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Bees Local Phase Quantization Feature Selection for RGB-D Facial Expressions Recognition

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- **Introduction**

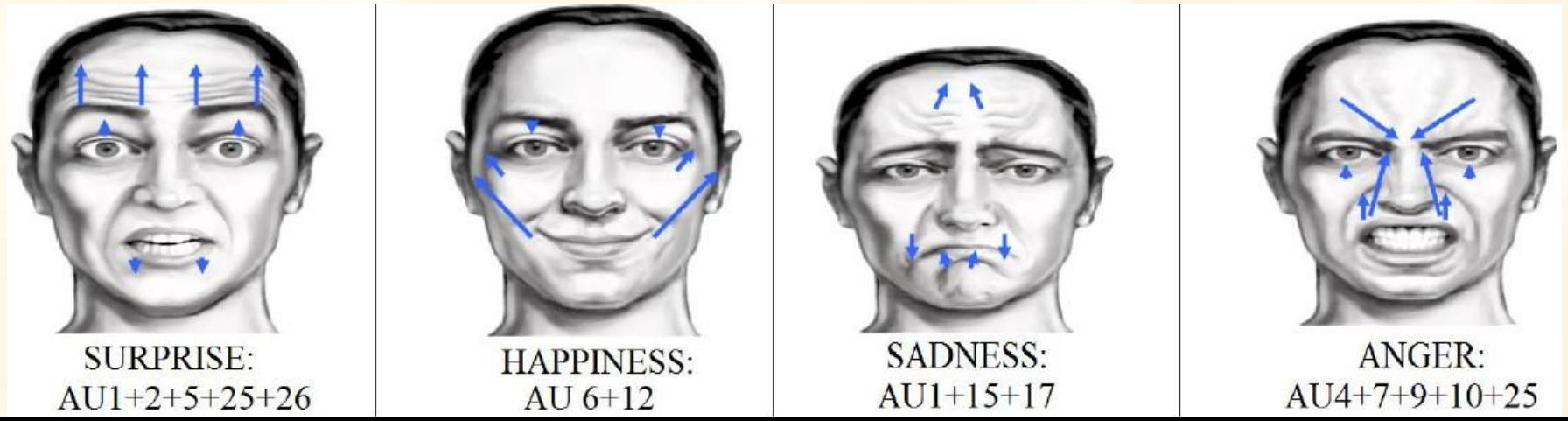
Facial Expressions Recognition

- After face detection and face recognition.
- Facial Expressions Recognition (FER) and Facial Micro Expressions Recognition (FMER).
- Harder than face detection and recognition as they could have micro-movements.
- Differs from one person to another.
- Each expression could be misunderstood in different races as skin wrinkles effects recognition direction.
- Facial expressions are made and calculated by Facial Action Coding Systems (FACS).

- **Introduction**

Facial Expressions Recognition

- Categorized in seven primary facial expressions of Joy, Anger, Disgust, Sadness, Fear, Surprise and Neutral.
- For example, and for Joy expression, Action Units (AU) of 6 + and 12 are involved.
- FMER is FER with more precise calculations as little changes appear on the face.



- **Introduction**

Bio-inspired algorithms

- Bio-inspired algorithms are mathematical models of animals social behavior in a manner that leads problems to an optimal solution.
- These algorithms could be employed in multiple optimization tasks, such as regression, clustering, feature selection, Minimum Spanning Tree (MST), Hub Location Allocation (HLA) and a lot more.
- One of these bio-inspired algorithms which has very high efficiency is called Bees Algorithm (BA) .

- **Introduction**

Bees

- Bees Algorithm, simply implements the social behavior of honey bees to search (in neighborhood manner) for food in flowers.
- Agents, Scouts and Forager bees are involved in global and local search to reach the best solution.
- Waggle dance in done by scouts which found the best sites.
- Those who landed on elite sites, recruit new members.
- List of best bees based on local and global goes to next generation and cycle stopes by termination criterions conditions.

- **Introduction**

Kinect Sensor and Depth Data

- Kinect V.2 is cheap and for educational purposes.
- Color data with 1920*1080 resolutions and Depth data in 512*424 resolutions with 30 (FPS).
- Color data is based on Red, Green and Blue (RGB) channels.
- Depth data is a grey like image which sometimes called 2.5-Dimensional (2.5-D) image.

- **Introduction**

Kinect Sensor and Depth Data

- Each pixel of Depth image in Kinect sensor, represents the distance between Sensor and Subject in millimeters.
- For instance 2000 value in pixels means object is in distance of 2 meters from the sensor.
- Depth images aids color images to increase recognition accuracy.
- As depth images are generated from infrared particles, the Kinect sensor could operate in absolute darkness.

- **Introduction**

Feature Selection

- Is useful In dealing with big data or massive number of samples (specially image samples).
- After the feature extraction step, selecting the most impactful features out of data.
- Feature selection or dimensionality reduction helps to decrease computational time and getting rid of outliers in the dataset.
- Outliers lead classification task into misclassification and removing them is vital.

- **Introduction**

Feature Selection

- In this paper, Bees Algorithm is employed as a feature selection tool.
- Here, the Local Phase Quantization (LPQ) feature is extracted.
- LPQ provides 256 features and Bees feature selection, select less than 128 features without classification accuracy drop.

- *Prior Related Researches*

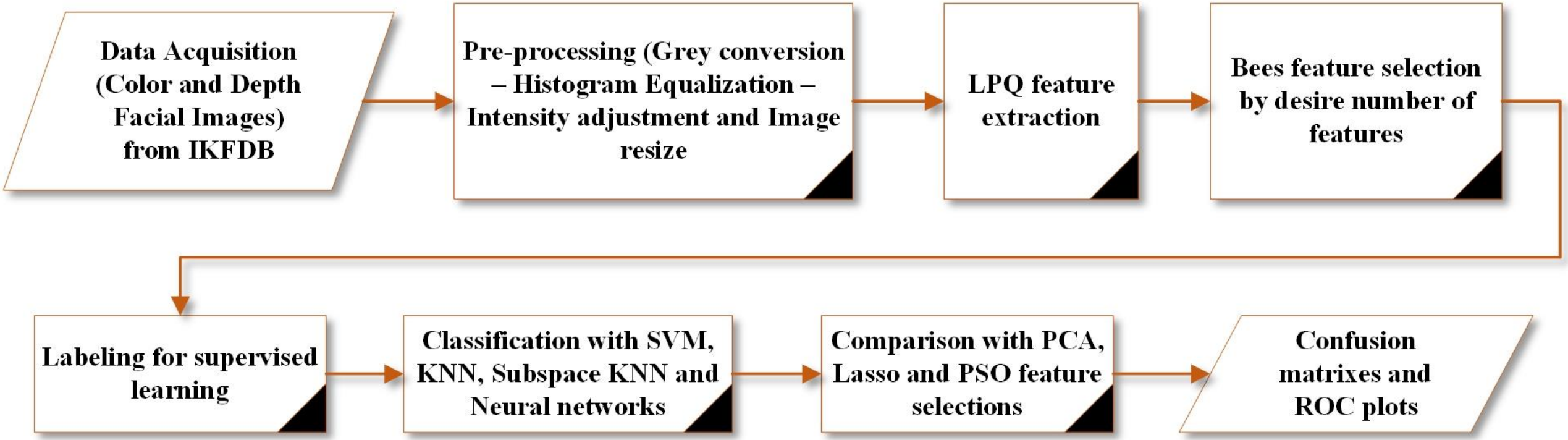
- These algorithms could be applied directly on extracted image or signal features.
- Or could be applied on unfolded version of images, signals or any type of numerical matrix.

- *Prior Related Researches*

- Principal Component Analysis (PCA) (invented by Karl Pearson in 1901) generates new matrixes, named Principal Components (PA).
- Each PA is a linear mixed of the original matrixes.
- By selecting best principles components, best features will be chosen.
- The Lasso (Robert Tibshirani in 1996) is a regularization method for estimating generalized linear models.
- Lasso is a shrinkage approximator: it makes coefficient approximated that are biased to be tiny.
- By shrinking features, best features remain.

- *Prior Related Researches*

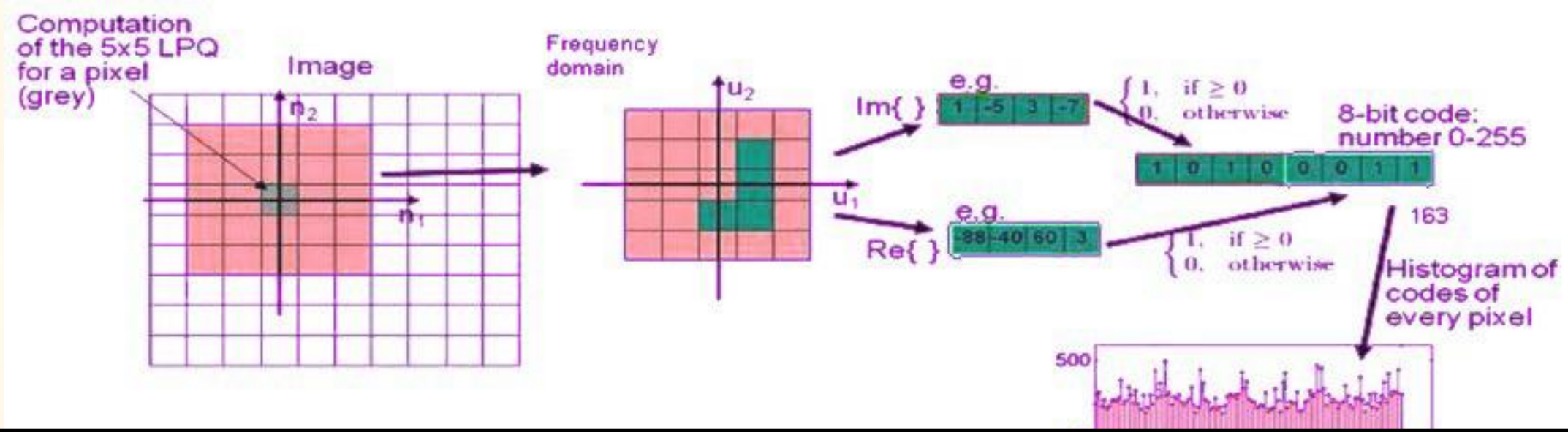
- The chi-square test (Jin, Xin, 2006) is a statistical method employed to contrast observed data and expected ones.
- The objective is to specify if there is any changes between observed data and expected data.
- If the target variable is independent of the feature variable, it is possible to ignore that specific feature.
- If they are dependent, the feature is very significant.
- PSO feature selection
- Firefly feature selection
- Bees feature selection.


Data Acquisition (Color and Depth Facial Images) from IKFDB
Pre-processing (Grey conversion – Histogram Equalization – Intensity adjustment and Image resize
LPQ feature extraction
Bees feature selection by desire number of features
Labeling for supervised learning
Classification with SVM, KNN, Subspace KNN and Neural networks
Comparison with PCA, Lasso and PSO feature selections
Confusion matrixes and ROC plots

- *Proposed Method*

Local Phase Quantization

- LPQ is a frequency neighborhood-based feature based on Fourier transform.
- It manipulated blurring effect in magnitude and phase channels.
- Phase channel is capable of deactivating low pass filters that exists in some images.
- LPQ features is perfect to be use on depth data in frequency domain.



- *Proposed Method*

Bees Feature Selection

- Number of Features of "NF", weight of feature or "w" and Mean Square Error (MSE) [32] which should be minimized to select the feature.
- Also, if x_i are values of NF then, $\hat{x_i}$ would be selected features out of NF.
- So, considering number of features entering the system, "y" would be the output and "t" would be the target.
- In order to calculate final error, e_i need to be calculated which is t_i - y_i .
- So final error is min $MSE = \frac{1}{n} \sum_{i=1}^{n} e_i^2$+w*NF.

- *Proposed Method*

Bees Feature Selection

- This goes for all features and finally those features with lowest MSE will be selected.
- In combination of Bees and feature selection, each feature vector is considered as a bee with different fitness function.
- Those bees which could fit into final iteration would be selected alongside with their related features with lowers error as it mentioned.

- *Proposed Method*

Bees Feature Selection

Start
Load LPQ features
Generating initial population (Features of F)
Define NF (number of features) and w (wight of features)
Evaluating the population based on fitness function
Sorting
While *max iteration is not satisfied*
Select elite patches and non-elite best patches for local search
Recruit forager bees for elite patches and non-elite best patches
Evaluate the fitness value of each patch
Sorting (select NF of F)
Allocate the rest of the bees for global search
Evaluate the fitness value of non-best patches
Sorting (Select NF of F)
End While
Select best first NF's
End

- *Validation and Results*

- IKFDB data is used which is consisted of color and depth frames of seven main facial expressions for this experiment.
- Here 1000 color and depth samples of five expressions (each 200 samples) are used.
- Comparison would be between proposed Bees LPQ, PSO LPQ, PCA LPQ, Lasso LPQ and solo LPQ.
- SVM, KNN, Shallow Neural Network and Ensembles Subspace KNN classification algorithms.

- *Validation and Results*

Algorithm	Bees	PSO
Iteration	100	100
Population	10 Bees	20 Particles
Decision Variable	20	20
Decision Variable Size	[1, 20]	[1, 20]
Lower Bound (LB)	-10	-10
Upper Bound (UB)	10	10
Mutation Rate	0.2	0.2
Inertia Weight	-	1
Inertia Weight Damping Ratio	-	0.99
Personal Learning Coefficient	-	1.5
Global Learning Coefficient	-	2
Selected Sites (SS)	Bees * 0.5	-
Select Elite Sites	SS * 0.4	-
Recruited Bees for Selected Sites	Bees * 0.5	-
Recruited Bees for Elite Sites	SS * 2	-
Neighbourhood Radius	0.1 * (UB – LB)	-
Neighbourhood Radius Damp Rate	0.2 0.96	-

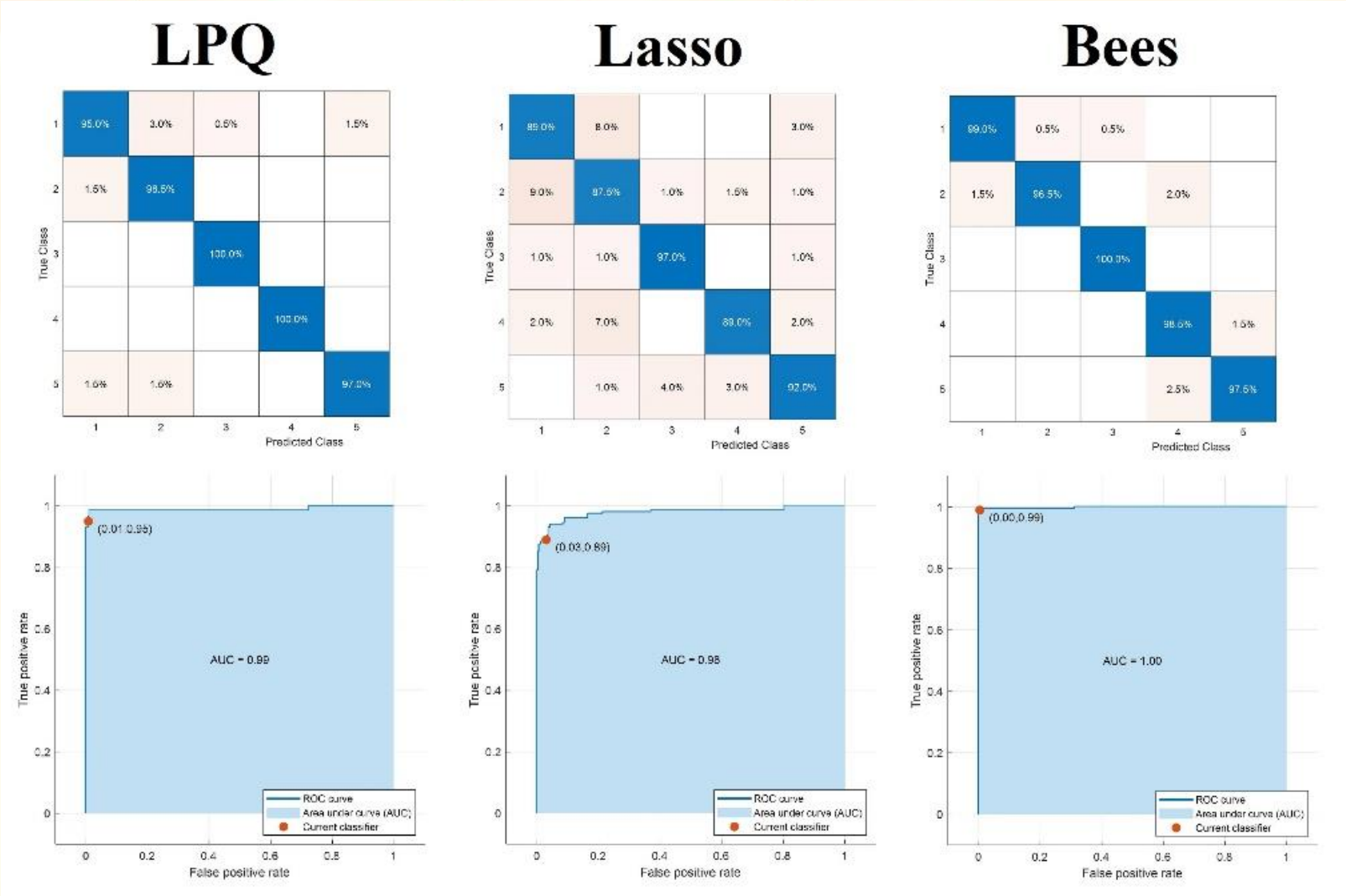
- *Validation and Results*

	LPQ	PCA	Lasso	PSO	Bees
SVM	256 : 98.8 %	128 : 98.4 % 64 : 98.0 % 32 : 90.8 %	128 : 90.6 % 64 : 89.3 % 32 : 84.5 %	128 : 99.1 % 64 : 98.6 % 32 : 97.4 %	128 : 99.6 % 64 : 98.9 % 32 : 97.3 %
KNN	256 : 98.0 %	128 : 98.1 % 64 : 97.9 % 32 : 97.5 %	128 : 93.0 % 64 : 93.9 % 32 : 92.8 %	128 : 98.8 % 64 : 98.2 % 32 : 97.6 %	128 : 99.2 % 64 : 98.1 % 32 : 97.7 %
Shallow NN	256 : 97.6 %	128 : 97.3 % 64 : 96.6 % 32 : 95.8 %	128 : 96.7 % 64 : 90.7 % 32 : 91.2 %	128 : 99.1 % 64 : 97.8 % 32 : 96.9 %	128 : 99.4 % 64 : 98.7 % 32 : 97.9 %
Ensemble Subspace KNN	256 : 98.3 %	128 : 97.9 % 64 : 97.7 % 32 : 98.1 %	128 : 95.6 % 64 : 93.1 % 32 : 89.1 %	128 : 99.5 % 64 : 98.3 % 32 : 98.0 %	128 : 99.8 % 64 : 98.9 % 32 : 98.5 %

- *Validation and Results*

SVM

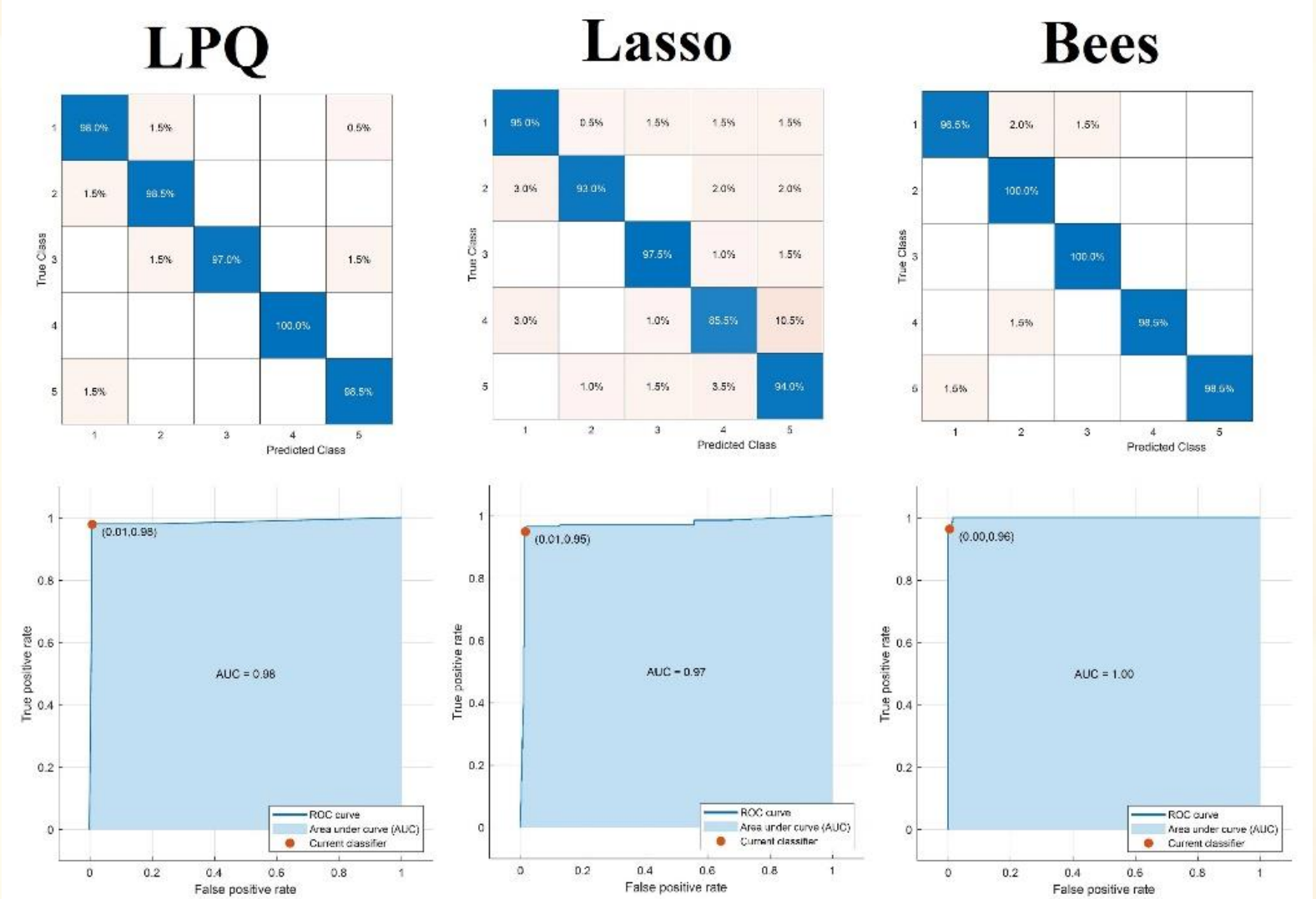
LPQ = 256 feature
Lasso= 64 Features
Bees = 64 Features



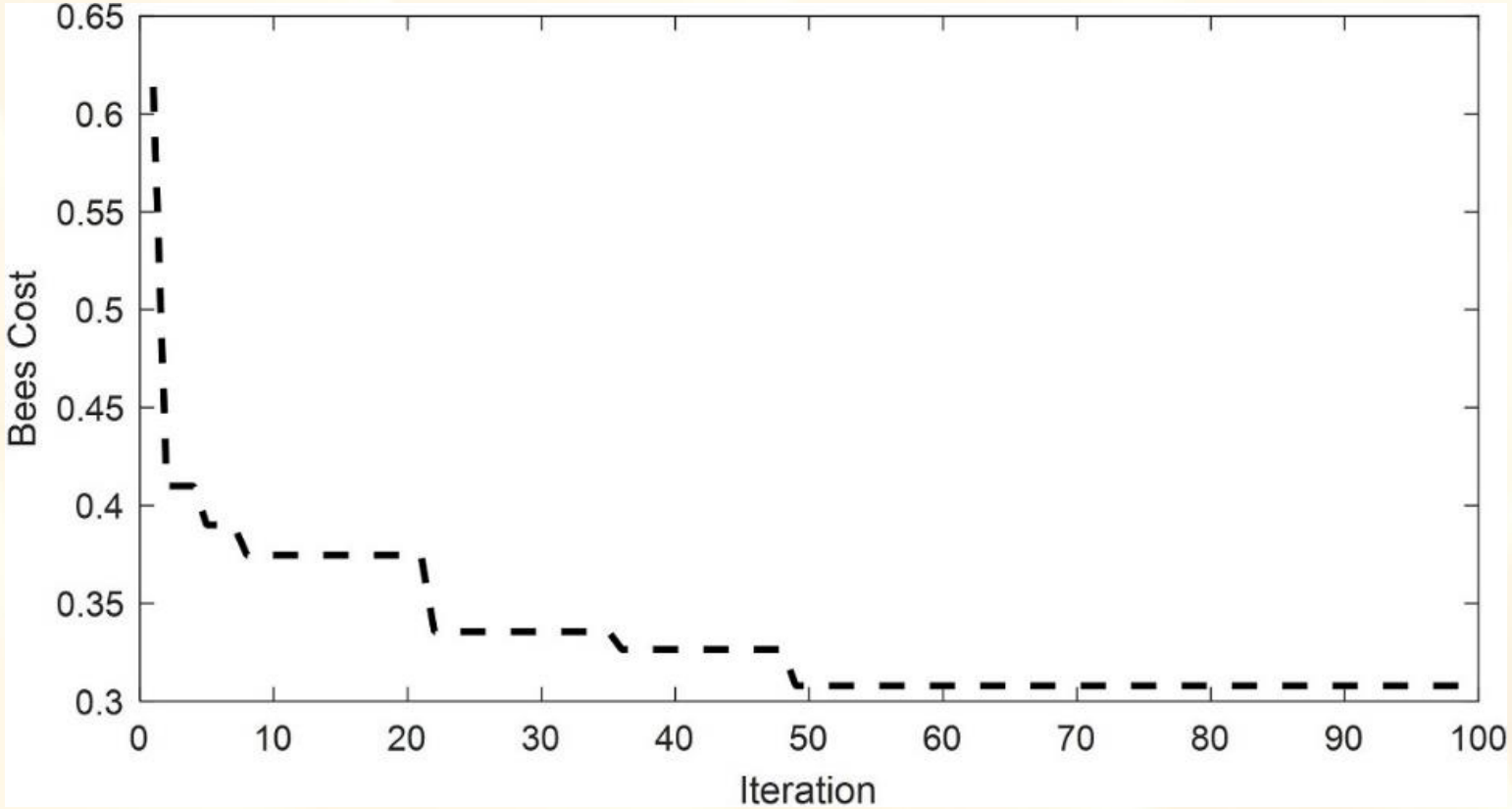
- *Validation and Results*

KNN

LPQ = 256 feature
Lasso= 64 Features
Bees = 64 Features



- *Validation and Results*



- *Conclusion and suggestions*

- Employing bio-inspired algorithms for feature selection task could perform better than traditional feature selection algorithms in face analysis and especially facial expressions recognition task.
- Defining feature selection cost function for Bees algorithm returned successful results for all four classification algorithms.
- It can be concluded, Bees algorithm has great impact in feature selection optimization
- However, run time increases
- Bees algorithm with using just a quarter of features, could reach to a point which traditional algorithms are not capable of.
- Using proposed method on more facial expressions and in other face analysis tasks such as face recognition is of future works.
- It is suggested to use proposed method with more classification algorithms like tree, bayes.
- It is suggested to comparing with more traditional and bio-inspired feature selection techniques such as fisher, GA and more.

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Thank you for your Attention

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