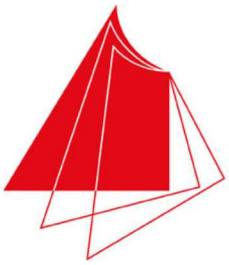

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Master Thesis

Development of e-Learning tutorial for GIS

Place	:	Karlsruhe University of Applied Science (HSKA) Information Management and Media (IMM) International Master Program Geomatics
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Aufgabenstellung

für die

Master-Thesis

von

Herrn Dilip Kumar B i s w a s

Titel: **ENTWICKLUNG VON LERNMATERIALIEN FÜR DEN GIS-UNTERRICHT**

Einführung

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Aufgabenstellung

- Entwicklung eines Konzeptes zum computerunterstützten Lernen für die Lehrveranstaltung Grundlagen GIS
- Realisierung eines Systems in Form von mehreren kleinen Lehreinheiten
- Systemtest mit Probanden

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Beginn:	1. März 2014	Korreferent:	Prof. Dr. habil. Mark Vetter
Ende:	1. August 2014		

Prof. Dr.-Ing. H. Saler

Declaration of Authorship

I declare that the work presented here is, to the best of my knowledge and belief, original and the result of my own investigations, except as acknowledged, and has not been submitted, either in part or whole, for a degree at this or any other university. Formulations and ideas taken from other sources are cited as such. This work has not been published.

Karlsruhe, 12th August 2014

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Dilip Kumar Biswas

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Abbreviation

AOI	:	Area of Interest
CDT	:	Component Display Theory
CSS	:	Cascading Style Sheets
CSS3	:	Cascading Style Sheets, Level 3
ELAN	:	e-Learning Academic Network Lower Saxony
ELITE@TUB	:	e-Learning in Tertiary Education at Technical University Berlin
ESRI	:	Environmental Systems Research Institute, Inc.
FerGI	:	Distance Learning Materials Geoinformatics
FID	:	Field Id
GIS	:	Geographic Information System
GITTA	:	Geographic Information Technology Training Alliance
gvSIG	:	Special type of GIS software
HCMm	:	Hexa-C Metamodel
HTML	:	HyperText Markup Language
HTML5	:	HyperText Markup Language, Level 5
IMM	:	Information Management and Media
JPEG	:	Joint photographic Experts Group, image format
OER	:	Open Educational Resources
PDF	:	Portable Document Format
PHP	:	Hypertext Preprocessor
PNG	:	Portable Network Graphics
QGIS	:	Quantum GIS
SVG	:	Standard Vector Graphics
UTM	:	Universal Transverse Mercator
W3C	:	World Wide Web Consortium
WGS	:	World Geodetic System
XML	:	Extensible Markup Language
ZIP	:	Postal Codes

Abstract

This Study will give the concept how to work with the spatial analysis tools of ArcGIS, especially with the overlay functions like Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union. The students can use this e-Learning tutorial, which is considered the didactic and pedagogical aspects of learning from the e-Learning of GIS.

Chapter one defines the introductory part of the e-Learning module. The objective of the study will focus in this chapter. The scopes and limitations of the study will be also described in this chapter.

Chapter two will highlight the theoretical aspects of e-Learning taken from the secondary sources, which is termed as literature review. In this chapter you will find the logical and theoretical overview of e-Learning aspects; the models and forms for effective e-Learning, the components of e-Learning model and the pedagogical aspects of e-Learning development process.

Chapter three focuses the information of the e-Learning overview of GIS in Germany. This will give the ideas of the e-Learning modules of ELAN, ELITE@TUB, ESRI, FerGI, FreeGIS, geoinformation.net and gimolus. It will highlight the contents and technical aspects of e-Learning overview of different e-Learning tutorial in Germany.

Chapter four is for the methodological overview of the e-Learning development process of this tutorial. It includes a spiral model development, which defines the planning, pedagogical requirements, developing prototype, trailing, implementation, course delivery, evaluation and post-course evaluation and reflection of the e-Learning tutorial of GIS.

Chapter five will give information about the overlay functions of spatial analysis regarding Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union of GIS. Each of these functions are described with the practical example along with different situation analysis.

Chapter six generate the information regarding the development process of web-development, which is done with the different techniques e.g. GIS, HTML5, CSS3, JQuery, JavaScript, SVG and Adobe Illustrator. After following the development techniques, the students will be able to develop the same web or to maintain the further development of the e-Learning module.

Chapter seven will discuss the analysis with the result oriented discussion of the Study. This gives the ides of the spatial analysis regarding the results of Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union which is performed in chapter five through ArcGIS. There are also the mathematical concepts of each individual functions of geoprocessing, upon which these functions work in other GIS software.

Chapter eight highlights the summary of the expected output, conclusion and recommendations and also the further work for the development and maintenance of the e-Learning tutorial.

1. INTRODUCTION

1.1 Introduction

The e-Learning tutorial, will give you the theoretical and technical knowledge of different spatial analysis functions of ArcGIS, as well as other GIS related software like QGIS, gvSIG etc. Under this tutorial you will find different sub modules of learning materials, which is based upon several practical examples with geo-spatial data. All the examples are based of hypothetical, you can use the same way to perform your desired overlay functions for spatial analysis. If you follow the tutorial step by step, you will be able to work with different overlay methods, especially Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union.

This study will be helpful for the bachelor and master students of the faculty of Information Management and Media (IMM). To have a basic idea about GIS, several tutorials with audio and video support, which are available after in this study. After learning the study materials from the e-Learning, the students will be able to evaluate themselves by answering several multiple choice questions and can review themselves.

1.2 Objective of the Study

In the descriptive part, there will be more details of every overlay functions of geo-processing tools of ArcGIS, including the definition of each functions, tips and cautions to work with raster as well as vector data, analysis of different functions, steps of geo-processing from ArcGIS which will be described the attribute table of geospatial features with the practical works along with the scientific discussions of individual results.

In website for the e-Learning there will be the results of the ArcGIS functions, with dynamic methods, so that the students can identify the attribute table of the geo-spatial features. The generalized questions will be highlighted in the website along with each of the topics, to understand the theoretical part in website. The situation analysis is the benchmark of the research, where the students can identify different situations and can use the methodological approach for deciding the suitable overlay functions in the real world examples. The practical work of the ArcGIS will give the students, the use of different geo-spatial data for various overlay functions and can use their knowledge within different geospatial problems.

The technical point of view is to develop the interactive website for the e-Learning tutorial, with different technical aspects in different phases; such as using the SVG, which is the exported file from ArcGIS. The reason of selecting the SVG format is described in the technical part of development process. After selecting the SVG format, the suitable rendering has been performed by Adobe Illustrator, for taking the PNG, JPEG and SVG format. Here both the JPEG and SVG format of results are used in the website for the interactivity among the components of the website. The PNG format is used for the report, as PNG gives the best quality image. The SVG is an XML format, which is selected to get the better quality of features and to make it interactive. CSS3, HTML5, JavaScript and jQuery will be used to make the website interactive between different components of the website. For the better understanding of the tutorial, several video and audio files will be attached in the website.

1.3 Scope and Limitations of the Study

This thesis paper was conducted to develop the study materials for the students of IMM to support them with the technical and theoretical help of GIS. In order to support this several small units of learning materials were developed. Upon several Geospatial Phenomena of GIS, overlay functions, as well as geoprocessing functions are used as one of the useful tools in ArcGIS for spatial analysis. The overlay functions are related to simple to complex phenomena, according to the demand of analysis. It is necessary for the students to understand different geospatial related real world problems. This study will focus the overlay functions of ArcGIS, and with the results from the ArcGIS and the scientific discussions of the results; an interactive website was developed for the students to understand the overlay functions such as Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union.

In the theoretical part of this study you will find the theories, practices with the different overlay functions of ArcGIS as well as the practical examples which is performed with different spatial phenomena of the real world. The website is focused on the practical part of the study, where you will find the interactive elements in website, which is directly linked and animated with the several analysis results regarding the geo-spatial problems. Moreover, the raster and the vector data which is obtained from after the GIS analysis, were interactively developed in such a way, so that you can perform and switch to different pages, regarding your demands of need. Different slideshows were developed relating to different spatial analysis. For the better understanding to work with ArcGIS, several YouTube videos are added in the website, so that the students can have better understanding how to work with the ArcGIS 10 with several spatial analysis. By following each individual tutorials the students will be able to work with different spatial related problems.

GIS contains the great platform for the spatial analysis and contains huge material for learning the spatial analysis for the interpretation of geographically referenced data and is used to geographic information systems for the data capture, data management, spatial modeling, spatial analysis and cartographic visualization. It is limited time to work within six months to have an effective results. Moreover, it was difficult to select the content materials at the beginning of the study. After having the precise contents, the next problem was to develop the study materials by following the pedagogical aspects of the e-Learning tutorial, as the learning process varies from individuals to individuals. With several discussions with the supervisors and depending upon several prototypes, a final version of the e-Learning material for this study was developed.

The study fails to interact directly with the client and server interface, which supports interactively working both from the students and from the tutor point of view. The chat based feedback and the webinar session is not included in this study. By using the video and the audio signals to link participants at different and remote locations, can be also termed as Videoconferencing, which is not present in this study. So the real feedback from both the students and from the tutor point of view does not support in the study phase. With the choice of interest, the students can only use this e-Learning tutorial and can solve their spatial related problems of above described spatial analysis functions.

2. THEORETICAL BACKGROUND

Computer-based learning can be classified in several types, e.g. as distance learning, online learning and e-Learning (Moore et al. 2010, p.129-130). Distance learning is normally offering the access to them who are geographically distant. The instructional delivery of distance learning of pervious time period was offered by an instructor, who was physically located in a different place from the learner. It also provides the instructions at disparate times (Moore, 1990 & Dede 1996, p. 1) illustrated the distance learning by including a comparison of the pedagogical methods, which are used in traditional environments and referring to the instruction as "teaching by telling". Now a days the system has changed, there are numerous e-Learning tutorial, where the tutor is not present. The e-Learning is used to mean the geographical influence on this study. Keegan (1996) suggested the distance learning as an "umbrella" term, or correspondence education, which helps the students to learn parallel with their study. Thus the term "distance learning" is evolved to describe other forms of learning with the variation of time, such as online learning, e-Leaning, mediated learning, online collaborative learning, virtual learning and web-based learning (Conrad, 2006). Different types of learning is illustrated below to understand the differences among them.

In the early period, beginning of 80's, e-Learning is originated, within the same time frame of other delivery mode of online learning (Moore et al. 2010 & Nichols 2003) illustrated e-Learning as technical tools that can be either web-based, web-distributed, or web-capable. The instructional method is also depicted with their description. The media of e-Learning is delivered via CD-ROM, the Internet or an Intranet (Benson et al. 2002; Clark, 2002) but also with audio-and videotape, satellite broadcast and interactive TV. Triacca et al. (2004) defined e-Learning as a type of online learning. Here the different uses of e-Learning technical aspects are illustrated.

Buzzetti-More (2008, p.113) depicted that the e-Learning can be either fully online, mixed mode or hybrid method or web assisted technique. Kandies and Stern (1999) illustrated Web-enhanced learning improves instruction, course management and offers numerous pedagogical benefits for the students. It can be open and distributed learning environment by using the pedagogical tools, which is enabled by internet and web based technologies to facilitate learning and knowledge building through meaningful action and interaction both from the tutor and from the learners perspectives (Dabbagh 2005, p.20).

About last twenty years, e-Learning has become a pioneer platform for learning. Moreover, it offers numerous resources than the traditional classroom to facilitate learning. It has also overcome the limitations of time and space of traditional teaching. It allows the learners to learn independently, which means it lacks the supervision and enforcement mechanisms of traditional teaching in classroom (Wang, 2011a). Here the technical evolvement has been defined with the barrier and success and also the evolvement of e-Learning in broad category to serve the purpose of learning.

Dichanz, the German professor of distance University, described e-Learning as the collection of teaching and information packages for further education which is available at any place and is delivered to the learners electronically. They contain units of information, self-testing and tests, which allow quick self-evaluation for quick placement (Rekkedal 2003, p.3). Here the content of it is described with the geographic independence of learning.

Here the e-Learning has been described from the technical point of view again and has been illustrated as it is often seen as the learning platform, where the Internet and the web play a vital role. The term is also employed in a broader sense, namely as learning where any electronic technology is used, but are not electronic such as books. An attempt to define e-Learning is to look at the relationships between e-Learning and some closely related concepts as Internet, Web, online learning and computer-based technologies. (Hadjerrouit, 2007, p. 28)

Hadjerrouit, (2007, p. 28-29) has also described the three main terms of Internet based learning. He has described this term with three different point of view, describing the people use it and interact with this system. Firstly, the concept of internet based learning is broader than the web based learning. The web is only one of the internet services that use HTML, browsers, and URL. Internet also offers many other services, not only web, but also e-mail, file transfer facilities etc. Learning could be based on the web, but also as correspondence via e-mail. Here again the techniques of e-Learning has described.

Secondly, online learning could be organized through any network. Internet-based learning is only a subset of online learning. Thirdly, learning may take place via any electronic medium. It is not automatically connected to a network. Learning includes computer based learning that is not network-based.

Finally, the term is employed in a broader sense, namely learning takes place via combination of face-to-face and e-Learning (Frank et al. 2002). This kind of learning is called hybrid e-Learning. It tries to overcome the disadvantages of pure e-Learning. Again the basic different of different t terms of e-Learning is used here in this study.

To sum up, e-Learning include both network-based (online learning, internet-based learning and web-based learning). Figure 1 describes the components of e-Learning, which gives general idea about this technique with different forms and evolvement.

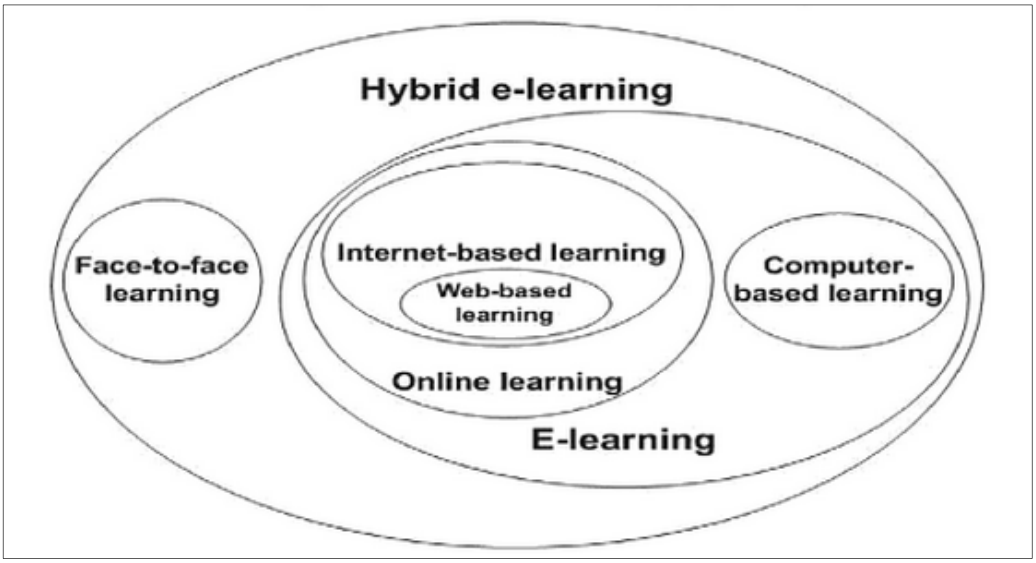


Figure 1 : Components of e-Learning and hybrid e-Learning
Source : Hadjerrouit (2007, p. 29)

2.1 Models and forms for effective e-Learning

For the effectivity of the use of this system it is always necessary to fix the content which is relevant to the users. There are different approaches to build e-Learning course depending on the context. For example, it is not possible to build up e-Learning course that teaches biology in the same way used for teaching any software, so it must be different from each other to meet the goal of users.

Models and forms of e-Learning concerned is shortly described here in the following, which is based upon the Hexa-C Metamodel (see figure 2).

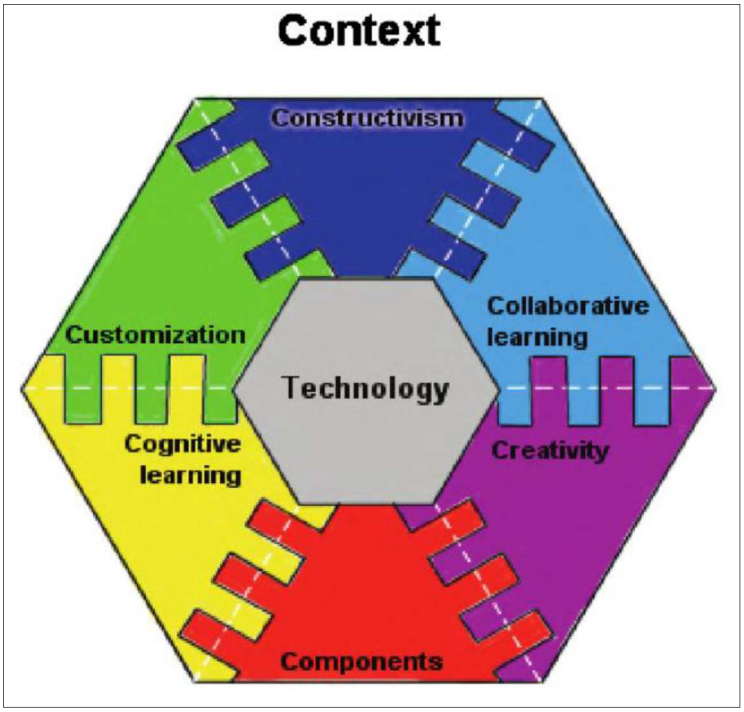


Figure 2 : Framework of the Hexa-C Meta model
Source: Villiers (2002 p.195-196)

2.1.1 The Hexa-C Metamodel (HCMm)

The Hexa-C Metamodel (HCMm) is a synthesis of contemporary learning theories and practices. The model, developed by De Villiers, shown in Figure 2, contains six inter-related elements. They are cognitive learning, constructivism, components, creativity, customization and collaborative learning; which can play a role in the design and development of e-Learning. Since learning content and instruction differ from one situation to another and also from one subject to another, these six elements are embedded within context and are interrelated to each other. The hub of the framework is technology, which is the medium that transfers the message to learn it in effect way (Ssemugabi, 2006 p.46-59).

The detailed description of the components of the Hexa-C Metamodel, which is developed by De Villiers, (2002), also described by Ssemugabi, (2006 p.56-59) can be described as in the following -

2.1.1.1 Cognitive learning theory

It shows learning is related with cognition, formation of knowledge structure, among the learner and retention. Learning is to be treated as the reorganization of internal knowledge structures, as learners construct meaning by integrating the new knowledge with the existence of knowledge of the learners. One of the approach is the incremental introduction of new learning approach by the alternation of learning contents with question segments and interactive activities, to highlight the view of the concept. Sometimes thinking of the depth of topics are fostered by the learners in the context of solving the authentic problems.

2.1.1.2 Constructivism

It depends on learners actively constructing their own knowledge with different problems and can be implemented by educational environments, which support problem-based learning, open-ended learning, flexibility, and authentic tasks to enforce the way of learning. It focuses the learner oriented environments with different activities in which learners their choice of learning ways as tools to search for material, to manipulate information and to develop their own thoughts and use to generate their own products.

2.1.1.3 Components

It refers to the basic knowledge, skills and methods to solve inter related problems, which could be unitary or composite components, as well as decontextualized skills. Merrill (1983), illustrated that it is a way that uses components and is based on relationships between the thought and to perform different steps with the kind of content taught: fact, concept, procedure or principle, and the level of performance required: to remember, use or find.

2.1.1.4 Creativity

The goal of this is to motivate learners intrinsically to engage them and strengthen the affective-cognitive bond. The design of educational applications should be characterized by innovation and learner engagement, which fosters creativity among learners. It is the internal performance to understand the problem solving method in different ways.

2.1.1.5 Customization

This learning focuses the instruction that adapts to individual learners' profiles, supports the personal processes and products, and allowing learners to take initiative with regard to different methods with temporal and geographical and based on the content of learning.

2.1.1.6 Collaborative learning

It is the team work, negotiation with different levels and customs, accountability and peer evaluation. Co-operative problem solving, learning from the practical works, two-at-a-computer or more, has shown itself to be a means of learning and confidence building with the group work. It is optimal in contact situations, but can also be applied in distance learning; for example, by using e-mail, bulletin boards, discussion forums, social forums that provide an infrastructure for teamwork, joint projects, and collaborative problem solving.

2.2 Three components of e-Learning model

Three-component e-Learning model contains three key components, which are working collectively to foster meaningful learning and interaction for a topics and problem solving methods. They form an iterative relationship in which pedagogical models grounded in the situated cognition view inform the design of e-Learning by leading to the specification of instruction and learning strategies that are subsequently enabled or enhanced through the use of learning technologies. Furthermore, as learning technologies become ubiquitous and new technologies continue to emerge bringing forth new affordances, pedagogical practices and social structures are transformed due to the time span of learning forms. Therefore, three-component model implies a transformative interaction affecting e-Learning. Educators and instructional designers can think of this model as a theory-based or grounded design framework that guides the design of e-Learning (Dabbagh, 2005).

2.2.1 Pedagogical models

Pedagogical models are cognitive models or theoretical constructs derived from knowledge acquisition models or views about cognition and knowledge, which form the basis for learning theory. In other words, they are the mechanism by which theory can be linked to practice. Pedagogical models lead to the specification of instructional strategies, which is the second key component of the theory-based design framework for e-Learning as depicted in Figure 3. Instructional strategies are the instructors or instructional systems to facilitate student learning.

Dabbagh (2005 p.29-31) described five different models for the pedagogical model of e-Learning. They are open learning, distributed learning, learning communities, communities of practice and knowledge building communities.

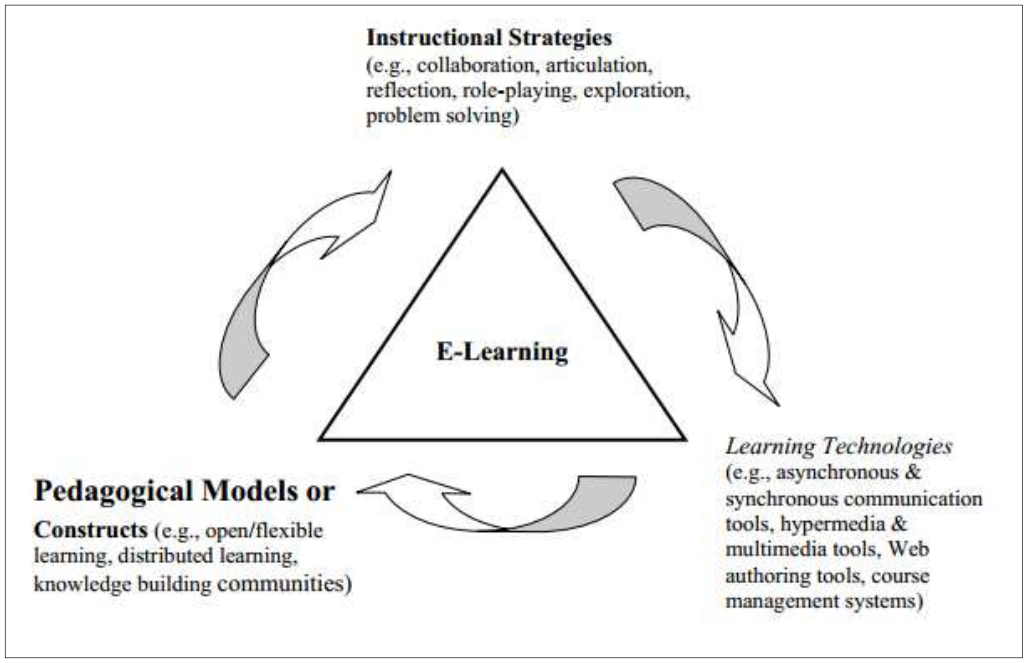


Figure 3 : Three-components of e-Learning model

Source: Dabbagh, 2005, p.32

2.2.1.1 Open learning

It is a new approach which describes distance education where the emphasis shifts from delivering a pre-established curriculum to focus on individual and local needs and requirements, and to open learning places based on here and now (Edwards, 1995). Key principles of open learning are student-centeredness and also to focus on learning rather teaching (The Open University, 2002). Open learning provides the students with flexibility and choice to meet their own educational goals. It can include a variety of non-traditional learning opportunities, like: short courses, night courses, workshops, seminars, conferences, certificate programs, customized training packages, and degree-credit and non-credit distance education courses which can be also informal learning (University of Guelph Office of Open Learning, 2003). Examples of open or flexible learning environments that depends on the use of Internet and Web-based communications technologies include virtual knowledge networks, knowledge portals, asynchronous learning networks, virtual classrooms and tele learning, video-conferencing (Dabbagh, 2005).

2.2.1.2 Distributed learning

It is described as education delivered at any time, at anywhere, to multiple locations, using one or more technologies or none at all (Jones Knowledge, 2000). When telecommunications media is utilized, distributed learning means off-site learning environments where learners complete courses and programs at home or work by communicating with faculty and other students via e-mail, electronic forums, videoconferences, and other forms of computer-mediated communication and Internet and Web-based technologies (Dabbagh, 2005). The California State University Center for Distributed Learning (2003), descried the distributed learning that supports a “pull” model of education where students engage in learning activities at their own pace and at a self-selected time, in contrast to the traditional “push” model of education where students have to synchronize their needs and schedules to the delivery model of the institution. From a pedagogical standpoint of view, distributed learning environments “result in a diffuse sense of cognition - where what is known lies in the interaction between individuals and artifacts, such as computers and other technological devices” (Pea et al. 1990). Here for the e-Learning technique, the computer and electric medium of learning was focused.

2.2.1.3 Learning communities

It define the groups of people who support each other in their learning agendas, working together on projects, learning from one another as well as from their environment and engaging in a collective socio-cultural experience, where participation is transformed into a new experience or new learning (Rogoff et al 1994). Learning communities focus an intentional restructuring of students' time, credit and learning experiences around an interdisciplinary theme to foster more explicit intellectual and emotional connections between students, between students and their faculty, and between disciplines (MacGregor et al. 1999). Learning communities act as academic and social support structures which allow students to learn in more authentic and challenging ways. They are considered as informal learning environments, moving the emphasis from teaching to learning. Communities of practice and knowledge building communities are

synonymous constructs. However, the term learning communities may be perceived as a broader or more loosely defined term that encompasses any social network or infrastructure to bring people together to share and pursue knowledge (Dabbagh, 2005).

2.2.1.4 Communities of practice

Communities of practice refer to “the activity of groups of people informally bound together by shared expertise and passion for a joint enterprise” (Wenger et al. 2000, p. 139). The construct has become popular in the business community and also in organizations that focus on knowledge as an intellectual capital. Communities of practice are different from formal work groups or project teams in that they are defined by knowledge rather than task, and members are self-selecting rather than assigned by a higher authority (Allee, 2000).

2.2.1.5 Knowledge building communities

It refers to the learning in communities where communication is perceived as transformative (resulting in a new experience or learning) through knowledge sharing and generation. Participants in a knowledge building community “share a common goal of building meaningful knowledge representations through activities, projects and discussion” and the instructor or tutor “is an active, learning participant in the community” (Selinger et al. 1999, p. 41). A common goal of knowledge building communities is to advance and share the collective knowledge. Research teams in the scientific disciplines provide a prototypical example although knowledge building communities can also exist in other forms such as film societies or industrial firms. What is defining about a knowledge building community is a commitment among its members to invest its resources in the collective pursuit of understanding (Hewitt et al. 1995).

In addition to this definition, the following attributes apply: (1) globalization and learning as a social process are inherent and enabled through telecommunications technology; (2) the concept of a learning group is fundamental in achieving and sustaining learning; (3) the concept of distance is relatively unimportant or blurred, and is not limited to the physical separation of the learner and the instructor; (4) teaching and learning events are distributed over time and place occurring synchronously and/or asynchronously; (5) learners are engaged in multiple forms of interaction: learner-learner, learner-group, learner-content, and learner-instructor; and (6) internet and Web-based technologies are utilized to support the teaching and learning process and to facilitate learning and knowledge building through meaningful action and interaction (Dabbagh, 2005).

2.2.2 Instructional strategies

Instructional strategies can be described as “the plans and techniques that the instructor uses to engage the learner and facilitate learning” (Jonassen et al. 1991, p. 34). Instructional strategies operate pedagogical models. When implications of learning theory for education are discussed, instructional strategies translate into instructional procedures (Shuell, 1980), resulting in “a plan, method, or series of activities, aimed at obtaining a specific goal” (Jonassen et al. 1991, p. 31). Instructional strategies are therefore derived from pedagogical models, which in turn are derived from learning theory.

Examples of instructional strategies that embody the characteristics of pedagogical models grounded in the situated cognition and constructivist views include: (a) promoting or supporting authentic learning activities; (b) facilitating problem-solving, exploration, and hypothesis generation; (c) promoting collaboration and social negotiation; (d) supporting or facilitating role-playing activities; (e) promoting articulation and reflection; (f) supporting multiple perspectives; (g) supporting modeling and explaining; and (h) providing scaffolding. Overall, the goal of these instructional strategies is to create a learning culture where collaboration, learning with self-awareness, multiple perspectives, and self-management are promoted, and where the role of the teacher is reciprocal, supportive, and communicative as it is responsive to learner needs (McLoughlin et al. 1999).

2.2.3 Learning technologies

Dabbagh (2005, p 34), described the following e-Learning contexts, using learning technologies to solve problems, exploration and to generate Hypothesis of using web authoring tools and scripting languages to develop self-contained instructional modules such as micro-worlds, simulations, and virtual reality environments that engage students in exploratory-type activities. To use digital audio and video to present unfinished excerpts of real world events and occurrences, allowing learners to provide an ending to the scenario and a rationale of why they think it should end the way they envisioned.

2.3 Pedagogical aspects in e-Learning development process

An evolutionary process model is useful to support effective learning from e-Learning. It needs to evolve rapidly in order to ensure the relevance, correctness, and completeness of the content available online. A continuous, incremental and evolutionary development process is of crucial importance for ensuring the quality of e-Learning. (Hadjerrouit, 2007, p. 34).

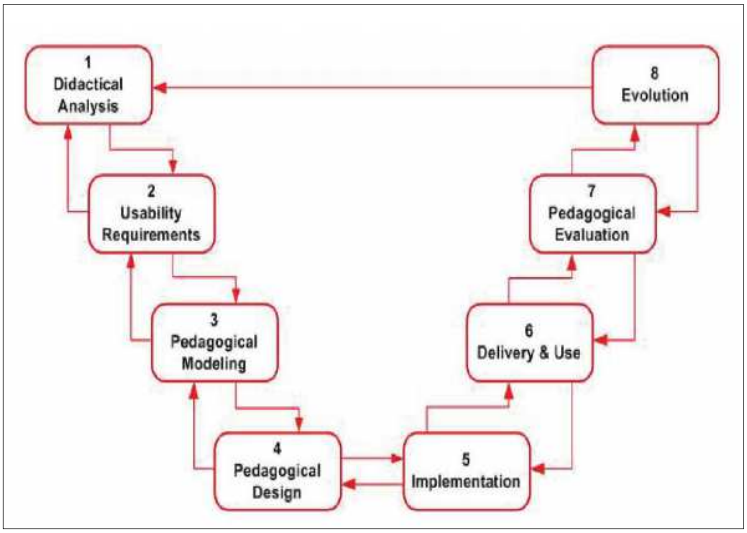


Figure 4 : e-Learning development process
Source: Hadjerrouit, 2007, p. 34

The figure 4 which is depicted above, is the description of different phases of e-Learning which is illustrated by (Hadjerrouit, 2007, p. 34). When applying learning theories to e-Learning, it is necessary to map the theories onto didactic categories. Such mapping is

necessary step in any attempt to examine an e-Learning implementation. The major advantages of adopting such an approach is that it transposes learning theories to a pedagogical model which is understood teachers and instructional designers. A didactical relation model is necessary, which describes the broad principles that can be applied to the design of learning and teaching.

2.3.1 Didactical relational model

A didactical model describes the environment by which teaching and learning take place together. It offers a space where learners can draw upon educational resources and teacher guides to achieve meaningful learning. This environment can be illustrated as didactical relation model (Hiim et al. 1998). The environment describes that the different didactical elements are related to each other, and there is a reciprocal influence between those elements. The didactical relation model consists of six dimensions. They are as learning outcomes, learners' ability, structures and resources, learning content, teaching and learning methods, and assessment methods (Hadjerrouit, 2007).

Hadjerrouit (2007, p.35) described in the Figure 5, the teaching and learning environment based on the didactical relation model" in the following way.

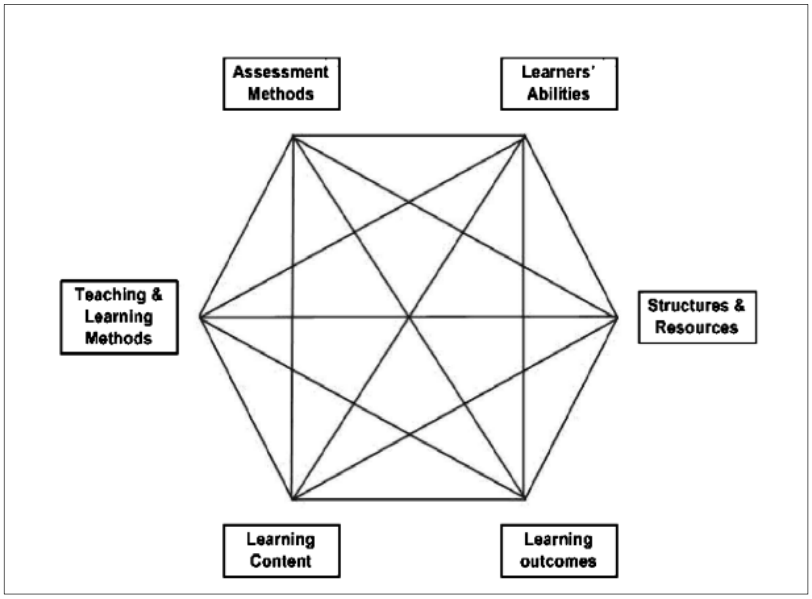


Figure 5 : Teaching and learning environment
Source: Hadjerrouit, 2007, p.35

2.3.1.1 Learning outcomes

Learning outcomes define the activity of the learners about what they should possess after finishing learning activities in terms of concepts, methods, theory, practices, ideas, and principles.

2.3.1.2 Learners' ability

Learners' abilities are the basics by which the prerequisite knowledge of the learners' can be measured. These are the skills, educational background, as well as personal

experiences. In this case if the leaners ability differ from person to person. The person who has the better learner ability, can grasp the knowledge quicker as possible than the others. Also personal trainings and workshops helps this ability to raise in a better way.

2.3.1.3 Structures and resources

These are the technical part, which boost up the learners ability. Structures and resources are such factors which influence the quality of education example can be the technical part also the computer equipment, educational staff, library, books, time table, location, classroom settings, economic conditions, legal and ethical conventions, curriculum, syllabus, etc.

2.3.1.4 Learning content

It defines the learning material which deals with the subject matter, the volume of the topics and subtopics, and how there are broken down into lessons. The more the content, the difficult to divide it in several parts. But a continuous and regular practice with the learning connect helps to understand the learning material. If there are the problems with the learning in content, the students should try better to conduit with other learn partner and try to start a team work.

2.3.1.5 Teaching and learning methods

The learning focus is with the teaching and learning methods are connected with each other and the activities and ways of working, such as lecturing, scaffolding, reading textbooks, doing exercises, performing projects, discussing and collaborating, etc. if the lectures are with the mathematical or social, depends with the students ability to capture the class notes. The learning methods can be always developed in a regular phases. Moreover discussion with the related persons, who are expert in defined topics, can also improve the quality either by formal or informal education.

2.3.1.6 Assessment methods

They are concerned with the process of assessing the students' learning using assessment procedures such as oral and written exams by the teachers, writing a report, performing a projects. Sometime open book exams is also applied to assess the quality of learning.

2.3.2 Usability requirements

In this various steps will be described with the usability requirements, which apply to e-Learning. According to Hadjerrouit (2007, p.41) this can be divided into two parts, such as: Technical and pedagogical usability. It means techniques and methods for ensuring a trouble-free interaction with e-Learning while pedagogical usability aims to support the learning process. Both aspects of usability are closely related to each other (Melis et al. 2003) and so that if the technical usability is better, the quality of learning is also quicker.

2.3.2.1 Technical usability requirements

This means how a system reacts with the content with the convenient, practicable, and usable for the learners. Broadly, Nielsen has illustrated some factors of web usability (Nielsen, 2000) define page and content design. Such as the page design is related to

cross platform, speed of page access, and page linking to other pages. Content design depends on writing for scan-ability and media use. It depends on different topics also with the learner's ability to understand from different type of technical drawbacks.

2.3.2.2 Pedagogical usability requirements

Hadjerrouit (2007, p.41) illustrated the pedagogical usability to divide the learning process into three types with respect to the learning cycle for the users. Out of them behaviorist, constructivist, and dialogue phase. The suitable combination of the requirements produces a pedagogical useable e-Learning. Mayes et al. (2005), described the important pedagogical usability requirements that have to be considered for behaviorism are as following:-

- To break down the subject matters into a hierarchy of small learning units and logically discrete instructional steps to start with the step by step learning.
- To provide a well-structured online presentation of the learning units and instructional steps which can help as a guideline to solve the problem.
- To easy accessibility of the subject and links to related study material which is relevant and user friendly.
- Well-structured description of the subject information using a clear and understandable language, so that it is not difficult to understand the subject matter.

According to Mayes et al. (2005), and Wilson (1998), Pedagogical usability can be described as:-

- Online examples, which are well designed help students to learn quicker with the task-based activities.
- Online presentation of knowledge from previous versions of the e-Learning system that students may adapt and reuse with some modifications to solve new problems.
- The authentic task-based activities taken from real-world situations and online learning material that is intrinsically motivating. The students can learn quickly if the example are based on real world activities.
- Information using various multimedia elements such as text, graphics, sound, animations, etc. which gives the quick view of the event and learn also quicker.
- Online feedback to learners' work and online submissions along with the teacher's feedback.
- Interactive learning is powerful and effective with the educational software for knowledge construction such as simulations, multimedia software, etc.
- Linking of online databases, online journals, software libraries, similar groups, forums to understand the quick view of the study materials.

Frank et al. (2002); Mayes et al. (2005) described the socially learning as the most important requirements for e-Learning which are considered as social interaction, collaborations, and dialogue with the fellow learners, teachers, and other stakeholders. Hadjerrouit (2007, p.42) explained the pedagogical consideration in the context of social perspective as follows:-

- Synchronized communication is accurate time contact such as chats where the participants can communicate with each other directly.

- Asychronized communication as discussion not real time contact which can be with forum, email, messages etc.
- There is a technical way where the teachers and students have the accessibility to a joint whiteboard, where the written or drawn are shared in real-time basis.
- The learners have the permission to submit a project, individually or as a group. Teachers can also share their comments, grades, give feedback, receive reports and documents online.
- Online spaces that can be with the situational needs. This includes leaners can add, modify, customize, manage and delete items themselves.

2.3.3 Pedagogical modelling

Hadjerrouit, (2007, p.43) described the pedagogical modelling by highlighting the users and their functionality in different e-Learning phases as in following way-

Users

The users of e-Learning are teachers, learners. The activity of them are as below-

- Learners use e-Learning to participate in the educational phase. As the learners are the most important users of e-Learning, so the content should be set up such a way to satisfy their educational demands.
- Teachers use e-Learning to provide the upcoming study content, update the existing learn materials, supervision, coaching, assistance and evaluation of the student's learning, participate in discussions, communications and exchange of personal messages.

Functions

It includes the definition and specifications of the set of functional activities that e-Learning must provide for the users. These can be divided as the operations of teaching, and learning operations.

- Teaching operations are to register teacher information, teacher login, update course content (display, create, change and delete course content), review task-based activities, answer questions and requests, assess student learning, check courseware evaluations.
- Learning operations are to register learner information, information of learner login, course content, to perform task-based activities, perform dialogue and group collaboration, working with projects, assessment of performances, and the evaluation.

2.3.4 Pedagogical design

As described by Hadjerrouit, (2007, p.45) it is to divide the e-Learning into five different major components as conceptualization, construction, dialogue, learning assessment and courseware evaluation. The top level of this design is divided into a hierarchical order of the main page presenting the general information, login and registration process.

2.3.5 Implementation

Hadjerrouit (2007, p.47) described mainly two ways of implementing the proposed e-Learning model.

Firstly, it can be implemented from the ground using programming languages, specialized authoring systems, as FrontPage or Macromedia Dreamweaver for web pages, or similar software tools.

Secondly, the model may be implemented by using standard software such as Learning Management Systems as there are the most common modes for delivery.

In addition, independently of the chosen solutions, it is also recommended to modify, refine, and reuse e-Learning components (Krauss et al. 2005 and Rokou et al. 2004). Components may include reusable course units, lessons, exercise, assignments, learning activities, project reports, case studies, past exams, evaluation questionnaires, students' discussions, links to interactive software, and other files, documents, multimedia elements etc.

Hadjerrouit (2007, p.47) illustrated that before the delivery of the e-Learning, it needs be tested systematically. Testing is the process of exercising the system with the internet of finding and ultimately correcting various errors. These errors can be typographical errors, grammatical mistakes, errors in content, errors in graphical and multimedia representations, cross referencing errors and navigations errors.

2.3.6 Pedagogical evaluation

Hadjerrouit (2007, p.47), described about the pedagogical evaluation by pointing out several aspects. He mentioned that the evaluation ensures that the objectives are kept in mind and that the decisions made throughout the phases of usability requirements definition and modeling, design, implementation, and testing are achieved.

Dyson et al. 2003 and Storey et al. 2002 illustrated that there are many methods and instruments that may be used to assess the pedagogical value of e-Learning, for example online standard questionnaires, individual and group interviews, and eventually video-taped observation sessions, are relevant instruments to obtain data on what learners feel and think about e-Learning.

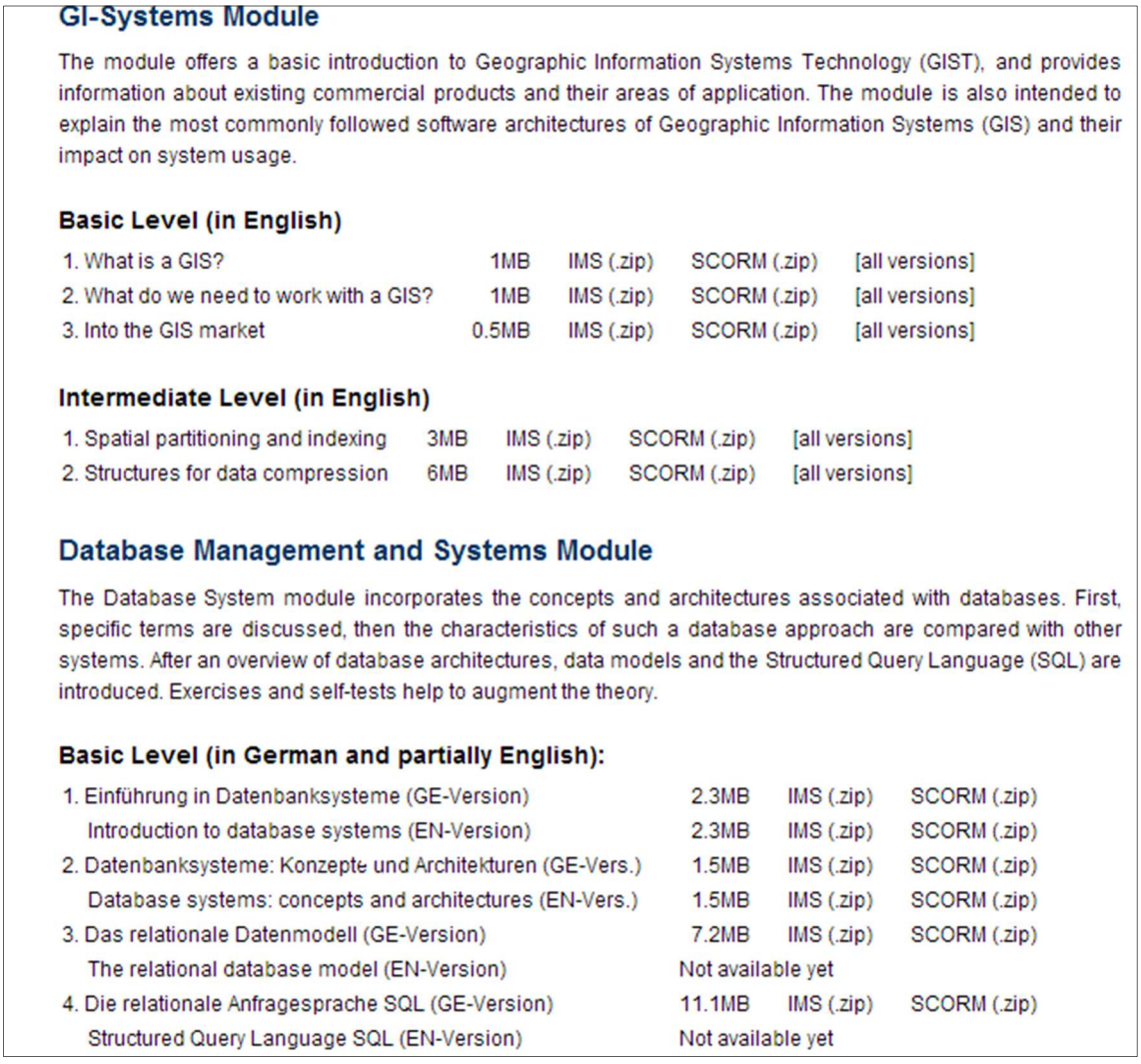
2.3.7 Evaluation

Hadjerrouit (2007, p.48) described evolution by considering, e-Learning undergo change once it is used and evaluated, it is necessary to plan an evolution phase to ensure that the content is updated and revised, and the pedagogy is improved. A continuous evolution is of crucial importance for the quality of e-Learning. The evaluation method varies from type of learning and with the content of learning.

3. E-LEARNING OVERVIEW OF GIS

3.1 Geographic Information Technology Training Alliance

The Geographic Information Technology Training Alliance (GITTA) is a platform to provide the e-Learning content, where the Open Educational Resources (OER) are available. There are over 40 e-Learning lessons covering subject areas of GITTA. They are the basics of geographic information systems, data capture, data management, spatial modeling, spatial analysis and also cartographic representation of geographic data. The content is based on English, German and French languages. In addition, lessons on multimedia are available in this e-Learning. The Internet cartography is also available here. The entire GITTA content was developed by a consortium of ten institutions, which is based upon different universities in Switzerland and released as Open Content, under the Creative Commons license. In 2008 GITTA was among the winners of the Medida Prix, the most important international prize for new media didactics in Europe (see gitta.info, 2014). In the following figure 6, an overview of e-Learning process of GITTA is depicted.



GI-Systems Module

The module offers a basic introduction to Geographic Information Systems Technology (GIST), and provides information about existing commercial products and their areas of application. The module is also intended to explain the most commonly followed software architectures of Geographic Information Systems (GIS) and their impact on system usage.

Basic Level (in English)

1. What is a GIS?	1MB	IMS (.zip)	SCORM (.zip)	[all versions]
2. What do we need to work with a GIS?	1MB	IMS (.zip)	SCORM (.zip)	[all versions]
3. Into the GIS market	0.5MB	IMS (.zip)	SCORM (.zip)	[all versions]

Intermediate Level (in English)

1. Spatial partitioning and indexing	3MB	IMS (.zip)	SCORM (.zip)	[all versions]
2. Structures for data compression	6MB	IMS (.zip)	SCORM (.zip)	[all versions]

Database Management and Systems Module

The Database System module incorporates the concepts and architectures associated with databases. First, specific terms are discussed, then the characteristics of such a database approach are compared with other systems. After an overview of database architectures, data models and the Structured Query Language (SQL) are introduced. Exercises and self-tests help to augment the theory.

Basic Level (in German and partially English):

1. Einführung in Datenbanksysteme (GE-Version)	2.3MB	IMS (.zip)	SCORM (.zip)
Introduction to database systems (EN-Version)	2.3MB	IMS (.zip)	SCORM (.zip)
2. Datenbanksysteme: Konzepte und Architekturen (GE-Vers.)	1.5MB	IMS (.zip)	SCORM (.zip)
Database systems: concepts and architectures (EN-Vers.)	1.5MB	IMS (.zip)	SCORM (.zip)
3. Das relationale Datenmodell (GE-Version)	7.2MB	IMS (.zip)	SCORM (.zip)
The relational database model (EN-Version)	Not available yet		
4. Die relationale Anfragesprache SQL (GE-Version)	11.1MB	IMS (.zip)	SCORM (.zip)
Structured Query Language SQL (EN-Version)	Not available yet		

Figure 6 : e-Learning overview of GITTA
Source : gitta.info, 2014

The GITTA teaching material on the website is continuously updated and compliant with the latest version. This means that the content is constantly changing as it is updated. Use lecturers content GITTA should be taken to ensure that the students always get the same version, otherwise there may be ambiguities.

The modules provide the basic introduction to Geographic Information System Technology (GIST), and provide information on existing commercial products and their application areas. Each module can be downloaded separately and consists of several sub-folders. For each language, there is a separate folder, unless the module is in the form of multilingual. These are then divided into html, image, latex, multimedia and text.

Each module is a detailed description of the subject with subsequent exercises, the learner must edit the exercises with a GIS software.

If an exercise of GITTA edited, the requirement is a pre-installed GIS software. Table 1, represents the most common GIS software products that are used by GITTA. It should be noted that some products are free of charge (e.g. ArcGIS for the student version, which is valid for one year, but students can use the ArcGIS in their study period in different universities at different academic levels), but there are also some demo and trial versions available as well as some are free to use like gvSIG or QGIS.

Table 1 : Overview of GIS Software

Product	**Firms**	**Operating System**	**Cost**
ArcGIS	ESRI	Windows	1 Year Free for students
GeoMedia	Intergraph	Windows	1 Year Free
MapInfo	MapInfo	Windows	Around 2500€ or 20 Days Demo
TNT	MicroImage	Windows, MacOS X, Linux und Unix	Between 3000-5000$ or Free TNTlite Version
Quantum GIS	-	Windows, MacOS X, Linux und Android	Free
GRASS	-	Windows, MacOS X, Linux und Unix	Free

Source : Biswas, 2014

3.1.1 Pedagogical e-Learning module of GITTA

There are several e-Learning tutorials in Germany, out of them Geographic Information Technology Training Alliance (GITTA) is very renowned. GITTA is a platform to learn GIS online, offering e-learning content as Open Educational Resources (OER). It offers a pool over 40 e-Learning lessons which covers the thematic areas such as GI Systems, data capture, data management, spatial modelling, spatial analysis and cartographic presentation (GITTAa). GITTA has developed a didactic model which has six different phases for the pedagogical e-Learning development (GITTAb). The figure 7 gives the elaborate step by step classical example of GITTA e- Learning phase. The entire step is composed with student and tutor together. Which starts with definition of a project. Based upon the project, different problems are analyzed. After analyzing the planning phases are identified. To implement the goal of the project is performed with the identification of tasks with different work flow diagrams, process. With upon the result an evaluation task is done by the tutor. The tutor controls the task and evaluate under different phases. This is the complete process of the e-Learning phases. In the following figure 7, there is the classical example of GITTA study phase, which is used as a didactic model for the e-Learning tutorial of GIS, in the following is the detailed description of this didactic model.

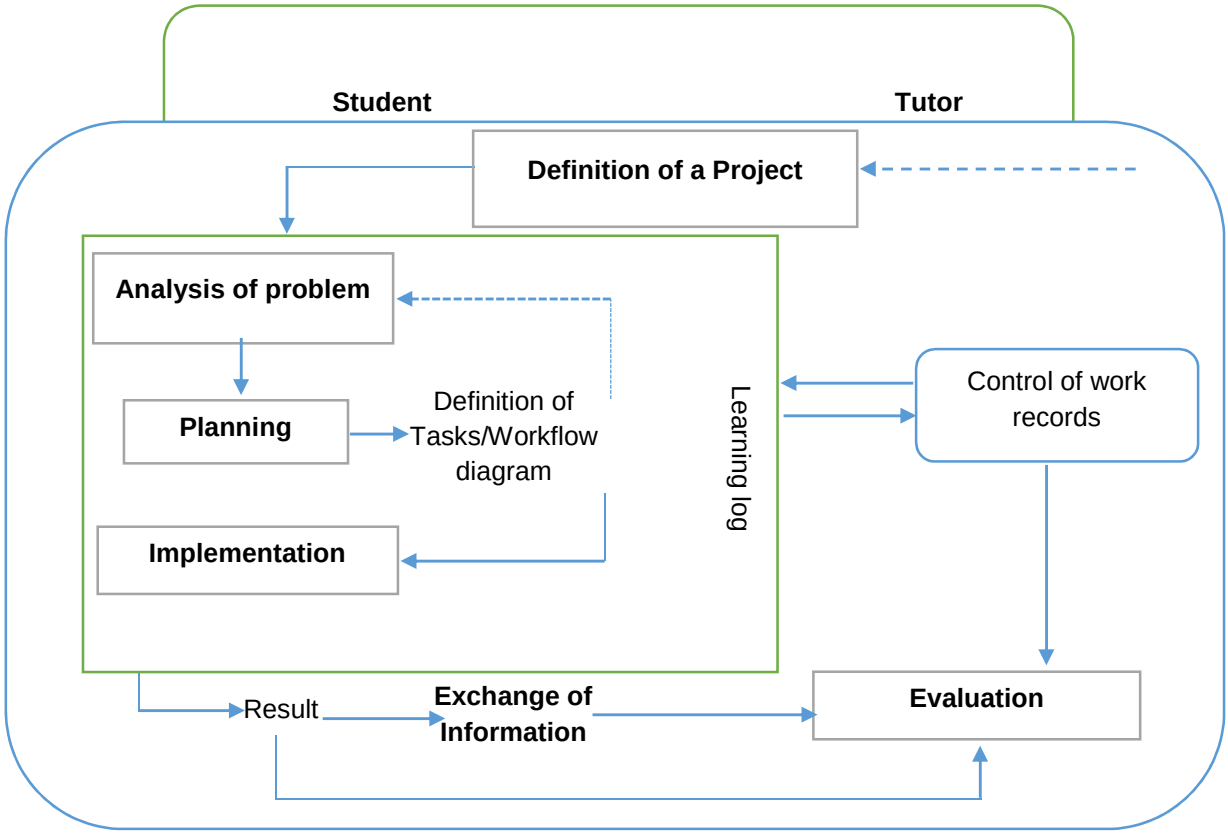


Figure 7 : Classical example of GITTA study phase
Source : GITTAb, 2014

3.1.2 Definition of a project

In this phase, the student will receive the full case study including material and labor for the supplementary information. It is expected form the student's point of view that the students work personally and are familiar with the study material. In the context of a mandatory orientation session, the students have the opportunity to discuss open questions. Following this, the students can begin their work. The students can thereby

divide their work free of choice, but must take into consideration of the predetermined milestones.

3.1.3 Analysis of problems

In this phase, the students will intensively deal with the tasks and target position. Here different approaches will be discussed and the advantages and disadvantages will be evaluated to find the best solution. The "problem-solving-strategies" will be applied here. From this stage it is obligatory for the students to keep a learning diary for regular check of scheduled tasks by themselves.

3.1.4 Planning

Focus of the planning phase is to create work plans and diagrams of work-schedule. The assistance of planning to formulate the "work-techniques". The students can discuss about the work plan or the flowchart with their supervisor before the students start the implementation (Phase 4). If the work plan or the flow chart of the students satisfy the requirements, they can start with the "implementation", if not they have to work again with the problem analysis

3.1.5 Implementation

The students start implementing their planned operations. Focus of this phase is GIS data processing and graphical representation of result or documentation. At this stage, it would be highlighted whether the proposed solution of students lead to success, or whether need to find alternative solution.

3.1.6 Exchange of information

In this stage the result of students can be discussed with the other colleagues of the class and the discussion among the class. There are three objectives of this phase such as a) the result must fulfill the learning goal, b) critical questions and comments about the work, c) to know different solutions and alternative ways.

3.1.7 Evaluation

In this stage the tutor can evaluate the result of students, he/she can check the work-records and can rate the participation of the information exchange phase. There is no direct participation of the students at this stage.

3.2 ELAN

ELAN (eLearning Academic Network Lower Saxony), an interactive self-learning area for the GIS. With the practical example of “Analysis of a forest intervention”, an e-Learning tutorial was developed for the students or for the professionals. It is free of use, the students can easily download the study materials and can reuse for their own purposes. In the figure 8 you will find the overview of ELAN project in Germany (see figure 8).

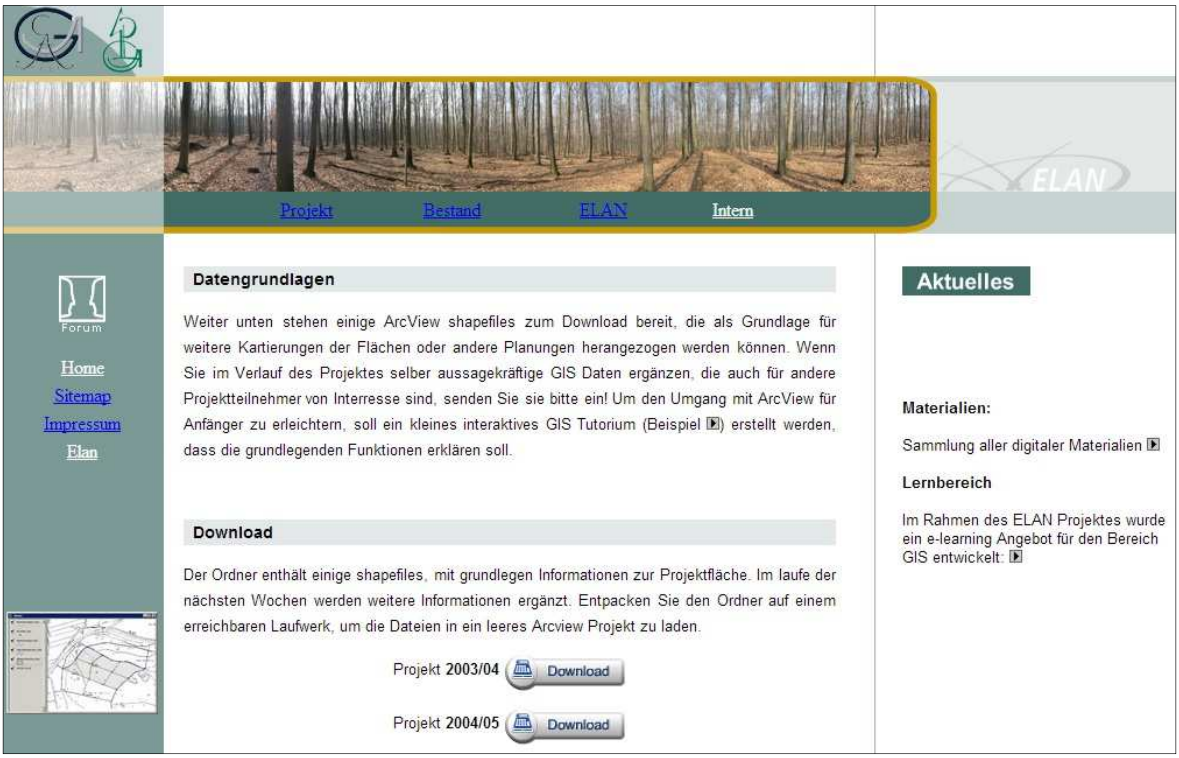


Figure 8 : e-Learning of ELAN

Source : elan.forst.uni-goettingen.de (2014)

3.3 ELITE@TUB

ELITE@TUB (e-Learning in Tertiary Education at Technical University Berlin) is based on developments which is initiated by the members of the department of photogrammetry. Koenig et.al (2004) illustrated that the central idea of the tutorial is to offer students learning material dependent on individual pre-knowledge and skills. With the introduction of the international Master's course 'Geodesy and Geo-information Science' a redesign of the tutorial is in progress, which will allow the students to deal more extensively with remote sensing and GIS topics.

3.4 ESRI

ESRI offers online e-Learning tutorials for the students as well for the professionals. The learners have to pay in order to take part of the tutorial course. GIS plays an important role in teaching, research and administration. There are already no longer just the geographers and environmental scientists that deal with GIS. From archeology to medicine to engineering and economics now use more than 100 academic disciplines spatial analysis functions. Also in administrations GIS is required. It allows the creation of campus maps for web and mobile, it searches for the ideal path for wheelchairs, assisted in the planning of sites or helps company's network analysis. Standard equipment in campus license program is the use of ArcGIS in the campus administration (see esri.de, 2014).

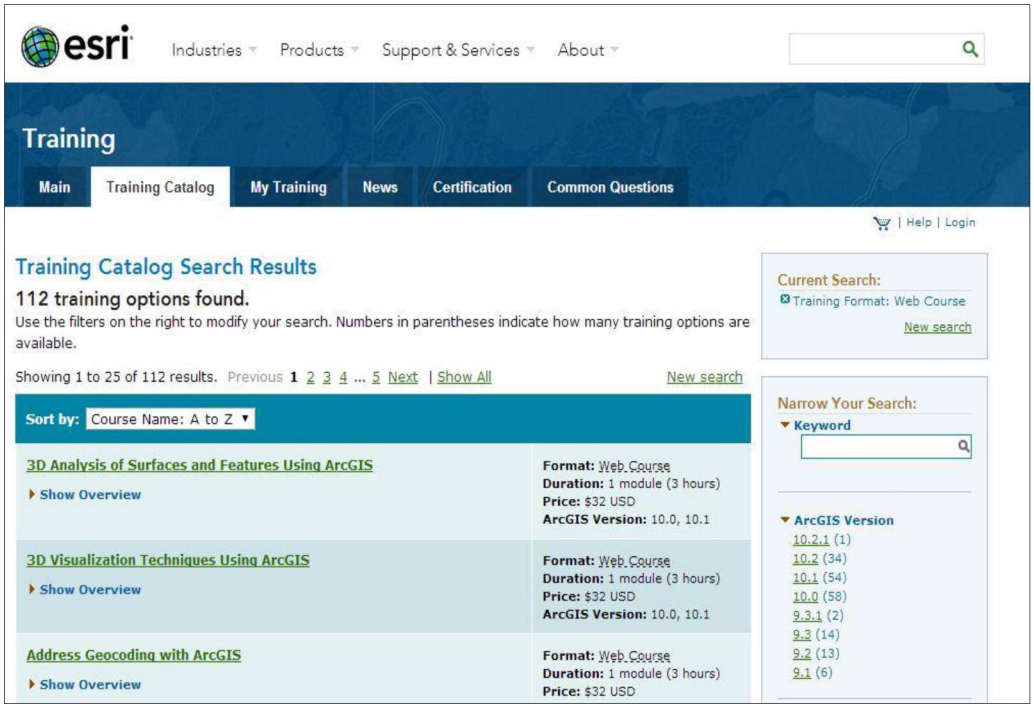


Figure 9 : ESRI e-Learning training overview
Source: esri.de, 2014

Since the processing of spatial information is a very comprehensive and broad and disciplined field, it is important to have the course content well understood. However, if some content is unclear, there is on the ESRI website eLearning courses that are offered as a web course. "ELearning gives you the flexibility to learn when you want, where you want. Self-study courses and training seminars cover a variety of ESRI technology-focused topics "(see esri.com). There are more than 100 online eLearning courses (see Figure 9 above) is available which can be booked for about $ 32 for 3 hours. With the Virtual Campus User License provides the user with free access to all e-Learning courses for a year for nothing.

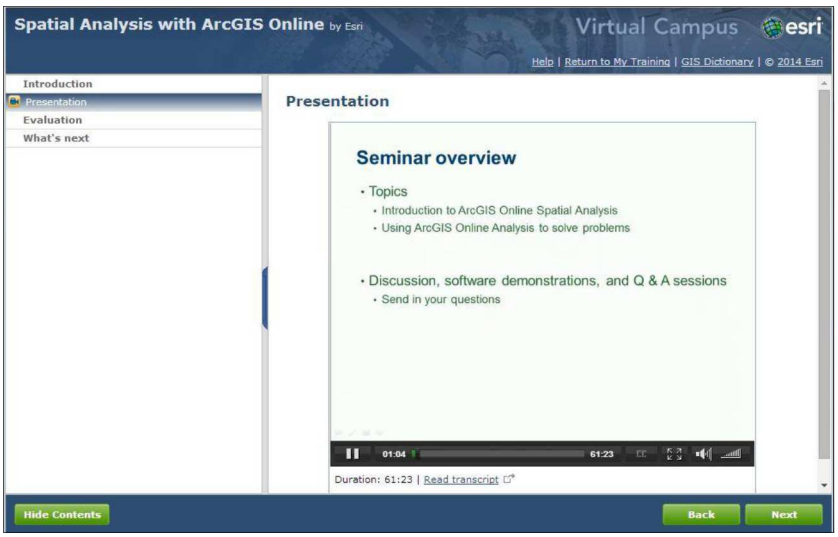


Figure 10 : ESRI e-Learning seminar overview
Source: esri.de, 2014

However, there is also the possibility to log in training courses that last between 60-120 minutes and are also free. In these courses, videos are shown, in which the topics of GIS experts are clearly explained with a desktop recording. At the beginning of each exercise, an overview of the selected topic is displayed (Figure 10). The exercises are very close to reality-designed so that the user can see the usefulness of the tasks required by the program and the instructions of GIS professionals can follow. At the end of each course there is a general survey of the videos and exercises to make the courses more successful or to give ideas to make the courses more interesting (see figure 11).

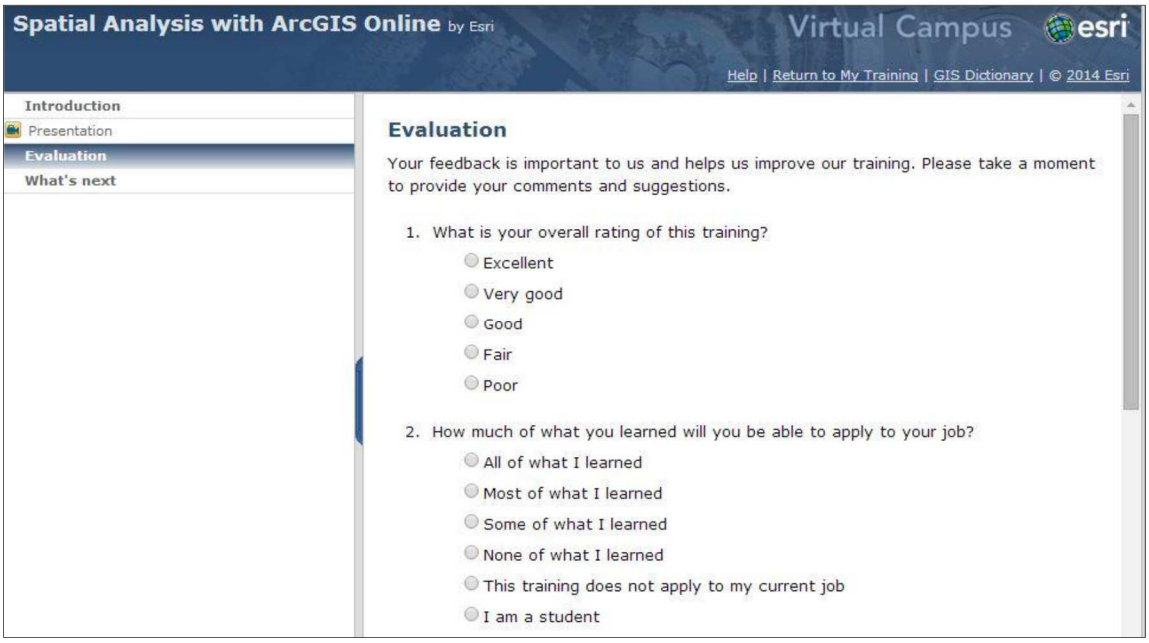


Figure 11 : ESRI e-Learning evaluation overview
Source: esri.de, 2014

3.5 FerGI

The distance learning materials Geoinformatics (FerGI) covers e-Learning projects of Geoinformatics and Remote Sensing in Lower Saxony. The goal of FerGI is to create small and flexible usable e-Learning modules on current and application-related issues of geoinformatics to evaluate and use. Moreover, the updating of existing and development of new modules with the help of a central body such as the Association for the Promotion of geoinformatics in Northern Germany (GIN e.V.) is to be a sustainable basis.

The main target group are mainly the students in the geo-and engineering-science subjects. But also people from business and government, who are interested in a training and development of geoinformatics have the opportunity to finished modules either to use free of charge for a limited time or to buy a certificate of completion in the context of in-service training FERGI @ SMEs. The eLearning modules are therefore suitable both to support and supplement classroom teaching as well as for self-study. (see fergi-online.uni-osnabrueck.de, 2014)

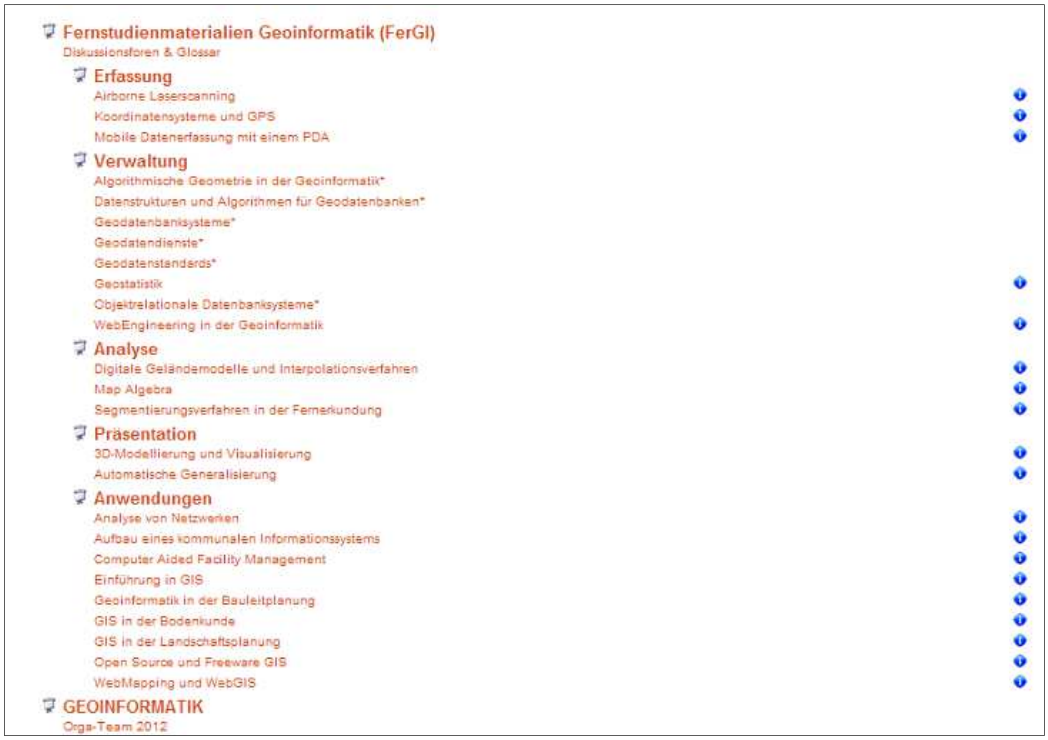


Figure 12 : FerGI e-Learning overview
Source: fergi-online.uni-osnabrueck.de, 2014

In Figure 12, it can be seen that the FerGI has a wide range of modules. There are issues concerning the collection of spatial data, the management of spatial data, the analysis of spatial data as well as other topics such as the presentation and application of spatial data.

The FerGI uses the online platform Moodle, which makes available online "classrooms" in which study materials and learning activities are provided.

For the participants inside of Moodle, there are the following possibilities:

- Operation: intuitive learning environment
- Support: tutor support and learning support
- Cooperation: promoting active engagement with the learning content through group work
- Communication: a variety of contact and exchange opportunities (e-mail, forum, chat) with participants / inside and lecturer / inside, notification by e-mail or RSS feed
- Organization: simple and rapid deployment of learning content and documents

(See moodle.de, 2014)

In addition, each module is divided into different topics. There is the beginning of each module, the topic General will be provided where there are various forums for each module in which FAQs, a glossary, and a list of used or to be recommended literature. Furthermore, there is a master copy of the entire module.

3.7 FreeGIS

The FreeGIS tutorial is a collection of images, videos and Audio data and produced as part of FreeGIS project next to the FreeGIS portal and FreeGIS CD. In the figure 13, you can find the e-Learning content of FreeGIS. An intention is there, but almost bring the users of GIS software, with the exemplary processing of tasks in the fields of surveying, and remote sensing by using free software with paid software and its practical application in these areas.

It is crucial for the inclusion of software in the FreeGIS tutorial that it is free software in terms of the Free Software Foundation (FSF). The Free GIS Tutorial is published under GNU Free Document License in order to give the users the possibility to use it just like the Free Software which deal with under the terms of the foregoing license to disseminate, use and modify.

In order to ensure the unity of software, data and tutorial was largely ensured that the data used are released in one of the General Public License appropriate manner and therefore spread by the FreeGIS tutorial together, can be used and modified. (see freegis.org, 2014).

Figure 13 : FreeGIS e-Learning overview
Source : freegis.org, 2014

In preparing the FreeGIS tutorials, special emphasis was placed on ensuring that can be freely disposed on the used data bases according to the tutorial that they can be changed by any means and that they are further distributable without limitations. Through the help of various companies, student groups or associations the record of FreeGIS is continuously expanded.

Especially by supporting the RWE Rhein-Braun AG, which has provided for the tutorial 10 aerial photographs under the GNU General Public License. This color aerial images have been scanned at a resolution of 21 microns which corresponds to a ground resolution of less than 20 cm. Next to the aerial survey data, control point sketches, coordinates of the control points and with the measurement of calibration, the series measuring chamber are available.

3.8 geoinformation.net

geoinformation.net was developed in a consortium of nine university institutes from the areas of geodesy, geography, computer science, spatial planning and pedagogy. This website supports online learning of GIS, cartography, remote sensing. It comprises 14 coordinated, but self-contained learning modules. Modules are designed to enhance face to face teaching, but can also be used by students for preparation and follow-up work (Dörschlag et al.). For each learning module two versions are available: one version is optimized for supporting lecturers in classes, the other version is for Internet use. This version complements and enhances content of course transparencies with additional text, points out correlations and interconnections and provides tests and exercises.

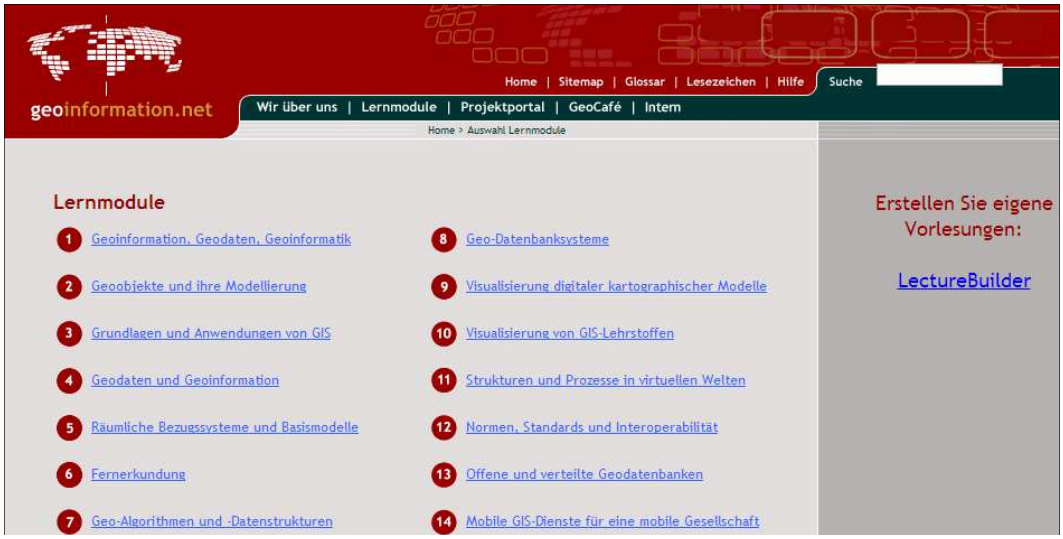


Figure 14 : geoinformation.net e-Learning overview
Source: geoinformation.net, 2014

3.9 gimolus

Gimolus group (partner: Universities Stuttgart, Würzburg, Duisburg and Oldenburg) was developed learning modules for different disciplines in environmental science (Müller 2004). Usage is limited to members of the participating universities. The content of this e-Learning tutorial is GIS and hydrology. In order to enter in this website, you need the login data, which you can get the login information, by requesting the university authority of the University of Stuttgart. After successful log in data, you can have the access on this e-Learning tutorial.

Figure 15 : gimolus e-Learning overview
Source: geoinformation.net, 2014

Table 2 : e-Learning Overview of GIS

Synonym	Internet Address	Topics	Techniques	Partner
ELAN	http://elan.forst.uni-goettingen.de/analyse/gisdaten.htm#	GIS	PDF, Flash	Uni Göttingen
ELITE@TUB	http://www.zewk.tu-berlin.de/v-menue/wissenschaftliche_weiterbildung/e-learning/kursangebot/	remote sensing, photogrammetry, (GIS)	HTML, PHP, Flash, Servlets	Berlin
ESRI	http://www.esri.de/schulung/kursangebot	GIS	JavaScript, HTML	Karnzberg
FerGI	http://www.fergi-online.uni-osnabrueck.de/	GIS, remote sensing, photogrammetry, cartography	HTML, Flash, PDF	Osnabrück, Hannover, Oldenburg, Hildesheim
FreeGIS	http://freegis.org/	GIS	Latex, PDF and HTML	University of Applied Sciences Oldenburg
geoinformation.net	www.geoinformation.net	GIS, cartography, remote sensing	XML, PDF, PowerPoint	Bonn, Karlsruhe, TU-München, LMUMünchen, Uni BW München, Münster, Potsdam
gimolus	http://www.gimolus.org/	GIS, hydrology	XML, PDF,Flash, ArcIMS	Stuttgart, Würzburg, Duisburg, Oldenburg
GITTA	http://gitta.info/website/en/html/website_contact.html	GIS	PDF, HTML	Zürich

Source : Koenig 2006 and Biswas 2014

3.9 Techniques used for e-Learning overview in Germany

The following table will highlight the techniques used for e-Learning tutorial in Germany and also the suggested techniques for developing the e-Learning techniques for this study.

Table 3 : Programming Language used in e-Learning GIS in Germany

Language	Advantages	Disadvantages
CSS	By using this, there are less HTML and JavaScript to code that helps to create less bytes to download. It helps to load the page quicker and easier. It has different versions, which supports different level of styling to page layouts.	The newer version does not support all the browsers.
HTML	One of the updated version is HTML5, supports neater code, has standardized semantics, and supports reduced need for JavaScript codes, which has better accessibility of smart or mobile phone use. It support the database and also the geo-location possibilities.	The main problem with HTML5′s acceptance is that only modern browsers support this. Technically, any of the elements could change at any time, as it is development phase.
JavaScript	JavaScript is very fast and client side script language. It is relatively simple to implement and works independently with the browsers. It is easy to change the codes and helps to reduce load in server side.	The security in this language is not enough to preserve the organizational norms. Anyone can see the codes online with the help of browsers.
JQuery	It helps to perform complicated JavaScript operations with very small line of codes. It has the built in UI and effect libraries for the animations.	Extra JavaScript code to page can be included with this language.
PHP	It is the server side scripting language that works with extensive databases, file systems and images.	Global configuration of parameters changes the language semantics, difficult to deployment and portability.
XML	The advantage is that it provides developers with a tool that is concise and unambiguously, that defines the format of data records.	The parsers are very large with the large memory.

Source: Biswas, 2014

Table 4 : Software used in e-Learning GIS in Germany

Software	**Advantages**	**Disadvantages**
Flash	It is used as lightweight browser which is plugged-in and rich Internet application runtime with the support of audio/video playback. Google Chrome browser has already included Flash Player in-built and they automatically update when new versions of Flash Player are available. More than 96% of users use this software.	It increase the design abuse, and breaks the web contents.
Camstudio3	It is very easy to use, several tutorials give the guideline to use it. Almost all of the YouTube videos for the study purposes are done by this. It's free to use.	The editing in video is complex.
PowerPoint	The tools offered are very user friendly and easy to follow step-by-step.	Sometimes the animations in slides, destroy the quality. The variety of animation available in PowerPoint is tempting for the audience.

Source: Biswas, 2014

Table 5 : Other techniques used in e-Learning GIS in Germany

Techniques	**Advantages**	**Disadvantages**
PDF	PDF protects the intellectual property. This format enables the creator to insert information that's stays with the content so readers can easily retrieve the information. It maintains the printed format.	Browser loading times, destroys user experience, non-standard navigation and non-editable content.
YouTube	It is easy to use, supports all videos types. Learning with the help of YouTube video is widely used.	Abuse of videos, anyone can visit the videos, should impose restrictions using it.

Source: Biswas, 2014

4. METHODOLOGY

The spiral model was first adopted by Calvo. To develop the e-Learning of GIS, the spiral model is used with the incorporation of several items with this model. This model was chosen as, this supports the continuous feedback for the methodological development of learning modules. The Model contains four stages and each of stages has two different parts. It covers an iterative process, which is made up of engineering and educationally driven stages. The engineering stages are namely planning, developing a prototype, implementation and evaluation. These stages are the key element of the methodological process, which covers the four educational stages which are defined as pedagogical requirements, trailing, course delivery and post-course evaluation and reflection. There are two more fields added in this model. One is the story board in the planning phase and the other one is to include the didactic model in pedagogical requirements.

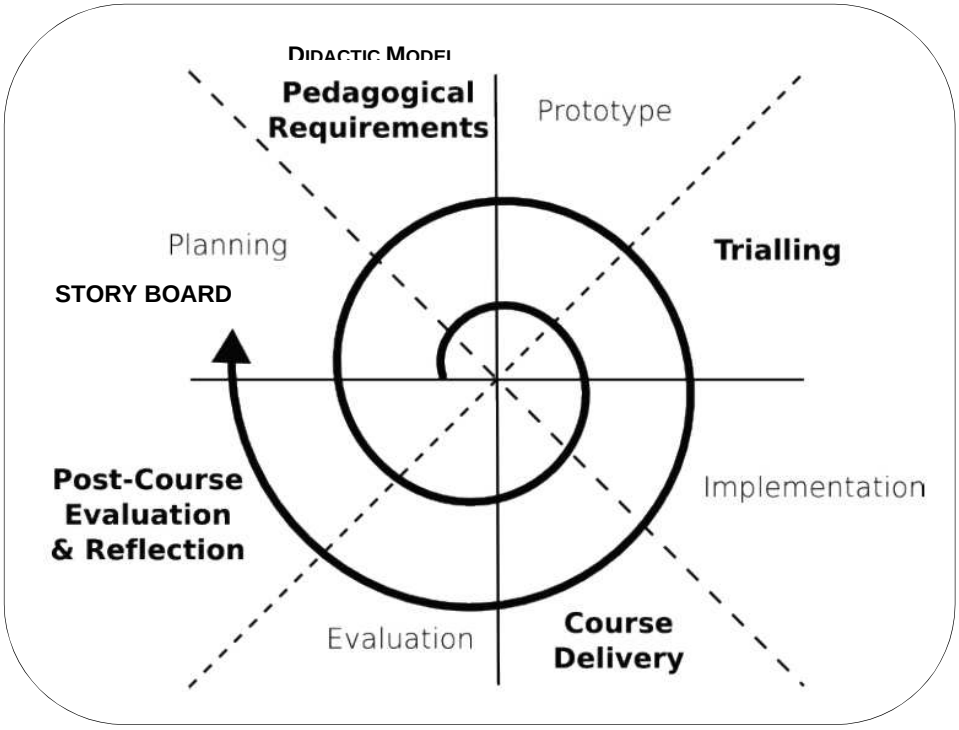


Figure 16 : Spiral model for methodological development
Source: In comparison with Calvo et al. (n.y.)

The figure 16 for methodology which is depicted as above, will be described details as below-

4.1 Planning

This phase covers the planning part for the e-Learning development process. In this early stage of e-Learning development process, several planning was performed which include the pedagogical requirements, developing didactic model, upon which the students can be more benefited by using the e-Learning step by step. In the following several steps are described. At the time of planning phase, storyboard was developed. The storyboard comprised with the sequences of the prototype, to understand how the

tutorial will be interactive after development. Sometime it was developed by sketching in paper as well as also using the PowerPoint slides.

4.2 Pedagogical requirements

Before developing the prototype, the pedagogical aspects were defined and following a didactic model, upon which the user can use the e-Learning tutorial in effective way. These are formed with the control of assessment which is developed at the end of the e-Learning tutorial. The pedagogical aspects were also identified by following the course contents of the supervisor. After analyzing the course content the topics for the prototype was selected. With several discussions with the supervisor and the supervisors the final content was defined. At this time the post-course evaluation was also taken into consideration.

4.2.1 Didactic Model

The figure 17 gives the idea of didactic model to learn from the e-Leaning tutorial of GIS. The didactic model is the process by which the students can learn from this tutorial. The following method is applied here to use this e-Learning tutorial.

First of all the selection of topics for the geoprocessing in ArcGIS. These topics are buffer, clip, dissolve, erase, intersect, merge, spatial join and union. After selection phase there is the dependency of the data sets. In other ward, several time the same data are used like point, line or polygon data. Example cane be given that the locations of schools are used for the point data manipulation. The line data is used for all the streets, which are always same and the polygon data such as the neighbourhoods or the area of interest. In this case the data dependency is shown in the input dataset.

The e-Learning platform is completely interactive to each other functionality. All the raster data, suppose the images are also interactive, by using the slideshow effects among them. Moreover the vector data is also interactive, by using the animation with the tool-tip or mouse over effect, thus the interactivity support can be described here in this part.

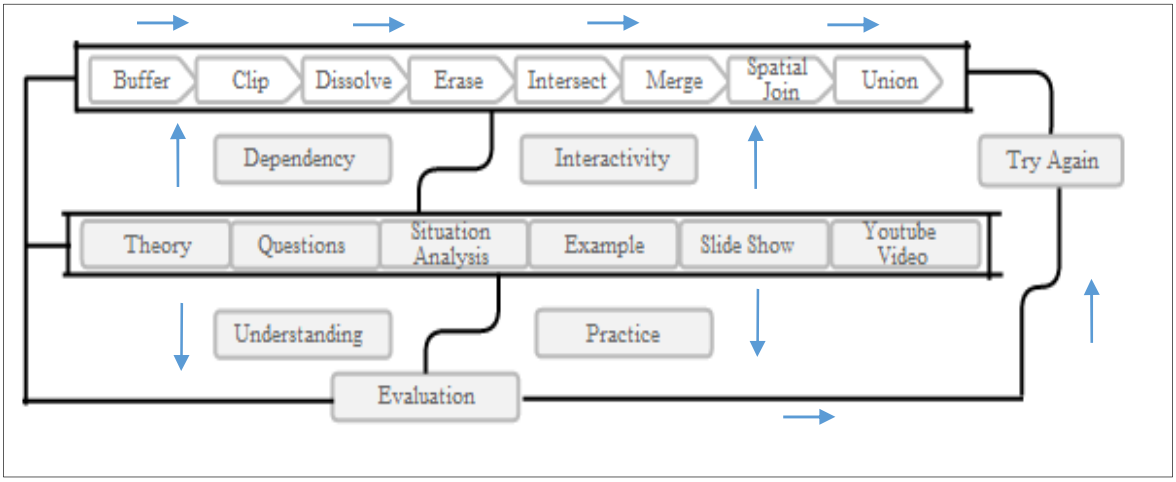


Figure 17 : Didactic model for the methodology
Source : Biswas, 2014

The next step is comprised with theory, questions, situation analysis, example, slideshow and YouTube video. Here in the next page, theses will be described sequentially -

4.2.2 Theory

In the theory part, the basic concept of related topics are defined. It gives the theoretical knowledge about different functions of GIS. Those who are very new to this software has more complexity to work with different spatial problems. The theoretical part of GIS is the key factor to understand and differentiate different spatial problems to deal with and to use the GIS tools in efficient manner.

4.2.3 Questions

There are several questions in this study, especially in the theoretical part. Several individual questions with related topics are included in this section. Different questions have different parameters with the relevant topics. Based upon these questions, the different solutions of the spatial problems will be analyzed and will be solved. By answering different questions with the theory and the practice will give the better understanding of particular problems. That's why in the study paper different questions are used in different spatial analysis.

4.2.4 Situation Analysis

Situation analysis is the major part of this tutorial. Depending upon the various real world problems, the solutions will be discussed with several modules of learning based on the spatial analysis functions. Both in the theory and in the practical part which is described both in the report and in the website is very much helpful for the students, because it gives you the rea world problems describing the different situations or problems which can be solved by using GIS.

4.2.5 Example

Example through the GIS with different spatial overlay functions are performed with GIS as in this example students can learn better. GIS is a user-friendly software, the students can handle it quickly and easily, by using different problem based spatial functions. The focus is to understand, what they are doing and how a particular problem will be solved in GIS with different functionalities of spatial analysis of buffer, clip, dissolve, erase, intersect, merge, spatial join and union.

4.2.6 Slideshow

For the quick review of the output the slideshows are used for the interactivity of image change in the e-Learning. In e-Learning part, the slideshow effects are used to understand different results though geoprocessing. To foster the analytical ability of the students the series of still images on a screen are displayed by the slideshow event in the e-Learning web. The slideshows are the automatically changed at regular intervals of 3 seconds are fixed in the development process as well as it can also have the manually controlled by the students.

4.2.7 Video

Now a days for the e-Learning education purpose, video is used to have the quick overview of the technique. In this study, eight different YouTube videos along with the audio files are added to have the clear understanding about the different functionalities of GIS. It will be very helpful for the students, if they follow the guidelines which are

described. YouTube is used to have the widely use and also for the free of cost to upload. My YouTube account was used for this purpose to upload the videos. The next step was the understanding about the several topics of the contents. Several sub modules were developed, which can help the students to support practices with different datasets, so that they can have clear understanding about the topics.

4.3 Developing prototype

This is the prerequisite to develop a prototype. After developing the prototype, it was tested with different individuals in order to have the feedback. After testing it, the new ideas were also included in the development phase to finalize the expected output which can serve the project meeting its outcomes.

4.4 Trialing

The outcome of this stage is to test the prototype, which needed to test among the students. This step has not been applied, so the trailing period has not come out success, because of semester break, so the focused group of students were not accepted to suggest. But the informal meetings were performed to understand their feedback with different students. Before final implementation, these feedbacks were taken into consideration. Moreover the acceptance of efferent technical experts, also from the supervisor were considered carefully.

4.5 Implementation

To implement the tutorial was the key achievement of this study in order to get the functionality and effectiveness of use of this tutorial. For the functional achievement the e-Learning tutorial was tested to serve the quality assurance. In this study it was an iterative approach, so that the implementation was performed in several steps.

4.6 Course delivery

At the end of the implementation and testing phase, the software will be benefited for the students of bachelor as well as master students of IMM can be used to solve their technical questions with the geoprocessing functionalities, where students are expected to use the software to achieve specific learning outcomes of GIS.

4.7 Evaluation

Evaluation is the judgment of the student's quality about GIS. It is not only going through the tutorials, but also taking part into it. After the evaluation, the students will be able to measure their strength and weakness of various points in spatial analysis. After following the online e-Learning content, an evaluation platform where the GIS Quiz tests are used to justify the knowledge of the students, so that the students can judge themselves with GIS viewpoint and can improve their knowledge by following again the tutorial sequentially also with the YouTube videos.

4.8 Post-course evaluation and reflection

It is also recommended to perform a post-cycle evaluation and reflection for the judgment of the e-Learning project of the GIS. During this phase the data collected for the student's experience will be analyzed, and recommendations from the results are reported.

5. GEOPROCESSING

Geoprocessing is used to manipulate the spatial data and to analyze the data by performing differ spatial overlay operations. Out of several spatial operations, geoprocessing can be done through different spatial functions like buffer, clip, dissolve, erase, intersect, merge, spatial join and erase. In this study these functions will be described sequentially with different type of spatial analysis, basically with the point, line and polygon data.

First of all there are several general questions formed, as with the comparison with different GIS Books published; have some basic questions at the beginning of the topics. The questions are very basic ideas about the topics, which is also formed for the users or the students, who starts with ArcGIS or they are at the beginning stage of learning this software. For the students, who already know the buffer function, can also start at any level of their learning either with this study or from the e-Learning tutorial; depending upon their choice of interest. The text describes the general idea of buffer function, the projection type and the data type used for buffer function. It also gives the answers of the questions, which you will find at the top of the content. Several situations or scenarios are described parallel with the description to understand, where you can use the buffer function. In the chapter seven, you will find the general ideas of buffer function upon which you can distinguish with several other GIS software, where the same idea is applied to understand the buffer function. Here the buffer function is used for point, line and polygon, which are basically vector data. To analyze the buffer function, the following figure for the workflow which is illustrated in the figure 18, is followed for the different steps of geo-processing function. Several results of the buffer function are illustrated in this chapter by giving the results of the practical examples sequentially done by ArcGIS.

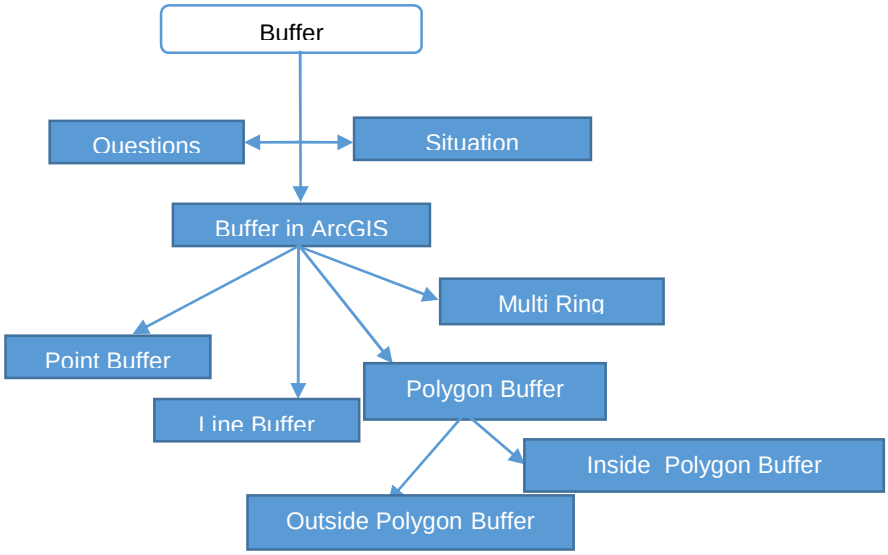


Figure 18 : Flow diagram of Buffer function
Source : GIS Practical Work (Biswas, 2014)

5.1 Buffer

Buffer is used to create polygons around the input features to user defined distance. Here the buffer of point, line and polygon features will be discussed with different situation analysis or problems

Questions

- What is the meaning of buffer?
- Which data can be used for buffer?
- Does ArcGIS support both raster and vector data for buffer?
- Which projection is needed for buffer?

The buffer function is used to create an area from the point, line and polygon features. The buffer distance should not cover large distance example like 10,000 km, which can cause inaccurate buffers to be produced or distortion of the buffer results. The distortion can be completely reduced or avoid in the following ways:-

Use a feature class that has a geographic coordinate system. Use buffer distance in linear units such as meters, feet. It is recommended not to use an angular units like degrees. Before starting work with buffer, select a coordinate system, supposed to work with the Germany map use the coordinate system as “Projected Coordinate System: WGS_1984_UTM_Zone_32N”. The buffer output will be this coordinate system, once you fix it before the creation of buffer of point, line or polygon features. The point features are location of schools in a city, or location of well in an area, or location of bus-stoppage of a city. It will give you the information about the location of point features. The example of line features can be streams, Road network or train line network in a city. The polygon features are waterbodies, administrative boundaries, vegetation types, land parcels or urban areas of the city.

5.1.1 Situation Analysis

You can consider the following example for point buffering -

A City authority is planning to develop the secondary schools. In order to make a database of school locations, the authority is hiring an engineer to fix the coordinate points of school locations. The schools will have enough open space of around 100m. So the engineer will select the school locations first, and then will create a buffer of each school locations of 100m through ArcGIS. Generally in order to create a buffer of point features, you need to understand first, where is the point location, then selecting the buffer of the point features, you can have also different buffer distance value, by giving selecting the individual point features and then by fixing the different value of buffer distance. Here the example of selecting the school locations within the neighbourhoods is a relative example, it can be used for any other location of the world, which has a projection coordinate system, and which fits the user defined requirements.

The example of locating a bus-stoppage in a city can be also done by the city authority. The City authority is trying to renovate the bus stoppage of the city and trying to rebuild the bus-stoppage of 10m area. The engineer will use ArcGIS and perform the buffer function of the point locations, and then will create a buffer distance of 10m, with this result the city planning authority will reconstruct the area of 10 meters

Let us consider also this example as a point buffer. A University Authority wants to make sure that every meter of the main campus is covered by a wireless network. The university has deployed a large number of wireless access points at various points on

campus. The goal of project is to find if the wireless network covers all points in the map shown. For the buffer distance, let's assume that the wireless range of each access point is 300m. Now, let us apply the concept of point buffering for the wireless access points with a buffer distance of 300m. The next step is to remove overlaps. Now the region that do not fall under the resultant buffer polygon(s) are the regions that do not have any wireless network coverage.

You can consider the following example for line buffering -

Line features as we illustrated earlier can be streams, road network or train line can be also used to create buffer by selecting the required buffer distance. Assume that there are many train line networks in a city, out of them we can fix the train number 1; which has a specific network. The city authority is planning to 2m of walking distance from the train line. The network engineer will select the line features from the city map. After selecting the defined route, he/she will work in ArcGIS with Buffer tool. The buffer distance will be fixed as 2m, he/she will run the process and will get the required output. The planning authority will rely upon the result and will construct the new pedestrian or walking zone for the inhabitants of the city. In order to develop a buffer area from the streams or road network, the same process can be applied.

Let us consider also this example as a line buffer. Consider a huge ship, the boundary of which can be modeled as a set of line segments. The owner of the ship want to know if all the deck areas near the edges have been water proofed. For this example, let us say that only deck areas within a distance of 10 meter from any edge need to be water proofed. Now, by applying line buffering to all line segments that form the exterior of the ship with a buffer distance of 10 meter, we obtain a polygonal area that needs to be water proofed. By checking if all area under this polygon have been water proofed, the owner achieves his/her goal.

You can consider the following example for polygon buffering -

Polygon features as we discussed before as waterbodies, administrative boundaries, vegetation type, land parcels or urban areas of a region. The planning authority is planning to grow vegetation area of 100m around the waterbodies. First of all the Engineer will select the waterbodies locations by using ArcGIS, then the buffer distance of 100m will be fixed, after processing by ArcGIS, he/she can determine the area of interest. This technique can be also used for creating buffer distance of administrative boundaries, vegetation, land parcels or urban areas.

It is recommended from the city authority to identify the hazardous chemical storage sites in relation to health care facilities in a city. The purpose of this project is to facilitate the evacuation of the inhabitants to prevent them from the event of a leak oil spill of hazardous materials. The representation of each hazardous material storage location as a point. Each point can be stored with different information relating the hazardous material spread with high as well as low wind speeds. So you can use the buffer function from ArcGIS and set up the required evacuation zone by analyzing the data you get to serve the purpose.

Now, let us look at another real world application of polygonal buffering. Consider a scenario where the University Authority is hosting a special event and hence is planning to create a few make-shift parking spots around the campus. Now, a few rules need to be followed, i.e., no vehicle can be parked within 10 meter of any campus building and

all parking spots need to be off road parking. We can model this situation by buffering polygons around each campus building with a buffer distance of 10 meter. Here we make use of outer polygonal buffering. After eliminating the overlaps, all areas that do not fall under the resultant buffer polygon(s) are free for parking.

5.1.2 Buffer Function in ArcGIS

To describe the buffer function of ArcGIS, here the buffer of point, line and polygon features will be described, along with the buffer of inside, outside polygon and also the buffer of multiple ring buffer. At first the buffer function of ArcGIS will be shown; then the line, point and polygon features will be shown separately as well as with the attribute tables of each features.

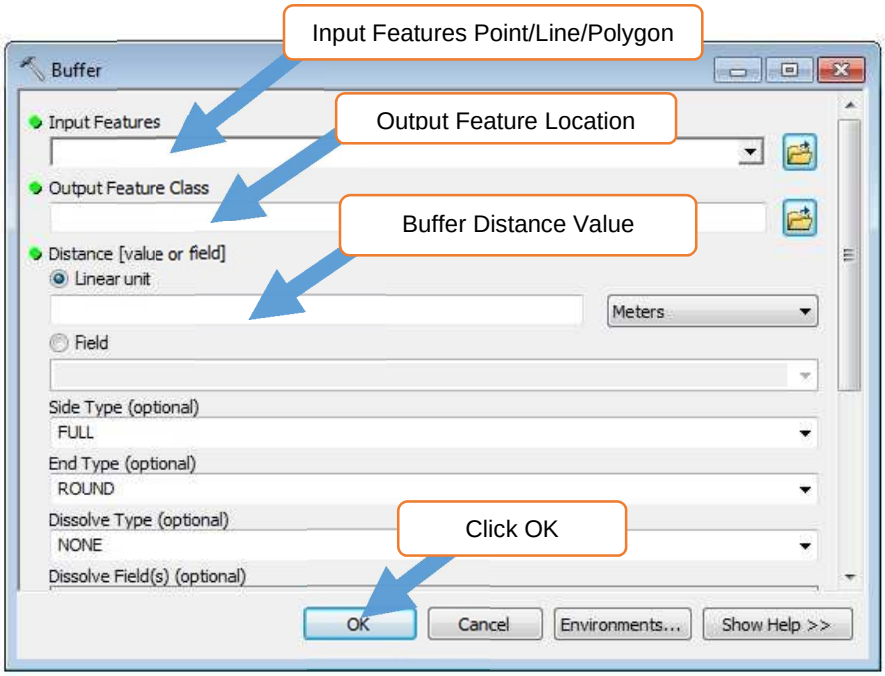


Figure 19 : Buffer function in ArcGIS
Source : GIS Practical Work (Biswas, 2014)

5.1.2.1 Buffer of Point Feature

In input features you can select point features from your location of file. Example can be the location of airport, location of pizza places in a city. The output features of the buffer process is the name of the output buffer area. In linear unit, you can select different units of measurement, as default is in meters, but you can change it as in feet, kilometers, feet, and others unit of measurement required by the user specifications.

In the figure 19, you will find the buffer function of ArcGIS, by highlighting the input and output features as well as the selection field of buffer distance. In the distance field you can select distance around the input features. Distances can be provided as either a value representing a linear distance or as a field from the input features that contains the distance to buffer each feature. If linear units are not specified or are entered as Unknown, the linear unit of the input features' spatial reference is used. When specifying a distance in scripting, if the desired linear unit has two words, like Decimal Degrees, combine the two words into one (for example, '20 Decimal Degrees').

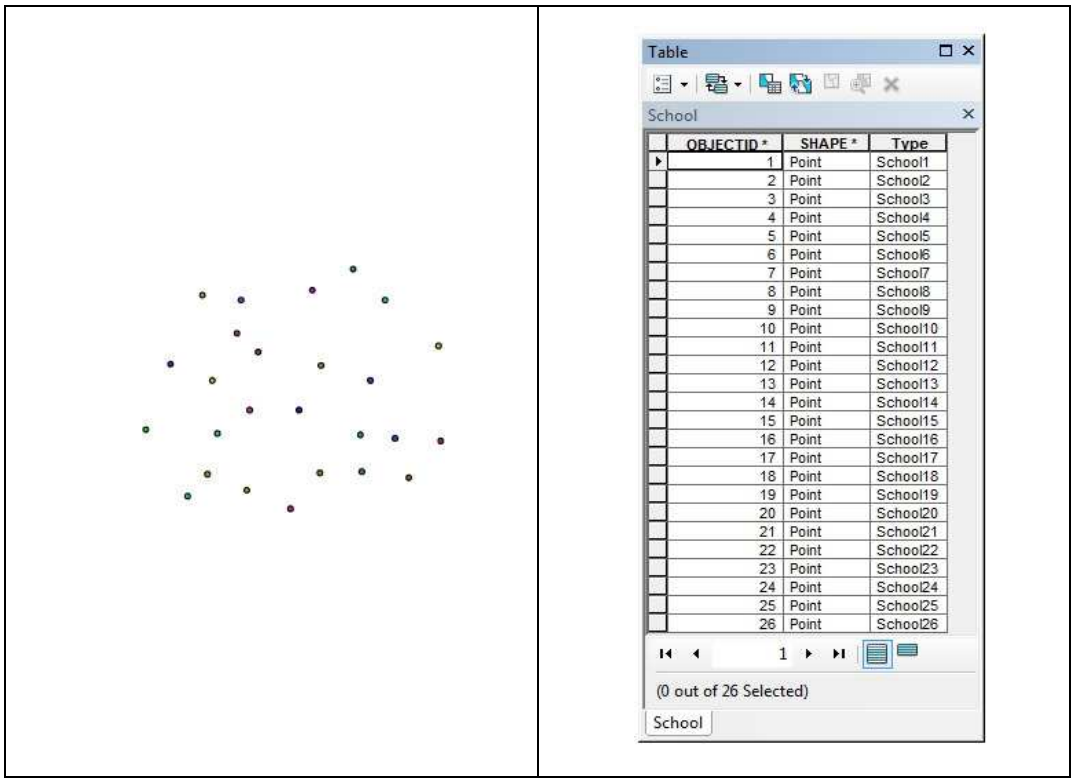


Figure 20 : School locations with attribute table
Source : GIS Practical Work (Biswas, 2014)

For better understanding the use of buffer for the point locations, here is described as school locations of four neighbours which is shown in figure 20; these are the shape files which is performed by the ArcGIS. The attribute table of the point features are illustrated in this figure. The first column of the figure shows the point id as object id, the second column is highlighting the shape file type as a point feature and the third column is the type of id as schools. There are 26 point features, described as school locations.

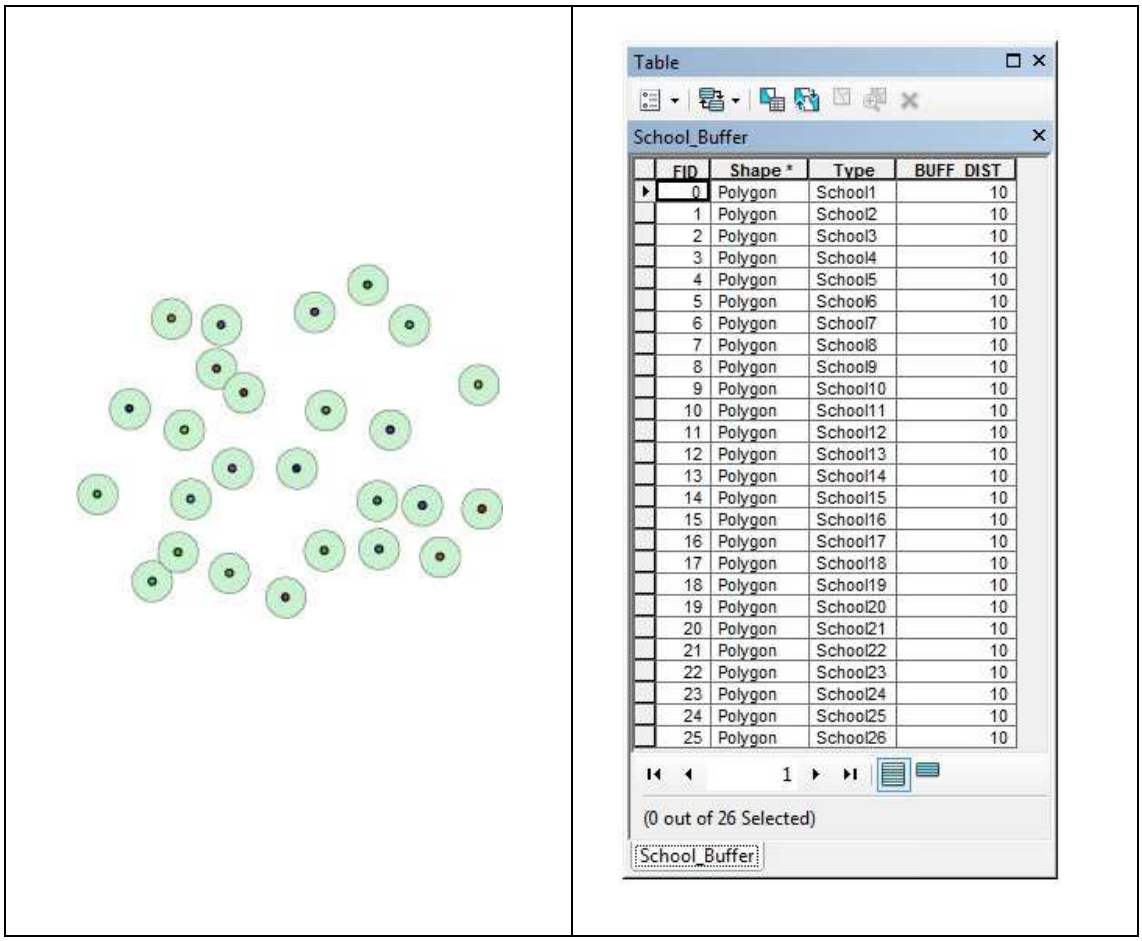


Figure 21 : Buffer of school locations with attribute table
Source : GIS Practical Work (Biswas, 2014)

The locations of school buffers are shown in figure 21. The buffer distance is fixed 10 meters. So there are the polygon buffered with the distances of 10 meters are shown in this figure. As all the school locations targeted to buffer of 10 meters, so the results are shown as 10 meters of buffer region as polygon features. The attribute table of 10 meters buffer distance of school locations is also shown in the figure. If you look the attribute table, the new shape of point feature is changed into polygon features. So if you buffer a point feature it has changed into polygon features.

5.1.2.2 Buffer of Line Features

In the following figure of 22, you will find the line feature, which is described here as street network. Three streets are namely as street1, street2 and steert3 and they make a network within four neighbourhoods. The street networks are shown in the following figure. There is also the attribute table of the three street networks. In the first column, the different object ids; the second column shows the shape file type as polyline, and then the next column shows the name of the street networks and last column shows the length of the each individual streets.

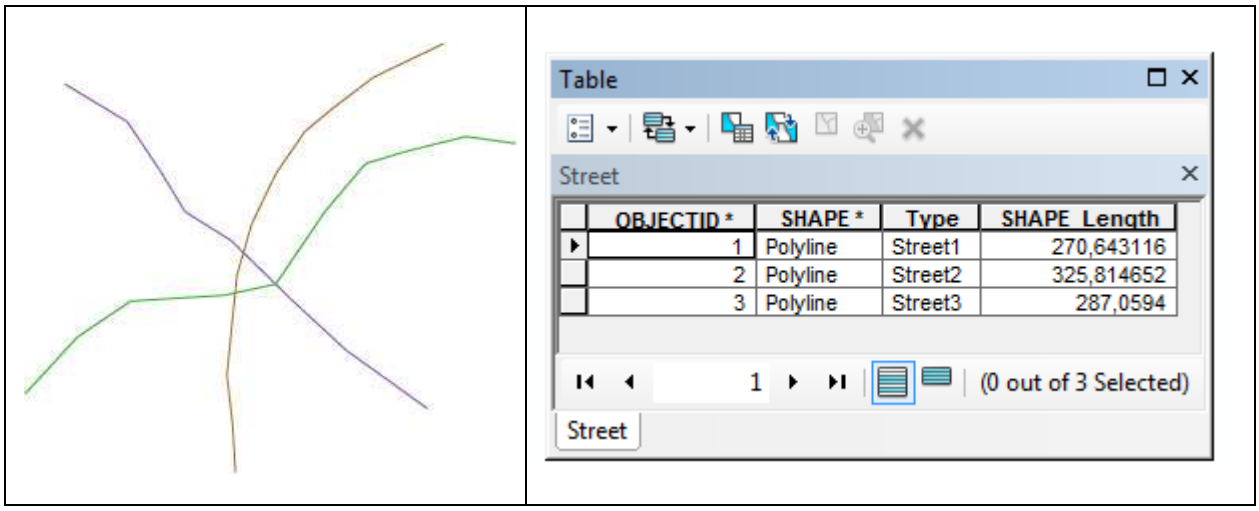


Figure 22 : Street network with attribute table
Source : GIS Practical Work (Biswas, 2014)

The buffer areas of five meters of the three streets are performed by the ArcGIS and shown in the figure 23. Here all the streets are buffered to five meters, as the buffer distance is selected to five meters, at the time of buffering.

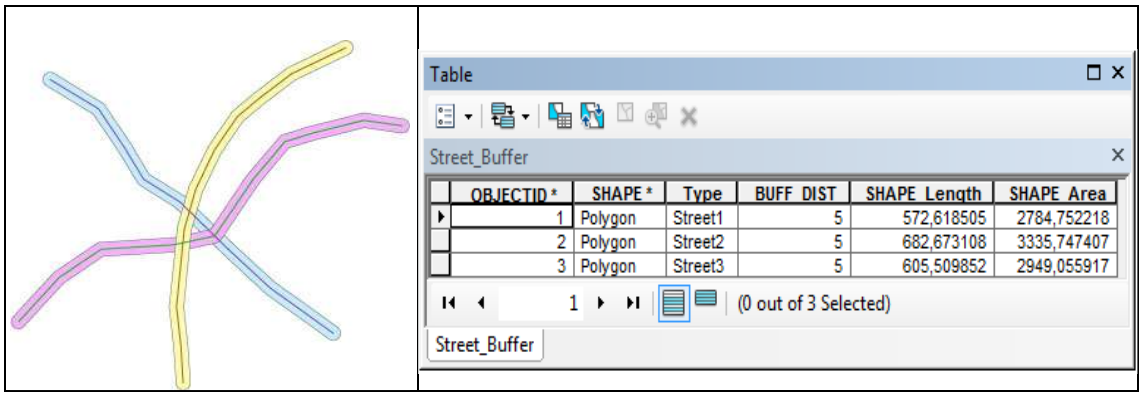


Figure 23 : Buffer of street network with attribute table
Source : GIS Practical Work (Biswas, 2014)

The attribute table is the buffered distance of five meters. If you compare to the attribute table of streets, illustrated at figure 23; you will find the differences that the shape file is changed now to the polygon, as after the buffering function the line shape is changed to polygon feature, the length and also the shape area and new column of buffer distance with five meters appeared in the figure.

5.1.2.3 Buffer of polygon features

In the buffer of polygon features, which is described here; can be described basically of two types, one is the buffer of outside neighbour and the second one is the buffer of inside polygon. In order to understand the differences between these, both the attributes tables and the polygon features are illustrated here.

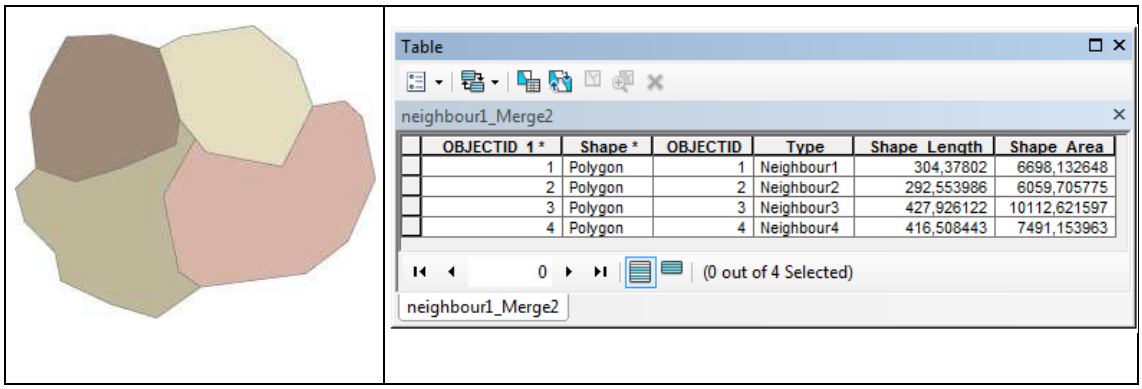


Figure 24 : Polygon Feature with attribute table
Source : GIS Practical Work (Biswas, 2014)

In the figure 24 depicted as above, you will find the four different neighbourhoods, which are polygon features. In order to show the variations among the area of the neighbourhoods, different symbologies are used in this figure. There is also an attribute table of the four different neighbourhoods as polygon features. The first column show the four different object ids, then the shape file as polygon features, the next is the type of the features, the next column shows the length of the shape and the last one shows the total shape areas of each individual neighbourhoods.

Buffer outside neighbour

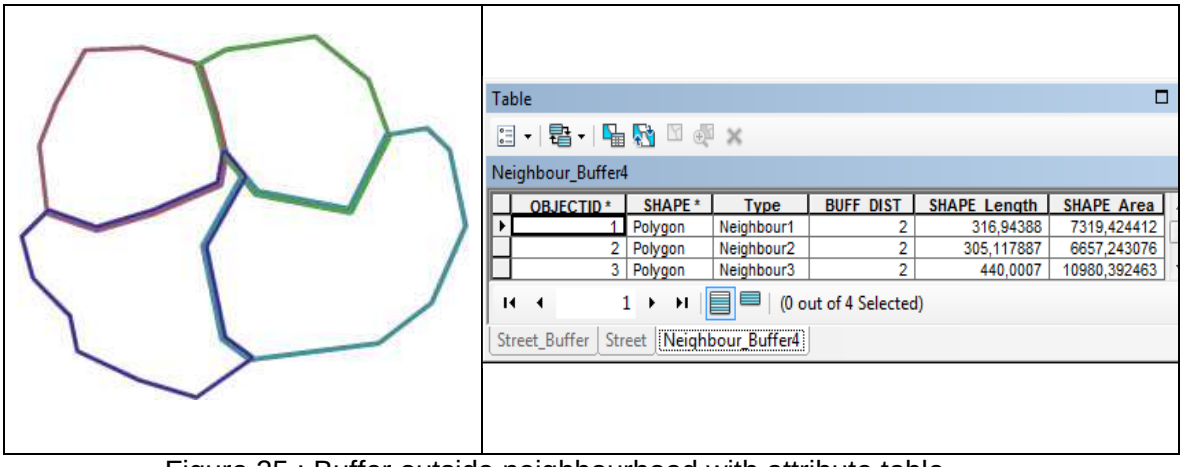


Figure 25 : Buffer outside neighbourhood with attribute table
Source : GIS Practical Work (Biswas, 2014)

In the above figure of 25 you will find the outside buffer of polygon features of two meters. Here no dissolve function of buffer is used, at the choice of interest you can select also the dissolve function of buffer. As we discuss the dissolve function in the chapter 5.3

separately, so we can see the use of dissolve function there. To create a buffer distance outside of the polygon, you have to select always the positive value for the buffer distance. If you compare two figures of 24, you will find that a new column of buffer distance is appeared, which shows that each polygon features have buffered at a distance of two meters.

Buffer inside neighbour

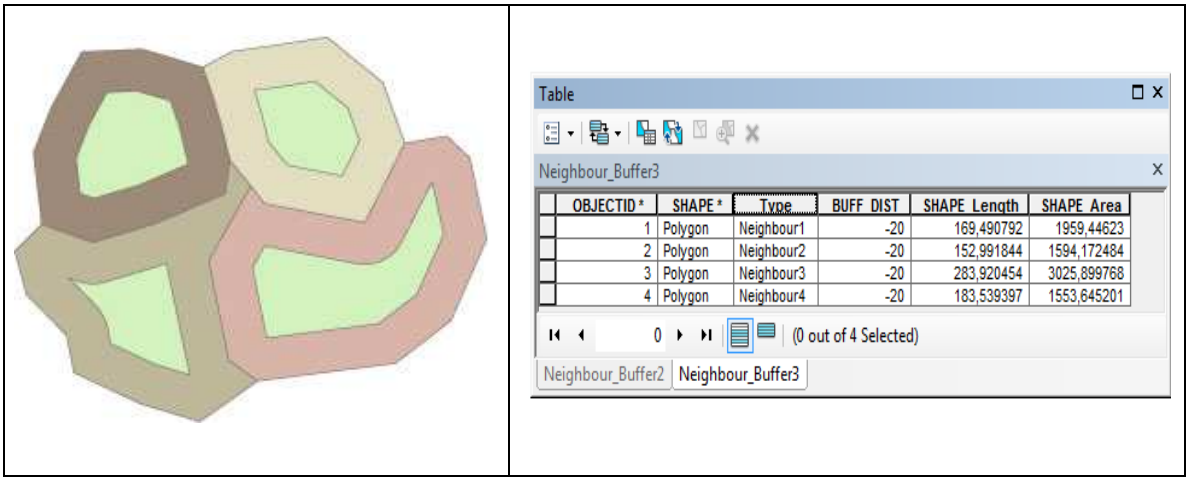


Figure 26 : Buffer inside neighbour with attribute table
Source : GIS Practical Work (Biswas, 2014)

In the above figure of 26, you will find the inside buffer within different polygon features. The four neighbourhoods are buffered at the same distance of minus twenty meters, in order to get the buffer distance of inside neighbourhoods. In the attribute table of inside neighbourhoods, where the last Buff_Dist column is showing the buffered distance of minus twenty meters.

Multiple ring buffer

The Multiple Ring Buffer tool is used to input several distances at once to create multiple buffers. When the multi-ring buffers are created, a dissolve option is found. Not dissolving will provide a full circle feature for each distance provided. The features will be overlapped. If these are used to do an overlay analysis, features could reside in several of the buffer rings created. In fact, features at the center of the buffered area would be inside all of the buffer rings.

The fire chief wants to find the number of houses within certain distances of each fire station. The chief figures that a fire truck average about 30 mile per hour on a fire run, and wants you to create rings that represent 1 minute, 2 minutes and 3 minutes driving time from the fire station. You'll create those rings and do an overlay analysis on the building footprints.

As a geomatic engineer, it can be also mentioned that because of expert knowledge of ArcGIS, you will be informed to create the buffer with multiple features at a time. Suppose the point features need 2, 5, 10 meters of buffer distances, or the line feature need 5, 10 and 15 meters of buffer distances and the polygon feature needs 10, 15 and 20 meters of buffer distances. In this case the buffer operation will be done in the following way using the multiple ring buffer from the Analysis tools of ArcGIS. If the output multiring buffers are dissolved, the features assume as a doughnut with the interiors clipped out where they overlap the other rings. The important difference is that the output buffer rings contain a field showing the buffer distance for each ring. It is also important that the distance values can be of any sequence. They do not have to be at regular intervals. In figure 27, you will find the tool of multiple ring buffer, which is used in ArcGIS, which you can find in the proximity tools.

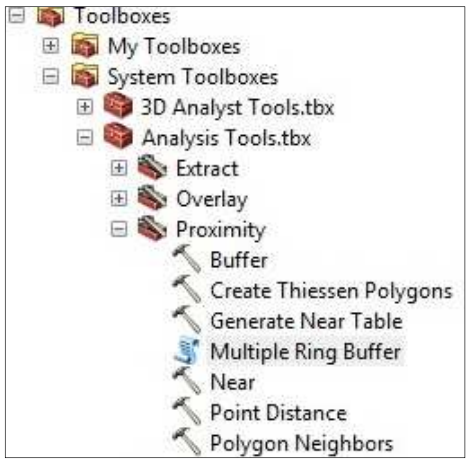


Figure 27 : Multiple ring buffer

Source : GIS Practical Work (Biswas, 2014)

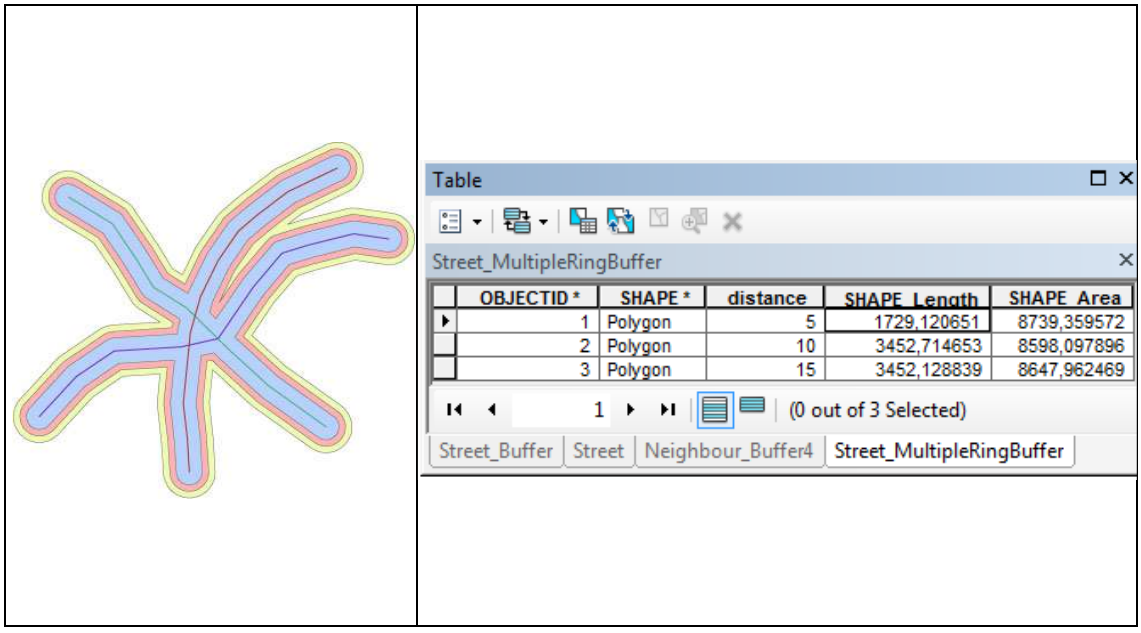


Figure 28 : Multiple ring buffer of streets

Source : GIS Practical Work (Biswas, 2014)

The multiple ring buffer is used to find alternative solutions of a problem or to fix different buffer area with the user specified requirements. In the figure 28, you will find that multiple ring buffer of three streets of five meters, ten meters and fifteen meters, which is done by giving different distances at the time of buffering for multiple ring buffer. In attribute table of multiple ring buffer, where the buffer distance of five meters, ten meters and fifteen meters appears to the figure.

5.2 Clip

To understand the workflow of clip function, which is described in this chapter, is illustrated in the following figure 29. If you observe this figure clearly, it gives the idea that there are some general questions at the beginning of the clip function. Several problems are also described, to understand different situations, where the clip functions can be used to solve the real world geo-spatial phenomena. The next step of the flow diagram is the data type, which is used in this chapter to work with the clip functions. Both the raster and vector data is used to perform the clip function in ArcGIS. You will find the results of point, line and polygon clip sequentially in this chapter.

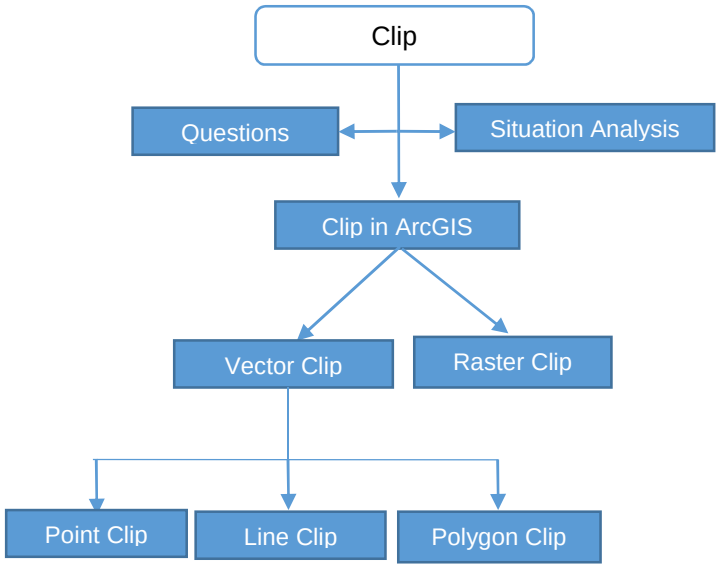


Figure 29 : Flow diagram of Clip function
Source : GIS Practical Work (Biswas, 2014)

Clip function is used to extracts input features that overlay the clip features.

Questions

- What is the meaning of clip?
- Which data can be used for clip?
- Does ArcGIS support both raster and vector data for clip?
- Where the clip function can be used?

This tool is used to cut out a piece of one feature class using one or more of the features in another feature class as a cookie cutter. This is particularly useful for creating a new feature class - also referred to as study area or area of interest (AOI) - that contains a geographic subset of the features in another, larger feature class. The Clip Features can be points, lines, and polygons, depending on the Input Features type. The area of interest can be either points, lines or polygons depending upon the choice of interest defined by the user.

5.2.1 Situation Analysis

Suppose there are 50 pizza places in a big city to deliver the pizzas for the city neighbourhoods. The planning authority of the city is trying to locate the pizza services within a particular area of the city. In this case the area of interest will be the particular area, defined as a small neighbourhood of the big city. By running the input features as all of the pizza locations and the clip feature as the small neighbourhood, will be defined

by the user. After running the clip operation, the new pizza locations among the small neighbourhoods will be identified. You can use the same function for all the point features (school location, shopping mall location, locations of supermarkets, locations of bus stoppage etc.) to get the point feature clip.

The city authority is planning to identify the street network of a particular city from the country street network to rebuild the street network among the city area. In in case, the city authority has selected the city street network as an Area of Interest (AOI) from the whole street network of the country, after that the clip function will be operated to get the new street network within the city. This means that, the city authority wants to cut out the city street network from the whole street network of the country.

Both the polygon areas are used to clip polygon features by using the ArcGIS. Suppose a particular city boundary is needed to select from the country map, in order to have a new developing zone of within the city boundary. In this case both the city area and the country area are in polygon shape file. The city area can be used as a cookie cutter, to fix the area of interest and to get the area boundary. By following the steps of clip function, a new shape file with the polygon boundary can be obtained as a new administrative boundary of the city.

For the description of clip function, you will find four neighbourhoods as a polygon features. The points are the locations of schools in the neighbours, the line features are the streets among the neighbourhoods. In clip functions we will discuss here how point, line and polygon features will be clipped with the area of interest. The area of interest here is selected with a polygon features, but you can choose line as an area of interest when your input features are lines, depending upon the choice of users. It can be also described here, when your input features are points, like of shopping mall, or location of pizza in a city; you can also the area of interest as a points, lines or polygons. When you clip point features with point features, only the coincident points will be stored as output feature. When you want to clip point features with the line features as an area of interest, only the point features that are coincident with the line features will be stored as clipped output features. It can be also described that you will find that the output feature class will contain all the attributes of the input features.

As a real world phenomena let’s think that we have four neighbourhoods. The planning authority have new plan to develop a new industrial zone for Audi, which will be shared from the four neighbourhoods. So the authority has defined an area of interest of 10,943.24 square meter as a new industrial zone. But the four neighbours have 3 different streets and 26 locations of school. In order to establish the new industrial zone, all the area covered within 10,943.24 square meter will be rebuilt by the city authority. The related person who is performing the task, can follow the steps, here I describe. First of all the point features, which is defined as school locations will be clipped within the area of interest (Point Feature Clip). Next the line features, which are here as streets can be clipped and lastly the area of neighbours can be clipped with the area of interest (Polygon Feature Clip). You can also change your task, I mean first to clip the area of neighbours, then the streets and lastly the schools. Finally you can have all the clipped features showing in a features class as a single layer file, and thus you get the new industrial zone by using the clip function.

5.2.2 Clip function of ArcGIS

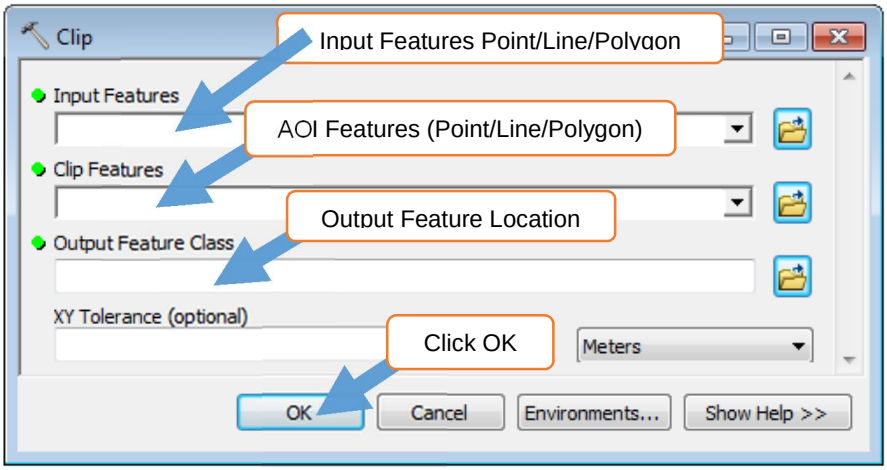


Figure 30 : Clip function in ArcGIS
Source : GIS Practical Work (Biswas, 2014)

In the above figure of 30, you will find the clip function of ArcGIS, whereas the input features can be either point, line or polygon features. You also need to select the clip feature. It can be also the point, line or polygon features; which is used as an area of interest. You get the result, after clicking the OK of this function.

5.2.2.1 Clip of point feature

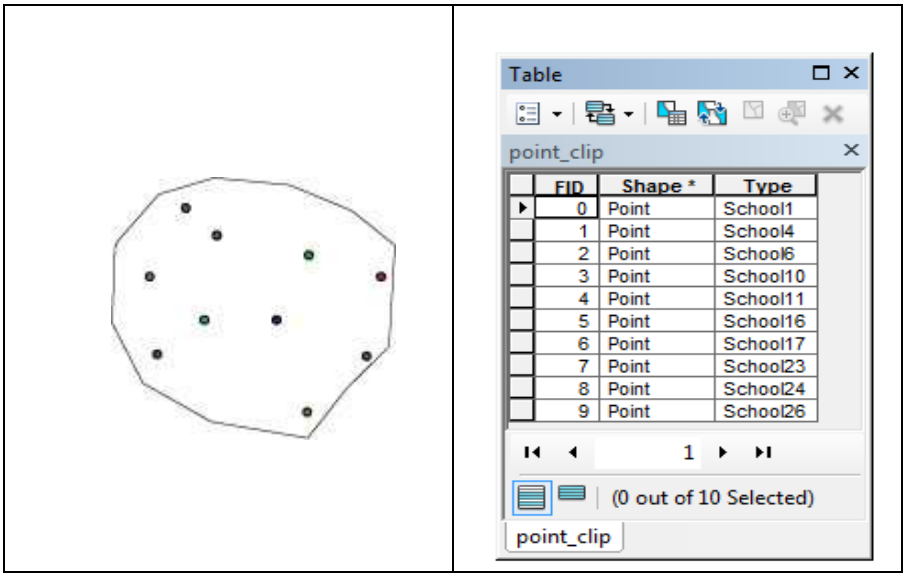


Figure 31 : Schools clip with AOI
Source : GIS Practical Work (Biswas, 2014)

In figure 31, you will find the clipped school locations within the area of interest. You can compare with the figure 20, that there are totally twenty six school locations. But after the clip function which is done by the ArcGIS, you can find only the ten school locations, which are within the area. Here the area of interest is fixed as a polygon feature. Depending upon the choice of interest, you can also select the cookie cutter or the area

of interest as point or line feature. The attribute table of clipped school locations, which gives you the idea that there are only ten different school locations and in the third column, you find the name of the school locations, which belongs to these ten different locations of schools.

5.2.2.2 Clip of line feature

In the following figure 32, you will find that the clipped line feature with the area of interest. Here the street network is clipped with the area of interest. If you compare with figure of 22, you will see that the street networks are clipped and are showing here only the clipped streets with the area of interest.

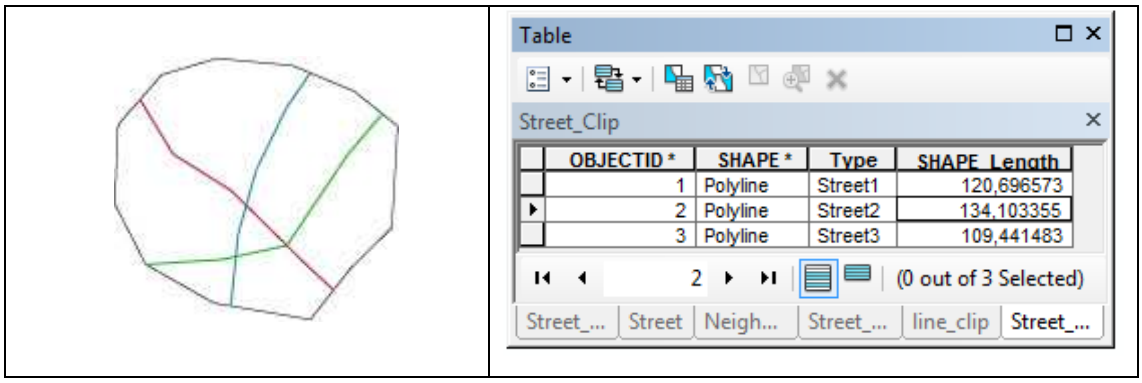


Figure 32 : Clipped streets with AOI
Source : GIS Practical Work (Biswas, 2014)

The attribute table of clipped streets, you will find that only the streets, which are clipped, with the area of interest are appeared on the figure. You can also compare with the attribute table of 25, you will find the change of attribute table for the line feature. The shape length has changed, means it has reduced the total shape length.

5.2.2.3 Clip of polygon feature

To clip the polygon feature, we need to select the four neighbourhoods as input, then we have the area of interest. In figure 33, you will find that the four different areas are clipped with the area of interest. In order to understand it better, different symbologies are used.

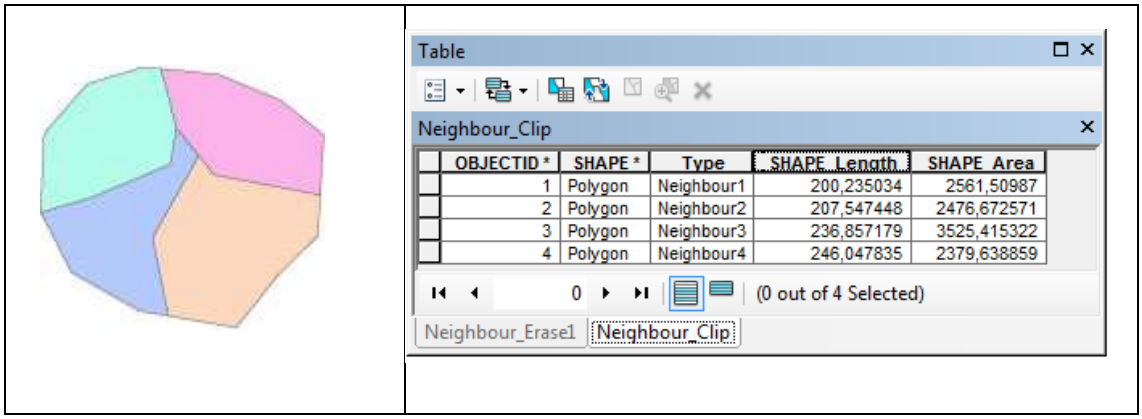


Figure 33 : Clipped neighbourhoods, AOI
Source : GIS Practical Work (Biswas, 2014)

5.2.2.4 Raster area clip

Raster area clip is used to clip the raster data set defining by pixel size. Suppose you need to cut out a country from the world map. In order to do that, you can choice the raster clip function. Both the clipped raster input and out should have the same pixel size, in order to get an effective result from the raster clip operation. It is also recommended to use higher resolution raster file or larger pixel size in order to get a good result from the raster clip output. You can use any type of raster based imagery data set, like aerial photo, LANDSAT data to use the raster clip function.

5.3 Dissolve

Like the other functions of buffer and clip, here is also a flow chart in figure 34, is drawn to understand the work process of dissolve function in ArcGIS. There are also several questions, the general description of dissolve function, the situation analysis is also described, before beginning the practical work of dissolve function. Like other functions, here is also the dissolve function of ArcGIS is shown, in order to find it quickly in the ArcGIS software. Moreover here only the vector data, especially with the polygon features are used in the practical work of dissolve function. The results parallel with the attribute tables, which are obtained from the ArcGIS geo-processing, are described for each individual results (see figure 34).

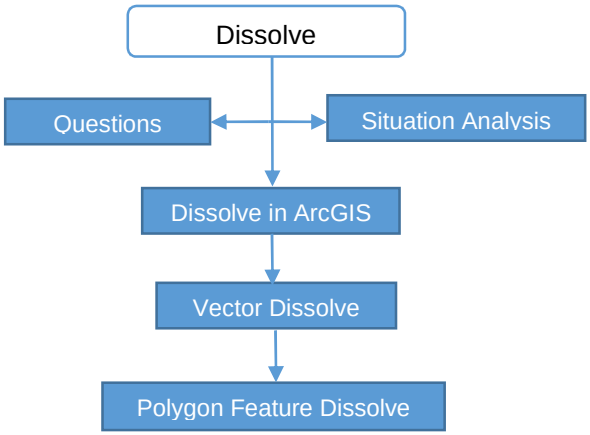


Figure 34 : Flow diagram of Dissolve function

Source : GIS Practical Work (Biswas, 2014)

Questions

- What is the meaning of Dissolve?
- Which data can be used for Dissolve function?
- Does ArcGIS support both raster and vector data for Dissolve?
- Where the Dissolve function can be used?

Dissolve is used to aggregate features based on specific attributes. It creates a new coverage by merging adjacent polygons, line or regions which have the same value for a specified item. It can also be described as the features which have the same value combinations for specific fields can be aggregated or dissolved into a single feature. The dissolve fields will be written to output feature class. Only vector data is used for dissolve function. The polygons, line or regions that have

the same value are used to dissolve features together. You can use statistical fields in order to summarize the attributes of features. The text attribute fields may be summarized using the statistics FIRST or LAST. Numeric attribute fields may be summarized using any statistic. Nulls are excluded from all statistical calculations.

5.3.1 Situation Analysis

Assume that a city authority wants to merge the post office name with the ZIP Code of the city. In this case the polygons based on the post office name. To calculate this it is needed to work with the "crosswalk", which lists all ZIP codes of the area and corresponding post office names, defining post offices by ZIP code areas.

Another Example of Dissolve, could be to dissolve a parcel map to create a zoning map that highlights a proposed commercial development, where presently the area is used as residential area. A commercial company wants to apply a zoning variance so that it can be used in the land in residential parcels with Parcel ID values of 2001, 2003, 2006, 2016, 2018, and 2020 for a commercial purpose. Change the zoning code of these properties to X and highlight them on your map with a color. This map could be used for further analysis depending on the new demand of the city authority.

5.3.2 Dissolve function of ArcGIS

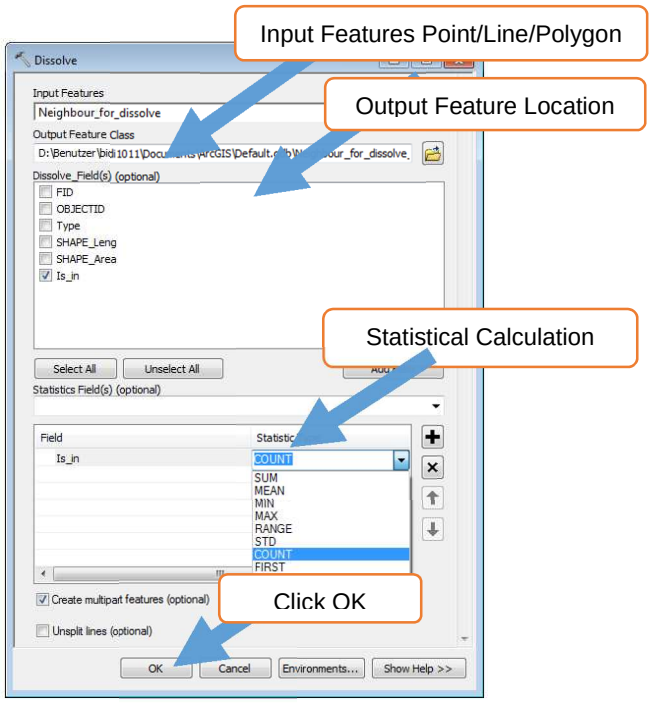


Figure 35 : Dissolve function in ArcGIS
Source : GIS Practical Work (Biswas, 2014)

In the above figure of 35, you will find the dissolve function of ArcGIS, which gives you the idea to work with the function. As input feature, you can choose either point, line or polygon feature. There is also an option in this function, where you can perform the statistical calculations, line claulation of summation, mean value or the count function. You can choose your own field of statistical calculations there. To undersatnd the

dissolve function, here only the area or polygon features are taken for the practical example.

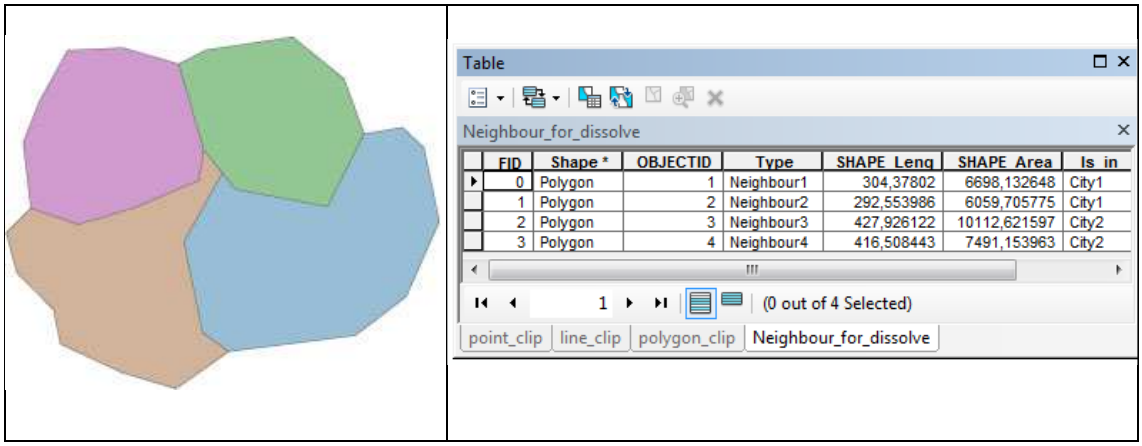


Figure 36 : Neighbourhoods with attribute table
Source : GIS Practical Work (Biswas, 2014)

In figure 36, you will find the neighbourhoods, which is developed for the calculation of neighbourhoods, by adding a new attribute filed as city, which is defined as the first two neighbourhoods are in city one and the rest two neighbourhoods are in city two. If you have a look on the attribute table, you will find that a new attribute field is added in the last column of the attribute table.

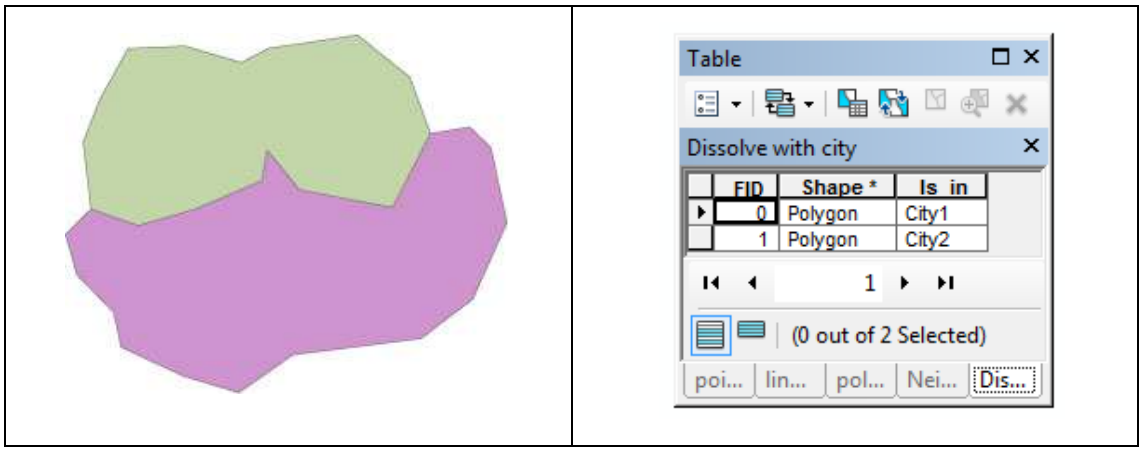


Figure 37 : Dissolved neighbourhood
Source : GIS Practical Work (Biswas, 2014)

In the figure 37, you get the result of dissolve function, which is now a dissolved polygon of two cities. Here first two neighbourhoods are dissolved together. For better understanding, a new symbology is added to the figure 37. From this figure, you can understand that dissolve function is used aggregate features, which have the specific attributes. So we get from four neighbourhoods, only two different cities; which have the same attribute field of city one and city two.

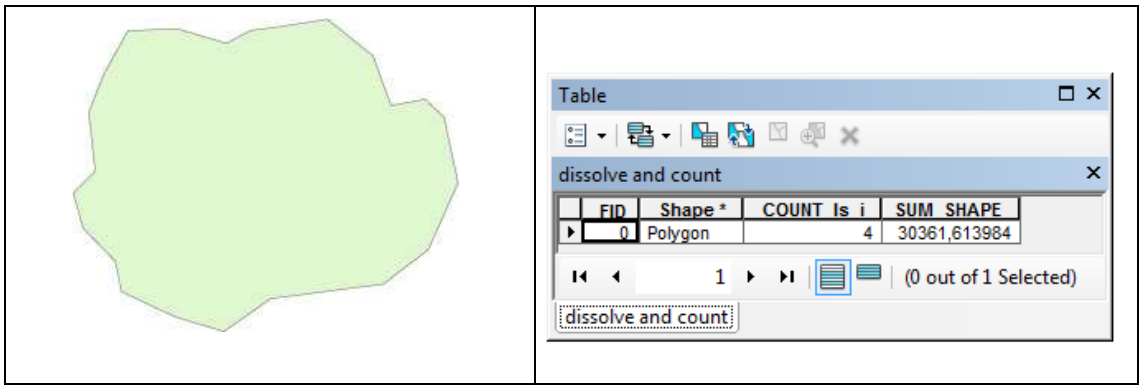


Figure 38 : Dissolved neighbourhoods with count and sum
Source : GIS Practical Work (Biswas, 2014)

In the figure 38, you will find that a new polygon is generated with the dissolve function. Here the new calculation field is added in order to know how many neighbourhoods area there in the total neighbourhood area, and also to know the total area of the four neighbourhoods. In order to do that the statistical calculation field of dissolve function of ArcGIS is used. In attribute table gives the information of total area of the four neighbourhoods. It gives you the total calculation of the four different neighbourhoods of neighbourhood one, neighbourhood two, neighbourhood three and neighbourhood four. In this case, the total shape of area, is aggregated together to get the new summarized polygon feature.

5.4 Erase

In the following figure 39, the flow diagram of erase function is described, in order to understand the work process. Different situations are illustrated, in order to understand where the erase function can be applied along with the general description also with some basic questions related to erase function. Then the erase function of ArcGIS is shown. By this function several vector data like point, line and polygon data are used to perform the erase function. The results are described by appropriate figures and their related attribute tables.

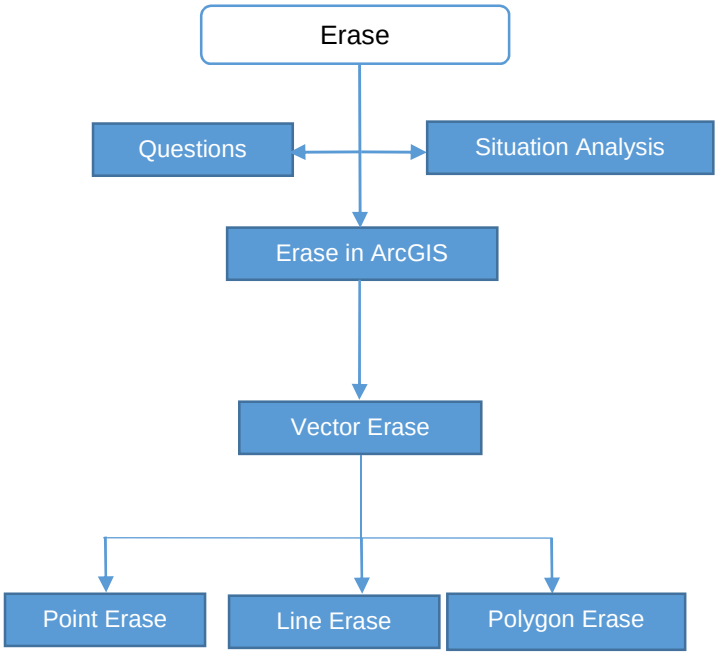


Figure 39 : Flow diagram of Erase function
Source : GIS Practical Work (Biswas, 2014)

Questions

- What is the meaning of Erase?
- Which data can be used for Erase function?
- Does ArcGIS support both raster and vector data for Erase?
- Where the Erase function can be used?

Erase is used to create a new output coverage by overlaying two sets of features. The polygon of the erase coverage define the erasing region. Input coverage features that are within the erasing region are removed as in the output coverage. The output coverage consists only those input coverage features that are outside the erasing region.

Polygon, lines or points as vector data can be input coverage; but the erase coverage features must be polygons. The output coverage features are of the same class as the input coverage features. They are clipped as the outer boundary of the erase coverage polygons. For the output coverage, topology is rebuilt by the erase operation.

The following methods are used for the input coverage of Erase functions in ArcGIS:

Point: Points inside the polygons are erased and the remaining points are built with a new point coverage.

Line: Erases the portions inside the erase polygons and builds the remaining lines into a new line coverage

Polygon: Splits the input polygon arcs where they overlap the erase polygons, drops the arcs inside the erase polygons, and builds the remaining arcs into a new polygon coverage. Input region subclasses are maintained and erased. They are maintained as empty subclasses when all the regions have been removed.

Input features which lay with the erase features geometries will be removed. The Erase Features can be point, line, or polygon. A polygon erase feature can be used to erase polygons, lines, or points from the input features. A line erase feature can be used to erase lines or points from the input features. A point erase feature can be used to erase points from the input features.

5.4.1 Situation analysis

The city authority is planning to develop new locations of existing tourist spots in the city. In this case all the locations of tourism places will be selected first, and then will be deleted from the spatial database. These efforts can be done by using the erase functions of ArcGIS.

Suppose the pipelines of underground water channel in a city need to be reconstructed because of the new construction demand. In order to that, the existing pipelines of underground network need to specify by selecting the existing network through ArcGIS. After selecting the pipelines, those can be eliminated by using the erase function and can replace with a new pipeline network or other type of utility services to facilitate the inhabitants of the city.

Suppose the city authority is planning to develop the residential area, which is now occupied with the forest planation. But due to increased population of the city, there is a tremendous need to acquire the forest area. For this reason, first the total forest area of the city need to define as polygon feature. After selecting the area, the forest area can be erased through the ArcGIS erase function and can merge together with the current residential area. In this scenario, we use the polygon feature erase.

5.4.2 Erase function of ArcGIS

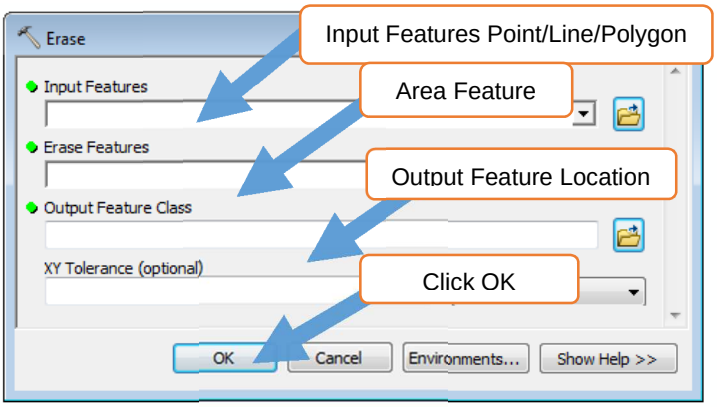


Figure 40 : Erase function in ArcGIS
Source : GIS Practical Work (Biswas, 2014)

In the figure 40, you will find the ArcGIS function of Erase. As input feature, you can choose either point, line or polygon feature. The erase feature could also be point, line or polygon. Here in the practical part, the area feature is again is used as erase feature.

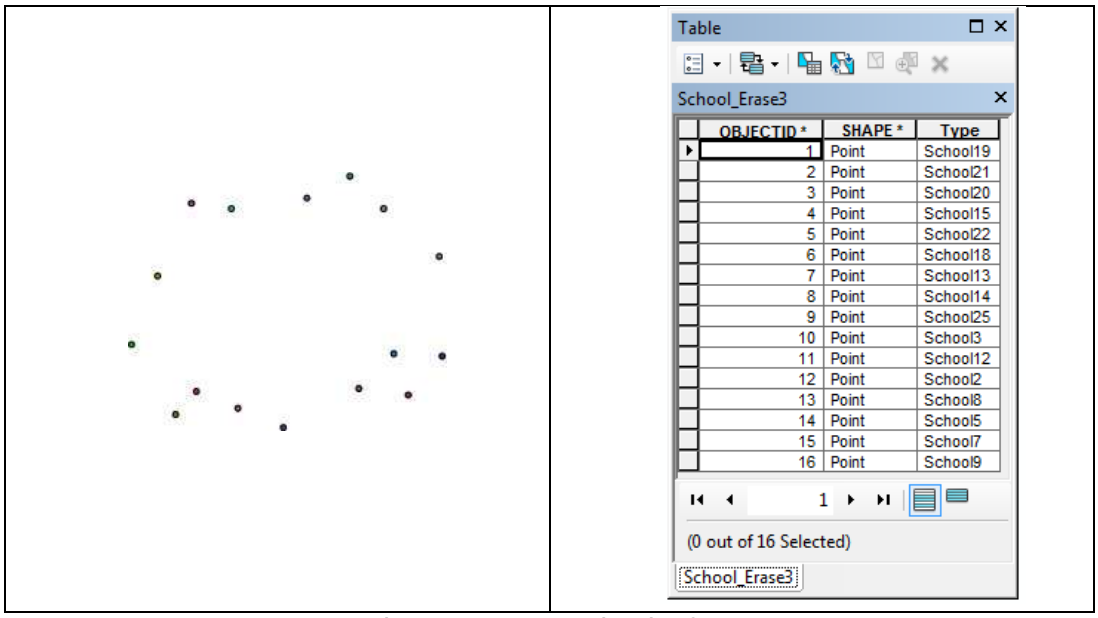


Figure 41 : Erased point feature

Source : GIS Practical Work (Biswas, 2014)

For the input features, here the school locations are used. The total number of schools are 26 but after the erase function the figure has changed to only 16 pints as the other 10 schools are erased with the area. The attribute table describes the different erased school locations, where only the remaining school locations are presented, which are not within the erased areas. The result can help you to show different changes of vegetation period and patterns in a country. Also to model and simulate different time spatial pattern as a geo-dataset for the city (see figure 41).

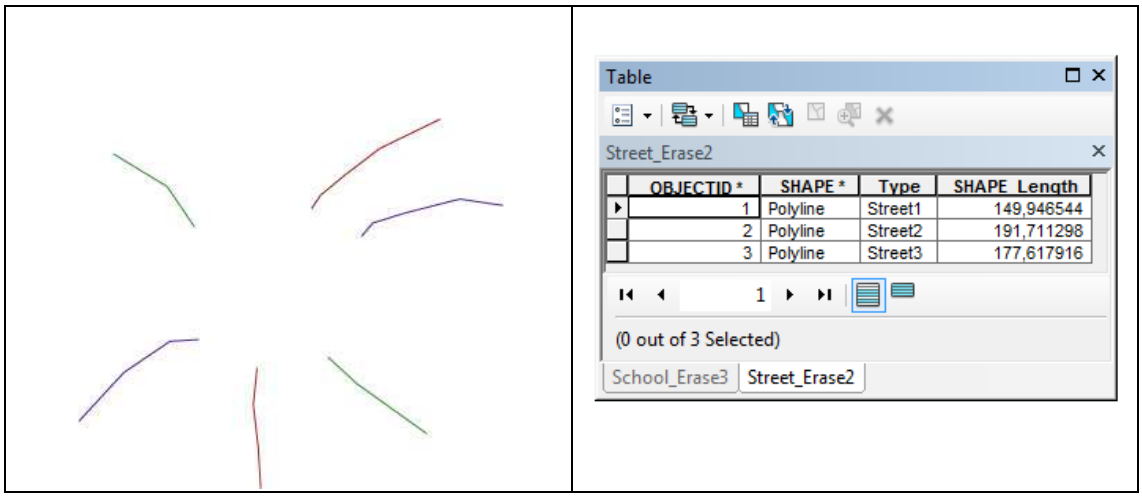


Figure 42 : Erased line feature

Source : GIS Practical Work (Biswas, 2014)

In figure 42, the erased street network. The areas which does not cover the erased area is only showing. The shape length of the street network is reduced with the function. This is used to show the documentation of each individual change, can be used to the change of streets in the last different years. The different data can be compared, and used to set up goals and activity. Other applied use can be used to make decision at different level of master plan of transportation system with a temporal aspects. The part of the changes can be used to model the city transportation network for last fifty years by combining the merged results together or showing the changes at different levels of development.

The following figure 43, is the erased area of the four neighbourhoods. The attribute table of new erased polygon features. Before erase function the length and the shape area was greater, which has changed after the erase function. The total area is reduced to area. Suppose an area is under the emergency because of the volcanic eruption. To save the common people, the country authority is trying to make a region and bring all the people to safer place. In this case the authority can select the affected area as danger zone. Thus change of geo-scenarios can be mapped through the erase function.

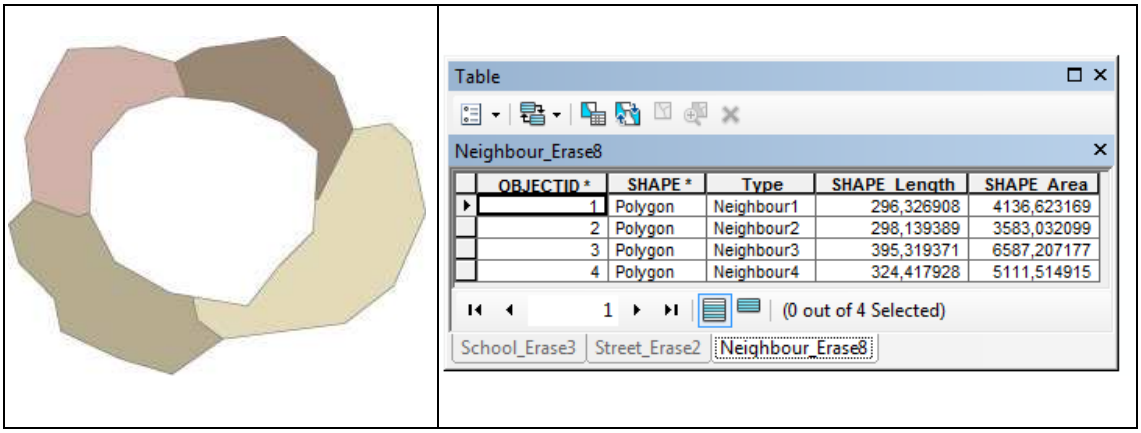


Figure 43 : Erased neighbourhoods
Source : GIS Practical Work (Biswas, 2014)

5.5 Intersect

In the flow diagram of the intersect function gives here the steps which are used here to understand this function. At first different questions related to the theme is raised and after analyzing the questions, a different scenarios are illustrated to matching with the intersection related problems. After that the vector data are analyzed in this geoprocessing part of intersect function. The results are compared with the different polygons, line and point features to find the differences among them. The flow diagram of intersect function is depicted. There should have the same projection coordinate system in order to have the suitable result of this function. It is applied not only for this functional but also with the other functionality of geoprocessing, the same projection coordinate system is always needed. To understand the differences among results several comparisons are applied with the attribute tables at different stages of description (see figure 44).

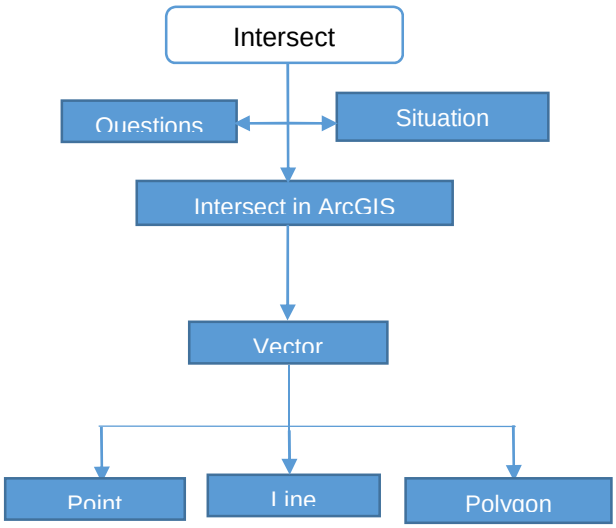


Figure 44 : Flow diagram of Intersect function
Source : GIS Practical Work (Biswas, 2014)

Questions

- What is the meaning of Intersect?
- Which data can be used for Intersect function?
- Does ArcGIS support both raster and vector data for Intersect?
- Where the Intersect function can be used?

Intersect is used to computes the intersection of the input features, which can be point, multipoint, line, polyline, or polygon or area features. The features or portions of the features which overlap in all layers or part of feature classes will be saved to the output feature class. The input features cannot be complex features as annotation features, dimension features, or network features. If one or more of the inputs is of type point, the default output will be point; if one or more of the inputs is line, the default output will be line; and if all inputs are polygon, the default output will be polygon. Let us consider following different situation analysis to understand the intersection related problems of geo-spatial databases.

5.5.1 Situation analysis

Let us also consider that the city authority wants to know that the locations of electric poles only in the southern part of the city. The city has already the database where all the electric poles are there. In order to know only the electric poles which are in the southern part of the city, the authority will use the intersect function of ArcGIS. By performing the intersect function of ArcGIS, a new map will be created, where only the electric poles which are in the southern part of the city will be there in the map.

Let us also consider that the authority is now trying to develop a new map, which will give only the city street network from the street network of the country map. In order to do that the authority will use again the intersect function so that the city street network will be created by the overlapping with the city map and the street network of the city map.

Let us consider the situation like, a city is flooded for couple of days. In order to save the people from the flood in the city, an emergency preparedness official might like to know the name of water boundaries that each road intersects. In order to do that the preparedness official will use the intersect function of ArcGIS to identify the water bodies which crosses over the each roads of the city.

5.5.2 Intersect function of ArcGIS

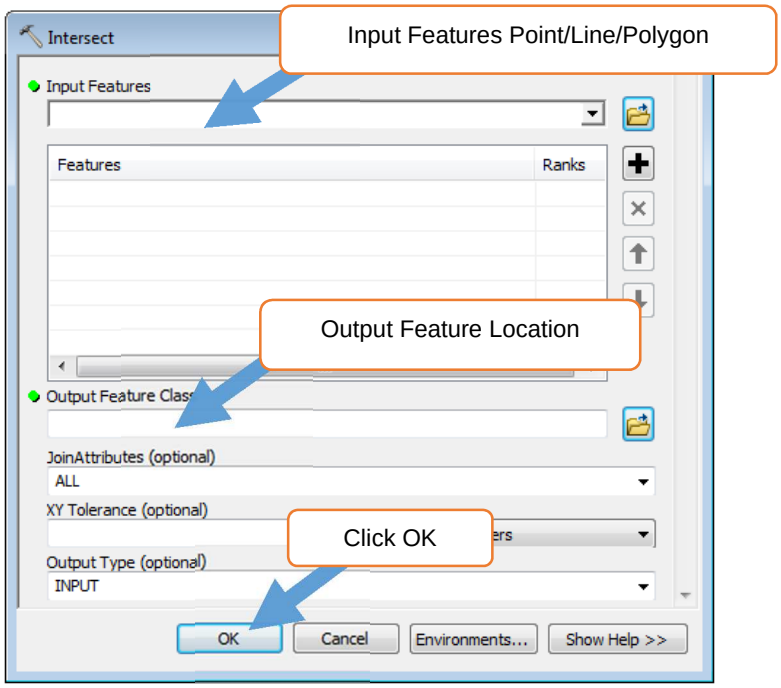


Figure 45 : Intersect function of ArcGIS
Source : GIS Practical Work (Biswas, 2014)

In the figure 45, you will find the intersect function of ArcGIS, which is used to perform intersection of point, line and polygon features. You can select either point, line or polygon features, which you want to have the intersection among the features. It can be of any combination deepening upon the choice of data analysis. Here the point, line and polygon features are used with the area feature, which can also be the same result as

the clip function. You will get the same result similar as the clip result, but the difference between the clip feature and between the intersect feature that it gives you a new feature in the attribute table, meaning the point of intersection, of portions of common features in real world based geo datasets. You can also partially choice the attributes of the table to a new attribute value.

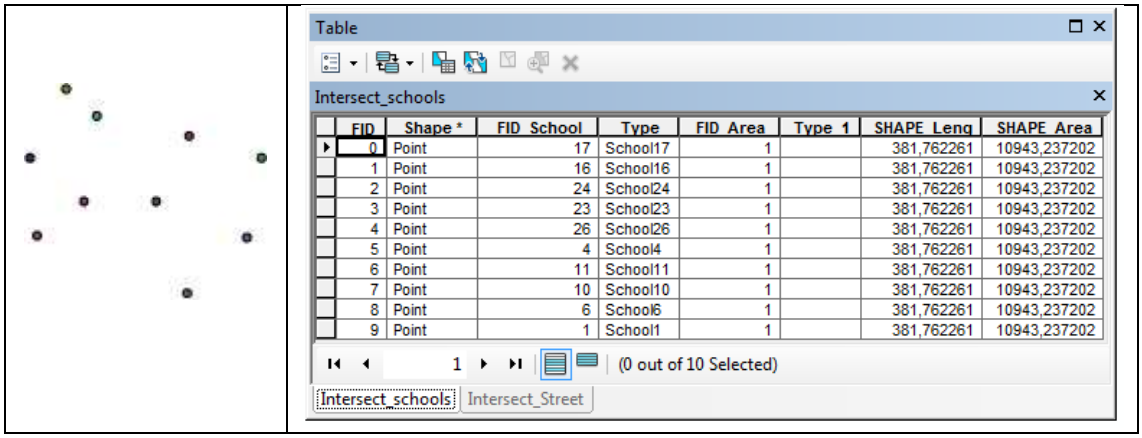


Figure 46 : Intersect of school locations

Source : GIS Practical Work (Biswas, 2014)

In the figure 46, you will find the attribute table of intersected school locations. The features of portions of features of school locations will be added to the output features. Difference is that new attribute table with the new attribute field, such as the FID_Area, where all the values are one, means these school locations are intersected within the area. There is also remarkable that the shape length gives the length of and shape area gives the area of intersection area. After viewing the figure there are only ten different school locations which are intersected with the area of intersection. For the choice of difference there can be also polygons of points or line feature can be added to intersect them simultaneously, but it depends on the problems, which you want to solve with the function.

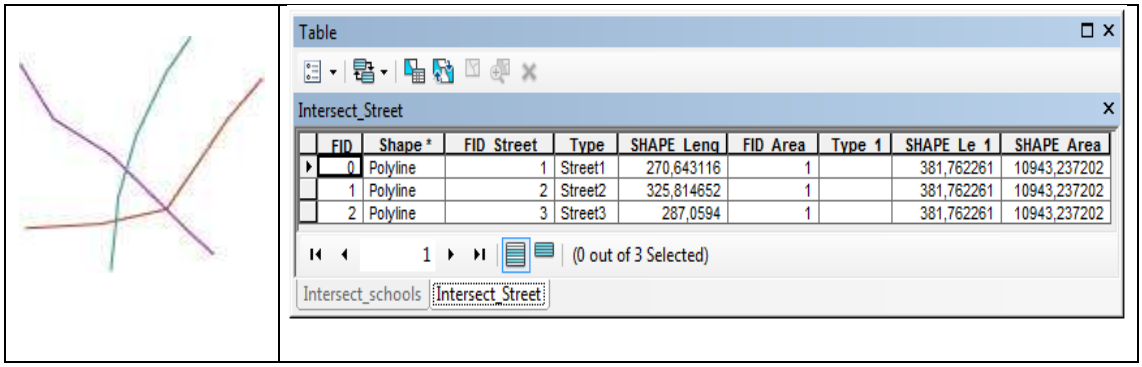


Figure 47 : Intersected streets

Source : GIS Practical Work (Biswas, 2014)

In the above figure 47 street network is intersected with the area, which gives also the same result as the result of clip function. But the difference is in attribute table, which gives new field with new attribute filed in intersect function. The FID_Area means it has intersected the street network with the area and has also changed the updated street

length and here all the layer attribute combined together for the result. Suppose also that there need to a model with number of population, those use the street networks and to model a transportation with the highway, streets and connecting roads within a country, which connects together or also to find out the road way crossing are between railway and rail ways in a city. In this case all the connecting features will be merged together between different layers and give output value.

In the figure 48, you will find that the intersected neighbourhoods, which is done with the polygon features and the area of intersection. They are mainly two polygon features. Where the attribute table showing in the intersect result which joins spatially two polygon features such as the intersection area and the areas of the neighbourhoods. In the FID_Area, the value is one, which means the area is the intersection of the area and the neighbourhoods. The new result has changed its shape length and shape area of each neighbourhoods.

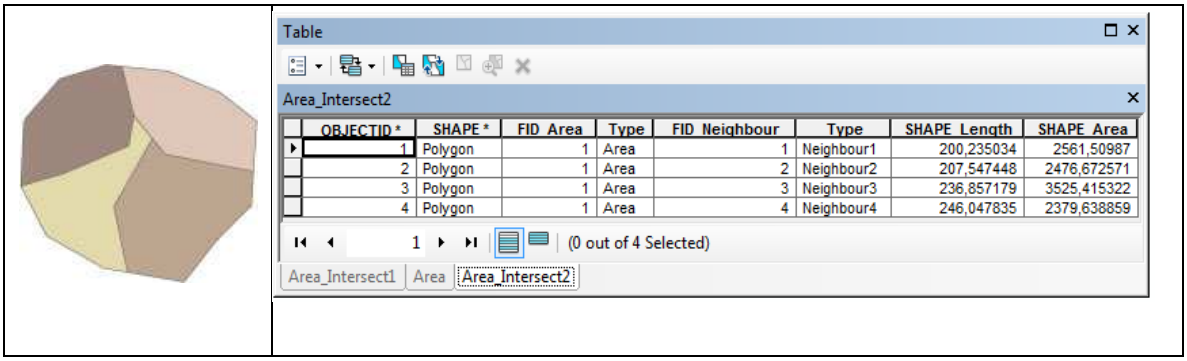


Figure 48 : Intersected neighbourhoods
Source : GIS Practical Work (Biswas, 2014)

In the practical case, we can use the polygon-polygon intersect to a river streams in different locality of a region. Here both the river as well as the locality is also polygon feature, which determines the linked objects. It must be always linked or part of it touches the other object. Without interlocking, no intersection can be performed among the features. So in the case of river and the locality, there will be new polygon feature, which gives the intersection of both features.

5.6 Merge

Like other functionality here is also a flow chat drawn to understand the steps how the merge function will be described. First of all the general description about the merge function is illustrated as well as with the questions and the different situation analysis. More over the ArcGIS functionality is how with the specific results. Here different point features are erased together, as well as for the line and polygon features. The following attrite table is also included here to compare the difference between results (see figure 49).

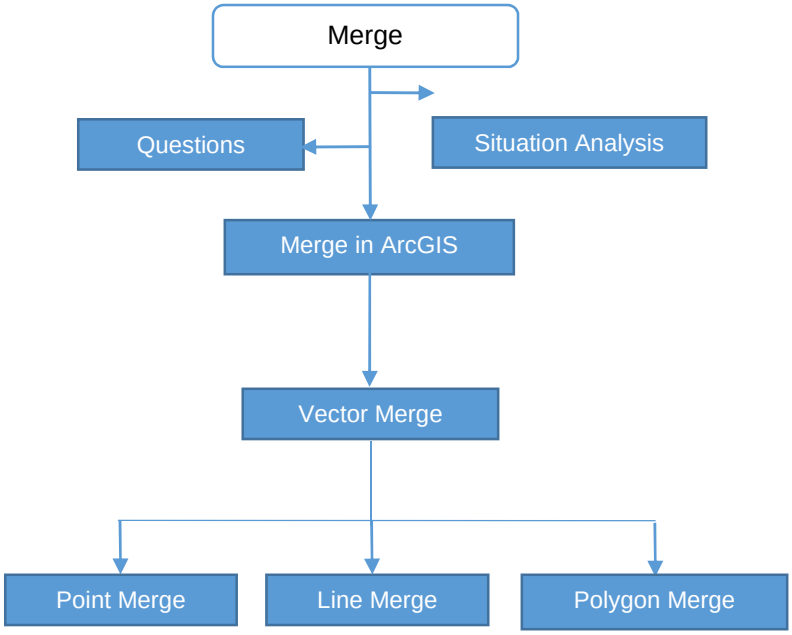


Figure 49 : Flow diagram of Merge function

Source : Biswas, 2014

Questions

- What is the meaning of Merge?
- Which data can be used for Merge function?
- Does ArcGIS support both raster and vector data for Merge?
- Where the Merge function can be used?

Merge is used to combine multiple input datasets to a new output dataset. This tool is used to combine point, line, or polygon features. In ArcGIS the vector data sets can be combined together to get a combined data set for use. The merge result fits together to append all the attributes of input features. Merge can also be used for the raster data set merge, but here only the vector data sets are merged together. Let us consider that different workers of a GIS company is working separately to develop a map of the city. The city authority hast divided the task according to the individual officials. And the end all the GIS tasks will be merged together to form the map, by collecting the individual tasks by merging together to form the map. You can use to merge point to line or line to polygon or any type of match, which is needed for the specific geo-spatial problem. The result of merge function is always the aggregated value of two or more related spatial datasets. To identify different problems various situations are described in the next page, where the merge function can be used.

5.6.1 Situation Analysis

The residential units of the big city has different places of supermarkets where the people can buy their products. The city authority wants to include these market places in their new map. In order to do that the city authority will use the merge function to merge the point and the polygon features together, in order to get the result. This result can be used to find the market places in the city.

The city environmental authority is trying to develop a water bodies inside the city with the administrative boundaries to have a new map which contains both the water bodies inside the city. The authority will use the merge tool to combine both attributes of the city administrative boundaries and also the waterbodies and will get the desired result.

The city authority is trying to develop a new map where different land use patterns can be found. The city has the residential zone, commercial zone, recreational zone, open spaces and water bodies. All the features are polygon features. In order to this the city authority will use the merge functions of ArcGIS. After merging the polygon features, a new map will be created which will give the new map which contains all the different land use patterns, where all the attribute values will be added to a new map.

To describe the merge function, let us consider the city authority is developing a new city map where all the school locations, the water bodies, the housing zone, the recreational zone, the transportation system like railways, streets and pathways will be merged together to form a new city map. In this case, all the attributes will be merged to get the result.

5.6.2 Merge function of ArcGIS

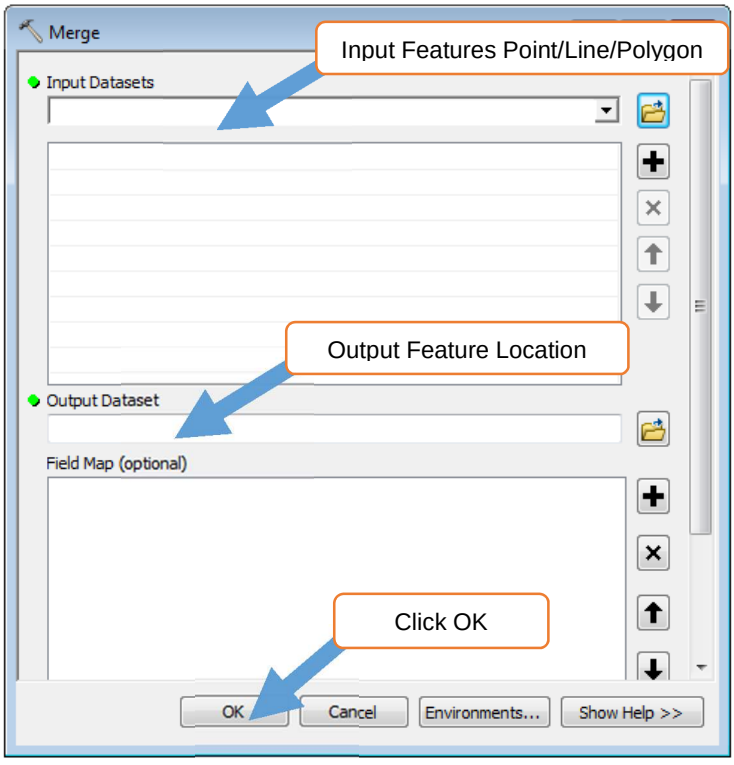


Figure 50 : Merge function of ArcGIS
Source : GIS Practical Work (Biswas, 2014)

In the following figure 51 the school locations are described. In order to get a merged dataset, you can add either the point datasets or the line datasets or the polygon datasets or you can also combine different datasets like point and line, or line and point or either polygon and line features; depends on which datasets you want to merge together. Here in the following practical example you will find that homologous datasets are used together to merge; means the all the points features are used together to merge all the point features, line features to merge all the line features and the polygon features to merge all the polygon features together. In the figure above shows the school locations are taken as input dataset, which belongs to the neighbourhood number one. There are total six point features, which are the locations of schools in neighbourhood.

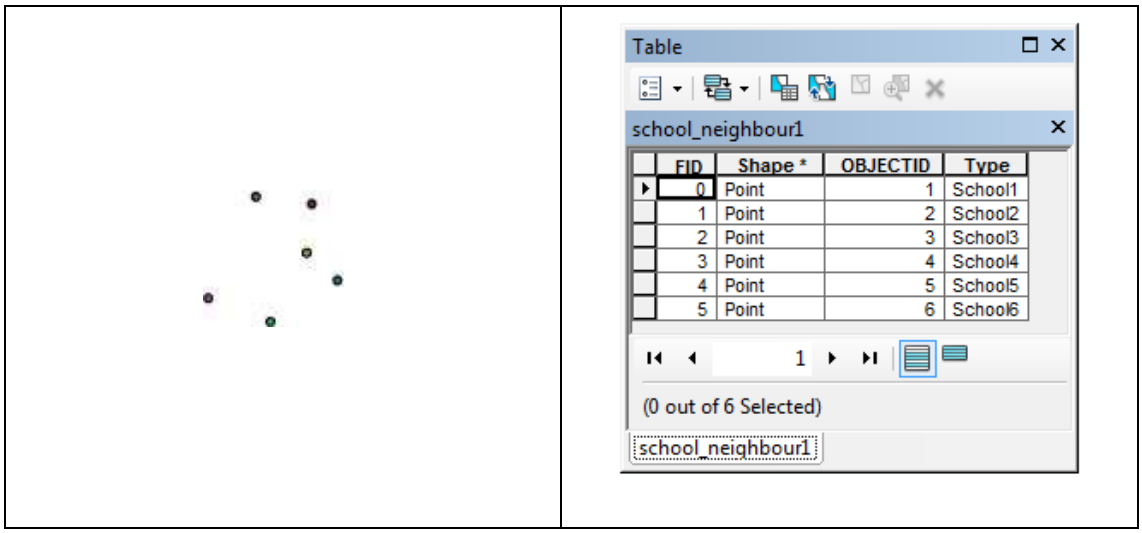


Figure 51 : School locations in neighbour one
Source : GIS Practical Work (Biswas, 2014)

In the next figure 52, the five locations of schools in neighbourhood two and also the attribute tables of these school locations. All the five features are of same geometry.

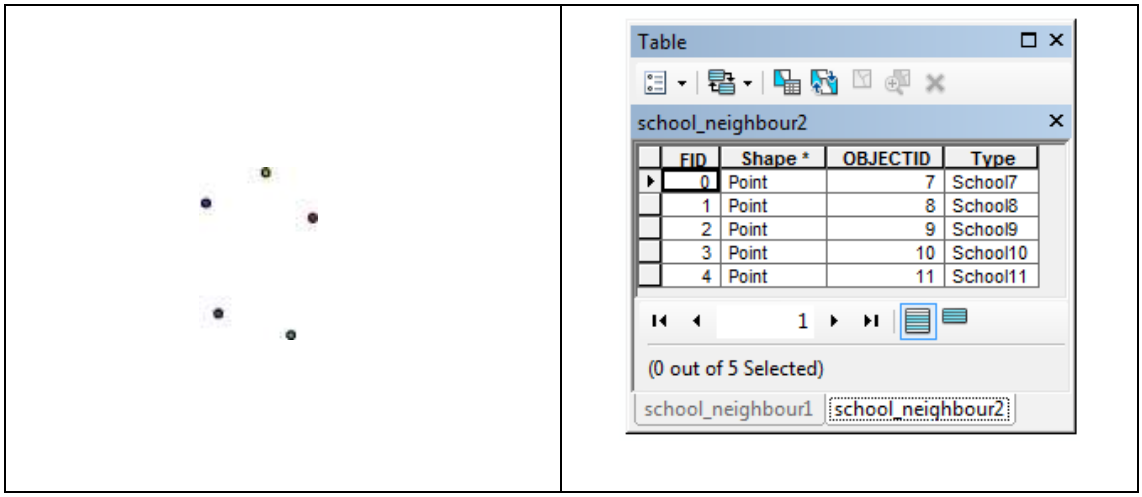


Figure 52 : School locations in neighbour two
Source : GIS Practical Work (Biswas, 2014)

In the figure 53 below, the nine locations of schools in neighbourhood three and the attribute tables of these school locations in neighbourhood three are shown. The individual locations with their identity type is also persevered in the attribute table of the figure.

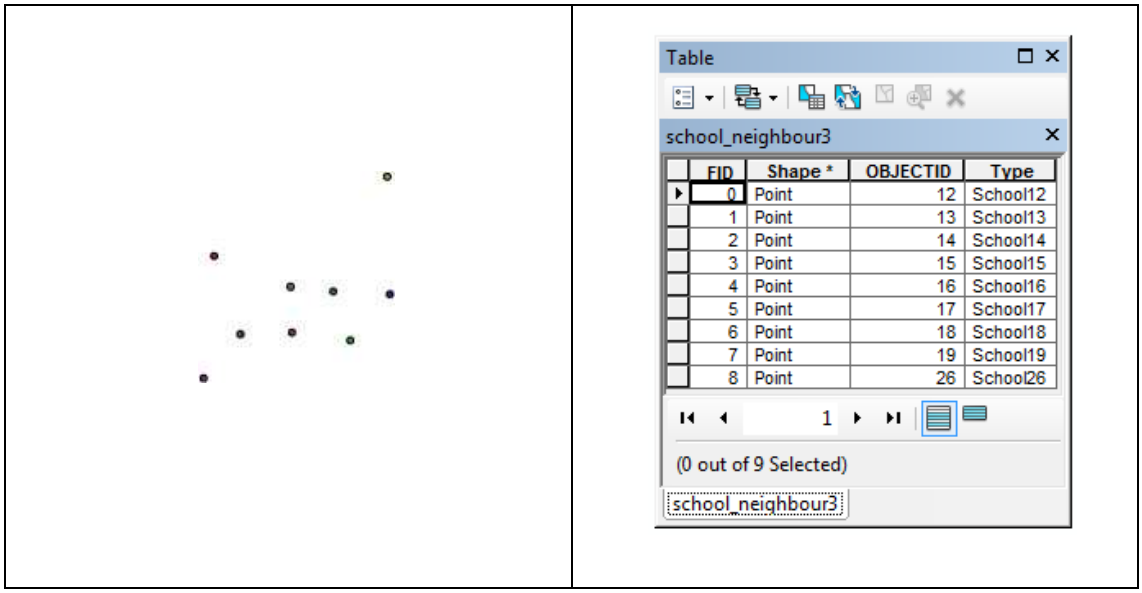


Figure 53 : School locations in neighbour three
Source : GIS Practical Work (Biswas, 2014)

In the figure 54 above, you will find the six locations of schools in neighbourhood four, and the attribute tables of these school locations with their names in database.

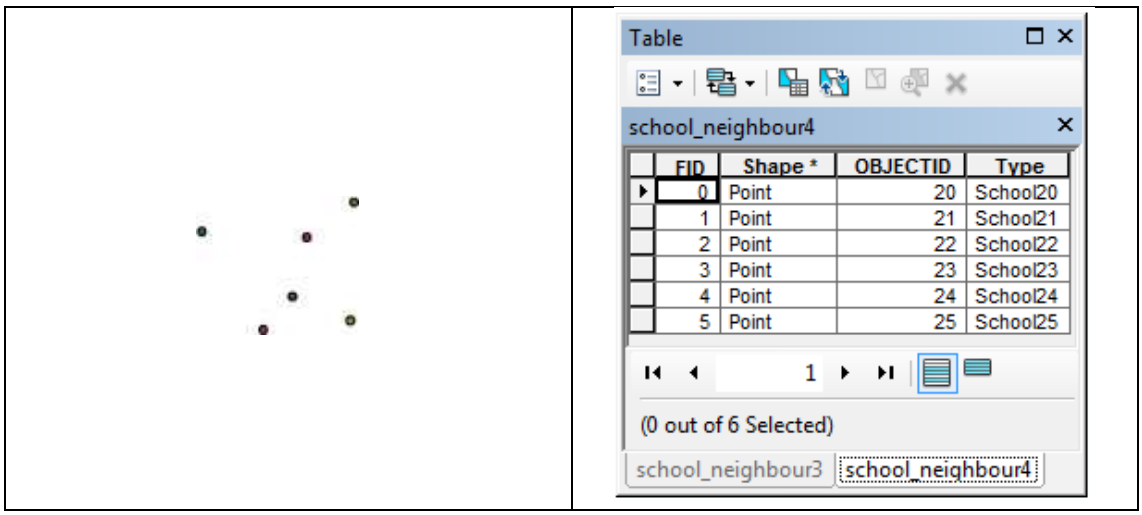


Figure 54 : School locations in neighbour four
Source : GIS Practical Work (Biswas, 2014)

In the next figures, the school locations will be merged together with the merge functionality, to aggregate these data sets.

In figure 55, you will find the merged locations of schools in different neighbourhoods. Now it appears total twenty six locations of schools among neighbourhood one, two, three and four. Here the identical features, like all the point features are merged together to get the output as a merged school locations.

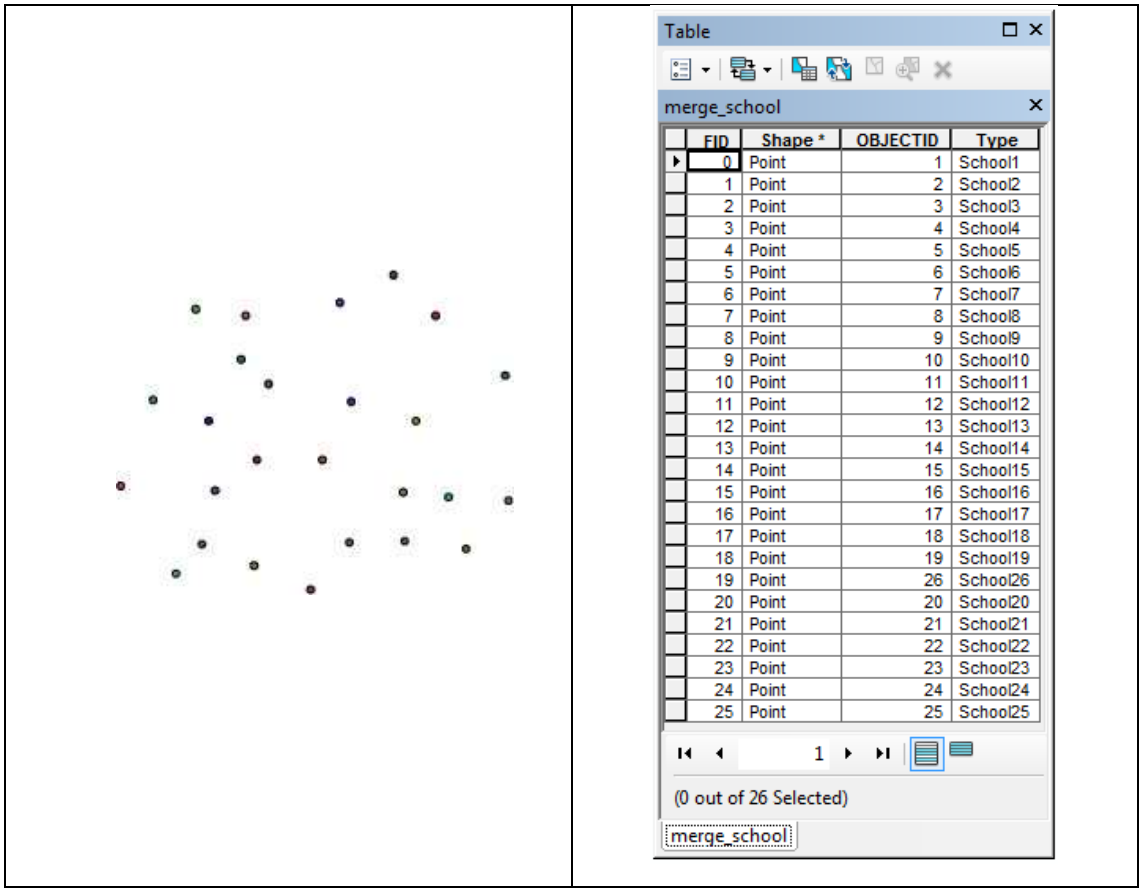


Figure 55 : Merged school locations
Source : GIS Practical Work (Biswas, 2014)

In the following figure 56, you will find the street number one with its shape length.

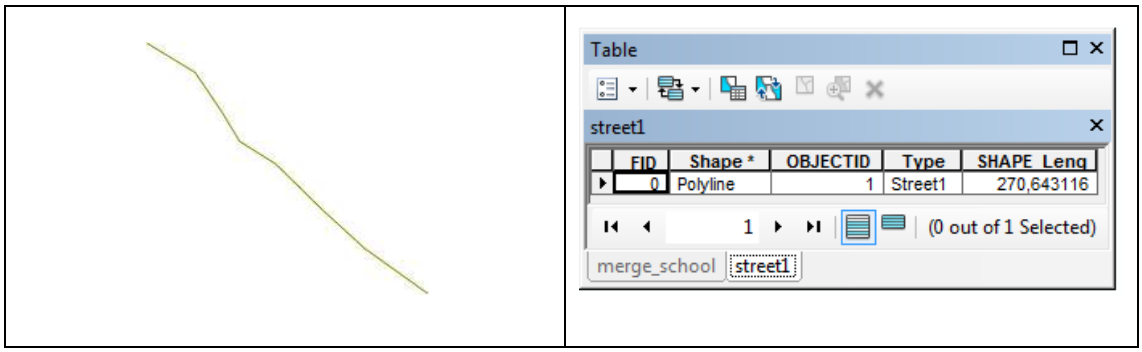


Figure 56 : Street number one
Source : GIS Practical Work (Biswas, 2014)

In the figure 57, you will find the street number two with the attribute table of street number two.

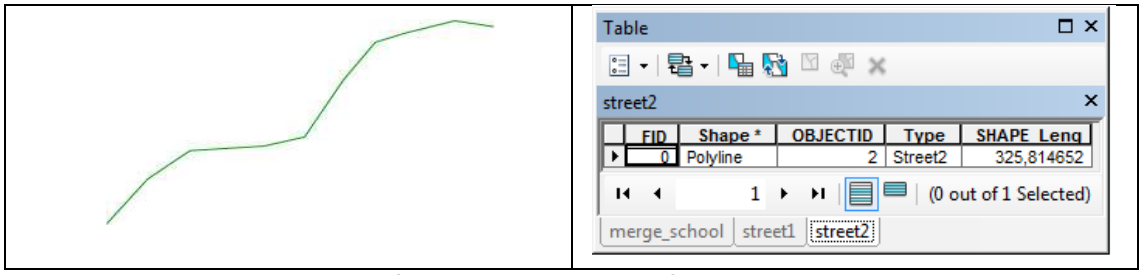


Figure : 57 Street number two
Source : GIS Practical Work (Biswas, 2014)

In the figure 58, you will find the street number three with the attribute table.

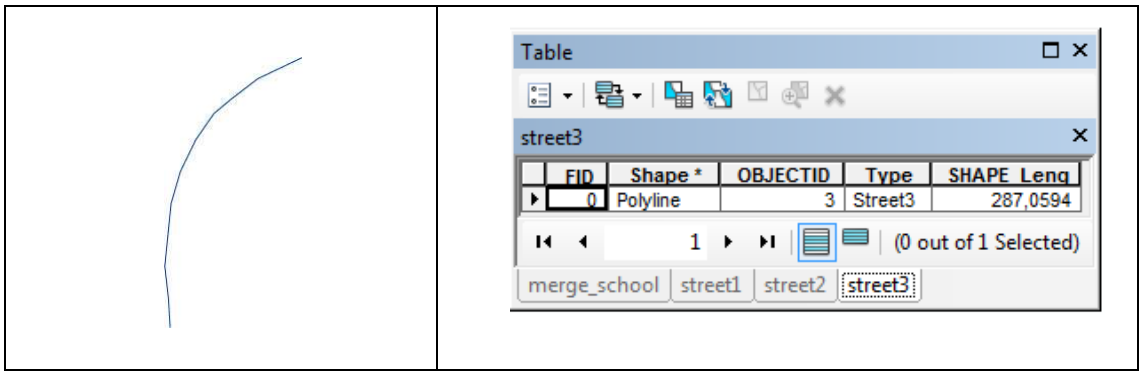


Figure 58 : Street number three
Source : GIS Practical Work (Biswas, 2014)

In figure 59, the merged streets of number one, two and three with the attribute table obtained from the ArcGIS; where the length of the shape files are merged, aggregated or added together to get the result. The individual shape lengths are added in the figure.

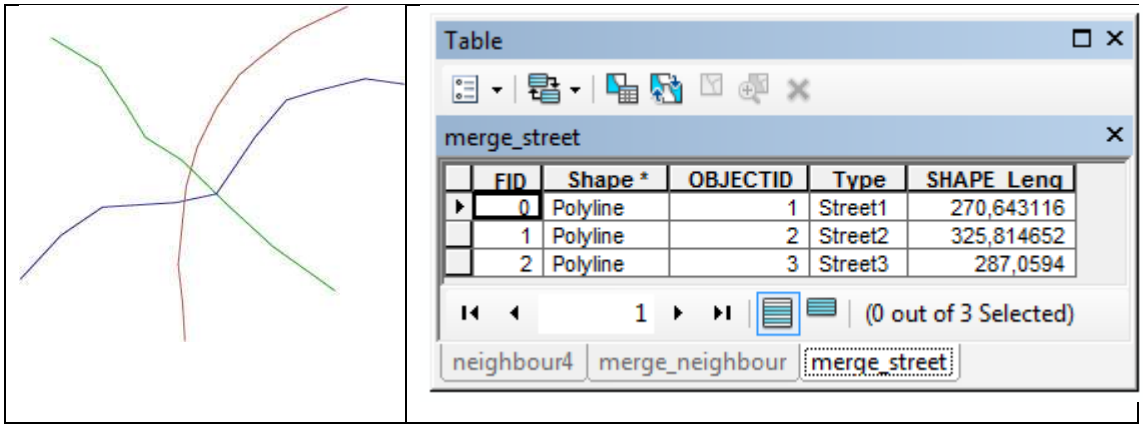


Figure 59 : Merged streets
Source : GIS Practical Work (Biswas, 2014)

In the following figure 60, you will find the neighbourhood one, which is a polygon feature with its attribute table.

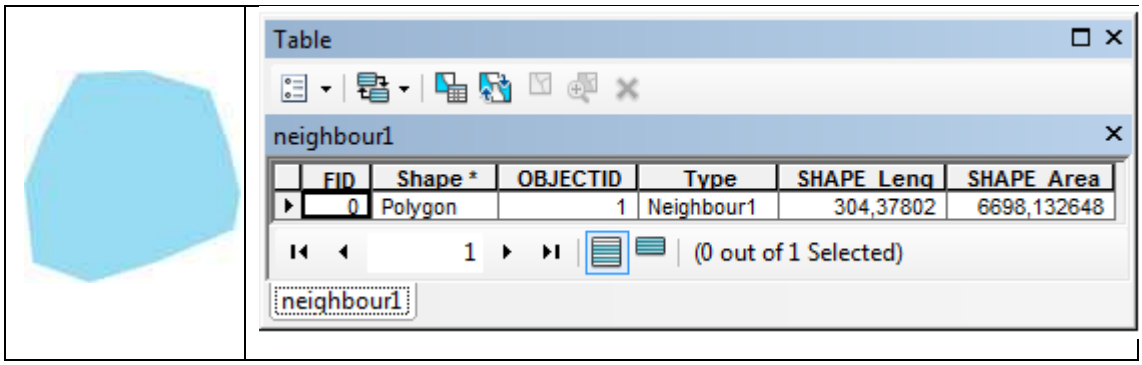


Figure 60 : Neighbourhood one
Source : GIS Practical Work (Biswas, 2014)

In the following figure 61, you will find the neighbourhood two with its attribute table.

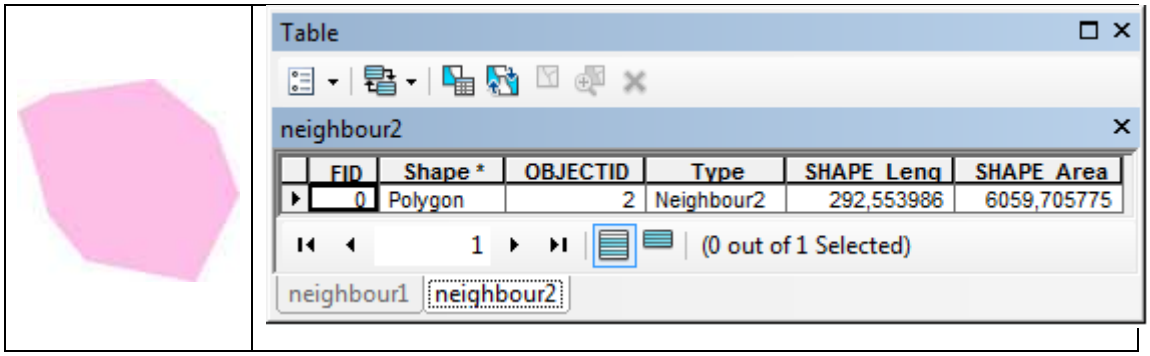


Figure 61 : Neighbour two
Source : GIS Practical Work (Biswas, 2014)

In the above figure 62, you will find the neighbourhood three with its attribute table

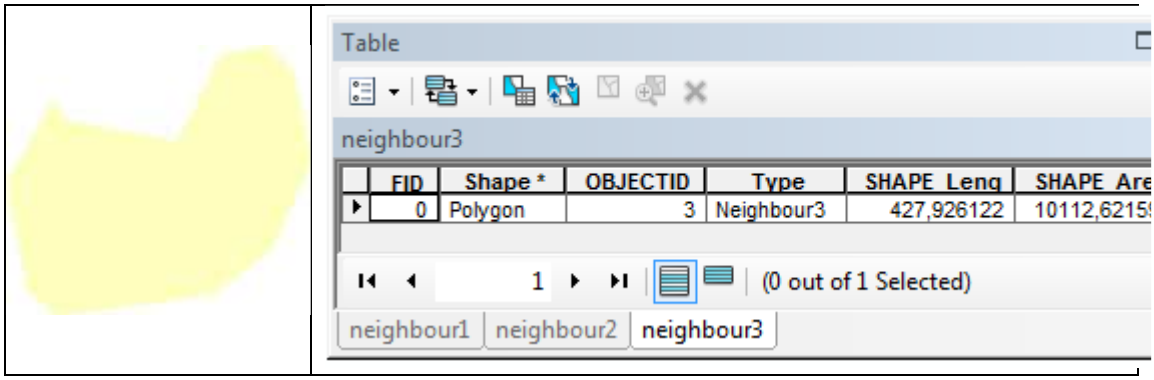


Figure 62 : Neighbour three
Source : GIS Practical Work (Biswas, 2014)

In the following figure 63, you will find the neighbourhood four with its attribute table

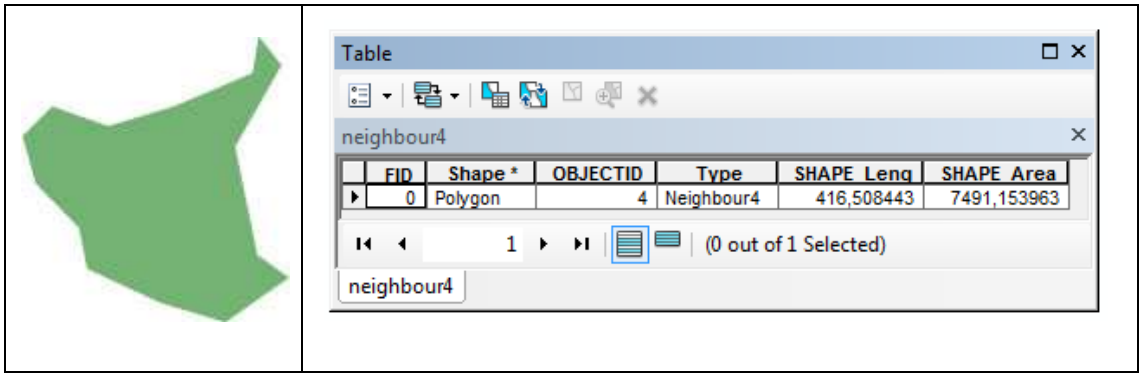


Figure 63 : Neighbour four
Source : GIS Practical Work (Biswas, 2014)

In figure 64, he attribute table of merged neighbourhoods of four different neighbourhoods are aggregated. In this figure all of the individual polygons are aggregated together. In the attribute table the total length and shape areas are covered together.

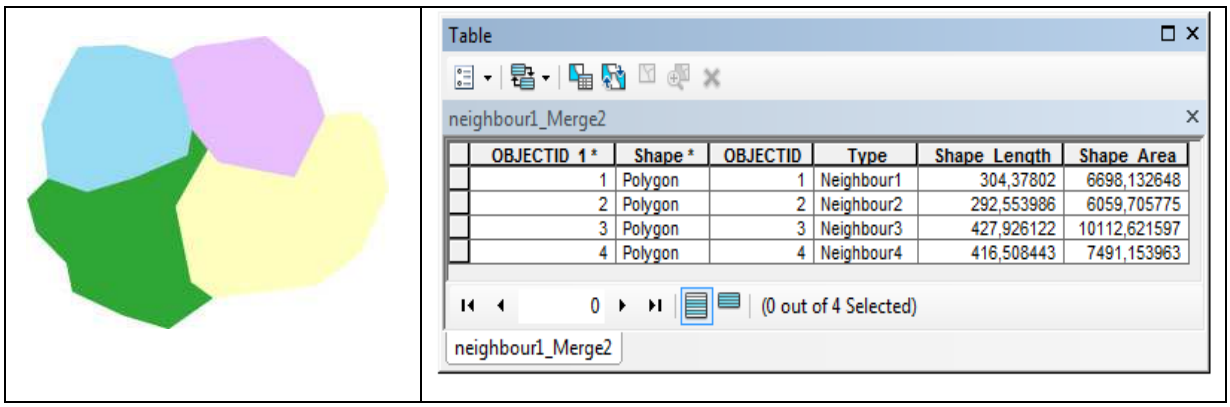


Figure 64 : Merged neighbours
Source : GIS Practical Work (Biswas, 2014)

5.7 Spatial Join

Spatial join is also figured out with the flow diagram to understand the steps which are done accordingly. First of all the spatial join function is described to get the theoretical background. After that several questions are imposed to understand the practical part of the next step. The ArcGIS functionality is used with different vector datasets, which are based with different problems. In the practical example, the point and polygon features as well as the point and line features are joined together based on the match operation of spatial join function. In figure 65, describes the flow diagram of spatial join

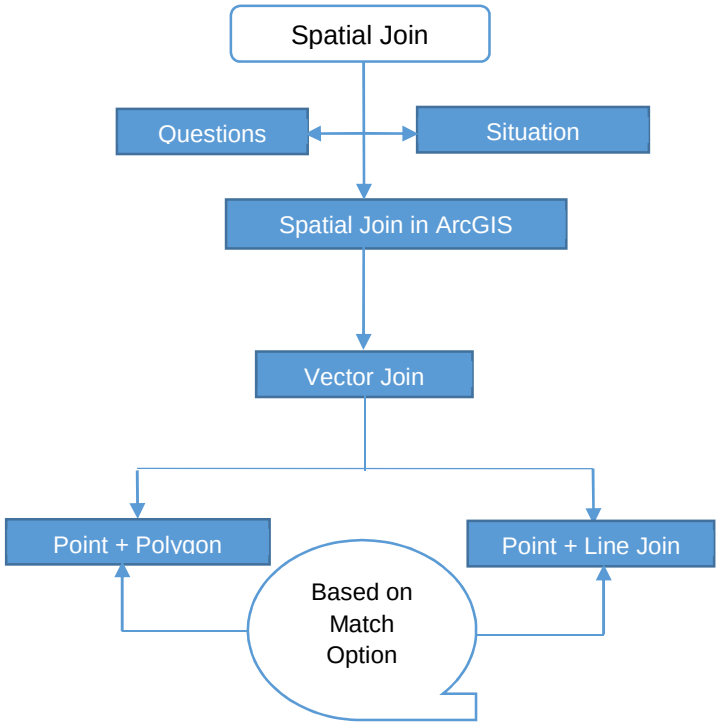


Figure 65 : Flow diagram of Spatial Join function

Source : GIS Practical Work (Biswas, 2014)

Questions

- What is the meaning of Spatial Join?
- Which data can be used for Spatial Join function?
- Does ArcGIS support both raster and vector data for Spatial Join?
- Where the Spatial Join function can be used?

Spatial join is used to join attributes from one feature to another feature based on the spatial relationship between the features. In the output feature both the attributes of the target features and the joined features are stored with a new feature class. In ArcGIS, the vector data such as line, point and polygon are used to perform the spatial join. Spatial Join is very much used to perform different spatial queries and calculations. Different types of match of datasets are used, can be poly-line, line-line, or point-point datasets, where after spatial join two sets of data are joined together. The match options can be either one-many or many-many relation based upon the geo-datasets. To understand different uses of spatial join function, in the next page several situations are depicted.

5.7.1 Situation Analysis

Let us consider that the city authority wants to have a new map which will contain the locations of bus stoppage with the different residential zones. In order to that the spatial join function will be used to join the bus stoppage within each residential zones. To perform this join spatially, a one to one relationship will be stablished, because there will be no bus stoppage locations which will be in another residential zone. Because the city authority has set up before the name of bus stoppage. Now the bus stoppage will be added spatially, so have a better database system for the city as also to have a new city map. After performing the spatial join function, the new map will developed which will give the information by locating all the bus stoppage in different residential zones. The bus stoppage, which have the same residential zone, can have same legends, to understand better the locations of bus stoppage of each residential zone.

Let us consider a mathematical operation by working with the spatial join function of ArcGIS. In order to do that we consider that the city authority is now trying to develop a new map, which will give the total location of restaurants in a city. In order to that the city authority will use the spatial join function, which will give the total summation of the restaurants based upon the city part. With the legend based on a graduated color ramp, this can be better visualized and can be used for the public use, so that the people of the city have also a quick view of this map and can use the map.

Let us consider another example using the spatial join function. Let us think that the city authority is now thinking of developing a new map which will give the information about locations of bus stoppage which is close to 100 meters of the street network of the city. So the city authority has already the bus stoppage locations and also the street networks. They will use the spatial join function, which will serve the purpose of one to many relationship, means, one street can have more bus stoppage places, which are close to 100 meters of the street networks of the city.

Let us consider our last scenario where we use spatial join again. Let us consider that a the city authority wants to highlight only southern part of the city, and wants to develop a new map, to show number of bus stoppage only within or bus stoppage locations that contain in the southern part only of the city. So they will select only the south part of the city map and also the total number of bus stoppage in the city. By using the spatial join function, this calculations can be easily done.

Let us also consider that there are primary, secondary and tertiary school locations in different places in a country, and you want to join spatially with these schools and want to perform some statistical analysis. First of all you want to know how many schools are located within a specific region. They you want to categories them with the school types. There also some information relate to these schools like, the number of students, number of teachers, the subjects taught in different schools, the registration costs of the schools etc. now you want to perform several statistical analysis among these information. In this case the spatial join function can help you to support to join these schools to your map supporting the basic mathematical calculation which need to be matched with each other.

5.7.2 Spatial Join function of ArcGIS

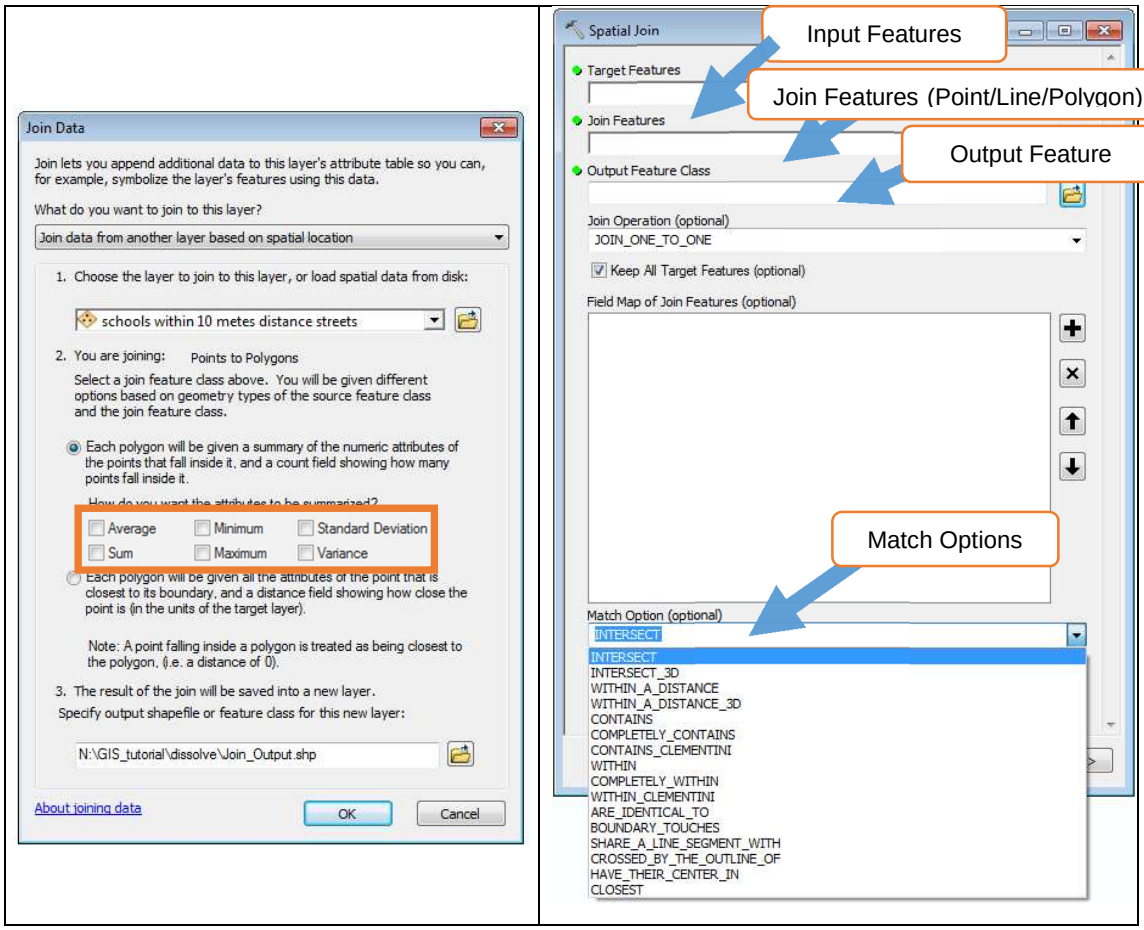
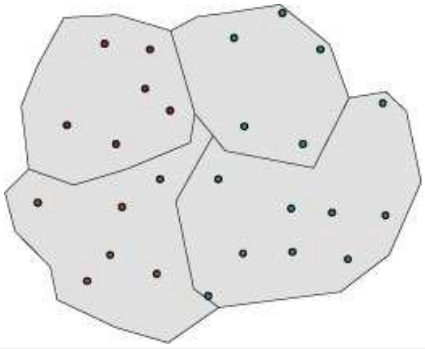


Figure 66 : Spatial join function one in ArcGIS
Source : GIS Practical Work (Biswas, 2014)

In the figure 66, the spatial join function of ArcGIS is shown. Spatial join can be performed in two ways, either with join data and other with the spatial join function. Spatial Join is used to join two tables which are related to each other. In the following practical work, different functions of spatial joins are described. Spatial join is very much used to the spatial analysis. This supports numerous calculations, which is very much relevant for the mathematical calculations, as well as condition based spatial analysis. The figure in the right gives the idea, that it can be used for the match operations like intersect, intersect_3D, within a distance, conations, completely contains, within, completely within, are identical to, boundary touches, share a line segment with, crossed by the outline of, have their center in or to find the closest element relating with two features. Here the following four examples are taken into consideration. Firstly, the locations of schools in individual neighbourhoods will be identified by using spatial join; secondly, the total number of school locations based upon each neighbourhoods; then the locations of schools within ten meters of streets; and finally the which schools are completely within the specific area will be discussed sequentially. The figure showing in the left side, is the operation, where you can perform some mathematical operations like, average, sum, minimum, standard deviation and variance depending on the data types, you want to have some calculations.

In the following figure 67, you will find that the school locations are spatially joined with one to one relationship, which gives the location of schools in each neighbourhood. Which means that no school that has the same id cannot be twice in different places, like in different neighbourhood. Here different symbology is used to represent the location of schools in different neighbourhoods. The attribute table shows the school locations of twenty six places are shown in different neighbourhoods like neighbourhood one, neighbourhood two, neighbourhood three and neighbourhood four; from which you can identify the shape area of different neighbourhoods and also the id of the school locations. There is a field appeared as the Joint_Count, which counts each individual points once and for the calculation you can also sum up your result.



Table

which school which neighbour

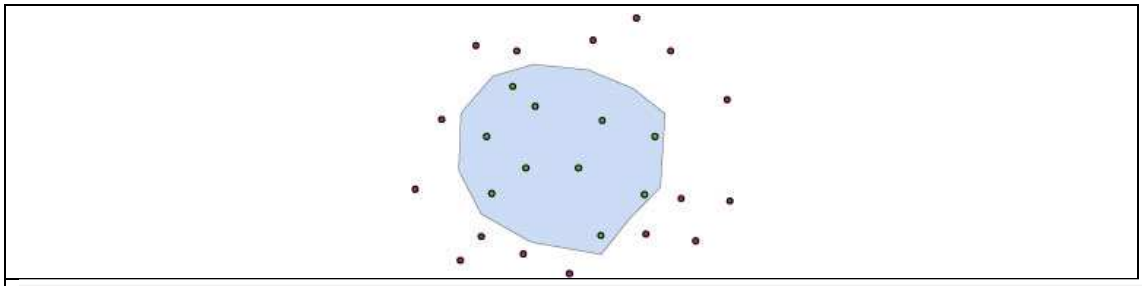
FID	Shape *	Join_Count	TARGET_FID	Type	Type_1	SHAPE_Leng	SHAPE_Area
0	Point	1	1	School1	Neighbour1	304,37802	6698,132648
1	Point	1	2	School2	Neighbour1	304,37802	6698,132648
2	Point	1	3	School3	Neighbour1	304,37802	6698,132648
3	Point	1	4	School4	Neighbour1	304,37802	6698,132648
4	Point	1	5	School5	Neighbour1	304,37802	6698,132648
5	Point	1	6	School6	Neighbour1	304,37802	6698,132648
6	Point	1	7	School7	Neighbour2	292,553986	6059,705775
7	Point	1	8	School8	Neighbour2	292,553986	6059,705775
8	Point	1	9	School9	Neighbour2	292,553986	6059,705775
9	Point	1	10	School10	Neighbour2	292,553986	6059,705775
10	Point	1	11	School11	Neighbour2	292,553986	6059,705775
11	Point	1	12	School12	Neighbour3	427,926122	10112,621597
12	Point	1	13	School13	Neighbour3	427,926122	10112,621597
13	Point	1	14	School14	Neighbour3	427,926122	10112,621597
14	Point	1	15	School15	Neighbour3	427,926122	10112,621597
15	Point	1	16	School16	Neighbour3	427,926122	10112,621597
16	Point	1	17	School17	Neighbour3	427,926122	10112,621597
17	Point	1	18	School18	Neighbour3	427,926122	10112,621597
18	Point	1	19	School19	Neighbour3	427,926122	10112,621597
19	Point	1	20	School20	Neighbour4	416,508443	7491,153963
20	Point	1	21	School21	Neighbour4	416,508443	7491,153963
21	Point	1	22	School22	Neighbour4	416,508443	7491,153963
22	Point	1	23	School23	Neighbour4	416,508443	7491,153963
23	Point	1	24	School24	Neighbour4	416,508443	7491,153963
24	Point	1	25	School25	Neighbour4	416,508443	7491,153963
25	Point	1	26	School26	Neighbour3	427,926122	10112,621597

1 (0 out of 26 Selected)

which school which neighbour

Figure 67 : Spatially joined schools in neighbourhoods
Source : GIS Practical Work (Biswas, 2014)

In the figure 68, it is shown the attribute table of schools along with the figure to that top that are completely within the area. The attribute table there is a field, calls joint count. Where the values are either one or zero. The value, which have the one, means they match the criteria; which belongs within the area. And the value of joint count zero, means they do not match the criteria, means they are outside the area. There are ten different school locations, which have the joint count field as one, and which are completely within the area.



Table

completely within

FID	Shape *	Join_Count	TARGET_FID	Type	Type_1	SHAPE_Leng	SHAPE_Area
0	Point	1	1	School1		381,762261	10943,237202
1	Point	0	2	School2		0	0
2	Point	0	3	School3		0	0
3	Point	1	4	School4		381,762261	10943,237202
4	Point	0	5	School5		0	0
5	Point	1	6	School6		381,762261	10943,237202
6	Point	0	7	School7		0	0
7	Point	0	8	School8		0	0
8	Point	0	9	School9		0	0
9	Point	1	10	School10		381,762261	10943,237202
10	Point	1	11	School11		381,762261	10943,237202
11	Point	0	12	School12		0	0
12	Point	0	13	School13		0	0
13	Point	0	14	School14		0	0
14	Point	0	15	School15		0	0
15	Point	1	16	School16		381,762261	10943,237202
16	Point	1	17	School17		381,762261	10943,237202
17	Point	0	18	School18		0	0
18	Point	0	19	School19		0	0
19	Point	0	20	School20		0	0
20	Point	0	21	School21		0	0
21	Point	0	22	School22		0	0
22	Point	1	23	School23		381,762261	10943,237202
23	Point	1	24	School24		381,762261	10943,237202
24	Point	0	25	School25		0	0
25	Point	1	26	School26		381,762261	10943,237202

1 (0 out of 26 Selected)

which school which neighbour | completely within

Figure 68 : Schools completely within area
Source : GIS Practical Work (Biswas, 2014)

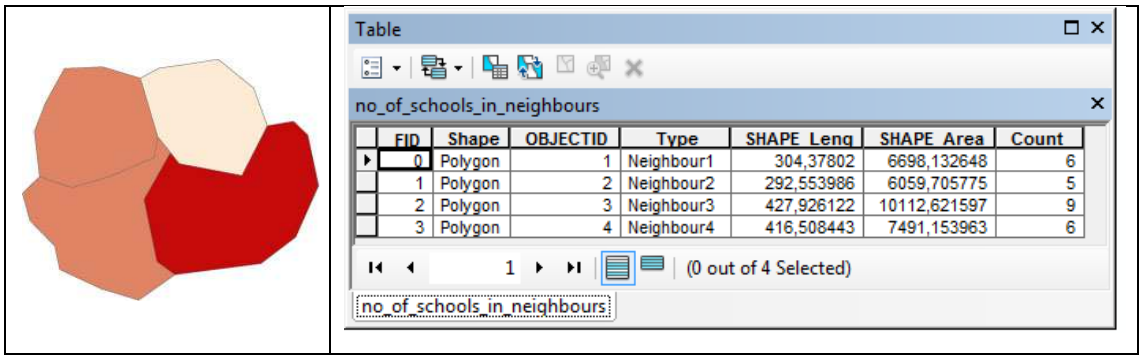
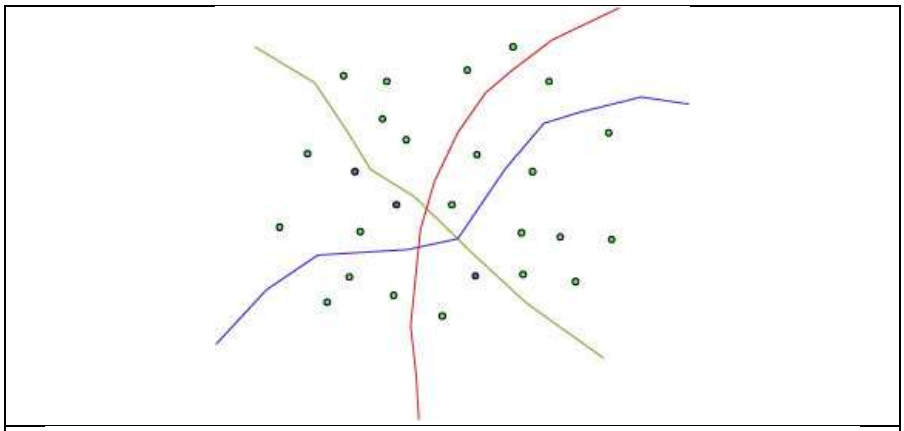


Figure 69 : Number of school locations in neighbours
Source : GIS Practical Work (Biswas, 2014)

In the figure 69, the summation of number of school locations in different neighbourhoods. By using join data function of ArcGIS, we get the result of sum, which is used for the statistical calculation. Here different colours are used to understand it better. If you see on the figure, it can be easily assumed that the neighbourhood one and the neighbourhood four has the same number of schools, and the summation of the schools in these two neighbourhoods are twelve, where each neighbours have six locations of schools. The neighbourhood two and neighbourhood three have the summation of school locations of five and nine respectively.

By using spatial join, we can also count which feature is located within a certain distance. Here in the figure 70 in the next page, there are three different locations of schools which are within a distance of ten meters. That means, out of twenty six different school locations only three of them meets the criteria, which are within the distance of ten meters. In the figure, you will find the attribute table of the school locations of ten meters along streets. If you observe it clearly, you will find that in the field of joint count there are only three values which have the value of one, which means that they matches the criteria, which are within the distance of ten meters. And the rest, does not locate inside the distance of ten meters. They are with the value of zero in the field of joint count of the attribute table. Thus we can perform different statistical calculations with the spatial join functionality of ArcGIS, which is much used for the spatially join of two or more related features. With the use of match optional; you can perform the intersection, contains, completely contains, within, completely within, are identical to, have their center etc.; depending upon the choice of interest upon which you want to analyze with different spatial join functionality.



Table

schools within 10 metes distance streets

FID	Shape *	Join_Count	TARGET_FID	Type	Type_1	SHAPE_Leng
0	Point	0	1	School1		0
1	Point	0	2	School2		0
2	Point	0	3	School3		0
3	Point	1	4	School4	Street1	270,643116
4	Point	0	5	School5		0
5	Point	0	6	School6		0
6	Point	0	7	School7		0
7	Point	0	8	School8		0
8	Point	0	9	School9		0
9	Point	0	10	School10		0
10	Point	0	11	School11		0
11	Point	0	12	School12		0
12	Point	0	13	School13		0
13	Point	0	14	School14		0
14	Point	0	15	School15		0
15	Point	0	16	School16		0
16	Point	1	17	School17	Street1	270,643116
17	Point	0	18	School18		0
18	Point	0	19	School19		0
19	Point	0	20	School20		0
20	Point	0	21	School21		0
21	Point	0	22	School22		0
22	Point	1	23	School23	Street1	270,643116
23	Point	0	24	School24		0
24	Point	0	25	School25		0
25	Point	0	26	School26		0

1 (0 out of 26 Selected)

no_of_schools_in_neighbours | schools within 10 metes distance streets

Figure 70 : School locations of ten meters along streets
Source : GIS Practical Work (Biswas, 2014)

5.8 Union

The following work flow is the concept, by which you can understand different steps which are performed for the union function. First of all like other functionality, the basic information regarding the union is illustrated, after that several questions related to the union function appeared to the page. The answers are written in the textual background. To understand the union function, moreover there are several situations described with the geo-spatial phenomena. After that the union function is shown in ArcGIS to have a quick idea about the function. And lastly the vector data are analyzed with different examples (see figure 71).

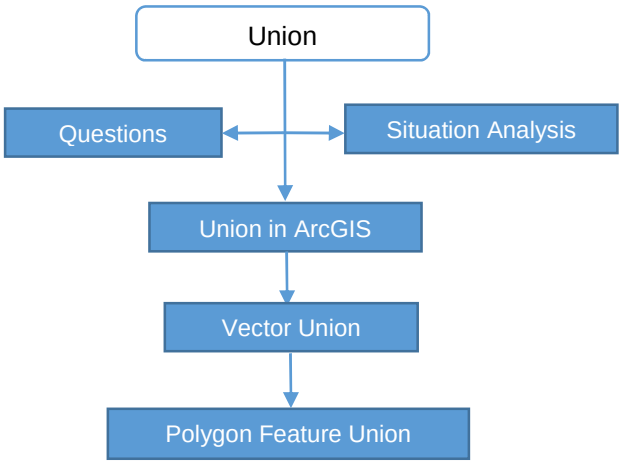


Figure 71 : Flow diagram of Union function

Source : GIS Practical Work (Biswas, 2014)

Questions

- What is the meaning of Union?
- Which data can be used for Union?
- Does ArcGIS support both raster and vector data for Union?
- Where the Union function can be used?

Union is used to join two layers together visually with the new attribute table consisting of shared or overlapping areas. It is used only in the polygon features. All the feature attributes and the features which is used to union is preserved in the output feature class. Only the polygon features are used for union. No point or line features can be used in ArcGIS for union function. ArcGIS supports only the vector data for union function to work with. It creates the overlapping areas between two input features and gives a new output which have all the attributes.

5.8.1 Situation Analysis

Let us consider a city has three different universities and the each university has different catchment areas. The city authority is needed to have the catchment areas of universities in the city, and the city boundaries need to join together in order show a new area for the city development authority. In this situation, the universities catchment areas will be joined together with the boundaries of the city. In this case, we use union function. In this scenario a set of polygons will be joined tighter to have the new area which contains the catchment areas of the university and the city.

Let us consider another situation where the city authority is trying to have new area features of each neighbourhoods and the boundary of each residential units. In this scenario, both the areas of the neighbourhoods features will be joined together with the residential units and each overlapping areas will be generated as new area features. Let us consider that the residential units have the attributes of id number of the residence, area code, name of the residence holder, phone number of the residence and the each neighbour has the attributes of neighbour id, neighbour name, and area of each neighbour. After the union operation from ArcGIS, this will persevere all the attributes of both neighbourhoods and the residential areas and will generate a new feature area.

Let us consider also this example for the use of union of features. As union combines the geometry and attributes of two polygon layers to generate a new output polygon layer. In this example we will use union to combine ZIP codes with the neighbourhoods in a City. The output of the union will be a new feature layer of smaller polygons, each with the combined boundaries and attributes of both neighbourhoods and the ZIP Codes. Union keeps all features of the input layers, even if they do not overlap.

5.8.2 Union function of ArcGIS

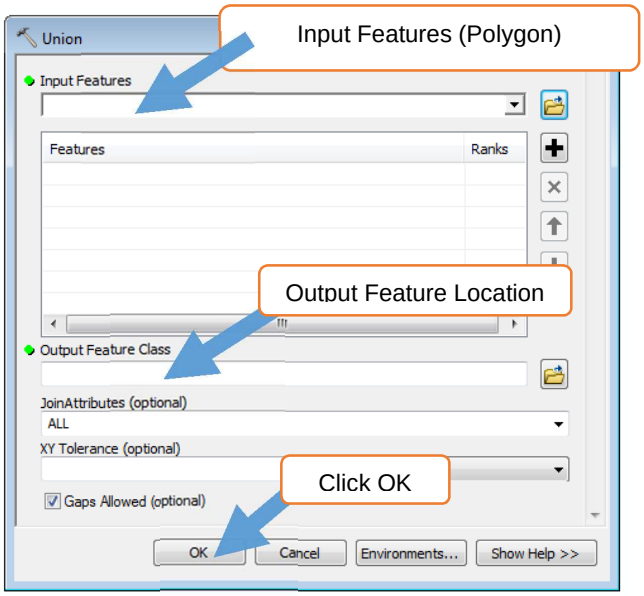


Figure 72 : Union function of ArcGIS
Source : GIS Practical Work (Biswas, 2014)

In figure 72, the union function of ArcGIS is illustrated where you will find that the input features should be always as polygon features. The output feature is also polygon features. You can also join attributes, which is as optional fixed as all, but you can also choose it with the attribute type. Here in the practical part, you will find the union of neighbourhoods with the area. The attribute values changes with the output values of union.

In figure 73, the result of union is shown, where additional polygons are added as output. As you see there are four neighbourhoods which are joined together to get the output as union polygon.

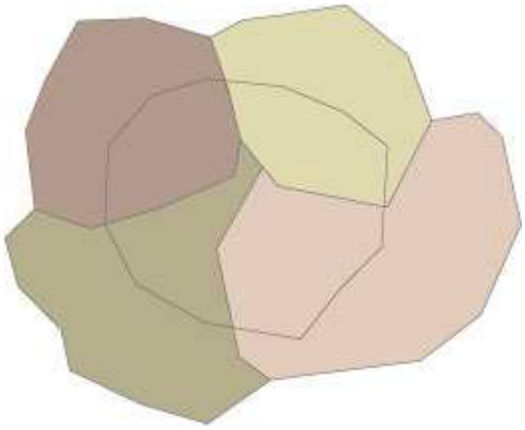


Figure 73 : Result one of area and neighbour union
Source : GIS Practical Work (Biswas, 2014)

In the following figure 74, you will find the attribute table of union result one, that there are eight polygons which is created with the union operation of ArcGIS. So each intersecting polygons are now created with a new polygon feature, with the shape of the area. In the FID_Area which is in the third column of the attribute table, gives two values. They are either plus one or minus one. The plus one value means, they intersects the other polygons. The minus value means, they do not interests with each other. Here in the result one, the neighbourhoods has given first as the input feature and then the area is has taken into consideration as the second input feature.

Table

Area_Union

OBJECTID *	SHAPE *	FID_Area	Type	FID_Neighbour	Type	SHAPE_Length	SHAPE_Area
1	Polygon	-1		1	Neighbour1	296,326908	4136,623169
2	Polygon	-1		2	Neighbour2	298,139389	3583,032099
3	Polygon	-1		3	Neighbour3	395,319371	6587,207177
4	Polygon	-1		4	Neighbour4	324,417928	5111,514915
5	Polygon	1	<Null>	1	Neighbour1	200,235034	2561,50987
6	Polygon	1	<Null>	2	Neighbour2	207,547448	2476,672571
7	Polygon	1	<Null>	3	Neighbour3	236,857179	3525,415322
8	Polygon	1	<Null>	4	Neighbour4	246,047835	2379,638859

1 (0 out of 8 Selected)

Neighbour_Union Area_Union

Figure 74 : Attribute table of result of area and neighbour Union
Source : GIS Practical Work (Biswas, 2014)

In the figure it has been described above the area has taken as the input feature and then the polygon feature like the neighbourhoods were placed together to perform the union function between them.

6. DEVELOPMENT PROCESS

6.1 Technical Details

Here the details of the software development will be discussed. First of all the geoprocessing functions (Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union) were performed in ArcGIS 10.1. Then the output/result/shape files were converted to the SVG as vector data. SVG stands for scalable vector graphics, which is an XML based vector image format, developed by the World Wide Web Consortium (W3C). As ArcGIS supports the SVG graphics, which can be scripted and use in the Web along with using the HTML5, and CSS3. Several animation functions have been developed at the e-Learning module, by scripting language, by using the SVG. There are several types of supported files to export from ArcGIS. They are especially as PNG, AI, JPG, TIFF and PDF. The other format of exporting file from ArcGIS cannot be used as vector data for the web. In that case, by considering the SVG file is the best use for the web development. The Vector Graphics are also saved as raster format like PNG and JPG. The JPG file is used for the slideshow in the e-Learning and the PNG file is used in the Report as it gives the best quality of image formats (see figure 75).

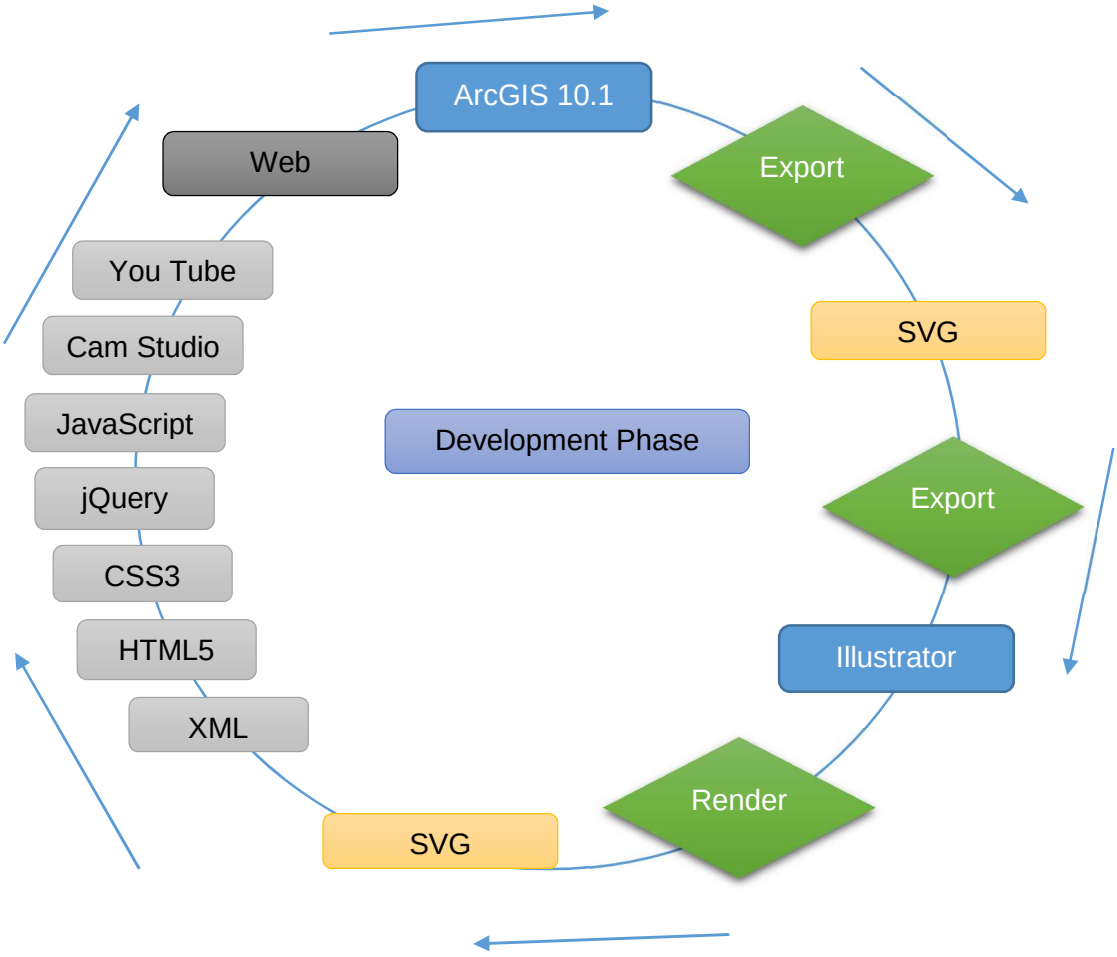


Figure 75 : Web development process

Source : Biswas, 2014

After exporting the SVG file, which is the XML format, is rendered by the adobe Illustrator software. As illustrator supports the rendering of SVG file, to get the actual height and width of the raster data. When the SVG file is exported from ArcGIS, it give the layout border and cannot be separated each individual features like, point, line or polygon. The reason is to get individual features, so that it can be animated in the in the web and to separate each of the features, adobe illustrator is used.

The next step is to bring the SVG file, which can be opened as HTML file. In the e-Learning tutorial layout for the web development, each results were included. For example the results of buffer function is incorporated to the layout of e-Learning. Other results of geoprocessing functionalities are also included in the same way. The basics of HTML5 codes are used for the development of e-Learning, in order to have better functionalities rather than using Adobe Flash in the web.

CSS3 is used to fix the position of each element in page layout of the webpage, as it is the newer version of the CSS, which is developed parallel with the HTML5 to work together. The most used CSS3 functionalities in the web page are the body, the header, footer, content, bottom, image padding and also the carousel functionalities. CSS3 is used to fix the height, width, display, margin and also for using the padding of the elements of the webpage. For the better outlook of the element in web, each CSS3 file is developed; such as Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union. These files are available in the software development phase and is recorded in the CD, which is already handed over to the supervisors.

JQuery, which is the in-built JavaScript functionality is used in the web development phase to animate elements in webpage. In the webpage of e-Learning development, JQuery functionality of Bootstrap is used. Bootstrap is a library which is used to develop interactive web page covering the HTML5, CSS3 as well as the JS framework and can be used to develop webpage for the desktop as well as for the mobile devices. In the e-Learning tutorial, the carousel effect is developed through the JQuery in order to have the slideshows of the images.

JavaScript is used in the part of evaluation form as well as to bind together with the JQuery functionalities of each linking pages for the web development such as Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union. In order to get the functional interactivity of the questions, answers, explanations of the answers as well as to get the total score after answering the questions; the JavaScript functionality is used in the web development phase. The other functionality of JavaScript is the collapse function, which is used to for the questions, situation analysis and example item of collapse function. With this function the items are expanded on click function, and hide if the other item is selected.

For the You Tube video, the Camstudio 3 software is used with the audio support. A personal account is used for the storage of You Tube videos. These Videos are related to eight different geo-processing functionalities.

6.2 Usage of e-Learning Tutorial

The e-Learning tutorial, which is a webpage can be used to have the ideas about Buffer, Clip, Dissolve, Erase, Intersect, Merge, Spatial Join and Union. In order to understand it from the tutorial user can have several options to learn it from the tutorials. These are mouse over effect and tooltip effects to show the feature name as well as also the feature attributes. There are also slide shows of each individual results of geoprocessing are supported in the e-Learning as well as the You Tube videos to understand the working process through ArcGIS. If the students follow the e-Learning tutorial step by step, they can also take part on the multiple choice questions, which are added in the evaluation part of the e-Learning tutorial.

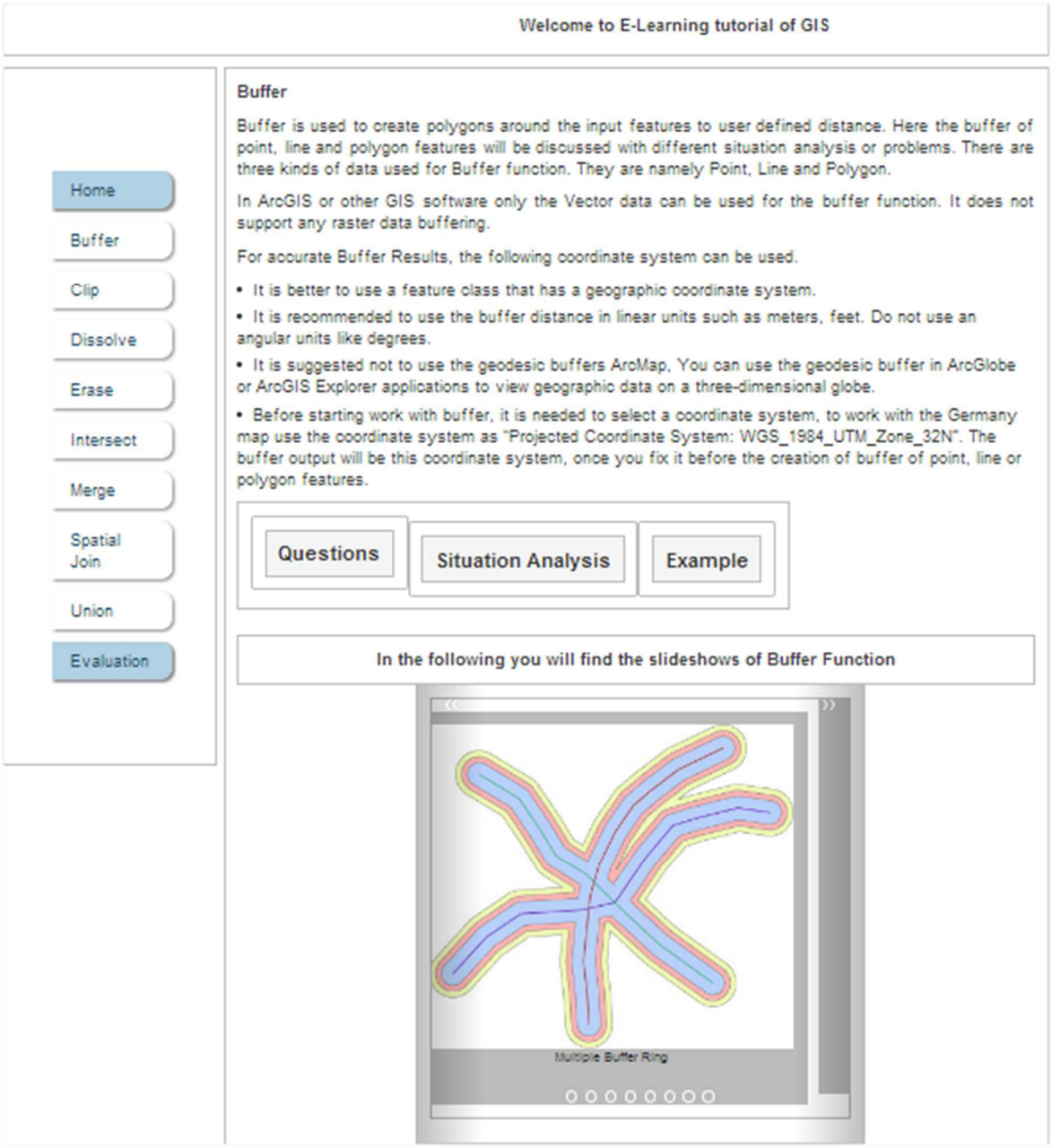


Figure 76 : e-Learning tutorial, Overview of Buffer
Source : Biswas, 2014

In the figure 76, the developed e-Learning tutorial of buffer function is shown. The top of the webpage, the welcome message is shown, which is a dynamic movement from right to left and vice versa. In the link, the navigation bar is shown, where they are connected to each other pages. On click to each navigation item, you can move from one page to another. There are a general description of buffer functionality on the top of the layout of buffer, which also give the idea of which coordinate system is needed for the buffer function.

In the following figure 77, you will find the general questions related to buffer functionality of ArcGIS. There are five general questions which are buffer meaning, data used for buffer functionality, the related projection and also the accuracy of buffer results. Similarly in other Geoprocessing functionalities the related general questions can be also found.

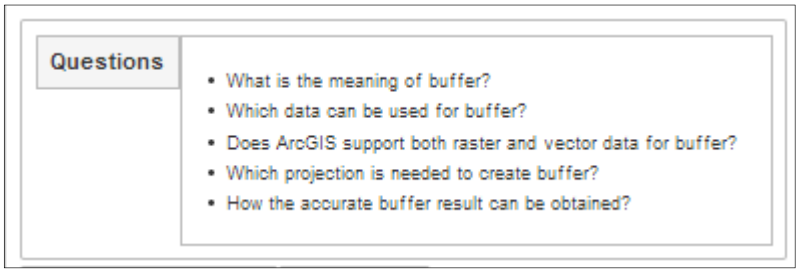


Figure 77 : e-Learning tutorial, Questions of Buffer
Source : Biswas, 2014

Situation analysis illustrates different scenarios for the buffer related problem. In the following figure of 78, you will find different situation analysis related to buffer functions of point, line and polygon features. This is included in the e-Learning tutorial so that the students or the user have the basic ideas upon where the buffer functions can be used. The similar questions, which can be found in more for the better understanding with real world geo-spatial problems. Similarly in other Geoprocessing functionalities the related situation analysis can be also found in the e-Learning tutorial.

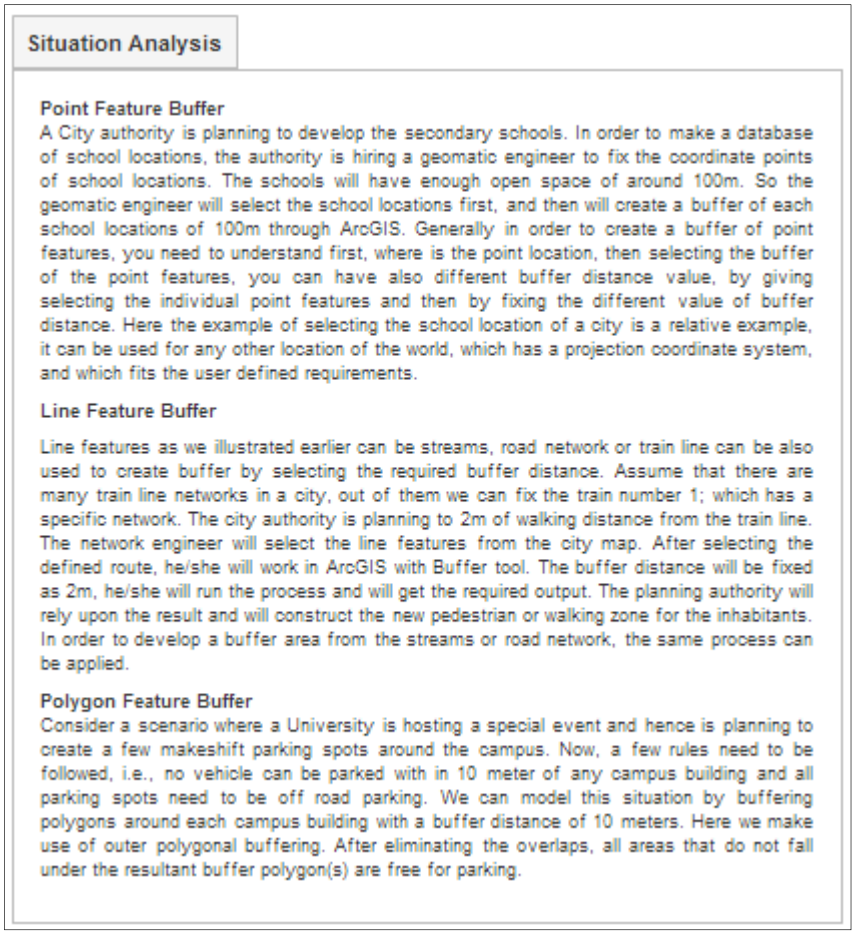


Figure 78 : e-Learning tutorial, Situation Analysis of Buffer
Source : Biswas, 2014

For the interactivity of the each elements of vector features in the e-Learning tutorial, the mouse over effect and tooltip effects are included. In figure 79, you will find a classical example of this interactivity. In this figure, you will find that the locations of school 5 appears and also the buffer result of 10 meter, by the mouse over effect. Similarly you can find all the interactivity of other point, line and polygon features only by mouse over effect, and the related information will appear by the tooltip functionality. This will disappear, when you unselect an element and if you want to have the information of other feature, you need to mouse over to your desired features in the e-Learning tutorial.

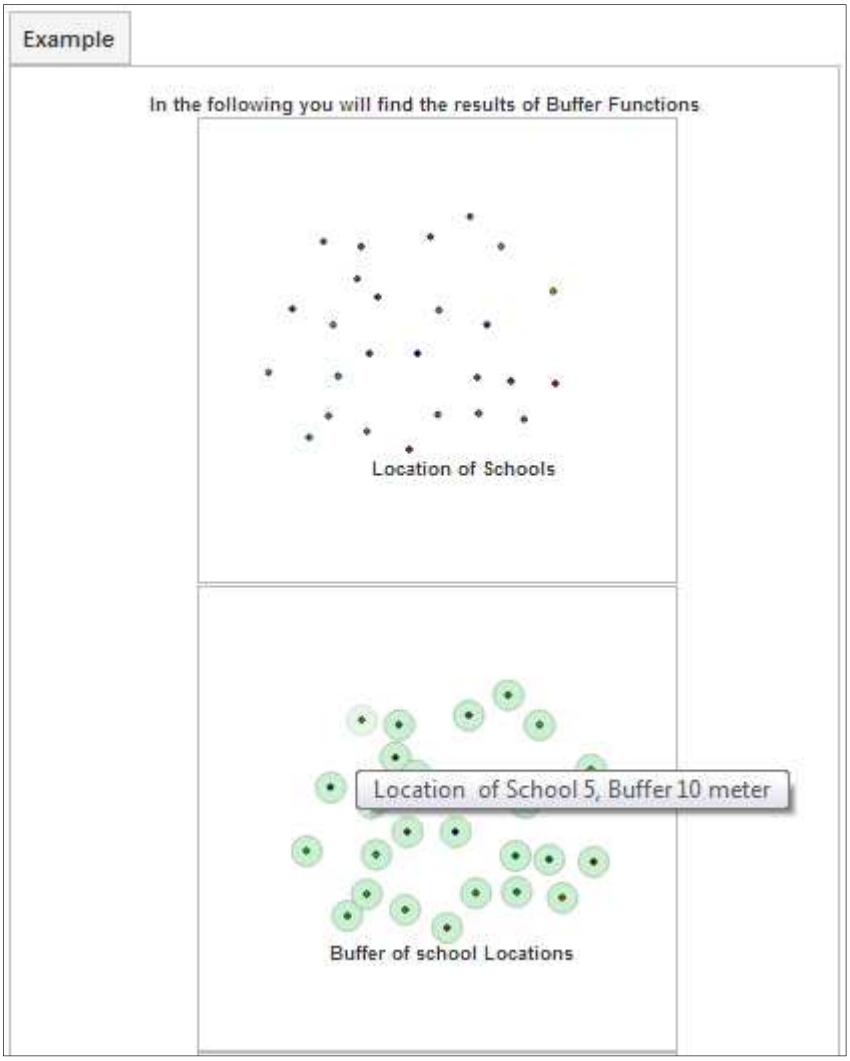


Figure 79 : e-Learning tutorial, Mouse over and tooltip effect of buffered Features
Source : Biswas, 2014

Slideshows gives the movement of the output images, which is performed by the ArcGIS, in the figure 80, you will find the seventh slideshow of neighbourhoods, which is a buffered item of polygon features. Similarly, in other slideshows of the e-Learning tutorial, you can also find a quick view of the result, which is related to the result of ach functionalities of geo-processing in ArcGIS. You can stop it just fixing your mouse to individual slide, you can change also using the down of slideshow control button or suing the next or back button in the top, or it will change accruing to one thousand millisecond, every slides of the e-Learning tutorial.

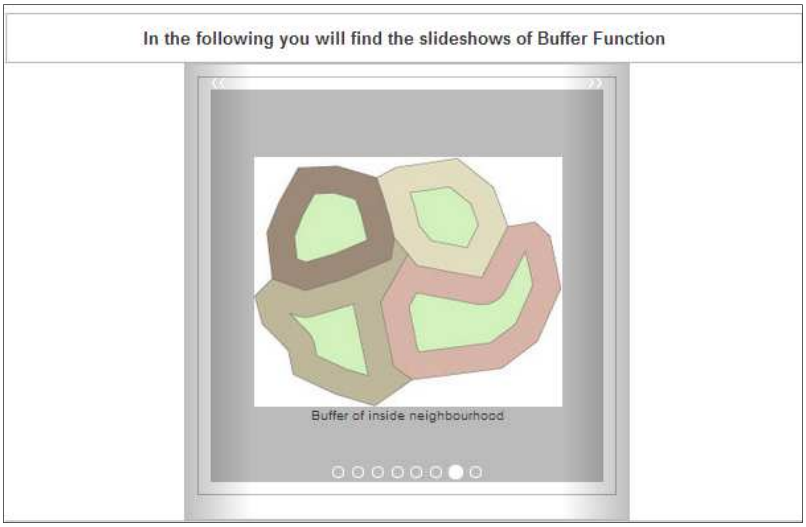


Figure 80 : e-Learning tutorial, Slideshows of inside buffered features
Source : Biswas, 2014

For the better performance of the e-Learning tutorial, it is recommended to use the google- Chrome browser, as all the functionality of this e-Learning tutorial, is developed with the HTML5 and with the support of CSS3. The Internet Explorer and the Mozilla Firefox will not support all the CSS3 functionalities, so there could be unavailability of these functionalities in these browsers. It has been tested several times, at the development phase of e-Learning tutorial. Also this application in mobile device has not been tested yet, so it is recommended only to use in desktop or in laptop use for the better performance of this e-Learning tutorial.

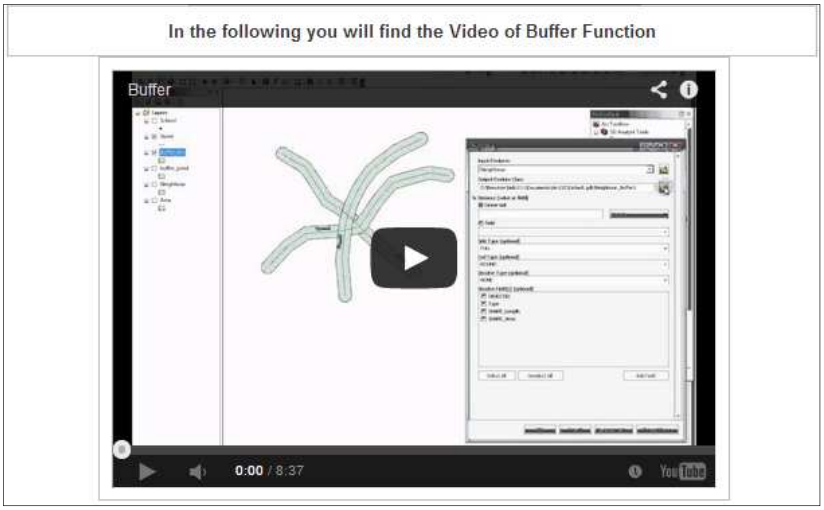


Figure 81 : e-Learning tutorial, You Tube Videos of Buffer function of ArcGIS
Source : Biswas, 2014

In the above figure of 81, you will find the related YouTube videos for the buffer function of ArcGIS. By following this video, you can go through step by step to perform the buffer functionality. In the video, you can find how to buffer the point, line and polygon features as well as how to buffer the inside, outside of polygon and also the buffer of multiple ring. Similarly there are total eight different videos of each geo-processing functionalities, which are developed with the Camstudio 3 software, which is free to use. You can find the other developed e-Learning tutorial in Appendices, so that you can have an overview of all other functionalities of geo-processing.

7. DISCUSSION AND ANALYSIS

In this chapter the analysis of the geoprocessing will be described with the appropriate mathematical operations. Each individual functions of geoprocessing will be discussed with the help of secondary sources of mathematical logic behind them and also to compare the functions to find the differences between them. A flow diagram will give the overview of this chapter to understand it clearly. The flowchart of the analysis and discussion of geoprocessing. In the first row of the flowchart, there are the different geoprocessing functions. Based on the mathematical operations, all the functions are discussed, analyzed and summarized the differences sequentially in this chapter (see figure 82).

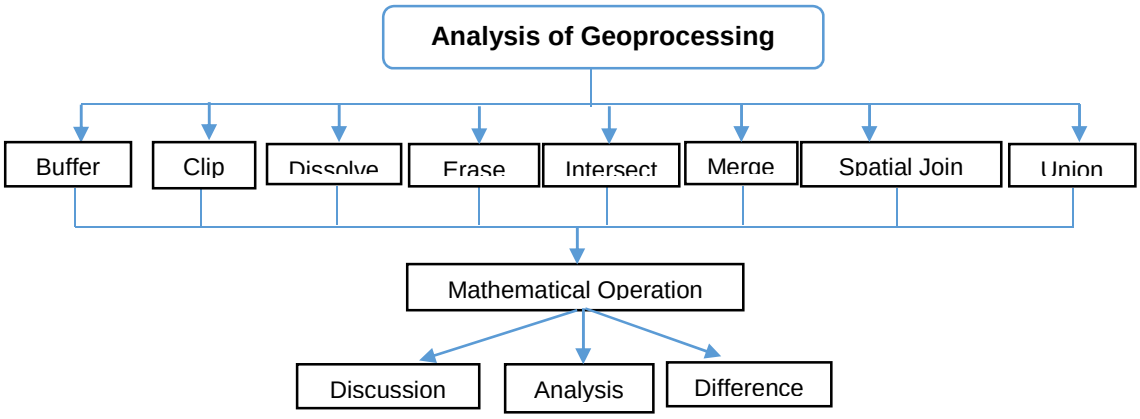


Figure 82 : Flowchart of analysis of Geoprocessing
Source : Biswas, 2014

7.1 Buffer Analysis

We have the results of buffer of point, line and polygon in the chapter 5.1; which we have obtained from ArcGIS will be discussed here in this chapter. The basic logic behind the point, line and polygon buffer is same, even it can be performed with other GIS software. There can be two types of buffer, one of them is with the constant distance buffer and the other one is the variable distance buffer. With the constant distance buffer, we use the same distance for each feature and with the variable distance buffer, we normally give different buffer distance values for buffer. One of example of variable distance buffer is the multiple ring buffer. If we consider the figure 28 in chapter 5.1 where the multiple ring buffer is used. And in the figure 21 in chapter 5.1, the constant distance buffer is used there.

In the figure 83, we have three different buffer distances for point, line and polygon; which are shown in the figure 83(a), (b), (c) respectively. In the buffering of point feature, there is a circular distance created with a buffer distance of five meters. The radius of this circular distance is called the buffer distance. For the buffering of line, buffer distance is created for each segments with the same buffering distance of two meters. This buffering distance is used for both the sides of a line. Normally the buffer distance of line feature contains tangent line and circle at each nodes or vertexes. The circles are calculated for each vertex and also at each node of the polygon. If you look through the buffering of polygon features, it gives the idea that the buffering distance of 10 meters is used only one side of the polygon. It is either inside of the polygon or outside of the polygon. So

the buffering of polygon features uses almost the same concept as the buffering of line features.

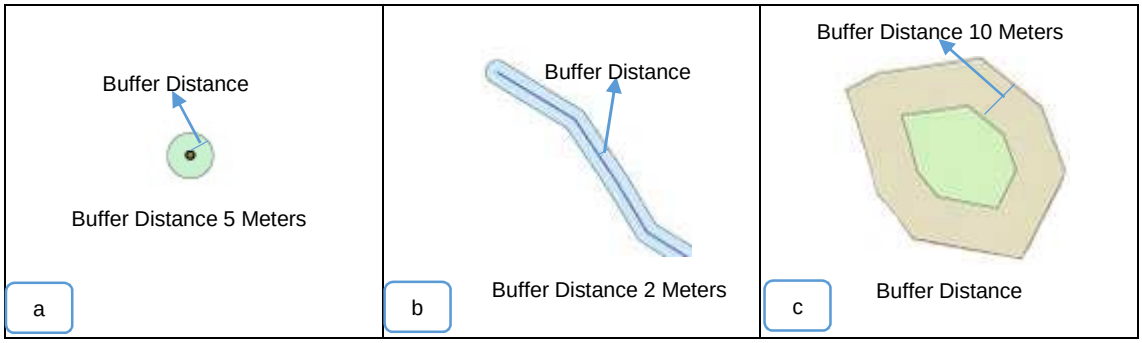


Figure 83 : Buffer analysis
Source : GIS Practical Work (Biswas, 2014)

For the comparison of buffer which is illustrated as in figure 83 distances of point, line and polygon features, the distance of Euclidean as buffer distance can be applied. This mathematical equation is described in equation 1 with the figures of 84 and 85. For the point buffer distance the distance of Euclidean is followed. In order to perform the buffer for line and polygon features, the same mathematical function is used as described in figure 85 for line buffer, the main difference is with the polygon buffer and line buffer is that, with the polygon buffer, it can be either inside or outside of the polygon. But for the line buffer, it is done only with the parallel to the line feature.

In the figure 84, the mathematical background of buffer for point and line is illustrated. Where the buffer distance is followed by the Euclidean distance both for the point, line or polygon feature.

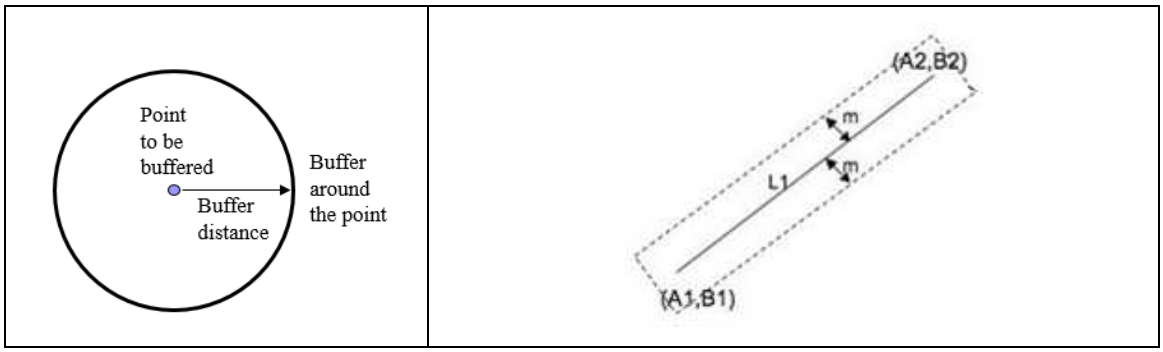


Figure 84 : Mathematical operation of point and line buffer
Source : Wing et al. (n.y) and Mandagere (n.y)

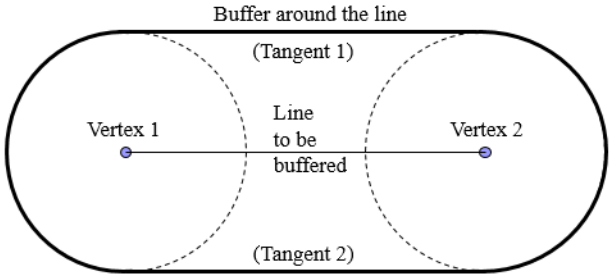


Figure 85 : Mathematical operation of line buffer
Source : Wing et al. (n.y)

For calculating the buffer distance, let us consider the followings -

m = Buffer distance
L1 = sine and cosine component for line one

Let us consider L1, describes the line with the endpoints (A1,B1) and (A2, B2) as shown in Figure 84.

To calculate the buffer distance between two end points we use the following equation number 1.

$$m = \sqrt{(\Delta x)^2 + (\Delta y)^2} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad \text{.....(1)}$$

Equation 1 : Equation of buffer distance
Source : Euclidean distance

We can replace the endpoints (A1, B1) and (A2, B2) with (x_1, y_1) and (x_2, y_2) in the equation 1 to get the buffer distance.

7.2 Clip Analysis

To discuss the clip function, we have already the results in the chapter 5.2 done by ArcGIS. In clip function, there are two types of features which overlays together to get the result. The first feature is our input feature and the second one is the area of interest or cookie cutter, which we have already discussed in the chapter 5.2. If we look through the figure 86, we will see that the boundary of the area of interest is imposed in the first input feature. There only the polygon feature is used to clip. In that figure all the area which is not inside the area of interest does not belong to the output feature. Only the clipped data becomes the output feature. In order to perform the clip function, the three things can be considered. They are, if the input features are points, the area of interest can only be either points, lines or polygons. If the input features are lines, the area of interest can be either lines of polygons and if the input features are polygons, the area of interest must be polygon. In the output feature, the spatial reference of the input data sets are preserved (see figure 86).

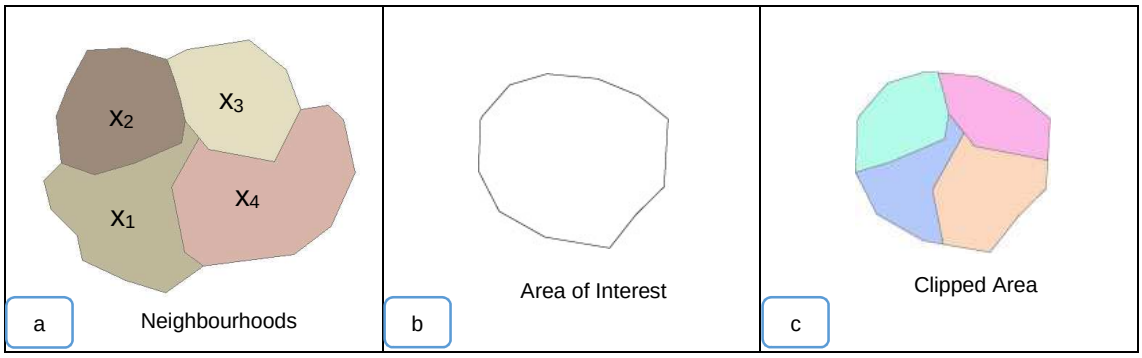


Figure 86 : Clip analysis
Source : GIS Practical Work (Biswas, 2014)

Clip is opposite of erase which preserve the inside objects of the cookie cutter. The rest of the objects between two features are erased by showing the result. In figure 86, the neighbourhoods 86(a), and the area of intersect is shown in 86(b). The clip function can

be also shown as with the subtraction of mathematical operation which is shown in the equation number 2 as followings –

Let us consider as below-

x_1 = neighbourhood1

x_2 = neighbourhood2

x_3 = neighbourhood3

x_4 = neighbourhood4

a = (x_1, x_2, x_3, x_4)

b = area of interest/cookie cutter

c = clipped area

$$c = a-b \ldots\ldots\ldots\ldots (2)$$

$$c = (x_1 + x_2 + x_3 + x_4) - b$$

Equation 2 : Mathematical operation of clip

Source : Subtraction

7.3 Dissolve Analysis

Dissolve function is used to aggregate multiple boundaries to create an aggregated single boundary. We have already the results by using the dissolve function of ArcGIS in chapter 5.3. The most common use of dissolve function is in buffer function, where the dissolve function is used to merge the polygons which have same attribute value. The undissolved buffers gives the separate polygons as output feature. If you compare the figures in figure 87, you will see that the four neighbours are aggregated together to get the dissolved output as a merged boundary of all these neighbourhoods of the input feature. This function has removed the boundaries of the adjacent polygons of neighbourhoods and has created a new boundary as an output feature. One thing is always require for dissolve function that it uses only the polygon features to aggregate together (see figure 87).

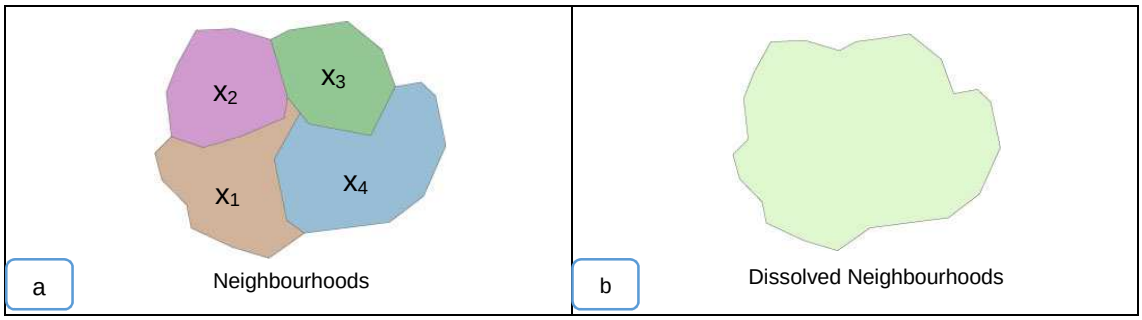


Figure 87 : Dissolve analysis

Source : GIS Practical Work (Biswas, 2014)

Dissolve function is done with the mathematical operation of addition which is shown in the equation 3. In figure 87, there are neighbourhoods 87(a) and the dissolved result is in 87(b). The result of dissolve function shows only the merged border which acts as adding all the input feature but gives only the outer polygon with new shape file.

Let us consider as below-
a = (x_1, x_2, x_3, x_4)
x_1 = neighbourhood1
x_2 = neighbourhood2
x_3 = neighbourhood3
x_4 = neighbourhood4
b = dissolved area
In comparison with the mathematical operation of addition we can calculate the dissolved area with the following equation number 3.

$$b = x_1 + x_2 + x_3 + x_4 \ldots\ldots\ldots\ldots (3)$$

Equation 3 : Mathematical operation of dissolve
Source : Addition

7.4 Erase Analysis

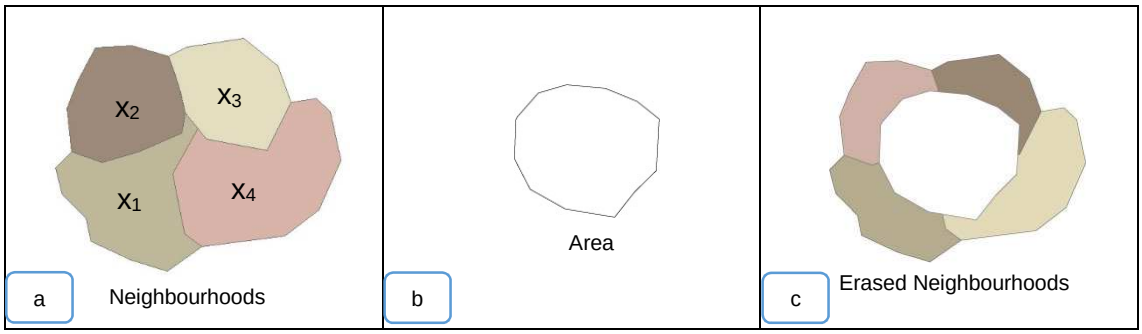


Figure 88 : Erase analysis
Source : GIS Practical Work (Biswas, 2014)

Erase is used to erase a feature layer with the feature of a polygon layer. The outputs are created with the new feature class (point, polyline or polygon depending on the type of the original layer). In the output features, the attributes are preserved and also the spatial reference of the input data are preserved. Erase function is opposite of the clip function, where the clip function preserve the attributes of clip area, but in erase function the erase area is completely erased. In figure 88, the neighbourhoods 88(a), and the area of erase is shown in 88(b). The erase function can be also shown as with the subtraction of mathematical operation which is shown in the equation number 4 as followings –
Let us consider as below-
x_1 = neighbourhood1
x_2 = neighbourhood2
x_3 = neighbourhood3
x_4 = neighbourhood4
a = (x_1, x_2, x_3, x_4)
b = area of erase
c = erased area

$$c = a - b \ldots\ldots\ldots\ldots (4)$$
$$c = (x_1 + x_2 + x_3 + x_4) - b$$

Equation 4 : Mathematical operation of erase
Source : Subtraction

7.5 Intersect Analysis

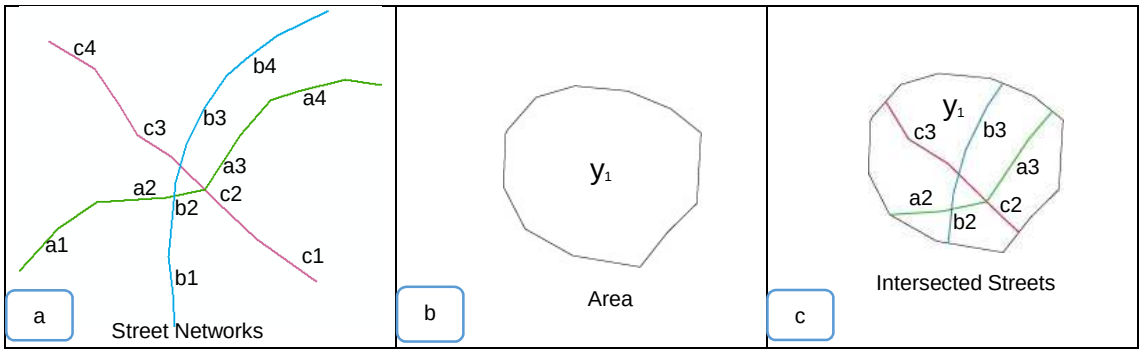


Figure 89 : Intersect analysis
Source : GIS Practical Work (Biswas, 2014)

In chapter 5.5 the intersect function is described briefly with individual point, line and polygon features. There the different changes are observed with the comparison of the intersect result as well as with the change of attribute tables of every individual results of intersection. Here the internal function of intersect will be discussed, to understand how the intersect function works not only with ArcGIS but also with the other software when the intersect function is applied. As we know that the intersect function creates a new features from the common areas or edges of any types of selected features of the same geometry type. Here in the figure 89(a), the street networks are intersected with the area in figure 89(b). The result of intersection is depicted in figure 89(c).

The logic behind intersect function works with the set theory of mathematical operation. As we know the set theory as using the intersection of two sets a and b is the set of all elements that also belong to c, which are only intersected with each other.

Suppose there are two sets a and b which comprised with the figure 89(a), 89(b) and the result of intersection is Let us consider below-

Street one = a_1, a_2, a_3, a_4
Street two = b_1, b_2, b_3, b_4
Street three = c_1, c_2, c_3, c_4

The street network = $\{a_1, a_2, a_3, a_4, b_1, b_2, b_3, b_4, c_1, c_2, c_3, c_4\}$
b, the area = $\{ y_1 \}$

The results of two sets of intersection is zero, if they do not joint each other.

$$c = a \cap b \ldots\ldots\ldots\ldots (5)$$

$$c = \{ a_2, a_3, b_2, b_3, c_2, c_3, y_1\}$$

Equation 5 : Mathematical operation of intersect
Source : Set Theory, Intersection

7.6 Merge Analysis

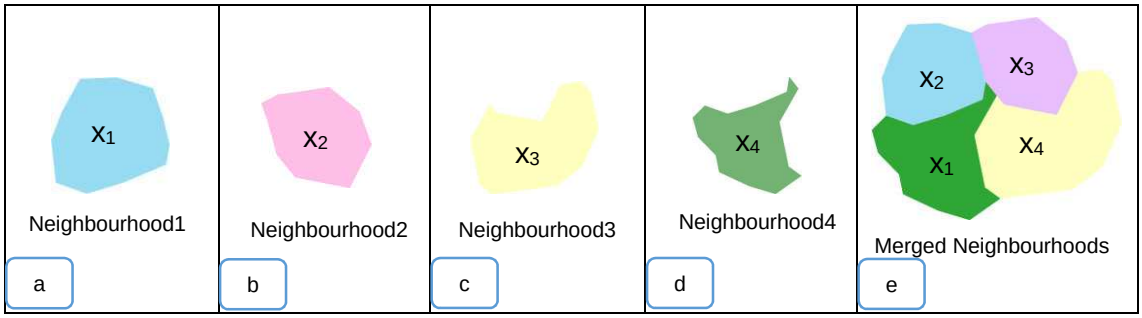


Figure 90 : Merge analysis
Source : GIS Practical Work (Biswas, 2014)

In chapter 5.6 the merge function is described with the use of point, line and polygon features, which are of the same feature type. At the end of merge function, all the feature types are merged together sequentially. In the figure 90, only the polygon features are taken from the practical part to analyze the merge function. In the figure 90(a), 90(b), 90(c), 90(d) are the input features and the 90(e) is the merged polygon of the input polygon features. In comparison with the dissolve function, it can be added that in dissolve function, all the input features are added together but showing only the outside borders in the output feature. But in merge function, all the input features are added together to show the output features. The spatial join function also use the same functionality of merge, but there the comparison is that in merge function, the same type of data is merged together. In spatial join different types of input features can be joined together also with some conditions, which can be applied in the case of spatial join. The conditions of spatial join is described in the part of spatial join analysis in chapter 7.7.

For the merge operation the simple addition operation of mathematical function is applied, for example in the figure 90(a), 90(b), 90(c) and 90(d) are merged together in the figure 90(e) with the mathematical operation of equation 6.

Let us consider as below-

a = x_1 = neighbourhood1
b = x_2 = neighbourhood2
c = x_3 = neighbourhood3
d = x_4 = neighbourhood4
e = merged area

$$e = a+b+c+d \quad \ldots\ldots\ldots\ldots (6)$$
$$e = x_1+ x_2+ x_3+ x_4$$

Equation 6 : Mathematical operation of merge
Source : Addition

7.7 Spatial Join Analysis

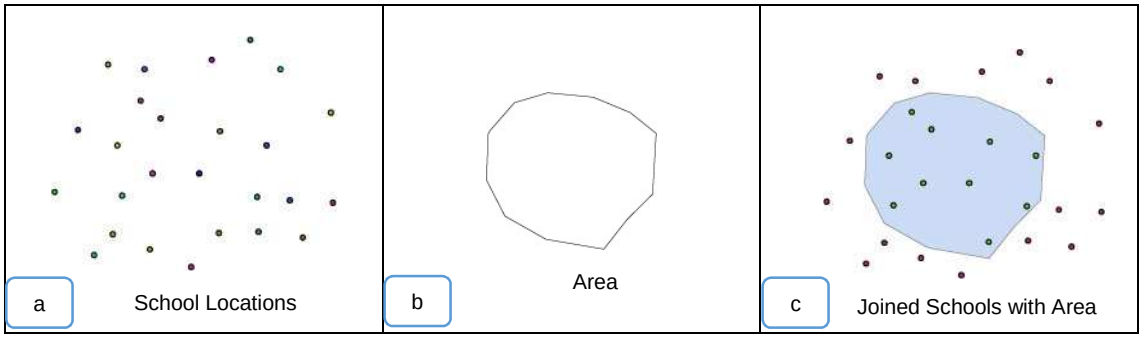


Figure 91 : Spatial join analysis
Source : GIS Practical Work (Biswas, 2014)

As we discussed in chapter 5.7, the spatial join is used to join the attributes of feature classes based on the spatial relationships of the feature. Here in the figure 91, the input of two attributes are shown. Out of them 91(a), showing the locations of schools and in 91(b) is the area with whom the school locations will be joined together. There is also the condition applied, as the school locations are completely within the area. The figure 91(c) gives the result of spatially joined features. In comparison with the merge and dissolve function, spatial join sets some conditions. These conditions can be found in the match option of spatial join of ArcGIS functions of Spatial join. The conditions are as (intersect, within, within a distance of, completely within, within a distance of, etc.), and also with the mathematical calculation of (summation, count, average, standard deviation etc.).

$a = (x_1, x_2, x_3, \ldots\ldots, x_n)$
x_1 = First school location
x_2 = Second school location
x_3 = Third school location
x_n = Last school location
b = Area

In comparison with the mathematical operation of addition we can calculate the spatial join with the following equation number 7.

$$c = a+b \quad \ldots\ldots\ldots\ldots (7)$$
$$c = (x_1 + x_2 + x_3 + \ldots\ldots + x_{n)} + b^*$$

Equation 7 : Mathematical operation of spatial join
Source : Addition

* At a glance the spatial join can be performed with the addition operation of mathematical function is used + some math conditions and/or with the mathematical calculations.

7.8 Union Analysis

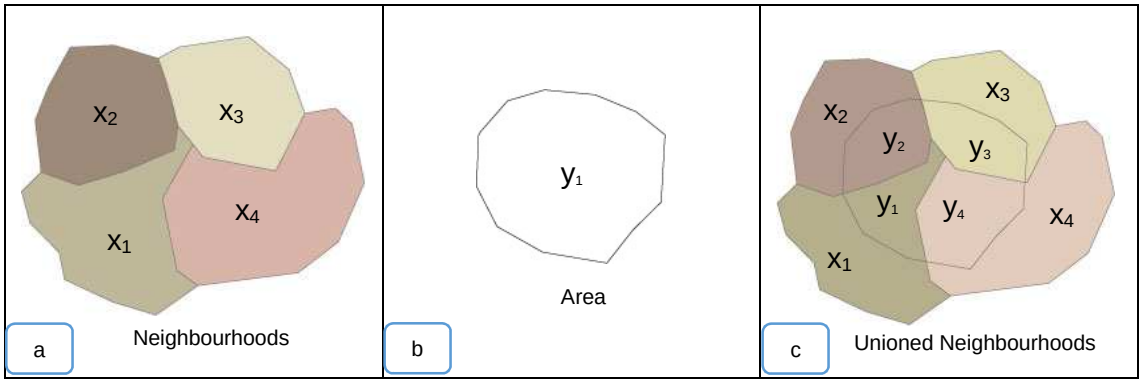


Figure 92 : Union analysis
Source : GIS Practical Work (Biswas, 2014)

The union function is described in chapter 5.8. There we have already the results by using two polygon features. One is the neighbourhoods and the area, which is also illustrated here in figure 92. The figure 92(a) is the neighbourhoods and 92(b) is the area and the figure 92(c) is the result of both input features. The comparison between the intersect function and the union function is that in the intersect, only the intersected features are shown in the output feature. But in union, both the input and output features are merged together and all the intersecting features create new polygon in the output feature.

The logic behind the union function works with the set theory of union of mathematical operation. As we know the set theory as using the union of two sets a and b is the set of all elements that also belong to c, which belongs with each other.

Suppose there are two sets a and b which comprised with the figure 92(a), 92(b) and the result of union is in figure 92(c).

Let us consider below-
$a = \{ x_1, x_2, x_3, x_4 \}$
$b = \{ y_1 \}$

The results of two sets of union is the combination of both sets. In GIS, new polygon appears to the union of both sets of elements

$$c = a \cup b \ldots\ldots\ldots\ldots (8)$$

$$c = \{ x_1, x_2, x_3, x_4, y_1, y_2, y_3, y_4 \}$$

Equation 8 : Mathematical operation of union
Source : Set Theory, Union

7.9 Difference between spatial analysis functions

Table 6 : Difference between spatial analysis functions

Operation	Description	Attribute Tables	Attribute table change	New Shape file	Toolbox location
Buffer	Creates a new polygon at a buffered distance around a point, line or another polygon	Attributes of layer buffered	Yes	New polygon of distance	Geoprocessing > Buffer or Analysis Tools >Proximity > Buffer
Clip	Cuts out a piece of one theme using another theme as a "cookie cutter"	Input layer	Yes	Overlay layer	Geoprocessing > Clip
Dissolve	Removes boundaries between adjacent polygons	Only contains values that the dissolve affects. Lose all other attributes	Yes	Polygon layer of areas that share the specified value.	Geoprocessing > Dissolve
Erase	Erases by overlaying two sets of features	Erased with the erased feature coverage	Yes	Areas overlapping is erased.	Analysis Tools >Proximity > Erase
Intersect	Integrates two spatial data sets while preserving only those features falling within the spatial extent common to both themes (similar to Boolean AND)	Combined attribute table of all layers used in operation	Yes	Just the areas in common between the layers	Analysis > Overlay >Intersect Analysis Tools >Proximity > Intersect
Merge	Used to combine multiple input datasets to a new output dataset	Merges the overlapping areas	Yes	Areas in common between the layers	Geoprocessing > Merge
Spatial Join	Creates a table join in which fields from one layer's attribute table are appended to another layer's attribute table based on the relative locations of the features in the two layers	Target layer attribute table with join features attributes at end.	Yes	Shape of target features layer (first one input)	Analysis > Overlay >Spatial Join
Union	Joins two layers together with the new attribute table consisting of shared/overlapping areas	Attributes of shared areas.	Yes	Both layers used in operation	Analysis > Overlay > Union (Can also perform this via Editor Toolbar in ArcMap)

Source : Biswas, 2014

8. CONCLUSION AND RECOMMENDATIONS

8.1 Summary of the result

About 20 years ago geoinformatics appeared to be as a new interdisciplinary emerging field, which exerts a bridging functions between computer science, geographic information technologies and Geosciences or space-based working Sciences. Meanwhile, the Geo-informatics is regarded as a distinct discipline and has spread like other sciences established as a module in higher education. Frequently, the term of GIS is mentioned, but this is equated in the narrower sense of geo-informatics. Due to the dominance of inter alliances, spatial working disciplines are mainly due to the rapid advances of software development of GIS technology and the accelerating very broad application of these technologies. Due to the large information content of Geoinformatics, therefore, can quickly lose the Guide students. Therefore, many colleges and universities offer modules in which the learners can register and log on and so independently repeat the lecture material and to have more information about the modules. Of course, care must be taken that the teachers do not overwhelm the students with too much input, so the interest is lost. In the e-Learning modules, students can have an overview of the entire module, and then brought closer to the learning material with explanatory text. Since then, similar e-Learning modules are offered not only by universities, but also by various companies such as ESRI GIS itself.

e-Learning tutorial of this study is comprised with several modules on the basis of geoprocessing. Out of them the buffer, clip, dissolve, erase, intersect, merge, spatial join and union functions are taken to develop the e-Learning module. First of all the pedagogical elaboration of e-Learning techniques are described in the part of literature review. Then the overview of GIS application in e-Learning technique was illustrated sequentially. After the methodological description, the module content was developed. Each module has different sub parts, describing different practices of vector data, especially with the point, line and polygon features. In the description part of the study, there are detailed description including the practical work, the techniques and functions used in ArcGIS with different modules. Moreover, each individual results are described with their attribute tables to understand the differences among the functionalities. The results which we have found in this study is categorized according to the geoprocessing parts and also in the discussion and analysis chapter with the mathematical background. In the e-Learning tutorial the similar results are imposed with the interactivity of both the raster and vector data, and only the summarized version of the report is shown in the e-Learning tutorial. So that the students can easily have an idea about individual topics.

8.2 Expectations and output

It was recommended to develop a learning module of GIS by dividing into different sub modules. The analysis tools of GIS is very much necessary for the students who want to analyze the geospatial data calculations and analysis in different level of expertise. If the background of the student's understanding about the spatial analysis tools is strong, it is easy to work with ArcGIS with simple as well as complex calculation. Under these considerations, the different analysis for geoprocessing tools (Buffer, clip, merge,

dissolve, intersect, erase and spatial join and union) were introduced in this study to serve the purpose.

The next step was to develop an e-Learning platform for the students, so that the students can take part in different sub modules in Internet and can develop their knowledge about the spatial analysis. At the end of the learning session, the students will be able to judge their level of learning quality by answering several multiple choice questions.

8.3 Remarks of the methodological approach

With the supervision of Prof. Dr. Heinz Saler, Prof. Dr. rer. nat. Mark Vetter and along with Dipl.-Ing. (FH) Christian Stern, as a supervision team, by following several meetings after every two weeks; the plan was set up to develop the research paper including the e-Learning as well as the contents of individual modules. The preparation of prototype for the module content, the systematic development of e-Learning was the goal from the beginning to the end. The methodological aspect follows the spiral model of software development, which has the continuous effect of the success of this research.

The methodological approach fails to form like other scientific work, as the other scientific work or to develop a new software or for a research, there should be some new ideas in the methodology. There should be a concrete methodological approach. But as this is an e-Learning tutorial, several pedagogical aspects were described in different steps of the development phase, especially in the literature review. After the literature review, the spiral model was used with some modifications, as this supports all the pedagogical and technical aspects to develop an e-Learning tutorial. In this sense, the methodological approach fits the goal of this study.

8.4 Future Work

To maintain the e-Learning module is the future work of this research paper. It was difficult from the beginning to fix the target of the research paper, because the GIS contains a large volume of learning and analyzing the geospatial analysis. Out of them, to find out the spatial analysis problems related to the spatial overlay functions, as well as the use of them was the best task of this paper.

It can be also mentioned that the e-Learning tutorial which is developed for the study is based only with the geoprocessing part of ArcGIS. As the learning strategies vary from time to time, the contents can be updated depending upon the needs of students. Several aspects can be added like, the geo-coding or with the emphasis on the Python related software development for the further development of ArcGIS tools. The content can also be modified with the advance development of mobile GIS or GIS application for the smartphone development, depending on the choice of interest.

The further work includes a webinar support, which deals with a short version for Web-based seminar. A presentation, lecture, workshop or seminar that is transmitted over the Web. Can be video, audio or chat-based delivery of study materials of GIS. By using the video and the audio signals to link participants at different and remote locations, can be also termed as Videoconferencing.

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APPENDICES

Appendix A: e-Learning tutorial

Figure 93 : e-Learning tutorial, Home
Source : Biswas, 2014

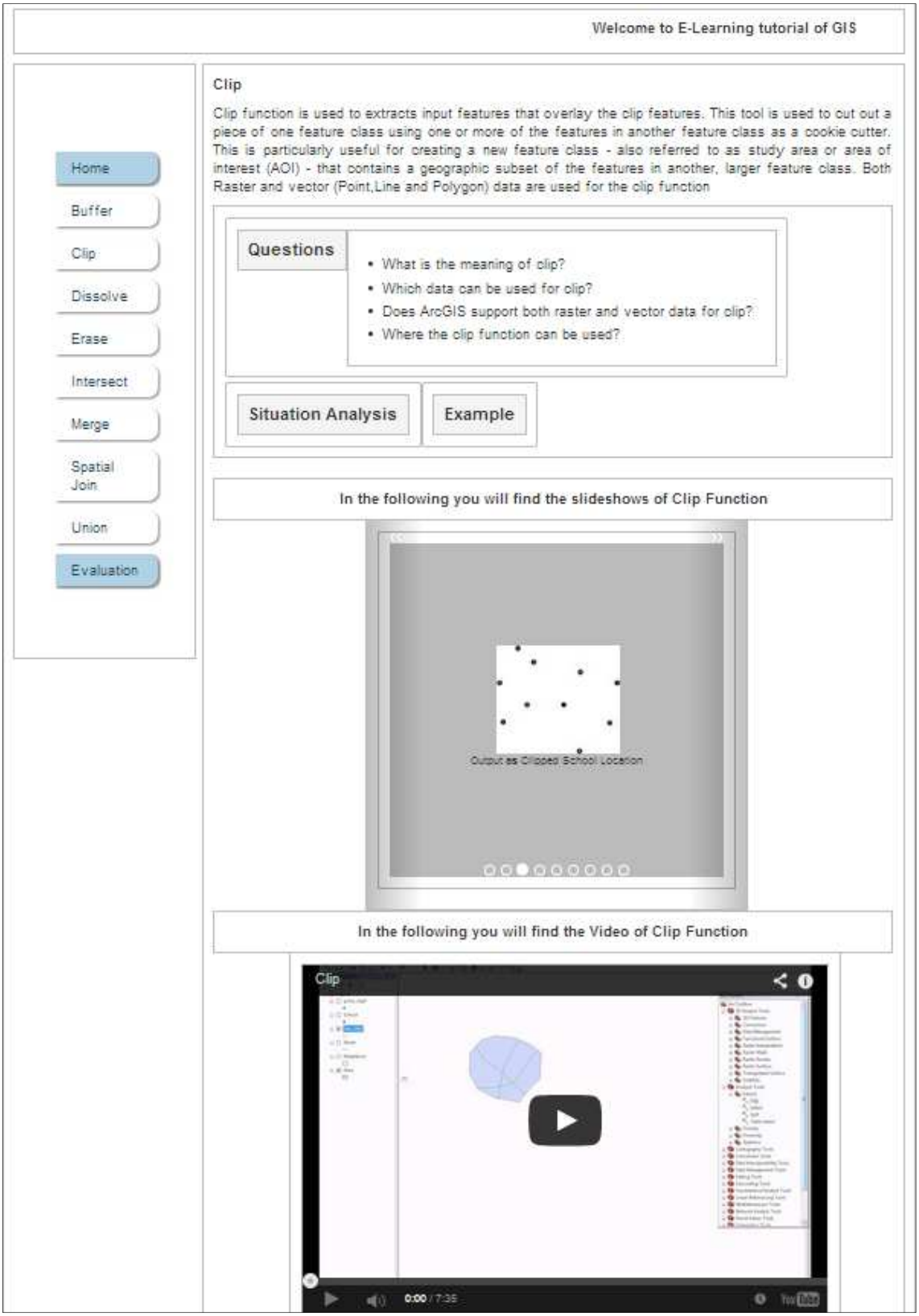

Figure 94 : e-Learning tutorial, Clip
Source : Biswas, 2014

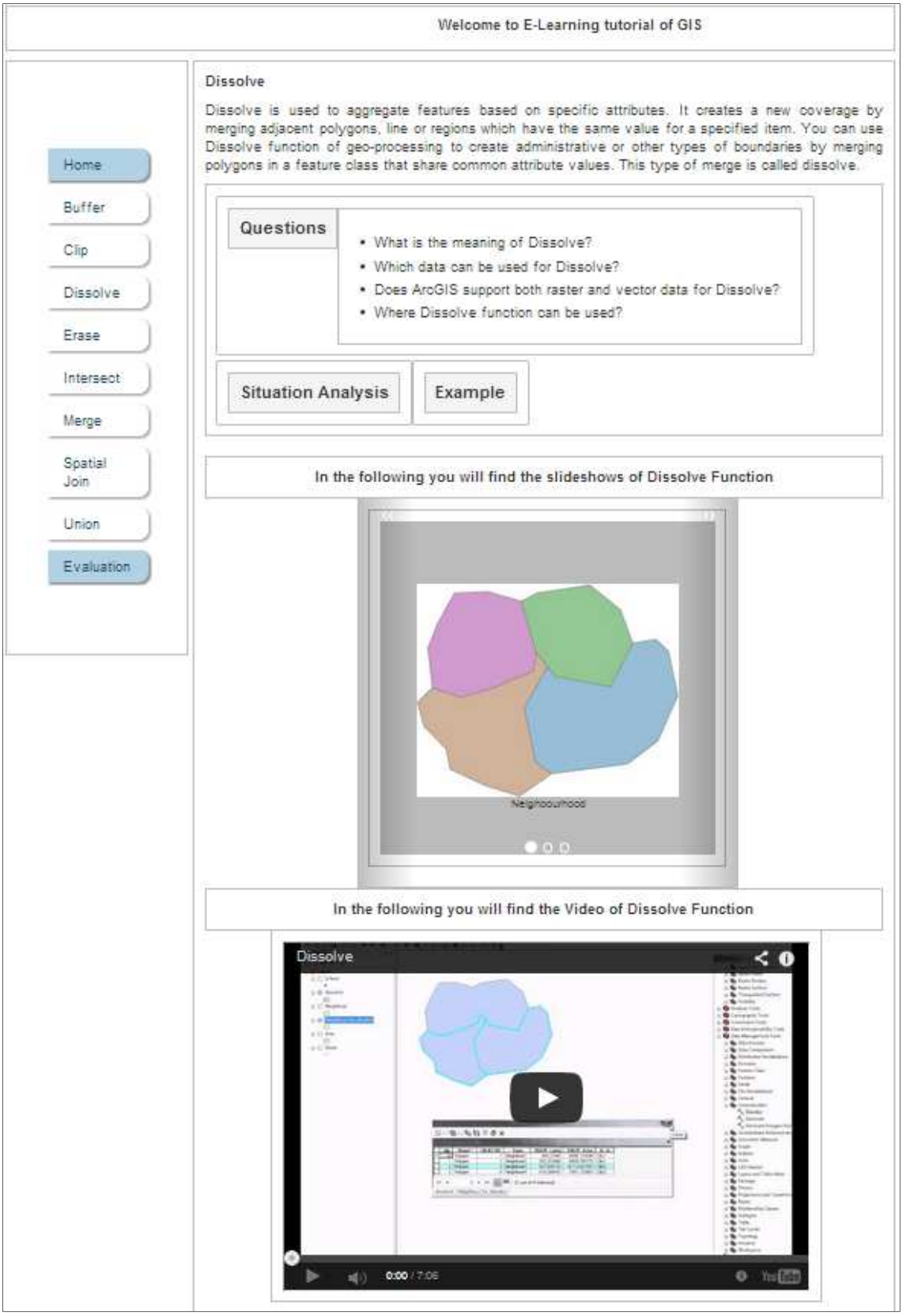

Figure 95 : e-Learning tutorial, Dissolve
Source : Biswas, 2014

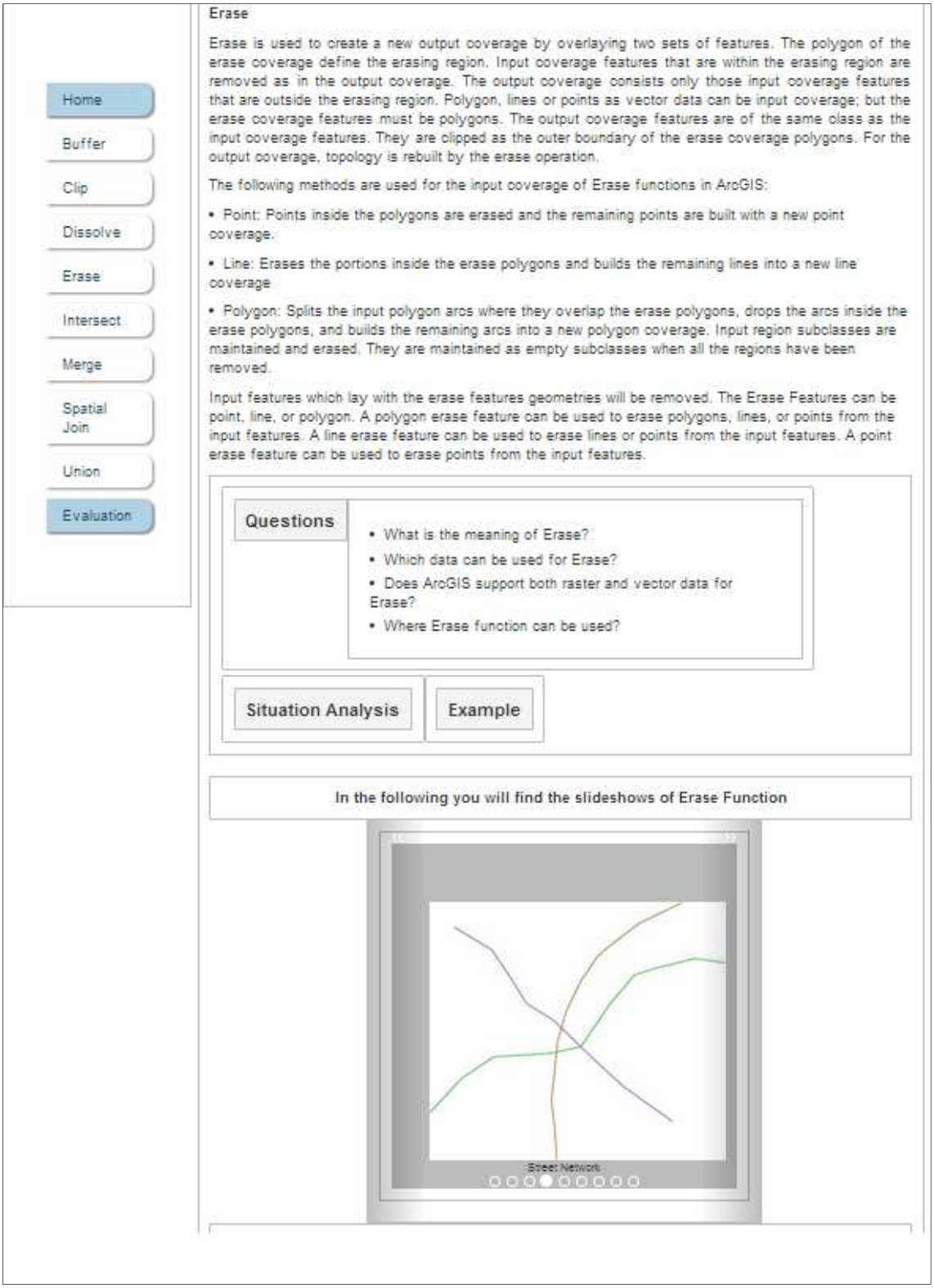

Figure 96 : e-Learning tutorial, Erase
Source : Biswas, 2014

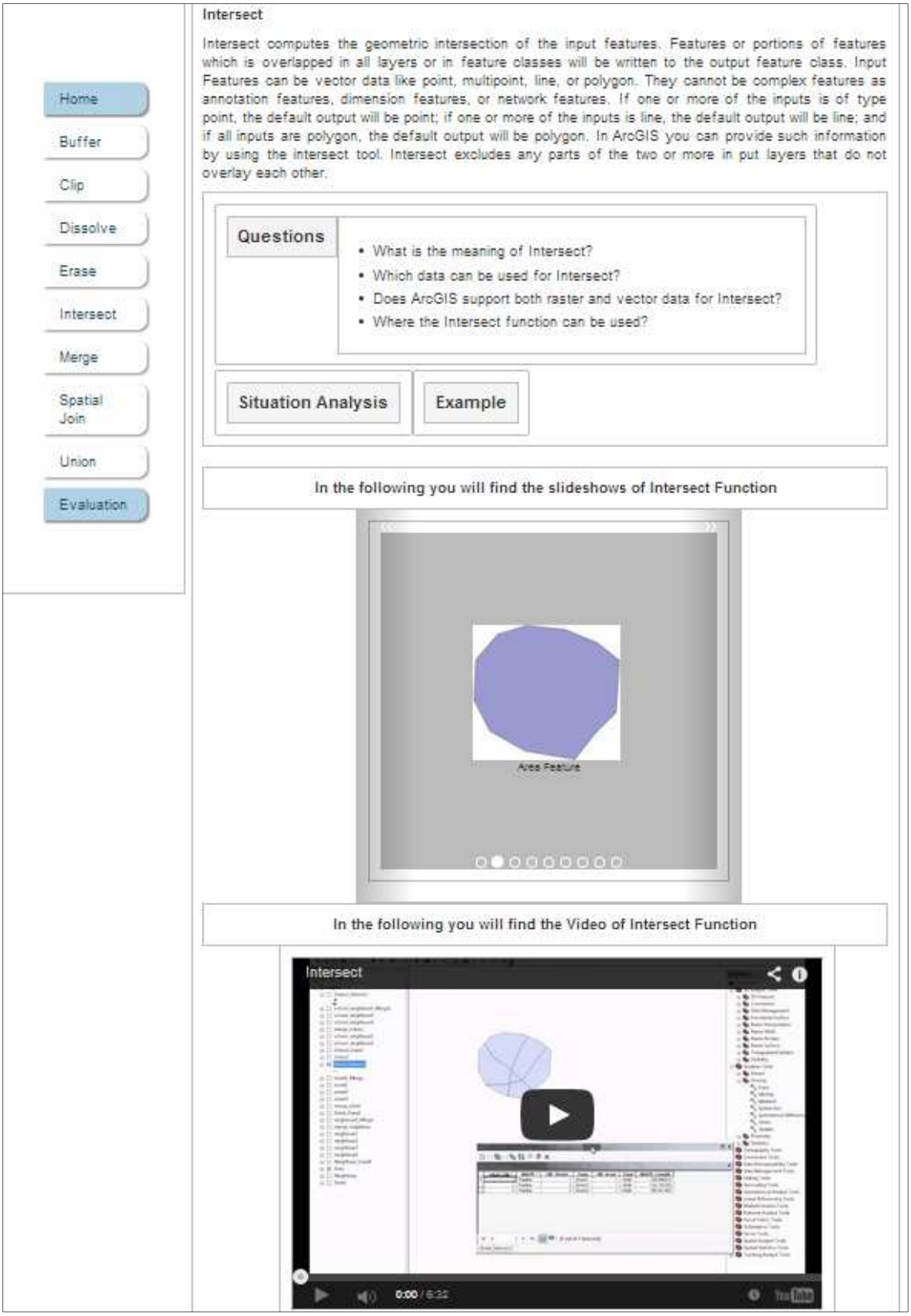

Figure 97 : e-Learning tutorial, Intersect
Source : Biswas, 2014

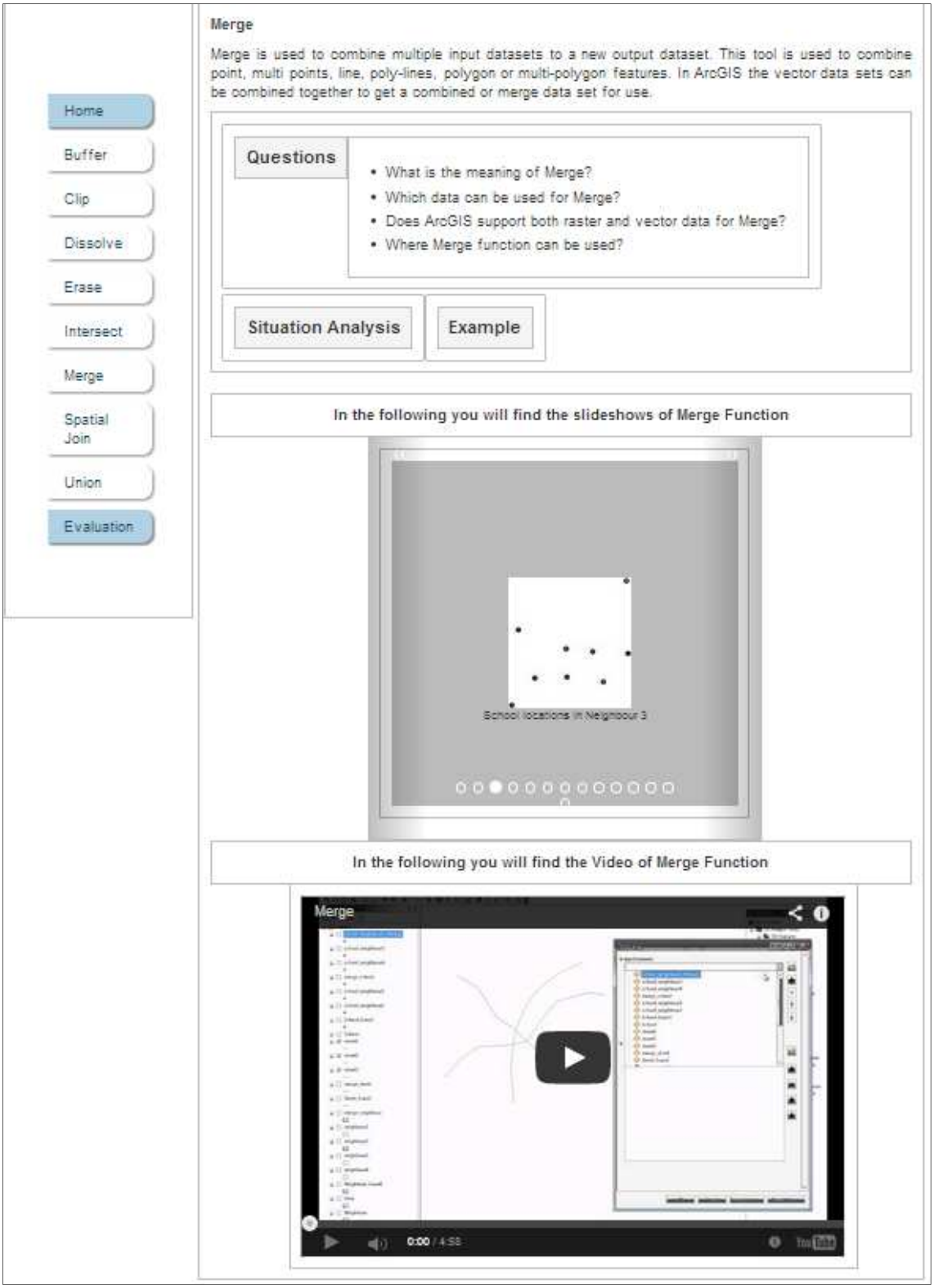

Figure 98 : e-Learning tutorial, Merge
Source : Biswas, 2014

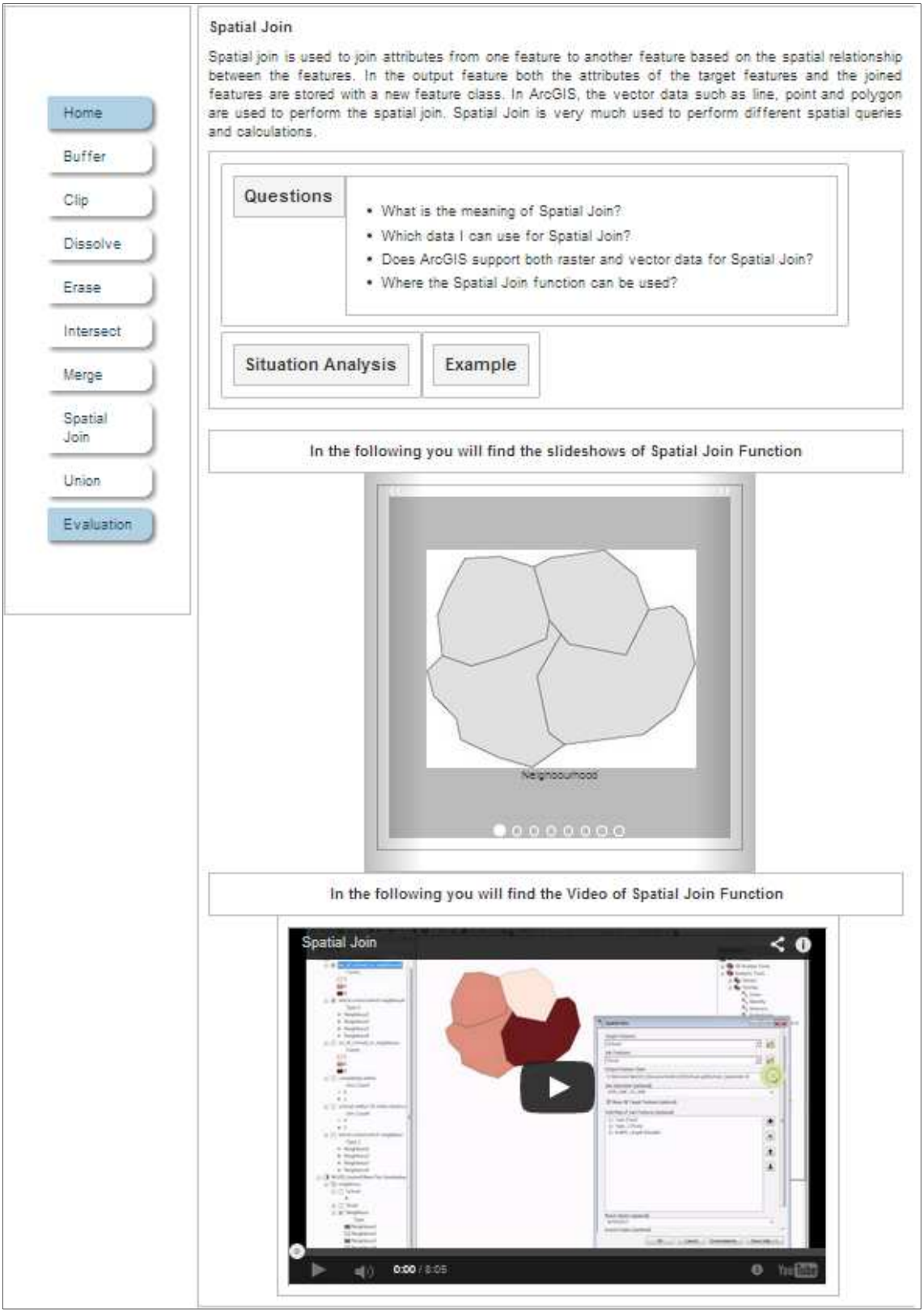

Figure 99 : e-Learning tutorial, Spatial Join
Source : Biswas, 2014

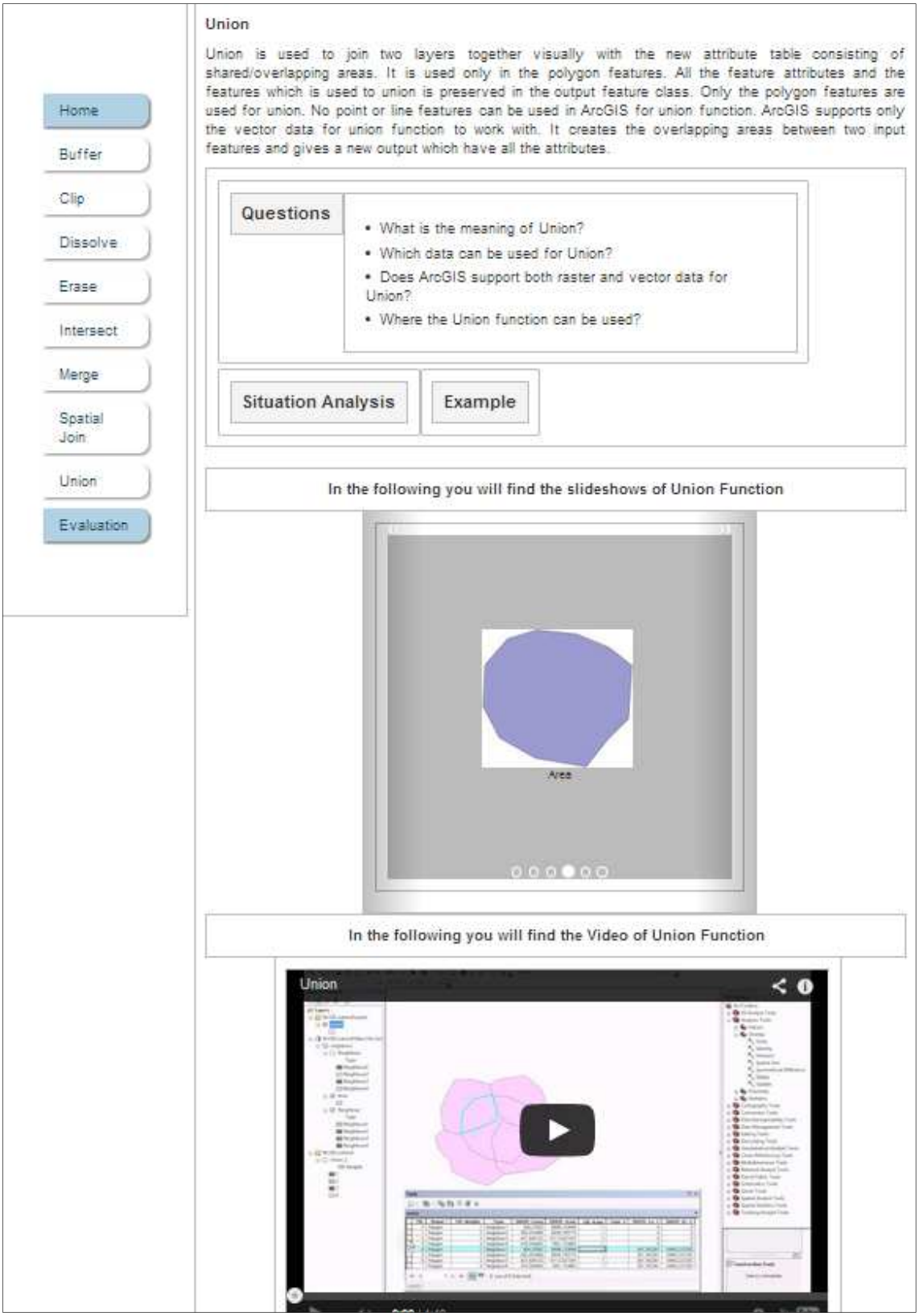

Figure 100 : e-Learning tutorial, Union
Source : Biswas, 2014

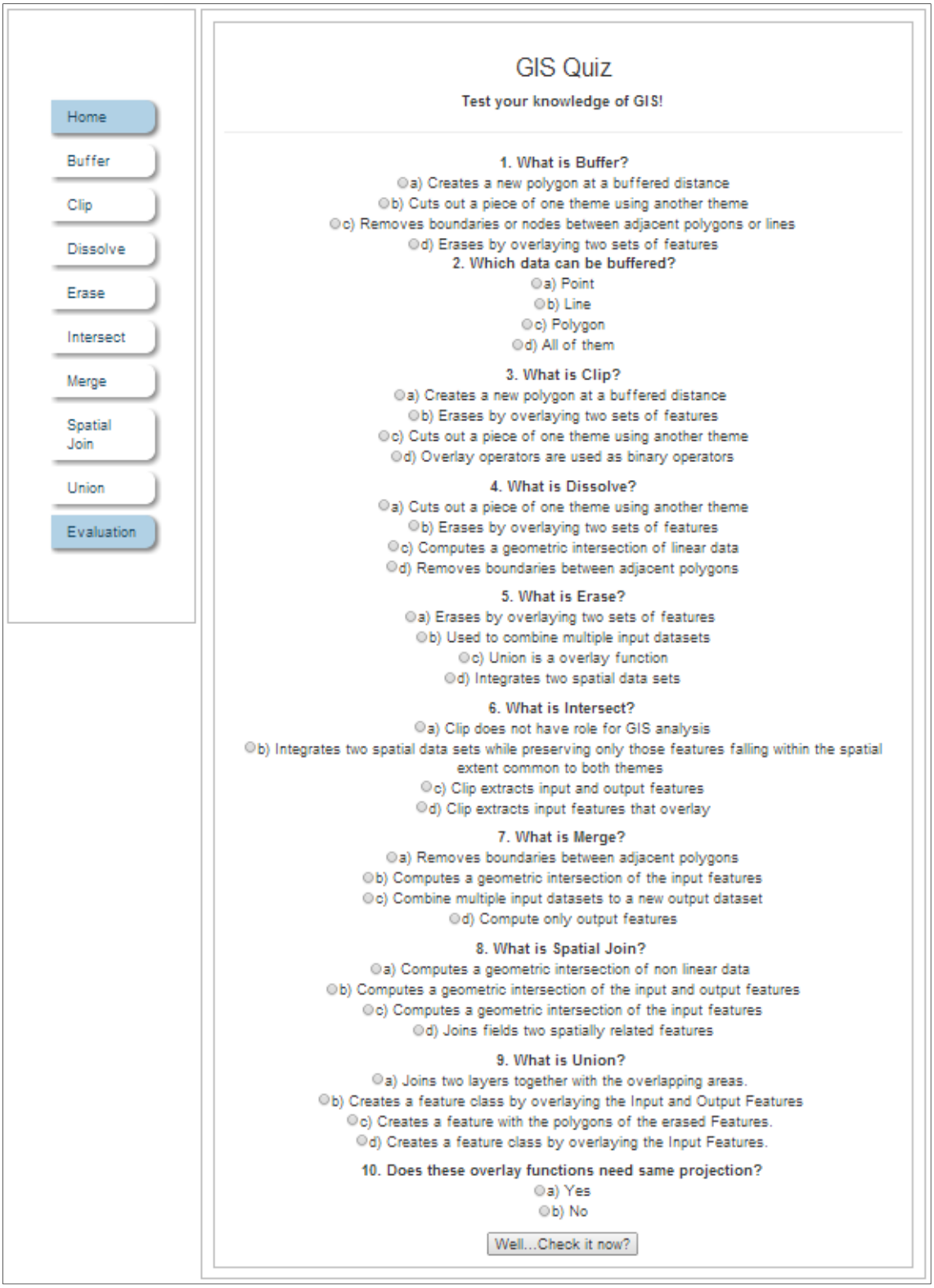

Figure 101 : e-Learning tutorial, Evaluation
Source : Biswas, 2014

Appendix B: Programming Codes

Here is the programming codes which is used for the development of a part of Union function of geoprocessing showing in the e-Learning tutorial.

```
<html lang="en">
<head>
<meta charset="utf-8">
   <meta http-equiv="X-UA-Compatible" content="IE=edge">
   <meta name="viewport" content="width=device-width">
            <title>Layout</title>
            <link rel="stylesheet" type="text/css" href="union.css">
           <!-- Bootstrap -->
   <link href="../gis-tutorial/css/bootstrap.min.css" rel="stylesheet">
           <link rel="stylesheet" href="../gis-tutorial/css">
           <!-- jQuery -->
           <!-- Call Carousel -->
           <script type="text/javascript">
           (function($){$('.carousel').carousel({ interval: 1000, pause:'hover'});
           })(jQuery);
            </script>
           </head>
           <body>
           <div id="wrapper">
           <div id="header"> <b>
           <marquee behavior="alternate">Welcome to E-Learning tutorial of GIS</marquee>
            </b>
           </div>
           <div id="content">
   <div id="content-left">
/ For the Navigation bar/
<ul class="nav">
<li> <p id="home"><a href="./Home.html">Home</a></li>
<li> <p style="font-size:13px"><a href="./Buffer.html">Buffer</a></li>
<li> <p style="font-size:13px"><a href="./Clip.html">Clip</a></li>
<li> <p style="font-size:13px"><a href="./Dissolve.html">Dissolve</a></li>
<li> <p style="font-size:13px"><a href="./Erase.html">Erase</a></li>
<li> <p style="font-size:13px"><a href="./Intersect.html">Intersect</a></li>
<li> <p style="font-size:13px"><a href="./Merge.html">Merge</a></li>
<li> <p style="font-size:13px"><a href="./Join.html">Spatial Join</a></li>
<li> <p style="font-size:13px"><a href="./Union.html">Union</a></li>
```

```
<li> <p id="evaluation"><a href="./Evaluation.html">Evaluation</a></li>
        </ul>
                </div>
                <div id="content-main">
                <p><b>Union</b></p>
                <section>
                <p class="text-justify">
```

Union is used to join two layers together visually with the new attribute table consisting of shared/overlapping areas. It is used only in the polygon features.

```
                </p>
                </section>
                <div class="panel-group" id="accordion">
        <div class="panel panel-default">
  <div class="panel-heading">
   <h6 class="panel-title">
    <a data-toggle="collapse" data-parent="#accordion" href="#collapseOne">
    <b>Questions </b>
    </a>
   </h6>
  </div>
  <div id="collapseOne" class="panel-collapse collapse in">
    <div id="questions" class="panel-body">
                <li> What is the meaning of Union? </li>
                <li> Which data can be used for Union? </li>
                <li> Does ArcGIS support both raster and vector data for Union? </li>
                <li> Where the Union function can be used? </li>
   </div>
  </div>
 </div>
 <div class="panel panel-default">
  <div class="panel-heading">
   <h6 class="panel-title">
    <a data-toggle="collapse" data-parent="#accordion" href="#collapseTwo">
     <b>Situation Analysis</b>
    </a>
   </h6>
  </div>
  <div id="collapseTwo" class="panel-collapse collapse">
   <div class="panel-body">
```

```
            <p class="text-justify">
             </div>
  <div class="panel panel-default">
    <div class="panel-heading">
      <h6 class="panel-title">
        <a data-toggle="collapse" data-parent="#accordion" href="#collapseThree">
         <b>Example</b>
        </a>
      </h6>
    </div>
    <div id="collapseThree" class="panel-collapse collapse">
<div class="panel-body">
<center> <b> Here you can find the practical work of Union</center> </b>
<div id="a">
<?xml version="1.0" encoding="utf-8"?>
<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG 1.1//EN"
"http://www.w3.org/Graphics/SVG/1.1/DTD/svg11.dtd">
<svg version="1.1" id="Ebene_1" xmlns="http://www.w3.org/2000/svg"
xmlns:xlink="http://www.w3.org/1999/xlink" x="0px" y="0px"
 width="258.006px" height="209.299px" viewBox="13.441 6.774 258.006 209.299"
enable-background="new 13.441 6.774 258.006 209.299" xml:space="preserve">
<g id="Layers">
<g id="Neighbour">
<g>
            <defs>
            <rect id="SVGID_1_" width="576" height="643.493"/>
            </defs>
            <clipPath id="SVGID_2_">
            <use xlink:href="#SVGID_1_"  overflow="visible"/>
            </clipPath>
<path clip-path="url(#SVGID_2_)" fill="#A69388" stroke="#6E6E6E" stroke-width="0.48" stroke-
linecap="round" stroke-linejoin="round" stroke-miterlimit="10" d="
M33.602,44.938l16.561-30.003l33.121-1.44l32.881,9.601l8.88,25.922l6.24,25.203l-3.12,18.001l-
38.881,16.562l-33.121,9.601  l-27.601-9.601l-4.56-39.124L33.602,44.938z"
            onmouseover="evt.target.setAttribute('opacity', '0.5');"
            onmouseout="evt.target.setAttribute('opacity','1)');"/>
            <title> Neighbourhood1</title>
            </g>
            <g>
            <defs>
```

<rect id="SVGID_3_" width="576" height="643.493"/>

</defs>

<clipPath id="SVGID_4_">

<use xlink:href="#SVGID_3_" overflow="visible"/>

</clipPath>

<path clip-path="url(#SVGID_4_)" fill="#DED8AF" stroke="#6E6E6E" stroke-width="0.48" stroke-linecap="round" stroke-linejoin="round" stroke-miterlimit="10" d="

M116.164,23.096l16.32-8.641l20.16-2.64l31.201-4.8l30.721,24.722l12,32.883l-22.081,43.204l-54.481-10.561l-18.72-23.042 l-4.56-18.722l-4.8-15.602L116.164,23.096z"

onmouseover="evt.target.setAttribute('opacity', '0.5');"

onmouseout="evt.target.setAttribute('opacity','1)');"/>

<title> Neighbourhood2</title>

</g>

<g>

<defs>

<rect id="SVGID_5_" width="576" height="643.493"/>

</defs>

<clipPath id="SVGID_6_">

<use xlink:href="#SVGID_5_" overflow="visible"/>

</clipPath>

<path clip-path="url(#SVGID_6_)" fill="#DEC3B8" stroke="#6E6E6E" stroke-width="0.48" stroke-linecap="round" stroke-linejoin="round" stroke-miterlimit="10" d="

M226.566,64.619l22.8-3.84l12.48,12.001l9.36,43.684l-19.921,44.884l-30.241,23.042l-74.881,9.601l-15.6-11.521l-11.28-54.004 l23.041-40.563l7.68,9.361l54.481,10.561L226.566,64.619z"

onmouseover="evt.target.setAttribute('opacity', '0.5');"

onmouseout="evt.target.setAttribute('opacity','1)');"/>

<title> Neighbourhood3 </title>

</g>

<g>

<defs>

<rect id="SVGID_7_" width="576" height="643.493"/>

</defs>

<clipPath id="SVGID_8_">

<use xlink:href="#SVGID_7_" overflow="visible"/>

</clipPath>

<path clip-path="url(#SVGID_8_)" fill="#BDB391" stroke="#6E6E6E" stroke-width="0.48" stroke-linecap="round" stroke-linejoin="round" stroke-miterlimit="10" d="

M146.164,193.991l-31.44,21.842l-32.641-9.601L46.082,189.19l-4.32-20.161l-21.6-22.082l-6.48-23.762l14.88-14.401l27.601,9.601 l33.121-9.601l38.881-16.562l3.12-18.001l11.041,13.681l-23.041,40.563l11.28,54.004L146.164,193.991z"

onmouseover="evt.target.setAttribute('opacity', '0.5');"

```
onmouseout="evt.target.setAttribute('opacity','1');"/>
<title>Neighbourhood4</title>
                    </g>
                    </g>
                    </g>
                    </svg>
                    </div>
                    <div id="myCarousel" class="carousel slide" data-ride="carousel">
                    <!-- Indicators -->
<ol class="carousel-indicators" style="list-style: none;">
                    <li class="active" data-target="#myCarousel" data-slide-to="0"> </li>
                    <li data-target="#myCarousel" data-slide-to="1">  </li>
                    <li data-target="#myCarousel" data-slide-to="2">  </li>
                    <li data-target="#myCarousel" data-slide-to="3">  </li>
                    <li data-target="#myCarousel" data-slide-to="4">  </li>
                    <li data-target="#myCarousel" data-slide-to="5">  </li>
</ol>
<!-- Carousel items -->
<div class="carousel-inner">
<div class="item active">
<img src="../gis-tutorial/Neighbourhood.jpg" style="display:block; margin:0 auto 0 auto" height="" width=""
alt="Image Text1" class="image0">
<center> <p style="font-size:11px"> Neighbourhood</center>
</div>
<div class="item">
<img src="../gis-tutorial/Area.jpg" height="" width="" alt="Image Text2" class="image1"/>
<center> <p style="font-size:11px"> Area </center>
</div>
<div class="item">
<img src="../gis-tutorial/Union_result_1.jpg" height="" width="" alt="Image Text3" class="image2"/>
<center> <p style="font-size:11px"> Output Union</center>
</div>
<div class="item">
<img src="../gis-tutorial/Area.jpg" height="" width="" alt="Image Text3" class="image3"/>
          <center> <p style="font-size:11px"> Area</center>
          </div>
          <div class="item">
<img src="../gis-tutorial/Neighbourhood.jpg" height="" width="" alt="Image Text3" class="image4"/>
          <center> <p style="font-size:11px"> Neighbourhood</center>
```

```
            </div>
            <div class="item">
<img src="../gis-tutorial/Union_Result_2.jpg" height="" width="" alt="Image Text3" class="image5"/>
            <center> <p style="font-size:11px"> Output Union</center>
            </div>
            </div>
            <!-- Carousel nav -->
<a class="carousel-control left" href="#myCarousel" data-slide="prev">
‹‹</a> <a class="carousel-control right" href="#myCarousel" data-slide="next">››</a>
</div>
<div id="text">
<b><center>In the following you will find the Video of Union Function </b></center>
</div>
<div id="video">
<iframe width="520" height="345" src="http://www.youtube.com/embed/0t1DnGE6RSw"> </iframe>
            </div>
            </div>
            </div>
 <div id="footer">@Copyright Dilip Kumar Biswas <br> Master Thesis : Online E-Learning Tutorial for GIS
</div>
<div id="bottom"><a title="Geomatics-HSKA" href="http://www.hs-
karlsruhe.de/en/faculties/geomatics/institute-of-geomatics.html">Geomatics-HSKA</a></div>
</div>
 <!-- jQuery (necessary for Bootstrap's JavaScript plugins) -->
<script src="https://ajax.googleapis.com/ajax/libs/jquery/1.11.0/jquery.min.js"></script>
<!-- Include all compiled plugins (below), or include individual files as needed -->
<script src="../gis-tutorial/js/bootstrap.min.js"></script>
<script src="../gis-tutorial/bootstrap/js/carousel.js"></script>
<script src="../gis-tutorial/js/bootstrap-magnify.js"></script>
</body>
</html>
```