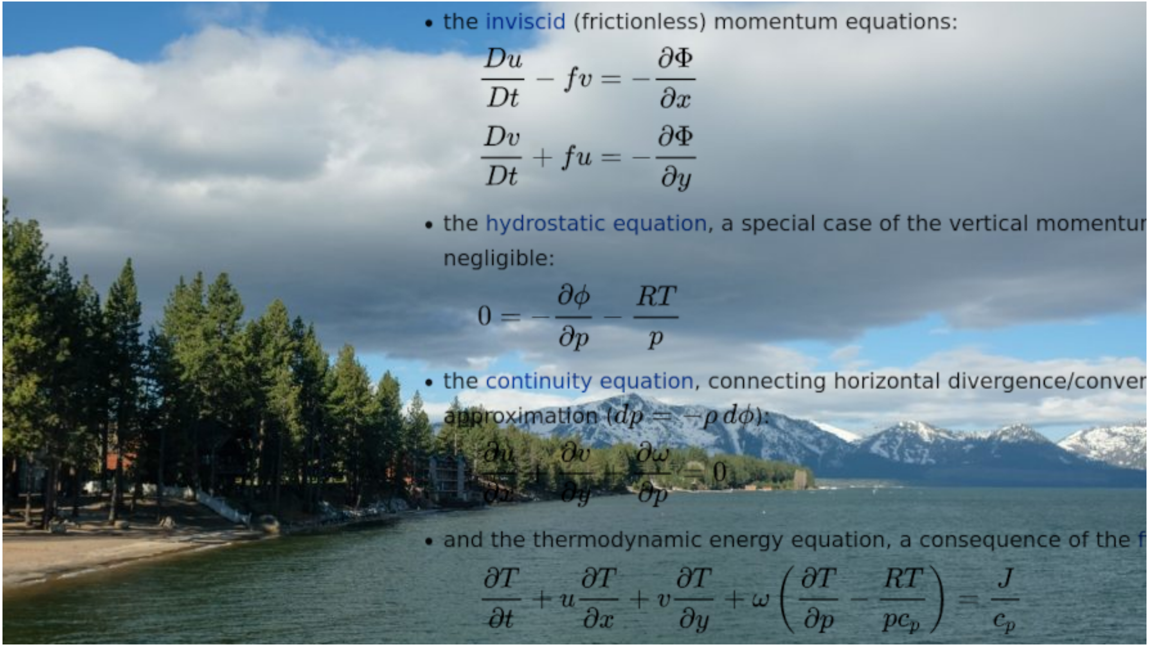

okapi.math.unr.edu
24 cores
2 GPUs
384 GB RAM
20 TB HD



- the inviscid (frictionless) momentum equations:

$$\frac{Du}{Dt} - fv = -\frac{\partial \Phi}{\partial x}$$

$$\frac{Dv}{Dt} + fu = -\frac{\partial \Phi}{\partial y}$$

- the hydrostatic equation, a special case of the vertical momentur negligible:

$$0 = -\frac{\partial \phi}{\partial p} - \frac{RT}{p}$$

- the continuity equation, connecting horizontal divergence/conver approximation ($dp = -\rho \, d\phi$):

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial \omega}{\partial p} = 0$$

- and the thermodynamic energy equation, a consequence of the f

$$\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} + \omega\left(\frac{\partial T}{\partial p} - \frac{RT}{pc_p}\right) = \frac{J}{c_p}$$

```
!-------------------------------------------------------------------
!***  FIRST THE TEMPERATURE
!-------------------------------------------------------------------
!$omp parallel do
!$omp& private(cft,cfu,cfv,cmt,cmu,cmv,crt,cru,crv
!$omp&        ,pdop,pdopu,pdopv,pvvlo,pvvlou,pvvlo
!$omp&        ,rcmt,rcmu,rcmv,rdp,rdpu,rdpv,rstt,r
!$omp&        ,u_k,un,v_k,vn,vvlo,vvlou,vvlov,vvup
!!$omp& private(adtp,adup,advp,ttlo,ttup,tulo,tuup
!-------------------------------------------------------------------
!
    main_vertical: DO J=MYJS2,MYJE2
!
!-------------------------------------------------------------------
!
      iloop_for_t: DO I=MYIS1,MYIE1
!
!-------------------------------------------------------------------
!***  EXTRACT T FROM THE COLUMN
!-------------------------------------------------------------------
!
```

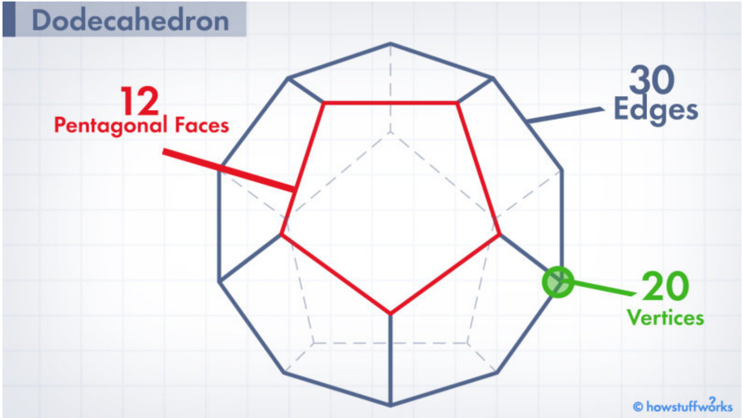
How do you get started with

- statistical simulation?
- high-performance computing?
- data science?
- machine learning?

Ideas:

- Attend the graduate student seminar.
- Solve a simpler problem first.
- Watch how other people do it.
- Try it yourself.

Simpler Problem. Consider a randomly-generated regular Hamiltonian valence-3 graph on twenty vertices. What it the chance that it is a dodecahedron?

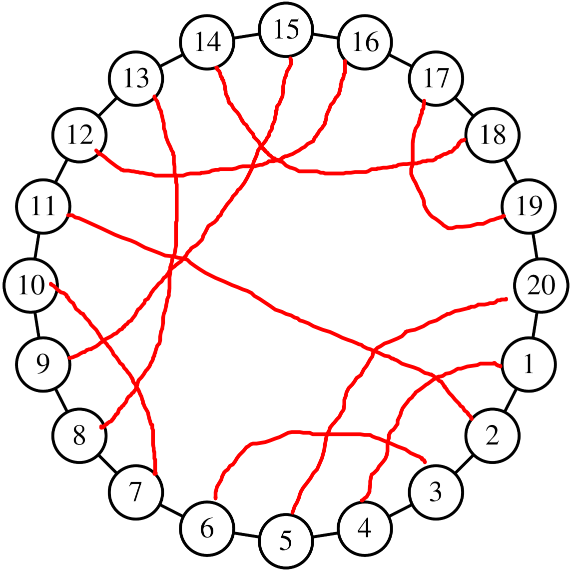


A computational approach to understanding the problem:

- Make a randomly-generated graph.
- Check if it's is a dodecahedron.
- Precisely state a mathematical question.
- Run a simulation to approximate the answer.

A simple way to randomly-generate a regular Hamiltonian valence-3 graph on twenty vertices.

- Start with a Hamiltonian cycle.
- Randomly add 10 additional edges connecting in pair each of the 20 vertices.
- Check the result is regular and valence 3.
- It's easier to understand with pictures.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A simple way to check if a regular Hamiltonian valence-3 graph on twenty vertices is a dodecahedron.

- Construct the adjacency matrix A as

$$A_{ij} = \begin{cases} 1 & \text{if an edge between vertex } i \text{ and } j \\ 0 & \text{otherwise.} \end{cases}$$

- Let $C = A^5$.
- If $C_{ii} = 6$ for $i = 1, \ldots, 20$ it's a dodecahedron.
- If you prove this at home, please let me know.

The mathematical question:

- Let $\Omega = \{\, p : p$ is a per~~tur~~mutbation of $1, \ldots, 20\,\}$.
- Let $B = \{p \in \Omega : G(p)$ is a regular 3-valence graph$\,\}$.
- Let $A = \{p \in \Omega : G(p)$ is a dodecahedron$\,\}$.
- $\boxed{\text{Find } P(A|B)} = \dfrac{P(A \cap B)}{P(B)} = \dfrac{\mathrm{card}(A)}{\mathrm{card}(B)}$.

Note that

$$\mathrm{card}(\Omega) = \boxed{2432902008176640000}.$$

Therefore,

- checking which are dodecahedrons could take centuries.
- given a clever use of symmetry, it might be possible to answer this question using pencil and paper.
- one could use simulation to approximate the answer.

Statistically sample Ω as follows:

- Choose an element $p \in \Omega$ at random.
- Check if $G(p)$ is a regular 3-valence graph.
- Check if $G(p)$ is a dodecahedron.
- Do this in parallel 3000000000 times.
- Let's try it ourselves on Okapi!

More information at

$\boxed{\texttt{http://fractal.math.unr.edu/\textasciitilde okapi/}}$