Breast Cancer Detection

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1 Preprocessing

We chose not to resize the images to a fixed dimension (128×128) when the original resolution is already consistent and informative.

We propose adding a preprocessing step that was not covered in class: CLAHE (Contrast Limited Adaptive Histogram Equalization). This method enhances the local contrast of ultrasound images, allowing better distinction of suspicious areas, even in low-contrast regions.

CLAHE limits noise amplification and preserves relevant medical structures, which is particularly useful for differentiating benign from malignant tissues

2 Feature engineering

3 Modeling & Evaluation

Table 1: Global performance comparison — SVM, Logistic Regression, and CNN

Metric	**Raw**		**Harris**		**HOG**		**Canny**		**HOG + Harris**		**CNN**
	SVM	LOG	SVM	LOG	SVM	LOG	SVM	LOG	SVM	LOG	
Class 0 (SAFE)											
Precision	0.000	0.000	0.32	0.22	0.64	0.60	0.53	0.50	0.62	0.70	**0.74**
Recall	0.000	0.000	0.78	0.05	0.50	0.57	0.21	0.21	0.79	0.62	**0.62**
F1-score	0.000	0.000	0.76	0.82	0.56	0.59	0.31	0.30	0.87	0.88	**0.68**
Support	42	42	42	42	42	42	42	42	42	42	**42**
Class 1 (SICK)											
Precision	0.722	0.722	0.75	0.73	0.83	0.84	0.76	0.76	0.91	0.87	**0.87**
Recall	0.956	0.956	0.78	0.94	0.89	0.86	0.93	0.92	0.82	0.90	**0.92**
F1-score	0.823	0.823	0.76	0.82	0.86	0.85	0.84	0.83	0.87	0.88	**0.89**
Support	114	114	114	114	114	114	114	114	114	114	**114**
AUC	0.235	0.235	0.58	0.59	0.81	0.81	0.65	0.64	0.84	0.85	**0.87**

3.1 Which metric should matter most: accuracy, precision, or recall ?

As a team, we discussed a lot about whether to focus on precision or recall. We agreed that recall should be our main priority, because missing a cancer case (a false negative) can have very serious consequences for the patient. However, we also recognize that too many false positives create their own problems: extra costs for the hospital, stress for patients, and reduced trust from doctors. So, our conclusion is that recall must come first, but the right balance really depends on how the model is used. In large-scale screening, sensitivity should be maximized to make sure no patient is missed. But in a

Table 2: Global performance comparison — CNN (BreastMNIST, Augmented vs Base)

Metric	CNN (v1, Augmented)	CNN (v2, Base)
Class 0 (SAFE)		
Precision	**0.74**	0.75
Recall	**0.62**	0.64
F1-score	**0.68**	0.69
Support	42	42
Class 1 (SICK)		
Precision	**0.87**	0.88
Recall	**0.92**	0.92
F1-score	**0.89**	0.90
Support	114	114
Accuracy	**0.84**	0.85
Macro Avg (F1)	**0.78**	0.79
Weighted Avg (F1)	**0.83**	0.84
AUC	**0.87**	0.865

clinical setting where the model supports a radiologist, precision also matters to avoid overwhelming them with too many false alarms.

3.2 Consequences of each error type

A false positive occurs when the model incorrectly indicates that a patient has cancer when she is actually healthy. For the patient, this can have several consequences: significant psychological stress related to the announcement of an incorrect diagnosis, additional medical tests that are sometimes invasive (such as biopsies), unnecessary treatments or increased exposure to radiation, as well as financial costs and a loss of confidence in the medical system. For the hospital, false positives lead to an overload of work for medical staff, inefficient use of resources (time, equipment, beds), and can damage its reputation if they occur too frequently.

A false negative, on the other hand, occurs when the model fails to detect an existing cancer. The consequences are much more serious for the patient: she may not receive treatment in time, which increases the risk of cancer progression, complications and lower chances of survival. It can also lead to a loss of confidence in healthcare professionals once the error is discovered. For the hospital, a false negative can have significant ethical, legal and reputational repercussions, particularly in the event of a documented delay in diagnosis. It can also compromise the perceived quality of care and call into question the reliability of decision support tools.

In summary, false positives mainly harm the well-being