

BINARY GLIOMA GRADING: RADIOMICS VERSUS PRE-TRAINED CNN FEATURES

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Abstract

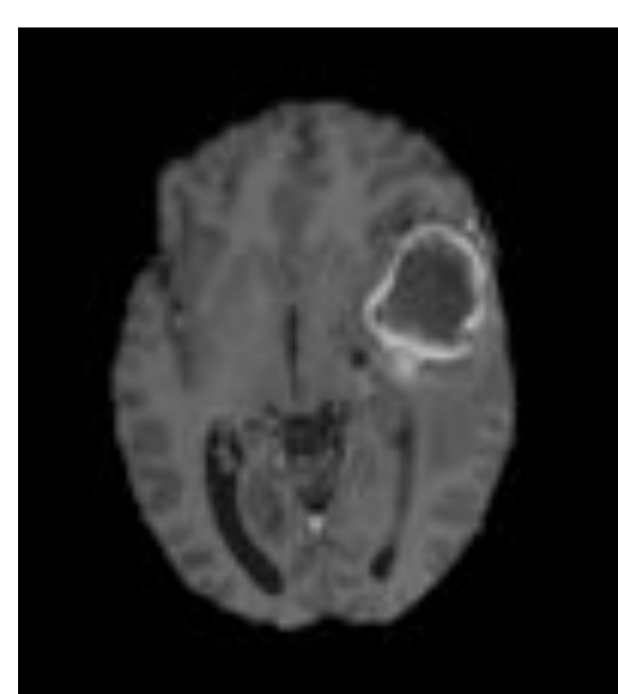
We compare the predictive performance of hand-engineered radiomics features with features extracted through a pre-trained CNN for discriminating glioblastoma from lower-grade glioma. The BRATS 2017 database was used containing MRI data of 285 patients. State-of-the-art performance was achieved (AUC of 96.4%) with radiomics features extracted from manually segmented tumour volumes. With pre-trained CNN features extracted from the tumour bounding box, an AUC of 93.5% was obtained.

Introduction

- Determining glioma malignancy is highly important for initial therapy planning
- Biopsies negatively impact overall survival
- Need for noninvasive, accurate, automatic, reproducible and robust CAD systems

Materials and methods

MICCAI BRATS 2017 Database
210 GBM + 75 lower-grade tumours

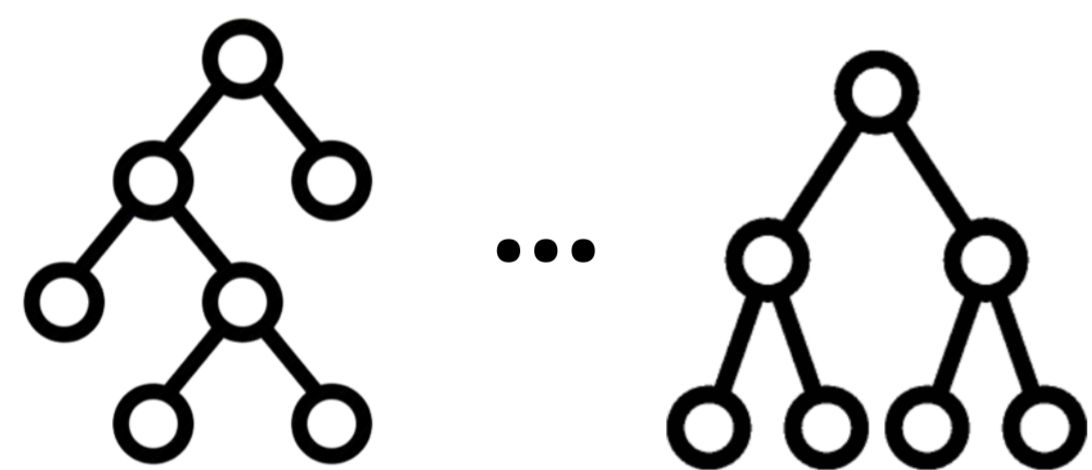


T1ce



Segmentation Labels

Random Forest Classification

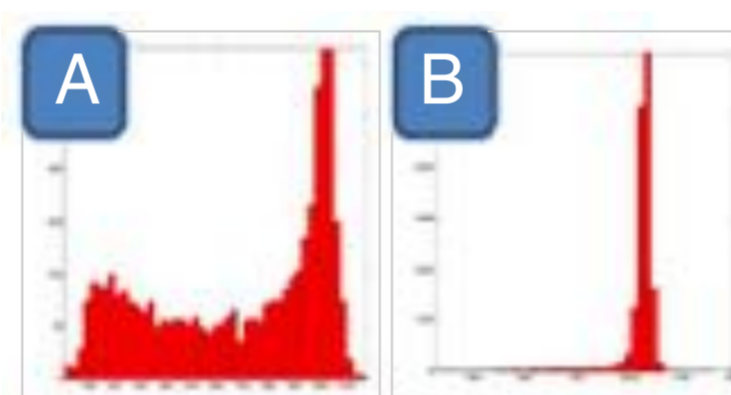


Slice level prediction: no tumour, LGG, GBM

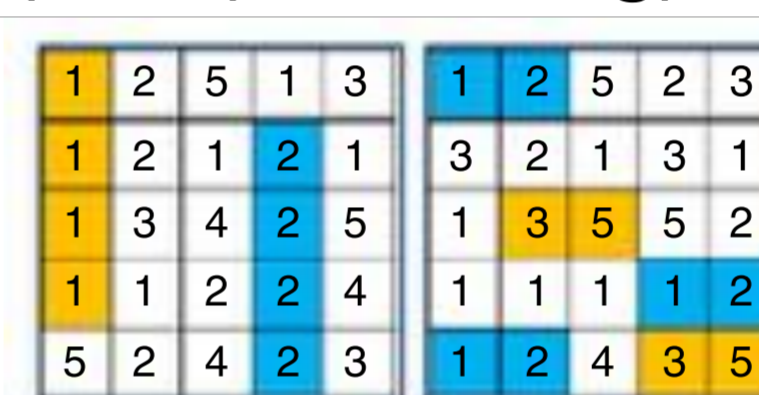
Mean probability for each patient

1. Feature Extraction: Radiomics

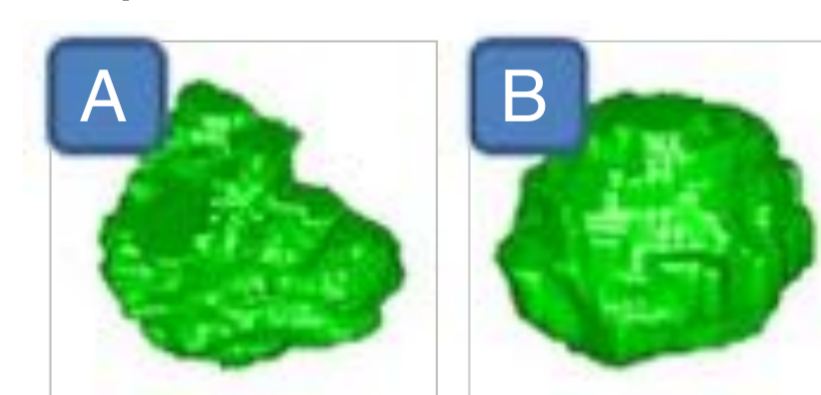
207 quantitative features for each of 5 tumour regions:
Total abnormal, core, enhancing, necrosis, oedema



Tumour Intensity



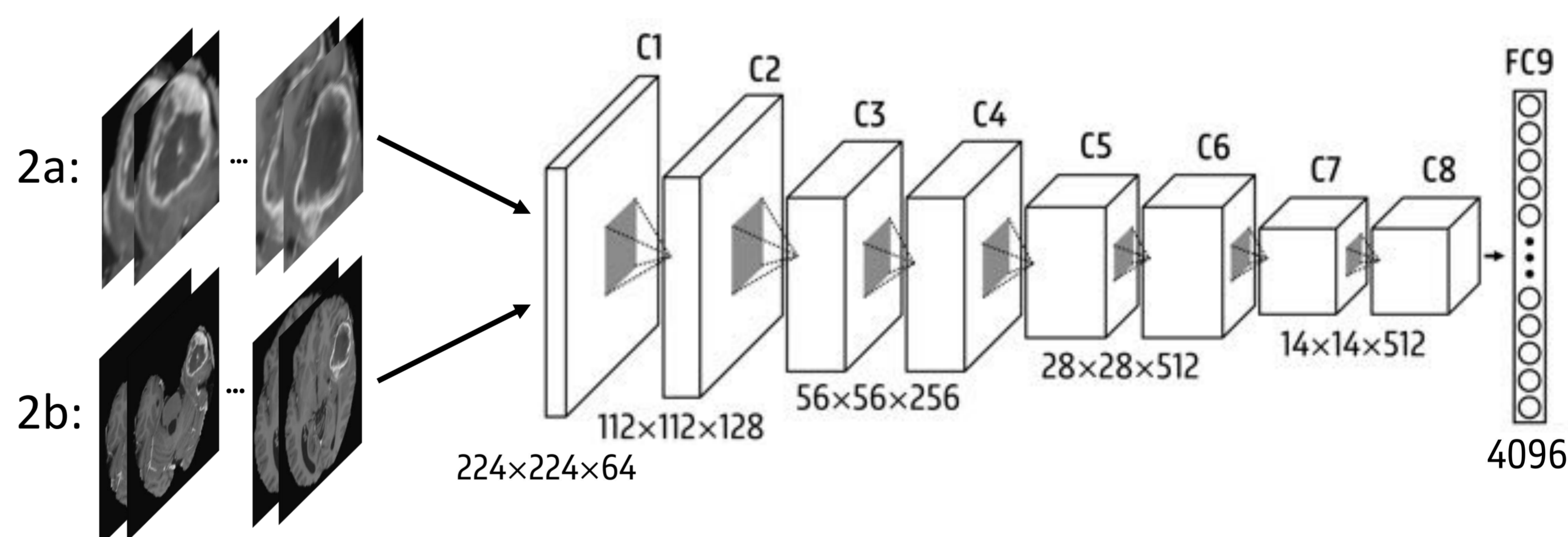
Tumour Texture



Tumour Shape

2. Feature Extraction: VGG-11 network pre-trained on ImageNet

2a: CNN applied on Tumour Bounding Box | 2b: CNN applied on Full Slice



Results and Discussion

- State-of-the-art performance
- AUC of 93.5% while only requiring a bounding box around the tumour.
- No tissue segmentation necessary

| | AUC | Acc. | Sens. | Spec. |
|-----------|-----------|-----------|-----------|-----------|
| Radiomics | 96.4(2.6) | 89.6(3.8) | 89.9(5.4) | 88.8(8.6) |
| CNN 2a | 93.5(3.0) | 86.1(4.3) | 85.4(5.4) | 88.5(8.1) |
| CNN 2b | 91.1(3.6) | 82(5.3) | 81.5(7.2) | 83(9.6) |

Conclusion

- Best performance with radiomics, but requires accurately segmented tumour tissues
- With a pre-trained CNN, an accurate, automatic and robust binary grading system could be designed

References

- [1] K. B. Ahmed, L. O. Hall, D. B. Goldgof, R. Liu, and R. A. Gatenby, "Fine-tuning convolutional deep features for MRI based brain tumor classification," 2017, p. 101342E.
- [2] B. H. Menze *et al.*, "The Multimodal Brain Tumor Image Segmentation Benchmark (BRATS)," *IEEE Trans. Med. Imaging*, vol. 34, no. 10, pp. 1993–2024, Oct. 2015.