

Fundamentals of Spatial Thinking for Learning in the Social Sciences

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- Experiences of CSISS (2000-2007)
- *A Spatial Turn* in the Social Sciences
- Fundamental Concepts
- Enhancing Capacity for Spatial Literacy in Social Science Undergraduate Education



The CSISS Mission recognizes the growing significance of space, spatiality, location, and place in social science research. It seeks to develop unrestricted access to tools and perspectives that will advance the spatial analytic capabilities of researchers throughout the social sciences. CSISS was funded in 1999 with support from the [National Science Foundation](#) under its program to promote research infrastructure in the social and behavioral sciences.

CSISS News

[Gradchild Receiving GIS Lifetime Achievement Award](#)

Core Programs

Learning Resources

Spatial Resources

Spatial Tools

2007 Workshop Programs:



These introductory materials include [CSISS Classics](#) and [select video clips](#) from the CSISS summer workshops.

CSISS has compiled e-journals, bibliographies, and other spatial resources for the social sciences.

Here's where you'll find information about software for the exploration and analysis of spatial data.

Search Engines

CSISS Events

Spatial Literature

About CSISS

Try out one of our custom search engines to find spatial analysis resources on the Internet.

Here's where you'll find information and registration for workshops, conferences and specialist meetings.

Bibliographies and publications related to spatial methods and their use in the social sciences.

CSISS presentations, news, personnel, and sitemap. Our Strategic Plan and Annual Reports are also found here.

Modeling a Center for Spatially Integrated Social Science

Critical Themes in Social Science

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Tools and Concepts for Spatial Thinking

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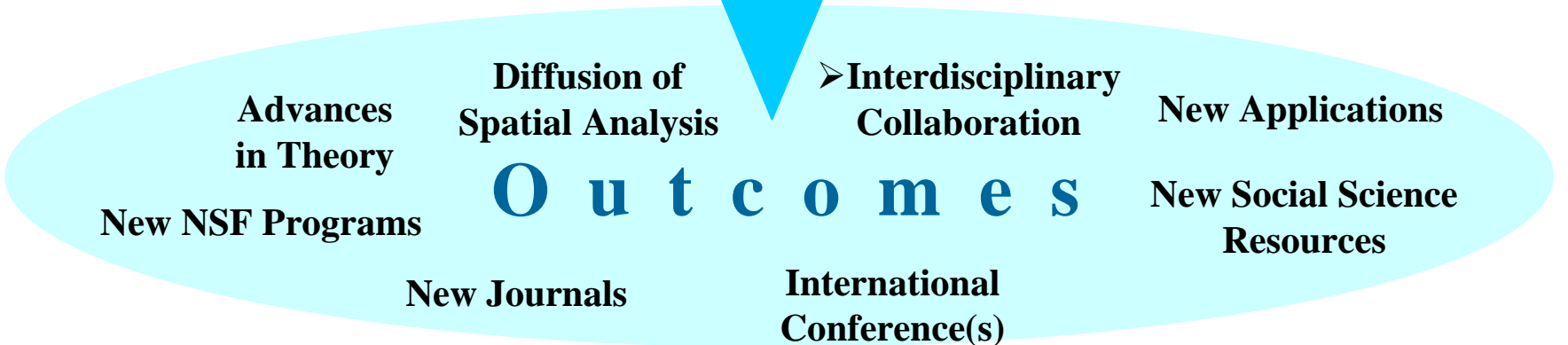
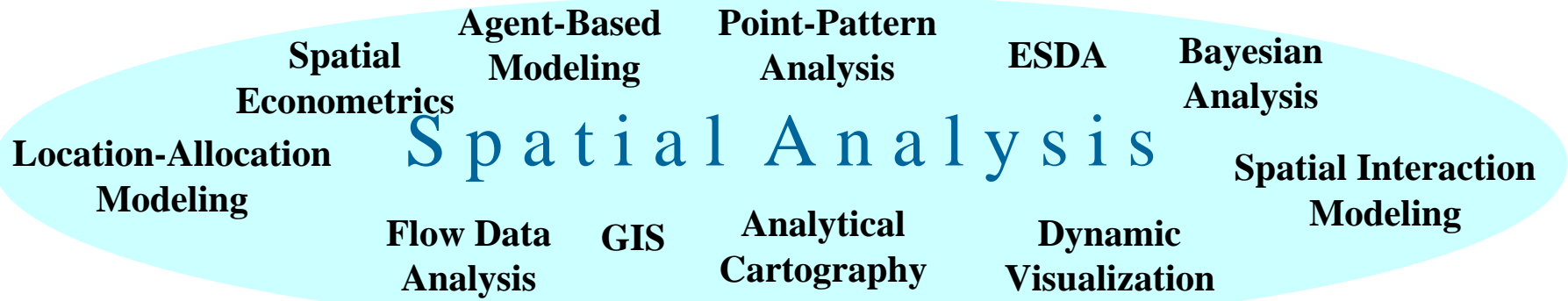
Advances in Spatial Social Science

Some Critical Themes in the Social Sciences:

- **Space-time accessibility**
- **Equity**
- **Externality effects**
- **Risk assessment**
- **Small-area analysis**
- **Sense of place**
- **Cultural analysis**
- **Demographic processes**
- **Health and disease**
- **Crime mapping and law enforcement**
- **Community organization**
- **Governance**
- **Electoral processes**
- **Globalization**
- **International conflict**
- **Coupling human and environmental systems**
- **etc**

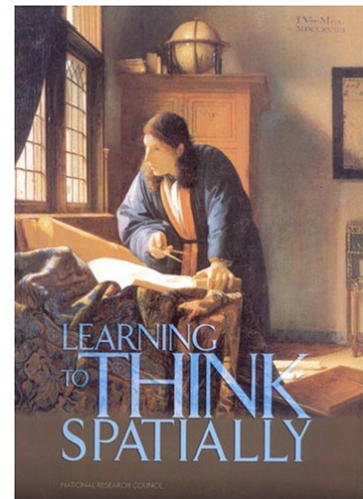
Tools for Spatial Analysis:

- Agent-based spatial modeling
- Point-pattern analysis
- Exploratory spatial data analysis
- Bayesian analysis
- Spatial interaction modeling
- Dynamic visualization
- Flow-data analysis
- Analytical cartography
- Spatial econometrics
- Location-allocation modeling
- GIS
- Remote sensing
- etc.



Interest in Spatial Perspectives

- NSF Science of Learning Center at Temple / Chicago / Northwestern
- New initiatives at Harvard, Brown, Stanford
- A “spatial turn” in the social sciences
- The New Economic Geography
- Spatial technologies
 - Google Earth, Google Maps, Microsoft Virtual Earth
 - geotagging in Wikimapia, Flickr, ...
 - GIS, remote sensing, GPS
- Visualization, geovisualization
- NRC report *Learning to Think Spatially*



A *Spatial Turn* in the Social Sciences

- Adding space to social science theory
 - the *New Economic Geography*
 - space impeding flows of information, operation of markets
 - transport costs
- Reasoning from spatial data
 - cross-sectional
 - new tools to overcome methodological problems
 - impacts in all social & environmental disciplines

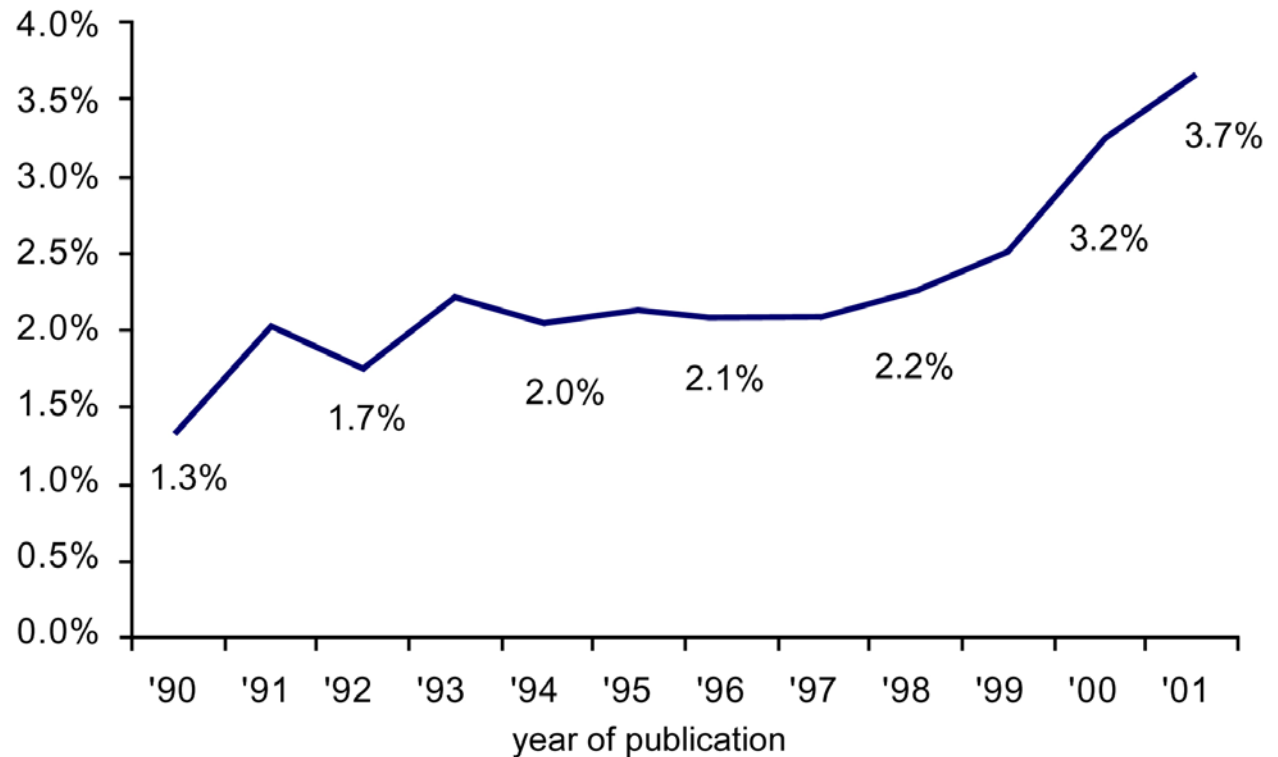
Building on the Numbers

- UCGIS member institutions – training and dissemination on their own campuses
- Growth in scientific literature using spatial perspectives
- CSISS/SPACE/GISPopSci summer workshops (since 2000)
- GeoDa (CSISS / Anselin) >20,000 downloads (May 2007)
- CSISS-supported “Spatial” sessions at academic meetings
 - Social Science History Association
 - American Sociological Association
 - American Political Science Association
 - American Agricultural Economics Association
 - American Anthropological Association
 - American Archaeological Society
 - American Criminological Society
 - Rural Sociology Society
 - American Population Association
- Need for documentation of the trends in literature, software adoption, and conference presence of spatial analysis across the sciences

A Growing Literature

Spatially Integrated Social Science (Goodchild and Janelle, OUP, 2004)

Percentage of Social Science Articles with Spatial Analytic Themes 1990-2001



**CSISS Residential Workshops
GIS and Spatial Analysis (2000 – 2007)**

Includes:

Eighteen 5-day **CSISS** workshops
2000 – 2005

Eleven 6-day **SPACE** workshops
(with UCGIS and Ohio State Univ)
2004 – 2007

Four 12-day **GISPopSci** workshops
(with Penn State Univ, Population
Research Institute)
2005 – 2006

	Attended	Applied
Anthropology / Archaeology	59	123
Criminology	21	45
Demography, Population & Health	98	227
Economics	63	192
Environmental Studies	18	33
Epidemiology	11	27
GIS	30	75
History	7	10
Human Geography	123	422
Political Science	55	95
Public Policy	17	80
Regional Science	5	6
Sociology	115	200
Statistics	9	22
Urban Studies & Urban Planning	44	133
Other	31	99
Totals:	706	1789

Identifying Foundation Concepts for Spatial Thinking

- Drawing on Nystuen, Golledge, Cutter et al, de Smith et al, Gersmehl, *GIS&T BoK*, etc.
- Demonstrable at all levels of space & time
- Applicable to all of science
- Expandable from simple illustrations to advanced thought processes relating to scientific and social problems

Eight Foundation Concepts in Spatial Thinking for STEM Disciplines

1 Location	Places abstracted as points, lines, and areas, and represented as points, polylines, and polygons. Rasters and grid cells. Mathematical approximations to the geoid, map projections, coordinate systems. Measurement and tracking of location: GPS. Location in human discourse: place names, prepositions, and movement verbs. Positional accuracy. The characteristics or attributes of places: scales of measurement. Concepts of land ownership in different cultures, administrative hierarchies, postcodes, linear referencing.
2 Distance	Metrics of distance on the plane and globe. Travel cost, travel time, and impacts on interaction and spatial behavior by humans and other organisms. Distance decay and spatial interaction models. Buffers. Weights matrices and their applications in spatial analysis and modeling. Geodesics, potential fields, and optimum paths.
3 Network	Linear networks for transportation, communication, and social interaction. Network metrics. Models of network development and design. Small worlds and degrees of separation. Representation of networks in spatial databases. Models of network flow assignment.
4 Neighborhood and Region	Definitions of neighborhood based on human spatial behavior. Formal and functional regions and concepts of territory. Models of region design and political districting. The modifiable areal unit problem and the ecological fallacy. Techniques of areal interpolation. Metrics of fragmentation and shape.

5 Scale	Level of detail in spatial data sets. Definitions of scale: extent and resolution. Scale-related concepts: self-similarity (fractals), generalization and down-scaling, line and surface smoothing, recursive subdivision, variance decomposition, and multi-level analysis. The role of scale in process.
6 Spatial Heterogeneity	Heterogeneity as a fundamental characteristic of spatial data. First-order effects, non-stationarity, and uncontrolled variance. Implications of spatial heterogeneity for sampling and statistical inference. Place-based analysis, local indicators of spatial association, and geographically weighted regression.
7 Spatial Dependence	Metrics of spatial dependence: Moran and Geary indices. Getis and Ord G statistic. Geostatistics as a theoretical framework for spatial data. Spatial interpolation. Statistical inference in the presence of spatial dependence; explicit models of spatial dependence. Analysis of point patterns and cluster detection. The role of spatial dependence in uncertainty.
8 Objects and Fields	Discrete objects and continuous fields as fundamental conceptualizations of space and as the basis for models of process. The dichotomy as an underpinning of methods of representation and analysis. Spatial correlation. Concepts of uncertainty in both conceptualizations.

Linking Foundation Concepts of Spatial Thinking to the Theories and Themes of the Social Sciences

- Concentrated disadvantage
- Social inequality
- Uneven development
- Externalities
- Neighborhood
- Community
- Social networks
- Social capital
- Collective efficacy
- Trust
- Power
- Service optimization

Building Foundations for Spatial Thinking in the Social Sciences

Lessons from CSISS

- Recognize social science theoretic and thematic perspectives
- Emphasize added value of spatial thinking to social science theory and problem solving, re:
 - integration of information / disciplines
 - inference from form to process
 - organizing and retrieving information
 - links to policy
- Recognize social scientists as leaders of spatial thinking in their fields
- Encourage support networks/mentors
- Emphasize ways of integrating and assessing time-space views of data and patterns

Conclusions

- The relevance of spatial perspective in science generally is increasingly appreciated across disciplines – providing grounds for curriculum change
- A growing level of expertise exists across disciplines on most campuses – allies and potential leaders in curriculum change (need for documentation)
- The ***necessary conditions*** to imbue science education with the powerful insights of the spatial perspective and visualization are now in place

Challenges

- Leadership (shared across the campus) is needed to position spatial thinking as important (essential) to scientific understanding and to sound public policies
- Support resources need to be assembled, organized, and made easily accessible:
 - Course units, exercises, instruments for learning assessment, etc.
- GI Science tools may need enhancement to meet the needs of social sciences (and sciences generally):
 - technologies for space-time integration of data resources for analysis and display (e.g., handling longitudinal analyses)
 - capabilities in analysis that match the capabilities of agent-based spatial modeling and micro-simulation to display space-time processes