

Data



Lecture 5

Data

- Data is what fills the computational arrays discussed earlier.
- Data in computational arrays has no generic physical mapping.
- Using mesh information we map data into physical space.

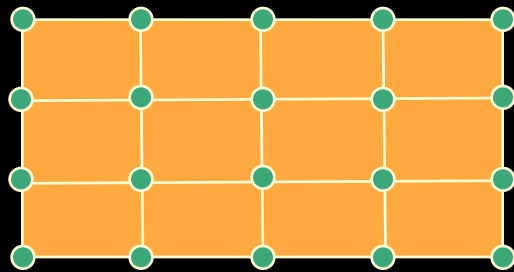
Mapping Data onto a Mesh

- There is however more than one way to map the data onto a mesh.
- The computational data may be:
 - *Node Data* - data at a point
 - *Cell Data* - data for a finite volume

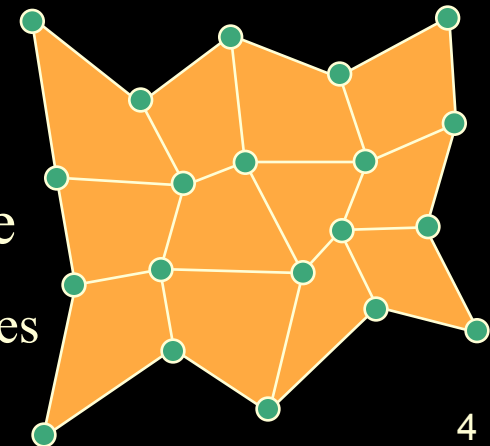
Node Data

Computational
1
Data Array

| | | | | |
|----|----|----|----|----|
| 23 | 41 | 13 | 46 | 19 |
| 18 | 72 | 42 | 9 | 85 |
| 45 | 13 | 35 | 26 | 12 |
| 67 | 34 | 27 | 66 | 11 |



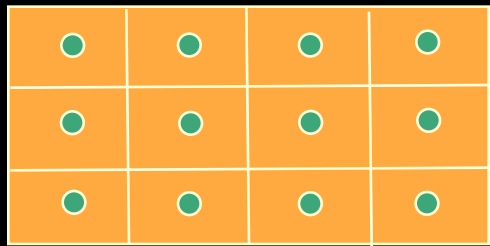
Physical Mapping
depends on *mesh* type
Here data forms node values



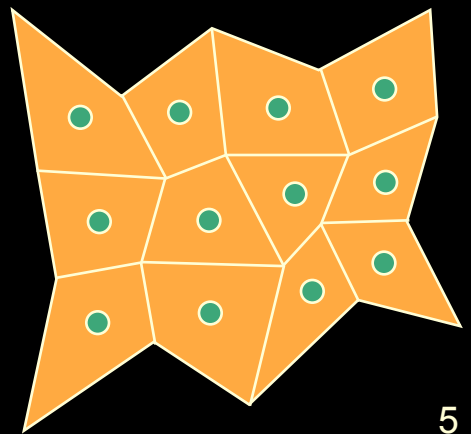
Cell Data

Computational
1
Data Array

| | | | |
|----|----|----|----|
| 23 | 41 | 13 | 46 |
| 18 | 72 | 42 | 9 |
| 45 | 13 | 35 | 26 |
| | | | |

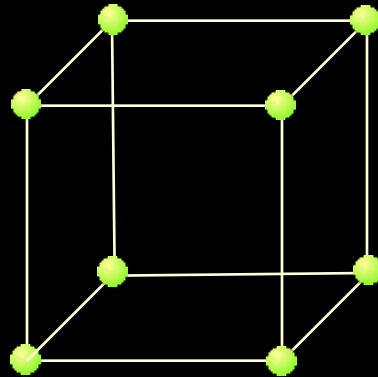


Physical Mapping
depends on *mesh* type
Here data forms cell values

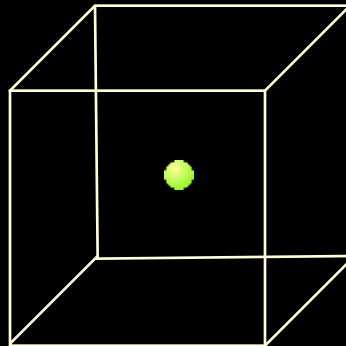


3D Node and Cell Data

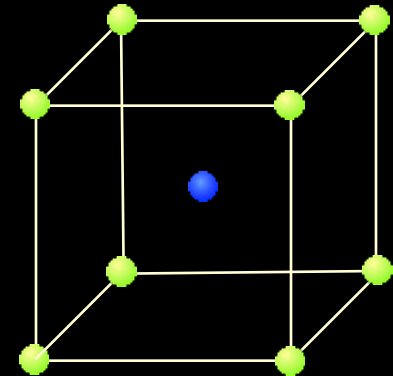
- Node Based



- Cell Based

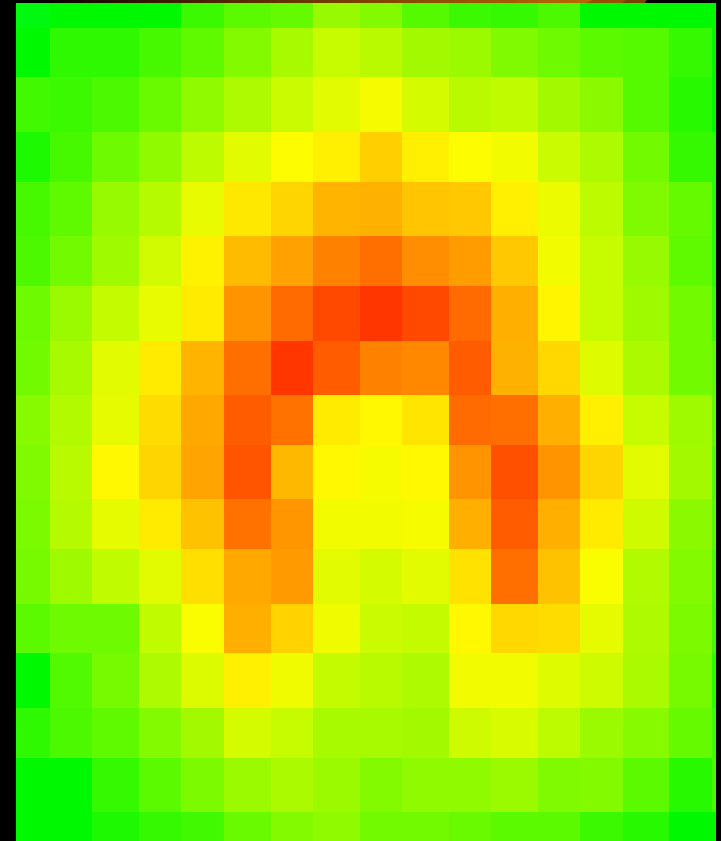


Combination



Visualising Node Data

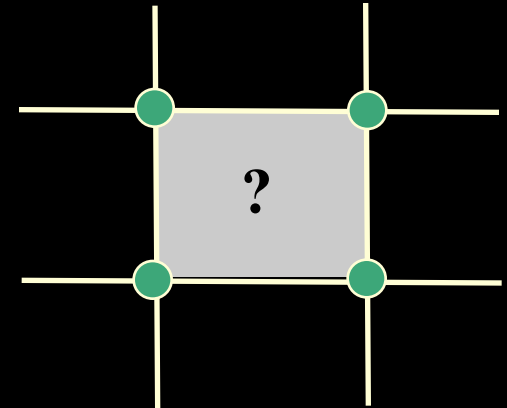
- Node data exists at a mathematical point.
- One technique is to display only coloured points.
- Node data is often displayed as an area.
- Why ? (Isn't this cell data ?)
 - Easier to see
- How does node data map to area ?



Node Data mapped to area

Facet Colouring with Node Data

- What facet colour ?
- There are 4 surrounding node values
- Methods include:
 - Average values
 - Choose corner (eg Bottom Left)
 - Offset grid by 1/2 cell
- Last two are similar
 - They do however spatially extend dataset by a row and column of cells.



Visualising Cell Data

- Two general approaches
 - Using 2D techniques by visualising the external surfaces
 - Using 3D volume visualisation techniques.

Data Types



Data Types

- Two perspectives of numeric data:
 - Abstract Scientific
 - Scalar, Vector
 - Computer Representation
 - Byte, Floats, Integers ...

Scalar and Vector Data

- The term *scalar* usually refers to the physical nature of the values.

Temperature, Pressure, Height, Time are scalars

Velocity, Gradients, Forces are vectors

- It is possible to have more than one value per node or cell.

Vector Data

- Vector data is normally represented as a set of orthogonal components.
- Some visualisation packages treat vector components just as a set of scalars, leaving it to the user to perform the appropriate operations.

Data Formats



Bits 'n' Bytes

Computer Data Types

- Understanding the intricacies of computer data types is an unfortunate necessity in scientific visualisation.
- Why ?
 - Data is stored in various formats
 - Formats have different limitations

Computer Representations

- There are many different numerical formats
 - Integers (8+ formats)
 - Floats (3+ formats)
- Why so many ? Speed/memory/accuracy
 - Float is not necessary more “accurate” than int
 - Some numbers cannot be exactly represented
 - Eg currency is often stored as integers

Integer Representations

- The following ranges are typical but may vary among computer systems
 - Bits
 - 0 or 1
 - Bytes (chars)
 - 0 to 255 (unsigned)
 - -128 to +127 (signed)
 - Shorts
 - 0 to 65,535 (unsigned)
 - -32,768 to 32,767 (signed)

Integer Representations...

– Ints

- 0 to 4,294,967,295 (unsigned)
- -2,147,483,648 to 2,147,483,647 (signed)

– Longs

- 2^{64} -- ie “lots”

Floating-point Representations

- Floats
 - Around 8 digits of precision, powers +/- 38
- Doubles
 - Around 15 digits of precision, powers +/- 308

Storage Formats



Storage formats

- The type is not the end of the story
- So far we have just dealt with the abstract concept.
- Other issues including Binary vs ASCII

ASCII

- Human readable
- Transport across different computer systems
- Takes around 3-5 times more space than binary
- No standard format but easy to interpret
- May not have a column delimiter (some FORTRAN)

Binary

- Inscrutable file formats
- Compact
- Transportation issues
 - Floating-point format
 - Integer formats
 - Big Endian / Little Endian
- Network formats: XDR

End

Lecture 5