The Role of Layout and Order in Treemaps for Showing Spatial and Temporal Variation in House Prices

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The price of property and how it varies spatially within cities through time can be linked to the economic and social processes of urban systems. We use treemaps (Shneiderman, 1992) for visually exploring 1.8 million property sales in London between 2000 and 2007 – and focus on how the *layout* and *ordering* of elements in the treemap can reveal different information.

Fig. 1 shows ordered squarified treemaps (Wood and Dykes, 2008) that provide overview summaries in which the size of each area corresponds to the number of sales and the colour corresponds to the average price.

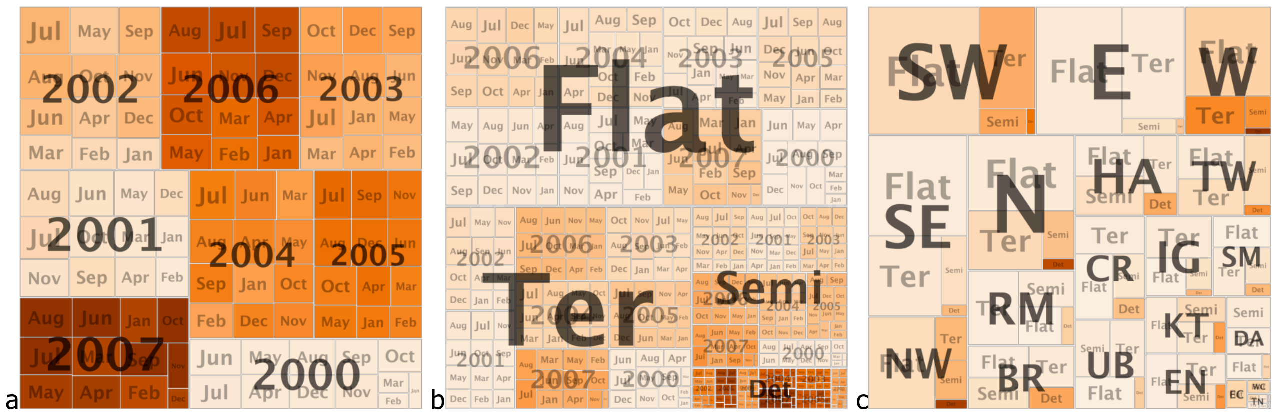

Figure 1: Squarified treemaps summarise the dataset by category through alternative hierarchies. (a) year»month; (b) type»year»month; (c) postcode»type. Local linear colour schemes are used (ColorBrewer "Oranges"; http://www.colorbrewer.org/) and ordering is by size from top left to bottom right. *The house price data are Crown copyright (Land Registry) and were retrieved from http://www.houseprices.co.uk/.*

Broad patterns that are detectable include:

- Fig. 1a - each year has a similar number of sales and 2007 saw the highest average price
- Fig. 1b - detached houses made up the smallest share of sales and had the highest average price
- Fig. 1c - most sales were made in SW and about two thirds of these were for flats

Whilst some inferences may be made by relating these views, using treemaps in this way is limited (Fabrikant, 2005; Slingsby *et al*, 2008). Firstly, patterns are dependent on *which* variables are included in the hierarchy (these are 'false hierarchies' in which categories have no inherent hierarchical relationship), their *order* and the hierarchy *depth* - this is the reason multiple treemaps are required. Secondly, the order in which rectangles are displayed affects their interpretation (Bederson *et al* 2002; Wood and Dykes, 2008). For example, the spatial categories in Fig. 1c are not arranged spatially (they are arranged by size), making it impossible to consider spatial patterns.

Adding interaction to treemaps can help (Slingsby *et al*, 2008). Our software (Fig. 2) allows layout and order to be varied interactively to support the exploration of this rich digital representation of an evolving city:

hierarchies can be switched, hierarchy depths can be changed; related nodes are identified across the hierarchies (2007 in Fig. 2b) and treemaps can used for variable selection (Kolatch and Weinstein, 2001; Theus, 2002; Slingsby et al, 2008).

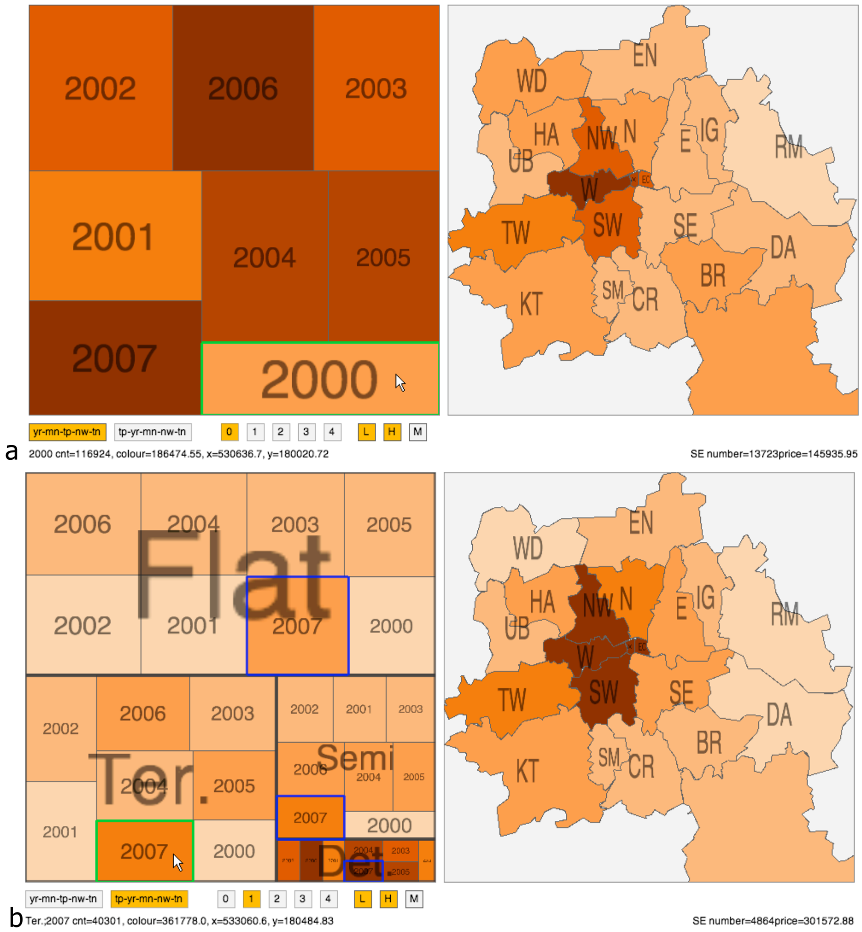

Figure 2: Interactive treemaps linked to a postcode map, both coloured by average price. (a) Property sold in 2000 is selected (left) and mapped (right). (b) Terraced housing sold in 2007 is selected (left) and mapped (right). All other 2007s are highlighted. *The house price data are Crown copyright (Land Registry) and were retrieved from http://www.houseprices.co.uk/. Postcode data © Crown Copyright/database right 2008. An Ordnance Survey/EDINA supplied service.*

In Fig. 2a, 'sales in 2000' is selected (lowest average price) resulting in a postcode map of 2000 prices (a large spatial variation in price). In Fig. 2b, 'terraced houses sold in 2007' is selected, showing that prices vary greatly again, but NW, W and SW postcodes areas have similar average prices. Additional interactions may help us explore the spatial and temporal consistency of this pattern.

Although size and colour are widely used to convey information in treemaps, order and layout is often neglected as an information-carrying property (Wood and Dykes, 2008). One-dimensional ordering by size is common but double encodes a variable. Fig. 3 shows how two-dimensional ordering can be more appropriate for some variables.

In Fig. 3a years are temporally ordered in one dimension and the months ordered in the other (a 'calendar view'). Although it carries exactly the same information as Fig. 1a, the temporal trends are much more prominent. Fig. 3b orders by geographic space producing a hierarchical cartogram of the postcode hierarchy where rectangles are placed as close to their true location as possible. It reveals that the spatial granularity of average prices varies spatially. Fig. 3c employs both spatial and temporal ordering at different levels in the treemap – a cartogram of postcode areas containing 'calendar views', showing that the temporal granularity of house prices varies over space and time.

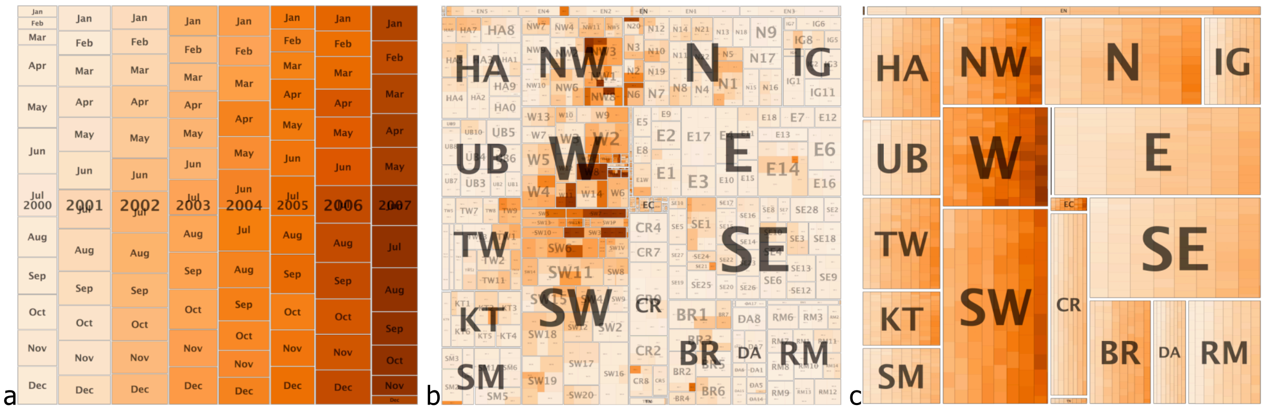

Figure 3: Treemaps with two-dimensional ordering (size and colour being used as before). (a) Treemap with a hierarchy of year»month - years ordered temporally (horizontal), months ordered temporally (vertical). (b) Spatially-ordered treemap using three hierarchical postcode levels. (c) Treemap hierarchy of postcode area»year»month, but using spatial ordering at the top level and temporal as in (*a*) at the lower two levels. *The house price data are Crown copyright (Land Registry) and were retrieved from http://www.houseprices.co.uk/. Postcode data © Crown Copyright/database right 2008. An Ordnance Survey/EDINA supplied service.*

Constraining size results in treemaps that use space more systematically to show variations in the data representing our city across space and time (Slingsby *et al*, 2008). The spatial calendar in Fig. 4 uses a hierarchy of grid-cell»year»month. The top level employs spatial ordering of regular 2km square spatial units for the central London postcodes. Subsequent levels use linear 'slice and dice' ordering (Shneiderman, 1992) with regular node size for the temporal data. This effectively produces a series of "small multiples" for the 2km grid squares.

Effective use of spatially adapted space-filling visualization techniques allows us to explore the large structured datasets that are digitally describing our cities. We are currently employing and evaluating these techniques in exploring the spatiotemporal nature of London house price data with researchers in economic and social geography. This involves using interactive methods to dynamically link treemaps of the kind described here with maps and other visual techniques to facilitate the data exploration process. We will demonstrate these and other techniques, describe opportunities for varying layout and order, present provisional results and look forward to feedback.

References

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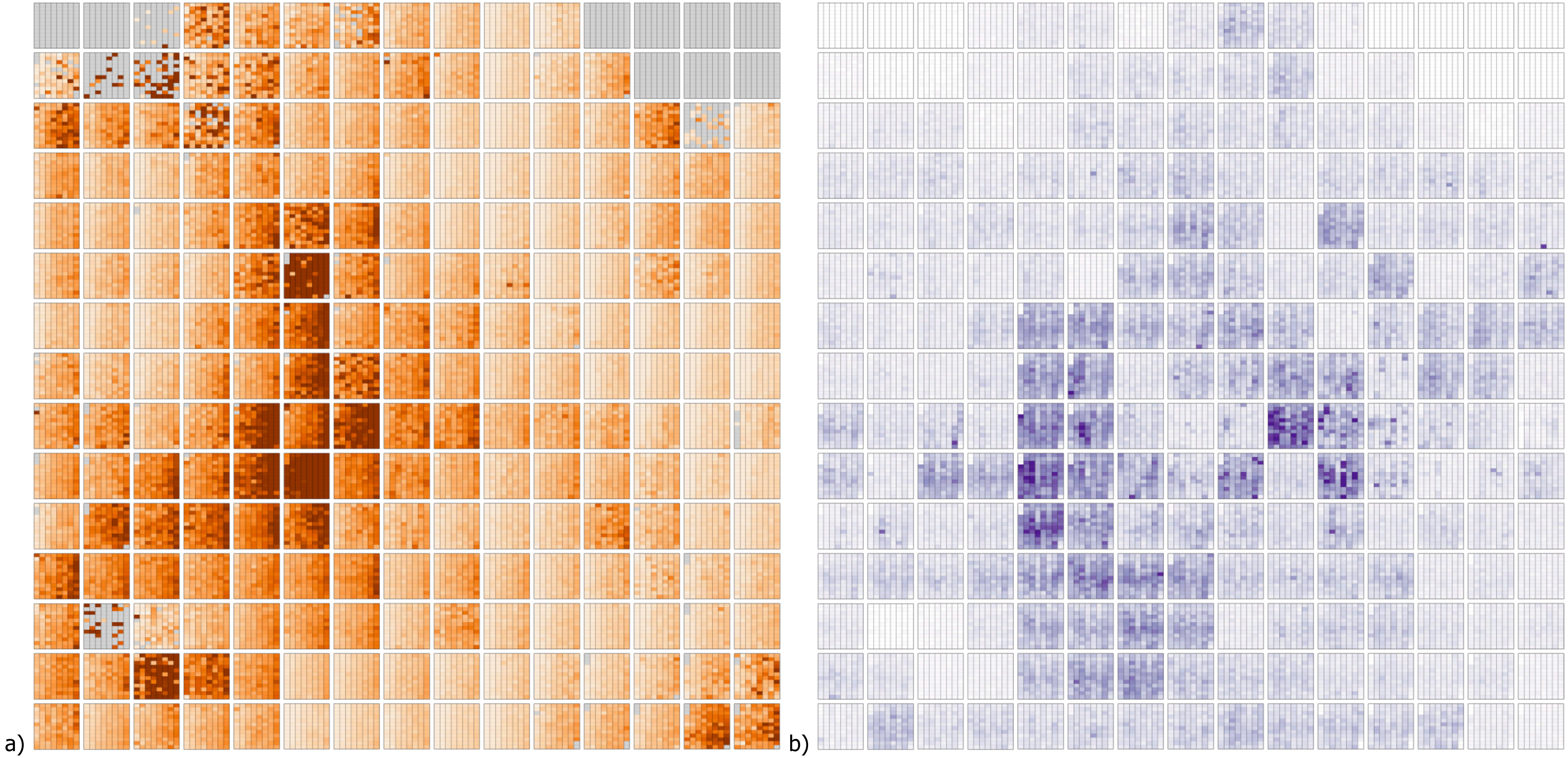

Figure 4: Treemaps with recursive two-dimensional ordering. Both treemaps use a hierarchy of cell»year»month for the area covered by NW, N, E, SE, SW, W, WC and EC – cells ordered spatially (like a 2km raster), years ordered temporally (horizontal), months ordered temporally (vertical), size is constant. (a) colour used as before. (b) colour is number of sales (ColorBrewer 'Purples'). *The house price data are Crown copyright (Land Registry) and were retrieved from http://www.houseprices.co.uk/. Postcode data © Crown Copyright/database right 2008. An Ordnance Survey/EDINA supplied service.*