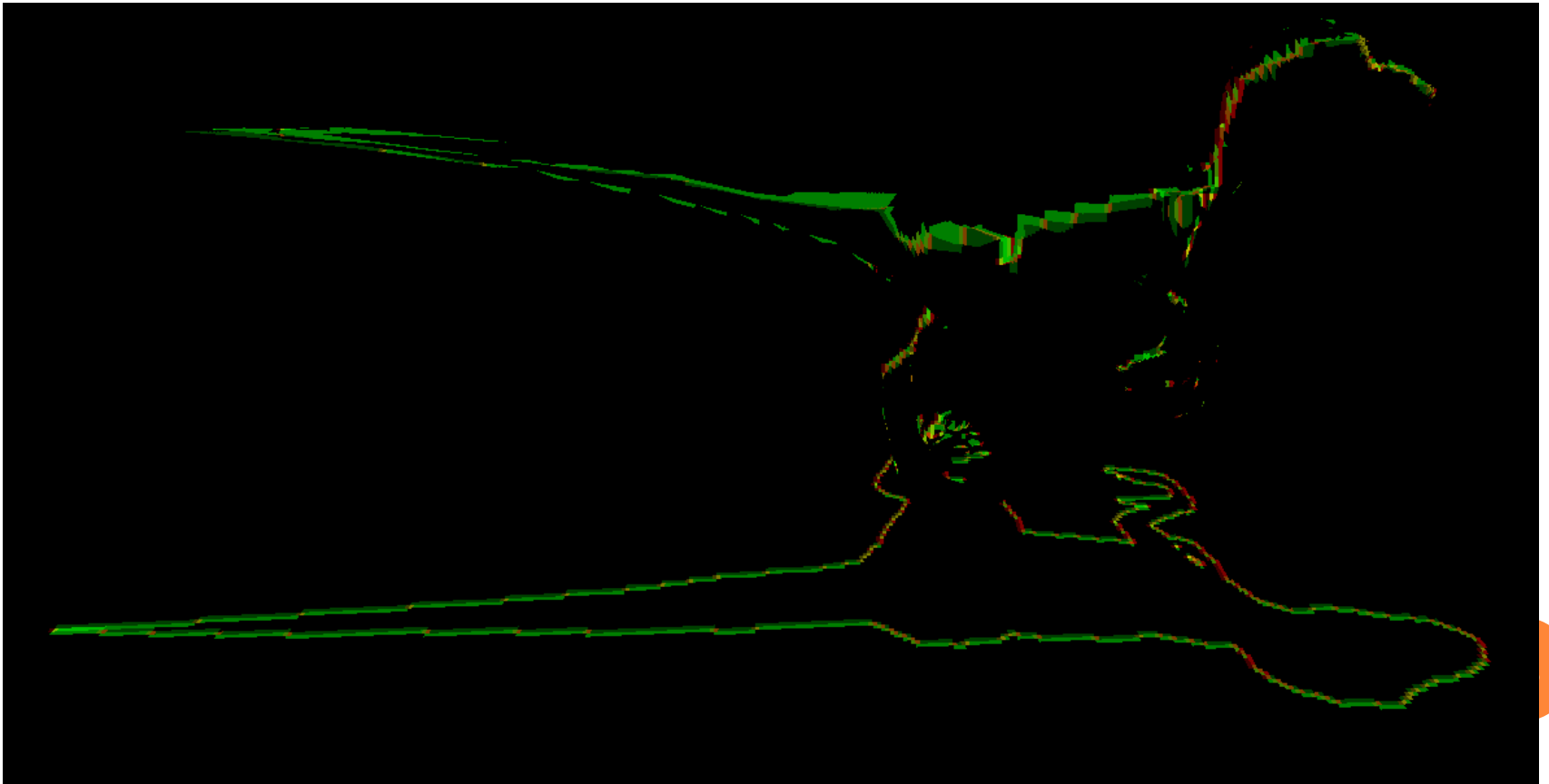
ALGORITHM

- Step 2 – Shadow Map Rendering [Williams1978]:



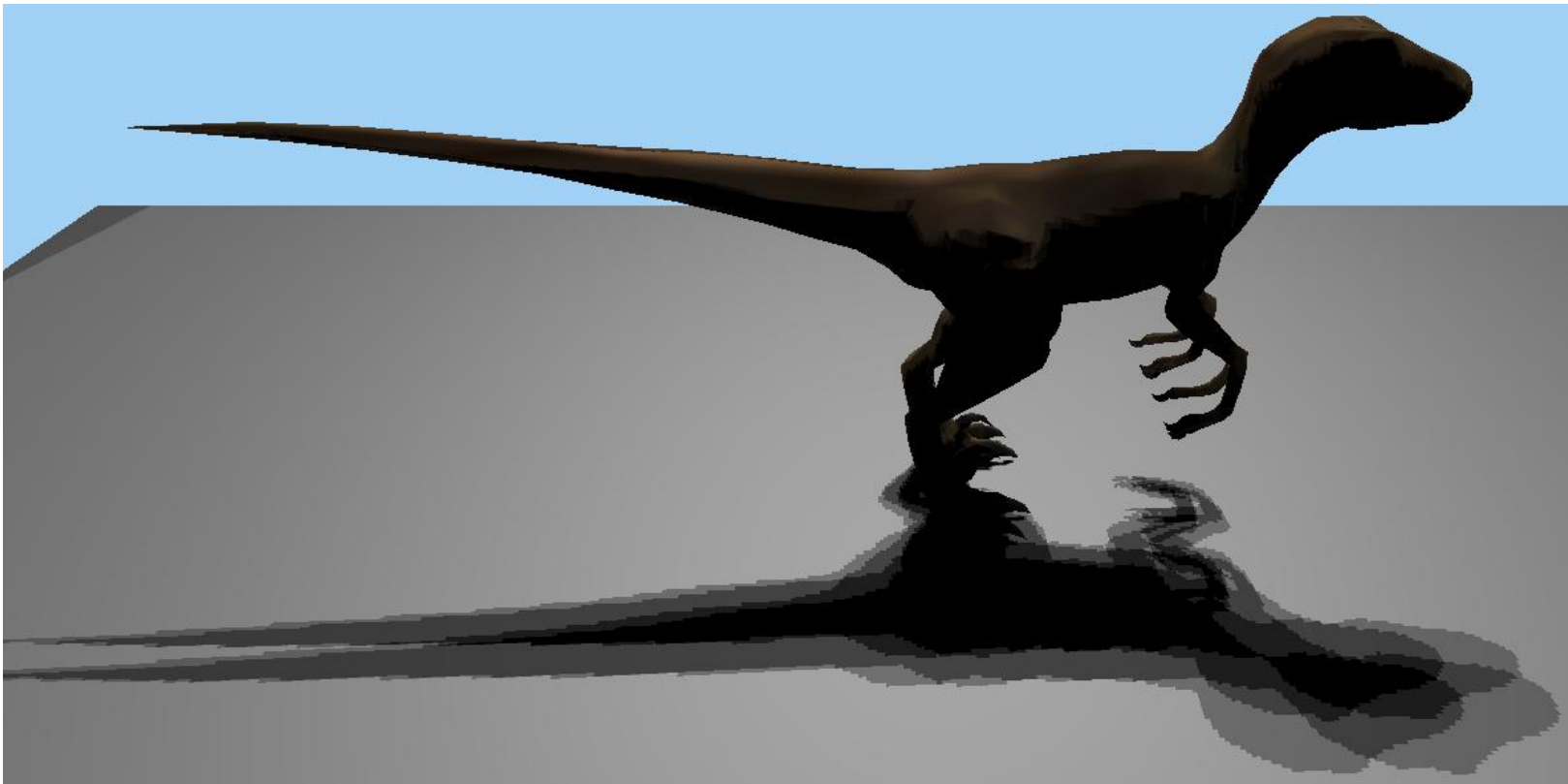
ALGORITHM

- Step 3 – Discontinuity Map Rendering [Macedo2016]:



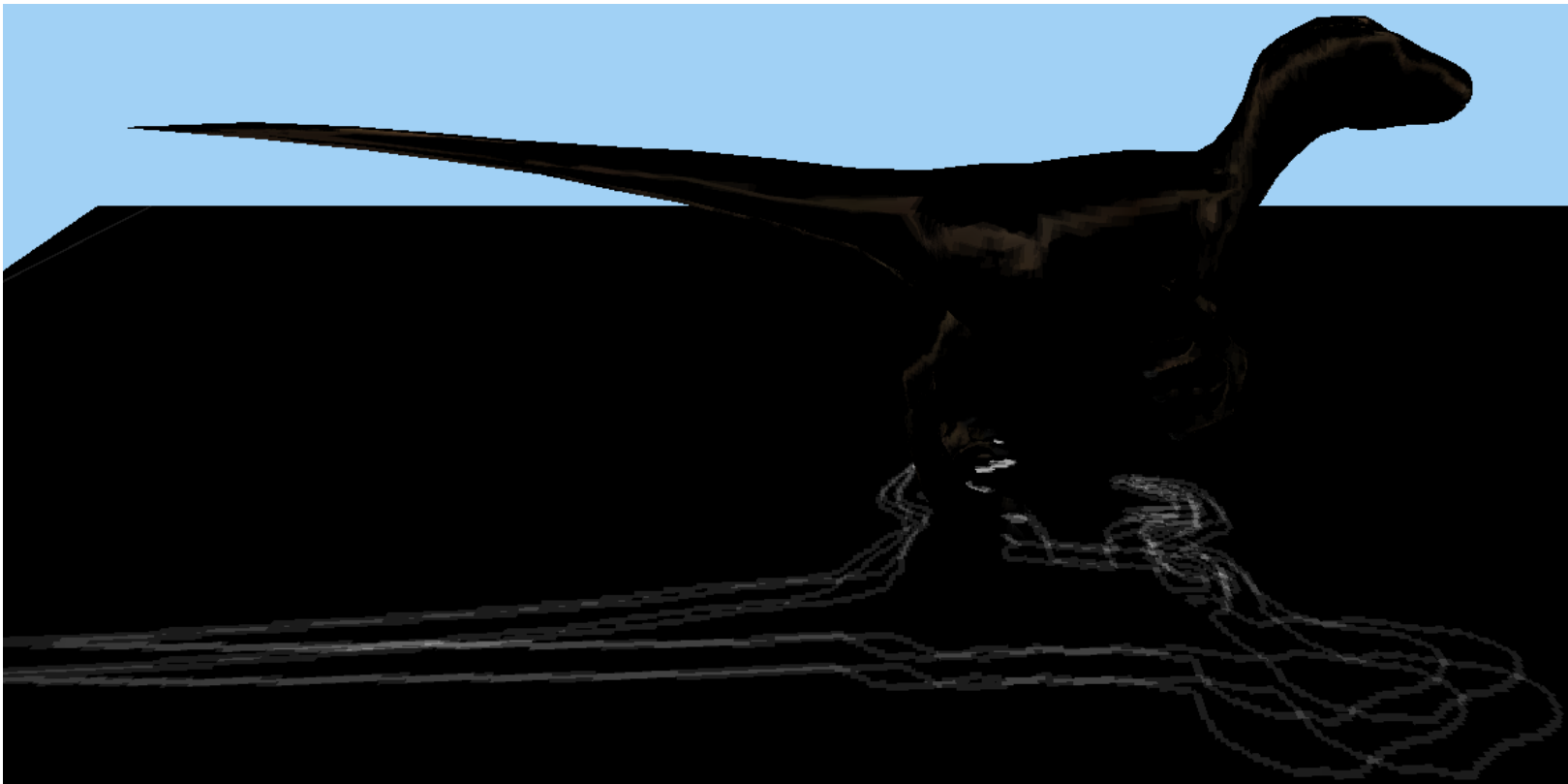
ALGORITHM

- Step 4 – Shadow Evaluation:



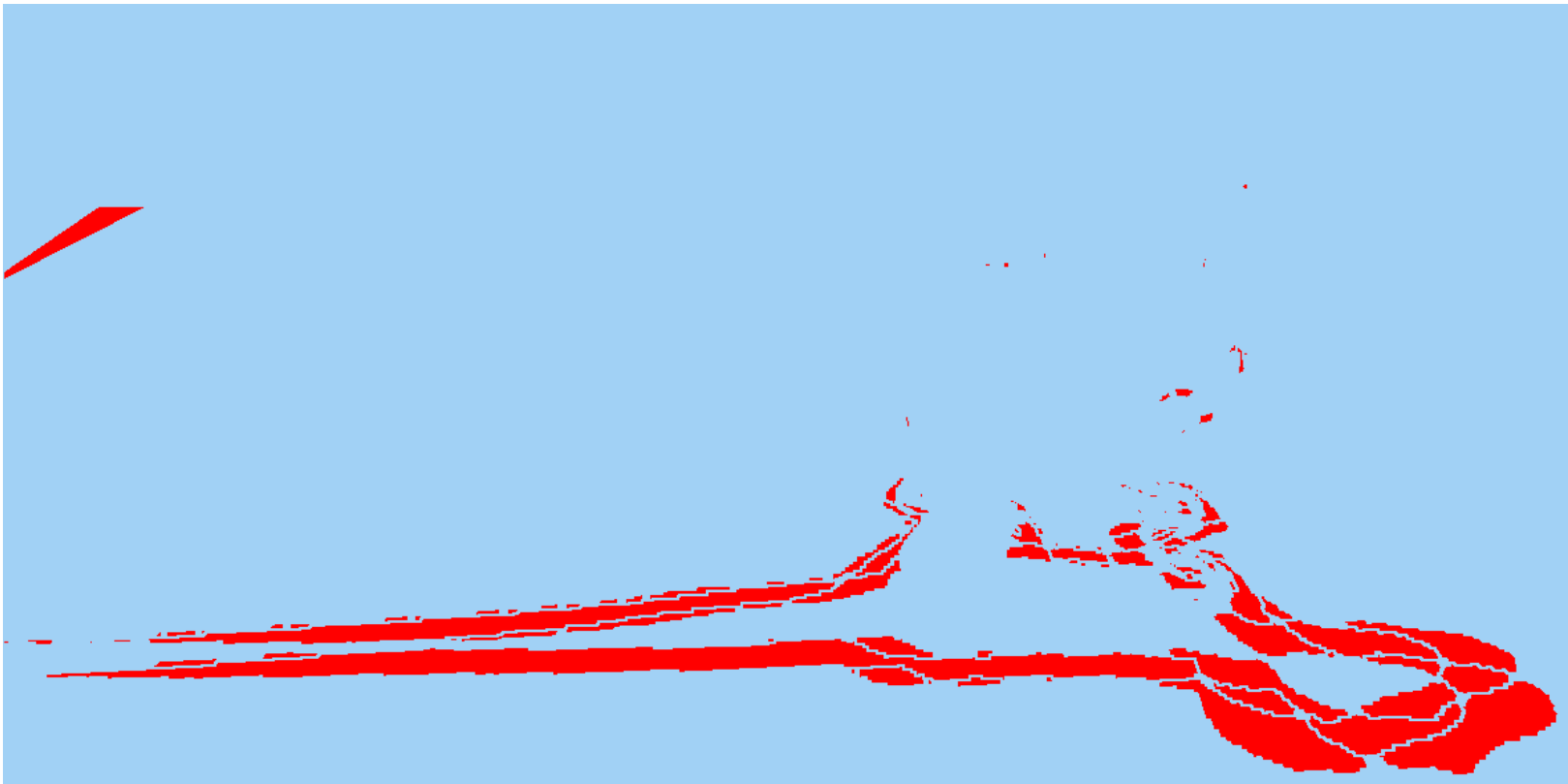
ALGORITHM

- Step 5 – Discontinuity Evaluation:



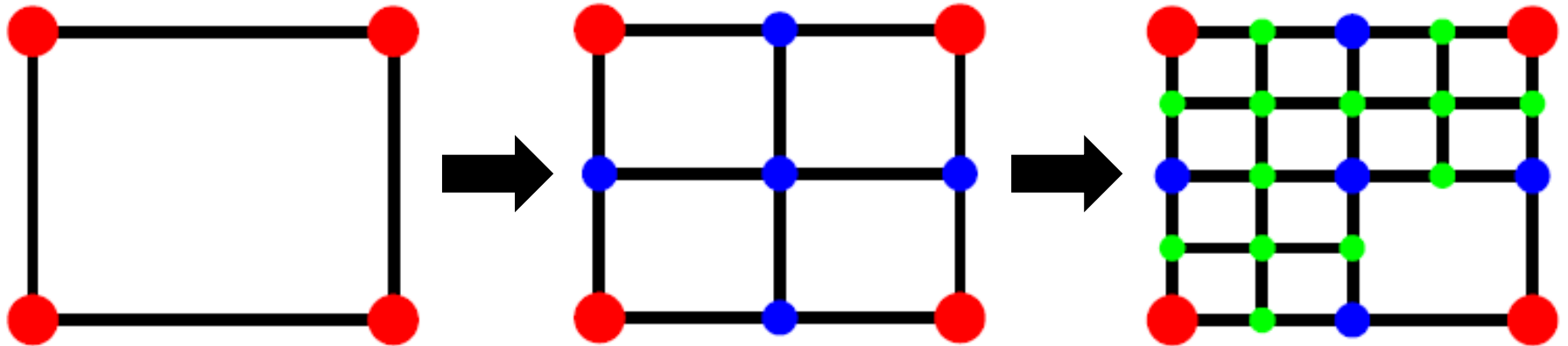
ALGORITHM

- Step 6 – Banding Artifact Detection:



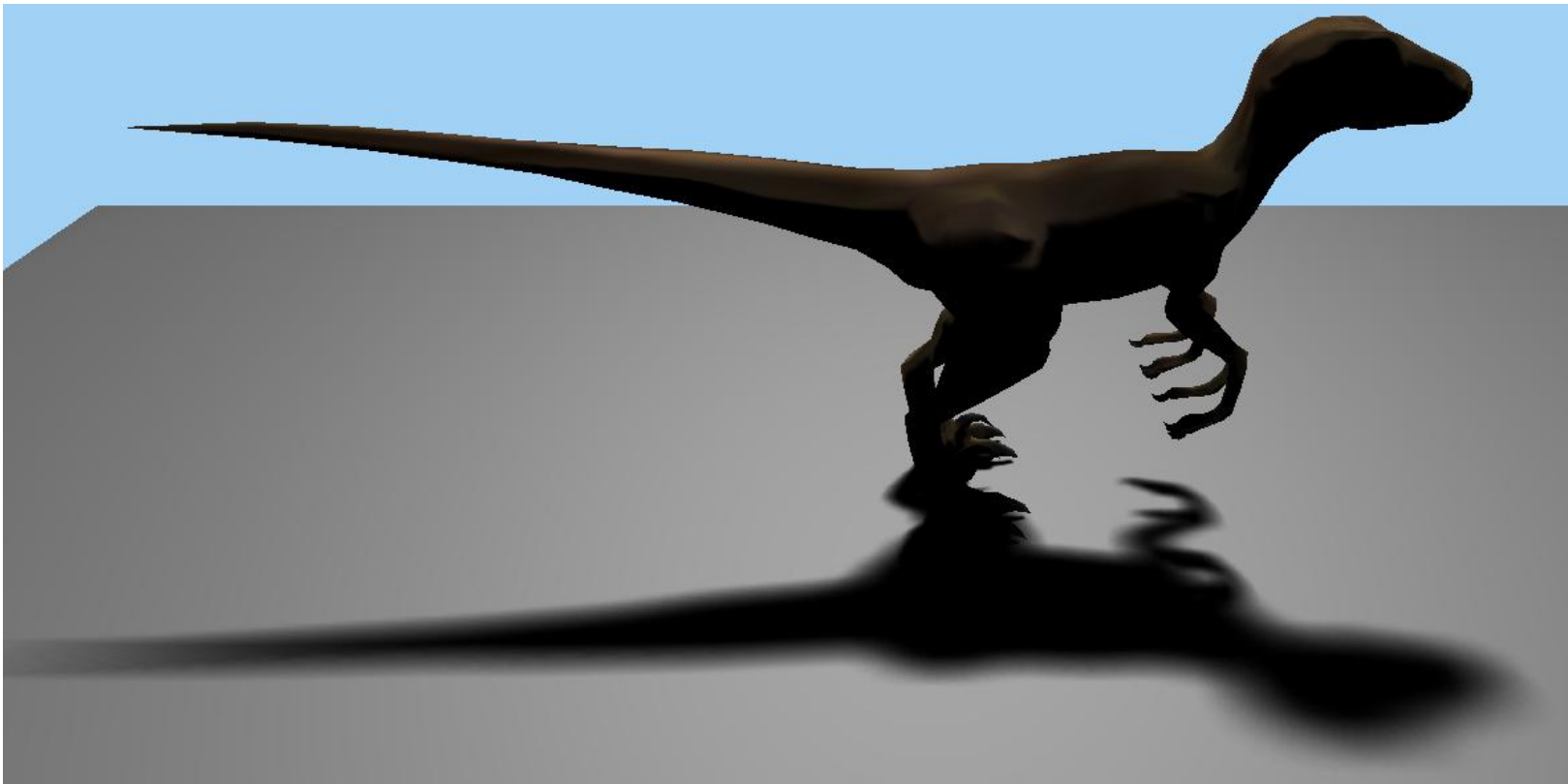
ALGORITHM

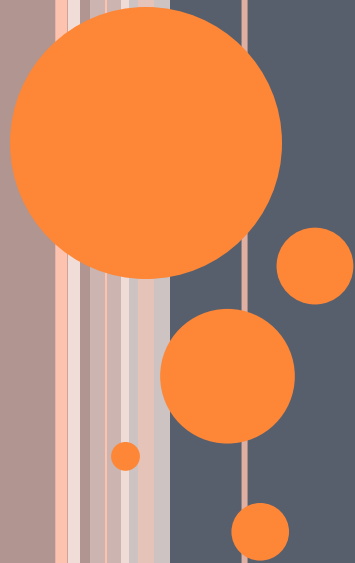
- Step 7 – Light Source Refinement:



ALGORITHM

- Step 8 – Final Rendering:





RESULTS AND DISCUSSION

EXPERIMENTAL SETUP

- For all tests, we used an Intel® Core™ i7-3770K CPU @3.50Ghz, 8GB RAM, NVIDIA GeForce GTX Titan X;
- We compare our approach with:
 - Uniform sampling of the area light source:
 - 289 samples;
 - Adaptive sampling proposed by [Schwarzler2012];
 - Percentage-Closer Soft Shadows [Fernando2005];
 - Moment Soft Shadow Mapping [Peters2016];

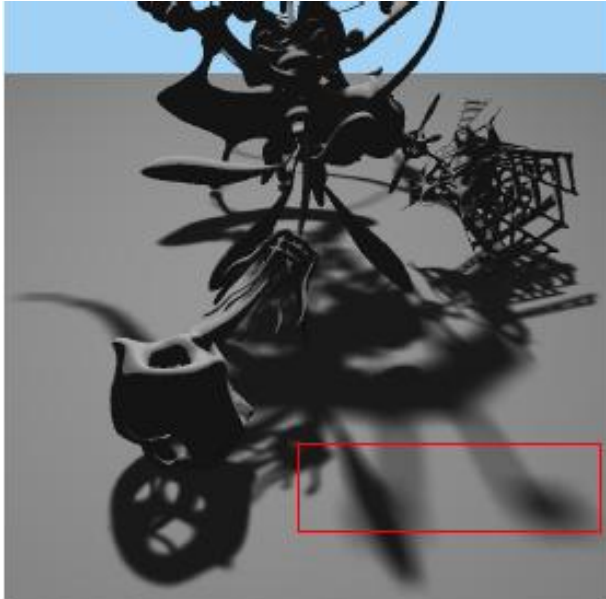
[Schwarzler2012] – M. Schwarzler et al. “Fast Accurate Soft Shadows with Adaptive Light Source Sampling”. Proceedings of the VMV, 2012.

[Fernando2005] – R. Fernando. “Percentage-Closer Soft Shadows”. Proceedings of the SIGGRAPH Sketeches, 2005.

[Peters2016] – C. Peters et al. “Beyond Hard Shadows: Moment Shadow Maps for Single Scattering, Soft Shadows and Translucent Ocluders”. Proceedings of the ACM I3D, 2016.

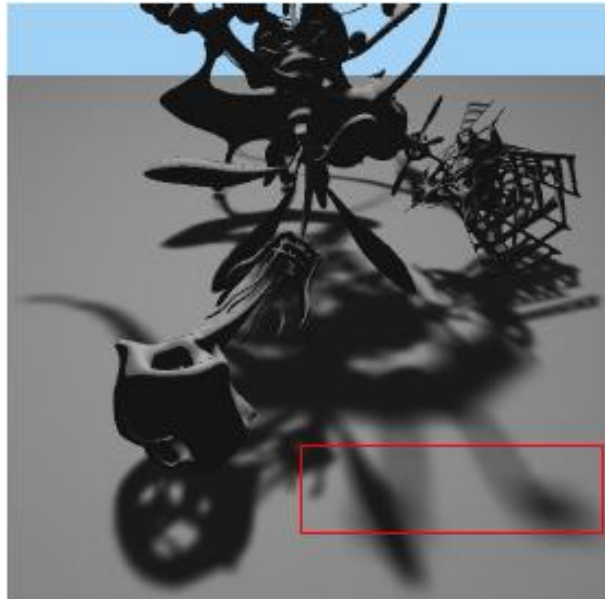
VISUAL QUALITY

Uniform Sampling



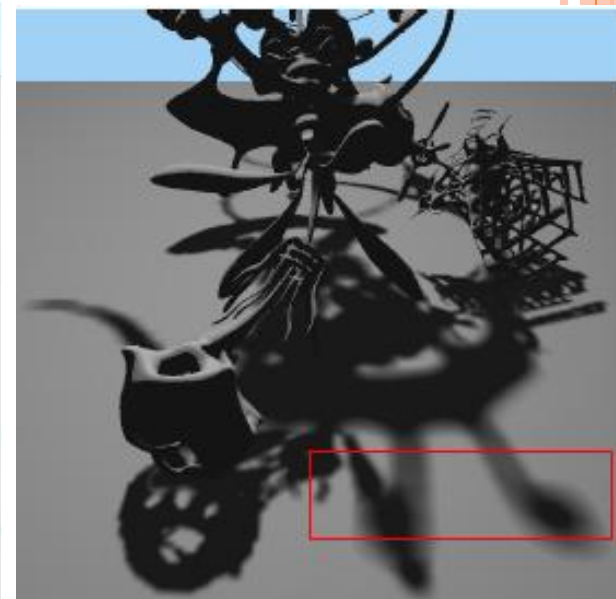
1.4s

Our Approach

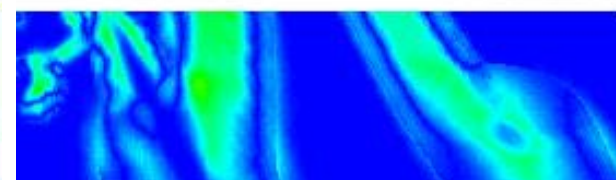
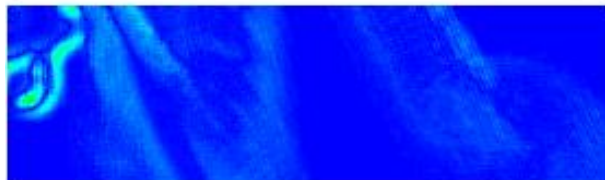


495 ms

PMSS [Suh et al. 2003]

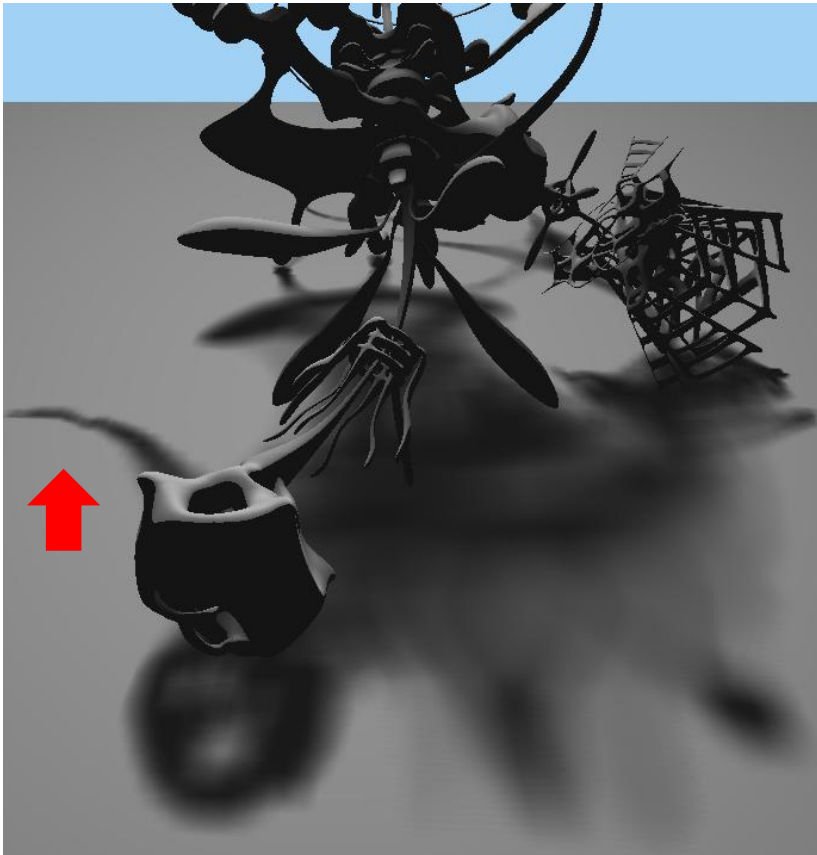


1770 ms

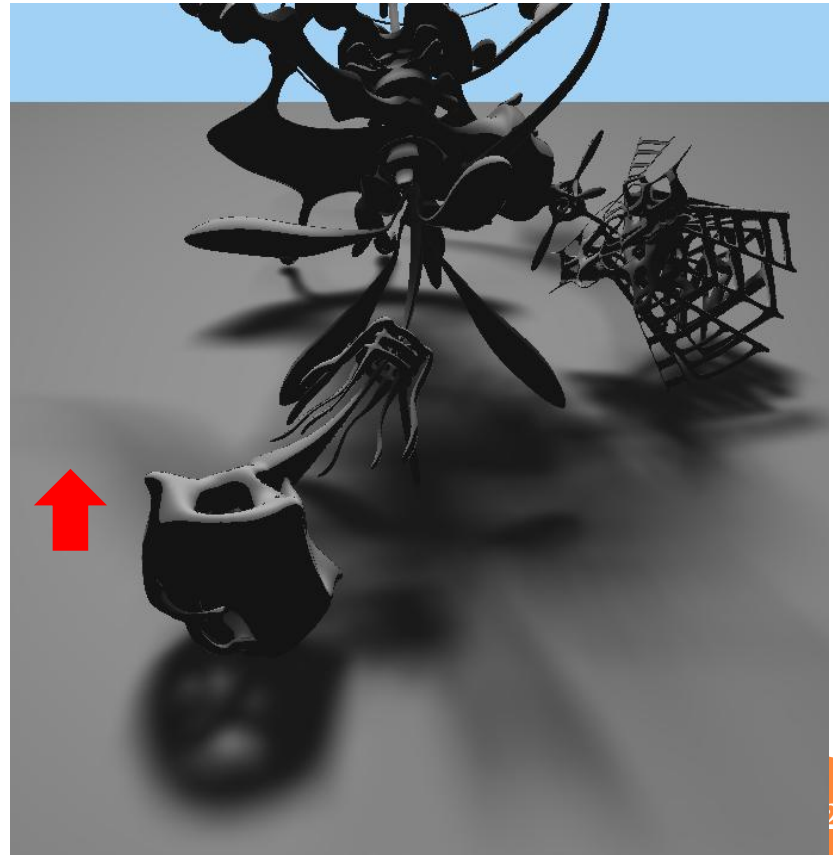


VISUAL QUALITY

- Large Penumbra Sizes:



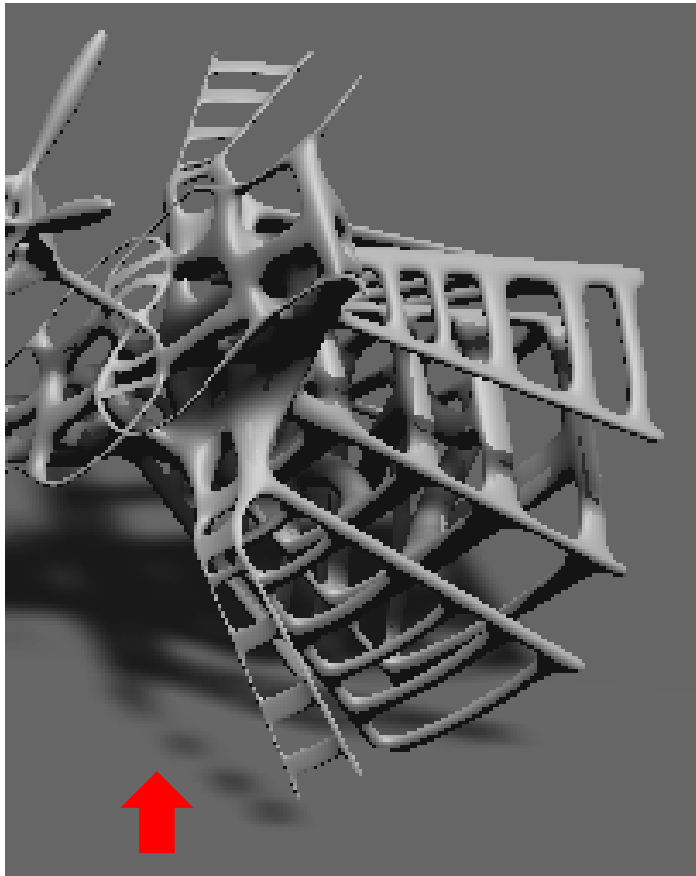
Percentage-Closer Soft Shadows



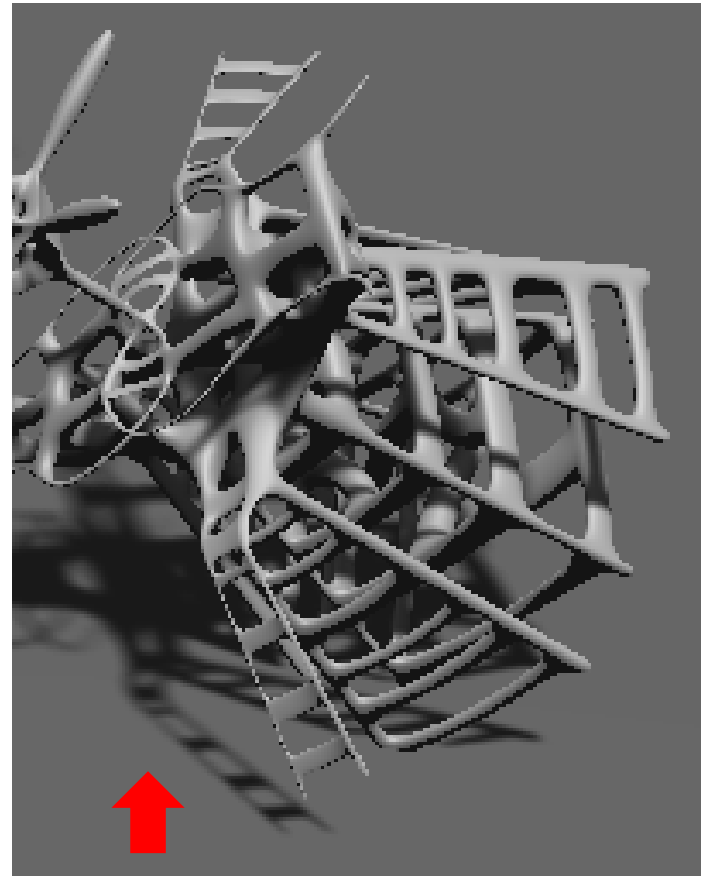
Our approach

VISUAL QUALITY

- Subsampling Artifacts:



Shadow Map Resolution:
512 x 512



Shadow Map Resolution:
1024 x 1024

RENDERING TIME

- Shadow Map Resolution:

Model	Method	Shadow Map Resolution		
		512 ²	1024 ²	2048 ²
Armadillo	Uniform S.	350 ms	360 ms	380 ms
	Adaptive S.	175 ms	100 ms	95 ms
	RB Adaptive S.	95 ms	80 ms	80 ms
	PCSS	5.3 ms	5.4 ms	5.5 ms
	MSSM	4.0 ms	5.8 ms	7.1 ms
YeahRight	Uniform S.	1.4s	1.4s	1.4 s
	Adaptive S.	1.5 s	770 ms	950 ms
	RB Adaptive S.	340 ms	495 ms	620 ms
	PCSS	11.2 ms	11.3 ms	11.7 ms
	MSSM	10.8 ms	11.0 ms	11.1 ms
QuadBot	Uniform S.	800 ms	820 ms	830 ms
	Adaptive S.	950 ms	840 ms	610 ms
	RB Adaptive S.	380 ms	385 ms	400 ms
	PCSS	7.4 ms	7.5 ms	7.6 ms
	MSSM	6.4 ms	8 ms	9.2 ms

RENDERING TIME

- Viewport/Output Resolution:

Model	Method	Output Resolution		
		SD	HD	Full HD
Armadillo	Uniform S.	360 ms	360 ms	360 ms
	Adaptive S.	50 ms	100 ms	270 ms
	RB Adaptive S.	70 ms	80 ms	250 ms
	PCSS	3.7 ms	5.4 ms	8.1 ms
	MSSM	5.4 ms	5.8 ms	6.6 ms
YeahRight	Uniform S.	1.4 s	1.4 s	1.4 s
	Adaptive S.	280 ms	770 ms	1.6 s
	RB Adaptive S.	180 ms	495 ms	850 ms
	PCSS	10 ms	11.3 ms	14.4 ms
	MSSM	10.0 ms	11.0 ms	12.6 ms
QuadBot	Uniform S.	800 ms	820 ms	830 ms
	Adaptive S.	220 ms	840 ms	1 s
	RB Adaptive S.	130 ms	385 ms	680 ms
	PCSS	6 ms	7.5 ms	10.2 ms
	MSSM	7.5 ms	8 ms	8.6 ms



CONCLUSION AND FUTURE WORK

FINAL CONSIDERATIONS

- Conclusion:
 - Our technique produces temporally coherent accurate soft shadows;
 - Our technique produces accurate soft shadows at interactive speed;
- Future Work:
 - Extend the approach for textured and non-planar area light sources;
 - Speed-up the accurate soft shadow computation:
 - View-Independent Rasterization [Marrs2017];

ACKNOWLEDGMENTS

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