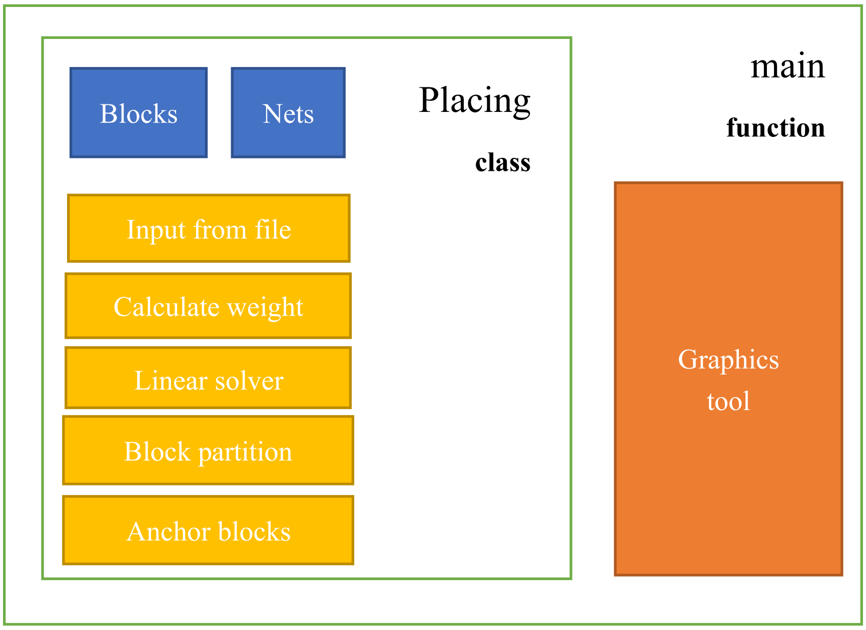
ECE1387 Assignment2 Report -Analytical Placement Zhiyuan Gu (1004920400)

1. Software description

1) Overview



Above is the basic structure of the program. Main function instantiates an object of class named “Placing” to solve the placement and calls functions in order to use the graphics tool. Inside class “Placing”, “Blocks” and “Nets” are two key elements. They hold the information of the placement problem waiting to be solved. “Blocks” is basically an array of blocks to be placed and stores the numbers of connected nets, block position, whether the block is fixed, anchor position, etc. “Nets” represents the source-load connections among blocks and has information such as which blocks are in the net. Below them are the methods required to call the linear solver in umfpack and solve placement plus spreading the blocks with fixed anchors.

2) Main methods

a) Input from file

Nets and blocks and their connection information are input from file. Fixed cells and their position are also known.

b) Calculate weight

According to the network connections read from input file and the specified network model, connection between blocks with its weight can be figured out. Combined with position of fixed blocks, matrices Q and $\underset{b}{\rightarrow}$ can be formed.

c) Linear solver

Before being sent into the linear solver, matrix Q needs to be processed into smaller matrices in order to explore its sparsity. Then linear solver takes in all the required inputs and outputs solved position of non-fixed blocks after two runs for both x and y coordinates. After that, the results are written back into “Blocks”.

d) Block partition

To spread the placed cluster of cells with all the overlapping, the first step is to partition them into each sector. The method used in this program is similar to that used in SimPL design which spreads horizontally first and then vertically. This is done by sorting the array of blocks according to x coordinate first, dividing by 4 with each vertical stripe having roughly equal number of blocks, sorting again in the four stripes in y coordinate ascending order, and dividing again each vertical stripe into 4 sectors with roughly equal number of blocks. Each block is now assigned with a destination or the so-called anchor.

e) Anchor blocks

After block partition, the weight information needs to be updated to the matrices. Specifically, on-diagonal elements of Q and all the elements in $\underset{b}{\rightarrow}$ need to be updated.

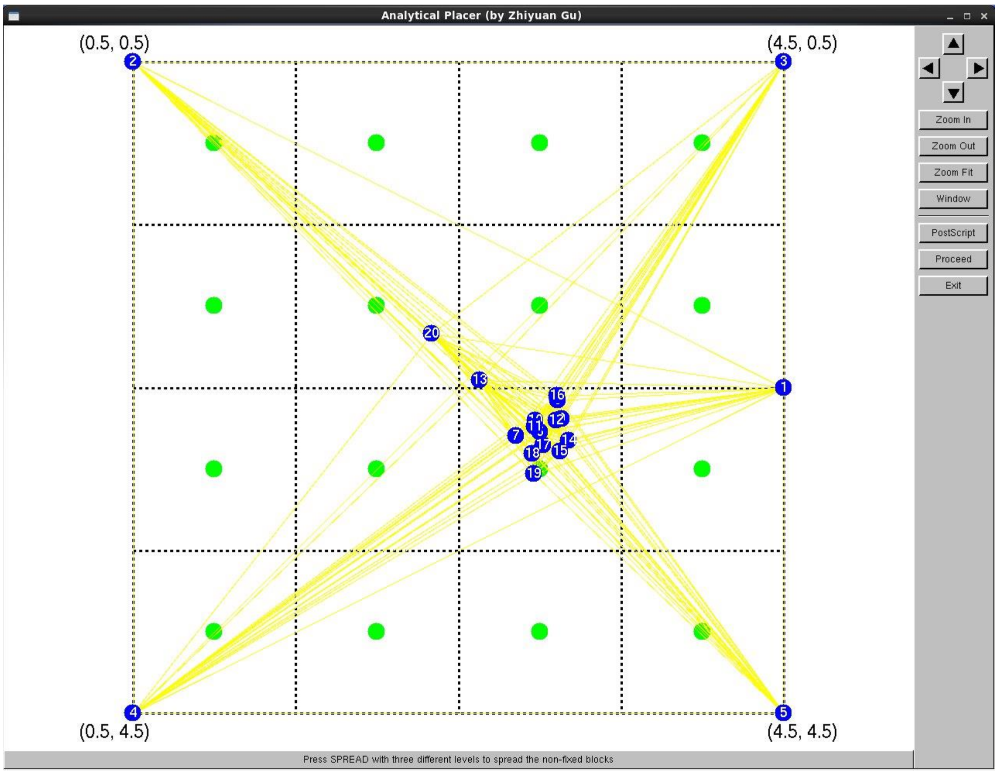
The following steps to calculate and update the new positions of blocks are the same as previously mentioned.

2. Program outputs

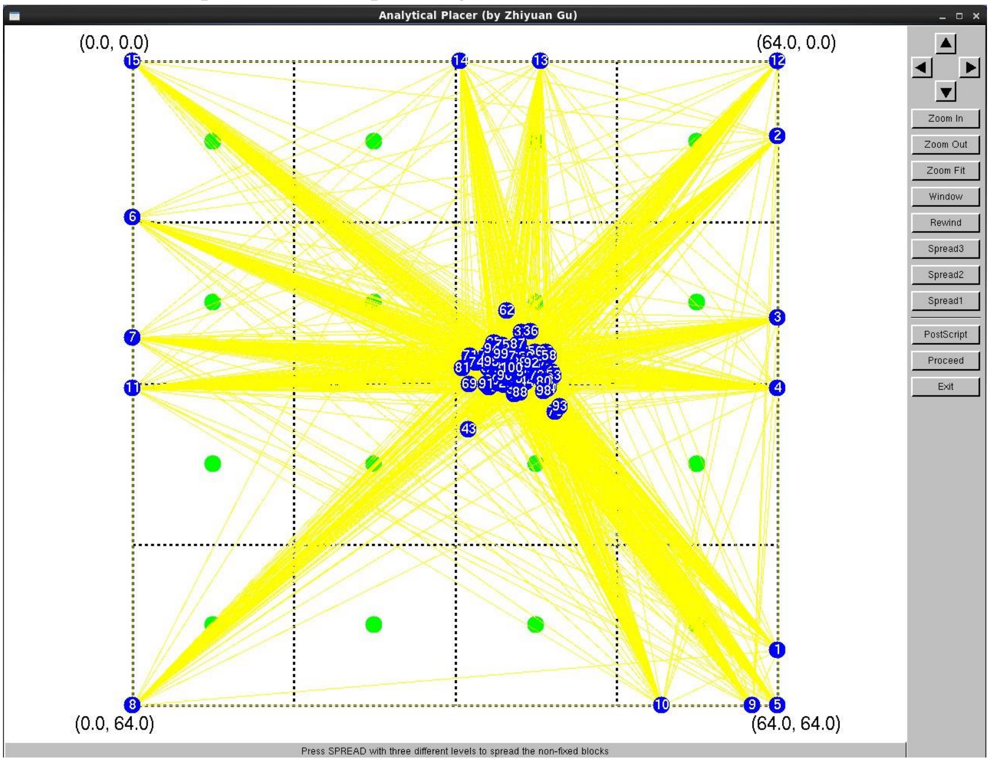
1) Plots for all circuits with clique model

Note that blue circles with numbers in them are all the blocks given, including fixed blocks on the grid. Yellow lines depict the rat's nest connecting block to block. And finally, green circles are the center of all 16 sectors which are used in the spreading process as anchors.

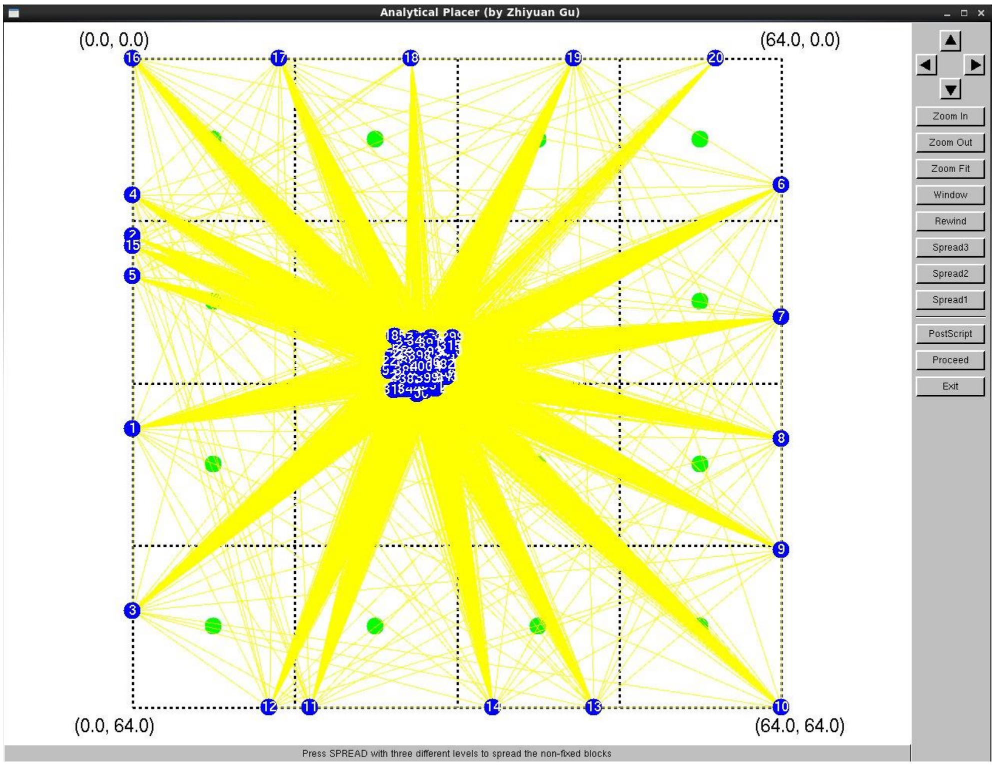
a) Circuit 1, clique model, no spreading



b) Circuit 2, clique model, no spreading

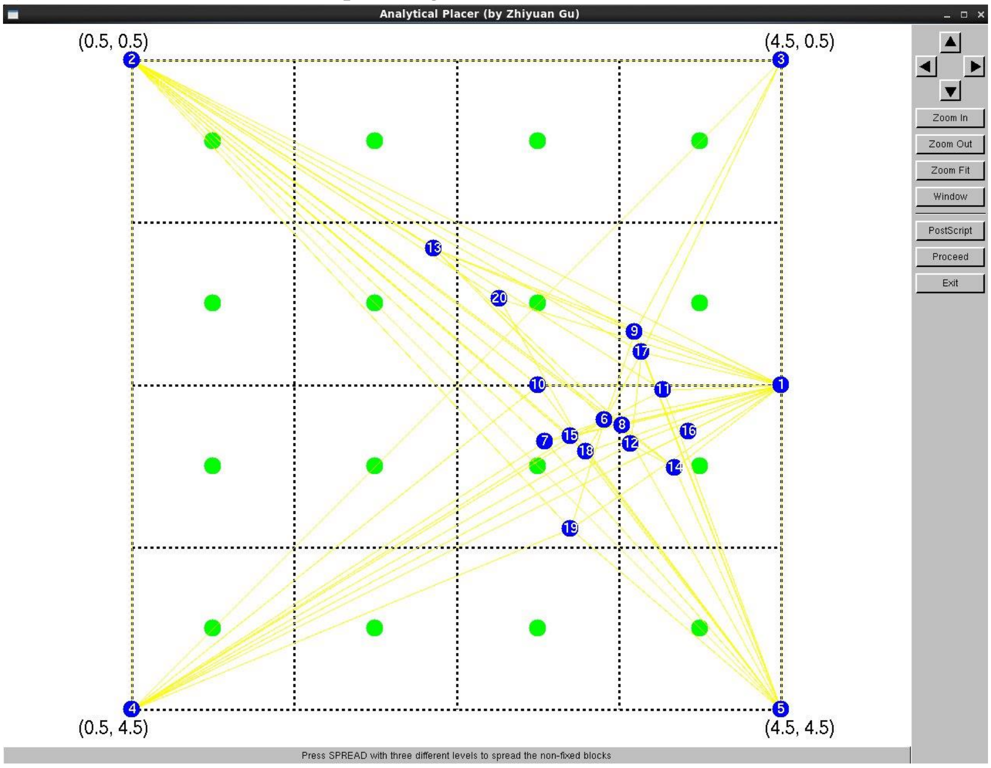


c) Circuit 3, clique model, no spreading

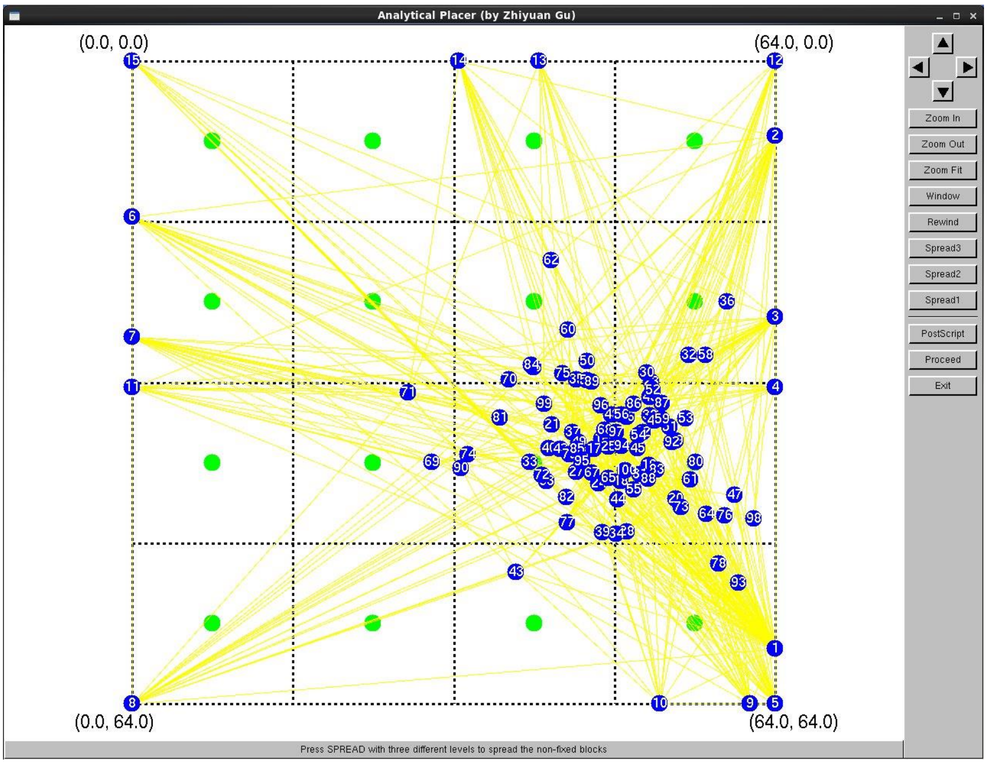


2) Plots for all circuits with tree model

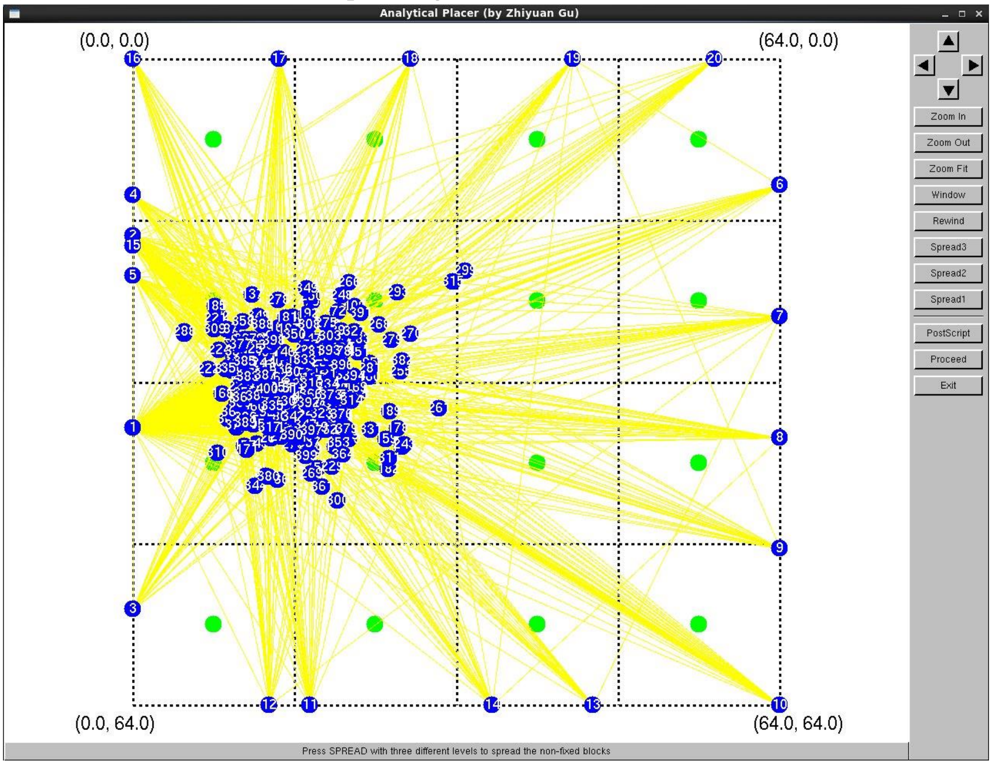
a) Circuit 1, tree model, no spreading



b) Circuit 2, tree model, no spreading



c) Circuit 3, tree model, no spreading

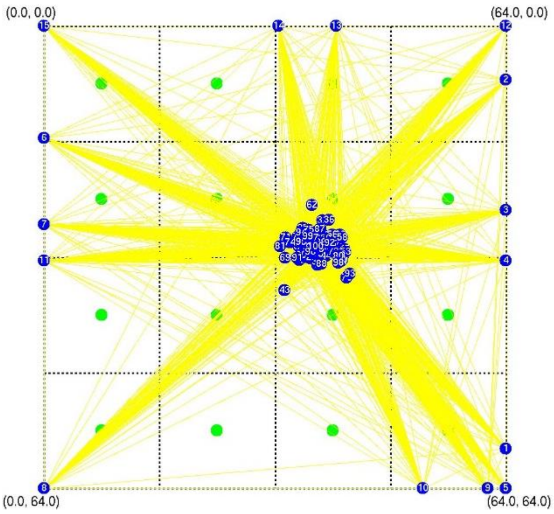


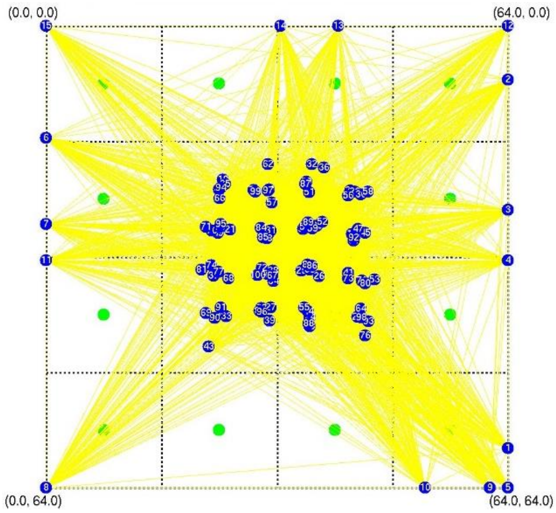
3) Table for HPWL of two models and three circuits

Net model \ Circuit	Circuit 1	Circuit 2	Circuit 3
Clique	106.9	4774.8	7764.9
Tree	116.5	6137.6	12641.5

4) Plots for spreading circuit 2 and circuit 3

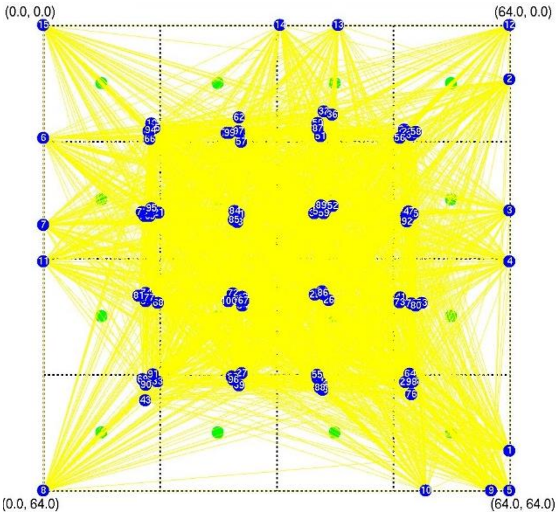
a) Circuit 2, clique model, spreading



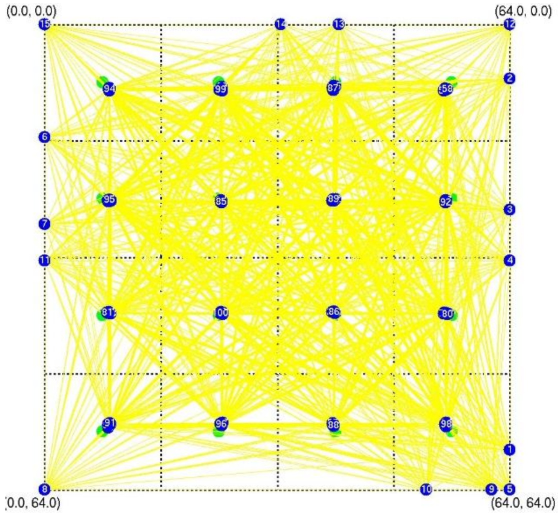


no spreading

spreading effort = 1

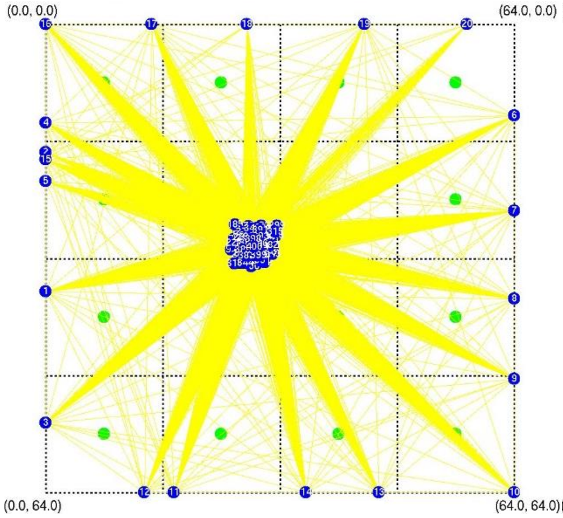


spreading effort = 2

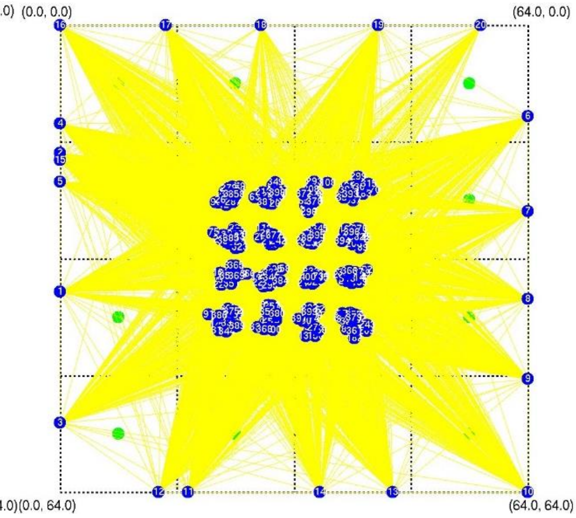


spreading effort = 3

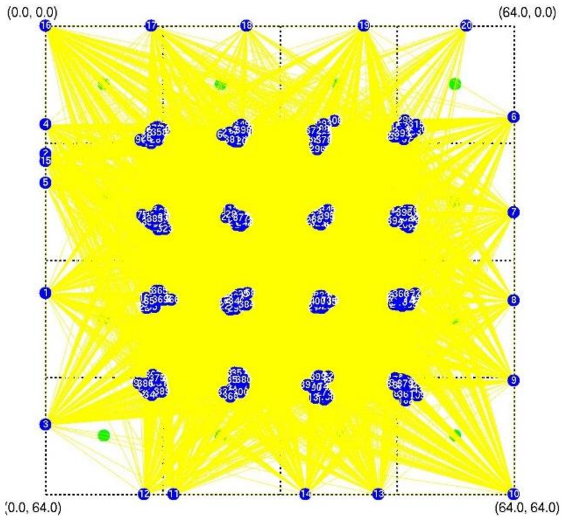
b) Circuit 3, clique model, spreading



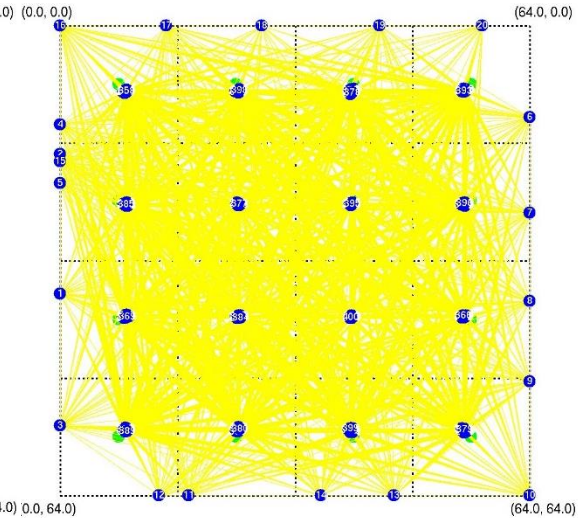
no spreading



spreading effort = 1



spreading effort = 2



spreading effort = 3

5) Table for HPWL when spreading for circuit 2 and 3

Circuit \ Spreading effort	0	1	2	3
Circuit 2	4774.8	6392.1	8329.5	9651.1
Circuit 3	7764.9	15754.3	25501.7	32376.6

3. Observation

1) Clique net model is better than tree net model with regard to modeling the half perimeter bounding box and giving HPWL results. The plots also show blocks with clique model are closer to each other. Testing spreading placement for tree model also shows that HPWL results from clique net model are having smaller advantages over those from tree model. For example, clique model for circuit 3 has 38.6% shorter HPWL than tree model. But that drops to only 4.2% when enabling strong pulling power from anchors. This drop does not only appear by ratio of shorter HPWL to the larger one but also by the actual difference of HPWLs between the two models from 4876.6 to 1415.7. In other words, net model advantage can be reduced greatly after spreading placement. But as will be discussed in the next observation, HPWL increases after spreading. As a result, this observation could be interpreted as a side effect of spreading's reducing the benefits of analytical placement without restriction on overlapping.

   *Table for HPWL of circuit 3 with two models and two spreading effort levels

\ Spreading effort	no spreading effort	spreading effort = 3
clique model HPWL①	7764.9	32376.6
tree model HPWL②	12641.5	33792.3
difference: (②-①)	4876.6	1415.7
advantage ratio: (②-①)/②	38.6%	4.2%

2) Increasing weight on connections between anchors and moving blocks causes moving blocks to be pulled harder towards anchors. Spreading placement increases HPWL which was calculated without considering the problem of overlapping. It is also apparent that HPWLs of larger circuits with more connections among moving cells will suffer more if spreading is applied. Spreading placement should be regarded as bring back the actual effect of placement with overlapping restriction thus wire length is bound to get worse.