Information-extreme intellectual technology

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Sumy-2017

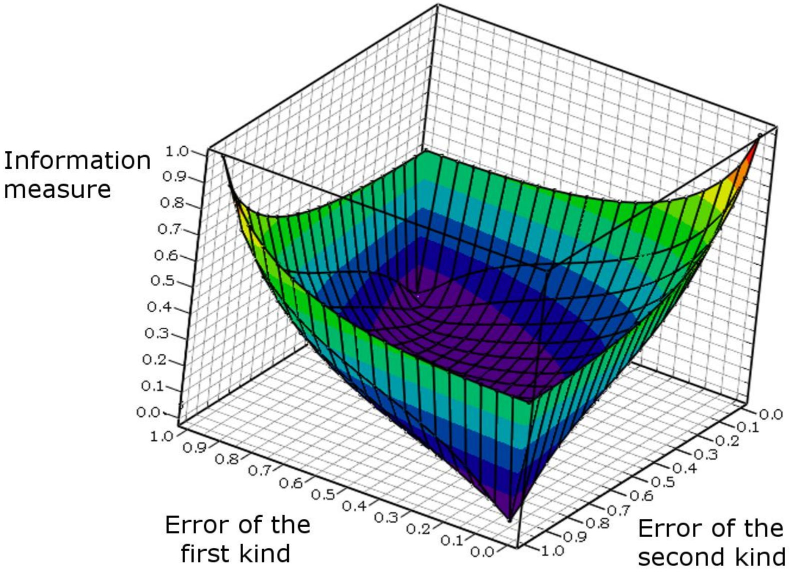
GENERALIZED CRITERION

We are designing our solution from the ground up to run on a very low-spec hardware and be robust in real-world applications where objects need to be viewed from any distance or angle and training sample sizes are small.

We use **Generalized Criterion** to maximise efficiency by constantly adapting to information conditions and resource constraints

Generalized Criterion = Information_measure * Resource_saving_score

- smoothing effect of Information Measure function reduces probability of getting trapped in local extrema
- information criterion provides good generalization ability for **small / imbalanced training datasets**
- Using Resource Saving Score as a functional cost efficiency measure enables:
  - use of **low-spec hardware** for embedded applications
  - **energy saving mode**
  - **real-time data processing**



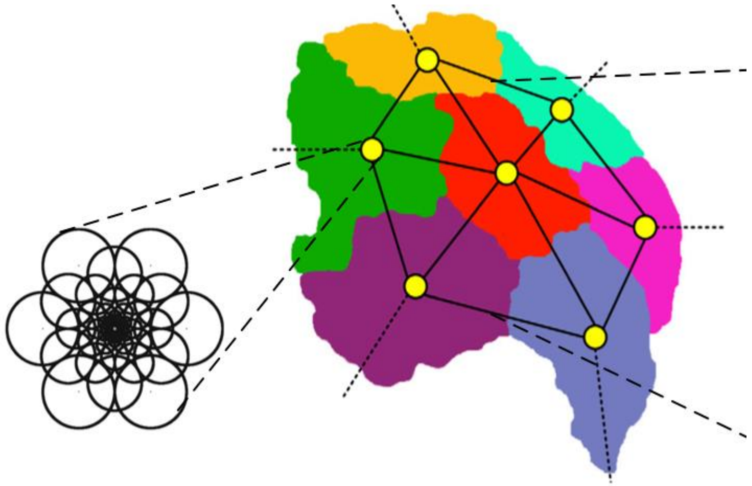
Information Measure as a function of Type I and II errors

UNSUPERVISED FEATURE LEARNING

Our innovative use of nature-inspired search algorithms allows for low computational complexity in both training and decision-making modes. This makes our technology particularly suitable for autonomous device applications, where computational resources and amount of training data are constrained

Unsupervised Feature Learning functionality enables our system to automatically learn feature representations from unlabelled data

- **unsupervised feature learning** capability is created by combining **information-extreme coarse binary coding of retinal *local* features with spatial information** and **population-based information-extreme adjustment of soft quantized *macro* features**



- **Benefits of our approach:**
  - viewpoint and illumination **invariance**
  - computational **efficiency**
  - **informativeness** of selected features
  - **adaptability**
  - ability to cope with **hundreds of classes**

INFORMATION-EXTREME COARSE BINARY CODING

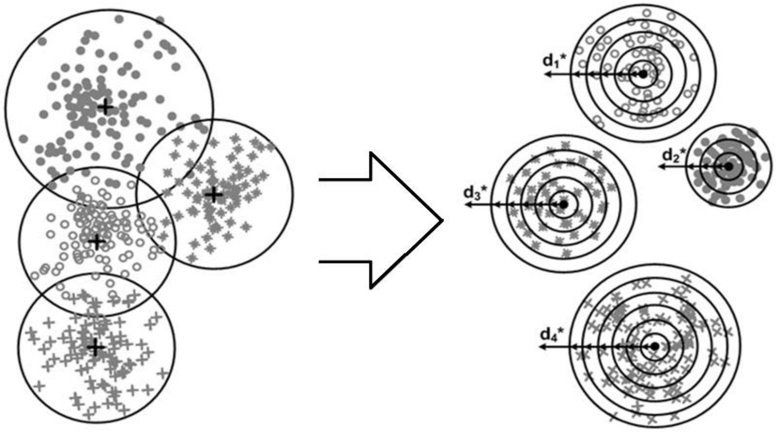
Information-Extreme Coarse Binary Feature Vector Coding enables a **very fast search** for **optimal decision rules**

- Information-extreme coarse binary coding of feature vectors allows for a very fast search for optimal decision rules using **radial basis functions** in **Hamming space**
- Multi-layer Fast Binary Matrix Factorization for reducing the complexity of binary bottleneck features extraction

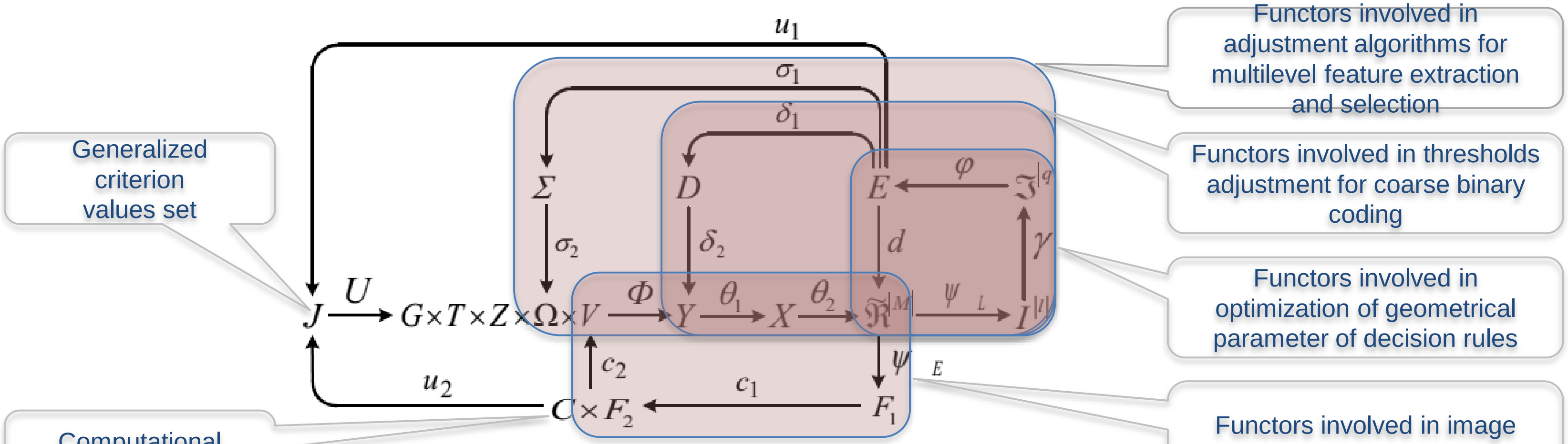
- **Benefits of our approach:**
  - **Elimination of** high variance / overfitting
  - **Real-time** Machine Learning and re-learning
  - Highly **accurate decision rules**
  - **Immunity** to noisy data

Overlapping classes in Euclidian Space

Clear separation in Hamming Space



Our solution is **built** and **documented** with **object-functional approach** which allows to extend basic methods via inheritance and analyze optimization contours with categorical-functor modelling



Categorical-Functor Diagram

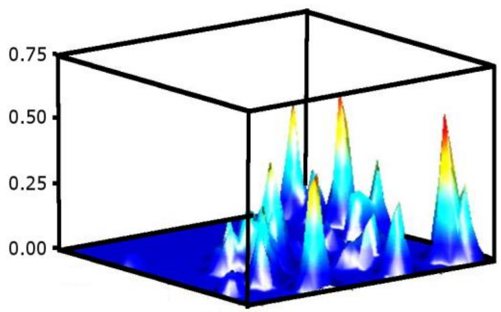
POPULATION-BASED IMAGE SCANER WITH ADAPTIVE FILTERING

Our original **population-based** image scanner with **adaptive filtering** provides **fast detection** and **accurate localization** of **multiple objects** in each video frame:

$$<x^*, y^*, m^*> = \arg\max_{G_{xy} \cap G_\mu} \{\mu_m(x,y)\},\ m = \overline{1, M},$$

where x, y – coordinates of scanner window, μ_m – fitness-function of population-based search algorithm characterizing probability of an object belonging to m-th class of interest.

Localized objects



Estimated Probabilities – 3D Map

- Our solution, running on a single-board Raspberry Pi, allows to **localize multiple objects** in full HD video stream at **5-10 fps** frame rate
- This rate **exceeds** the result produced by many commonly used algorithms, such as **Sliding Window, RASW** and **Efficient Subwindow Search**

PREDICTION OF PERFORMANCE DEGRADATION

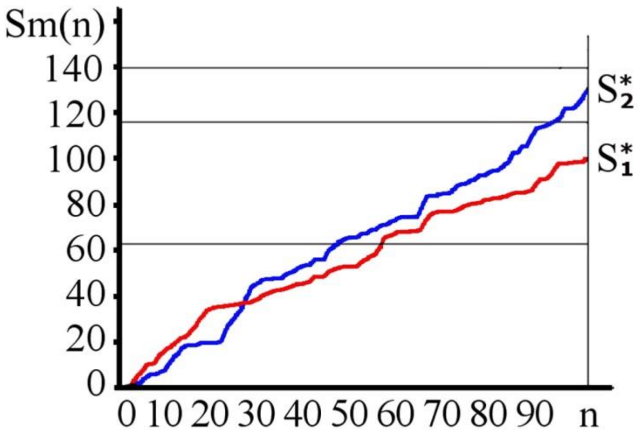
Prediction the time of performance degradation of decision rules using subsequent formation of variational series of **extreme order statistics** (EOS) in training mode and checking EOS extends beyond the variational blocks in operational mode.
Herewith as EOS of the sample set of class X_m^o we consider normalized statistics of the number of entries of the attributes to their multi-level receptive fields for n trials.

$$S_{m,n} = \sum_{j=1}^{n} \left(\frac{k_{m,j} - \bar{k}_{m,n}}{s_{m,n}} \right)^2 ,$$

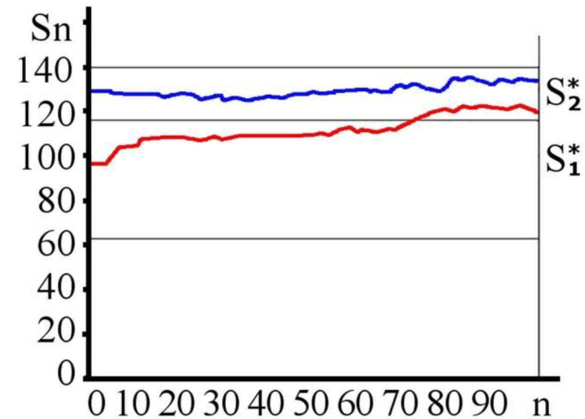
$k_{m,j}$ – is the number of successes at the j–th trial;

$\bar{k}_{m,n}$ – is the sample mean of the number of successes after n trials;

$s_{m,n}^2$ – is the sample unbiased dispersion for n trials.



Graphs of dependence of EOS on the number of trials at the optimal parameters for learning



Graphs of dependence of EOS on the number of periods of examination in the process of growing demand for new services

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- Moskalenko V. **Designing algorithms for optimization of parameters of functioning of intelligent system for radionuclide myocardial diagnostics** / A. Dovbysh, A. Moskalenko, V. Moskalenko, I. Shelehov // Information and controlling system. – Eastern-European Journal of Enterprise Technologies. – 2016. – № 3/9(81). – P. 11 -18.
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