Global PCA of Local Moments

With Applications to MRI Segmentation

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Abstract

We are interested in describing the information contained in local neighborhoods, and higher moments of local neighborhoods, of complex multimodal imaging techniques at the population level. This is problematic because of the size of medical imaging data. We propose a simple, computationally-efficient approach for representing the variation in multimodal images using the spatial information contained in all local neighborhoods across multiple subjects. This method achieves 3 goals: 1) decomposes the observed variability images at the population level; 2) describes and quantifies the main directions of variation; 3) uses these directions of variation to improve segmentation and studies of association with health outcomes. To achieve this, we efficiently decompose the observed variation in local neighborhood moments. In order to assess the quality of this method we show results using the 2015 Ischemic Stroke Lesion Segmentation (ISLES) Challenge.

Introduction

Every image can be vectorized. However, its meaning, interpretation, and complexity is encapsulated in the collection of all neighborhoods of all locations. More precisely, every image with V voxels can be represented as a $V \times V$ matrix, where every row represents a location in the image and every column reprents a particular position in the neighborhood of that location; e.g., the first column could be the neighbor just above the location, the second column could be the neighbor to the left. Such matrices are very large and store information inefficiently, but they provide a useful theoretical framework for representation of imaging information. Here we propose to exploit this theoretical framework to introduce simple methods to quantify the variation in multimodal images based on the shared information across local spatial neighborhoods and subjects.

$$\begin{aligned} X_j = &(0.34, 0.58, -0.73, 1.74, -0.69, -1.34, 0.71, -1.87, -1.97,\\ &0.11, 0.34, 0.53, 3.03, 0.48, 1.81, 0.50, 3.48, 3.89,\\ &0.04, 0.19, -0.39, 5.28, -0.33, -2.43, 0.35, -6.50, -7.68,\\ &0.01, 0.11, 0.28, 9.19, 0.23, 3.27, 0.25, 12.13, 15.16).\end{aligned}$$

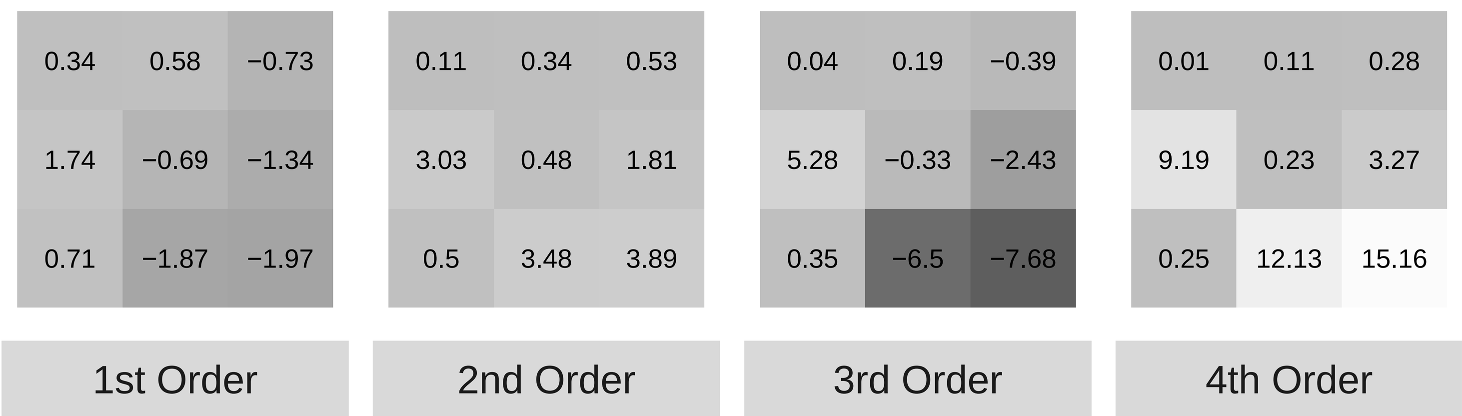

Figure 1: Figure caption

Main Objectives

1. Decompose observed variability images at the population level
2. Describe and quantify the main directions of variation
3. Use these directions of variation to improve segmentation and studies of association with health outcomes.

Materials and Methods

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Mathematical Section

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$$E = mc^2 \tag{1}$$

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Vestibulum ac diam a odio tempus congue. Vivamus id enim nisi:

$$\begin{aligned} \cos\bar{\phi}_k Q_{j,k+1,t} + Q_{j,k+1,x} + \frac{\sin^2\bar{\phi}_k}{T\cos\bar{\phi}_k} Q_{j,k+1} = \\ -\cos\phi_k Q_{j,k,t} + Q_{j,k,x} - \frac{\sin^2\phi_k}{T\cos\phi_k} Q_{j,k} \end{aligned} \tag{2}$$

and

$$\begin{aligned} \cos\bar{\phi}_j Q_{j+1,k,t} + Q_{j+1,k,y} + \frac{\sin^2\bar{\phi}_j}{T\cos\bar{\phi}_j} Q_{j+1,k} = \\ -\cos\phi_j Q_{j,k,t} + Q_{j,k,y} - \frac{\sin^2\phi_j}{T\cos\phi_j} Q_{j,k}. \end{aligned} \tag{3}$$

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Results

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Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 1: Table caption

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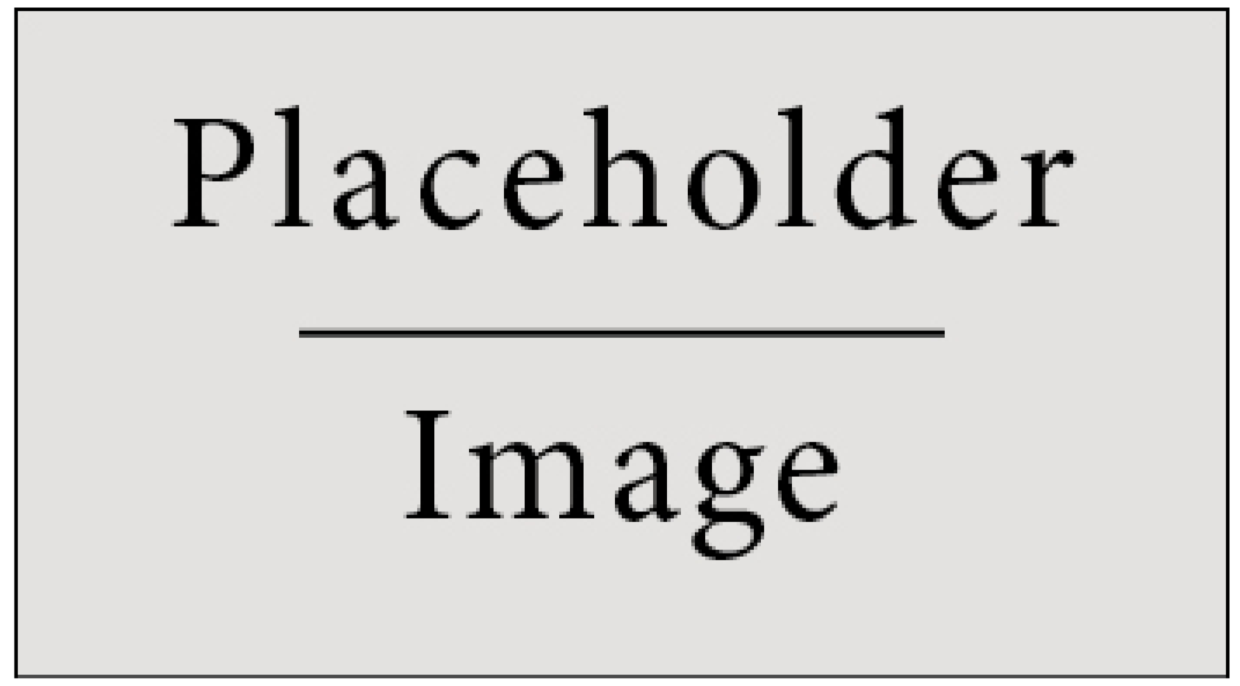

Figure 2: Figure caption

In hac habitasse platea dictumst. Etiam placerat, risus ac.
Adipiscing lectus in magna blandit:

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
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Table 2: Table caption

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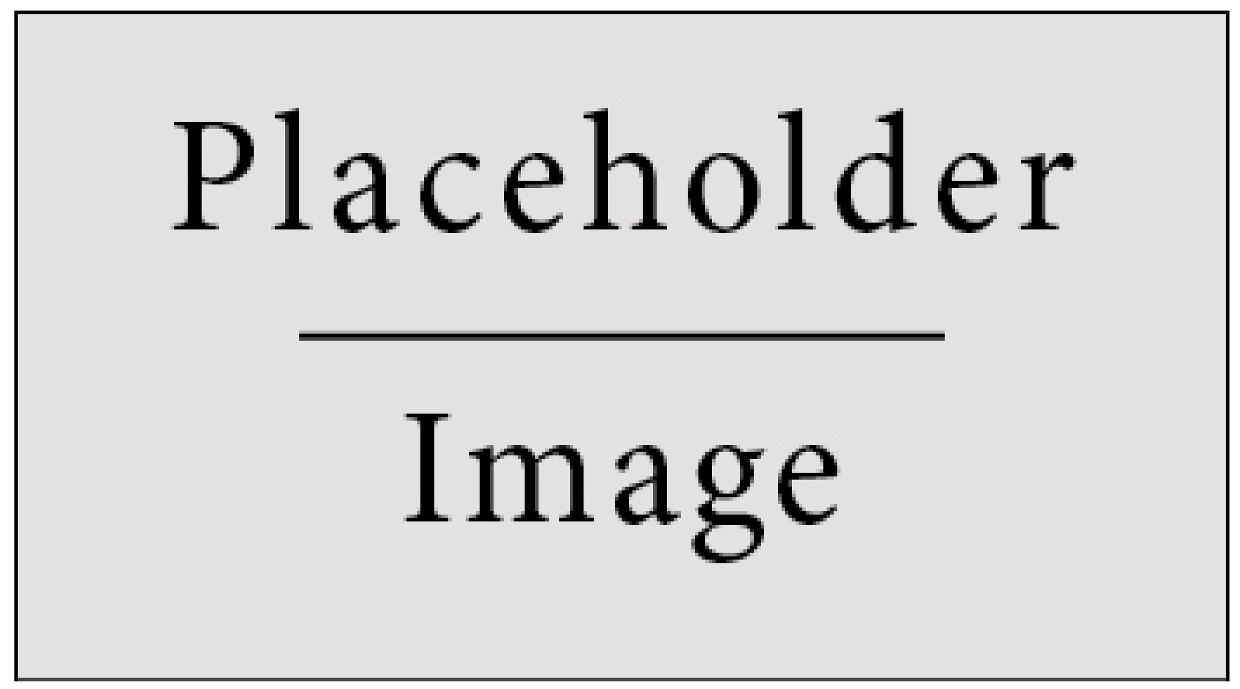

Figure 3: Figure caption

Conclusions

- Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh. Phasellus fermentum rutrum elementum. Nam quis justo lectus.
- Vestibulum sem ante, hendrerit a gravida ac, blandit quis magna.
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- Nunc at convallis urna. isus ante. Pellentesque condimentum dui. Etiam sagittis purus non tellus tempor volutpat. Donec et dui non massa tristique adipiscing.

Forthcoming Research

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Acknowledgements

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