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Supplementary Material for MIQP-based Layout Design for Building Interiors

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In this document, we provide more details of our method and additional results.

Refinement constraint for the horizontal split. The refinement constraint for the horizontal split is defined as:

$$\begin{cases} x_{i1} & \geq & x_i - \delta \\ x_{i1} & \leq & x_i \\ x_{i1} + w_{i1} & \geq & x_i + w_i \\ x_{i1} + w_{i1} & \leq & x_i + w_i + \delta \\ y_{i1} + d_{i1} & \geq & y_i + d_i \\ y_{i1} + d_{i1} & \leq & y_i + d_i + \delta \\ x_{i2} & \geq & x_i - \delta \\ x_{i2} & \leq & x_i \\ y_{i2} & \geq & y_i - \delta \\ y_{i2} & \leq & y_i \\ x_{i2} + w_{i2} & \geq & x_i + w_i \\ x_{i2} + w_{i2} & \leq & x_i + w_i + \delta \end{cases}$$

where $(x_{i1}, y_{i1}, w_{i1}, d_{i1})$ are parameters of child room $i1$, $(x_{i2}, y_{i2}, w_{i2}, d_{i2})$ are parameters of child room $i2$, and δ is the refinement range.

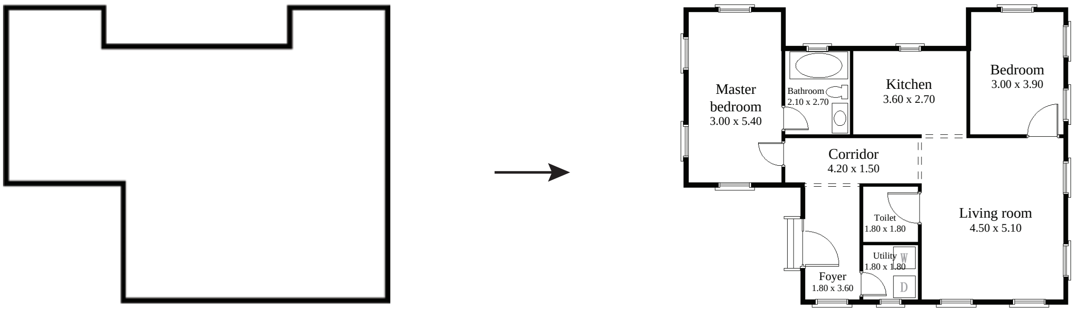
Additional results. Fig. 1 shows an interior layout generated according to the listed constraints. All of our constraints are formulated as templates and they can be set easily in our algorithm.

Given the same input (layout domain and constraints), our method can provide multiple layouts that meet all constraints (see Fig. 2). Fig. 3 shows nine layouts of single-storey house with different boundary complexities. Our method can also generate mutli-storey house. Fig. 4 shows eight layouts of two-storey houses. Fig. 5 shows interior layouts generated by our algorithm for different kinds of high-rise residential buildings. We evaluate our method on large-scale examples. Fig. 6 and Fig. 7 show the layout generation processes for the supermarket and office building, respectively. Fig. 8 shows three layouts for office building, supermarket, and shopping mall.

Fig. 9 shows optimization results with different λ_{cover} (coverage term) and λ_{size} (size error). We perform a comparison with the stochastic method. We find that our method can generate reasonable results efficiently. Fig. 10 shows layouts generated by two methods, running time for each layout is also shown.

References

[MSK10] MERRELL P., SCHKUFZA E., KOLTUN V.: Computer-generated residential building layouts. In *ACM Transactions on Graphics (TOG)* (2010), vol. 29, ACM, p. 181. 8



Room	Size target	Size constraint	Aspect ratio constraint	Boundary constraint	Adjacency constraint	Adjacency constraint for three rooms
Foyer	w(Foyer) = 2.03, d(Foyer) = 2.92	1.02 ≤ w(Foyer) ≤ 3.05, 1.46 ≤ d(Foyer) ≤ 4.38		Y	Corridor	
Corridor		1.76 ≤ w(Corridor) ≤ 5.27, 0.59 ≤ d(Corridor) ≤ 1.76	2 ≤ r(Corridor) ≤ 5	N	Living room	
Utility		0.39 ≤ w(Utility) ≤ 2.34, 0.93 ≤ d(Utility) ≤ 2.79	1≤ r(Utility) ≤ 3	N	Foyer	
Toilet	w (Toilet) =1.88, d (Toilet) = 2.35	0.94 ≤ w(Toilet) ≤ 2.82, 1.18 ≤ d(Toilet) ≤ 3.53		N		Living room, Corridor
Kitchen	w (Kitchen) =3.28, d (Kitchen) = 2.26	1.64 ≤ w(Kitchen) ≤ 4.92, 1.13 ≤ d(Kitchen) ≤ 3.39		N		
Living room		1.70 ≤ w(Living room) ≤ 5.09, 2.17 ≤ d(Living room) ≤ 6.51		Y	Kitchen	
Master bedroom		1.60 ≤ w(Master bedroom) ≤ 4.80, 2.21 ≤ d(Master bedroom) ≤ 6.63		Y	Bathroom	Living room, Corridor
Bedroom	w (Bedroom) = 2.86, d (Bedroom) = 3.96	1.43 ≤ w(Bedroom) ≤ 4.29, 1.98 ≤ d(Bedroom) ≤ 5.94		Y		Living room, Corridor
Bathroom	w (Bathroom) =1.88, d (Bathroom) = 2.35	0.94 ≤ w(Bathroom) ≤ 2.82, 1.18 ≤ d(Bathroom) ≤ 3.53		N		

Figure 1: *An interior layout is generated according to the constraints listed in the table. In the size constraint, $w(\cdot)$ and $d(\cdot)$ denote the width and depth operators, respectively. $r(\cdot)$ is the aspect ratio operator. If a room is adjacent to the boundary, Y is assigned in the boundary constraint column, otherwise N is set for the room. Please note that the inside constraint and non-overlap constraint are not listed here.*

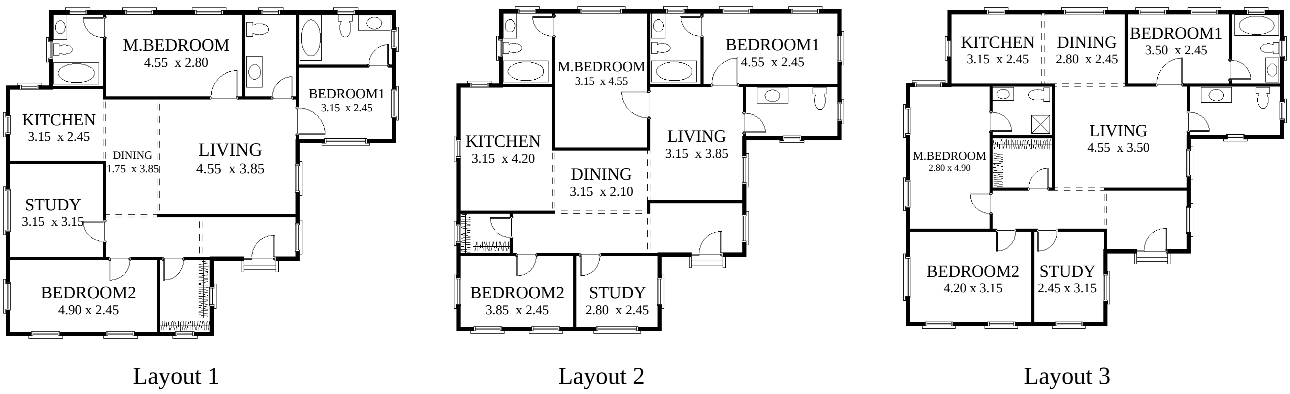


Figure 2: *Given the same input (i.e., layout domain and constraints), our method generates three different layouts. The position of the front door is given.*

Figure 3: *Nine layouts of single-storey house synthesized using our algorithm. The complexity of the house boundary gradually increases.*

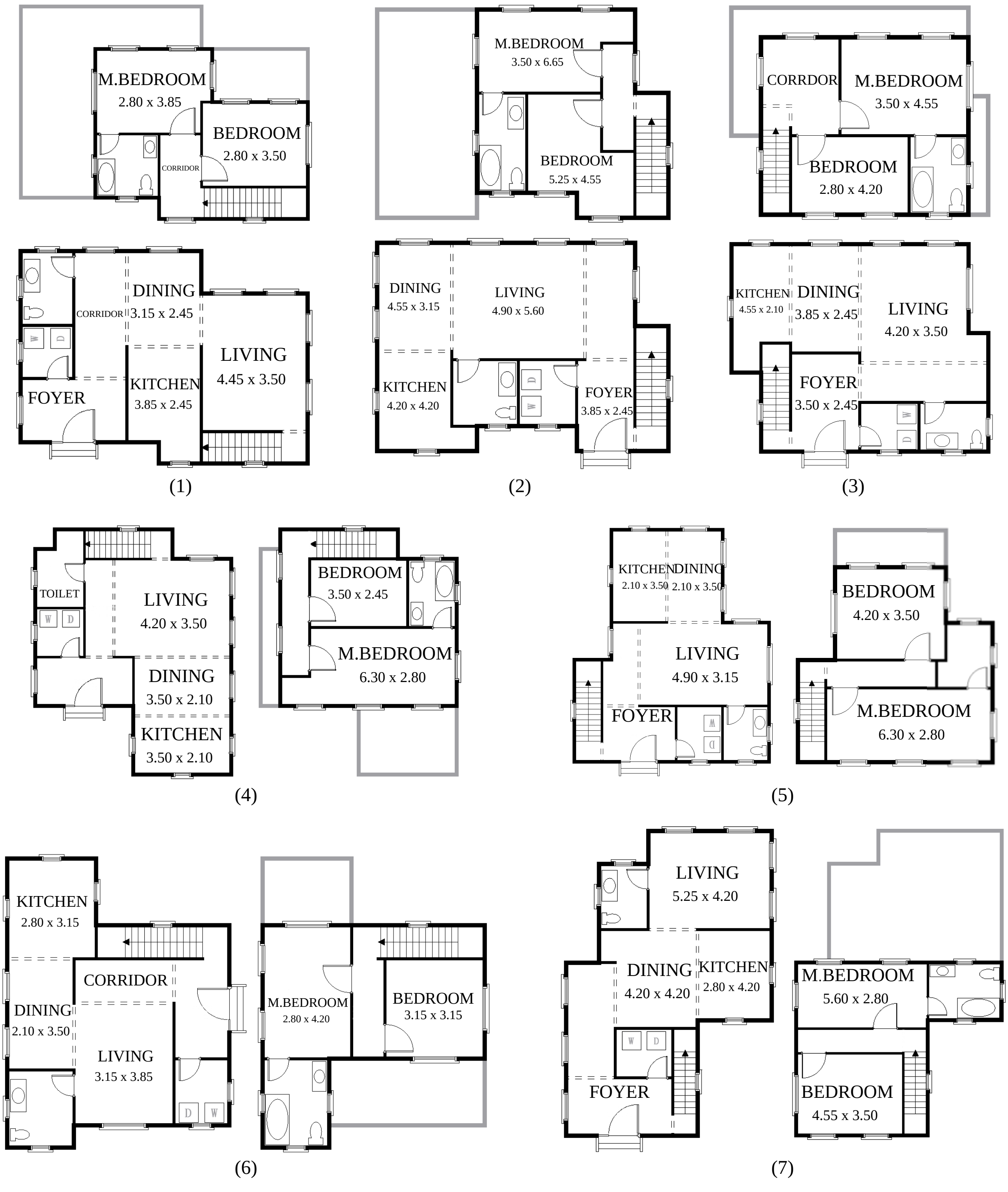


Figure 4: *Seven layouts of two-storey house generated using our method. The stairs are consistent between two floors. For (1,2,3), the layout of the first floor is shown on the bottom, the layout of the second floor is shown on the top. For (4,5,6,7), the layout of the first floor is shown on the left, the layout of the second floor is shown on the right.*

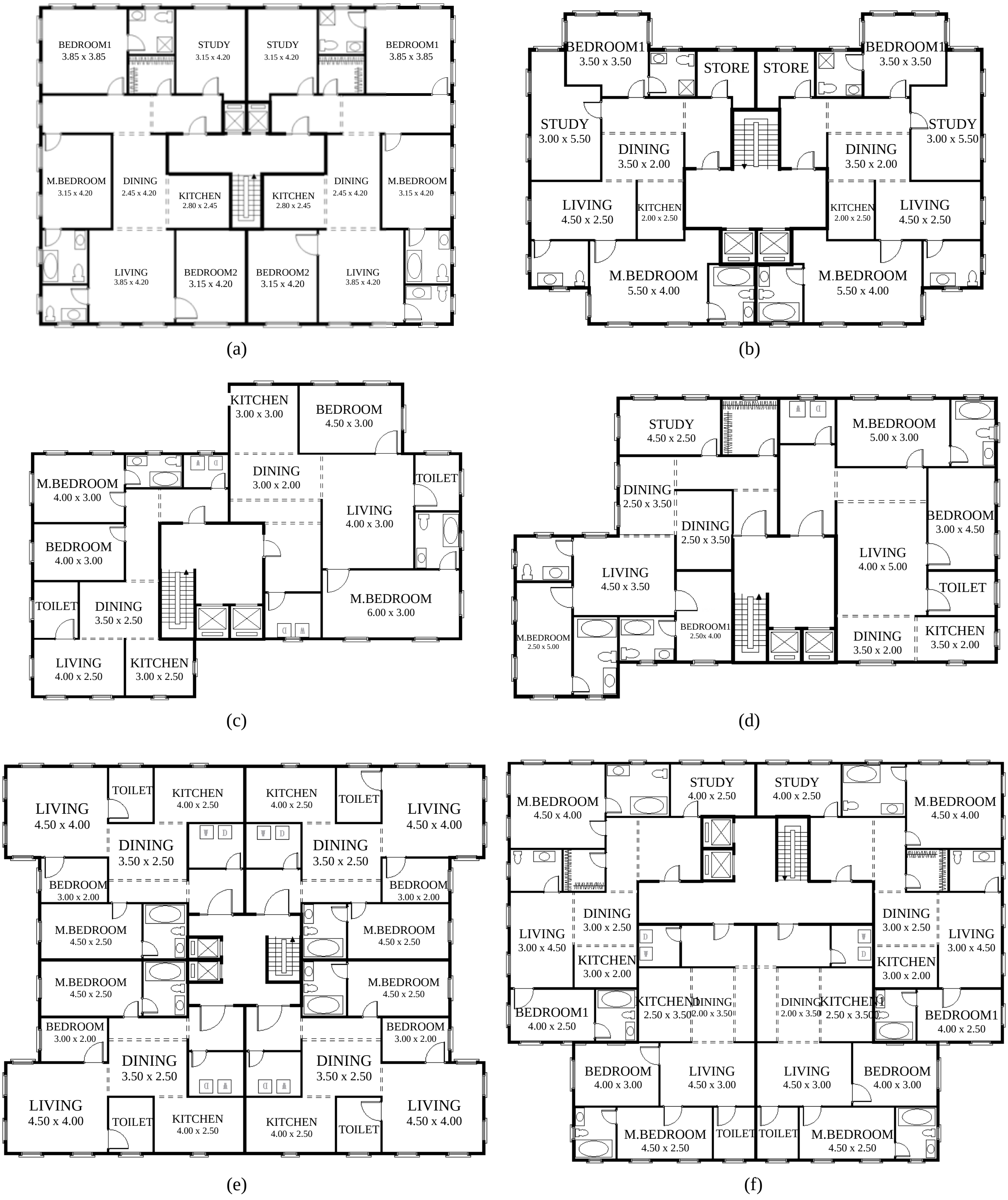


Figure 5: *Layouts of residential building generated using our method. (a,b) two symmetric apartments on one floor; (c,d) two asymmetric apartments on one floor; (e,f) four apartments on one floor.*

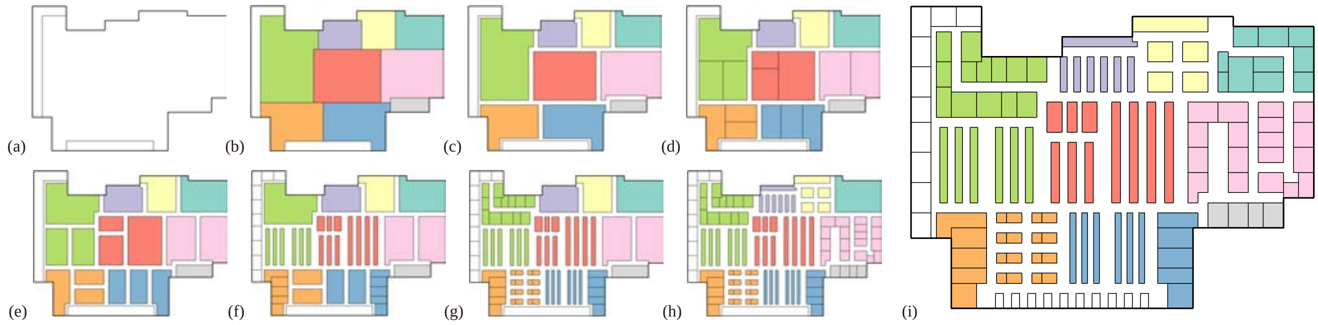


Figure 6: *An interior layout of the supermarket is generated by our hierarchical framework.*

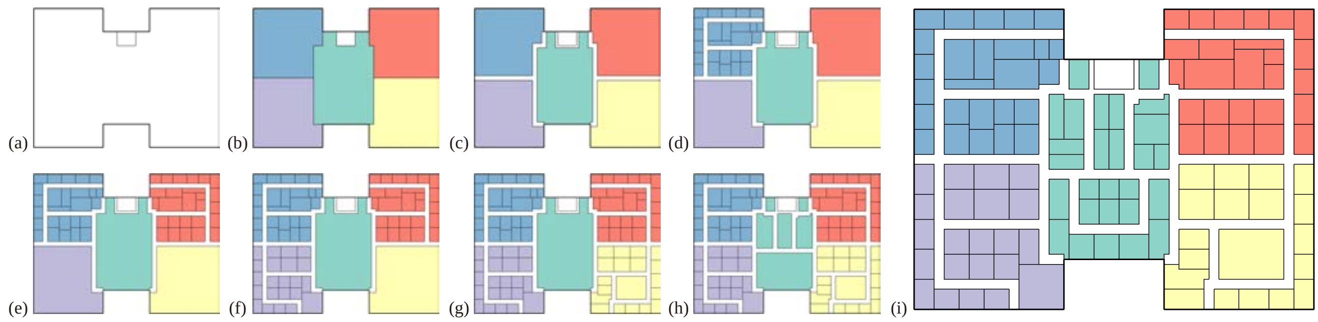
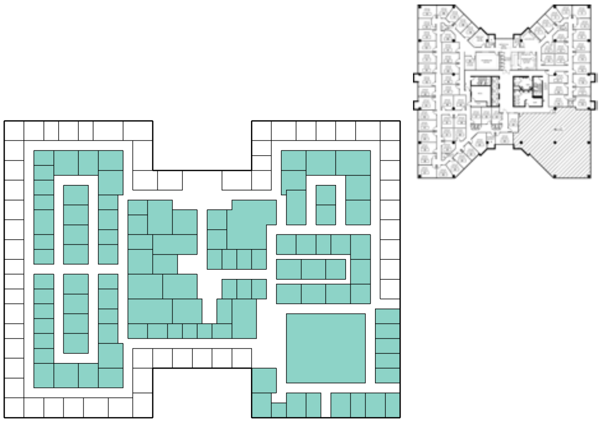
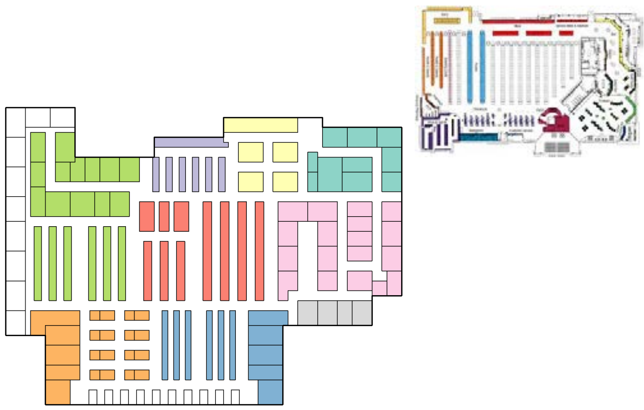


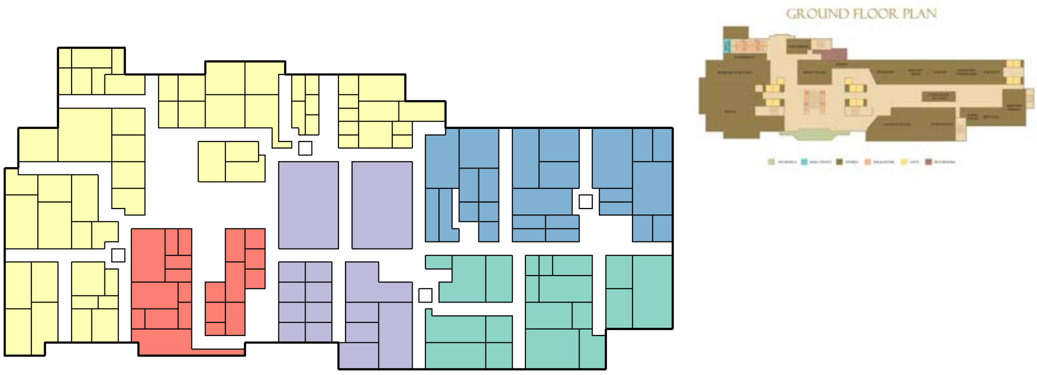
Figure 7: *An interior layout of the office building is generated by our hierarchical framework.*



(a)



(b)



(c)

Figure	# Rooms	# Constraints	Time (sec.)
(a)	132	264	74.48
(b)	125	250	72.21
(c)	138	280	79.36

(d)

Figure 8: *Three large-scale layouts generated by our hierarchical algorithm. (a) office building, (b) supermarket, (c) shopping mall. The boundaries are abstracted from real cases which are shown in the top-right of each layout. (d) shows the number of rooms, the number of constraints, and the running time for each layout.*

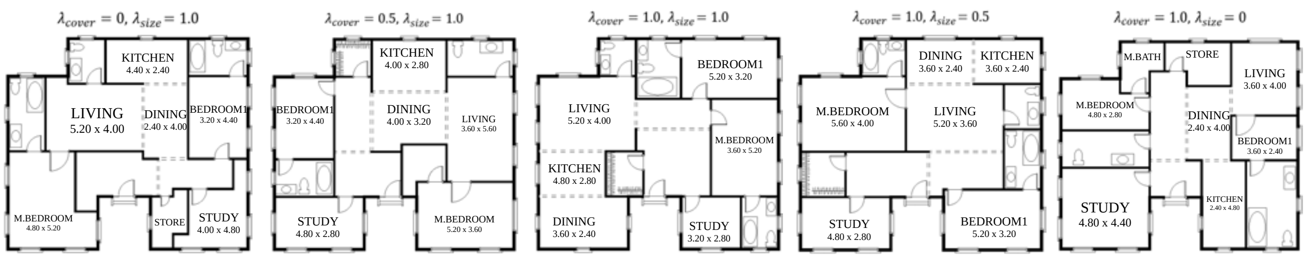


Figure 9: *Layouts generated by our algorithm using different weights: λ_{cover} and λ_{size}. A small λ_{cover} gives rise to complex room shapes, while a small λ_{size} leads to layouts with large size error.*

Figure 10: *Comparison with the stochastic approach [MSK10]. We show comparisons on rows. Left column: layouts generated by our algorithm. Right column: layouts generated by the stochastic method. Running time of each layout is shown below. Uncovered regions are highlighted in red.*