Using A.I. and Entropy Measures for Biomedical Image Classification using Texture

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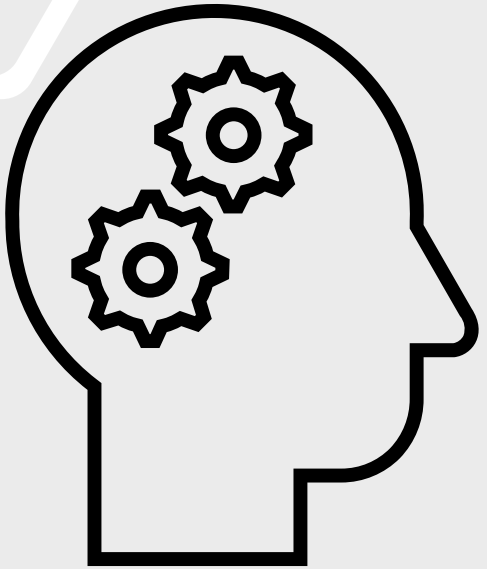
Introduction

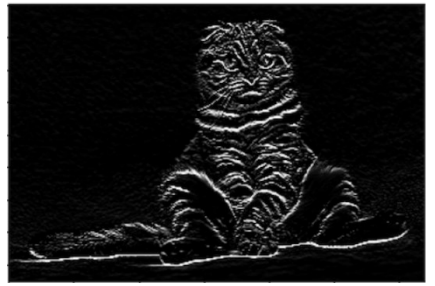
- Personal Background
- Undergraduate Study
- Postgraduate Study
- Internship



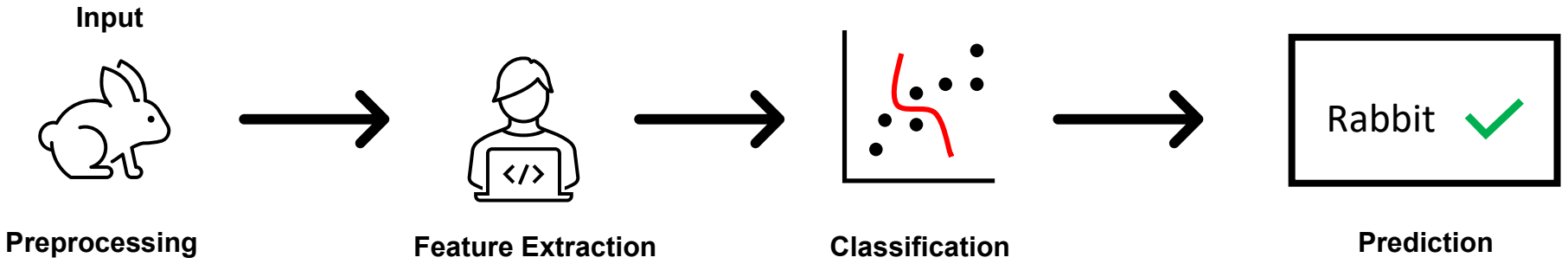
Artificial Intelligence

- What is A.I.?
- Machine Learning
- Machine Learning Flowchart

Original Input

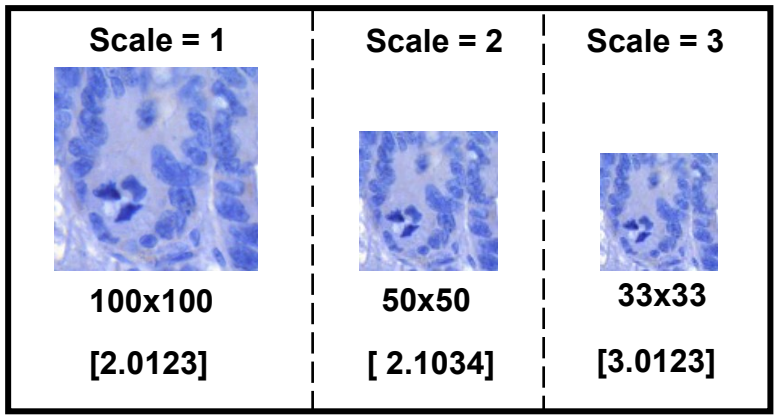


Extracted Features



Entropy

- What is Entropy
- Unidimensional vs Bidimensional Data
- Irregularity vs Complexity
- Dispersion & Fuzzy Entropy



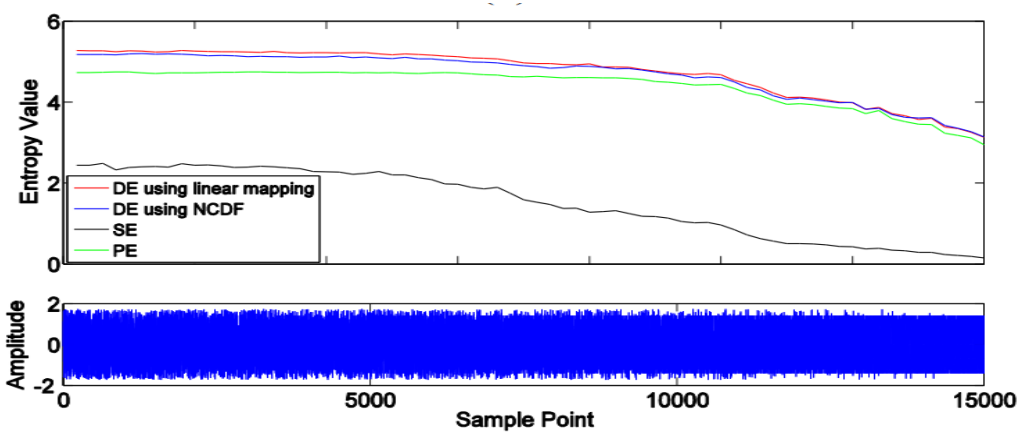


Fig 1) - Rostaghi et al. (2016)

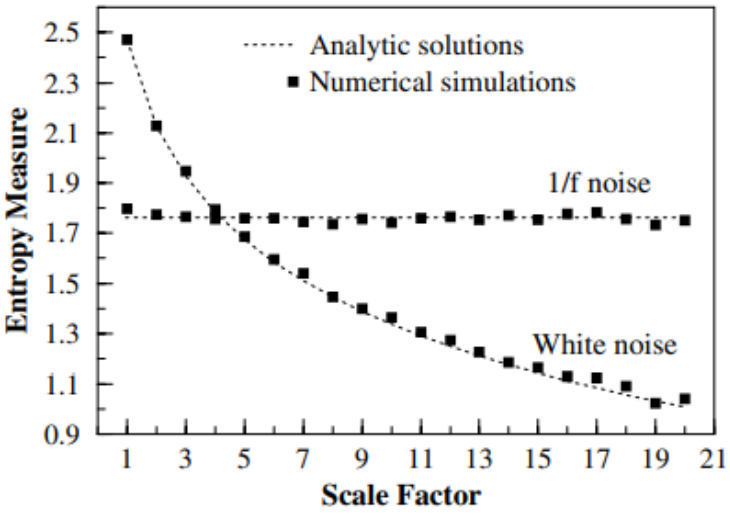


Fig 2) - Costa et al. (2002)

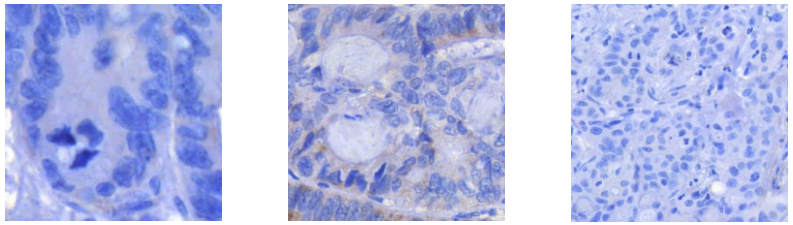
Research Objective

- Classification Performance
- Computation Speed
- Parameter Optimization
- Practical Application

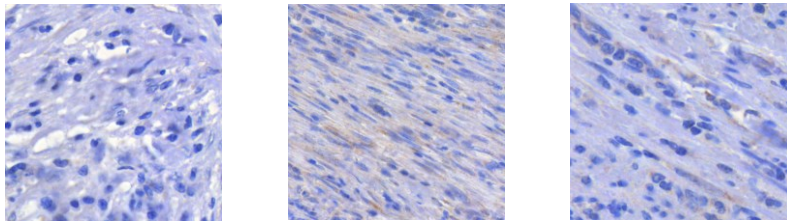
EpiStroma Tests

Dataset

Epithelium

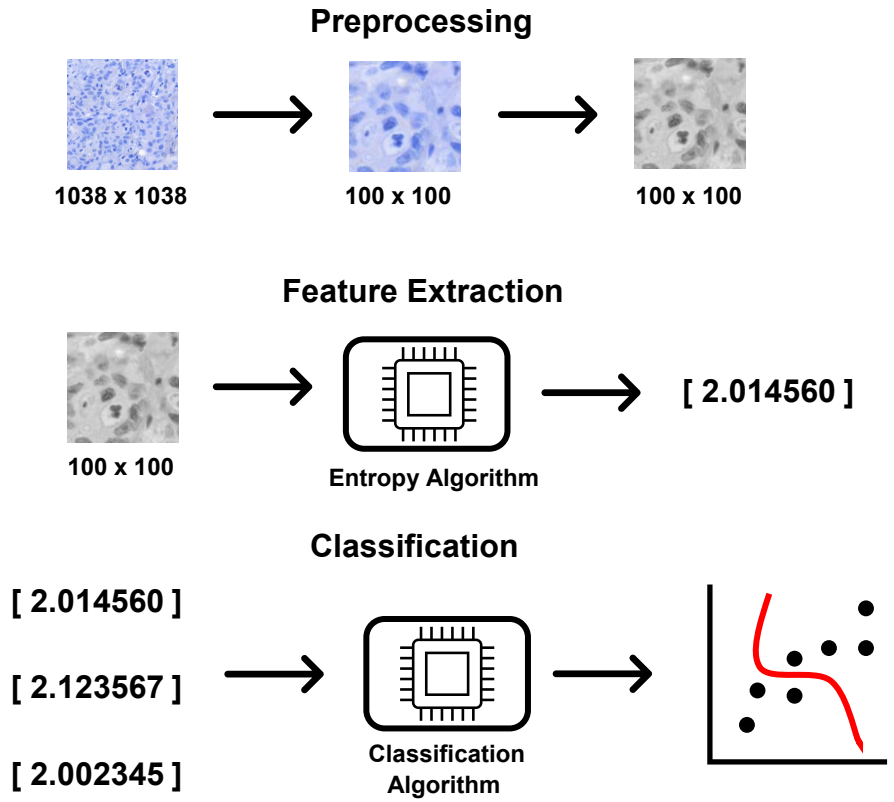


Stroma

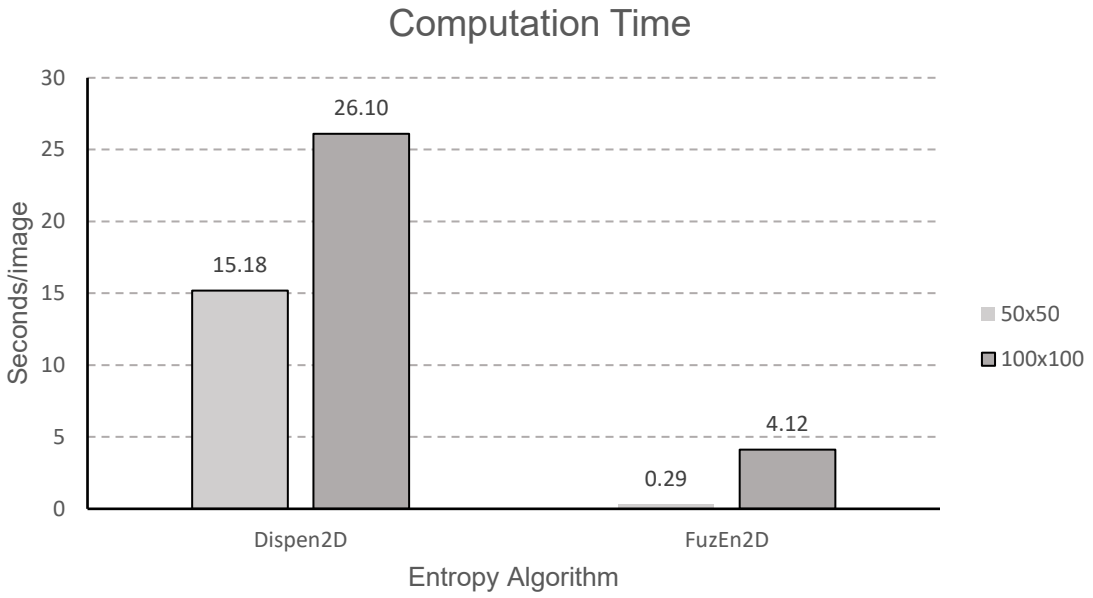


Linder N, Konsti J, Turkki R, et al. Identification of tumor epithelium and stroma in tissue microarrays using texture analysis. *Diagn Pathol*. 2012;7:22. Published 2012 Mar 2. doi:10.1186/1746-1596-7-22

Experimental Procedure



Results



Max Classification Accuracy

Classifier	Fuzzy Entropy		Dispersion Entropy	
	50 x 50	100 x 100	50 x 50	100 x 100
Naïve Bayes	96.22	96.51	88.37	80.23
Decision Tree	97.67	98.84	*97.09*	*96.80*
SVM	93.90	95.64	88.08	86.05
MLP	93.02	97.97	89.24	88.95
KNN	*98.84*	*100*	94.19	95.93

Parameter Testing

FuzEn2D

m

	1	2
50x50	3	2
100x100	1	4

r

	0.12	0.24	0.36	0.48
50x50	0	0	0	5
100x100	0	0	1	4

n

	2	3	4	5
50x50	0	0	3	2
100x100	1	0	1	3

DispEn2D

m

	2	3
50x50	0	5
100x100	1	4

nc

	3	4	5	6
50x50	3	0	0	2
100x100	0	1	2	2

Biomedical Applications

- Colorectal Cancer

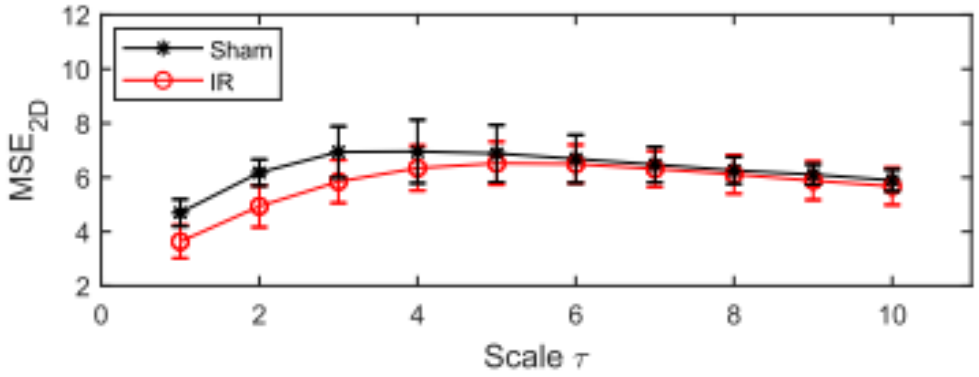


Fig 3) – Humeau-Heurtier et al. (2018)

- Myocardial ischemia-reperfusion

- Pseudoxanthoma Elasticum (PXE)

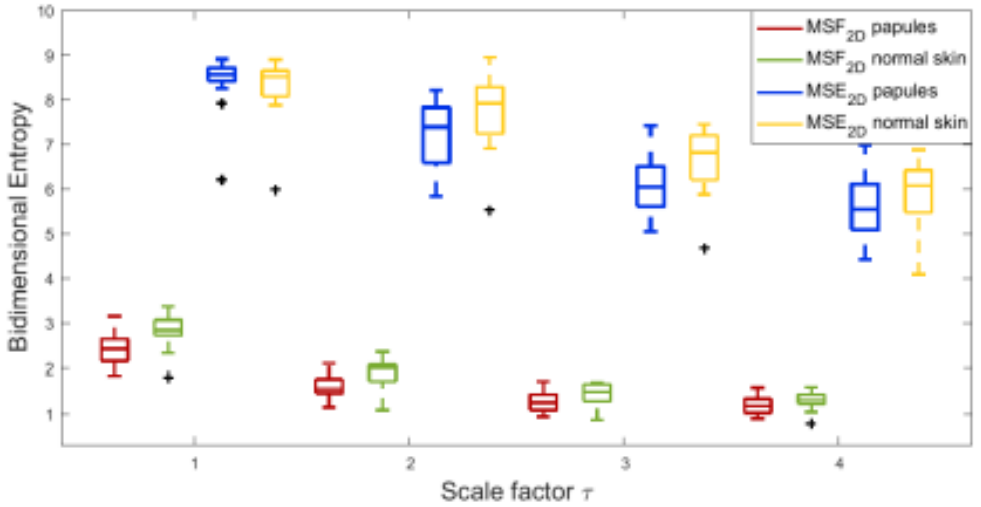


Fig 4) - Hilal et al. (2020)

QUESTIONS?

Thank you for your time!

References

- Fig 1) - Rostaghi, M. and Azami, H. (2016) ‘Dispersion Entropy: A Measure for Time-Series Analysis’, *IEEE Signal Processing Letters*, 23(5), pp. 610–614. doi: 10.1109/LSP.2016.2542881.
- Fig 2) - Costa, M., Goldberger, A. L. and Peng, C. K. (2002) ‘Multiscale Entropy Analysis of Complex Physiologic Time Series’, *Physical Review Letters*, 89(6), pp. 2–9. doi: 10.1103/PhysRevLett.89.068102.
- Fig 3) - Humeau-Heurtier, A., Omoto, A. C. M. and Silva, L. E. V. (2018) ‘Bi-dimensional multiscale entropy: Relation with discrete Fourier transform and biomedical application’, *Computers in Biology and Medicine*. Elsevier Ltd, 100(May), pp. 36–40. doi: 10.1016/j.compbiomed.2018.06.021.
- Fig 4) - Hilal, M. *et al.* (2020) ‘Bidimensional Multiscale Fuzzy Entropy and Its Application to Pseudoxanthoma Elasticum’, *IEEE Transactions on Biomedical Engineering*, 67(7), pp. 2015–2022. doi: 10.1109/TBME.2019.2953681.