Generating Multi-Destination Maps

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Eye Candies

(a) Charleston Map with 2 destinations

(b) Charleston Selected Roads

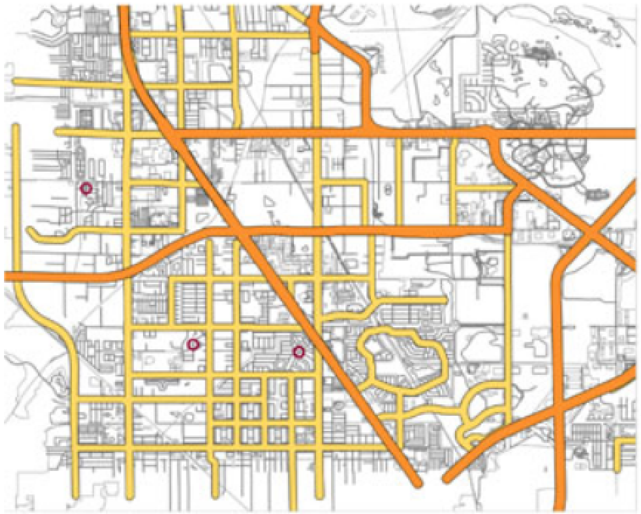
(c) Charleston Result

(d) Charleston Map with 3 destinations

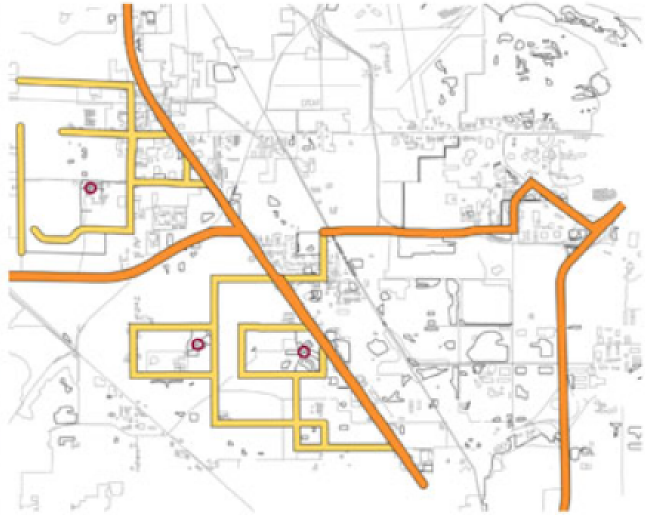
(e) Charleston Selected Roads

(f) Charleston Result

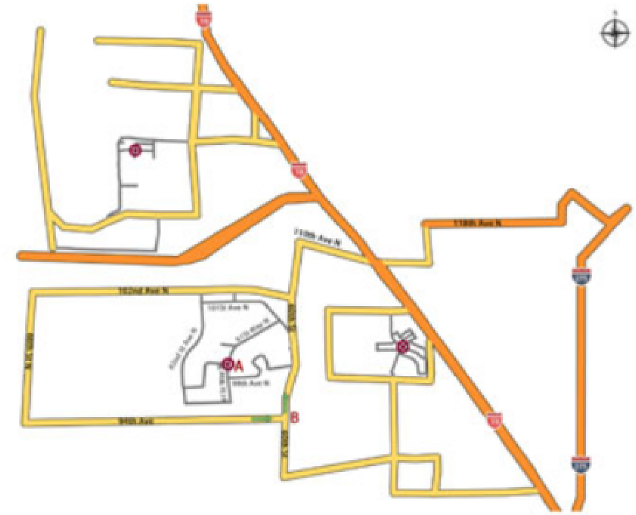
Eye Candies (Cont.d)



(g) Largo Map with 3 destinations



(h) Largo Selected Roads



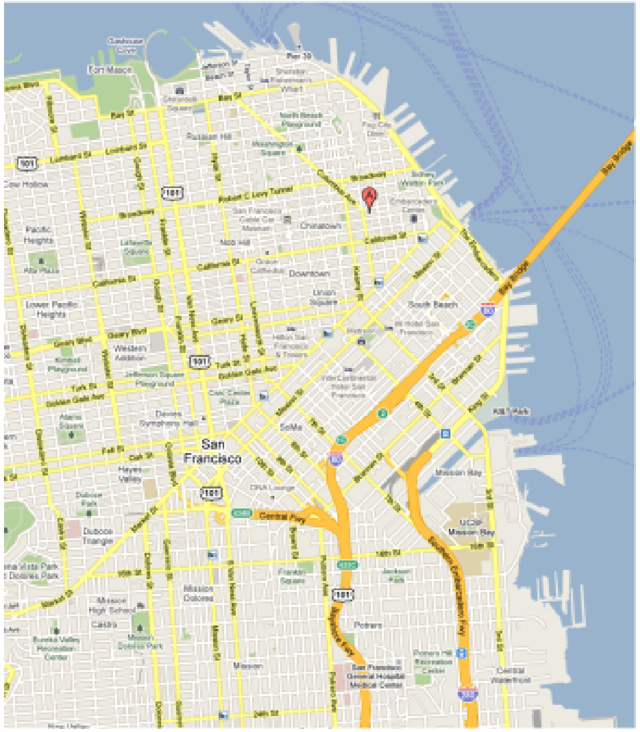
(i) Largo Result

(j) Hong Kong Map with 4 destinations

(k) Hong Kong Selected Roads

(l) Hong Kong Result

Automatic Generation of Destination Maps

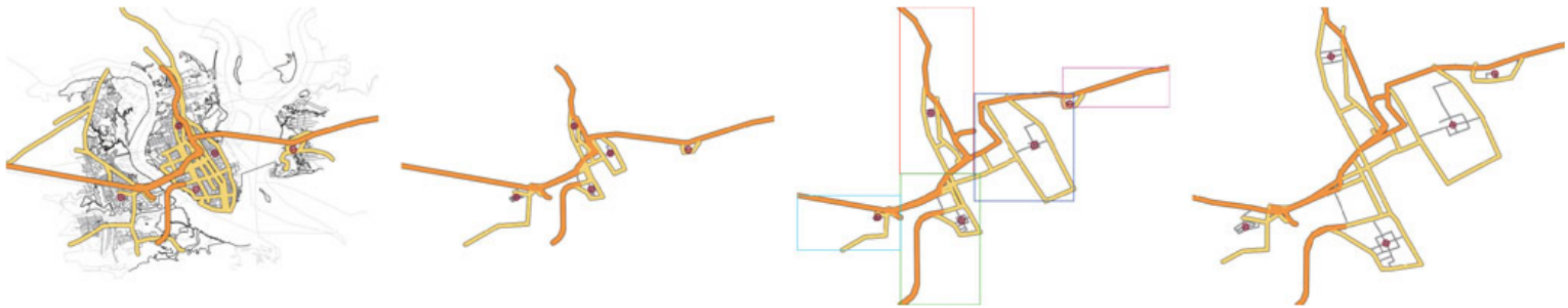


General Purpose Online Map

Selected Roads

Our Result

GENERATING MULTI - DESTINATION MAPS



(a) Specify Destinations (b) Roads Selection (c) Global Layout (d) Local Layout

Road Selection

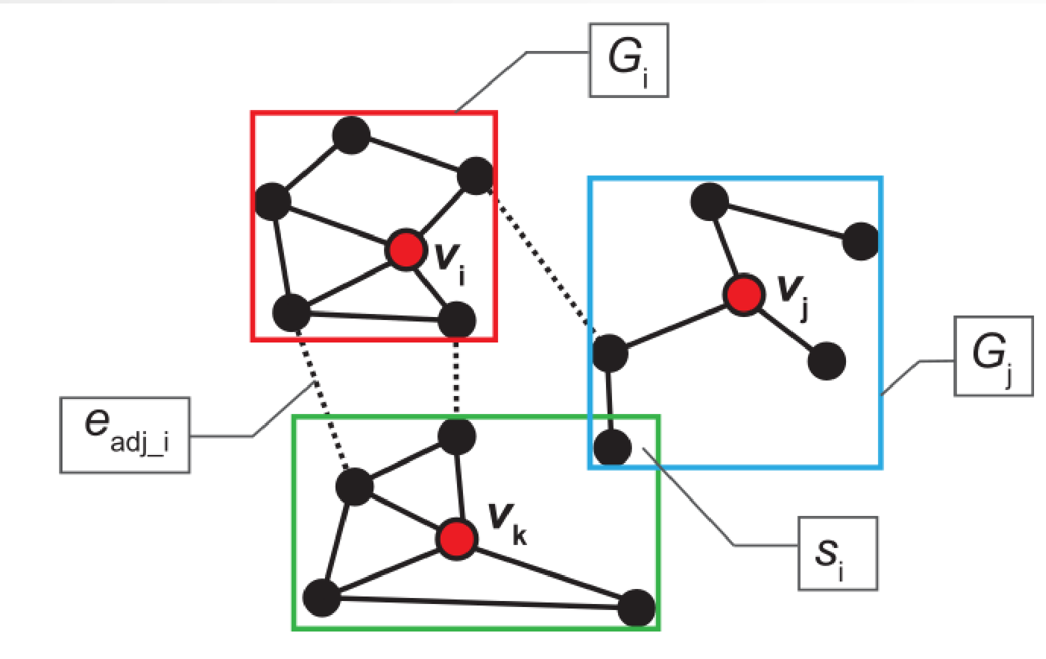
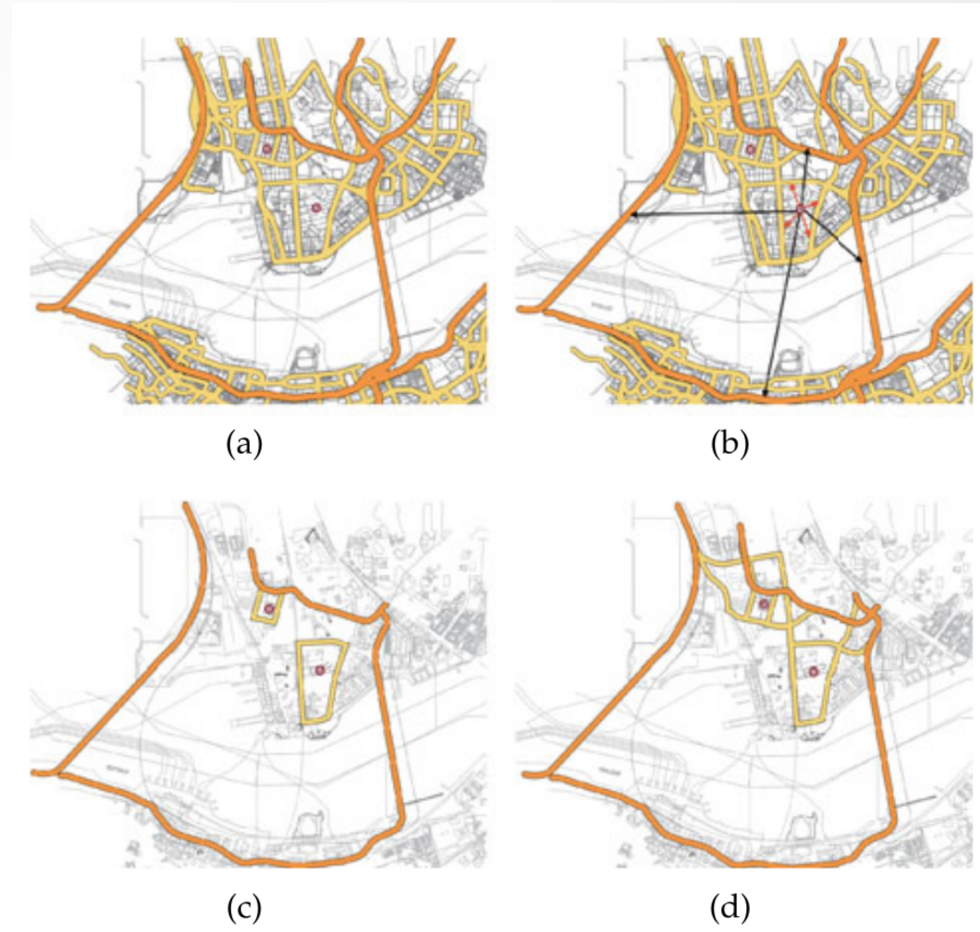


Fig. 2. Layout model for multi-destination maps.
v : Destination
e_{adj_i} : Connecting edge i between ROIs
s_i : Overlapping area.



Hierarchical road selection a la “Automatic Generation of Destination Maps“

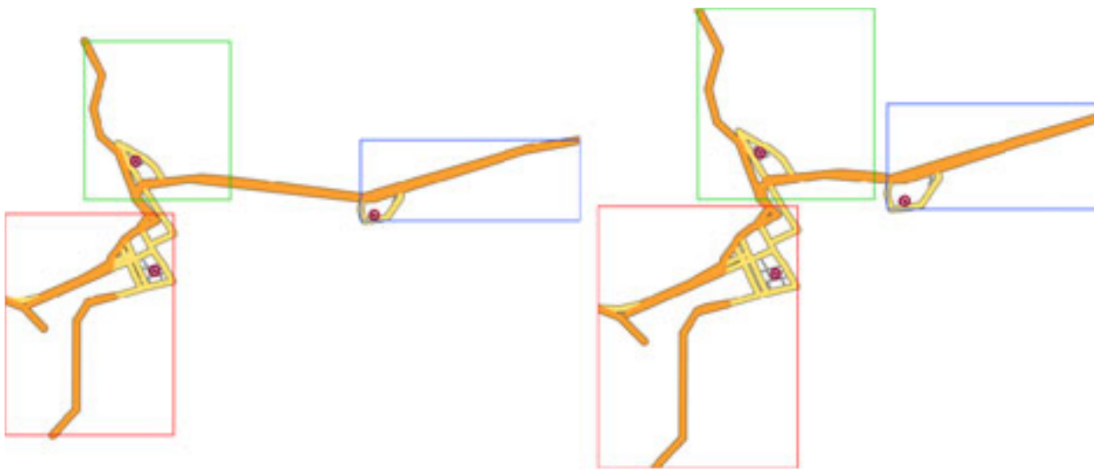
Global Layout

(a) Maintaining minimum edge length for visibility

(b) Retain the original orientation of connecting edges to ensure a right relative angle among roads.

(c) Full utilization display space, minimum ROI overlaps.

(d) Correct topology



(a) (b)

Map Segmentation

Objectives :

(a)Keep the uniqueness of the destination in a ROI.

(b)Keep the connecting edges between ROIs to a minimum.

(c)Minimize the overlapping area among ROIs.

(d)Keep the completeness of the routes in each ROI.

$$\Gamma(G, D) = \alpha f_{des}(G, D) + \beta f_{edge}(G, D) + \gamma f_{ovl}(G, D),$$

(a) (b)+(d) (c)

Map Segmentation : Terms

Destination

$$f_{des}(G, D) = \begin{cases} 1, & if\ there\ is\ a\ singular\ graph \\ 0, & else. \end{cases}$$

Alpha = inf

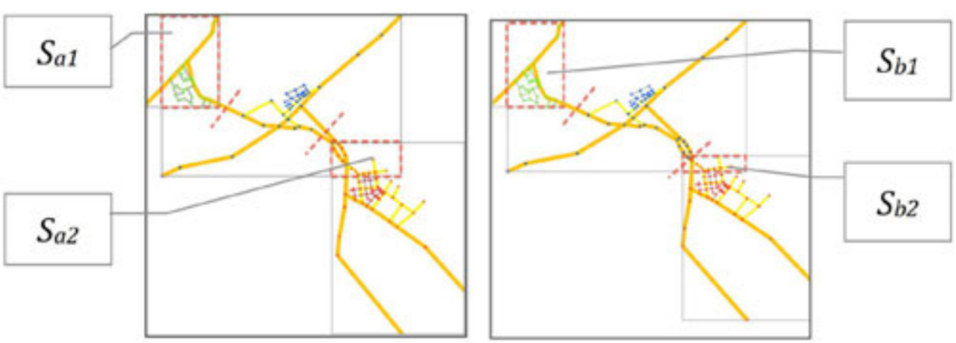
Complete Surrounding Routes

$$f_{edge}(G, D) = \sum_{e_i \in E_{street}} \gamma_{street} + \sum_{e_i \in E_{road}} \gamma_{road} + \sum_{e_i \in E_{highway}} \gamma_{highway},$$

$Gamma_{street}$ > $gamma_{road}$ > $gamma_{highway}$

Overlapping

$$f_{ovl}(G, D) = \sum_{i=1}^{n} s_i - \left(s_1 \bigcup s_2 \bigcup, \ldots, \bigcup s_n\right)$$



Uses Graph cutting method for segmentation

Global Layout Refinement

$$F_{global} = \omega_{length} f_{length} + \omega_{angle} f_{angle\_e_{adj}} + \omega_{area} f_{area} + \omega_{topo} f_{topo},$$

Balance Road Identifiability : f_{length}

$$f(G_i) = \sum_{i=1}^{n} \lambda_i (l_{min} - min(l_{min}, l_i))^2$$

$$\lambda_i = \begin{cases} \lambda_{street} & \text{when } e_i \text{ is a street} \\ \lambda_{road} & \text{when } e_i \text{ is a road} \\ \lambda_{highway} & \text{when } e_i \text{ is a highway} \end{cases}$$

$$\lambda_{street} > \lambda_{road} > \lambda_{highway}.$$

$$f(e_{adj}) = \sum_{i=1}^{k} (l_{min} - min(l_{min}, l_i))^2$$

$$f_{length} = \sum_{i=1}^{n} \delta_i f(G_i) + f(e_{adj}), \delta_i = \frac{p_i}{s_i}, p_i = \frac{num_i}{|E_i|}.$$

f_{area}, f_{topo}, f_{angle}

$$f_{area} = (s_1 \bigcap s_2 \bigcap, \ldots, \bigcap s_n) - \sum_{i=1}^{n} s_i,$$

$$f_{angle} = \sum_{i=1}^{|E|} (\theta_{oi} - \theta_i)^2,$$

$$f_{topo} = \begin{cases} \infty, & if\ false\ topology \\ 0, & else. \end{cases}$$

Global Layout Perturbation and Optimization

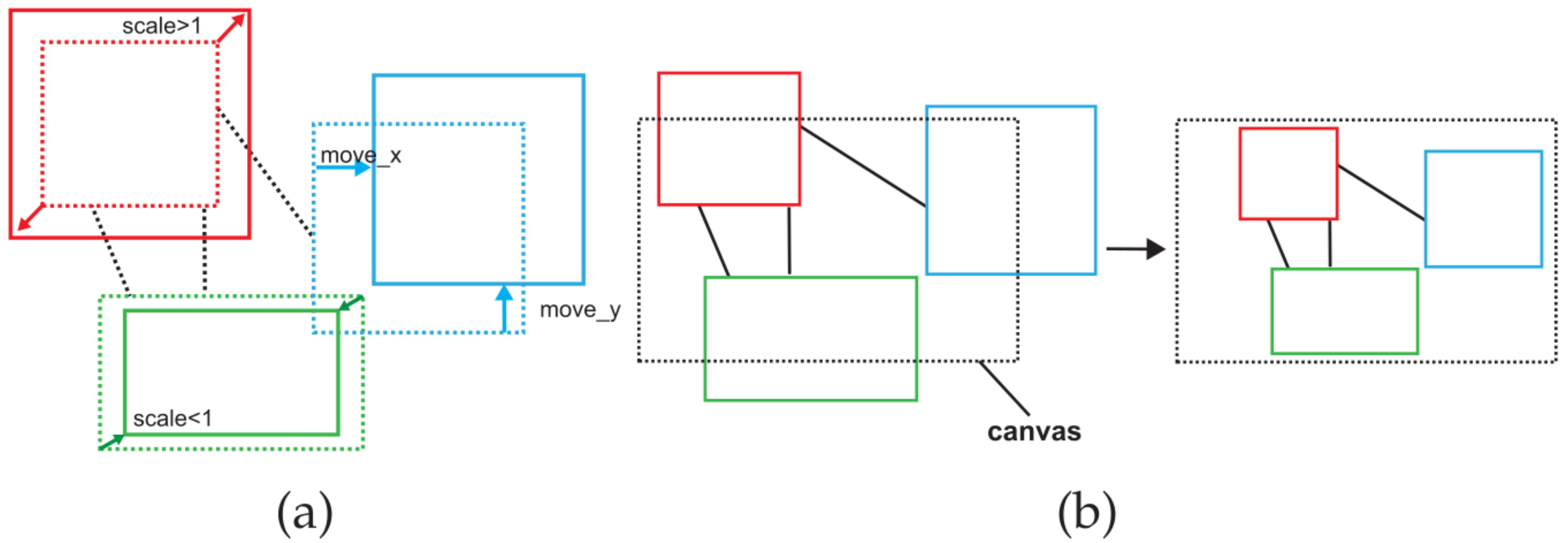


Fig. 7. Perturbation of global layout. (a) Rescale and move ROIs randomly. (b) Rescale the entire road network to fit within the pre-specified canvas size .

Simulated Annealing Psuedo Code

```
Initialize (); //Set the initial temperature T and thecooling rate
F = EvaluateLayout (G); //use equation (5) to score
While (! termination condition)
{
    G' = PerturbLayout (G);
    F' = EvaluateLayout (G');
    ΔF = F'- F;
    if (ΔF < 0) {G = G'; F = F'} //accept this perturb
    else
    {
        if (Math.exp ((0-ΔF)/T) > Math.random (0,1))
        {
            G = G'; F = F';
        }
        else reject this perturb;
    }
    T=T*rate;
}
```

Local Layout

- Objective :

  (a)Ensure that all edges in ROI have good visibility to provide a clear path display.

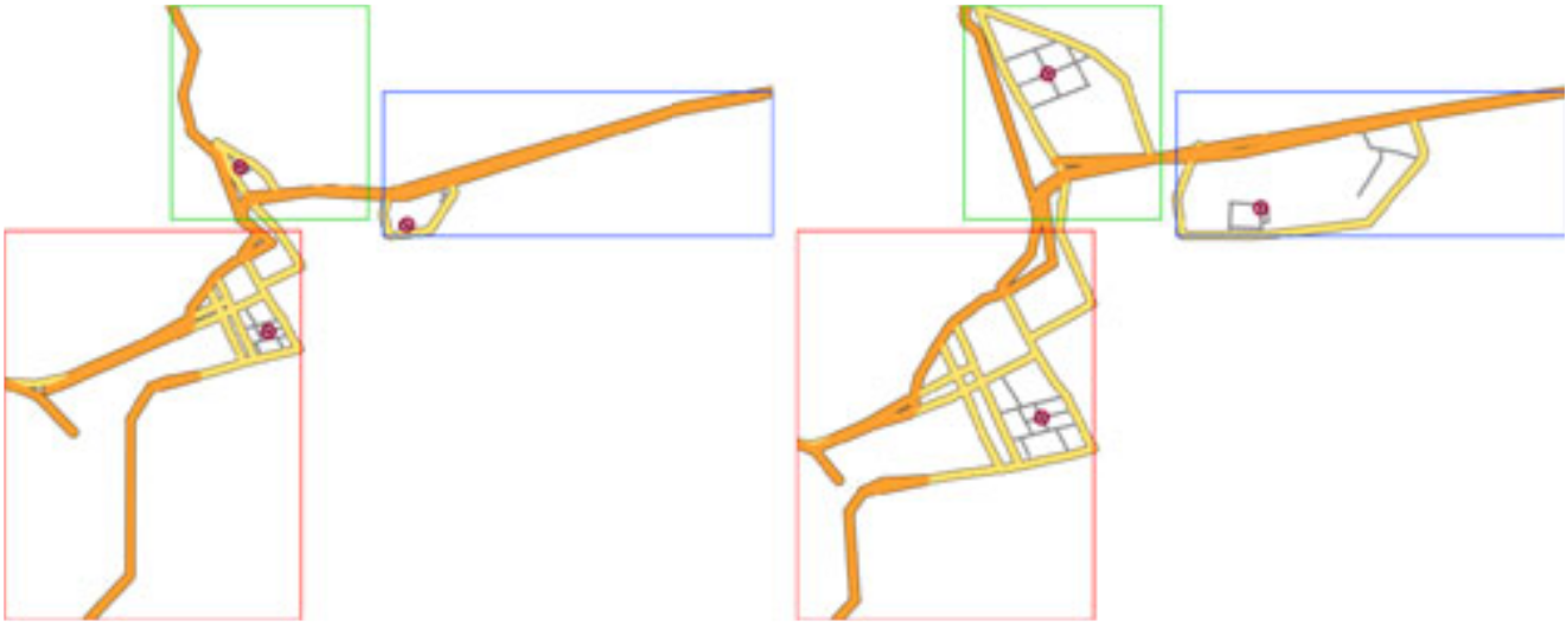
  (b)Retain original orientation of each edge to ensure a right relative angle among roads.

  (c)Keep all edges in ROI, preserving their relative orientation to ensure a right relative angle among roads.

  (d)Preserve correct topology of the road network all the time.

$$F(L_{i\_local}) = \omega_{length} f_{length} + \omega_{angle} f_{angle} + \omega_{r\_angle} f_{r\_angle} + \omega_{topo} f_{topo},$$

Local Layout :Result



(a) (b)

Relative Angle

$$f_{r\_angle} = \sum_{i=1}^{|E_i|-1} \sum_{j=i+1}^{|E_i|} (\theta_{ij} - \theta_{o\_ij})^2.$$

Local Layout Perturbation and Optimization

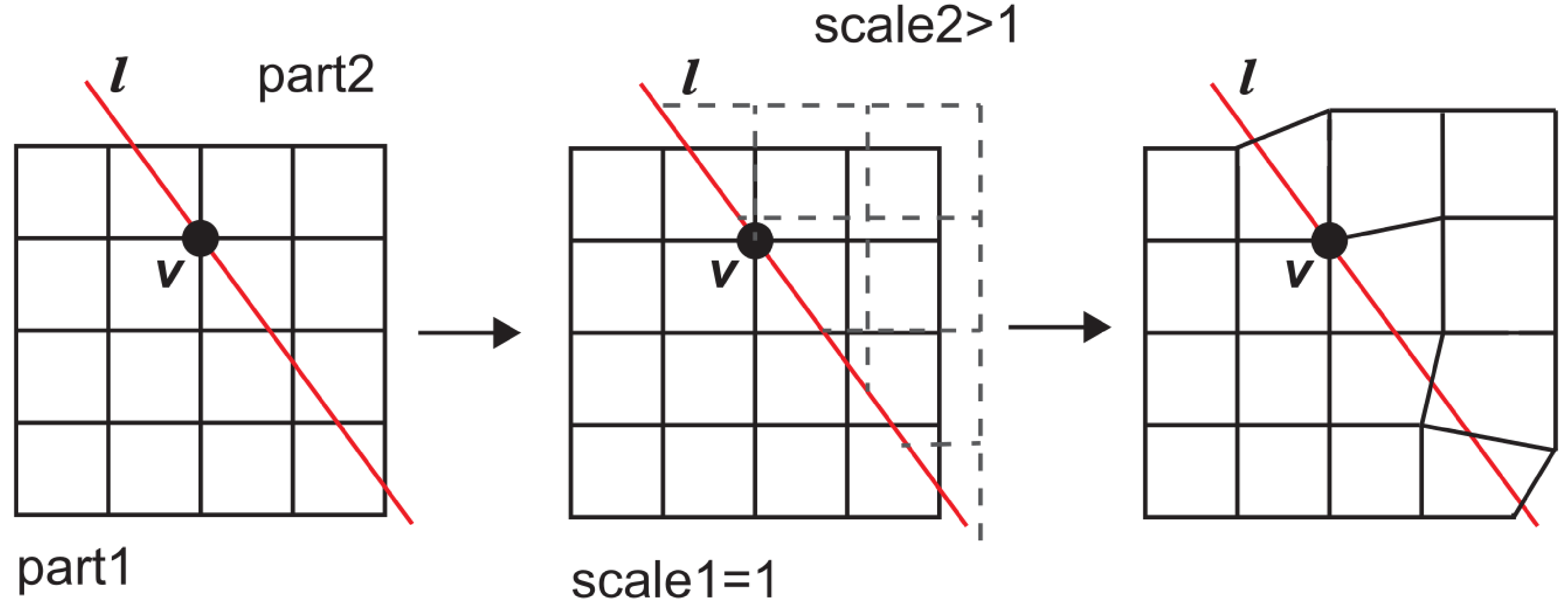


Fig. 10. Perturbation of local layout.

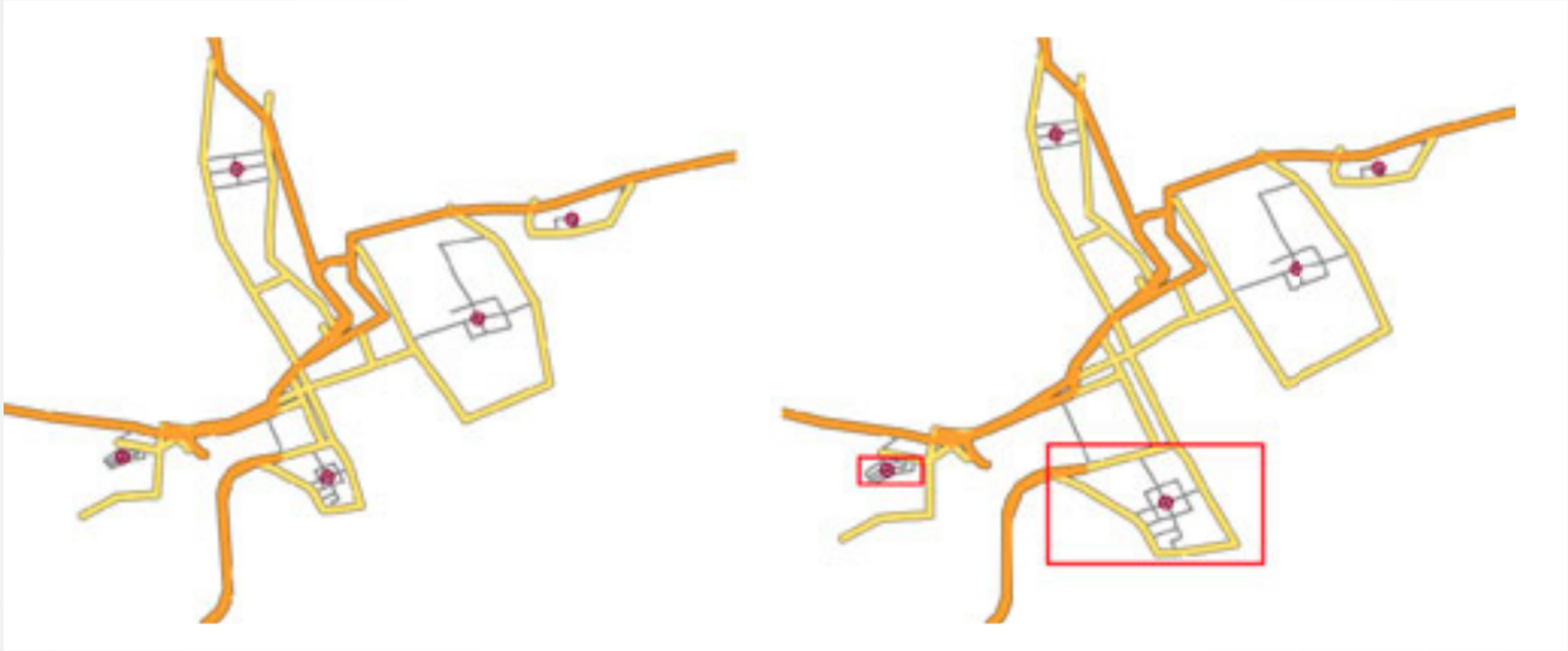
Layout Trimming : Terms

$$f_{r\_length} = \sum_{i=1}^{k-1} \sum_{j=i+1}^{k} (l_i/l_j - l_i^{'}/l_j^{'})^2$$

$$F_{trimming} = \omega_{length} f_{length} + \omega_{r\_length} f_{r\_length} + \omega_{angle} f_{angle} + \omega_{r\_angle} f_{r\_angle} + \omega_{topo} f_{topo},$$

Then Perturbates again

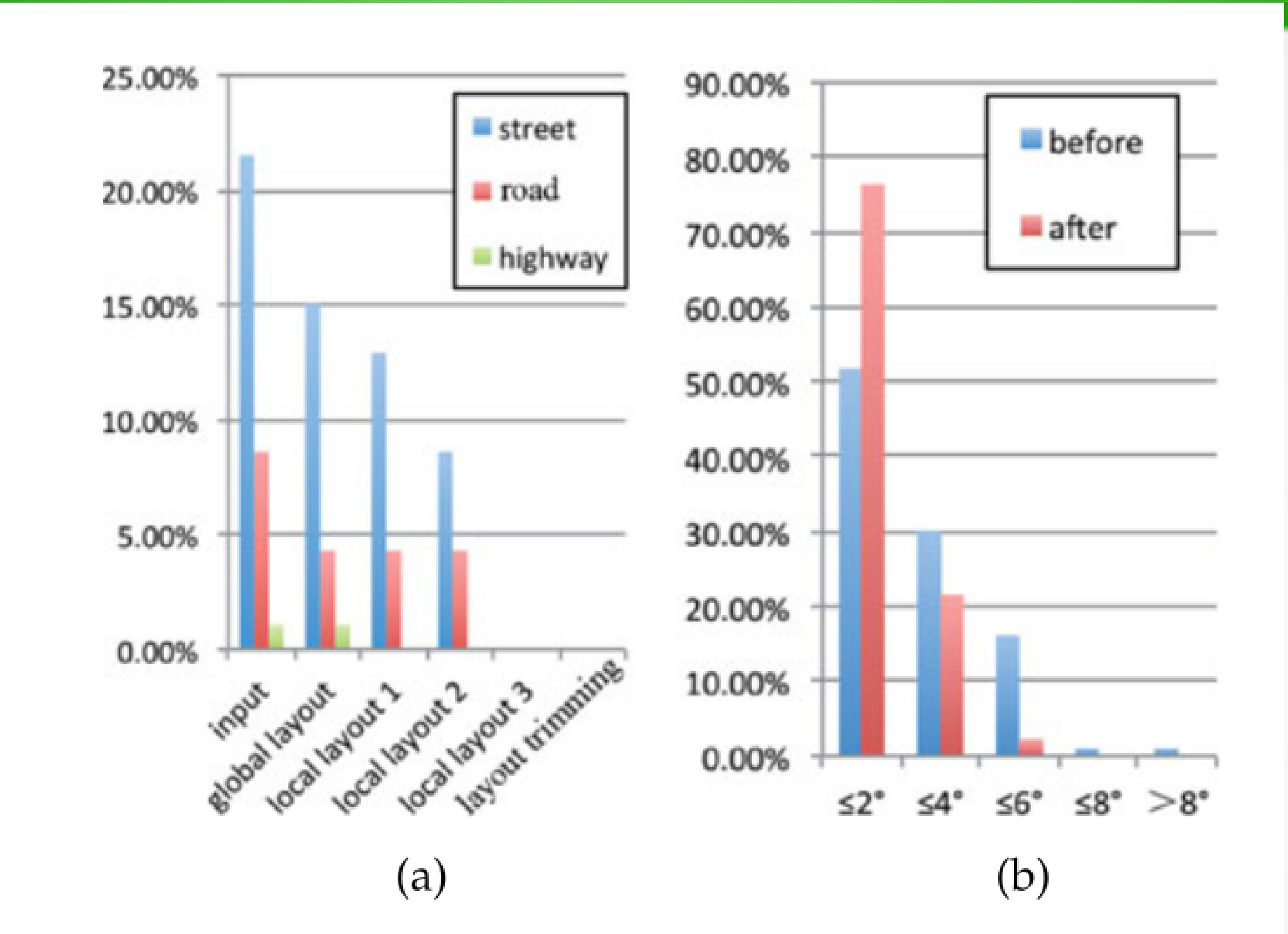
Layout Trimming



(a) (b) (c)

Fig. 12. Evaluating the objectives of map segmentation. (a) A good map segmentation satisfies the two soft constraints. (b) The map segmentation without considering the principle *“Complete Surrounding Routes”* and (c) The map segmentation without considering the principle *“minimizing the overlapping area”*.

Evaluating layout optimization method



Evaluating layout optimization method.
(a) The percentage of edges whose lengths less than the minimum display length (10 pixels) in each key step.
(b) The percentage of edges that deviate from its original orientation before and after the layout trimming optimization.

TABLE 1
Weights Setting at Each Optimization Step

	ω_{length}	ω_{r_length}	ω_{angle}	ω_{r_angle}	ω_{area}
global	9,000	\	5,000	\	18,000
local	5,000	\	4,000	4,000	\
trimming	5,000	1,000	5,000	6,000	\

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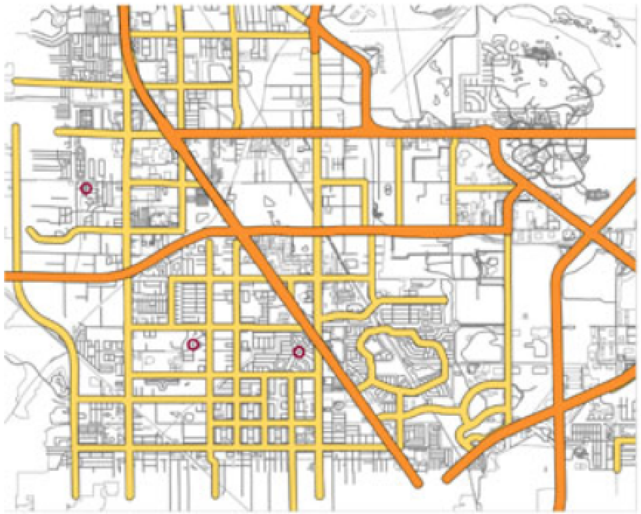

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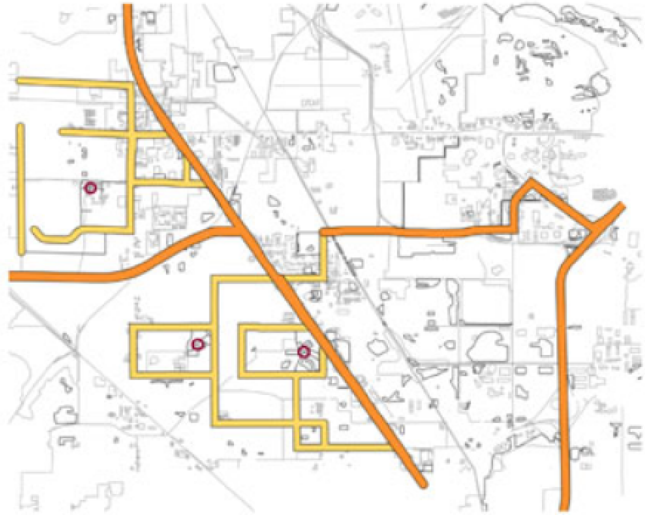

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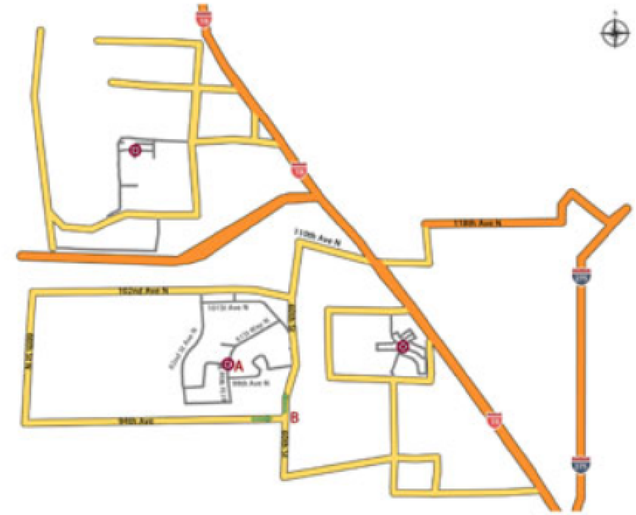

(i) Largo Result

(j) Hong Kong Map with 4 destinations

(k) Hong Kong Selected Roads

(l) Hong Kong Result

Performance

- Java Script
- 1.6 GHz Intel Core i5 machine with 4 GB of RAM.
- All the map data are from OpenStreetMap (http://www.openstreetmap.org).

TABLE 2
Timing Results for Our Layout Algorithm

Maps	Road Selection	Map Segmentation	Global Layout	Local Layout	Layout Trimming
Fig. 19a	6 s	2 s	107 s	64 s	49 s
Fig. 19d	8 s	16 s	371 s	180 s	129 s
Fig. 19g	16 s	14 s	358 s	184 s	151 s
Fig. 19j	35 s	15 s	299 s	128 s	102 s

(a) Charleston Map with 3 destinations (b) our method (c) Kopf's method

Fig. 14. Result comparison. Our result (b) shows adequately scales all the ROIs than that of Kopf's method(c).

(a) Haunert's result (b) Our result

Fig. 15. Result comparison with Haunert's method. The same input data is the road network of Largo, USA from OpenStreetMap. Haunert's result applying zoom factor 2 for ROIs.