



Representing and Querying Moving Objects



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INFORMAČNÍCH
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Moving objects

- Spatial object
 - the object with some position (extent, shape)
- Moving object
 - a geometry, which changes continuously in time
 - spatial object with other dimension (time)

Cellular automata

- edge and background object detection

- formally:

$$\mathbf{A} = \{\mathbf{d}, \mathbf{S}, \mathbf{N}, \mathbf{f}\}$$

d number of dimensions

S finite-state set

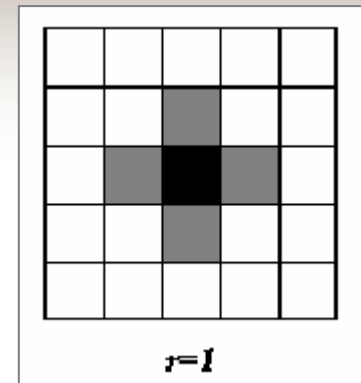
N neighborhood; $N = (S_1, S_2, \dots, S_n)$

f $f: S^n \rightarrow S$

Neighborhood

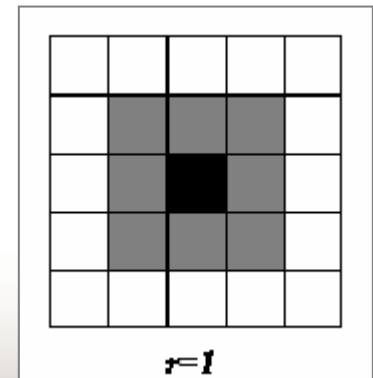
- Von Neumann

- $N_{i,j} = \{ (k, l) \in L \mid |k - i| + |l - j| \leq r \}$



- Moore

- $N_{i,j} = \{ (k, l) \in L \mid |k - i| \leq r \wedge |l - j| \leq r \}$



Moving object detection

- Subtract frame $t+1$ and $t \rightarrow$ initial image
- Celles status: $t+1$, every celles status to gray
- Moore neighborhood (edge detection)
- Rule of f :

– initial image pixel = 0 \rightarrow new image pixel = 0

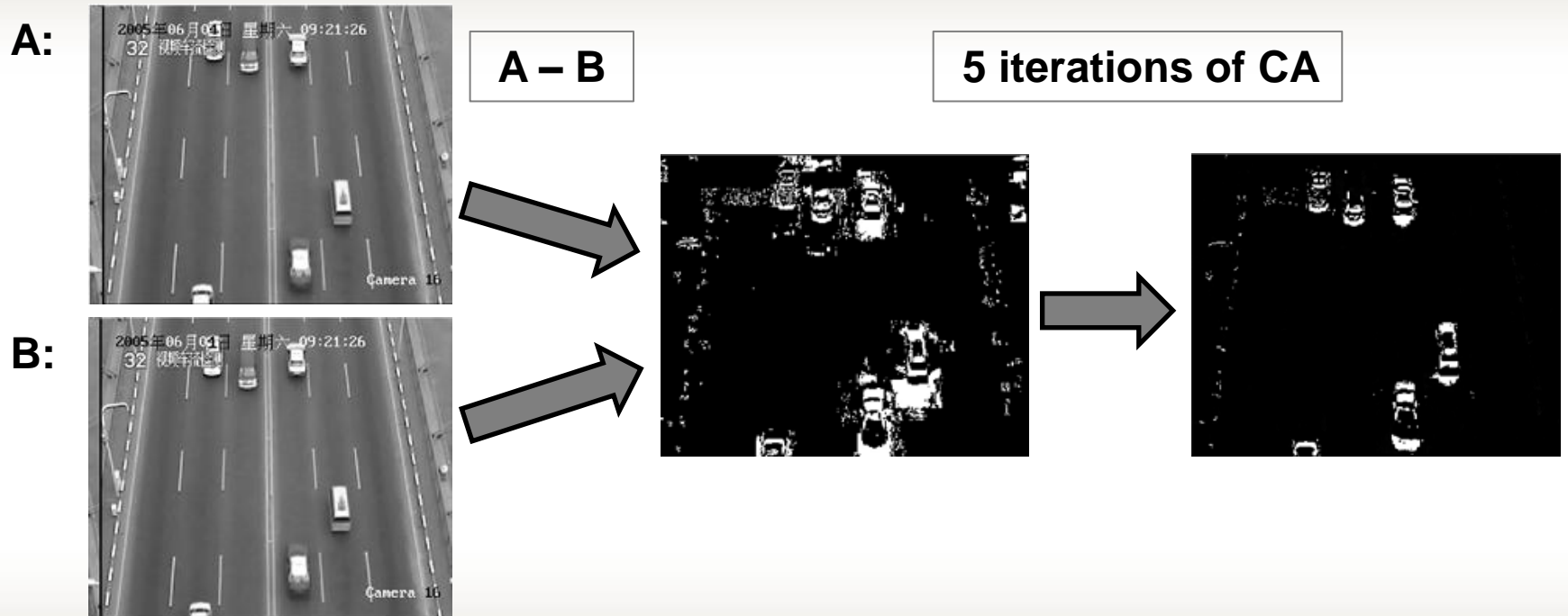
– initial image pixel \neq 0:

$$f(i, j) = |8 * I(i, j) - \sum I(k, l)|$$

$I(i, j)$ = grayscale value of the image pixel

$I(k, l)$ = value of the neighborhood of $I(i, j)$

Moving object detection



Moving object database

- A database, which can represent and query moving objects

Motivation of Moving Object DB

- Cars, transport
 - traffic jam, control center of public transport
- People
 - land use plan
- Nature
 - migration of animals (ornithologist), weather
- Security
 - surveillance systems, protection against terrorism

Perspectives of Moving Object DB

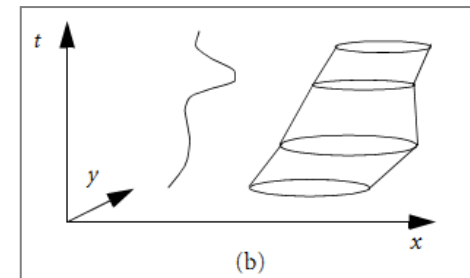
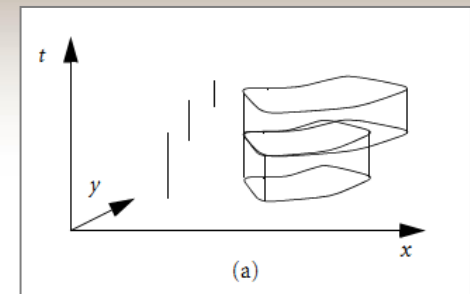
- The location management perspective
 - snapshot (no history)
 - query current or near-future position
- The spatio-temporal data perspective
 - all changes of spatial objects

The location management perspective

- trade-off:
 - very often updates
=> small error, high load of update
 - less frequently updates
=> large error, low load of update
- solution:
 - store speed and direction of motion

The spatio-temporal data perspective

- discrete changes:
 - point, line, region, networks, partitions
- continuous changes:
 - moving objects:
 - moving point
 - only position is relevant
 - example: monitored vehicle in public transport
 - moving region
 - position, extent and shape are relevant
 - example: land use plan



Spatio-temporal data types

- values are continuous functions
- Moving point (mpoint)
 - instant \rightarrow point
- Moving region (mregion)
 - instant \rightarrow region

Spatio-temporal operations

- intersection:
 $\text{mpoint} \times \text{mregion} \rightarrow \text{mpoint}$
- distance (time distance):
 $\text{mpoint} \times \text{mpoint} \rightarrow \text{mreal}$
- trajectory:
 $\text{mpoint} \rightarrow \text{line}$

Spatio-temporal operations

- deftime (time when defined):
mpoint \rightarrow periods
- length:
line \rightarrow real
- min:
mreal \rightarrow real

Example of Querying Moving Object

- flight (id: int; from: string; to: string; route: mpoint)
- Which plains were during their flight closer than 1km?

```
SELECT f1.id, f2.id
FROM flight f1, flight f2
WHERE f1.id <> f2.id
      AND min(distance(f1.route, f2.route)) < 1
```




Thank you for your attention.

Tomáš Volf: Representing and Quering Moving Objects

Bibliography

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