



# Tracing the Evolution of Digital Cartography in Cartography Textbooks

Sangho Lee

23.09.2022

## Outline



- 1. Background
- 2. Research Objectives
- 3. Methodology
- 4. Results
- 5. Conclusion and Outlook



## 1. Background

- 1. Digital Cartography as a Discipline
- 2. Comparing Text in Books
- 3. Content Analysis
- 2. Research Objectives
- 3. Methodology
- 4. Results
- 5. Conclusion and Outlook

Tracing the Evolution of Digital Cartography in Cartography Textbooks

# Digital Cartography as a Discipline 🛛 🕅 🔛 😳 🧑



The 1984 ICA Meeting in Perth (Source: International Cartographic Association)

"the fast-growing sub-discipline concerned with the use of information technology in the making and use of maps" (Visvalingam, 1990).





RESEARCH OBJECTIV

METHODOLOGY

## **Comparing Text in Books**



1830 Edition	1837 Edition	1840 Edition
	1 NEPHI 13:40	
	(32:10)	+
the Lamb of God is the [] Eternal Father and the Saviour	the Lamb of God is the Son of the eternal Father, and the Savior	the Lamb of God is the Son of the eternal [J] Father, and the Savior

Comparison of three editions of the Book of Mormon (Source: Larson, 1974)

## **Comparing Text in Books**



Select Document . Select Section Match \* Righlighting \* Find Additional Matches \* Selected Paragraph \* Navigation \* buyiding of the Citie of Rome 679. be[///egible]ore the comming of Chrift .72. and before match 1 match 2 match 3 the Romaines entred Brytaine .xix. yeares. In the same citie also he solorned for the more part, Fabian, by reason whereof the inhabitants increased, Gal. Mon. and manie habitations were builded to receive them. This Lud proued a right worthie prince, A worth[ Illegible ] prince, almending the lawes of Matt. West, and he himselfe caused buildings to be made betwixt London stone and the realme that were defectute, abolifhing euill cuftomes and maners vied amongit his Ludgate, and builded for himselfe not farre from the said gate a faire palace, which is the people, and repairing old Cities and townes which were decayed: but [pecially he de]lyted bishop of Londons palace beside Paules at this date. The bisshops palace, as some moft to beautifie & enlarge with buildings the Citie of Troynouant, which he co~palled with thinke; yet Harison supposeth it to have bin Bainards castell, where the blacke friers now a ftrong wall made of lime and ftone, London enIclofed with a wall, John, Hard, in the beft standeth. He also builded a faire temple néere to his said palace, which temple (as some maner fortified with diuerle fayre towers: and in the weft part of the fame wall he erected a take it) was after turned to a church, and at this daie called Paules. By reason that king ftrong gate, which he commaunded to be cleped after his name, Luds gate, and fo vnto Lud so much esteemed that ciltie before all other of his realme, inlarging it so greatlie as this day it is called Ludgate, [ illegible ]he, s, only drowned in y^e pronunciatio~ of the he did, and continuallie in manner reimained there, the name was changed, so that it was word. In the fame citie alfo he foiorned for the more part, Fabian. Gal. Mon. Mat. VVeft. by called Caerlud, The name of Troinouant changed and called London that is to saie, Luds reafon whereof the inhabitants encreafed and many habitations were buylded to receyue towne: and after by corruption of spéech it was named London. them, & he himfelfe cauled buildings to be made betwixt London Itone & Ludgate, & buyl/ded for him/elf not farre from the layd gate a faire palace, which is the Bifh, of Londons palace, The Bilhop[ illegible ] palace, belfide Paules, at this day (as fome think) yet Harif. Juppofeth it to have bin Bainards caftel, wher the black friers now ftandeth. He allo builded a faire Temple nere to his faid palace, which temple (as fome take it) was after turned to a church, and at this day cleped Paules. By reafon that K. Lud fo much efterned yhe citie before al other of his realme, enlarging it fo greatly as he did, and co-tinually in manet remained there, the name was cha-ged, The name of Troynouan[ Illegible ] chaunged and called London. fo y\*e it was called Cairlud, y\*t is to fay, Luds towne: & after by corruptio~ of [peech it was named Lo~don. Belide the princely doings of this Lud touching the aduancement of the co~mon wealth by itudies aperteyning to the time of peace, hee was allo ftrong and valiant in armes, in fubduing his enilmies. He was allo bounteous and liberall both in giftes and in keeping a plentifull houle, to that he was greatly beloued of all the Brytaynes # Filnally, when he had thus raigned with great holnor for the fpace of .xj. yeres, he died, and was bulried nere Ludgate, leauing after him two fonnes, Indrogeus and Theomancius or Tenancius.

## Text comparison engine (TEI-Comparator) displaying a match between two editions of text (Source: Cummings & Mittelbach, 2010)

RESEARCH OBJECTI

METHODOLOGY

RESULTS CONC



"A research technique for making replicable and valid inferences from texts, pictures, audio, video, and other sources to examine patterns in communication"

(Bryman & Bell, 2011; Krippendorff, 2018).



## **Content Analysis**



Higher levels of abstraction- Reflects the interpreted, latent meaning of the text	Overarching theme	The emergency centre through patients' eyes Alone and cold in chaos
	Theme	Not a person, just a body in the hectic EC
	Category	Staff actions and non-actions
	Code	Left alone
	Condensed meaning units	Pushed to the middle of the room, walked away, left me
Lower levels of abstraction- Close to the text and manifest content	Meaning unit	"They pushed me into the middle of the room and then walked away they just left me"

(Source: Erlingsson & Brysiewicz, 2017)



METHODOLOG

## **Content Analysis**



Projection Name	Pre-Computer Era	Mainframe Computer Era	Desktop Computer Era	Internet Era
Azimuthal equidistant				
Lambert azimuthal equidistant				
Mercator				
Sinusoidal				
Albers equal area conic				
Lambert conformal conic				
Orthographic				
Bonne				
Polyconic				
Stereographic				

(Source: Kessler, 2018)

BACKGROUND RESEARCH OBJECTIVES METHODOLOGY RESULTS CONCLUSION & OUTLOOK



## 1. Background

- 1. Digital Cartography as a Discipline
- 2. Comparing Text in Books
- 3. Content Analysis
- 2. Research Objectives
- 3. Methodology
- 4. Results
- 5. Conclusion and Outlook

Tracing the Evolution of Digital Cartography in Cartography Textbooks



1. Background

## 2. Research Objectives

- 3. Methodology
- 4. Results
- 5. Conclusion and Outlook

## **Research Objectives**



- Analysing the changes related to digital cartography found in different editions of cartography textbooks.
- 2. Identifying in which ways the increased relevance of digital technologies has been reflected in cartography textbooks.
- 3. Exploring how content analysis can be used as a tool for mapping changes in textbooks and understanding the evolution of a theme.

METHODOLOGY



- 1. Background
- 2. Research Objectives
- 3. Methodology
  - 1. Data Collection and Transformation
  - 2. Content Analysis
  - 3. Author Interviews
  - 4. Text Mining
- 4. Results
- 5. Conclusion and Outlook

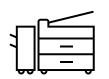
**Data Collection & Transformation** 





## Textbook selection and acquisition

- Slocum et al.'s Thematic Cartography and (Geo)Visualization
- Kraak & Ormeling's Cartography: Visualization of (Geo)Spatial Data



## **Book Digitisation**



OCR and Layout Clean-Up



**Text File generation** 

### 15

18

33

METHODOLOGY

## Analysis of Table of Contents and Prefaces

### Contents

**Content Analysis** 

#### Preface

#### Chapter 1 Introduction

- 1.1 What is a Thematic Map? 2
- 1.2 How are Thematic Maps Used? 3 1.3 Basic Steps for Communicating
- Map Information 3 1.4 Consequences of Technological Change in
- Cartography 6 1.5 Geographic Visualization 11
- 1.6 Related Techniques 12
- 1.7 Cognitive Issues in Cartography 14
- 1.8 Social and Ethical Issues in Cartography 15

#### Part I Principles of Cartography

#### History of U.S. Academic Chapter 2 Cartography

2.1 Four Major Periods of U.S. Academic Cartography 18

#### 2.2 The Paradigms of American Cartography 30

- Statistical and Graphical Chapter 3 Foundation
- 3.1 Population and Sample 34
- 3.2 Descriptive Versus Inferential Statistics 34

- 3.3 Methods for Analyzing Spatial Data, Ignoring Location 34
- 3.4 Numerical Summaries in Which Location Is an Integral Component 47

#### Principles of Symbolization 56 Chapter 4

- 4.1 Spatial Arrangement of Geographic Phenomena 57
- 4.2 Levels of Measurement 60
- 4.3 Visual Variables 61
- 4.4 Comparison of Choropleth, Proportional Symbol, Isopleth, and Dot Mapping 64

#### Chapter 5 Data Classification

74

- 5.1 Common Methods of Data Classification 75 5.2 Using Spatial Context to Simplify
- Choropleth Maps 89 5.3 Cluster Analysis 92

#### Chapter 6 Scale and Generalization 103

- 6.1 Geographic and Cartographic Scale 103
- 6.2 Definitions of Generalization 104
- 6.3 Models of Generalization 105
- 6.4 The Fundamental Operations of Generalization 110
- 6.5 An Example of Generalization 117

Preface

#### PREMISES AND OBJECTIVES

This book has been written to assist in cartographic education and intends, as a first objective, to provide an overview of the role that maps will play both today and in the near future in the world of geospatial data handling. It shows the background against which the provision and visualization of geospatial information takes place. It provides awareness of the Web both as a spatial data source and as a means for distributing the results of visualizing this spatial information. To realize that first objective, the nature of geospatial data is described as well as the characteristics of maps and the ways in which they can be put to use. A development stimulated by the Web was the increased use of spatial data infrastructures, for sharing national and global geodata with the professional and general public. The development of the Internet has boosted the possibilities for interaction and for querying the databases behind the maps presented there. The number of databases available via the Web has increased dramatically and so has the ability to interact with them (guery, process, etc.) online. Maps have acquired an important interface function in this new cyberspace geo-information distribution environment. If mapmaking with GIS (geographical information system) mainly involved geo-professionals, the World Wide Web potentially allows everyone to have access to this new medium to create maps.

But not everyone is aware of the intricacies of map design and of the characteristics of the various map types and their limitations. That is where our second objective comes up: teaching map design. What types of geovisualization are appropriate, and how do we translate the numbers collected through censuses or the data measured by sensors into images that allow us to draw sensible conclusions? The answers are shared out over topographic, statistical (or thematic) and temporal maps. For all three categories of maps, we intend to provide sufficient relevant knowledge of cartography and geovisualization concepts and techniques to those accessing the World Wide Web for the production and use of effective visualizations of geospatial information.

Showing the manner in which maps function, either independently or combined in atlases, and can be analysed and interpreted, either in stand-alone or in geo-information environments, is the third main objective of this book. Since the position of the Web has strengthened and stabilized itself, it also stimulated a more integrative approach to problem-solving with geo-information (GIScience (geographical information science)). Since the World Wide Web is highly interactive, and since it allows one to integrate data files, and to link distributed databases, this makes maps suitable instruments for exploring these databases.

- 4.5 Selecting Visual Variables for Choropleth Maps 70





### Analysis of Table of Contents and Prefaces

Chapter of the previous edition	Chapter of the new edition (1)
Discontinued chapter	Chapter of the new edition (2)



## **Content Analysis**



### Chapter-by-Chapter Comparison & Change Documentation

The introduction of on-screen maps and their corresponding databases resulted in a split between these functions. To cartographers it brought the availability of database technology and computer graphics techniques that resulted in new and alternative presentation options such as threedimensional and animated maps. In a GIS environment, geospatial analysis often begins with maps; maps support judging intermediate analysis results, as well as presenting final results. In other words, maps play a major role in the process of geospatial analysis. They have acquired an additional role with the advent of geospatial data infrastructures (GDI). These new infrastructures for accessing geospatial data are being developed all over the world in order to allow access to the geospatial datafiles created and maintained in order to monitor the population, resources and environment. Access to the data needed requires complex querying procedures that are simplified when using maps to pinpoint the areas and themes for which data are needed (Figure 1.1).

A	В	с	D
1 CHAPTER 1 Geographic information syste	ems and maps		
2 Kraak_1	Kraak_2	Kraak_3	Kraak_4
3			The ever more detailed satellite imagery available, the increasing number of sensor networks and new
4		The rise of Internet brought the next revolution in mapping. Access to interactive maps is no longer	
5	They have acquired an additional role with the advent of geospatial data infrastructures (GDI). These new		
6	Possibilities for interaction are boosted by the advent of the Internet and its potential for querying the		
7	Currently GIS is used in virtually all disciplines that require geospatial data to execute their tasks or solve		
8	The potential for analysis is already greatly enhanced by the possibilities of applying GIS processing on the		
1.5 The relation between GIS and cartography 9	1.5 The relation between GDI and cartography (whole new)	1.5 The spatial data infrastructure and maps	
10	Companies and government departments at different levels (municipal, provincial/county, state, or national)		
11	In order to enable data users to find out whether data sets from different information systems can be		
12	A next step is the development of distributed geospatial warehouses, central repositories where not		
GIS and cartography Many of the concepts and functions of GIS were first conceived by cartographers.			
14		In Europe the GDI implementation is guided by the EU INSPIRE initiative which, based on legislation, will	1

BACKG

RESEARCH OBJECTIV

METHODOLOGY

Y RESULT

CONCLUSION & OUTLOOK



## **Coding the Documented Changes**

"This approach is also used by volunteers who want to update map data for humanitarian purposes after disasters such as hurricanes, flooding or earthquakes. The volunteers use recent satellite imagery to, for instance, indicate where the damage is most severe, and the new maps, often part of the OpenStreetMap, can be used to restore the basic infrastructure"

(Kraak & Ormeling, 2020).

Codes: web, remote sensing, participation

## **Author Interviews**



### Section I

Below are the points that I would like to hear your opinion about. They are general and open questions concerning your book.

- 1. What made you decide to write this textbook in the first place?
- 2. What kind of materials did you have available before starting to write the book?
- 3. What was the key motivation for each later edition to be published?
- 4. What was the writing process like when examining and updating the contents?
- 5. Have you recognised any changes in the cartographic teaching environment that the rapid growth of digital technologies has brought?
- 6. How has the relationship between cartography and the digital technology evolved throughout the editions of the book?

#### Section II

Below are the updates in the book that I would like to contextualise why they were added or deleted. Unlike the ones above, I do not expect a lot of discussion about these, and the answers can be succinct (e.g., "because the website was deprecated"). It is also okay if you cannot recall the reasons.

- [Deleted in the second ed.] Why were two examples 'TOP10vector' from the Netherlands and 'ATKIS' from Germany deleted?
- [Added in the third ed.] Why did you newly introduce the subchapter "Geographical Names"?
- [Deleted in the third ed.]
  Why was the website 'Odden's Bookmarks' deleted?
- 10. What was the motivation to start providing hyperlinks of web resources in the textbook since the third edition?
- 11. Were there any criteria about which hyperlinks to add and which to leave out in the textbook?

# **Text Mining**



"In a manner analogous to data mining, text mining seeks to extract useful information from data sources through the identification and exploration of interesting patterns"

(Feldman & Sanger, 2006).

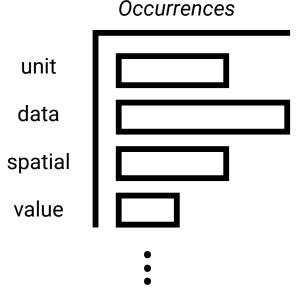


## **Text Mining**

## 

### Word frequency

In section 2.1, we showed how we might combine the optimal classification approach with a spatial constraint. We utilized two criteria to accomplish this: (1) minimizing the difference between data values in classes (i.e., minimizing the tabular error, a nonspatial constraint), and (2) simplifying the map pattern by defining class limits such that contiguous enumeration units fall in the same class (a spatial constraint). Marc Armstrong and his colleagues (2003) have argued that we should consider a broader set of criteria when classifying data, including minimizing the tabular error, minimizing the difference between classes for contiguous enumeration units (i.e., minimizing the boundary error), maximizing the overall spatial autocorrelation in the resulting classed map, and equalizing the area in each class (which is often useful when we wish to compare choropleth maps). Note that the latter three of these are all spatial constraints.



### KGROUND RESEARCH OBJECTIVES METHODOLOGY RESULTS CONCLUSION & OUTLOOK

## **Text Mining**



- Word frequency
- Bigram Analysis

# "In German, the at sign was referred to as spider monkey." german at | at sign | sign refer | refer spider | spider monkey







- 1. Background
- 2. Research Objectives
- 3. Methodology
  - 1. Data Collection and Transformation
  - 2. Content Analysis
  - 3. Author Interviews
  - 4. Text Mining
- 4. Results
- 5. Conclusion and Outlook



- 1. Background
- 2. Research Objectives
- 3. Methodology
- 4. Results
  - 1. Thematic Cartography and (Geo)Visualization
  - 2. Cartography: Visualization of (Geo)Spatial Data
- 5. Conclusion and Outlook

## Evolution of the Overall Structure



### Edition 1 (1996, 239 pages)

Edition 2 (2003, 223 pages)      Geographic Information Systems and May      Data Acquisition      Map Characteristics      GIS Applications: Which Map to Use?      GIS Applications: Which Map to Use?      Topography and Base Maps?      Map Design      Statistical Mapping      Cartographic Tools      Advanced Mapping Environments      Cartography at Work: Maps as Decision Tr      References & Index      Color Plates	ToC & Pretace	
Data Acquisition    Geographic Information Systems and May      Map Characteristics    Data Acquisition      GIS Applications: Which Map to Use?    GIS Applications: Which Map to Use?      Topography and Base Maps?    Topography      Map Design    Map Design      Statistical Mapping    Cartographic Tools      Cartographic Tools    Atlases      Advanced Mapping Environments    Cartography at Work: Maps as Decision T(      Cartography at Work: Maps as Decision T(    References & Index		Edition 2 (2003, 223 pages)
Data Acquisition    Data Acquisition      Map Characteristics    Data Acquisition      GIS Applications: Which Map to Use?    GIS Applications: Which Map to Use?      Topography and Base Maps?    Topography      Map Design    Map Design      Statistical Mapping    Statistical Mapping      Cartographic Tools    Atlases      Advanced Mapping Environments    Gartography at Work: Maps as Decision Tr      Cartography at Work: Maps as Decision Tr    Cartography at Work: Maps as Decision Tr      References & Index    References & Index	Geographic Information Systems and Mar	ToC & Preface
Map Characteristics    Map Characteristics      GIS Applications: Which Map to Use?    GIS Applications: Which Map to Use?      Topography and Base Maps?    Topography      Map Design    Map Design      Map Design    Statistical Mapping      Statistical Mapping    Cartographic Tools      Advanced Mapping Environments    Maps as Decision Tr      Cartography at Work: Maps as Decision Tr    Cartography at Work: Maps as Decision Tr      References & Index    References & Index	Data Acquisition	Geographic Information Systems and Mar
GIS Applications: Which Map to Use?      GIS Applications: Which Map to Use?      Topography and Base Maps?    Topography      Map Design    Map Design      Statistical Mapping    Statistical Mapping      Cartographic Tools    Atlases      Advanced Mapping Environments    Map Design      Cartography at Work: Maps as Decision Tr    Cartography at Work: Maps as Decision Tr      References & Index    References & Index	Map Characteristics	Data Acquisition
GIS Applications: Which Map to Use?      Topography and Base Maps?    Topography      Map Design    Map Design      Statistical Mapping    Statistical Mapping      Cartographic Tools    Atlases      Advanced Mapping Environments    Maps and the World Wide Web Geovisualization      Cartography at Work: Maps as Decision Tr    Cartography at Work: Maps as Decision Tr      References & Index    References & Index		Map Characteristics
Map Design  Map Design    Statistical Mapping  Statistical Mapping    Cartographic Tools  Cartographic Tools    Advanced Mapping Environments  Mapping Time    Cartography at Work: Maps as Decision Tr  Cartography at Work: Maps as Decision Tr    References & Index  References & Index	GIS Applications: Which Map to Use?	GIS Applications: Which Map to Use?
Map Design  Statistical Mapping    Statistical Mapping  Statistical Mapping    Cartographic Tools  Cartographic Tools    Advanced Mapping Environments  Mapping Time    Cartography at Work: Maps as Decision Tr  Cartography at Work: Maps as Decision Tr    References & Index  References & Index	Topography and Base Maps?	Topography
Statistical Mapping  Cartographic Tools    Cartographic Tools  Atlases    Cartographic Tools  Mapping Time    Advanced Mapping Environments  Geovisualization    Cartography at Work: Maps as Decision Tr  Cartography at Work: Maps as Decision Tr    References & Index  References & Index	Map Design	Map Design
Cartographic Tools  Atlases    Advanced Mapping Environments  Mapping Time    Cartography at Work: Maps as Decision Tr  Cartography at Work: Maps as Decision Tr    References & Index  References & Index	Statistical Mapping	Statistical Mapping
Cartographic Tools  Mapping Time    Advanced Mapping Environments  Maps and the World Wide Web    Cartography at Work: Maps as Decision Tc  Cartography at Work: Maps as Decision Tc    References & Index  References & Index		Cartographic Tools
Advanced Mapping Environments  Maps and the World Wide Web Geovisualization    Cartography at Work: Maps as Decision T( References & Index  Cartography at Work: Maps as Decision T(		Atlases
Advanced Mapping Environments  Geovisualization    Cartography at Work: Maps as Decision T(  Cartography at Work: Maps as Decision T(    References & Index  References & Index	Cartographic Tools	Mapping Time
Cartography at Work: Maps as Decision Tr References & Index References & Index	Advanced Manning Environmente	
References & Index      References & Index	Advanced wapping Environments	Geovisualization
	Cartography at Work: Maps as Decision To	Cartography at Work: Maps as Decision Te
Color Plates Color Plates	References & Index	References & Index
	Color Plates	Color Plates

### Edition 3 (2010, 243 pages)

	100
ToC & Preface	
Geographical Information Science and Ma	Geo
Data Acquisition	Dat
Map Characteristics	Ma
GIS Applications: Which Map to Use?	GIS
Map Design and Production	Ma
Topography	Тор
Statistical Mapping	
Mapping Time	Sta
Maps at Work: Presenting and Using Geos	
Maps at Work: Analysis and Geovisualizat	
Cartography at Work: Maps as Decision Te	Ma
References & Index	Ma
	Ma
Color Plates	Car

### Edition 4 (2020, 252 pages)

Geographical Information Science and Ma Data Acquisition Map Characteristics GIS Applications: Which Map to Use? Map Design and Production Topography Statistical Mapping Mapping Time Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat Cartography at Work: Maps as Decision Tr	ToC & Preface
Map Characteristics GIS Applications: Which Map to Use? Map Design and Production Topography Statistical Mapping Mapping Time Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat	Geographical Information Science and Ma
GIS Applications: Which Map to Use? Map Design and Production Topography Statistical Mapping Mapping Time Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat	Data Acquisition
Map Design and Production Topography Statistical Mapping Mapping Time Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat	Map Characteristics
Topography Statistical Mapping Mapping Time Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat	GIS Applications: Which Map to Use?
Statistical Mapping Mapping Time Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat	Map Design and Production
Mapping Time Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat	Topography
Maps at Work: Presenting and Using Geos Maps at Work: Analysis and Geovisualizat	Statistical Mapping
Maps at Work: Analysis and Geovisualizat	Mapping Time
	Maps at Work: Presenting and Using Geos
Cartography at Work: Maps as Decision Te	Maps at Work: Analysis and Geovisualizat
References & Index	References & Index

RESEARCH OBJECTIVE

METHODOLOGY

RESULTS

CONCLUSION & OUTLOOK

# Codes Found & Categories Formed 11 🔛



Copyright	Educatio
Definition	Web
GDI	File Forr
International	GIS
Toponym	Remote

ducation Veb Tile Format GIS Remote Sensing Generalisation Hardware Software Multimedia Participation Printing Animation Atlas Database Visualisation Design User

- GDI and Geodatabases
- Electronic Atlases
- Animation, Multimedia, and Web Mapping
- Map Production
- Remote Sensing Technologies and Applications
- Semantics and Policies

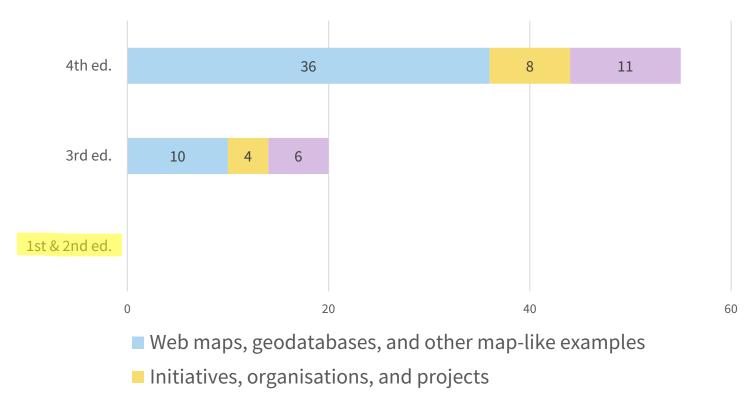
RESEARCH OBJECTIVES

METHODOLOGY

RESULTS

## **Evolution of Web Resources**

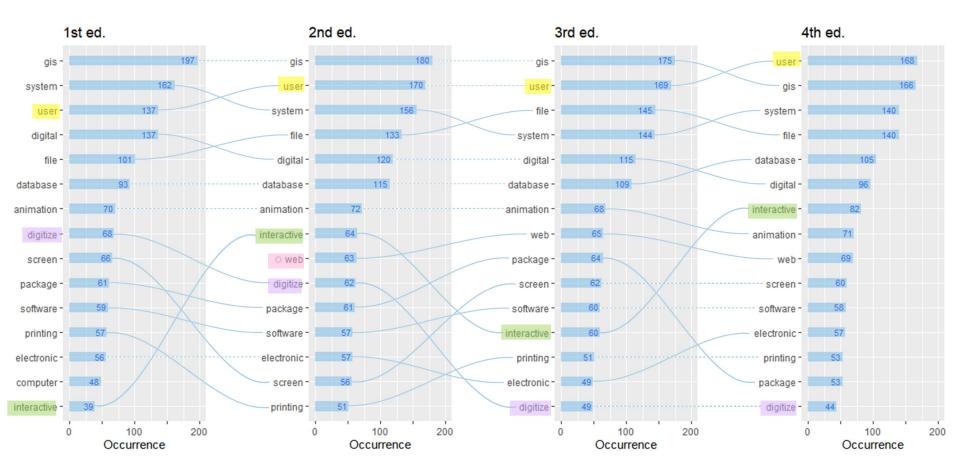




Other web resources (Wikipedia, toponyms, etc.)

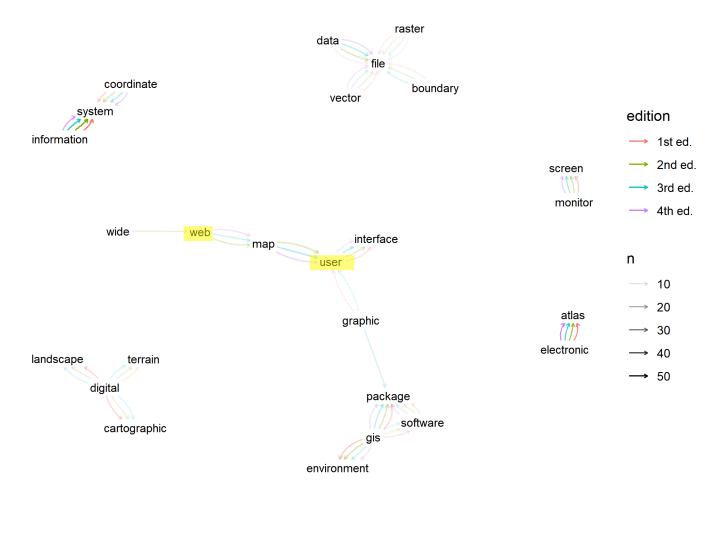
## **Occurrence of Digital Keywords**





BACKGROUND RESEARCH OBJECTIVES METHODOLOGY RESULTS CONCLUSION & OUTLO

## Bigram Analysis of Digital Keywords III 🔛 😳 🍥



GROUND RESEARCH OBJECTIVES METHODOLOGY RESULTS CONCLUSION



- 1. Background
- 2. Research Objectives
- 3. Methodology
- 4. Results
- 5. Conclusion and Outlook

## Conclusion



- The strongest current observed in both textbooks is the emergence and proliferation of computer-based GIS and the web and their influence.
- The number of hyperlinks included in textbooks has constantly increased.
- Words related to web mapping are significantly used more often with the progress of editions.

## Suggestions for Future Research



- Identifying the optimal intersection of the dataset size between content analysis and text mining.
- Exploring novel ways to exhibit the changes in textual data.
- Integrating the non-textual content (i.e., diagrams, maps) to the analysis.



Please feel free to ask questions and give comments regarding the project.