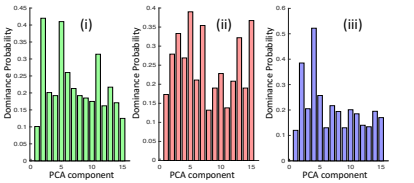
Does Alignment in Statistical Shape Modeling of Left Atrium Appendage Impact Stroke Prediction?

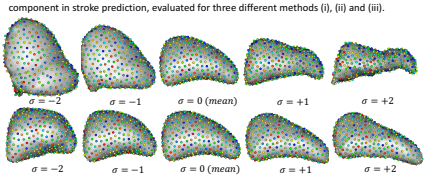
Riddhish Bhalodia, Archanasri Subramanian, Alan, Morris, Joshua Cates, Ross Whitaker, Evgueni Kholmovski, Nassir Marrouche, Shireen Elhabian

Scientific Computing and Imaging Institute, University of Utah
Salt Lake City, Utah, USA

Motivation: Evidence suggests that the shape of left atrium appendages (LAA) is indicative of stroke risk. Recently, statistical shape models (SSM) have been used to study left atrium (LA) and LAA anatomy. As LAA is attached to LA, its relative alignment could impact SSM making its choice important. We explore the alignment ambiguity associated with SSM of LAA in context of stroke prediction, with an emphasis on producing clinically interpretable shape modes of variation. **Methods:** A representative dataset of 60 LAA scans (50 normal(N) & 10 stroke(S)) is used to construct SSM based on different alignment strategies, (i) global center-of-mass (COM) alignment, (ii) global COM and rigid alignment, (iii) global COM and within cluster rigid alignment (4 clusters using K-means). For each strategy, we use *ShapeWorks* software to generate an optimal SSM, and use principal component analysis (PCA) to identify modes of shape variation (15 modes, 95% variability). We use a lasso model on random subsets to identify dominant shape modes for inferring stroke (Figure). **Results:** We use top 3 dominant modes to predict the stroke probability via logistic regression. We measure the average misclassification for each strategy: (i) N = 2.7/50, S = 5.1/10 ; (ii) N = 2.5/50, S = 6.8/10 ; (iii) N = 5.2/50, S = 4.3/10 (standard deviation for all < 0.2). **Conclusion:** We explore alignment strategies for SSM of LAA to identify the shape descriptors indicative of stroke prediction. Strategy (ii) performs poorly for stroke classification, suggesting a global rigid alignment causes the SSM to lose its stroke predictive component. As LAA has an inherent clustering, strategy (iii) outperforms (i) and (iii) and results in dominant modes indicating stroke which are clinically interpretable. Results suggest a joint SSM of LA and LAA which accounts for their relative alignment.



The above charts represent probability of dominance denoting the significance of each PCA component in stroke prediction, evaluated for three different methods (i), (ii) and (iii).



PCA variation using method (iii), for the dominant modes at number 2 (top) and 4 (bottom), the LAA curving and elongation are clinically interpretable factors which are associated with stroke risk. (these are similar for method (i) mode 2 and 5 respectively).