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Generating priors based on local statistics
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BACKGROUND: We have multiple MR contrasts aligned within each subject. The image intensities are normalized the same way (dividing by a quantile of a local neighborhood).

Suppose we have n contrasts. SIDE NOTE: We currently have FLAIR, 4 T1 echoes, water image, three MTC (magnetization transfer contrast), and proton density images. Then let C_i, for $i \in \{1, \cdots, n\}$ denote the specific contrast.

Suppose for each voxel v we have a vector of K statistics (called "textures" since they are local statistics). Then denote the value of each statistic by $(X_1(v), \cdots, X_K(v))$.

From Bayes' Theorem we can calculate that

$$P(v \in C_i \mid X_k(v) = \alpha) = \frac{P(X_k(v) = \alpha \mid v \in C_i)P(v \in C_i)}{\sum_j P(X_k(v) = \alpha \mid v \in C_j)P(v \in C_j)}$$

How do we use this? So far, this is what has been done

- $P(X_k(v) = \alpha \mid v \in C_i)$ is calculated from a density plot generated appropriately
- $P(v \in C_i)$ is simply the proportion of voxels in that given class (not clear if that is out of the cube-image or just the head)

Finally, suppose that for a given voxel v_0, the specific set of statistics is seen

$$(X_1(v), \cdots, X_K(v))$$

Then, using a Naive Bayes Classifier (BIG ASSUMPTION)

$$P(v \in C_i \mid (X_1(v), \cdots, X_K(v)) = (\alpha_1, \cdots, \alpha_K)) = \prod_k P(v \in C_i \mid (X_k(v) = \alpha_k))$$

This generates priors that work better than atlas-based priors. This is what Ziad Saad has published a paper on already.

Our goal is to improve this method. Perhaps Naive Bayes is not the best way. Maybe EM? The initial mask drawings also need improvement (what I have been working on the last two weeks).