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Dynamic layers of maxima with applications to dominating queries. (English) Zbl 1468.68081

Summary: Over the past years there has been an enormous increase in the amount of data generated on
a daily basis. A critical task in handling the information overload is locating the most interesting objects
of a dataset according to a specific configuration or ranking function. Our work is based on the concept
of dominance which compares data objects based on maximization preferences on the attribute values.
Each data object is represented as a point in a multidimensional space based on its attribute values.
The layers of maxima configuration assigns layer numbers to dataset points so that (some) points inside a
layer dominate (some) points in subsequent layers and no point in a layer dominates another in the same
layer. Furthermore, top-$k$ dominating queries combine the merits of skyline (maxima) queries and top-$k$
queries by returning the $k$ first points with the highest dominance score, where the dominance score of an
object is the number of objects it dominates. In this work we focus on 2-dimensional data and present,
for the first time, algorithms and data structures with non-trivial asymptotic guarantees for maintaining
the first $k$ layers of maxima of a dataset under point insertions and deletions. Furthermore, we apply
this solution in a sliding window problem setting, where one of the attributes is the insertion time of the
object, and deletions always remove the oldest object. Finally, we tackle updates of arbitrary points in the
semi-dynamic problem setting which permits point insertions and in the fully-dynamic problem setting
which supports both point insertions and deletions. All of our solutions assume the word RAM model of
computation. More precisely, the coordinates of each point are numbers that can be represented with
$w$ bits, where $w$ is a parameter of the model (for example, in practice, usually $w = 64$). All solutions require
space linear with the number of points which is a crucial requirement for modern day applications.

MSC:
68P05 Data structures
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