

1.2. Topological Methods for the Detection of Stereotypical Motor Movements in Video Data. One of the main diagnostic criteria for autism spectrum disorder (ASD) in *The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5) is the salience of restricted, repetitive patterns of behavior, interests, and/or activities. One way in which these behaviors manifest in children with ASD is stereotypical motor movements (SMM) such as hand flapping and body rocking.

Traditional measures of SMM primarily use rating scales filled out by clinicians via direct behavioral observation in person or video, all of which can be subjective, inaccurate, time-intensive, and difficult to compare across different individuals with ASD. Accurate and automated onset (start/stop time) detection of SMM, specially from passive sensors (e.g., video data), could provide important insights for understanding a core symptom of ASD and to lend assistance to individuals where needed.

Prior work of Tralie, Goodwin and Shapiro shows that TDA methods, in particular SW1PerS (Sliding Windows and 1-Persistence Scoring) on accelerometer data from sensors on wrist and torso, can be effective in detecting the onset of SMM episodes. The goal of this project is to accomplish the same task, but utilizing video data alone. Specifically, to apply SW1PerS to videos of patients with ASD, in order to detect the onset of SMM episodes. Indeed, repetitive movement should result in a circle in the sliding window space, which can be detected and scored with 1-dimensional persistent homology. One of the main challenges here is that individuals can change location/visibility from frame to frame in the video, so object tracking algorithms may be needed (e.g., with OpenPose <https://viso.ai/deep-learning/openpose> or other deep learning approaches <https://viso.ai/deep-learning/object-tracking>)

A place to start:

- (1) Watch the video in <https://dl.acm.org/doi/10.1145/2632048.2632096> (supplemental material) to get a better sense of the scientific context for this research, and the description of the accelerometer data.

References.

- (1) Moving towards a real-time system for automatically recognizing stereotypical motor movements in individuals on the autism spectrum using wireless accelerometry, M. Goodwin et. al., <https://dl.acm.org/doi/10.1145/2632048.2632096>
- (2) Accelerometer data: [Bitbucket repo with dataset](#)
- (3) Automated Detection of Stereotypical Motor Movements in Children with Autism Spectrum Disorder Using Geometric Feature Fusion (Poster Presentation) C. Tralie, M. S. Goodwin and G. Sapiro, <https://insar.confex.com/insar/2018/webprogram/Paper27315.html>
- (4) (Quasi)Periodicity Quantification in Video Data, Using Topology, by Christopher J. Tralie and Jose A. Perea, <https://arxiv.org/pdf/1704.08382.pdf>
- (5) Chris Tralie, Github Repo: <https://github.com/ctralie/AutismPeriodicities>