

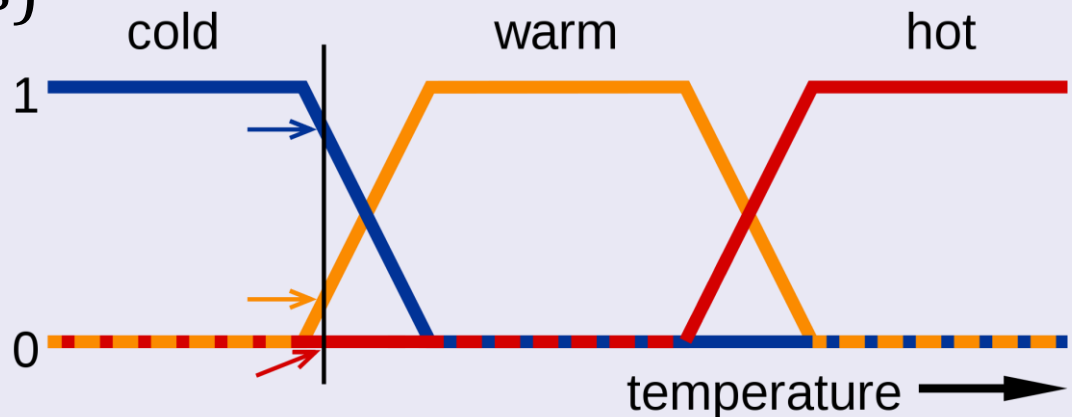
Video meteor detection filtering using soft computing methods

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Croatian Meteor Network

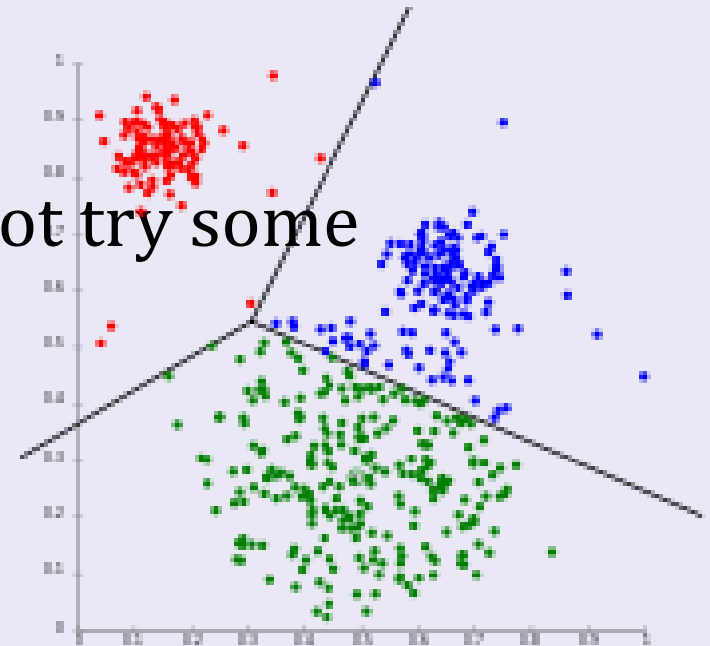
Soft Computing?

- Role model - the human mind
- Inexact solutions, tolerant to uncertainty and imprecision
- Neural Networks, State Vector Machines, Fuzzy Logic, Genetic Algorithms,...
- Used for very computationally hard tasks (NP-complete problems)



Problem and existing solutions

- Meteor detection using CAMS software
 - Meteors + birds, bats, planes, clouds...
- Current tool for detection filtering / classification by Damir Šegon (MTP Filter)
- Other approaches?
- Classification problem - why not try some classification algorithms?



Input data



Input data – CAMS detection format

- CAMS software detection format
- Data format:

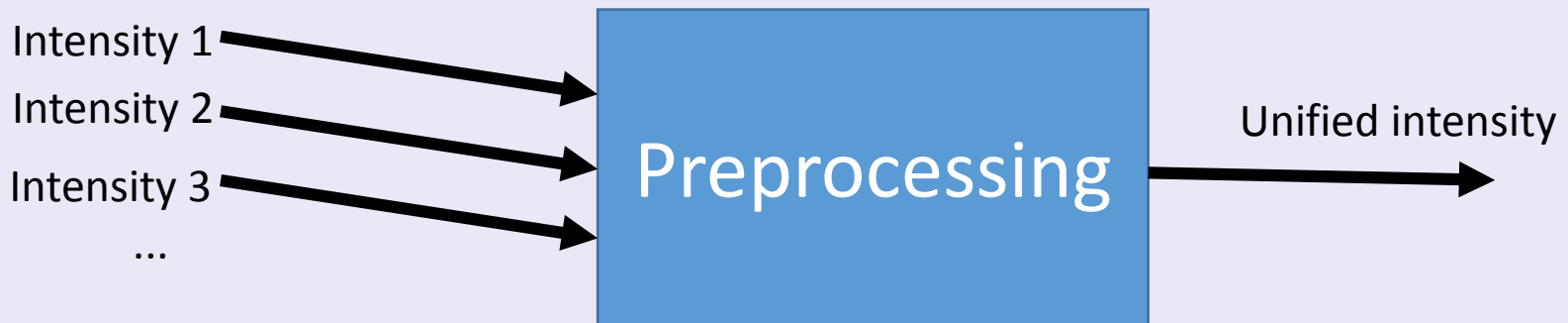
Cam# Meteor# #Segments fps hnr mle bin Pix/fm Rho Phi

Per segment: Frame# Col Row RA Dec Azim Elev Inten

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FF493 20150301 222012 823 0478464.bin 0493 0001 0010  
0025.00 069.4 039.9 -06.6 010.0 0038.3 0001.7 0041.0  
0417.53 0137.29 080.12 000.50 270.62 035.65 000268 0041.5  
0417.59 0142.19 080.12 000.50 270.62 035.65 000429 0042.0  
0417.51 0147.50 080.12 000.50 270.62 035.65 000928 0042.5  
0417.59 0152.20 080.12 000.50 270.62 035.65 000941 0043.0  
0418.33 0158.41 080.12 000.50 270.62 035.65 000822 0043.5  
0418.24 0163.49 080.12 000.50 270.62 035.65 000835 0044.0  
0418.33 0168.69 080.12 000.50 270.62 035.65 000694 0044.5  
0418.15 0173.07 080.12 000.50 270.62 035.65 000363 0045.0  
0418.52 0182.48 080.12 000.50 270.62 035.65 000192 0045.5  
0418.62 0186.82 080.12 000.50 270.62 035.65 000118
```

Preprocessing the data 1

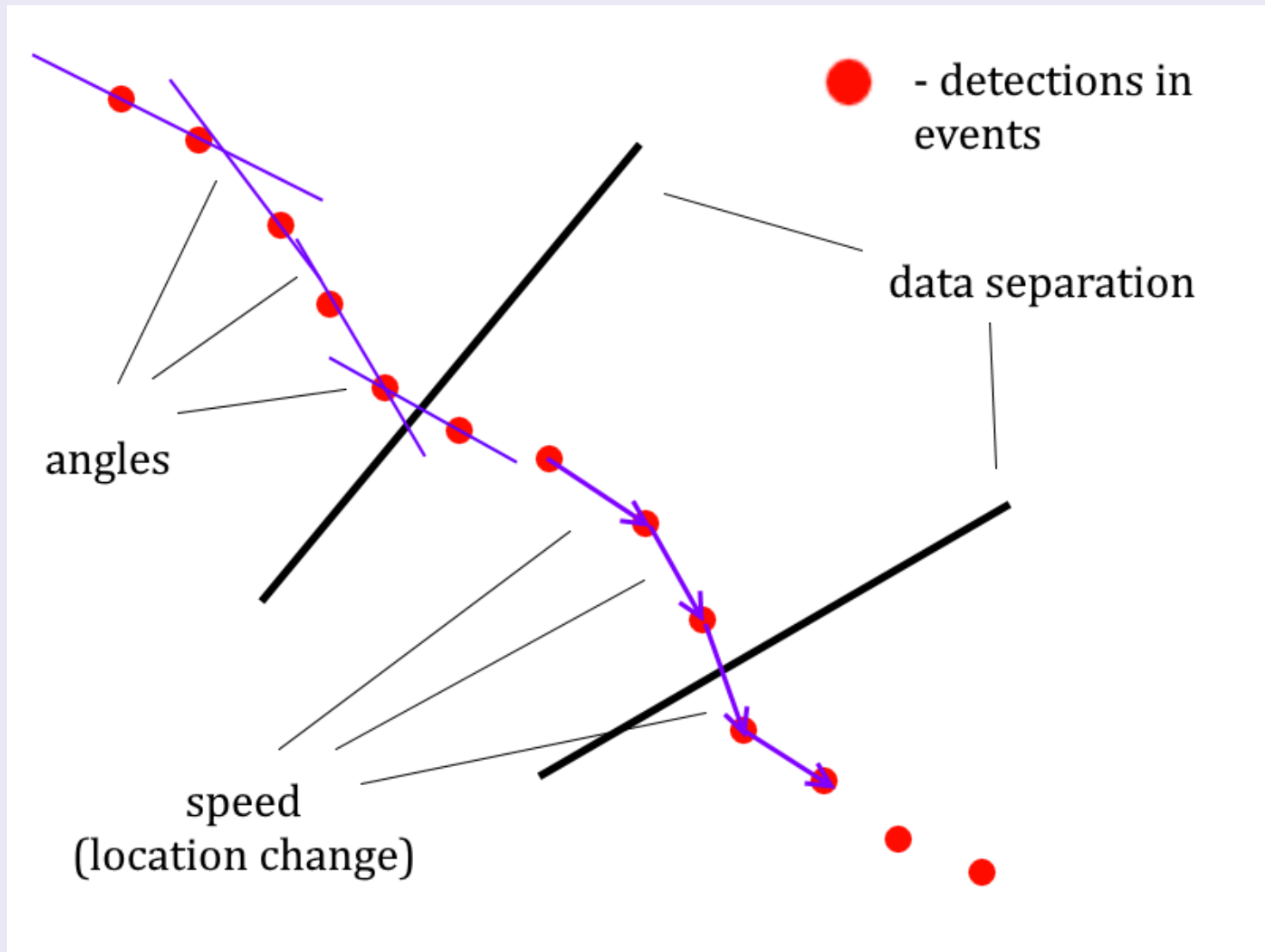
- Preparing the data for the Neural Network
- Dimensionality reduction
 - Time, position (X, Y), velocity, intensity \rightarrow 1 value per variable
- Data format
 - Divided by event
 - Each event consists of frames with the data



Preprocessing the data 2

- What we reduced:
 - Location change (angular velocity) from 1 detection frame to another relative to the angular velocity calculated on 2 detections
 - Fitted lines going through 2 detection points to obtain angles. Angles taken are also relative to the angle change on the central detections.
 - Light intensity is calculated in percentage where 100% is the brightest event in that night
- Events are split in even 3 parts and averages are calculated

Processing the data 3



Final preprocessed data

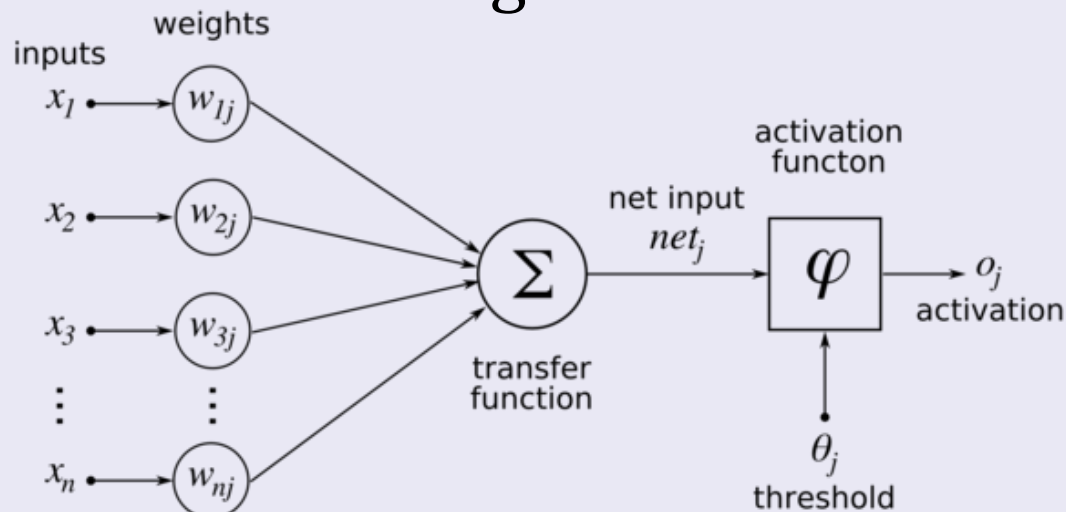
- Each event is represented in just 9 variables:

3.56, 4.77, 3.33, -0.36, -0.25, -0.23, 11.3, 21.78, 58.01, 1

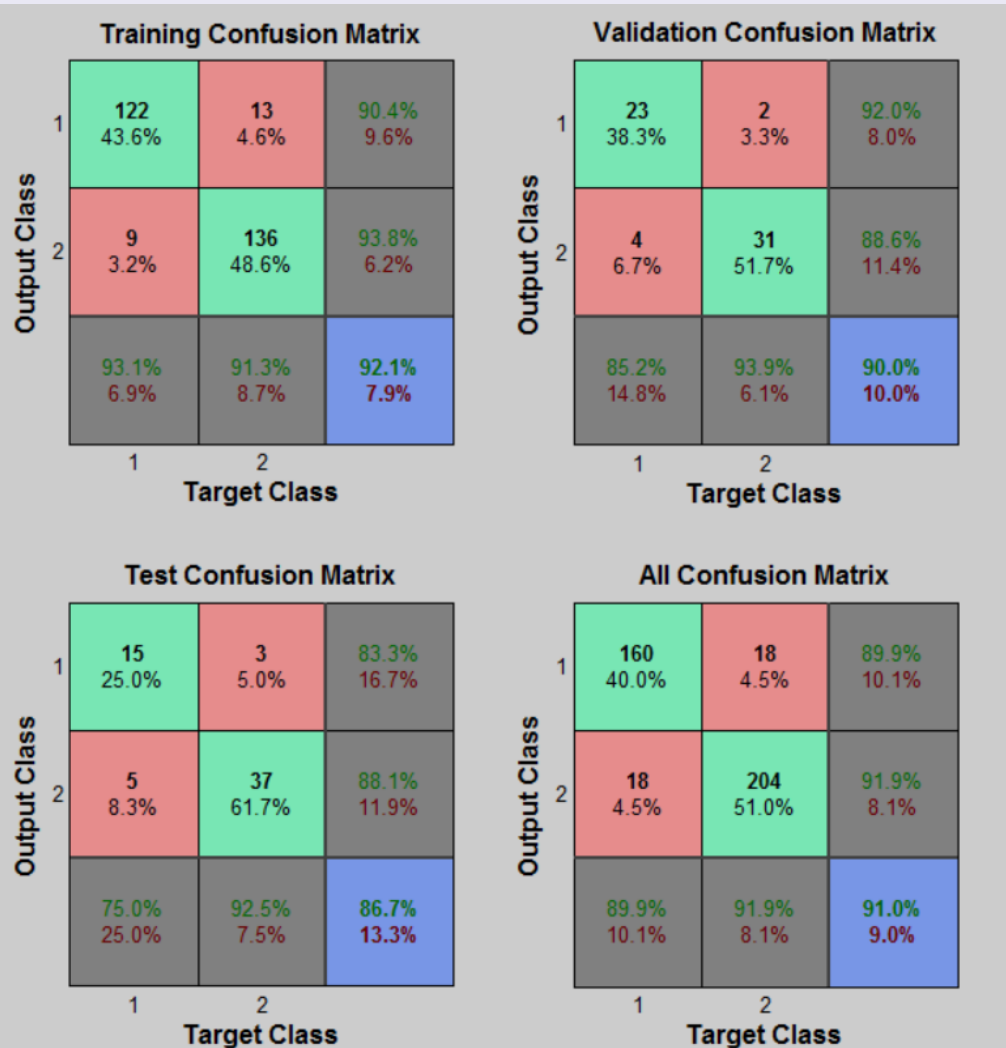
- First 3 are relative angle averages for each section, next 3 are relative angular velocities averaged for each section and last 3 are averages of light intensity for each section
- Last value - manual classification with CMN_binViewer software:
 - 1 – meteor
 - 0 – false detection

Algorithms: Neural Networks

- Each neuron has a trigger function which multiplies the input by a certain amount and sends it other neurons
- Must be trained with already classified data
- Separated in layers, each having it's own number of neurons and sending the data to the next layer



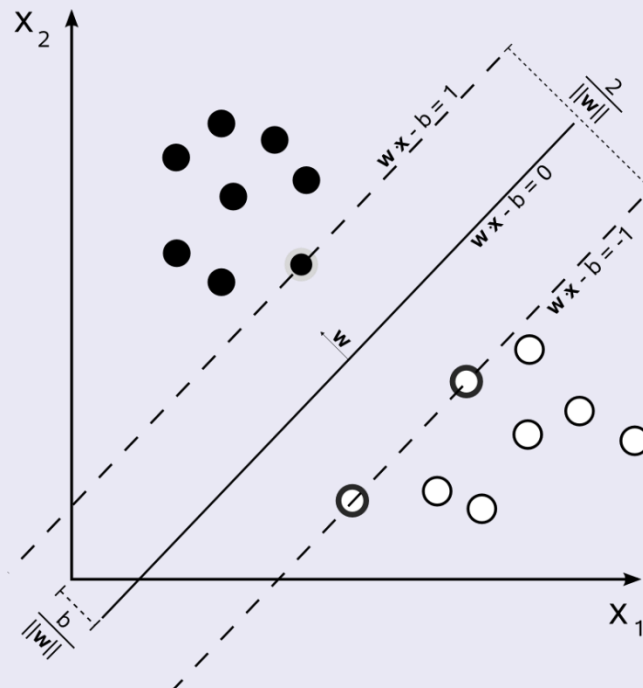
Results: Neural Networks



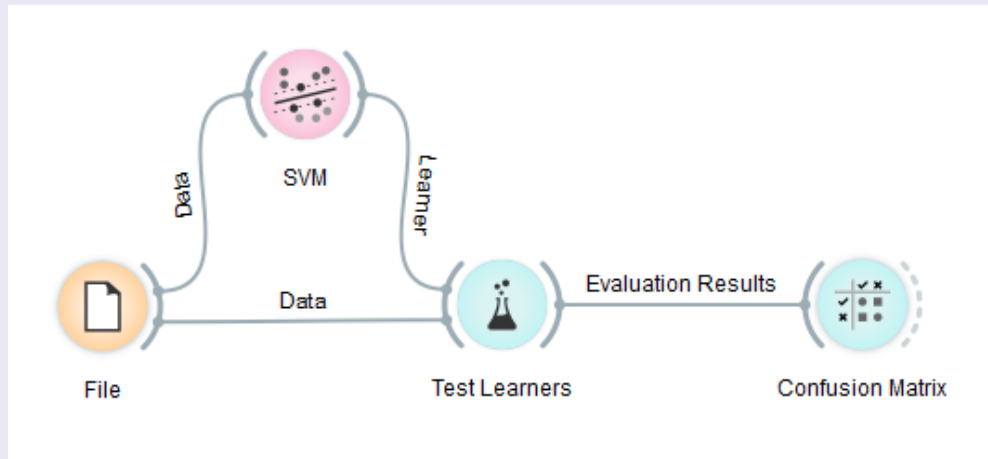
- Matlab nprtool is used (NN pattern recognition tool)
- 60 neurons gave best results
- 10.1% of meteors are wrongly classified as not being meteors
- 8.1% non-meteors are classified as meteors which gives us a total of 91% accuracy

Algorithms: State Vector Machine

- Principle: find a hyper-plane that separates the data in 2 classes
- Increase the number of dimensions to find a solution? (currently using 9 dimensions)



Results: SVM



- OrangeCanvas software is used
- 7.9% of meteors are classified as non-meteors, giving us slightly better results than the NN

		Prediction		
		0	1	
Correct class	0	88.7 %	11.3 %	222
	1	7.9 %	92.1 %	177
		211	188	399

Conclusion and future work

- Results – not good enough, need $<1\%$ meteor loss
 - More data for training the network?
 - Different dimensionality reduction?
 - Different algorithms?
-
- Only scratched the surface of soft computing for this purpose – need more people working on it!

Thank you for your attention!

Questions? (Send Emil an e-mail?)