Mobile map generalization approach considering user locational context

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Outline

- Introduction
- User locational context
- Relevance between user velocity and generalization constraints
- Road generalization implementation considering the user velocity
- Conclusion

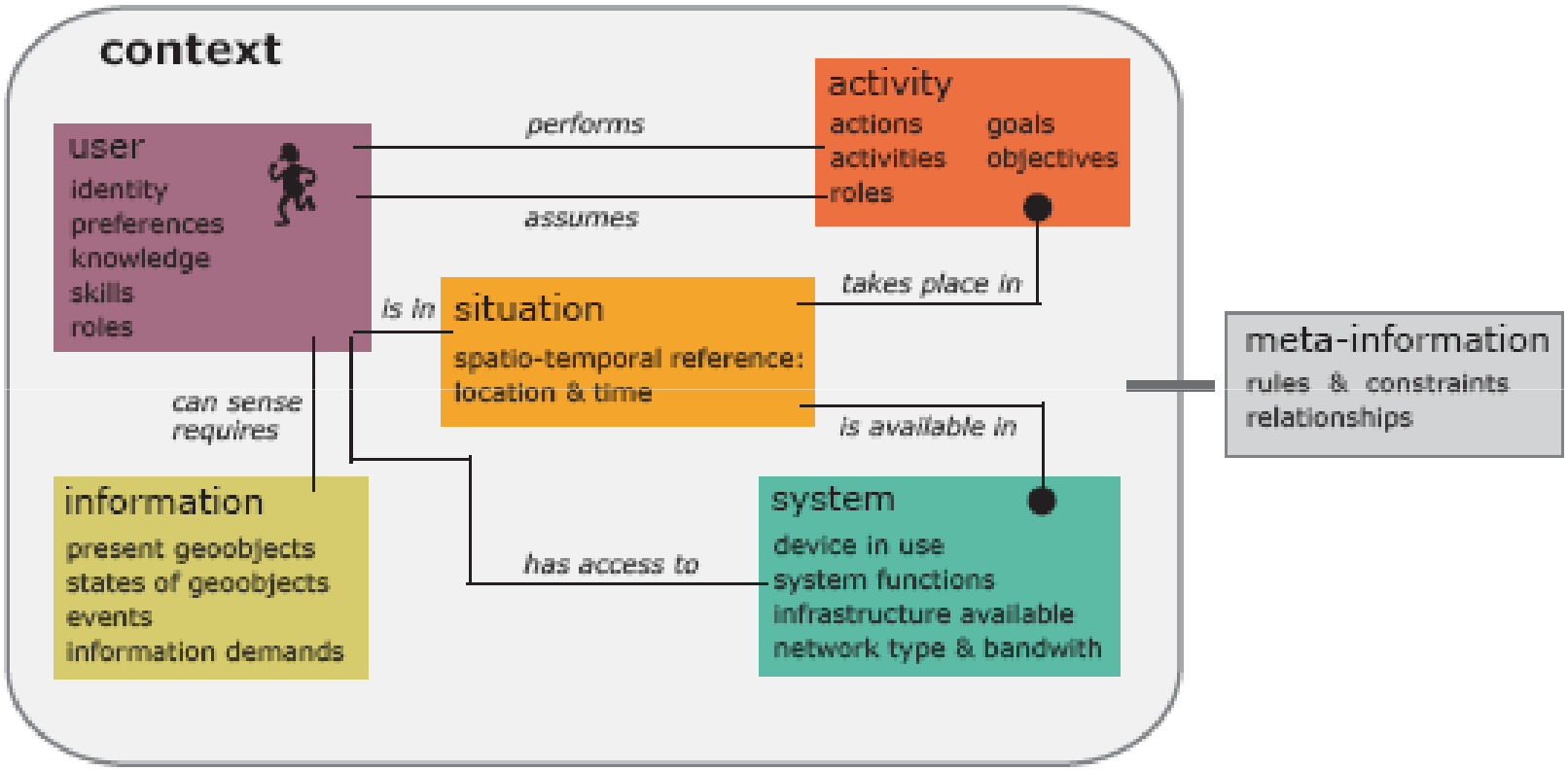
Introduction

- **Mobile map**
  - content, scale and representation
- **Context**
  - position, location, time, information, technology, activity, user
- **mobile map generalization**
  - partial, dynamic and on-demand

Characteristics of mobile map generalization

- The scope to be generalized cannot be clear before generalization being carried out. It is dynamic adjusted with the user locational context.
- The map cognition of the user in mobile environment is much more objective oriented and the burden of map cognition is heavier than it is in static environment.
- In mobile environment, the less interaction with the map, the user will feel better.

Generic context model for mobile cartography



(Reichenbacher, 2004)

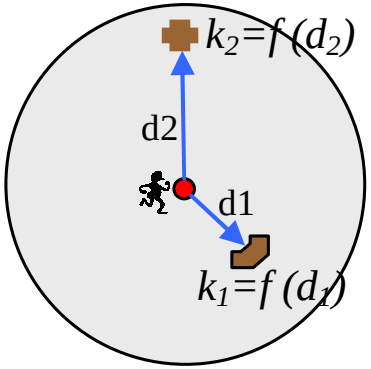
Activity and context

- **Dransch (2004) gave a conceptual framework about activity and context for mobile geoservices.**
- **Dransch (2004) gave three descriptions for space:**
  - Geographical, geodetical: absolute location
  - Topological: in relation to other objects
  - Spatial structure: arranged by persons and their activity
- **Werlen(1997): Space is only determined by activities, they form specific spatial area, the physical objects in these areas get importance and meaning only through an acting person and his or her action.**

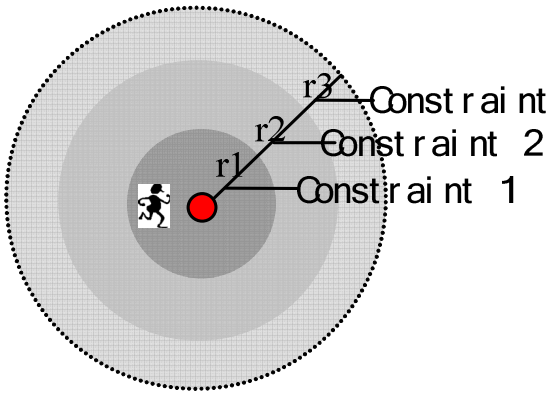
What is user locational context?

User locational context could be understood as situation of user which combines the location and time together. It is understood of being situated in a spatio-temporal reference system. It is not only the static spatial location information, but also the direction, velocity, trail information. User locational context will support the mathematical and the human-related concepts of space.

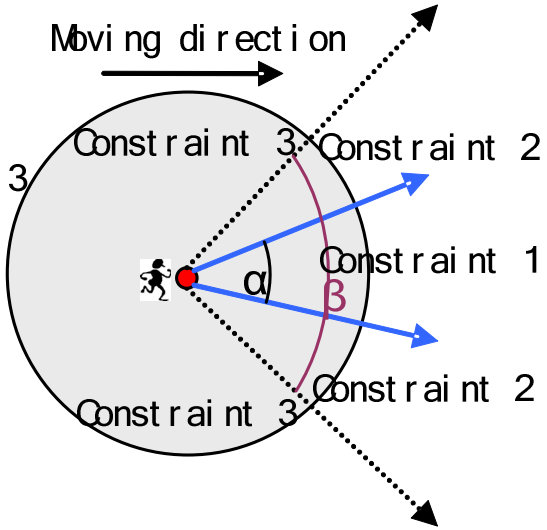
Design idea of mobile map generalization 1



A Distance Increment

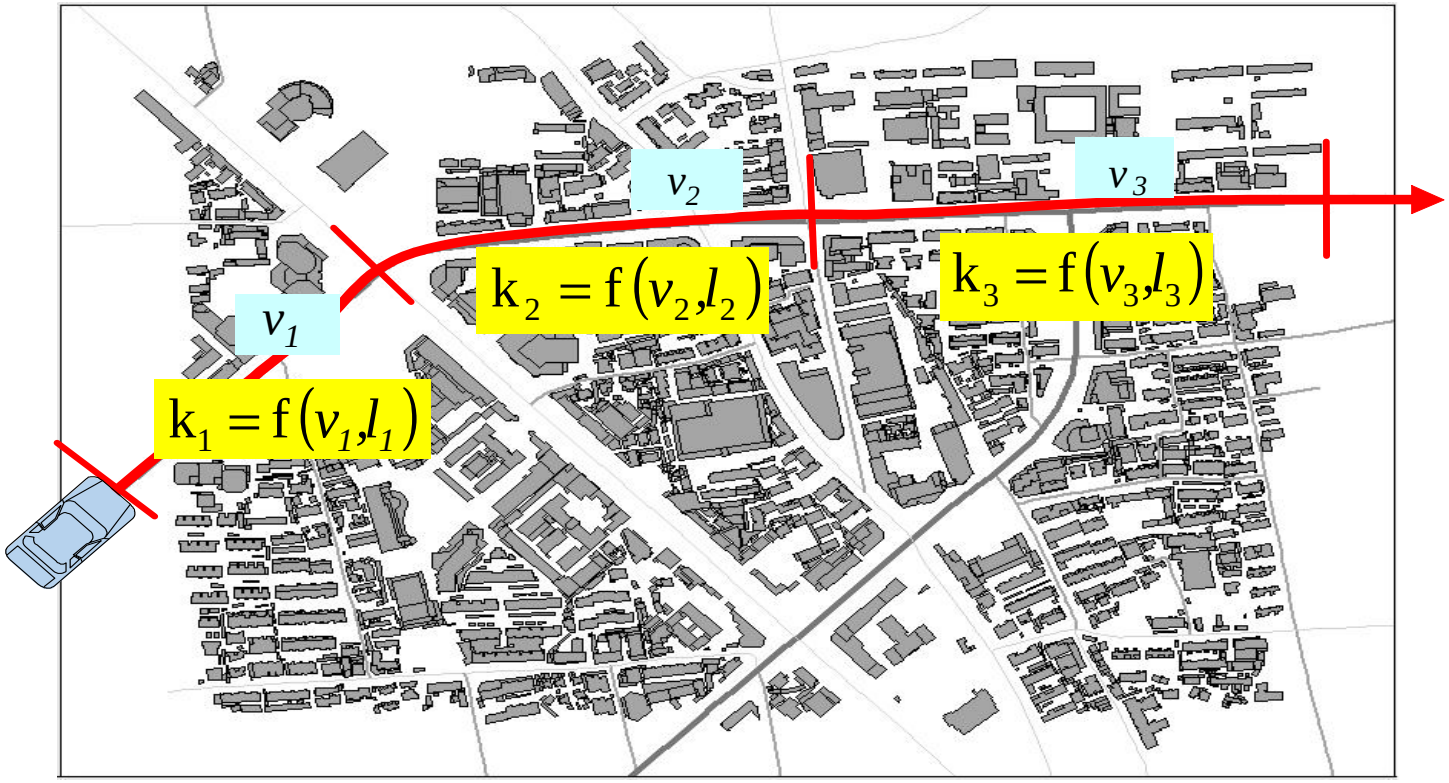


B Spatial Level

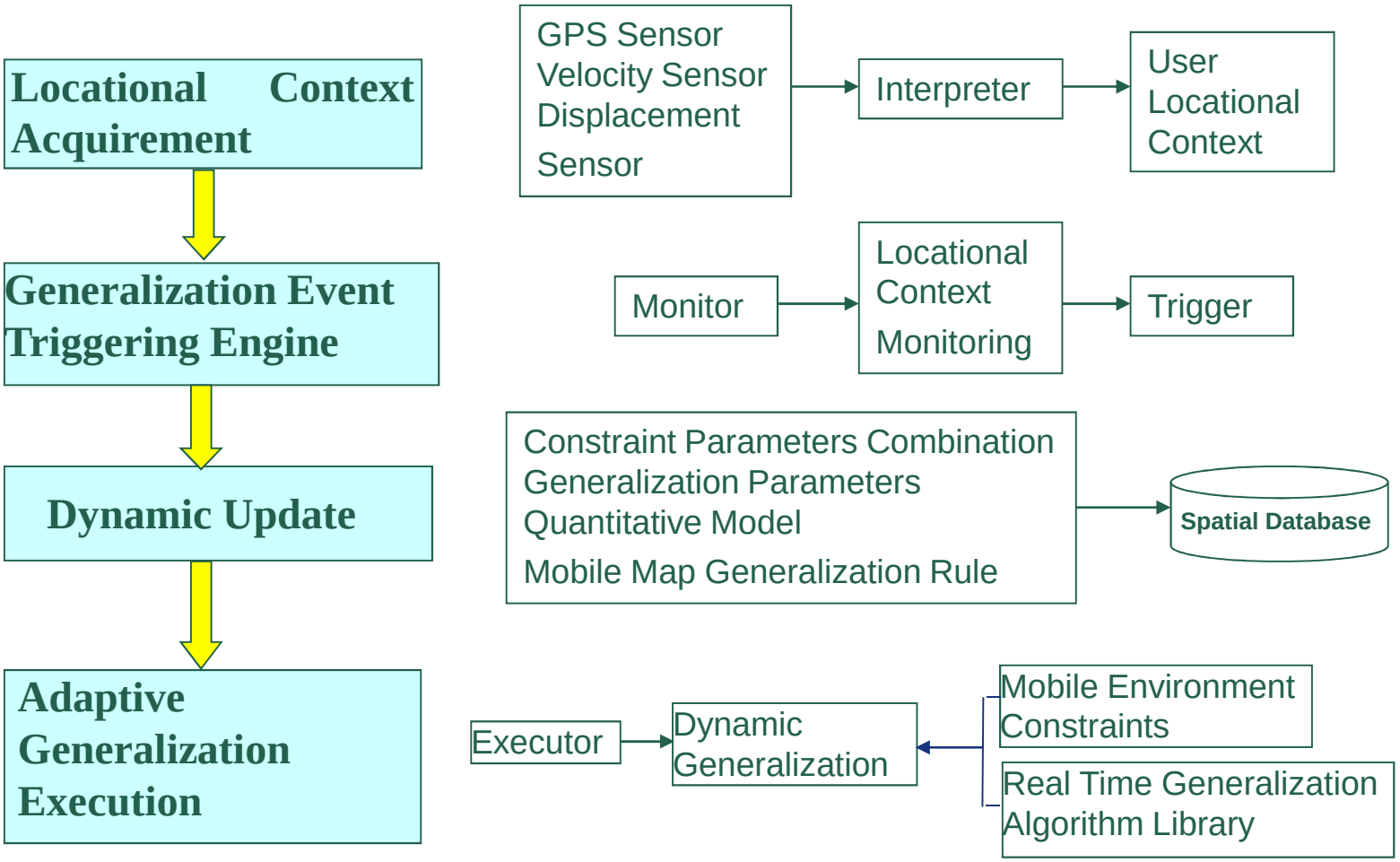


C Direction Angle

Design idea of mobile map generalization 2



Mobile map generalization framework

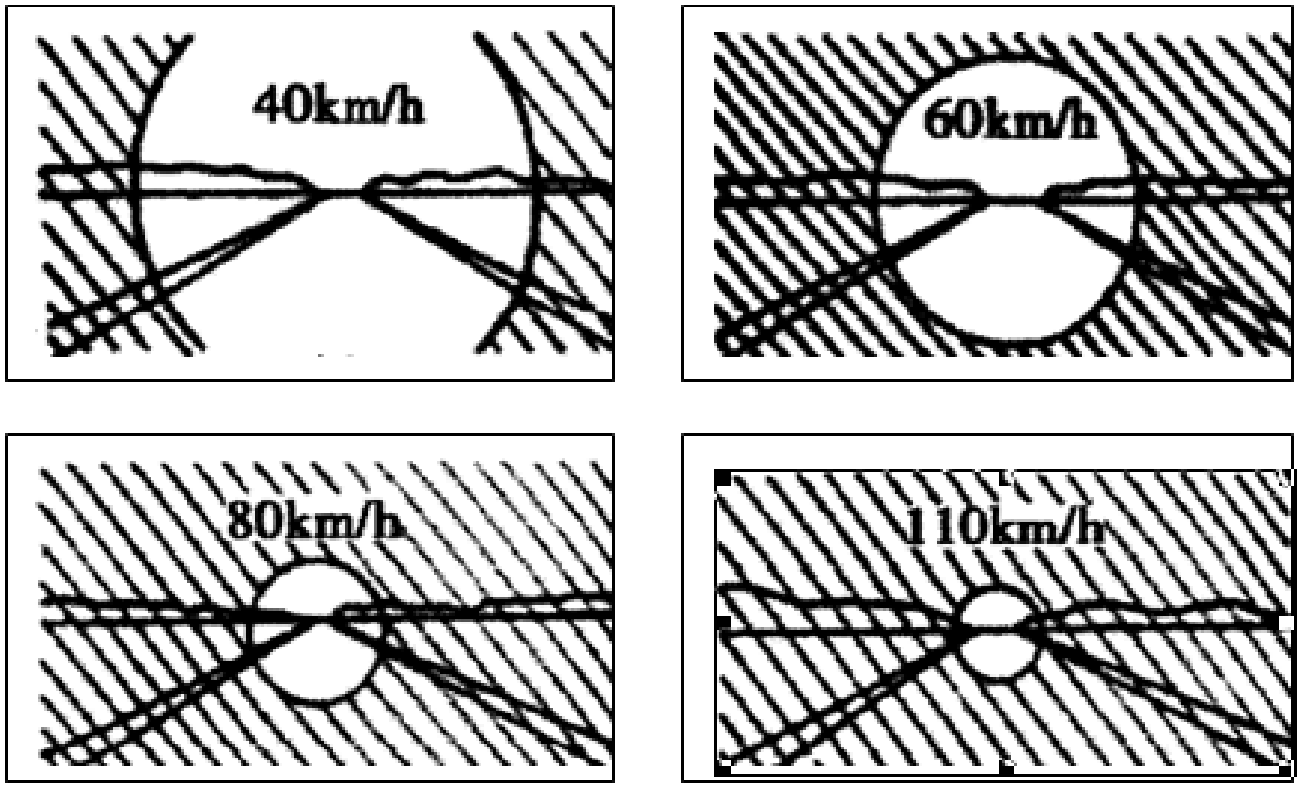


Relevance between velocity and generalization constraints

The procedure of our approach is to analyze the relationship:

- **velocity, visual field and attention distance .**
- **velocity and mobile map scale.**
- **scale and generalization operators.**
- **scale and the parameter of generalization algorithms.**

Relationship between speed, visual field and attention distance



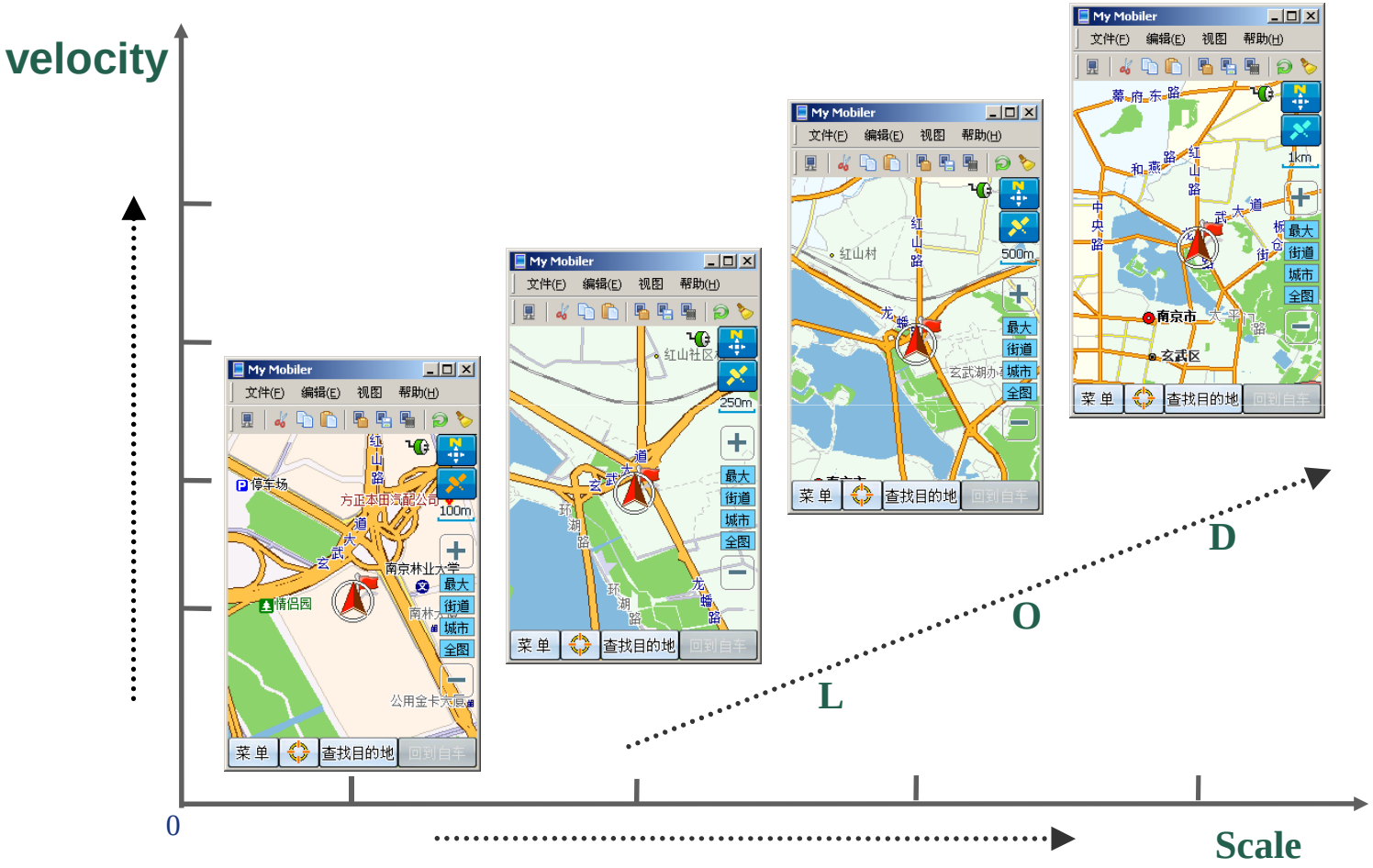
(Вабу МаркоВа , 1990)

Relationship between velocity, visual field and attention distance

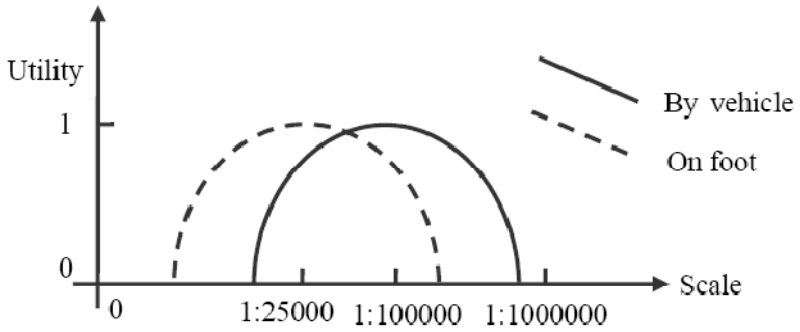
Velocity (km/h)	40	60	80	100	120
Visual field(°)	100	86	60	40	22
Attention distance(m)	180	335	377	564	710

(Pan, 2004)

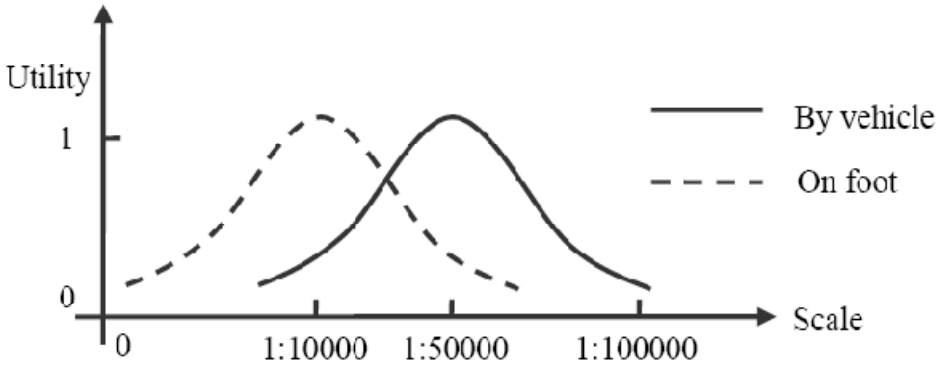
Relationship between user velocity and the scale of mobile map



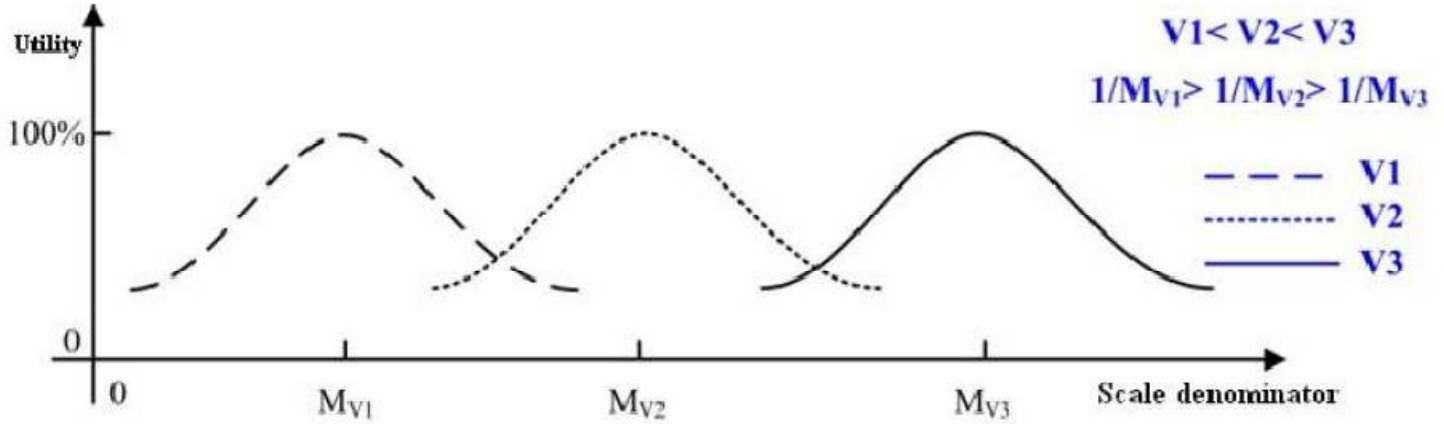
Relationship between movement velocity and map scale using the effectiveness curve



(Chalmers , 2001)



(Zhang H.2005)



"Time -to-edge "measurement method

- **Concept: The time lasted from the center of map to the edge of map with a special velocity.**
- **Usage: Transfer the mobile map scale from the spatial dimension to the temporal dimension.**
- **Computing model:**

$$T = \frac{9 \times W \times M}{500 \times V} \qquad M = \frac{500 \times V \times T}{9 \times W} \qquad V = \frac{9 \times W \times M}{500 \times T}$$

map scale: M,

user velocity: V(km/h),

time to edge: T (s),

size of mobile device: L*W(cm)

An experiment

- Calculating the time-to-edge of 1:10000 mobile map with different velocity
- Pocket PC Glofiish M700，Size of screen：5.7×4.3cm

(a) Velocity (4km/h)

(b) Velocity(50km/h)

(c) Velocity(100km/h)

Relationship between velocity and mobile map scale

- Selecting a suitable “time-to-edge”,according the fomula

$$M = \frac{500 \times V \times T}{9 \times W}$$

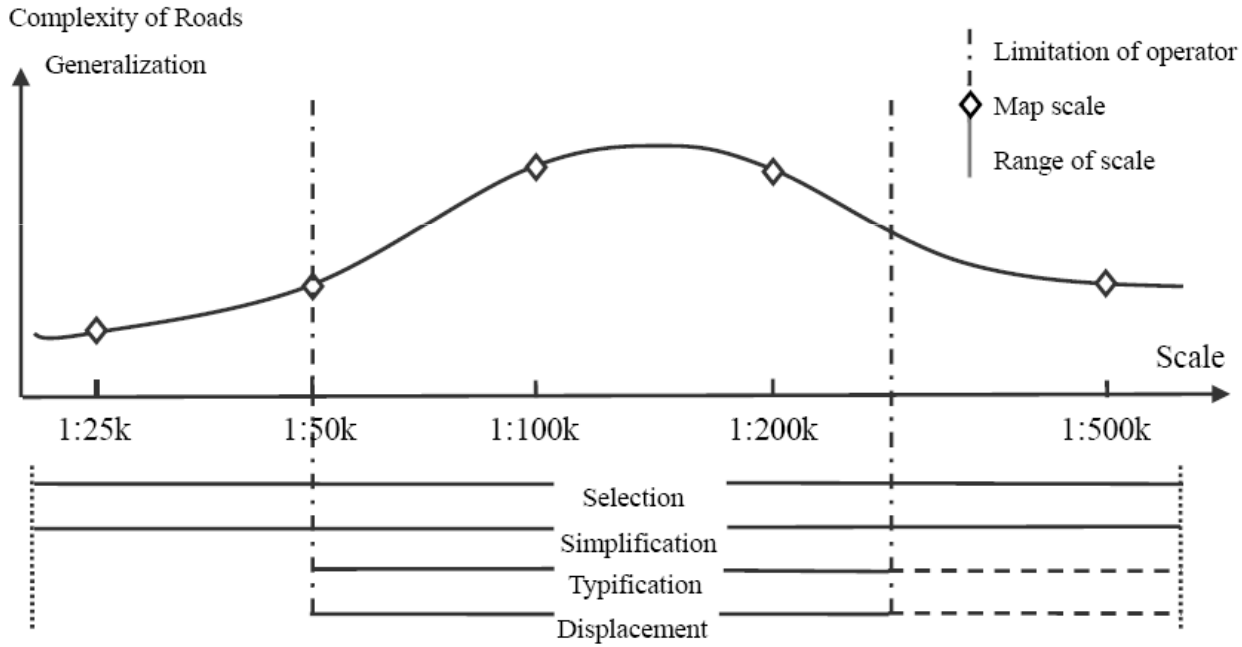
- We calculate the suitable displaying scale of mobile map

Velocity (km/h) / Time(min)	100	80	60	40	30
1	1:77500	1:62000	1:46500	1:31000	1:23300
2	1:155000	1:124000	1:93000	1:62000	1:46500
3	1:233000	1:186000	1:140000	1:93000	1:70000
4	1:310000	1:248000	1:186000	1:124000	1:93000

- But how to select a suitable “time-to-edge” is still not clear, may rely on the experiments of map cognition.

Relationship between scale and generalization operators

- **Cecconi (2003) studied map generalization for on-demand mapping, gave the applications of road generalization operators in different scale.**



(Cecconi，2003)

Relationship between map scale and the parameter of generalization algorithms

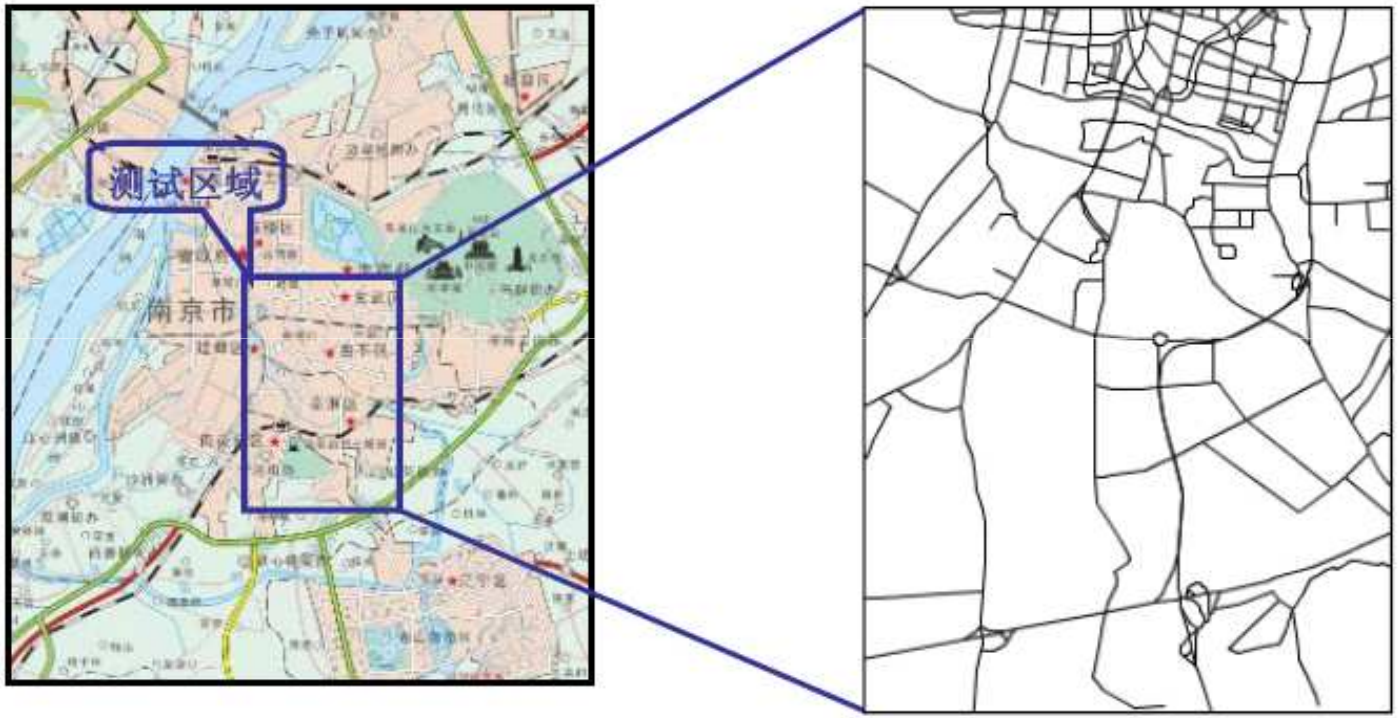
- Every map generalization algorithm has its own parameter.
- The parameter could be adjusted in a limitation.
- The selection of parameter is related with the map usage, scale and the characteristic of map region.

Operator	Algorithms	Parameter
Selection	According to the level of road	Level of road、attribute
Simplification	N^{th} point	Number of vertex
	Douglas-Peucker	Perpendicular distance
	Lang	Nmax，Dmax
	Perpendicular distance	Perpendicular distance
	Li-Openshaw	svo
	"embrace delete"simplification based on circle	Filter circle radius
	Progressive method	Square
	Visvalingam-Williamson	Square

Road generalization implementation considering the user velocity

- We investigated the typology of Chinese road and get the average speed of the road of testing area.
- We calculate the scale of the map according to the “Time-to-Edge” rule considering the velocity.
- Implementing the selection and simplification algorithm considering the average speed of the road.

Test area of Nanjing



Average speed of the road of testing area

The paper discusses the highways, expressways, trunk roads, sub-arterial roads and slip roads .

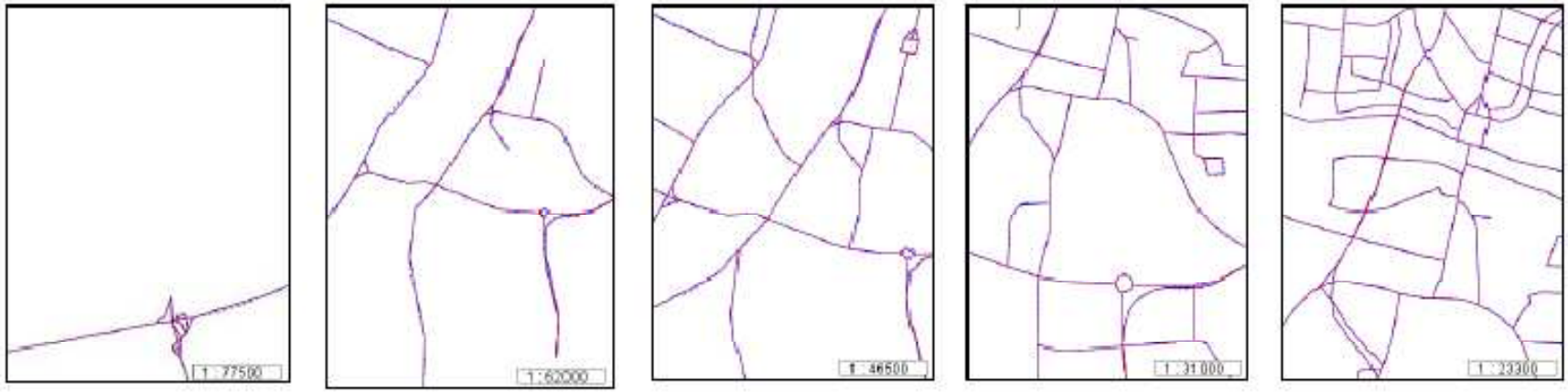
Type of road	High way	expressways	trunk roads	sub-arterial roads	slip roads
Speed(km/h)	100	80	60	40	30

Calculate the map scale according to the “Time-to-Edge” rule

Time (min) \ Speed(km/h)	100	80	60	40	30
1	1:77500	1:62000	1:46500	1:31000	1:23300
2	1:155000	1:124000	1:93000	1:62000	1:46500
3	1:233000	1:186000	1:140000	1:93000	1:70000
4	1:310000	1:248000	1:186000	1:124000	1:93000

- In this experiment, we assume 1 minute as the suitable “Time-to-Edge”.

Implementing the selection and simplification algorithm



(a) 100 km/h (b) 80 km/h (c) 60 km/h (d) 40 km/h (e) 30 km/h

Conclusion

- Mobile map generalization has its own characteristics as partial, dynamic and on-demand of user.
- User locational context is an important context which have to be considered for mobile map generalizasion.
- Velocity, time-to-edge, scale are related each other and selecting a suitable time-to-edge is helpful to improve the usability of mobile map.

Open issues

- This study did not get deeply with the problem of getting the suitable “Time-to-Edge”.
- The relationship between user locational context and scale, generalization constraits is not very clear.

THANKS FOR YOUR ATTENTION…

… comments and discussions are appreciated

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