A Fuzzy And Heuristic Approach To Segment Intersection
Detection And Reporting

by

Jose Armando Guevara Ph.D.
GIS Software Engineer - Assistant Professor of Computer Science

and

Dave Bishop
Senior Software Analyst

Environmental Systems Research Institute
380 New York St.
Redlands, California 92373
Tel. (714) 793-2853

Abstract

One of the fundamental Geographic Information System Procedures is that of
Polygon Overlay. Within the theme of Polygon Overlay there are many
interesting geometric and topological problems not yet efficiently solved.
Of particular interest and key to the whole overlay process is that of
segment intersection: the problem of dealing with the pairwise intersections
among a set of N segments.   In practical terms, the intersection process
calls for detecting, reporting and doing segment coordinate modification(s)
when   the   intersection is found.   Theoretical algorithms for segment
intersection have been developed, yet most of them do   not   address
implementation problems.   Another issue that is related to numerical error,
and also not discussed in the literature, is that of segment representation.
The implementation problem is intimately connected to the numerical error
problem. Both have an impact in the efficiency of the segment intersection
algorithms. The importance of efficient implementation is becoming more and
more apparent as data volume in geo-processing grows increasingly ambitious:
a single digital coverage may contain hundreds of thousands of segments.

    In this paper the authors, based on notions of computational geometry
[band sweeping], introduce an approach to segment intersection which yields
an efficient algorithm for the detection and reporting of N segments in the
plane. The segment intersection per se is based on a set of heuristic rules
and the concept of fuzzy intersection. Unlike ´exact´ intersection, where
two segments intersect only if there is a mathematical point that defines the
intersection, the fuzzy intersection defines an intersection point or points
when the two segments are within a ´fuzzy distance´ away from each other.
Four problems are addressed and resolved in this paper: 1) fuzzy creep, 2)
subtolerance segments, 3) segment intersection scanning order, and   4)
colinearity. Concurrently with the fuzzy intersection concept, a data
structure is presented that efficiently models the band-sweep idea.   Since
the system presented here has been implemented as part of the ARC/INFO
software, statistical profiles are given of its computational behavior.