1. Course Description:

This is an advanced GIS course covering analytical methods used in GIS and spatial analysis. The course is intended to provide students with a firm understanding of the theoretical/conceptual side of algorithms found in GIS software. We are concerned with the assumptions and underlying mathematical basis for widely-used techniques, and the degree to which analytical capabilities are constrained by those assumptions. Among the topics covered are methods for neighbourhood operation, map transformation, spatial interpolation, terrain analysis, network analysis, and spatial overlay. Other advanced topics such as fuzzy sets, and neural networks will also be covered. The emphasis is on the usefulness and limitations of competing algorithms, as opposed to optimal implementation.

The objectives are:

1) To provide students with a proper understanding of the usefulness and the limitations of GIS analytical techniques with the hope that students will observe these limitations when using these GIS techniques.
2) To develop students' analytical ability so that they will naturally investigate the limitations of GIS techniques which are new to them and thereby avoid misuse or abuse.

2. Prerequisites:

Geog 377/CEE 357 or equivalents.

3. Evaluation and grading:

3.1 Components of Evaluation:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Exercises</td>
<td>40%</td>
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<tr>
<td>Exam 1</td>
<td>30%</td>
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<tr>
<td>Exam 2</td>
<td>30%</td>
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3.2 Grading policy:

Grades of exercises are based on:

1) the academic merit of your answers to the questions
2) clarity of answers, *NO BEATING AROUND THE BUSH*
3) concise and logical presentation, no one wants to flip through a messy assignment report looking for answers. Here is a general format for your presentation:

**Question:**

*Your answer and discussion*

*Your support documents (images, graphs, tables, etc.)*

The grade for each of the exercises and examinations is reported as `points_scored / total_points_of_exercise`. For example, an assignment has 20 points and your answer is worth 18 points then you should see `18/20` on your marked assignment.

Each assignment is worth of 20 points. **5 of these 20** points are for doing the computer work and **15 of them** for answering questions.

3.3 Due date and time:

Each of the assignments will have a due day clearly written underneath the title of the assignment. The due time is the beginning of the lab session on the due day. Any assignment that is turned after the due time on the due day is considered late.

3.4 Penalty for late assignments:

The penalty of a late assignment is based on the number of days late (including weekends!). If an assignment is late less than 24 hours, it is considered 1 day late. If an assignment is late less than 48 hours but more than 24 hours, it is considered 2 days late, and so on. If you have to turn in an assignment late during the working hours and the instructor is not in his office, you can put it in the instructor’s mail box. However, the assignment will be considered to be turned in when the instructor takes it out of his mailbox.

Late assignments are penalized 10% per day. Here is the formula for calculating the points of a late assignment:
Points_get = Points_scored - 0.1*num_days_late*Points_scored

The minimum value of Points_get is 0. Assignments handed in after the instructor has returned the graded assignment to class (usually a week after the due date) will receive no points.

4. Computer Environment and Software:

ARC/INFO and IDRISI will be used for the exercises.

5. Other Important Issues:

There may be a time that the class is full and there are people waiting to get into the class. Those of you who are registered for this class but later decide not to take the course, please let the instructor know as soon as possible so that he can add the people on the waiting list to the class list.

Only medical reasons may be taken as excuses for turning in an assignment late or missing a class. However, you must provide a written report from a medical doctor stating your inability to attend class and/or complete an assignment.

The instructor will certainly give you ample time for each assignment. There is no reason for him to be informed that the computer is down or the software is not working a day before the assignment is due. He will NOT take this as an excuse for a late assignment!

6. Course Materials:

6.1 Course text:

None. Relevant references will be given in class or at the lecture material website.

6.2 Key texts:


6.3 Other GIS texts:


7. **Intended Topics and Schedule:**

**Lecture 01:** (Sept. 4)

**Introduction**
- Introduction to the course
- Classification of GIS Analytical Functions

**Lecture 02:** (Sept. 6)

**Logic frameworks I**
- Fuzzy sets vs. Crisp sets: basic concepts

**Lecture 03:** (Sept. 11)

**Logic frameworks**
- Fuzzy sets vs. Crisp sets: Operations and Applications

**Lecture 04:** (Sept. 13)

**Filtering**
- Raster neighborhood operators (filtering)

**Lecture 05:** (Sept. 18)

**Digital Terrain Analysis I**
- Basic operations on DEM
Lecture 06: (Sept. 20)
Digital Terrain Analysis II
   Drainage network extraction
   Slope partitioning

Lecture 07: (Sept. 25)
Map transformations I
   Ellipsoids and Datum

Lecture 08: (Sept. 27)
Map transformations II
   Affine Transformation

Lecture 09: (Oct. 2)
Map transformations III
   Rubber sheeting

Lecture 10: (Oct. 4)
Spatial Autocorrelation I
   Introduction: aspects of spatial autocorrelation

Lecture 11: (Oct. 9)
Spatial Autocorrelation II
   Geary Index
   Moran Coefficient

Lecture 12: (Oct. 11)
Spatial Autocorrelation III
   Joint count statistics
   For other types of features and attributes

Lecture 13: (Oct. 16)
Spatial Autocorrelation IV
   Semivariogram

Review Session (Oct. 18)

Exam 1: (75 minutes) (Oct. 23)

Lecture 14: (Oct. 25)
Point pattern analysis I
   Introduction
   Exploratory and descriptive methods

Lecture 15: (Oct. 30)
Point pattern analysis II
   Modeling approaches
Lecture 16: (Nov. 1)
Spatial interpolation I
   Introduction: Process and Issue

Lecture 17: (Nov. 6)
Spatial interpolation II
   Thiessen polygon (nearest neighbour)
   Triangulation

Lecture 18: (Nov. 8)
Spatial interpolation III
   Moving average
   Inverse distance weighting

Lecture 19: (Nov. 13)
Spatial interpolation IV
   Kriging

Lecture 20: (Nov. 15)
Spatial interpolation V
   Spline

Lecture 21: (Nov. 20)
Spatial interpolation VI
   Measures for evaluating spatial interpolation

Thanksgiving Recess (Nov 22-25)

Lecture 22: (Nov. 27)
Spatial Indices and Lanscape Measures I
   Spatial centroids
   Shape Analysis

Lecture 23: (Nov. 29)
Spatial Indices and Landscape Measures II
   Measures of landscape structures

Lecture 24: (Dec. 4)
Network analysis
   Pathfinding (Shortest path analysis)

Lecture 25: (Dec. 6)
Advanced Topics
   Neural networks and Class review

Review Session (Dec. 11)
Exam 2: (75 minutes) (Dec. 13)