

Kohonen Map, GIS and the Analysis of Real Estate Sales

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ABSTRACT

Real estate sales prices are analyzed using GIS database containing cadastral and topographic information. Self-organizing map (SOM) introduced by Teuvo Kohonen is used for analysis and visualization. Object oriented data model includes *observation* (components of property including location and sales date), *valuation* (comparable sales in the neighborhood) and *group* (neighboring sales). Components of the *observations* are coded and scaled properly for reasonable comparison of sales. Geographic location is balanced with other components and the *observations* are organized as *valuations* and *groups* using SOM (Kohonen Map) for each category of real property (woodlots, agricultural, recreational land, one-family houses etc).

Kohonen Map organizes observations into **topological groups**. The topological order in the observation space is preserved. Resembling observations are found in the topological neighborhood. Small differences in the component values may be seen as small distances between the units in the Kohonen Map. Exceptional cases found their place more or less isolated within the ordered display of units showing the average values for components.

Kohonen Map organizes observations into **nearly equally sized groups**. The distribution of the observations is preserved. The symbols of the *groups* and the *valuations* are used as links to the matching observations and the values of the components can be seen in the list and the location of the real property can be shown on a detail map.

GIS database is used to get cadastral and topographic information. Parcels, plans, buildings, shoreline, network connections, land use, neighborhood, distances and other factors can be seen and extracted for analysis. Overview and detail maps are used to display *groups*, *valuations* and *observations*.

Object oriented data model includes *observation*, *valuation* and *group* in one super class. The components or factors are computed using methods defined in this super class. The methods return discrete or continuous numeric values and are used in the sales comparison and in the analysis of individual components. General information for each category of real property includes the description and scaling of the components, sales price index produced with Kohonen Map and other important data.

Time is managed by organizing observations as first *valuations* using Kohonen Map and approximate long-term average prices are found. Actual sales prices are then compared to the *valuations* and the difference is seen as the effect of time. Sales price index is formed and the sales prices are transformed to a given level. The *valuations* organized as a new Kohonen

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Map give better estimates for the sales prices. The process is iterated once more and the final sales price index is produced. Structural market changes are recognized.

Location is managed by organizing neighboring observations as *groups* using Kohonen Map. Observed sales prices are compared to the matching *valuations* and the average value of the ratio and difference is computed for the *group*. These **local sales price undulations** are shown on the map and sales price topography can be visualized clearly. Local centers, attractive sites, shores, railways, highways, high voltage transmission lines and other local characteristics can be seen within the effect of a whole.

Local market is visualized as a local Kohonen Map. The *group* symbol is pointed on the geographic map and the neighboring observations are shown as an ordered display of units averaged from local observations only. The number of units may be the same as the number of observations. Small and old houses with oven or stove heating usually locate in one corner and large and new buildings with amenities and build-ups in the other. Another display is shown using the matching *valuations* computed from resembling observations in the surroundings. Scatter plots drawn according to principal components are helpful.

Individual components are analyzed by organizing selected observations as a one-dimensional Kohonen Map according to the selected component. Ad hoc methods returning a continuous or discrete numeric value can be used, too. The sales price ratios and differences are visualized as curves or bars and as tables. Local sales price undulations computed for the *groups* are taken into account in the comparison.

One-family houses in Helsinki capital region are analyzed. Ten components including location, sales price, floor area, year of construction, detail plan, parcel area, shore, building material and heating system are scaled properly for sales comparison. The 4750 observations are organized as 1428 *valuations* and 1134 *groups*. Special emphasis is given for location (neighborhood, local centers, shore, airport). The negative effects of highway (up to 15 percent), railway (up to 11 percent) and high voltage transmission line (up to 5 percent) are reported.

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