

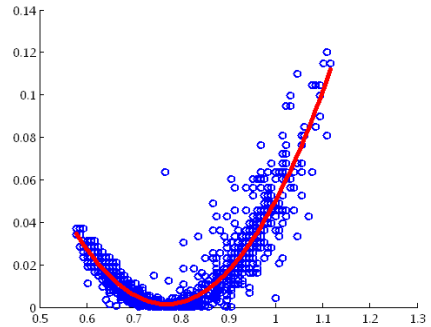
# Application of Novel Mapping for Heart Rate Phase Space and Its Role in Cardiac Arrhythmia Diagnosis

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The nonlinear analysis of Heart Rate Variability (HRV) is a valuable tool in both clinical practice and physiological research reflecting the ability of the cardiovascular system. Poincare plot is a geometrical representation of RR time series to demonstrate patterns of heart rate dynamics resulting from nonlinear processes.

In this paper, by using Poincare plot points we introduced a novel mapping for heart rate phase space which consists of all the ordered pairs:  $(RR_i, (\overline{RR} - RR_{i+1})^2)$ ,  $i = 1, \dots, N - 1$  where  $\overline{RR}$  is the mean of RR intervals. By analyzing the point's distribution in this new map, we could estimate a two degree polynomial equation in the form of  $y = Ax^2 + Bx + C$  in which  $y$  is  $(\overline{RR} - RR_{i+1})^2$  and  $x$  is



Estimation of a quadratic equation for point's distribution in HRV phase space.

$RR_i$ . The useful features obtaining of this map are the coefficients  $A$ ,  $B$ , and  $C$ . For evaluating them, we try to distinguish three groups of subjects using the Physionet database (Arrhythmia, Congestive Heart Failure (CHF), and Atrial Fibrillation (AF)) with Normal Sinus Rhythm (NSR). Kruskal-Wallis test was used to define the level of significance of each feature for different groups of subjects to demonstrate the usefulness of the proposed method in cardiac arrhythmia diagnosis. The results show that these features discriminate CHF from NSR subjects by  $p < E-4$ ; arrhythmia from NSR by  $p < E-5$ ; and AF from NSR by  $p < E-5$ .

In this novel method, we have used the function between current data of time series and the following one. Hence, it seems that this kind of mapping and the resulted quadratic equation has the capability of being used as a prediction method for some kinds of cardiac arrhythmia. So this method would be evaluated in most cases and compared with clinical results to detect its more advantages in cardiac arrhythmia diagnosis.