**An ensemble-based system for automatic screening of diabetic retinopathy**

***Hangi data’yi kullanmislar?***

Bantal et al. used publicly available MESSIDOR database which includes 1200 images. In this database, there are 3 size of images which are 440 x 960, 2240 x 1488 and 2304 x 1536 pixels. In Messidor databse there also information of grading score provided. Every image graded from R0 to R3. With grade R0 means that the patient does not have DR. R1 and R2 are mild and severe cases and if a patient has R3 it means that this is a serious condition of DR.

R0 – 540 46%

R1 – 153 12.75%

R2 – 247 20.58%

R3 – 260 21.67%

***Hangi yontemleri uygulamislar?***

Based on features extracted from the output of several retinal image processing algorithms:

* Image-level
* Lesion specific
* Anatomical

They firstly classified images based on characteristic features extracted by lesion detection and anatomical part recognition algorithms.

Afterwards, with ensemble of classifiers they have classified these features.

Components of their research are image-level, lesion-specific and anatomical

Image-level: In image level, they have used HM Random Fields for vessel segmentation.

As pre-screening they have classified images as severely diseased(abnormal) ones or to be forwarded for further processing. Each image, partitioned to disjoint regions and a simple texture descriptor is extracted for each region. Afterwards, based on these features a ML classifier is trained to classify these images. With signal processing techniques, the green channels of the images decomposed in to different representations.

Lesion-specific: MA and exudate detection

Anatomical: Macula and optic disc detection. For macula, their method is extracting the largest component from the image which is darker than its surroundings.

For selecting ensembles several wel-known classifiers are trained. These classifiers are

* Alternating Decision Tree
* kNN
* AdaBoost
* Multilayer Perceptron
* Naïve Bayes
* Random Forest
* SVM
* Pattern classifier

To choose best subsets of classifier several approaches tested which are Forward Search, Backward Search, All and Single Best.

With FWD search, after choosing the best individual classifier further classifiers are added if performance of the ensemble increases till the no further increase of performance. With BWD search, started with all the classifiers are considered as members of the ensemble and afterwards classifiers started to removed from the ensemble if the performance increases. In single best, only the best performing classifier chosen and for all as understand from the name, all classifiers are member of the ensemble.

Extracted features are as follows:

X0 is the result of quality assessment. Real number, between 0(worst) and 1(best).

X1 is a binary value which shows result of pre-screening. 1 – severe retinal abnormality and 0 its lack.

X2-X7 represent the result of MA detection. Xi, i represents number of MAs at the confidence levels…….

X8 – X16 this time it is for exudates. They are normalized by dividing the number of lesions with diameter of the ROI to compensate different image sizes.

X17 Euclidian distance of the centre of the macula and the centre of the optic disk.

X18 non-negative scalar indicating the confidence of the detection of DR; larger-higher probability that DR is present.

***Neyle test etmisler? Sonuclari neler?***

For disease/no-disease results are 90% sensitivity, 91% specificity, 90%accuracy and 0.989 AUC.

For ensemble selection Sensitivity, Accuracy and F-score energy functions are chosen.

10-fold cross-validation have been used for both the training phase and for the evaluation of the ensembles.

To compare their results with others they have fitted Reciever Operating Characteristic curves to the results and calculated AUC using JROCFIR.

They have 2 scenarios for evaluating ensemble creation strategies:

R0 vs R1

And

R0 vs {R1, R2, R3} = No DR vs DR

For R0 vs R1 best performing ensemble achieved 94% Sensitivity, 90% Accuracy, 90% Specificity using backward search, output fusion strategy Davg and energy function *Accuracy.*

No DR vs DR; 90% Sensitivity, 91% Specificity and 90% Accuracy with same search method and fusion strategy but different energy function which is Sensitivity.