Video meteor detection filtering using soft computing methods

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Soft Computing?

• Role model - the human mind
• Inexact solutions, tolerant to uncertainty and inprecision
• 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 – 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

Intensity 1
Intensity 2
Intensity 3
...

Preprocessing

Unified intensity
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

- detections in events

data separation

angles

speed
(location change)
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 to other neurons.
- Must be trained with already classified data.
- Separated in layers, each having its 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
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?)