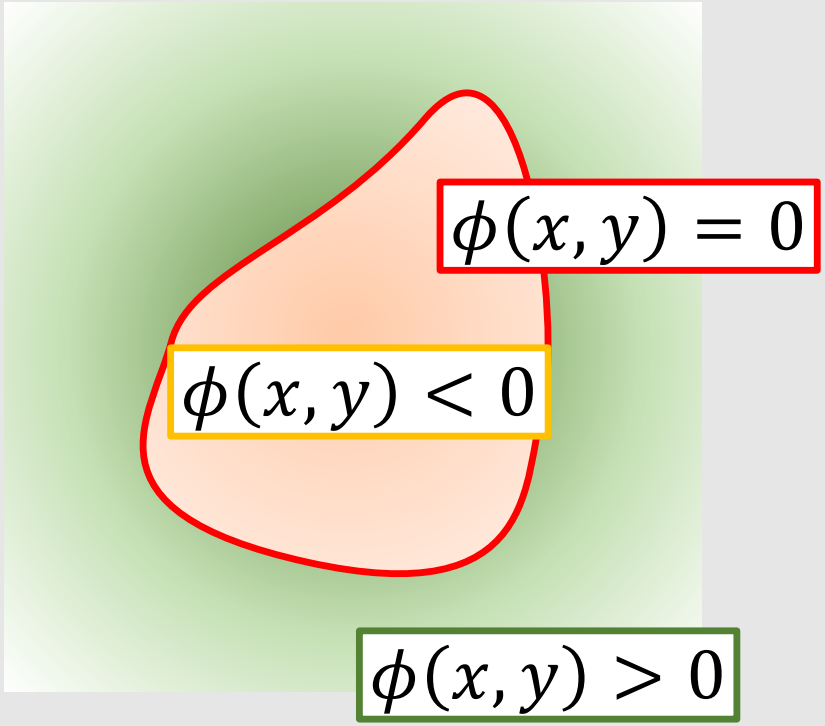
Implicit Modeling

Implicit Surface Representation

- Surface is where level set function is zero $\phi(x, y) = 0$

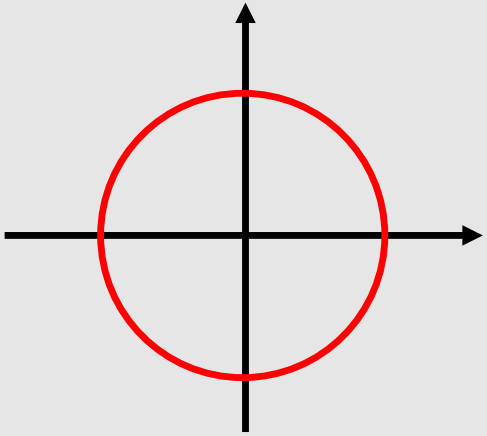


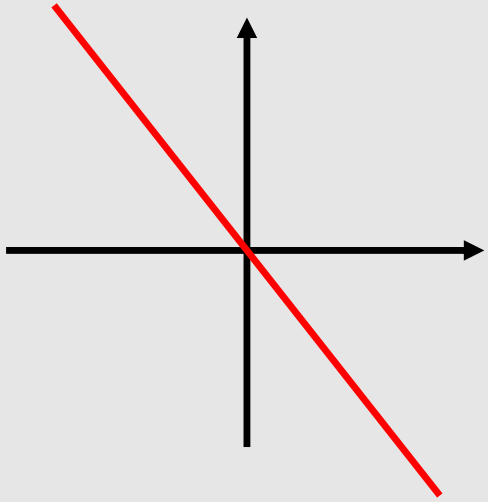
Signed distance function (SDF) is a common choice of level-set function

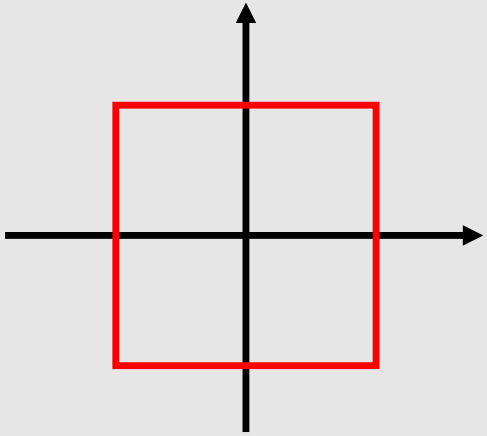
Level-set Function Practice

- What function become on the red curves 0?

Check it out!

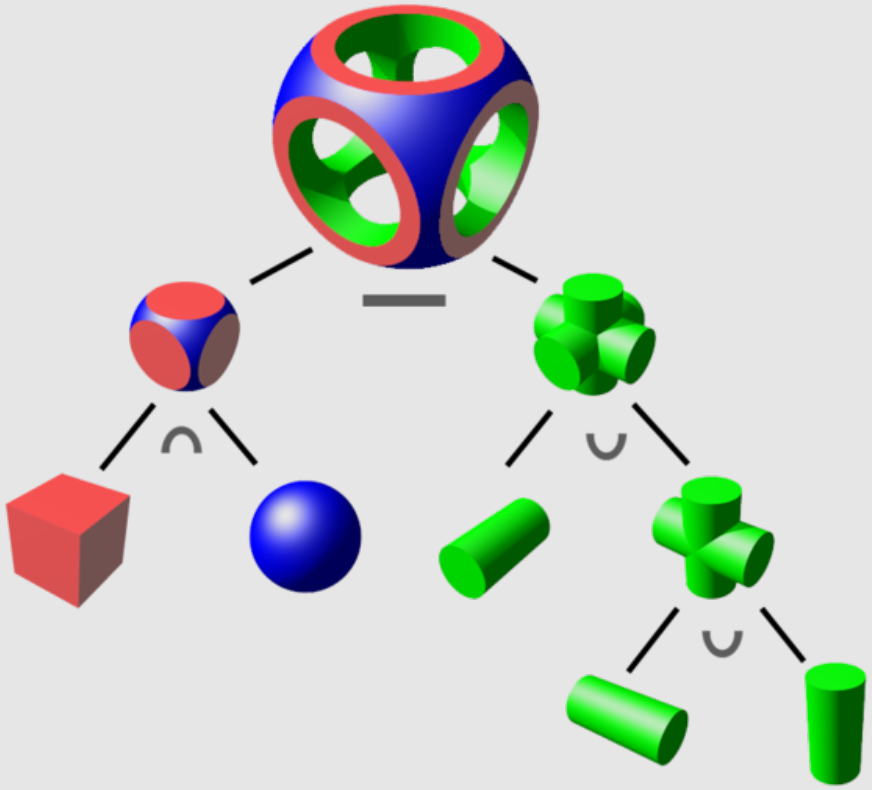




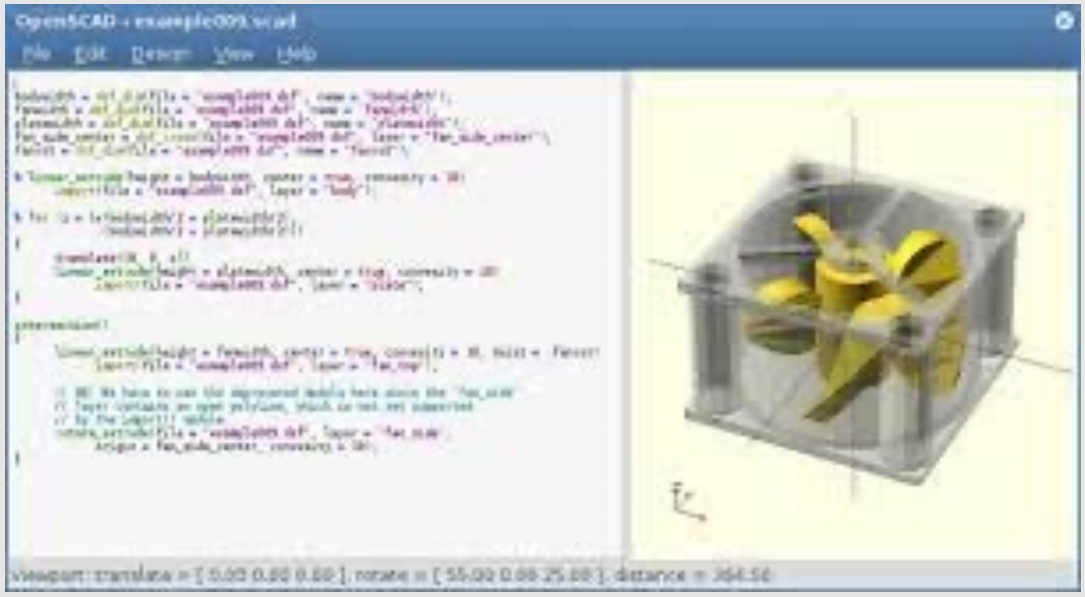


Constructive Solid Geometry (CSG)

- Modeling shape with *boolean* operation

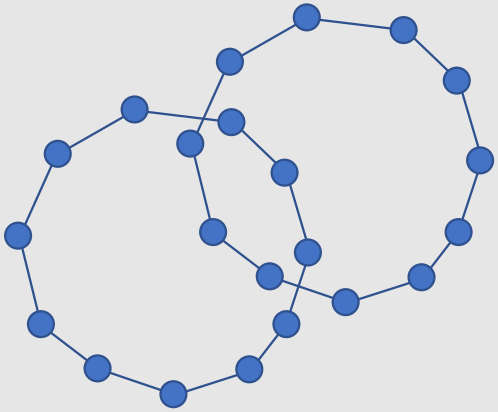


Try OpenSCAD!
https://openscad.org/



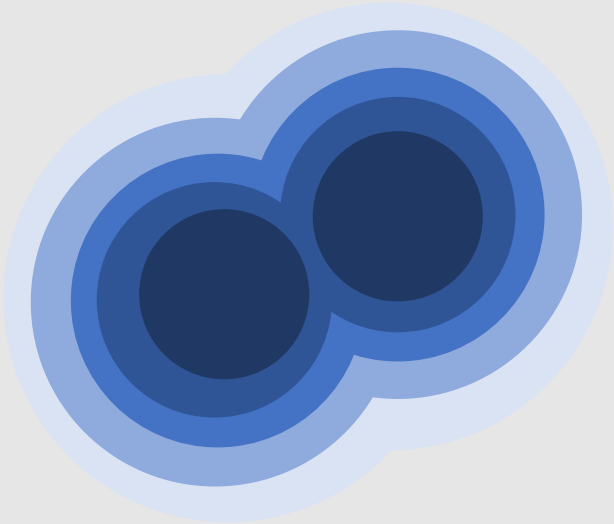
Mesh vs Implicit Representation

mesh representation



mesh surgery!

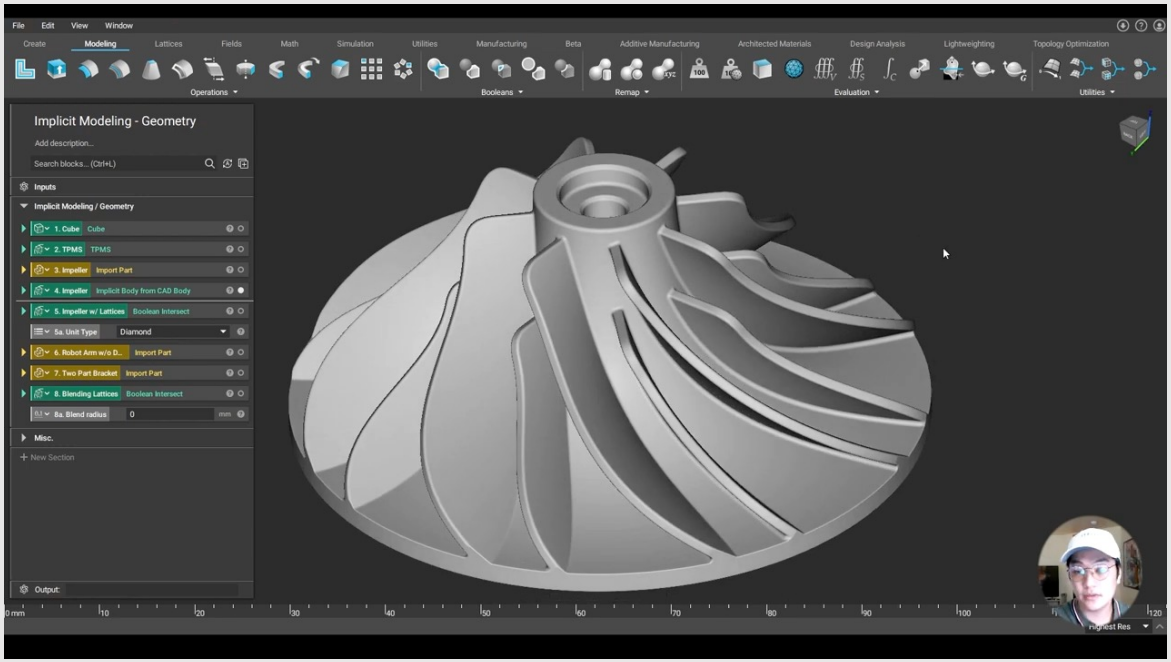
implicit representation



$$f(x, y) = \min(CircleA, CircleB)$$

Implicit Modeling in Engineering

- Lattice structure designed by nTopology
- Useful in aerospace, implants design, heat transfer…etc



nTop Live: What is Implicit Modeling in nTopology
https://www.youtube.com/watch?v=7HidZ9dHi5M

Ray Casting

- Shooting ray from camera

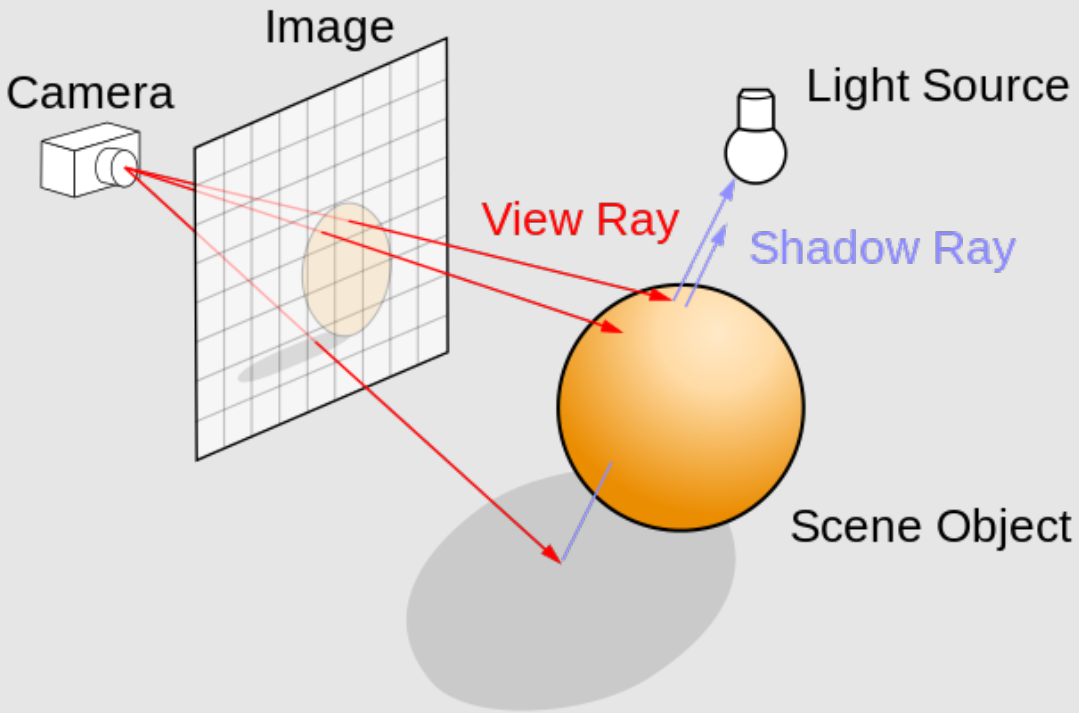
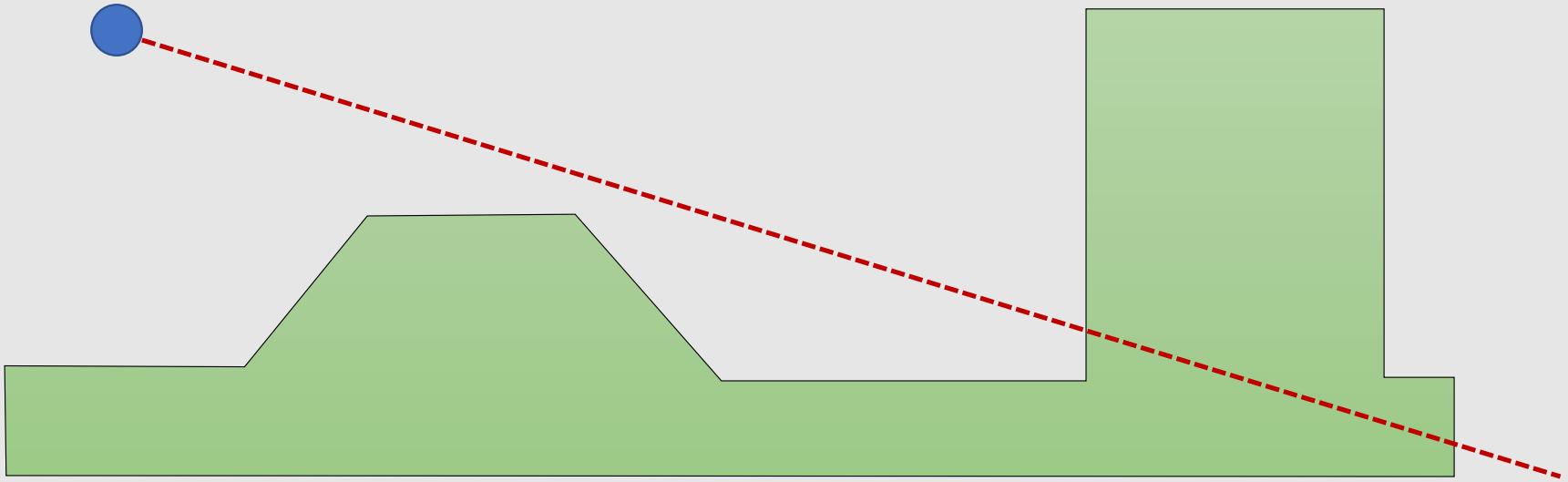


Image Credit: Henrik @ Wikipedia

Sphere Tracing Algorithm

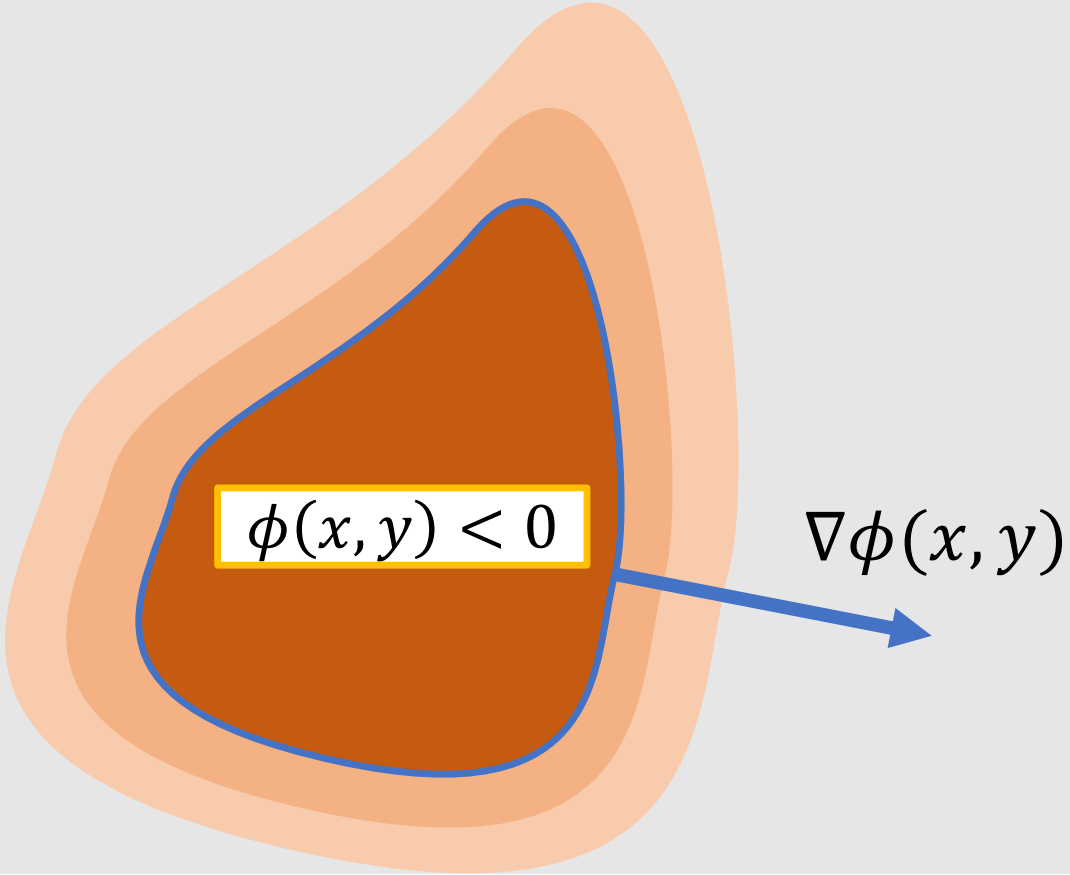
- Ray marching using ***signed distance function (SDF)***



Hart, John C.. “Sphere tracing: a geometric method for the antialiased ray tracing of implicit surfaces.” The Visual Computer 12 (1996): 527-545.

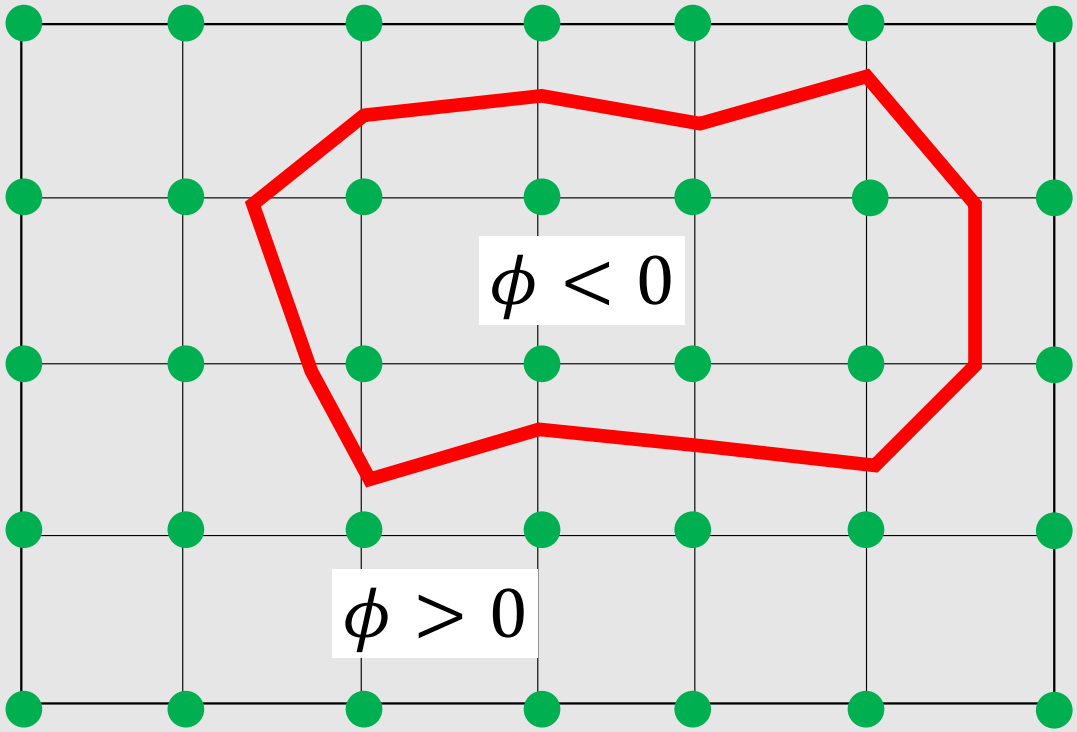
Normal of Implicit Surfaces

- Gradient of implicit function sives normal

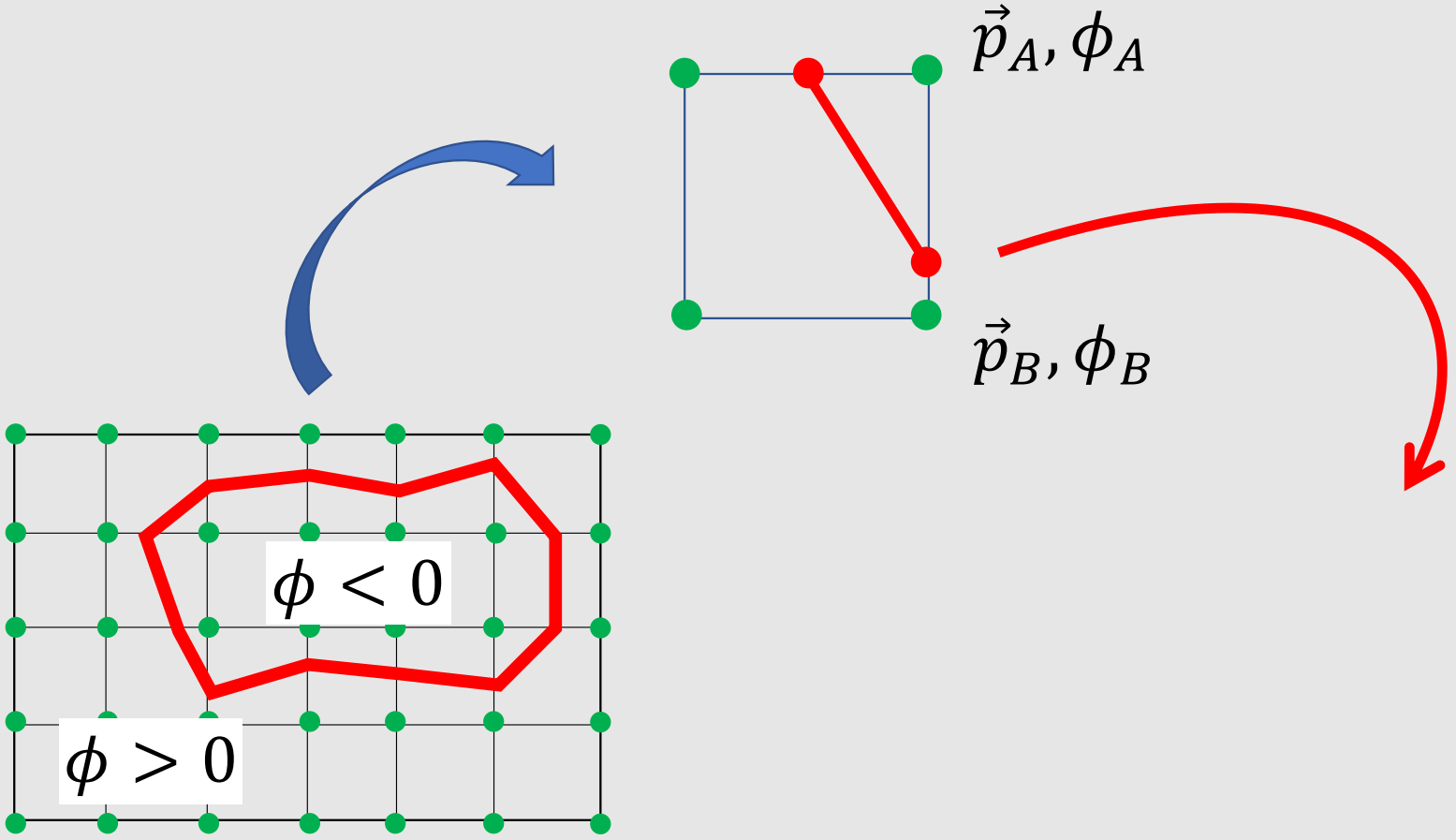


Level-set Function on a Regular Grid

- Define value on a vertices of the grid



Implicit Surface to Mesh: Marching Cube



Implicit Surface to Mesh: Marching Cube

15 patterns of signs at 8 vertices

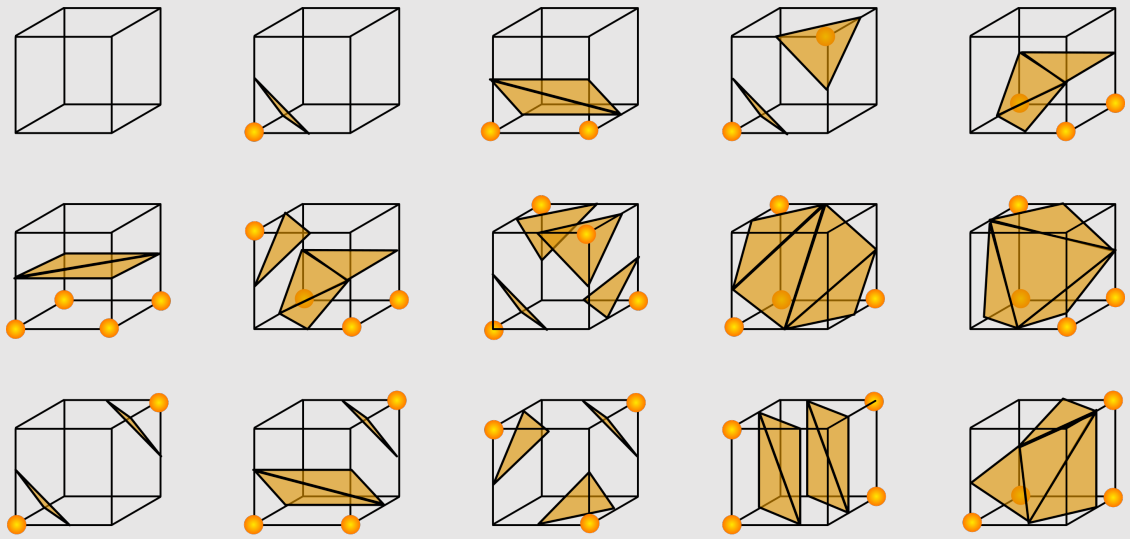


Image Credit: Jmtrivial @ Wikipedia

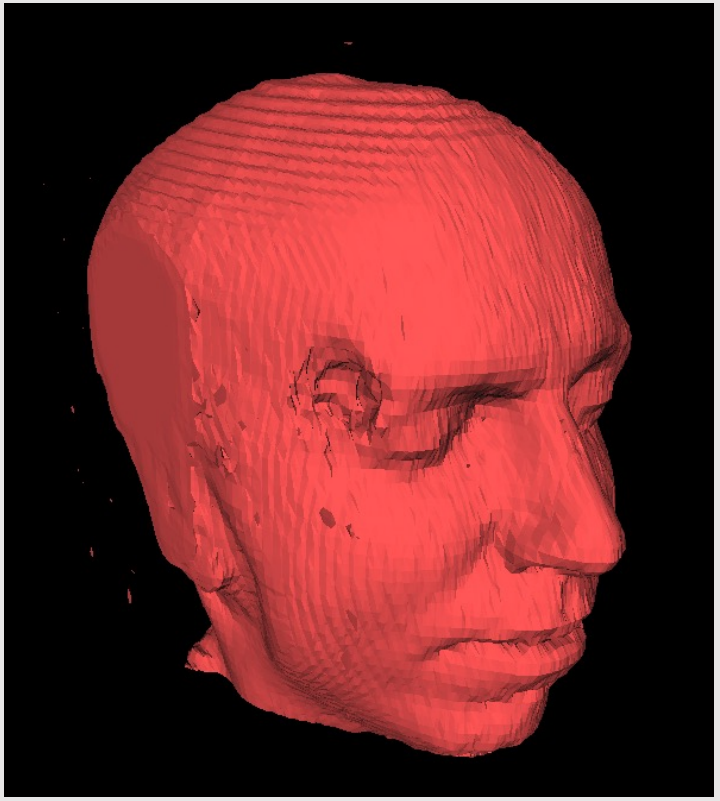


Image from Wikipedia

Metaball

$$\phi(\vec{p}) = \left(\sum_{i=1}^{N} \psi(|\vec{p} - \vec{q}_i|) \right) - \alpha$$

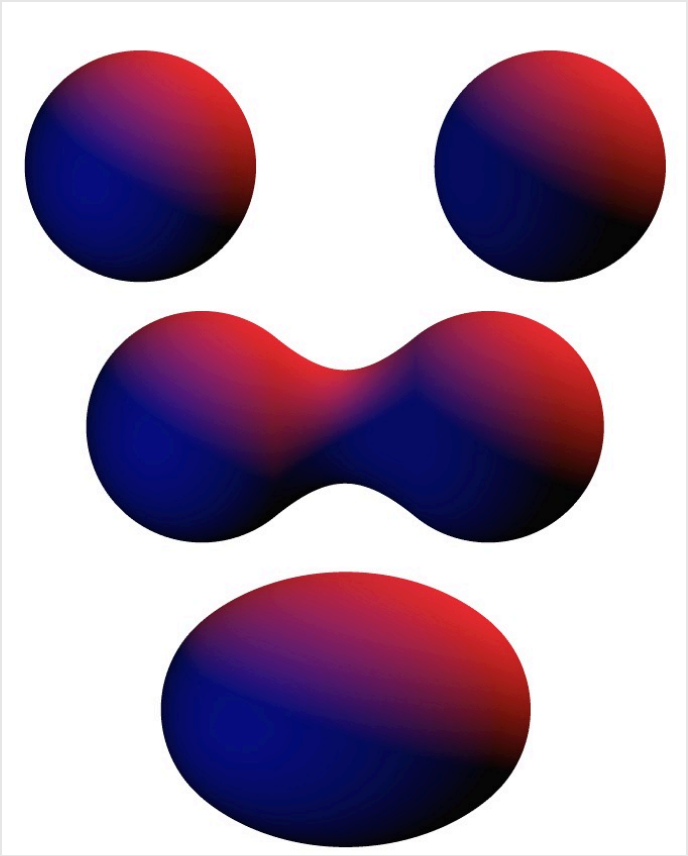


Image Credit: GlydeG @ Wikipedia

Meatball vs Metaball

- https://wikidiff.com/metaball/meatball

WikiDiff

What's the difference between [ ] and [ ] ?

Meatball vs Metaball - What's the difference?

meatball | metaball |

As nouns the difference between **meatball** and **metaball** is that **meatball** is a ball of minced or ground meat, seasoned and cooked while **metaball** is (computer graphics|demoscene) an n-dimensional object with an organic appearance, a popular visual effect in the demoscene.

Other Comparisons: What's the difference?

Meatballs vs Metaballs

meatball	metaball