Computational Microelectronics
L10

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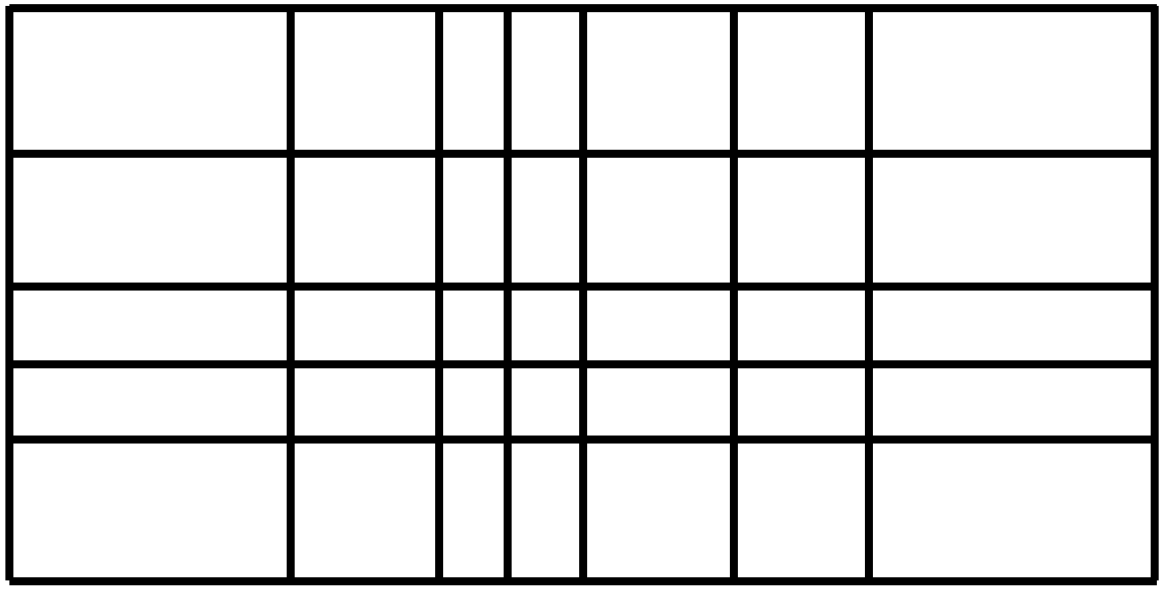
Unstructured mesh for 2D/3D structures

Structured mesh

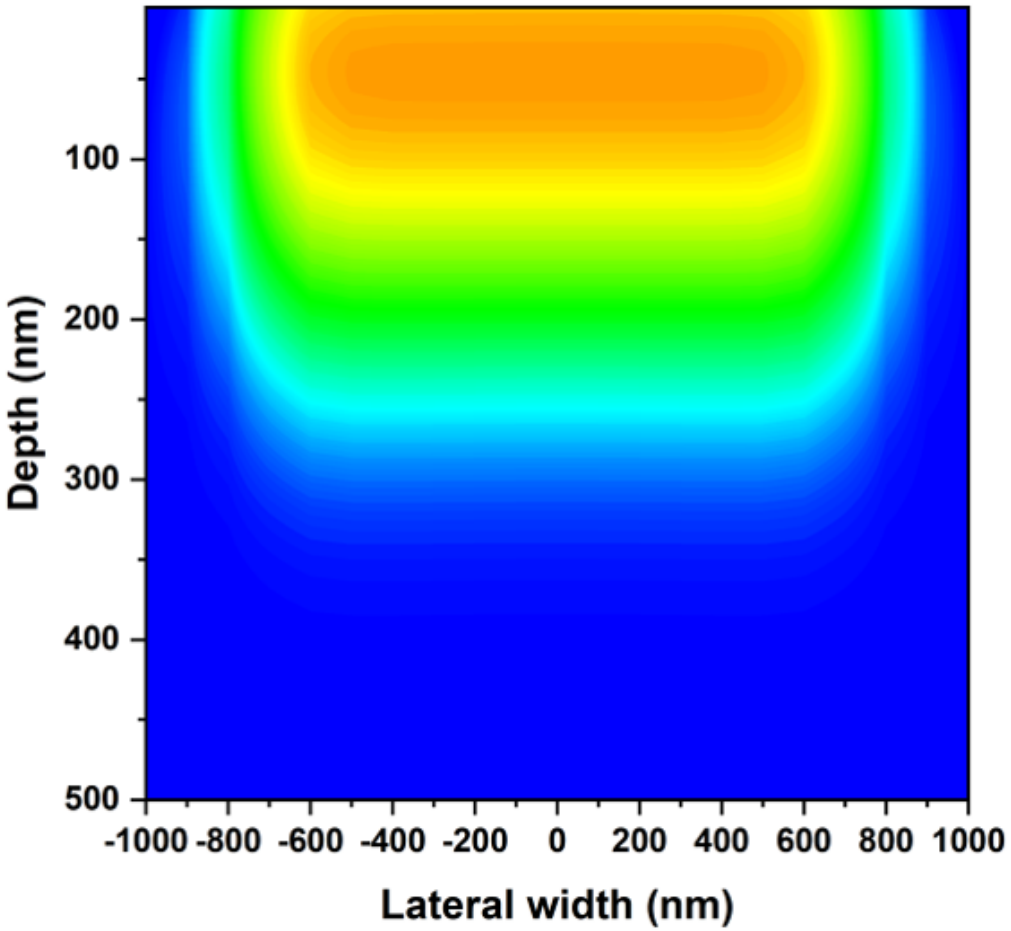
- Build directional meshes.
  - For example, x_0, x_1, x_2, …
  - Then,

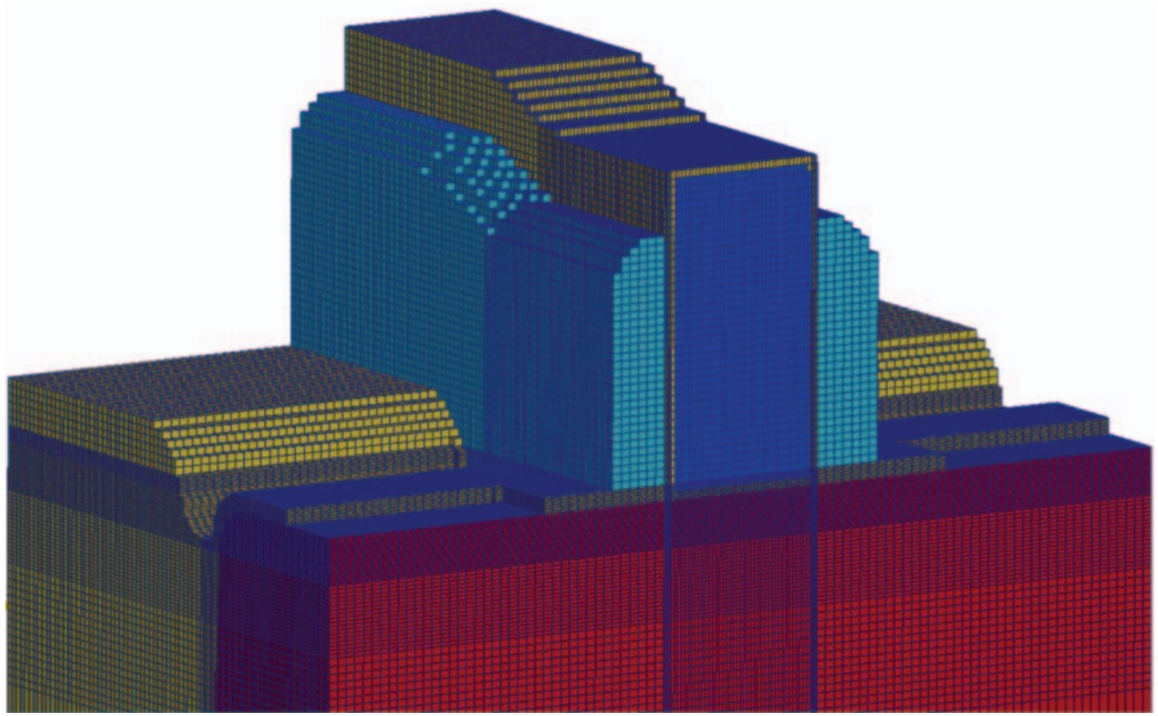
$$\mathbf{r}_{i,j,k} = \mathbf{a}_x x_i + \mathbf{a}_y y_j + \mathbf{a}_z z_k$$



Its inefficiency

- Consider a PN junction.
  - How can we describe this structure with a structured mesh?

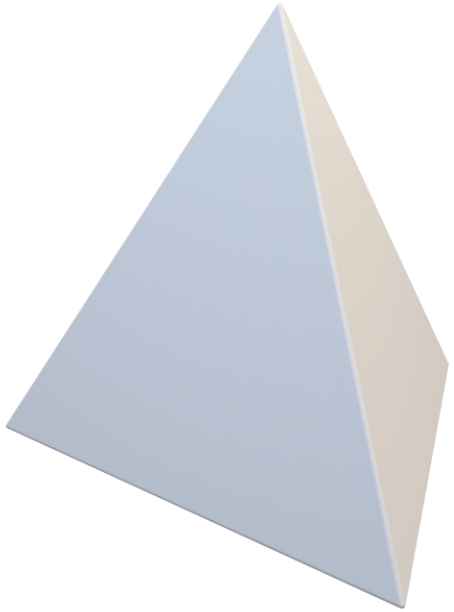


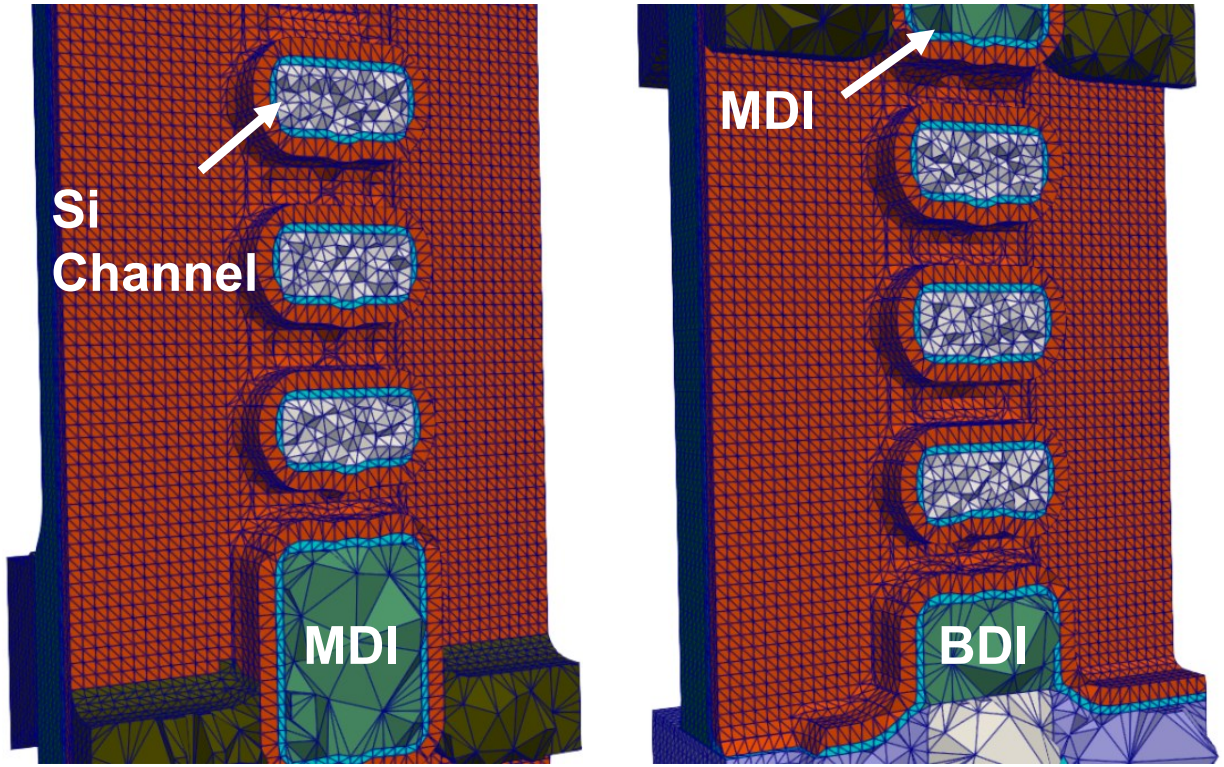


3D structured mesh (L. Wang et al., ULIS, 2014)

Unstructured mesh

- Instead of a lattice point, $\mathbf{r}_{i,j,k}$,
  - A vertex can be placed on any position, $\mathbf{r}_i$. (Here, i is not an index for the x direction.)
  - Triangles for 2D
  - Tetrahedra for 3D

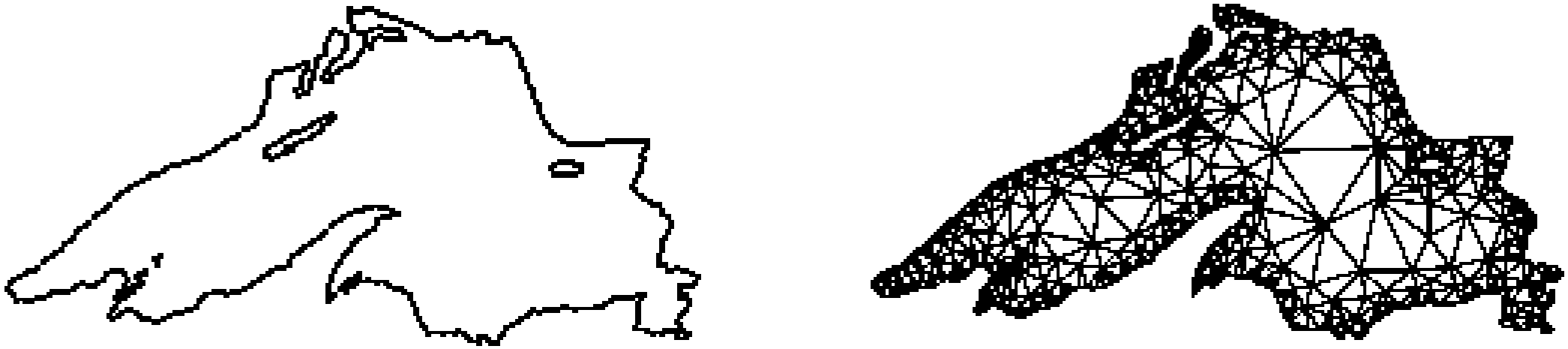




3D unstructured mesh (S.-W. Jung et al., SISPAD, 2024)

Mesh generator

- A computer program
  - It can create meshes from the boundary shape.



Triangular mesh for Lake Superior
(https://www.cs.cmu.edu/~quake/triangle.demo.html)

Structure file

A simple structure file for a resistor

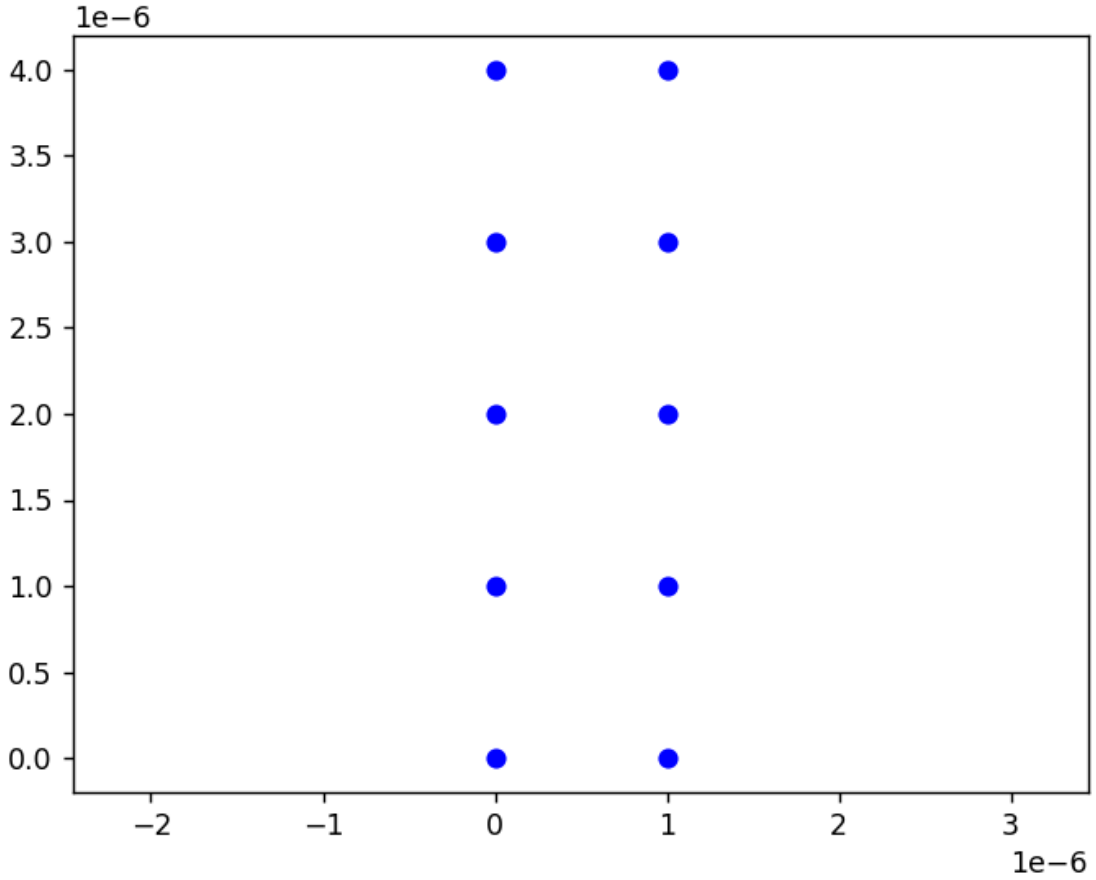
- Vertex file
  - It specifies vertices with (x, y).

```
9.9999999999999995e-07 9.9999999999999995e-07
-0 9.9999999999999995e-07
9.9999999999999995e-07 1.9999999999999999e-06
-0 1.9999999999999999e-06
9.9999999999999995e-07 3.0000000000000001e-06
-0 3.0000000000000001e-06
9.9999999999999995e-07 -0
-0 -0
-0 3.9999999999999998e-06
9.9999999999999995e-07 3.9999999999999998e-06
```

  - We must read each line. Each line defines a unique vertex.

Draw points.

- 10 points
  - We need also triangles.

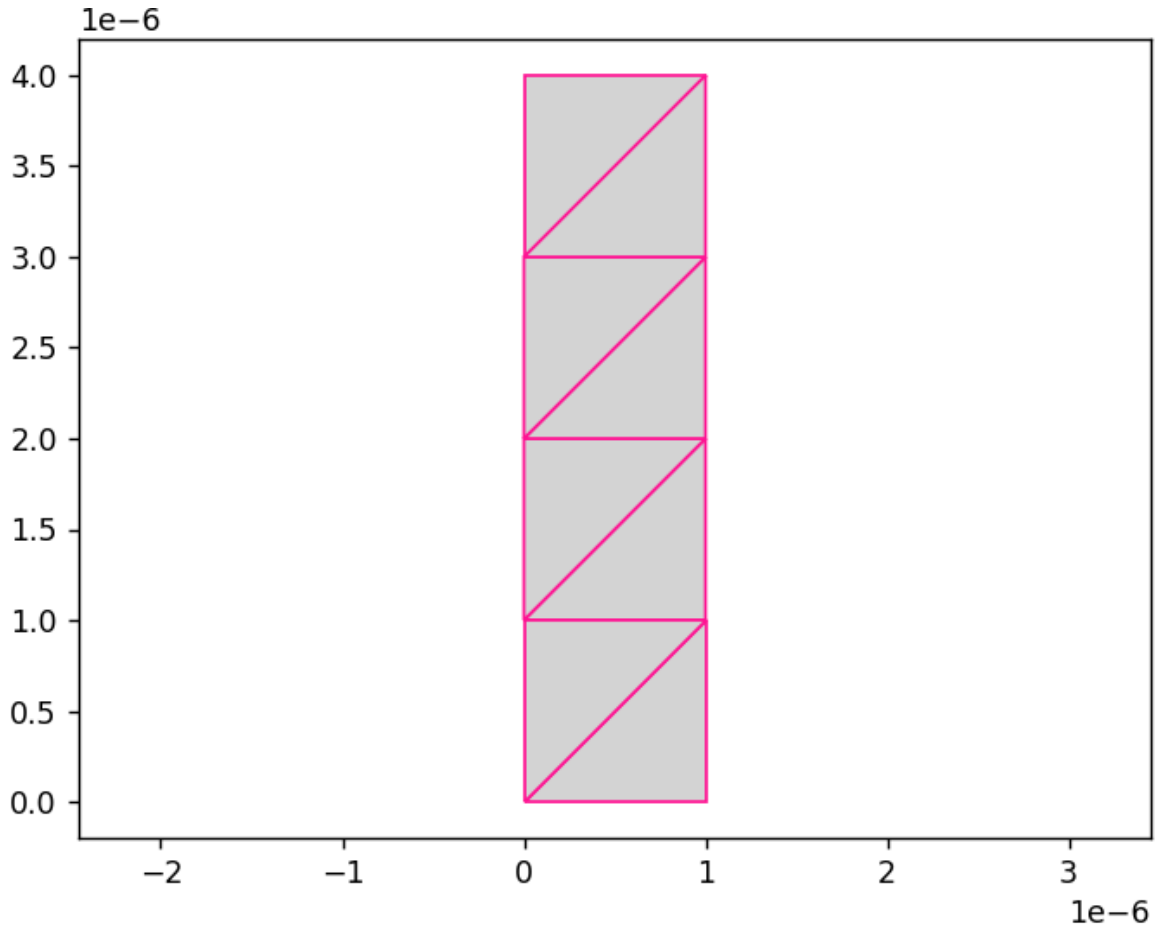


Element file

- It specifies triangles.
  - Numbers present vertex indices.

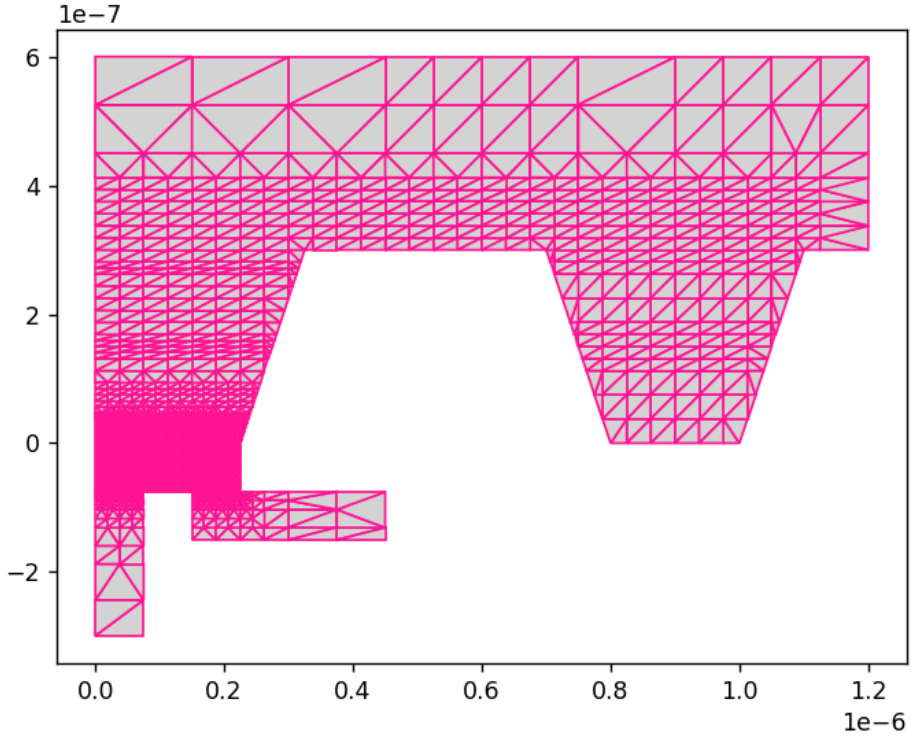
```
1 7 8
1 2 3
2 3 4
3 4 5
4 5 6
6 9 10
1 2 8
5 6 10
```

  - 1-based indexing



Homework#10

- Due: AM08:00, October 17
- Problem#1
  - Draw the structure by using “bjt.vertex” and “bjt.element” in our GitHub repository. (There are several triangles. You cannot draw them manually.)



Thank you for your attention!