Exercises on physical design

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1 Quadratic placement

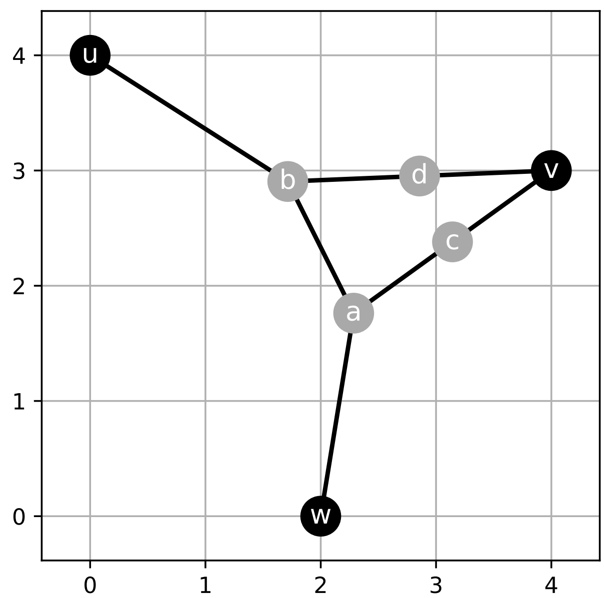
By computing the Laplacian matrix of the graph, and removing the rows and columns of the fixed cells, we get the matrix A used in the linear equation system.

$$A = \begin{pmatrix} 3 & -1 & -1 & 0 \\ -1 & 3 & 0 & -1 \\ -1 & 0 & 2 & 0 \\ 0 & -1 & 0 & 2 \end{pmatrix}$$

The right hand side for x is $b^x = \begin{pmatrix} 2 & 0 & 4 & 4 \end{pmatrix}^T$ and for y is $b^y = \begin{pmatrix} 0 & 4 & 3 & 3 \end{pmatrix}^T$, so we can solve now the two systems: $AX = b^x$ and $AY = b^y$ and obtain the coordinates of the non-fixed cells.

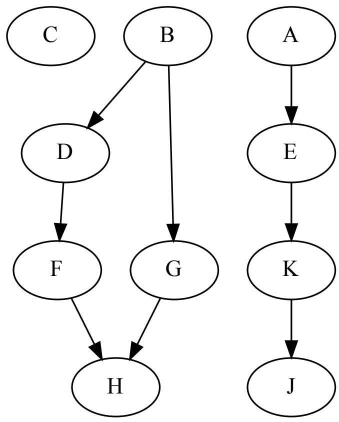
$$X = \begin{pmatrix} 2.29 & 1.71 & 3.14 & 2.86 \end{pmatrix}^T, \quad Y = \begin{pmatrix} 1.76 & 2.90 & 2.38 & 2.95 \end{pmatrix}^T$$

The graph can be plotted now, where the black nodes are the fixed ones $\{u, v, w\}$ while the gray nodes are the non-fixed cells $\{a, b, c, d\}$. For details see the python script `placement.py`.

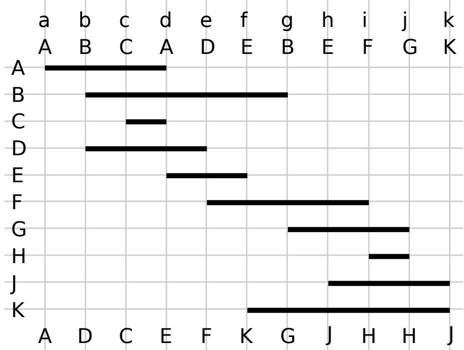


2 Channel routing

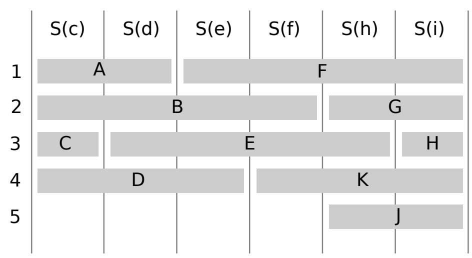
The vertical graph can be computed from the two vectors TOP and BOT.



As there are no loops, no conflicts are detected, and the graph corresponds with the vertical constraint graph with net splitting. The zone representation can be computed by first connecting the pins endpoints.



The set of maximal nets are $S(c) = \{A, B, C, D\}$, $S(d) = \{A, B, D, E\}$, $S(e) = \{B, D, E, F\}$, $S(f) = \{B, E, F, K\}$, $S(h) = \{E, F, G, J, K\}$ and $S(i) = \{F, G, H, J, K\}$. From which we can finally obtain the zone representation.



So we find that the minimum number of tracks is 5.