Cellular Fluid Dynamics

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Procedure

- Toss out the complex differential equations and start from scratch
- Observe and think about real world fluid behavior and formulate rules
- Translate the rules into math and then code

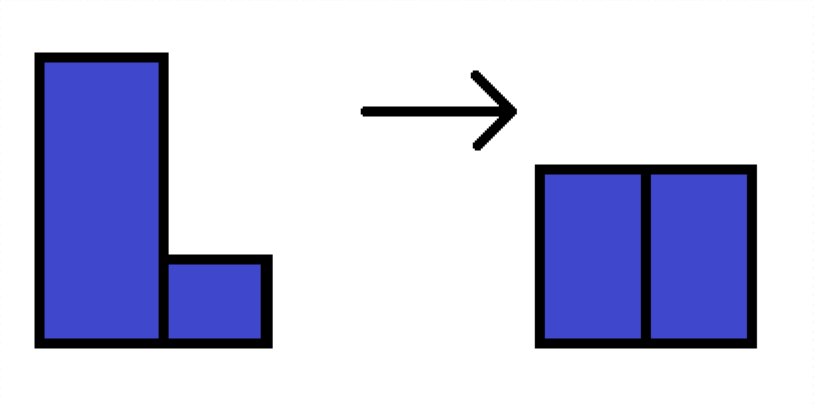
What happens to a pool of uneven water?

- The water level evens out over time

- Let's break this down to the small, cellular level
- What happens to two adjacent fluid cells with uneven fluid levels?

Rule 1: Volume

- When two adjacent cells have uneven levels, they will move towards equalizing their levels



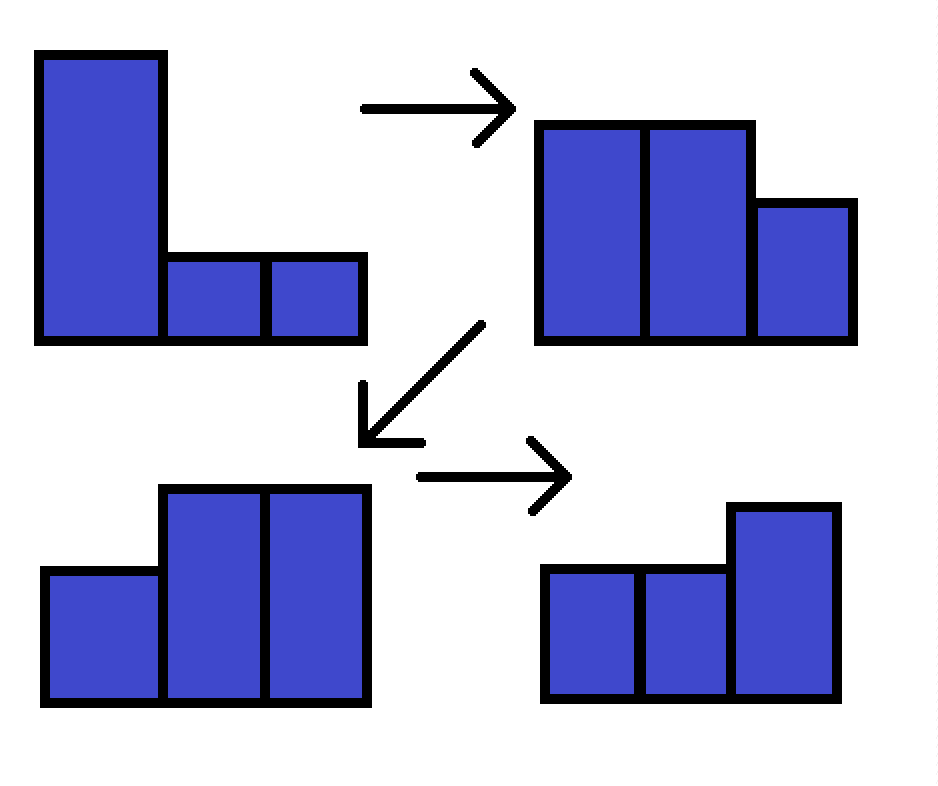
What happens when a still pool of water is suddenly disturbed?

- A ripple propagates through the pool
- How is this reflected on the cellular level?
- A region of higher water level moves from cell to another depending on momentum

Rule 2: Momentum

- Each cell has momentum
- Momentum increases when a cell gains fluid level
- Momentum decreases when a cell loses fluid level
- Has direction dependent on from where the fluid gain/loss originated
- Influences the calculations of Rule 1 (volume equalization)

Rule 2: Momentum



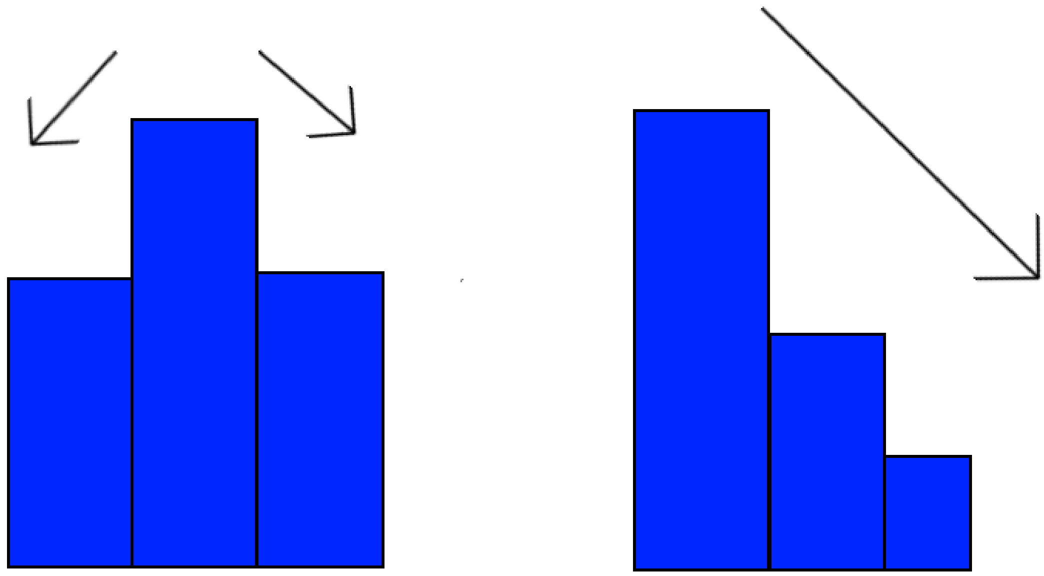
Wave Equation

$$\frac{\partial^2 u}{\partial^2 t} = c^2 \nabla^2 u$$

- Acceleration is proportional to the second order gradient of position
- The more fluid level changes relative to position in the pool, the faster a wave propagates

Applying Wave Equation to Cells

- Will be applied in Rule 1
- Rate of volume equalization is proportional on the difference in level between a adjacent cell and the cell behind the adjacent cell



Rule Equations

Rule 1: $\Delta V_n = K_1(V_{n-1} - V_n)(1 - \frac{V_{n-1} - V_{n-2}}{V_{n-1}}) + K_2(\frac{P_n + P_{n-1}}{A})$

Rule 2: $\Delta P_n = K_3(\Delta V_n)(A)$

Sources and Drains

- A Source is a cell that always maintains its level at or above a threshold
  - Adds fluid and potential to the system
- A Drain is a cell that always has a level of zero
  - Removes fluid and gives potential a zero to "fall" to in the system

- Fluid moves from sources to drains in accordance to Rule 1 and 2

Questions?