JULES FRANÇOISE

DESIGNING INTERACTIVE AUDITORY FEEDBACK BY DEMONSTRATION

jules.francoise@limsi.fr | julesfrancoise.com
LIMSI-CNRS
Orsay, France

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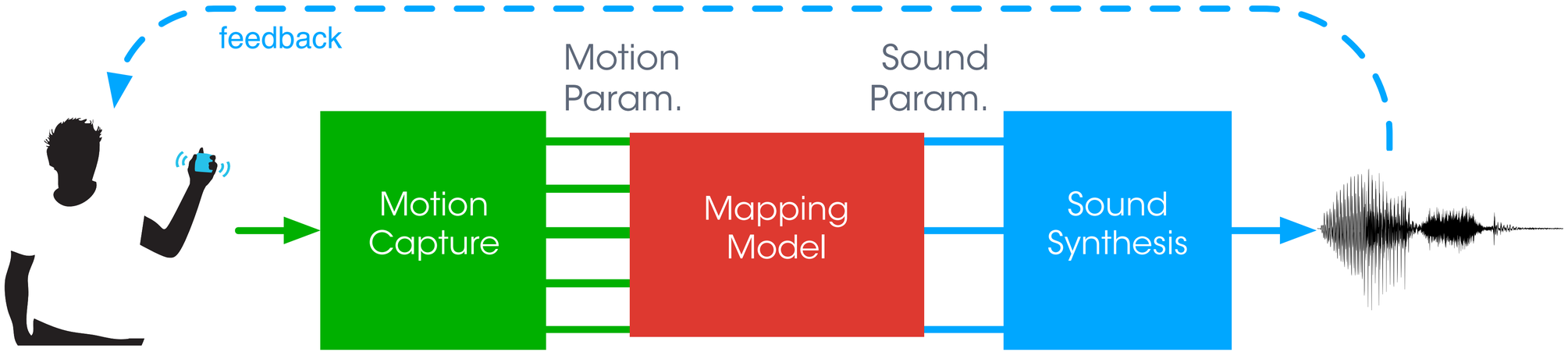
AUDITORY FEEDBACK SYSTEMS

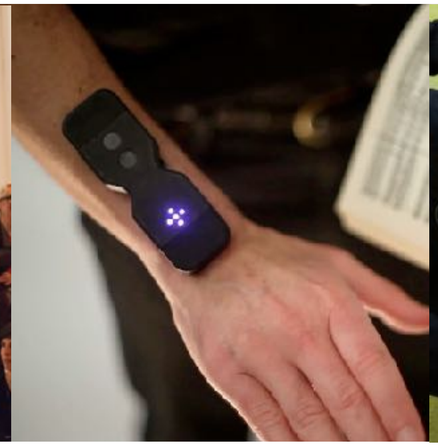


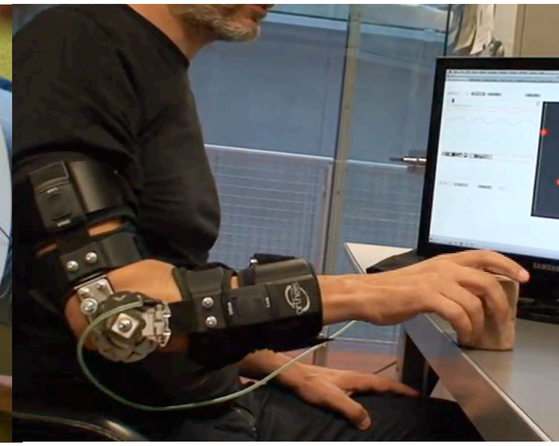
real-time **continuous** and **multidimensional** interaction

APPLICATIONS

Music & Performing Arts — Installations & Gaming — Movement Learning







sound = explicit goal

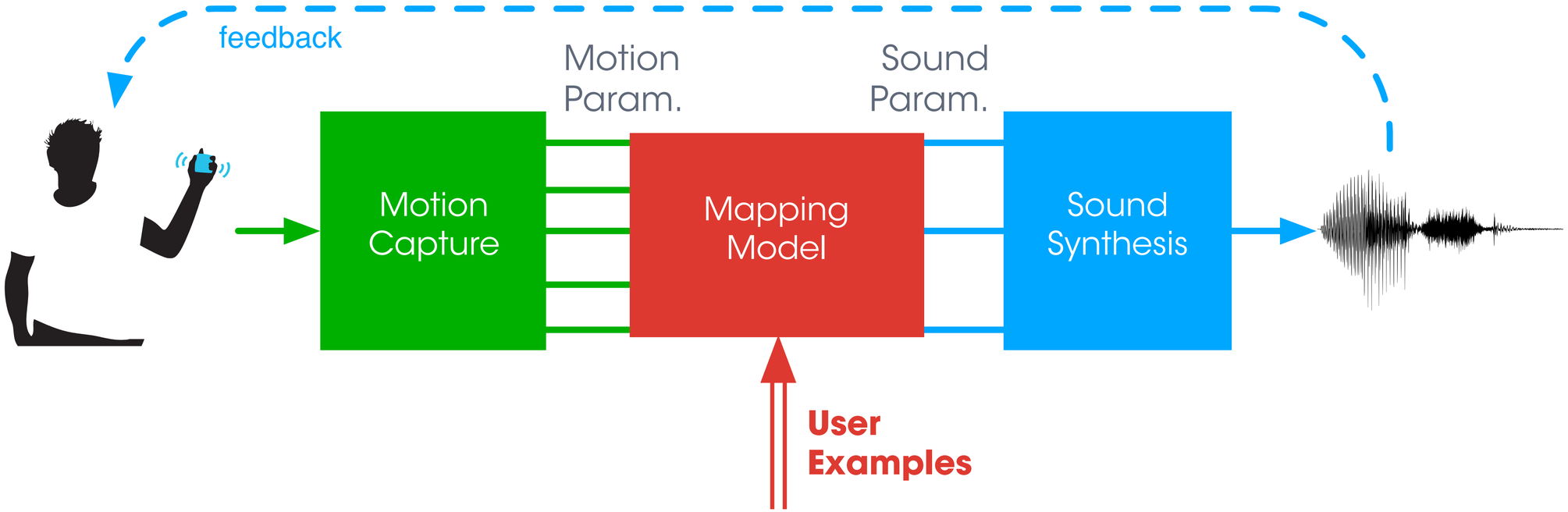
sound = implicit support to movement

=> need for personalization / user adaptation

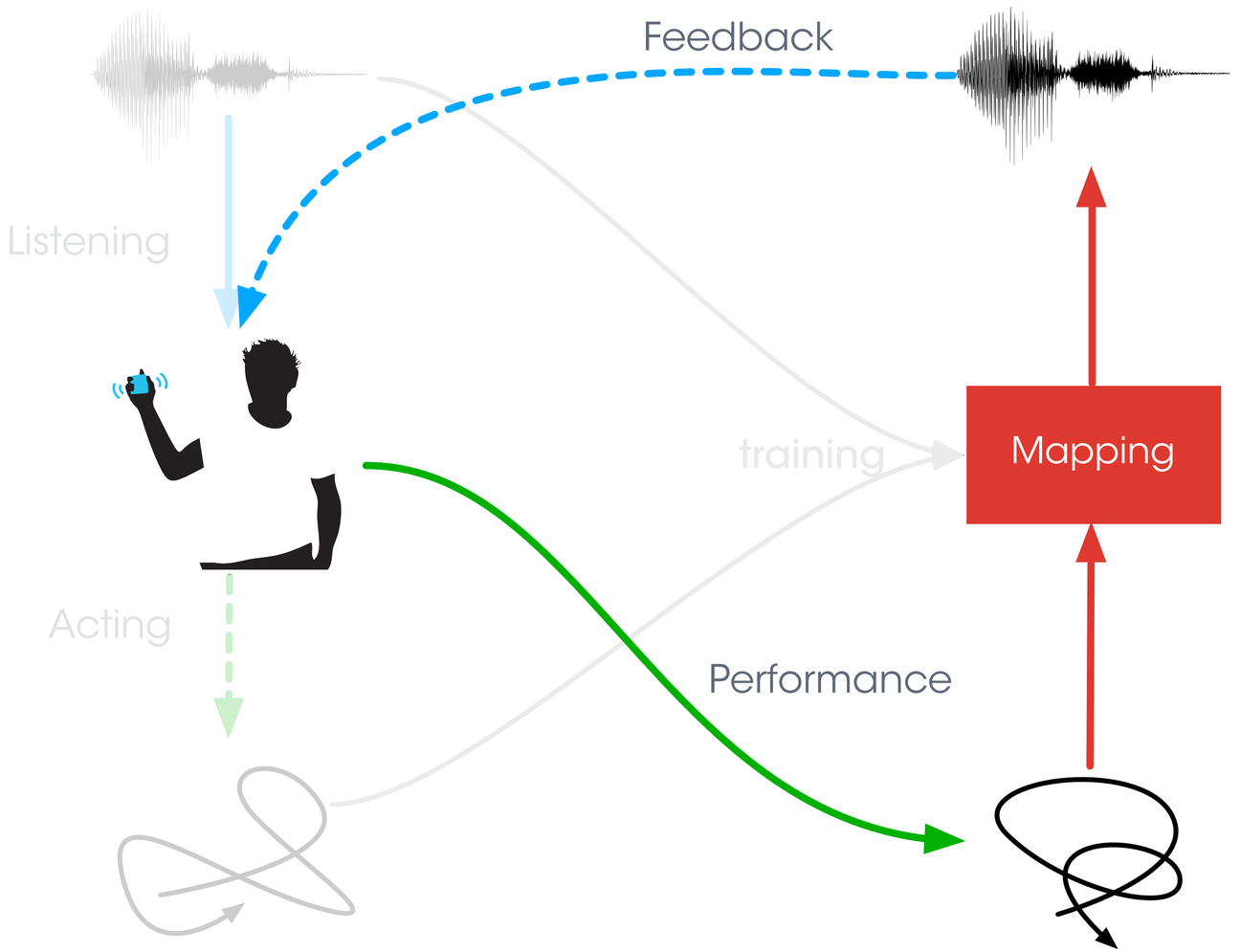
MOTION-SOUND MAPPING BY DEMONSTRATION

MOTION-SOUND MAPPING

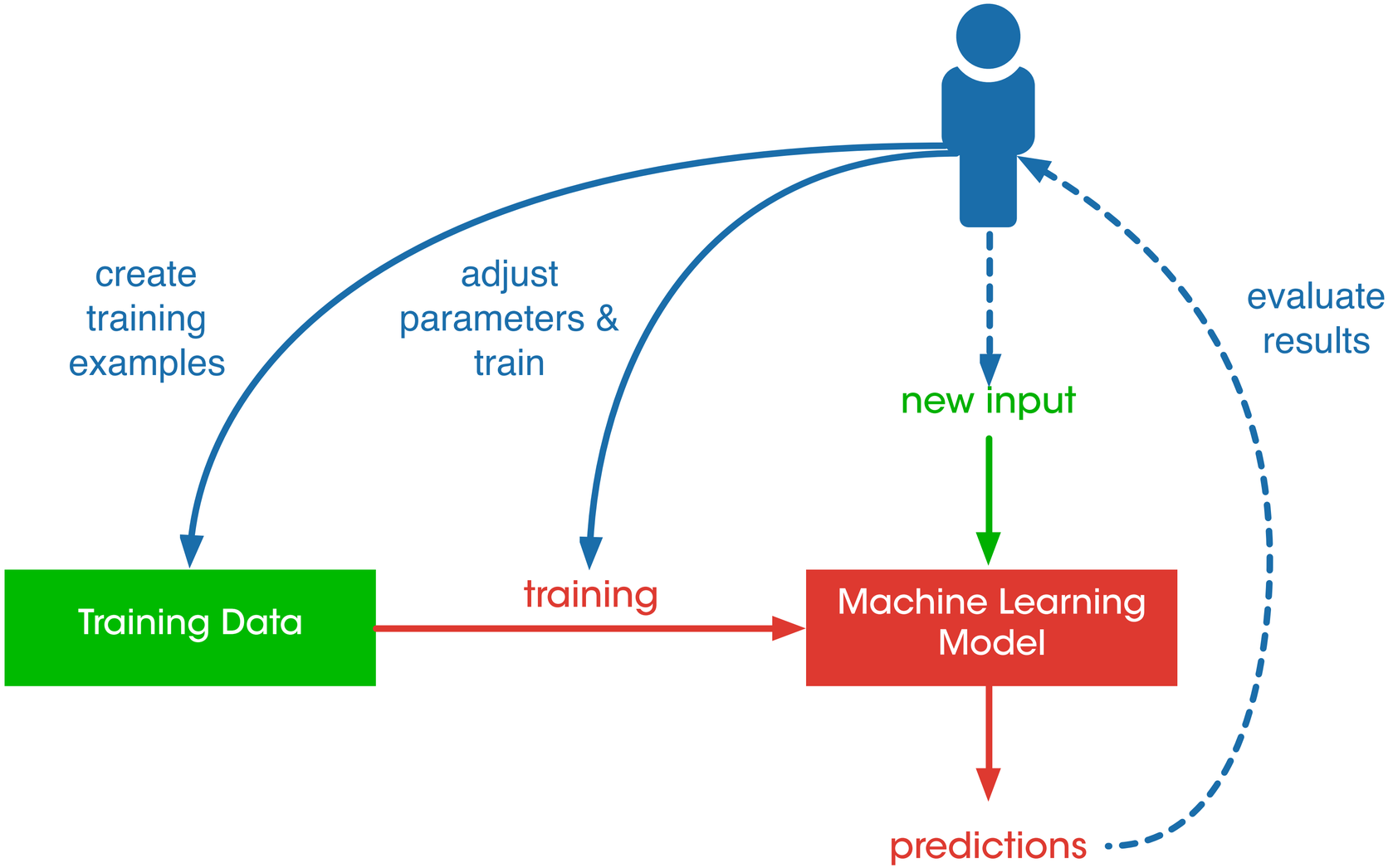
Implicit Mapping with Machine Learning



PRINCIPLE


Feedback
Listening
training
Mapping
Acting
Performance
demonstration
performance

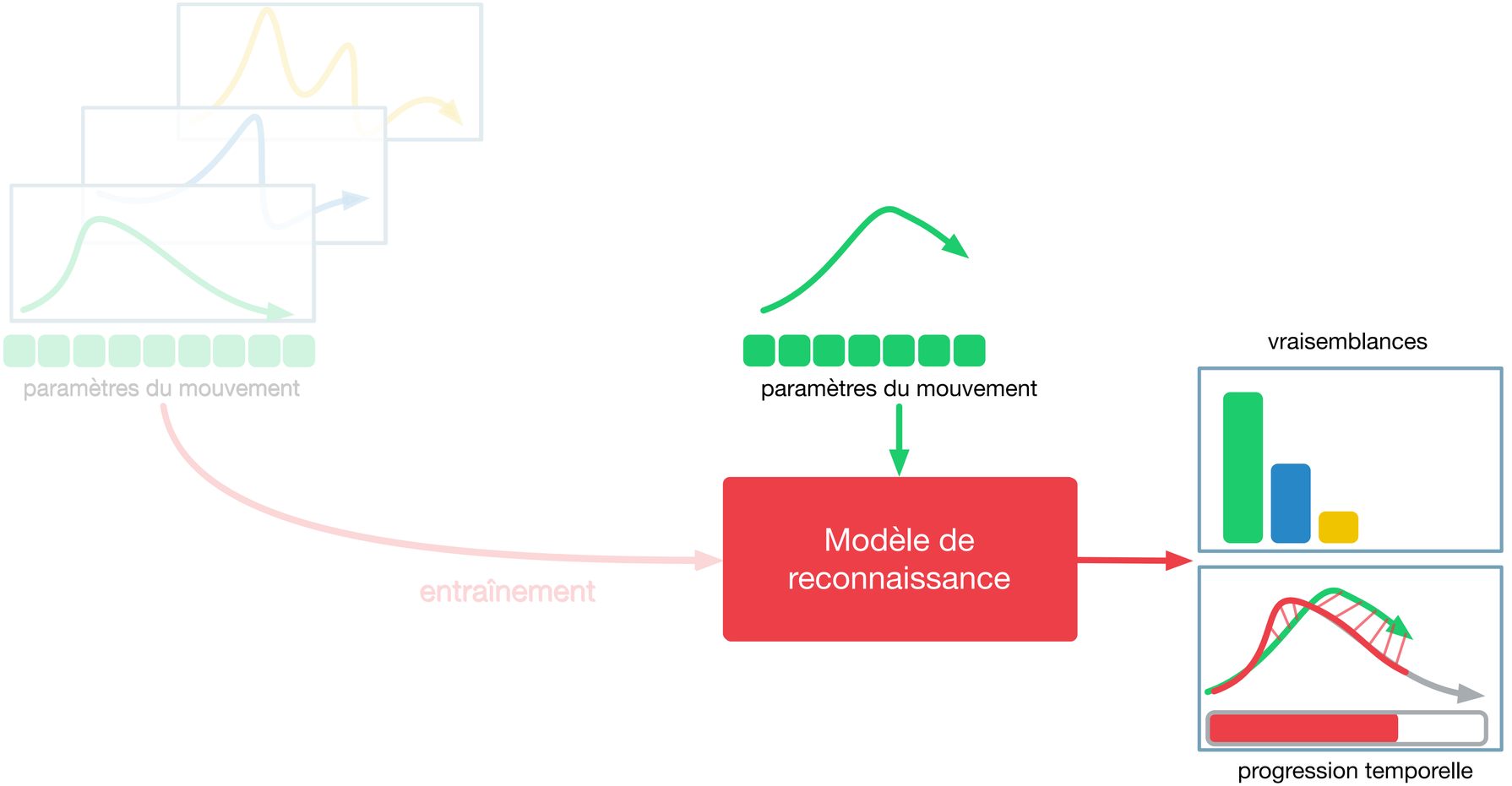
INTERACTIVE MACHINE LEARNING



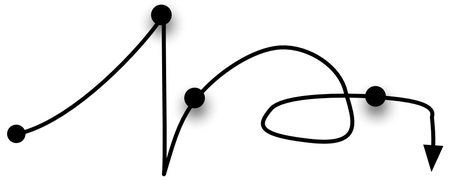
MODELS

	Recognition	Generation
Instantaneous	**Gaussian Mixture Models** gmm	**Gaussian Mixture Regression** gmr
Temporal	**Hierarchical Hidden Markov Models** hhmm	**Hierarchical Hidden Markov Regression** hhmr

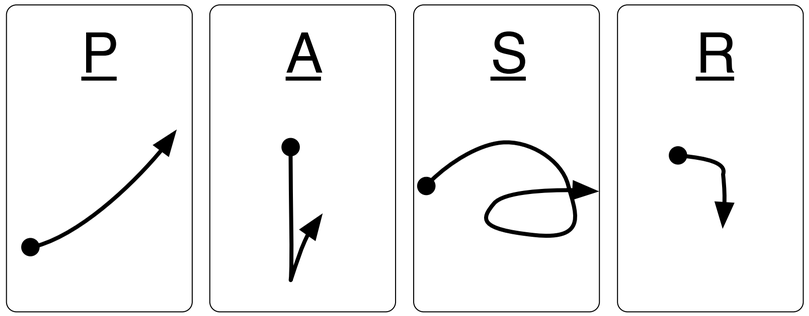
RECOGNITION MODELS



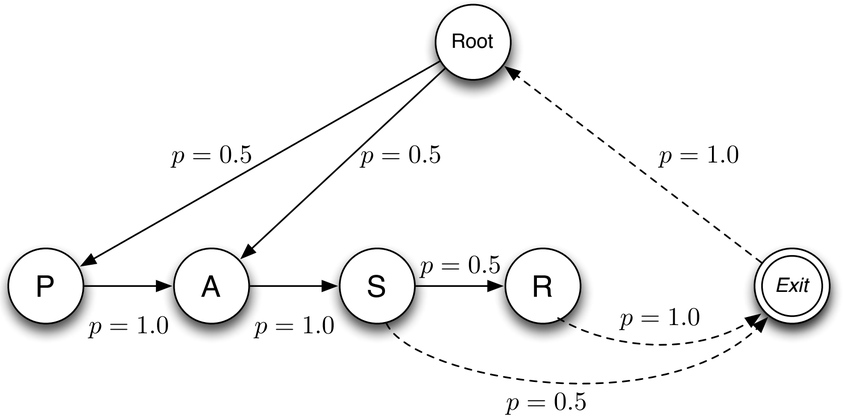
HIERARCHICAL MARKOV MODELS



Example gesture



PASR decomposition

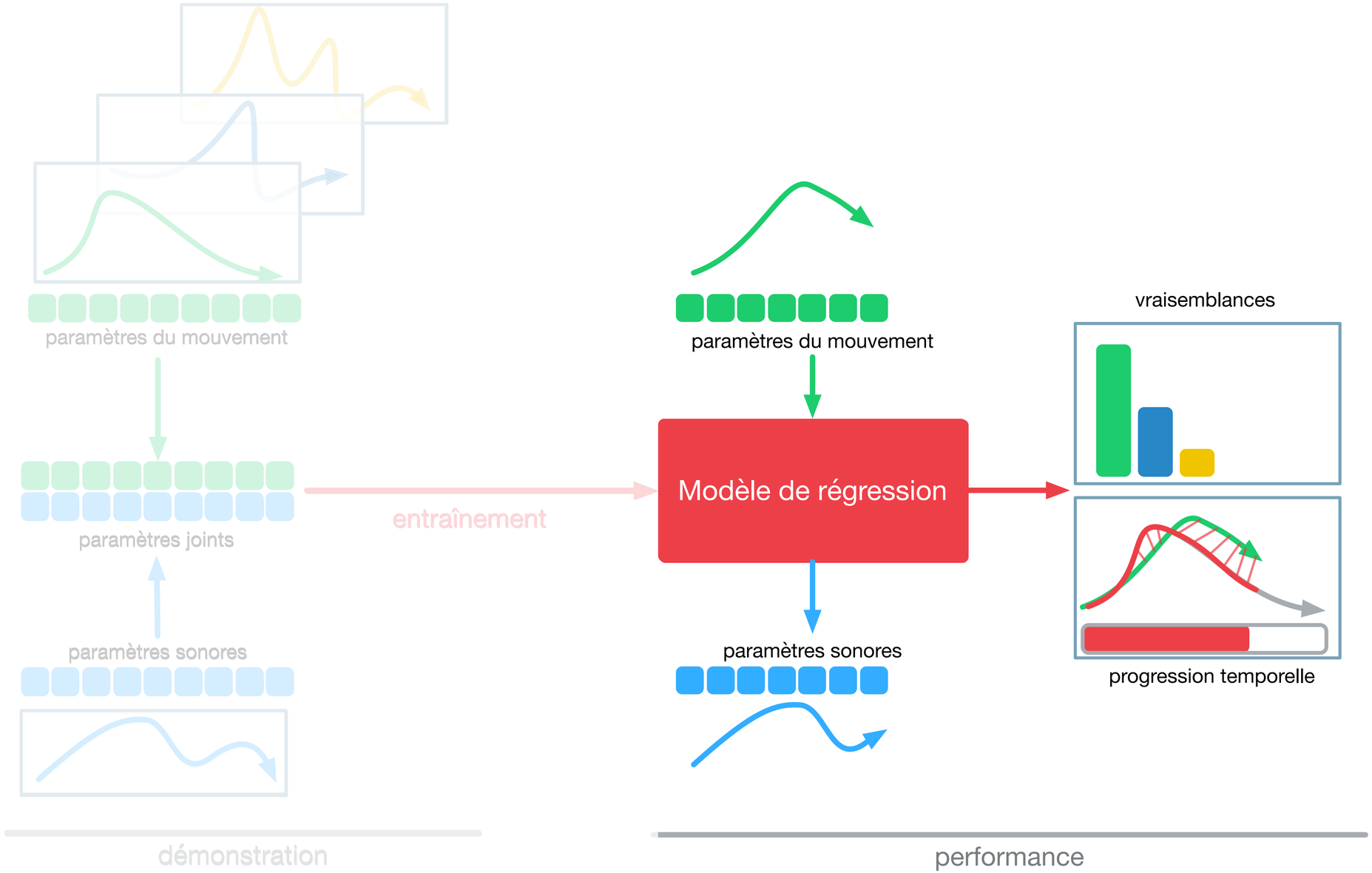


4 Phases:

Preparation	**(P)**	> anticipation gesture
Attack	**(A)**	
Sustain	**(S)**	
Release	**(R)**	> retraction gesture

[Francoise et al., SMC 2012]

GENERATIVE MODELS



DISCUSSION

Discussion

DESIGNING WITH MACHINE LEARNING

- **Advantages**
  - No need for a formal (mathematical) description of the problem
  - Design using bodily knowledge
  - Specification of (possibly complex) target gestures for sonification
  - Individualized adaptation

- **But…**
  - How do we make it work?

Discussion

DESIGN PROCESS

- **Process**
  - The user imagines a vocabulary of gestures (+ sounds)
  - The user records demonstrations
  - The ML algorithm learns the mapping/classifier
  - It does **not** work.
- **Reasons for Failure**
  - *Technical factors*
    - Appropriate choice of sensor, features, model, and parameters
    - High-quality examples
  - *Cognitive and sensori-motor factors*
    - Gesture design + Execution

Discussion

AN ITERATIVE PROCESS

- **Co-adaptive perspective (partnership?)**
  - The human and the machine iteratively learn from each other
  - The user is responsible for most of the adaptation
  - MbD as a reflective tool

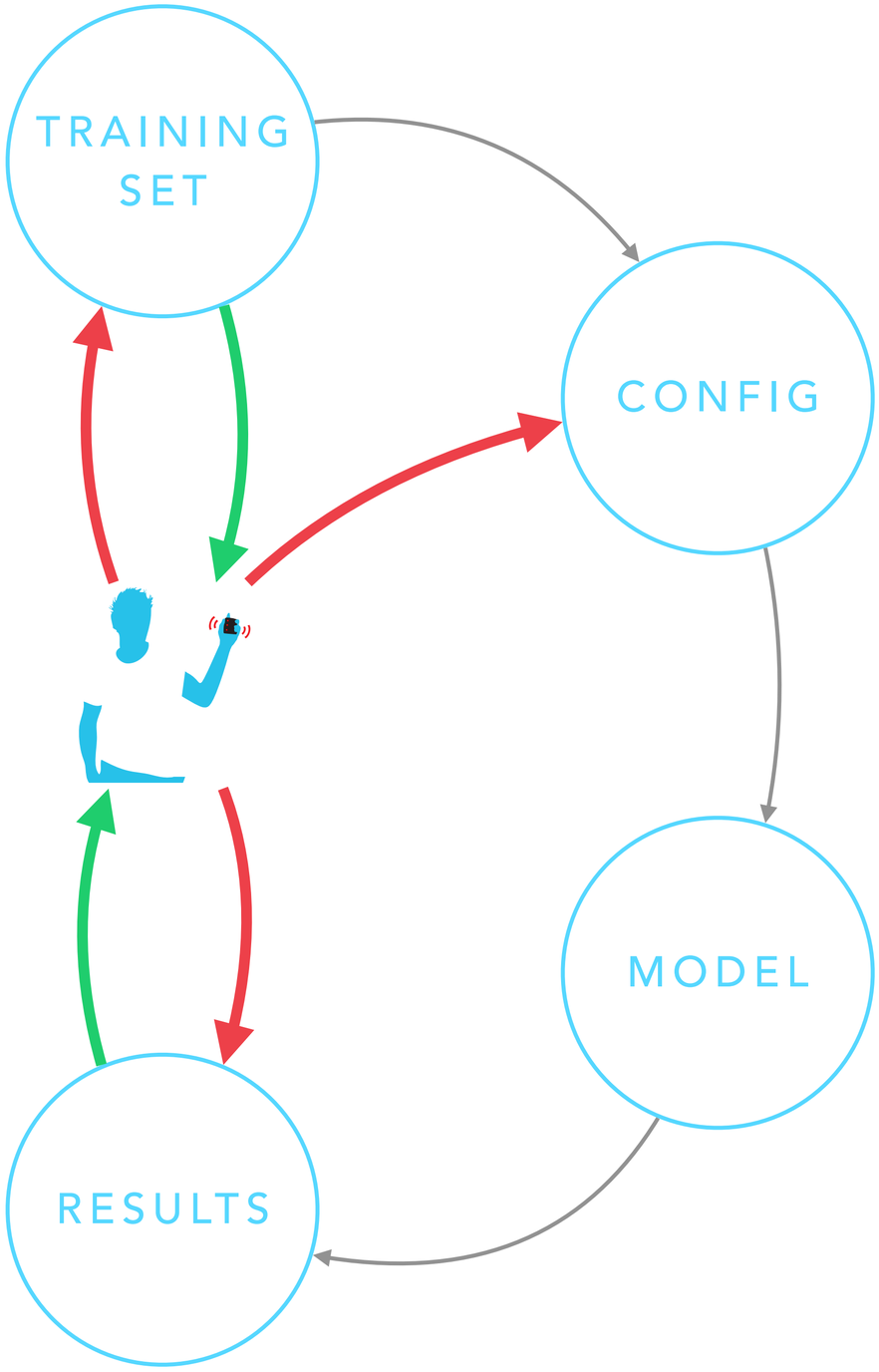
- **How to make it work?**
  - Improve the transparency
  - Support practice & exploration

VISUALIZING PROBABILISTIC MODELS

w. Fred Vernier, Antonin Cheymol

Visualizing probabilistic models

INTERACTIVE MACHINE LEARNING



1. Create Training Examples
    1. Feedback on Training Set
2. Adjust Parameters
3. Provide New Input
    2. Feedback on results {during interaction}

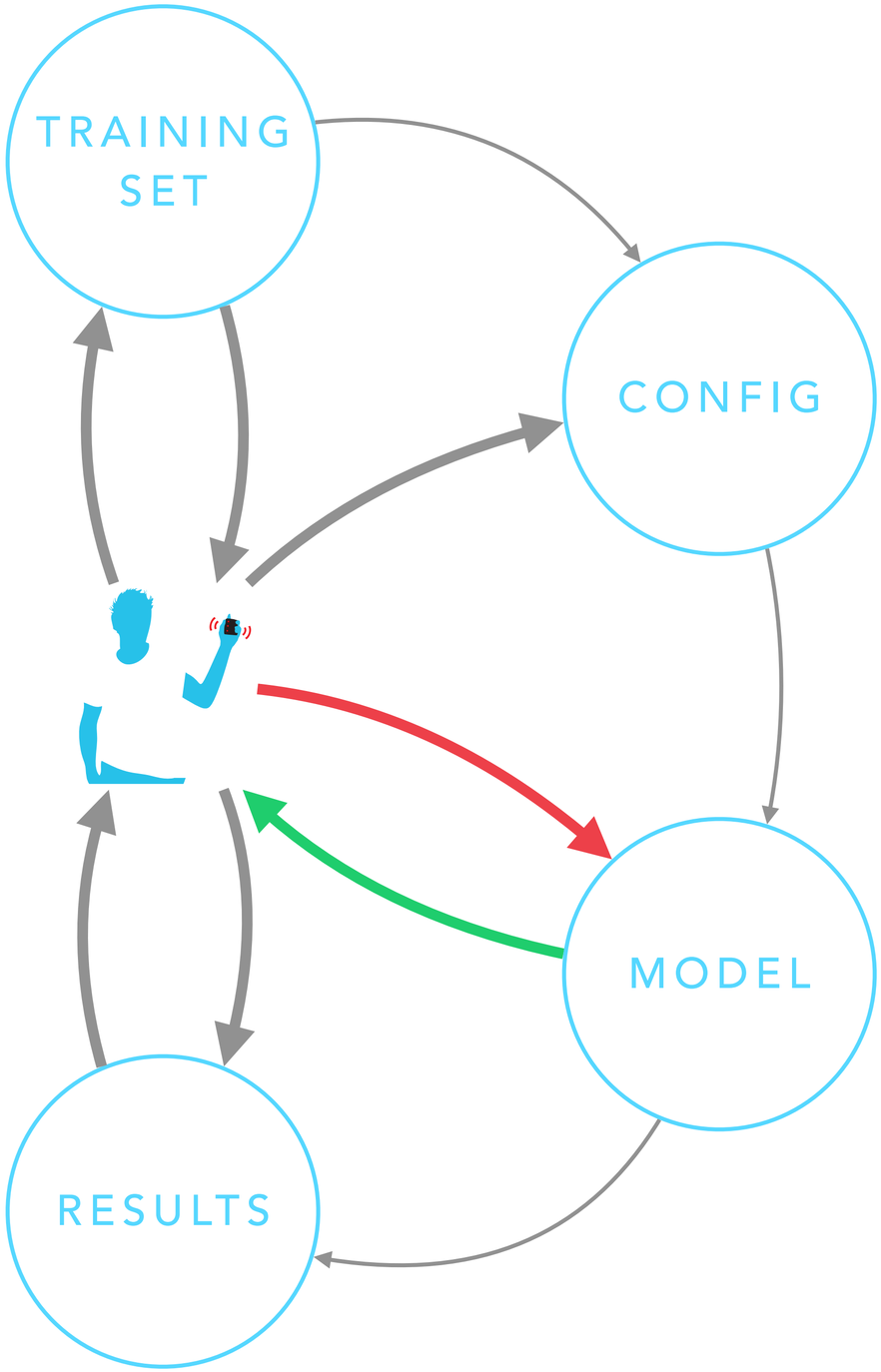
EnsembleMatrix, ModelTracker, …

Visualizing probabilistic models

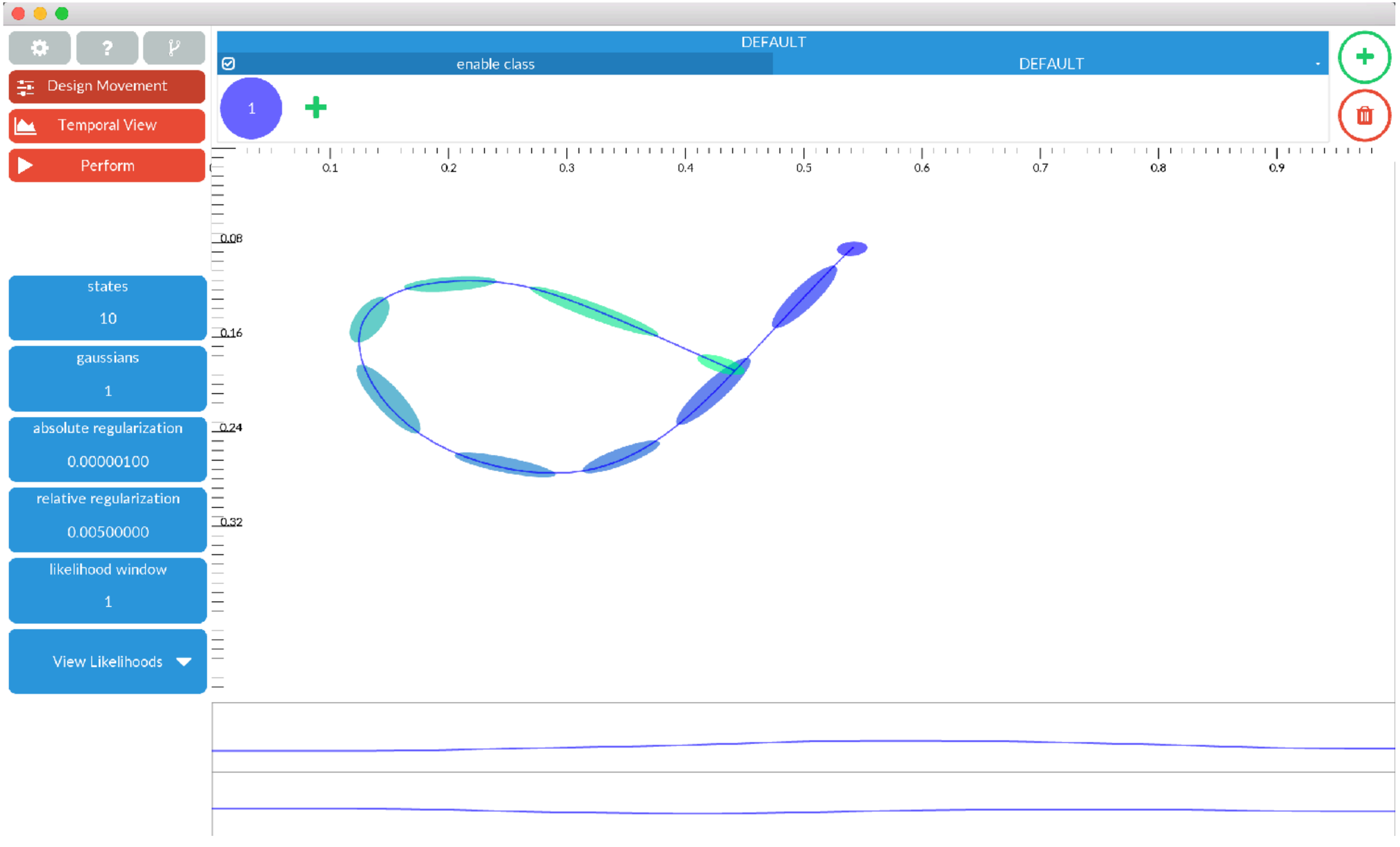
INTERACTIVE MACHINE LEARNING

1. Create Training Examples
    1. Feedback on Training Set

2. Adjust Parameters
    Visualize {inside} models
        => Manipulate models from visuals
3. Provide New Input
    2. Feedback on results {during interaction}



GAUSSBOX : HMM VISUALISATION



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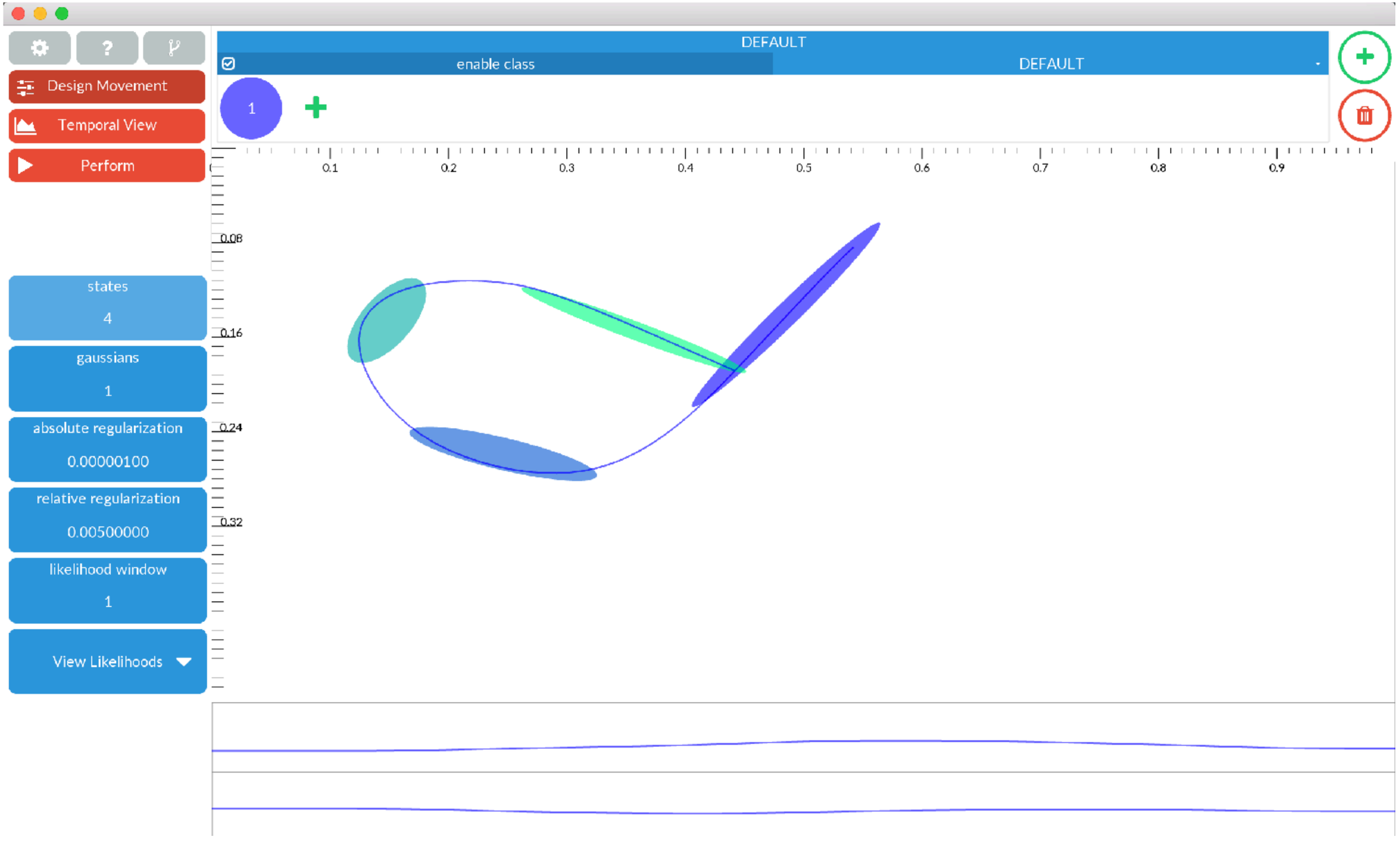

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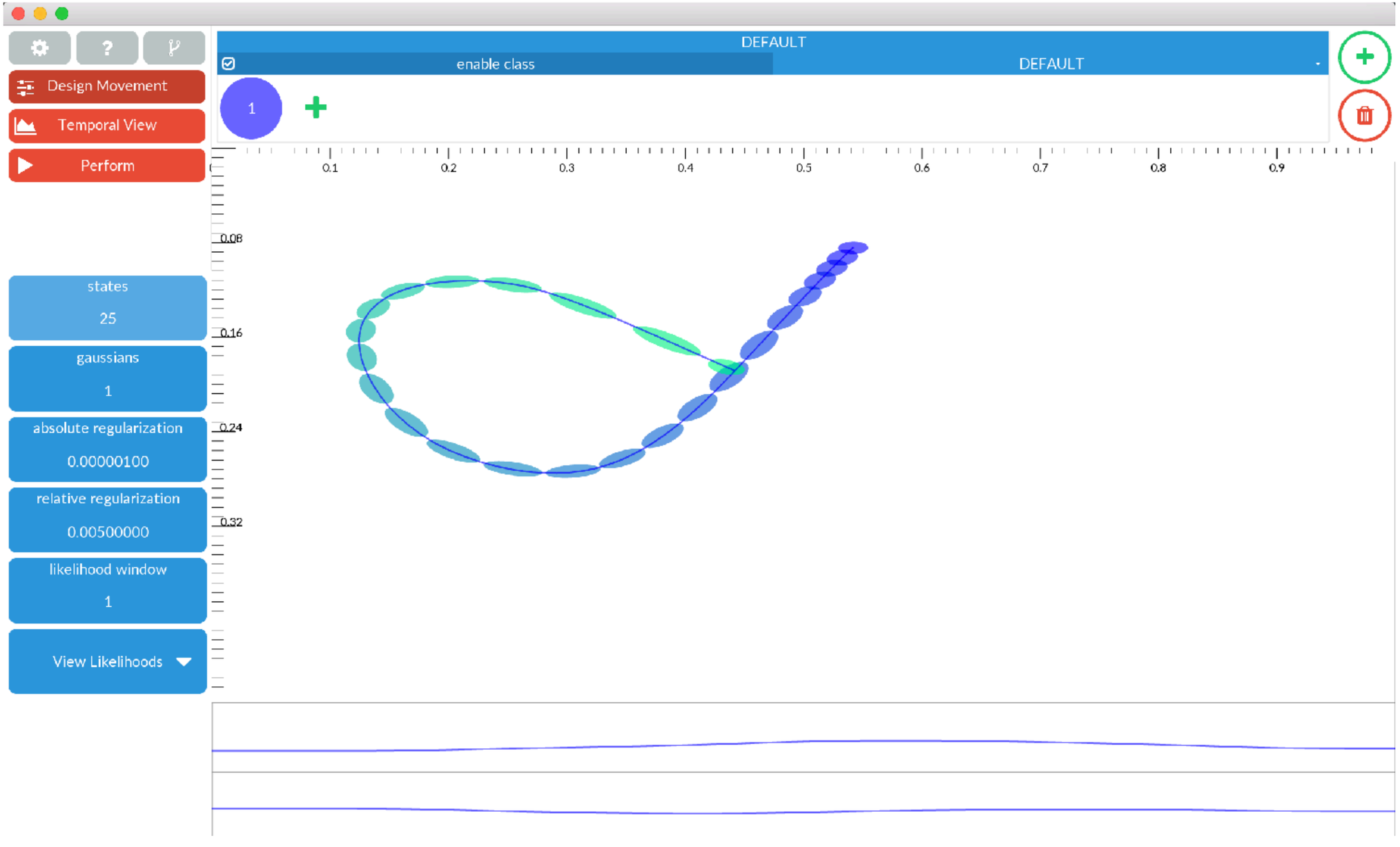

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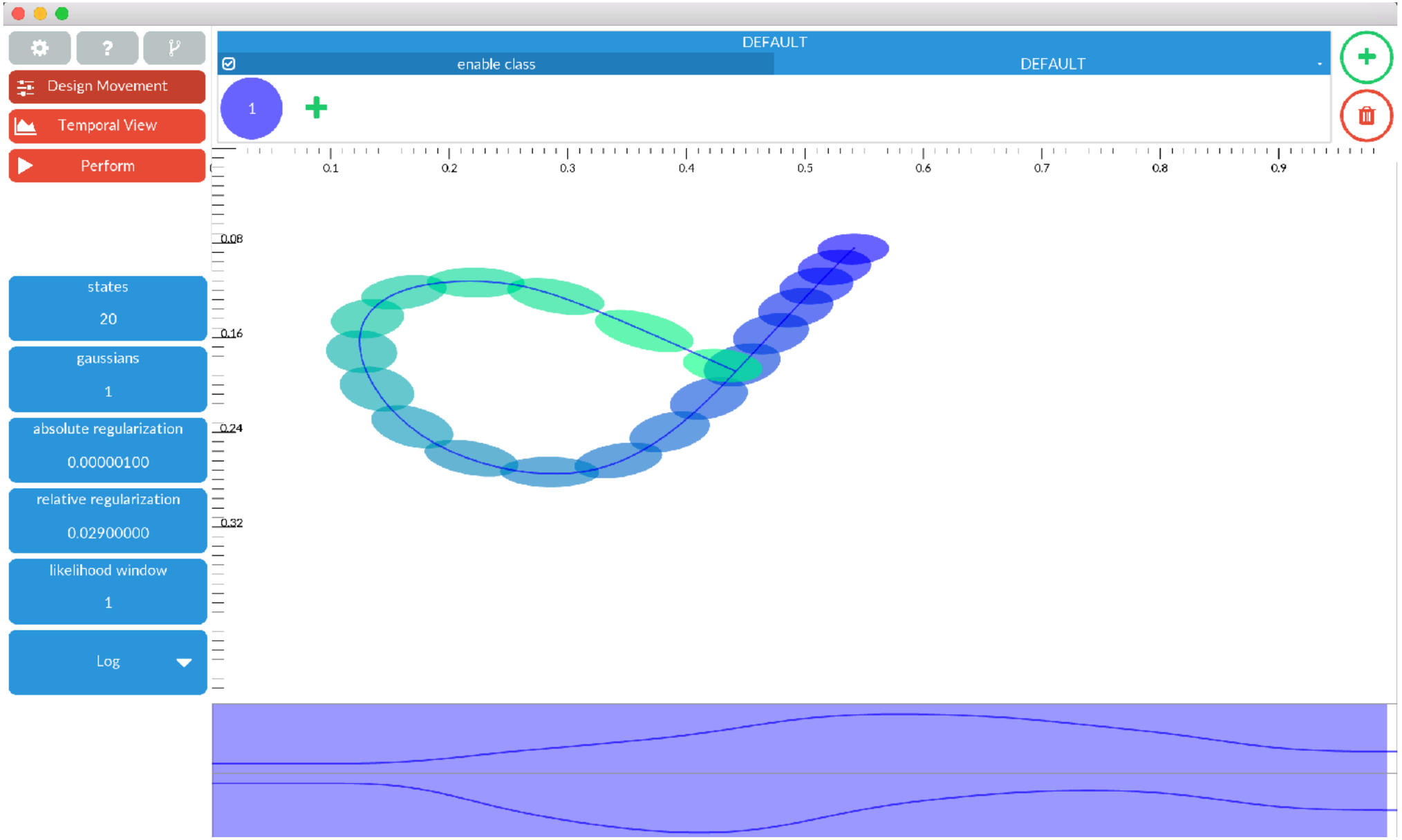

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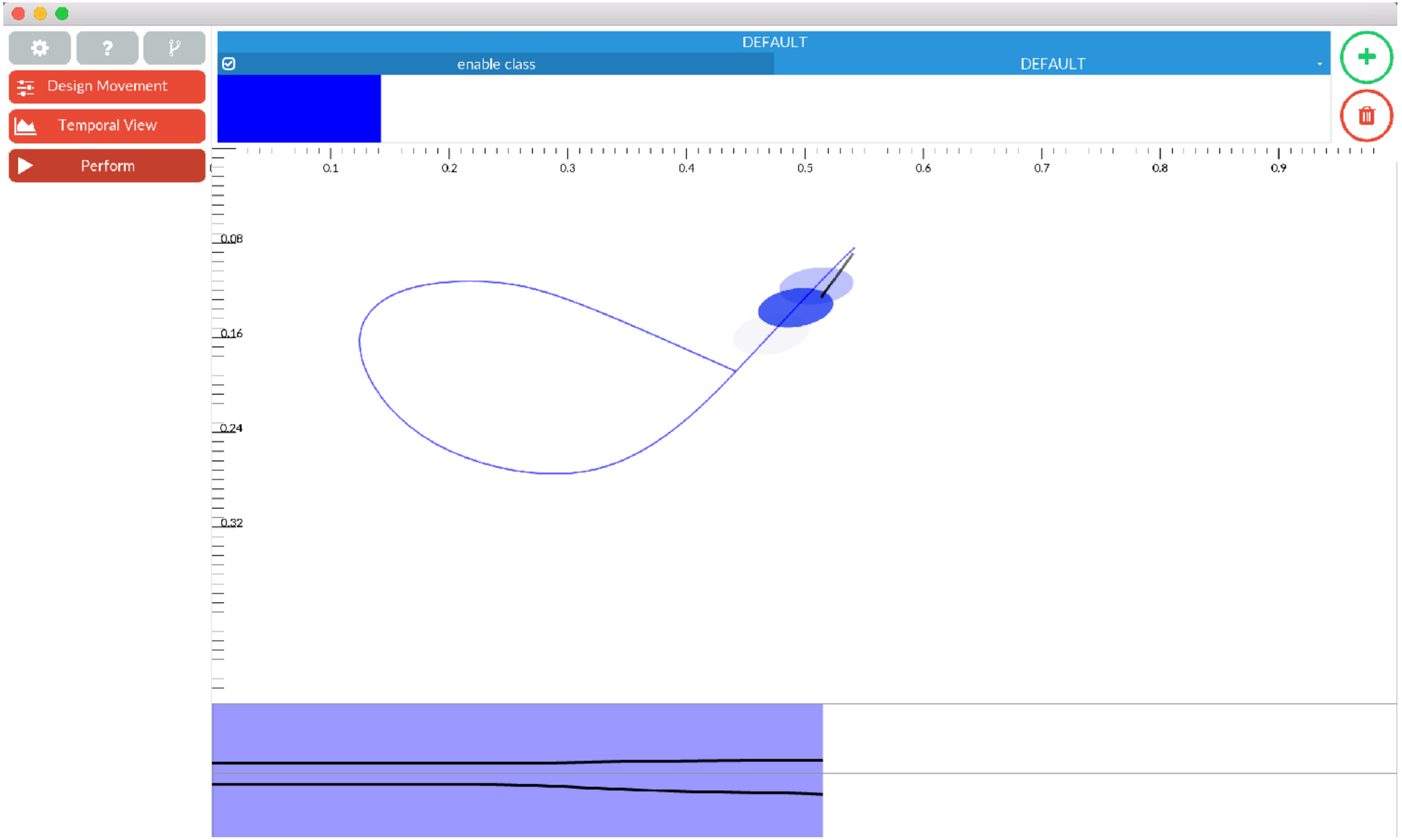

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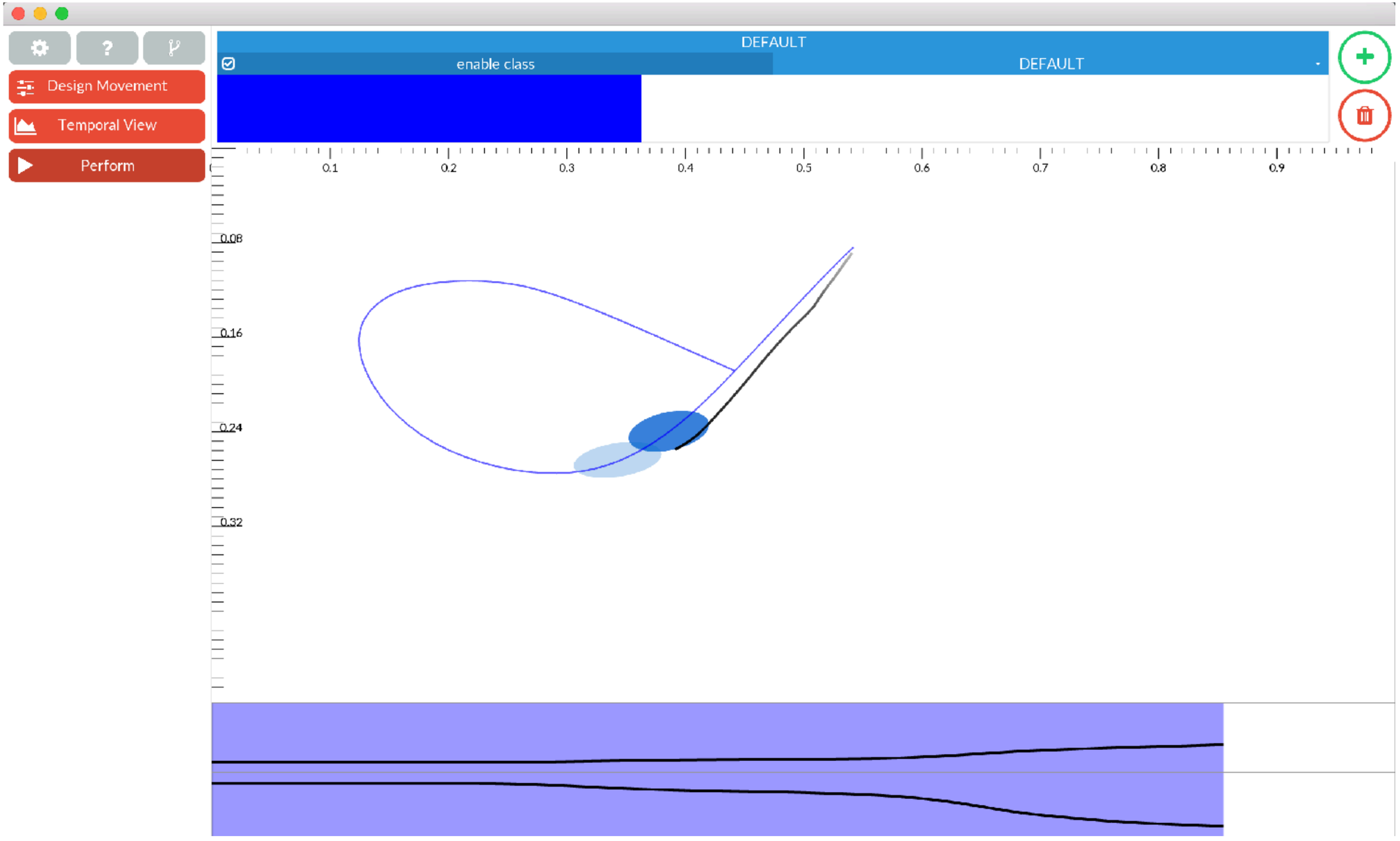

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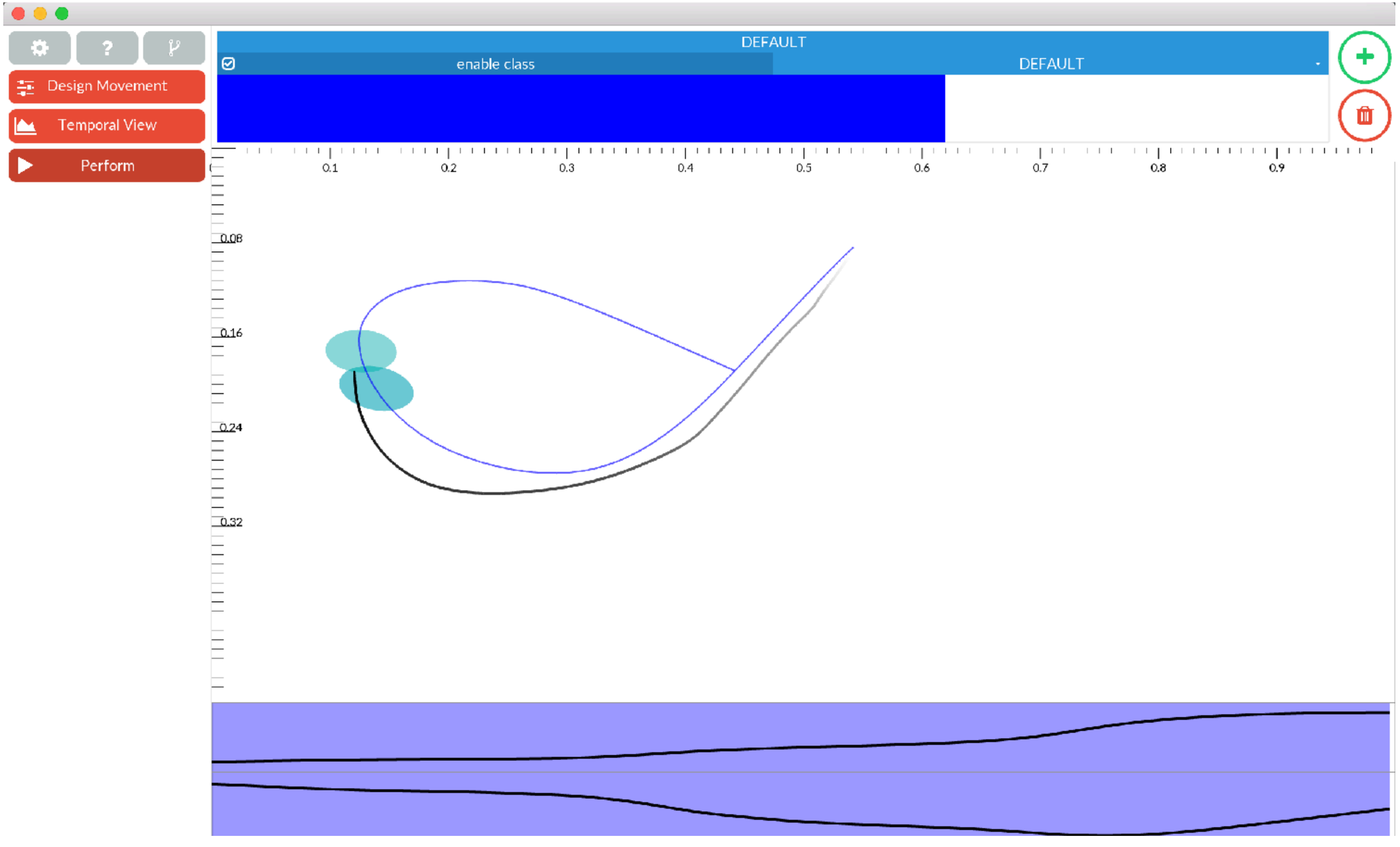

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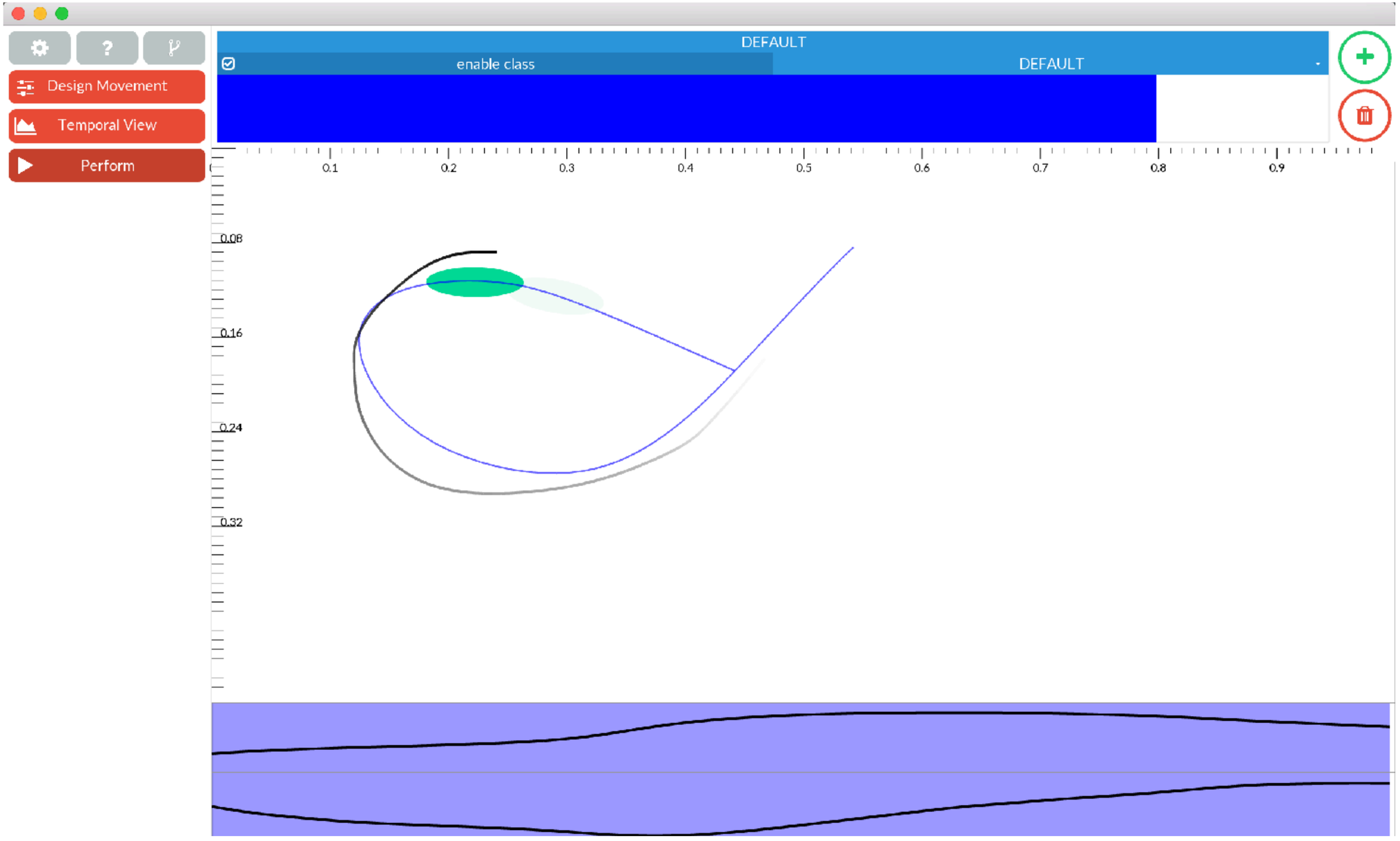

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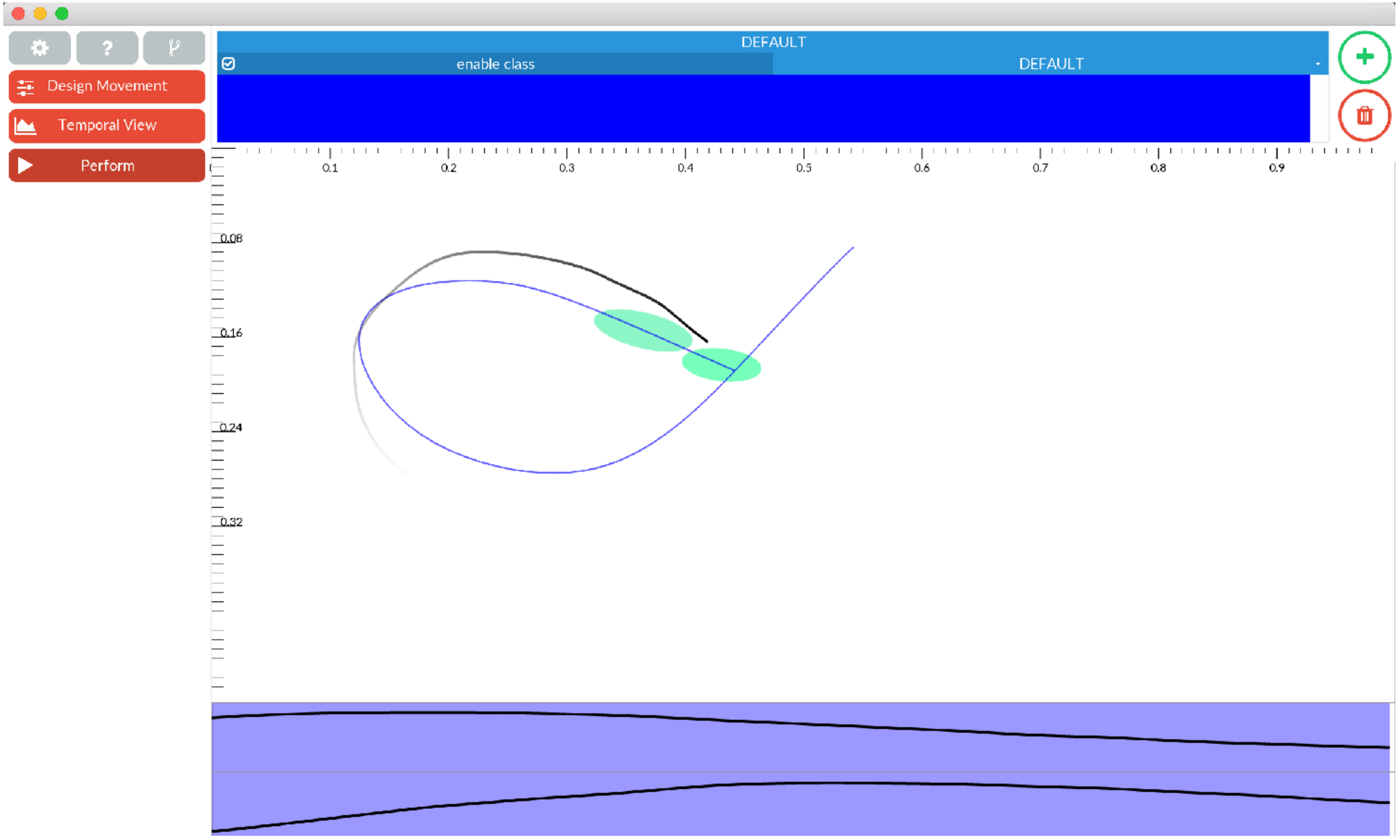

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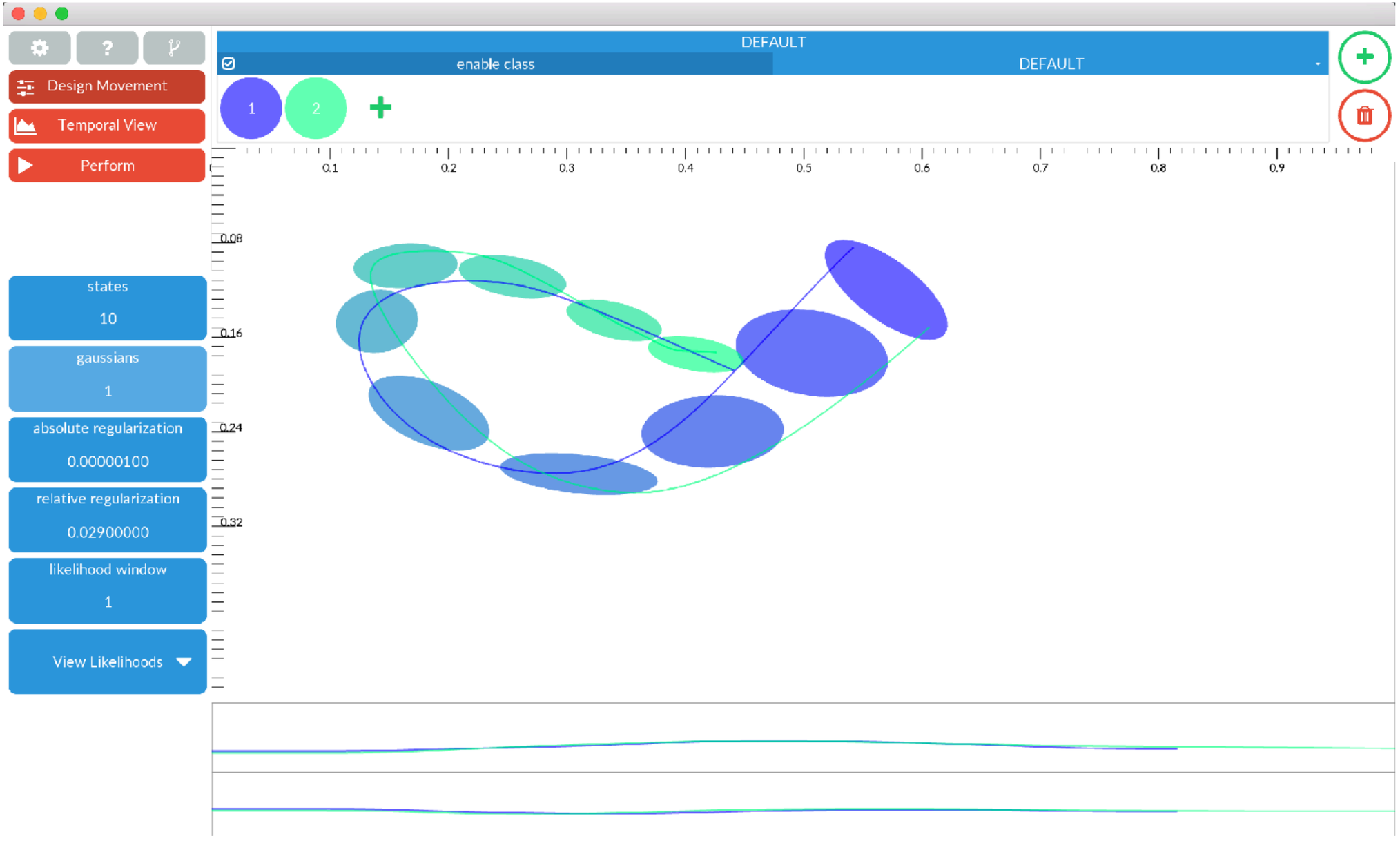
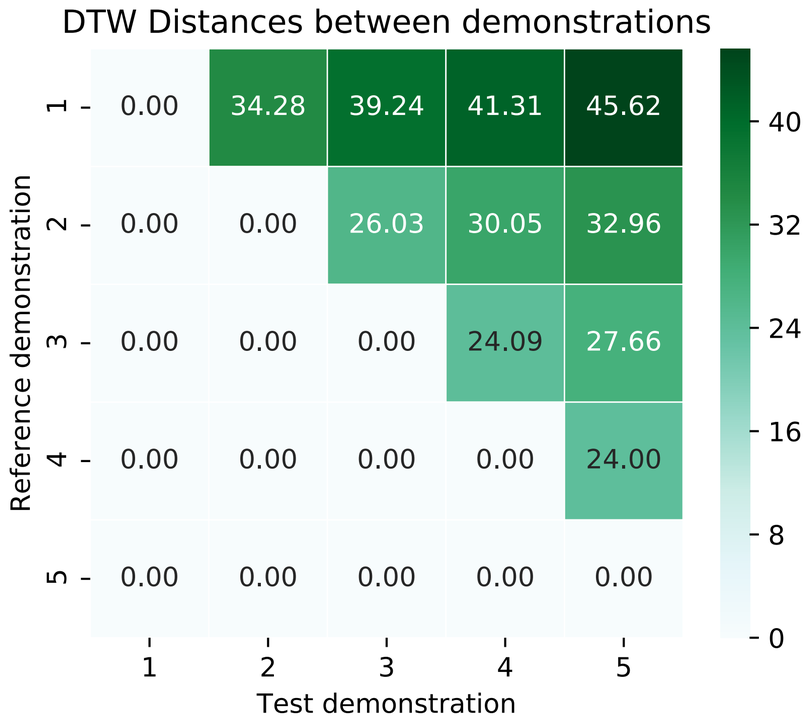
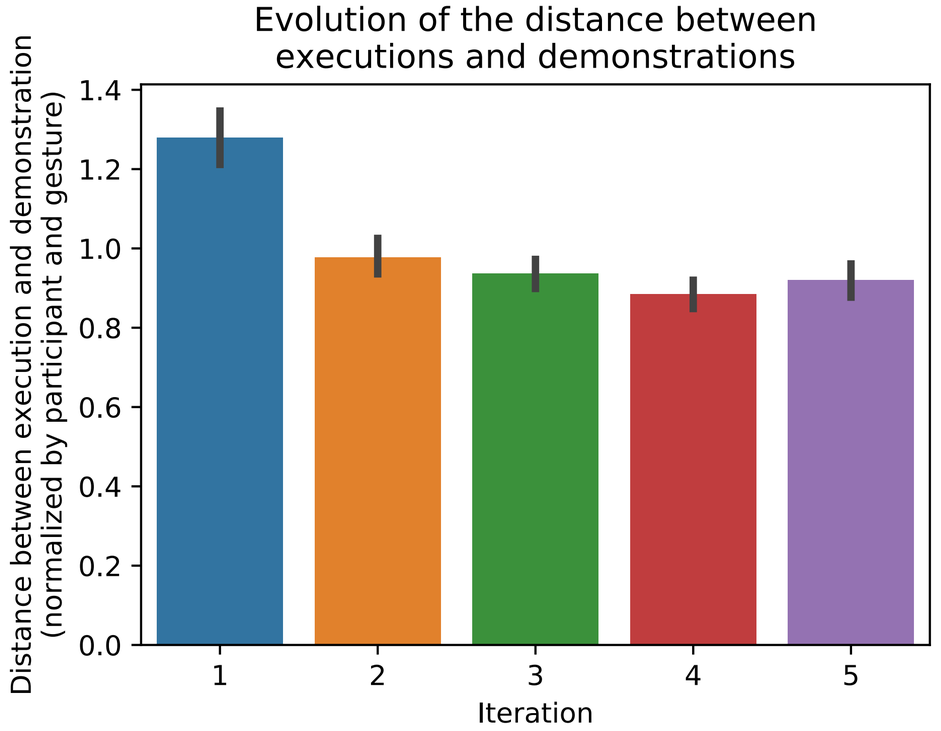


EXPLORING/PRACTICING

A LEARNING PROCESS

- *User study: sonification using vocalisation*
- Users adapt their gesture design by iterating over demonstration & performance
- The gesture design converges along iterations
- The consistency of the execution improves over time

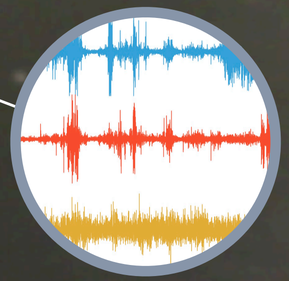




still, moving

(Interactive Sound Installation)

w. Sarah Fdili Alaoui, Yves Candau



Myo (Electromyogram)

Towards live-coding

w. Sarah Fdili Alaoui, Yves Candau, Lucie Van Nieuwenhuyze

CONCLUSIONS

- **Mapping by Demonstration**
  - Tool for personalising motion-sound interactions
  - From *designing by example* to *designing through practice*

- **How to support the design process**
  - Help users understand the models?
  - Support exploration & practice
  -

THANK YOU

… and thanks to many collaborators :

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