King Abdullah University of Science and Technology

KAUST

AMCS / CS 247 – Scientific Visualization
Lecture 5: Data Representation, Pt. 3

Markus Hadwiger, KAUST

Reading Assignment #2 + 3 (until Feb 18)

Read (required):

- Data Visualization book, finish Chapter 2
- Data Visualization book, Chapter 3 until 3.5 (inclusive)
- Data Visualization book, Chapter 4 until 4.1 (inclusive)

- Continue familiarizing yourself with OpenGL if you do not know it !

Next Lectures

Lecture 4: Feb 6 10:30

Lecture 5: Feb 7 10:30 (room 4140 !)

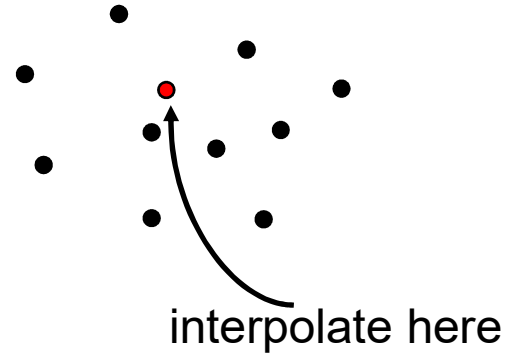
No regular lecture next week!

Tutorial: Feb 11 16:00 post questions/problems on piazza!

Lecture 6: Feb 18 16:00

Data Representation

Domain



- Scattered data interpolation
  - At each point the weighted average of all sample points in the domain is computed
  - Weighting functions determine the support of each sample point
    - Radial basis functions simulate decreasing influence with increasing distance from samples
  - Schemes might be non-interpolating and expensive in terms of numerical operations

Data Structures

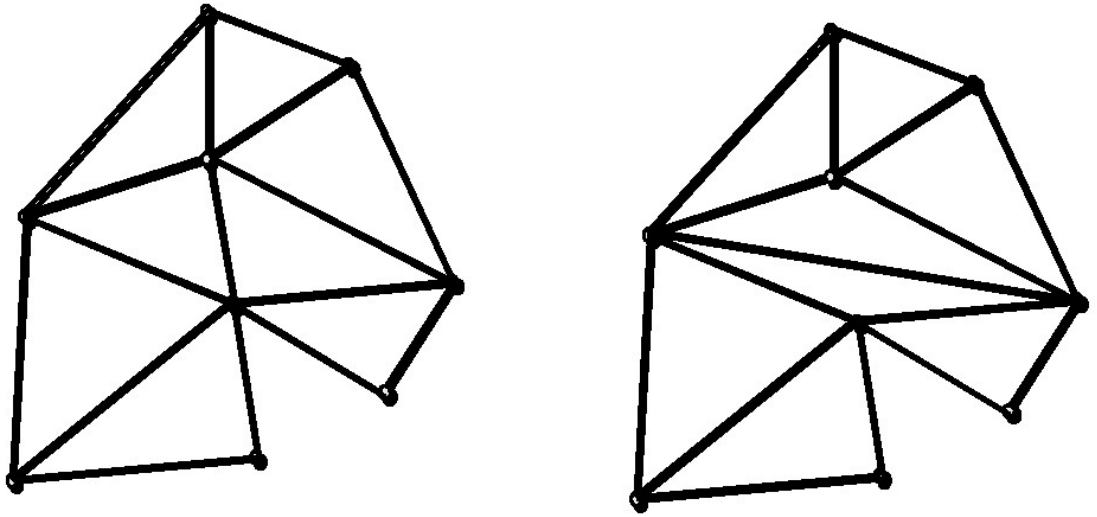
- Requirements:
  - Efficiency of accessing data
  - Space efficiency
  - Lossless vs. lossy
  - Portability
    - Binary – less portable, more space/time efficient
    - Text – human readable, portable, less space/time efficient
- Definition
  - If points are arbitrarily distributed and no connectivity exists between them, the data is called scattered
  - Otherwise, the data is composed of cells bounded by grid lines
  - Topology specifies the structure (connectivity) of the data
  - Geometry specifies the position of the data

Data Structures

- Some definitions concerning topology and geometry
  - In topology, qualitative questions about geometrical structures are the main concern
    - Does it have any holes in it?
    - Is it all connected together?
    - Can it be separated into parts?
- Underground map does not tell you how far one station is from the other, but rather how the lines are connected (topological map)

Data Structures

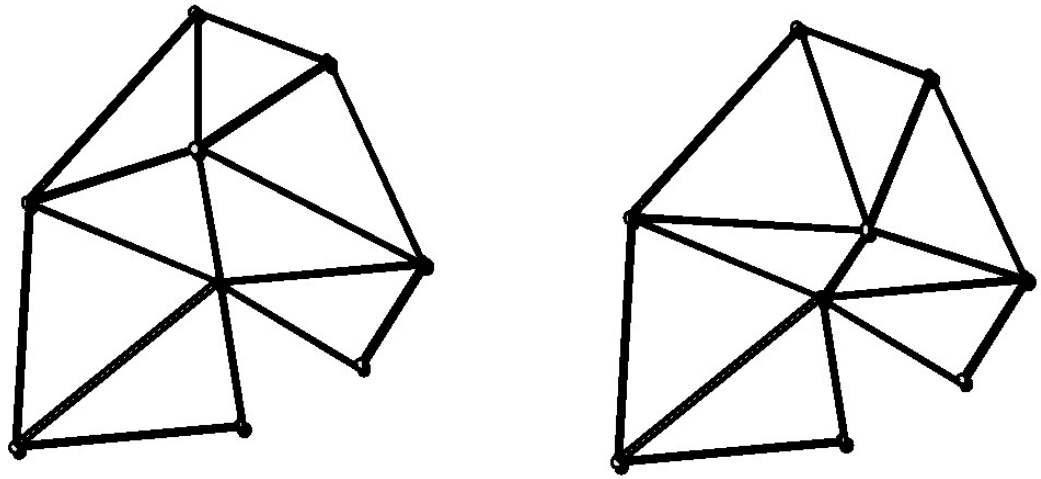
- Topology
  - Properties of geometric shapes that remain unchanged even when under distortion



Same geometry (vertex positions), different topology (connectivity)

Data Structures

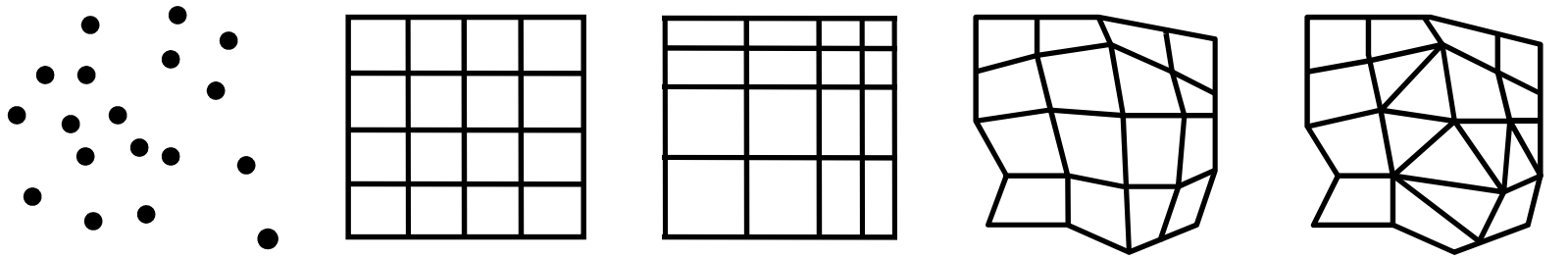
- Topologically equivalent
  - Things that can be transformed into each other by stretching and squeezing, without tearing or sticking together bits which were previously separated



topologically equivalent

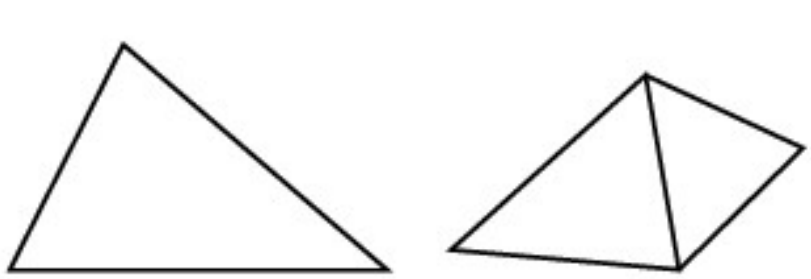
Data Structures

- Grid types
  - Grids differ substantially in the cells (basic building blocks) they are constructed from and in the way the topological information is given

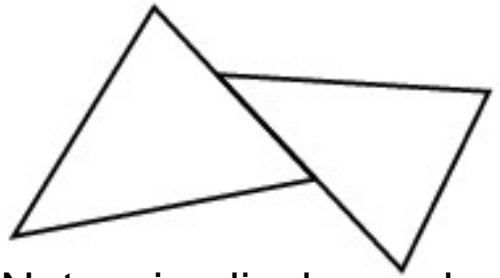


Data Structures

- An *n*-simplex
  - The convex hull of $n + 1$ affinely independent points
  - Lives in R^m , with $n \leq m$
  - 0: points, 1: lines, 2: triangles, 3: tetrahedra
- Partitions via simplices are called triangulations
- Simplical complex *C* is a collection of simplices with:
  - Every face of an element of *C* is also in *C*
  - The intersection of two elements of *C* is empty or it is a face of both elements
- Simplical complex is a space with a triangulation



Simplical complexes

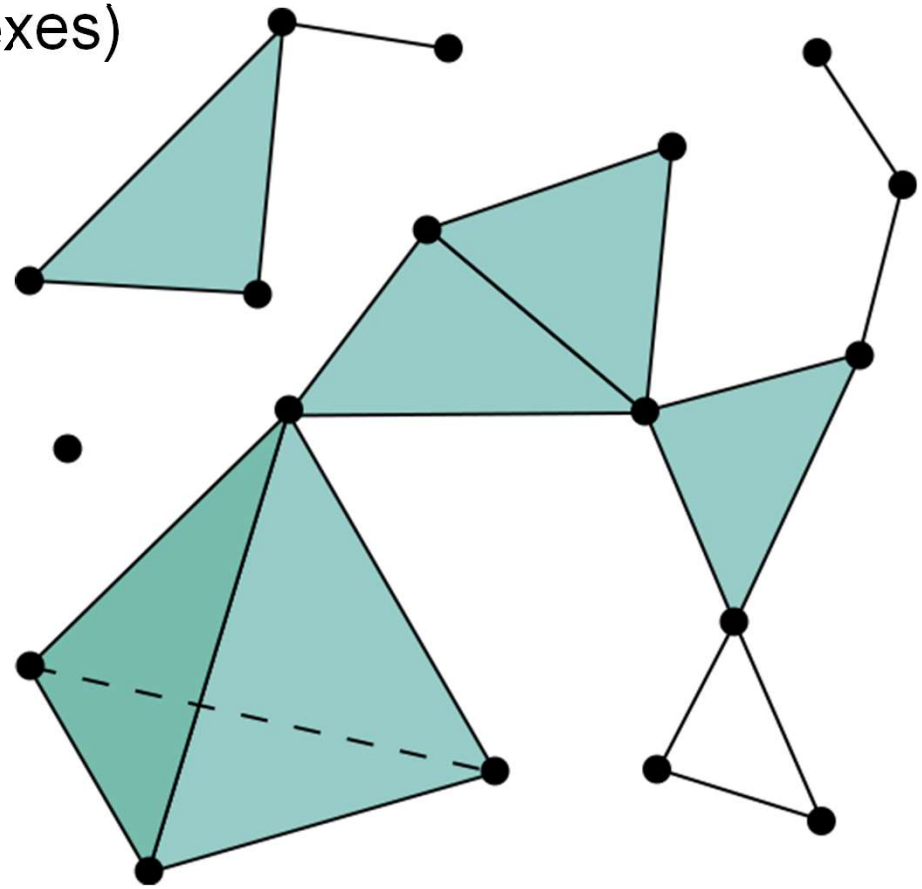


Not a simplical complex

Data Structures

- Simplicial complexes can be of mixed dimensions up to ≤ n
  (except if “pure” complexes)

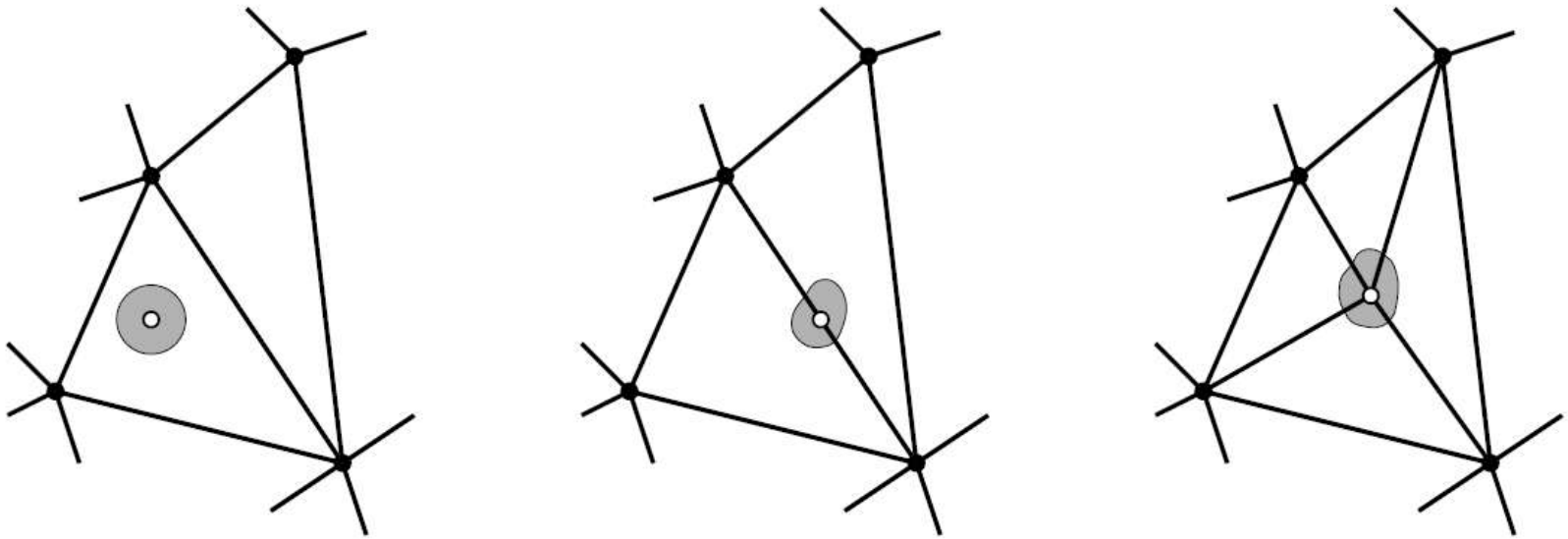
- Example:
  Simplicial
  3-complex



[Wikipedia.org]

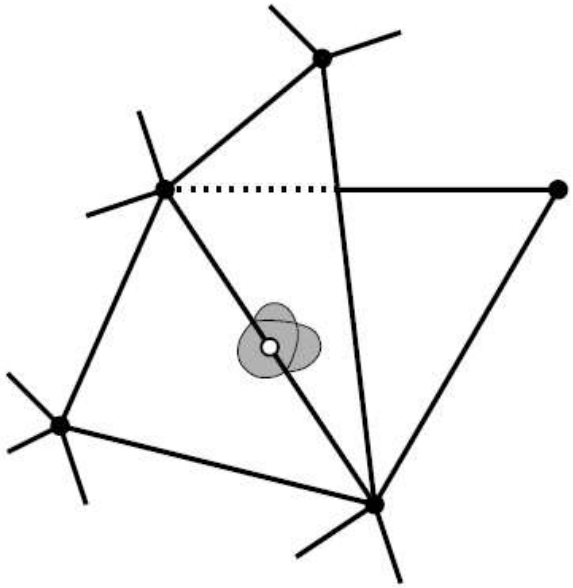
Data Structures

- 2-manifold meshes: neighborhood is 2-dimensional topological disc (or half disc for manifolds with boundary)

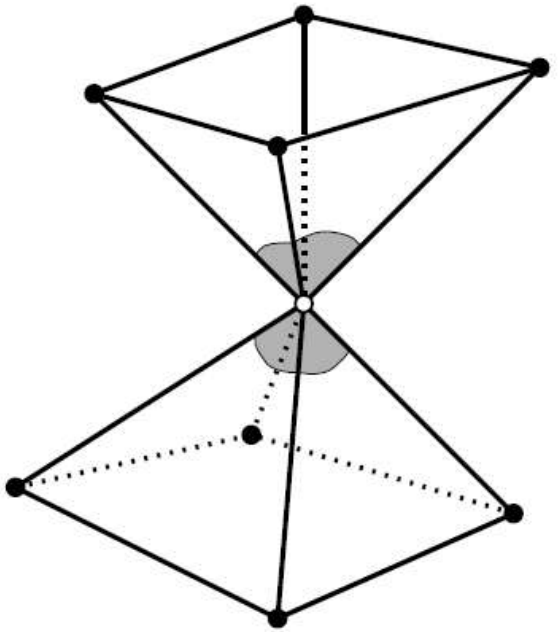


Data Structures

- Non-manifold meshes



(d)



(e)

Thank you.

Thanks for material

- Helwig Hauser
- Eduard Gröller
- Daniel Weiskopf
- Torsten Möller
- Ronny Peikert
- Philipp Muigg
- Christof Rezk-Salama