Patch Preprocessing

Extract and unwrap \( n \) randomly located patches from each section to form \( x \).

- Brightness and contrast normalise patches (each row of \( x \)):
  \[
  \bar{x} = \bar{x} - \text{mean}(x)
  \]
  \[
  \bar{x} = \frac{x}{\|x\| + \epsilon}
  \]

- Compute eigenvectors \( V \) and eigenvalues \( D \) of the covariance of patches.
  \[
  VDV^T = \text{cov}(x)
  \]

- Retain top \( k \) eigenvectors and values such that
  \[
  \sum_{i=1}^{k} D_i \leq 0.95
  \]
  to form \( \hat{V}, \hat{D} \).

- Compute the whitening matrix \( W \)
  \[
  W = \hat{V}(\hat{D} + \epsilon_w I)^{-1/2}\hat{V}^T
  \]

- Apply whitening
  \[
  x_{\text{final}} = xW
  \]

Whitened and normalised patches
Hierarchical Spherical K-Means

1. Sample \( k \) patches for initial cluster centers, \( C \), where \( C_j, j = 1, 2, \ldots, k \) denotes centroids 1 through \( k \).

2. Assign patches to closest centroid using cosine distance. \( x_j \) represents the patches assigned to the centroid \( C_j \).

3. Recalculate centroids:
   \[
   C_j = \frac{\sum x_j}{\|\sum x_j\|}
   \]
   If \( x_j \) is empty replace \( C_j \) with a new randomly selected patch.

4. Repeat for 10 iterations if more levels desired.

5. Compute final assignment of patches to centroids.


Repeat for samples assigned to each centroid.
Augmentation and Section Classification

Input RCM section

augment orientations

$0^\circ$ $90^\circ$ $180^\circ$ $270^\circ$

Extract patches

Whiten and normalise patches

Encode patches as most similar entry in dictionary

Count occurrences to form histograms

Train logistic regression classifier using each orientation as distinct example

Mean of histograms from each orientation

Classified section