Relevance-guided Feature Extraction for Alzheimer's Disease Classification

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Synopsis

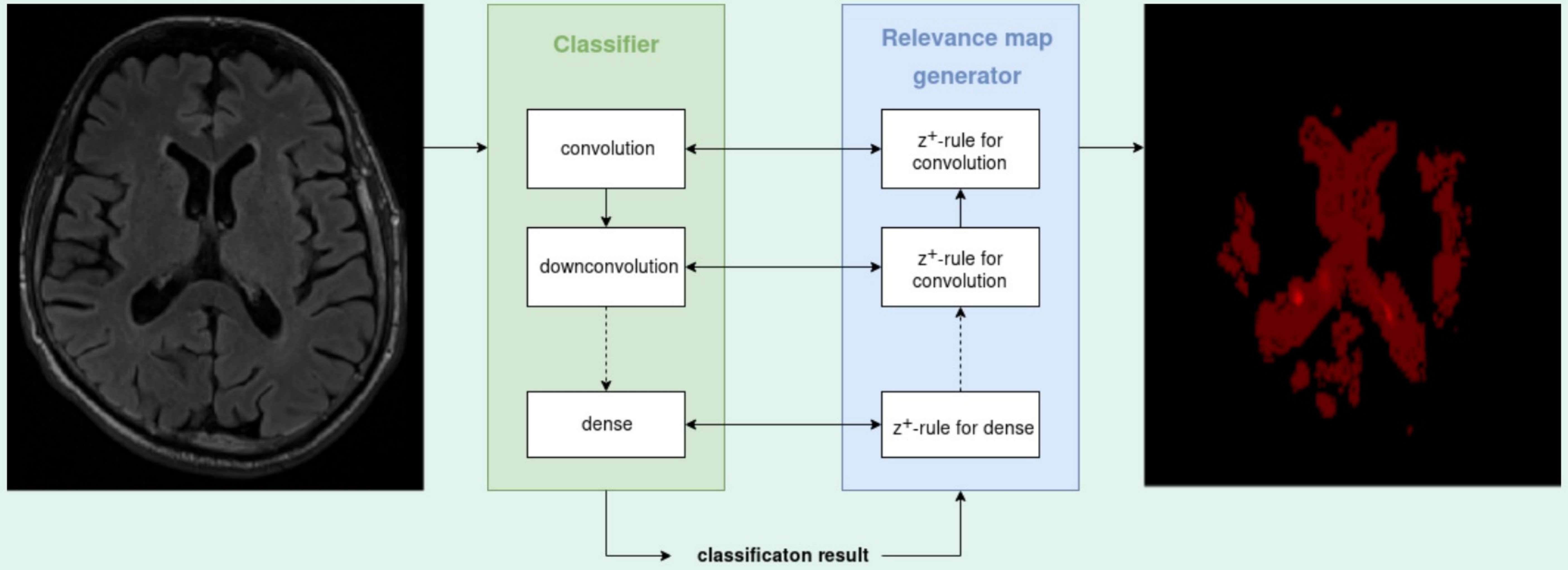
Using FLAIR images we separated Alzheimer's patients (n=106) from controls (n=173) by using a **deep convolutional neural network** and found that the classifier might learn **irrelevant features**.[1,2]

Preprocessing of MRI plays a crucial but often neglected role in classification and therefore we have developed a method **enforcing the relevant features to be within brain tissue**.

While our relevance-guided training method reached the same classification accuracy (around 85 %), incorporating relevance **improved feature identification in an anatomically more reasonable manner**.

Methodology

Illustration of the proposed network architecture



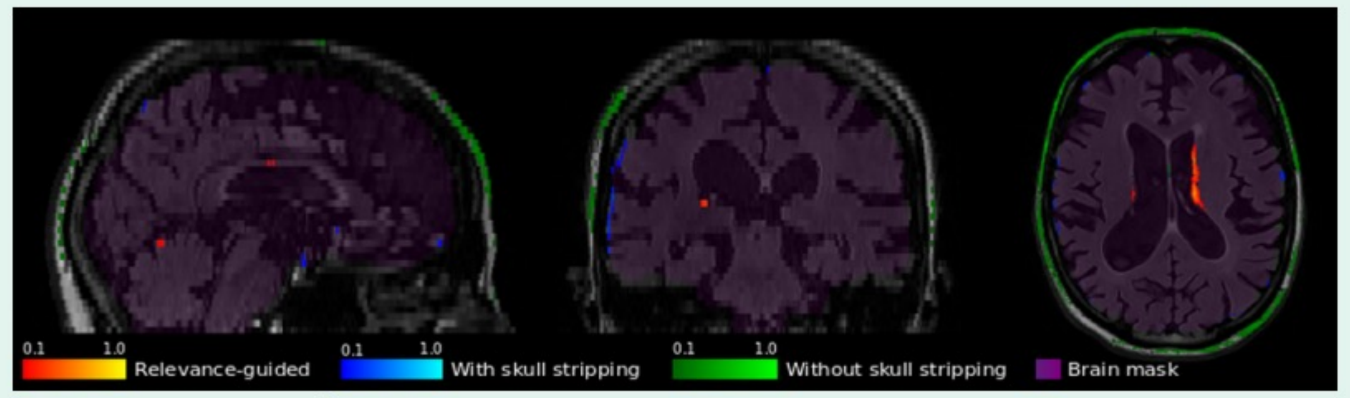
Extension to the classifier's loss function

$$loss_{relevance}(\mathbf{R}, \mathbf{M}) = -\mathbf{1}^T \operatorname{vec}(\mathbf{R} \odot \mathbf{M})$$

$\mathbf{R}$ denotes the relevance map, $\mathbf{M}$ is a predefined mask, $\operatorname{vec}(\mathbf{A})$ denotes the row major vector representation of $\mathbf{A}$, and $\mathbf{1}$ is a vector where all elements are set to one.

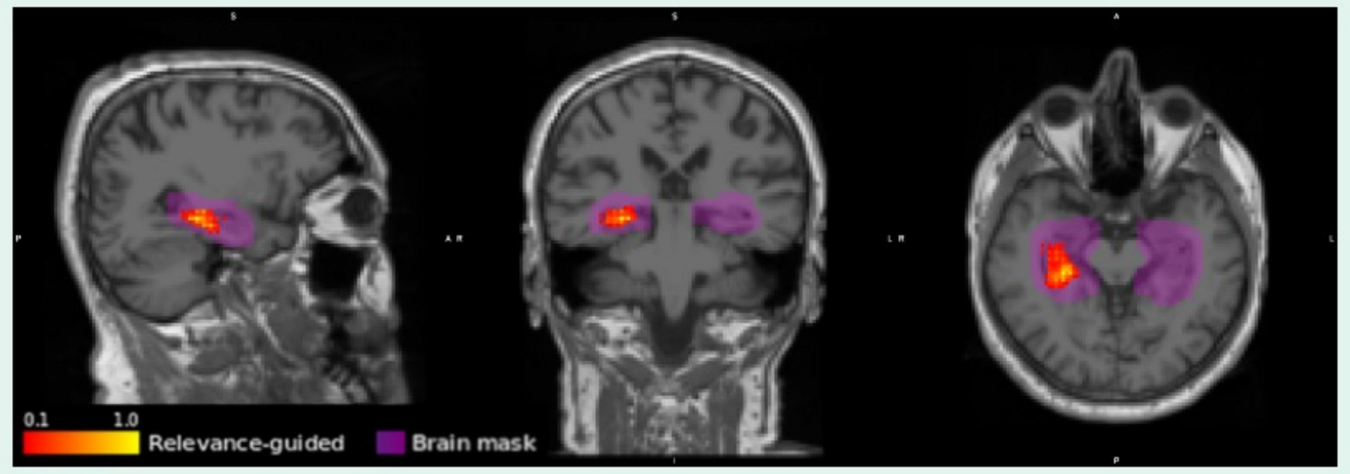
Experiments

Extracted features



0.9x0.9x3mm^3, TR/TE/TI=10s/70ms/2500ms, 44 slices

Relevance maps created using FLAIR image and brain mask.[3]



Relevance map created using T1-weighted image and hippocampi mask.[3]

References

[1] Liu S, et al.: Early diagnosis of Alzheimer's disease with deep learning. 2014 IEEE 11th International Symposium on Biomedical Imaging (ISBI). IEEE. 2014; 1015–1018.
[2] Samek W, et al.: Evaluating the Visualization of What a Deep Neural Network Has Learned. IEEE Trans Neural Netw Learning Syst. 2017;28: 2660–2673.
[3] Montavon G, et al.: Explaining nonlinear classification decisions with deep Taylor decomposition. Pattern Recognit. 2017;65: 211–222.

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