Geospatial Visual Analytics:
analysing movement

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GeoPKDD project

- Participants from the data mining, databases, and geovisualisation research communities
- Objective: develop methods for analysis of movement data
- Typical movement data structure: {<entity ID, time, position>}
  Position: <x, y> or <longitude, latitude>
- Source: GPS tracking, RFID, …
- Our task: develop interactive visual techniques working together with computational and database techniques

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Our techniques

- Cartographic visualization of movement tracks
- Space-time cube
- Time filter: selection of time intervals; focusing of space-time cube; map animation
- Computation of movement attributes: speeds, path lengths by time intervals, etc.
- Interactive classification
- Spatial clustering
- Spatial, temporal, and attribute aggregation
- Dynamic queries

➢ Need to be used in combination:

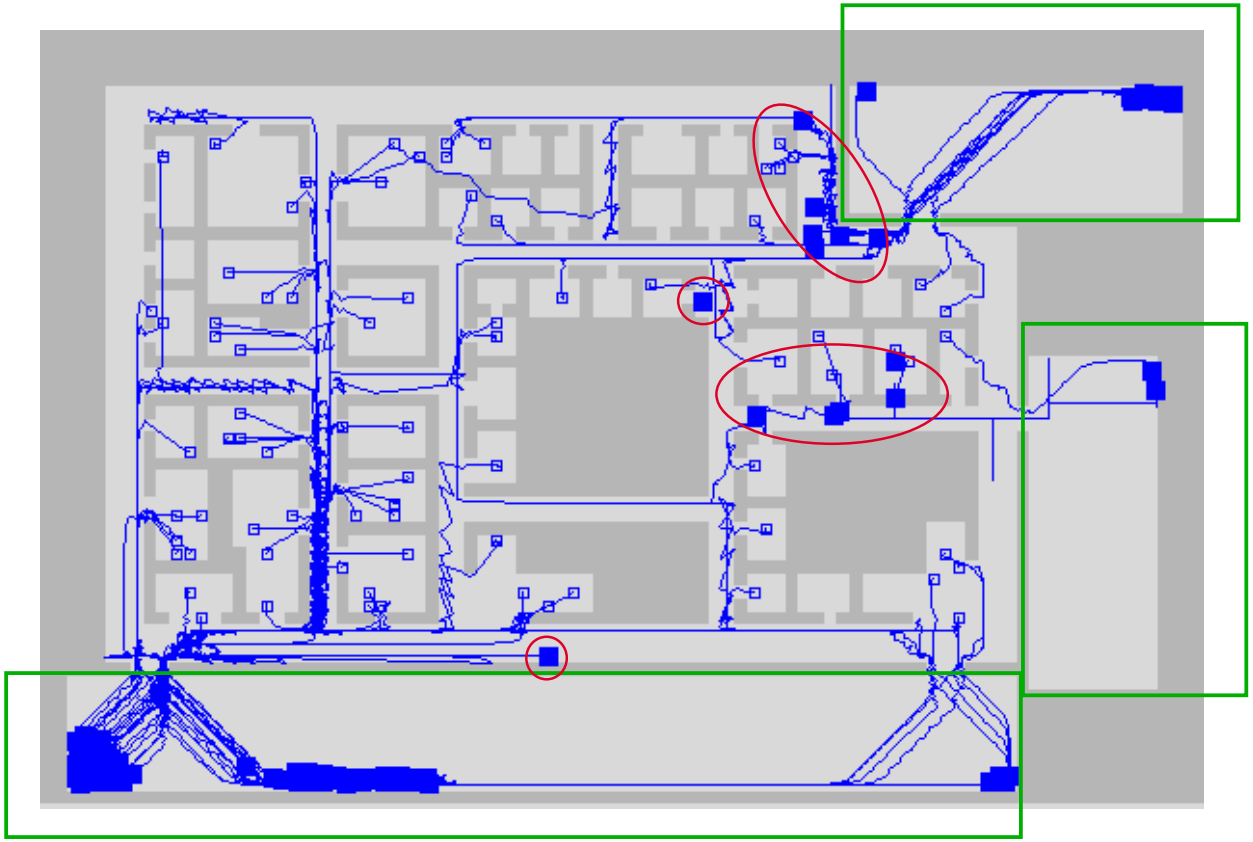
  ✓ movement data involve several heterogeneous aspects (space, time, moving entities + attributes of these);

  ✓ the context of the movement is very important for gaining understanding

Case study: VAST'08 mini-challenge
Analysis of evacuation traces

- Given: a synthetic dataset containing positions of 81 persons inside a building during 837 consecutive time moments
- Scenario: a terrorist or a group of terrorists set off a hand-made bomb inside the building resulting in moderate damage and casualties. The explosion caused evacuation of people.
- Analysis tasks:
  - find when and where the explosion occurred and who might set off the bomb
  - identify the casualties
  - describe the process of evacuation

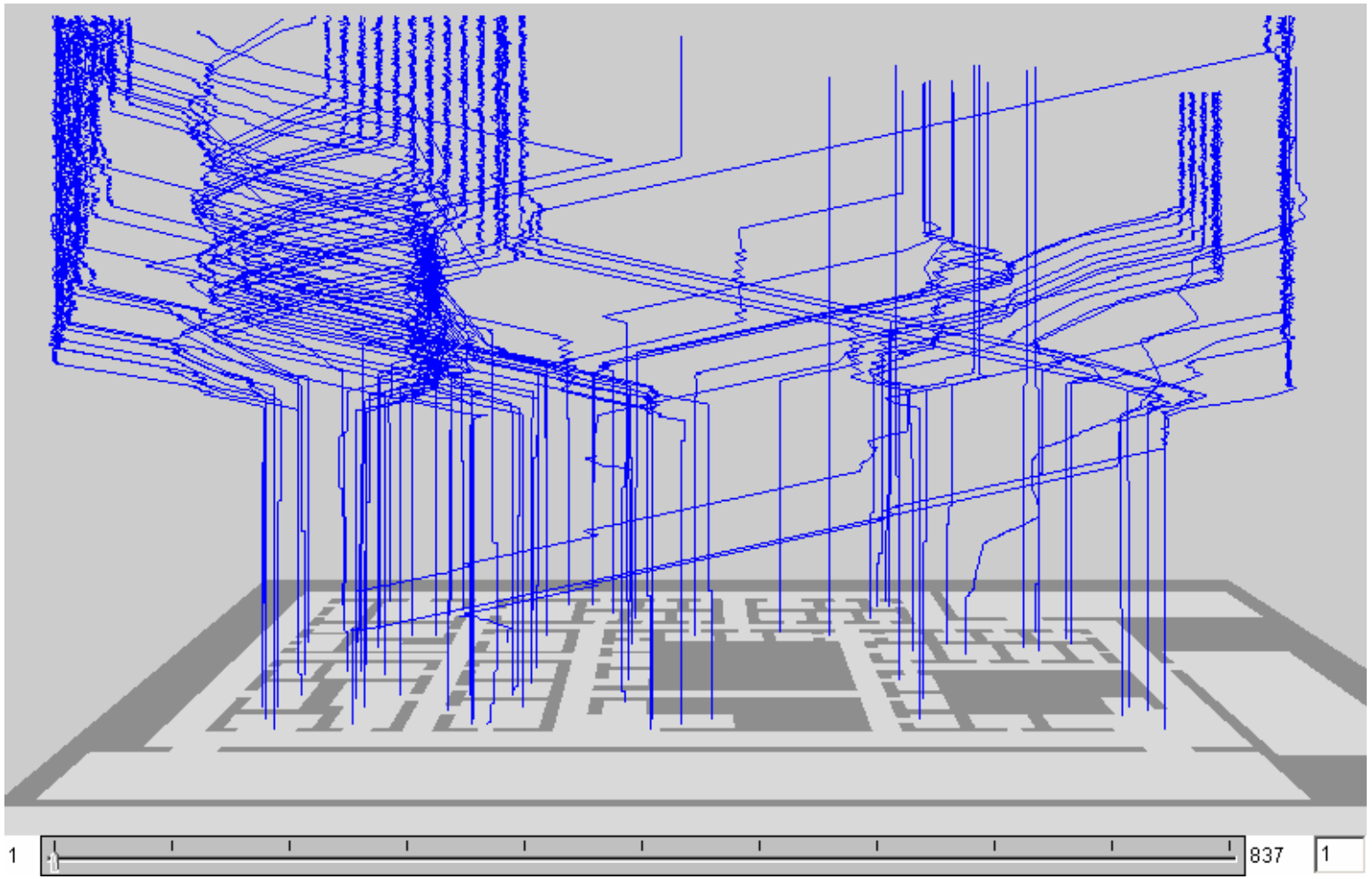
The first look at the map



Exits or safe areas (most people came to these areas)

Some people stayed inside the building: possible casualties?

A look into the space-time cube



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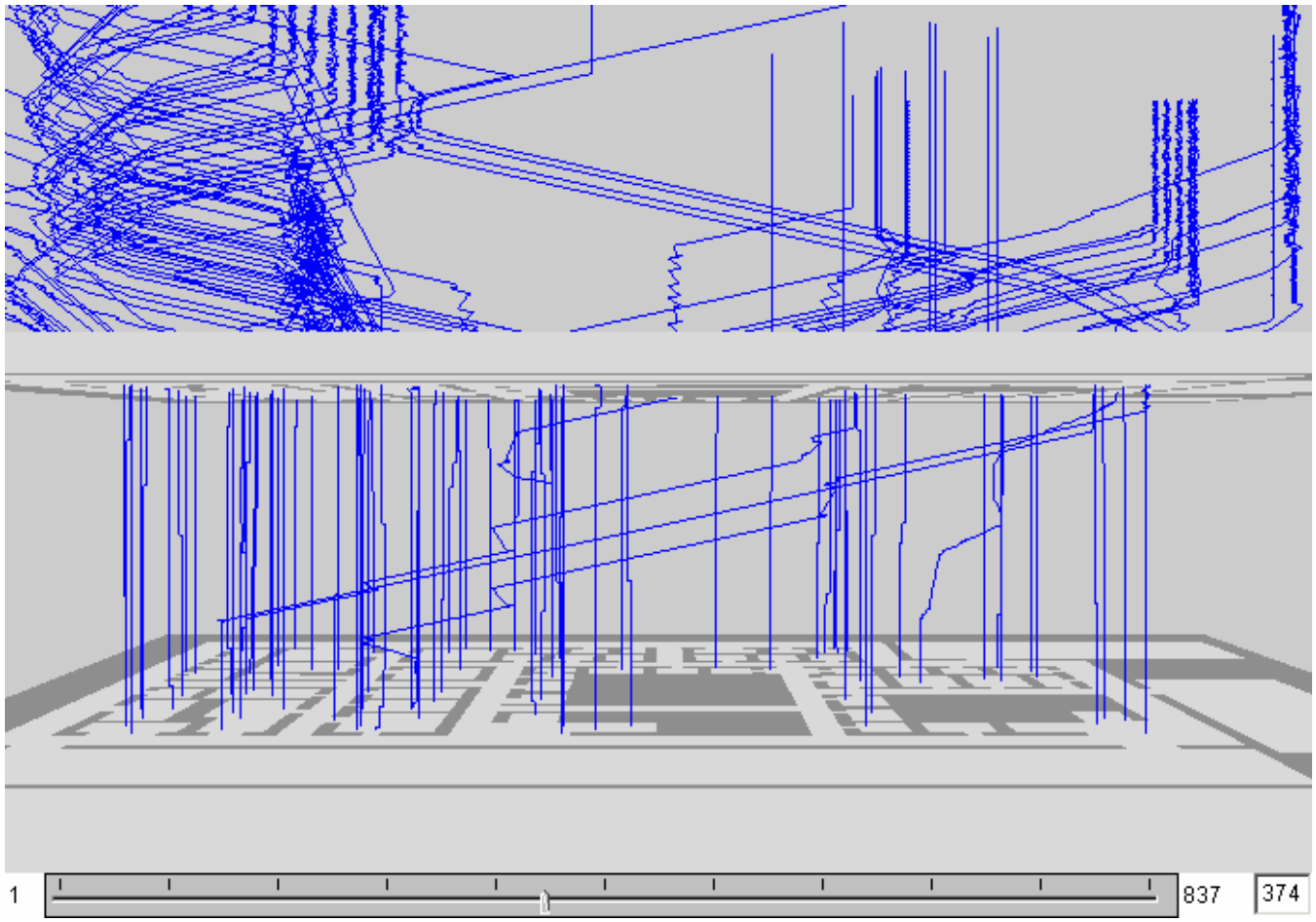
The approximate time when the evacuation began

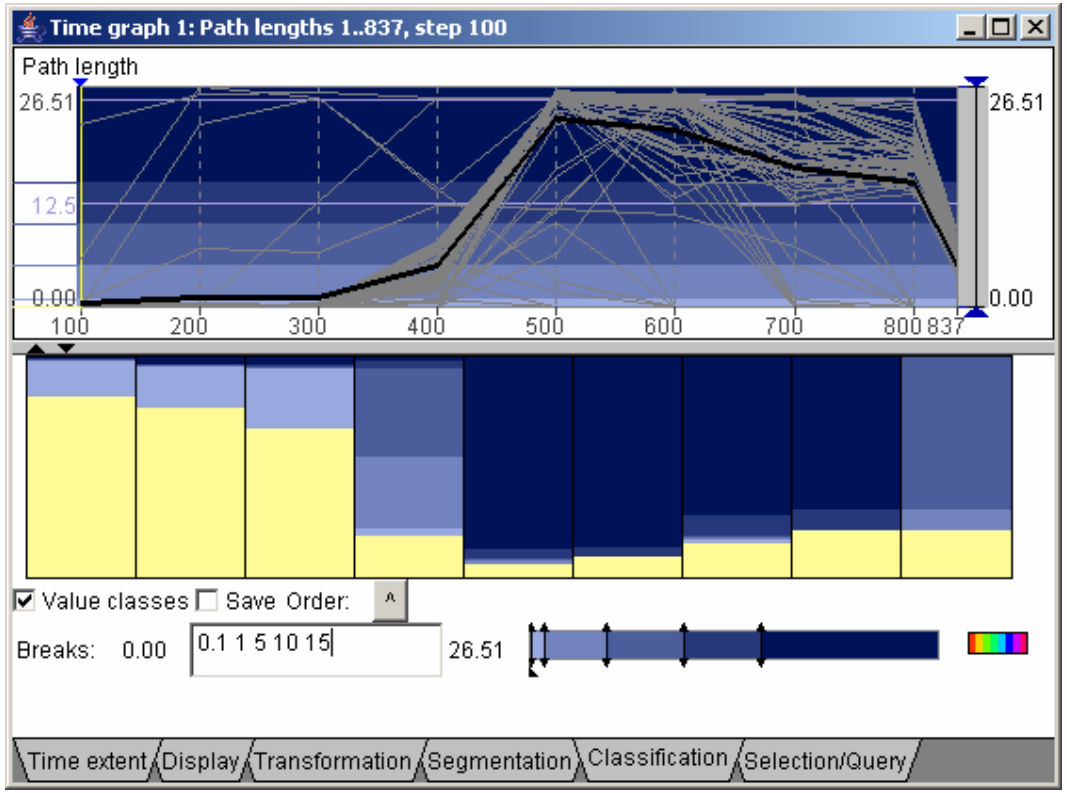


Determining the exact time of the explosion

Looking at the path lengths by time intervals (computed)

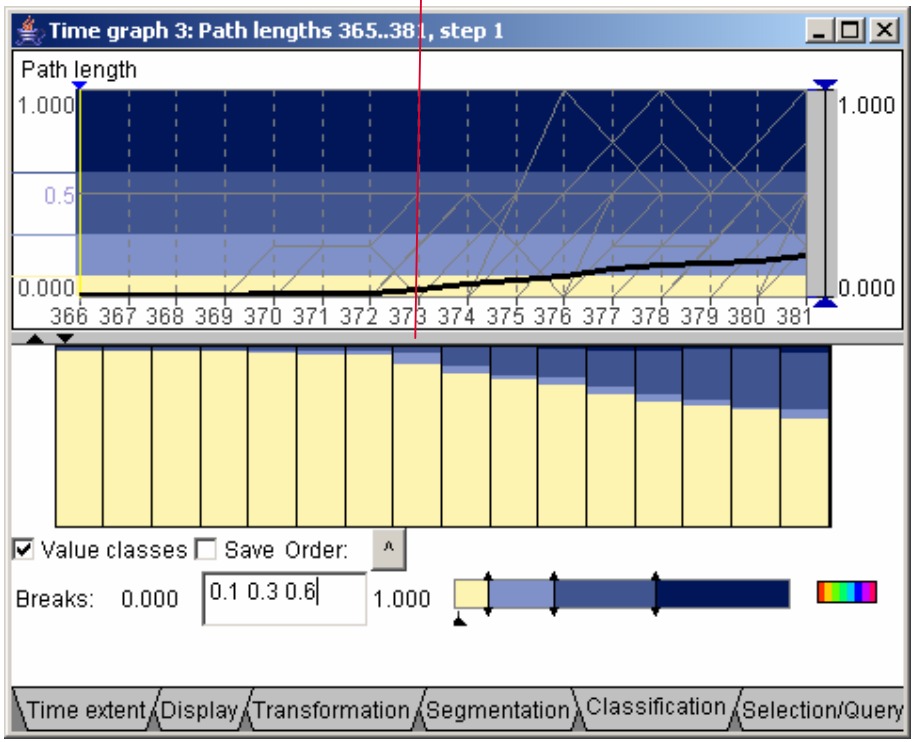
The first noticeable change occurred in the interval [372, 373]

Time graph



Time histogram

Time graph



Time histogram

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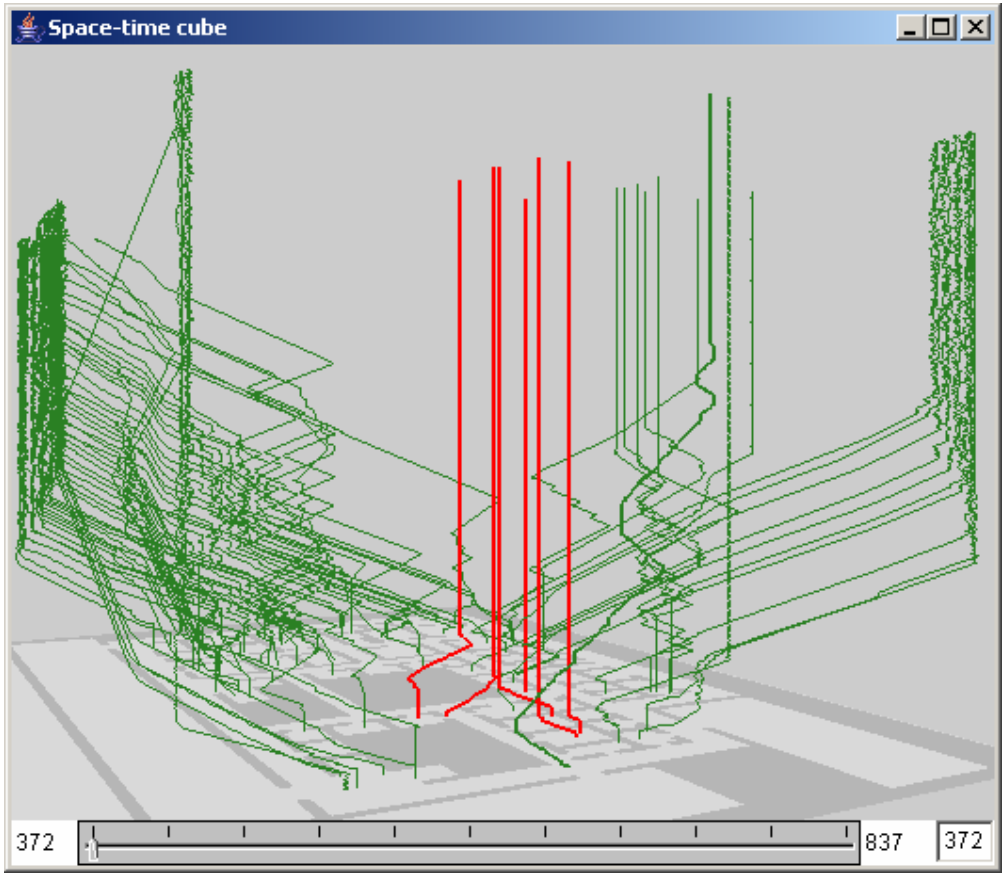
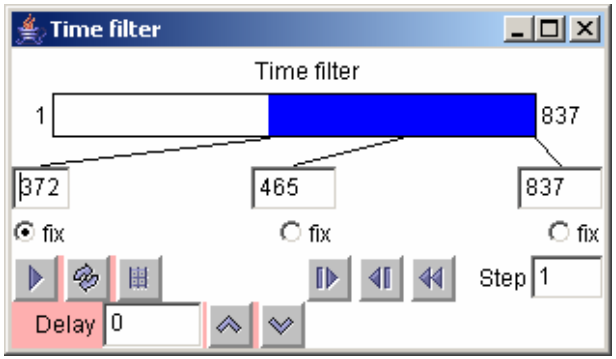
Who stopped moving earlier than others?

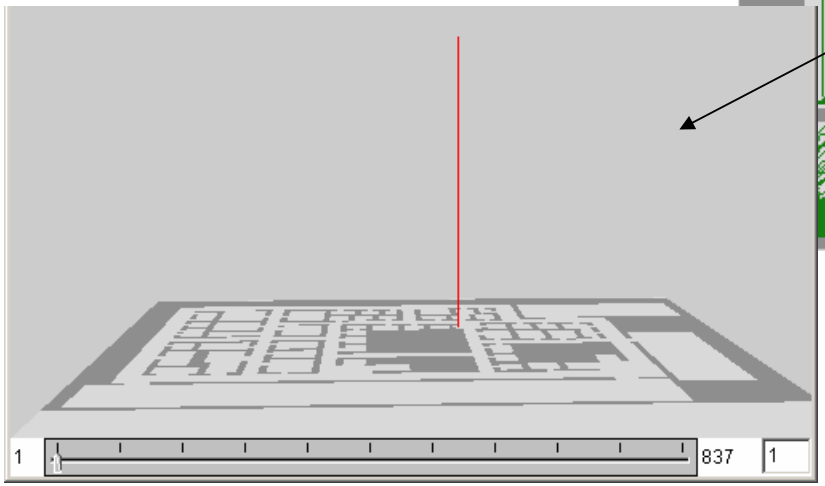


1. These are possible victims of the explosion
2. They are located close to the place of the explosion

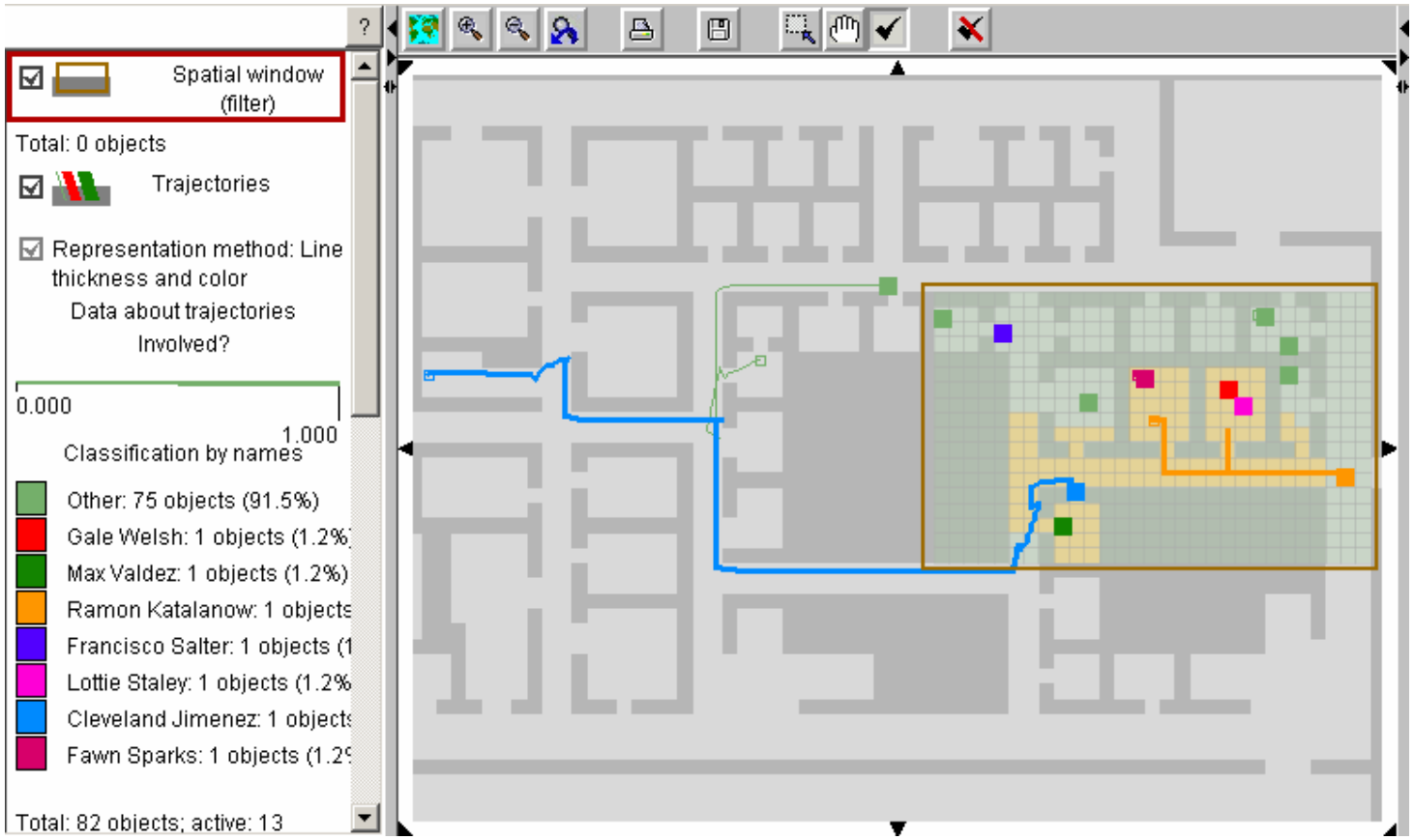


The area affected by the explosion

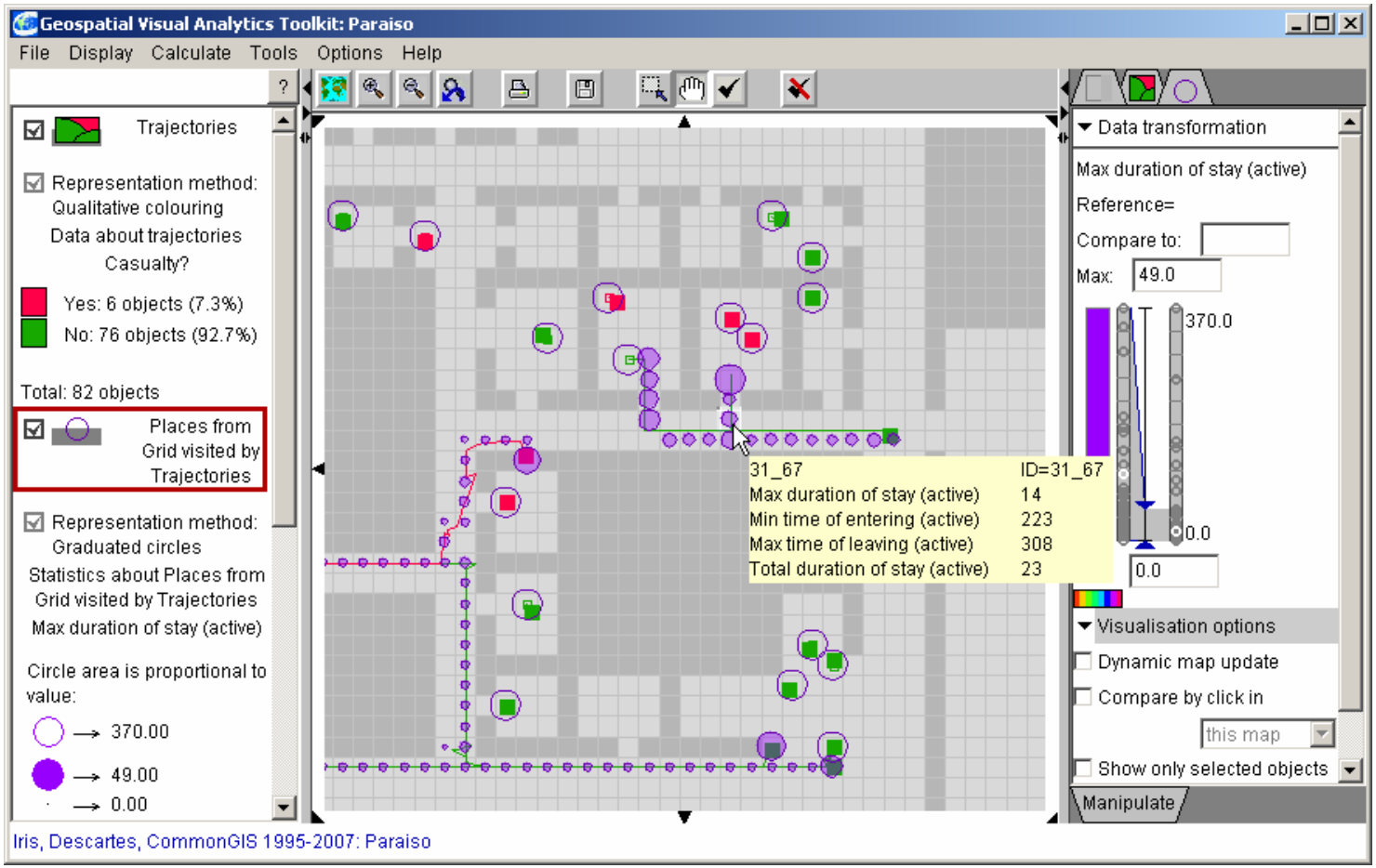
This person never moved
(or lost his RFID tag)



Movements in the area before the explosion



Who and where could put the bomb?

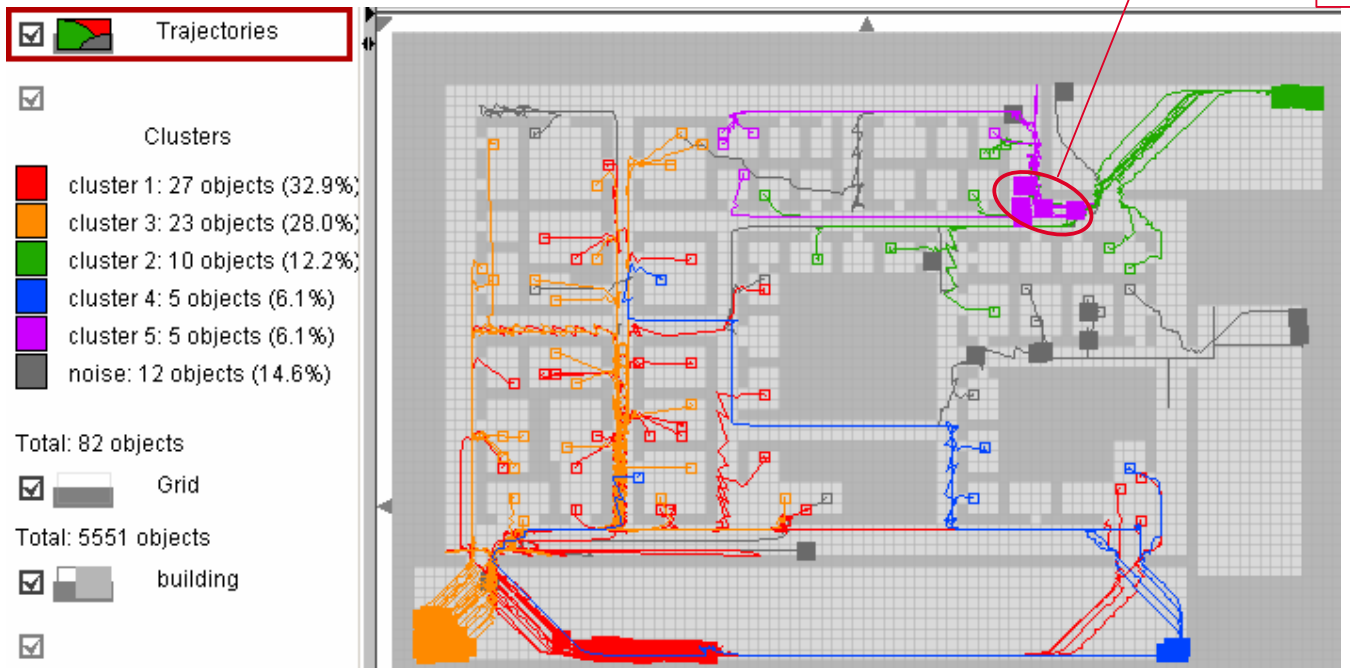


Spatial aggregation: time spent in grid cells (for the currently selected time interval)

The evacuation paths

Spatial clustering according to the end positions of the trajectories

It seems that something bad happened here



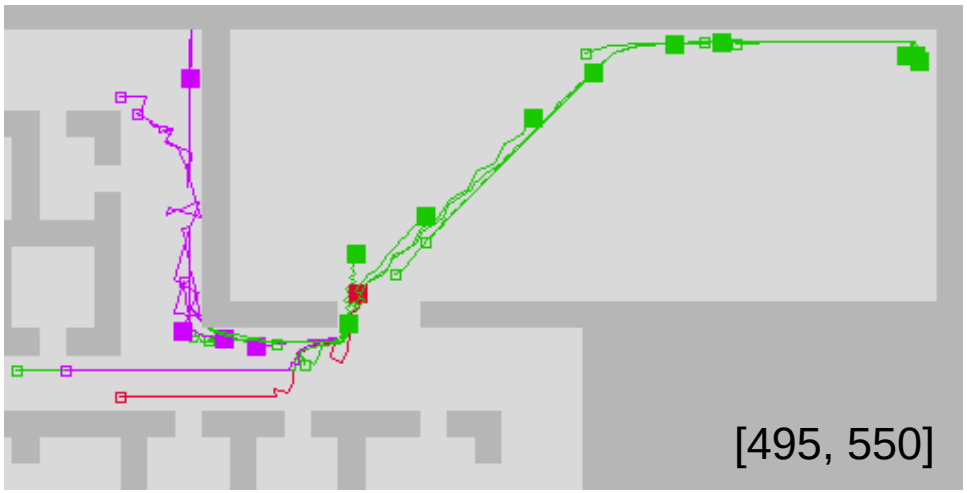
5 clusters (5 or more people came to a same place)
+ “noise” (end positions distant from others)

A possible secondary incident

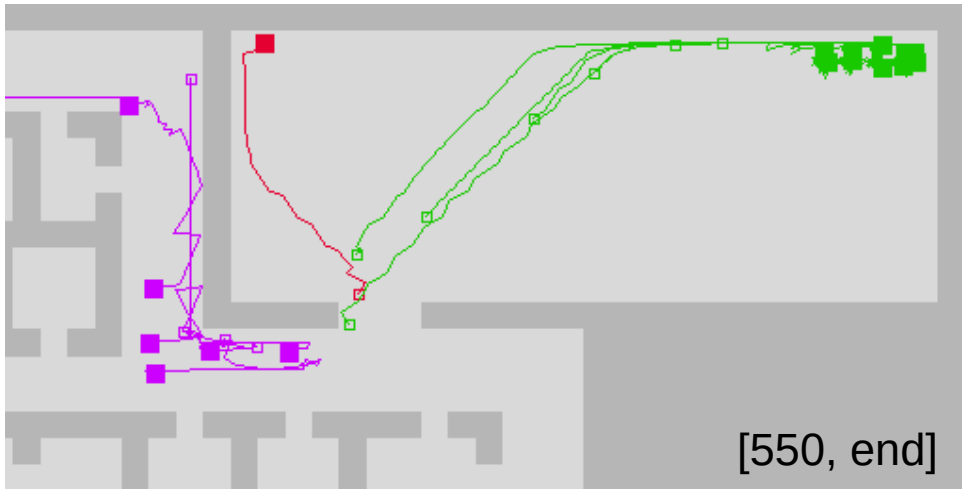
Table view: Data about trajectories

identifiers	Entity ID	Path length from 580 to 837	Path length from 668 to 837
Lavon Lockhart	60	0.0	0.0
Morton Kilgore	69	3.0000019838177927	0.0
Dian Crum	65	5.500000349875357	0.0
Rosario Oakley	47	6.250000881532441	0.0
Cleveland Hutchison	78	10.250003392457433	0.0

The people from the “violet” group stopped moving after moment 580 (latest by 668)

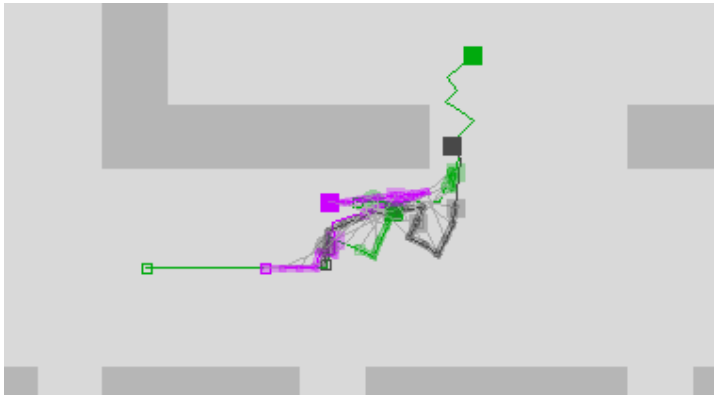


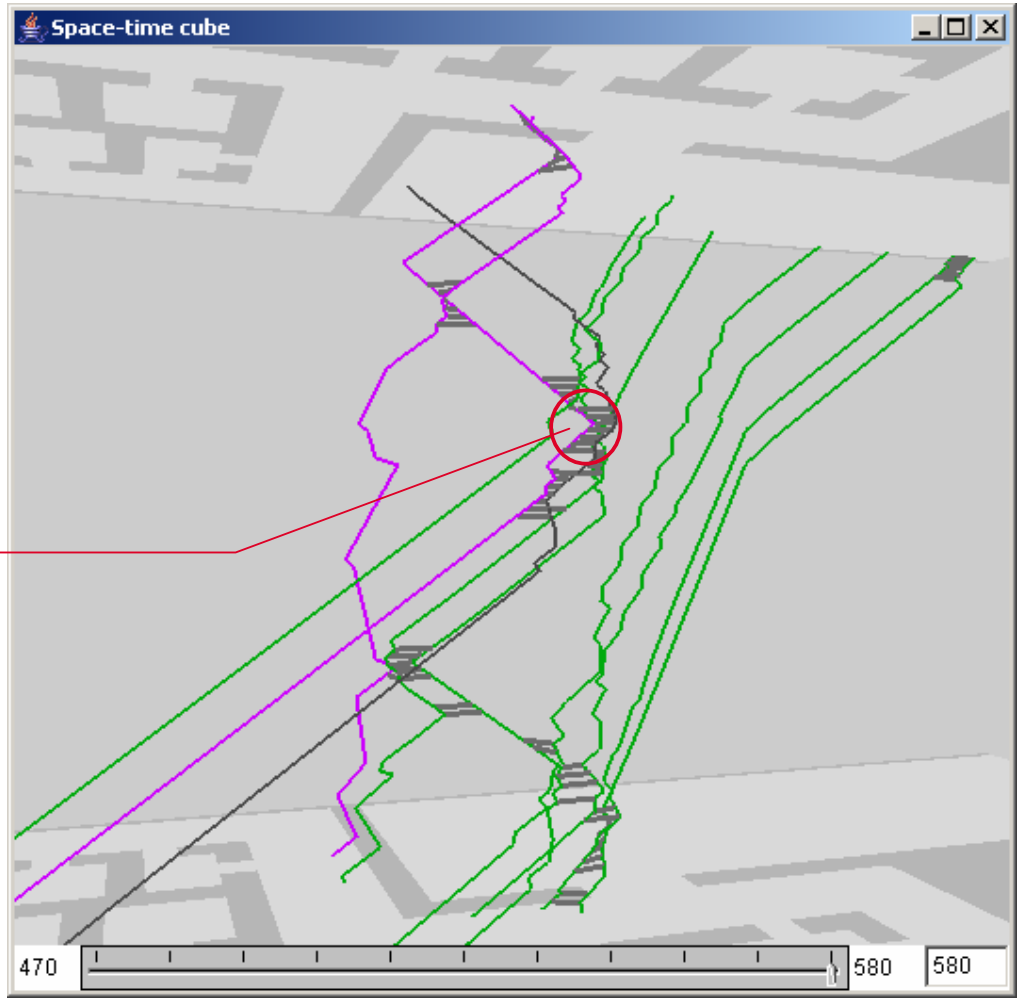
The last people passed through this door



The people from the “violet” group moved away from the door

The movements and interactions before moment 580





Two persons met, and one of them abruptly turned back. The other person then left the area but did not join the others.

Conclusion

- The VAST'08 challenge has been a good opportunity to test our tools: not only data available but also clear analysis tasks
- None of the tools alone would be sufficient; the possibility to combine the tools is advantageous
- Specific tools for analysis of movements: map display of trajectories, space-time cube, computation of derived attributes, spatial and temporal aggregation, detection of interactions between moving objects
- These were used in combination with generic tools: time filter, spatial filter, query, classification, table view, dynamic linking between displays
- Visual techniques supported overview, detection of anomalies, observation of behaviors, generation of hypotheses, finding approximate times and places
- Computational techniques: finding exact times and places, detecting interactions
- Space-time cube was more useful for presenting the results than for the analysis (except for the analysis of interactions)

Details:

- problem description (look Mini Challenge 4 - Evacuation Traces): http://www.cs.umd.edu/hcil/VASTchallenge08/
- our solution: http://geoanalytics.net/and/FhgIAIS-EvacTraces/ and http://geoanalytics.net/and/FhgIAIS-EvacTraces/and-VAST2008challenge.pdf
- other methods, papers, presentations: http://geoanalytics.net/and/