Representing and Quering Moving Objects

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Moving objects

- A geometry, which changes continuously in time

Cellular automata

- edge and background object detection

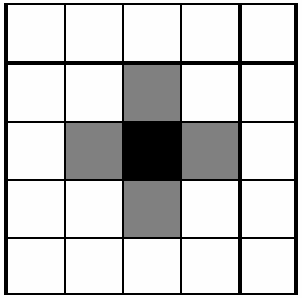
- formally:

A = {d, S, N, f}

d	number of dimensions
S	finite-state set
N	neighborhood; $N = (S_1, S_2, .., S_n)$
f	$f: S^n \rightarrow S$

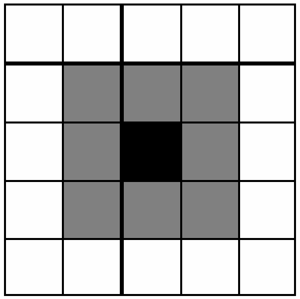
Neighborhood

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



r=1

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



r=1

Moving object detection

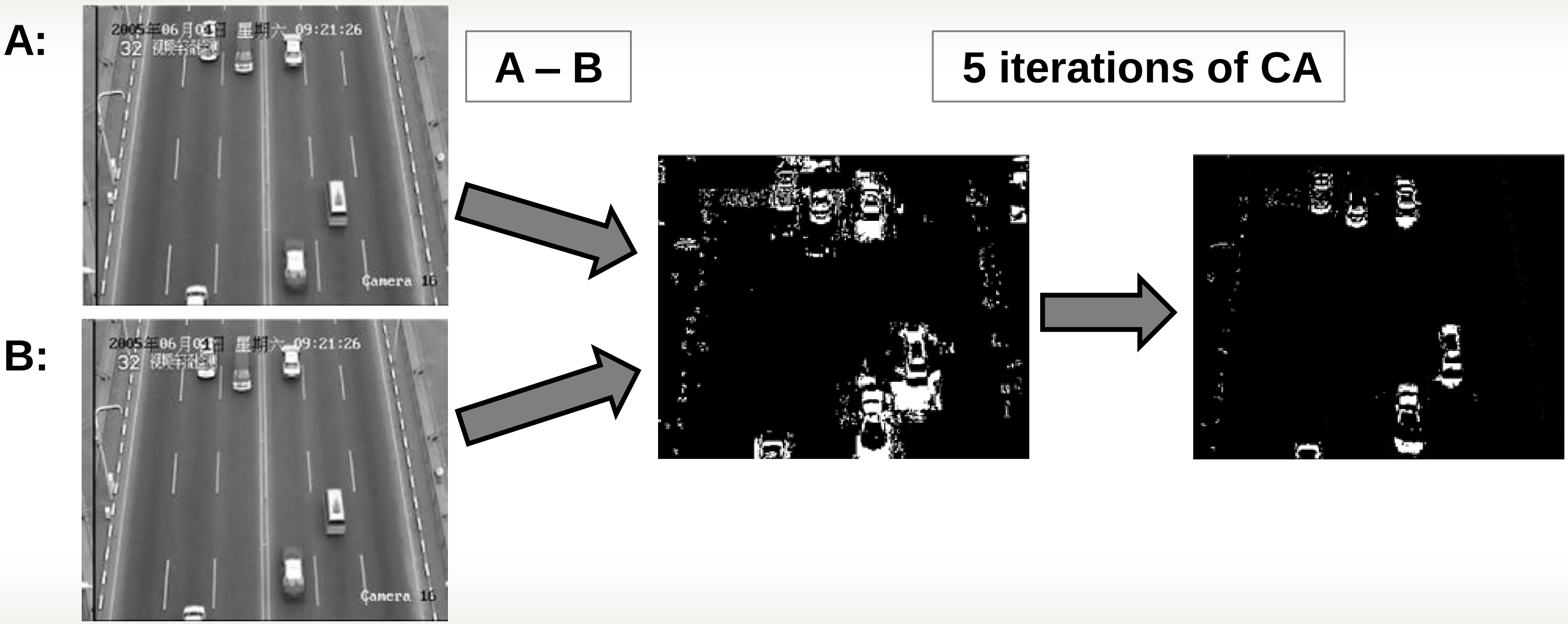
- Subtract frame t+1 and t ➔ initial image
- Celles status: t+1, every celles status to gray
- Moore neighborhood (edge detection)
- Rule of f:
  - initial image pixel = 0 ➔ new image pixel = 0
  - initial image pixel != 0:

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

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

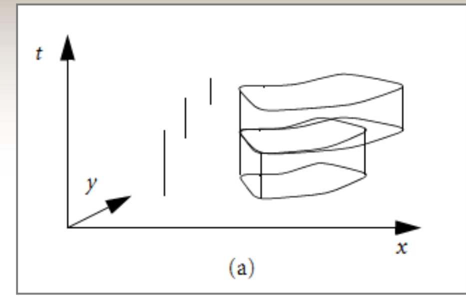
- The location management perspective
  - snapshot (no history)
  - query current or near-future position
- The spatio-temporal data perspective
  - all changes of spatial objects

The location management perspective

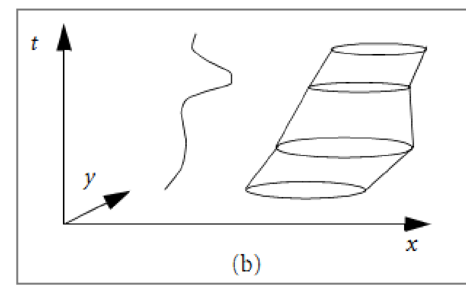
- trade-off:
  - very often updates
    => small error, high load of update
  - less frequently updates
    => large error, low load of update
- solution:
  - store speed and direction of motion

The spatio-temporal data perspective

- discrete changes:
  - point, line, region, networks, partitions



- continuos 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 continuos functions

- Moving point (mpoint)
  - instant → point
- Moving region (mregion)
  - instant → region

Spatio-temporal operations

- intersection:

  mpoint × mregion → mpoint

- distance (time distance):

  mpoint × mpoint → mreal

- trajectory:

  mpoint → line

Spatio-temporal operations

- deftime (time when defined):

  mpoint → periods

- length:

  line → real

- min:

  mreal → real

Example of Quering 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.

Bibliography

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