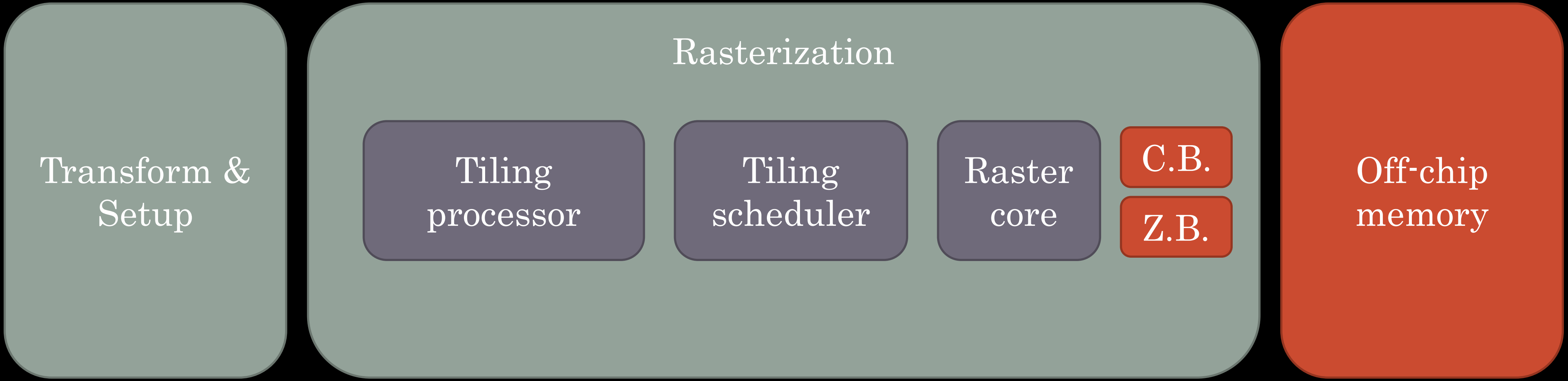
Tile based rasterizer

Bounding box tiling

General layout



C.B. : On-chip tile color buffer
Z.B. : On-chip Z-buffer

Transform & Setup

- Apply Modelview, Projection, Viewport mapping matrices to the ALL input vertices
- Rearranging ALL vertices to create triangles
- For each triangle the following data is needed

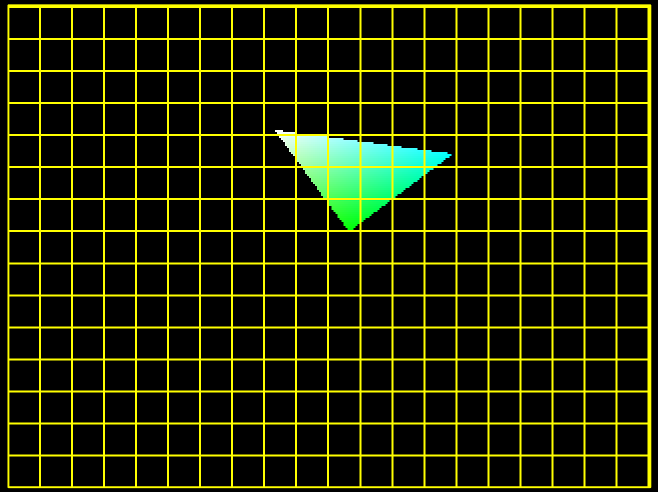
1. Triangle vertices coordinates
2. Triangle vertices colors

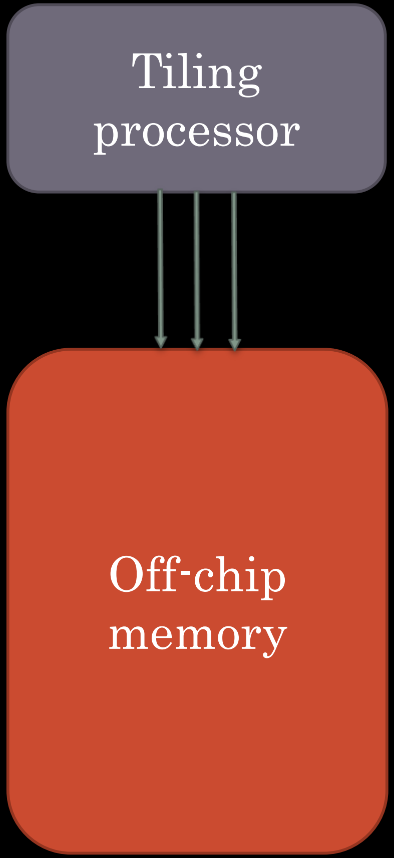
- In Matlab code "trans_ver_coord", "trans_ver_col" contain the required data

Tiling processor

- Fetch ALL triangles data (vertices coordinates, colors)
- For each triangles compute the following

1. **Ubeta_gamma**
2. **X_vertex**
3. **Z_coord**
4. **Vertices_colors**
5. **Bounding_boxes**





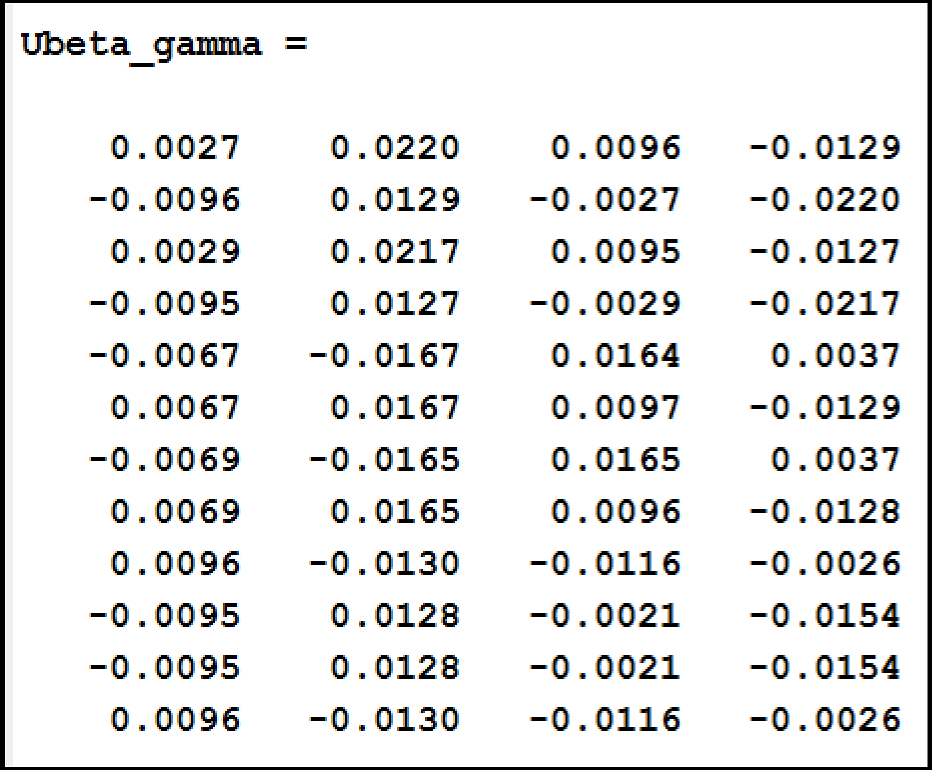
- ALL these variables are sent to be stored in external memory

Off-chip memory variables(1)

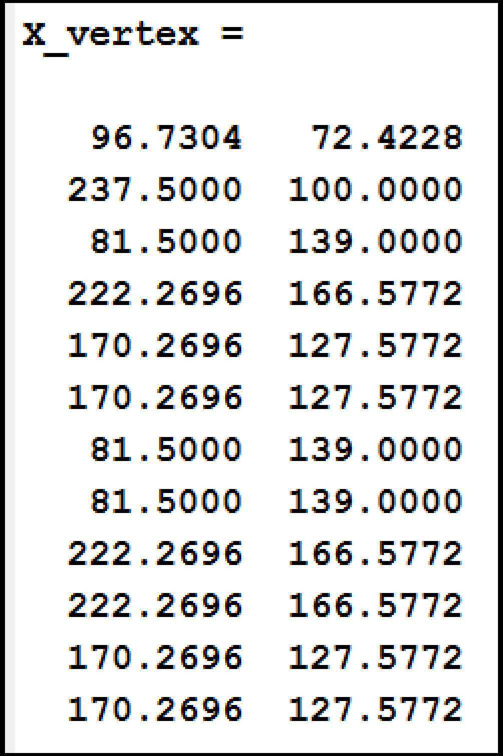
Triangle selection pointer → Tri3

indx	Ubeta_gamma				X_vertex		Z_coord			Vertices_colors									Bounding_ boxes			
Tri1																						
Tri2																						
Tri3																						
Tri4																						
Tri5																						
Tri6																						
Tri7																						

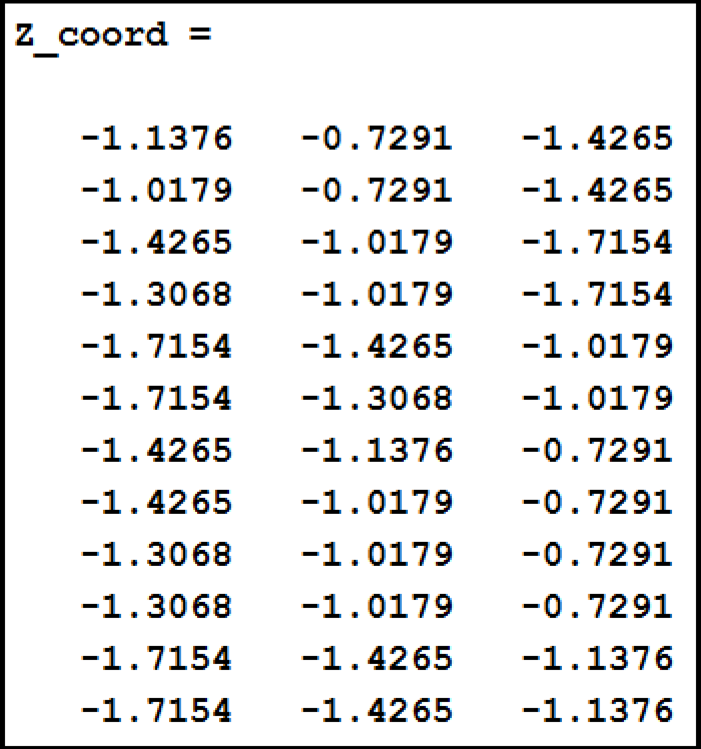
Off-chip memory variables(2)



```
Ubeta_gamma =


    0.0027    0.0220    0.0096   -0.0129
   -0.0096    0.0129   -0.0027   -0.0220
    0.0029    0.0217    0.0095   -0.0127
   -0.0095    0.0127   -0.0029   -0.0217
   -0.0067   -0.0167    0.0164    0.0037
    0.0067    0.0167    0.0097   -0.0129
   -0.0069   -0.0165    0.0165    0.0037
    0.0069    0.0165    0.0096   -0.0128
    0.0096   -0.0130   -0.0116   -0.0026
   -0.0095    0.0128   -0.0021   -0.0154
   -0.0095    0.0128   -0.0021   -0.0154
    0.0096   -0.0130   -0.0116   -0.0026
```

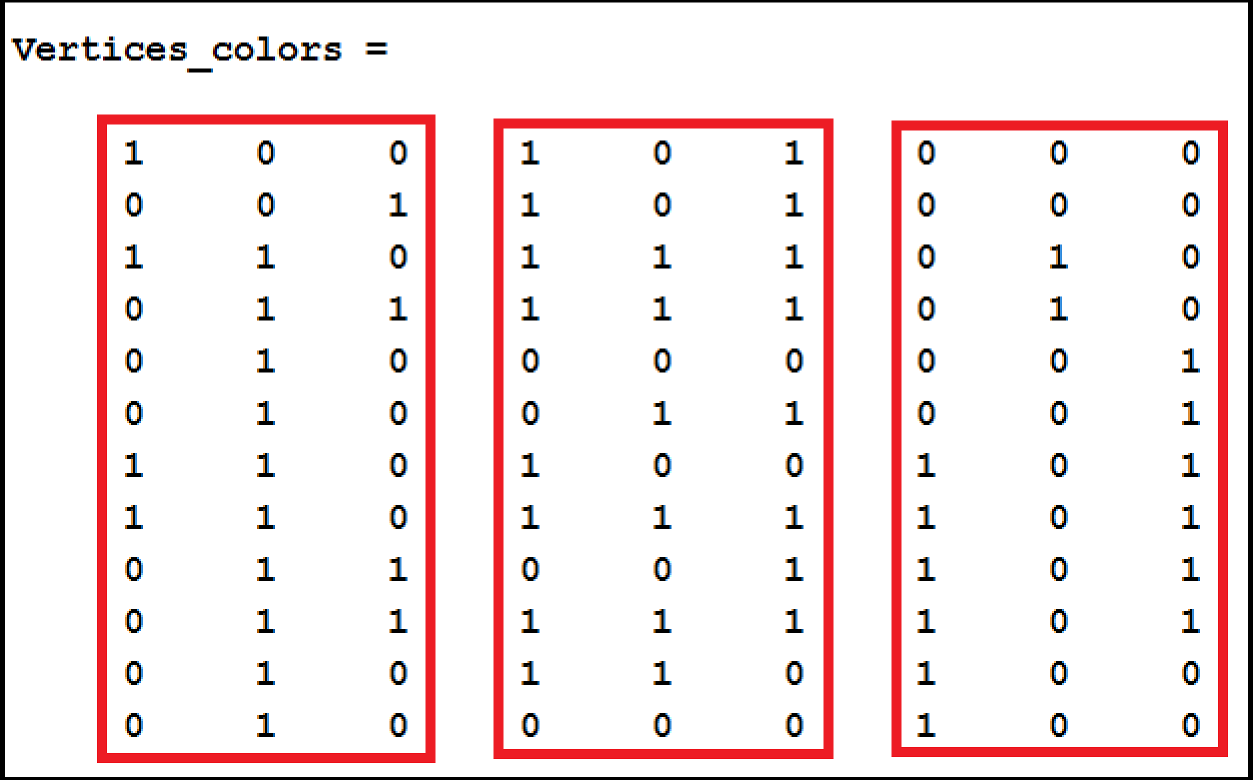


```
X_vertex =


   96.7304   72.4228
  237.5000  100.0000
   81.5000  139.0000
  222.2696  166.5772
  170.2696  127.5772
  170.2696  127.5772
   81.5000  139.0000
   81.5000  139.0000
  222.2696  166.5772
  222.2696  166.5772
  170.2696  127.5772
  170.2696  127.5772
```

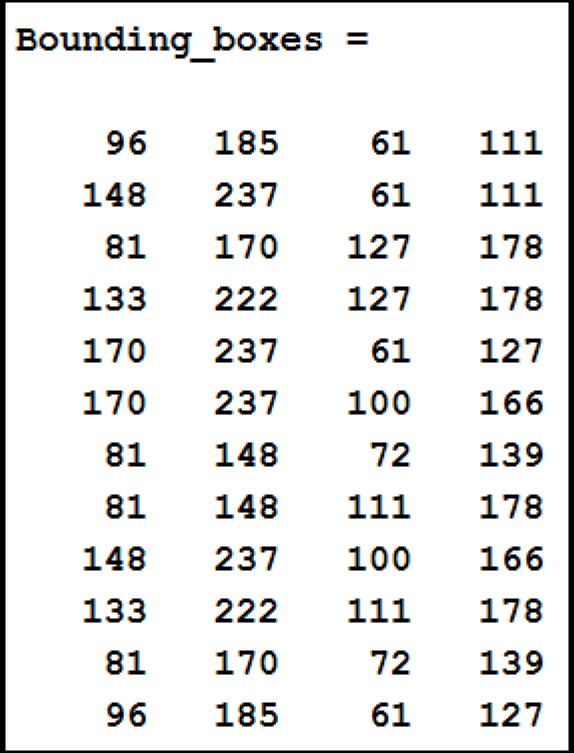


```
Z_coord =


   -1.1376   -0.7291   -1.4265
   -1.0179   -0.7291   -1.4265
   -1.4265   -1.0179   -1.7154
   -1.3068   -1.0179   -1.7154
   -1.7154   -1.4265   -1.0179
   -1.7154   -1.3068   -1.0179
   -1.4265   -1.1376   -0.7291
   -1.4265   -1.0179   -0.7291
   -1.3068   -1.0179   -0.7291
   -1.3068   -1.0179   -0.7291
   -1.7154   -1.4265   -1.1376
   -1.7154   -1.4265   -1.1376
```

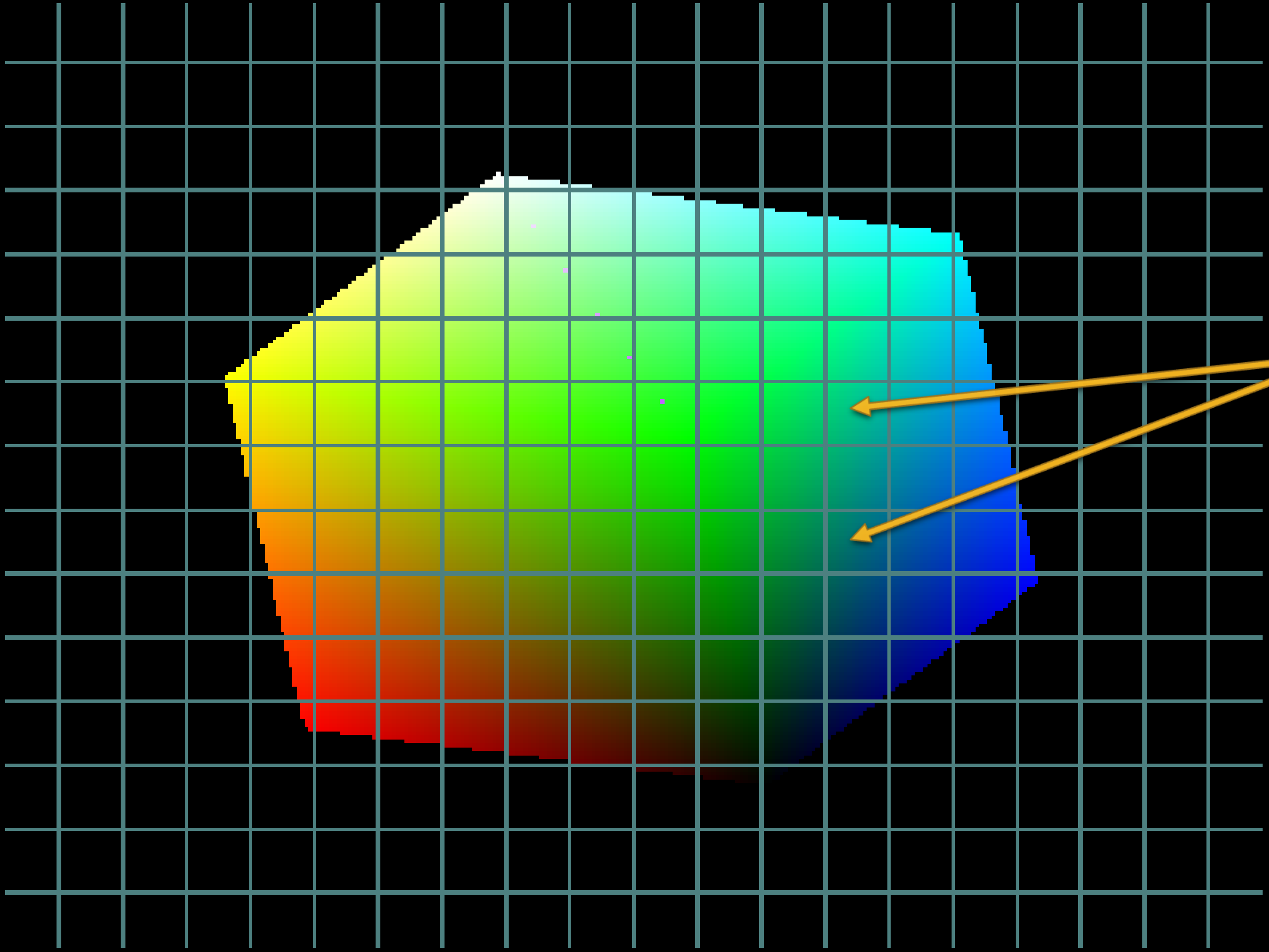
Off-chip memory variables(3)



```
Vertices_colors =

     1     0     0     1     0     1     0     0     0
     0     0     1     1     0     1     0     0     0
     1     1     0     1     1     1     0     1     0
     0     1     1     1     1     1     0     1     0
     0     1     0     0     0     0     0     0     1
     0     1     0     0     1     1     0     0     1
     1     1     0     1     0     0     1     0     1
     1     1     0     1     1     1     1     0     1
     0     1     1     0     0     1     1     0     1
     0     1     1     1     1     1     1     0     1
     0     1     0     1     1     0     1     0     0
     0     1     0     0     0     0     1     0     0
```

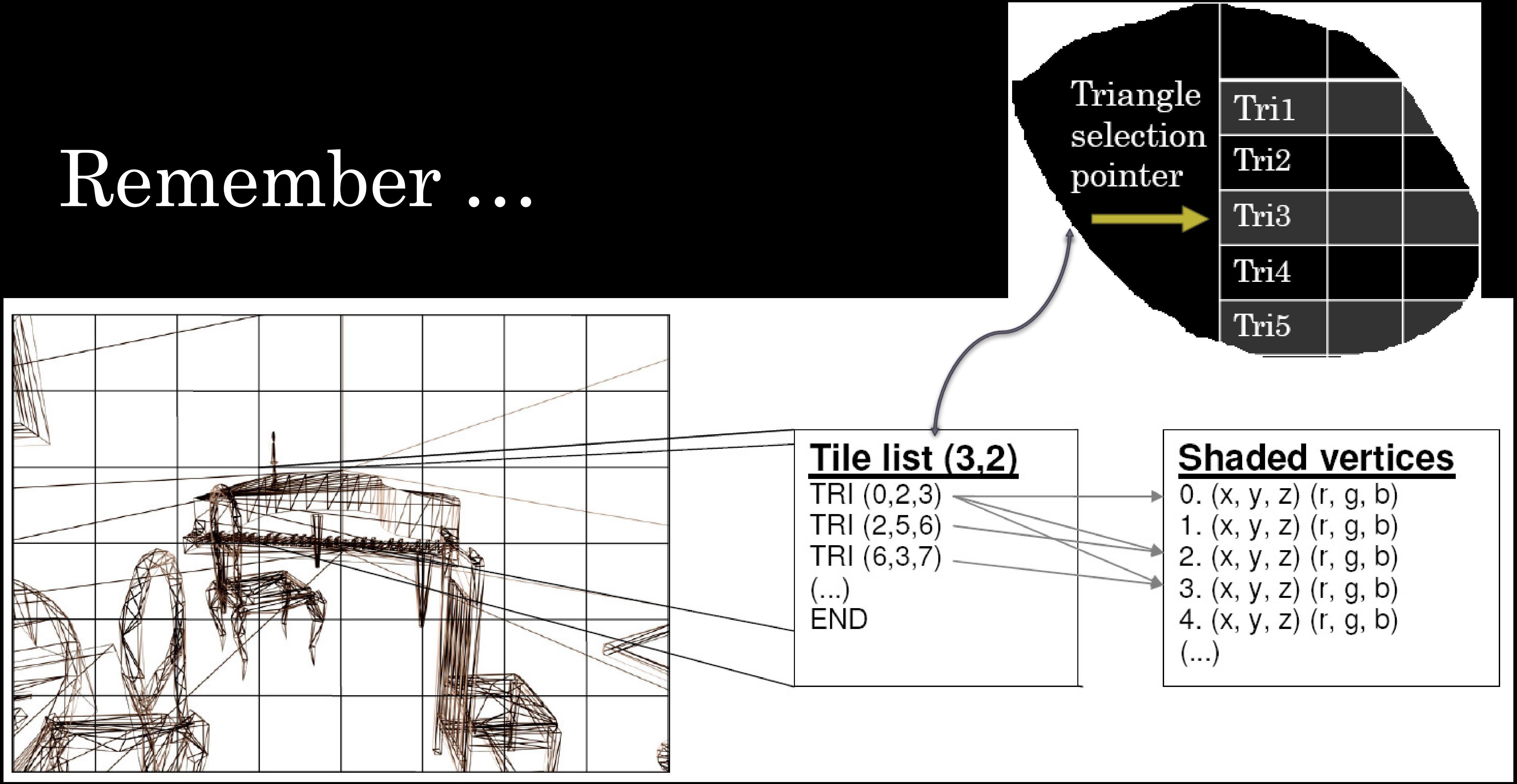


```
Bounding_boxes =


    96   185    61   111
   148   237    61   111
    81   170   127   178
   133   222   127   178
   170   237    61   127
   170   237   100   166
    81   148    72   139
    81   148   111   178
   148   237   100   166
   133   222   111   178
    81   170    72   139
    96   185    61   127
```



Each tile may cover more than one triangle

Remember …

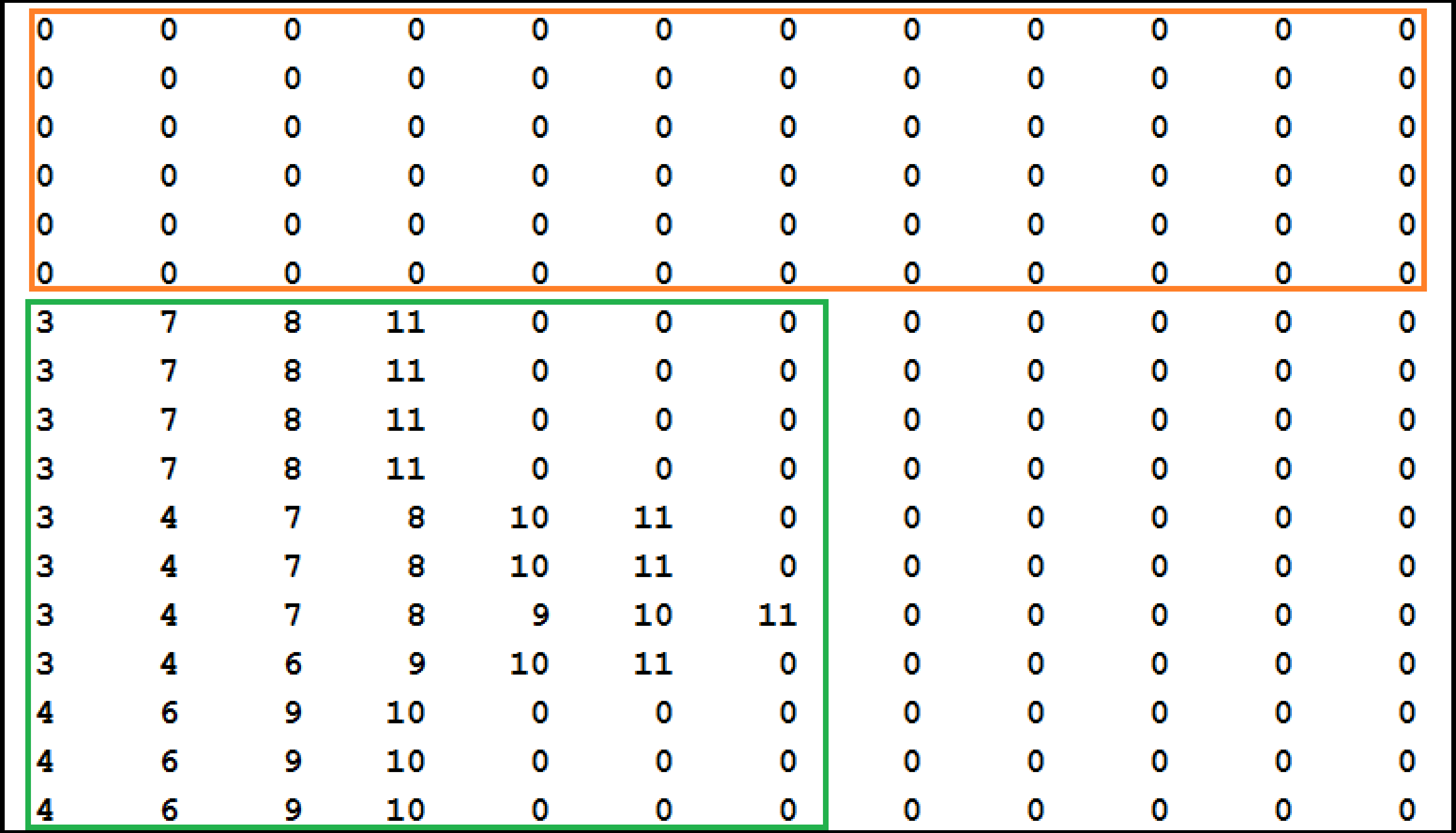


Tile list (3,2)
TRI (0,2,3)
TRI (2,5,6)
TRI (6,3,7)
(...)
END

Shaded vertices
0. (x, y, z) (r, g, b)
1. (x, y, z) (r, g, b)
2. (x, y, z) (r, g, b)
3. (x, y, z) (r, g, b)
4. (x, y, z) (r, g, b)
(...)

Tile_list

- Container that store pointer of triangles to be rendered



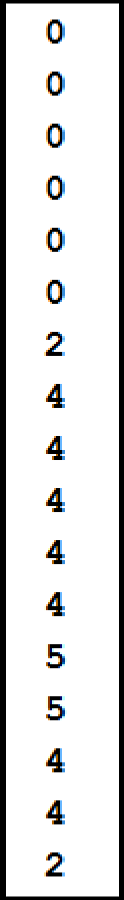
```
0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0
3    7    8   11    0    0    0    0    0    0    0    0
3    7    8   11    0    0    0    0    0    0    0    0
3    7    8   11    0    0    0    0    0    0    0    0
3    7    8   11    0    0    0    0    0    0    0    0
3    4    7    8   10   11    0    0    0    0    0    0
3    4    7    8   10   11    0    0    0    0    0    0
3    4    7    8    9   10   11    0    0    0    0    0
3    4    6    9   10   11    0    0    0    0    0    0
4    6    9   10    0    0    0    0    0    0    0    0
4    6    9   10    0    0    0    0    0    0    0    0
4    6    9   10    0    0    0    0    0    0    0    0
```

Empty tiles

Non-empty tiles

Tile_pointer

- A variable that indicate the total number of triangles per tile
- 0 : means no triangles to be rendered
- X : number of triangles
- This variable is used in tiling scheduler to control triangle drawing loop



```
0
0
0
0
0
0
2
4
4
4
4
4
5
5
4
4
2
```

Tile numbering methods

- Three methods are used

1. Tile numbers
2. Tile coordinates
3. Tile starting pixel

- The function “tileNo_2_Start_Tile_Corrd” converts from Tile numbers to Tile starting pixel
- The function “tile_coord_transform” converts from Tile coordinates to Tile numbers

Tile numbers

- Here we start counting from 1 to 300 (20x15 tiles)

20

15

1	2	3	4						20
21	22	23	24						40
41	42	43	44						60
261	262	263	264						280
281	282	283	284						300

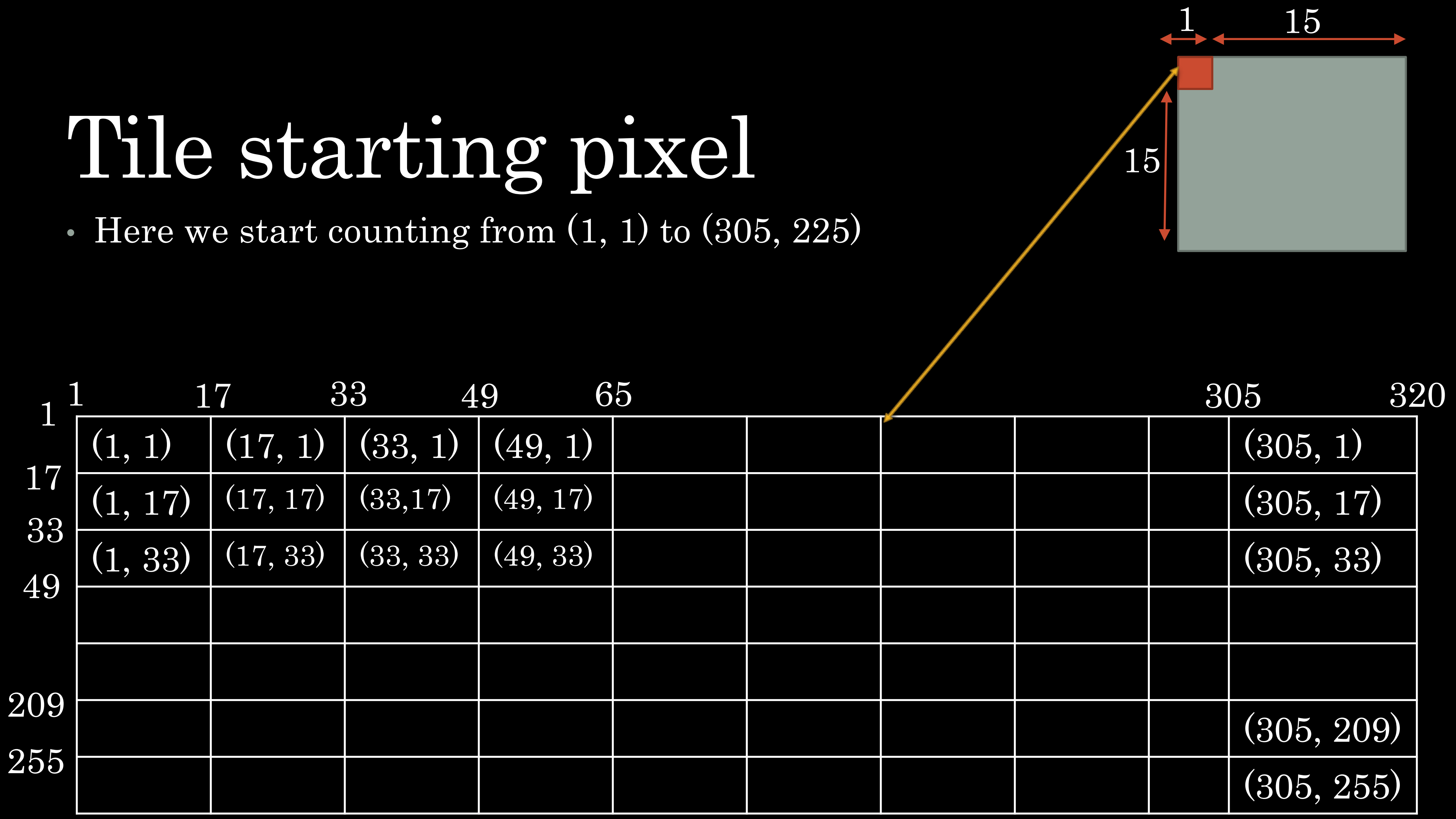
Tile coordinates

- Here we start counting from (1, 1) to (20, 15) (20x15 tiles)

	1	2	3	4						20
1	(1, 1)	(2, 1)	(3, 1)	(4, 1)						(20, 1)
2	(1, 2)	(2, 2)	(3, 2)	(4, 2)						(20, 2)
3	(1, 3)	(2, 3)	(3, 3)	(4, 3)						(20, 3)
14	(1, 14)	(2, 14)	(3, 14)	(4, 14)						(20, 14)
15	(1, 15)	(2, 15)	(3, 15)	(4, 15)						(20, 15)

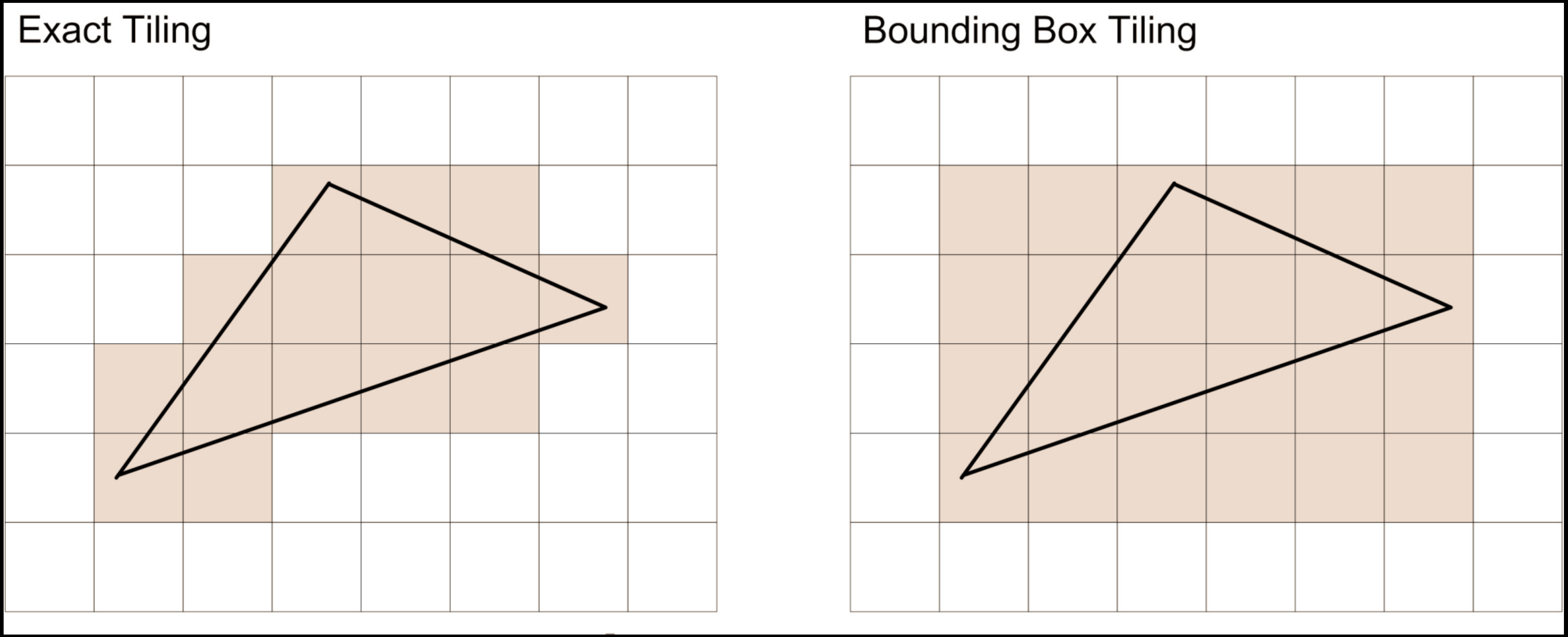
Tile starting pixel

- Here we start counting from (1, 1) to (305, 225)



	1	17	33	49	65					305
1	(1, 1)	(17, 1)	(33, 1)	(49, 1)						(305, 1)
17	(1, 17)	(17, 17)	(33,17)	(49, 17)						(305, 17)
33	(1, 33)	(17, 33)	(33, 33)	(49, 33)						(305, 33)
49										
209										(305, 209)
255										(305, 255)

Remember …


Exact Tiling
Bounding Box Tiling