MIALab Project HS2020

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***Abstract*—Here is the abstract.**

I. Introduction

Postprocesses of clinical diagnosis images for treatment planning often include manual segmentation of brain regions. To segment and label the brain structures in a large dataset is complicated and time-consuming by manual operator-guided segmentation. Furthermore, it is affected by user variability and prone to limiting the standardisation. This paper will depend upon automated segmentation that segments and labels five different brain regions.

To conclude we hypothesis that normalization has an important influence in the segmentation process of brain regions. We present in this paper the acquired results applying multiple normalization methods and comparing them for every segmented brain region. Furthermore, we analyse the results and conclude our findings.

Our hypothesis: "Image normalization has an important influence on the segmentation". Aims of the introduction:

- **To demonstrate importance/impact need**
- **To demonstrate novelty**
- **To justify the hypothesis / aims / investigated technology**
- **To establish expectations/scope of the report**

Some questions which could be answered: Currently, z score normalization is implemented.

- **Are there more powerful normalization methods?**
- **Is normalization really needed?**
- **Is the provided data already normalized in some way?**
- **Can you also unnormalize data to show a negative effect?**

For the research:

- **Understand the problem**
- **What have others already done / is there already a solution?**
- **Can I apply a solution to another problem to my problem?**
- **What lessons can I learn from others work?**
- **What deficiencies exist in others work?**

1) **Demonstrate importance**
   a) **Define the problem**
   b) **Explain the criticality, impact of the problem**
2) **Demonstrate Novelty**
   a) **Explain what is the state of the art / current practice**
   b) **Explain what preliminary / related work has been done towards solving the problem by you and others**
   c) **Explain what deficiencies / problems still exist (specifically the one that you will try to address)**
3) **Present and Justify the Hypothesis / aim / objective**
   a) **State Hypothesis /aim/ objective**
   b) **Describe evidence supporting hypothesis**
4) **Establish expectations of the report**
   a) **Describe scope of the presented work**
   b) **Present a summary of remainder of the report**

II. Methodology

A. Medical Backgrund

The five brain regions segmented in this paper are the white and grey matter, hippocampus, amygdala and the thalamus. All regions are visible in Figure 1.

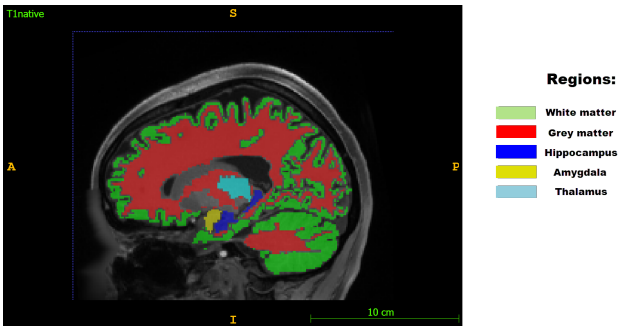


Fig. 1: All brain regions

B. Data

The data we used was provided by the Medical Image Analysis Lab team at the University of Bern. Overall, our dataset consists of 32 MRI, out of which 21 we used for training and 11 for testing our model. From each patient we have a T1-weighted and a T2-weighted image. Each MRI file is of the size 118x118x217.

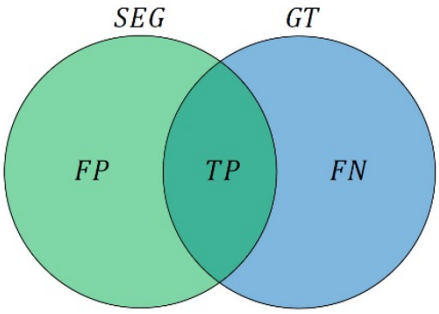
C. Model

The model we used is a Random Forest classifier with which we combined different parameters with all used normalization techniques. Which parameters lead to which result can be found in the results section. For normalization techniques, we used the following:

- zScore
$$z = \frac{x - \mu}{\sigma} \tag{1}$$
- minMax
$$z = \frac{x - x_{min}}{x_{max} - x_{min}} \tag{2}$$
- stikN
- Whitestripe
- Fuzzy-C means
  With fuzzy c-means we find a mask for a specified tissue type given a T1w image and its brain mask. Create a tissue mask from that T1w image's FCM tissue mask. Then we can use that tissue mask as input to the func again, where the tissue mask is used to find an approximate mean of the tissue intensity in another target contrast, and move it to some standard value.
- Histogram Matching
- Gaussian Mixture Model

D. Evaluation

For this paper, we evaluated our used normalization techniques on our inhouse T1-weighted and T2-weighted MRI data sets. We chose the Dice Similarity Coefficient (DCS) as well as the Hausdorff distance to evaluate the different normalization techniques. Dice Similarity Coefficient returns as a quality metric how much two regions overlap and is, therefore, a useful metric for segmentation. The dice coefficient of two sets is a measure of their intersection scaled by their size. The result is in the range from 0 to 1, where 1 is a perfect segmentation.



$$DICE(SEG, GT) = 2\frac{|SEG \cap GT|}{|SEG| + |GT|}$$

Fig. 2: Graphical representation of the Dice Similarity Coefficien. SEG stands for the achieved segmentation whereas GT means ground truth.

The Hausdorff distance measures how far two subsets of a metric space are from each other. So two sets are close if every point of either set is close to some point of the other set. Then the Hausdorff distance is the longest distance from one of the two sets to the other set.

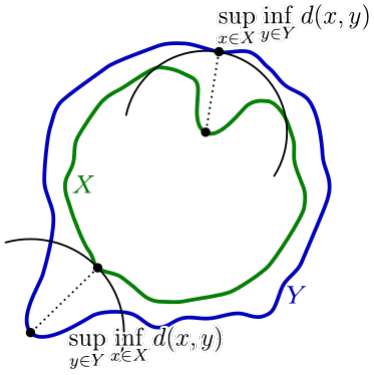


Fig. 3: Components of the calculation of the Hausdorff distance between the green line X and the blue line Y.

III. Results

A. Data

B. Model

C. Evaluation

IV. Discussion

Aims of the Discussion part:

- **Highlight importance of your work (highlight novelty /impact etc**
- **To interpret your results in relation to your original problem**
- **To put your work into the context of existing work**
- **To present any limitations of the presented work**
- **To make future recommendations**
- **To provide a conclusion of the work**

1) **Importance of the work**
    a) **Summarise your results**
    b) **Reiterate the importance of the work (novelty , impact etc)**
2) **Interpretation of results**
    a) **Interpret your results focussing on the problem described in the introduction. What do the results mean for the described problem?**
    b) **Explain any unusual/important findings (be careful if not your original investigative subject)**
3) **Provide context**
    a) **Describe your results in relation to others and try to explain any discrepancies**
    b) **Emphasize how your results support or refute your hypotheses current thinking in the field. Were results as expected? If not why and what does this mean?**
4) **Limitations of your work**
    a) **Describe any limitations /deficiencies of your work and what impact they have on the findings**
    b) **Suggest possible future solutions**
5) **Conclusions**
    a) **Summarise your findings and relate your findings back to your hypothesis / aim / objective and to your problem.**
    b) **Based on your findings, suggest next steps towards solving your problem**

V. Conclusion

References

[1] Test reference 1
[2] Test reference 2