Automatic Behaviour Pattern Classification for Social Robots

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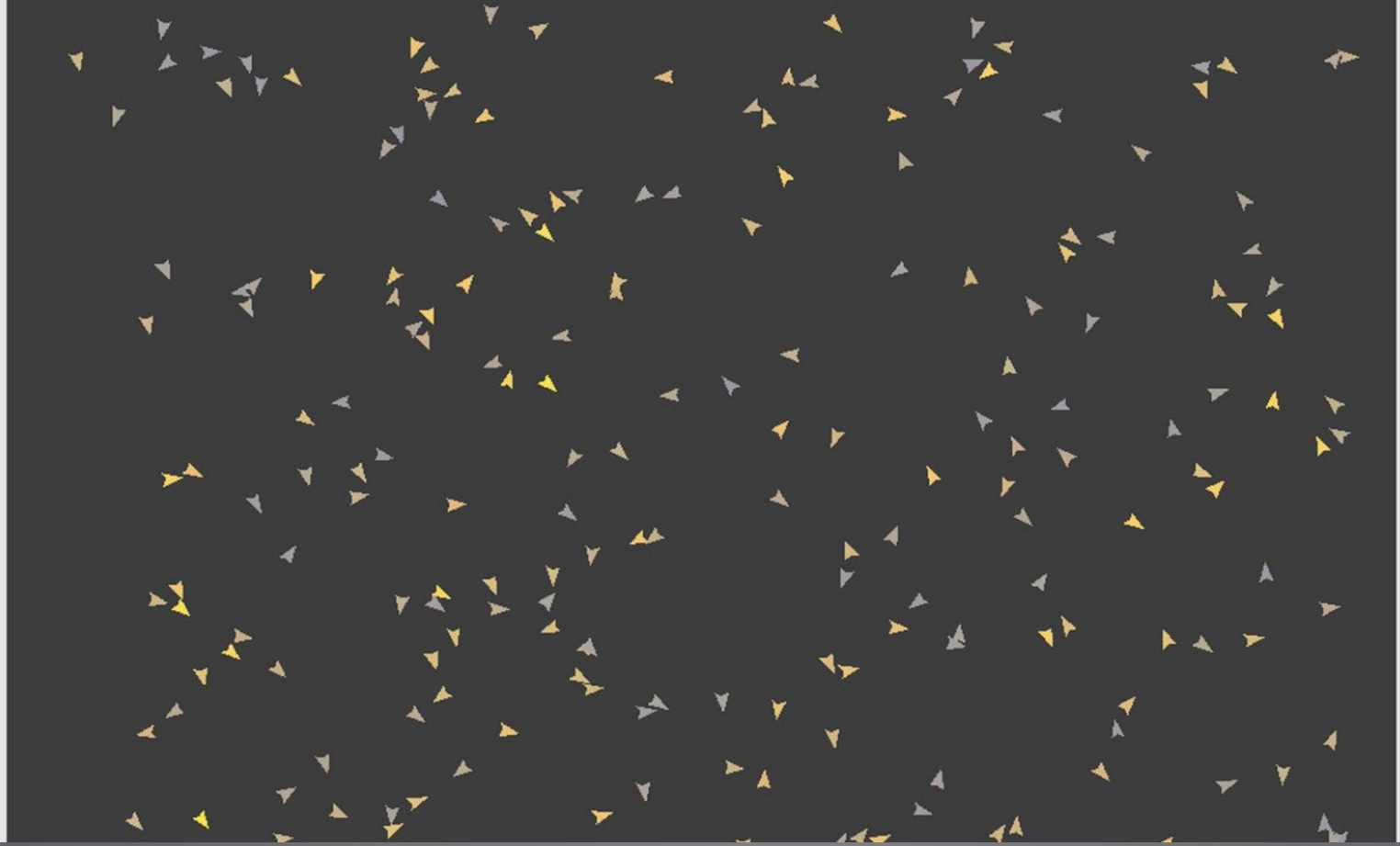
Overview

- Introduction:
  - Cognitive Developmental Robotics.
- Proposal
- Development:
  - ANPAC: Automatic Neural-based Pattern Classification.
- Results:
  - Motion patterns in flocks.
- Conclusions

Introduction

- ***Cognitive Developmental Robotics:***
  - It tries to obtain autonomous robot systems that continually adapt to their environment.
  - Autonomous development of social behaviours: communication, imitation, empathy, etc.
    - It must include some kind of description of the events that are not due to the robot.
- How to acquire and represent the information to guide the behaviour depending on the behaviour of its neighbors.

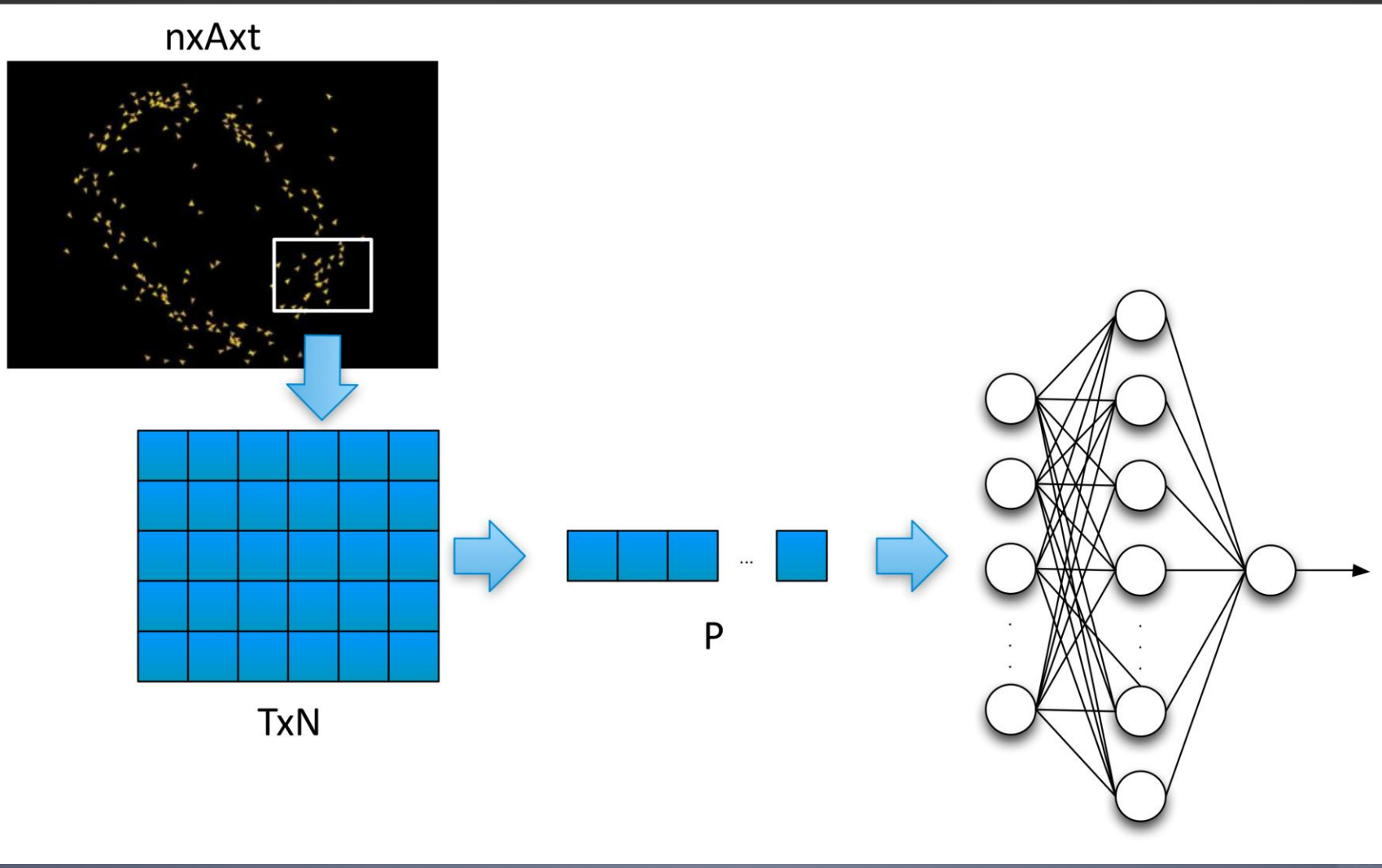
What is the problem?



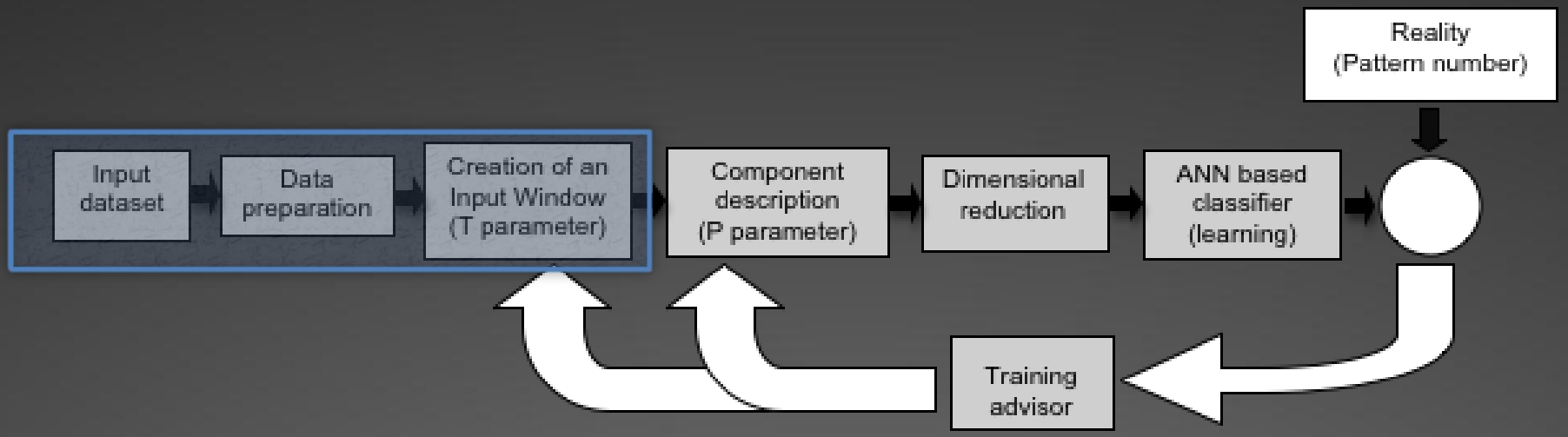
Proposal

- **A neural based pattern system which classifies behaviour patterns in other robot teams within the environment.**
- ***Main Contributions:***
  - It automatically adjusts the processing window size (T) and the preprocessing parameters.
  - It obtains the appropiate features (P) and reduces the amount of sensorial information.
  - Adaptive data classification strategy for large datasets.
- ***Objective:*** to classify the type of motion a multitude of agents is performing as a whole.

Development

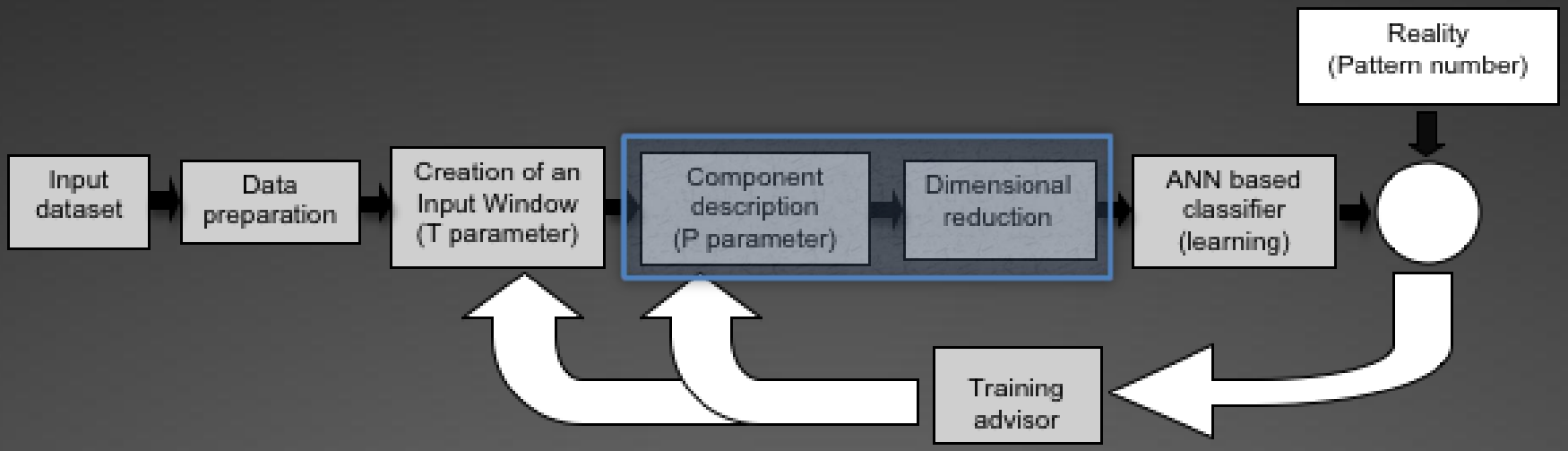


Development – Data preparation phase



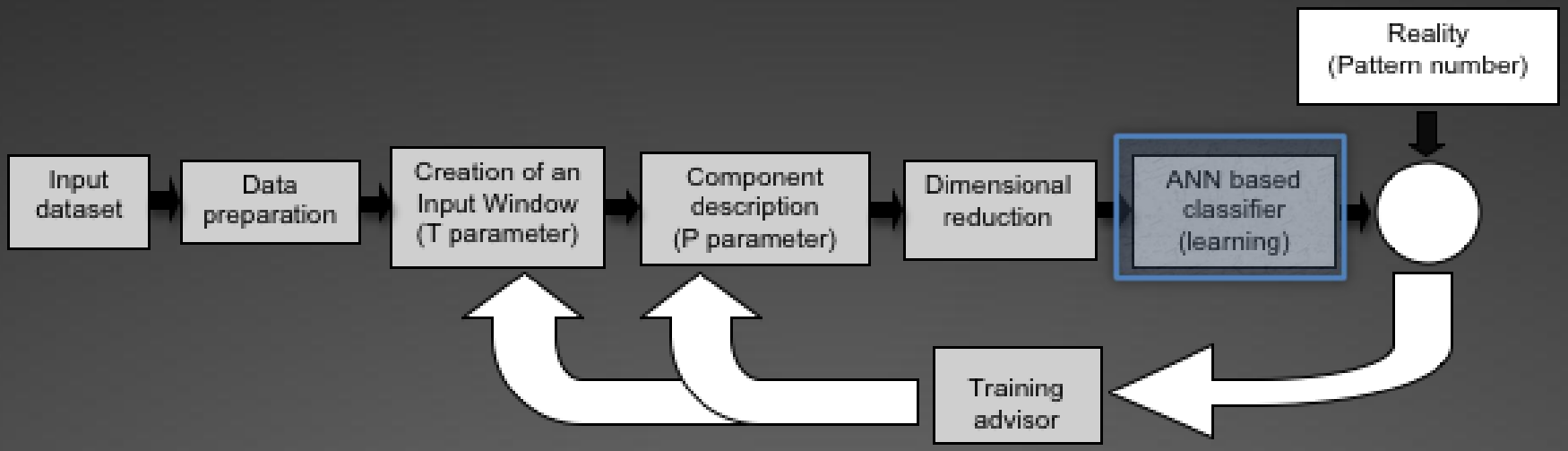
- ***Input dataset:*** high dimensional matrix with a representation of the behavior to be analyzed.
- ***Data preparation:***
  - Normalization to adapt the data to the ANN inputs.
  - ***Principal Component Analysis (PCA):***
    - It determines the principal components of the data.
    - It rewrites the vectors in terms of the projections over the principal components.
    - No information loss.
- ***Creation of the input window:*** select the T robots to be analyzed.

Development – Collective description phase



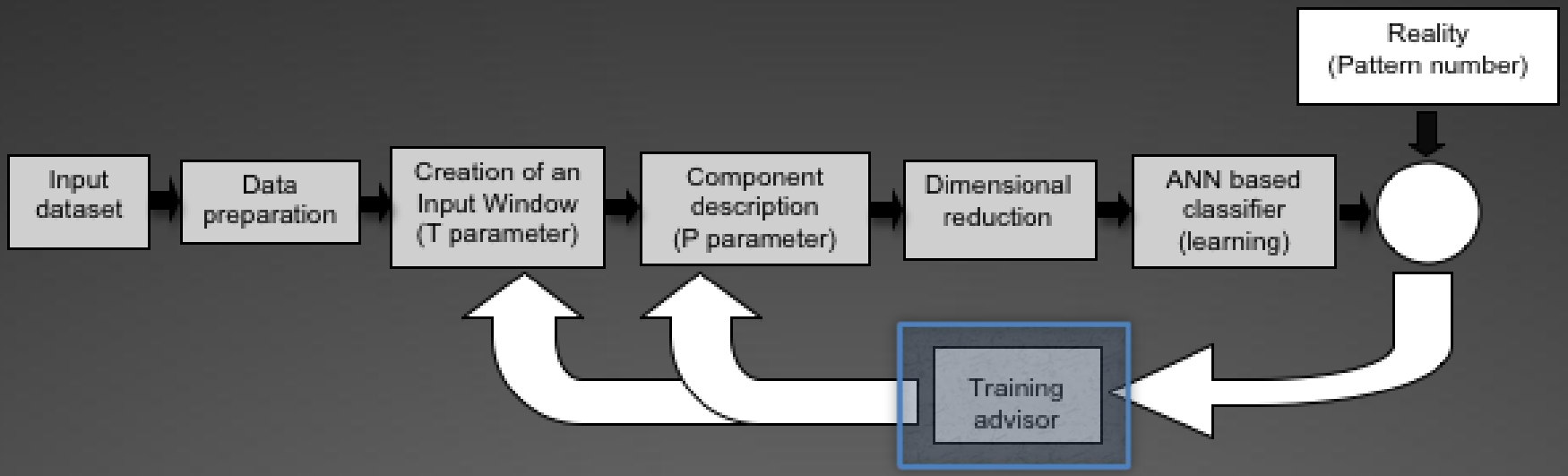
- ***Incremental description:***
  - The system generates the *P* ANN inputs from de principal components matrix through an incremental procedure.
  - The P inputs are a representation of the collective behavior.

Development - ANN training phase



- ***Radial Basis Function ANN:***
  - Allow the system to modify *P* during the training procedure without restart from scratch.
  - Smooth the consequences of the modifications: gradually increase or decrease the number of inputs and weights.

Development – Advisor training phase

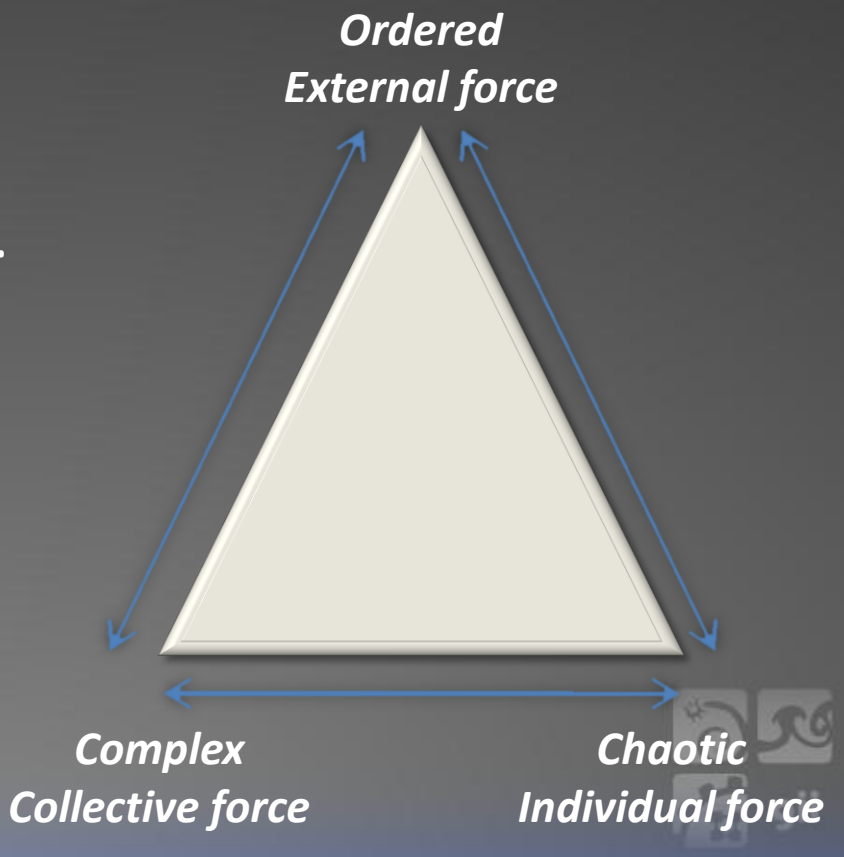


- It modifies the parameters *T* and *P* after the evaluation of the classification error.
  - Random initial search direction while the discrimination level decreases.
  - If the level error increases, a new random advance direction is selected.
  - Small probability of a random change.

Motion Pattern in Flocks

- Example based in Reynold's boids:
  - Group of virtual agents that using a simple computational model carry out a coordinated motion.

- ***External force:*** generated by the environment and varied with time.
- ***Collective force:*** local interaction rules (Reynold's rules).
- ***Individual force:*** each boid follows a variable trajectory.



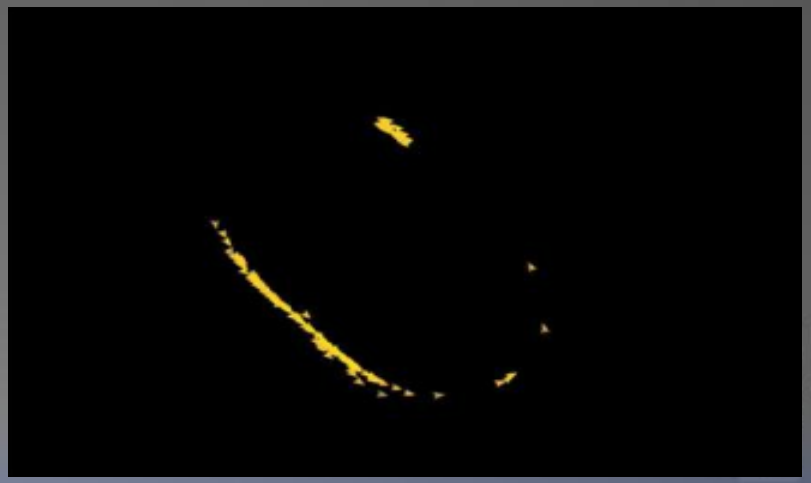
Motion Pattern in Flocks

Chaotic behavior

Orderer and chaotic behavior

Organized behavior

Complex and ordered behavior

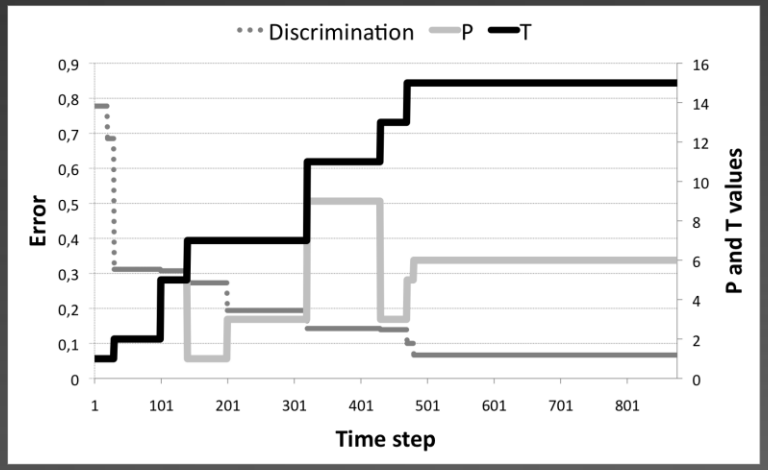


Motion Pattern in Flocks

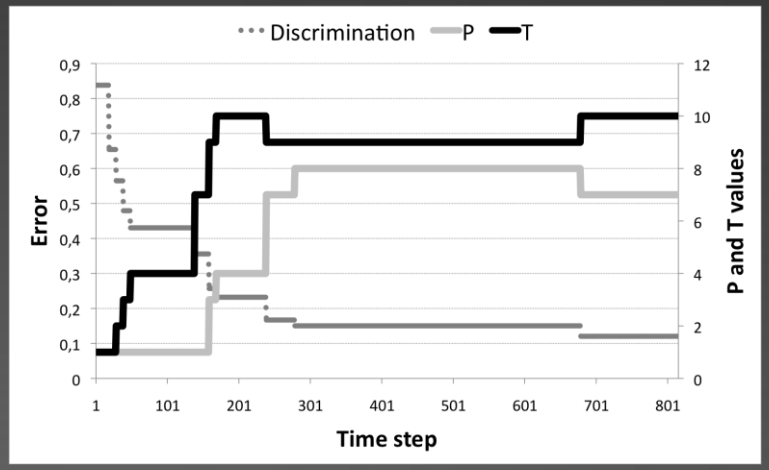
- ***Learning procedure:***
  1. Record the data:
     - *2xAxN* matrix of trajectories: *x* and *y* components.
  2. Data preparation:
     - *AxN* matrix of deviation with respect to the average of the group.
     - PCA analysis.
     - Create an input window of size *TxN*.
  3. Dimensional reduction:
     - Incremental description of the *TxN* principal components.
     - Select the *P* descriptors as network input.
  4. ANN learning:
     - Adjust *P* and *T* using the discrimination level.

Results

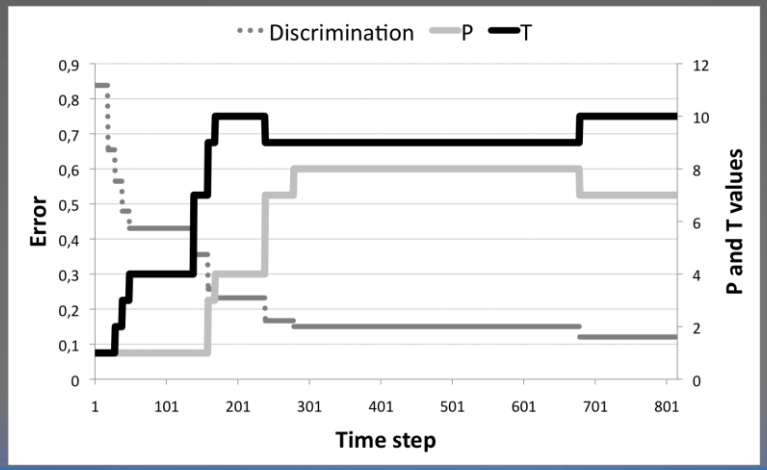
Fixed individual force: from ordered to complex



Fixed external force: from complex to chaotic



Fixed collective force: from ordeder to chaotic



Conclusions

- This system allows a simple training procedure for ANN based classifier systems which imply large amount of data.
  - It automatically adjusts the sampling window size.
  - It automatically generates the caracterization parameters.
  - It uses an incremental strategy to generate the inputs that does not distort the training process.
- The approach has been tested on a synthetic problem involving the classification of agents motion patterns with very satisfactory results.

Thank you for your attention.
Questions, suggestions, etc.