A Different Kind of Map

Integrating Document Content Representation, Cartographic Design, and GIS toward Knowledge Domain Visualization

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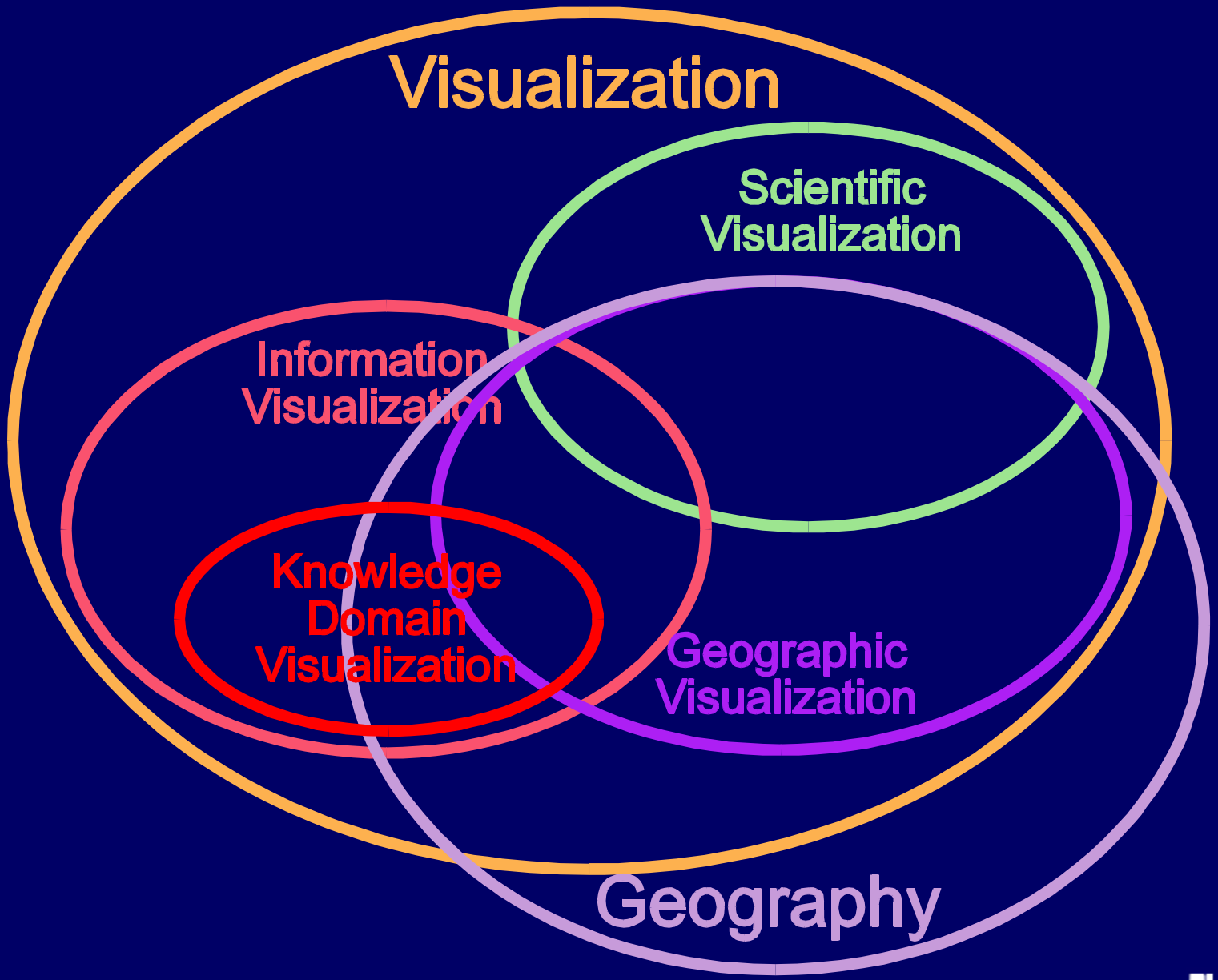
A Different Kind of Map - Overview

- *Knowledge Domain Visualization*
  - Why? Who? How?
- Cartographic/Geographic/GIScience Perspectives on:
  - Metaphors
    - map, landscape
  - Technology
    - GIS
  - Methods
    - *objects* vs. *fields*
    - visualizing *change*
  - Challenges
    - computation
    - cognition

Knowledge Domain Visualization (KDV)



KDV – Overview

- Why?
  - understand knowledge domains in terms of:
    - Past **à** how *did* this research area develop?
    - Present **à** who *are* the leading researchers and topics?
    - Future **à** what *will* have high priority for federal funding?
- Who are the users?
  - non-specialists:
    - teaching tool
  - specialists:
    - find trends, emerging topics, potential collaborators
  - b/w specialists from different domains:
    - enable communication about knowledge domains
  - funding agencies
    - research impact analysis

KDV – Overview

- How?
  - methodologies depend on source data
    - structure-based data
      - citation networks
      - co-author networks
      - hypermedia networks
    - content-based data
      - vector-space model
  - dimensionality reduction and spatial layout techniques
    - multidimensional scaling (MDS)
    - self-organizing maps (SOM)
    - pathfinder networks (PFN)
    - spring models
    - tree maps
  - map metaphors VERY popular

KDV – Overview

- How do I approach this?
  - Methodologies depend on source data
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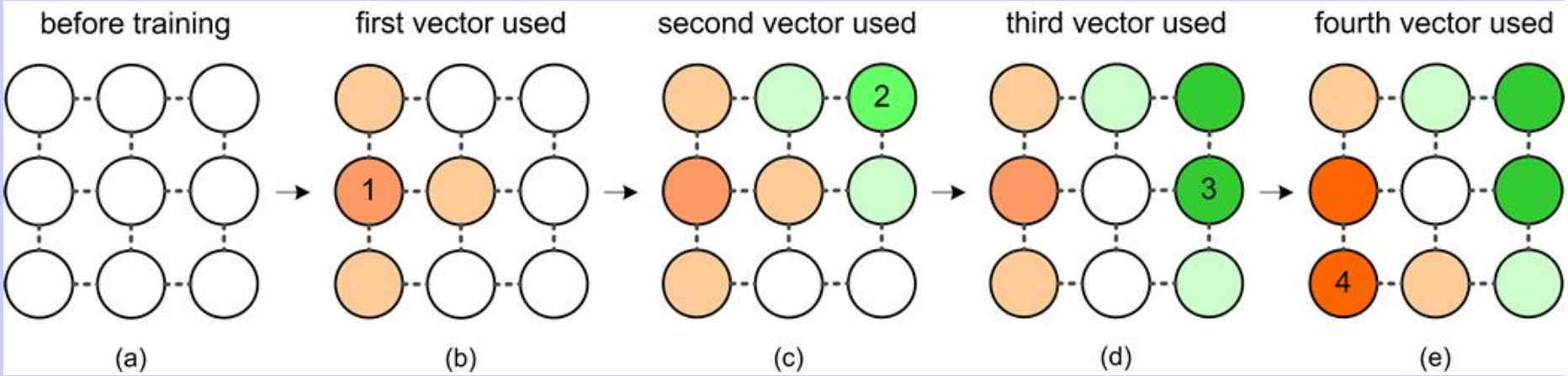
Self-Organizing Map (SOM) = Kohonen Map

- artificial neural network
  - 2D lattice of neurons
  - topology-preservation
  - training with n-dimensional data
    - e.g., census statistics; financial data; text documents



Cartographic and Geographic Perspectives

- Metaphors
  - proximity ß à similarity ("1st Law of Geography")
  - landscape
    - natural (mountain, valley, ridge, …)
    - man-made (city, village, road, …)
  - scale
    - global – regional – local (overlapping)
    - country – state – county – municipality (non-overlapping)
  - map
    - look-and-feel
    - multi-scale
    - axis definition
    - interaction

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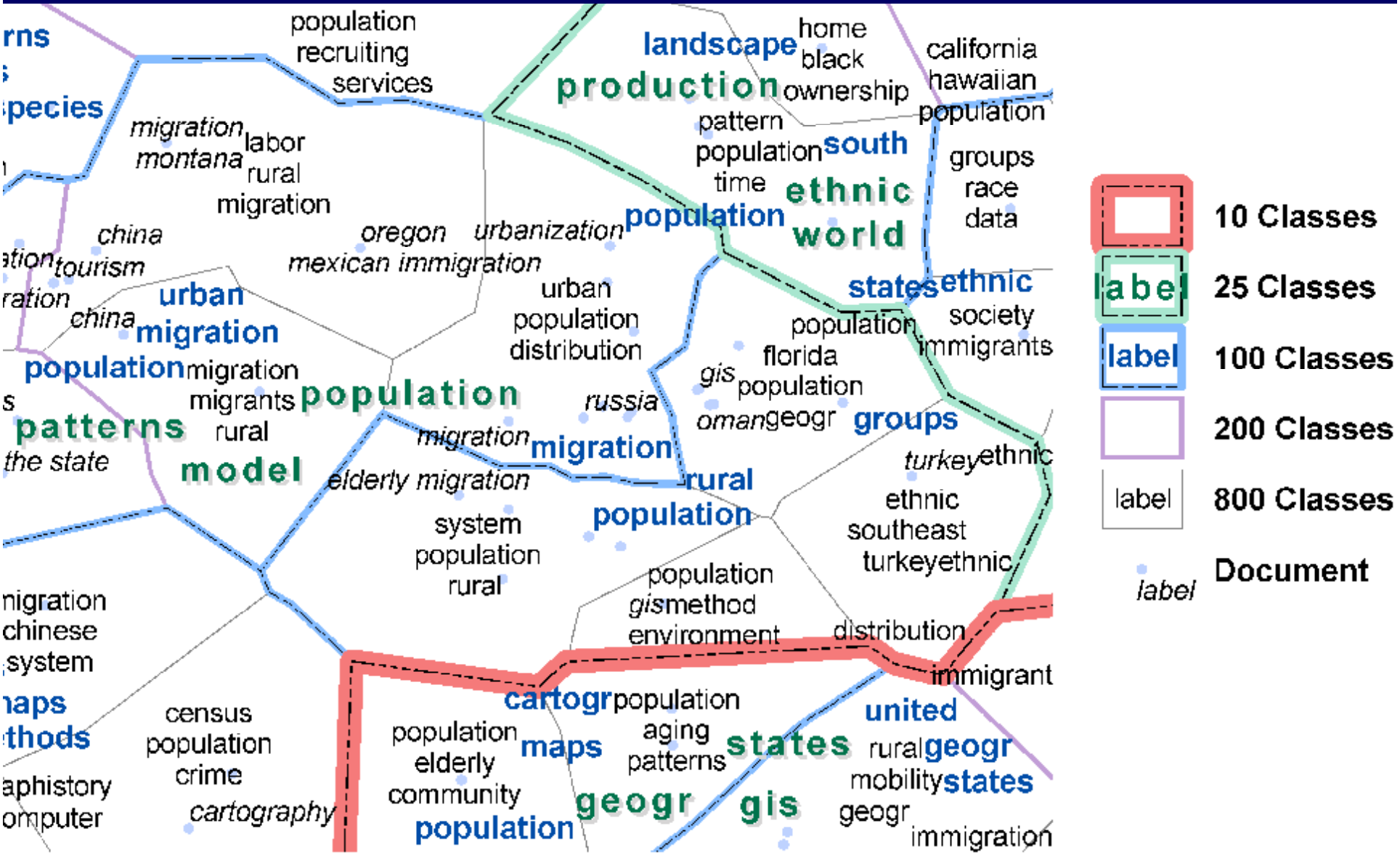
Multiple granularities à Simultaneous display



country – state – county – municipality

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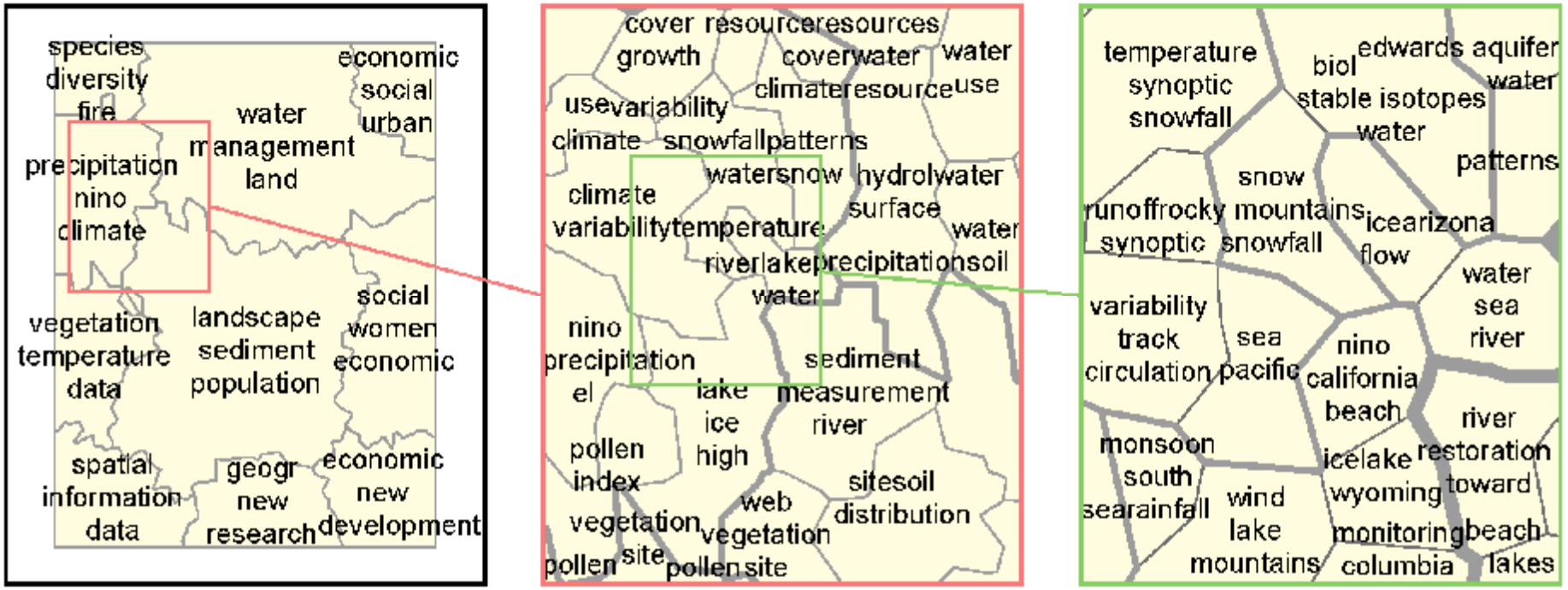
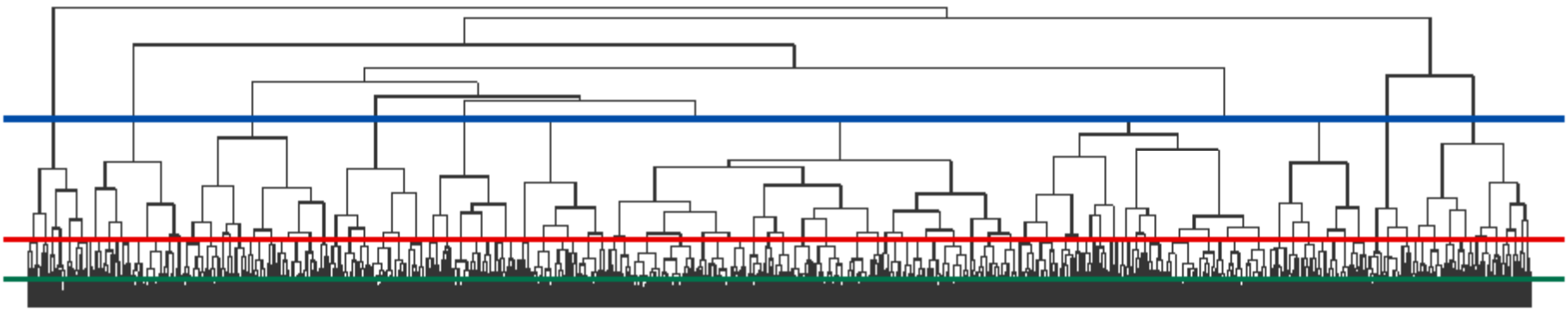
Multiple granularities **à** Semantic zooming





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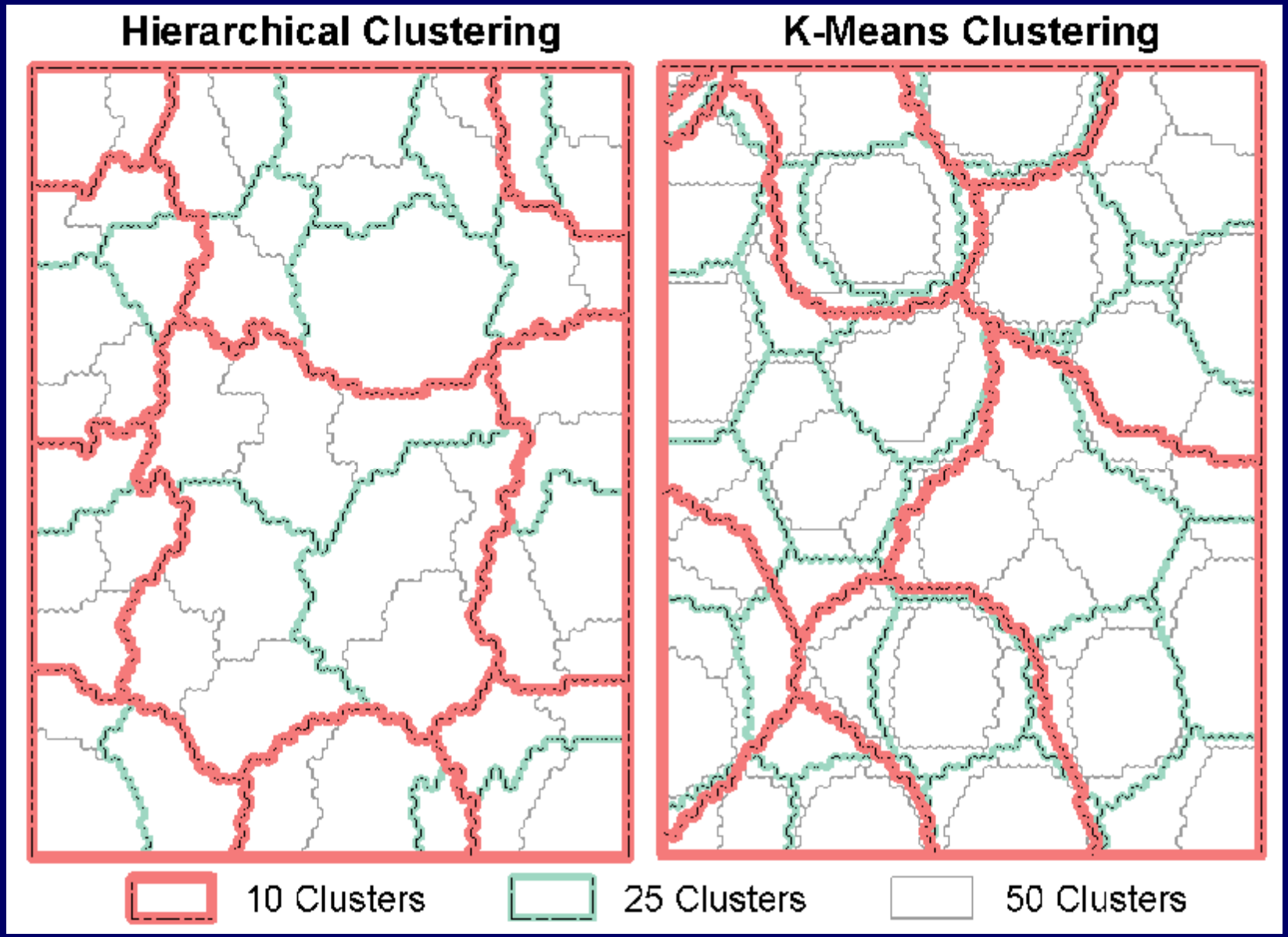
Cartographic and Geographic Perspectives



Hierarchies with/without overlapping levels

Cartographic and Geographic Perspectives

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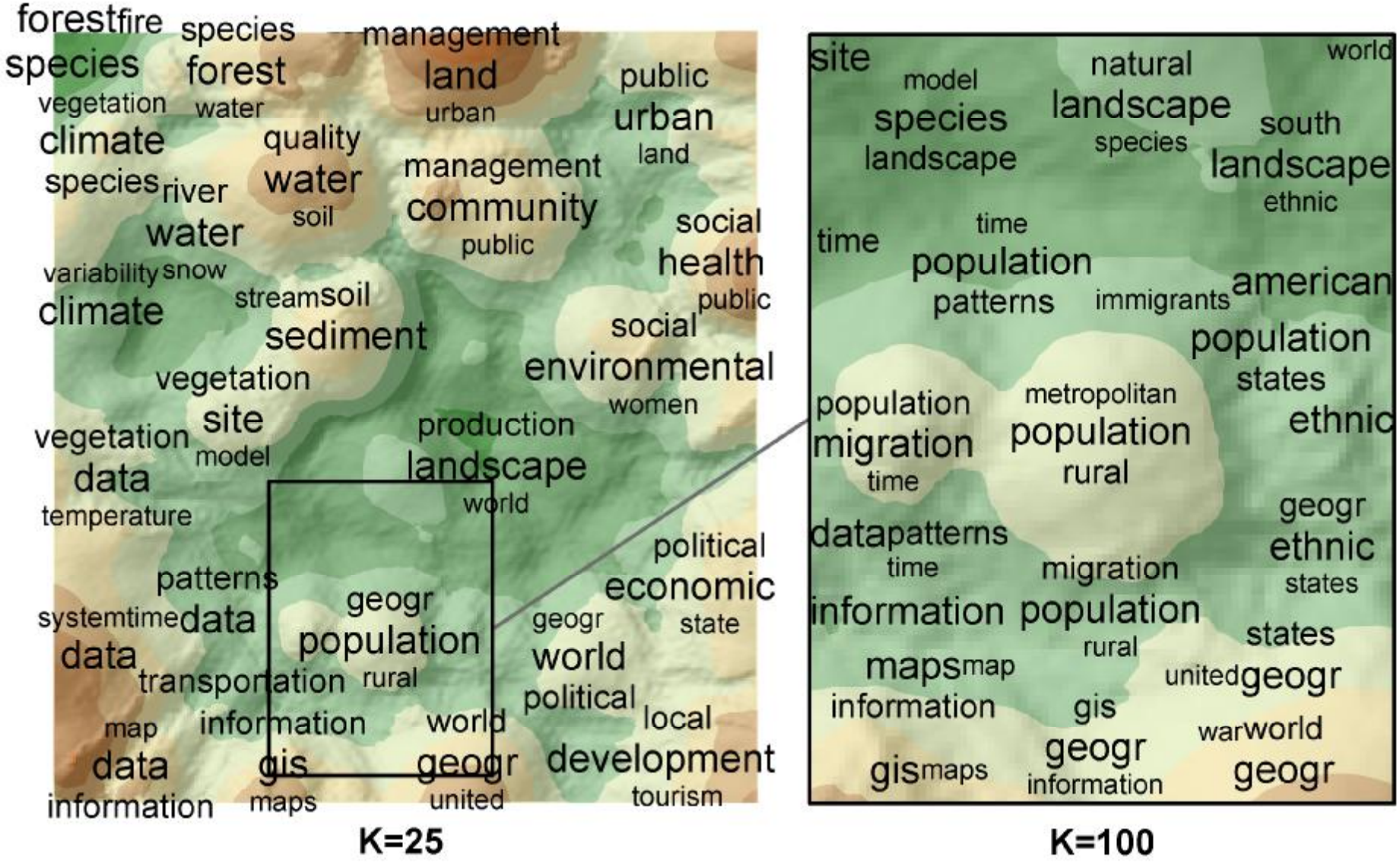
Multiple granularities à Semantic zooming



global – regional – local

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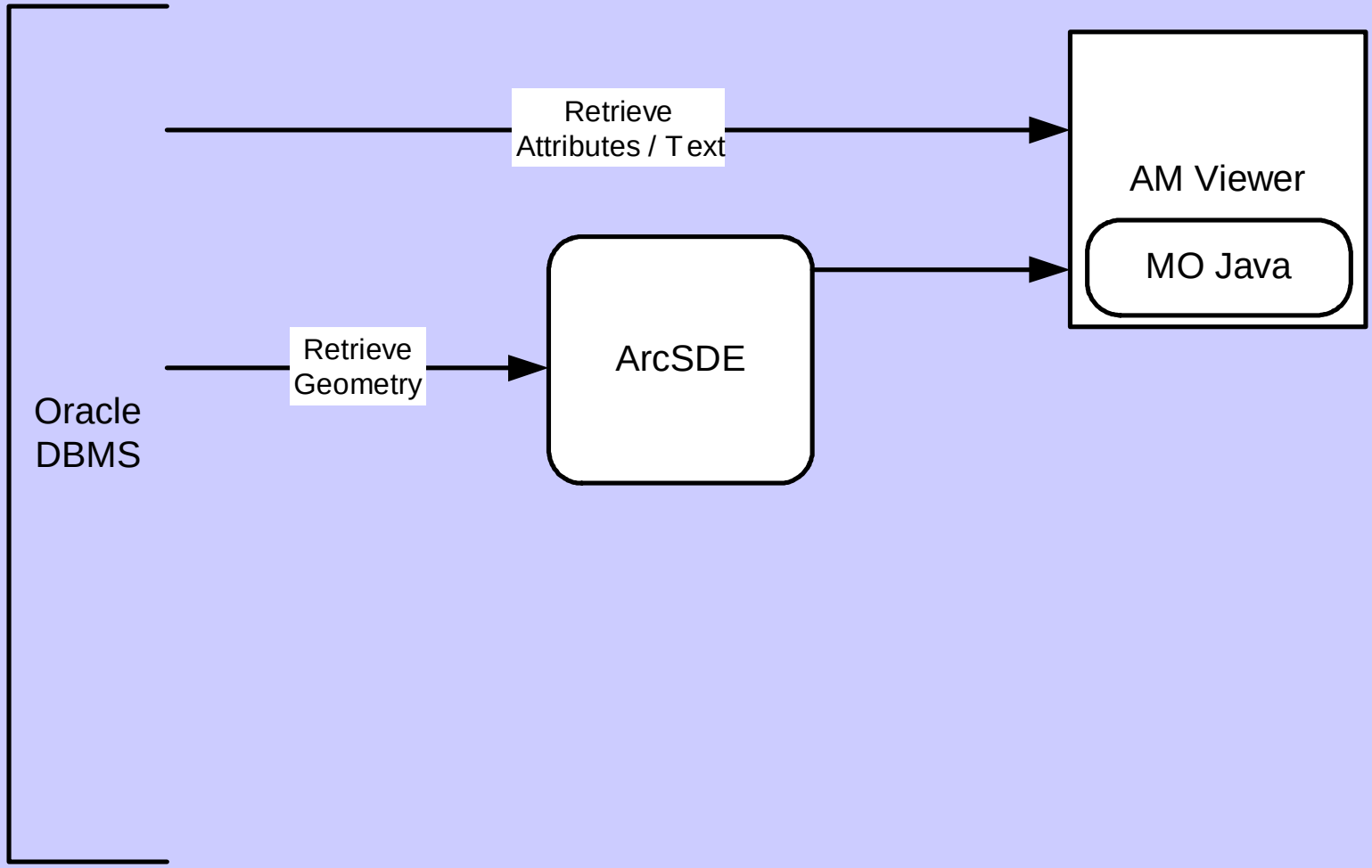
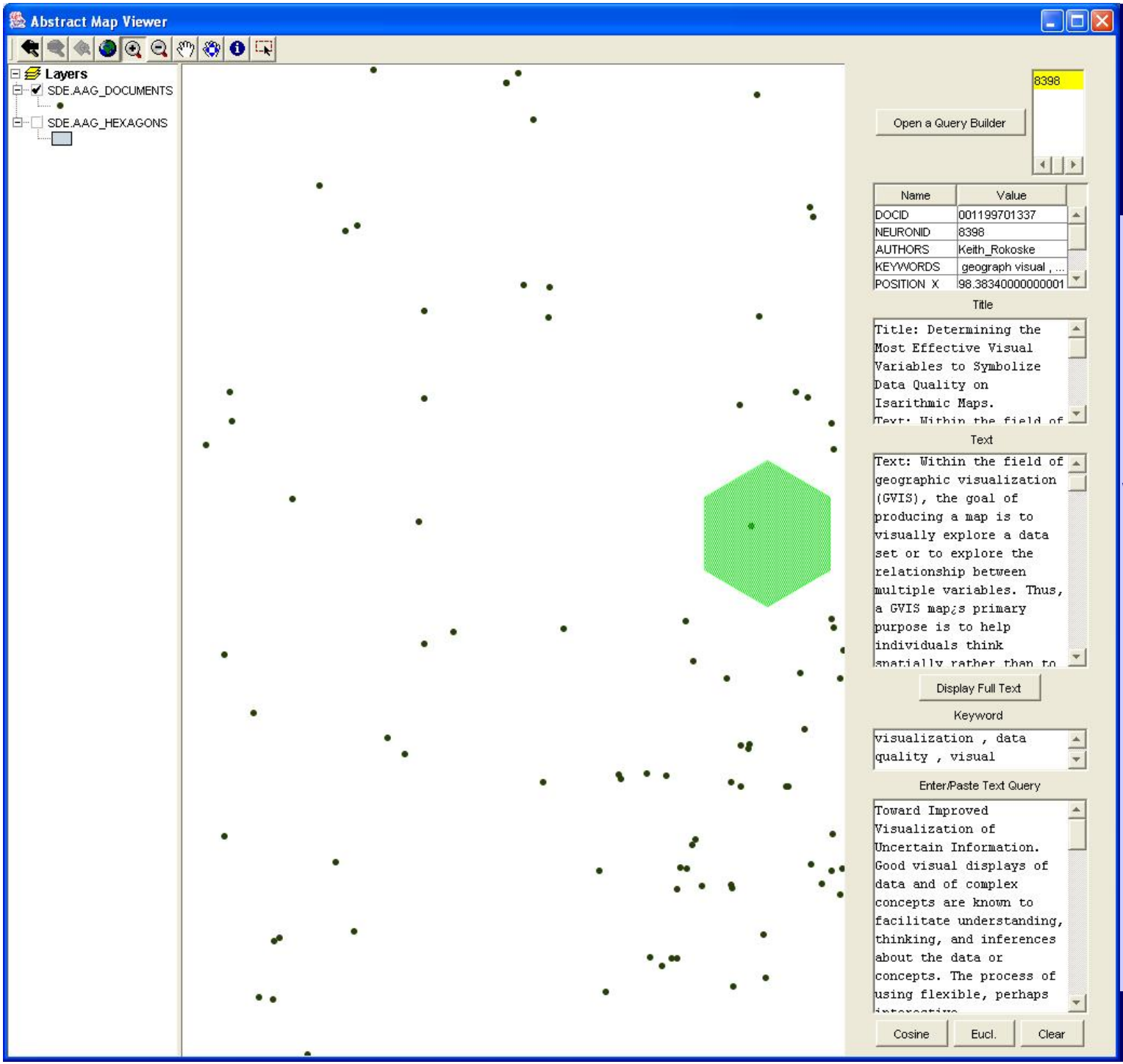
AbstractMap: AM Viewer





AM Viewer

Training Specs:

25,000 documents

10,000 neurons

Query:

workshop abstract

Response:

(1) best-matching unit

(2) documents at BMU

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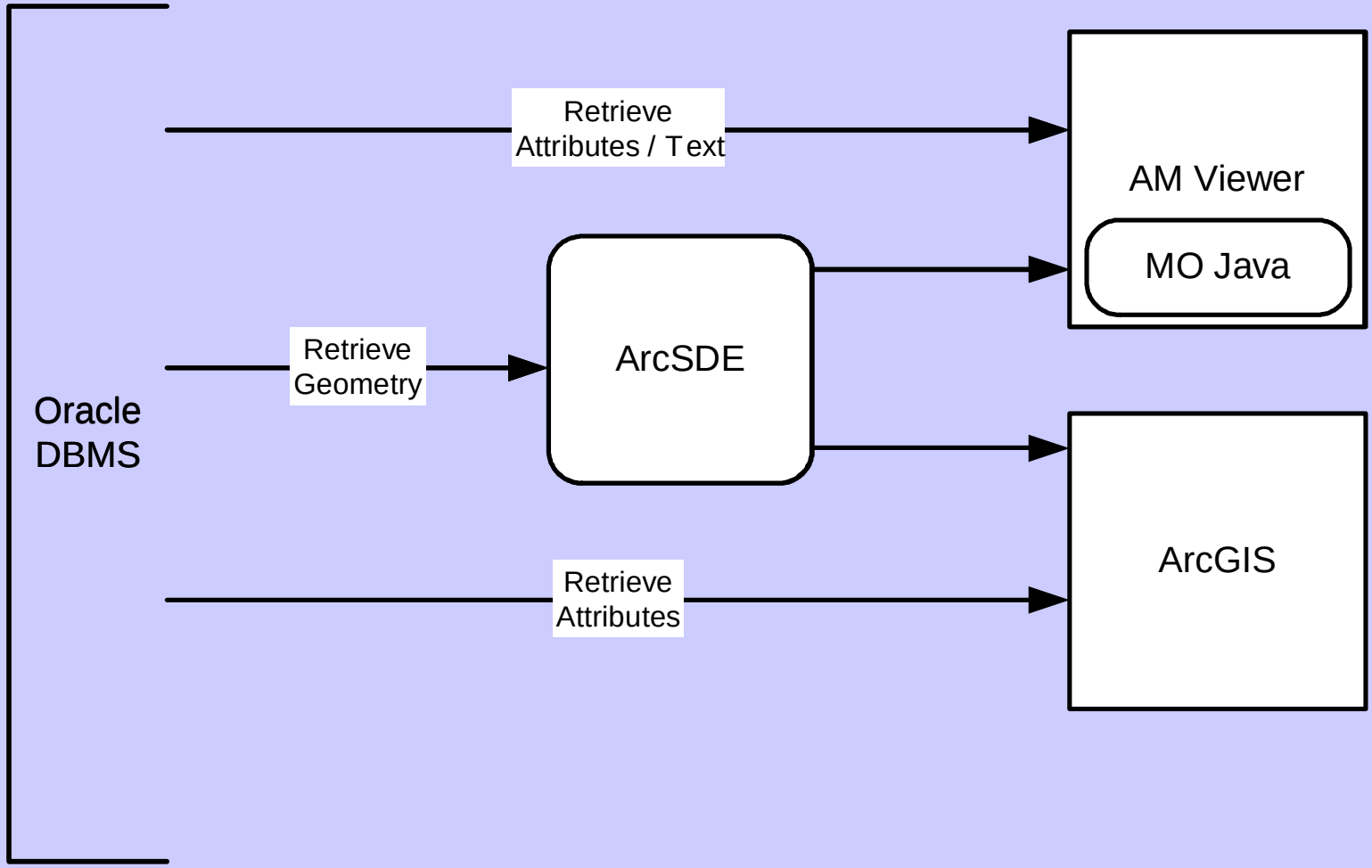
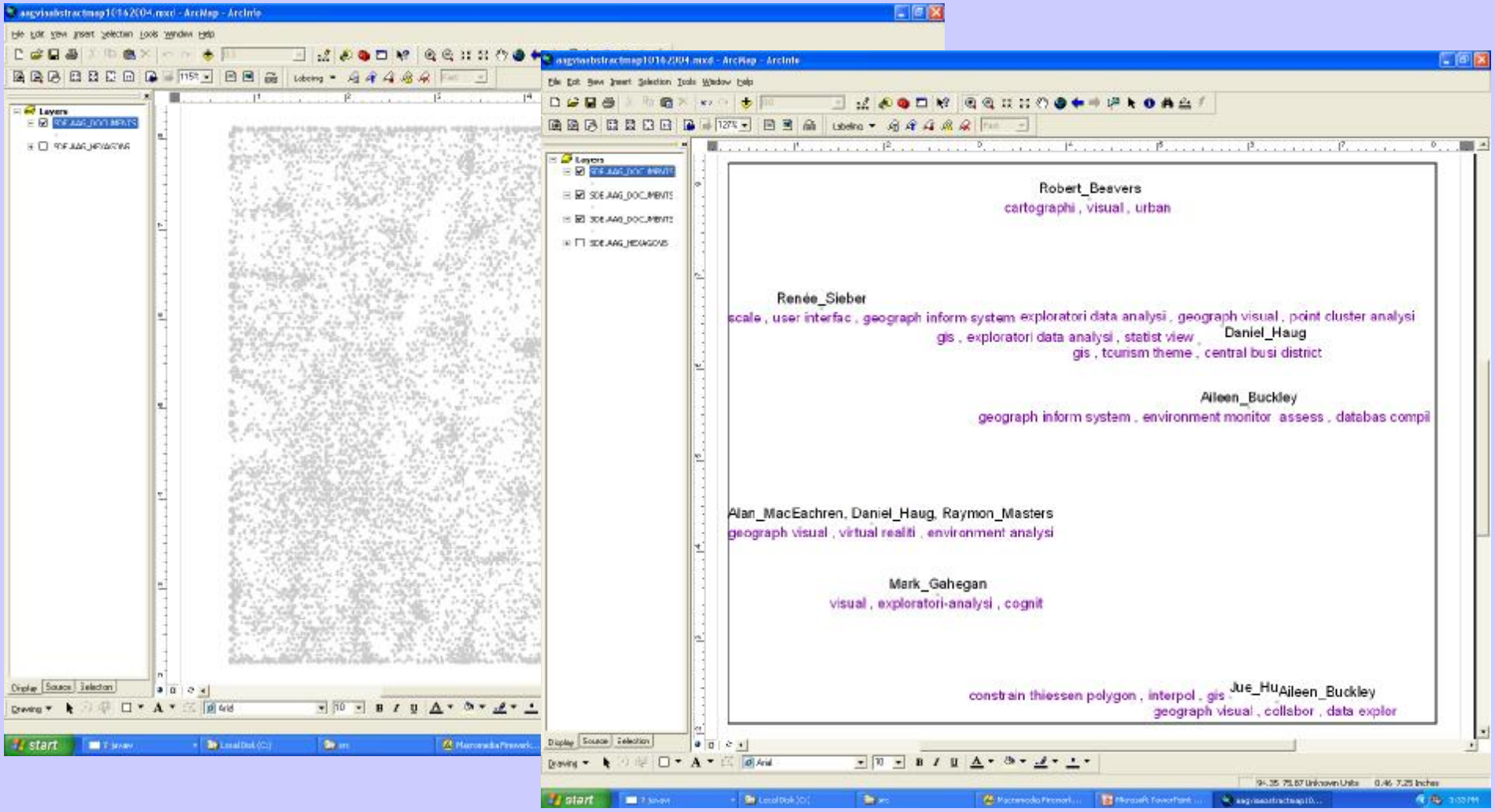
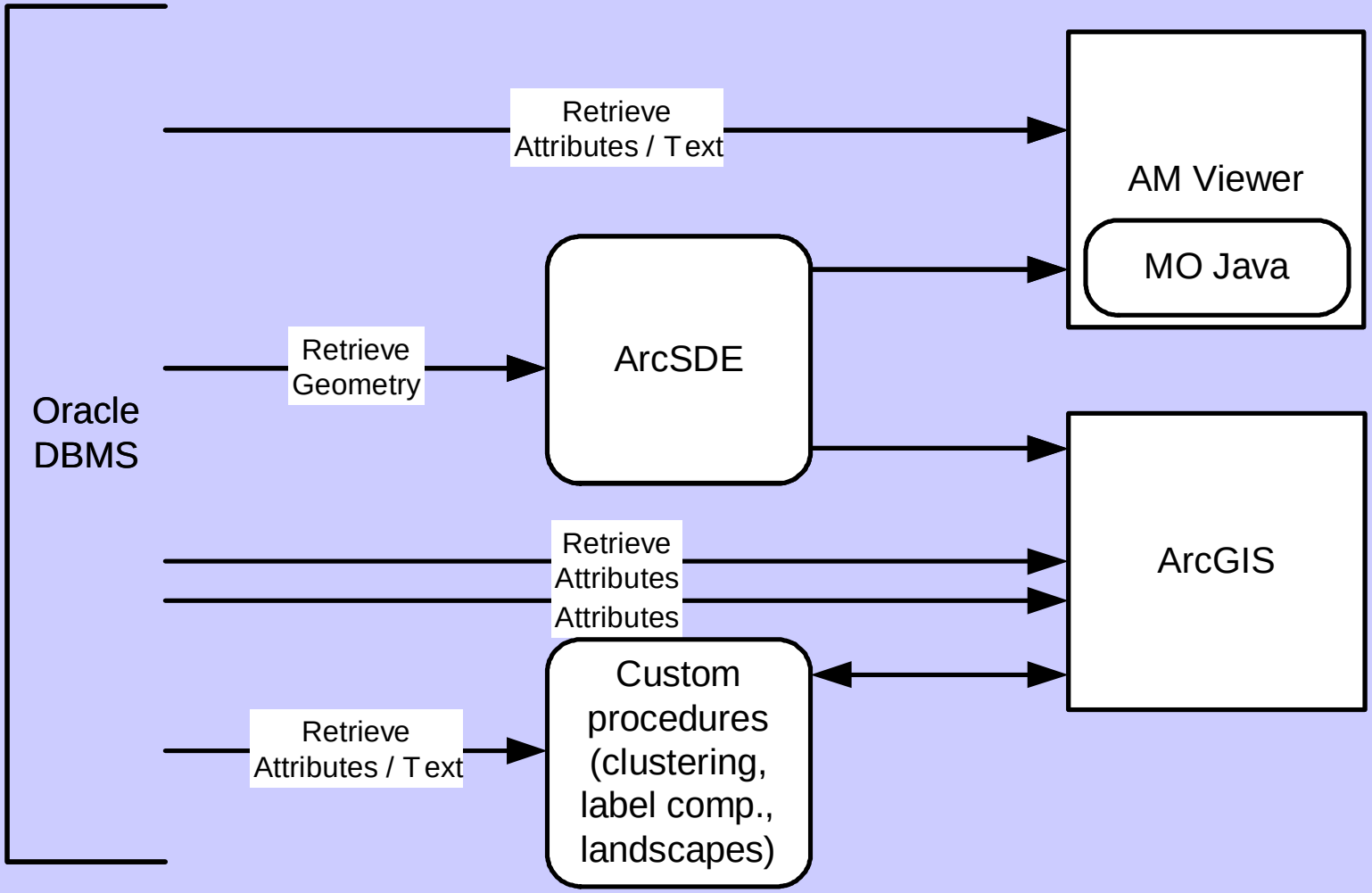
AbstractMap: Alternative Access

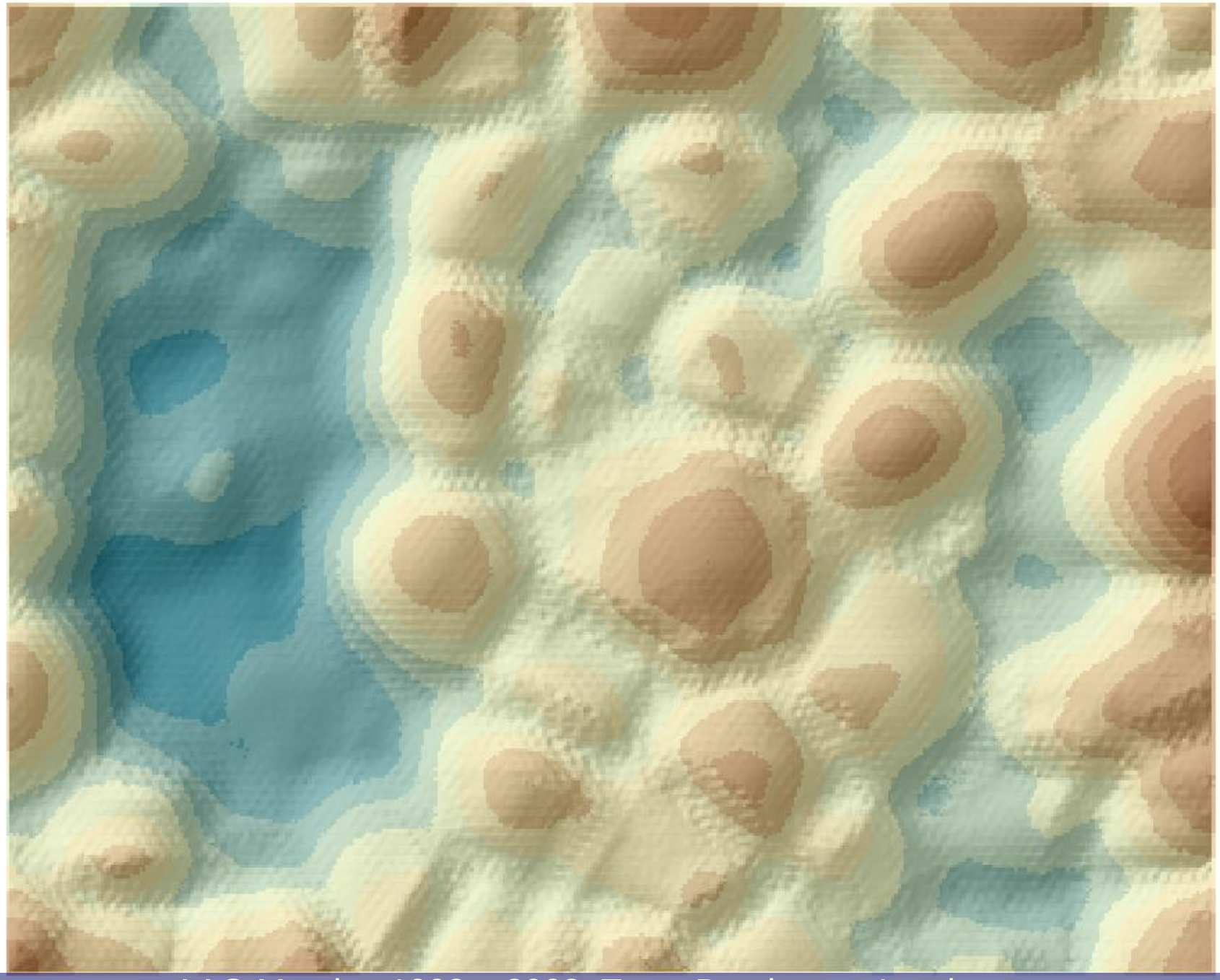


ArcGIS: AAG Meetings 1993-2002

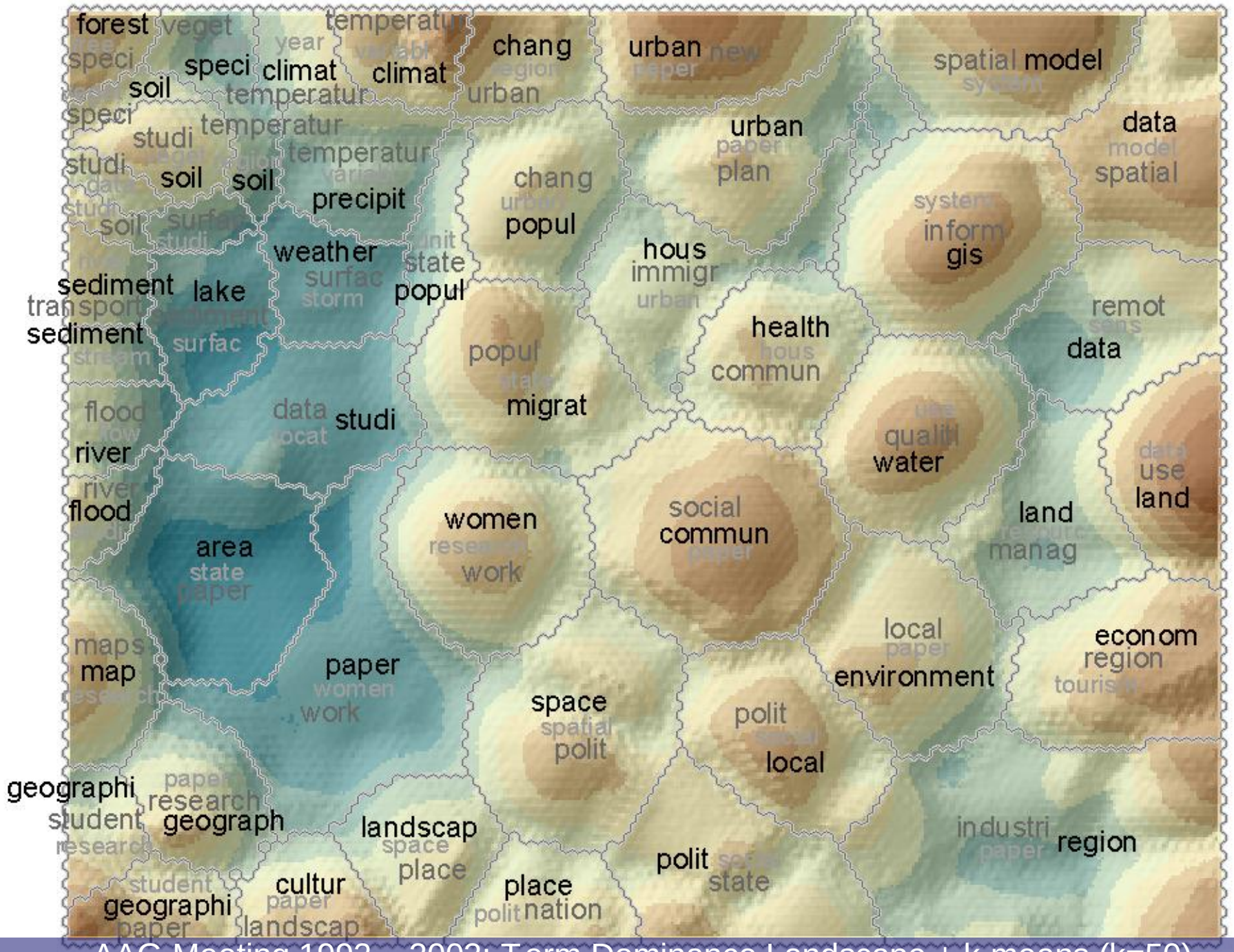


AbstractMap: Alternative Access

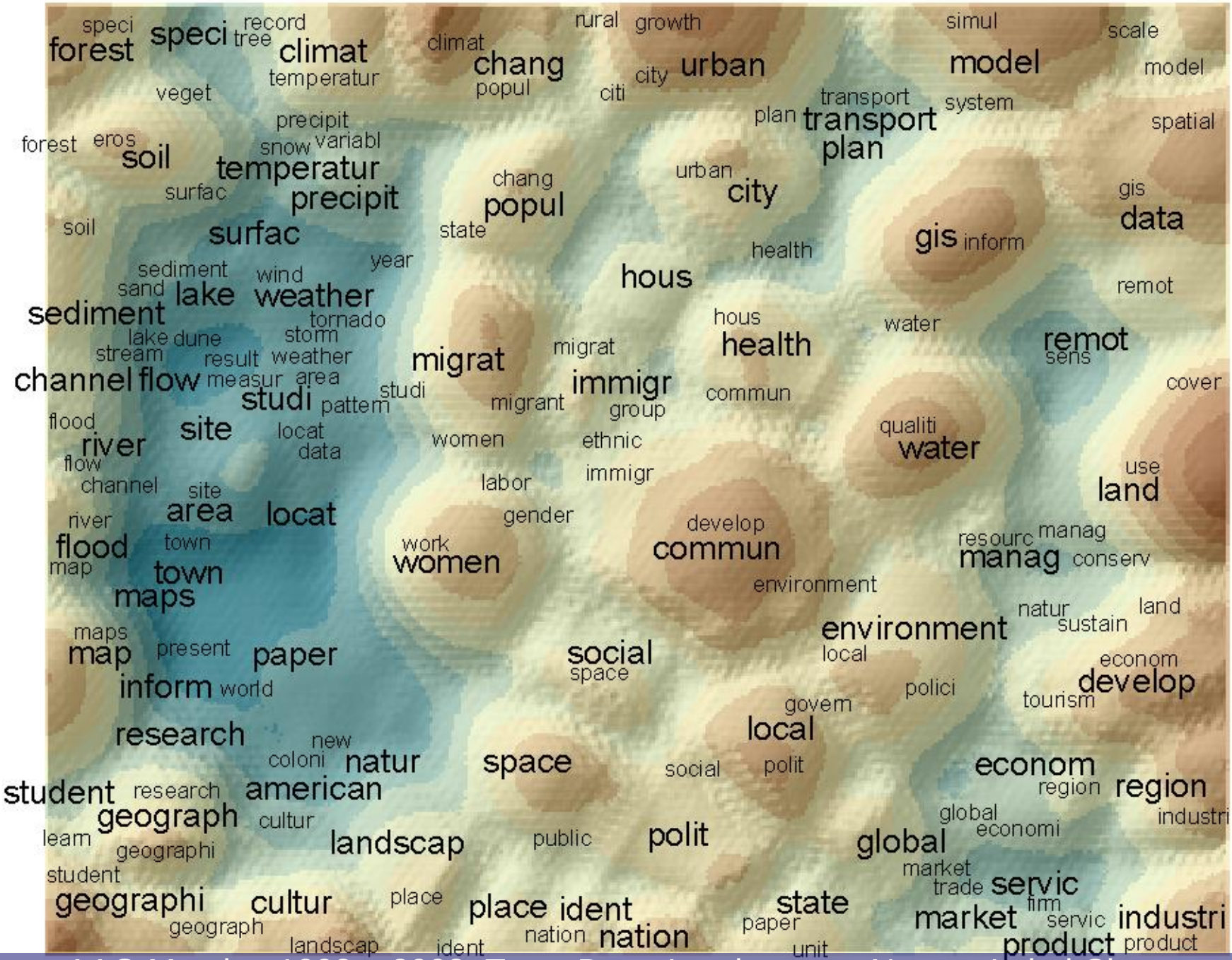




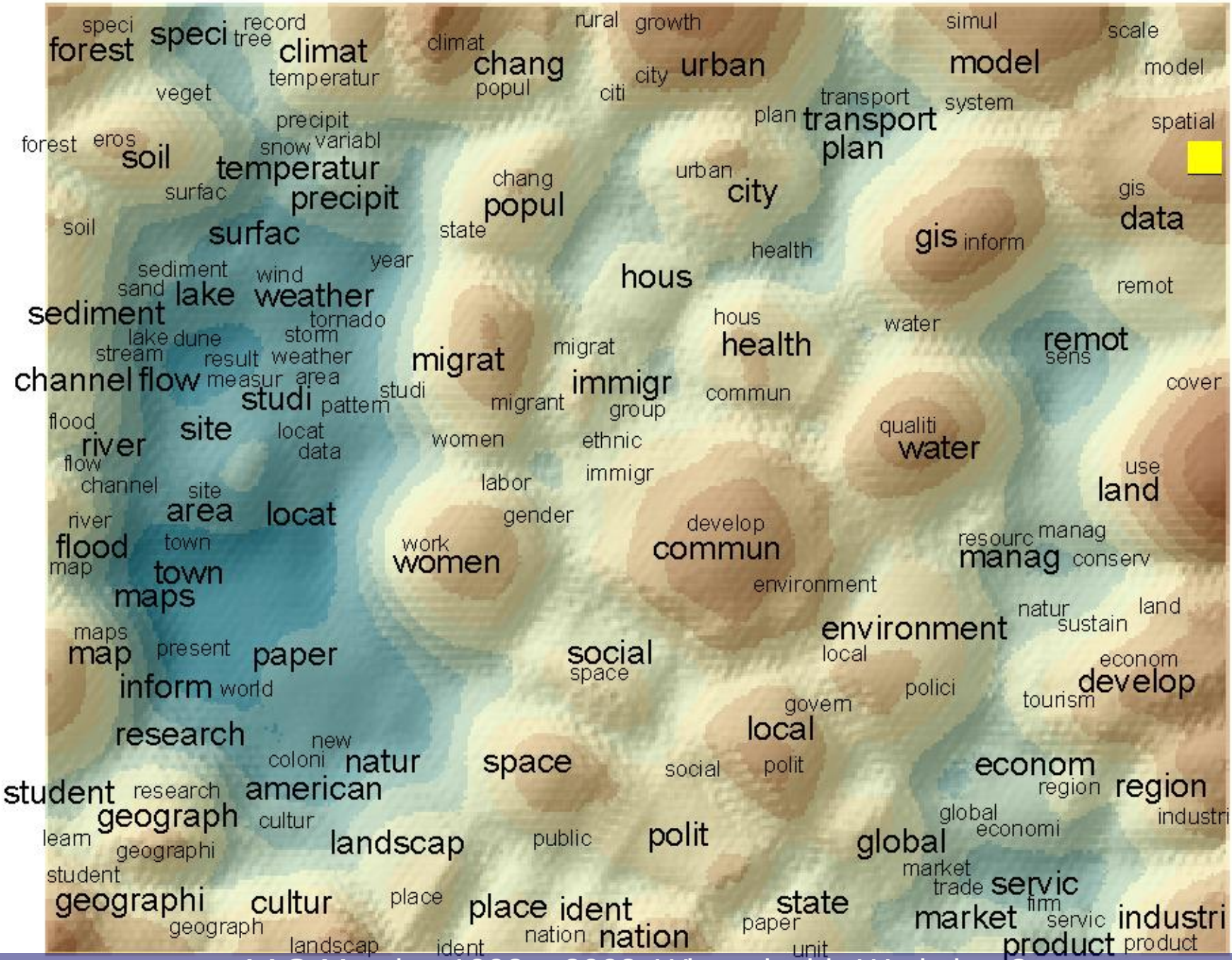
AAG Meeting 1992 – 2003: Term Dominance Landscape



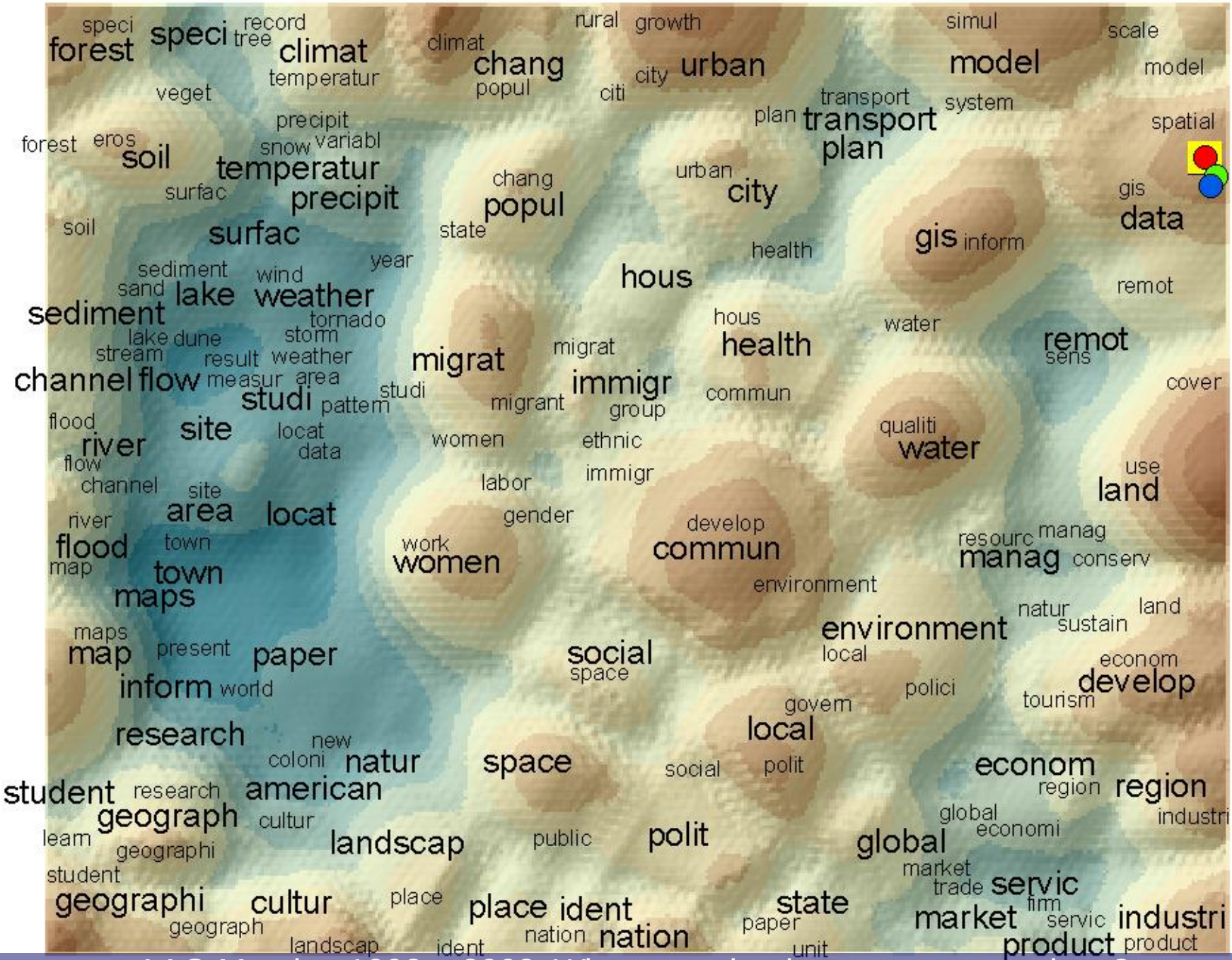
AAG Meeting 1992 – 2003: Term Dominance Landscape + k-means (k=50)



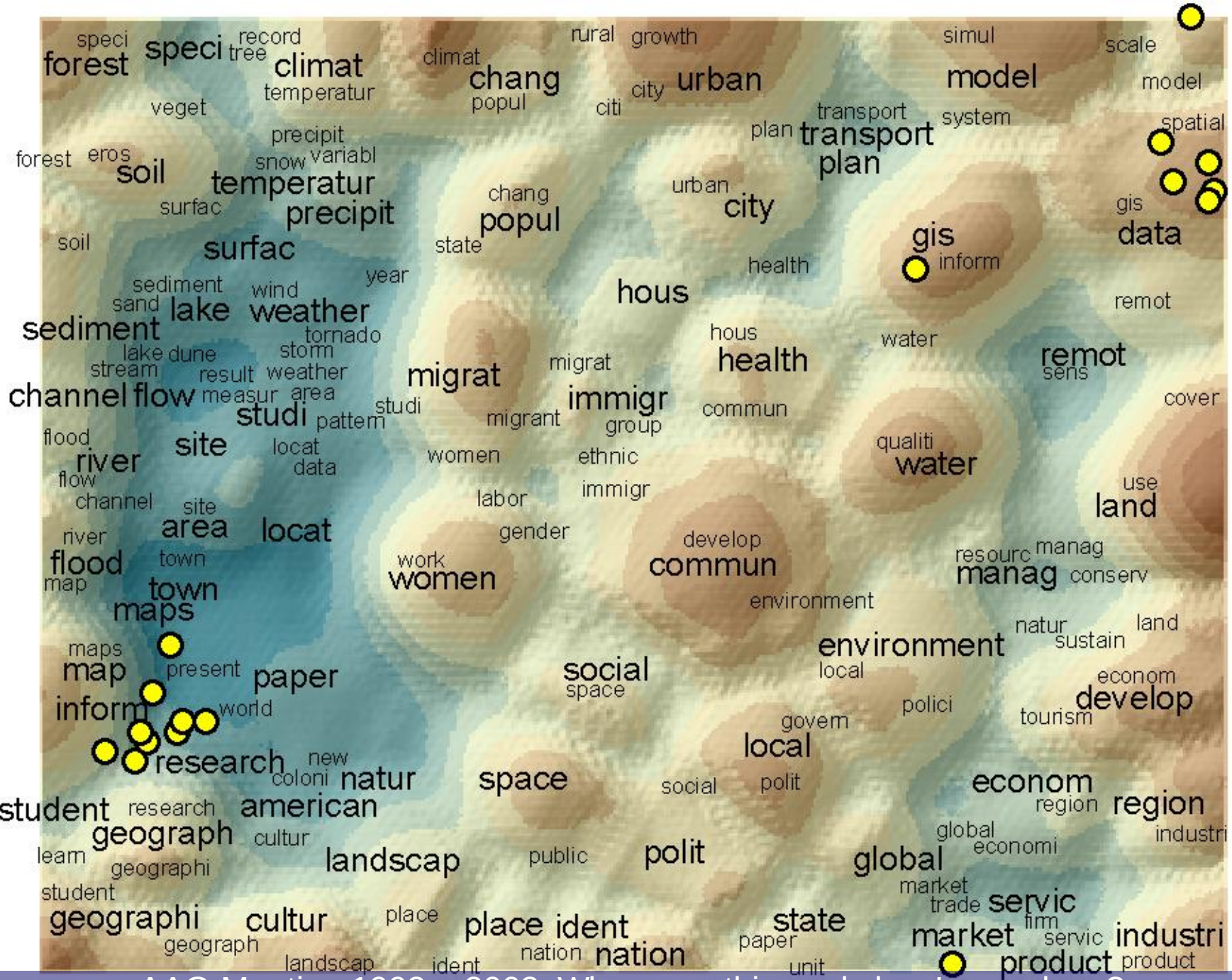
AAG Meeting 1992 – 2003: Term Dom. Landscape + Neuron Label Clusters



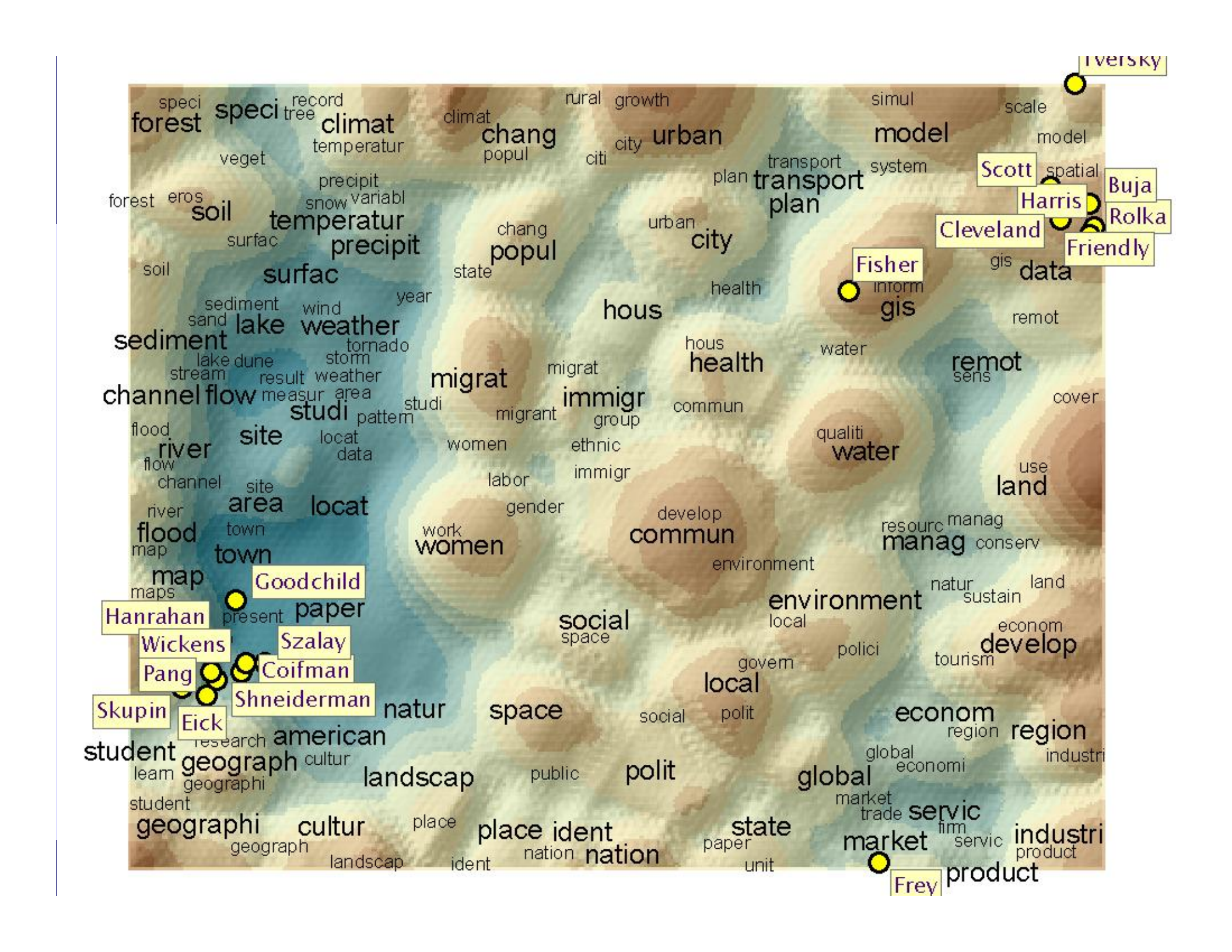
AAG Meeting 1992 – 2003: Where is this Workshop?



AAG Meeting 1992 – 2003: Where are the three context sessions?



AAG Meeting 1992 – 2003: Where are this workshop's speakers?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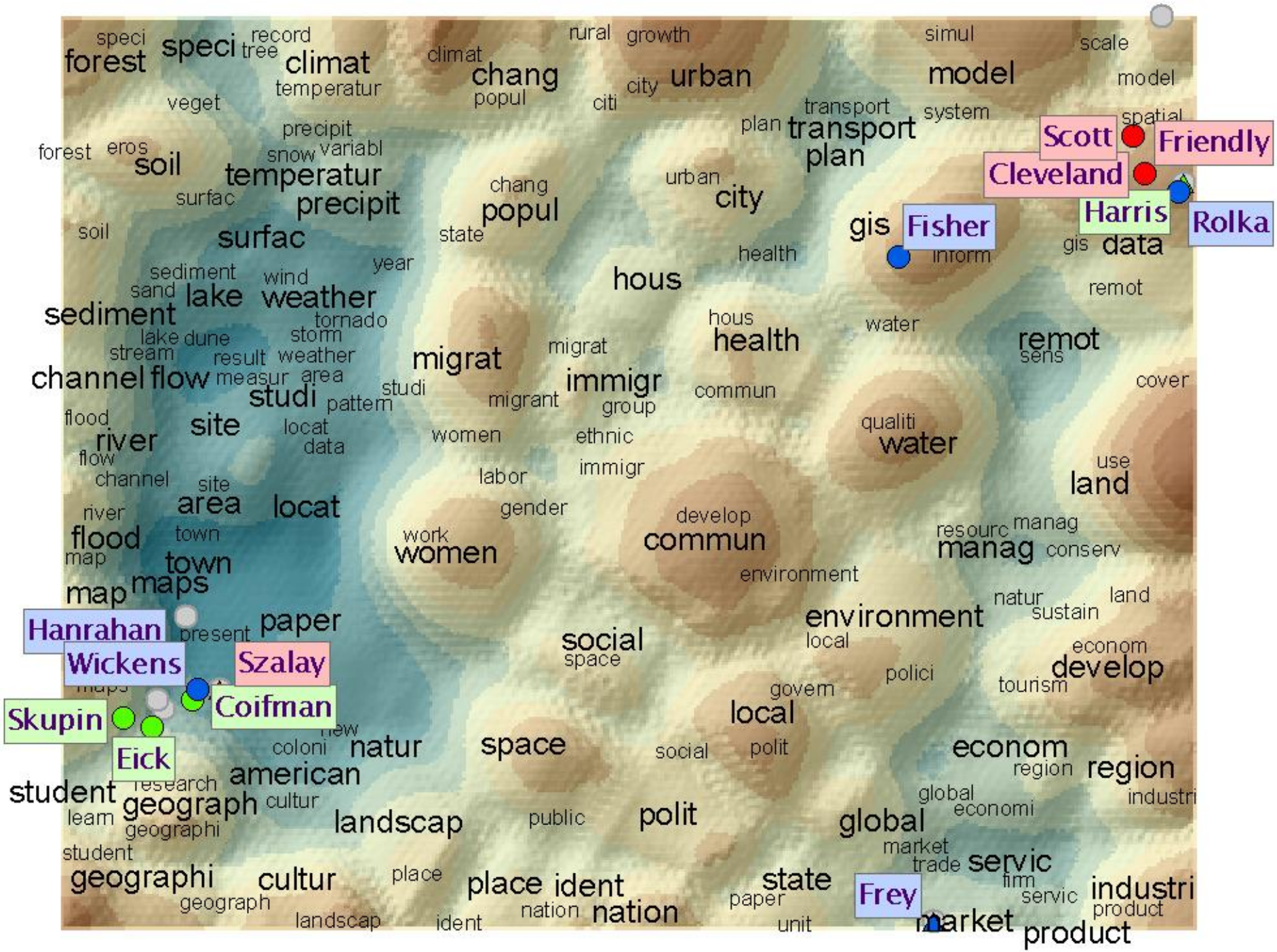
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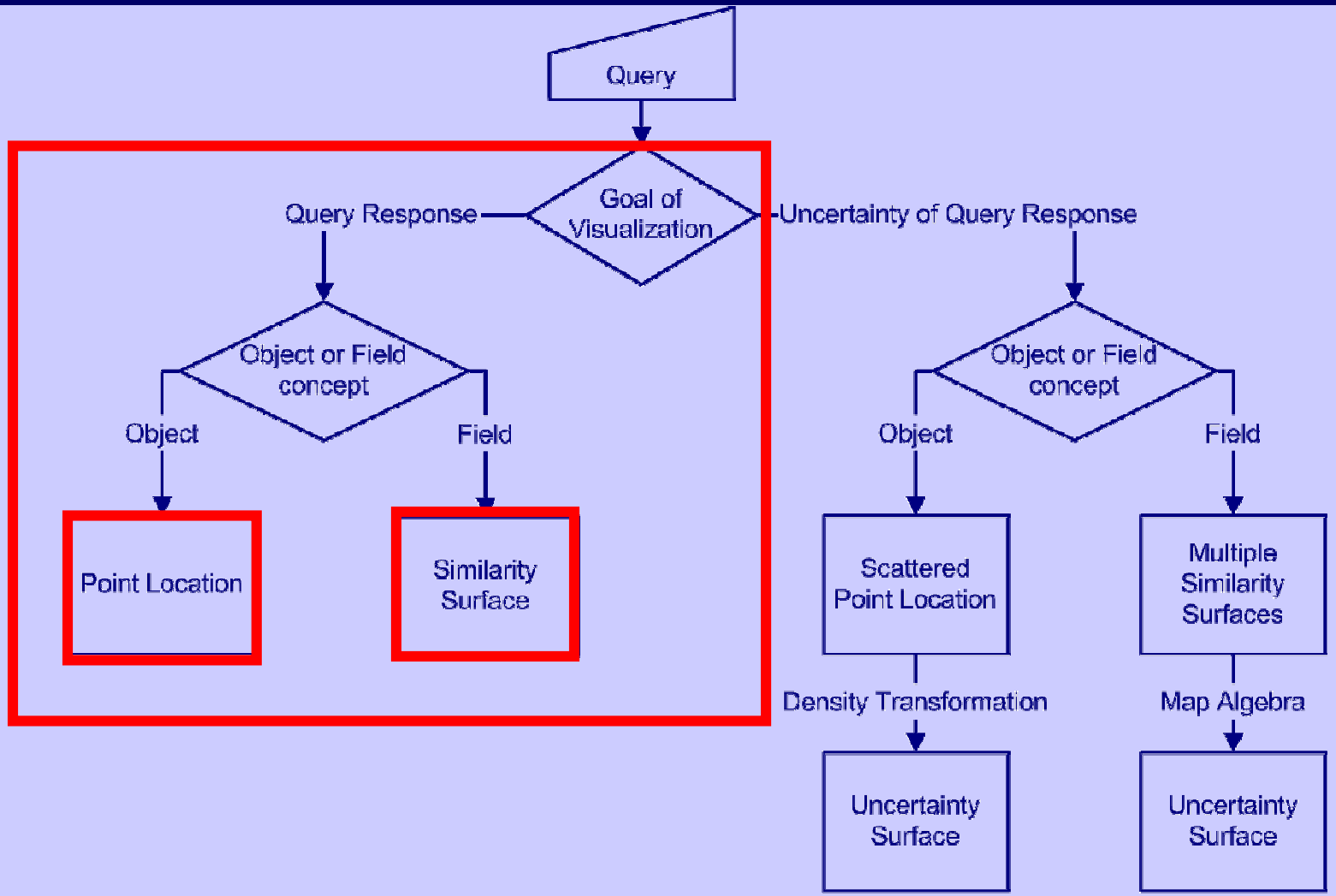
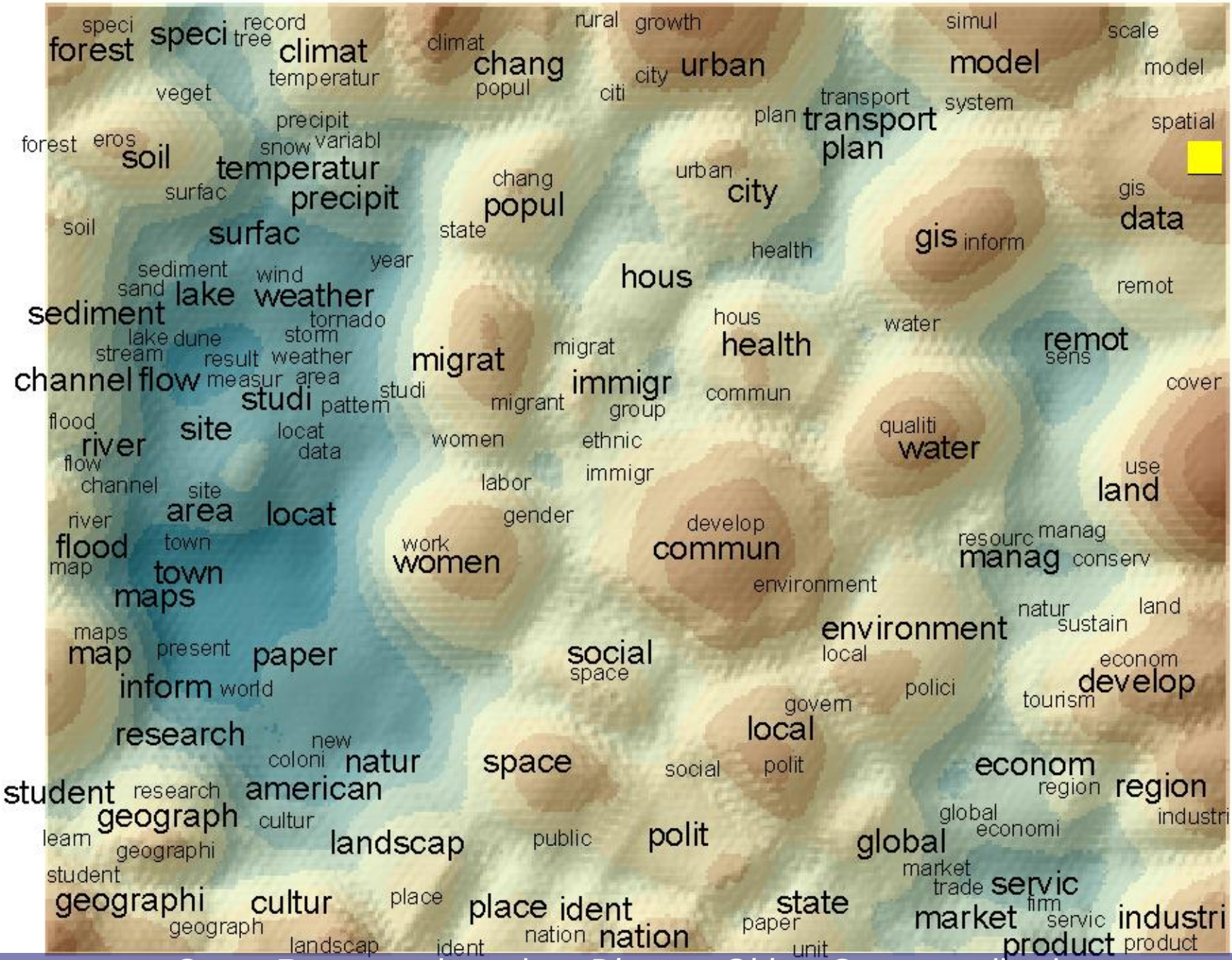
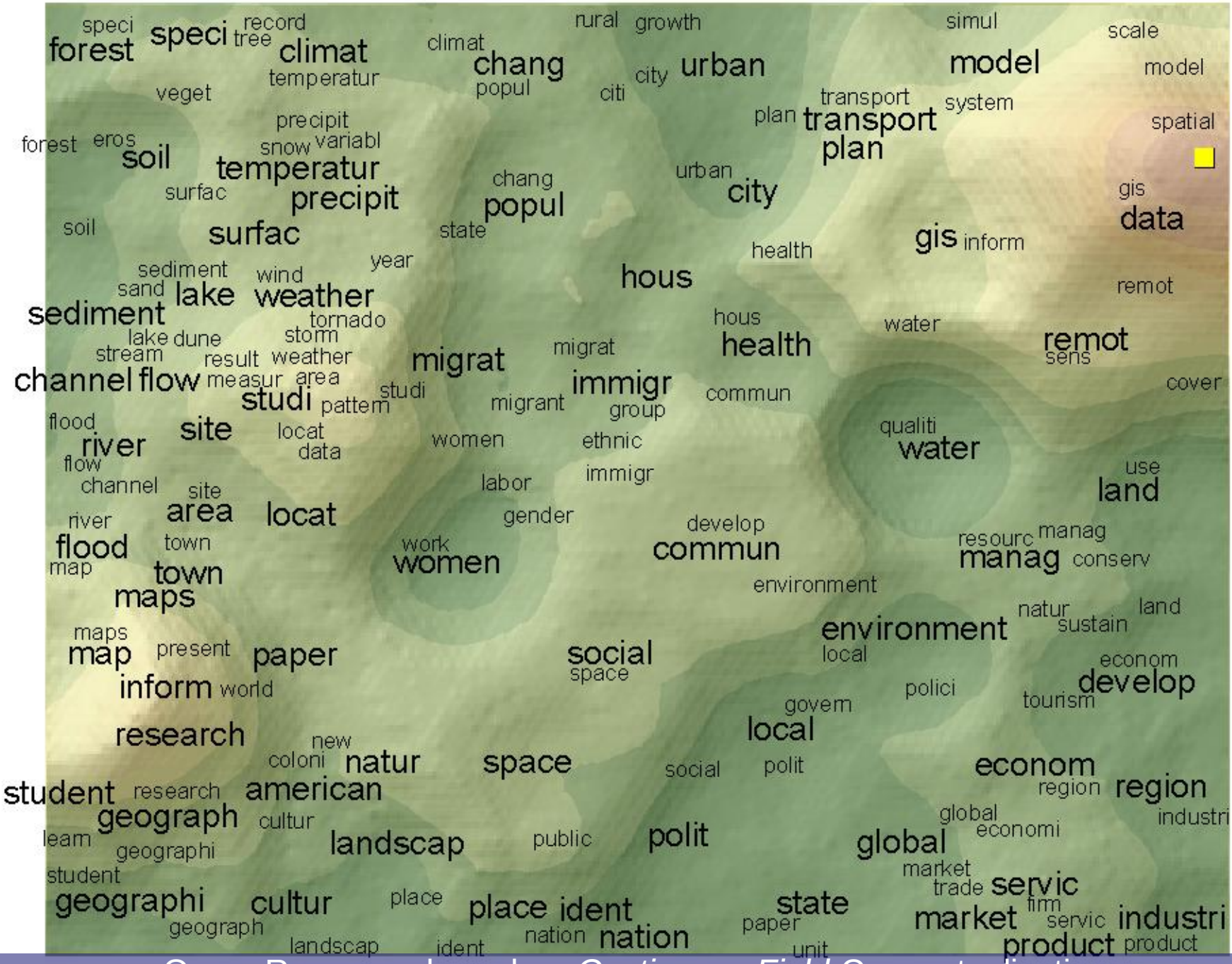
Query Processing: Object versus Field Conceptualization





Query Response based on *Discrete Object* Conceptualization



Query Response based on *Continuous Field* Conceptualization

Multi-Temporal Visualization

- e.g., author evolution

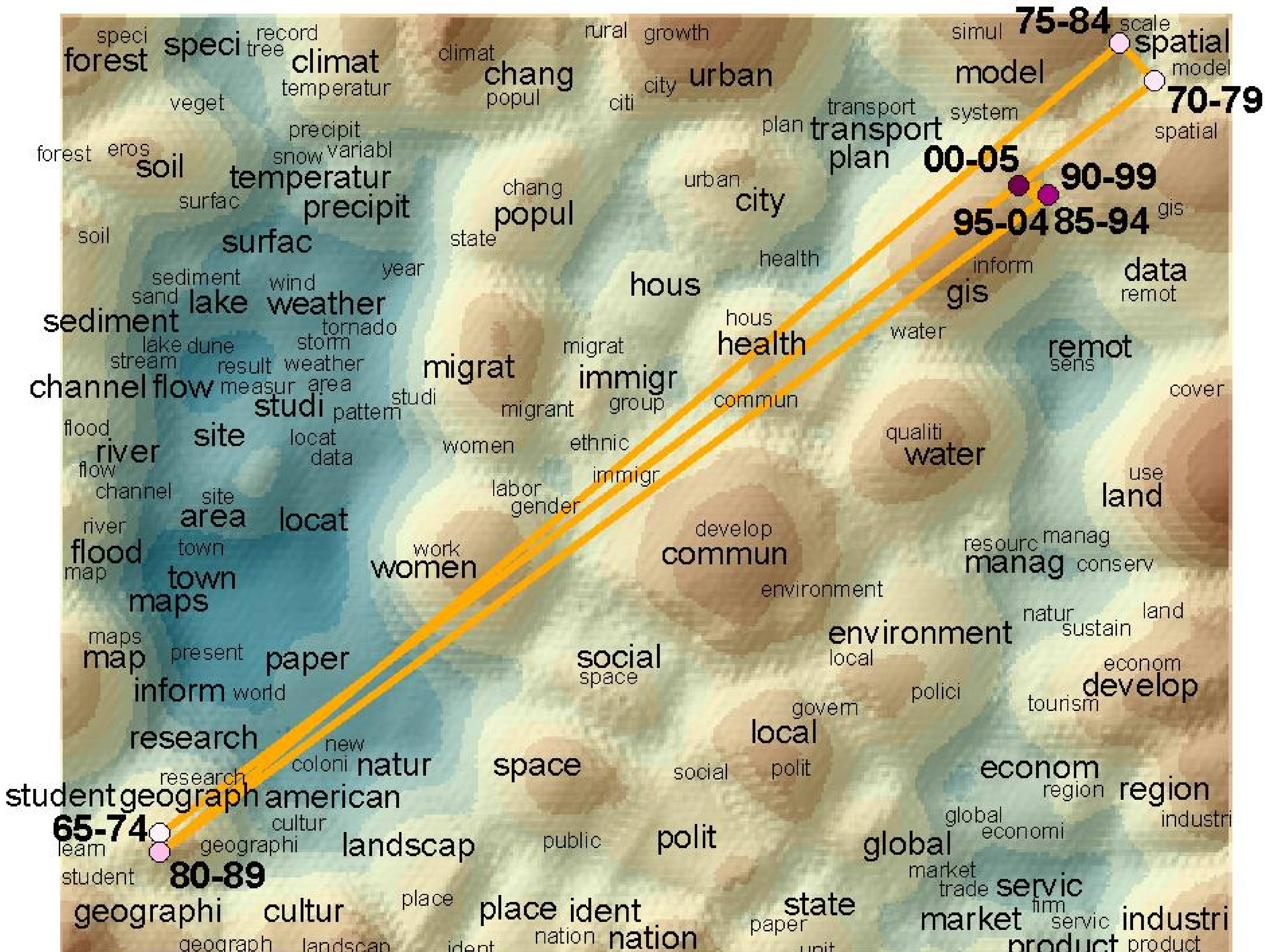
  a) object conceptualization

  author trajectory = sequenced point locations

  b) field conceptualization

  author change surface

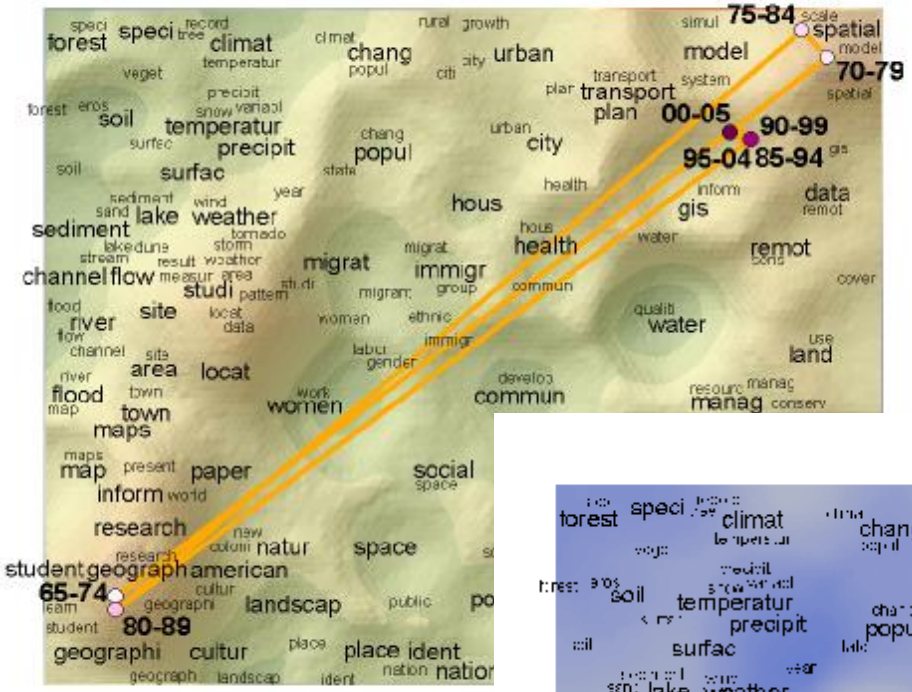
  = multi-temporal queries + map algebra



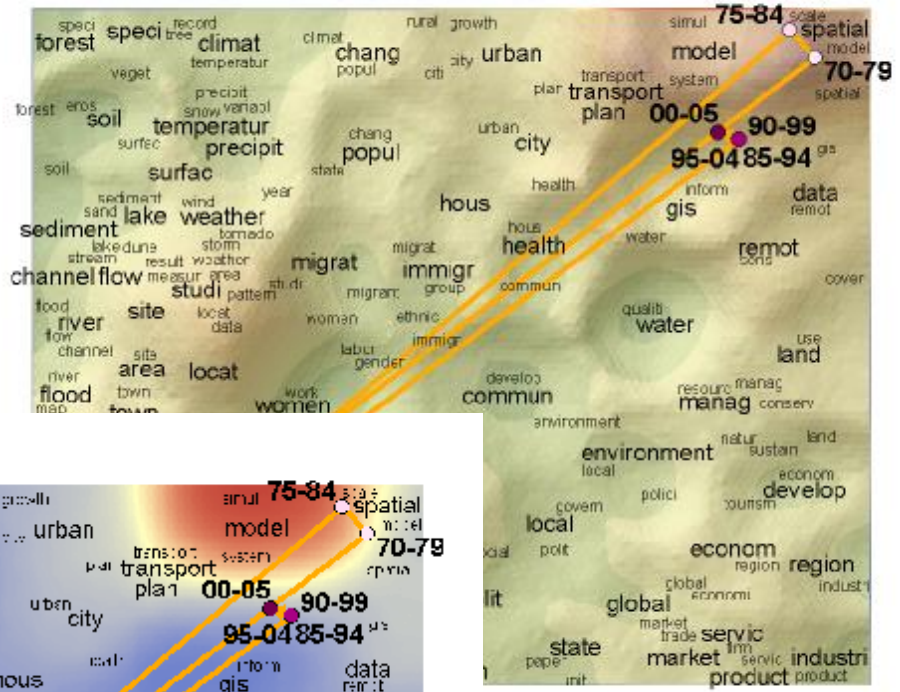
Author Trajectory: Michael Goodchild (Publications 1965 – 2005)

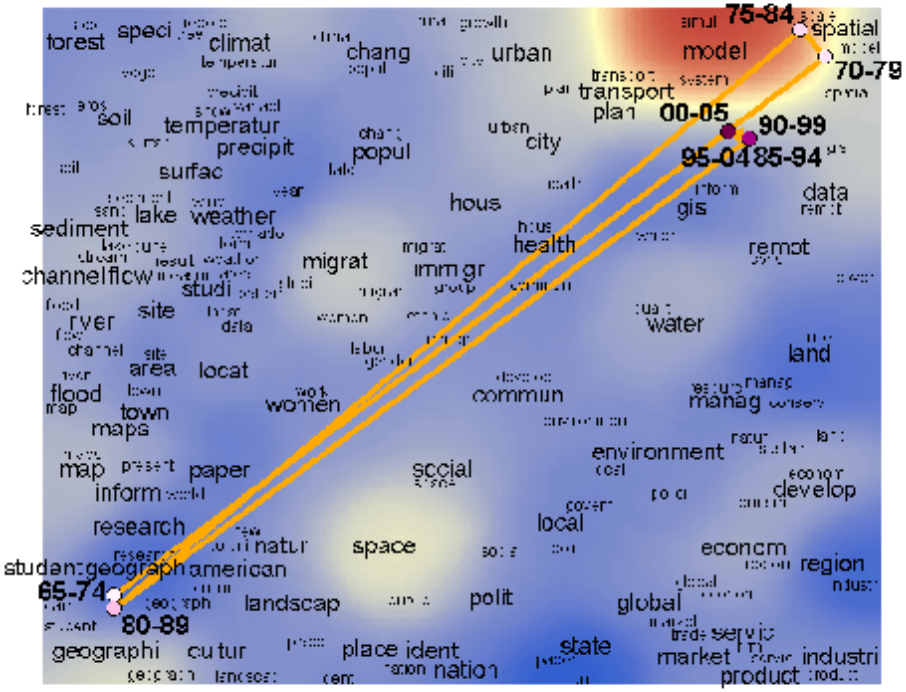
Author Change Surface – Michael Goodchild

1970 - 1979



1975 - 1984





['75-'84] minus ['70-'79]

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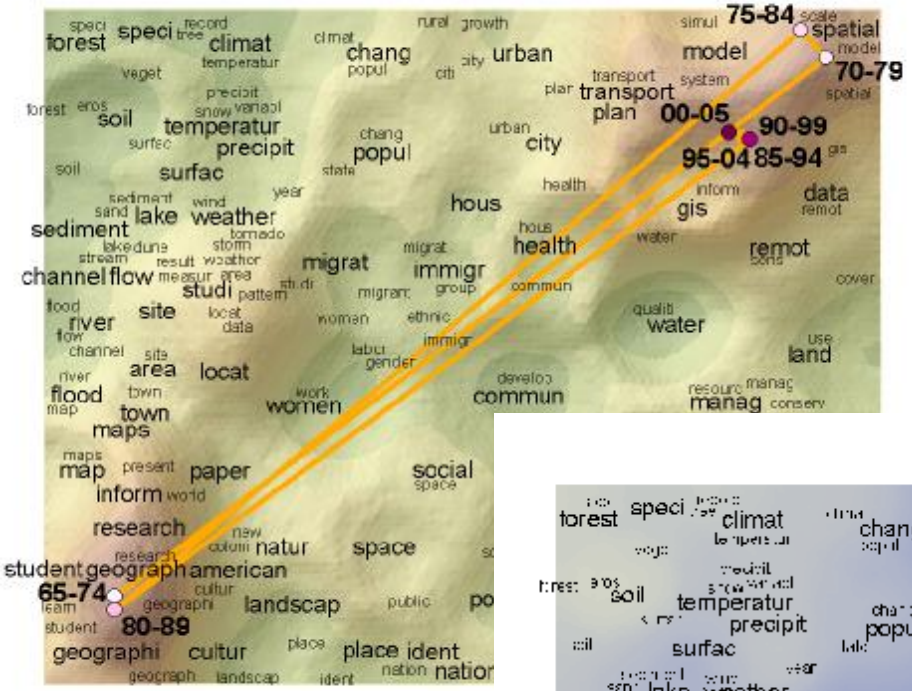
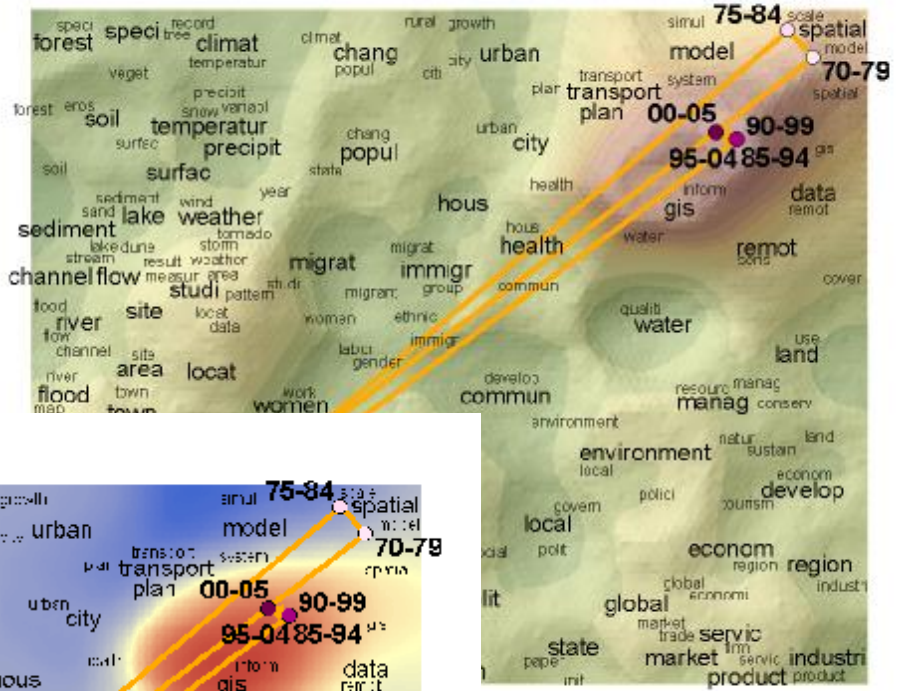
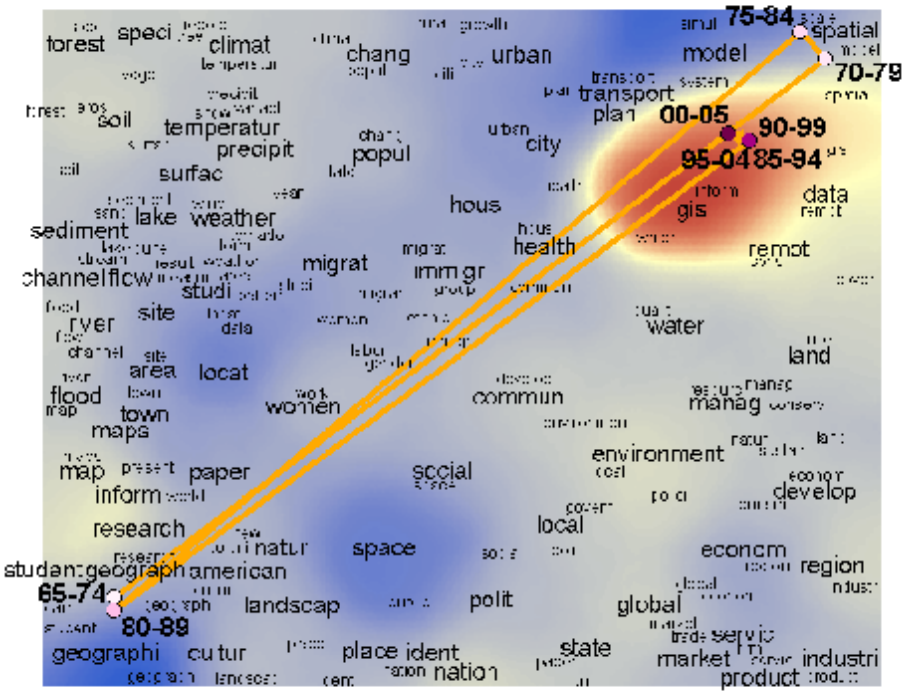
Author Change Surface – Michael Goodchild

1980 - 1989



1985 - 1994





['85-'94] minus ['80-'89]

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Knowledge Domain Visualization
Some Challenges

- software integration
  - text processing; neural networks; GIS
- intense interaction versus intense computation
  - sometimes high degree of user interaction
    - interaction with map-like information visualizations
  - sometimes high degree of core computation
    - neural network training
  - sometimes both
    - extract on-the-fly labels for interactively selected region
- cognition/usefulness/usability
  - Are invoked metaphors operating as intended/claimed?
    - e.g,. “landscape” “city” **à** Sara Fabrikant (UC Santa Barbara)
  - Do users comprehend distortions in high-D to low-D transformations?

Challenge: Role of Interactivity

non-interactive vs. *static* vs. *stable*?

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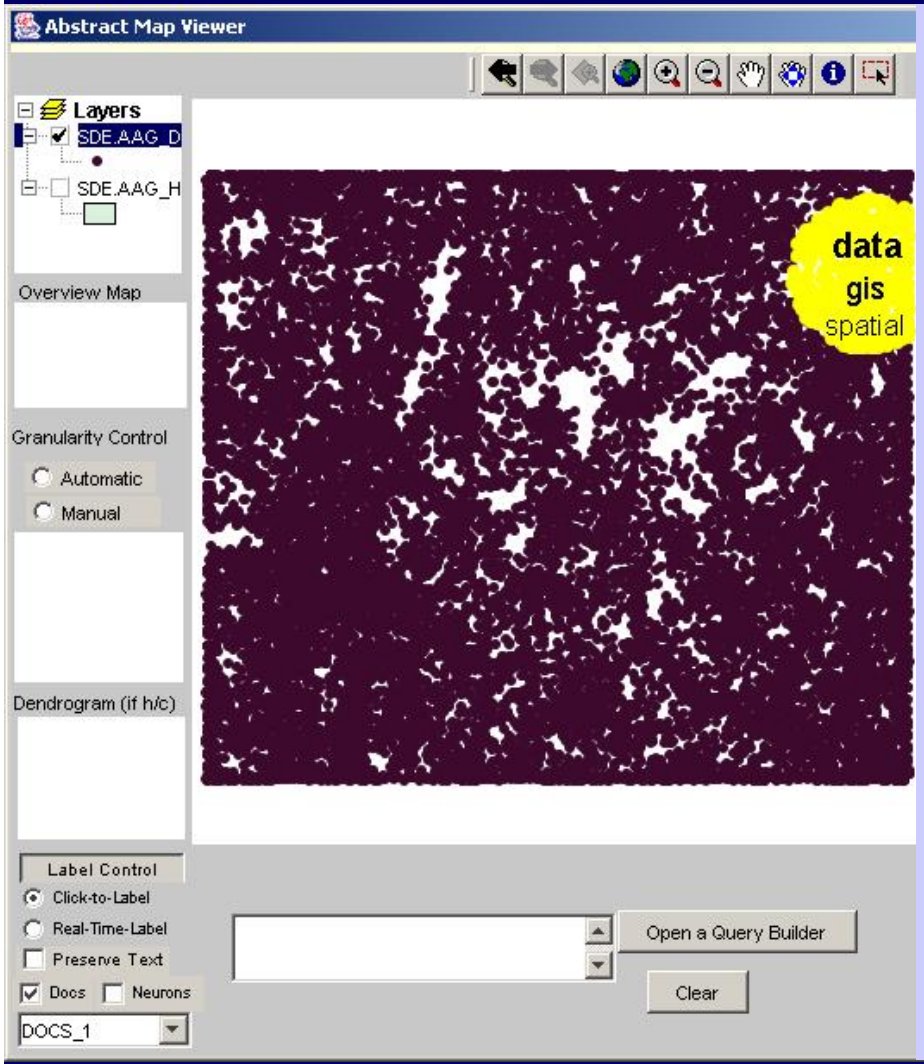
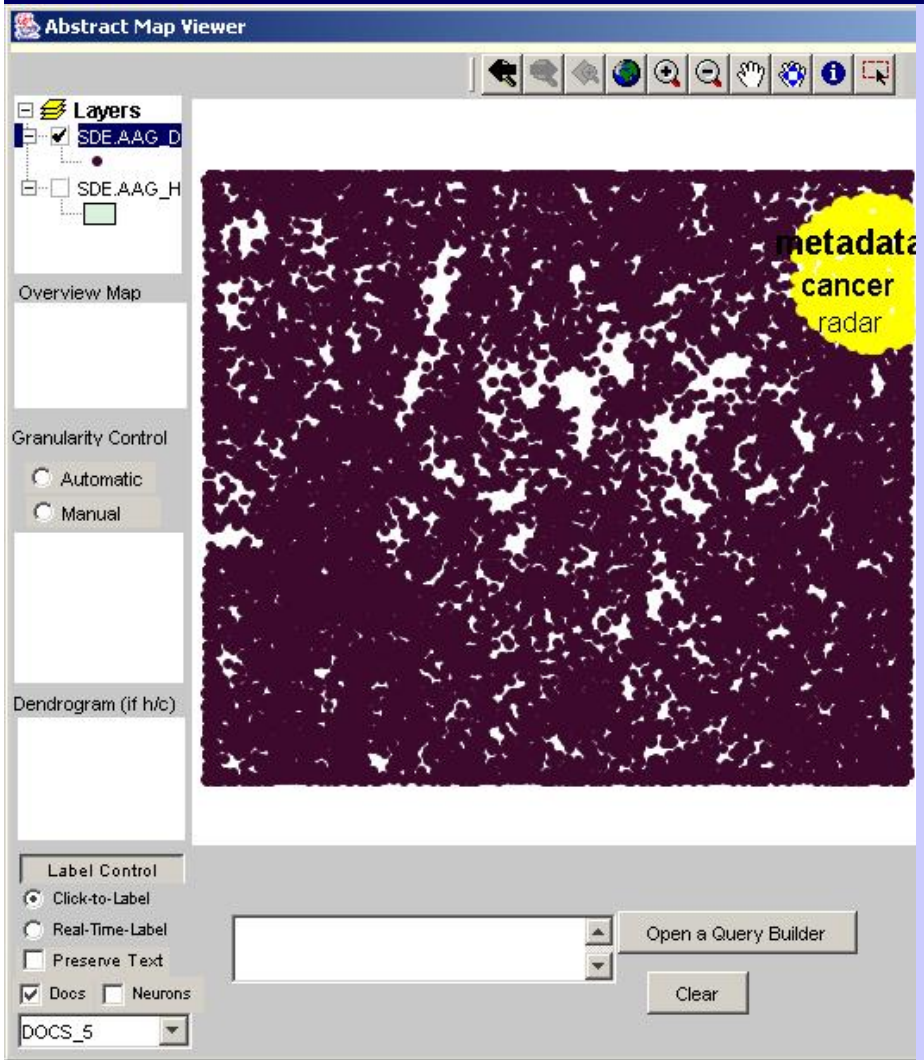
Challenge: Real-time Labeling



- same selection - different labels
- example: region around this workshop
  (a) labels too general ?
  (b) labels too specific ?

Challenge: Real-time Labeling



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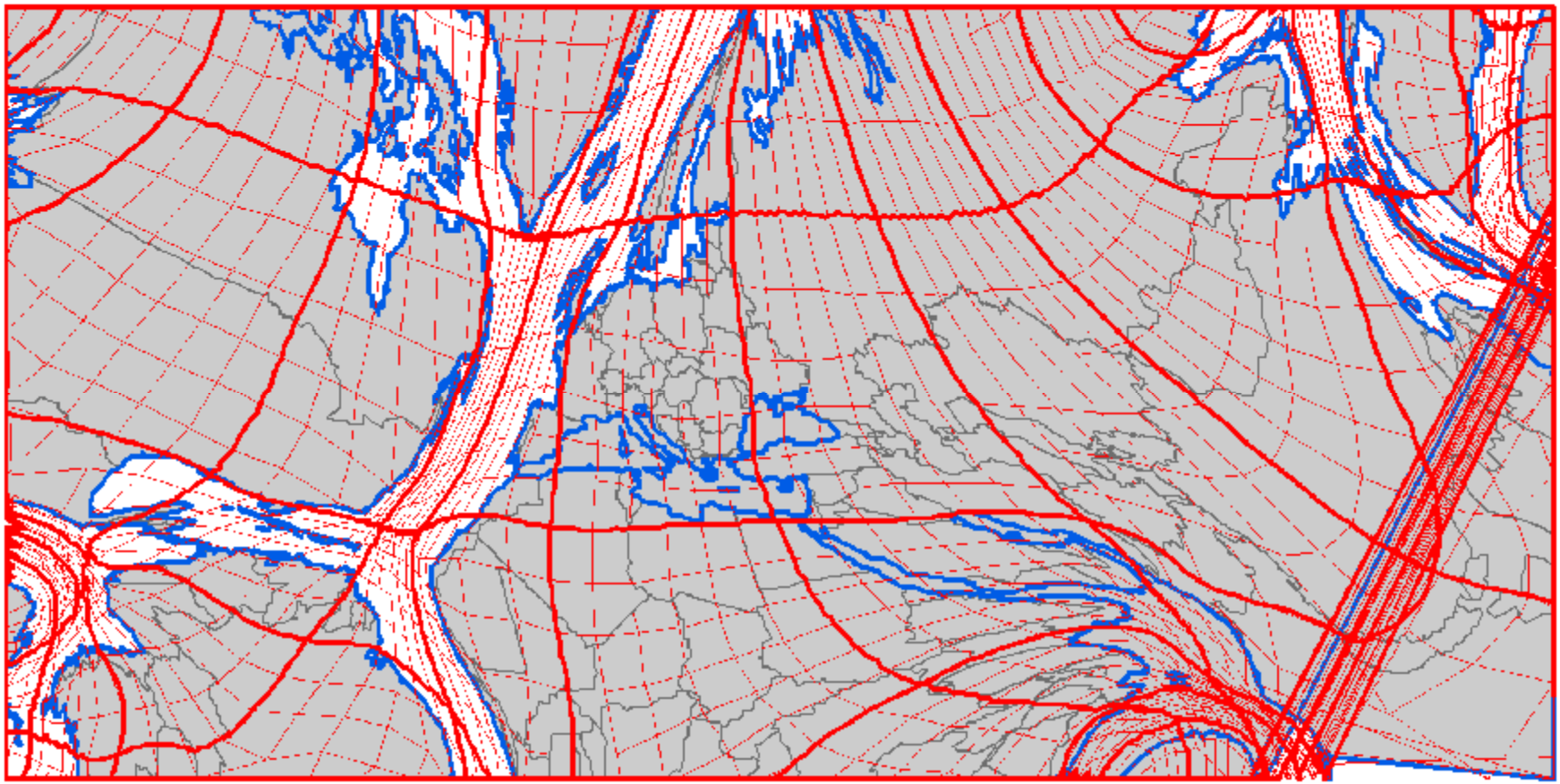
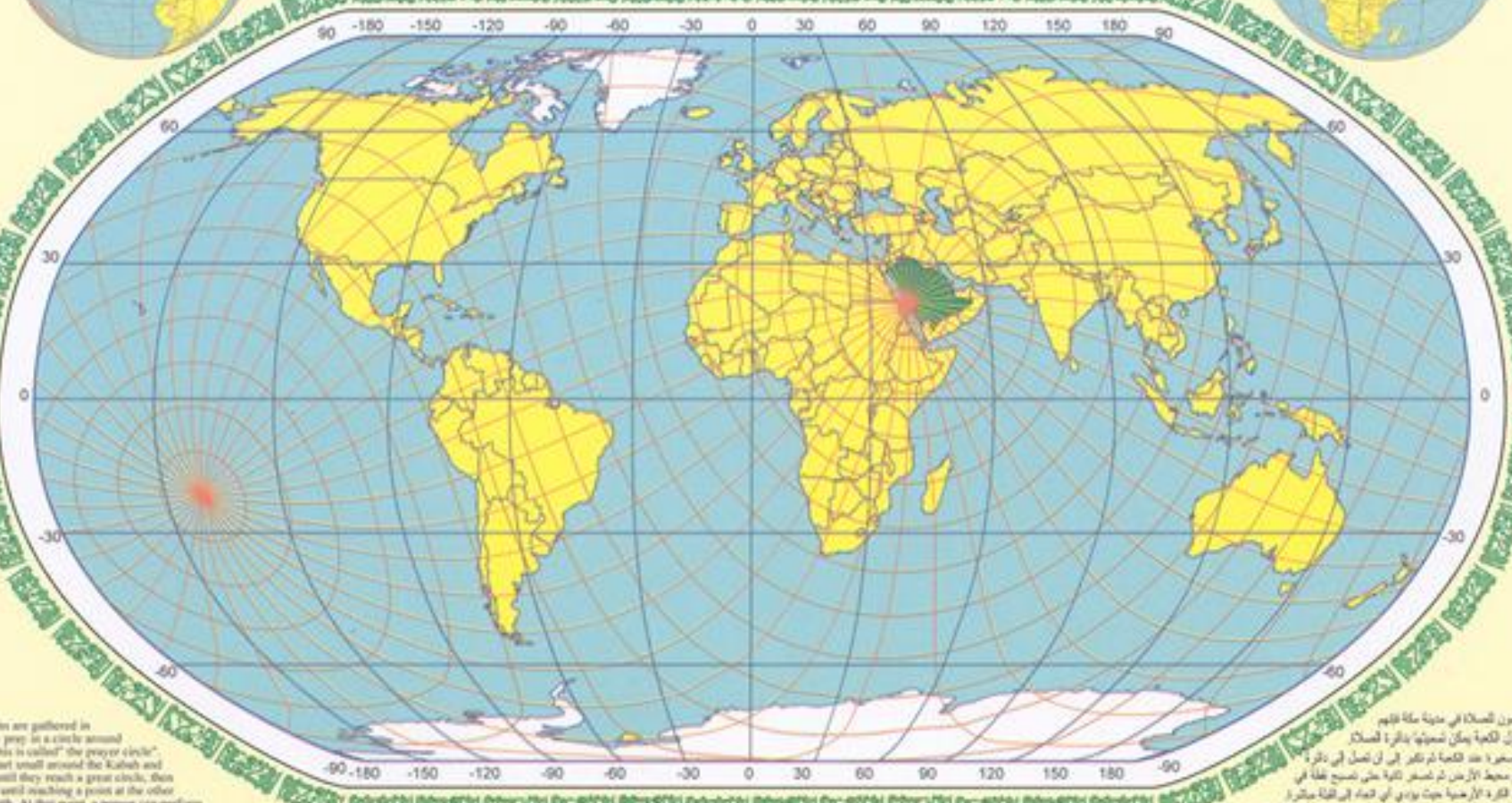
Challenge: Distortions in High-D to Low-D Transformation



بسم الله الرحمن الرحيم

وحيث ما كنتم فولوا وجوهكم شطره



When Muslims are gathered in Makkah, they pray in a circle around the Kabah. This is called" the prayer circle". The circles start small around the Kabah and grow larger until they reach a great circle, then grow smaller until reaching a point at the other side of the earth. At that point, a person can perform prayer in any direction, In order for a person to be praying correctly facing the Kabah, the prayer direction has to be perpendicular to the prayer circle. Persons standing behind each other will form another circle called "the prayer direction circle."

World Map, Robinson Projection, PC and PDC are calculated using spherical triangulation.

United Arab Emirates University
Faculty of Humanities and Social Sciences, Department of Geography
Made by: Ahmad S. Mansarati, Ph.D., March, 2003

دوائر الصلاة و دوائر اتجاه الصلاة

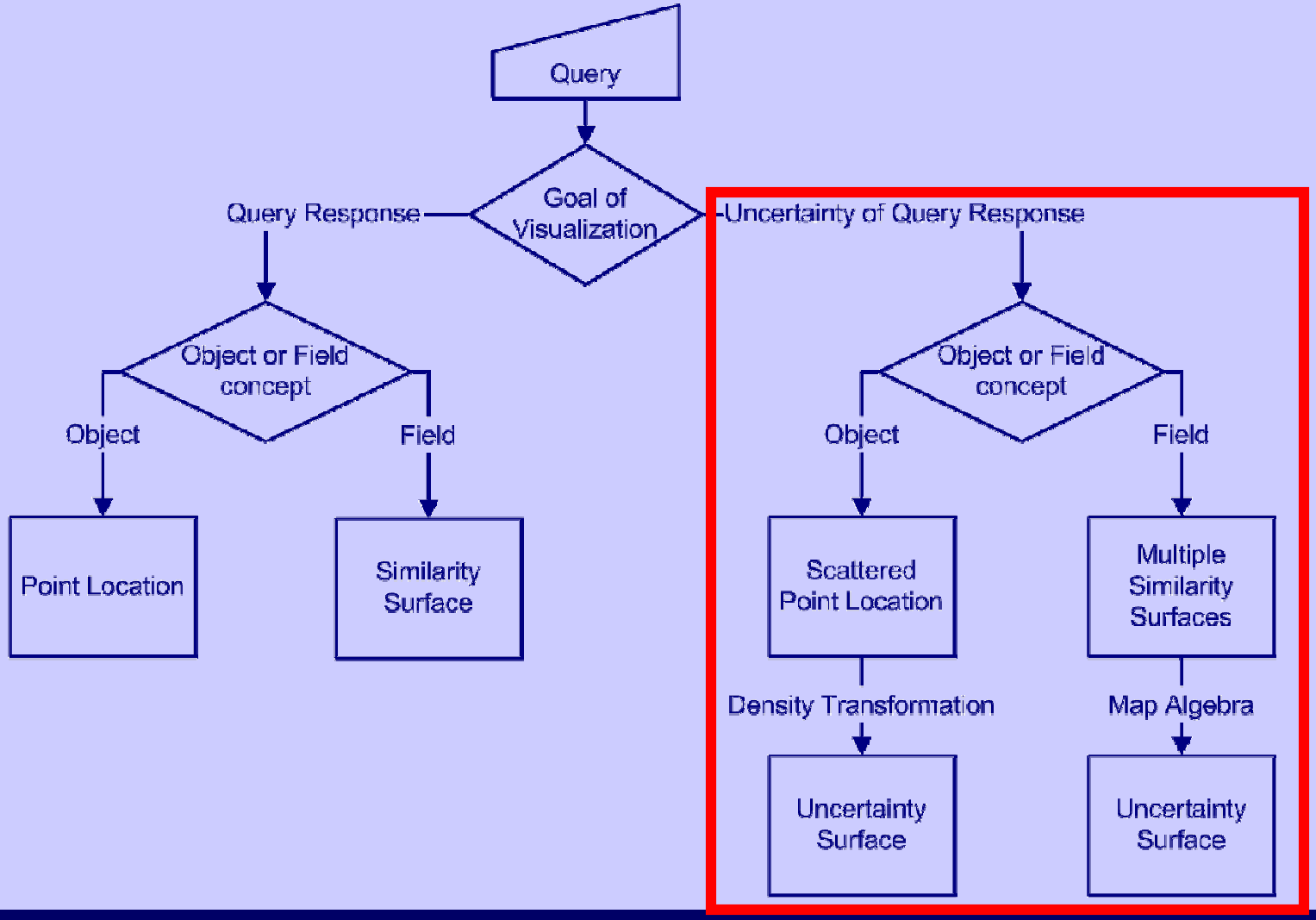
Prayer Circles (PC) and Prayer Direction Circles (PDC)

عندما يقف المسلمون للصلاة في مدينة مكة فإنهم
يشكلون دائرة حول الكعبة يمكن تسميتها بدائرة الصلاة
تبدأ هذه الدائرة صغيرة حول الكعبة ثم تكبر إلى أن تصل إلى دائرة
عظمى تقاس مع محيط الأرض ثم تصغر ثانية حتى تصبح نقطة في
الاتجاه الآخر من الكرة الأرضية حيث يؤدي أي شخص إلى القبلة مباشرة.
ومعلوم أنه لكي تصح صلاة الفرد فإنه يترتب عليه أن يولي وجهه شطر الكعبة وهذا
لا يتحقق إلا إذا استقبل الكعبة بشكل يتعامد مع دائرة الصلاة
المسلمون الواقفون خلف بعضهم يشكلون دائرة عظمى يمكن تسميتها بدائرة اتجاه الصلاة

خريطة العالم بإسقاط روبنسون. دوائر الصلاة ودوائر اتجاهات الصلاة تم حسابها باستخدام المثلثات الكروية

جامعة الإمارات العربية المتحدة - كلية العلوم الإنسانية والاجتماعية - قسم الجغرافيا
صنعها الدكتور أحمد مصاصاتي

… and speaking of visualizing uncertainty



THE END