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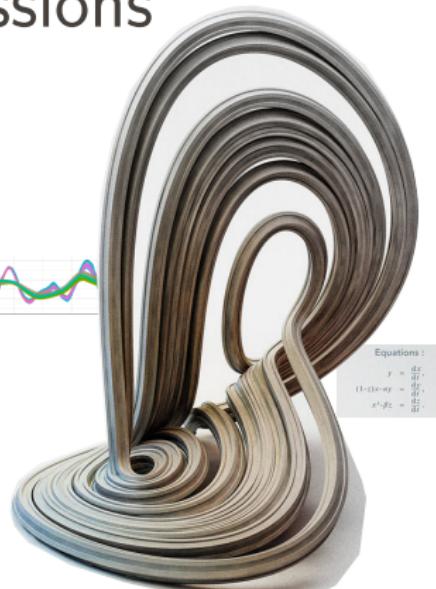
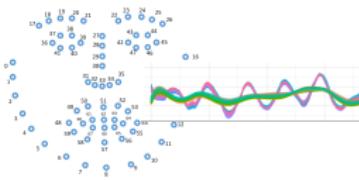
Towards the Analysis of Movement Variability for Facial Expressions with Nonlinear Dynamics

@CERE_Emotion #CERE2018

Glasgow, Scotland, 4-5 April 2018

Miguel P Xochicale and Chris Baber
@_mxochicale

School of Engineering
University of Birmingham



Equations :

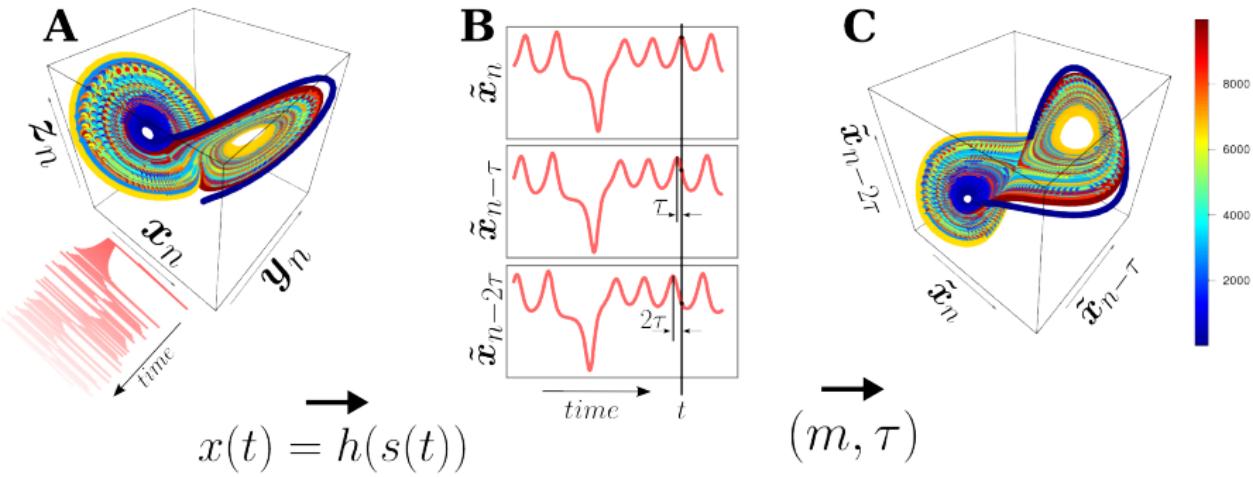
$$\begin{aligned} \dot{x} &= dx/dt \\ &= ax - by \\ (1-a)x - ay &= dy/dt \\ &= c - xz \\ x^2\beta z &= dz/dt \end{aligned}$$

MOVEMENT VARIABILITY

WHAT IS MOVEMENT VARIABILITY?

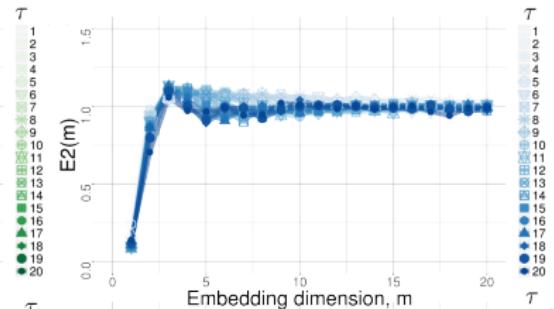
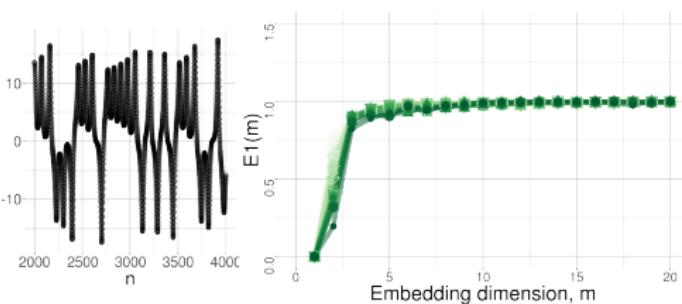
MOVEMENT VARIABILITY is defined as the variations that occur in motor performance across multiple repetitions of a task and such behaviour is an inherent feature within and between each person's movement.

STATE SPACE RECONSTRUCTION

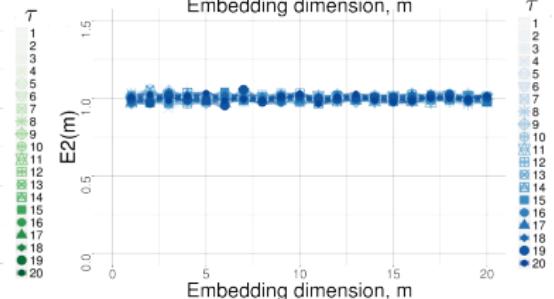
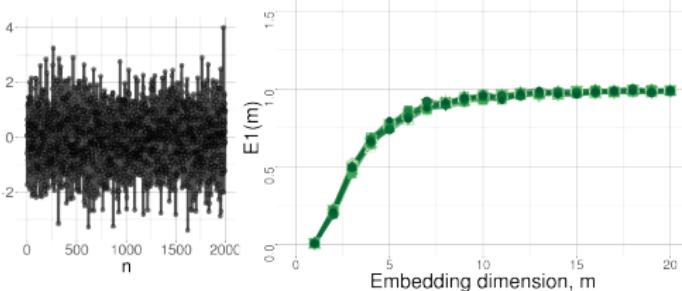


Uniform Time-Delay Embedding

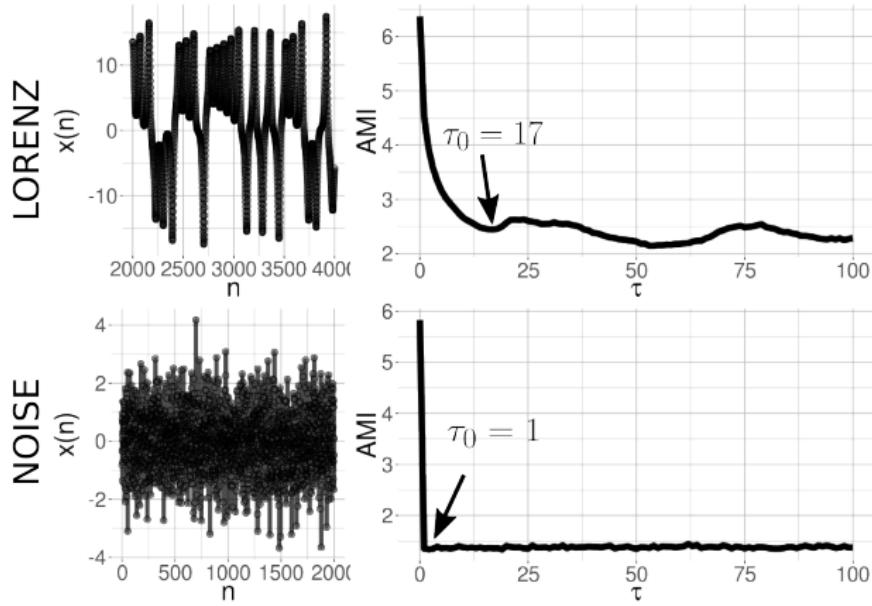
LORENZ



NOISE

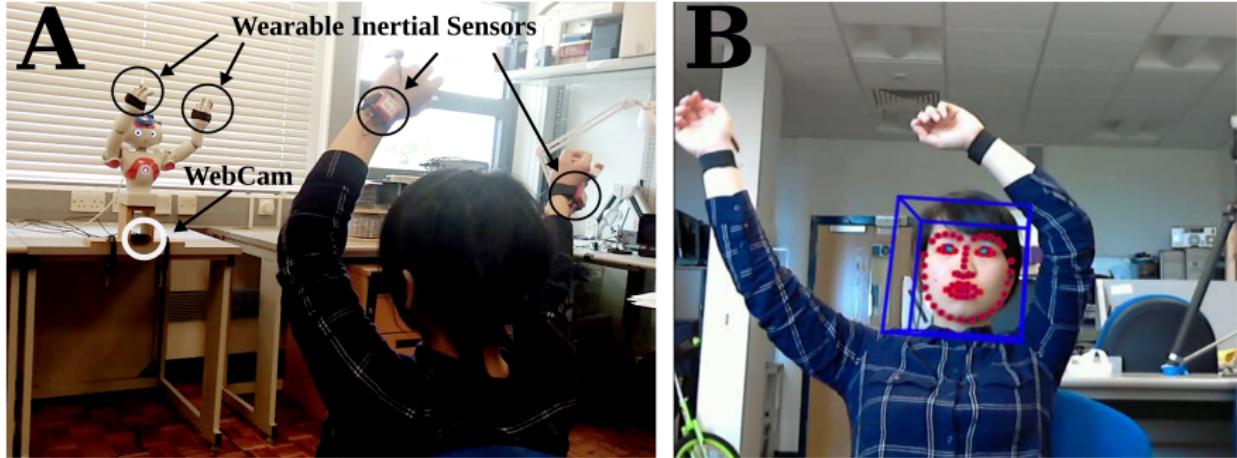


Minimum Embedding Dimension (m)

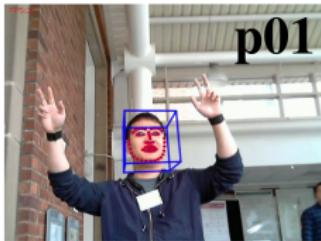


Minimum Embedding Delay (τ)

EXPERIMENT AND RESULTS



Human-Robot Imitation Activity



p01



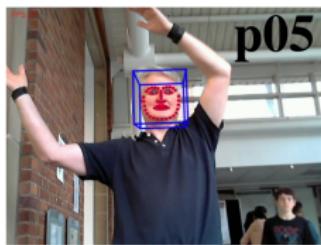
p02



p03



p04



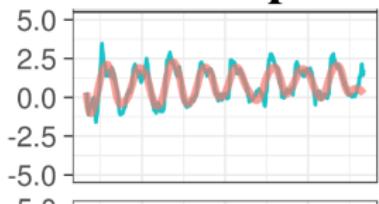
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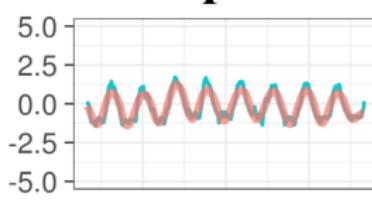
p06

Participants

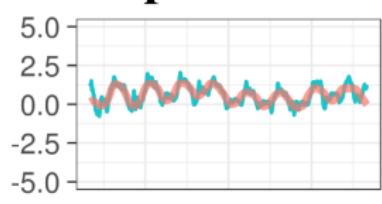
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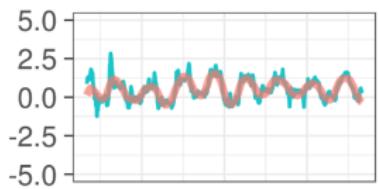
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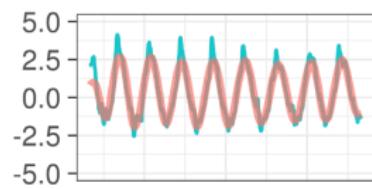
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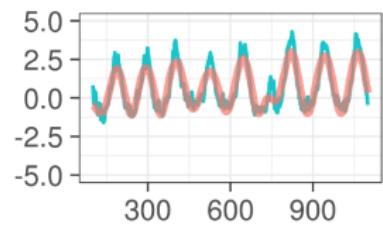
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p05

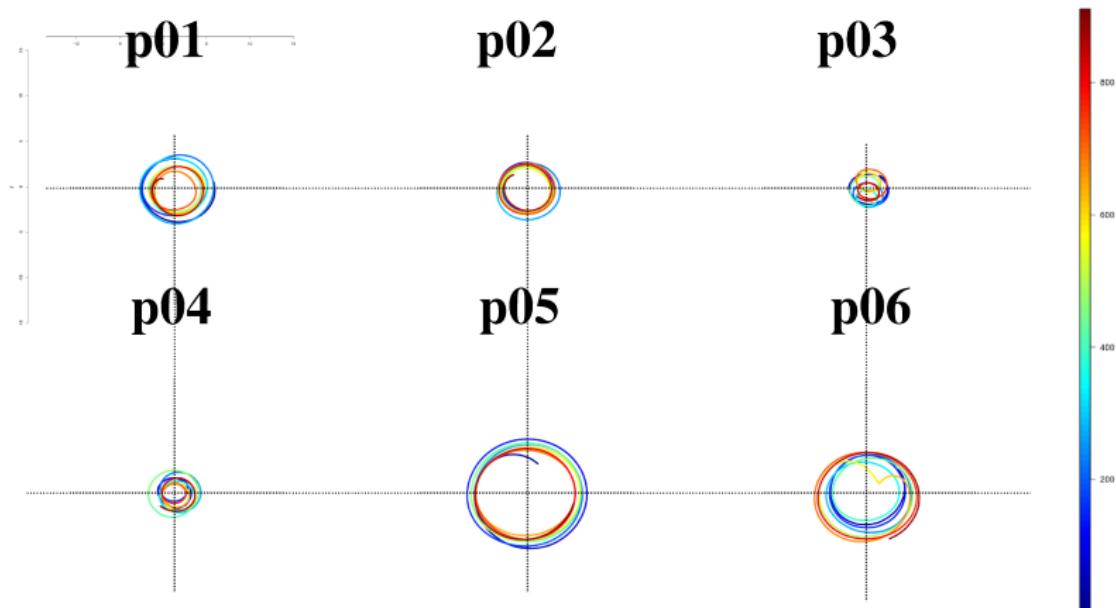


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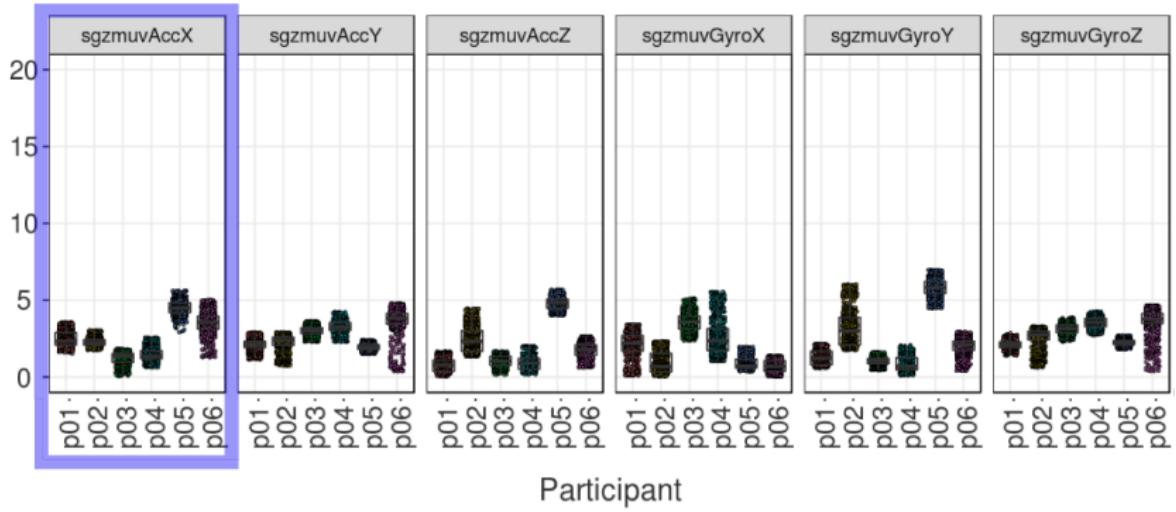


Feature
— sgzmuvAccX
— zmuvAccX

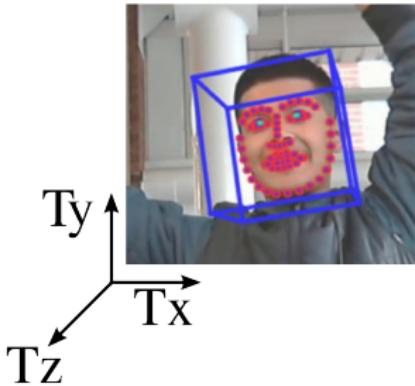
Time Series for IMU



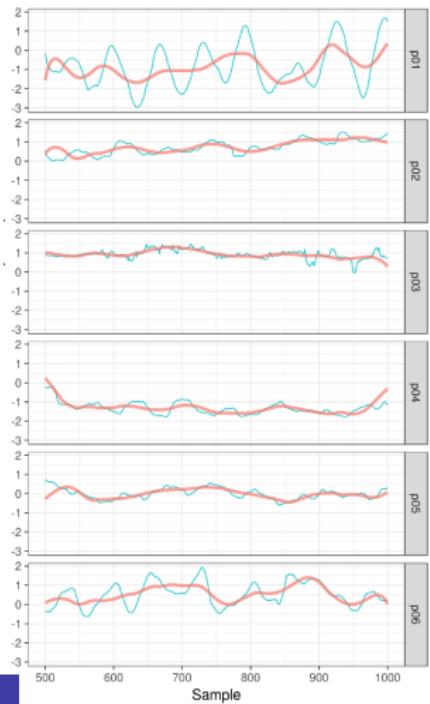
RSS ($m10 \tau 10$) for sgzmuvAx



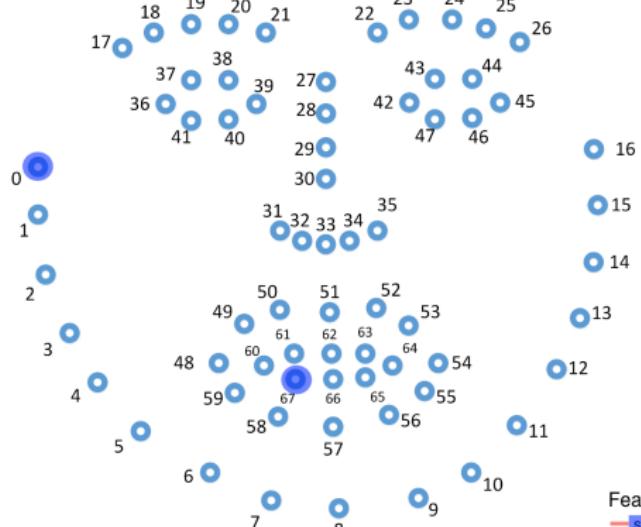
Euclidean Distances ($m10 \tau10$) for IMU



Features
— sgzmuvpose_ T_x
— zmuvpose_ T_x

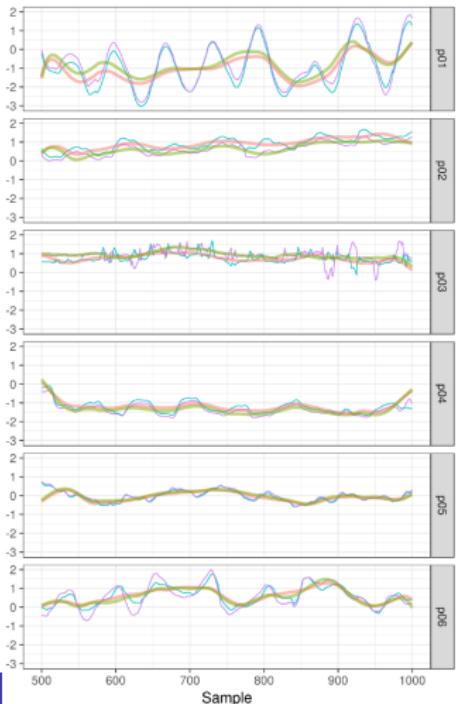


Time Series for OpenFace pose T_x

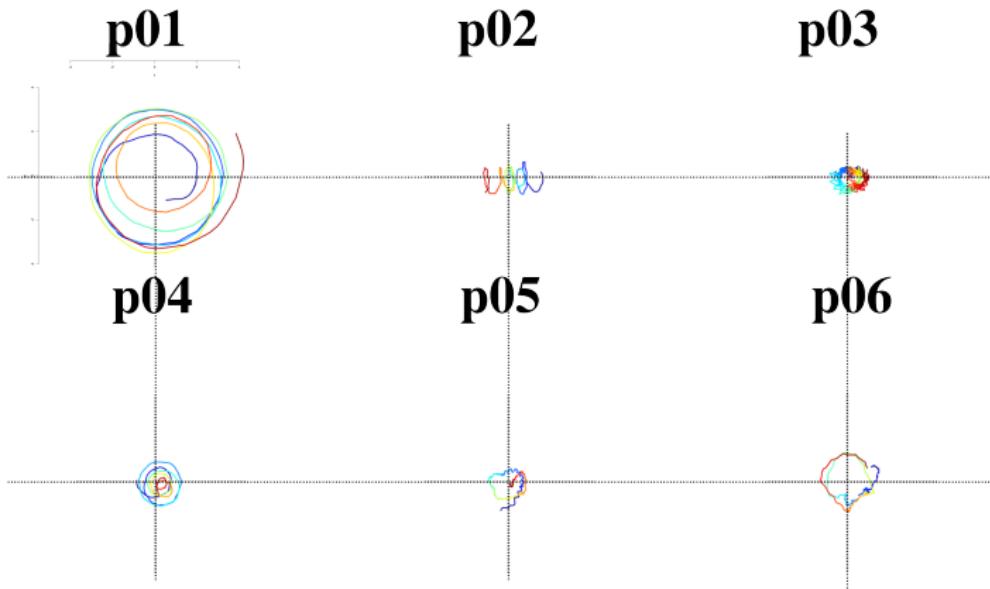


Features

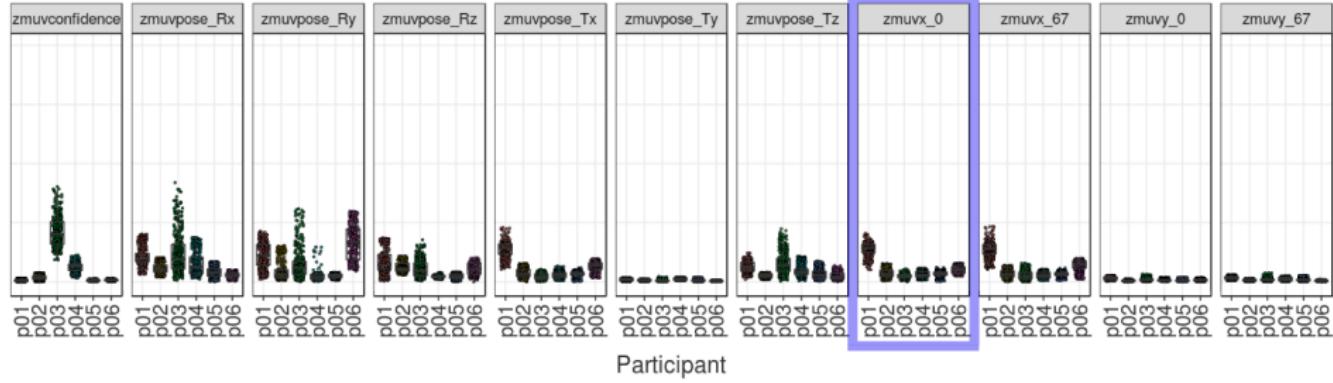
- sgzmuvx_0
- sgzmuvx_67
- zmuvx_0
- zmuvx_67



Time Series for OpenFace Landmarks



RSS ($m10 \tau10$) for zmuvx_0



Euclidean Distances ($m10 \tau 10$) for Openface

CONCLUSIONS AND FUTURE WORK

CONCLUSIONS FUTURE WORK

- Quantification Arm Movement Variability with Nonlinear Dynamics
- However,
- Timeseries from the landmarks are mounted on the pose location of the head.

- Test other techniques of Nonlinear Dynamics, e.g. Lyapunov Exponents, Recurrent Quantification Analysis
- Use of Convolutional Neural Networks for automatic identification of Movement Variability

BIBLIOGRAPHY



Jostine Ho

»Facial Emotion Recognition«

GitHub repository (2016), <https://github.com/JostineHo/mememoji>



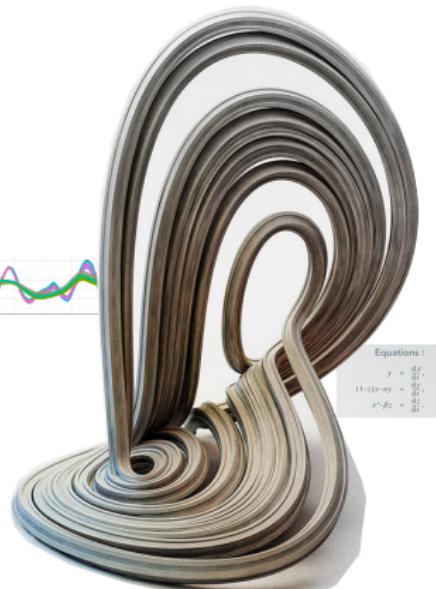
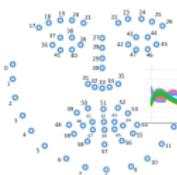
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<http://mxochicale.github.io/>



Equations :

$$\begin{aligned} \dot{x}_1 &= \frac{dx_1}{dt} \\ (1-\alpha)x_1\alpha x_2 &= \frac{dx_2}{dt} \\ x_1^2\beta_2 &= \frac{dx_3}{dt} \end{aligned}$$



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