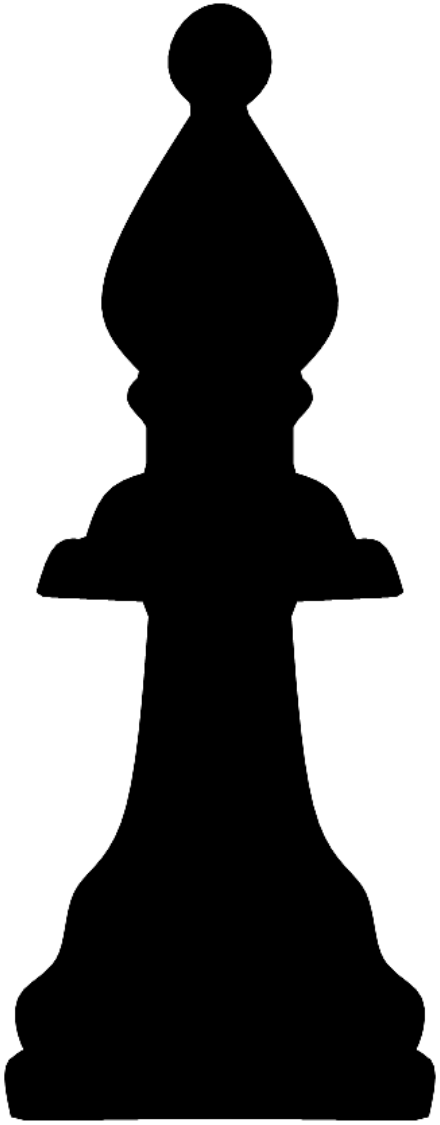
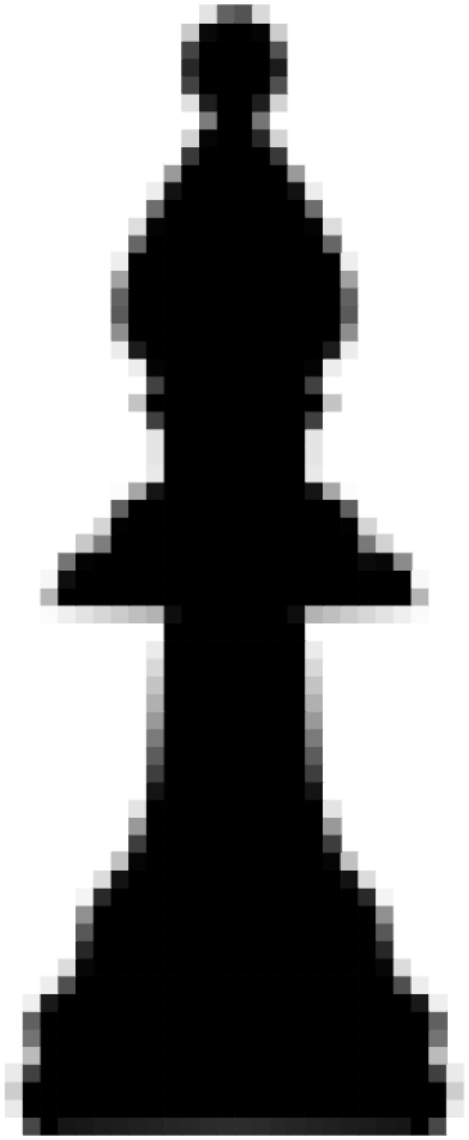
Contouring Discrete Indicator Functions

Jason Smith, Josiah Manson, and Scott Schaefer
Texas A&M University

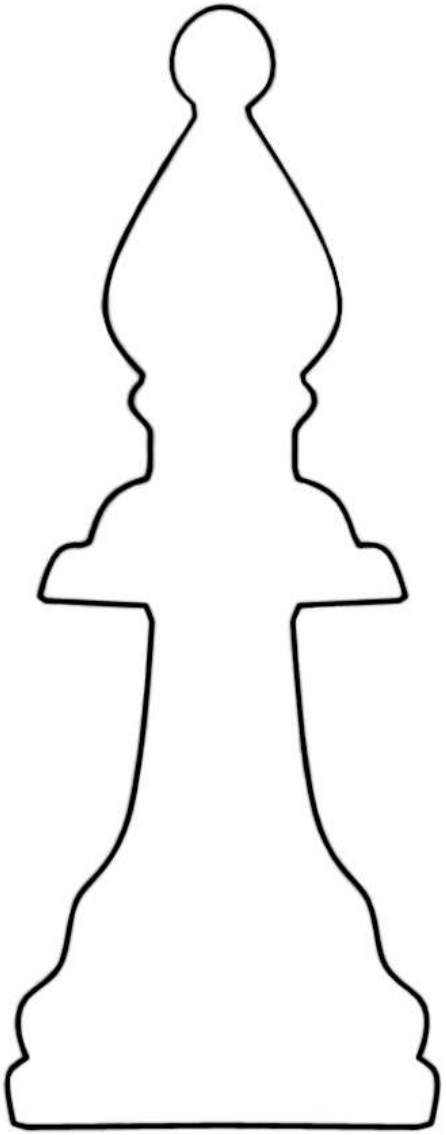
Indicator Functions



Discrete Indicator Functions (DIF)



Extracted Surface



Motivation

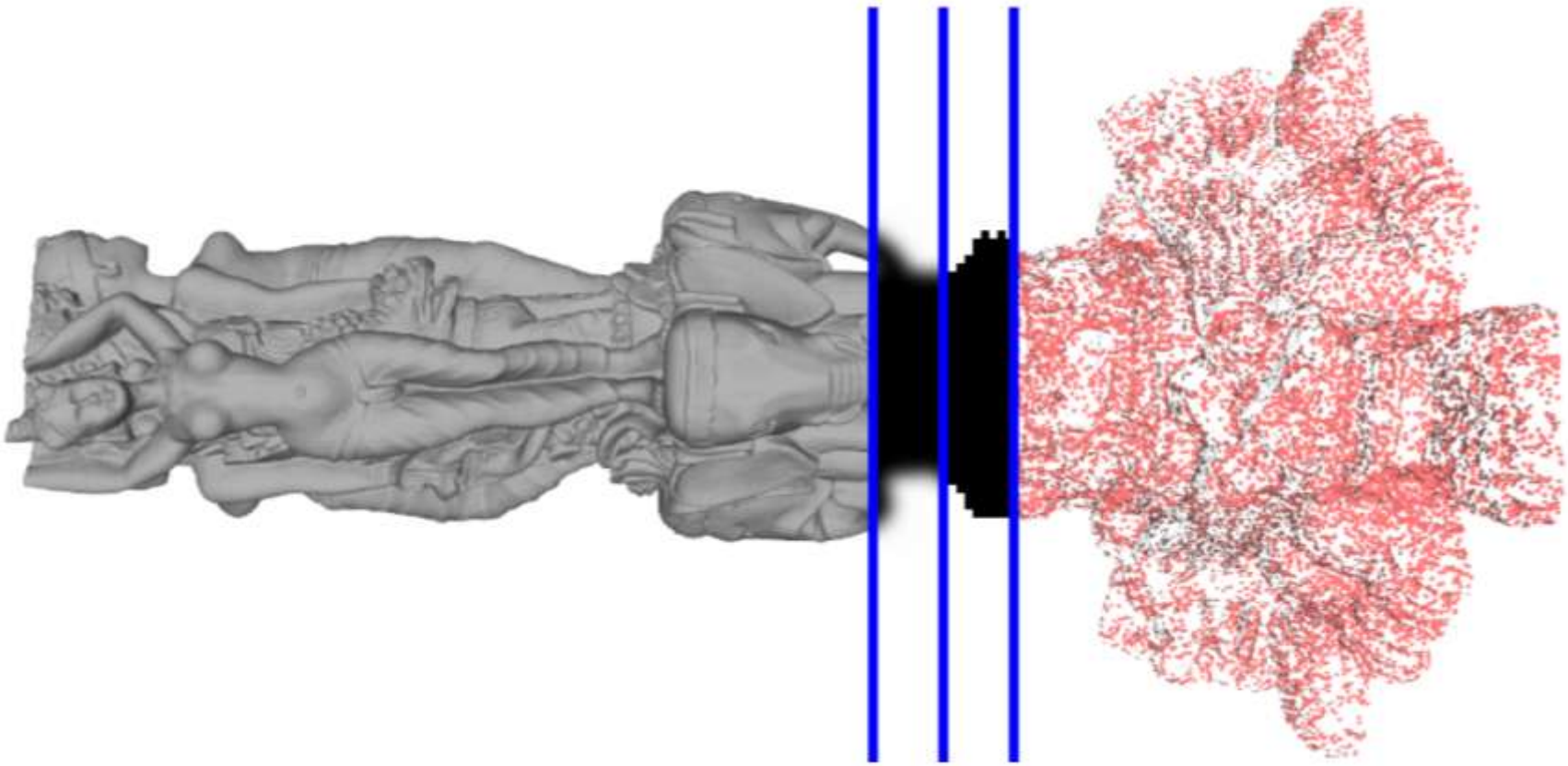
[Green 2007]

Motivation

[Warner Bros Pictures 2007]

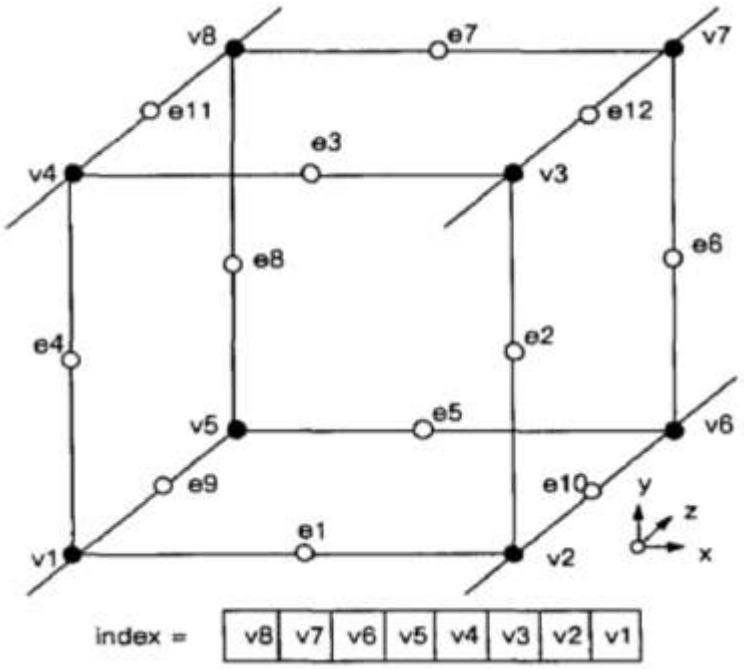
Motivation

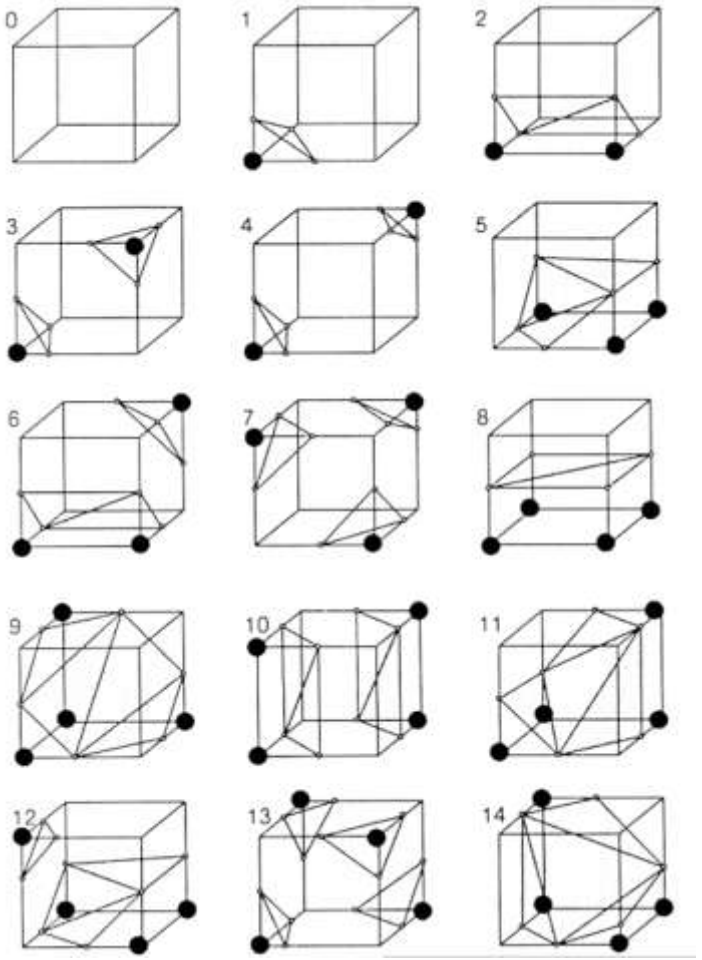
Motivation



[Manson et al. 2008]

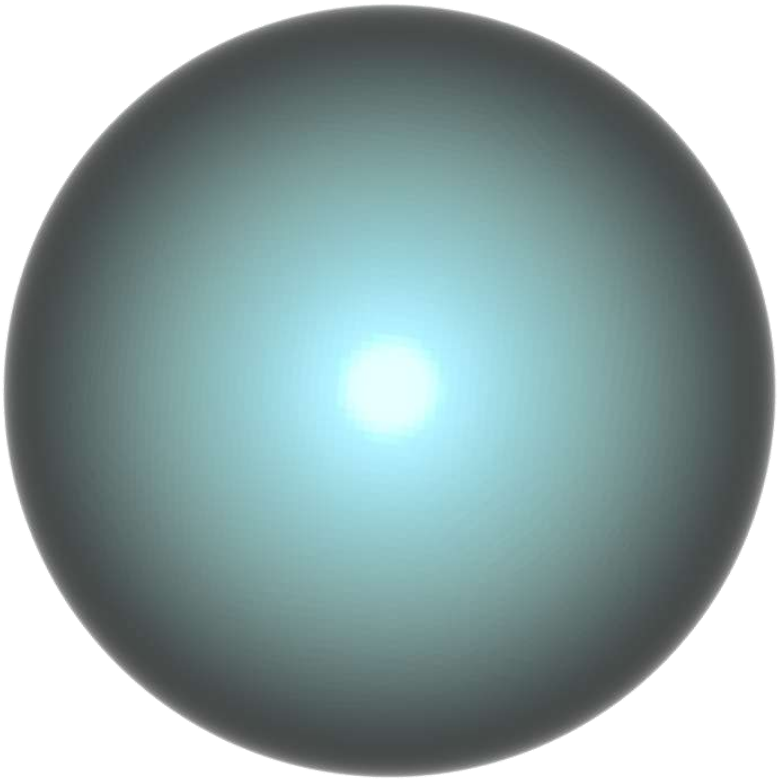
Marching Cubes



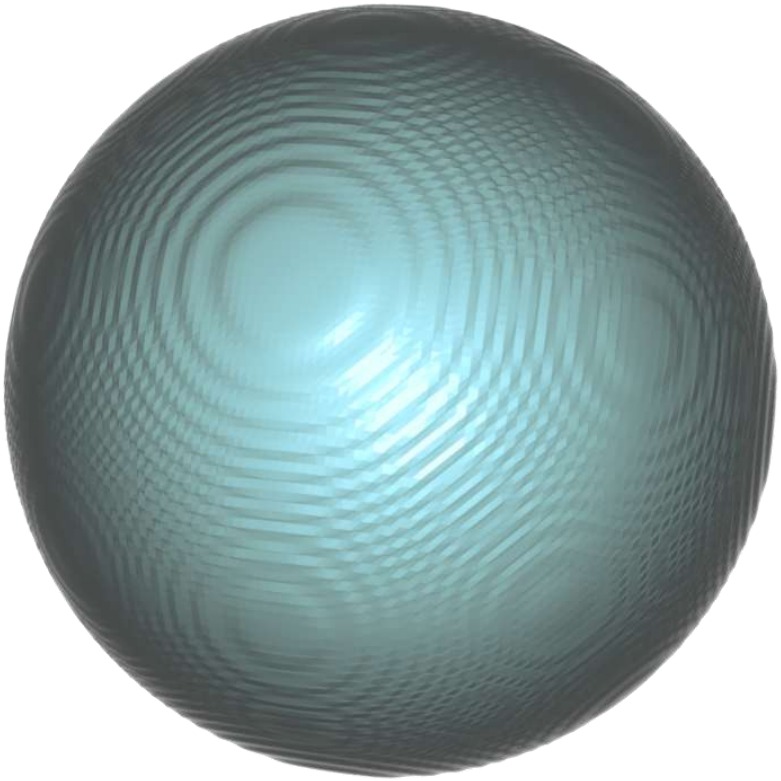


[Wyvill et al. 1986]
[Lorensen and Cline 1987]

Marching Cubes

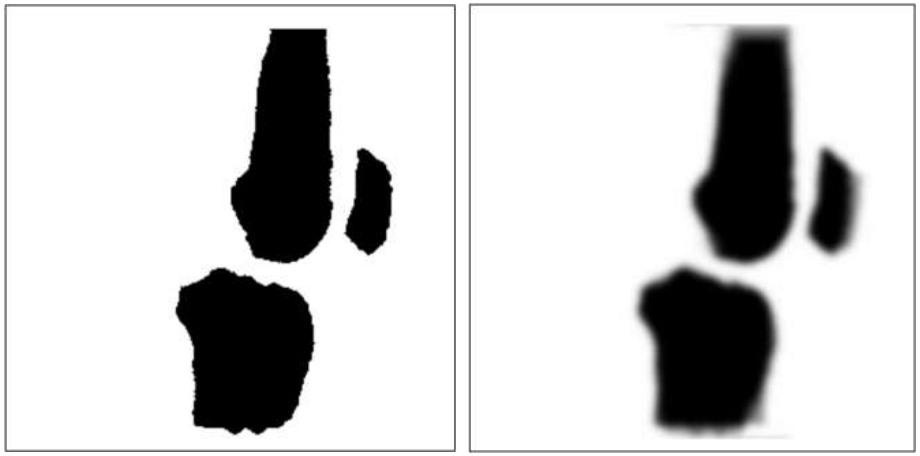


Perfect Sphere

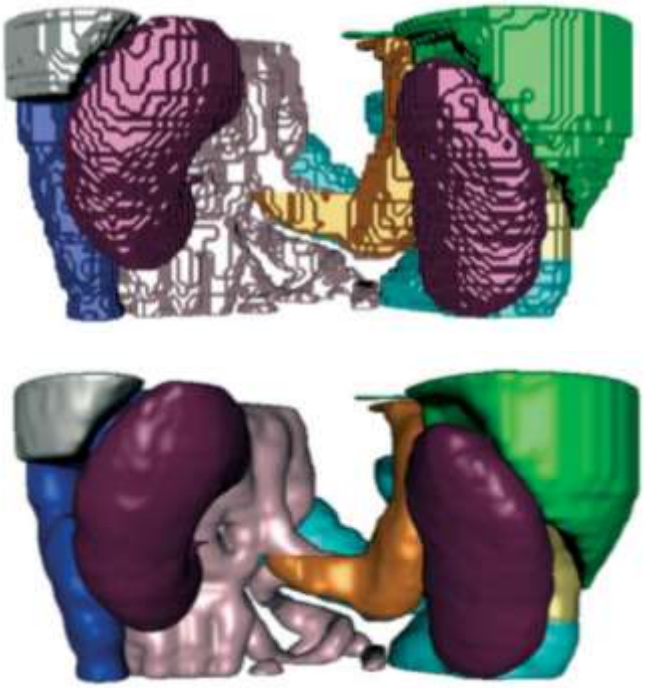


MC

Related Work



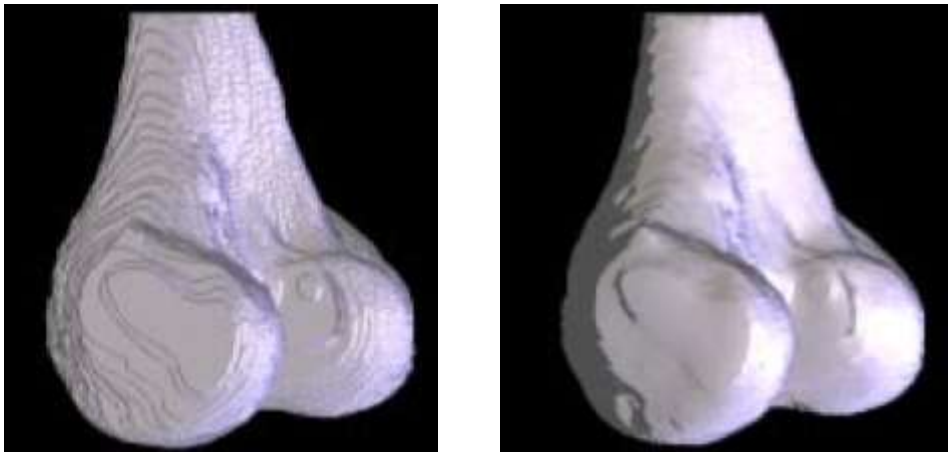
[Mor et al. 1996]



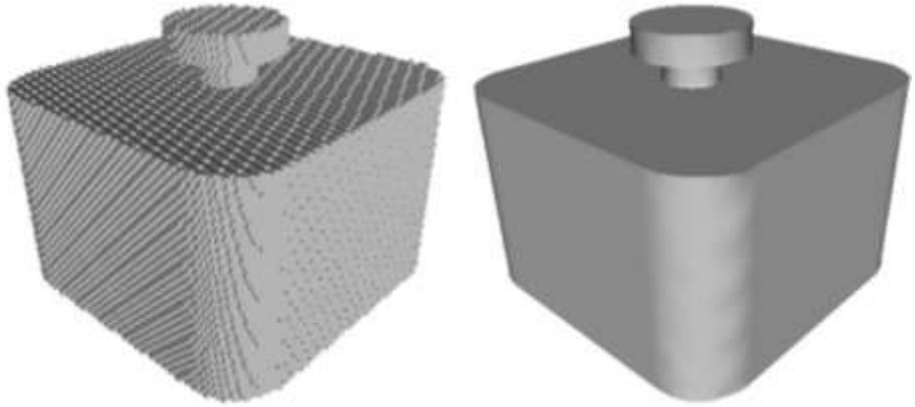
[Wu and Sullivan 2003]

[Reitinger et al. 2005]

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

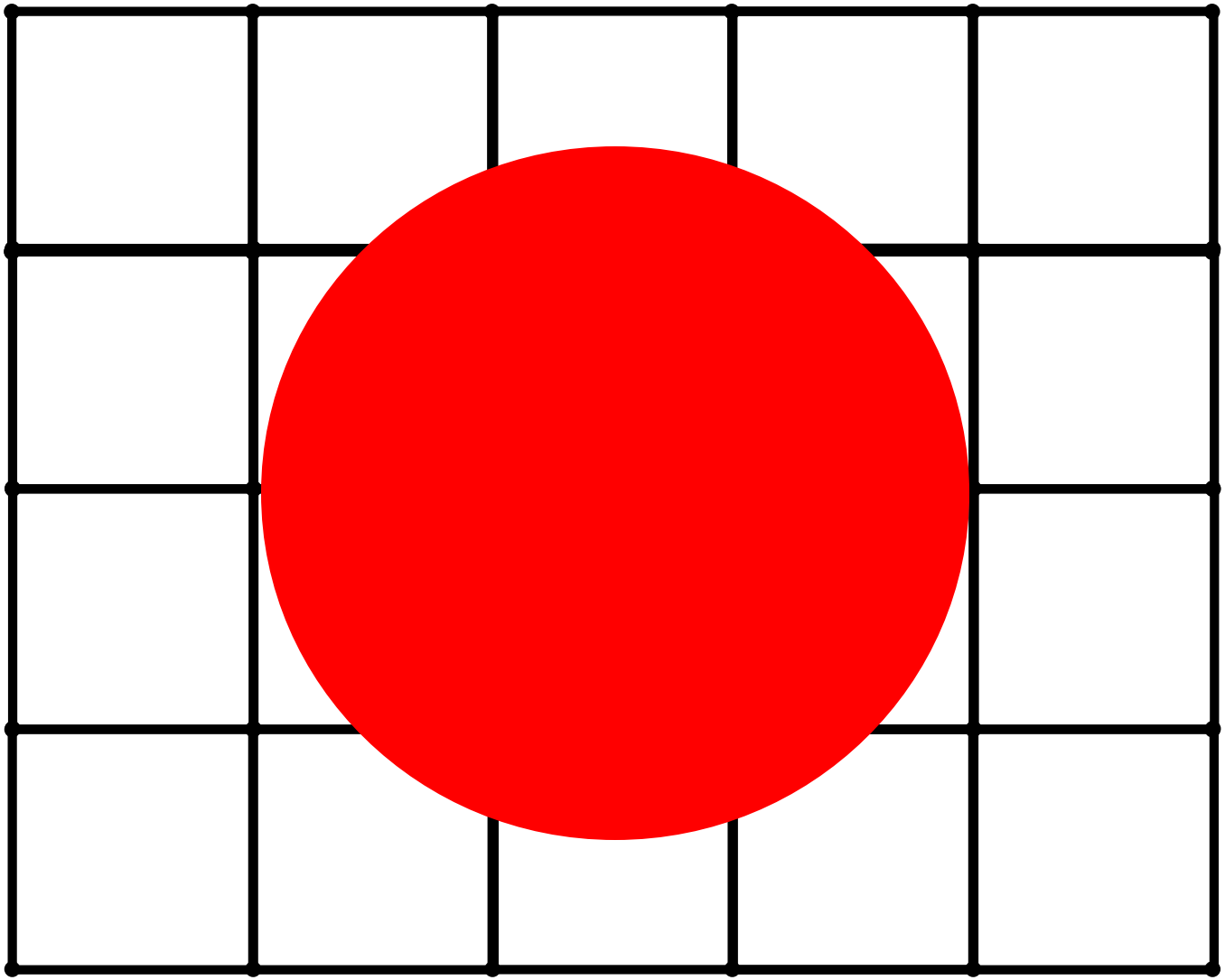
MC

Ours

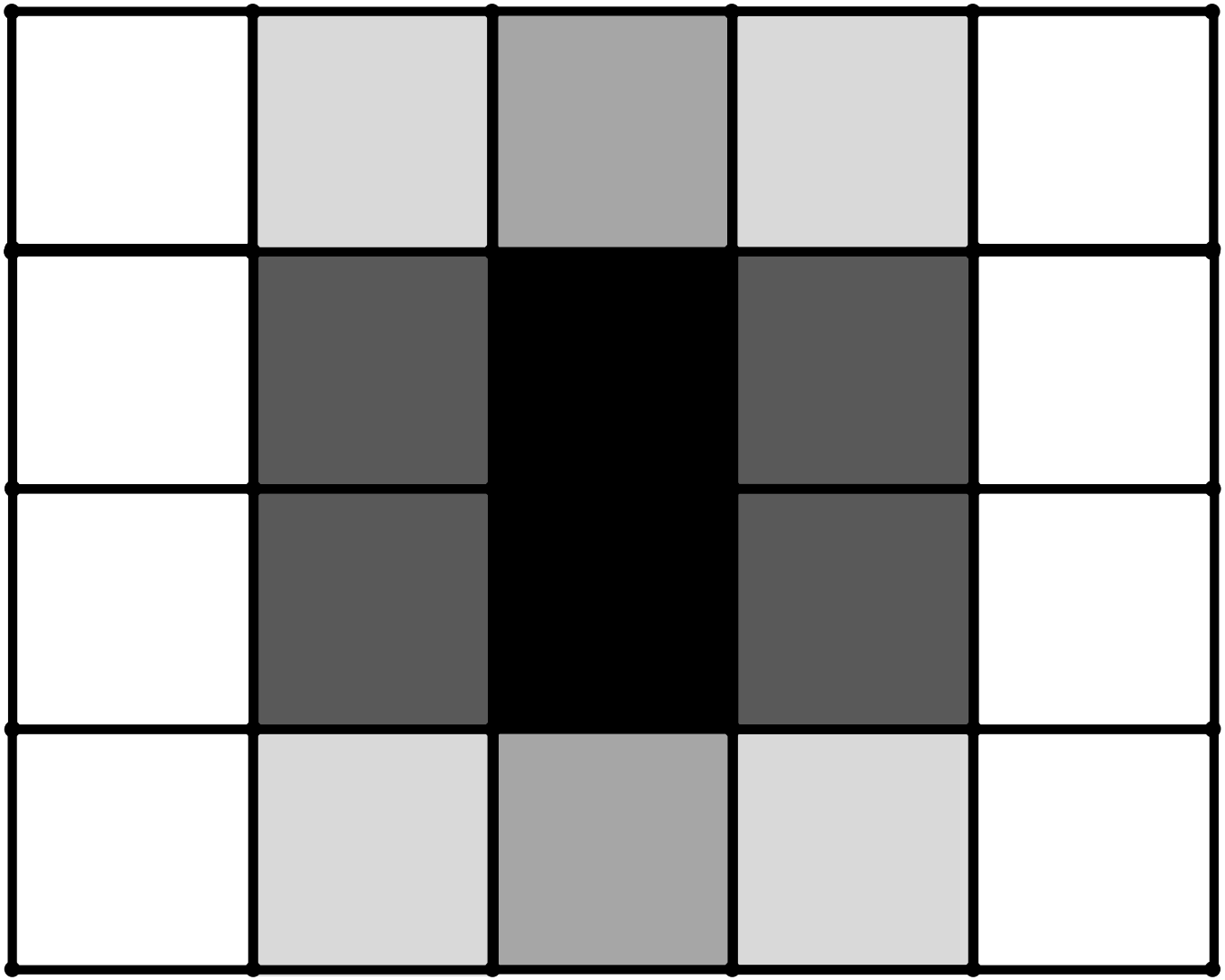
Contributions

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

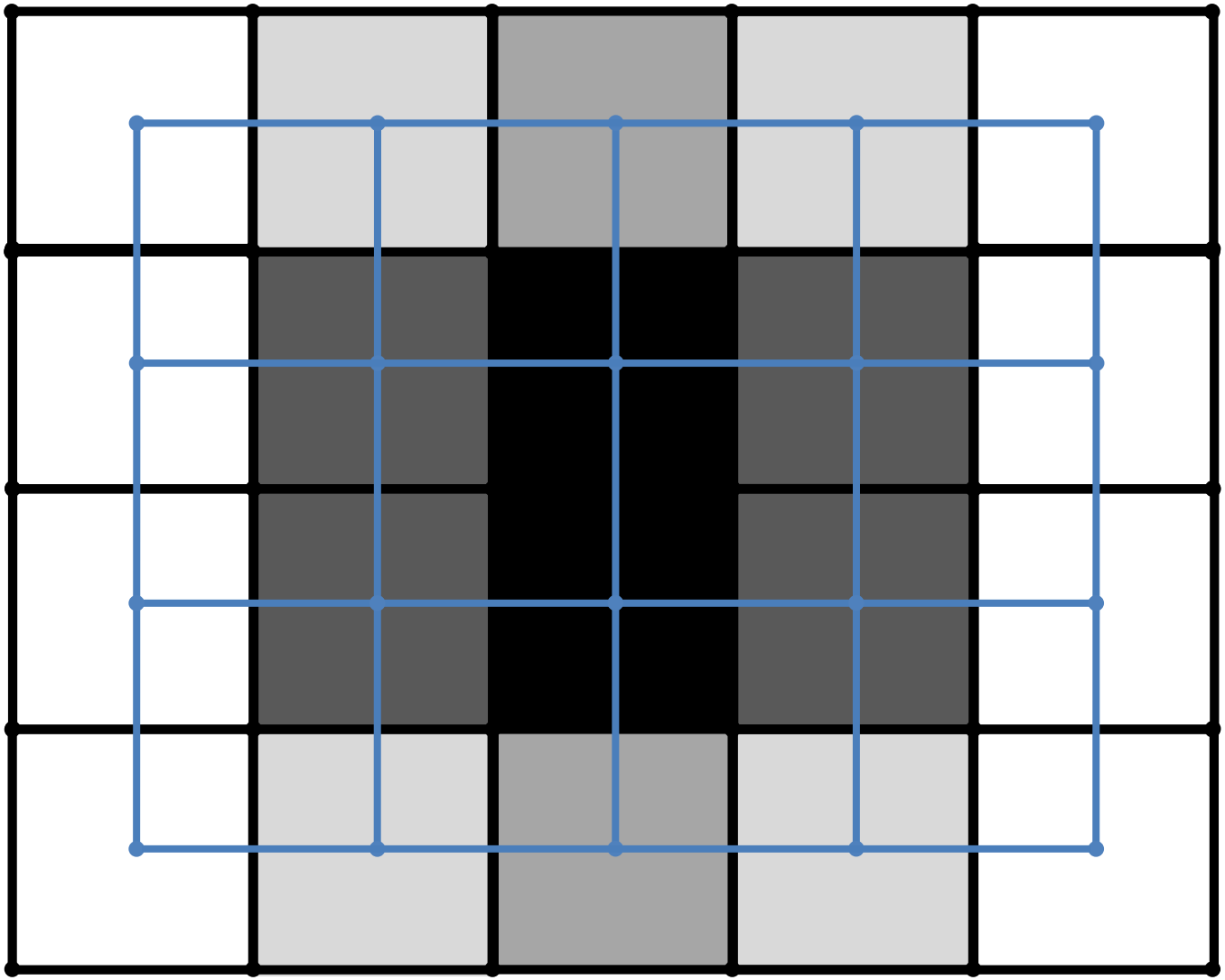
Contouring



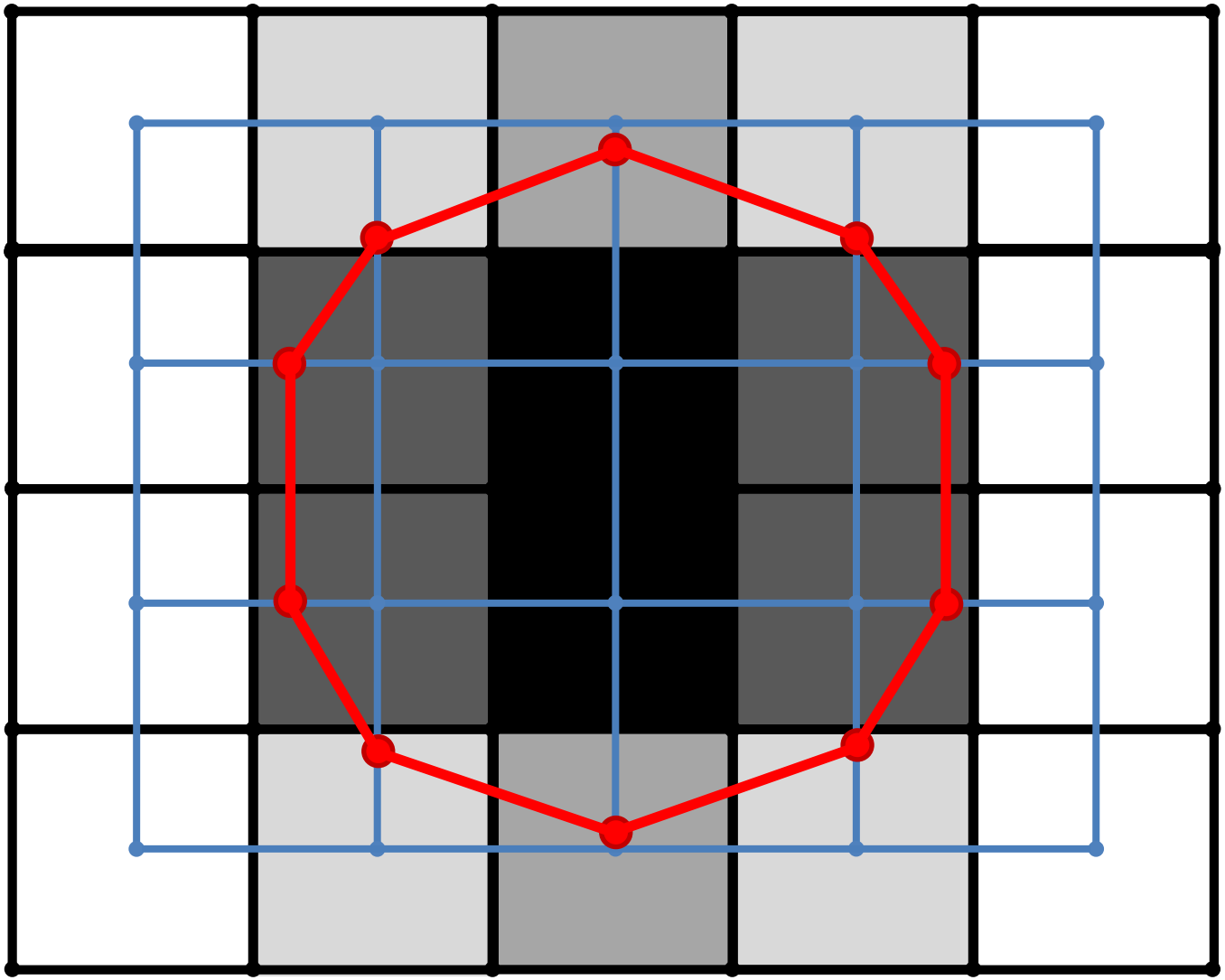
DIF



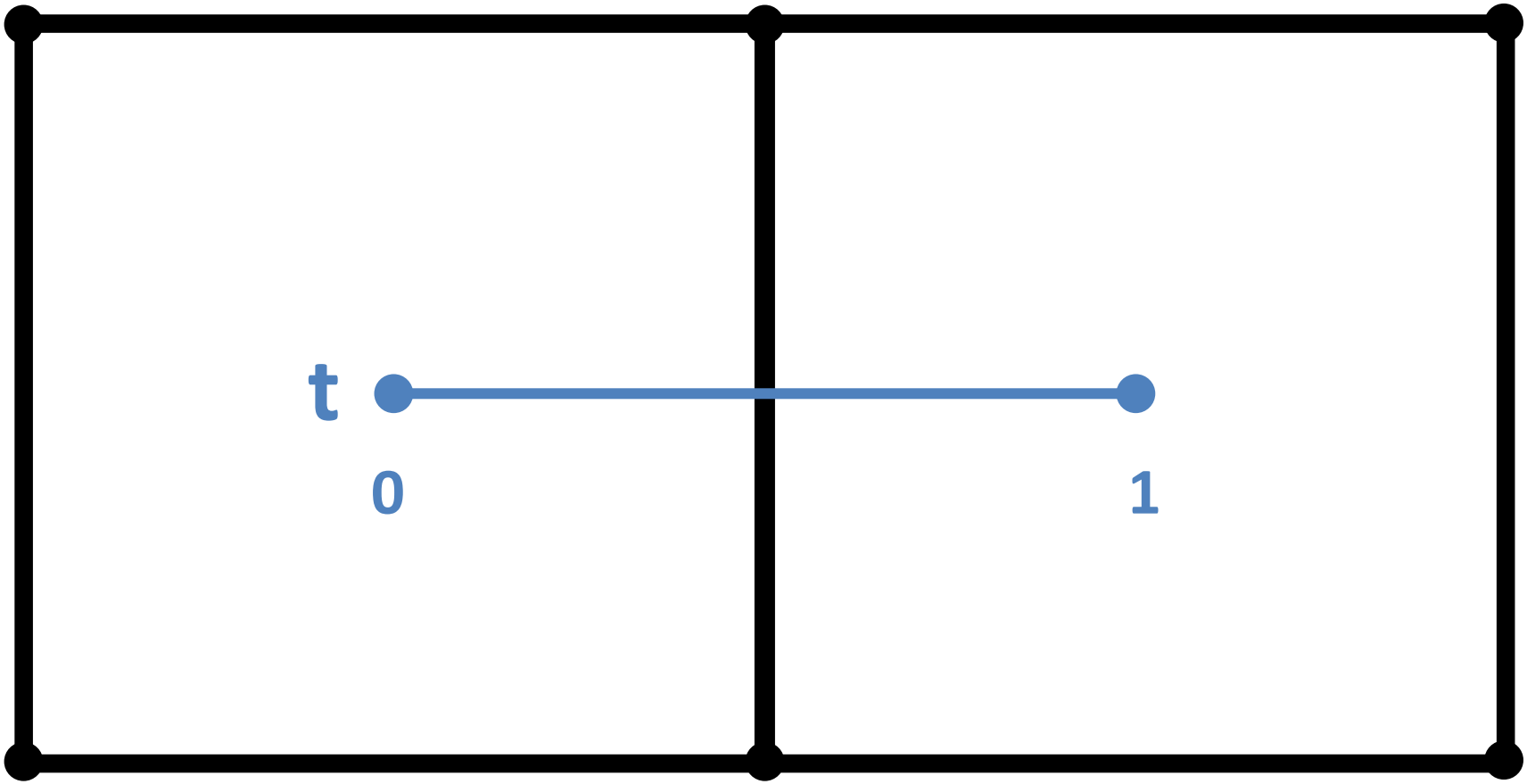
Dual Grid



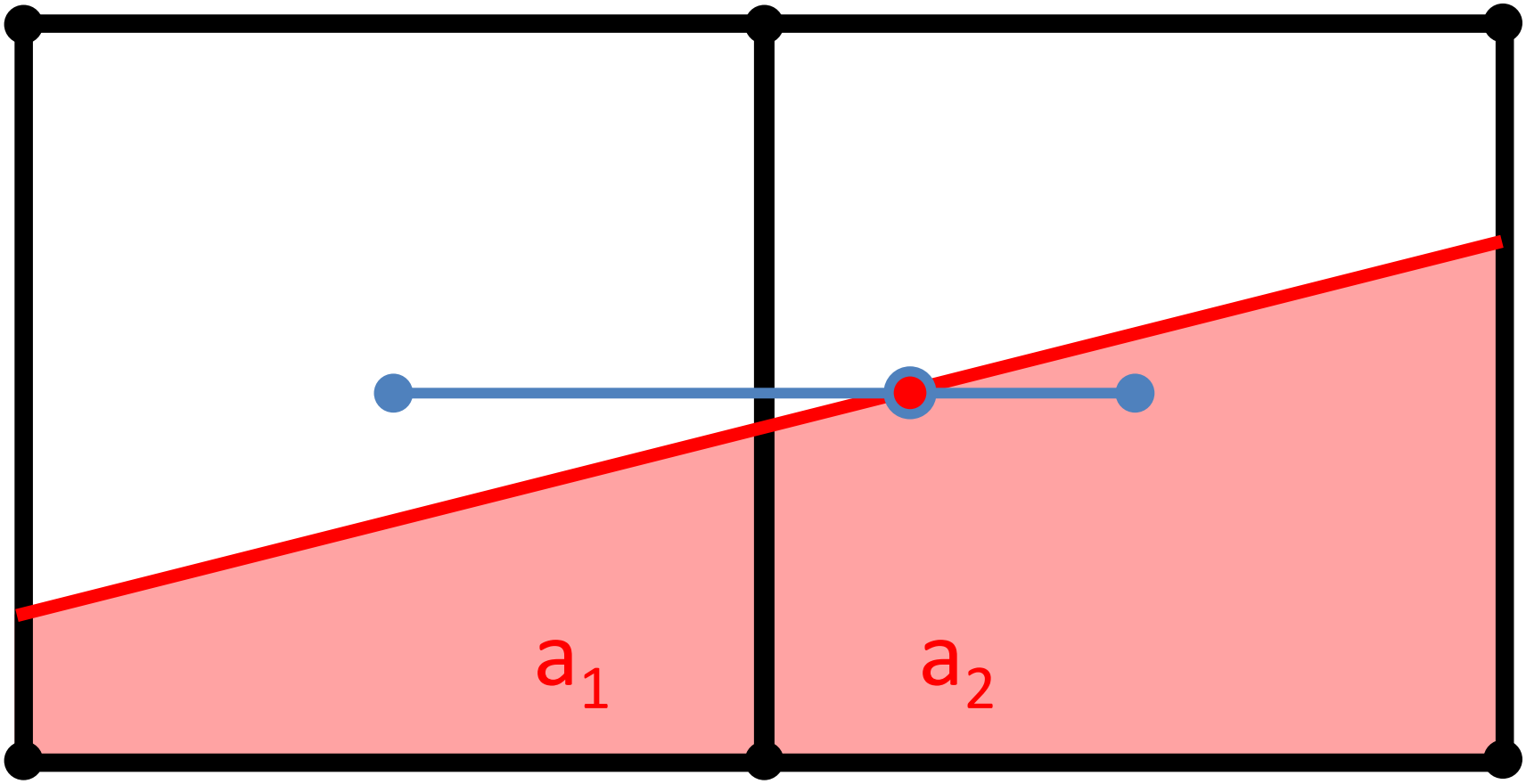
Dual Grid



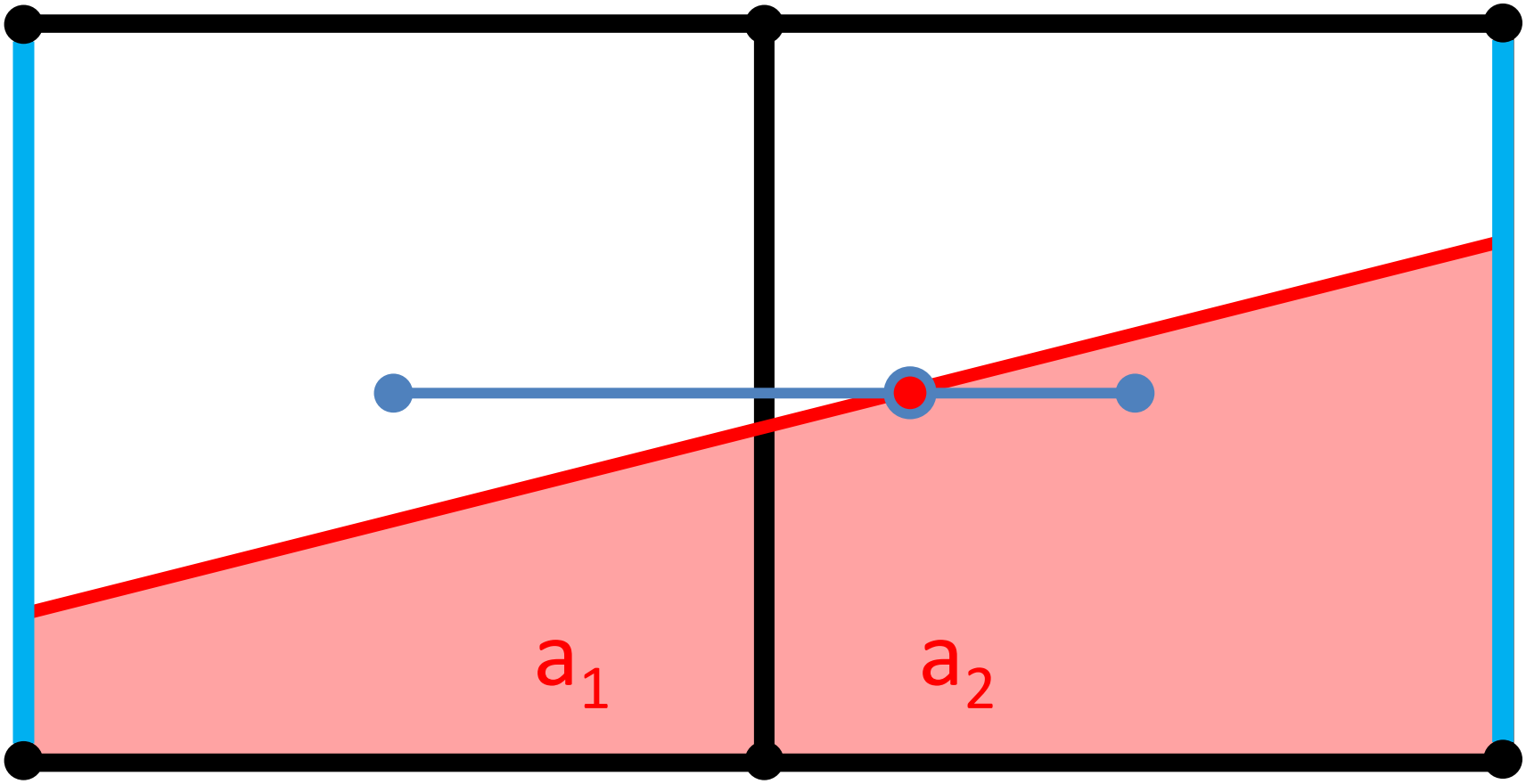
2D MC change



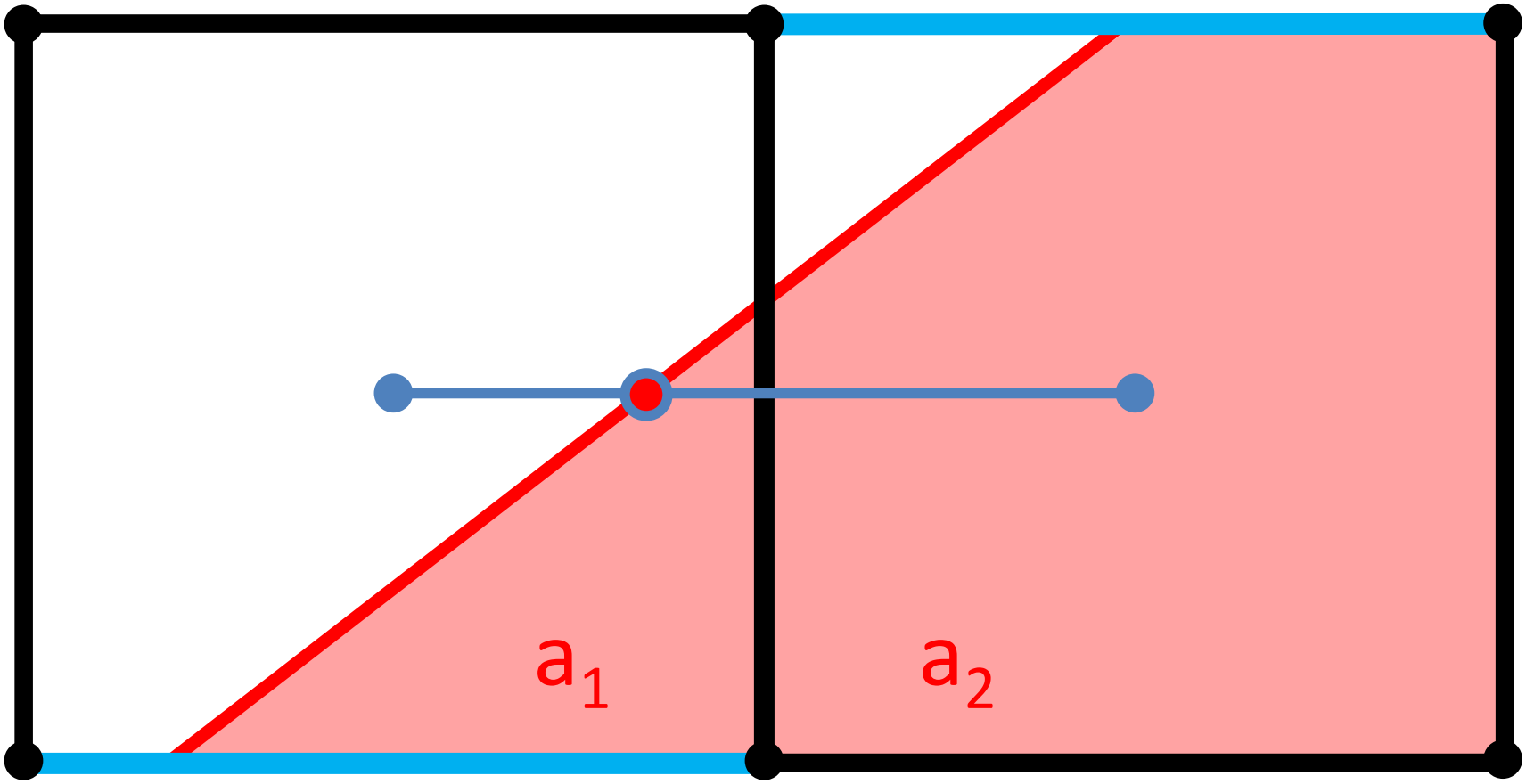
2D MC change



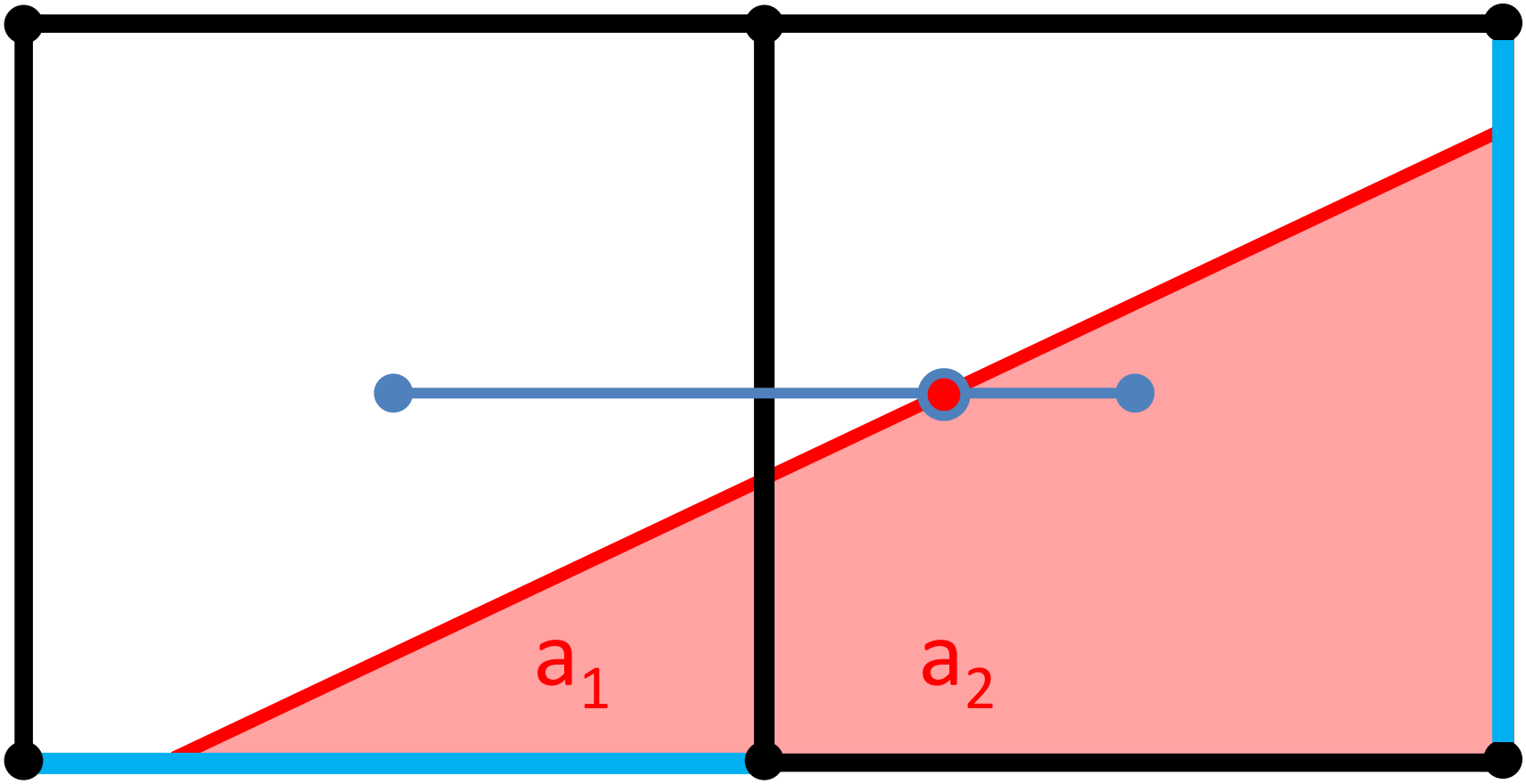
Side - Side



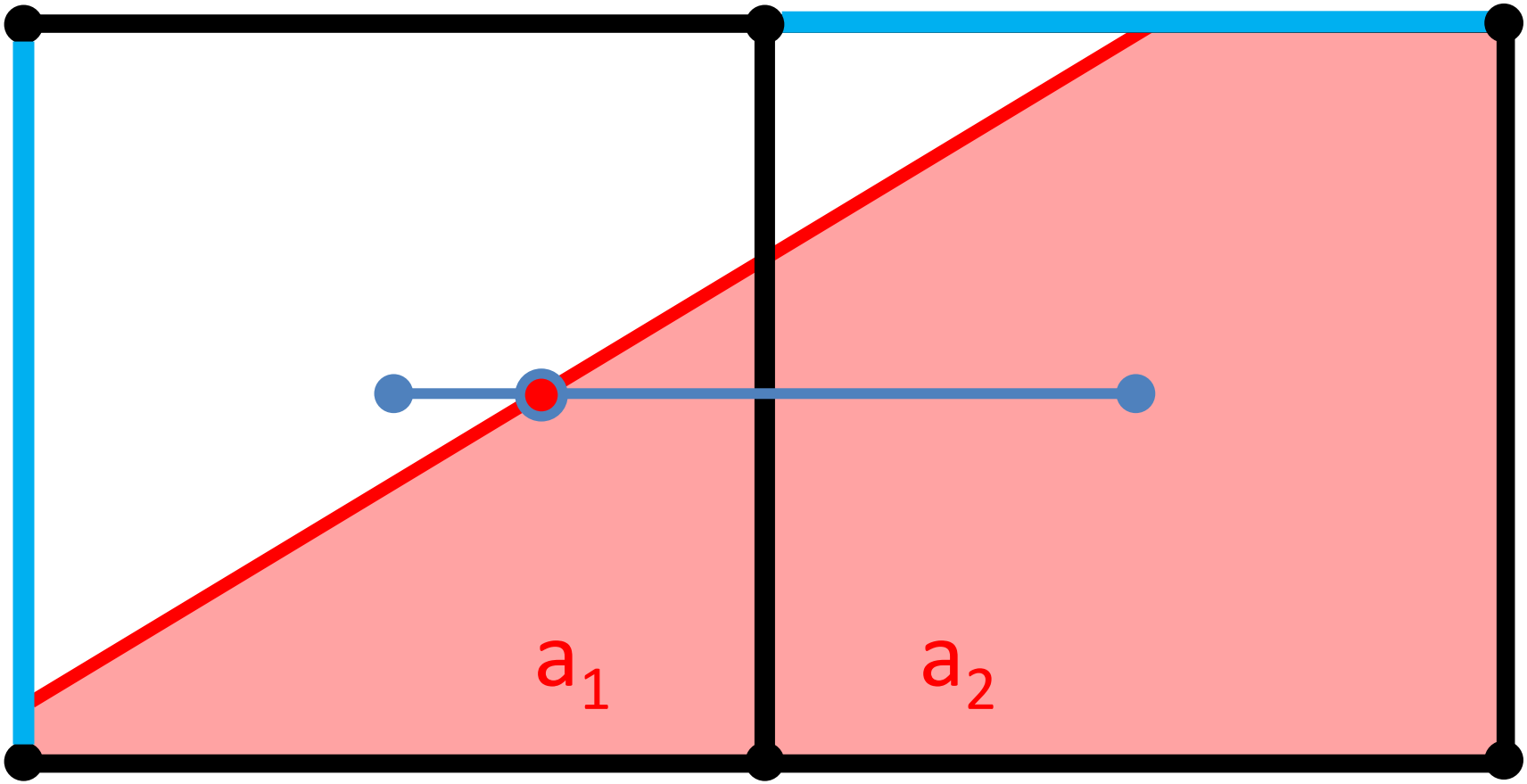
Bottom - Top



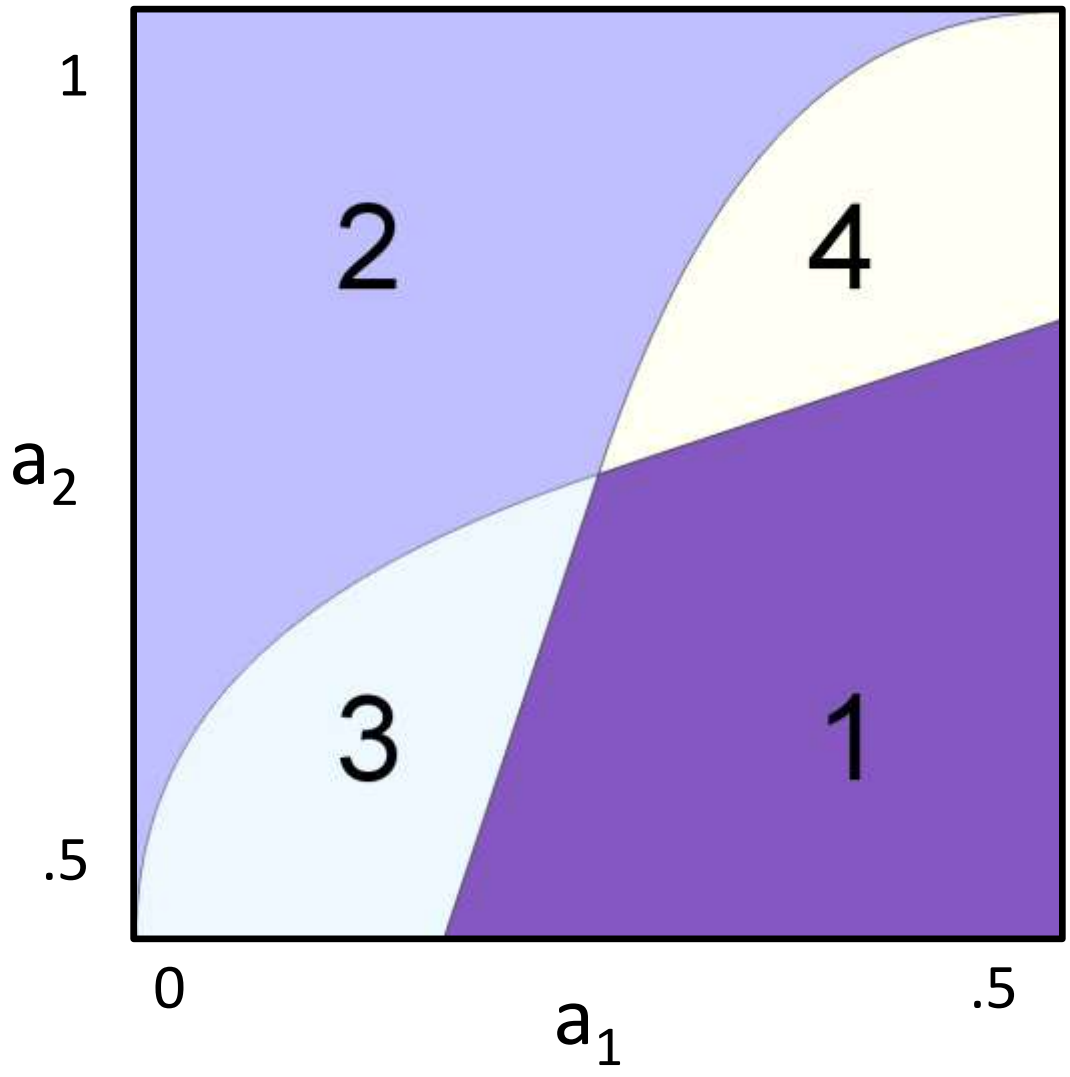
Bottom - Side



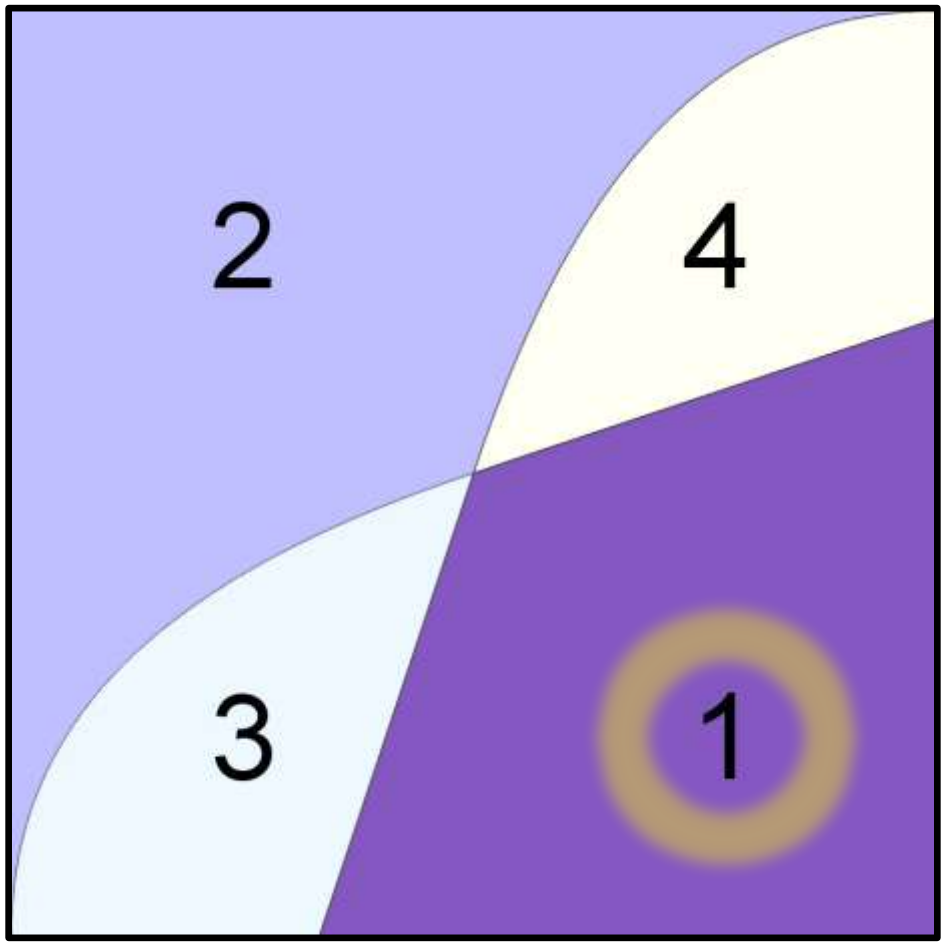
Side- Top



Parameter Space

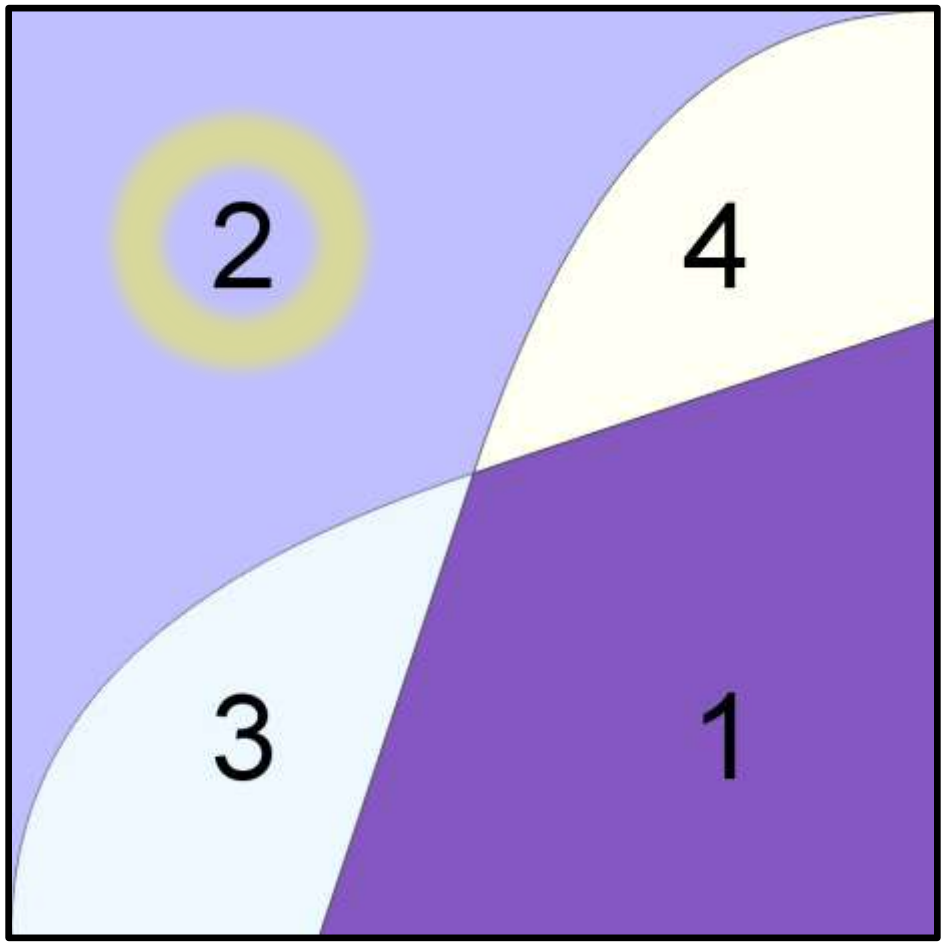


Parameter Space



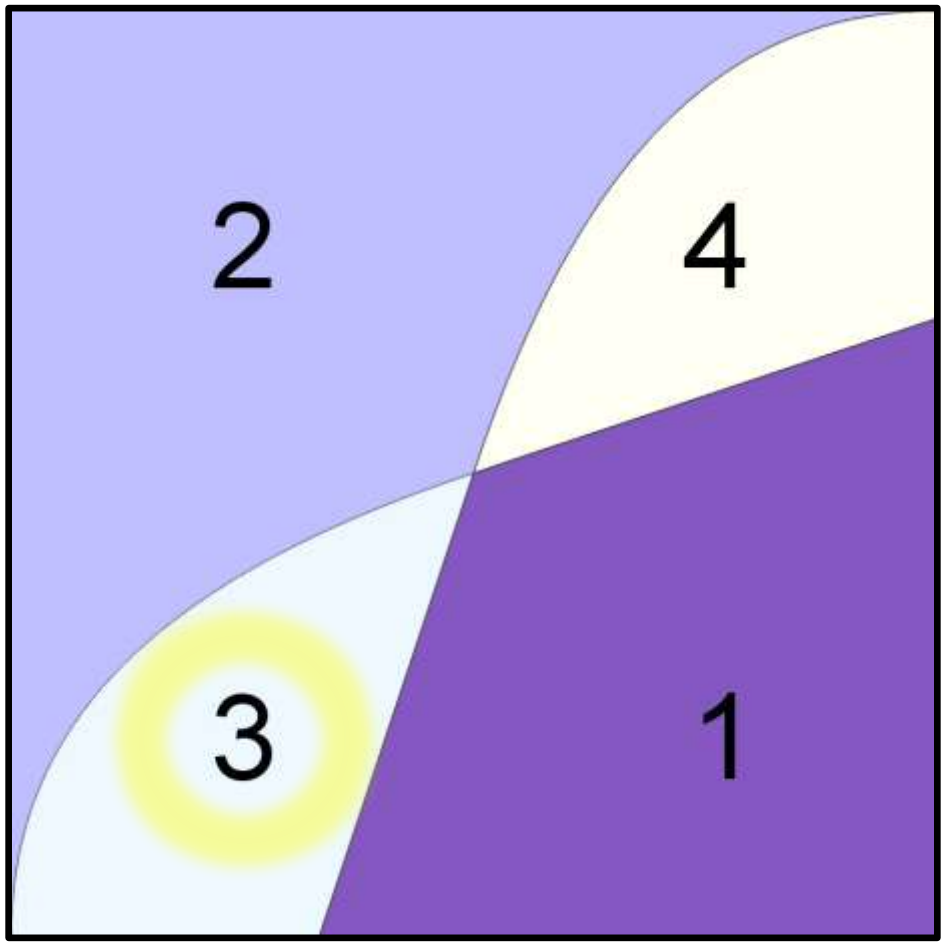
$$t = \frac{a_1 - \frac{1}{2}}{a_1 - a_2}$$

Parameter Space



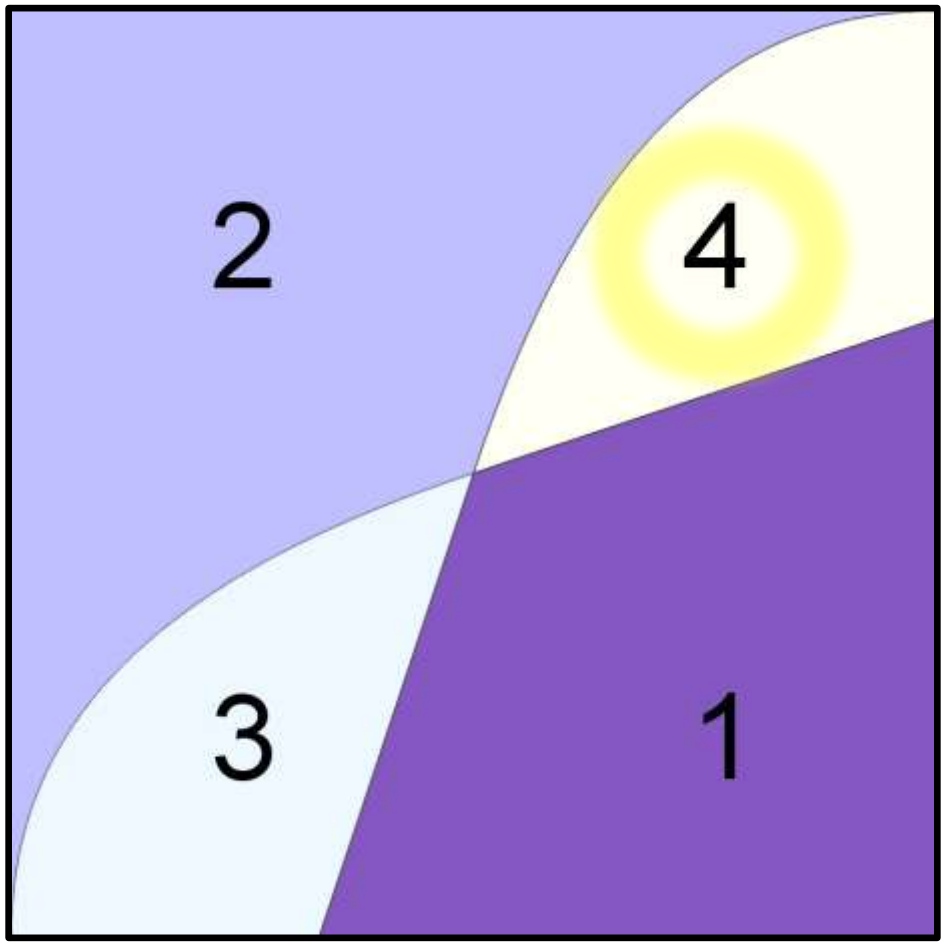
$$t = \frac{3}{2} - a_1 - a_2$$

Parameter Space



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

Parameter Space

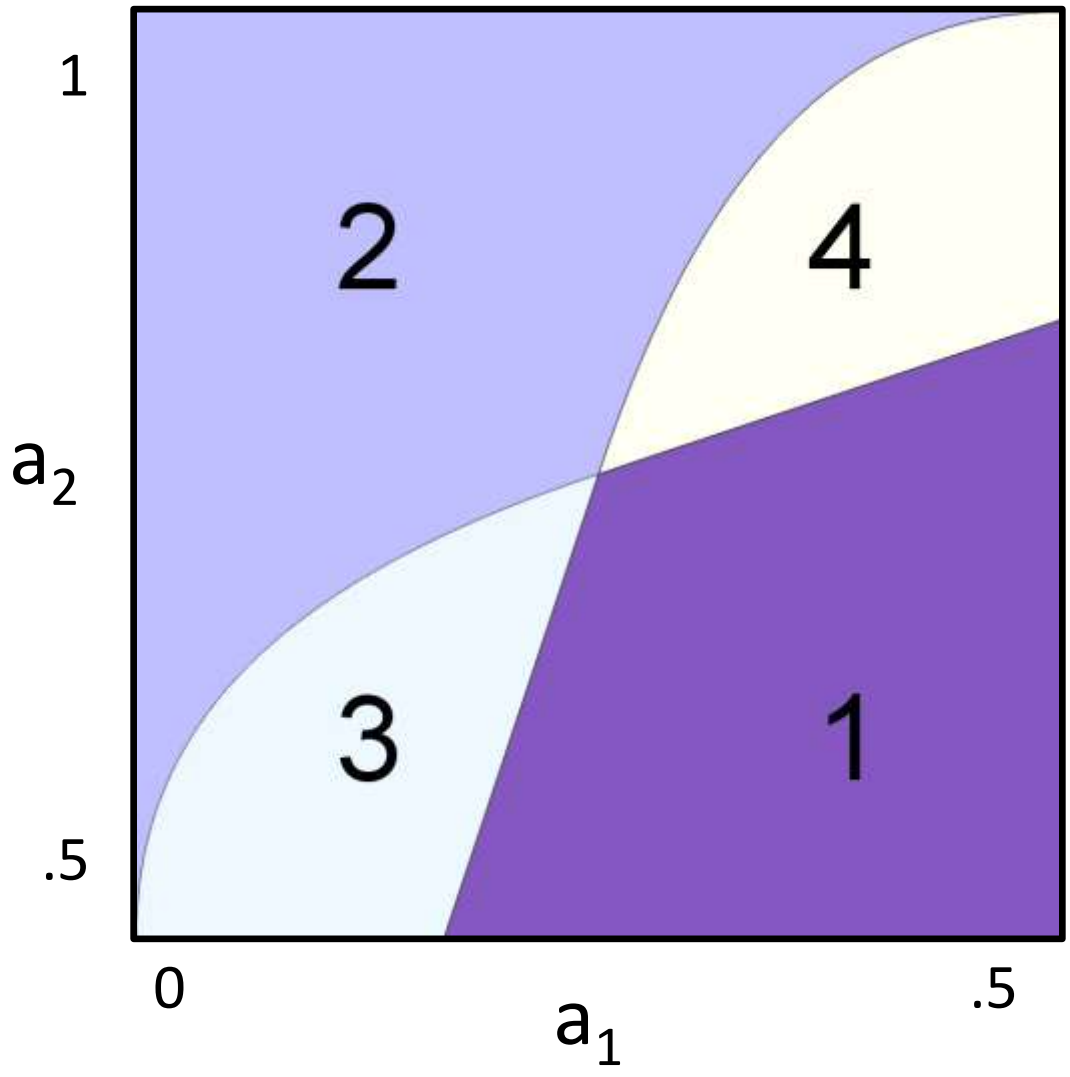


$$\bar{a}_1 = a_2 - 1$$

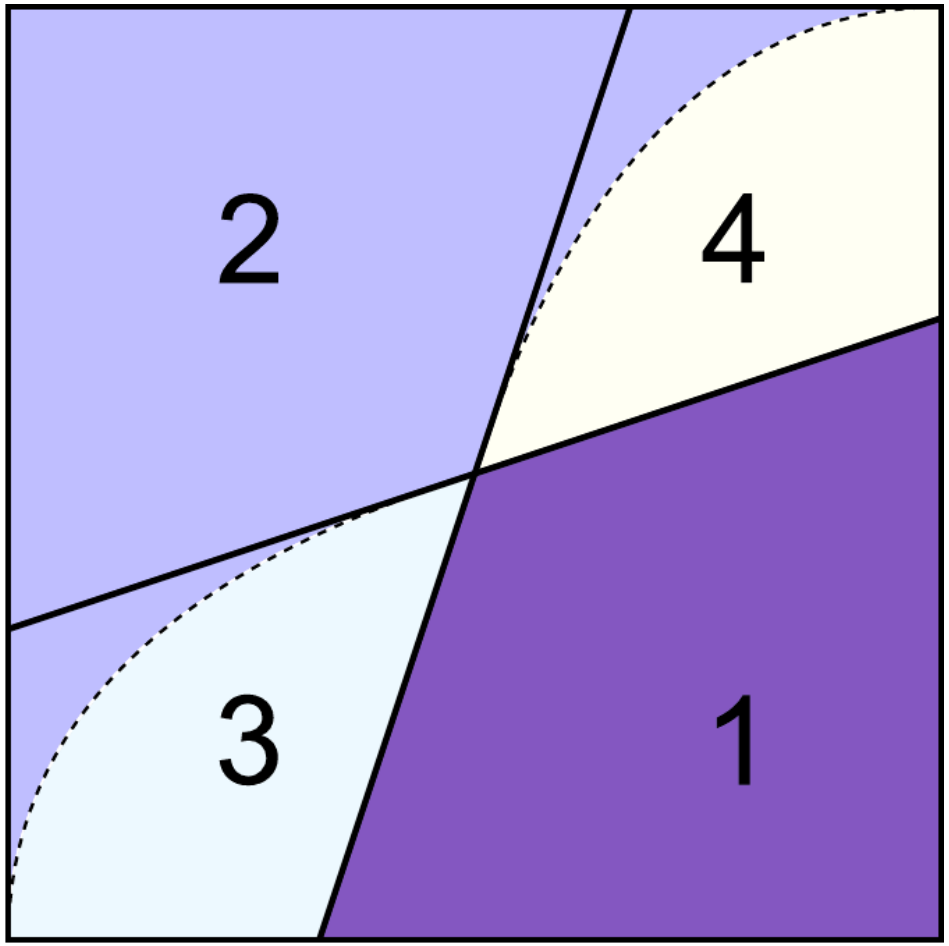
$$\bar{a}_2 = a_1 - 1$$

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

Parameter Space

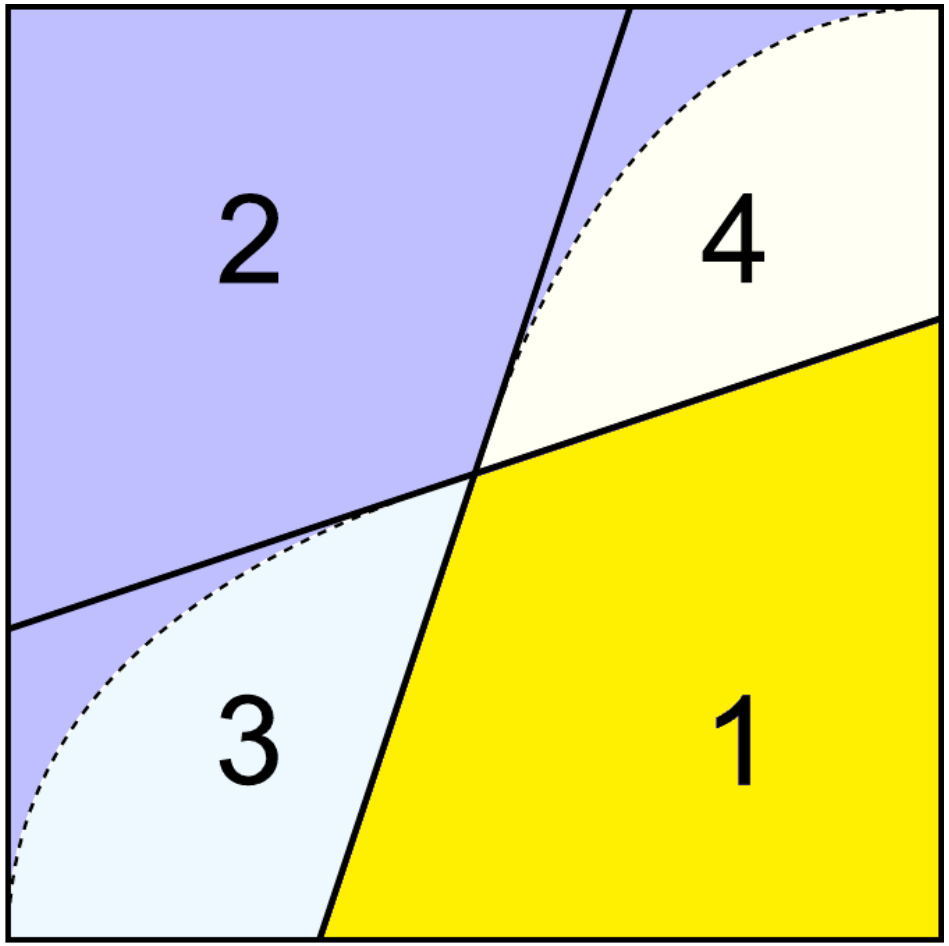


Parameter Space



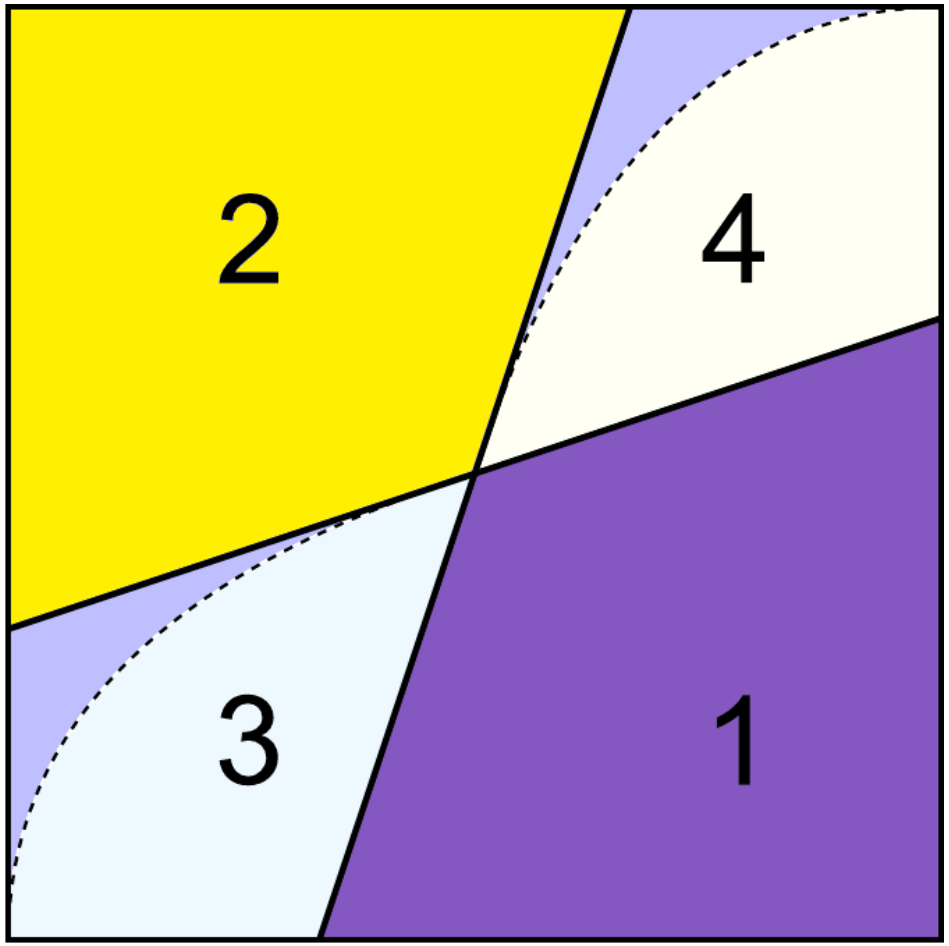
$a_2 \leq 3a_1$ $\quad$ $3a_2 \leq a_1 + 2$

Parameter Space



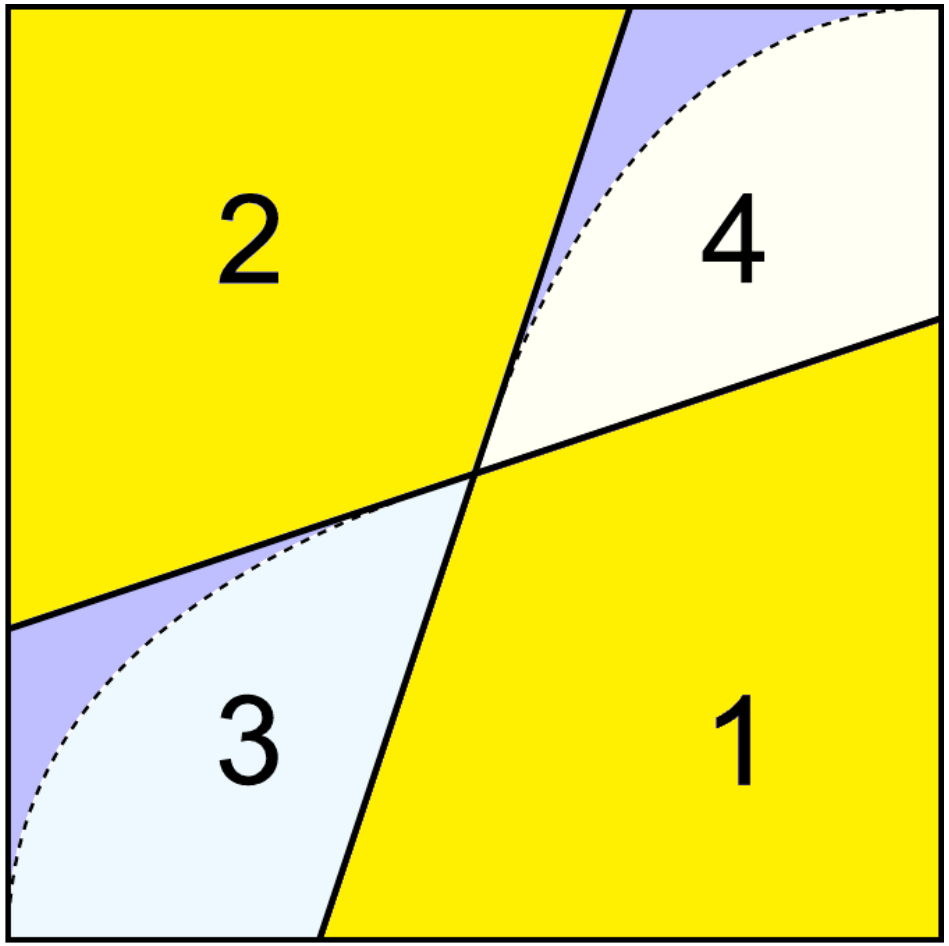
$a_2 \leq 3a_1$ $\quad$ $3a_2 \leq a_1 + 2$

Parameter Space



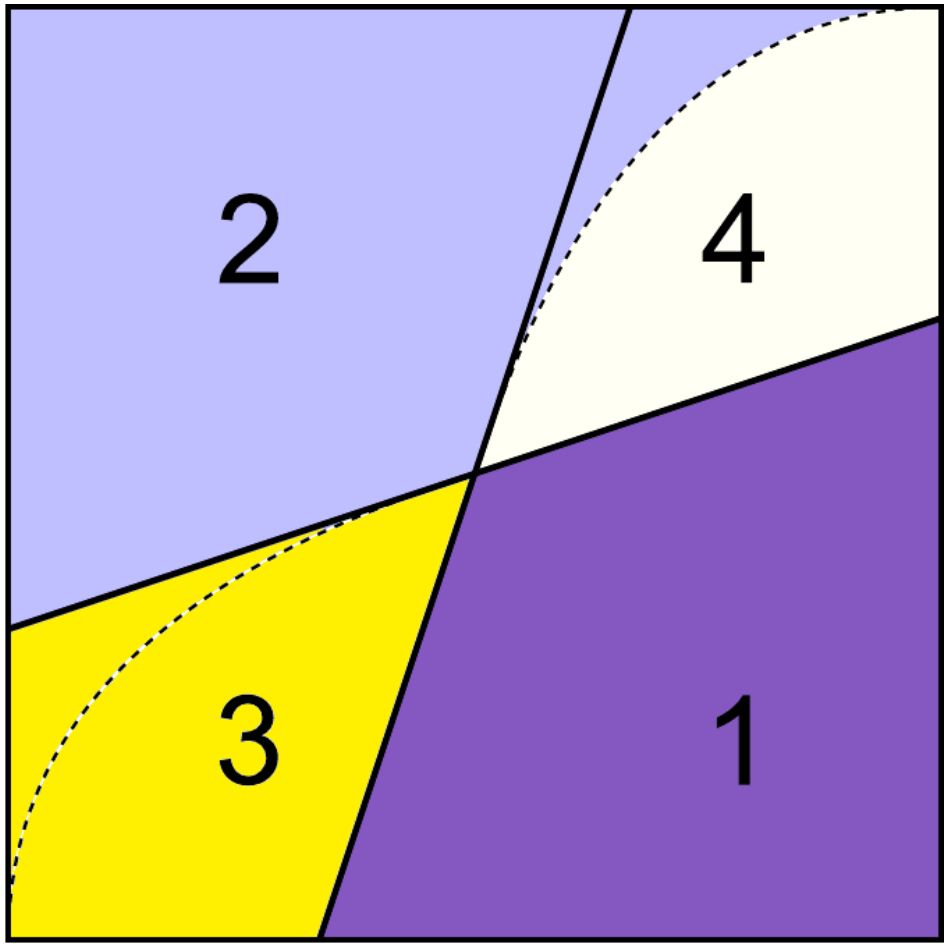
$a_2 \leq 3a_1$ $\quad$ $3a_2 \leq a_1 + 2$

Parameter Space

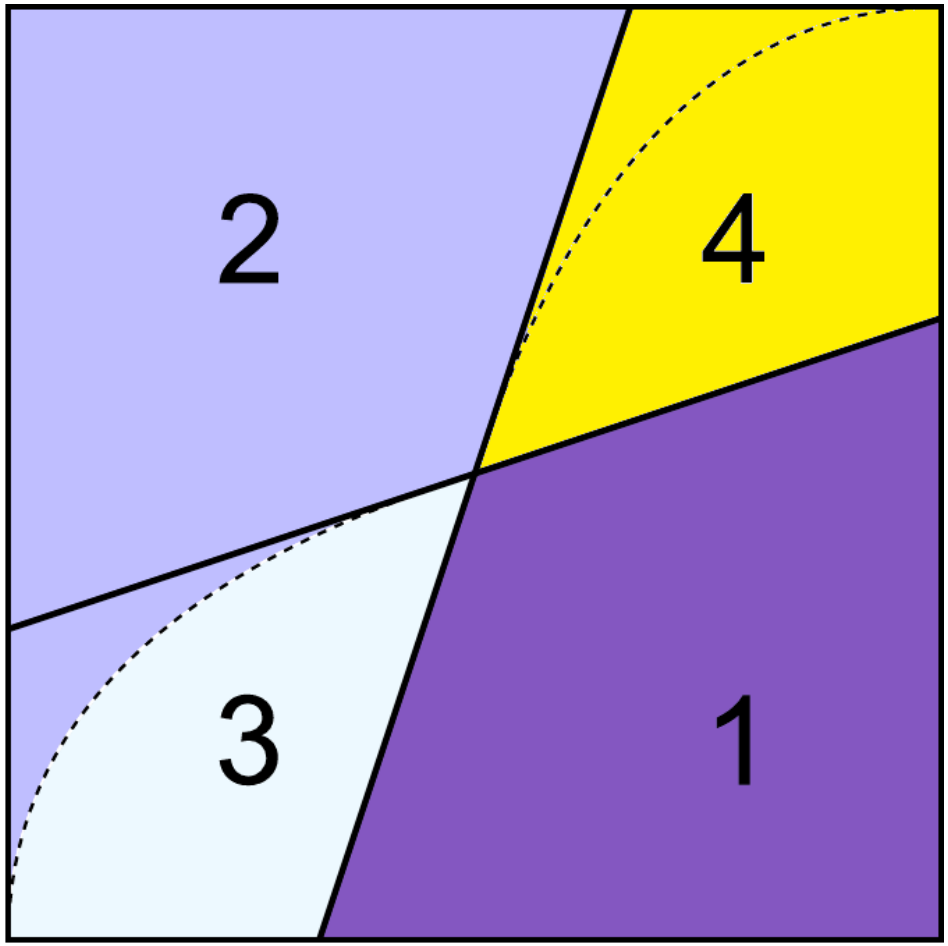


$a_2 \leq 3a_1$ $\quad$ $3a_2 \leq a_1 + 2$

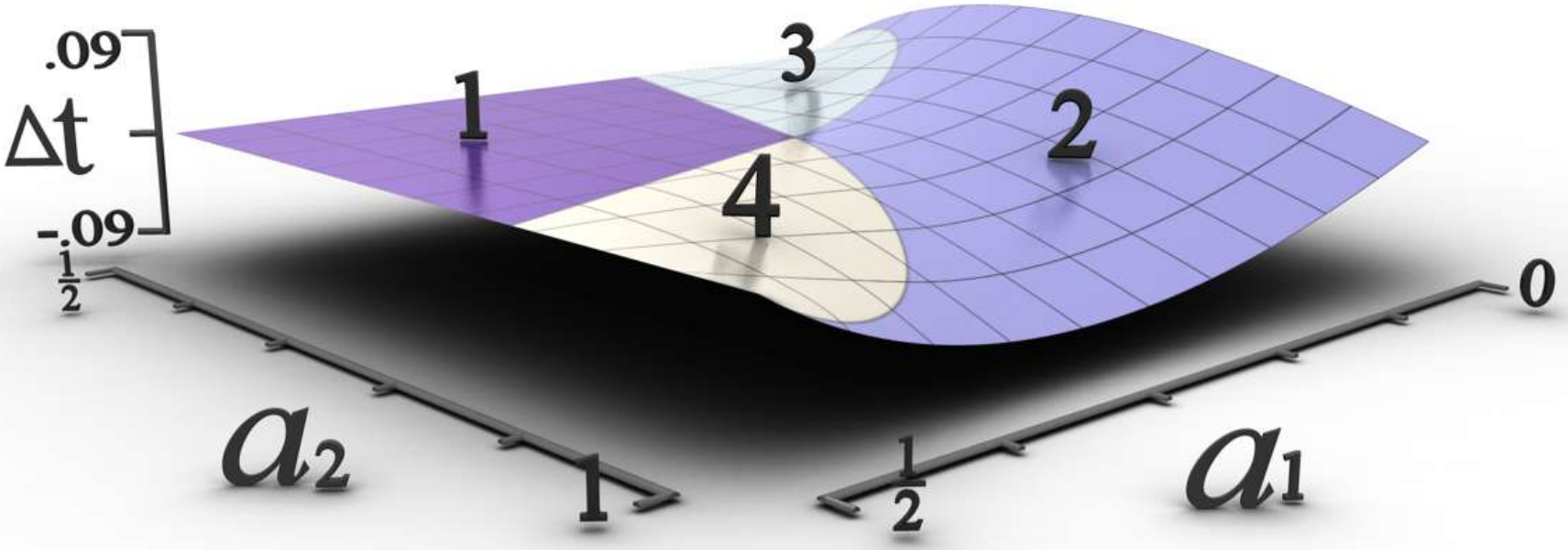
Parameter Space



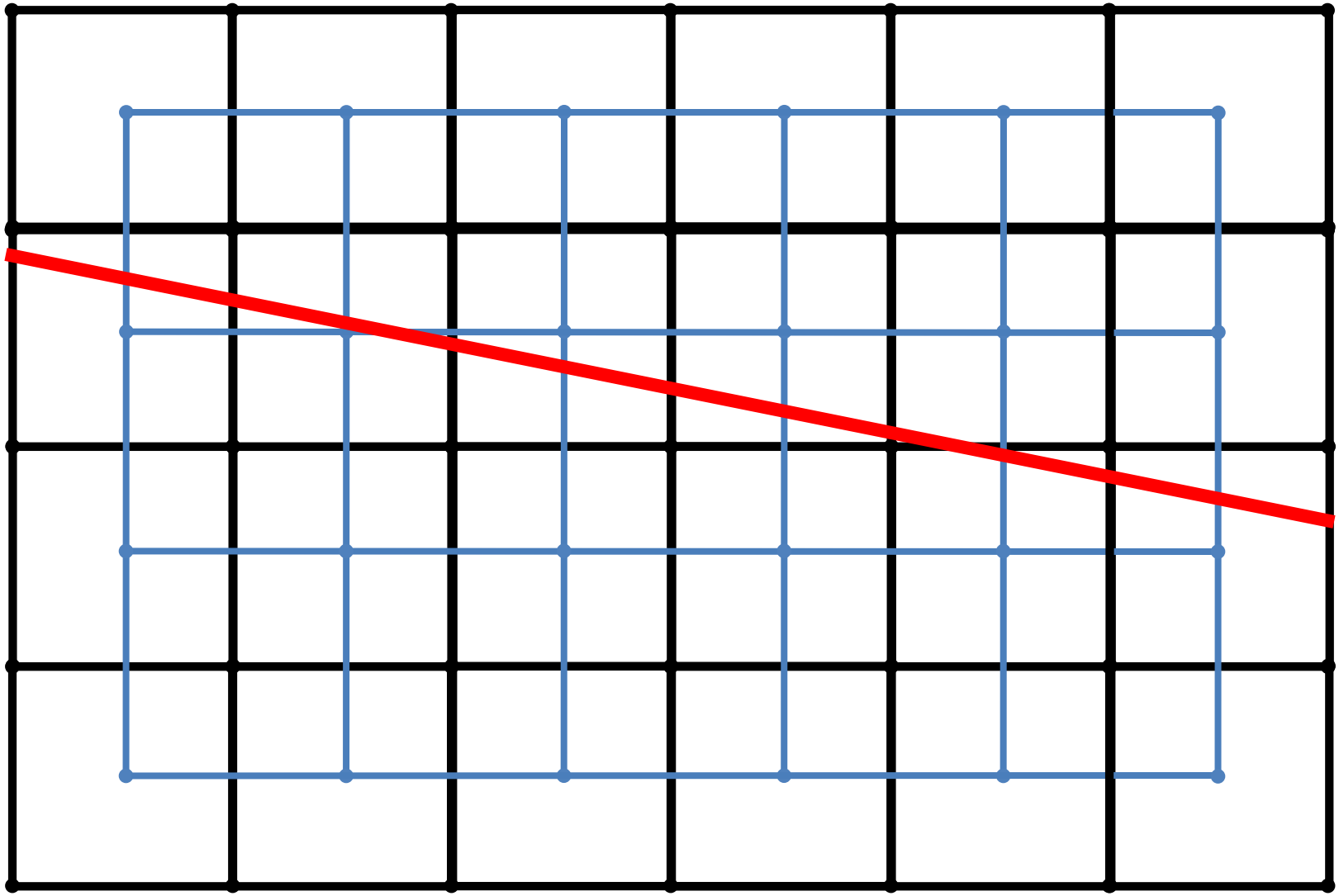
Parameter Space



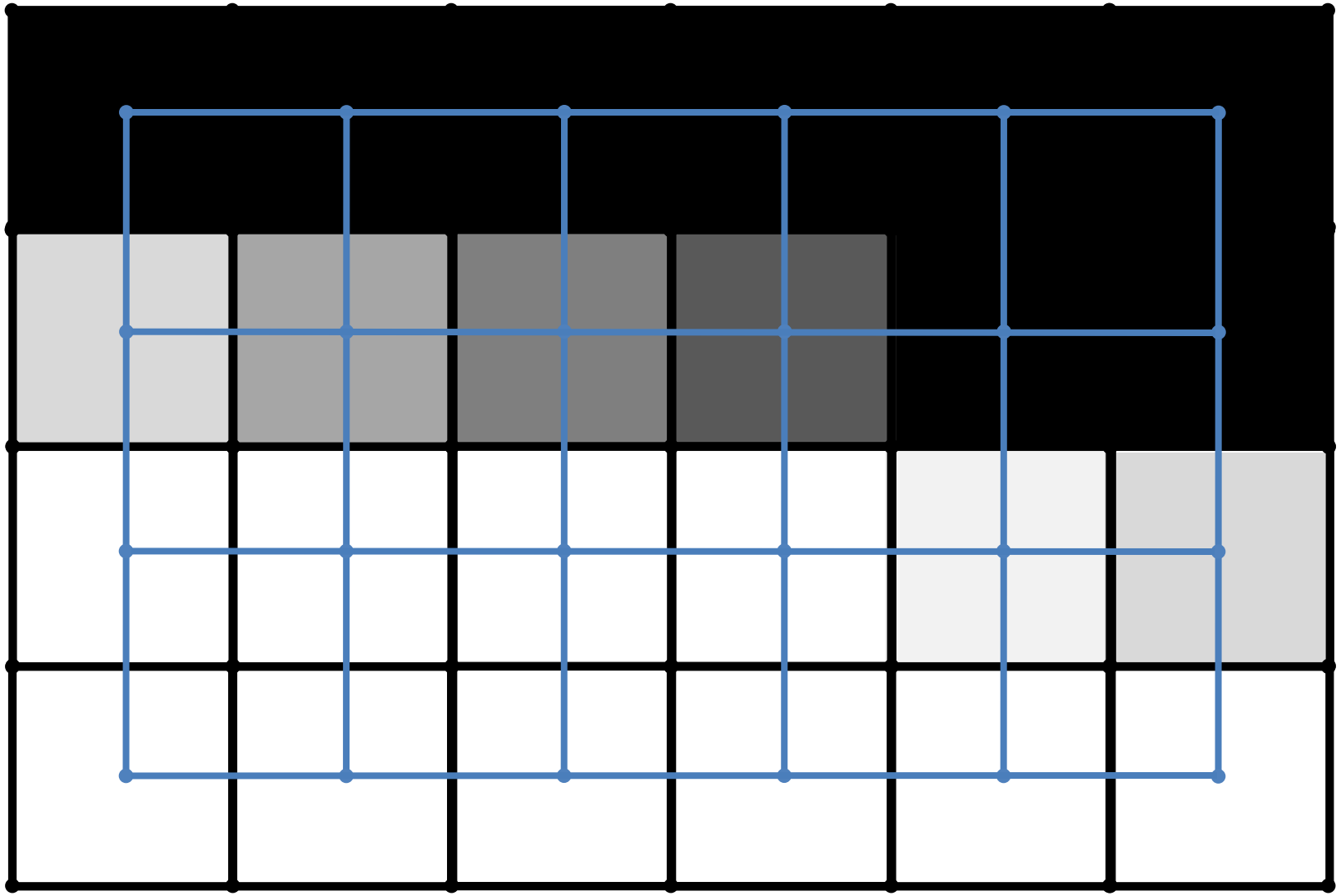
Difference from Linear Interp.



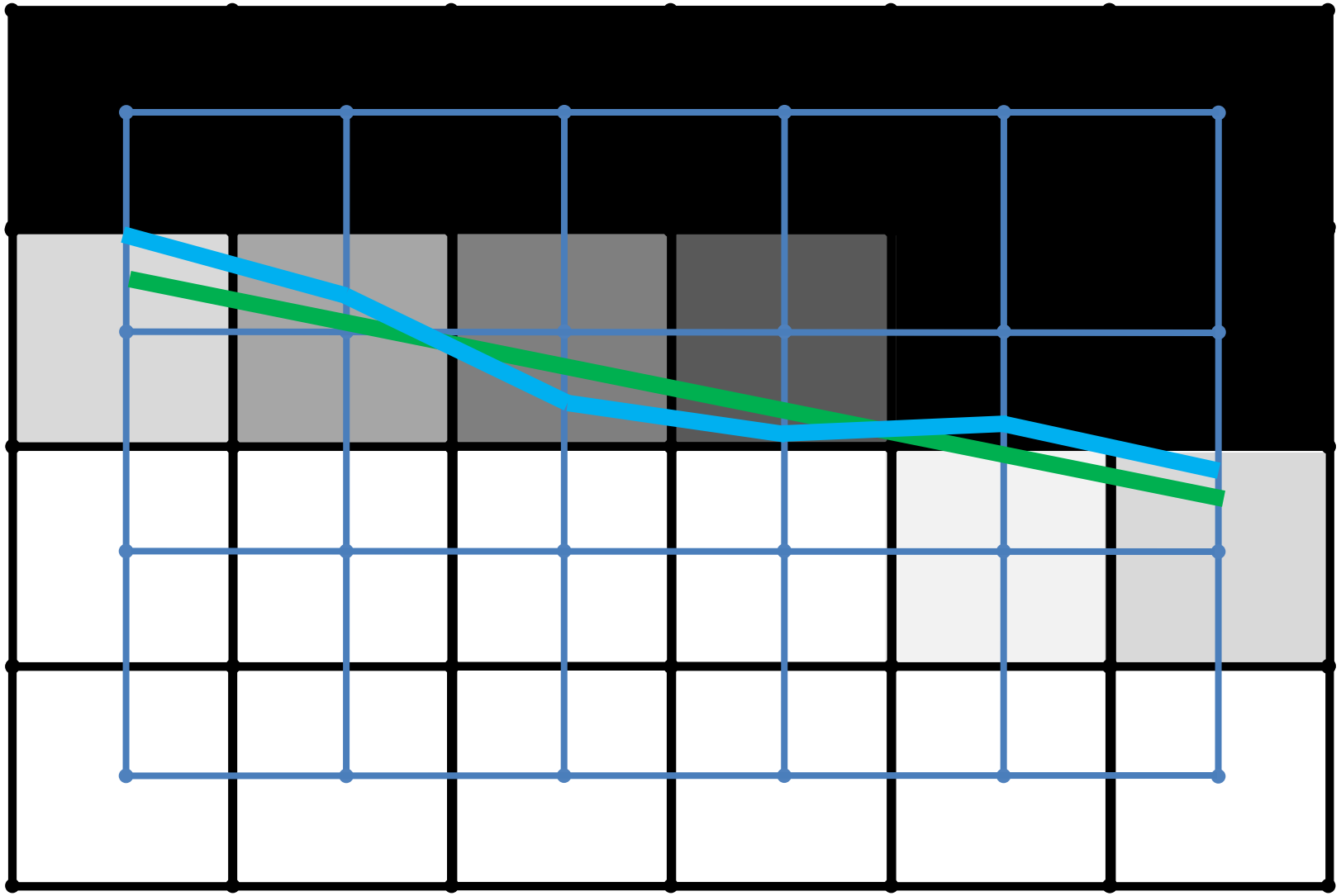
Linear functions



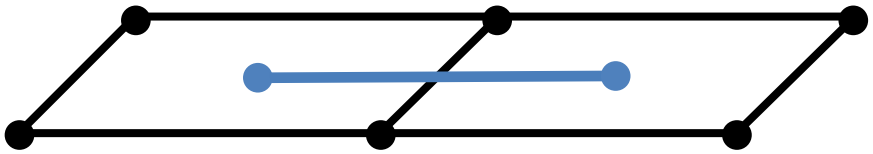
Linear functions



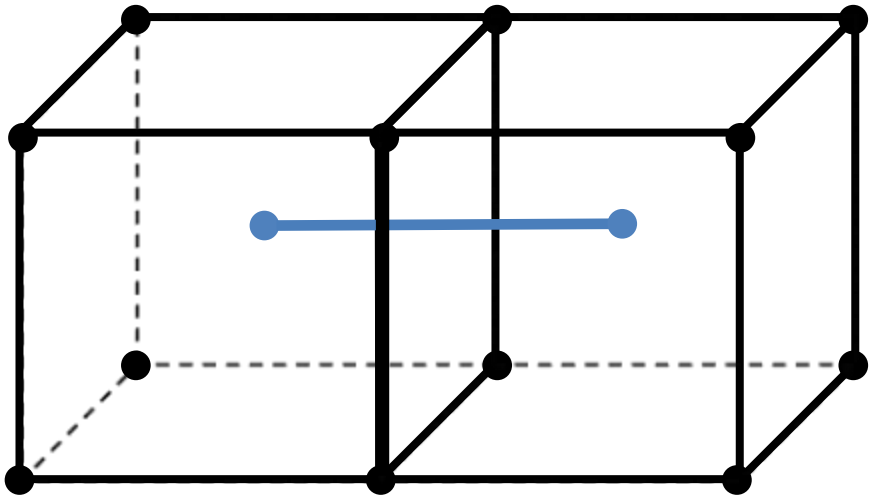
Linear functions



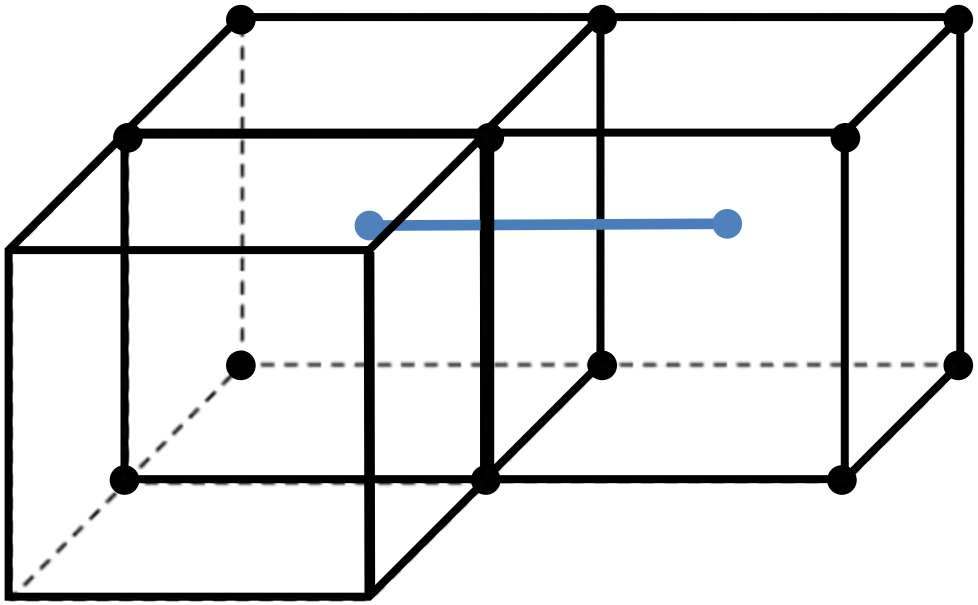
Expanding to 3D



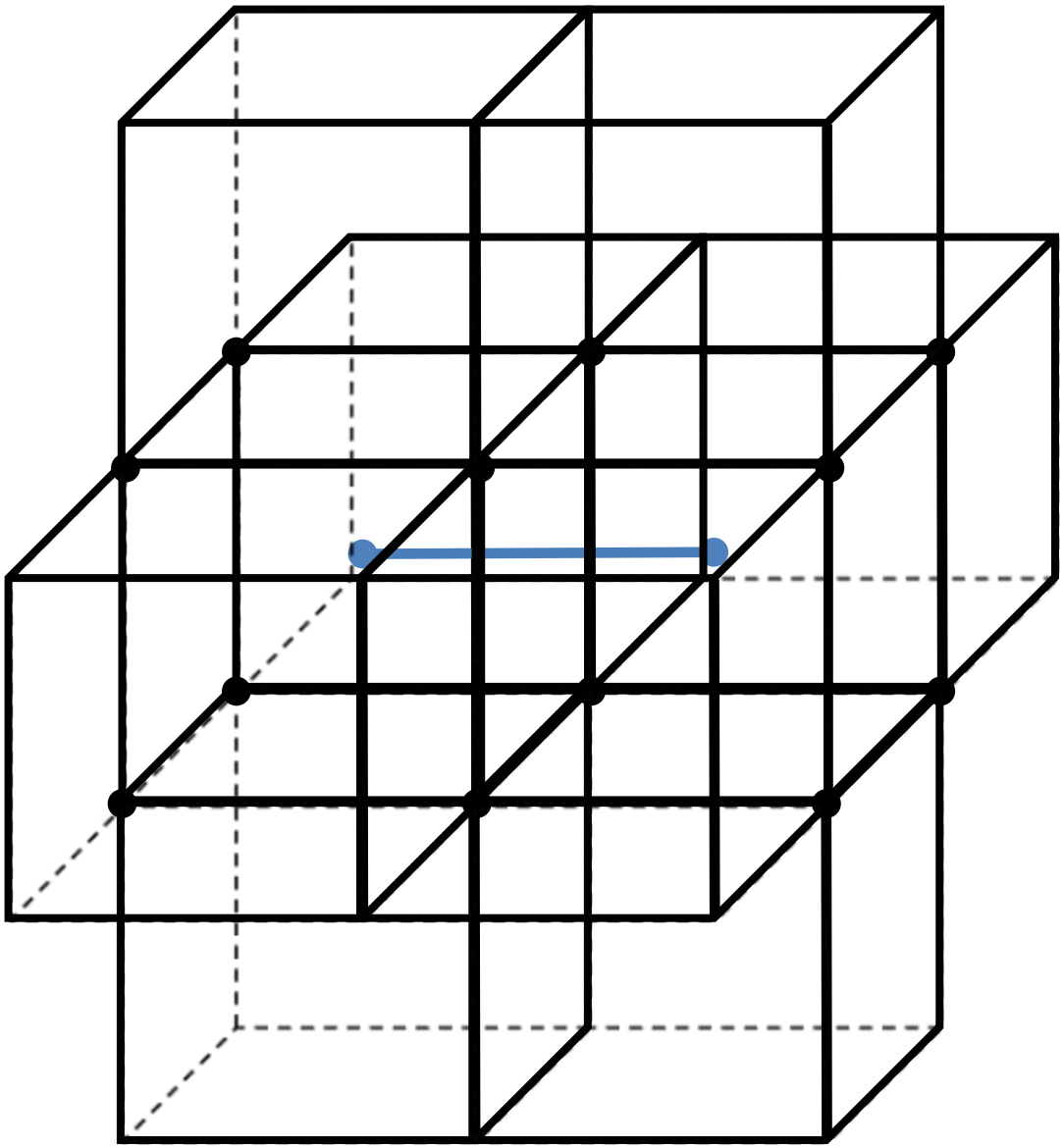
Expanding to 3D



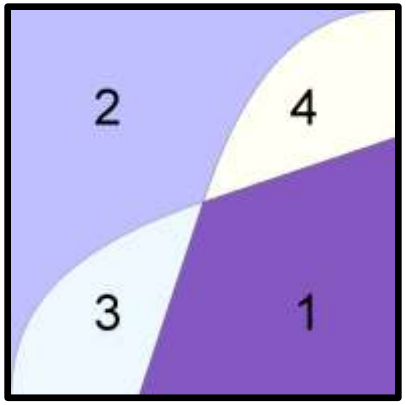
Expanding to 3D

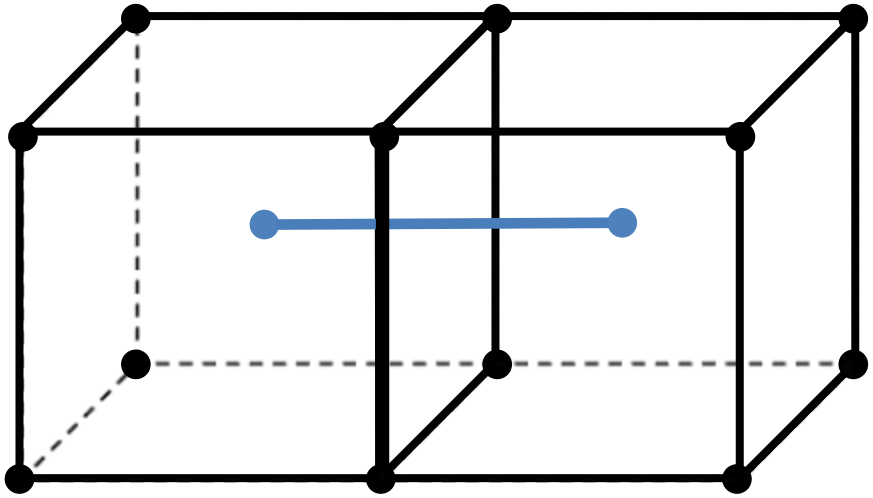


Expanding to 3D

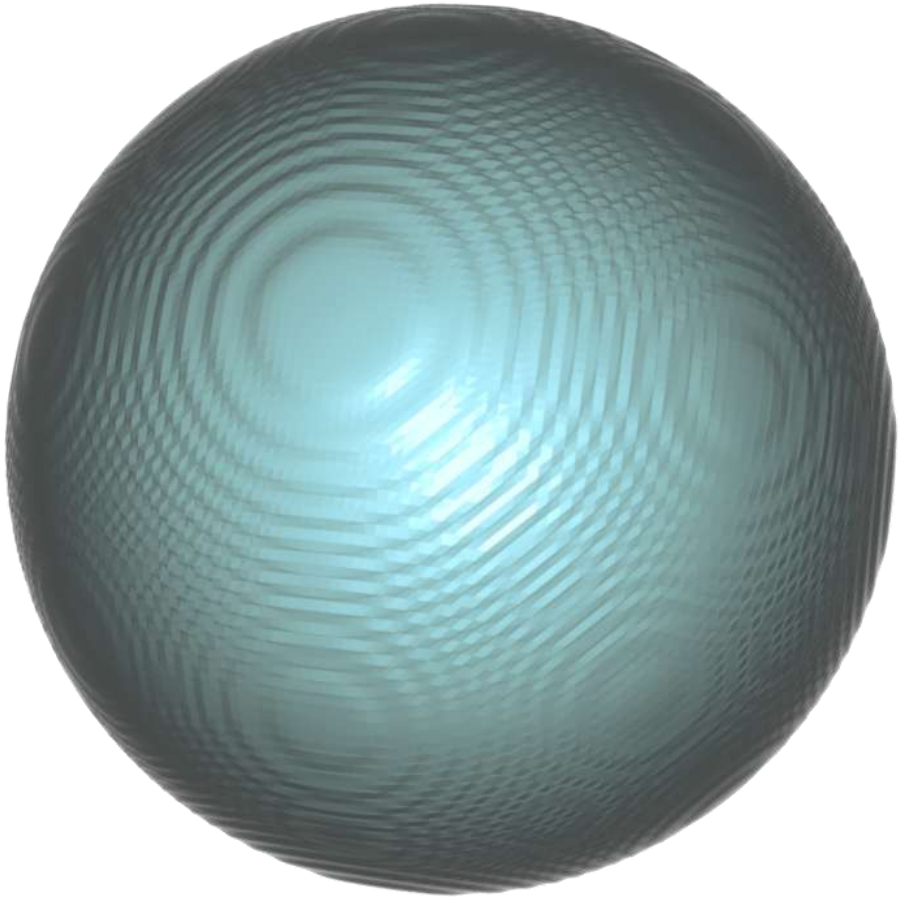


Expanding to 3D



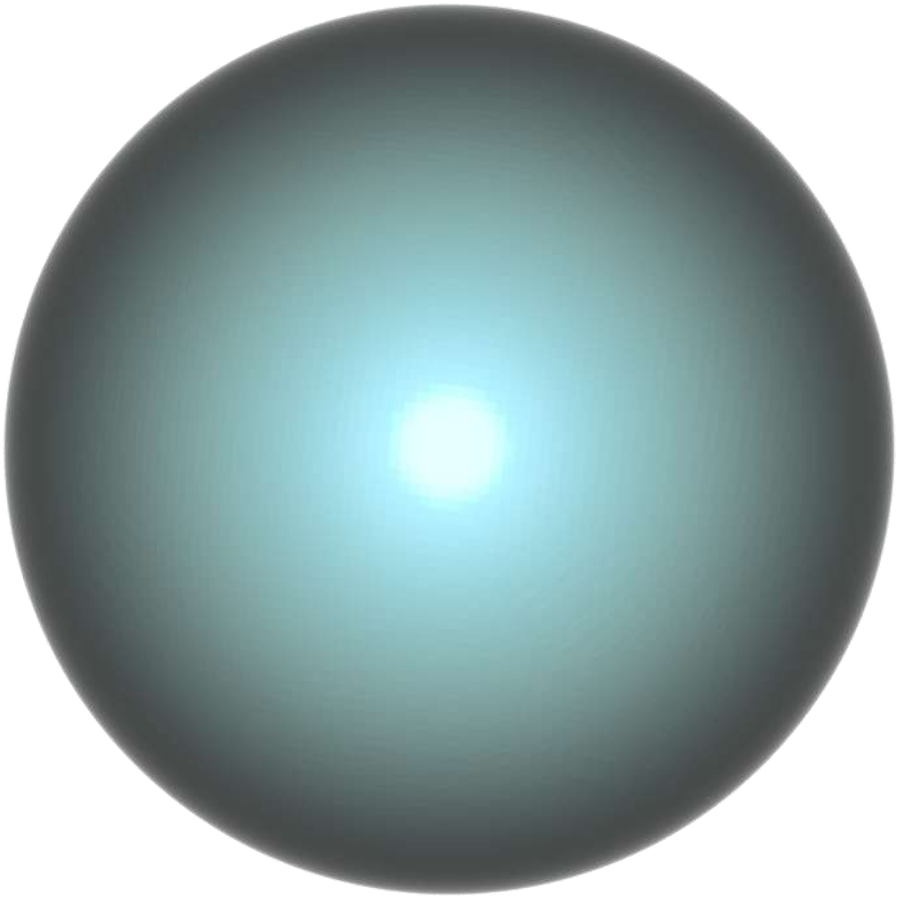


Expanding to 3D



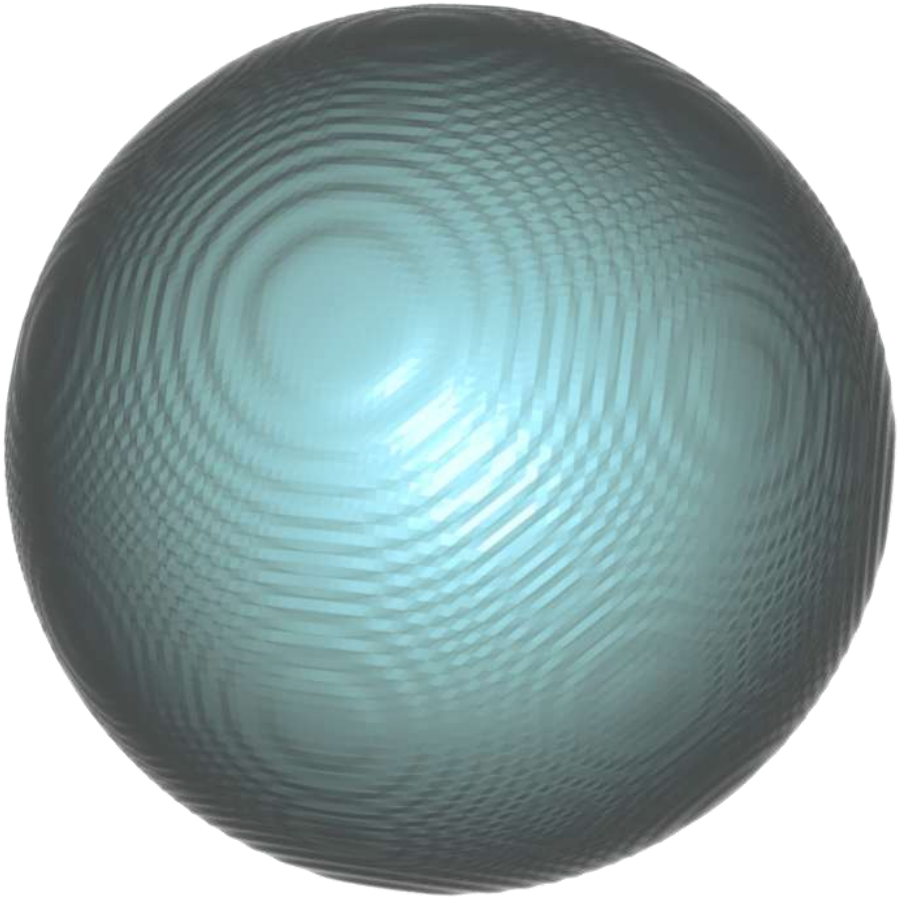
MC

Expanding to 3D

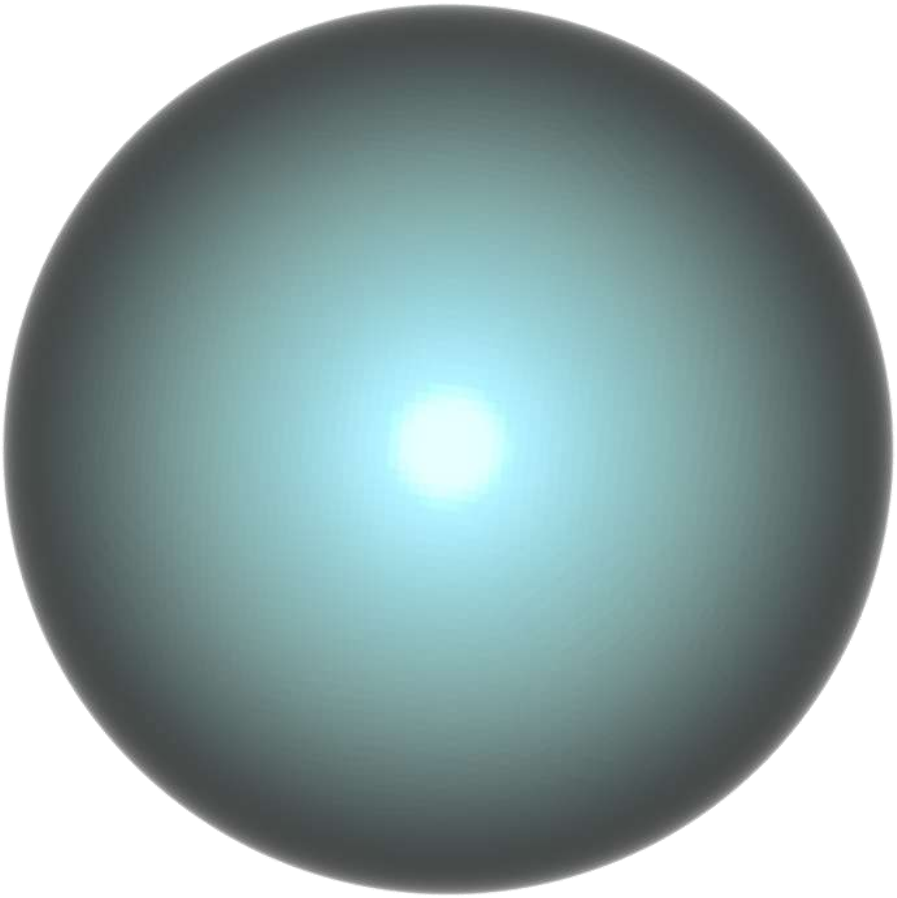


Ours

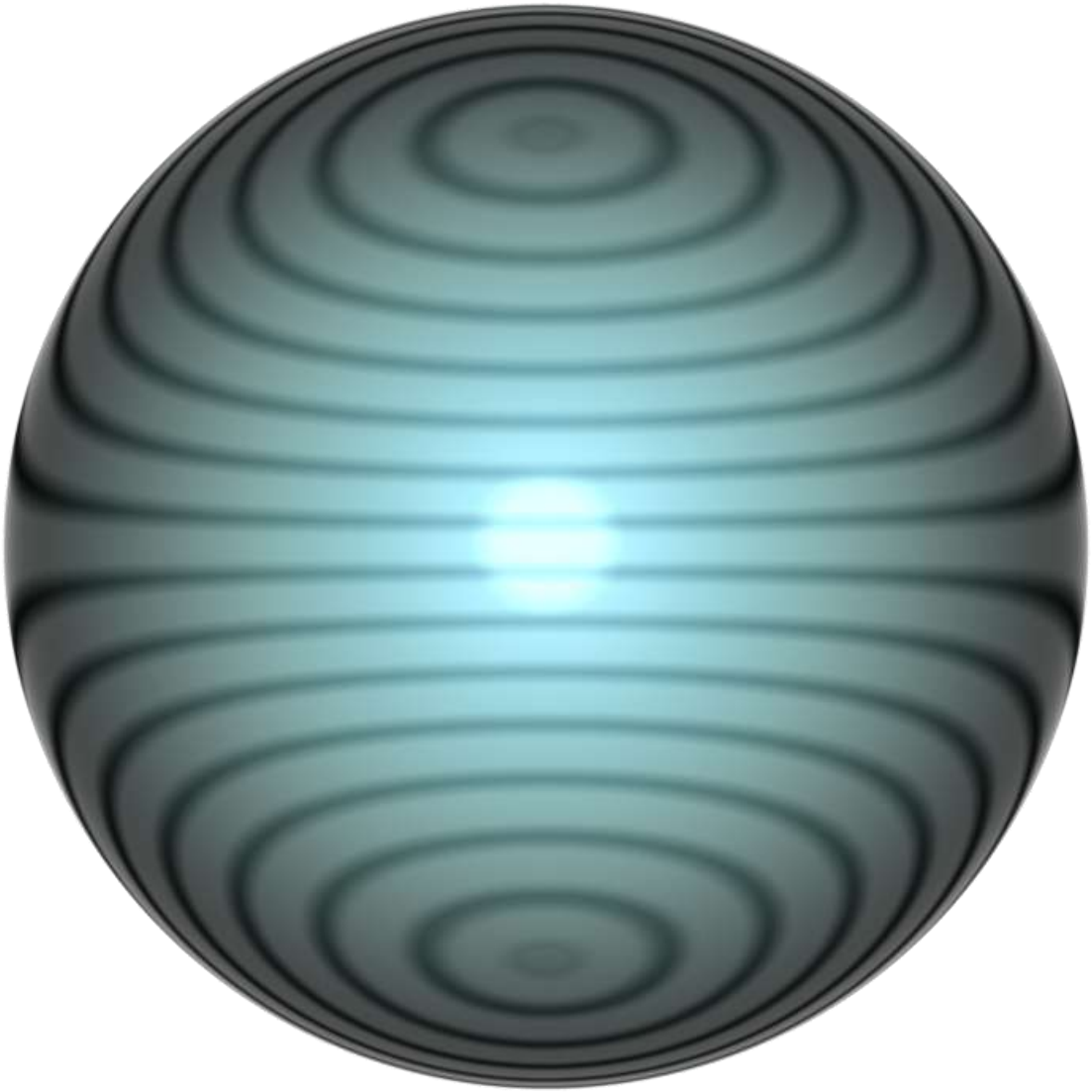
Expanding to 3D



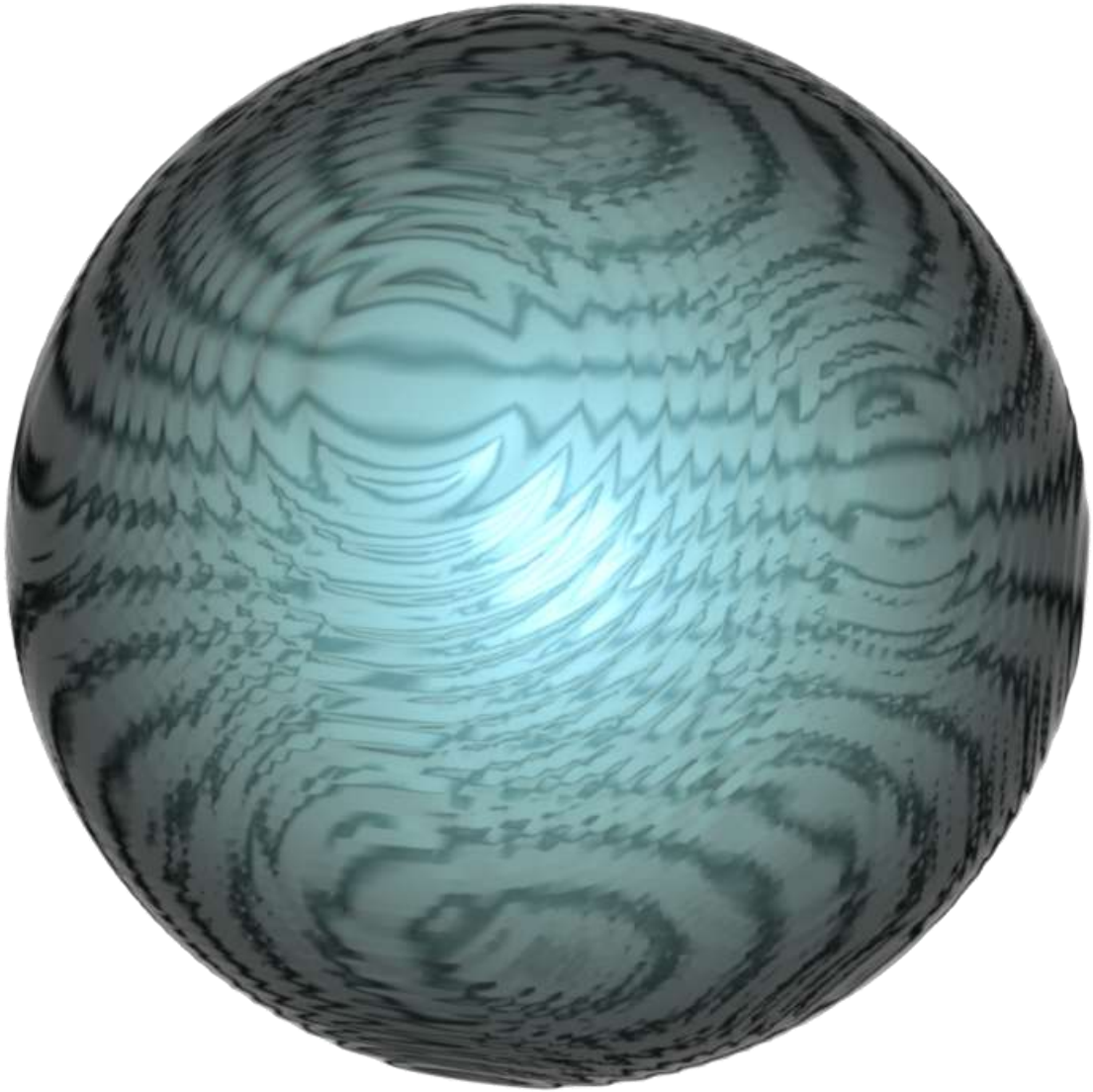
MC



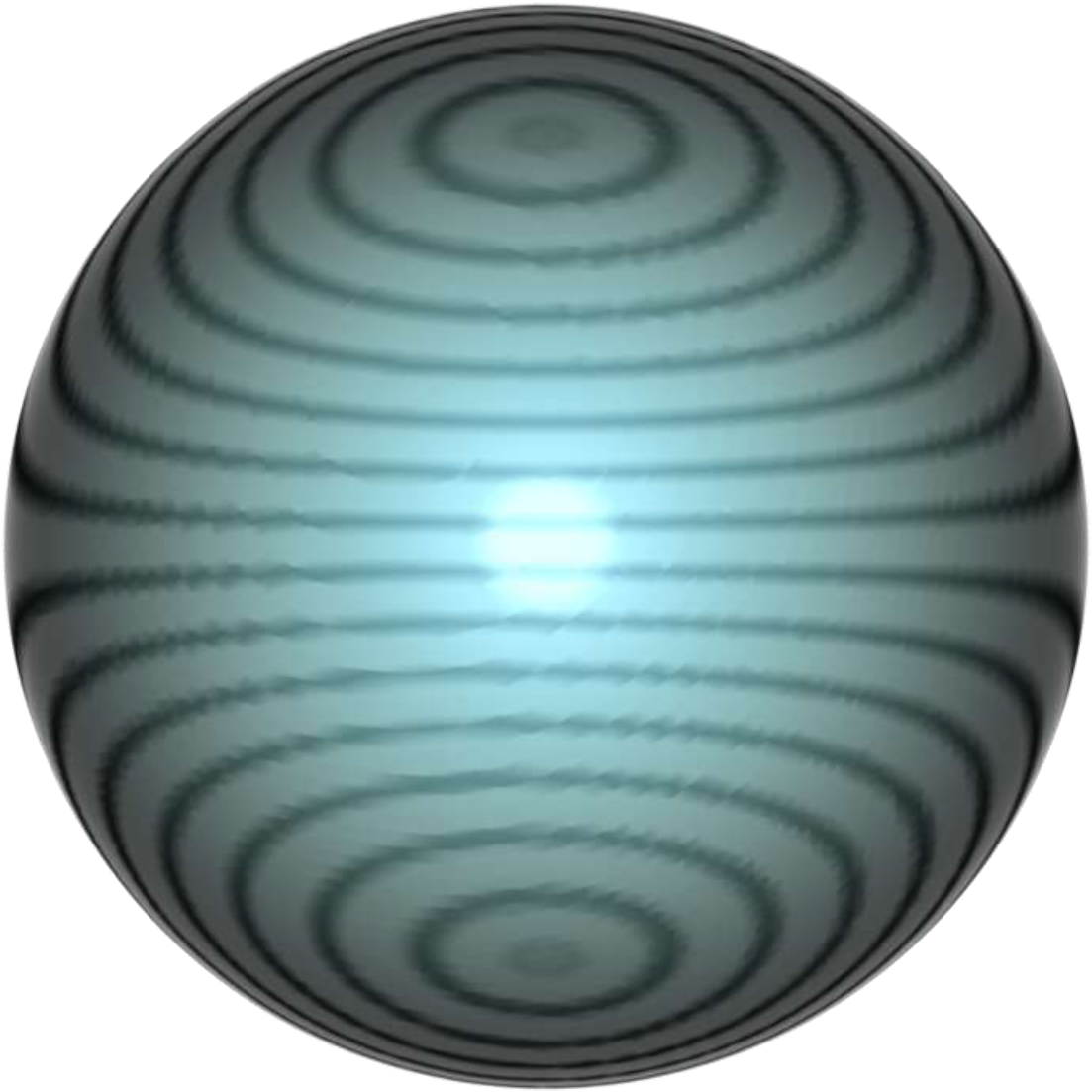
Ours



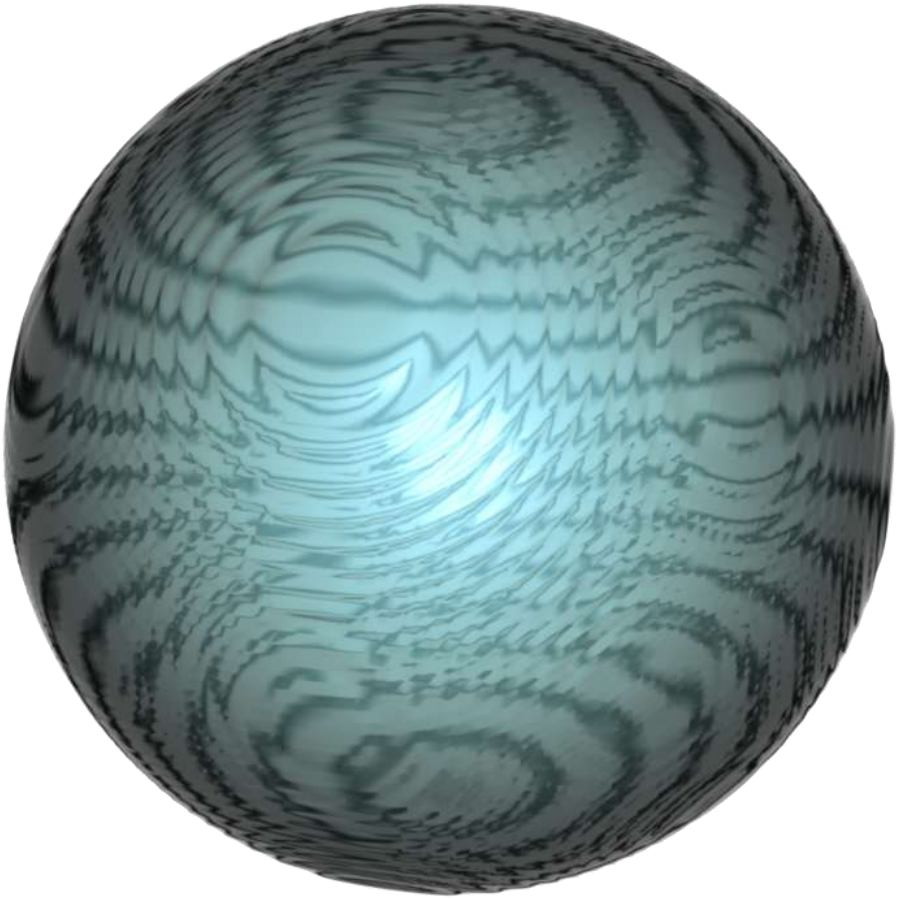
Perfect Sphere



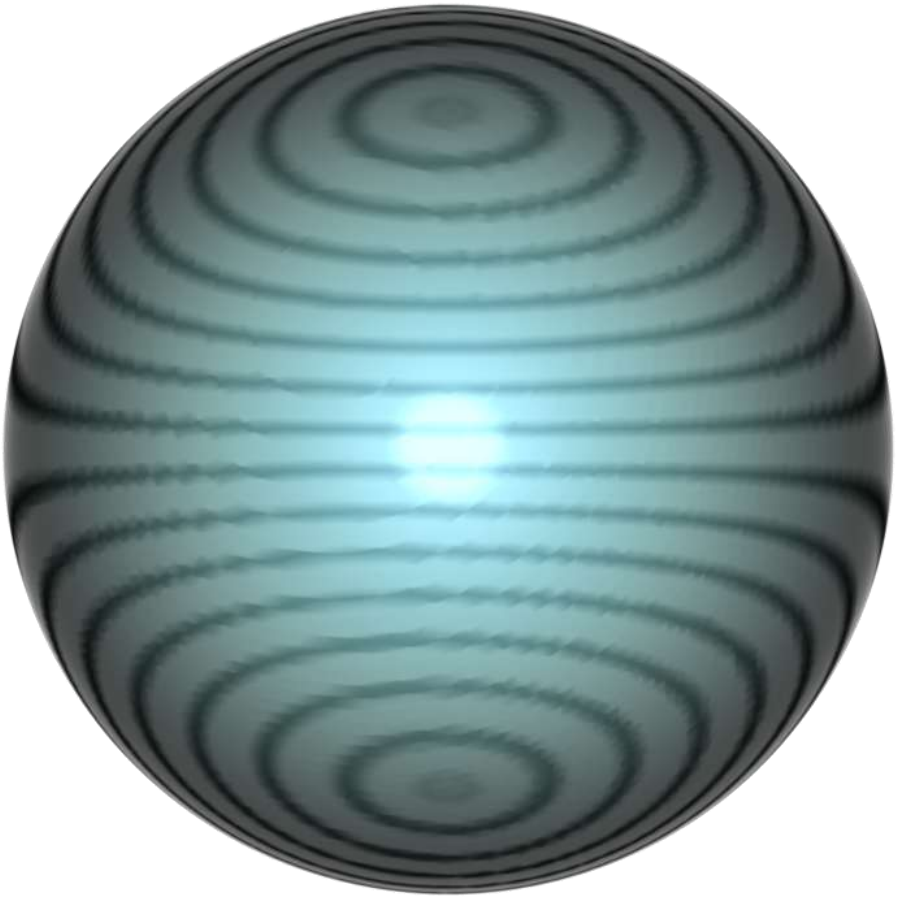
MC



Ours

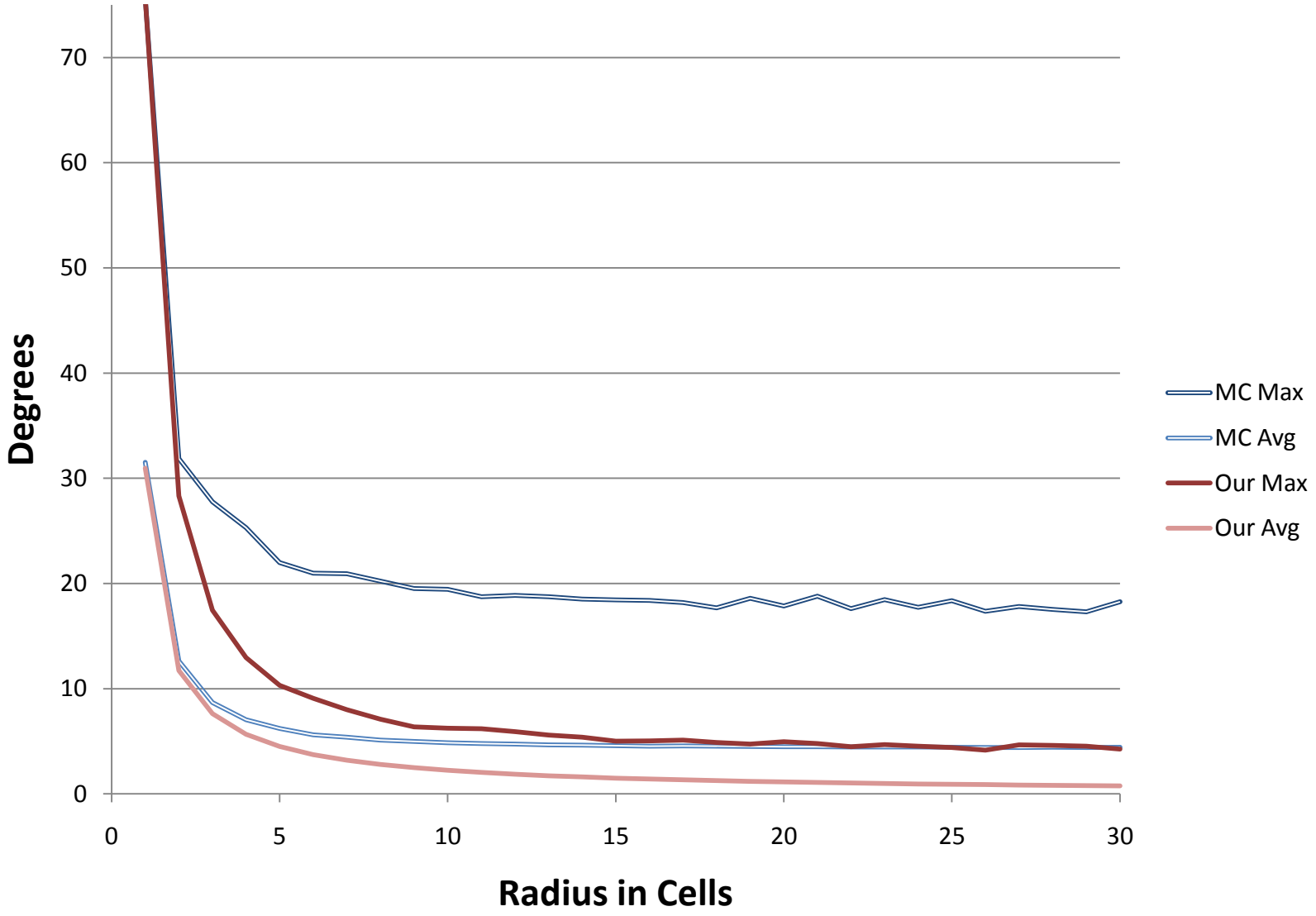


MC



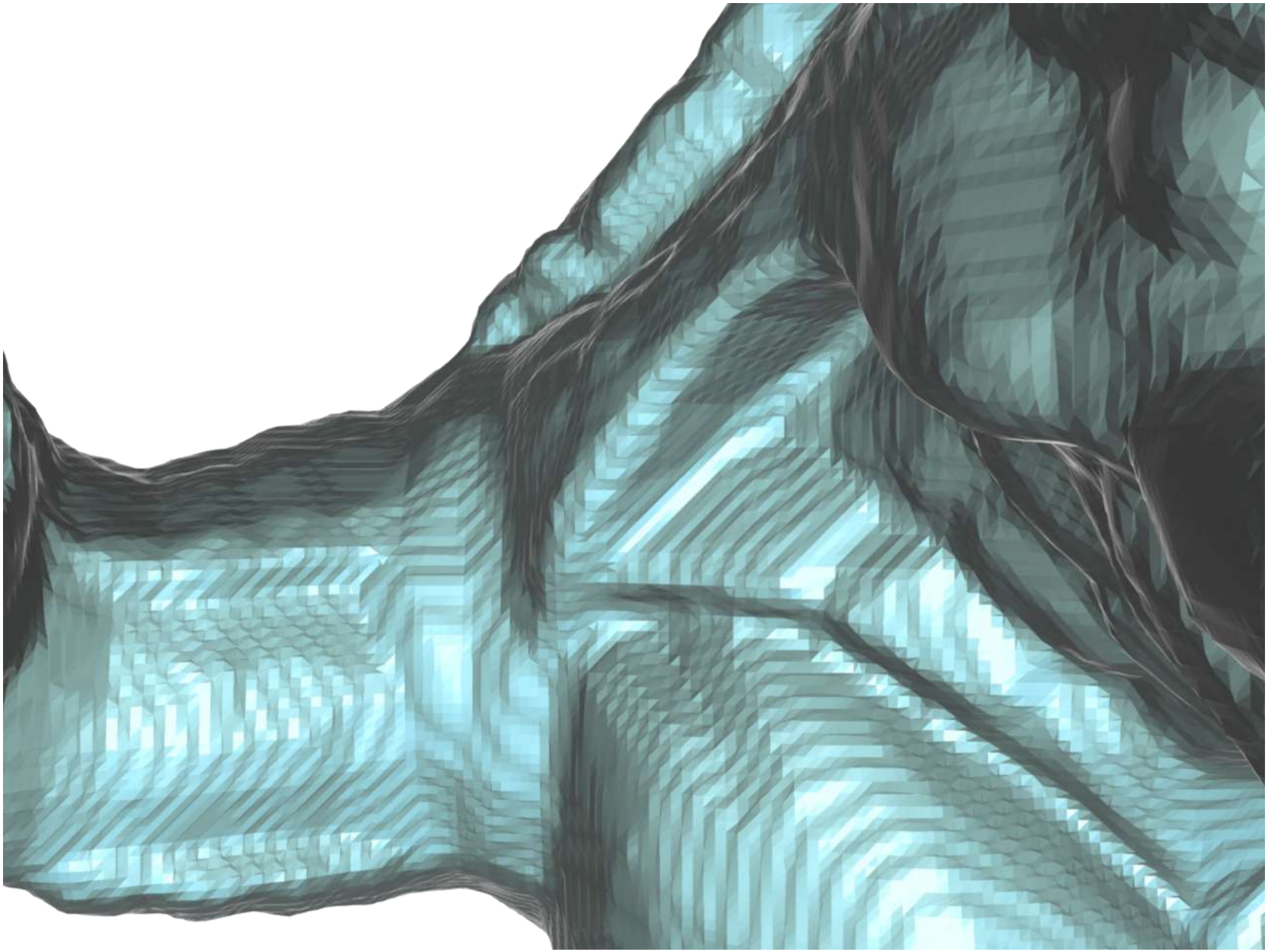
Ours

Sphere Normal Error

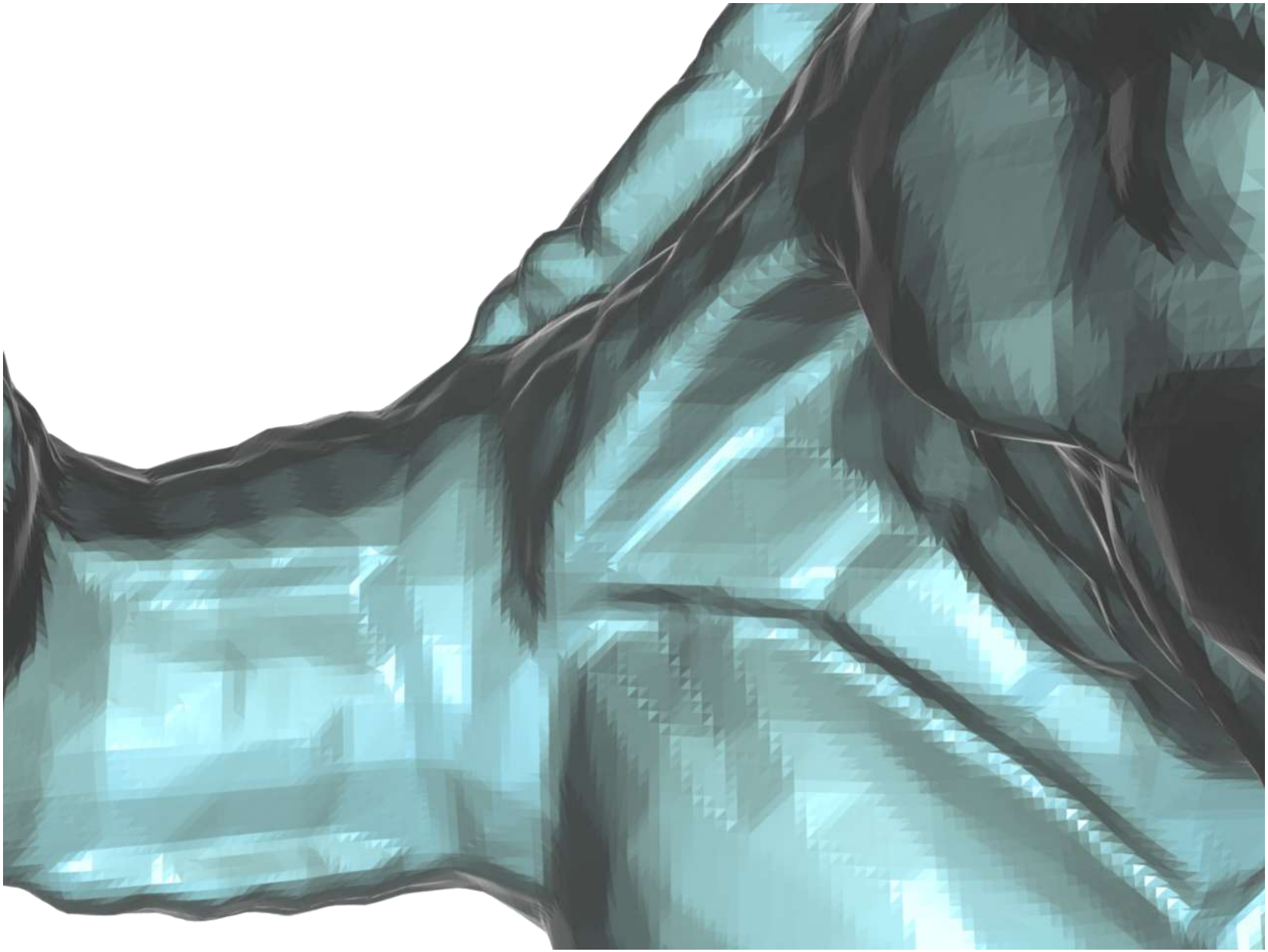


MC

Ours



MC



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.