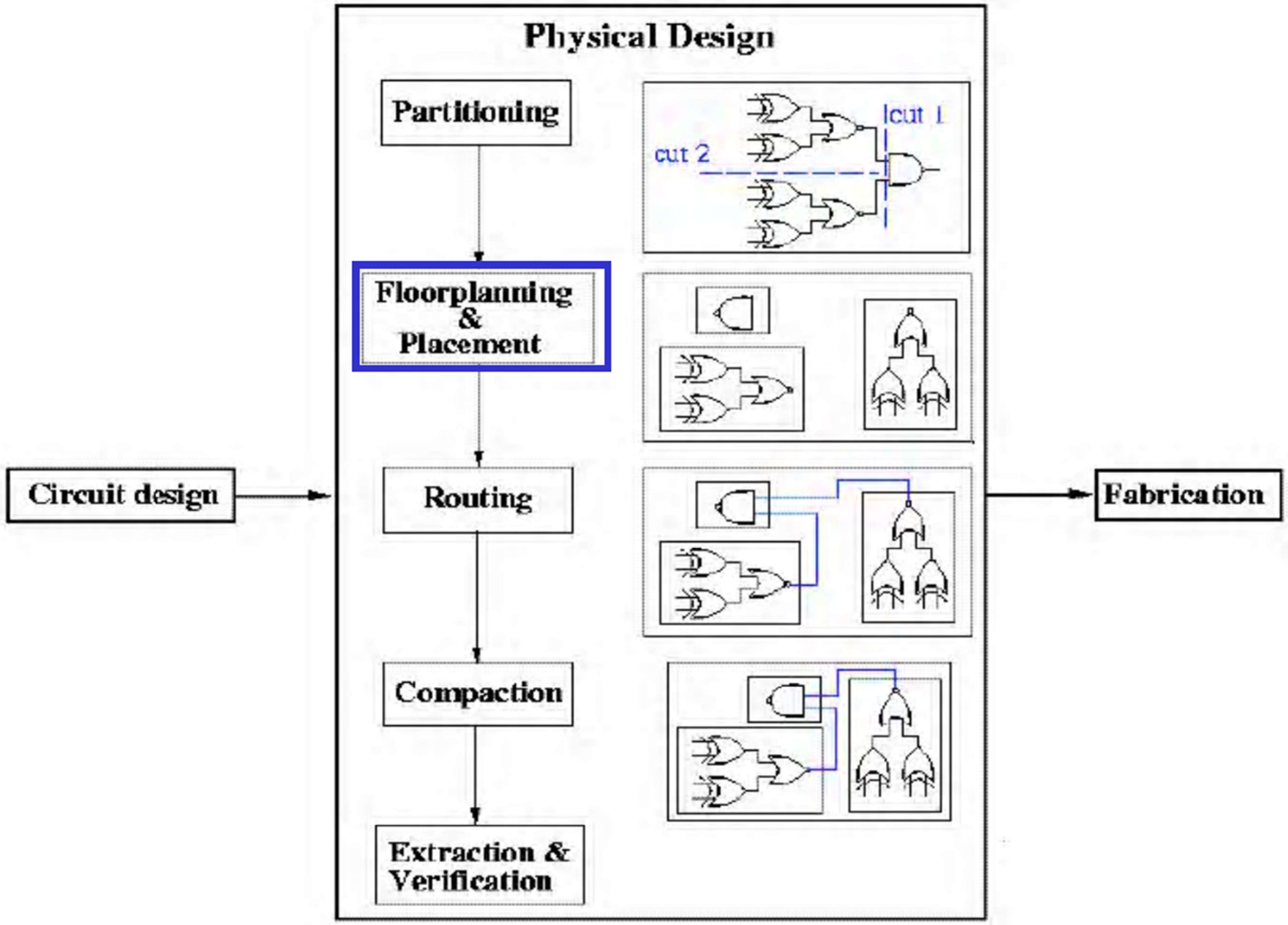
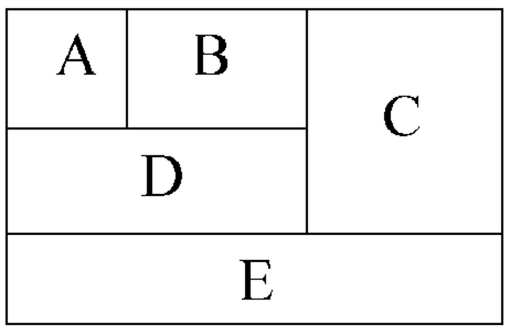
Floorplanning-1

Physical Design Flow



Floorplans

- A *floorplan* is the placement of (flexible) blocks with fixed area but unknown dimensions
- Blocks are usually assumed to be rectangular in shape
- Some work done with L-shaped blocks
- Usually a lower and an upper bound on the Aspect ratio are given



A Floorplan with 5 rectangular blocks

A floorplan is usually represented by a rectangular dissection

Floorplanning Problem

Objective :

Finding a suitable topology of the blocks and their dimensions such that

– Area minimized

– Critical net delay minimized

Floorplanning algorithm

A good Floorplanning algorithm should

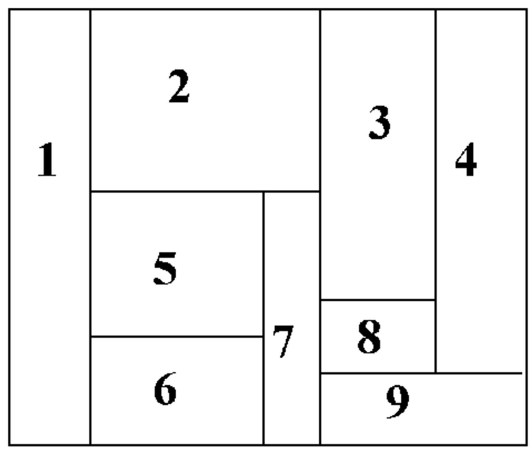
- minimize total chip area
- make the subsequent routing phase easy
- improve the performance, by, for example, reducing signal delays

It is difficult to

- consider all these goals simultaneously, as they mutually conflict
- consider algorithmically several objectives simultaneously

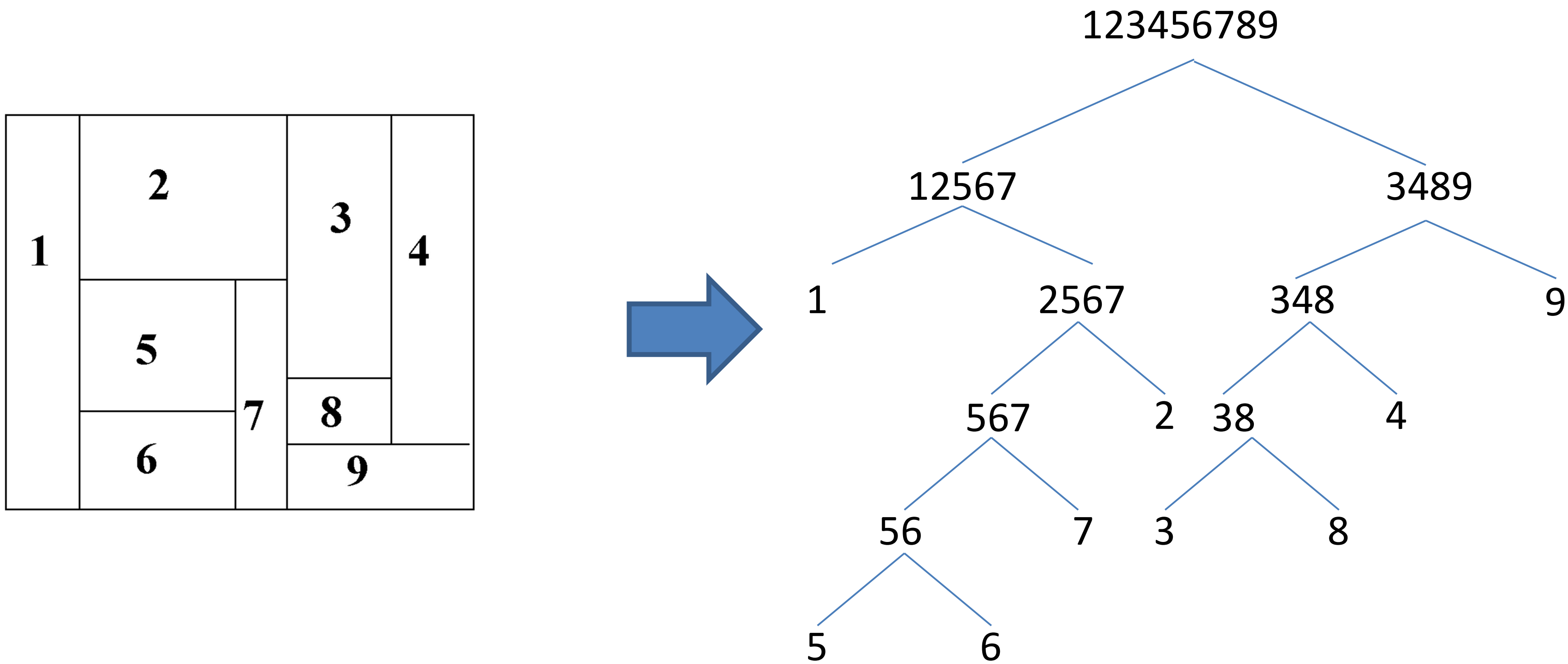
Slicible Floorplans or Rectangular Duals

A floorplan is *Slicible* if it is obtained by recursively bipartitioning a rectangle into two slicible floorplans either by a horizontal or a vertical line



Slicible Floorplan

Sliceable Floorplans



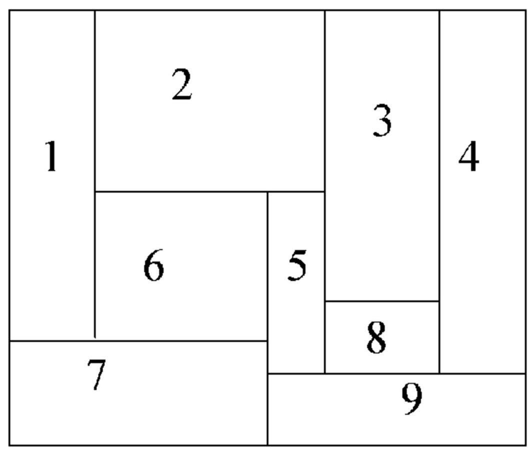
Easy to represent with binary tree

- facilitates efficient algorithm design

Sizing and routing algorithms execute in polynomial time

Non-Slicible Floorplans

A floorplan that is not *Slicible*

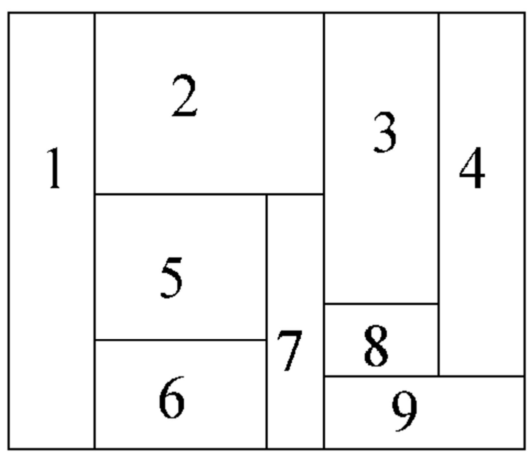


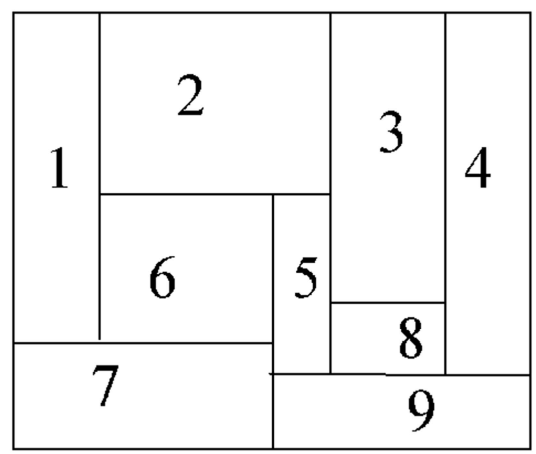
NonSlicible Floorplan

Floorplan sizing problem for nonslicible floorplan is NP complete

Floorplans

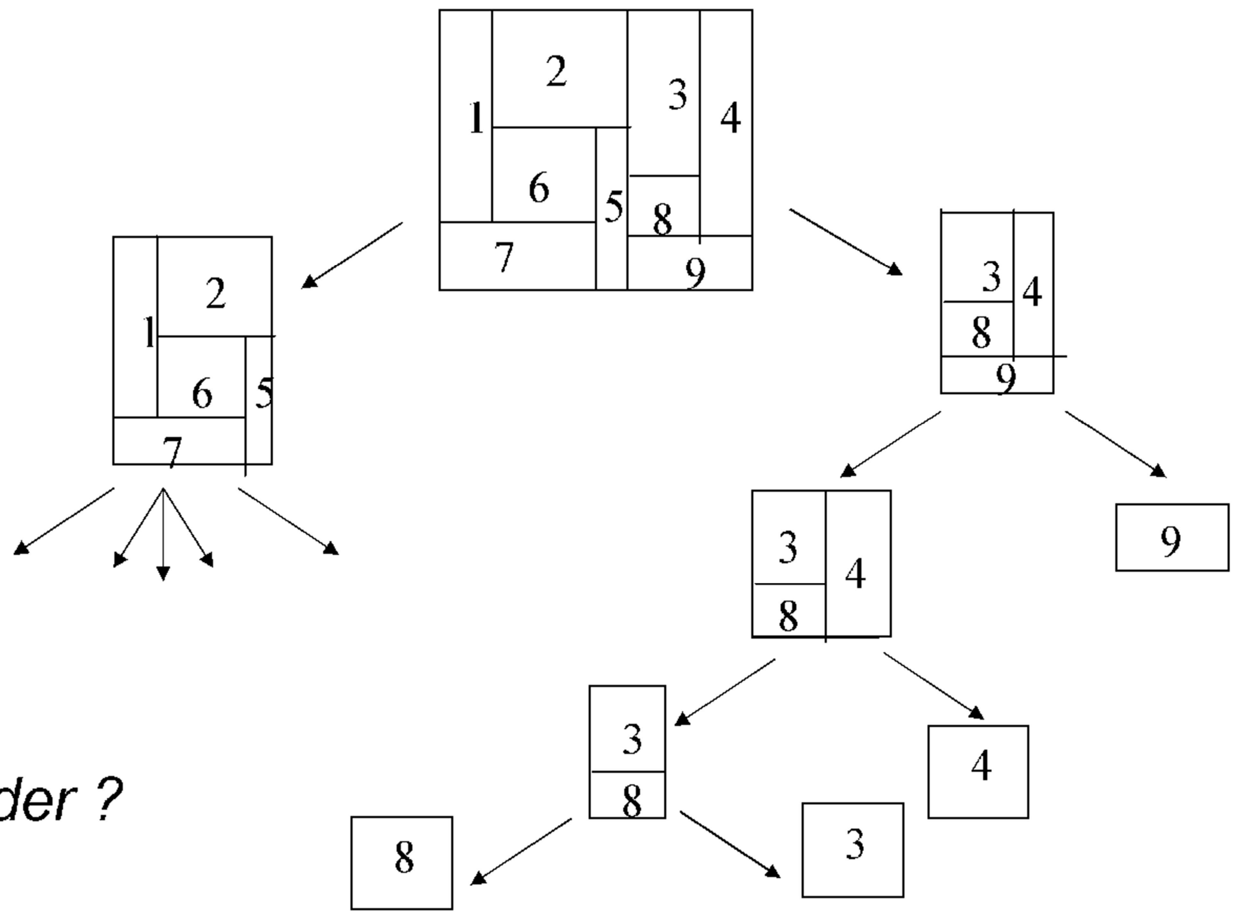
A *floorplan* is said to be hierarchical order of *k*, if it can be obtained by recursively partitioning a rectangle into at most *k* parts





What are the hierarchical orders of the above floorplans ?

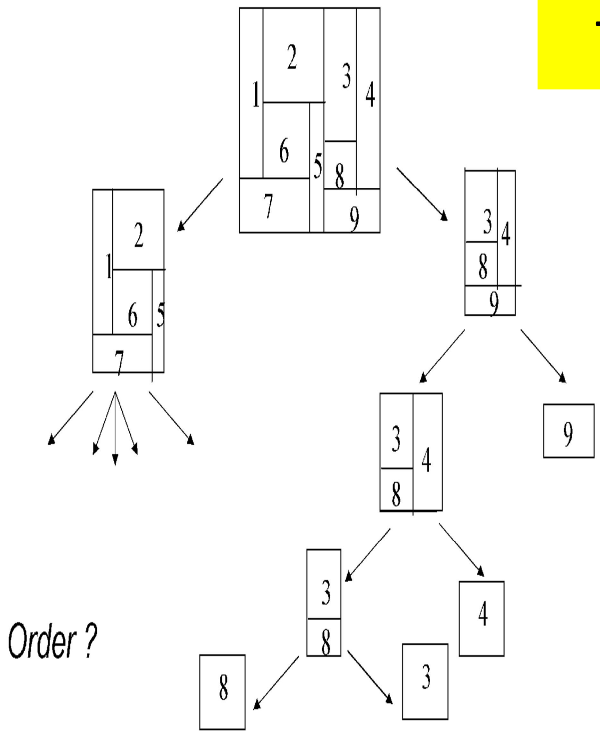
Hierarchical Floorplan Trees



Order ?

Hierarchially defined floorplan is a floorplan that can be described by a floorplan tree

Hierarchical Floorplan Trees



The leaves of the tree correspond to modules

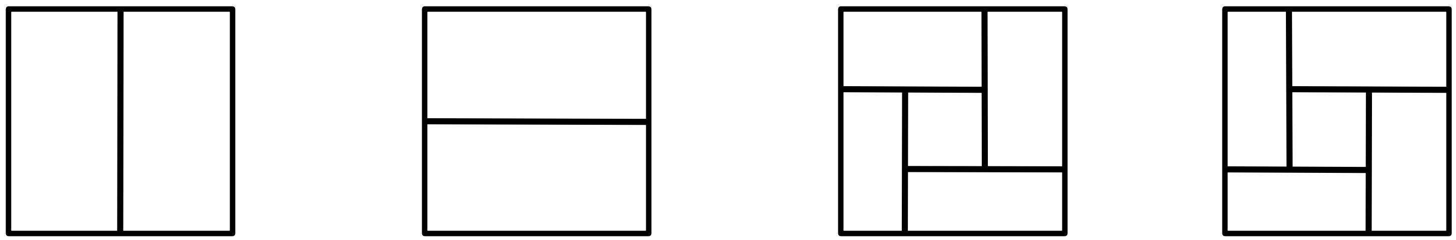
An internal node defines how its child floorplans are combined to form a partial floorplan

Various restrictions may be imposed on internal nodes

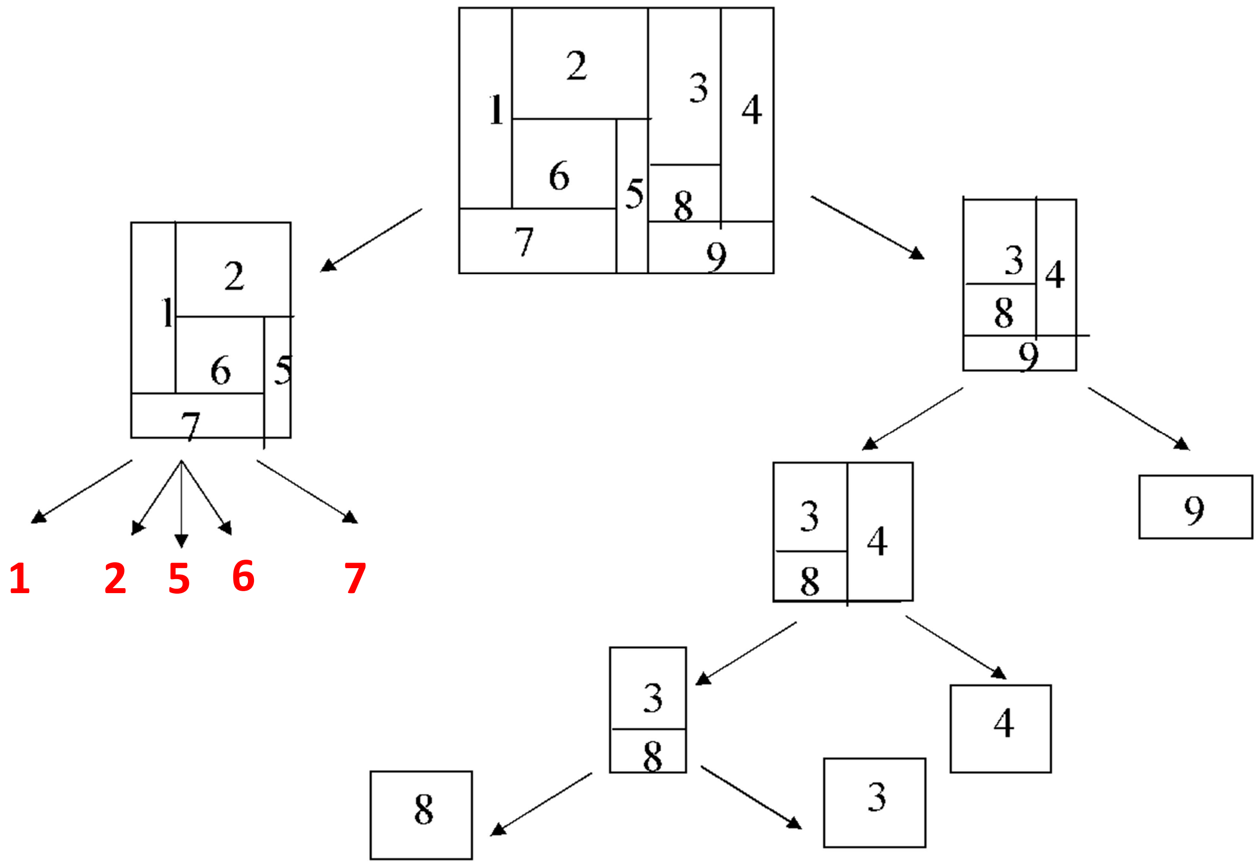
(a) The number of child floorplans cannot exceed a certain limit
(b) The shape of the floorplan corresponding to internal node is limited, for example, to rectangles or other simple shapes

Hierarchical Floorplan

Four types of Internal nodes



Hierarchical Floorplan Trees



Floorplan sizing problem for nonsliceable floorplan is NP complete

Floorplanning by Rectangular Dualization

Input :

A set of rectangular blocks
A set of realizations, i.e., (width, height) pairs, for each block
Adjacency graph for the blocks

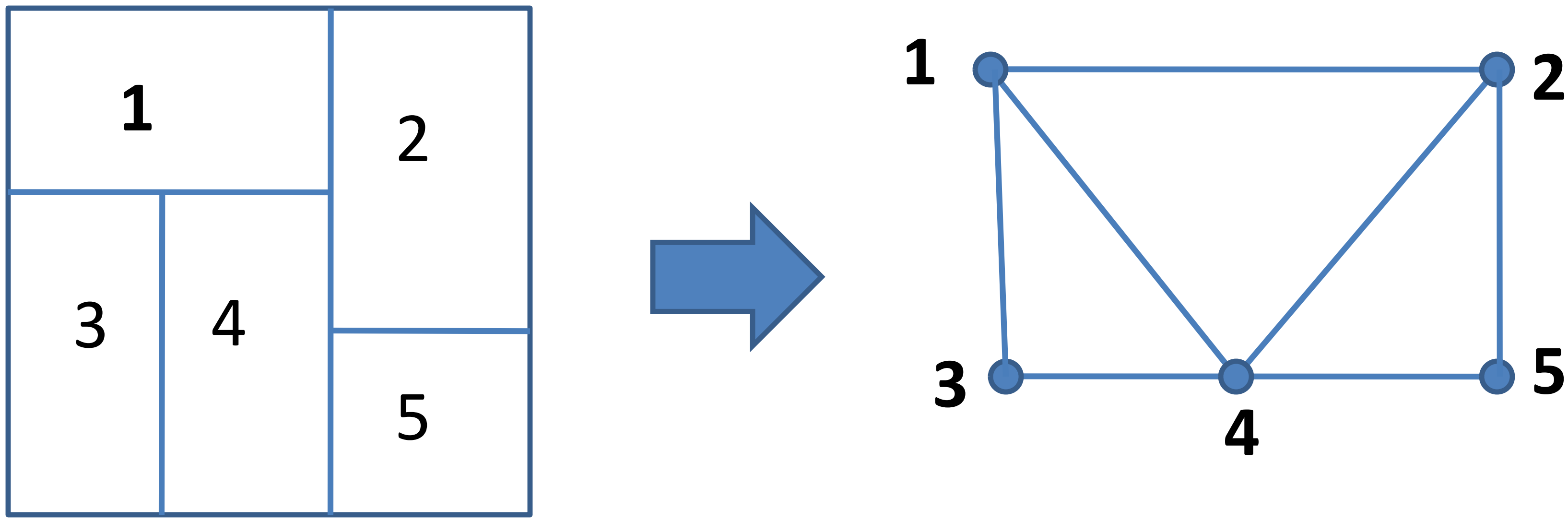
Requirements :

Topology generation --- Location of each block within a rectangular envelope such that no two blocks overlap
Sizing --- An appropriate size, i.e., width and height, of each block

Objectives :

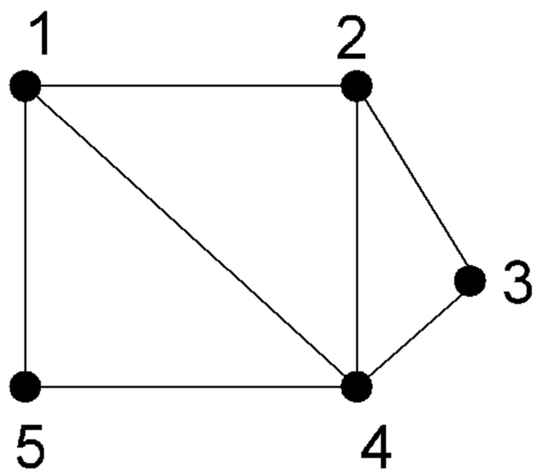
Minimize area of the rectangular envelope
Reduce net-length for critical nets

Rectangular Dual Graph



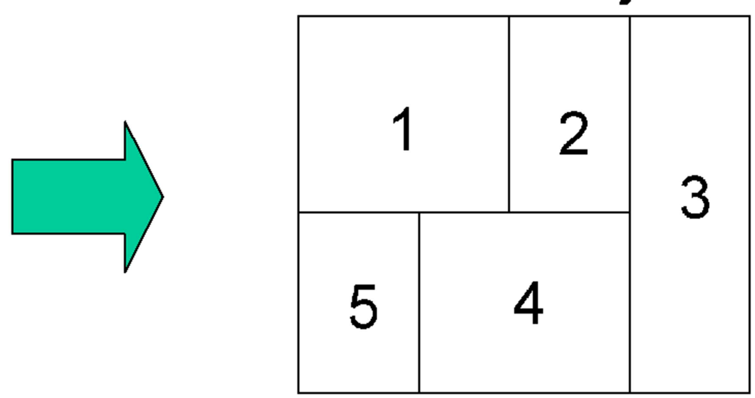
A rectangular dual graph of a rectangular floorplan is a plane graph G=(V,E), where V is the set of modules and (M_i, M_j) ε E if and only if modules M_i and M_j are adjacent in the floorplan.

Rectangular Dualization - An Example

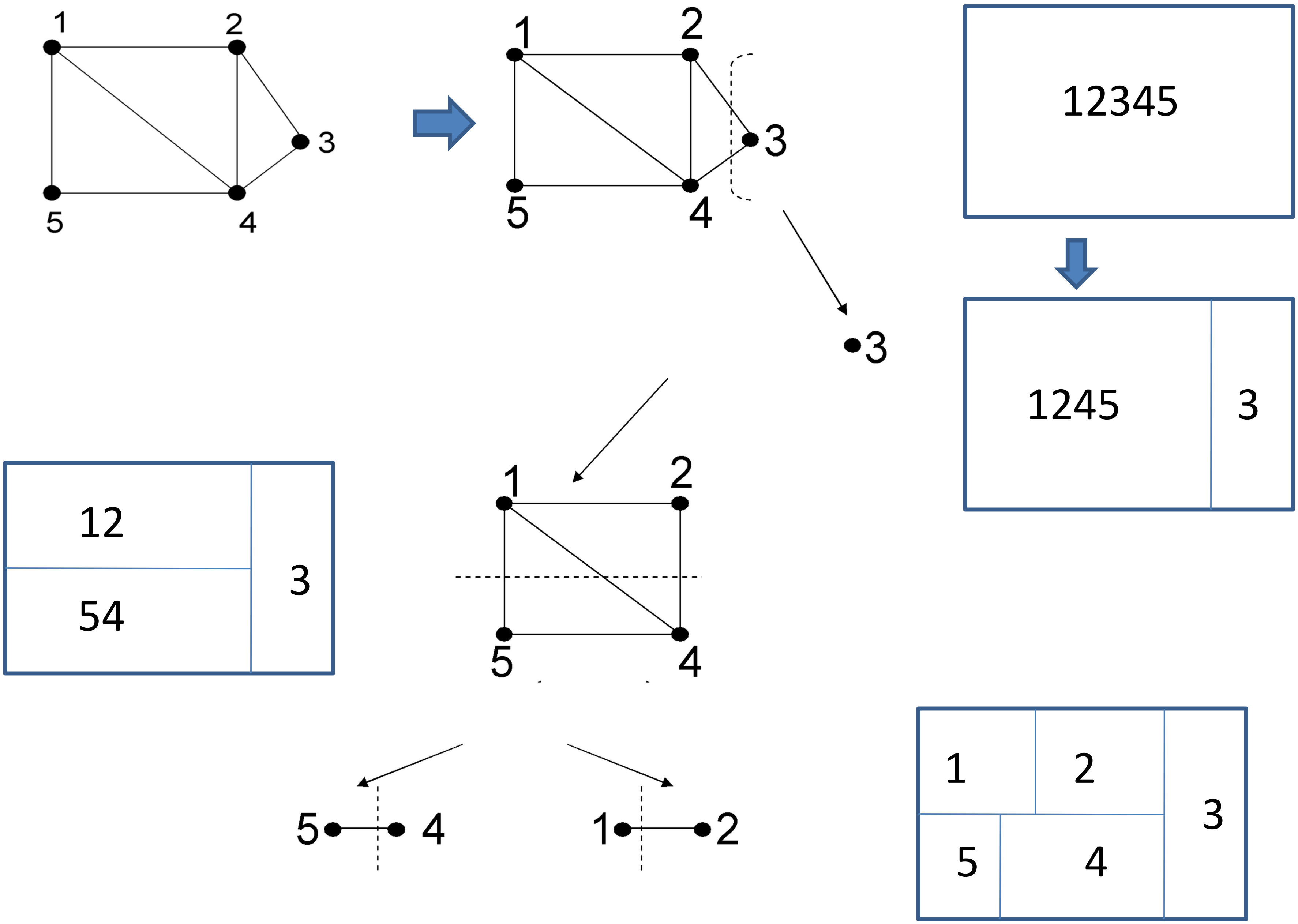


Adjacency Graph

Geometric Dual of Adjacency Graph

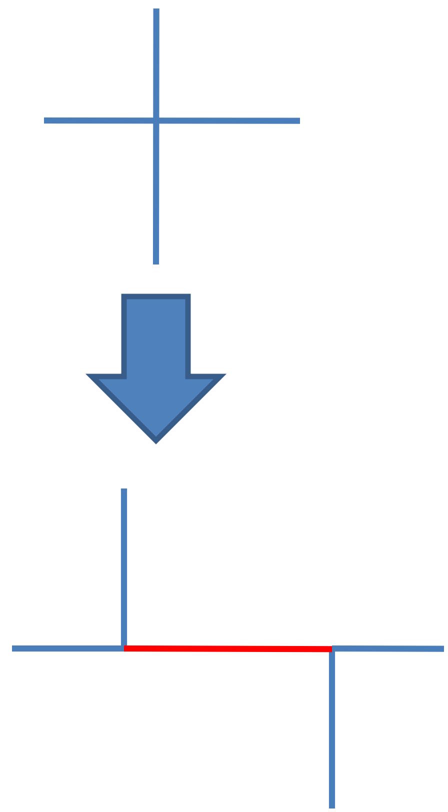


Topology Generation : A simple example



Rectangular Dual

Assumed that a rectangular floorplan contains no cross junctions



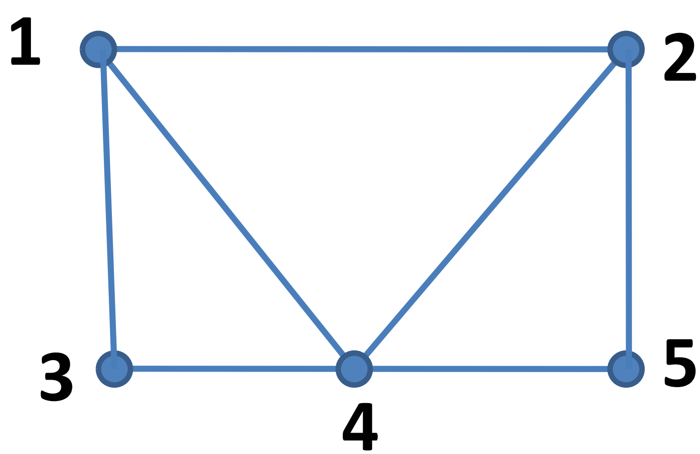
A cross junction is replaced by two T-junctions with another short edge

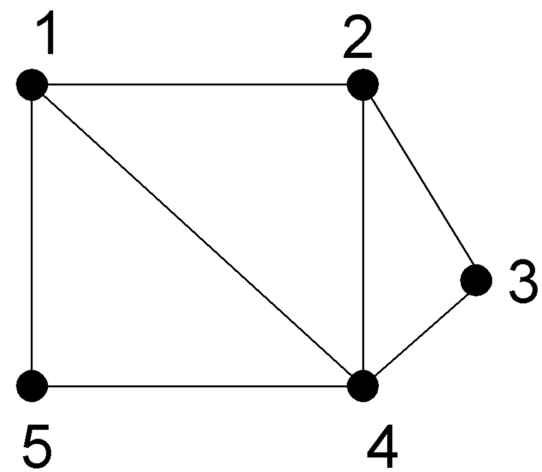
A graph is said to be planar if there exists some geometric representation of G which can be drawn on a plane such that no two of its edges intersect

Dual graph of a rectangular floorplan is a planar triangulated graph (PTG)

Rectangular Dualization: Planar Triangulated Graph

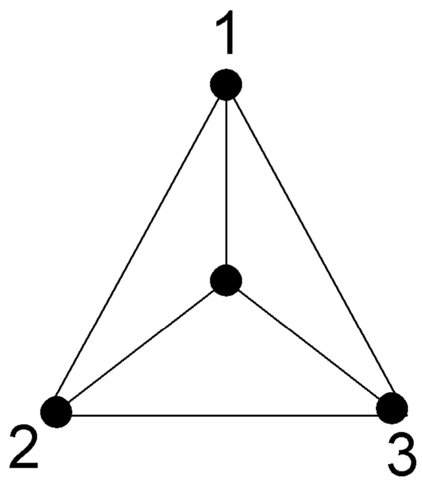
Dual graph of a rectangular floorplan is a planar triangulated graph (PTG)





- Every face, except the exterior, is a triangle
- All internal vertices have degree ≥ 4
- all cycles that are not faces and the exterior face have length ≥ 4

Rectangular Dualization: Planar Triangulated Graph



No corresponding rectangular floorplan exist

Only

Forbidden pattern in rectangular dual graph

Every dual graph of a rectangular floorplan is a planar triangulated graph (PTG)

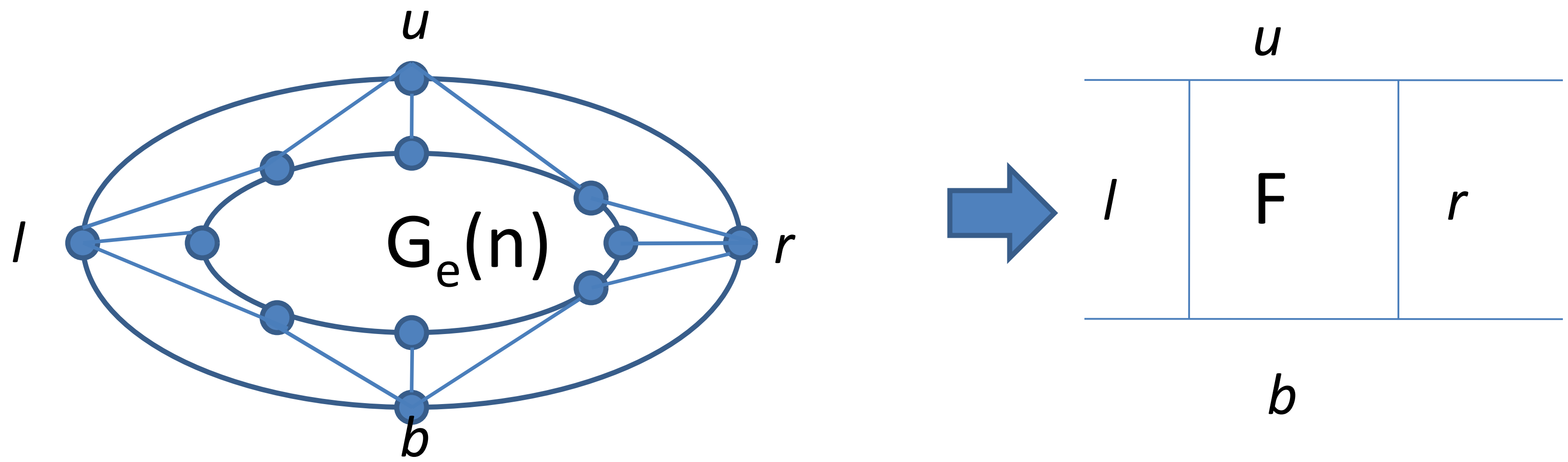
BUT not every PTG corresponds to a rectangular floorplan

A rectangular floorplan exists iff the dual of the floorplan contains no complex triangle

A rectangular graph is an adjacency graph

that yields a rectangular dual

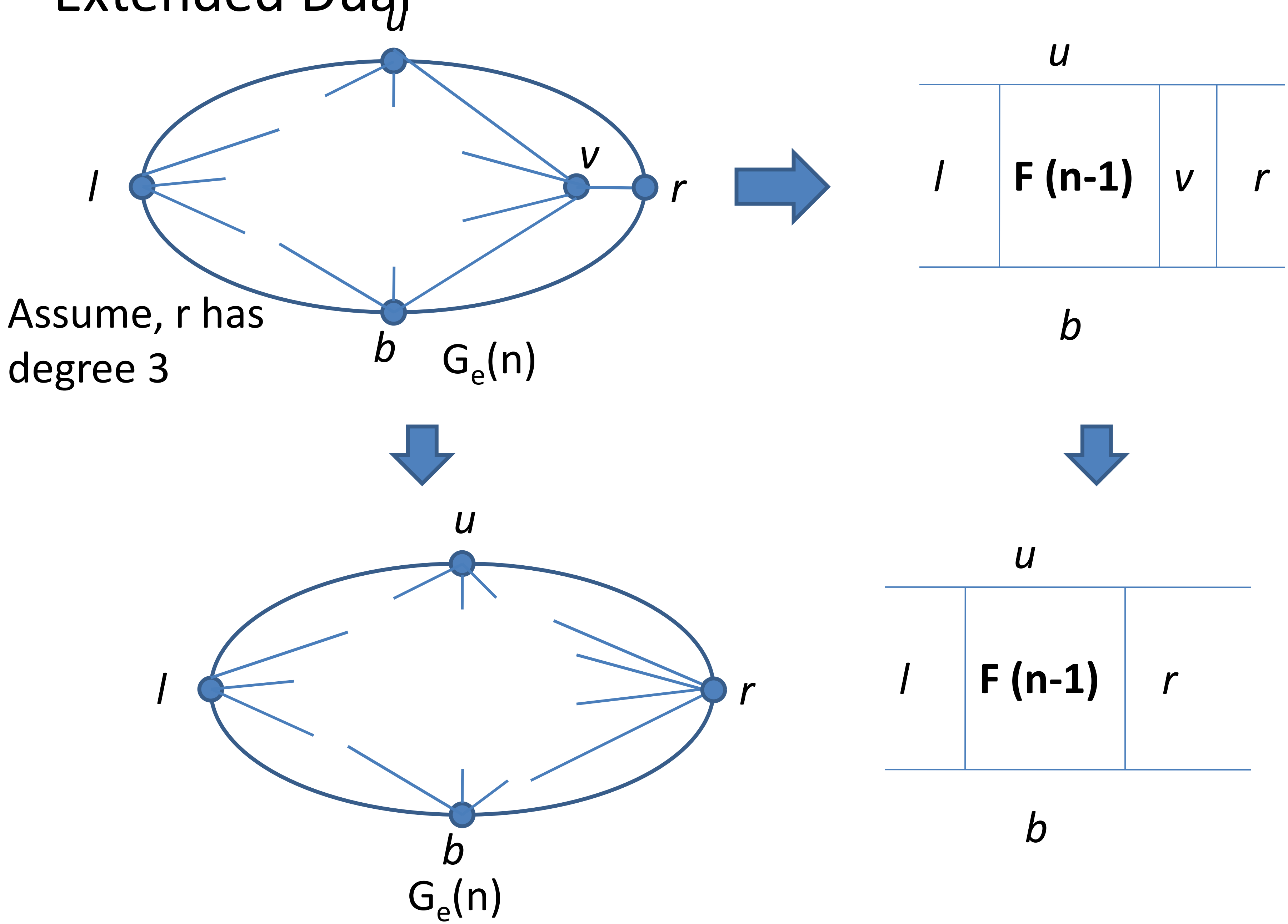
Extended Dual



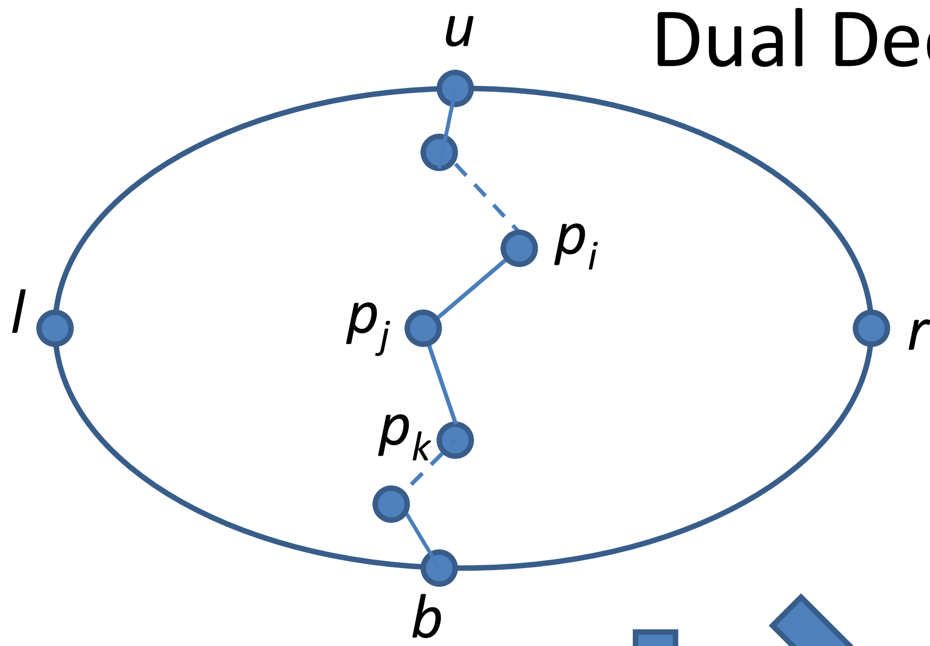
A rectangular floorplan exists if and only if the extended dual of the floorplan contains no complex triangles

Hypothesis: It is possible to generate a floorplan for any dual graph $G_e(k)$ for $k < n$

Extended Dual



Dual Decomposition



$G_e(n)$

A path $P_V = \{u=p_1, p_2,\ldots\ldots,p_m=b\}$

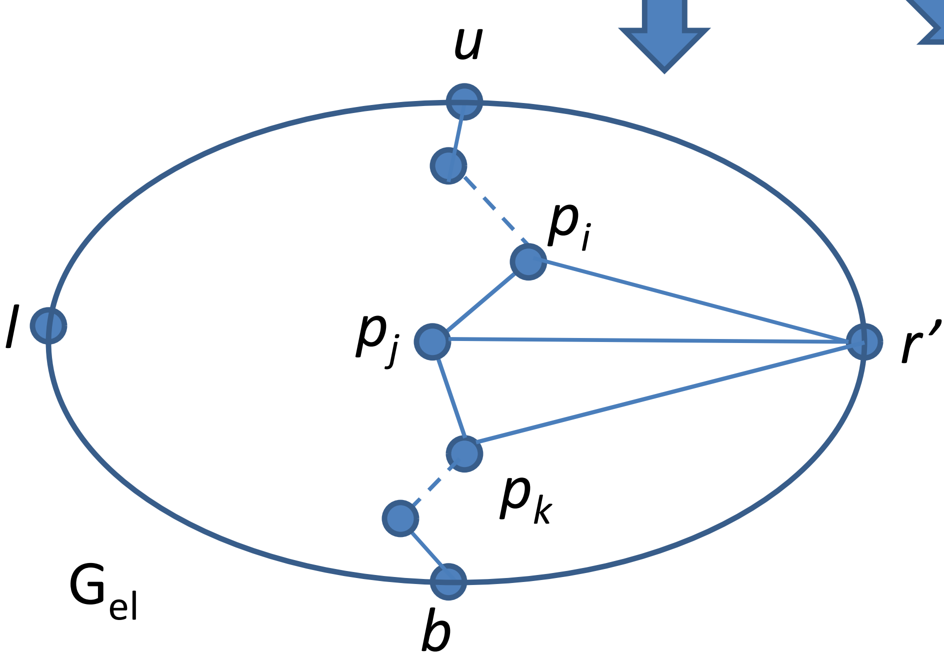
(i) $p_2,\ldots\ldots,p_{m-1} \notin \{r,u,l,b\}$

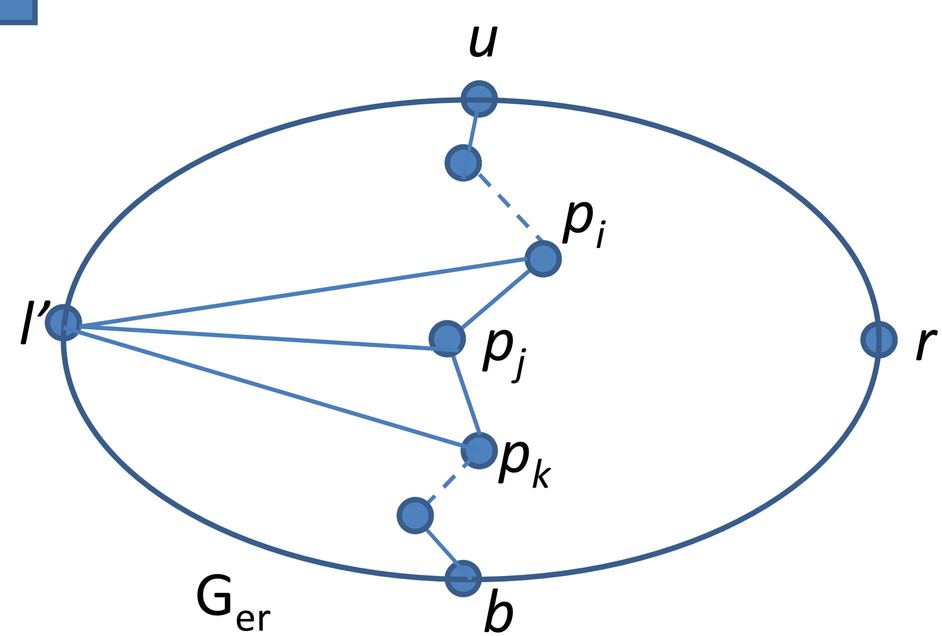
(ii) $(p_i,p_j) \notin G_e(n)$ for all distinct i,j

(iii) $(p_i,l) \notin G_e(n)$ for some i

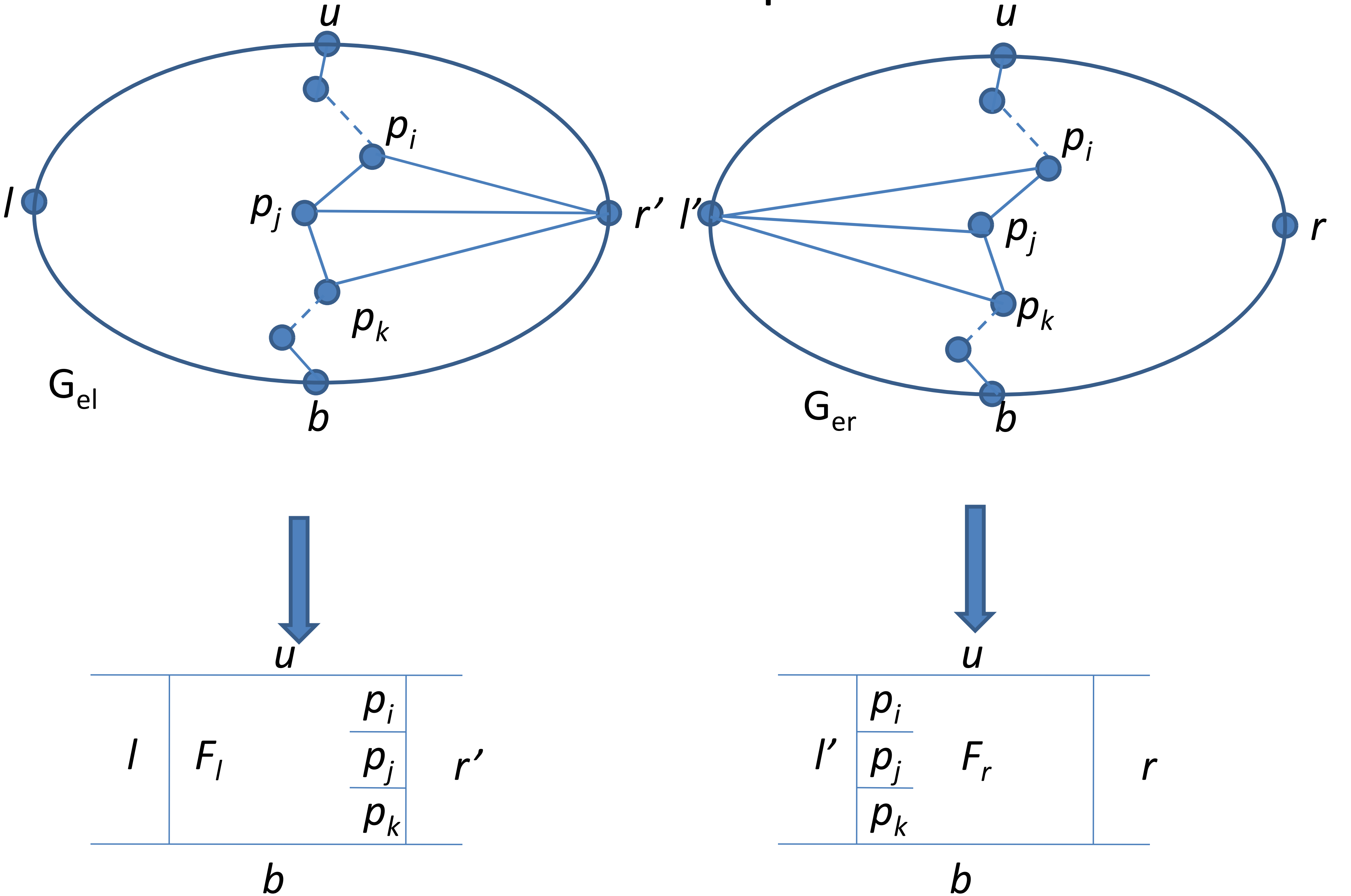
(iv) $(p_j,r) \notin G_e(n)$ for some j

Splitting path

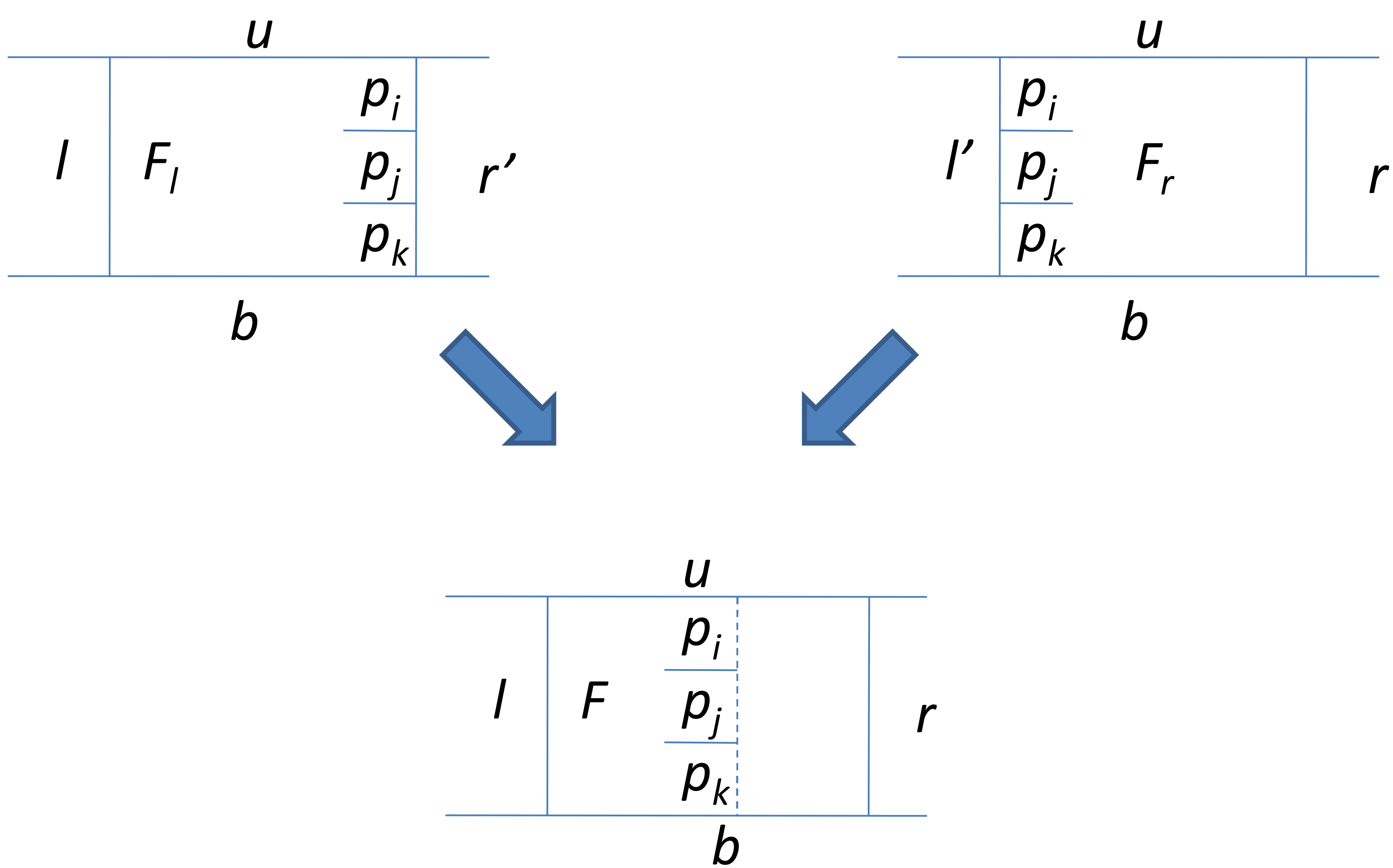




Dual Decomposition



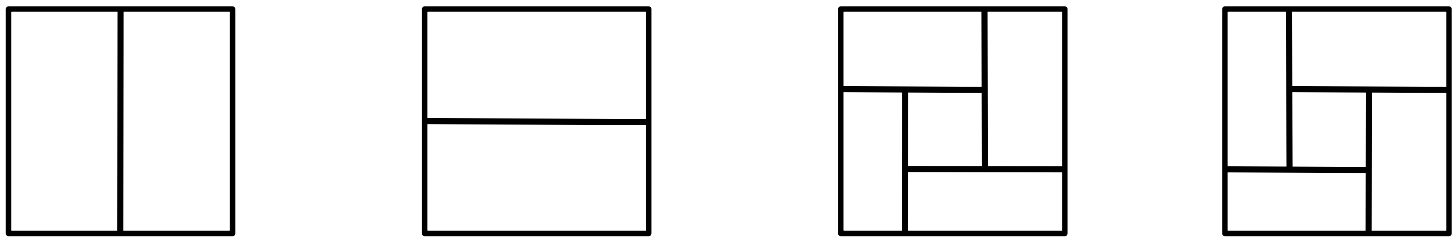
Merging Floorplans



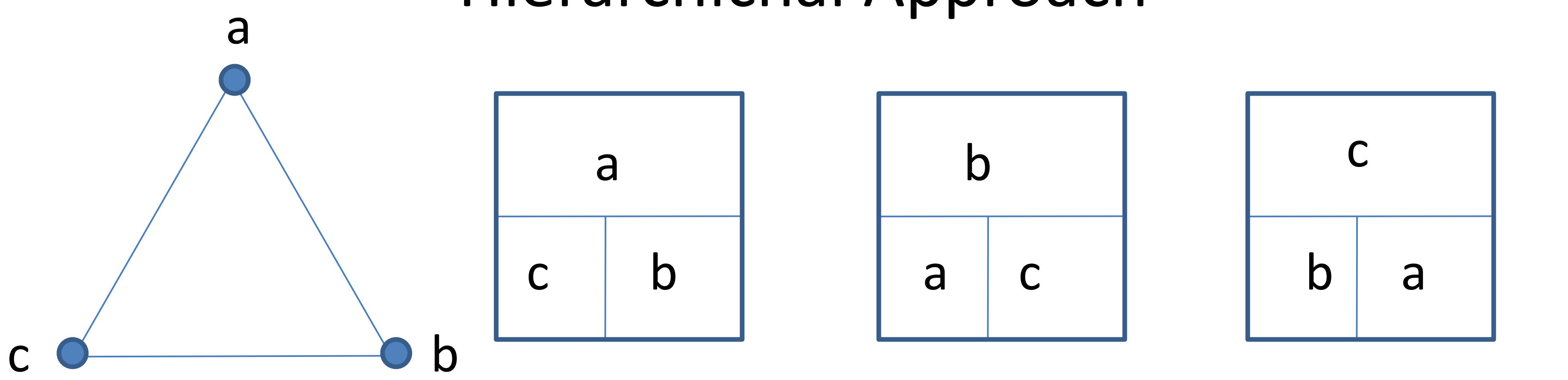
It is possible to generate a floorplan for any extended dual graph provided it contains no complex triangle

Hierarchical Floorplan

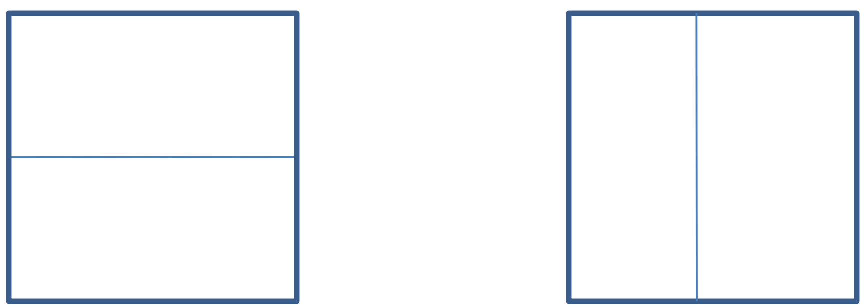
Four types of Internal nodes



Hierarchichal Approach



The number of possible floorplans increases exponentially with number of modules



d =2

d =3