m Warp1d: Manual one-dimensional data warping in
Python and PyQt

Todd C. Pataky1, Hanaa Naouma1, 2, and Cyril J. Donnelly3

1 Kyoto University, Department of Human Health Sciences 2 Shinshu University, Department of Bioengineering 3 Nanyang Technological University, Rehabilitation Research Institute of Singapore

Summary

“Warping” is a mathematical / computational process that transforms a domain like time or space so that its nodes (i.e., points in time or space) are unequally spaced. For one-dimensional (1D) domains like time, warping involves translating nodes forward or backward (in time). The goal of warping is usually “registration”, or the alignment of homologous events / features. An example is shown in Fig.1 below, where an original 1D observation (a force trajectory) is warped to become better aligned with a template 1D observation.

Warping 1D data has been shown to be necessary for minimizing variability in a variety of applications (Marron, Ramsay, Sangalli, & Srivastava, 2015; Ramsay & Li, 1998; Sadeghi et al., 2000), yet only a few open-source algorithmic techniques exist (Ramsay & Silverman, 2005; Wrobel, 2018; Zeng, Qing, & Kim, 2019), and no manual techniques exist for 1D registration. It has separately been shown that, for 2D data, manual registration can perform as well as, and in some cases better than algorithmic registration (Buckner et al., 2004; Iosifescu et al., 1997). Manual registration may also be necessary when algorithmic registration fails or requires manual interaction (Qin, Huang, & Suganthan, 2009).

m Warp1d is a tool for manually warping 1D data via Python scripting and also via a PyQt graphical user interface (GUI). m Warp1d implements two warping procedures: landmark and manual. Landmark registration was introduced to the literature more than 20 years ago, involving homologous point digitizing and subsequent piecewise interpolation. While simple, landmark registration was implemented in m Warp1d as a comparative baseline. The manual registration scheme is novel, involving domain warps through manually adjustable, globally-constrained asymmetric Gaussian warping kernels.

Statement of need

Research purpose: m Warp1d allows users to manually register 1D datasets, thereby achieving qualitatively optimal alignment of multiple 1D observations.

Problem solved: m Warp1d allows users to manually define arbitrarily complex warps, thereby solving the problem of potentially poor algorithmic registration performance. As far as we are aware, no other manual, GUI-based software exists for manual 1D data warping.

Target audience: The target audience is anyone working with or analyzing registerable 1D data, especially researchers in the human and animal movement sciences. Full documentation is available in the project repository.
Figures

![Figure 1: Example 1D warp.](image)

References


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