# Atrial Fibrosis Distribution Generation based on the Diffusion Model

Alexander M. Zolotarev, Caroline H. Roney

Queen Mary University of London, UK

Deep learning models have the potential to accurately predict atrial fibrillation (AF) ablation outcome based on patient-specific anatomical and physiological features. To overcome the lack of clinical data that is necessary for successful training, some of these features may be artificially generated. In this study we aim to generate artificial atrial fibrosis distributions to increase our training dataset size by imitating independent personalized AF episodes.

We used diffusion models to generate fibrosis distributions. Specifically, a Denoising Diffusion Probabilistic Model was trained on real fibrosis distributions to generate 100 artificial fibrosis distributions using a 2D representation of the atria (Universal Atrial Coordinates). AF episodes were simulated for a left atrial anatomy using these fibrosis maps.

Additionally, to test whether these generated fibrosis distributions were suitable for extending a training dataset we compared training a binary classifier for AF maintenance or termination from fibrosis and dominant frequency maps on generated fibrosis data to training it on 100 real fibrosis distributions on the same LA anatomy.

The number of sustained AF episodes (>15 seconds) in the real dataset is 40 cases versus 33 cases in the generated dataset (examples are shown in the Figure). For the baseline classifier trained and tested on real fibrosis data, the ROC-AUC score was 0.96. In contrast, training the classifier using generated cases, and testing on the real fibrosis data, resulted in ROC-AUC score of 0.92. The results indicate that the artificial fibrosis distributions correspond well with the real ones and can be used for dataset expansion.

This study is the first to our knowledge to generate artificial fibrosis distributions for AF computer simulations. This approach may be used to generate large virtual populations for in silico trials of different ablation therapies, and for improving patient-specific ablation prediction using digital twins.