Contouring Discrete Indicator Functions

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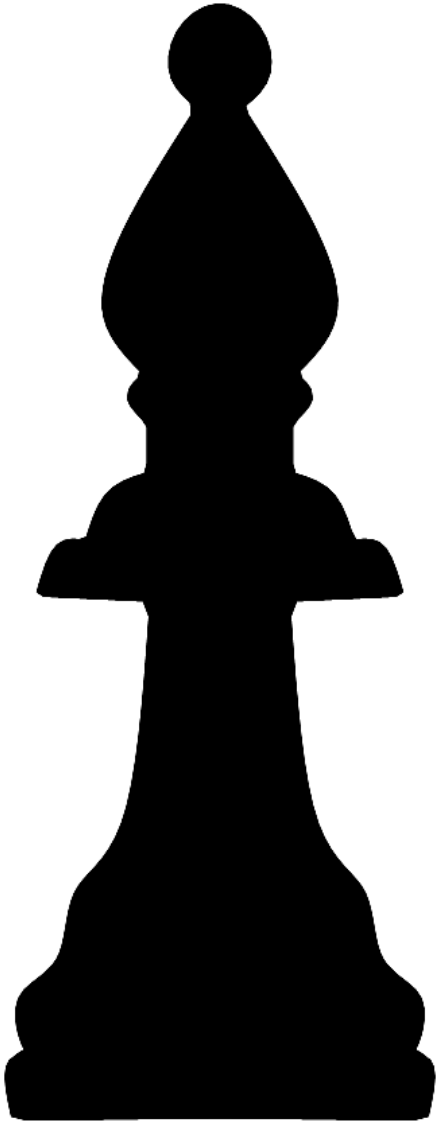
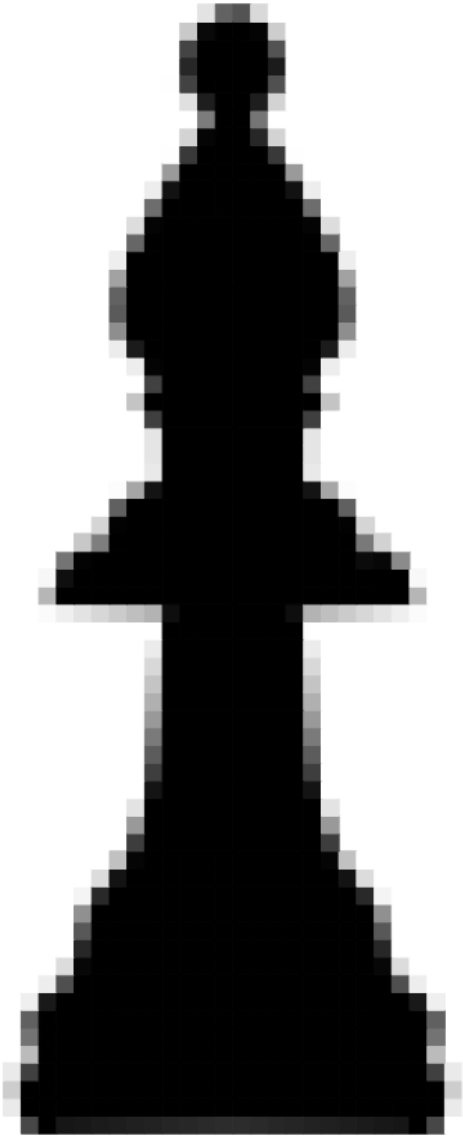
Texas A&M University

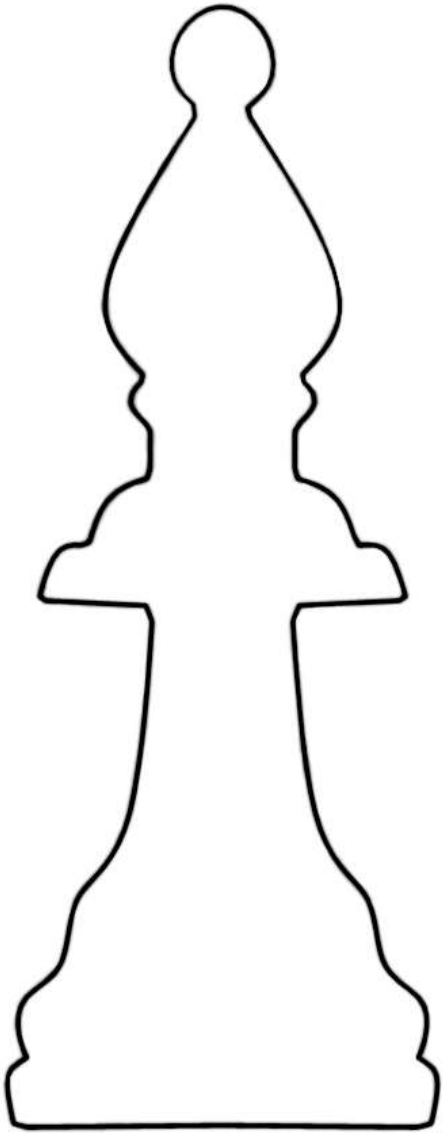
Indicator Functions



Discrete Indicator Functions (DIF)



Extracted Surface



Motivation

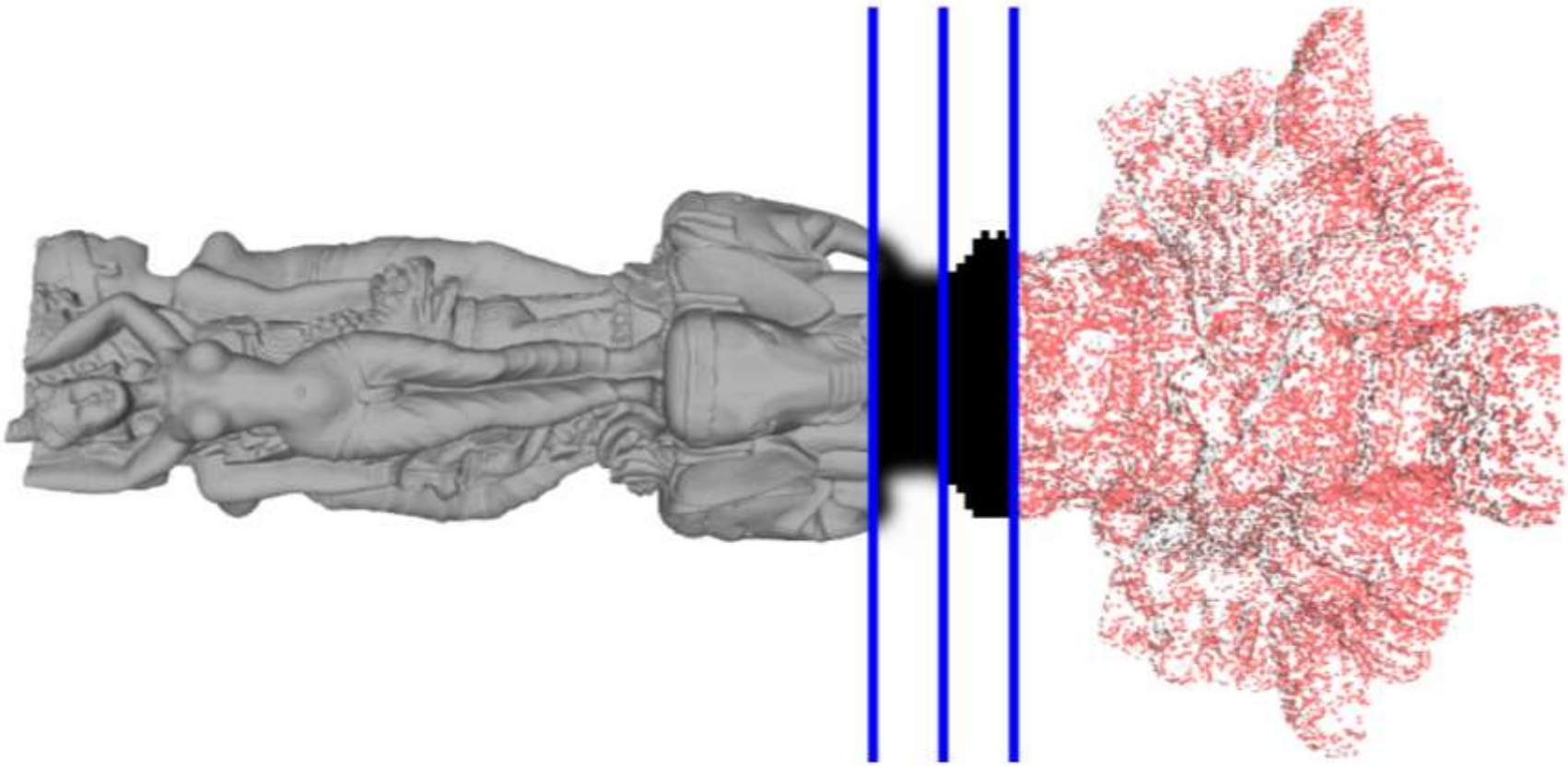
[Green 2007]

Motivation

[Warner Bros Pictures 2007]

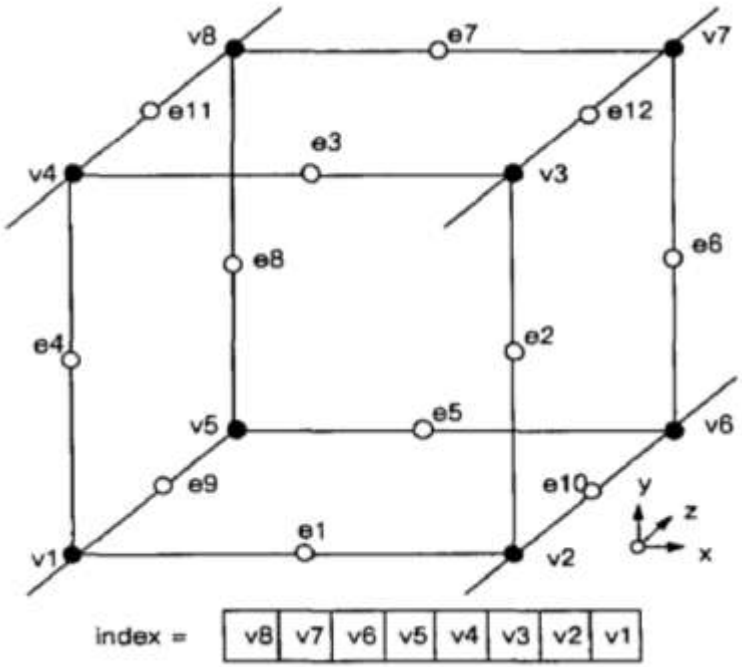
Motivation

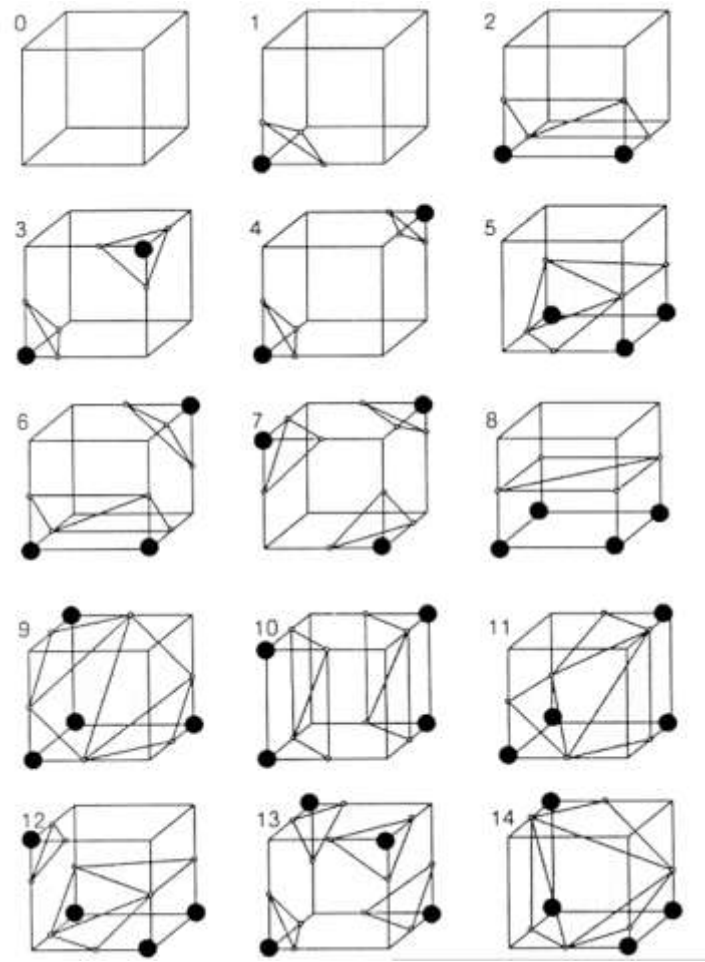
Motivation



[Manson et al. 2008]

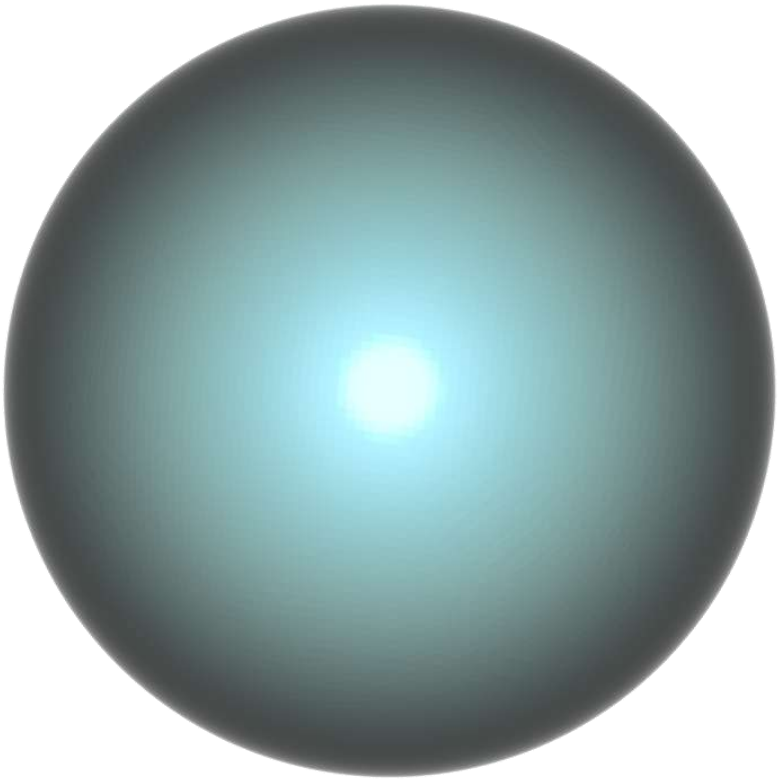
Marching Cubes



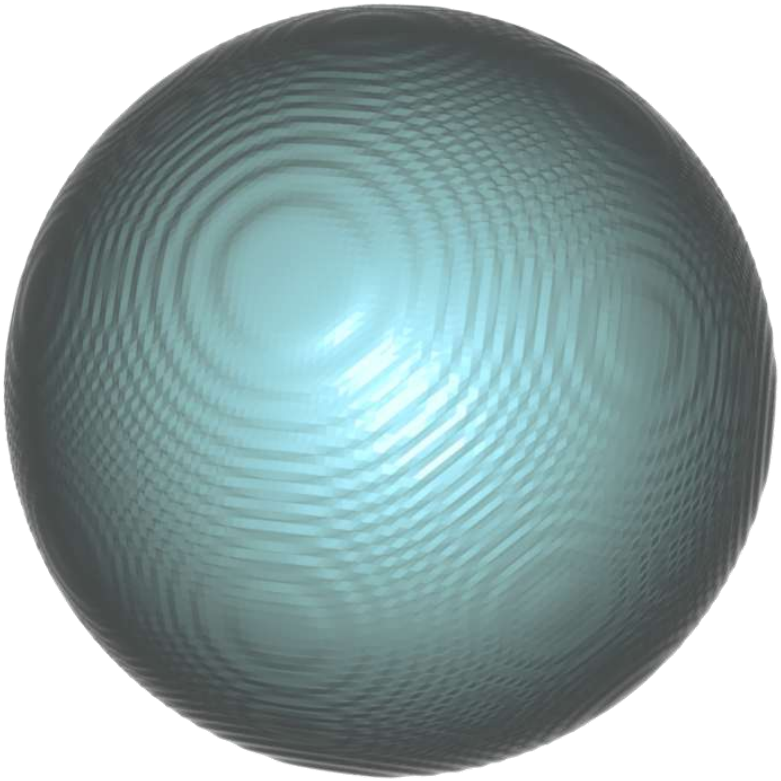


[Wyvill et al. 1986]
[Lorensen and Cline 1987]

Marching Cubes

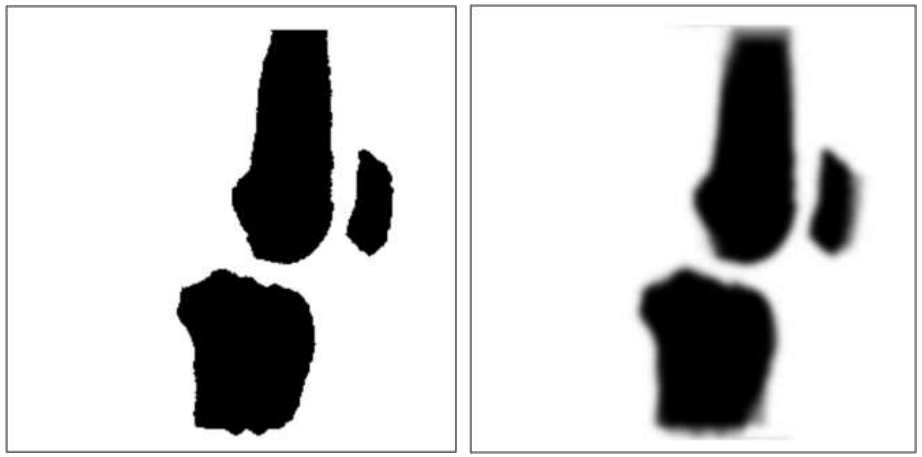


Perfect Sphere

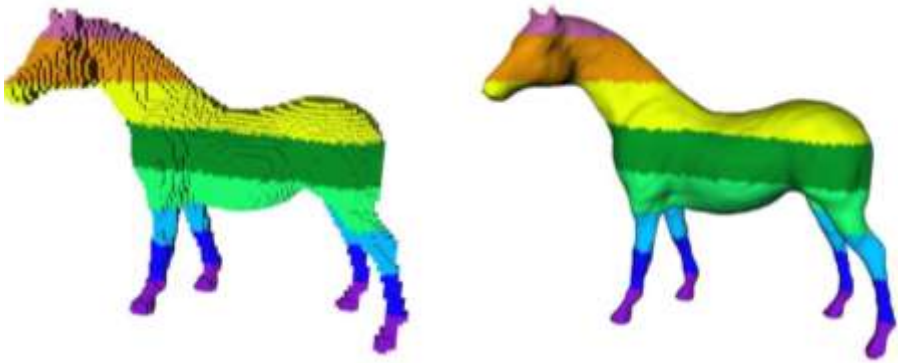


MC

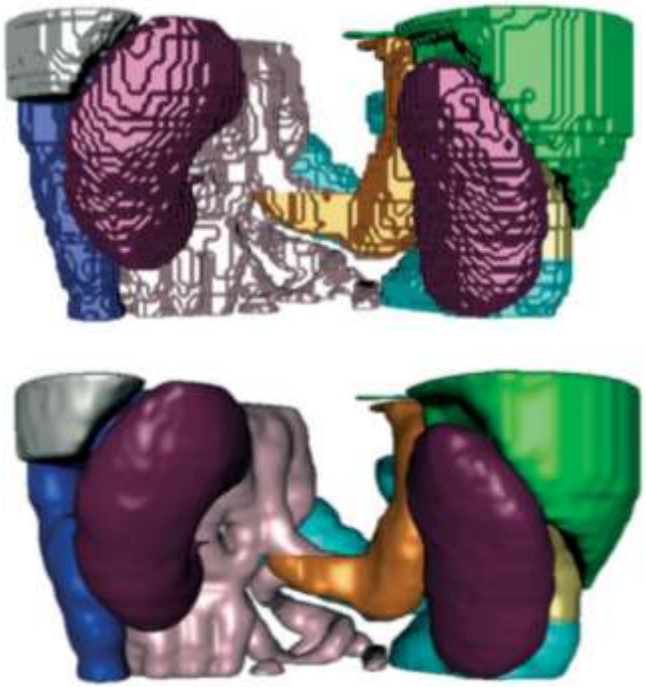
Related Work



[Mor et al. 1996]

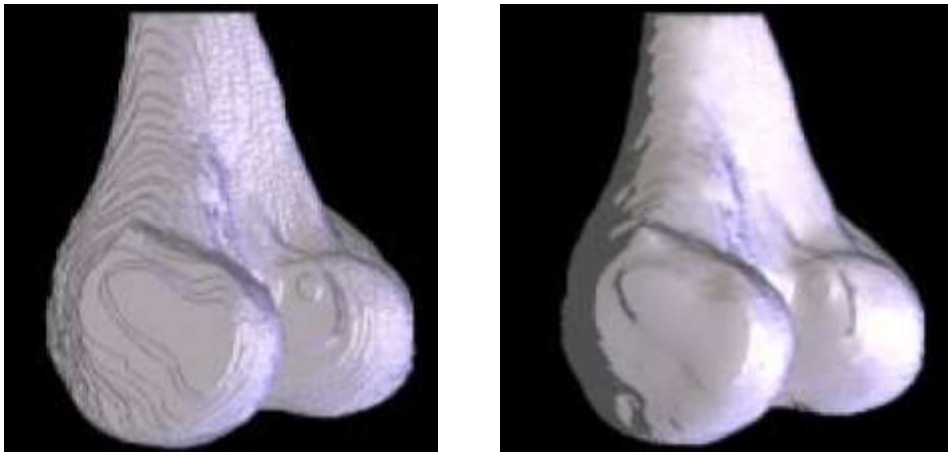


[Reitinger et al. 2005]

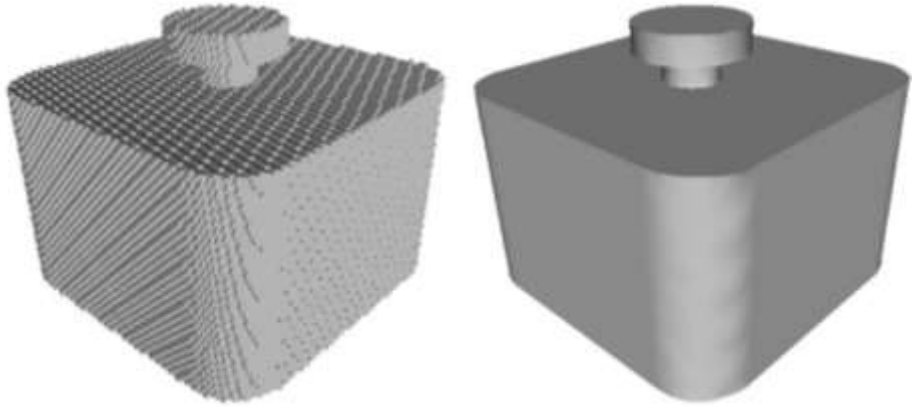


[Wu and Sullivan 2003]

Related Work



[Gibson and Frisken 1998]



[Chica et al. 2007]

Gaussian Blur

Poseidon

Gaussian Blur

MC

Gaussian Blur

Blur size 3

Gaussian Blur

Blur size 7

Gaussian Blur

MC Blur

Ours

Gaussian Blur

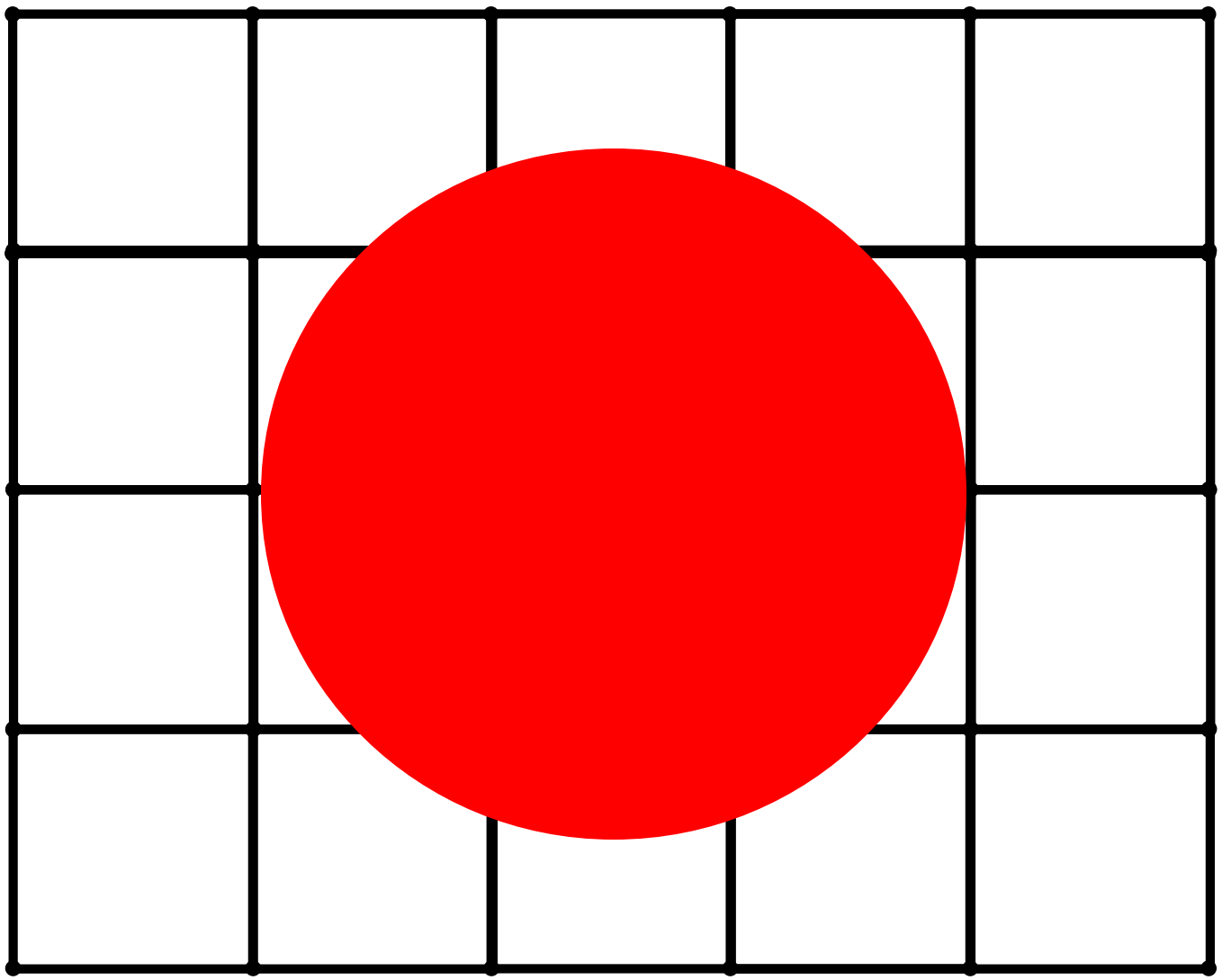
MC

Ours

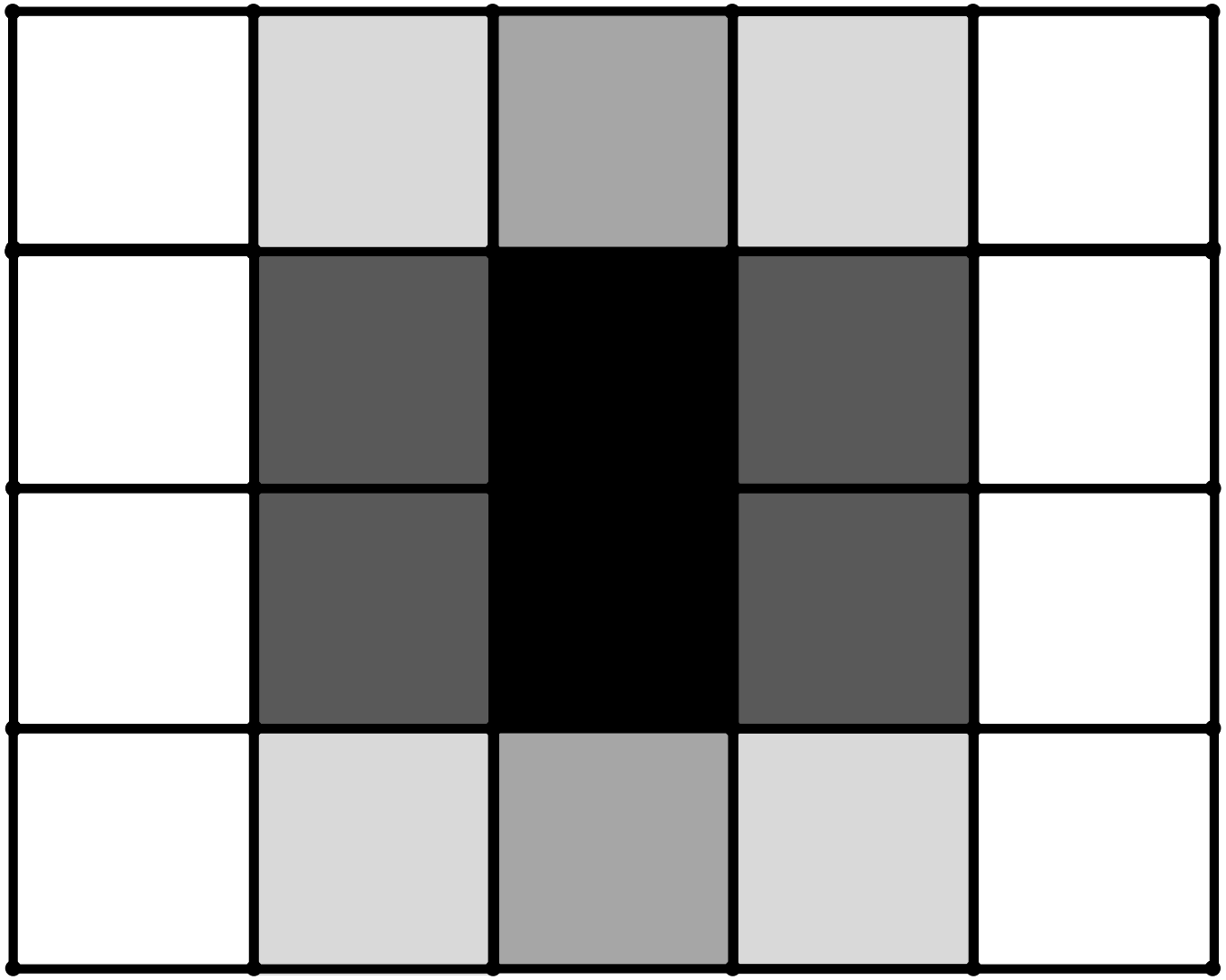
Contributions

- Simple and easy to implement modification to the MC algorithm
  - Replaces the linear interpolant in MC
- Computationally inexpensive
- Greatly reduces surface contouring artifacts

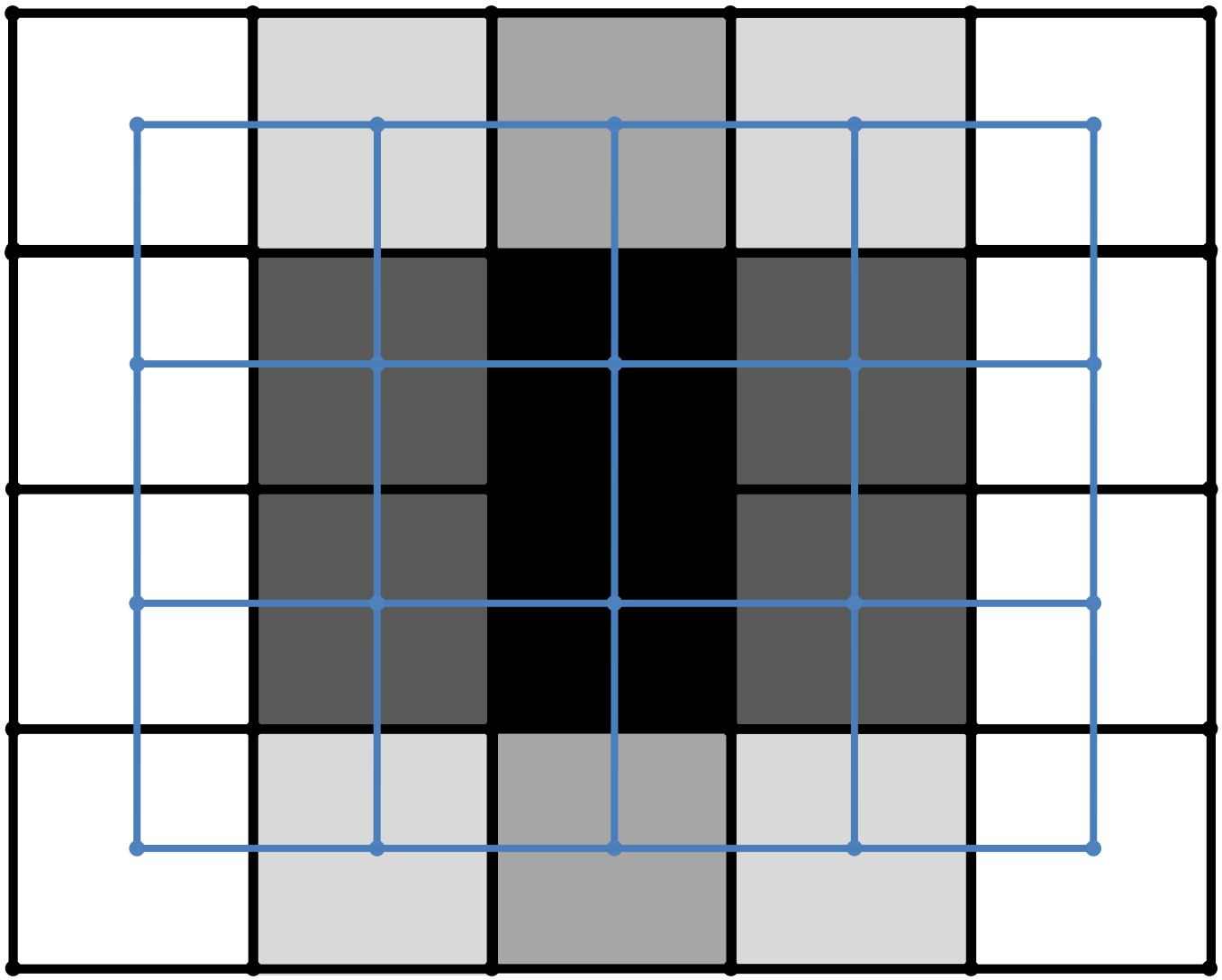
Contouring



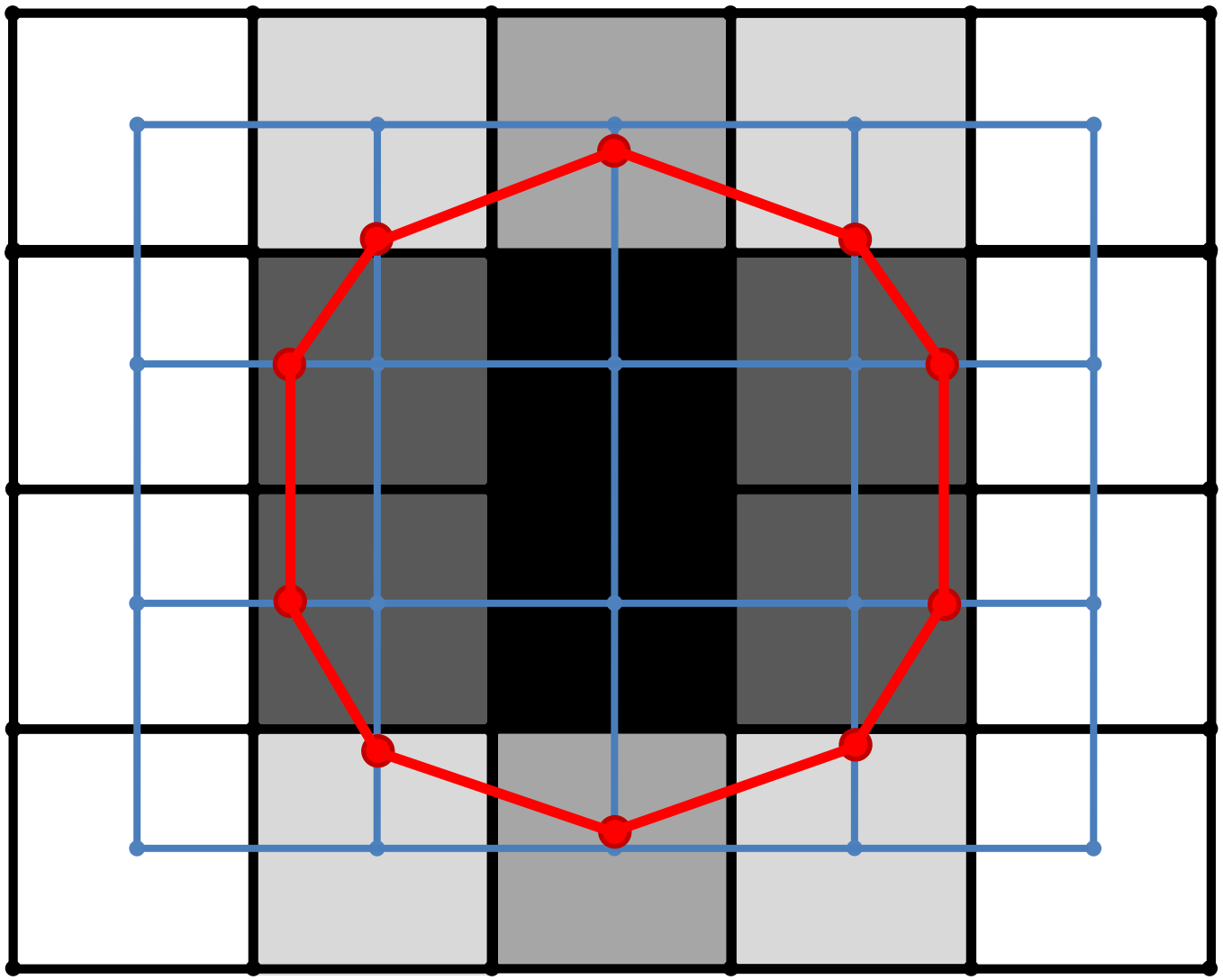
DIF



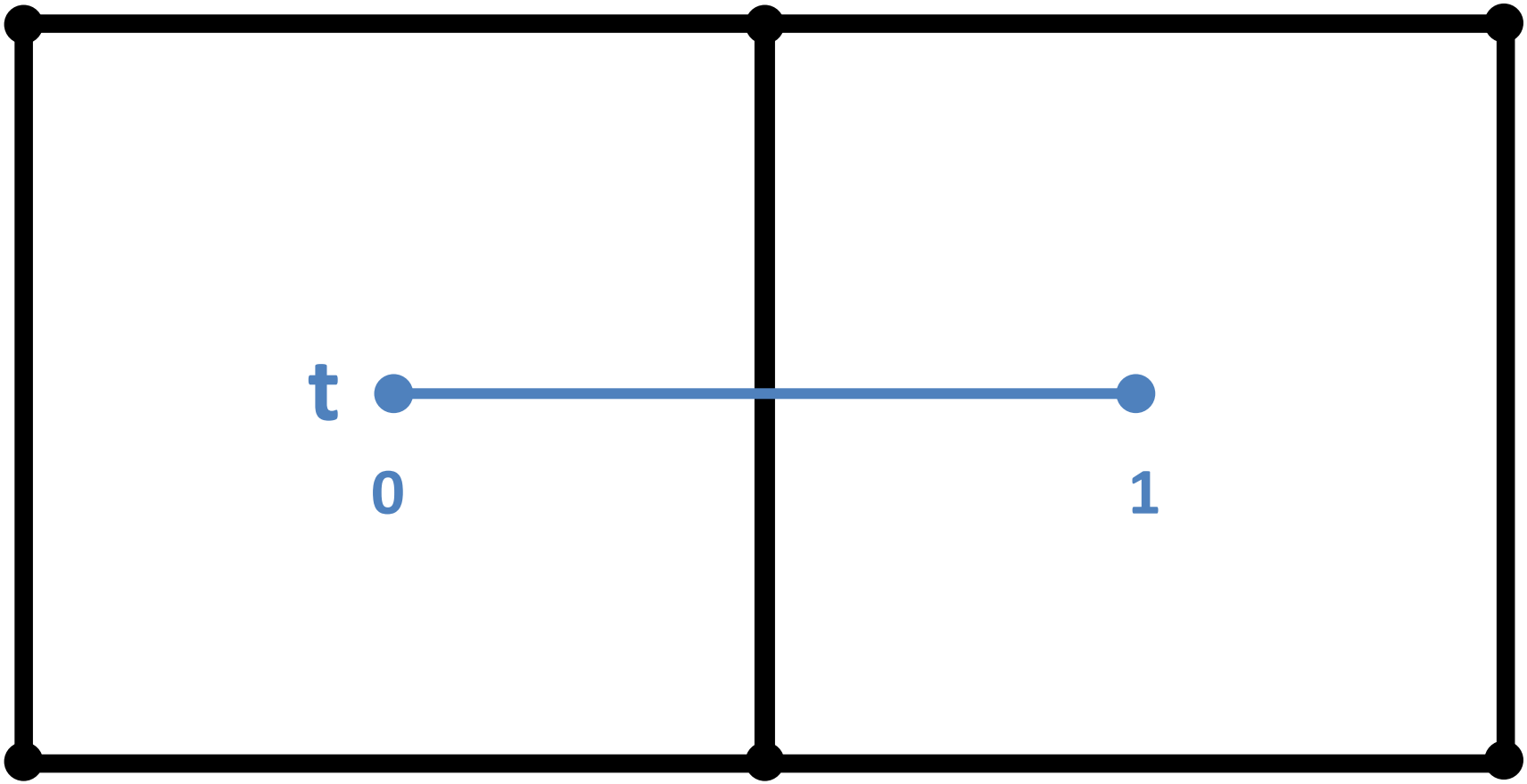
Dual Grid



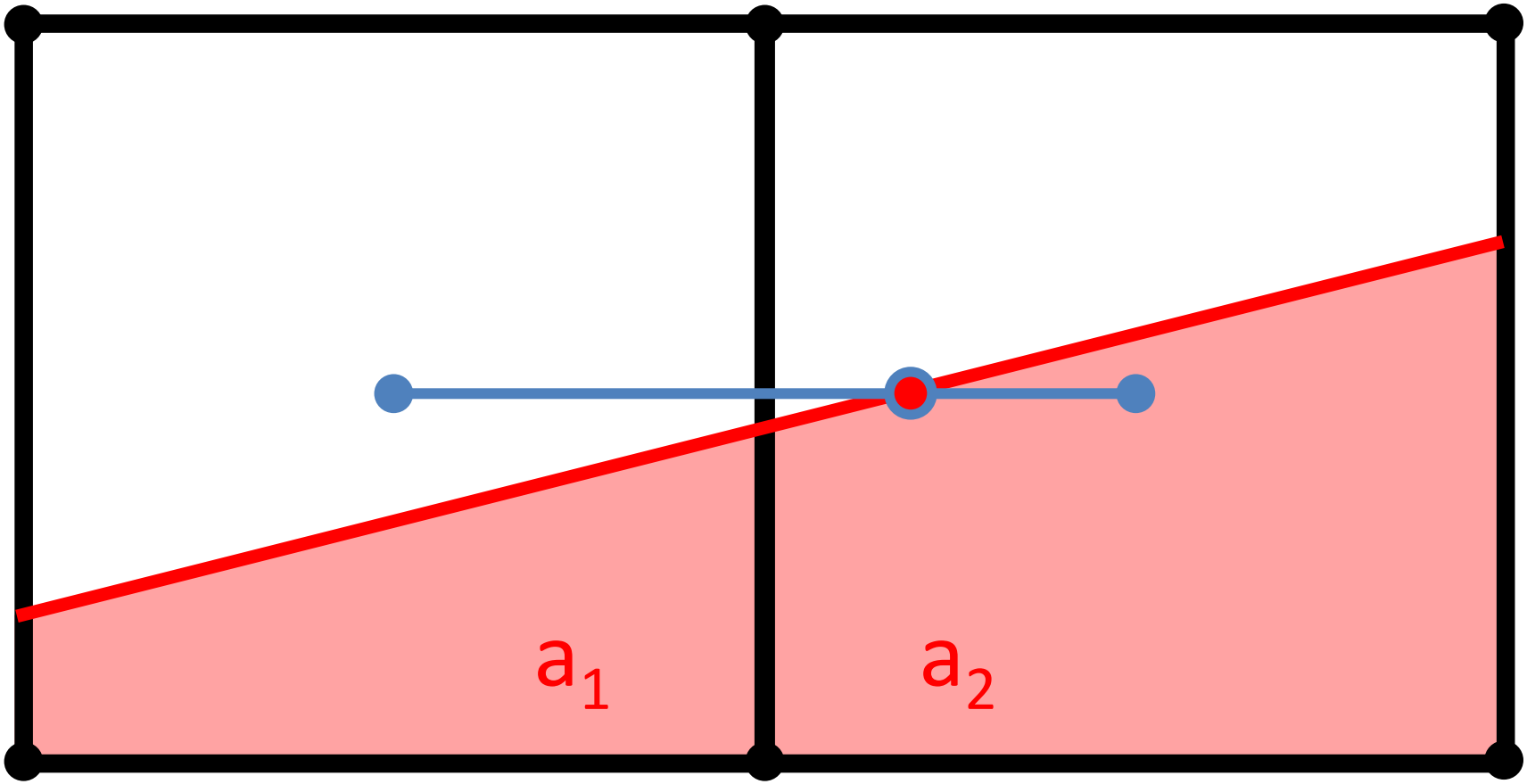
Dual Grid



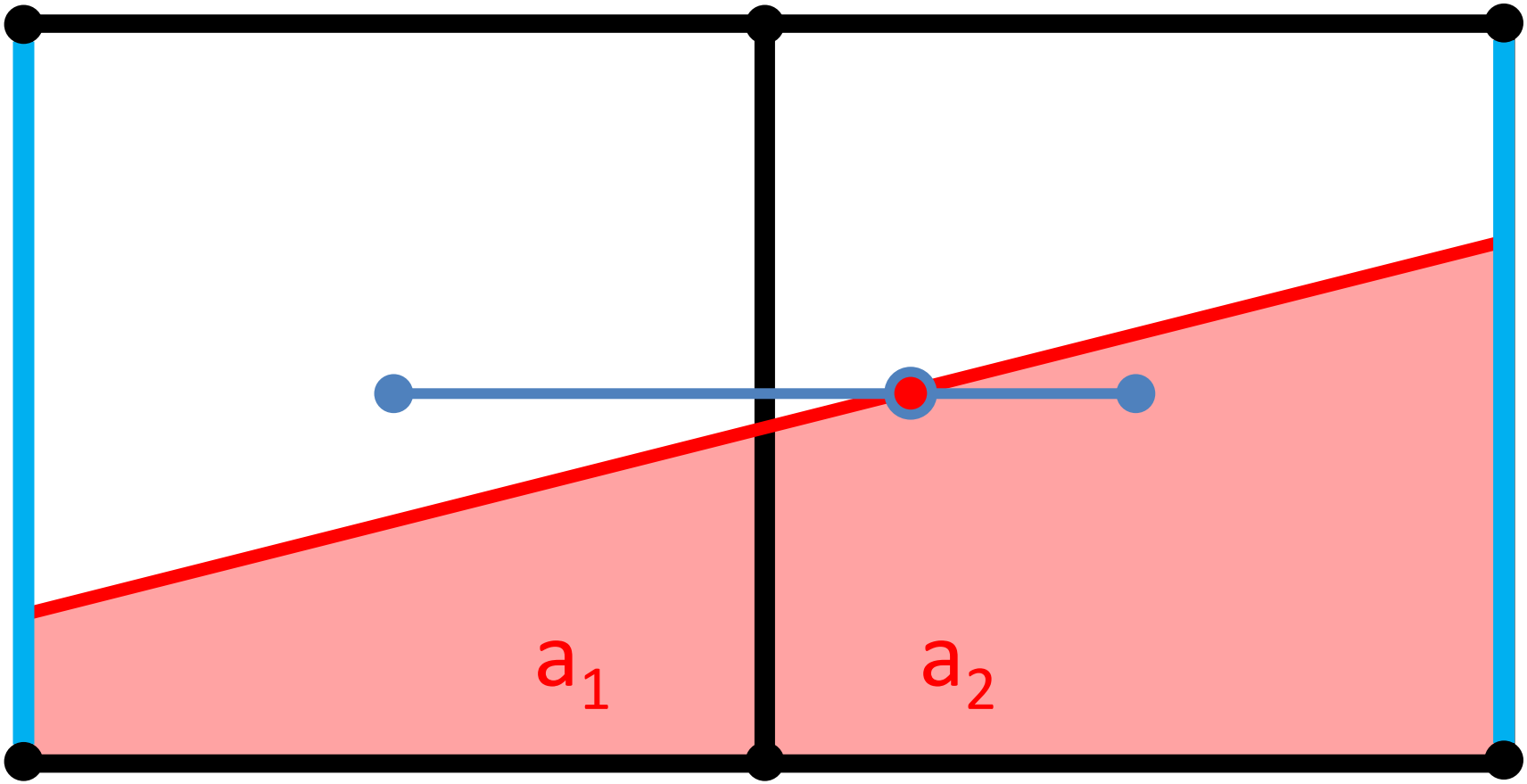
2D MC change



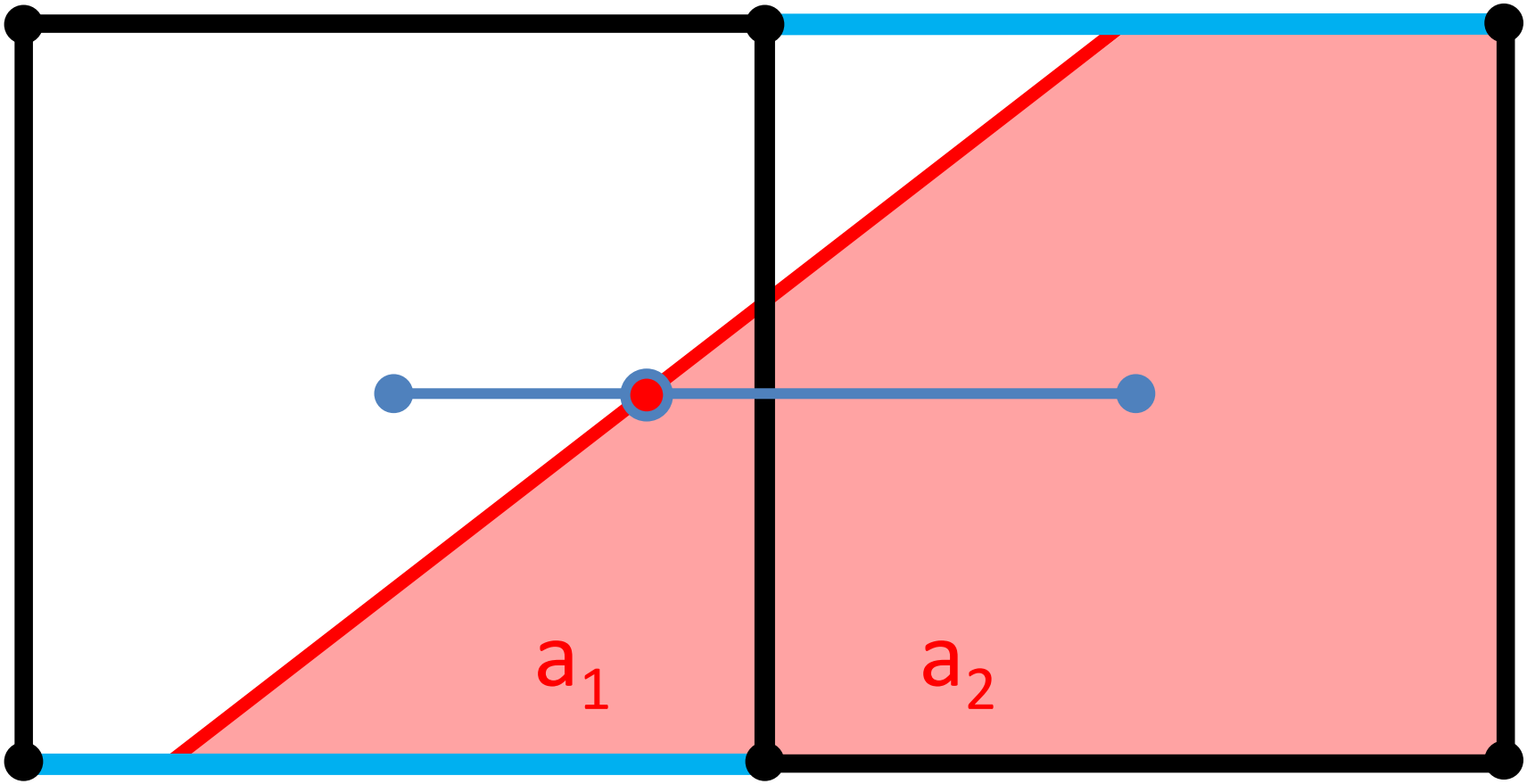
2D MC change



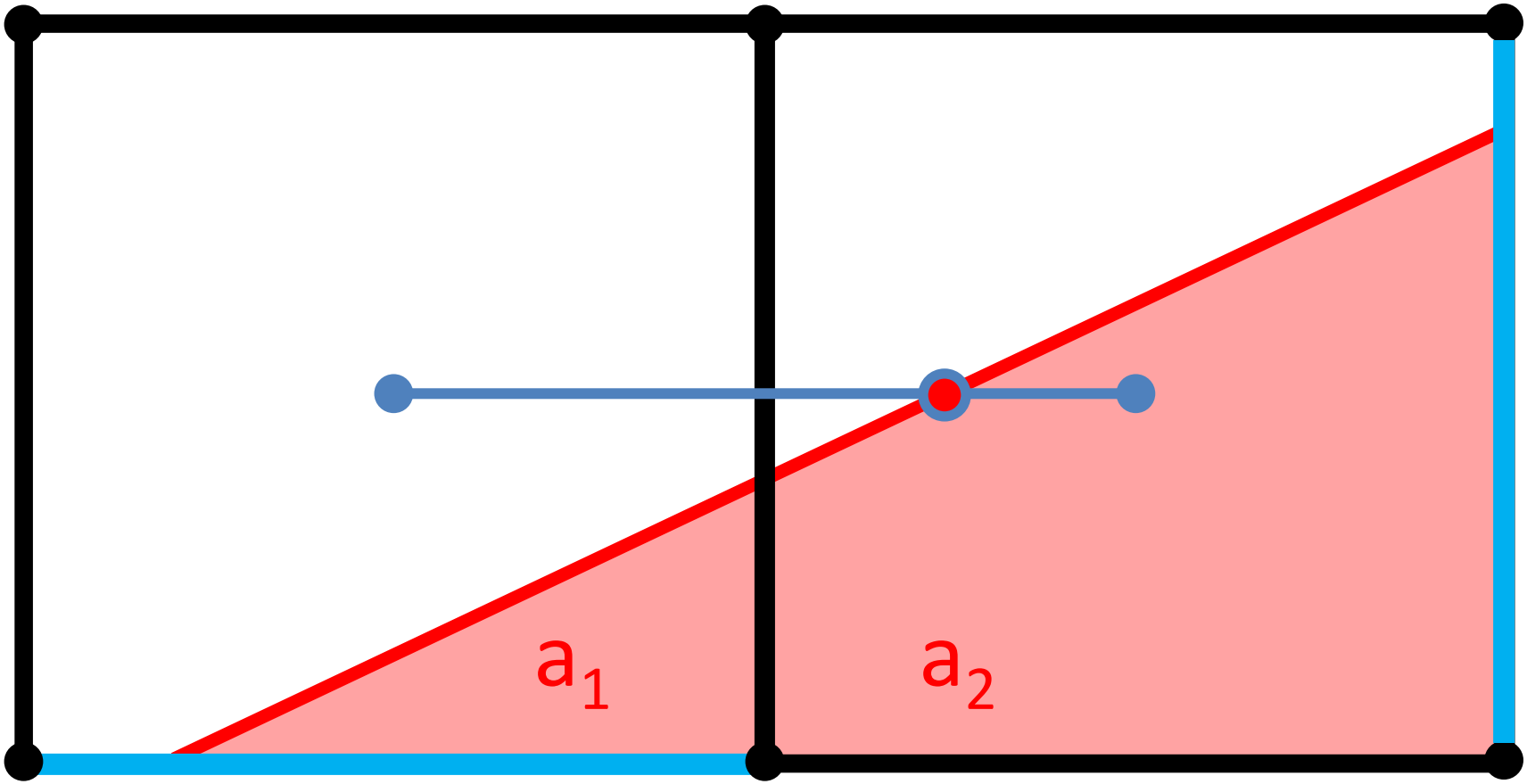
Side - Side



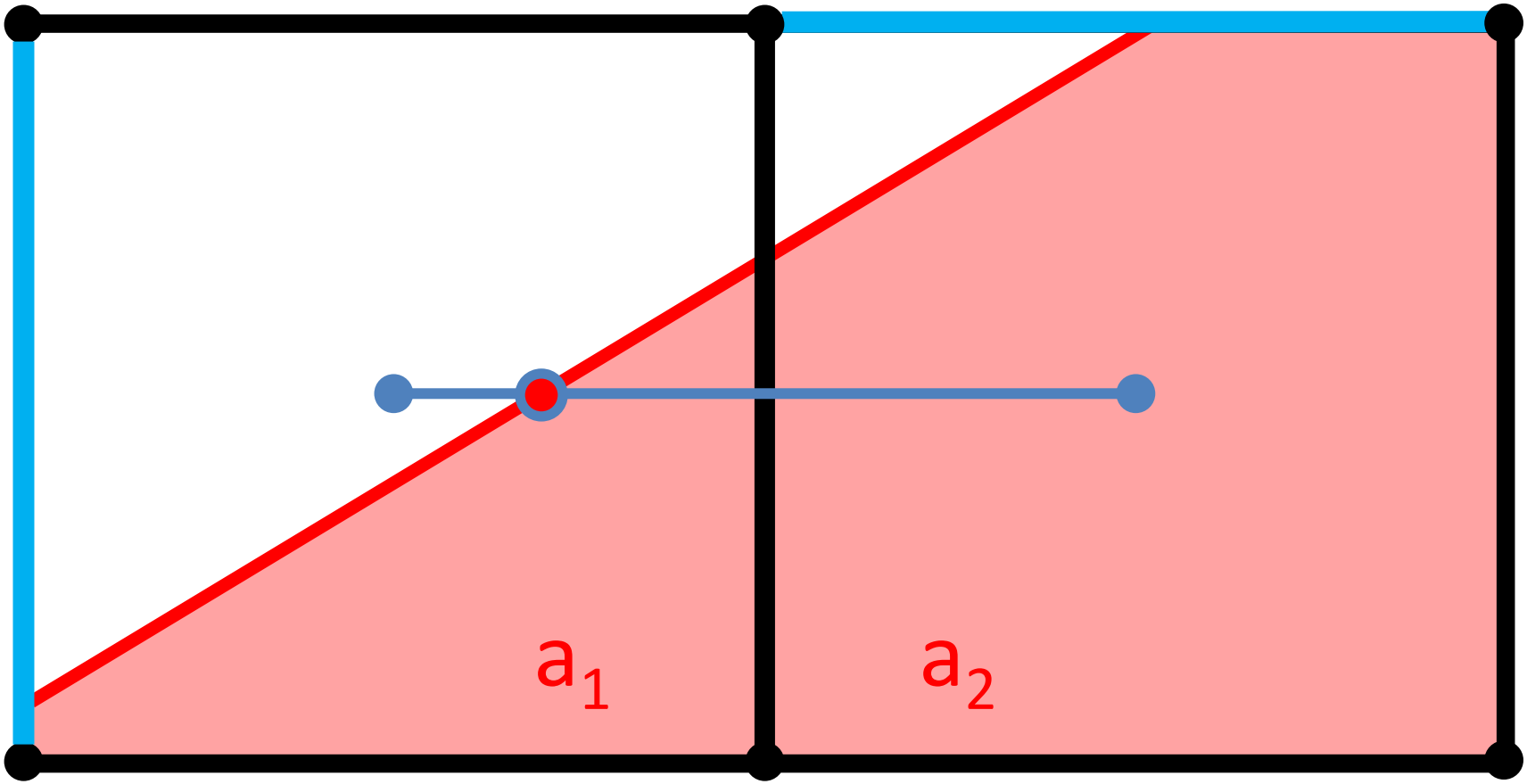
Bottom - Top



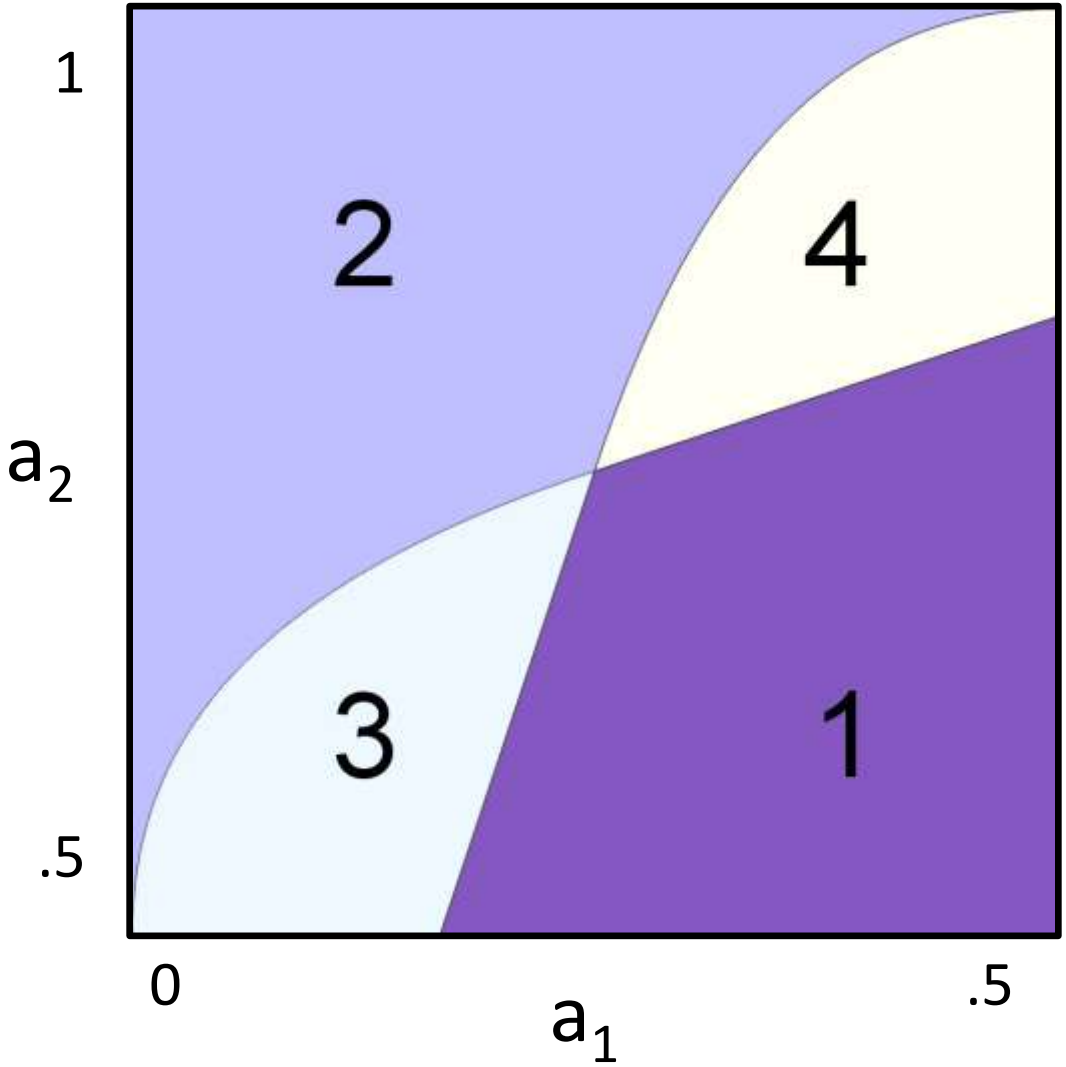
Bottom - Side



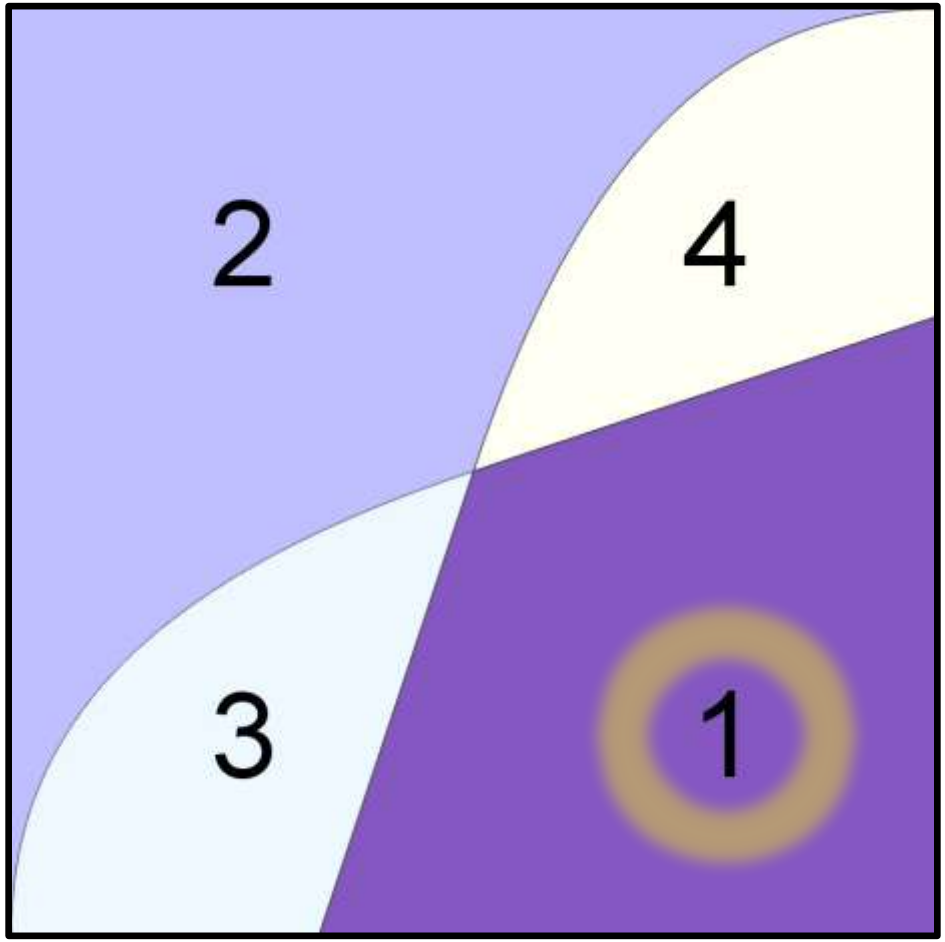
Side- Top



Parameter Space

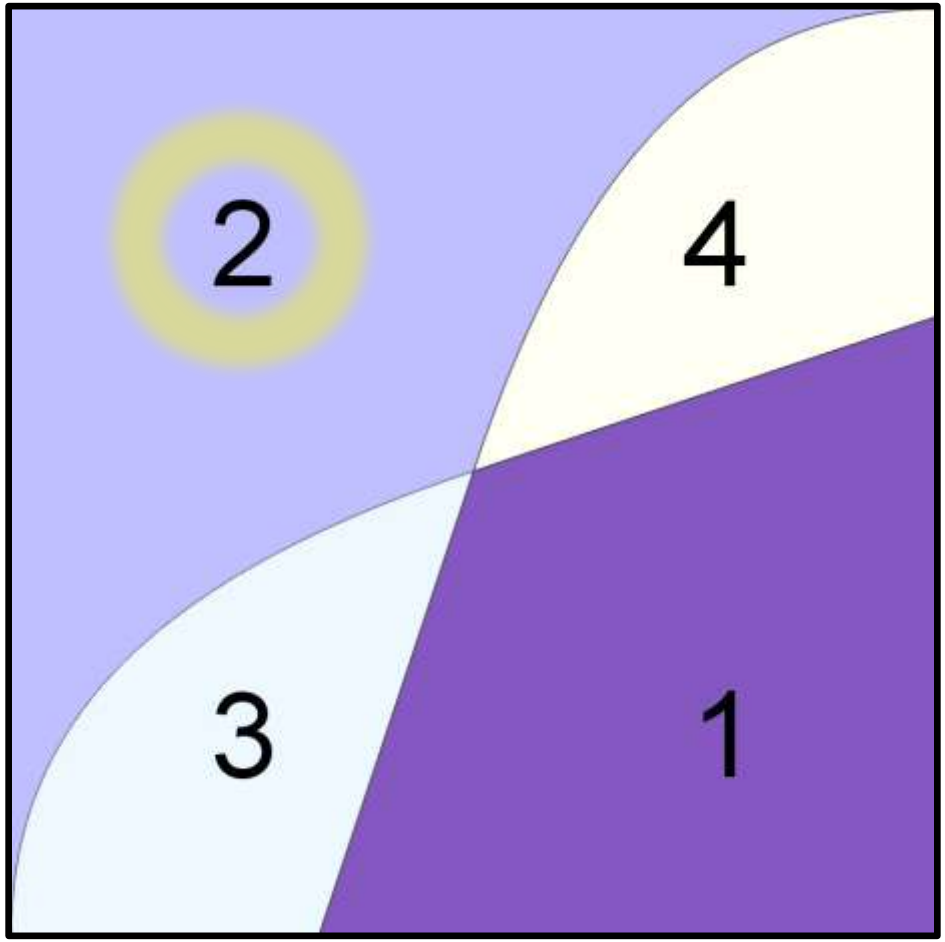


Parameter Space



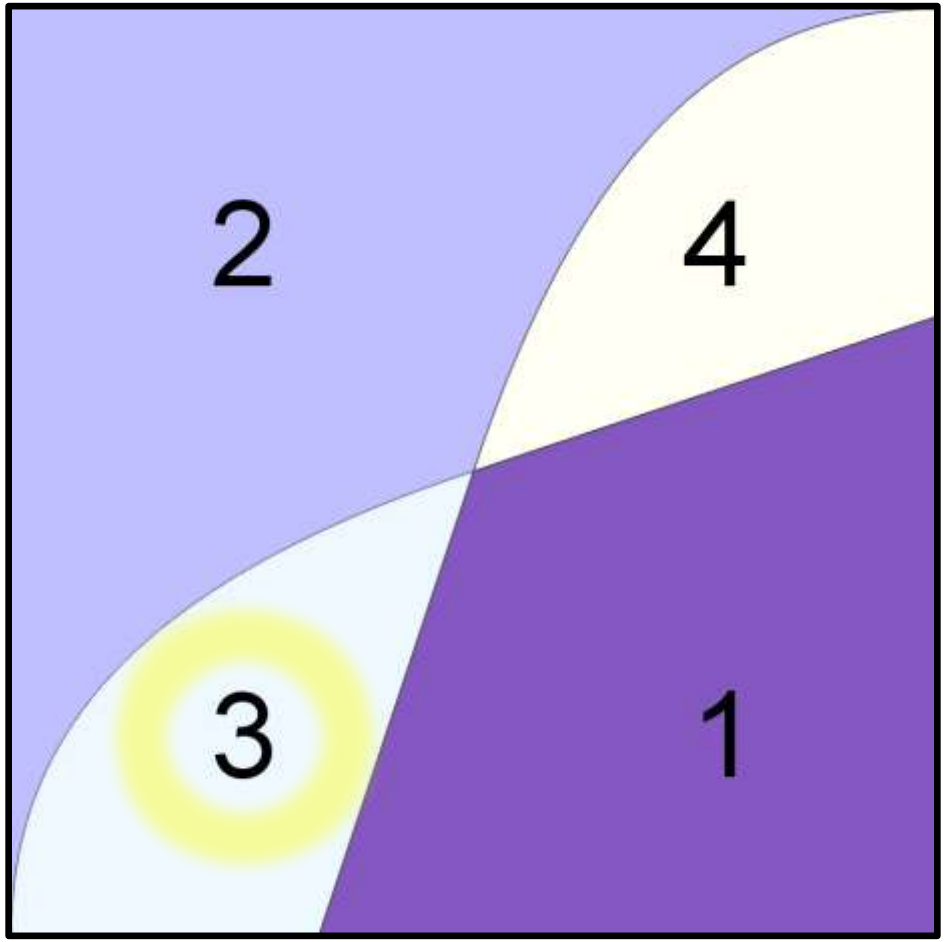
$$t = \frac{a_1 - \frac{1}{2}}{a_1 - a_2}$$

Parameter Space



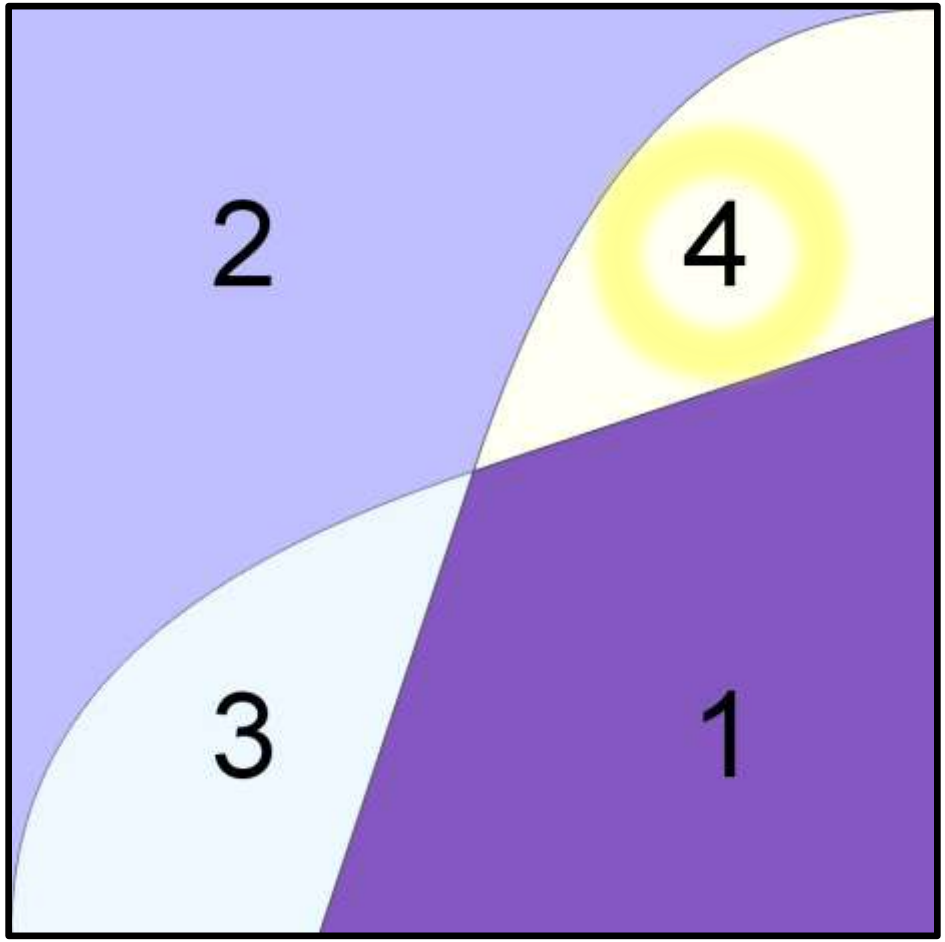
$$t = \frac{3}{2} - a_1 - a_2$$

Parameter Space



$$t = 1 - \frac{2a_2 - 1}{8a_1 + 4a_2 - 8\sqrt{a_1(a_1 + a_2)}}$$

Parameter Space

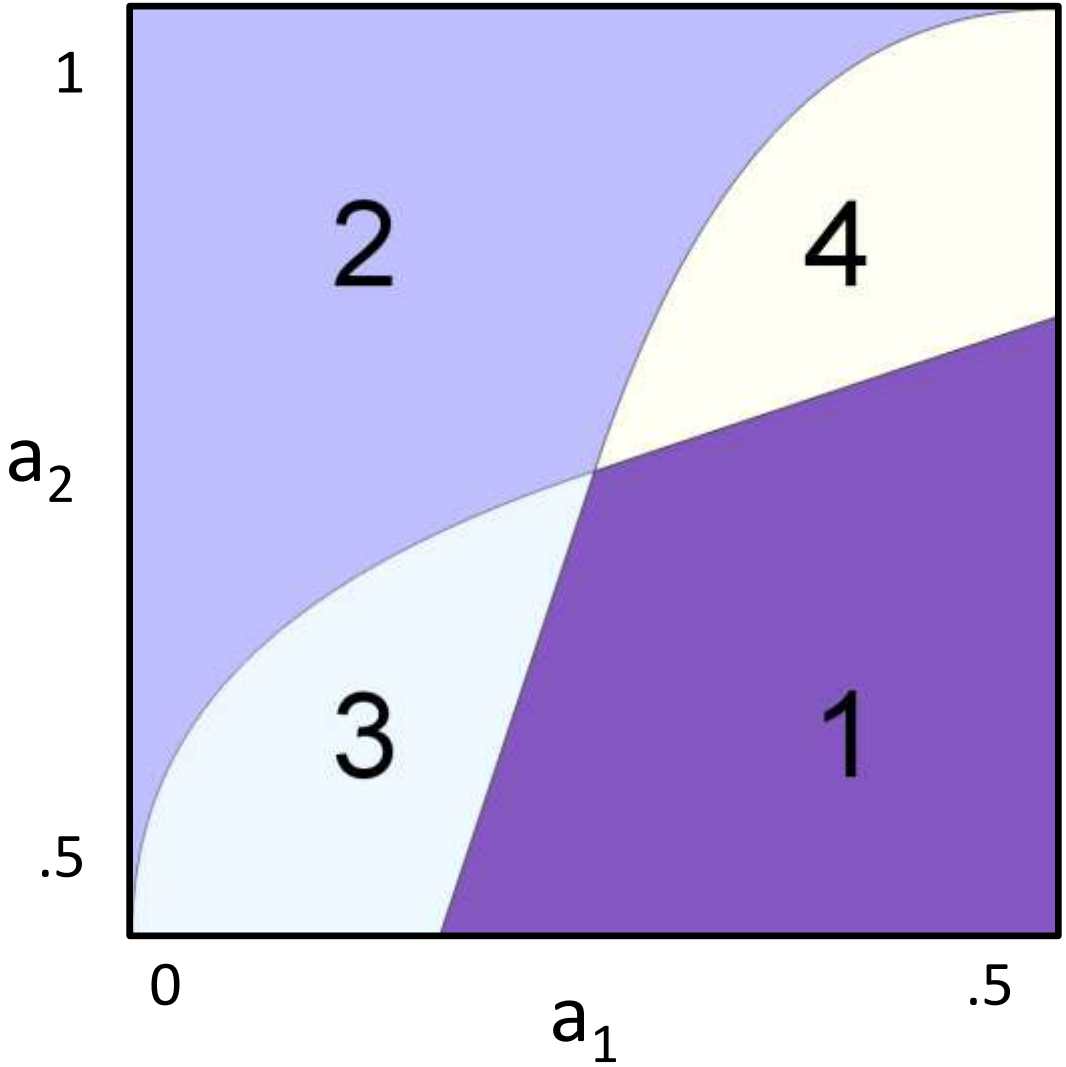


$$\bar{a}_1 = a_2 - 1$$

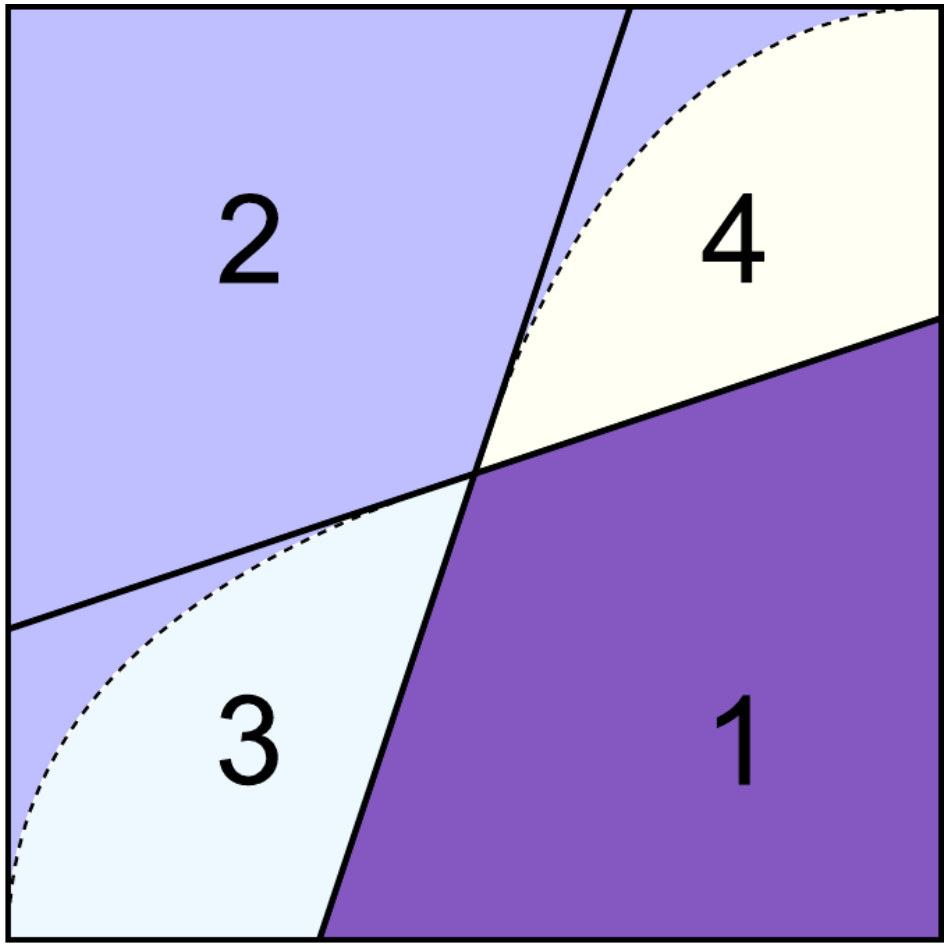
$$\bar{a}_2 = a_1 - 1$$

$$t = \frac{2\bar{a}_2 - 1}{8\bar{a}_1 + 4\bar{a}_2 - 8\sqrt{\bar{a}_1(\bar{a}_1 + \bar{a}_2)}}$$

Parameter Space

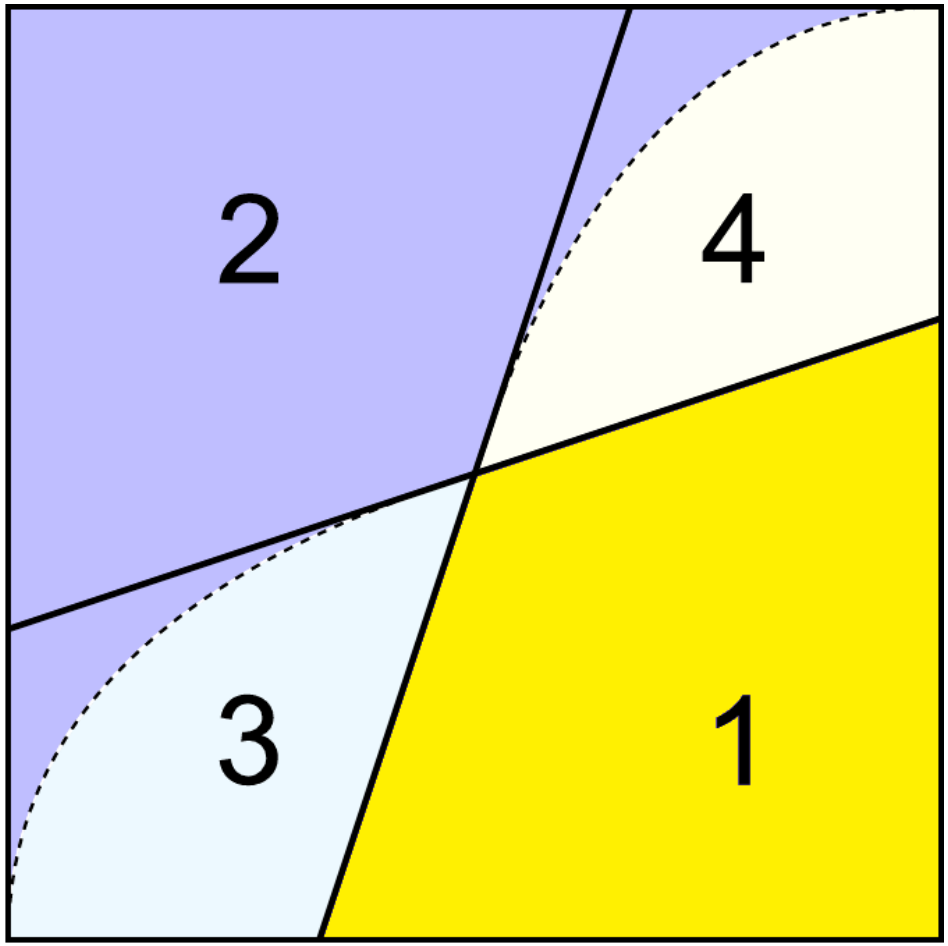


Parameter Space



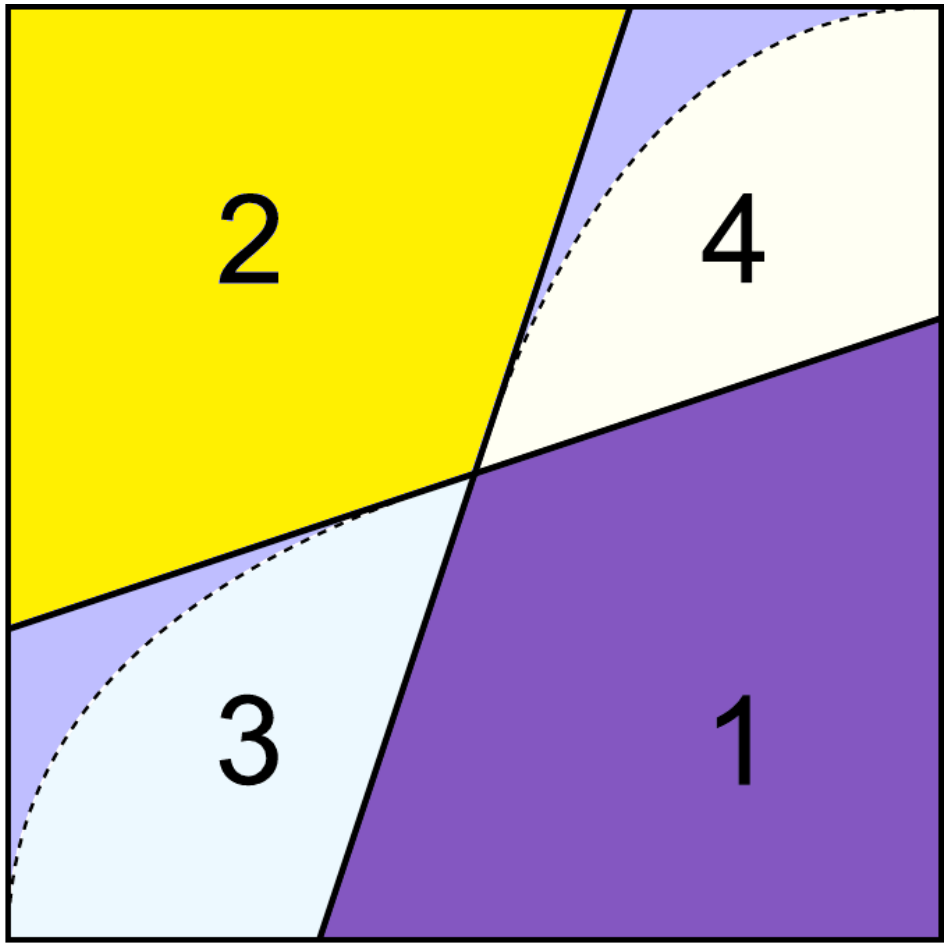
$a_2 \leq 3a_1$ $\qquad$ $3a_2 \leq a_1 + 2$

Parameter Space



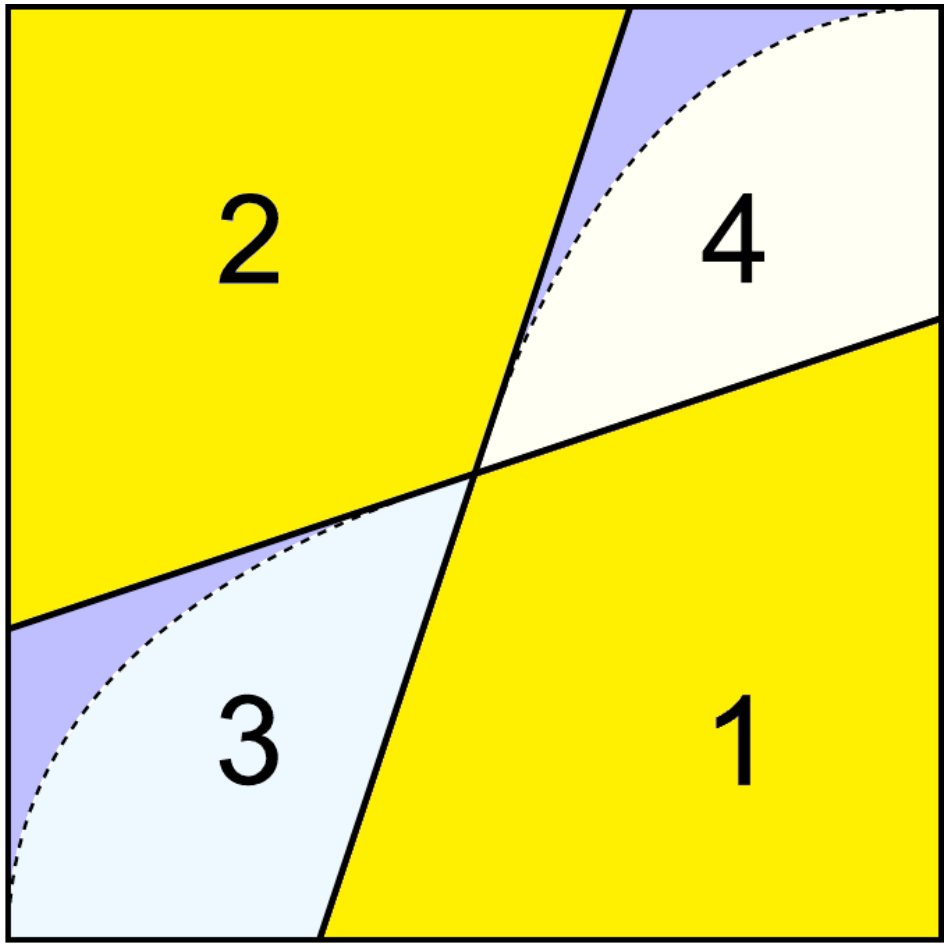
$a_2 \leq 3a_1$ $\qquad$ $3a_2 \leq a_1 + 2$

Parameter Space



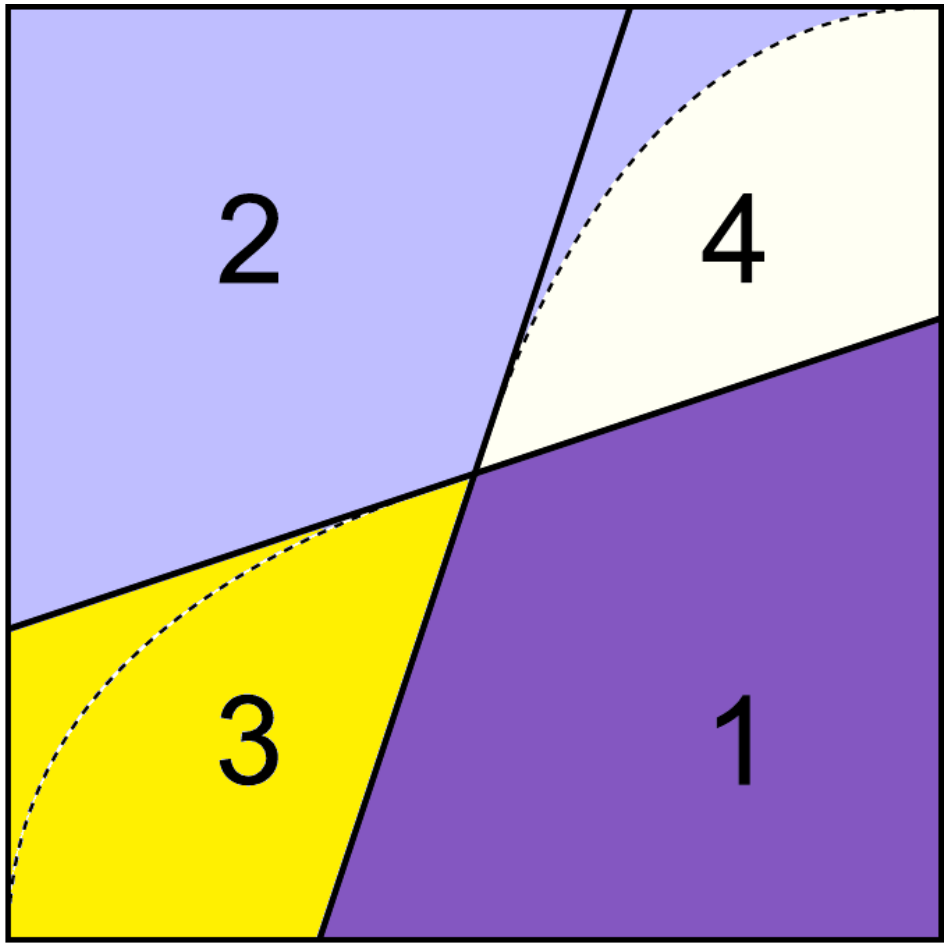
$a_2 \leq 3a_1$ $\qquad$ $3a_2 \leq a_1 + 2$

Parameter Space



$a_2 \leq 3a_1$ $\qquad$ $3a_2 \leq a_1 + 2$

Parameter Space



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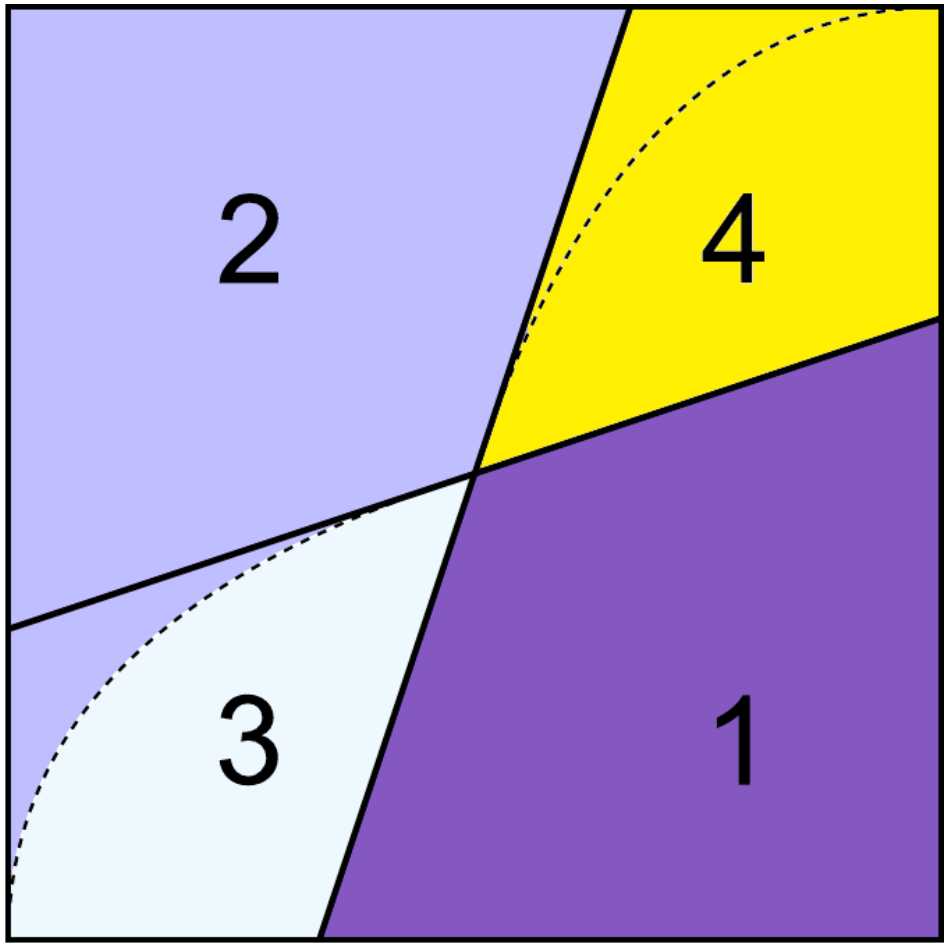
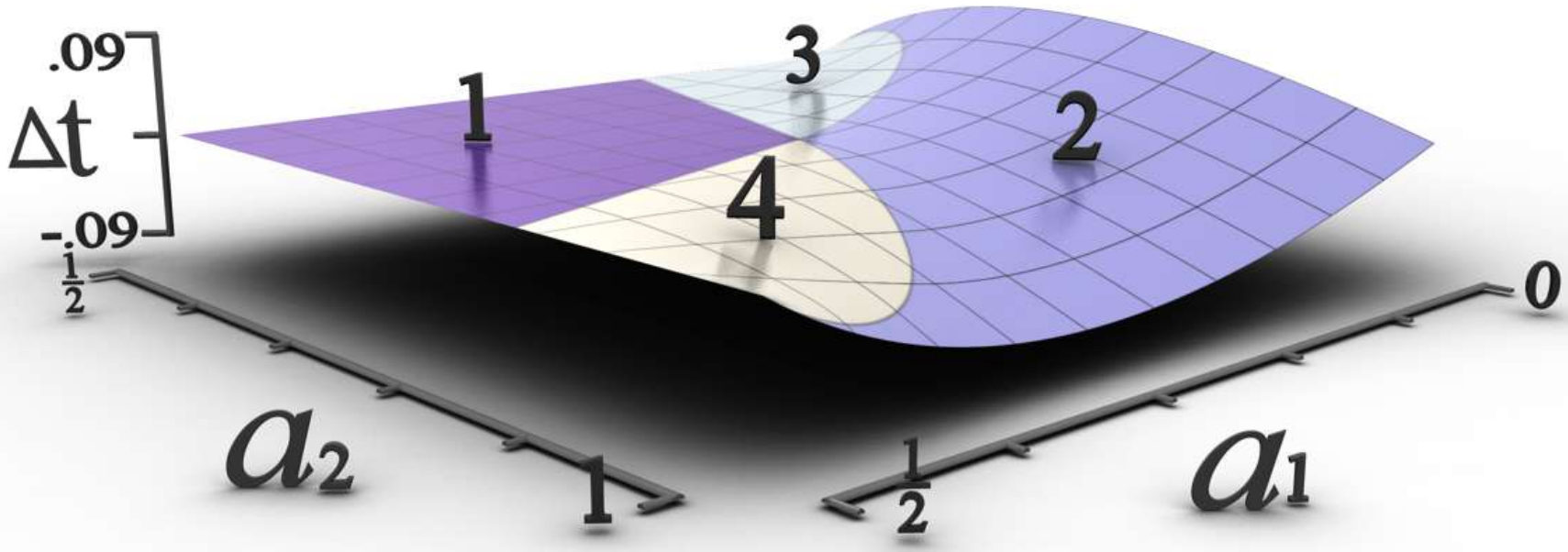
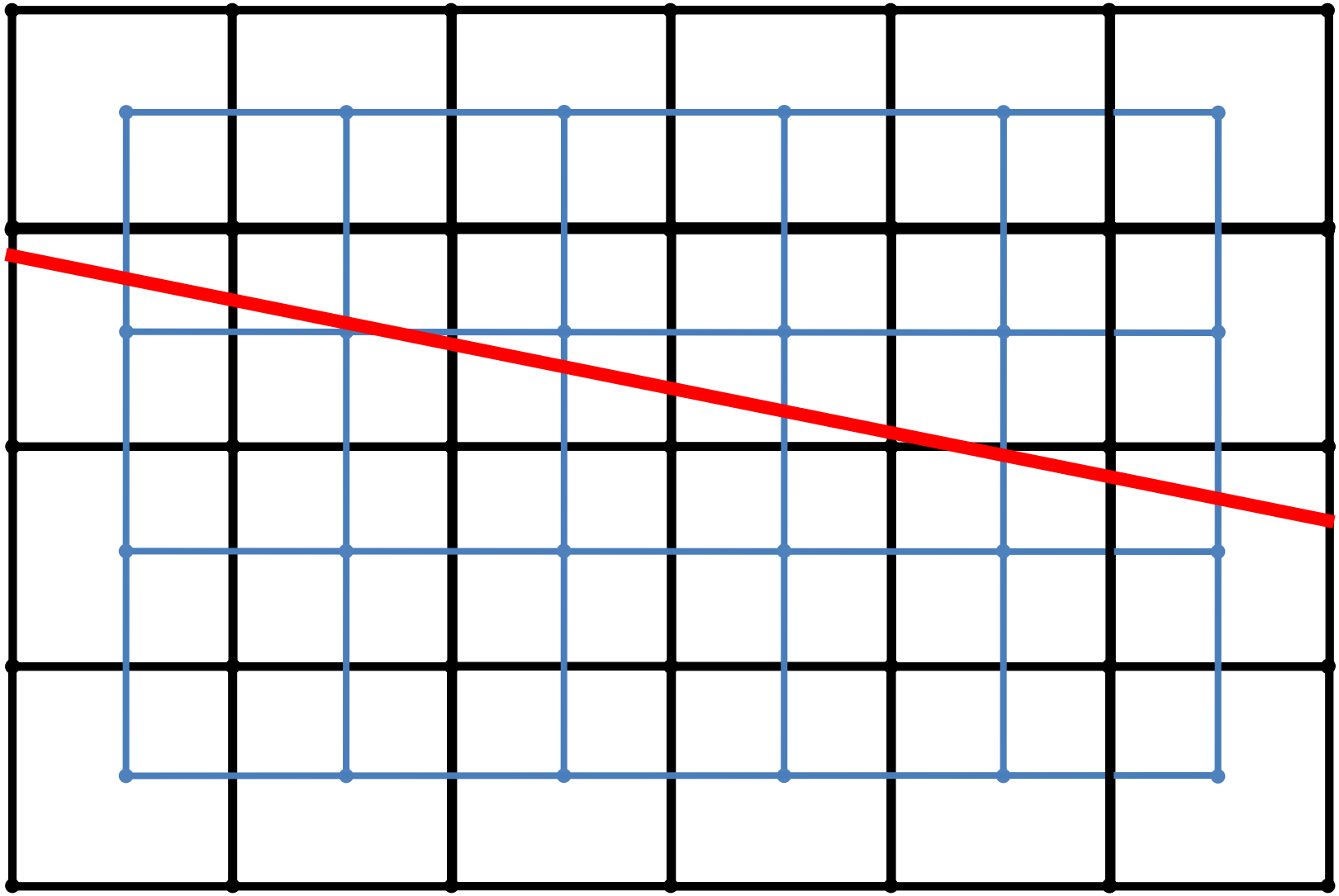


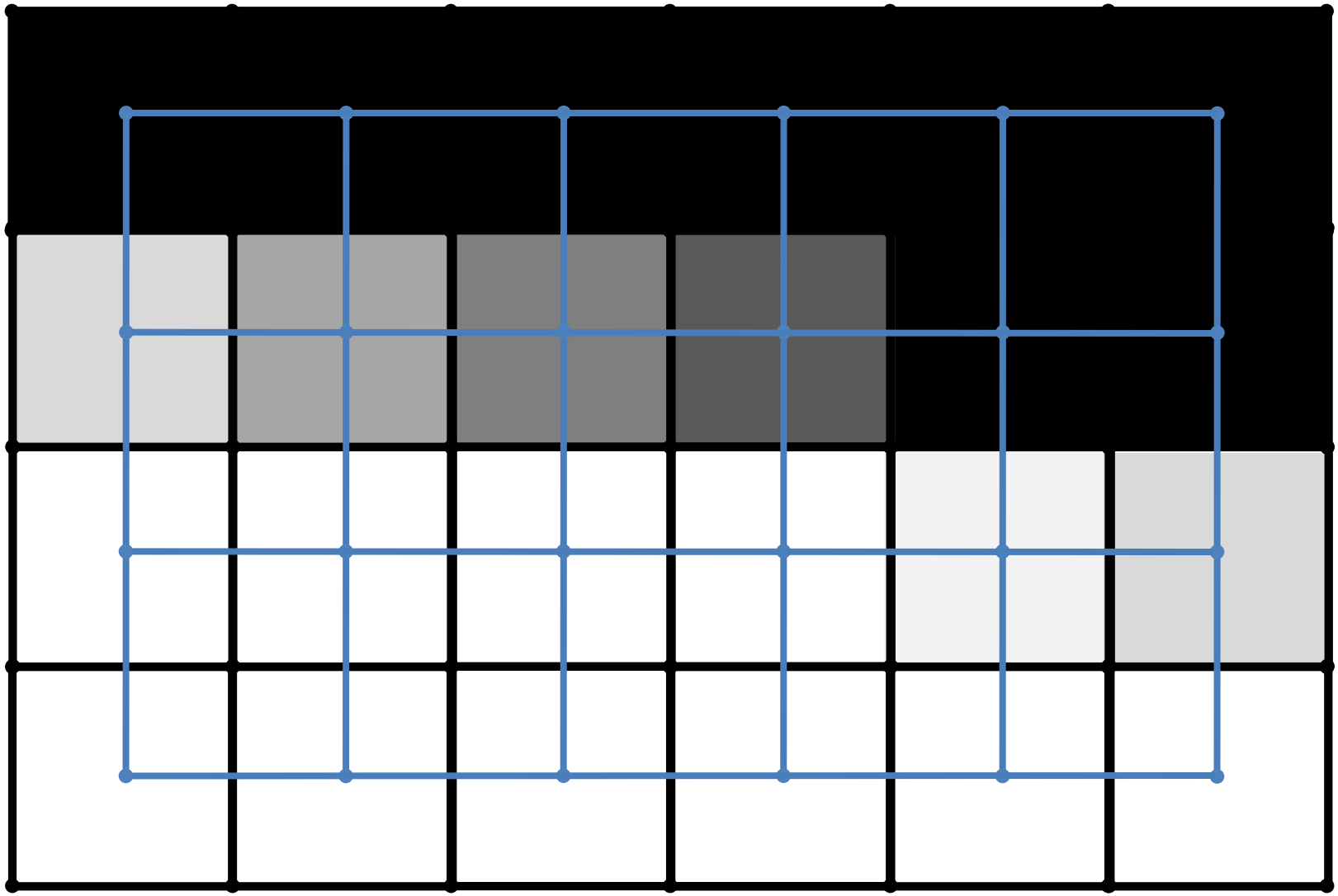
Difference from Linear Interp.



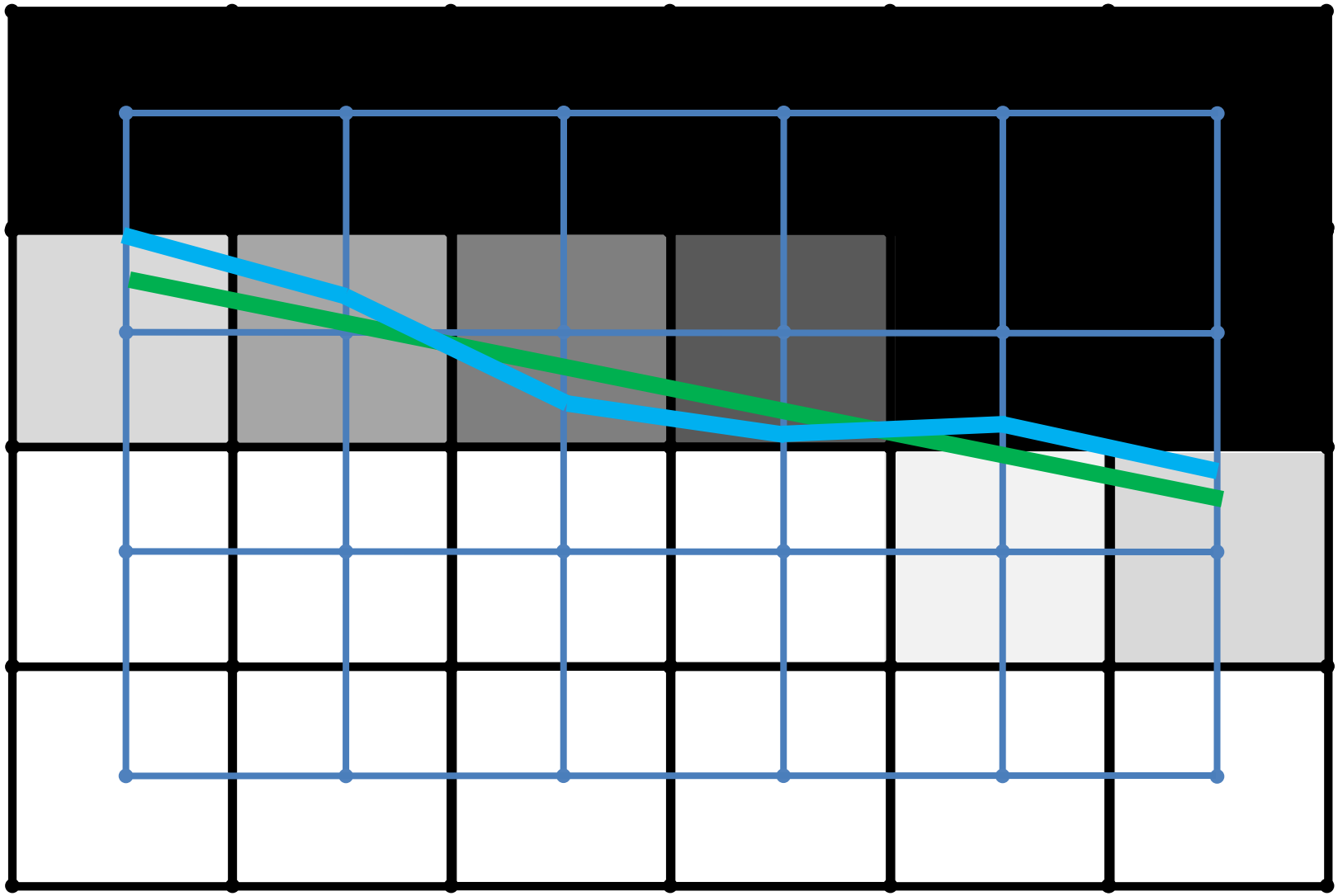
Linear functions



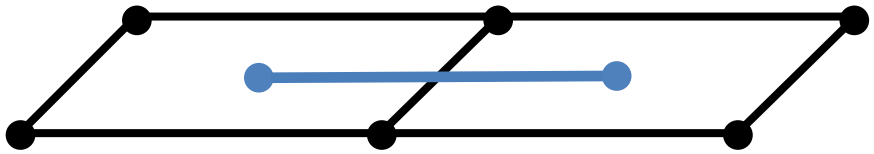
Linear functions



Linear functions



Expanding to 3D



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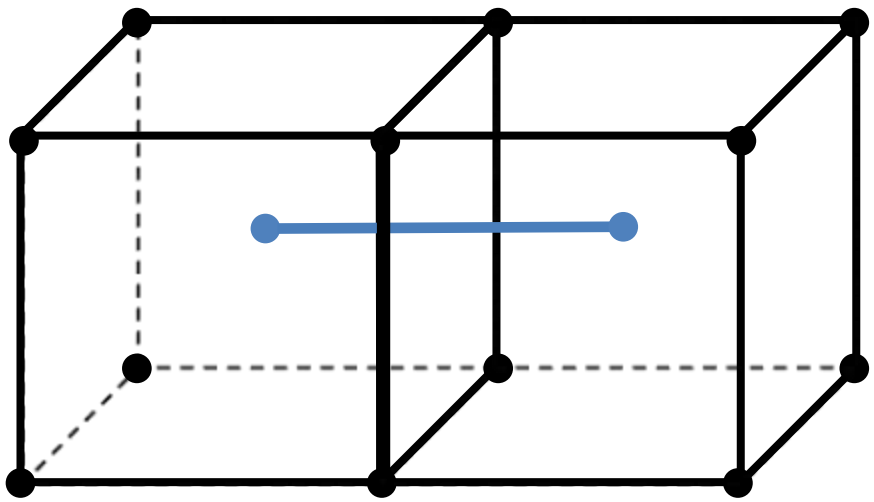

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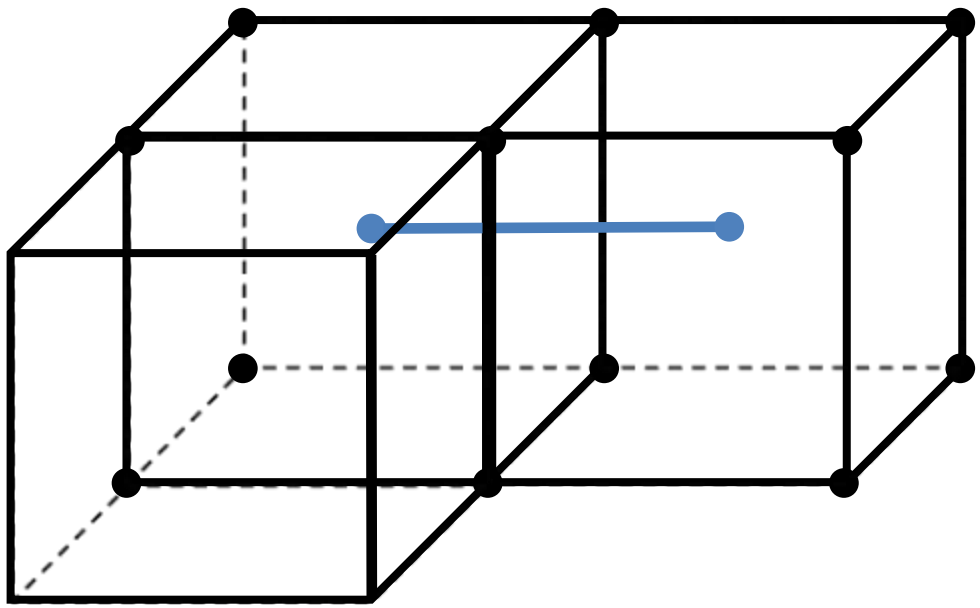
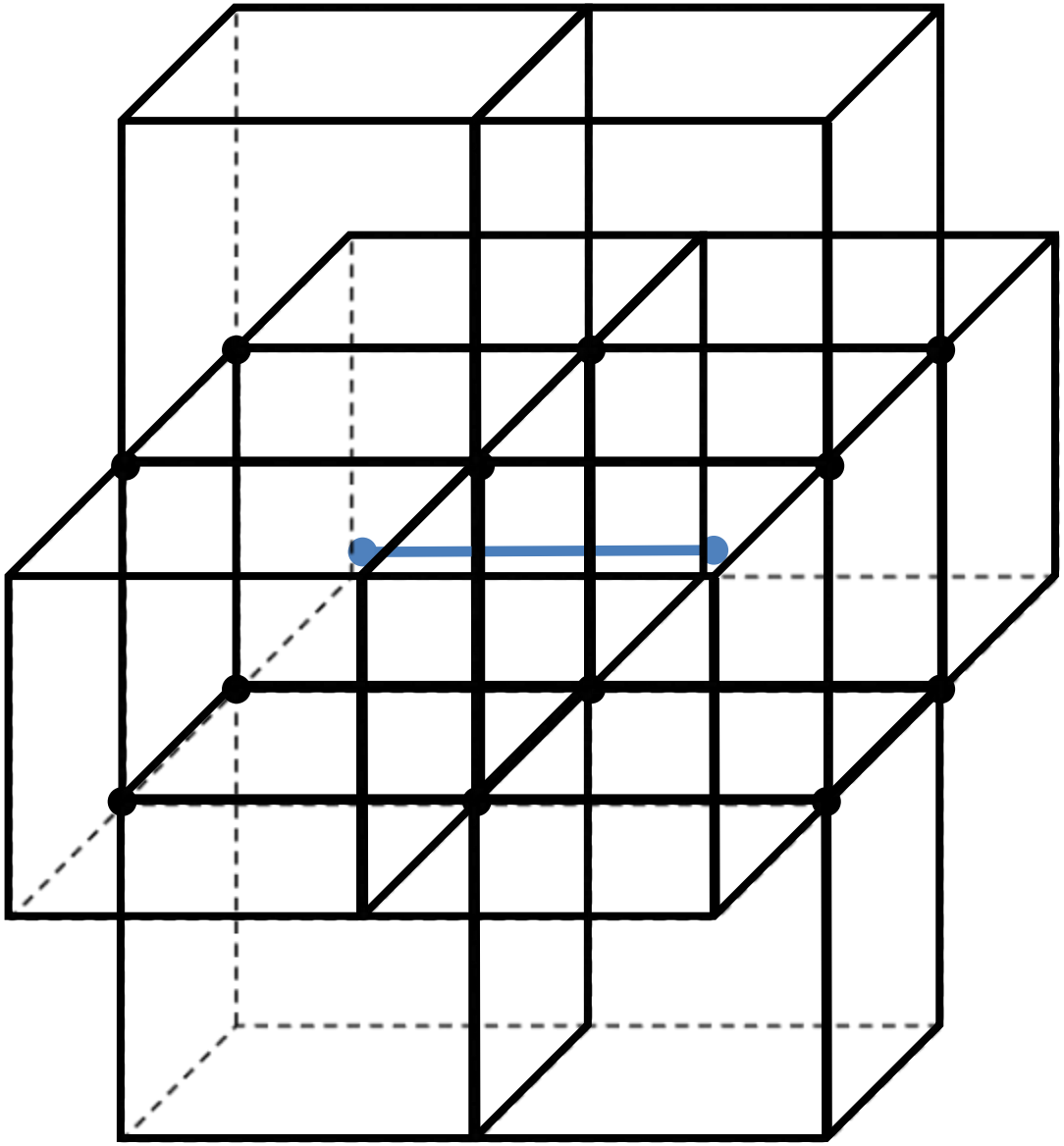
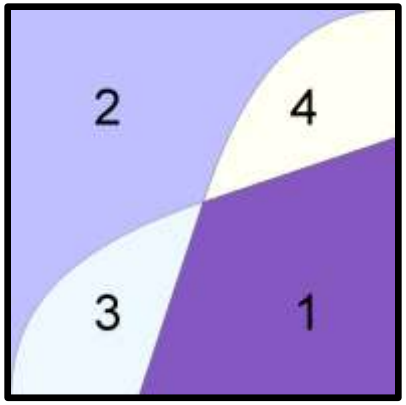
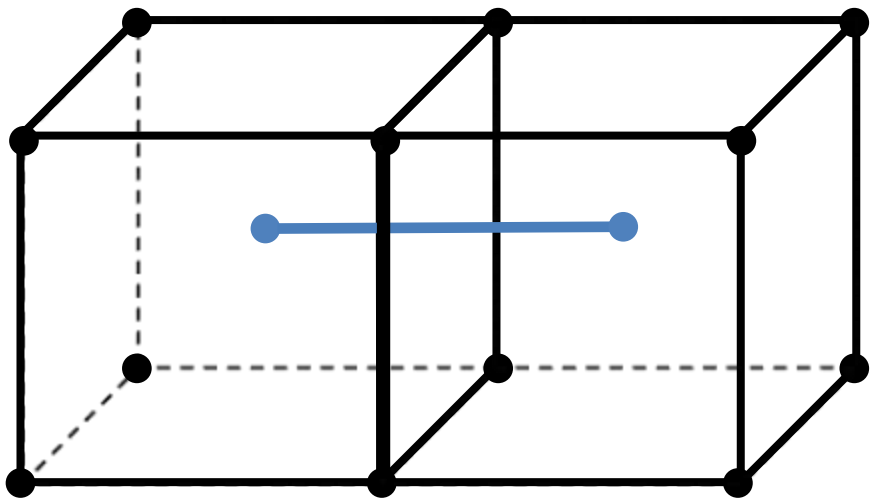


Expanding to 3D

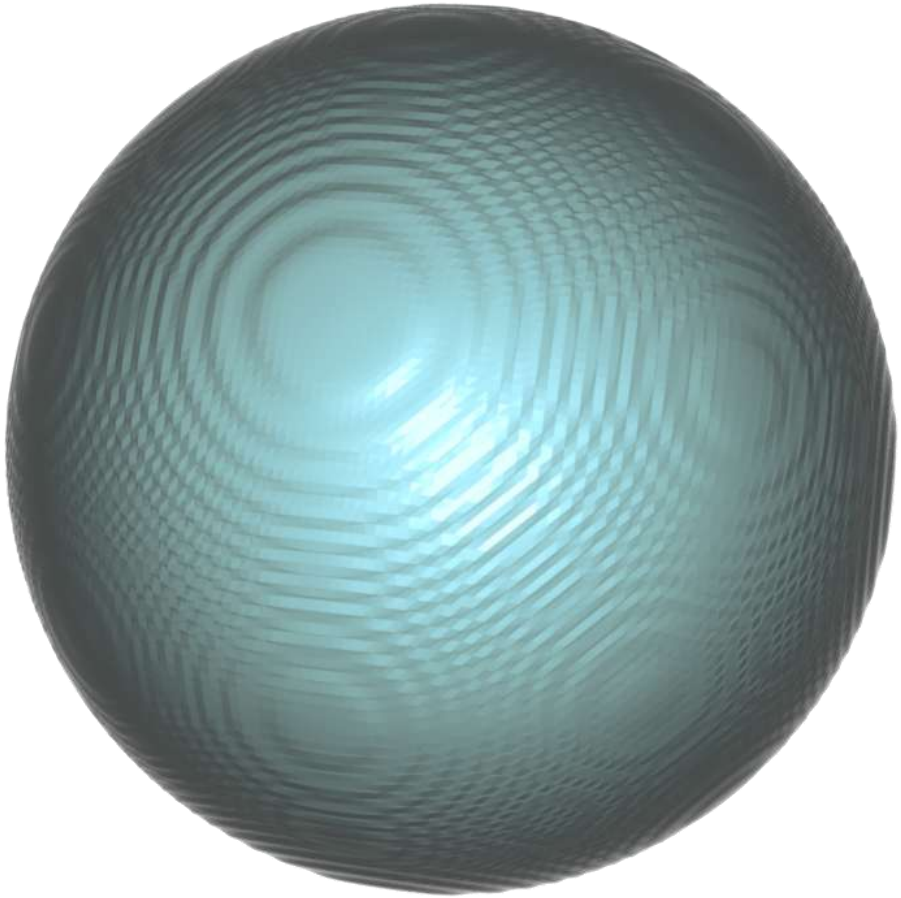


Expanding to 3D



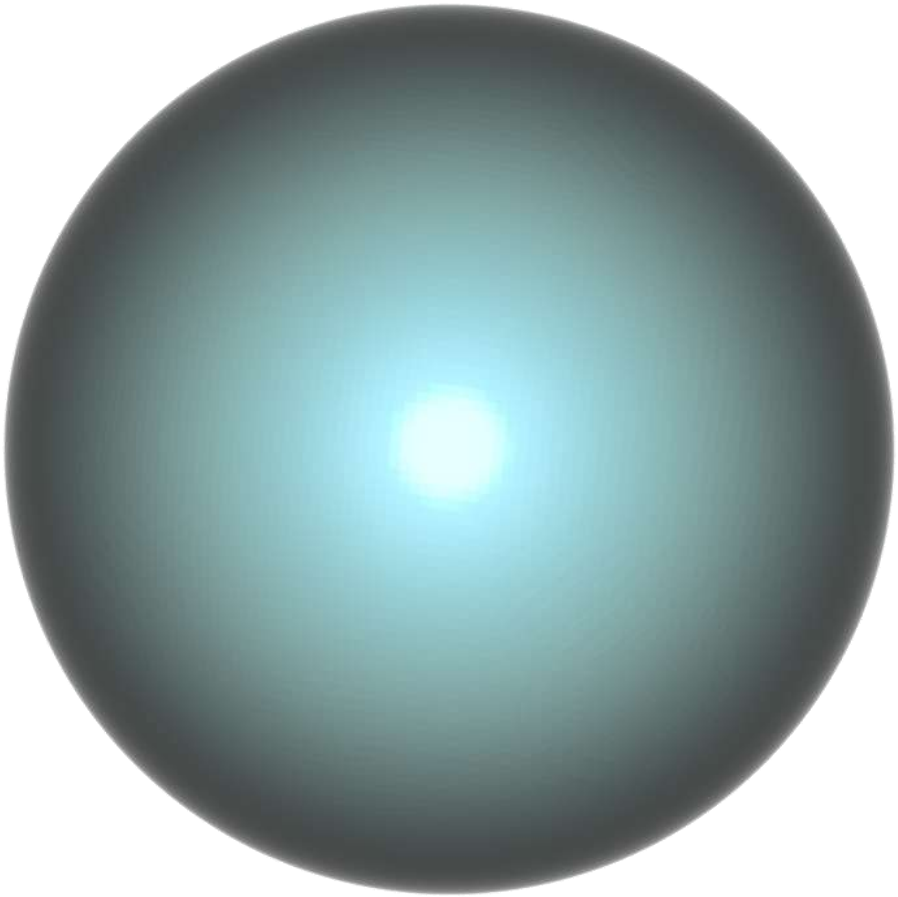


Expanding to 3D



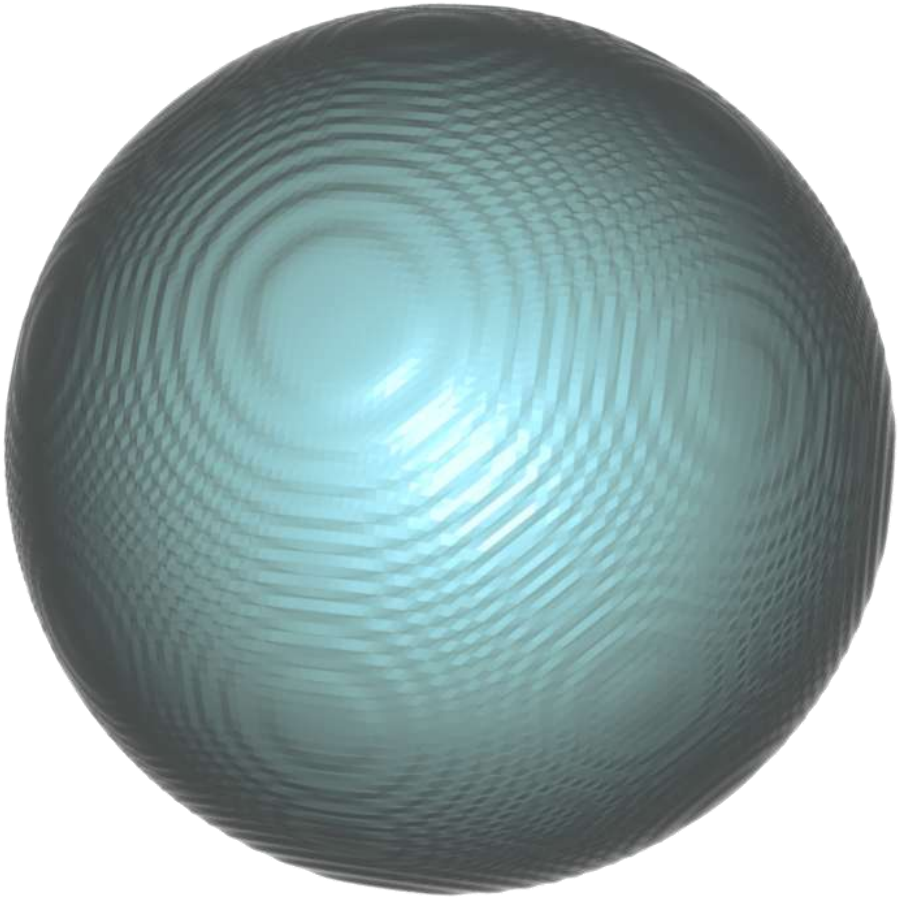
MC

Expanding to 3D

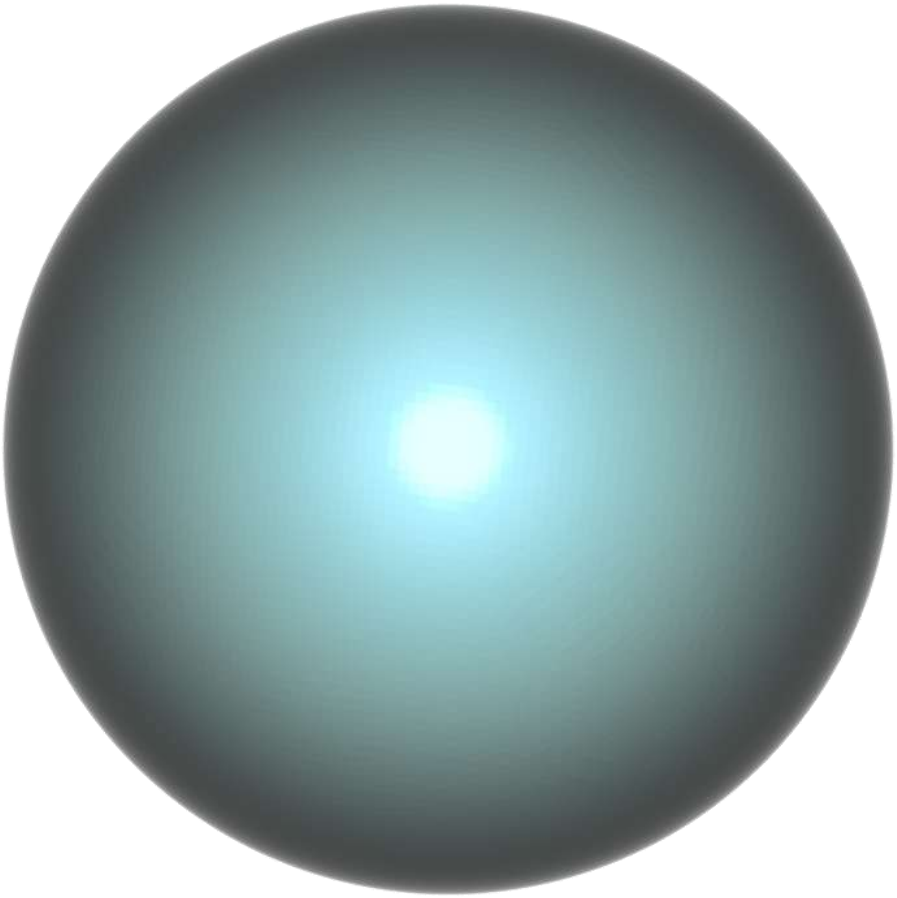


Ours

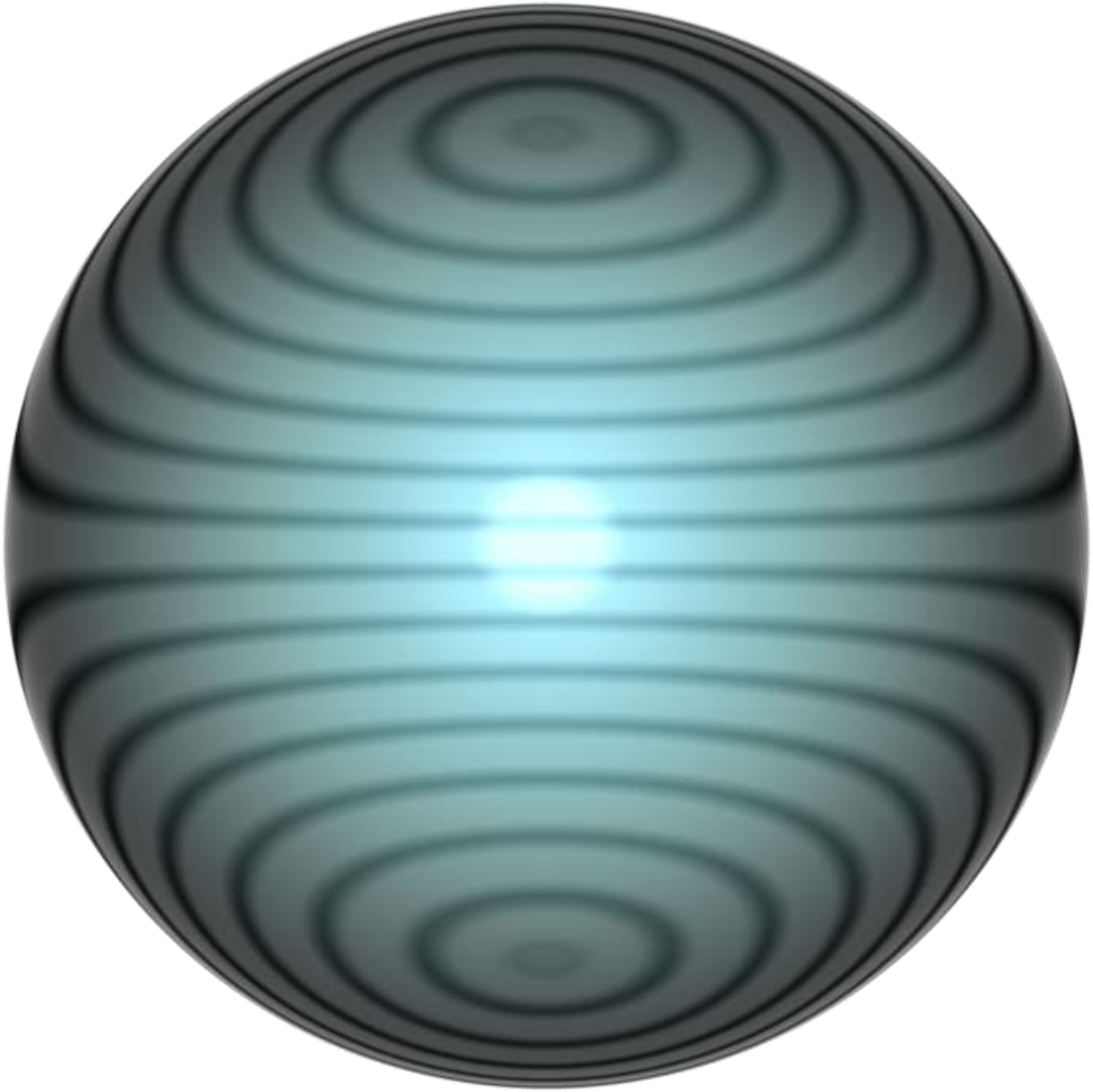
Expanding to 3D



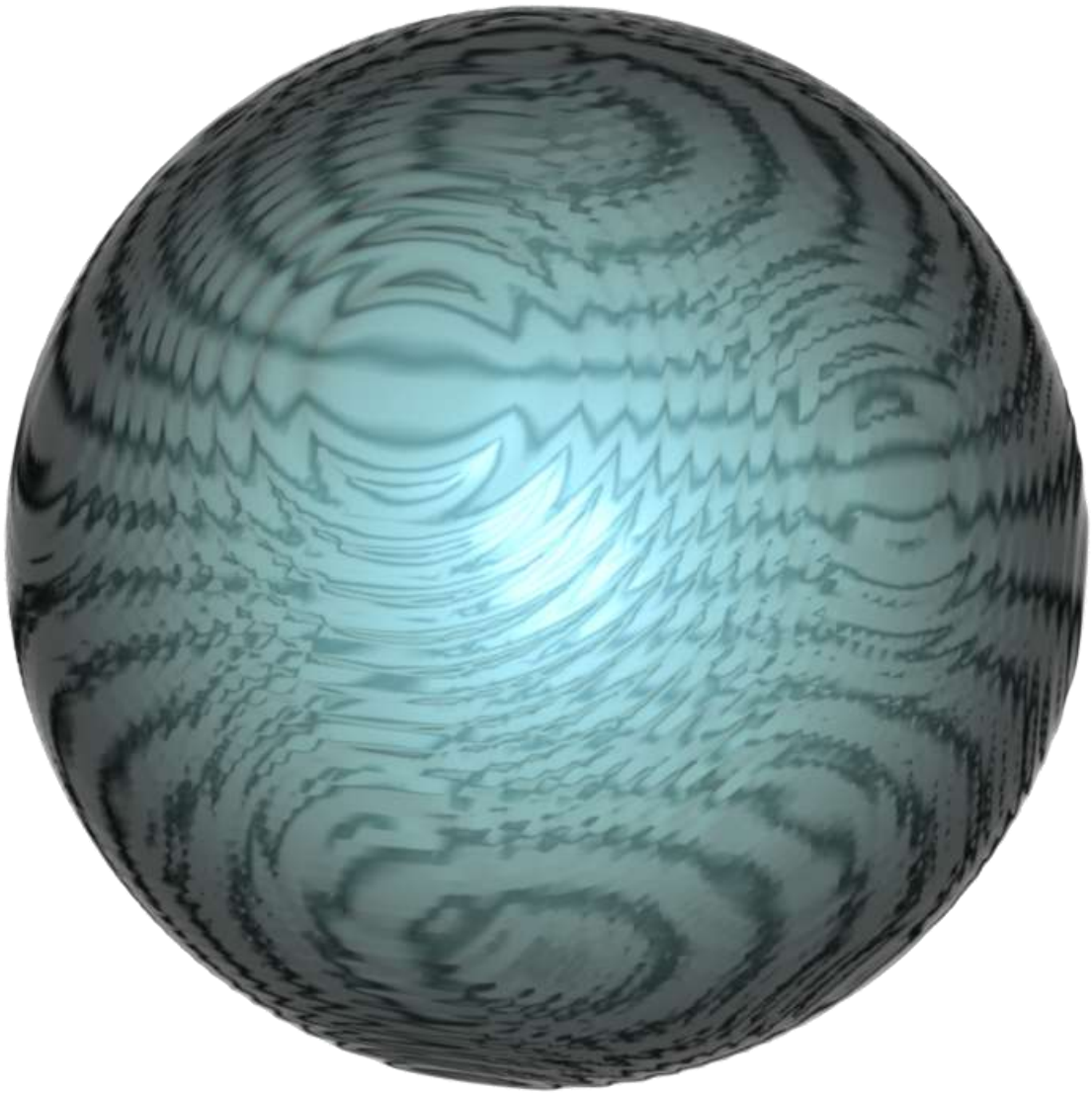
MC



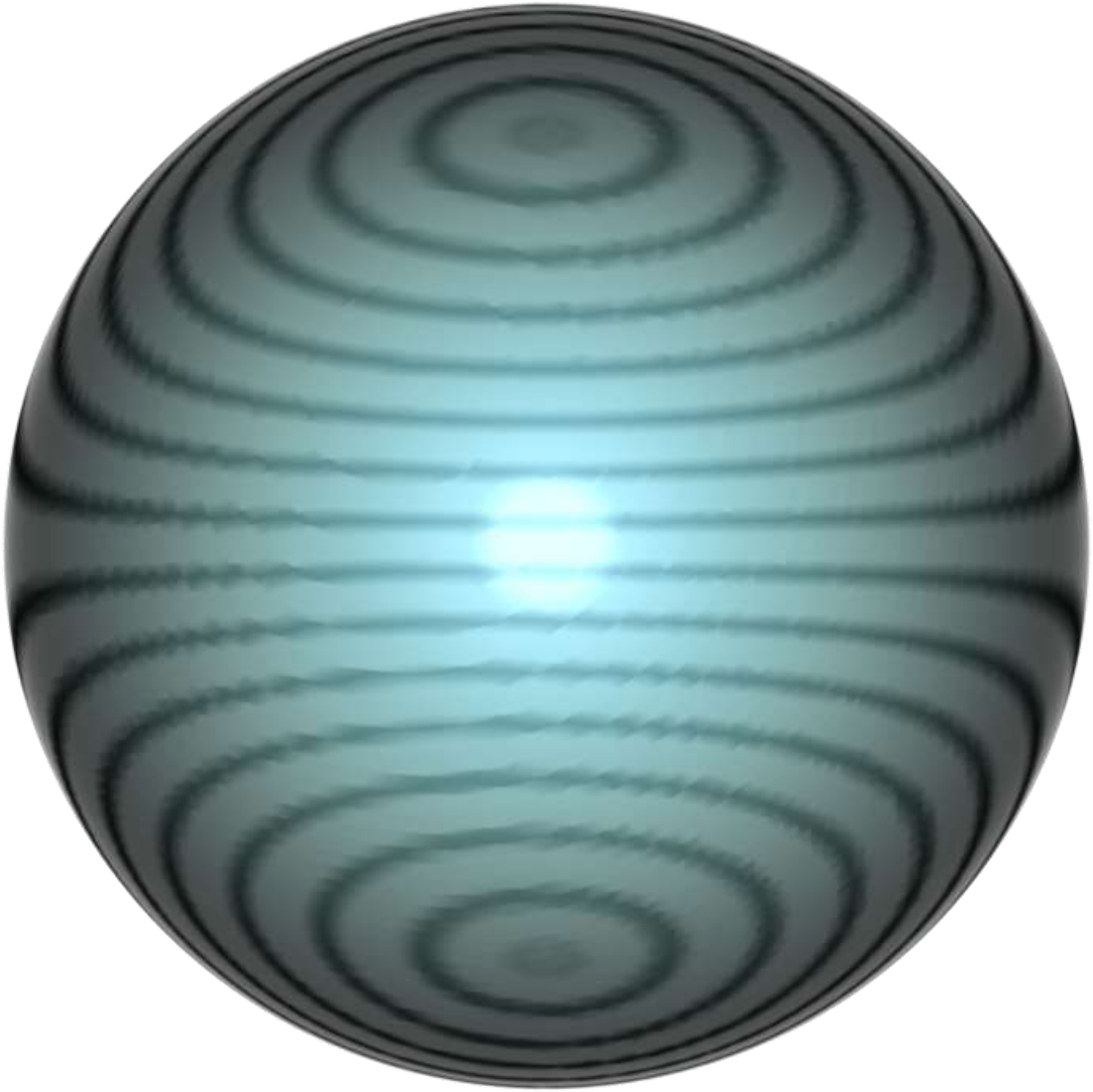
Ours



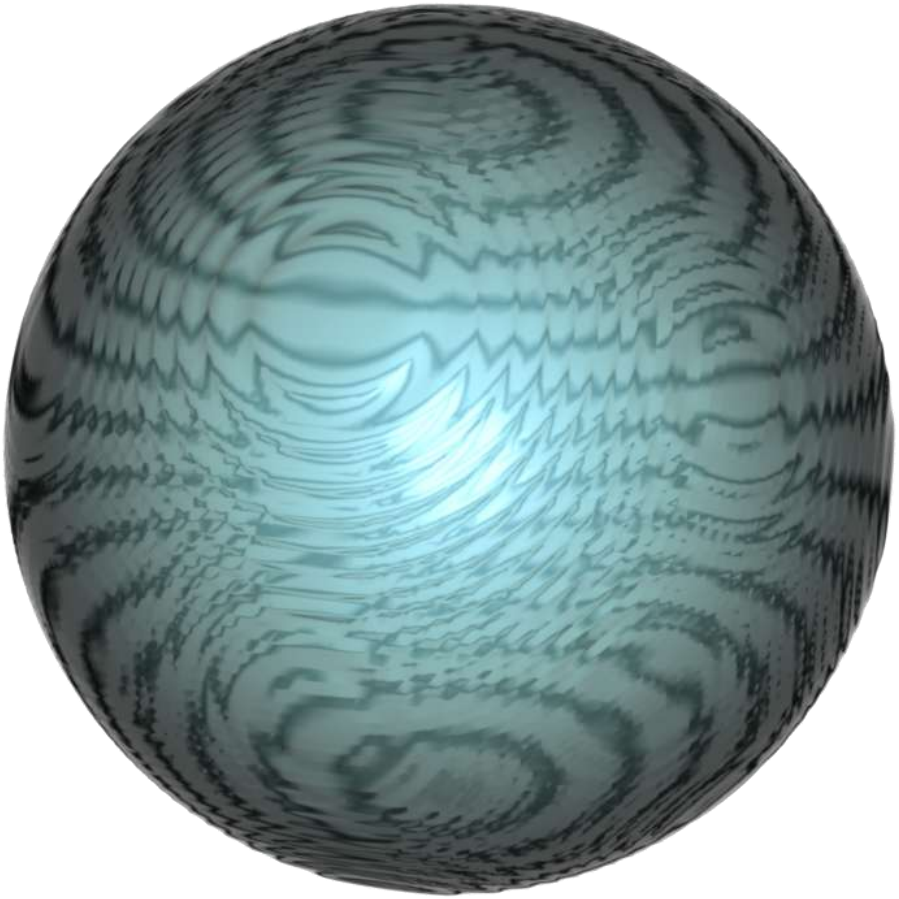
Perfect Sphere



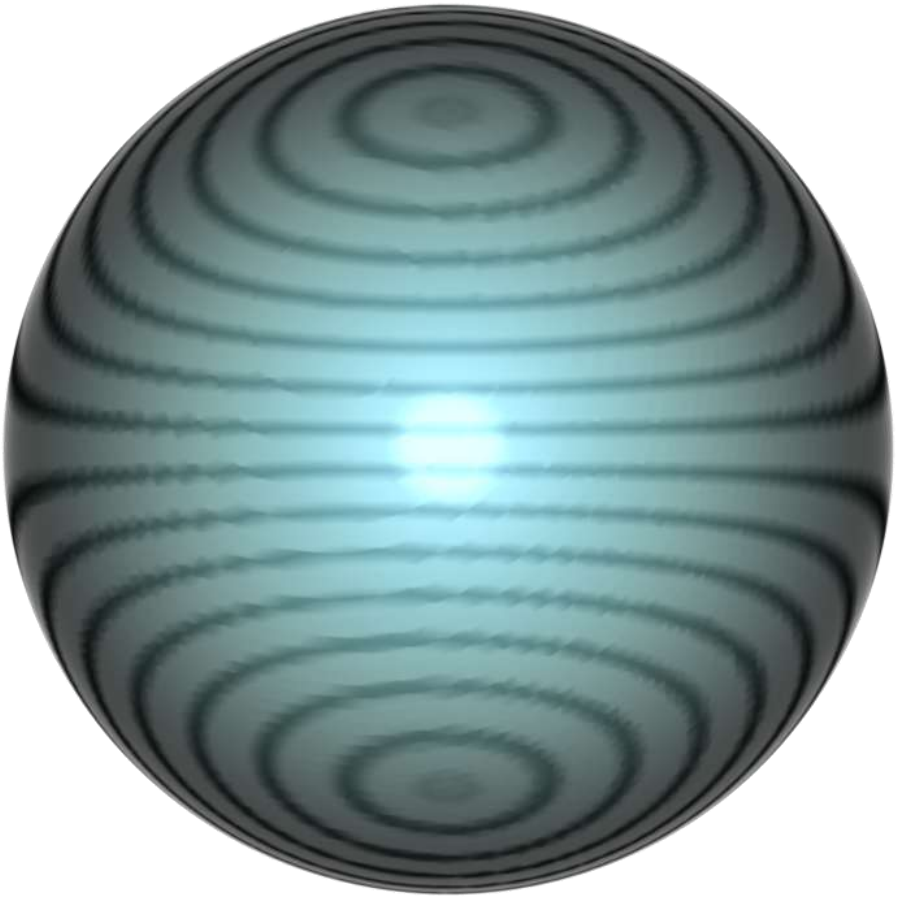
MC



Ours

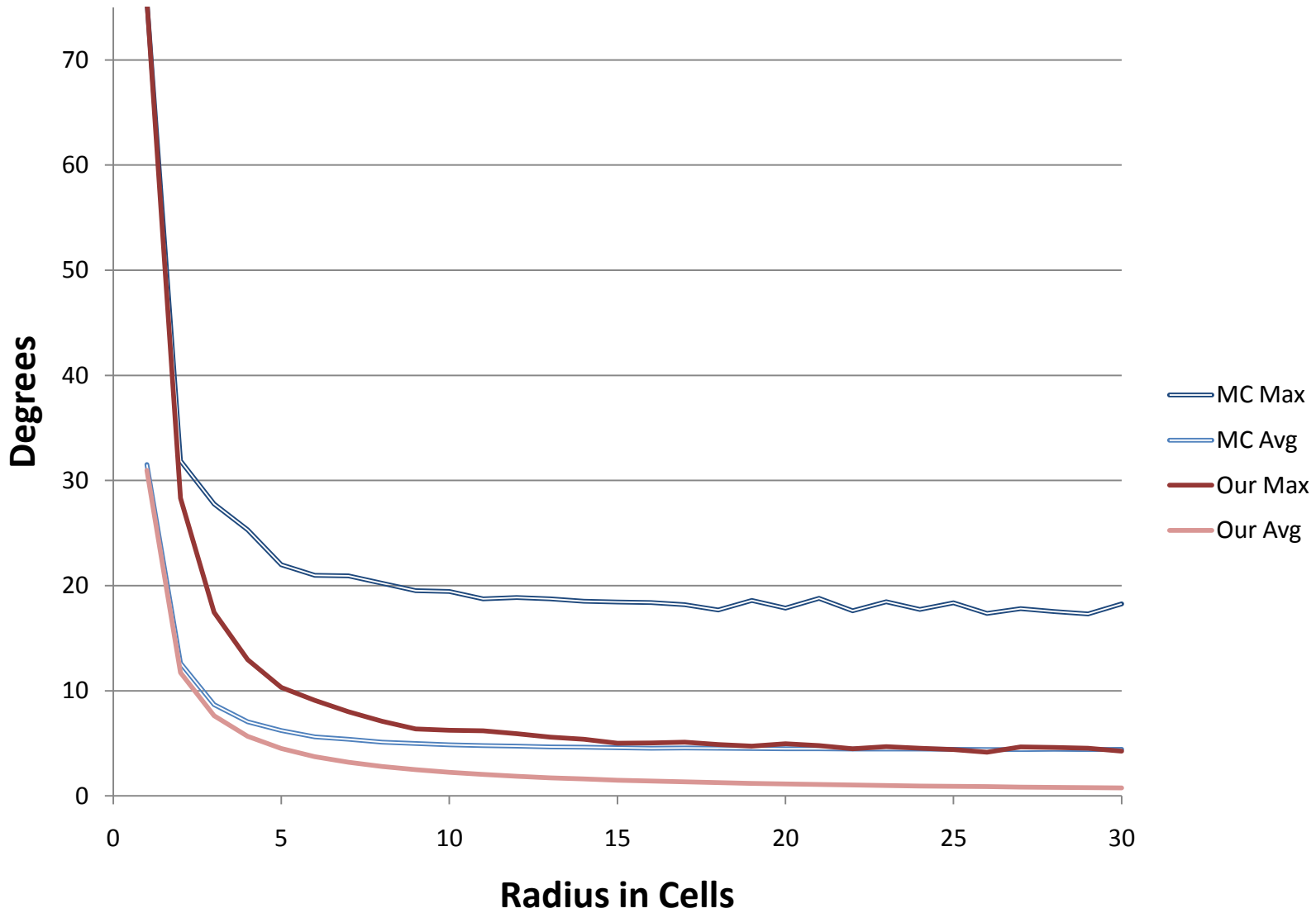


MC



Ours

Sphere Normal Error



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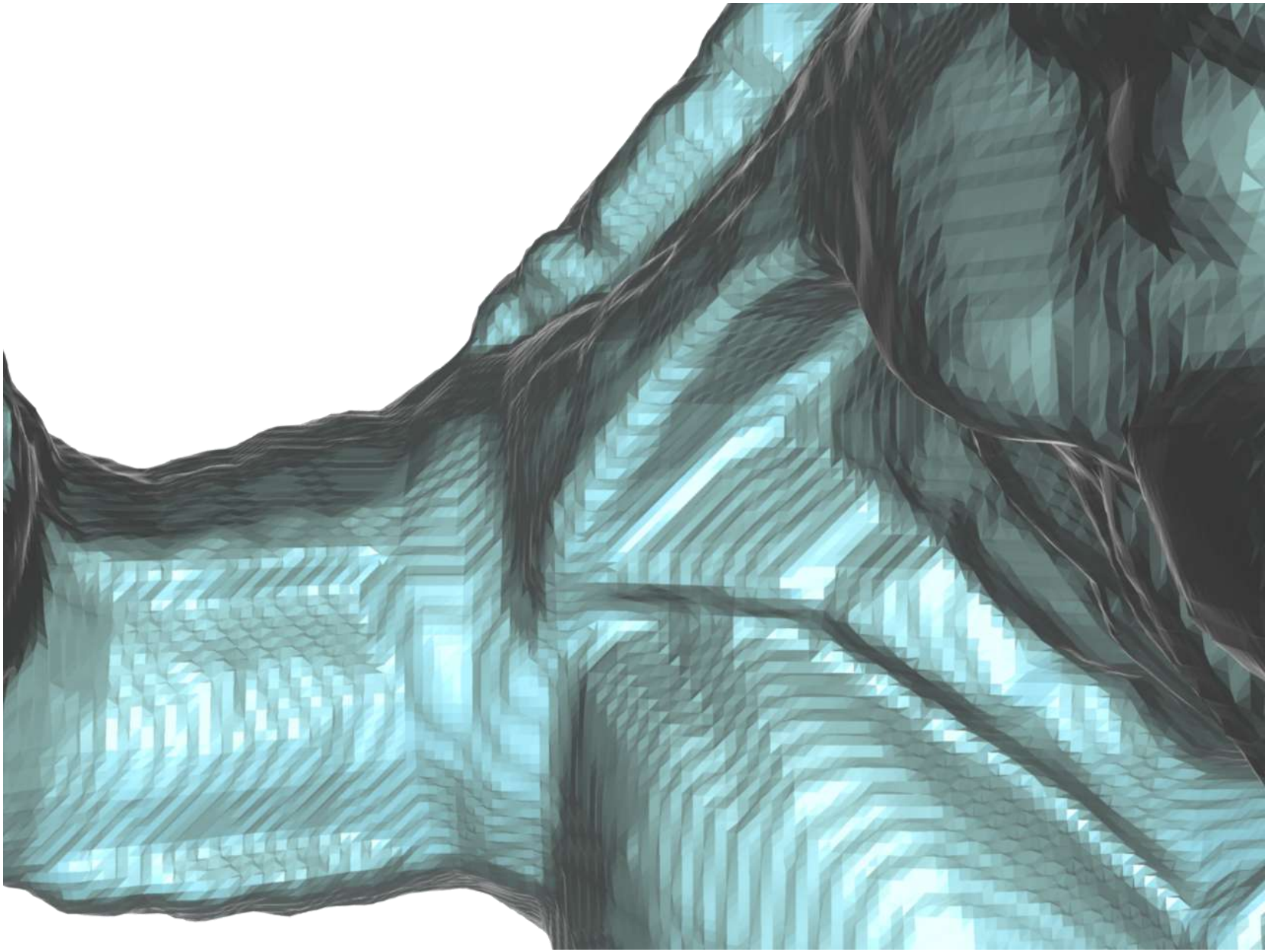
Ours



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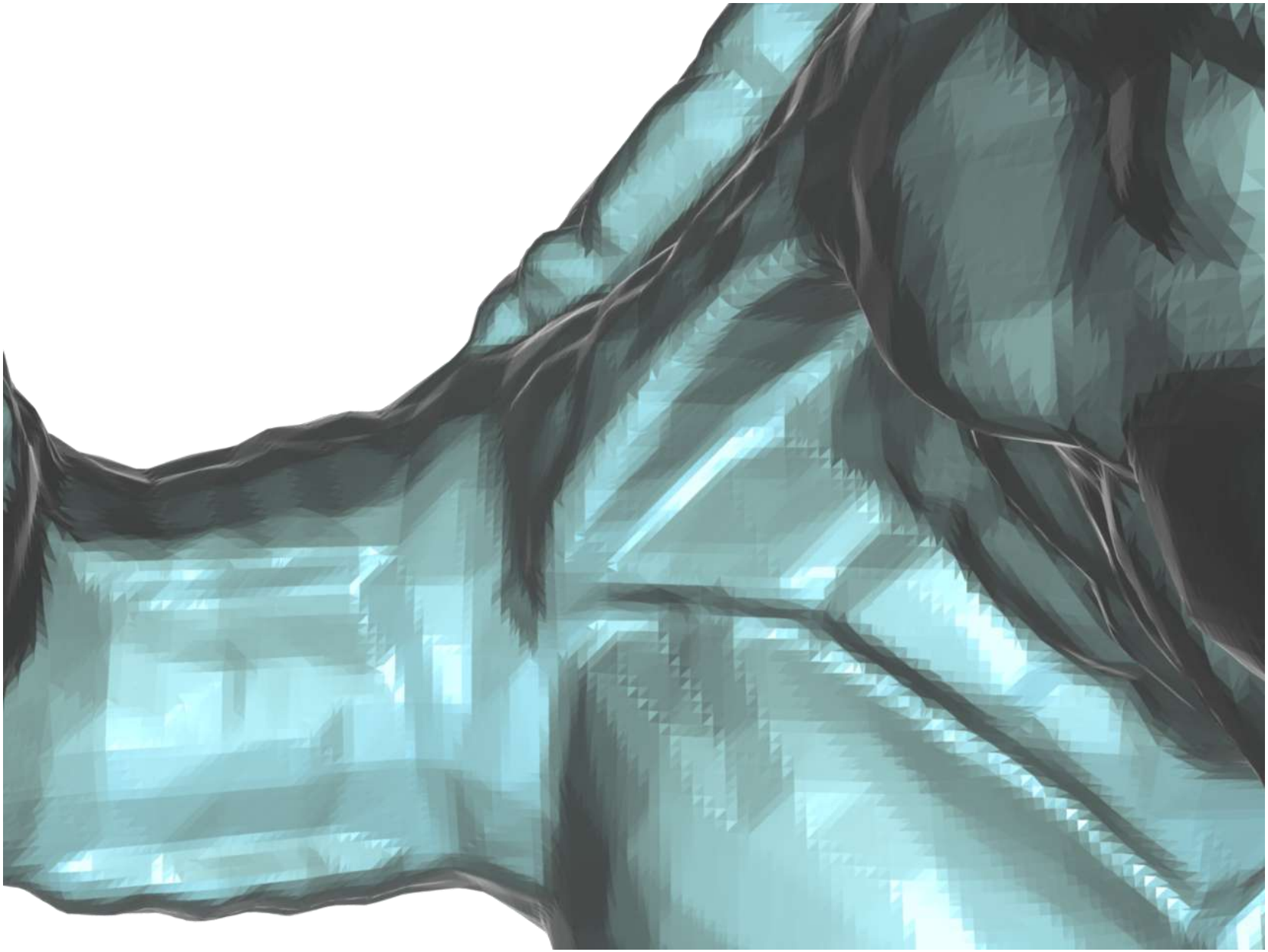

Ours

Limitations?

Conclusion

- Replaced Linear Interpolation of Marching Cubes.
- Oscillation artifacts removed from surface contours while preserving details.
- Inexpensive method not requiring any pre processing of function values, or post processing of output mesh.