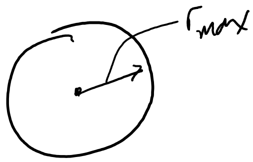
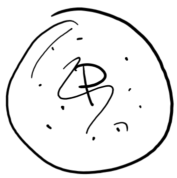
# k-Nearest Neighbor and SPH

08 March 2021 12:40

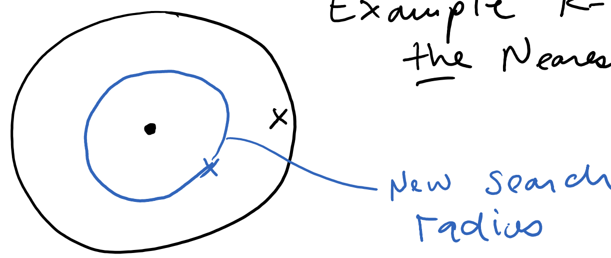



Smoothed
Particle
Hydrodynamics

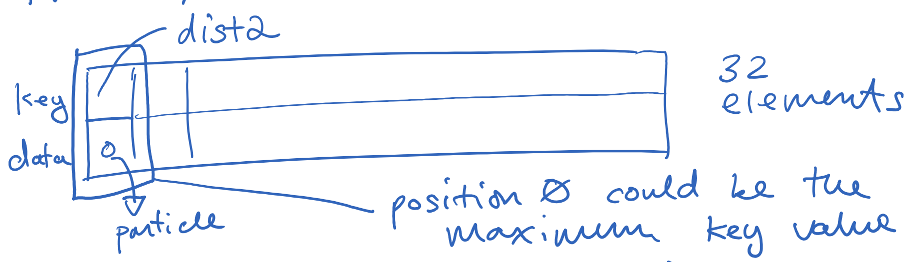
## K-Nearest Neighbors $k = 32$



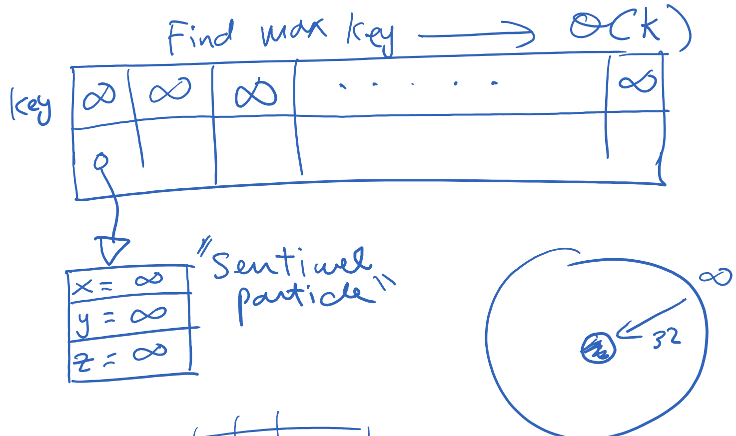
Example $k=1$
the Nearest

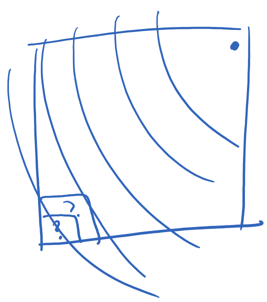


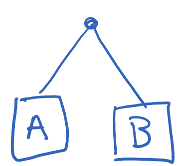

Use PRIORITY QUEUE




Start off with Sentinels




pick the closer cell to descend into first.

```
if (A.dist2 < B.dist2):
    BALLSEARCH(A, ....)
    BALLSEARCH(B, ....)
else:
    BALLSEARCH(B, ....)
```

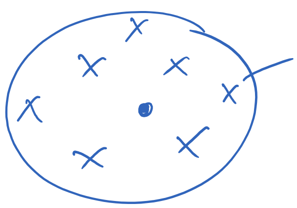
BALLSEARCH(A, ... )

Find Maximum element of PrioQ $O(1)$
Insert into PRIOQ $O(k)$ Heap $O(\log_2 k)$

Pop
PUSH/INSERT

REPLACE
HEAD or dist2

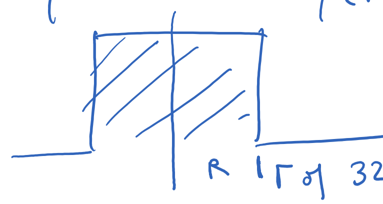
PRIOQ.dist2
↑ current max dist.



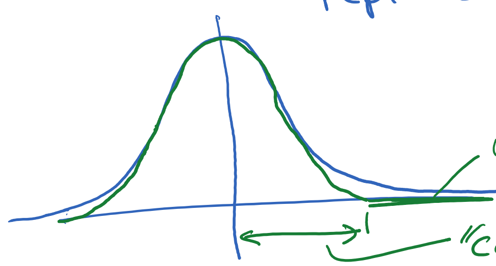
3D density $\rho(r)$

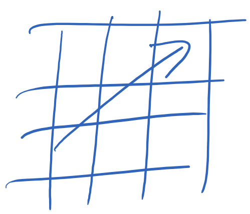
$$\rho(r) = \frac{\sum_k m_k}{\frac{4}{3}\pi R_0^3}$$

TOP HAT:

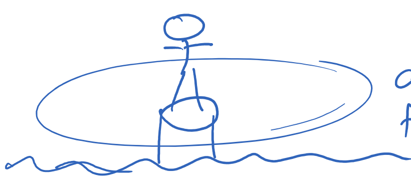



for SPH we replace this



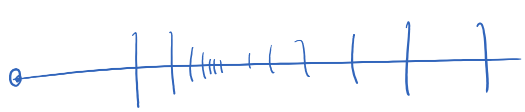



Grid
Methods
Eulerian approach



describe the fluid from the point of view of being in the flow.

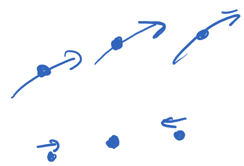
Lagrangian approach

1-D it works great

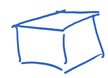
SPH: Particles represent parcels of the fluid

Lagrangian



PHYSICS: Equation of motion

$$\underline{F} = m \cdot \underline{a}$$




$$\underline{F} = \rho \delta V \frac{d\underline{u}}{dt}$$

$\underline{u}$ — fluid velocity in the moving frame of reference

$$\frac{d\underline{u}}{dt} = \text{"Time derivative following the motion"} \equiv \frac{\underline{u}(\underline{x}+\underline{u}\delta t, t+\delta t) - \underline{u}(\underline{x}, t)}{\delta t}$$

$$\frac{dF}{dt} = \frac{1}{\delta t}\left\{F(\underline{x}+\underline{u}\delta t, t+\delta t) - F(\underline{x}, t)\right\}$$

Taylor expand

$$F(\underline{x}, t) + \frac{\partial F}{\partial \underline{x}} \underline{u}\delta t + \frac{\partial F}{\partial t}\delta t - F(\underline{x}, t)$$

$$\boxed{\frac{dF}{dt} = (\underline{u}\cdot\nabla)F + \frac{\partial F}{\partial t}}$$

Convective derivative

$$\frac{d\underline{u}}{dt} = \underline{u}\cdot\nabla\underline{u} + \frac{\partial \underline{u}}{\partial t}$$

$$\rho \delta v \frac{d\underline{u}}{dt} = \rho \delta v \, \underline{g}$$

← don't forget the contribution due to pressure

$$\boxed{\frac{d\underline{u}}{dt} = \underline{g} - \frac{P}{\rho}}$$