TEXTURE DESCRIPTION FOR UNDERSTANDING BREAST ULTRASOUND IMAGES

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Summary

Texture is a powerful cue for describing structures that show a high degree of similarity in their image intensity patterns. This work describes the use of **sift!** (**sift!**), both as low-level and high-level descriptors, applied to differentiate the tissues present in breast US images. For such a task, a subset of 16 images has been randomly selected from a larger dataset of 700 **us!** (**us!**) images acquired at the *UDIAT Diagnostic Centre of Parc Taulí* in Sabadell (Catalunya), between 2010 and 2012. This subset has been complemented with multi-label **gt!** (**gt!**), as illustrated in figure **??**.
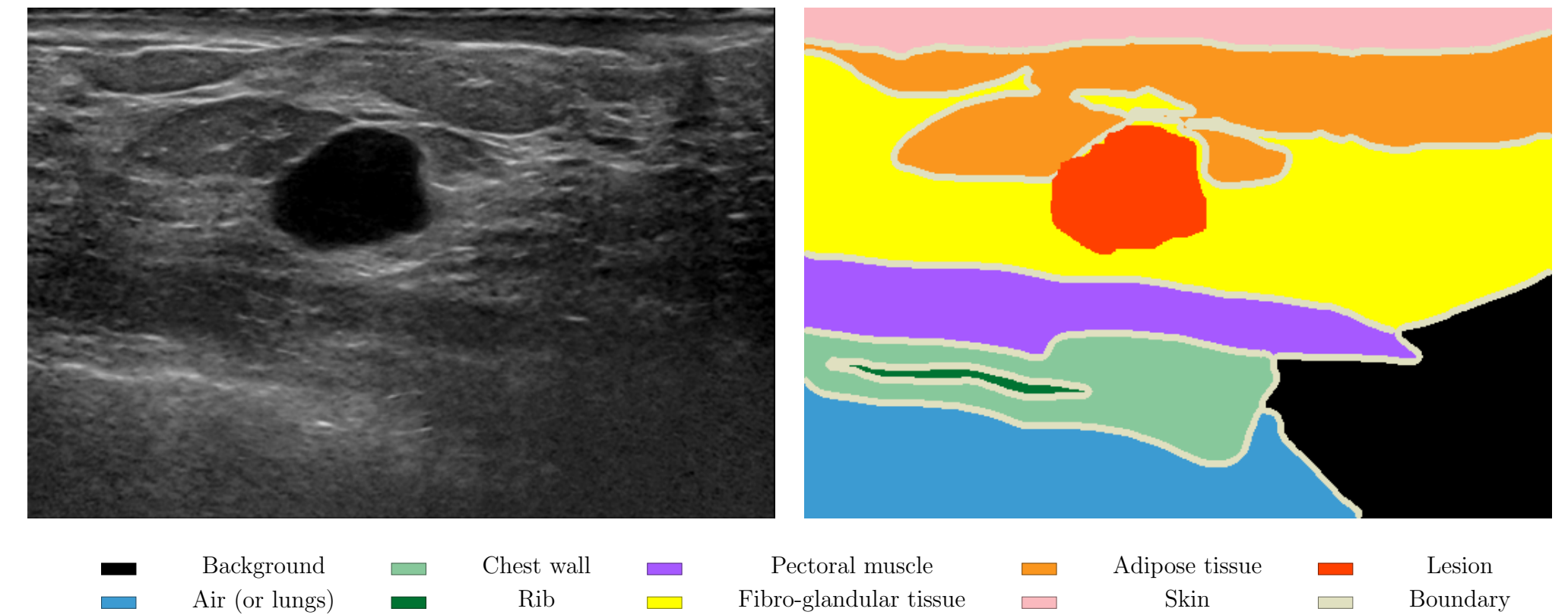
Fig. 1: Data sample: image, accompanying multi-label **gt!**, tissue label **gt!** color-coding.

sift! as a low-level descriptor, tested using map! (map!)

- Goal, analyze tissue classes separability based on:
  - Bayesian framework for tissue discrimination (see eq. **??**).
  - low-level descriptors based on **sift!**

$$P(\omega|\bar{x}) = \frac{P(\bar{x}|\omega) \cdot P(\omega)}{P(\bar{x})} \qquad (1)$$

- Feature Description.
  - Extract **sift!** descriptors at all pixel positions.
  - Project the $128D$ **sift!** to $2D$ using **pca!** (**pca!**).

- Qualitative analysis can be found in fig. **??**-**??**.
- Quantitative analysis can be found in fig. **??**, where a comparison with intensity feature can be found. The overall sensitivity for the intensity case is $16.6 \pm 27.5\%$, whereas for the **sift!** case is $18.8 \pm 17.2\%$ which show that both feature spaces produce similar results.
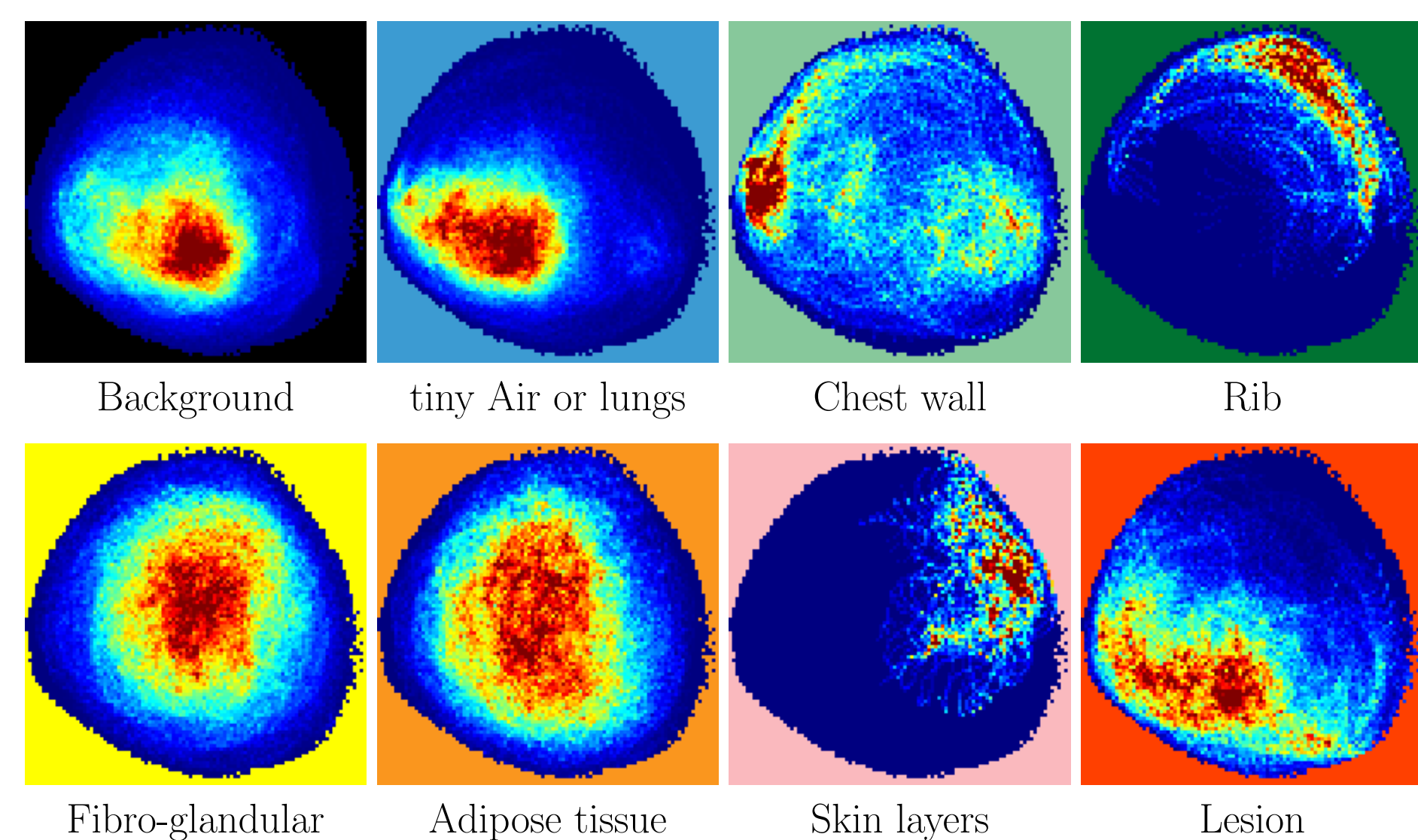

Fig. 2: Distribution of the **sift!** descriptors for some classes in the **gt!**.
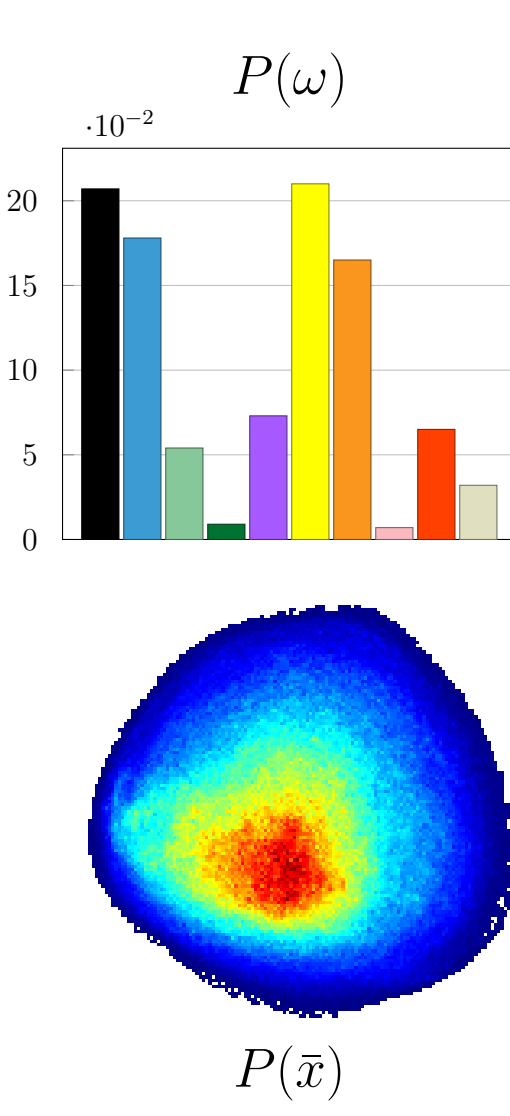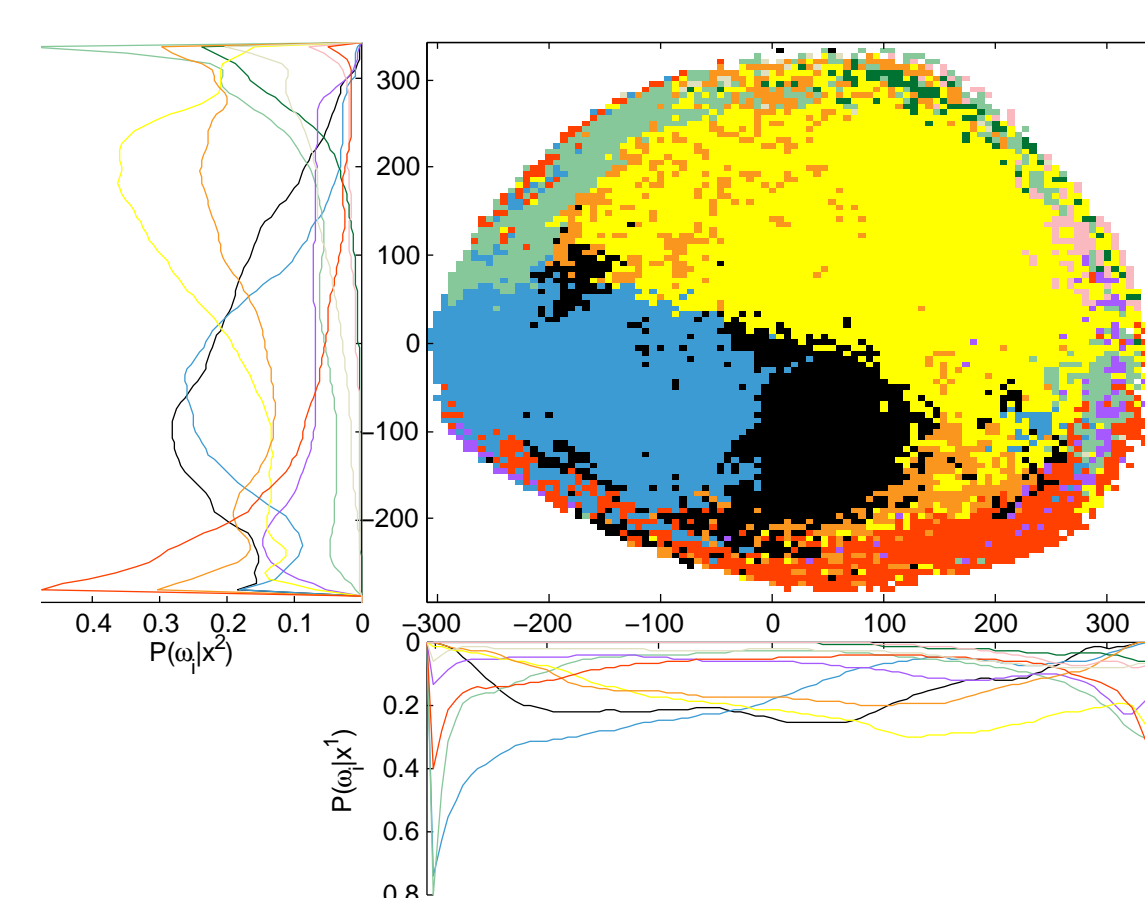

Fig. 3: Data prior knowledge.

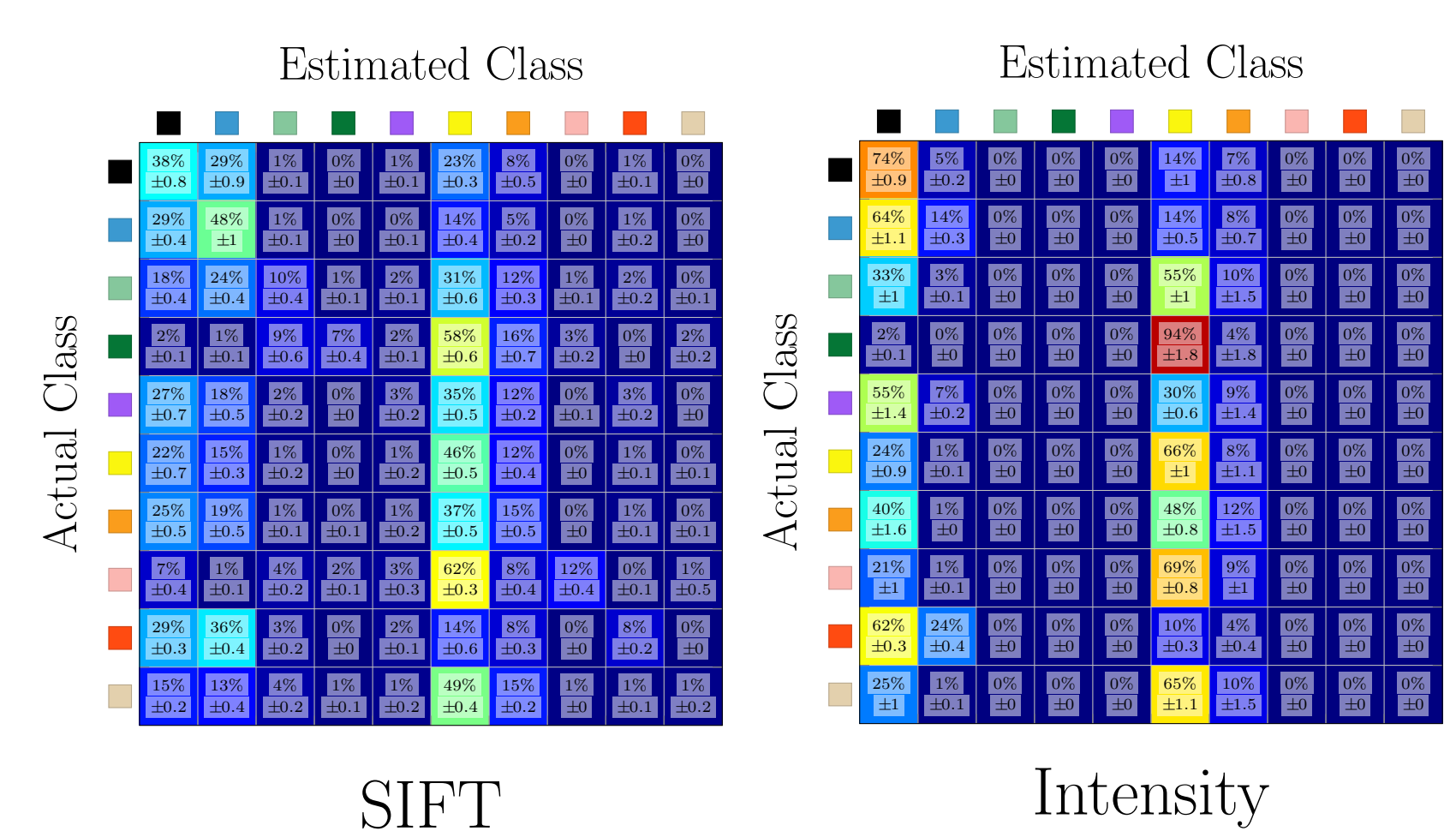Fig. 4: Qualitative evaluation of the **map!** labeling of the feature space.

Fig. 5: Confusion matrix showing quantitative results obtained from (10.000 samples × 10 classes) × 5 folds cross-validation.

sift! as a high-level descriptor using bof! (bof!), tested using rbf! (rbf!)-svm! (svm!) classifier

Texture is an area property related to spatial repetition of structures, statistical similarities, or both.

- Goal, analyze tissue classes separability based on:
  - Classification framework for tissue discrimination (**rbf!-svm!**).

  - High-level descriptors based on **bof!-sift!**.
- Feature Description (see fig. **??**).
  - Generate a codebook of the features (k-means, $k = 36$).
  - Extract superpixels (**qs!** (**qs!**)).

  - Occurrence study to describe each superpixel.
- Quantitative analysis can be found in fig. **??**, The sensitivity achieved is $29 \pm 3.6\%$ for the intensity and $33.5 \pm 2.3\%$ for **sift!**.

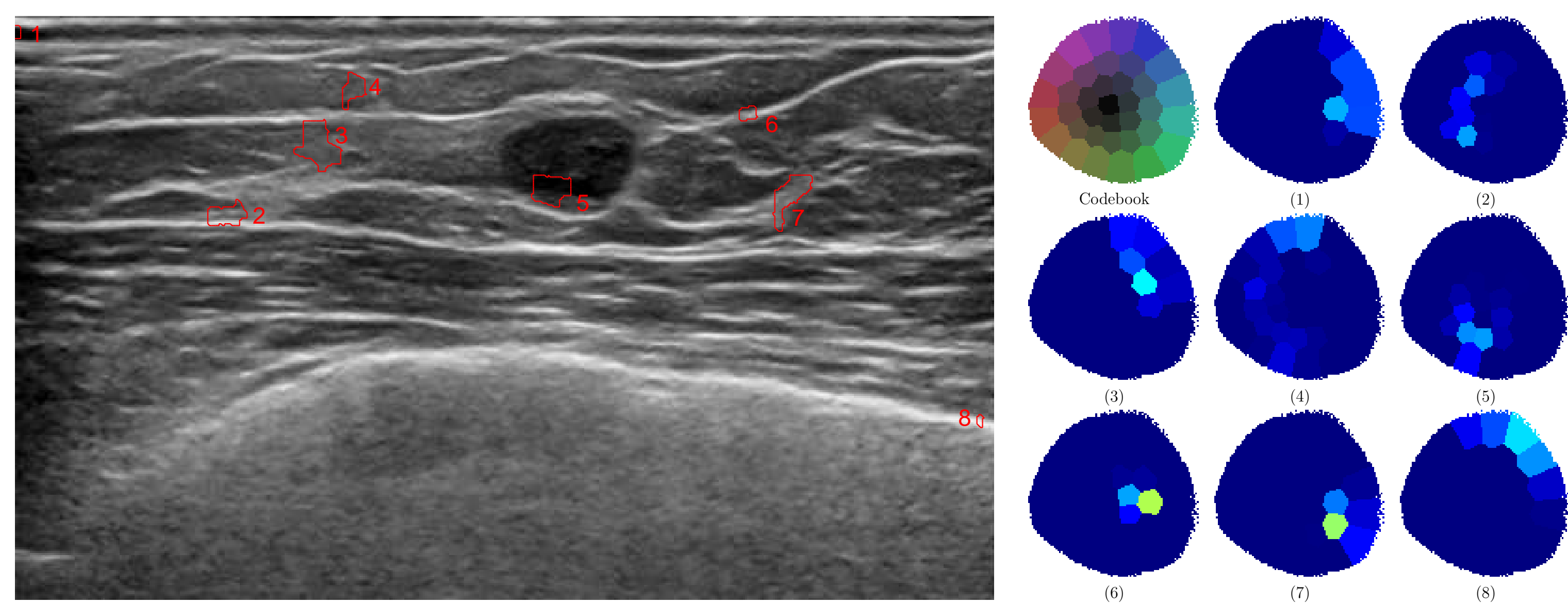Fig. 6: **sift!-bof!** descriptors qualitative analysis. Image example; dictionary example; dictionary occurrence associated with the highlighted superpixels.
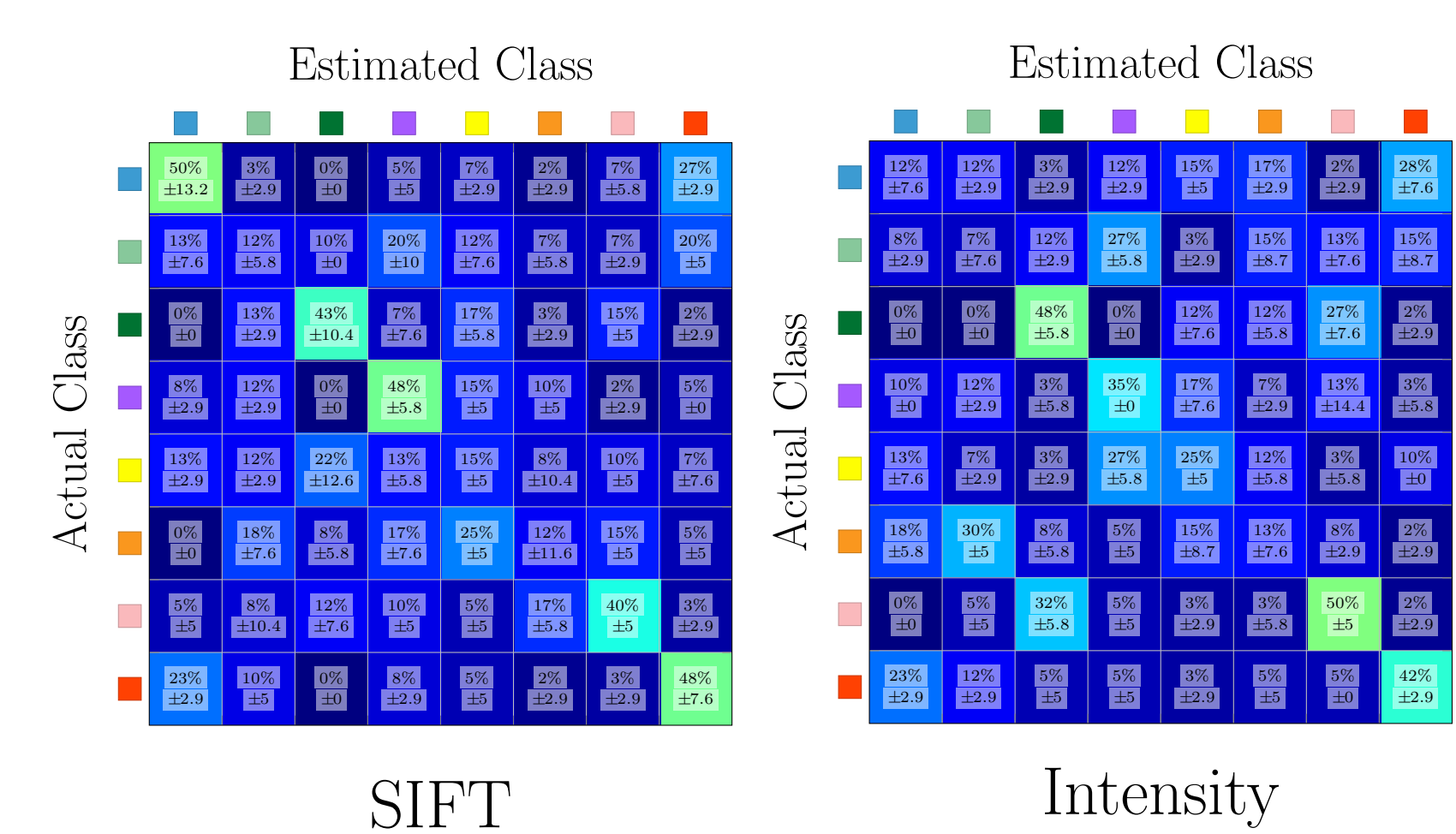

Fig. 7: Confusion matrix showing quantitative results obtained from (1 samples × 8 classes × 3 coodebooks) × 20 folds cross-validation.

Conclusion

The present study was designed to explore the usage of **sift!** feature space as a texture for characterizing the different tissues present in a breast **us!** image. The usage of **sift!** either as a low-level or high-level texture descriptor has been evaluated in comparison to intensity features, which are the features most commonly used. The fact that **sift!** and intensity descriptors produce similar results, encourages further studies on using **sift!** texture descriptors characterizing breast tissues in **us!** images.