An ENAS Based Approach for Constructing Deep Learning Models for Breast Cancer Recognition from Ultrasound Images

Mohammed Ahmed, Hongbo Du, Alaa AlZoubi

School of Computing, University of Buckingham, UK
{1200526, Hongbo.du, alaa.alzoubi}@Buckingham.ac.uk

MIDL 2020
Introduction

Background

• Widespread use of handcrafted CNN architectures (AlexNet, VGGNet, GoogLeNet, ResNet, etc.)
• CNN architectures: hard to design
• Recent Development: automatic architecture search
  ▪ Neural Architecture Search (NAS)
  ▪ Efficient Neural Architecture Search (ENAS)

Aim of the Study

To Investigate effectiveness of ENAS for breast cancer recognition from US images
Methods

Hyperparameter setting for Searching:
- Batch size = 8
- Image size = 100 x 100
- Other hyperparameter settings: the default values of ENAS

Hyperparameter setting for final CNN Model:
- Batch size = 8
- No. of epochs = 100
- Image size = 100 x 100
- Other hyperparameter settings: the default values of ENAS

Layers in final architectures:
- ENAS 17 (5*N, R, 5*N, R, 5*N)
- ENAS 7 (N, R, N, R, 3*N)

Optimal cells (Norman and Reduction) generated by ENAS for Breast Cancer classification.
Data and Results

Dataset

• Ultrasound images for breast lesions (262 Benign and 262 Malignant images)
• Different US machine makes

Data Preparation

• Manual cropping of RoI by radiologist
• Training data augmentation:
  ▪ Geometric Methods: Rotation (90, 180 and 270), and Mirroring
  ▪ Singular Value Decomposition (SVD) (25, 35 and 45)
• Bicubic Resizing (100×100)

<table>
<thead>
<tr>
<th>Models</th>
<th>TNR</th>
<th>TPR</th>
<th>PR</th>
<th>Accuracy</th>
<th>#Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENAS 17</td>
<td>86.7%</td>
<td>92.0%</td>
<td>87.5%</td>
<td><strong>89.3%</strong></td>
<td>4,251,780</td>
</tr>
<tr>
<td>ENAS 7</td>
<td>90.9%</td>
<td>86.7%</td>
<td>91.0%</td>
<td>88.8%</td>
<td><strong>2,342,484</strong></td>
</tr>
<tr>
<td>AlexNet</td>
<td>51.6%</td>
<td>48.5%</td>
<td>50.0%</td>
<td>50.0%</td>
<td>56,858,656</td>
</tr>
<tr>
<td>CNN3 [1]</td>
<td>80.5%</td>
<td>75.6%</td>
<td>84.0%</td>
<td>78.1%</td>
<td>619,202</td>
</tr>
</tbody>
</table>

Examples of ultrasound images with labeled region of interest
Concluding Remarks

• Conclusion:
  ▪ Investigated the efficacy of the ENAS approach for designing CNN architectures for breast lesion classification from US.
  ▪ Demonstrated that the ENAS technique reduces human interventions in CNN architecture design.
  ▪ The optimized architectures lead to more accurate classification yet simpler models than hand-crafted alternatives for breast lesion classification.

• Future work:
  ▪ Evaluating ENAS models on external datasets
  ▪ Exploiting ENAS architectures for other types of tumors/lesions from ultrasound images