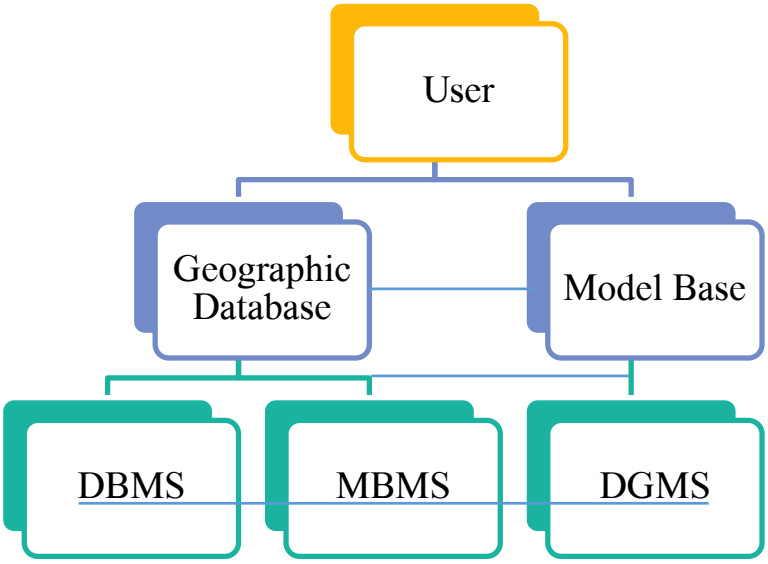
SPATIAL DECISION SUPPORT SYSTEM

(LECTURE NOTES)



MA/MSc Fourth Semester
Course No. GGY 4206 (9)
Course Name: Geoinformatics
Course Title: Applications of GIS and Remote Sensing (60 Marks)
Unit I; Spatial Analysis in GIS (40 Marks)
9. Spatial Decision Support Systems
A Syllabus for CBCS Based PG Corse in Geography, 2017
Department of geography
Gauhati University

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Course Objectives:

1. To familiarize the students with the emerging modern technologies such as computers and software,
2. To train the students in the application of computers, Remote Sensing, GIS, GPS etc. and
3. To acquainted the students with the application of GIS in spatial analysis.

Course Outcomes:

1. The students will enrich themselves with the concept of spatial decision support systems.
2. The students will learn to apply the GIS techniques in spatial analysis specially in spatial decision support systems.
3. The students will be able to handle the GIS software with the help of computers.

SPATIAL DECISION SUPPORT SYSTEM

Dr. P. K. Roy

Definition

SDSS is an interactive, computer-based system designed to support a user or group of users in achieving a higher effectiveness of decision making while solving a semi-structured spatial decision problem. The three (semi-structure spatial problems, effectiveness and decision support) capture the essence of the **SDSS** concept.

Historical Background

- The concept of Decision Support System (DSS) is based on the seminal work by Simon and associates in 1950s and 1960s.
- DSS evolved as a field of research, development and practice during the 1970s and 1980s.
- The SDSS concept has evolved in parallel with DSS.
- IBM's Geodata Analysis and Display System (GADS) developed in the 1970s was one of the earliest large DSS.
- The development of SDSS has been associated with the need to expand the GISystem capabilities for tackling complex, ill-defined, spatial decision problems (Densham and Goodchild, 1989).
- There has been considerable growth in research, development and applications of SDSS in the last one decade or so (NCGIA 1990; 1996).
- The field has now grown to the point that it is made up of many threats with different, but related names such as collaborative SDSS, group SDSS, environmental DSS, spatial knowledge based and expert system.

Spatial Decision-making and GISystems

Spatial Decision Problems

The main characteristics of spatial decision problems include:

- A large number of decision alternatives,

- The outcomes or consequences of the decision alternatives are spatially variable,
- Each alternative is evaluated on the basis of multiple criteria,
- Some of the criteria may be qualitative while others may be quantitative,
- there is typically more than one decision maker involved in the decision-making process,
- The decision makers have different preferences with respect to the relative importance of evaluation criteria and decision consequences and
- The decisions are often surrounded by uncertainty.

Decision-making Process

Simon (1960) suggests that any decision-making process can be structured into three major phases:

a. **Intelligence:**
b. **Design:**
c. **Choice:**

Decision Support

- How and what extent can GISystem provide support required in each of the three phases of decision-making?

a. Intelligence

- The intelligence phase involves searching or scanning the environment for conditions calling decisions;
- This phase requires an exploratory analysis of the decision situation;
- GIS can play a vital role at the initial stage of spatial decision-making;
- The system can help in coordinating decision situation analysis through its ability to integrate and explore data and information from a wide range of sources;
- GIS can effectively present information in a comprehensive form to the decision makers.

b. Design

- The design phase involves inventing, developing and analysing a set of possible decision alternatives for the problem identified in the intelligence phase;
- A formal model is typically used to support a decision maker in generating the set of alternatives;

- While an increasing number of GISystems are described as systems for supporting the process of designing and evaluating spatial decision alternatives, most commercially available GIS lack the kinds of spatial analysis and modelling required by decision makers;
- The capabilities of GIS for generating a set of alternative decisions are mainly based on the spatial relationship principles of connectivity, contiguity, proximity and the overlay methods;
- In current GIS environments, models for generating decision alternatives operate in the background, detached from user's insights and qualifications.

c. Choice

- the choice phase involves selecting a particular decision alternative from those variables;
- each alternative is evaluated and analysed in relation to others in terms of a pre-specified decision rule;
- the decision rules are used to rank the alternatives under consideration;
- the ranking depends upon the decision maker's preferences with respect to the importance of the evaluation criteria;
- criteria for use of GIS in the choice phase is the capacity of incorporating the decision maker's preferences into the decision-making process;
- in general, GISystem do not provide a mechanism for flexible incorporation of the decision maker's preferences into the decision making process.

Principle of SDSS

The DDM Paradigm

- the technology for a DSS must consist of three sets of capabilities in the areas of ***dialog, data*** *and* ***modelling*** (the DDM paradigm) (Sprague and Whatson, 1996).
- a well-design **SDSS** should have balance among the three capabilities.

The Components of SDSS

1. the ***Data Base Management System*** (DBMS) contains the functions to manage the geographic data base;

2. the ***Model Base Management System*** (MBMS) contains the functions to manage the ***model base;***
3. the ***Dialog Generation and Management System*** (DGMS) manages the interface between the user and the rest of the system.

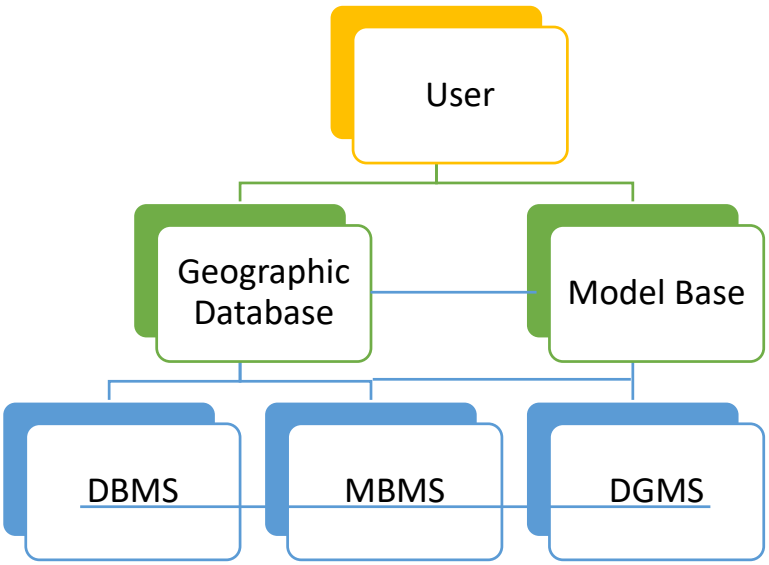

Figure 1: The components of SDSS

Table1: The functions of SDSS	
Components	**Functions**
Data Base and Management	**types of data** • locational (e.g., coordinates) • topological (e.g., points, lines, polygons & relationships) • attributes (e.g., geology, elevation) **logical data views** • relational dbms • hierarchical dbms • network dbms • object-oriented dbms **management of internal & external database** • **acquisition** • **storage** • **retrieval** • **manipulation** • **directory** • **queries** • **integration**
Model Base Management	**Analysis** • goal seeking • optimisation • simulation • what-if **Statistics & forecasting**

	• exploratory spatial data analysis • confirmatory spatial data analysis • time series • geostatistics **Modelling Decision Maker's Preference** • value structure • hierarchical structure of goals, evaluation criteria, objectives and attributes • pairwise comparison • multiattribute value/utility • consensus modelling **Modelling Uncertainty** • data uncertainty • decision rule uncertainty • sensitivity analysis • error propagation analysis
Dialog Management	**User Friendliness** • consistent, natural language comments • help and error messages • novice and expert mode **Variety of Dialog Styles** • command lines • pull-down menus • dialogue boxes • graphical user interfaces **Graphical and Tabular Display** • visualisation in the decision space (high resolution cartographic displays) • visualisation in the decision outcome space (e.g., 2D & 3D scatter plots and graphs, tabular rapports)

Technologies for Developing SDSS

- **DSS Tools** facilitate the development of either a DSS generator or a specific DSS.
  - Procedural programming language and code libraries e.g., Arc Macro Language (AML), scripting tool of ARC/INFO
- Visual programming language e.g., STELAA II
  - Inter-application communication software e.g., dynamic data exchange (DDE), Object Linking (OLE), open database connectivity (ODBC)
  - Application Programming Interfaces (API) e.g., IBM's geoManager API, Java Advanced Imaging API;

- Visual interfaces, graphics and colour subroutines e.g., graphical user interface (GUI).

- **DSS Generator** is a package of related hardware and software which provides a set of capabilities to quickly and easily build a specific SDSS. For example:
  - **GISystems** e.g., ARC/INFO, ArcView, ARCNetwork, Spatial Analyst, MapInfo, TransCAD;
  - **Database packages** e.g., dBase, Access, Paradox;
  - **Decision analysis and optimization software** e.g., LINCO, EXPERT CHOICE, LOGICAL DECISION;
  - **Statistical and geostatistical software** e.g., S-PLUS, SPSS, SAS;
  - **Simulation** e.g., Spatial Modelling Environment.
- **Specific DSS** are systems devoted to the analysis of a particular set of decision problems. The systems which actually support the decision makers in tacking semi-structured problems. For example:
  - **Active Response Geographic Information System;**
  - **IDRISI Decision Support;**
  - **GeoMed;**
  - **Spatial Group Chioco;**
  - **winR+GIS Spatial Decision Support**

Summary

SDSS has been defined as an interactive, computer-based system designed to support a user or a group of users in achieving a higher effectiveness of decision making while solving a semi-structured spatial decision problem. The SDSS concept is based on the DDM (dialog, data and model) paradigm. A well-design SDSS should have balance among the three capabilities. There are three sets of technologies for building an SDSS. The SDSS development tools, the DSS generators and specific SDSS. The SDSS tools facilitate the development of specific SDSS or they can be configured into a DSS generator which in turn can be used to build a variety of specific SDSS.

Conclusion

GISystems have limited capabilities of supporting the design and choice of phases of the decision-making process. The systems provide a very static modelling environment and thus reduce their scope as decision support tools- especially in the context of problems involving collaborative decision-making.

References

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