

# ARTIFICIAL INTELLIGENCE ENABLED CLASSIFICATION OF HEMATOXYLIN & EOSIN STAINED GLIOMA WHOLE SLIDE IMAGES

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## INTRODUCTION

- Gliomas are the most malignant type of brain tumours arising from the glial cells.
- Early diagnosis and grading of tumours are very important in increasing the chance of successful treatment and improved patient's prognosis.
- Histopathological examination of tumour tissues is currently the gold standard for diagnosis of gliomas; however, distinguishing the grade of tumours is challenging due to the heterogeneous characteristics of the tissue and and to pathologist's' intra- and inter-observer variability.
- Therefore, to assist the clinicians in the determination of glioma grades, we propose an artificial intelligence (AI) enabled method with transfer learning for the automatic classification of glioma slide images.

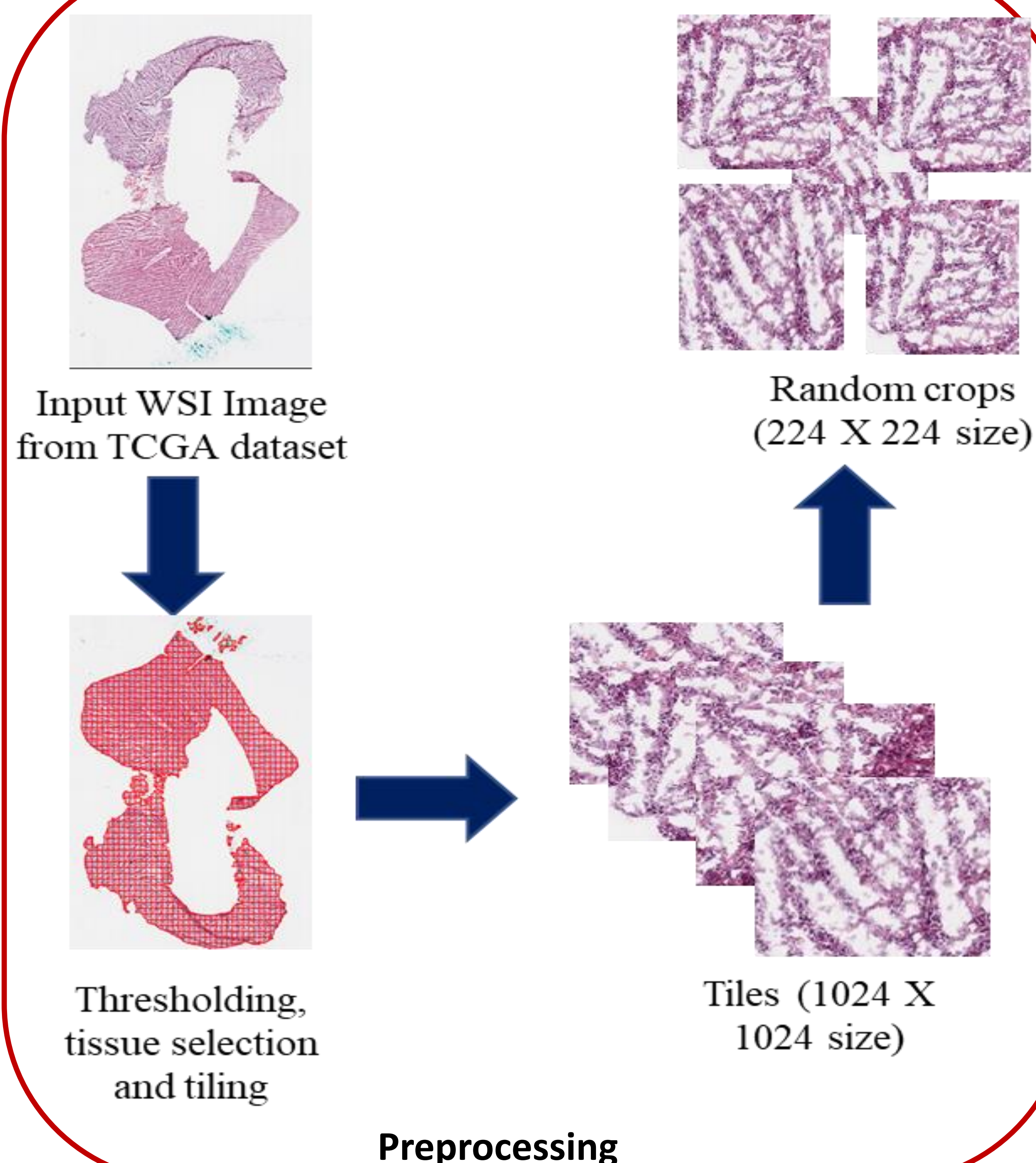
## METHODOLOGY

**Dataset:** The Cancer Genome Atlas (TCGA) data portal - 926 patients (Grade 2 - 214, Grade 3- 241 and Grade 4 - 471)

**Method:** Transfer learning with VGG19 and Resnet50

(i) **Ensemble method** – Lower grade glioma (LGG) vs glioblastoma (GBM); and then LGG into Grade 2 and Grade 3.

(ii) **Multiclass method** – classification of Grade 2, Grade 3 and Grade 4 using a single multiclass model.



## RESULTS

Task	Classifier	Labels	Performance Evaluation Metrics			Accuracy	
			Precision	Recall	F1-score	Image level	Subject level
LGG vs GBM	VGG19	GBM	0.84	0.81	0.83	83%	87%
		LGG	0.82	0.85	0.84		
	Resnet50	GBM	0.88	0.83	0.85	86%	89%
		LGG	0.84	0.89	0.87		
Grade 2 vs Grade 3	VGG19	Grade 2	0.71	0.45	0.55	57%	79%
		Grade 3	0.49	0.74	0.59		
	Resnet50	Grade 2	0.69	0.51	0.59	58%	68%
		Grade 3	0.5	0.67	0.57		
Multiclass	VGG19	Grade 2	0.57	0.41	0.47	63%	71%
		Grade 3	0.33	0.47	0.38		
		Grade 4	0.8	0.83	0.81		
	Resnet50	Grade 2	0.62	0.37	0.46	62%	71%
		Grade 3	0.29	0.51	0.37		
		Grade 4	0.83	0.83	0.83		

Confusion matrices for subject level classification of VGG19

	Grade 2	Grade 3	Grade 4
Ensemble Method			
Grade 2	15	9	3
Grade 3	1	15	1
Grade 4	3	5	40

	Grade 2	Grade 3	Grade 4
Multiclass Method			
Grade 2	13	6	8
Grade 3	5	8	4
Grade 4	2	2	44

Confusion matrices for subject level classification of Resnet50

	Grade 2	Grade 3	Grade 4
Ensemble Method			
Grade 2	15	11	1
Grade 3	2	14	1
Grade 4	2	6	40

	Grade 2	Grade 3	Grade 4
Multiclass Method			
Grade 2	11	12	4
Grade 3	2	12	3
Grade 4	0	6	42

## CONCLUSIONS

- For the classification with ensemble method, VGG19 and Resnet50 architectures offered an overall accuracy of 76% and 75% respectively. For the single multiclass model, both VGG19 and Resnet50 architectures obtained an overall accuracy of 71%.
- The experimental results obtained at subject level demonstrates that the proposed computational approach is effective to support the clinician in the differential diagnosis of H&E stained glioma images.