Discussion about the three presentations of the invited session "Image reconstruction, edge detection and feature-tracking"

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1. About the presentation by Fred GODTLIEBSEN

The major objective of the scale-space technique presented by Fred GODTLIEBSEN is for exploring features in signals at different levels of scales in the smoothing procedure used for extracting signals from observed noisy data. For discussing about the pros and cons of this technique, let us apply it to a sea-level pressure data introduced in Chapter 3 of Qiu (2005). To detect jumps in the underlying regression function $f(x)$, consider the criteria $M_n(x)$ and $M_n^*(x)$, where $M_n(x)$ is defined as the absolute difference between two one-sided local constant kernel estimators of $f(x)$, constructed from observations in intervals $(x-h_n, x)$ and $(x, x+h_n)$, respectively, $M_n^*(x)$ is defined in a same way by two one-sided local linear kernel estimators of $f(x)$, and h_n is the window width. The two criteria are shown in the two right panels of Figure 1. After using a threshold of 2.25, their binary versions are shown in the two left panels, with 1 denoting existence of jumps and 0 denoting no jumps.

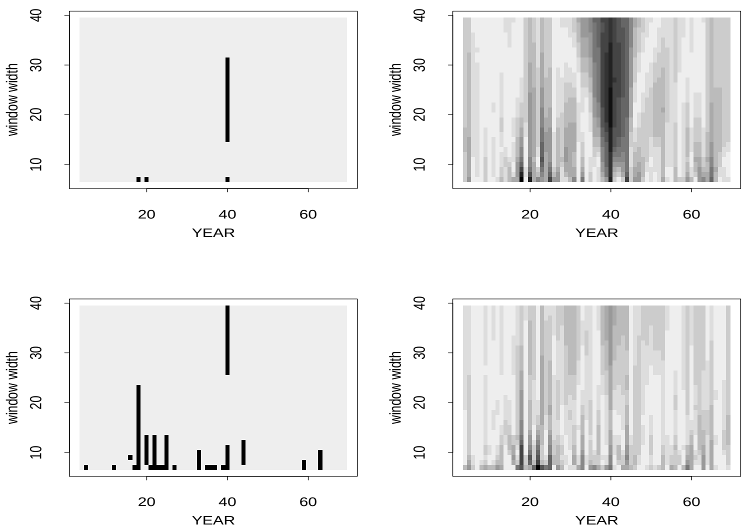

Figure 1: Upper-right and lower-right panels show the jump detection criteria $M_n(x)$ and $M_n^*(x)$, respectively. Left panels show their binary versions, using a threshold of 2.25.

Based on Figure 1, the following issues are raised and discussed: (1) In the scale-space technique, should we use the local linear kernel smoothing, or, local constant kernel smoothing, or, both? (2) Should we present the original feature detection criterion, or, its binary version? (3) It might be a good idea to add one more dimension to the SiNoS plot, using different colors for denoting different confidence levels. (4) Using this technique, we might still need to provide recommendations to users about the window width selection.

2. About the presentation by Alexandre LAMBERT

The 2-D jump-preserving surface estimation procedure suggested by Alexandre Lambert and co-authors is based on the following idea. At a given point (x, y), a circular neighborhood $N_n(x, y)$ is considered, which is divided into two parts $N_n^{(1)}(x, y)$ and $N_n^{(2)}(x, y)$, by a line passing through (x, y) and perpendicular to the estimated gradient $G(x, y)$ of the regression function f at (x, y). See Figure 2 for a demonstration. Then, three estimators of $f(x, y)$ are constructed from $N_n(x, y)$, $N_n^{(1)}(x, y)$, and $N_n^{(2)}(x, y)$, respectively. One of them is selected as the final estimator of $f(x, y)$, depending on whether there are jumps in $N_n(x, y)$, judged from observed data. The following issues are raised and discussed: (1) Bandwidth selection should be related to signal-to-noise ratio in the data, based on which, a variable bandwidth selection scheme is possible to use. (2) Further research is required regarding jump preservation around joint points of the jump location curves. (3) The spatial correlation among the observed data should be taken into account. (4) It is interesting to investigate iterative versions of the proposed procedure.

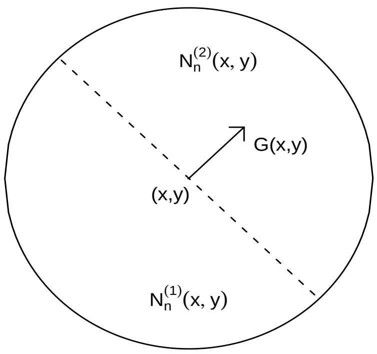

Figure 2: The neighborhood $N_n(x, y)$ is divided into two parts $N_n^{(1)}(x, y)$ and $N_n^{(2)}(x, y)$, by a line passing through (x, y) and perpendicular to the estimated surface gradient $G(x, y)$.

3. About the presentation by Jörg POLZEHL

Jörg Polzehl presented an interesting adaptive smoothing procedure for jump-preserving surface estimation. The presented procedure made several modifications to the procedure suggested by Polzehl and Spokoiny (2000). The major motivation of these modifications should be discussed. In the literature, there are several related procedures, including the adaptive smoothing filter by Saint-Marc *et al.* (1991), the bilateral filtering procedure by Tomasi and Manduchi (1998), the sigma filter by Chu *et al.* (1998), and the nonlinear diffusion filter by Perona and Malik (1990). It would be interesting to discuss the pros and cons of these procedures, compared to the suggested procedure. A brief introduction and related references about the procedures mentioned above can be found in Qiu (2005).

4. Additional references

Qiu, P. (2005), *Image Processing and Jump Regression Analysis*, Wiley: New York.