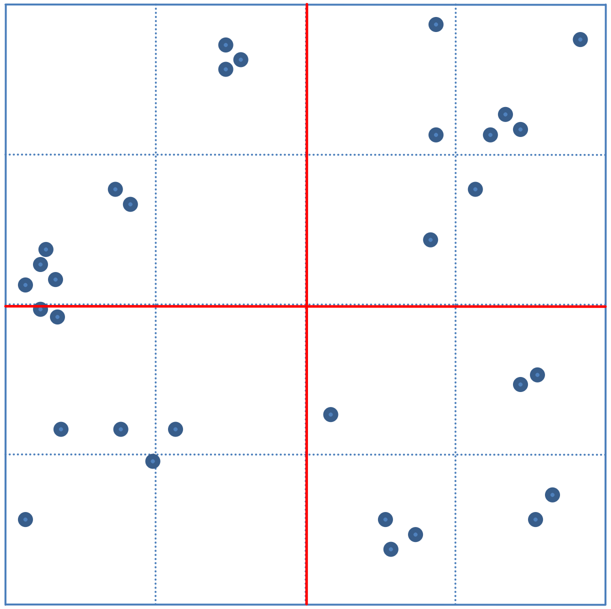
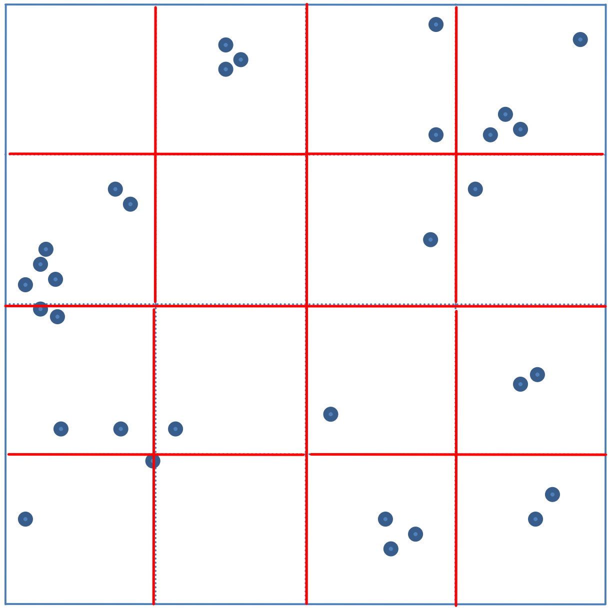
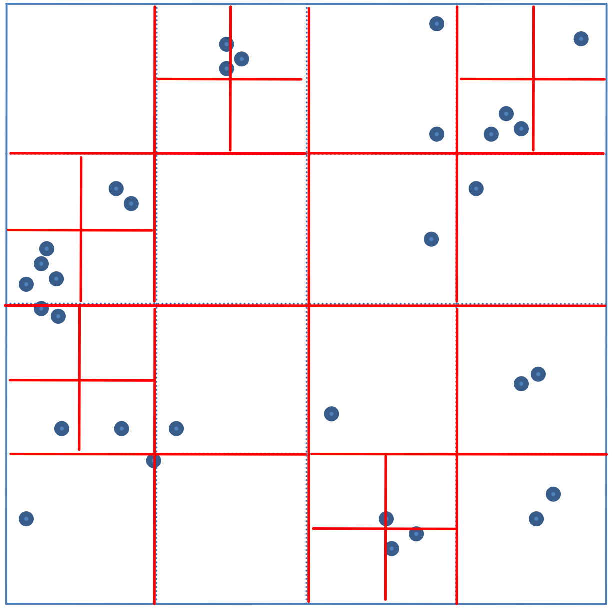
2-3a) Quadtree



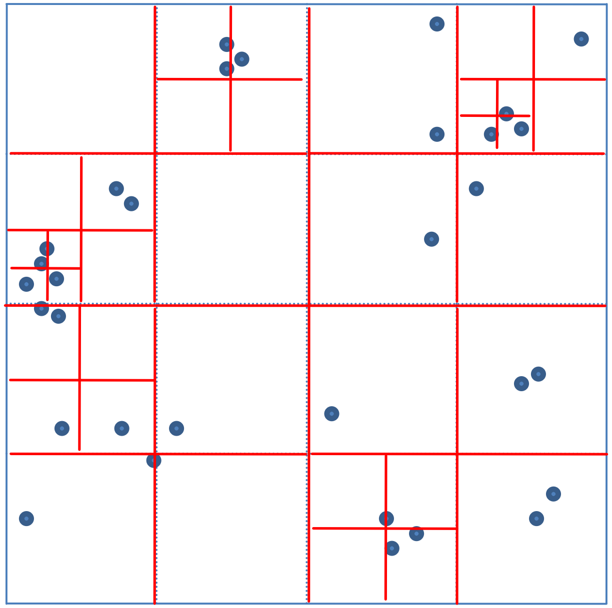
1. Partitioning



2. Partitioning



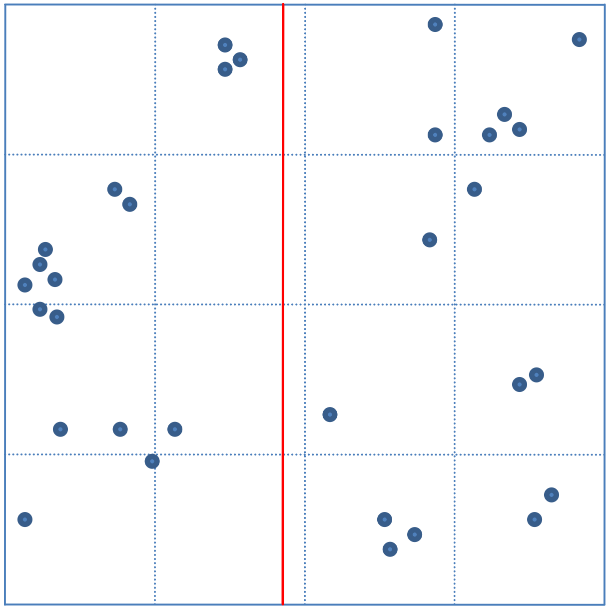
3. Partitioning



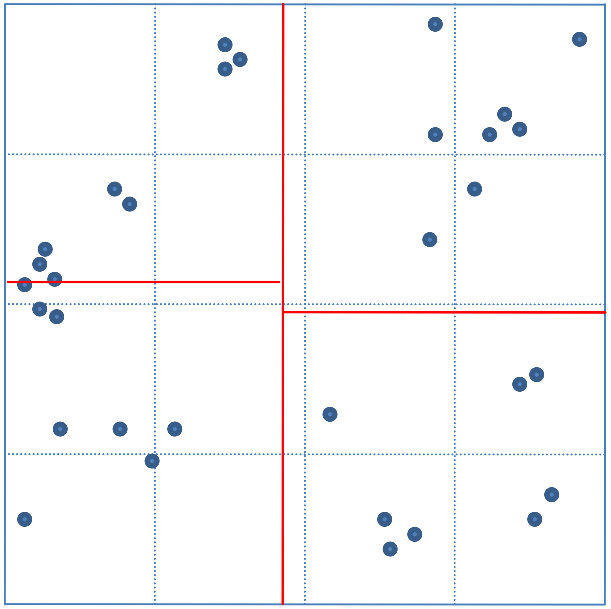
4. Partitioning

Now every page contains two elements or fewer, which was the requirement

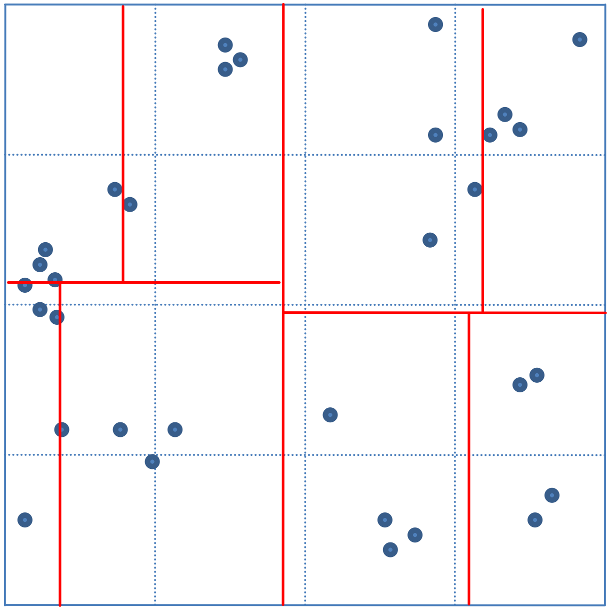
2-3b) kD-Tree



1. Partitioning (x-axis)

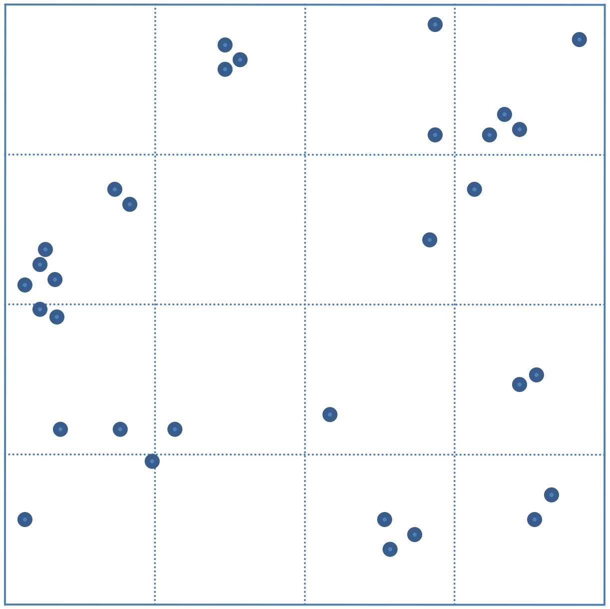


2. Partitioning (y-axis)

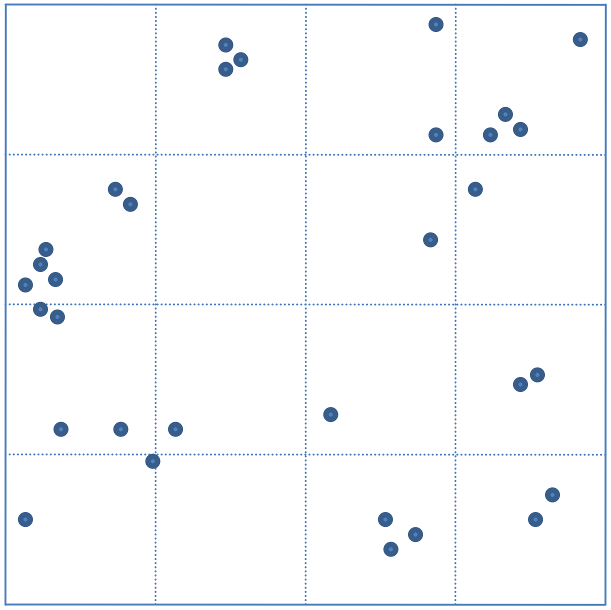


3. Partitioning (x-axis)
Now every page contains four elements or fewer, which was the requirement

2-3c) R-tree



Objects = n = 32

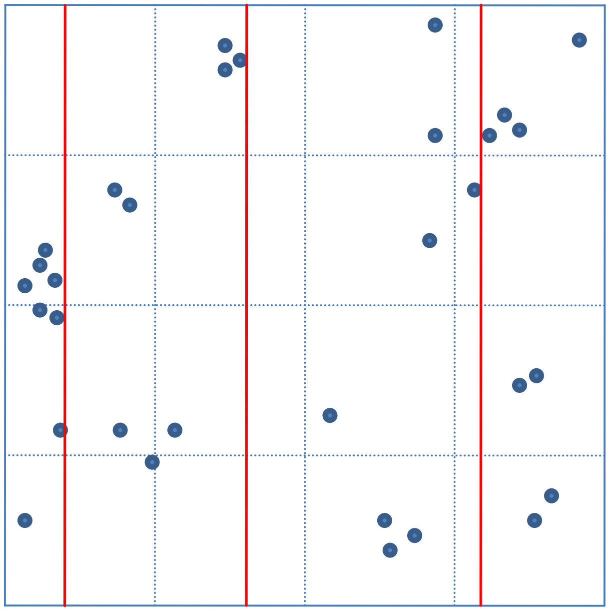


Objects = n = 32

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{32}{2}} \right\rceil = \left\lceil \sqrt{16} \right\rceil = 4$$

- 4 partitions per dimension

Number of objects in every partition of the x-axis: q*M=4*2=8

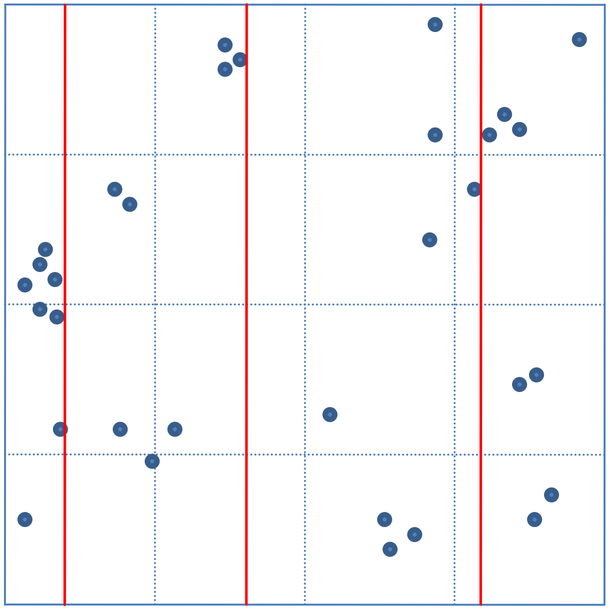


Objects = n = 32

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{32}{2}} \right\rceil = \left\lceil \sqrt{16} \right\rceil = 4$$

- 4 partitions per dimension

Number of objects in every partition of the x-axis: q*M=4*2=8



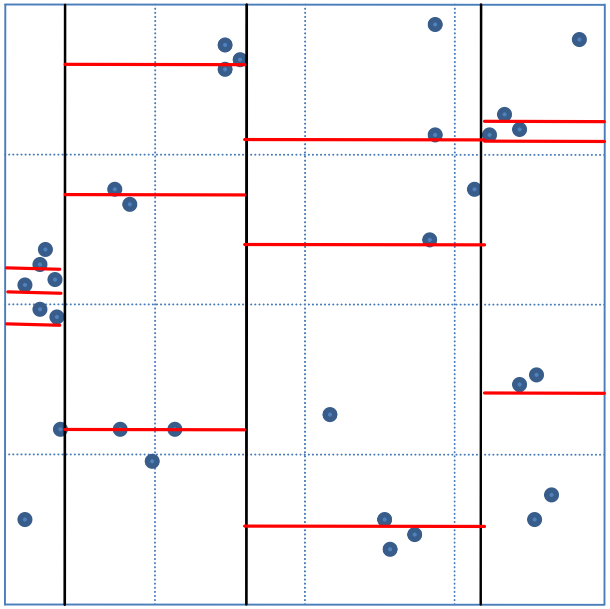
Objects = n = 32

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{32}{2}} \right\rceil = \left\lceil \sqrt{16} \right\rceil = 4$$

➢ 4 partitions per dimension

Number of objects in every partition of the y-axis: M=2

Hint: Two objects with the same y-coordinate can be distributed arbitrary to two partitions



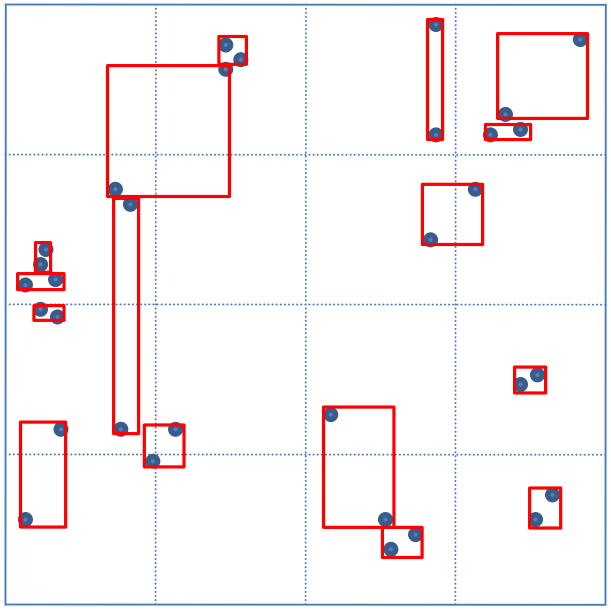
Objects = n = 32

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{32}{2}} \right\rceil = \left\lceil \sqrt{16} \right\rceil = 4$$

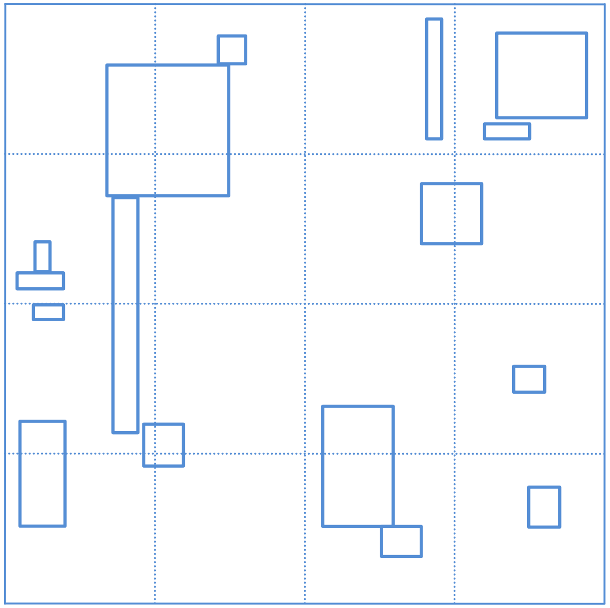
- 4 partitions per dimension

Number of objects in every partition of the y-axis: M=2

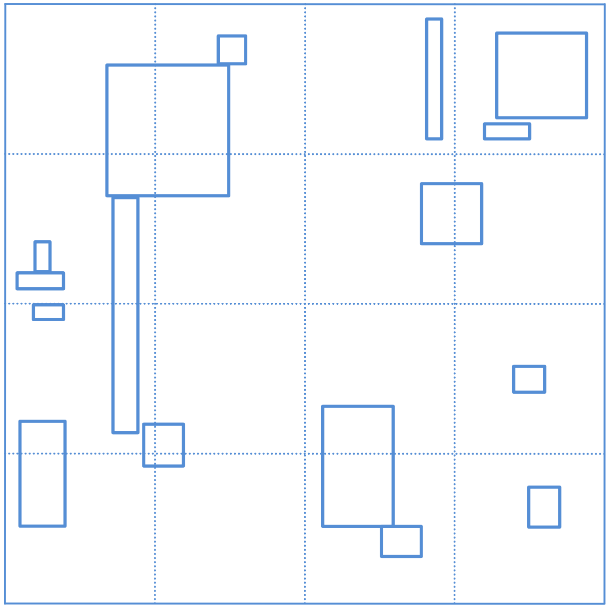
Hint: Two objects with the same y-coordinate can be distributed arbitrary to two partitions



Approximation of all objects of a cell with minimal bounding rectangles (MBR)



First Iteration finished.

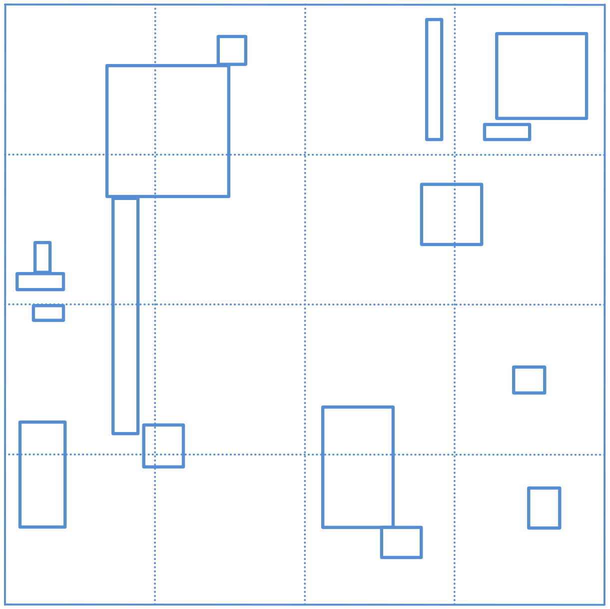


Objects = n = 16

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{16}{2}} \right\rceil = \left\lceil \sqrt{8} \right\rceil = 3$$

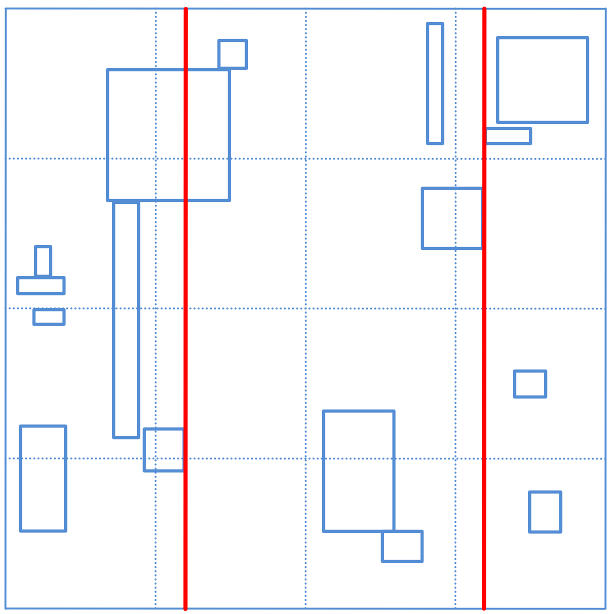
- 3 partitions per dimension

Number of objects in every partition of the x-axis: 3*M=3*2=6



Number of objects in every partition of the x-axis: 3*M=3*2=6

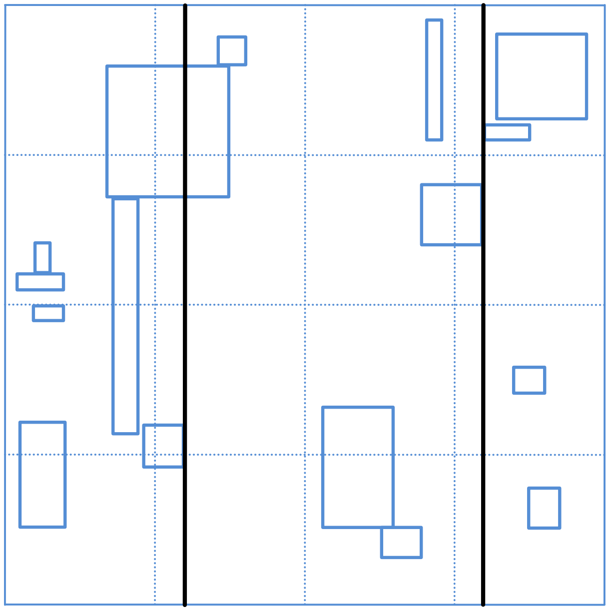
Important: this number of objects is used as long as there are enough objects



Number of objects in every partition of the x-axis: 3*M=3*2=6

Important: this number of objects is used as long as there are enough objects (what leads to the partitioning 6:6:4)

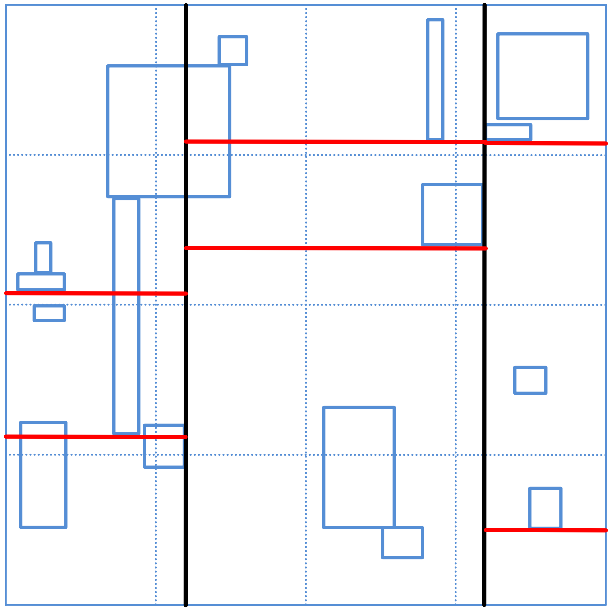
Uniqueness: Rectangles are allocated regarding their maximal value in the particular dimension. The big rectangle which intersects two partitions thus is belonging to the middle one, not to the left one



Number of objects in every partition of the y-axis: M=2

Important: this number of objects is used as long as there are enough objects (what leads to the partitioning 2:2:0 in the right partition)

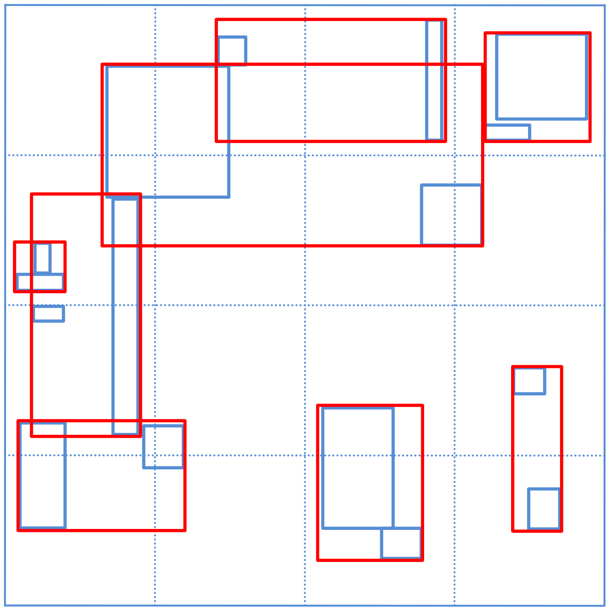
Hint: Empty partitions are discarded



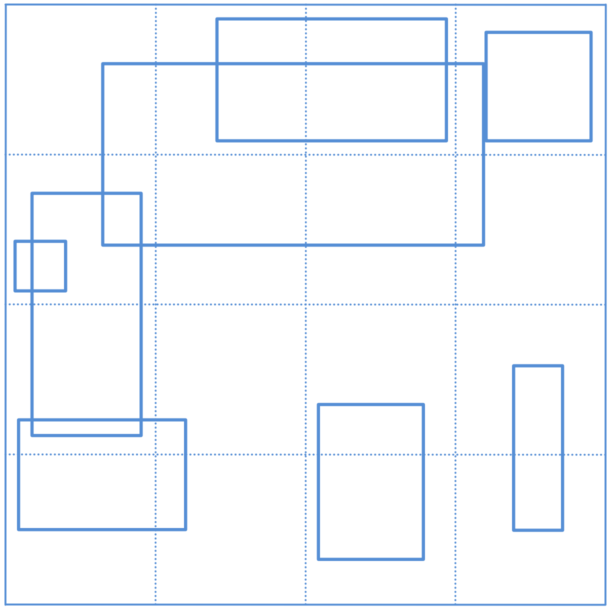
Number of objects in every partition of the y-axis: M=2

Important: this number of objects is used as long as there are enough objects (what leads to the partitioning 2:2:0 in the right partition)

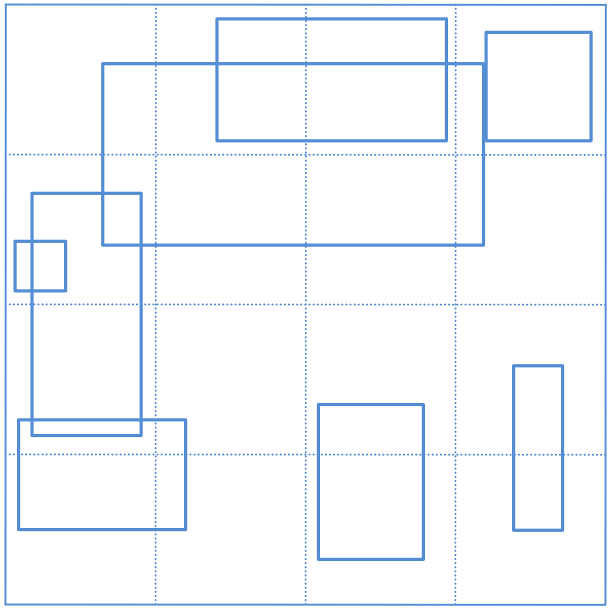
Hint: Empty partitions are discarded



Approximation of all objects of a cell with minimal bounding rectangles (MBR)



2nd Iteration finished.

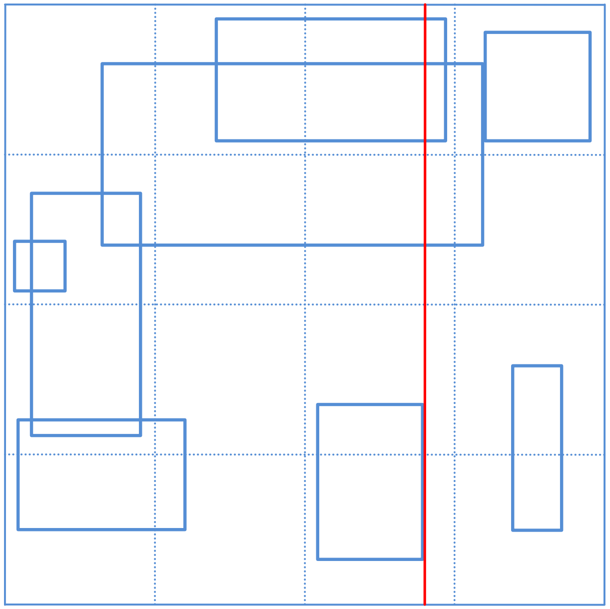


Objects = n = 8

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{8}{2}} \right\rceil = \left\lceil \sqrt{4} \right\rceil = 2$$

- 2 partitions per dimension

Number of objects in every partition of the x-axis: q*M=2*2=4

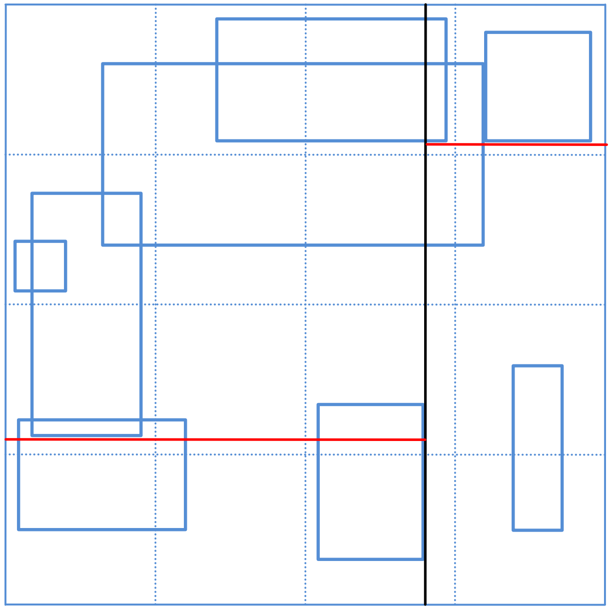


Objects = n = 8

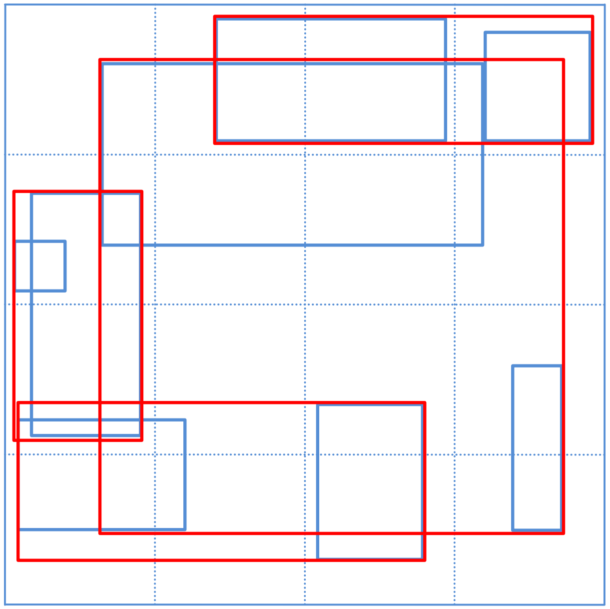
$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{8}{2}} \right\rceil = \left\lceil \sqrt{4} \right\rceil = 2$$

- 2 partitions per dimension

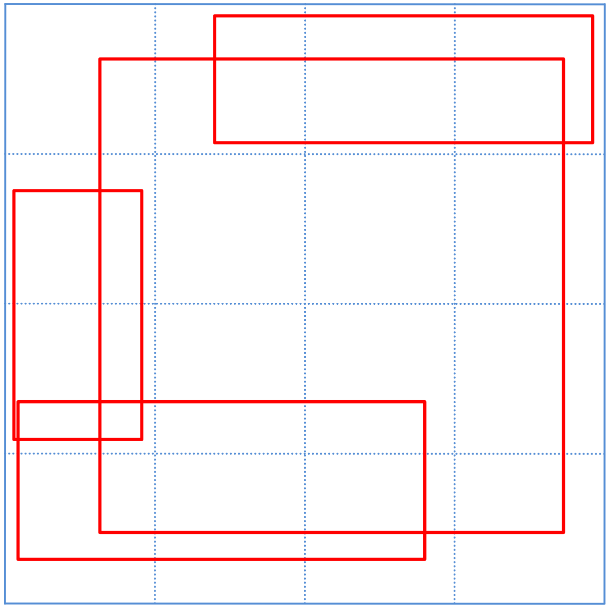
Number of objects in every partition of the x-axis: q*M=2*2=4



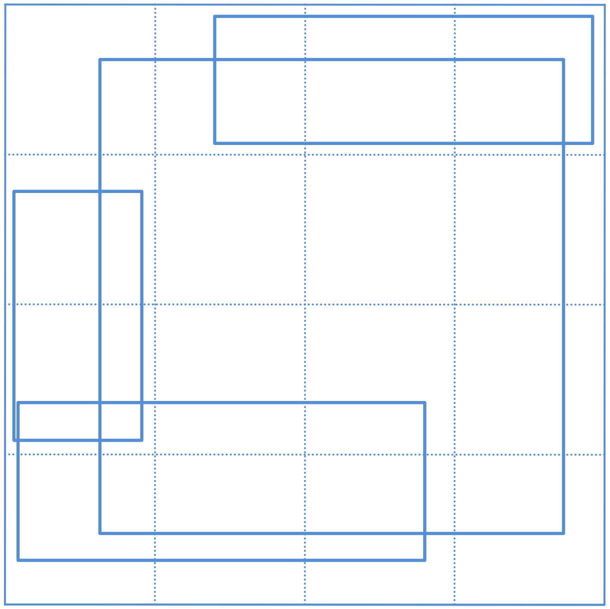
Number of objects in every partition of the y-axis: M=2



Approximation of all objects of a cell with minimal bounding rectangles (MBR)



3rd Iteration finished.

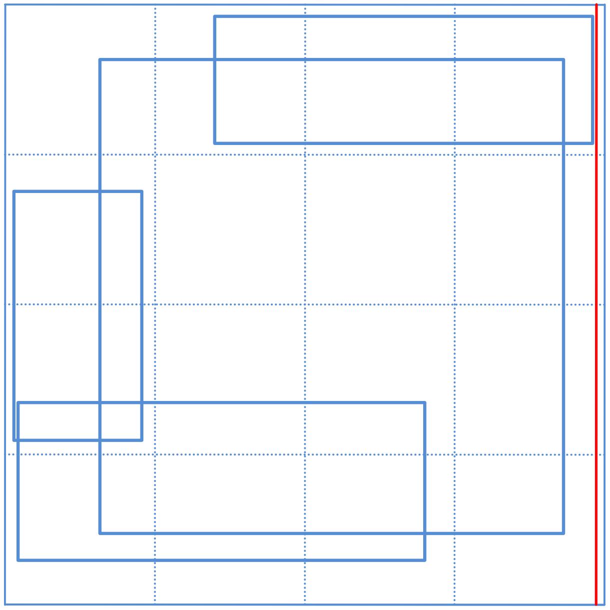


Objects = n = 4

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{4}{2}} \right\rceil = \left\lceil \sqrt{2} \right\rceil = 2$$

- 2 partitions per dimension

Number of objects in every partition of the x-axis: q*M=2*2=4

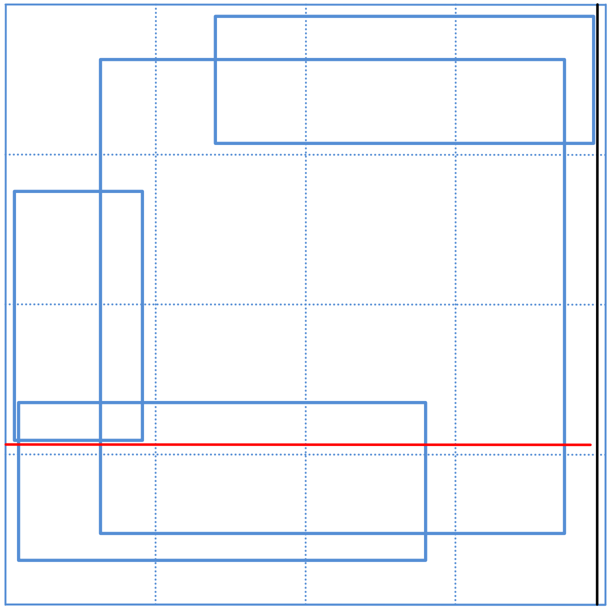


Objects = n = 4

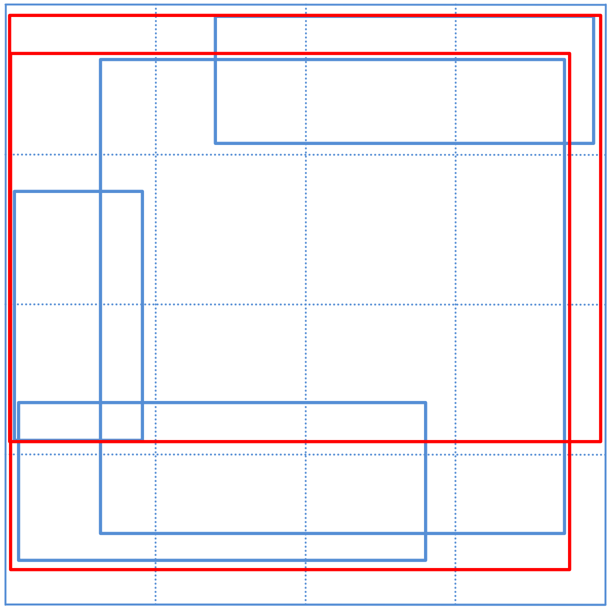
$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{4}{2}} \right\rceil = \left\lceil \sqrt{2} \right\rceil = 2$$

- 2 partitions per dimension

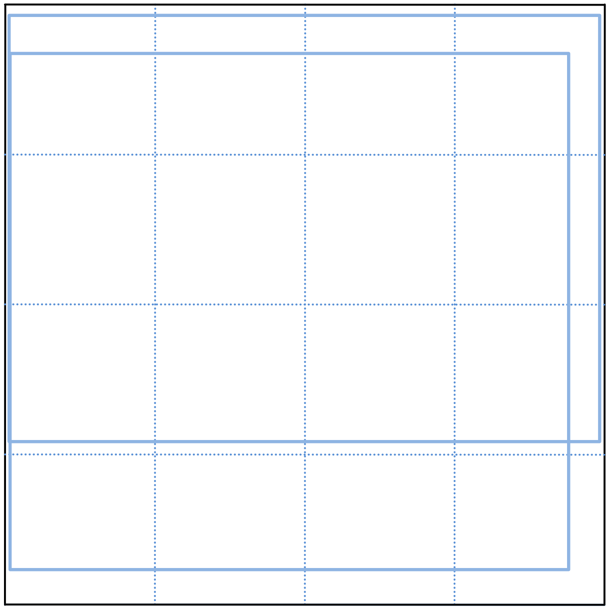
Number of objects in every partition of the x-axis: q*M=2*2=4



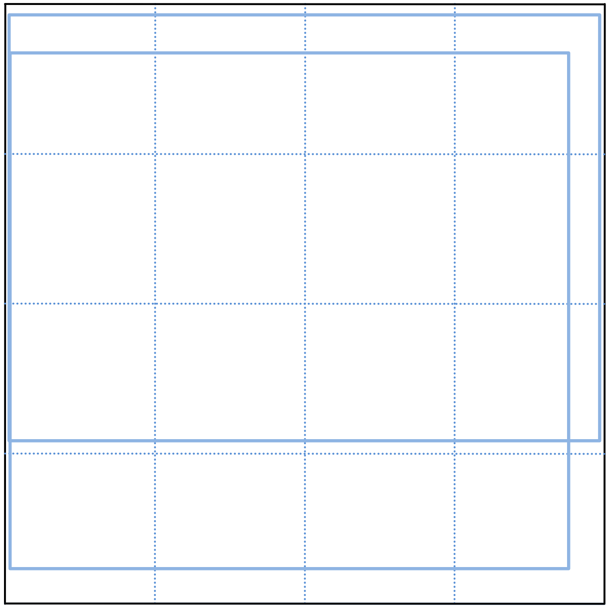
Number of objects in every partition of the y-axis: M=2



Approximation of all objects of a cell with minimal bounding rectangles (MBR)



4th Iteration finished.



Objects = n = 2

$$q = \left\lceil \sqrt{\frac{n}{M}} \right\rceil = \left\lceil \sqrt{\frac{2}{2}} \right\rceil = \left\lceil \sqrt{1} \right\rceil = 1$$

- 1 partition per dimension

Reached stopping criterion: Root contains residual objects