Effective Brain Hemorrhage Diagnosis from Image Using Machine Learning Approach

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Introduction

- Cerebrovascular diseases or brain hemorrhages are the third major death causing diseases in the world after cancer and heart diseases.
- There are three different types of brain hemorrhages which includes: epidural, subdural, and intraparenchymal hemorrhage.
- We propose a machine learning based approach for a computer-aided detection and diagnosis (CAD) system, to detect the existence and type of hemorrhages in human brains from the computed tomography (CT) scan images.

Data set

- The dataset used in this study consists of 100 human brain CT images:
  - 25 of these images represent normal brain
  - 25 images belong to Epidural Hemorrhage type
  - 25 images belong to Subdural Hemorrhage type and
  - 25 images belong to Intraparenchymal Hemorrhage type.
- The images were obtained from King Abdullah University Hospital in Irbid, Jordan.

Flowchart

Types of Brain Hemorrhage

Brain Hemorrhage Detection and Classification Steps

Image Processing

- Image processing involves conversion of the image from RGB to gray scale
- After the conversion, the image will contain pixel intensities in the range between 0 and 255.
- Next, the peripheral area is identified if the pixel value is greater than 240.

Image Segmentation

- The digital image is segmented into multiple regions based on a defined threshold.
- Irbou’s method is used to divide the pixels of an image into several classes, which automatically finds a threshold to minimize the within class variance.
- It basically looks at the histogram, pixel values, and the probability in order to obtain a segment.

Mathematical morphology is a technique used to analyze images by processing geometrical structures.
- It is widely used in digital images, graphs, etc. Mathematical morphology involves two basic operations:
  - Erosion, which is eroding away the boundaries of foreground.
  - Dilation, which is enlarging the boundaries of foreground pixels.

Morphological Operations

- We used the opening operation, which consists of an erosion operation followed by a dilation operation, which is used to filter out the small parts in the image that do not contain the suspicious region.
- A ⊗ B = (A ⊖ B) ⊕ B.

Region Growing

- A region growing algorithm is used to obtain the whole mass.
- Region growing starts with a seed region and grows it by appending to it those neighboring pixels that have properties similar to the seed region.
- The seed region used here is the result of the previous step.

Features

Table 1: Comparison of different machine learning methods

<table>
<thead>
<tr>
<th>Name of Models</th>
<th>Name of Features in ROI</th>
<th>Name of Features in Subimage</th>
<th>Evaluation Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM22</td>
<td>17</td>
<td>29</td>
<td>ACC 0.97</td>
</tr>
<tr>
<td>SM23</td>
<td>17</td>
<td>33</td>
<td>0.96</td>
</tr>
<tr>
<td>SM24</td>
<td>17</td>
<td>33</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Classification Methods

We evaluated several combination of the base-classifiers. The choice of base-classifiers is made such that the underlying principle of learning of each of the classifier is different from one other. Furthermore, the classifier that yields the highest performance among all the other individual classifiers is used in both the base as well as the meta-layer. Finally the stacking model that yields the highest performance is selected as the final predictor of brain hemorrhage types. A set of stacking models evaluated are listed below.

1) SM1: KNN, LogReg, BAG in base-layer and SVM in meta-layer.
2) SM2: KNN, LogReg, Bag, SVM in base-layer and SVM in meta-layer.
3) SM3: KNN, LogReg, ET, SVM in base-layer and SVM in meta-layer.
4) SM4: KNN, LogReg, RBF, SVM in base-layer and SVM in meta-layer.

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