Methods for hierarchical watershed
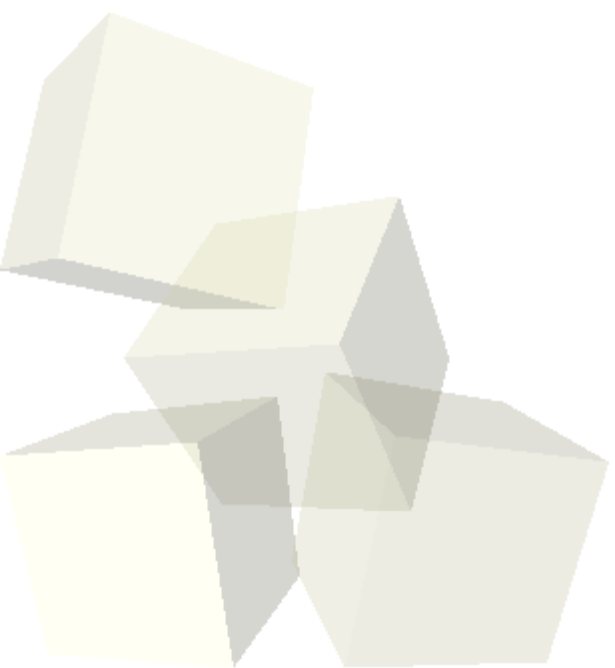
Michal Hučko
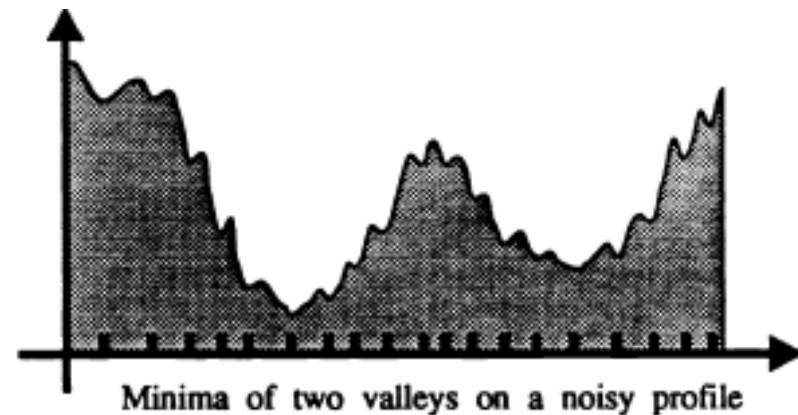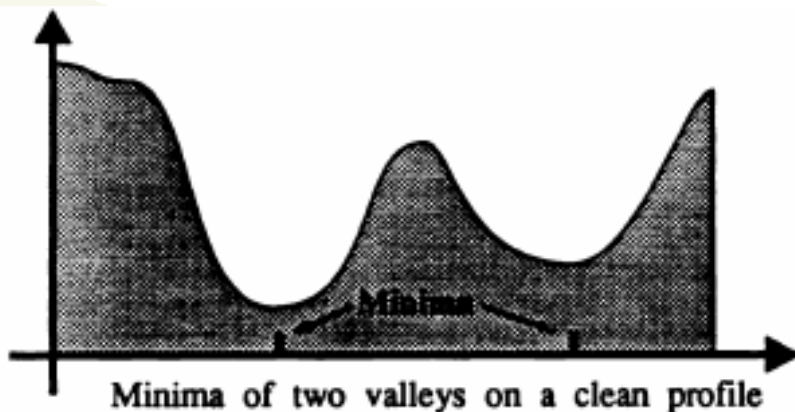
- Hierarchical watershed
- Methods
  - Dynamics
  - Mosaic image
  - Waterfall
  - Arcs dynamics

- **Watershed**
  - region for each local minimum
- **Oversegmentation reduction**
  - pre-filtering
    - denoising, removing of (insignificant) minima
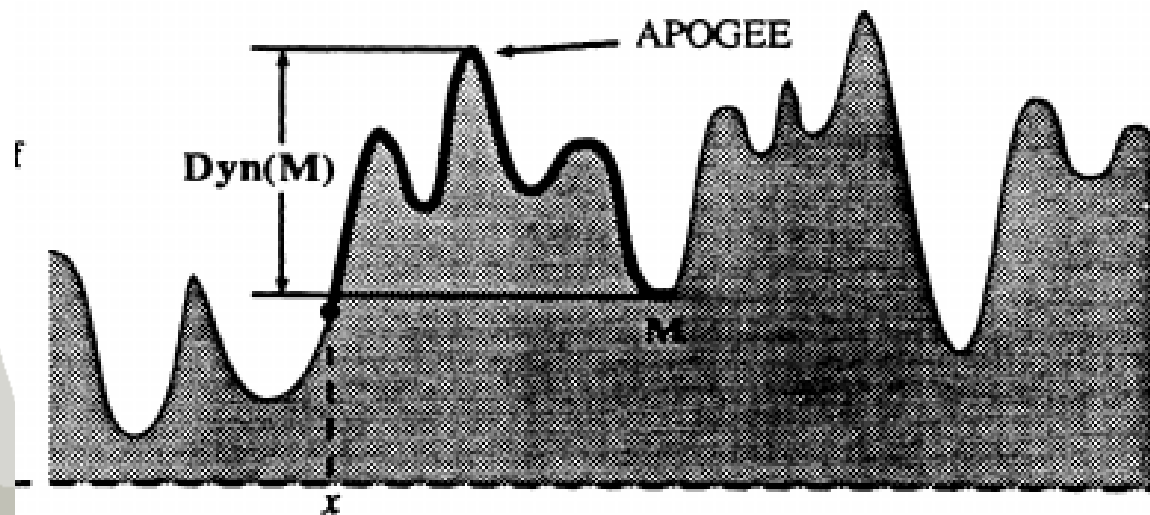 - merging of regions
    - grouping of minima

Minima of two valleys on a clean profile

Minima of two valleys on a noisy profile

- Hierarchical watershed
- Methods
  - Dynamics
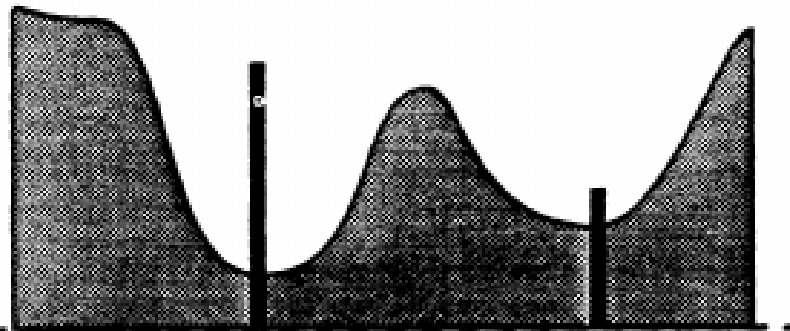 - Mosaic image
  - Waterfall
  - Arcs dynamics

■ **Valuation of minima**

- ◆ path to point belonging to region of minimum of lower value
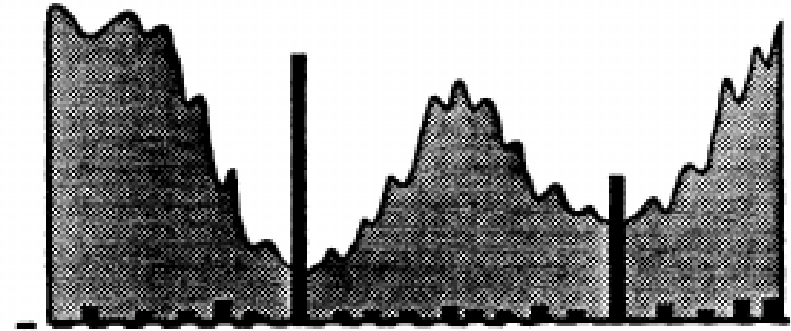- ◆ difference between height and apogee height on path

$$Dyn(M) = Altitude(APOGEE) - Altitude(M)$$
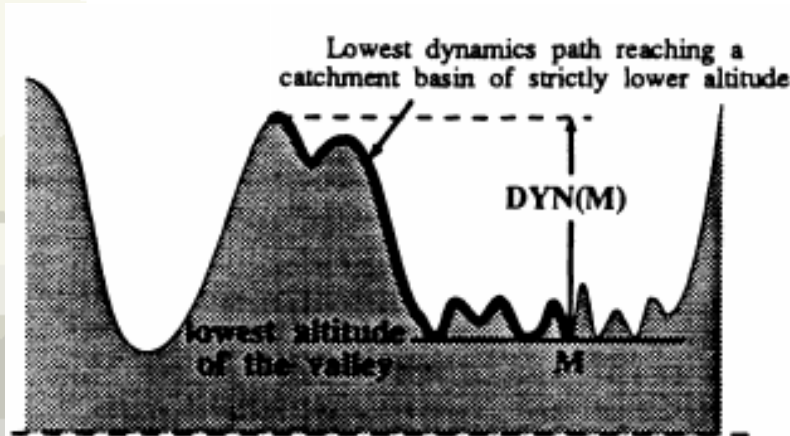
- **Using only minima of certain value**

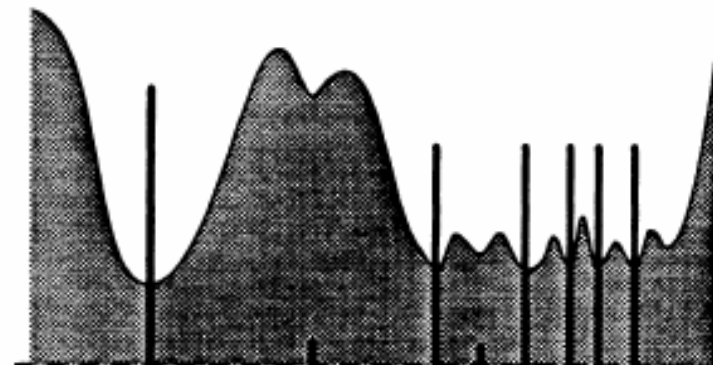(a) Dynamics of two valleys on a non-noisy profile

(b) Dynamics of two valleys on a noisy profile
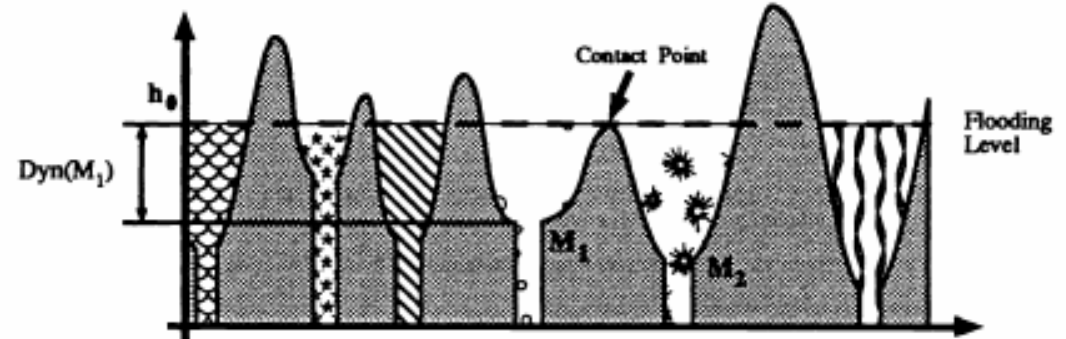
- **Wide valley problem**

(a) A few minima have the same altitude than the bottom of the largest valley.

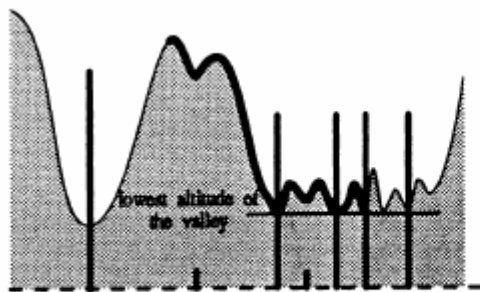(b) One valley is spotted with more than one minimum of high dynamics.

■ **Algorithm**
  - all minimas & regions at once

■ **Solves problem**

Contact Point

h_0

$Dyn(M_1)$

Flooding Level

M_1

M_2

(c) The process pauses when two different sheets get in contact. Let M_1 and M_2 be the minima feeding these sheets such that $alt(M_1) > alt(M_2)$. The dynamics of M_1 is then equal to : $h_0 - alt(M_1)$.

Flooding Level

M_1

M_2
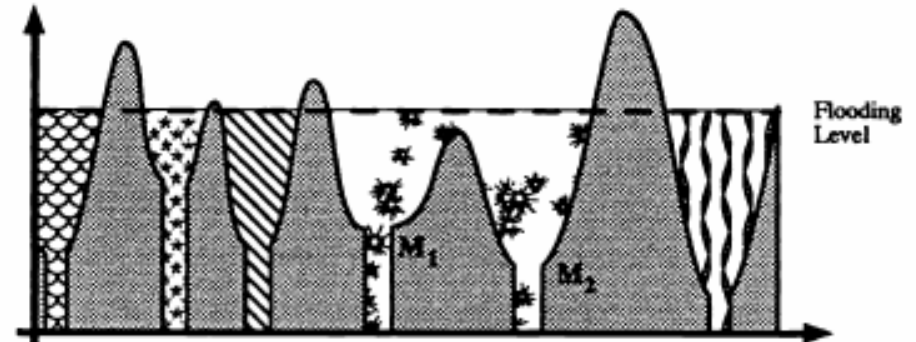
(d). The sheet coming from M1 is absorbed by M2 sheet. The oding starts again and pauses as soon as two new sheets get contact. The process ends when the whole relief is flooded.

lowest altitude of the valley

(a) Configuration on which dynamics gives undesired results. The biggest valley is spotted with more than one minimum of high dynamics.
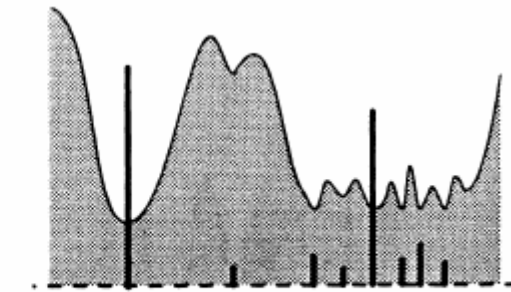
(b) Dynamics image after modification of the flooding algorithm. When two sheets issued from minima of same altitude got in contact, the smallest sheet is absorbed and the dynamics of its minima is calculated.
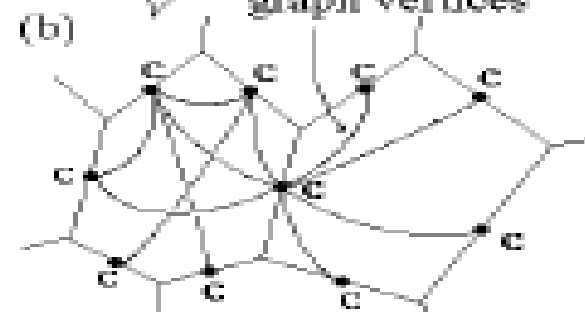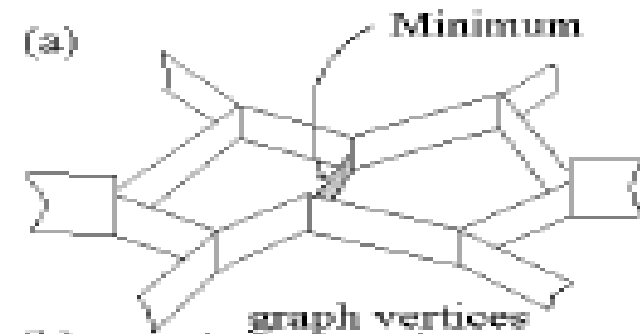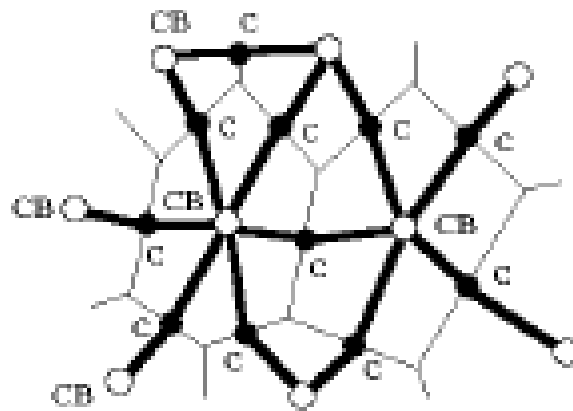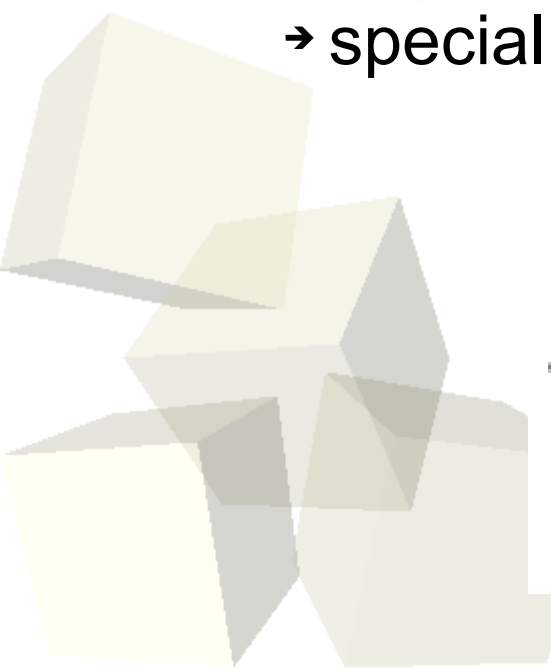
- Hierarchical watershed
- Methods
  - Dynamics
  - Mosaic image
  - Waterfall
  - Arcs dynamics

- **Mosaic image**
  - evaluation of watershed
  - replacement of values by mean region value
- **New graph**
  - vertices – watersheds
  - edges – connects edges of the same region
  - non-planar
    - special vertices for regions

- **Vertex value**
  - ◆ gradient size
    - ➔ mean values of separated regions
  - ◆ min. intensity of adjacent vertices
    - ➔ for region vertices
- **New pixel image**
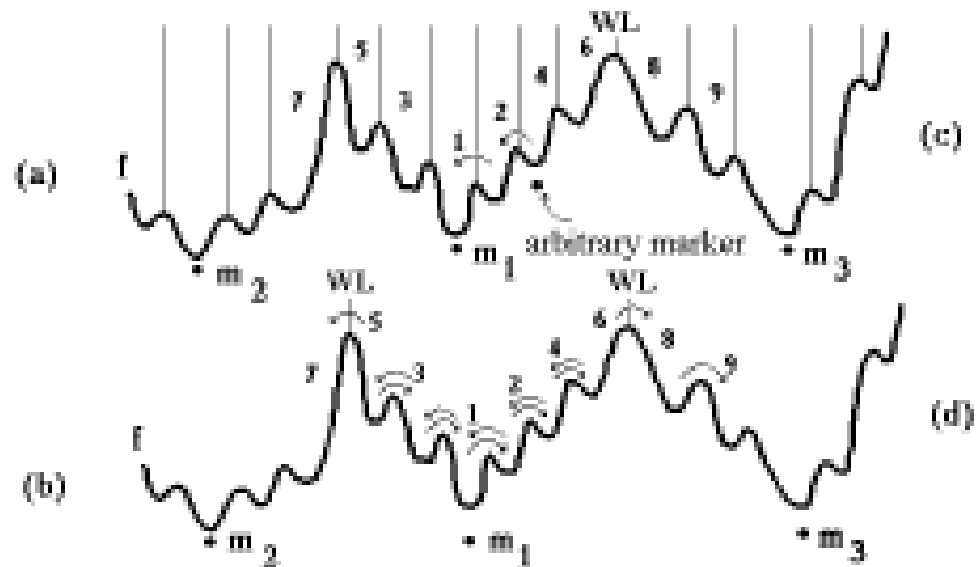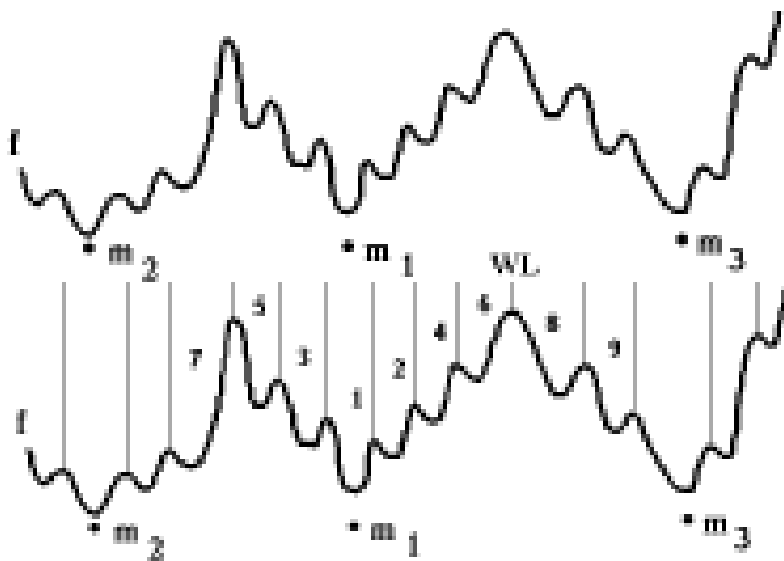 - ◆ values from graph
  - ◆ watershed segmentation

- Hierarchical watershed
- Methods
  - Dynamics
  - Mosaic image
  - Waterfall
  - Arcs dynamics
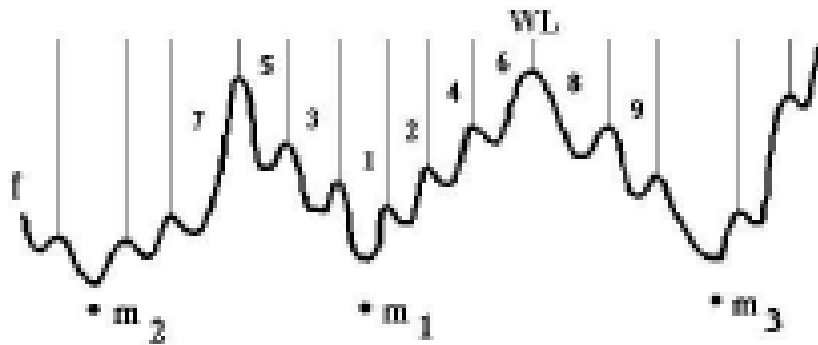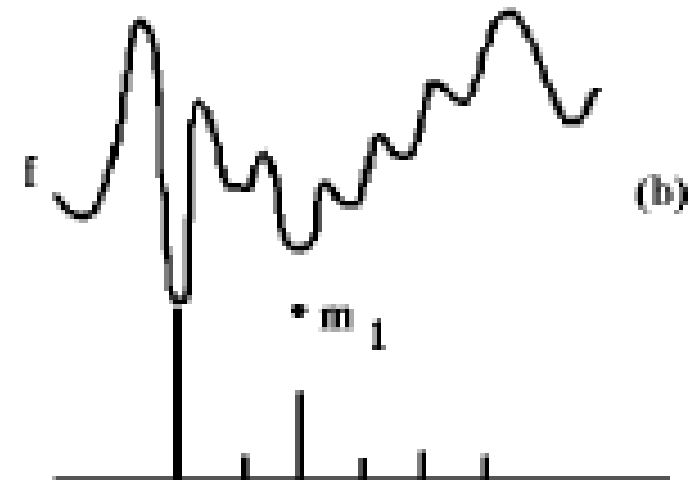
- **Identification of significant minimas**
  - reciprocal overflow
- **Identification of regions**
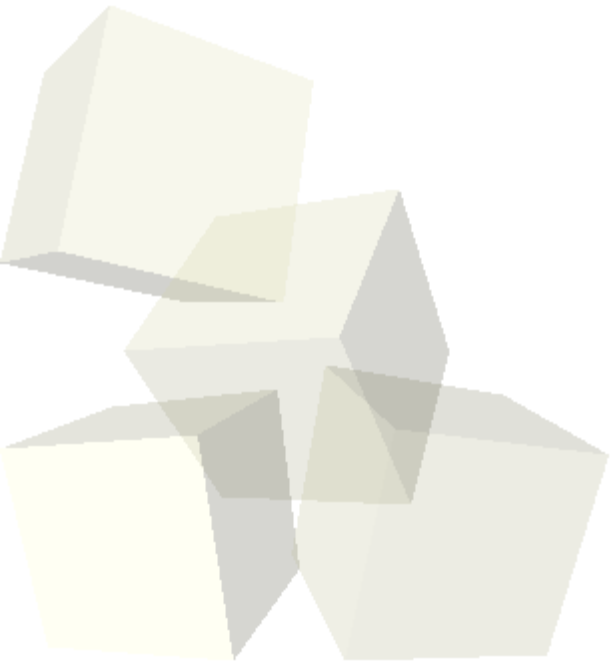 - without previous watershed transformation

- **Efficient algorithm**
  - ◆ geodetic reconstruction
- **Comparison**
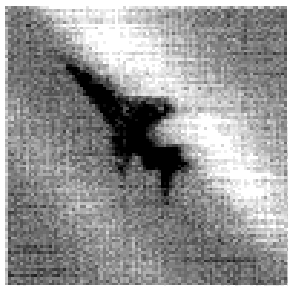 - ◆ mosaic image – equivalent
  - ◆ dynamics - differences

- Hierarchical watershed
- Methods
  - Dynamics
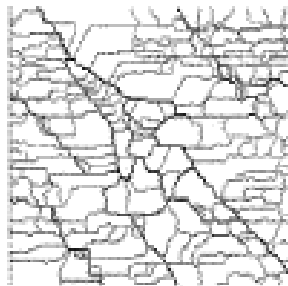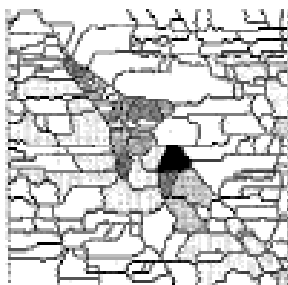 - Mosaic image
  - Waterfall
  - Arcs dynamics

■ Significancy (saliency)

- ✦ not minimas (regions)
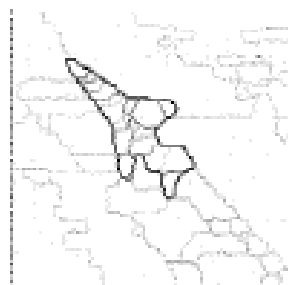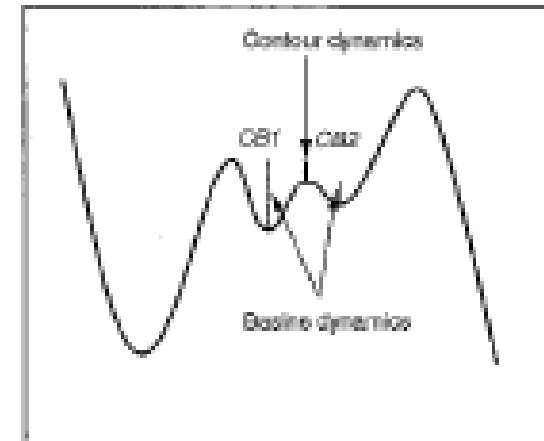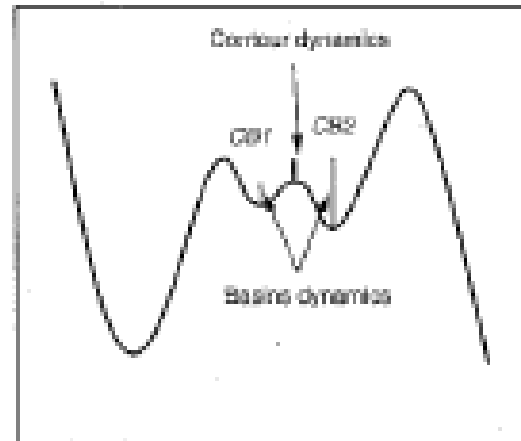- ✦ watershed lines

(a) Original image

(b) Waterfall algorithm

(c) Map of the basins valuated
by their dynamics
(white = low, black = high)

(d) Computation of the
dynamics of contours

- Grimaud M. - A new measure of contrast: the dynamics (http://dx.doi.org/10.1117/12.60650)
- Beucher S. - Watershed, hierarchical segmentation and waterfall algorithm (cmm.ensmp.fr/~beucher/publi/ismm94_beucher.pdf)
- Najman L. and Schmitt M. - Geodesic Saliency of Watershed Contours and Hierarchical Segmentation (www.laurentnajman.org/Papers/i1163.pdf)

Thank you for your attention