

The Bounded Weak Echo Region Detection Algorithm

V. Lakshmanan^{1,2*}, Arthur Witt¹

¹National Severe Storms Laboratory, Norman OK

²University of Oklahoma, Norman OK

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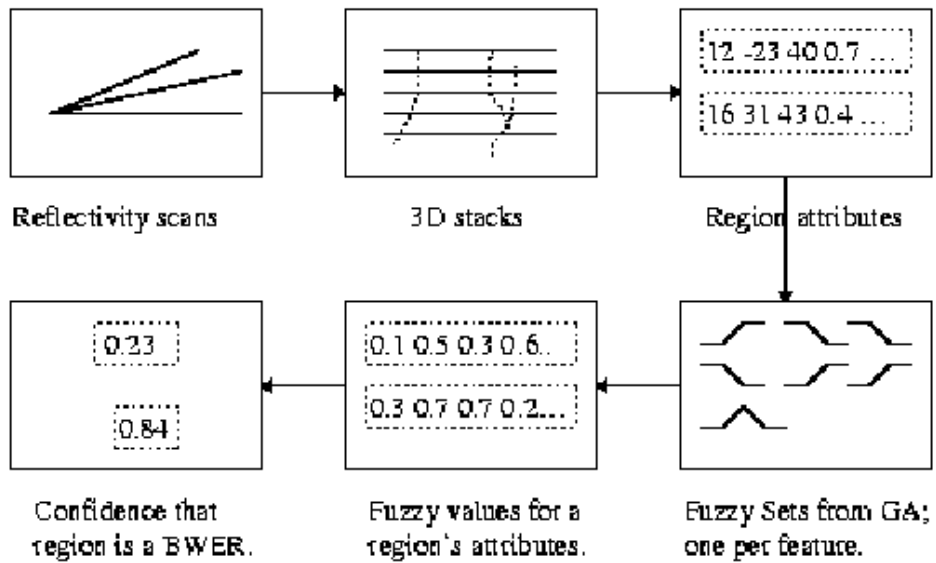
*lakshman@nssl.noaa.gov

Synopsis

A generate-and-test method:

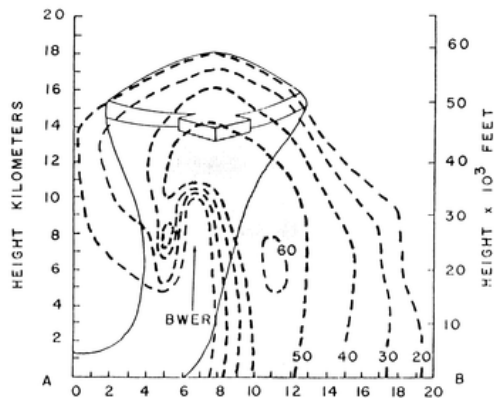
- Find candidate 2D regions
- Form all possible 3D structures
- Test them using rulebase

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I'll work backward.

The Rulebase



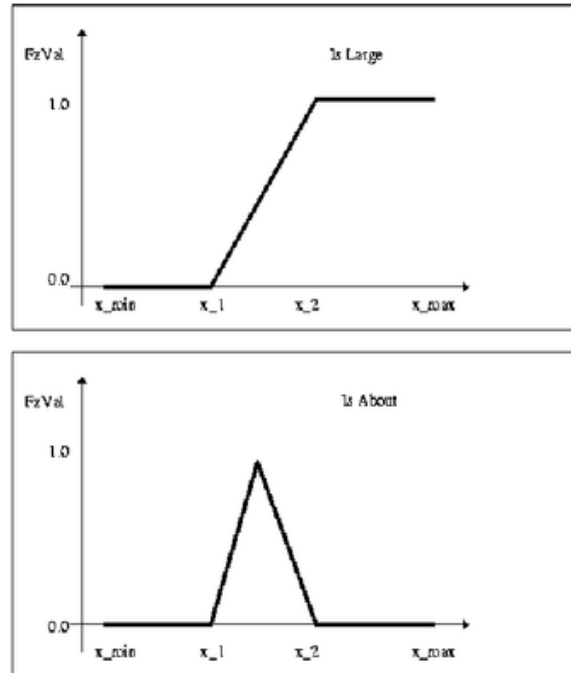
The rules describe what a BWER should look like:

- The minimum value inside the BWER is low.
- The average value inside the BWER is low.

- The average bounding value is high.
- The average bounding value is higher than the average value inside.
- The BWER is capped by high values.
- The BWER is aloft.
- The BWER doesn't have high dBZ values below it.
- There was a BWER around this spot in the previous volume.

There are rules ...

- Things to notice about these rules:
 - They are redundant: “minimum”, “average”
 - There are no numbers here. Just high, not “greater than 40 dBZ.”
 - Some of them will never be always valid. For example, the previous BWER condition – if followed strictly, the algorithm will never start.



- These are fuzzy rules.
- Find out how much each of the rules fires.
- “Aggregate” them. What I do is to aggregate based on sorting the numbers and then assigning weights (works when you tend to have very few items that actually meet these criteria).

Example of rule in rulebase

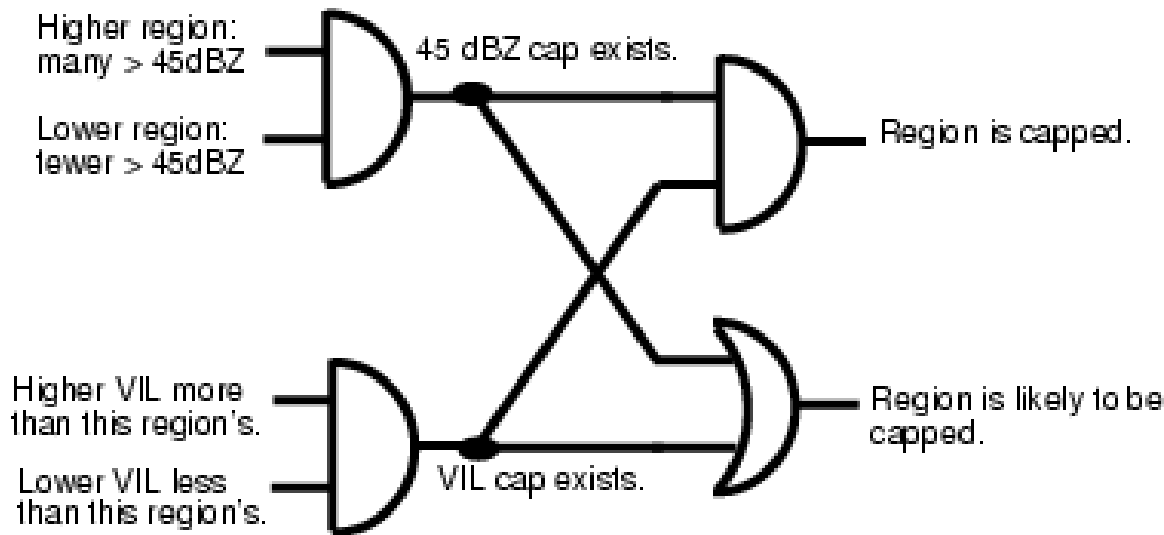
For example, the degree to which a region is capped is obtained from four fuzzy properties of the region:

- the degree to which there are many pixels above this region with reflectivities greater than 45dBZ,
- the degree to which there are fewer pixels with reflectivities greater than 45dBZ below this region than there are above it,
- the degree to which the average reflectivity above the region is higher than the average reflectivity within the region,

- and the degree to which the average reflectivity below the region is lower than the average reflectivity above this region.

Note that the properties that determine the 45dBZ capping extent correspond either to the region itself or to one of the regions above/below it and from which it can inherit attributes.

intermediate conclusions.



The GA

- The actual thresholds are upto us. I lob it off to a genetic algorithm.
- A genetic algorithm is an optimization technique based on “chromosomes”.
- Any assignation of thresholds for a fuzzy rule (one pair of thresholds for each rule) is a gene.
- A set of these genes, one for each fuzzy rule in our rule base, is a chromosome.
- The idea is that if a gene really improves performance, it will be kept by the evolution process.

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- Assign measure of fit to the chromosome by checking against truthed cases. (Different measure for run-time and NN).
- Run the optimization process several times, choose best chromosome of the runs.

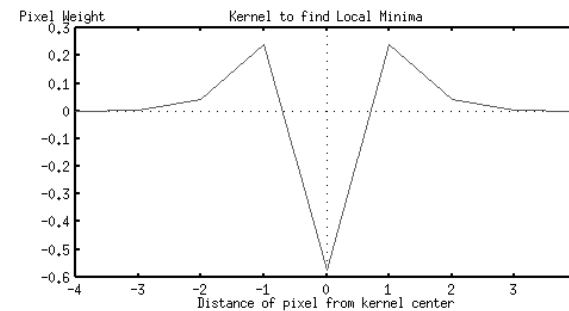
Any good chromosome works

GA Runs	Training CSI	Training HSS	Test CSI	Test HSS
1	0.435	0.603	0.467	0.633
2	0.473	0.634	0.500	0.663
3	0.382	0.548	0.390	0.557
4	0.404	0.572	0.308	0.467
5	0.364	0.529	0.168	0.483

Performance of the chromosome obtained by tuning the BWER algorithm using the GA. The numbers are traditional CSIs and HSSs obtained by thresholding the detections at a 0.75 confidence level.

Image Processing

Assign each pixel a fuzzy score based on convolving points “within

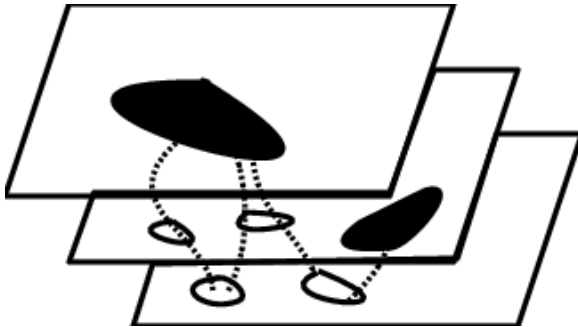


the storm” (≤ -7 dBZ) with this kernel: , its pixel value being low and close to 35-45 dBZ values.

Choose pixels that are in the top 15% of the grid and build regions based on four-neighbor contiguity and label them. and stack them and compute 3D properties for all possible 3D structures.

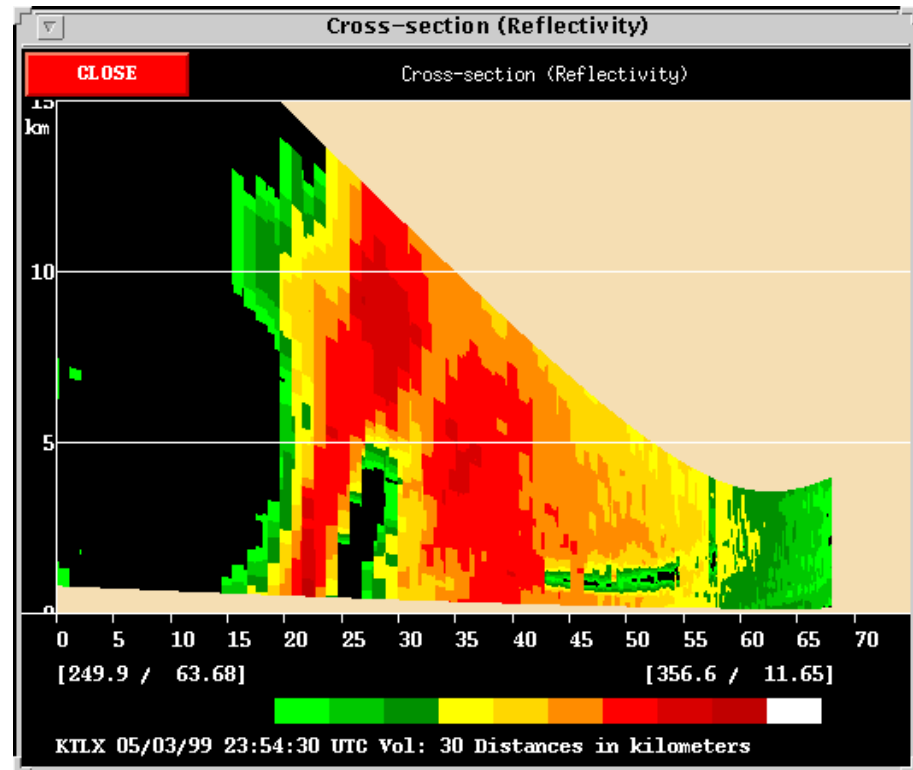
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Finding Candidates



(In reality, we don't need to consider all structures – min/max would be okay.)

Results (May 3 case)



From Pat Burke's study:

