High resolution measurement of time geographic entities and relationships

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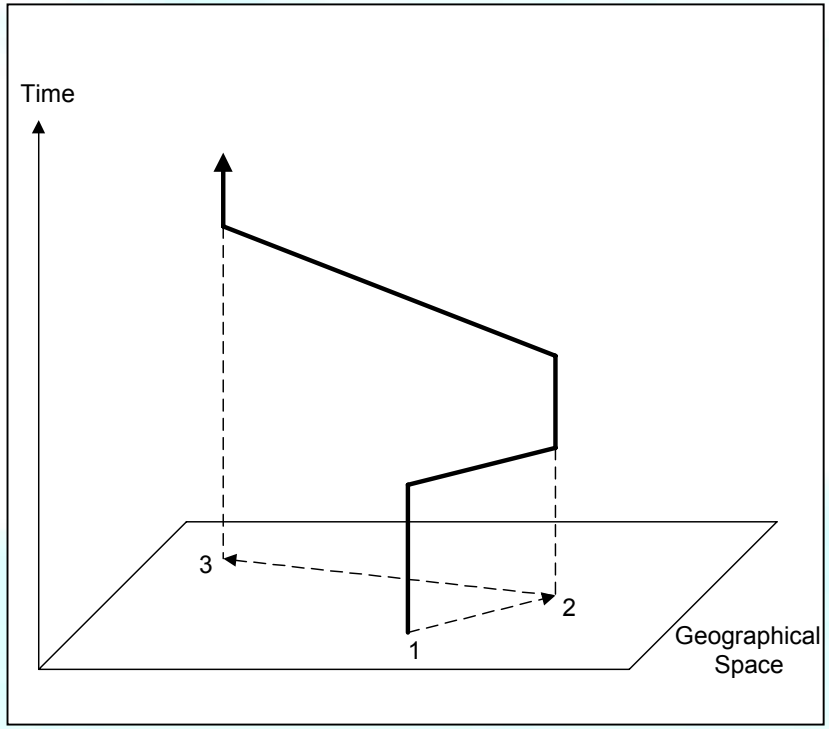
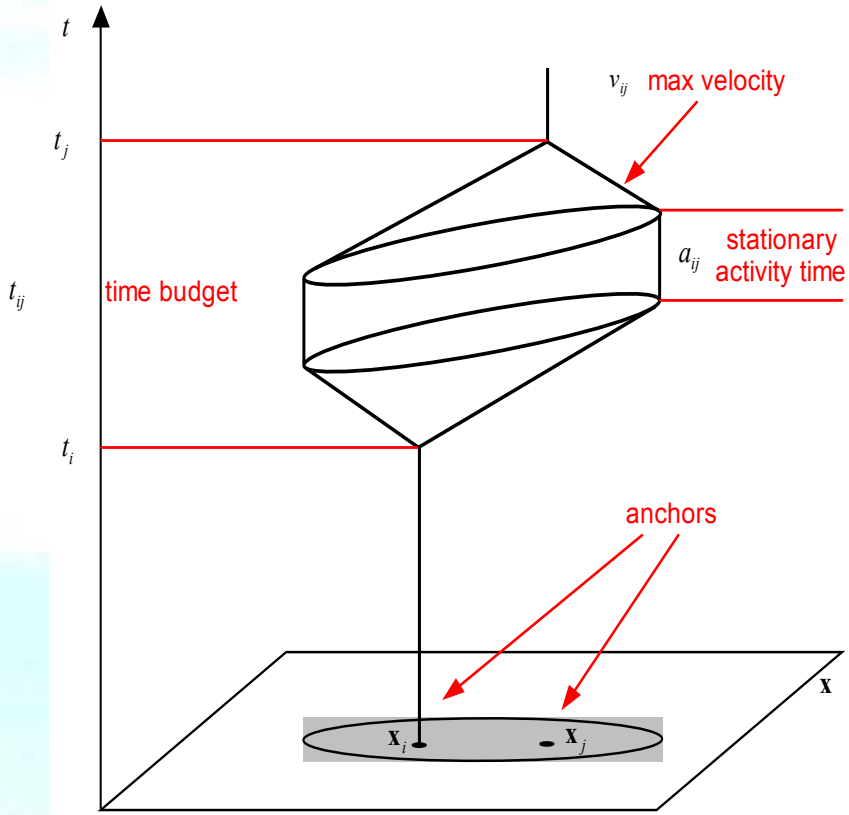
Time geography

- Person in space and time
  - Where and when of people & activities
  - Implications for cities, society…
- Space-time path
  - Movement in space with respect to time
  - Allocation of time to travel and activities



Time geography

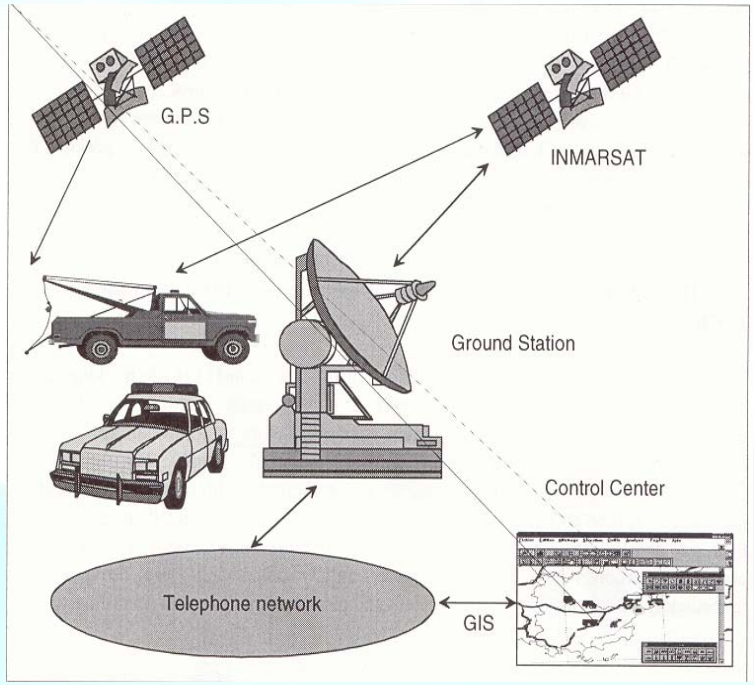
- Space-time prism
  - Possible locations for path
  - Accessibility measure
  - Determined by:
    - Space-time anchors
      - Home, work
    - Time budget
    - Stationary activity time
    - Travel velocity



High-resolution space-time data

- Empirical
  - Location-aware technologies
    - Global positioning system
- Synthetic
  - Geosimulation
    - Agent-based modeling

- We need to rethink theory and analysis of human behavior



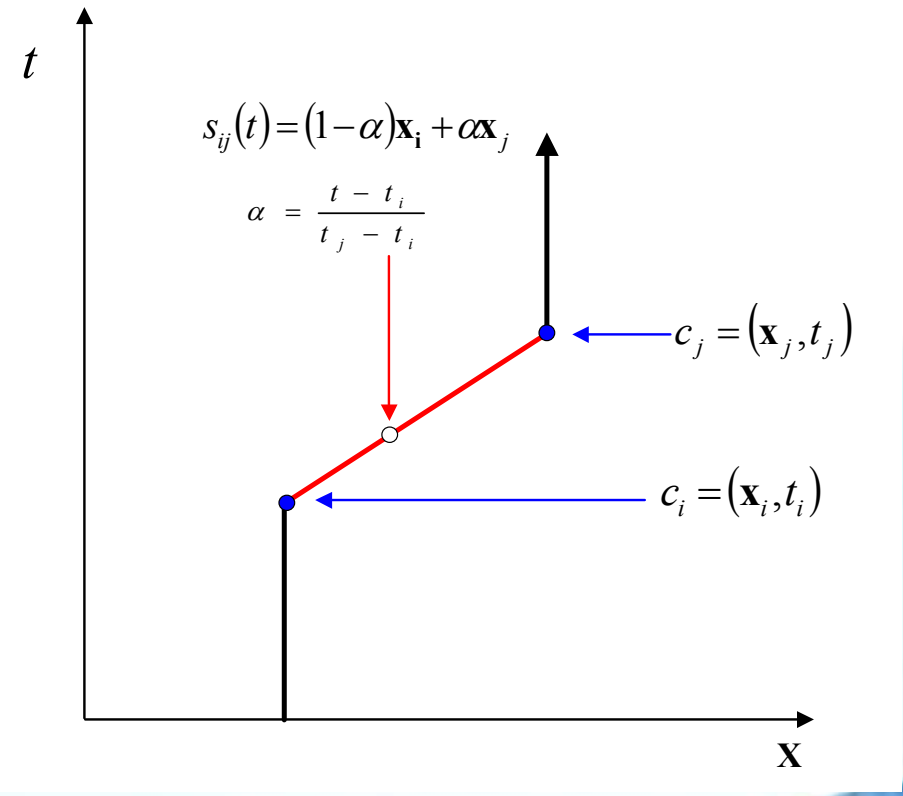
Laurini, R. (2000) "An introduction to TeleGeoMonitoring," in *GIS and GeoComputation*

Time geography: Not quite ready!

- Classical time geography (Hagerstrand, Lenntorp, Burns)
  - Quasi-formal narratives
  - Useful for some properties
    - e.g., prism volume
- "New" time geography (Some of the people in this room!)
  - Formalisms limited to specific cases
    - e.g., networks, opportunity sets
- Research objectives
  - An analytical theory for time geography
  - Support high-resolution measurement & simulation

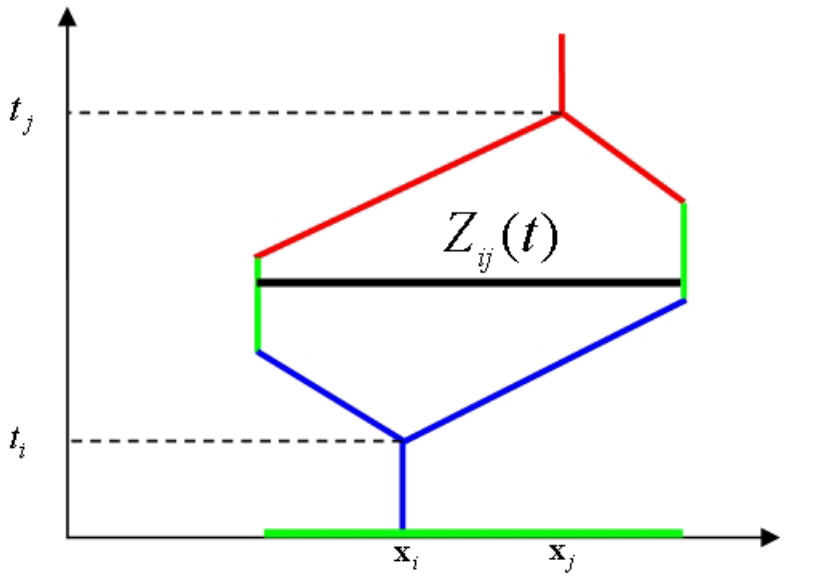
A measurement theory for time geography

- Assumptions
  - Finite measurement instrument
- Space-time path
  - Components
    - Control points - measured in space and time
    - Segments - unobserved paths between control points



A measurement theory for time geography

- Space-time prism
  - Temporally disaggregate prism
    - Prism at time *t*
  - Intersection of compact spatial sets
    - Future disc – possible futures at time *t*
    - Past disc - possible pasts at time *t*
    - Geo-ellipse – activity time constraints



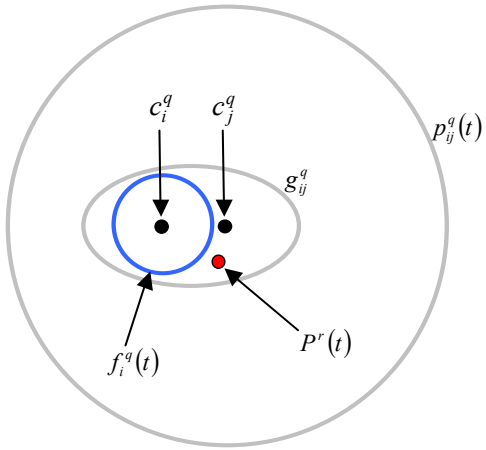
A measurement theory for time geography

- Prism geometry
  - Discs and intersections
  - Simple geometry
  - Easy and efficient to compute in low dimensional space

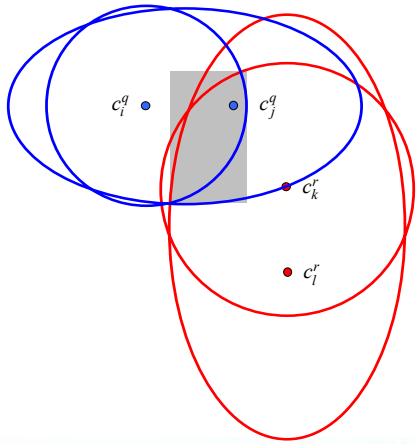
	Disc	Intersection
1D	Line segment	Line segment
2D	Circle	Lens-shaped region
3D	Sphere	Lens-shaped volume

A measurement theory for time geography

- Path-prism intersections
  - Is a path within a prism at time *t*?
  - Point in disc and/or ellipse problem



- Prism-prism intersections
  - Do two prisms intersect at time *t*?
  - Intersection of:
    - Two discs
    - Two discs & ellipse
    - Two discs & two ellipses



Conclusion

- A measurement theory for time geography
  - General analytical framework
    - Supports high-resolution measurement
    - Temporal disaggregation: Simple spatial sets
- Can be extended to virtual interaction
  - New time geographic entities
    - Portals – stations with ICTs
    - Message windows – temporal extents of communication

Future research

- Imperfect measurement
  - Sampling and measurement error
  - Error propagation through paths, prisms, intersections, bundles
- Privacy protection
  - Spatio-temporal masking
    - Extension of locational masking
    - Scott Bridwell (University of Utah)
- Application
  - Transportation, urban, social networks, epidemiology, etc

Bibliography

- Basic measurement theory
  - Harvey J. Miller (2005) "A measurement theory for time geography," Geographical Analysis, 37, 17-45

- Extension to ICTs & virtual interaction
  - Harvey J. Miller (2005) "Necessary space-time conditions for human interaction," Environment and Planning B: Planning and Design, 32, 381-401.

Available at:

www.geog.utah.edu/~hmiller/research.html