Fluid Simulation Project

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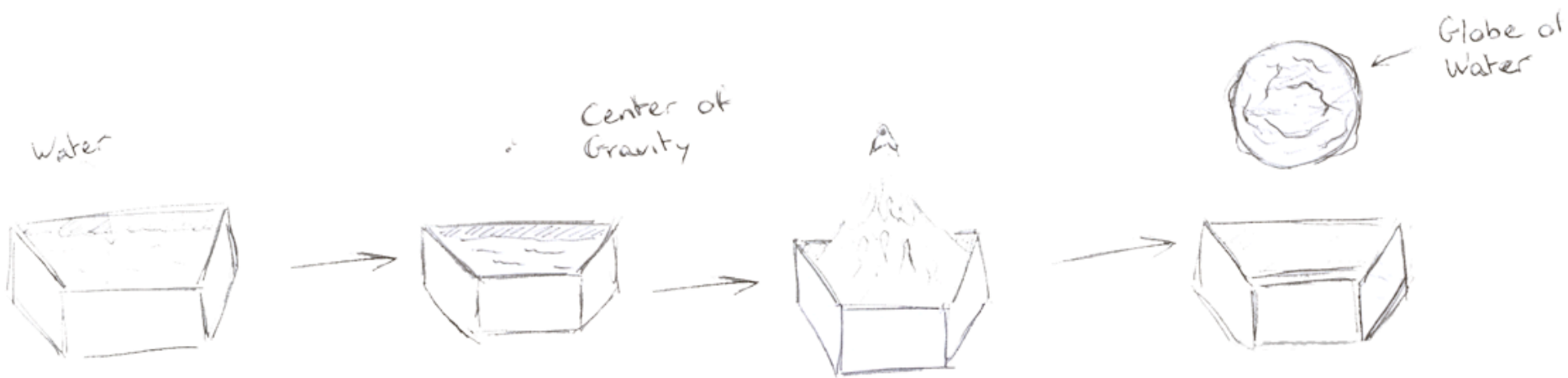

2. Physics

2.a. Simulation step

- Velocity advection
- Force addition → Euler
- Incompressibility conditions → Gauss-Seidel
- Surface tracking → Particles
- Boundaries tracking

2. Physics

2.a. Simulation step

Incompressibility

Incompressibility <=> Velocity Field Divergence Free
Solved using Gauss-Seidel iterations on the Poisson equation
(as seen during the lectures)

Interpretation of the divergence of a point in the grid:
divergence < 0: the fluid tends to collapse
divergence > 0: the fluid tends to expand

2. Physics

2.a. Simulation step

Surface Tracking

Approaches:

- Particle Testing (simple, no surface smoothing)
- Level Set (smooth surfaces, no ripples and small details)
- Particle Level Set (hybrid)

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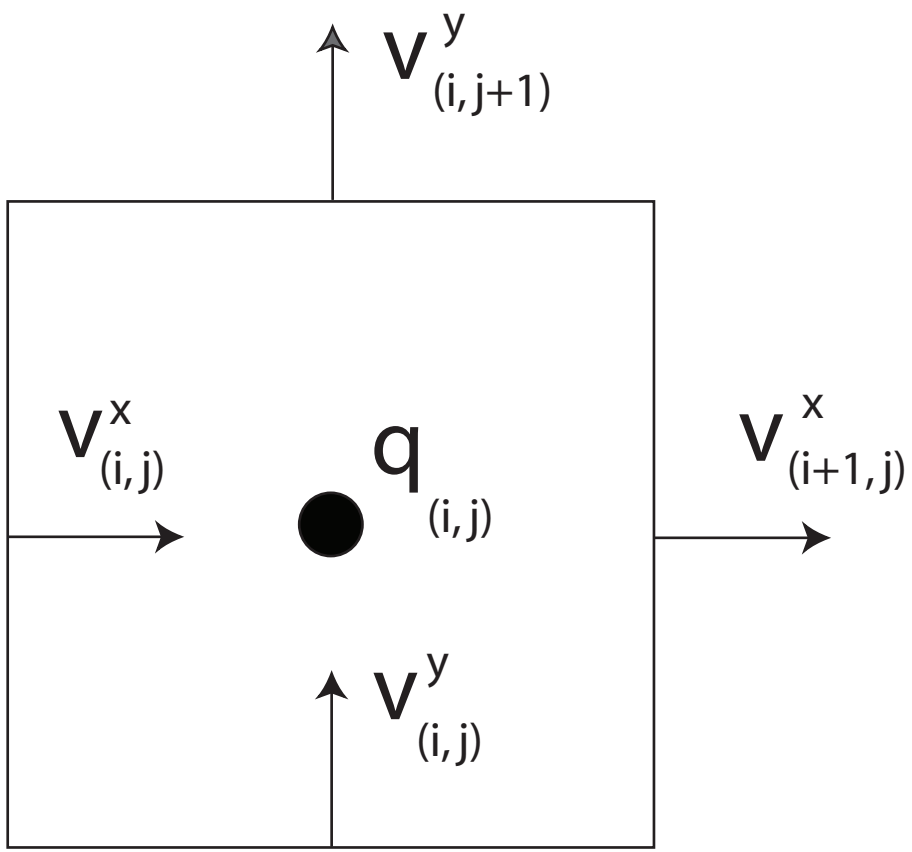
2. Physics
2.b. Grid

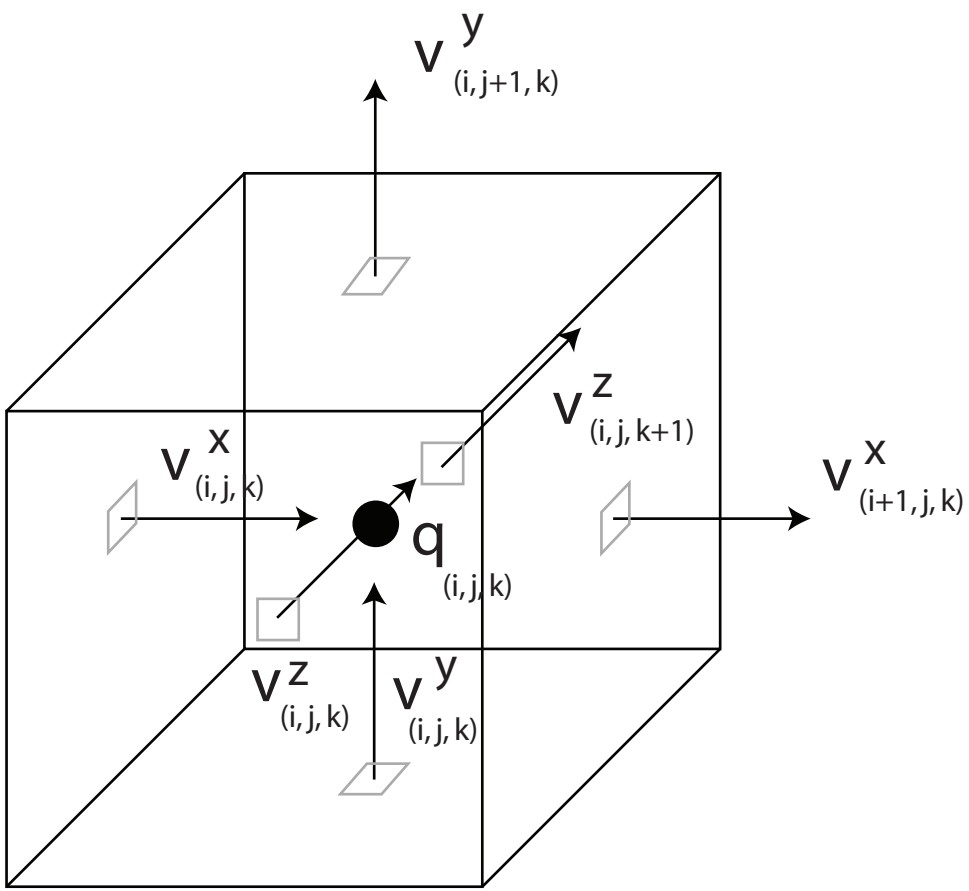


$q_{(i,j)} =$

- Pressure
- Force field
- Particle count
- Cell state

Cell states: Water, Air, Solid, Boundary

2. Physics
2.b. Grid



2. Physics
2.c. Notes

Two different particle generators
have two completely different effects:

8 random particles per cell:
- heavy loss of volume
- correct reaction to forces

1 random particle per cell
sector (8 total):
- gain of volume (variable)
- wrong reaction to forces

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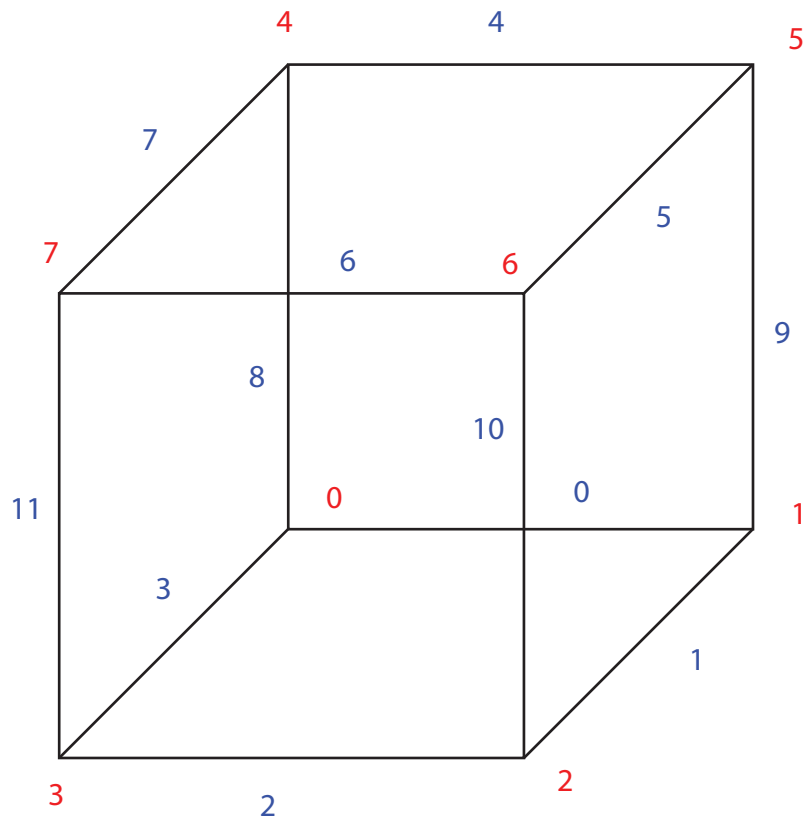
3. Marching Cubes

3.a. Main idea

Vertices

Edges



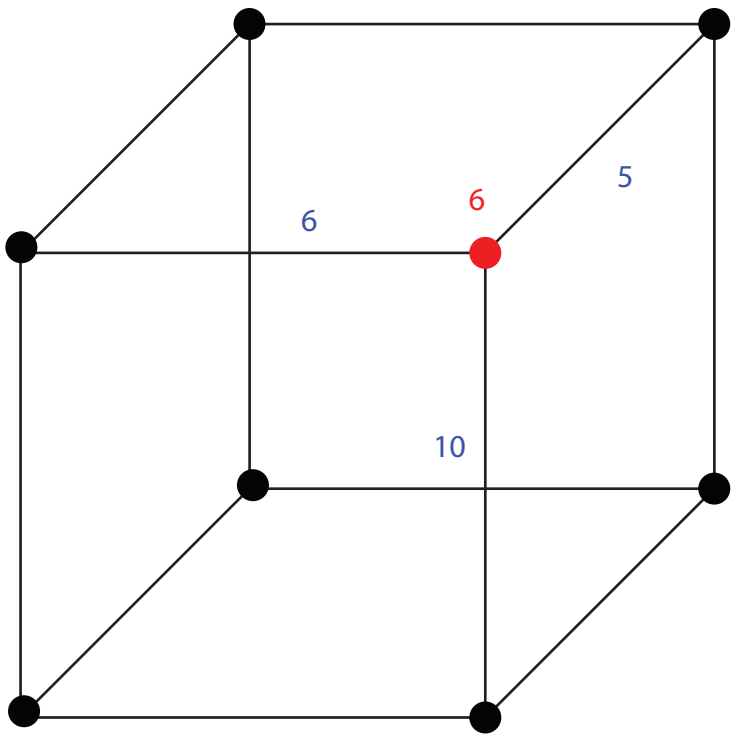
3. Marching Cubes

3.a. Main idea

Find which vertices are inside the surface and which are outside

8 bits vertex flag

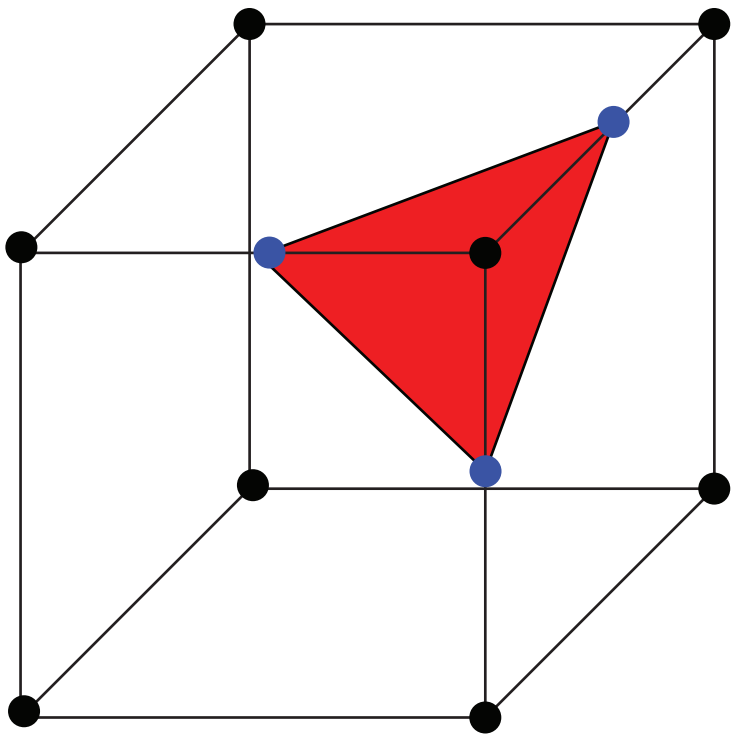
0	1	0	0	0	0	0	0



3. Marching Cubes

3.a. Main idea

Find which edges we have to cut to create the triangle(s)

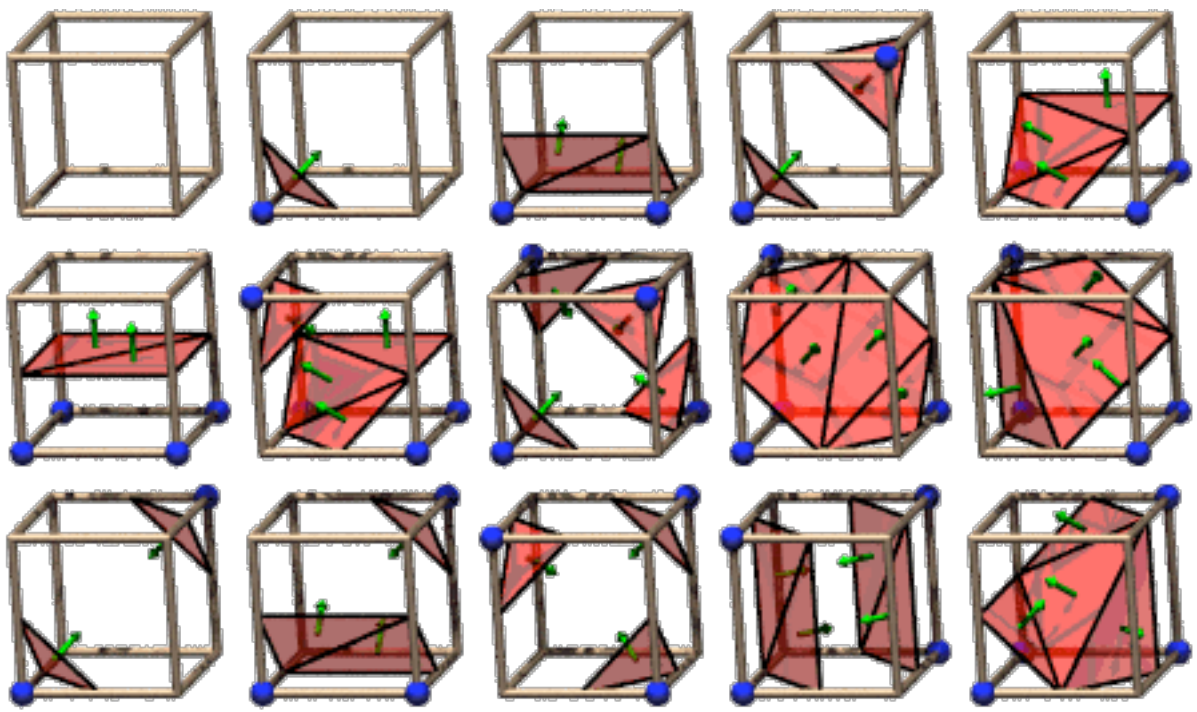


Edge index

{10, 6, 5, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1}

3. Marching Cubes

3.a. Main idea



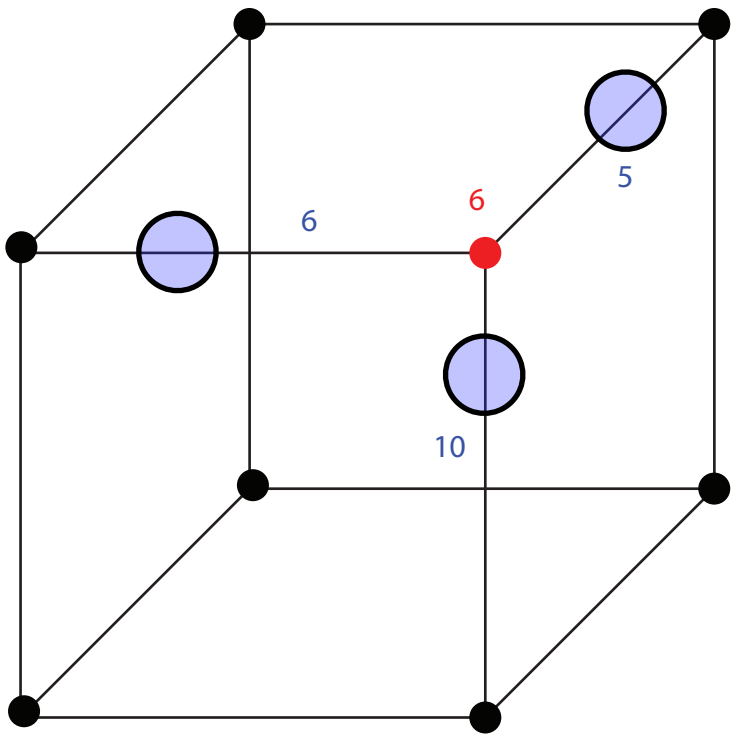
The 15 Cube Combinations

3. Marching Cubes
3.b. Problem

0	0	0	0	0	0	1	0

2^8 = 256
different combinations...

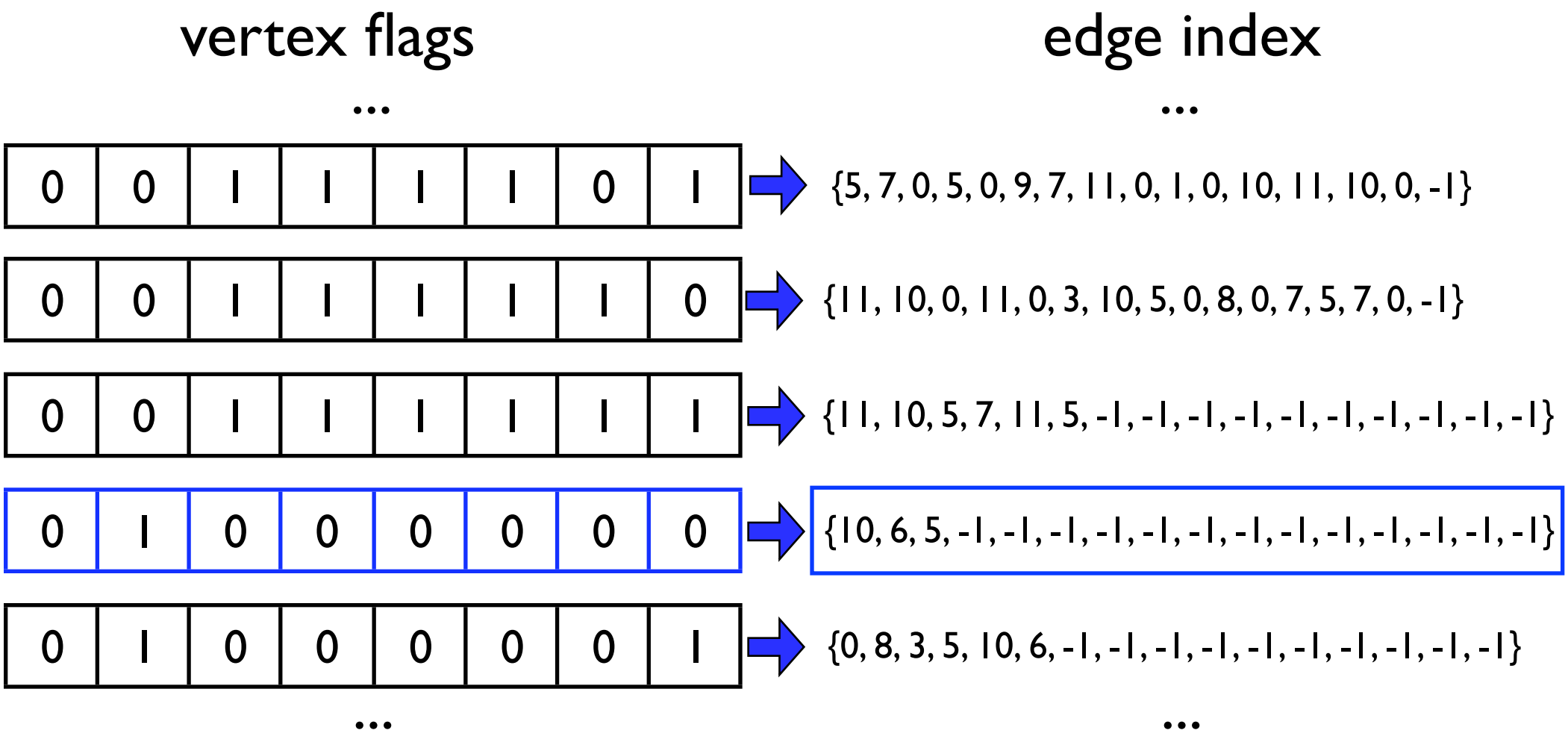
Where do we have to
cut the edges?



3. Marching Cubes

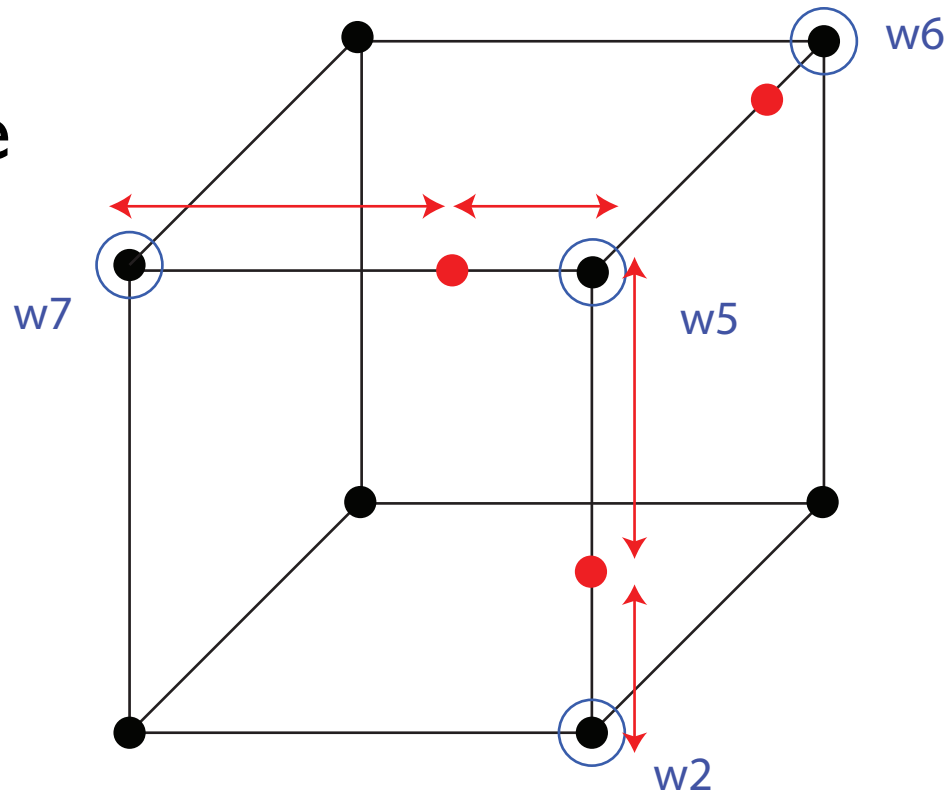
3.c. Solution

Using a "Look-up table":



3. Marching Cubes
3.c. Solution

- Linear interpolation with the weights of each vertex w0, w1, ..., w7
- Not used in our project. Take the point in the middle



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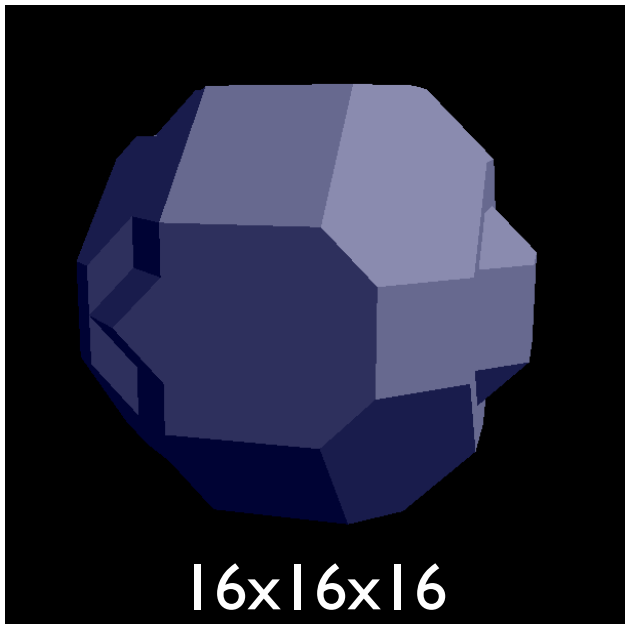

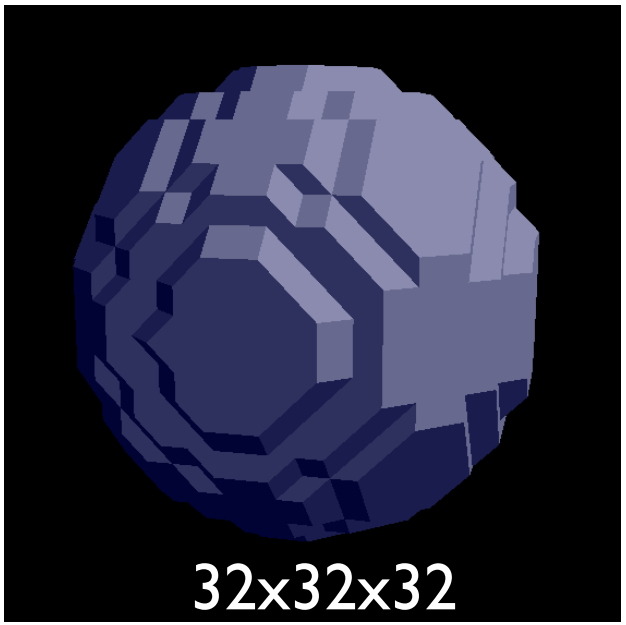

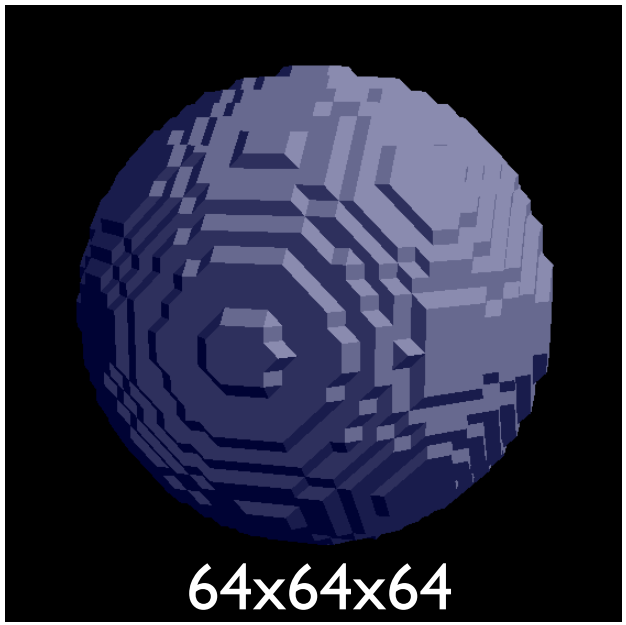

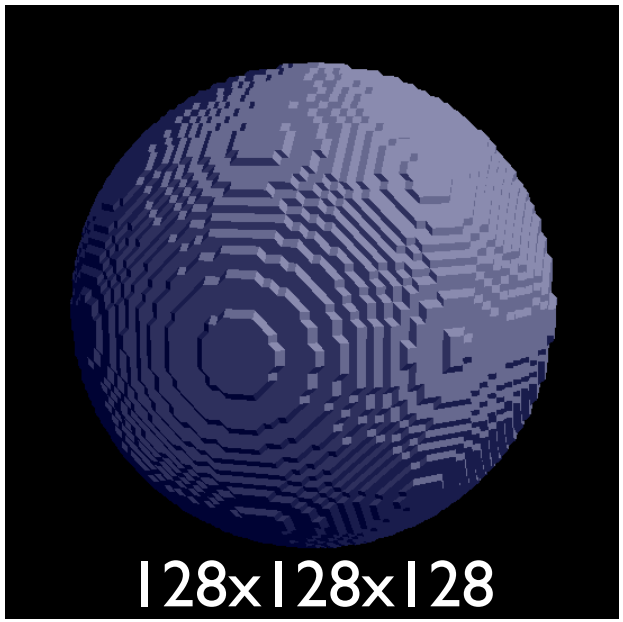

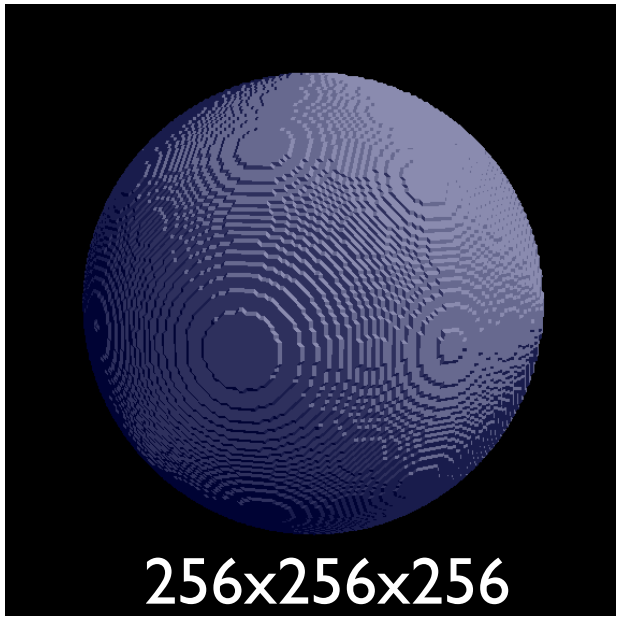

4. References

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Course Notes from "Physically-based Simulation",
ETHZ 2006

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http://www.google.com

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