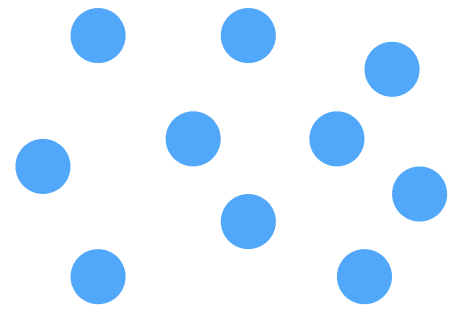


High Performance Computing for Science and Engineering I

Tutorial 5. Parallel data storage and visualization

Scientific data

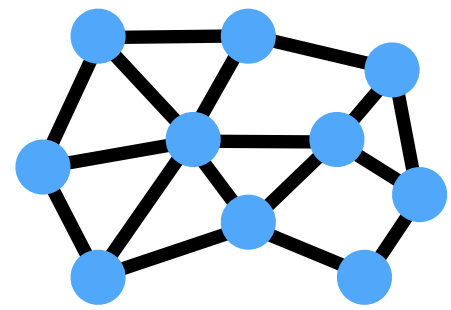
- Particles



points, fields

1D arrays

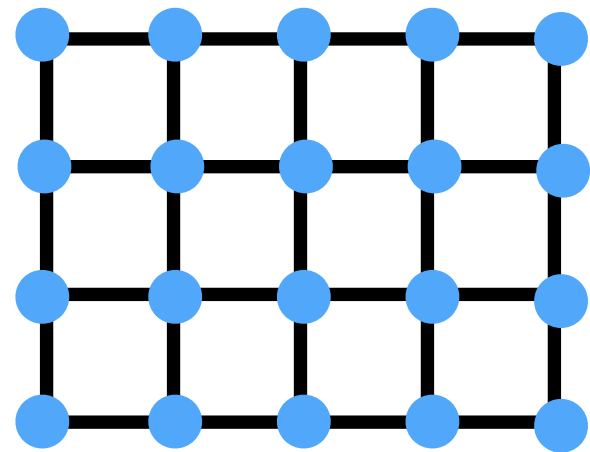
- Unstructured grid



points, connectivity, fields

1D arrays

- Structured grid



(points), fields

2D/3D arrays

- Statistics

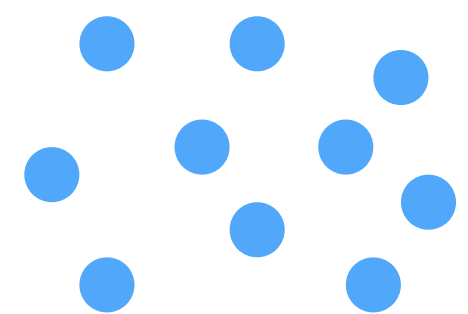
t	energy	circulation
0.0	1	0
0.1	1	0
0.2	1	0
0.3	1	0

Example 1: CSV

- Comma-separated values

```
x,y,z,r
-0.467,-0.0323,-0.22,0.517
-0.33,0.387,0.0173,0.509
-0.491,0.0225,-0.373,0.618
-0.483,0.143,0.33,0.602
-0.368,0.133,0.174,0.428
-0.309,-0.409,-0.155,0.536
```

- Particles



positions, fields
1D arrays

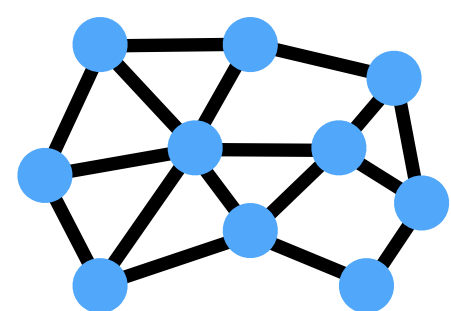
- Example **tut05/csv**
 - output one file from each rank
 - output from root after `MPI_Gather`
 - output using MPI I/O
- On Euler, load modules with
`source tut05/modules.euler`
- Build and run with **make**
- Copy data from `~/tut05` on Euler with
`rsync -Paz "euler:tut05/csv/part*.csv" .`

Example 2: VTK

- Name originates from library VTK (Visualization Toolkit)

```
# vtk DataFile Version 2.0
comment
ASCII
DATASET POLYDATA
POINTS 3328 float
1 0 0
0.988771 0.149438 0.006
0.999859 0.0168139 0.252
0.991144 -0.132792 0.246
...
POLYGONS 832 4160
4 0 1 2 3
4 4 5 6 7
...
```

- Unstructured grid



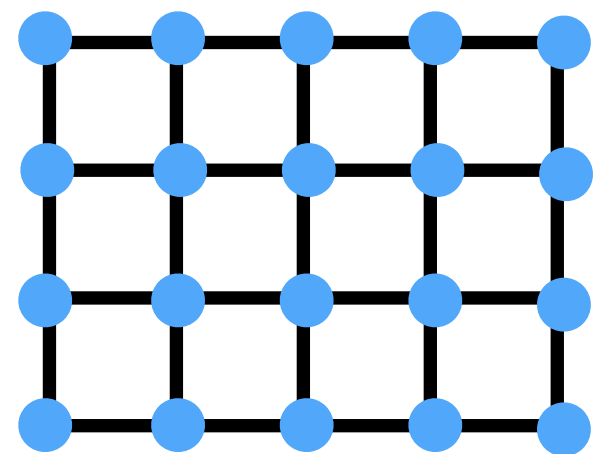
positions, connectivity
1D arrays

- Example **tut05/vtk**
 - output using MPI I/O
- On Euler, load modules with `source tut05/modules.euler`
- Build and run with **make**
- Copy data from `~/tut05` on Euler with `rsync -Paz "euler:tut05/vtk/poly.vtk" .`

Example 3: HDF

- Hierarchical Data Format
- Multi-dimensional arrays
- Library HDF5 uses MPI I/O

- Structured grid



field

3D array

- Example **tut05/hdf**
 - output using HDF5 library
 - tools **h5ls** and **h5dump** to view
 - geometry metadata in XMF file
- On Euler, load modules with
`source tut05/modules.euler`
- Build and run with **make**
- Copy data from `~/tut05` on Euler with
`rsync -Paz "euler:tut05/vtk/grid.{h5,xmf}" .`