

Autonomous Eye Pattern Classification in a Virtual Environment Applied to Sexual Offenders

Sylvain Chartier & Patrice Renaud
Institut Philippe Pinel de Montréal
Université du Québec en Outaouais

Sexual Offenders

- There are different problems associated to the diagnostic and the measurement of threat level from violent individuals
 - Phallometric measure is often used to determine their sexual preferences
 - Research has shown that it is possible to control sexual responses in presence of a visual or auditory sexual scene
 - New promising tool for the study of perceptual and motor processing is the utilization of virtual environment combined with video-oculography
 - From the oculomotor pattern recording it could be possible to determine if sexual offenders fake disinterest by, for example, looking away or to the periphery of the visual content to reduce their phallometric responses
- Is there a function that allows the classification of sexual offenders from non offenders ?

Outline

- **1. Avatars**
 - Male, female, young boy, young girl, neutral
- **2. Methods**
 - Eye tracker, HMD, data
- **3. Nonlinear Classification**
 - Multilayer Perceptron
- **4. Results and Discussion**

Avatars
Methods
Nonlinear
Classification
Results and discussion

Avatars



Avatars

Methods

Nonlinear

Classification

Results and discussion

Methods

- 10 participants
 - 6 offenders, 4 non offenders.
- 5 conditions (one per avatar)
 - 1 minutes of VR immersion.
- Data were collected using a visual tracker (ASL 504, 60 Hz, $\pm 0.5^\circ$) combined with a HMD (V8 Virtual Research, 600x800, FOV 60°)
 - GRAD = $\text{POR} \angle \text{VMP}$ (pubic, head)
 - For each condition, a vector of 3600 GRAD was obtained.

Avatars

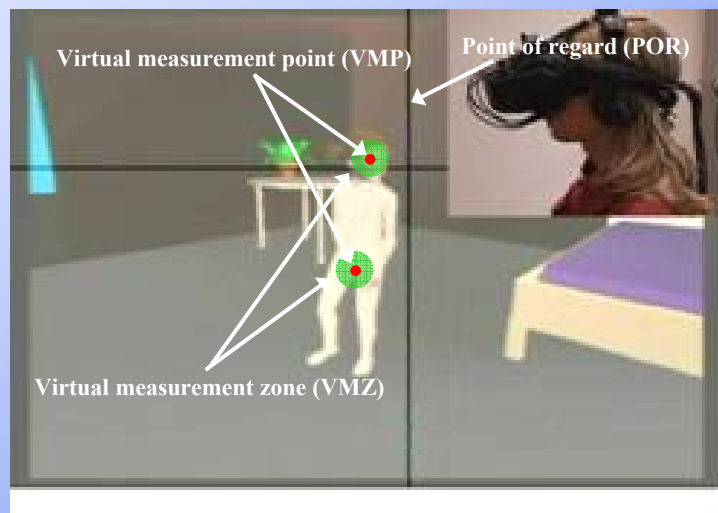
Methods

Nonlinear

Classification

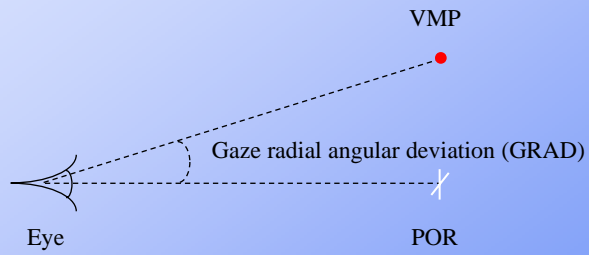
Results and discussion

Apparatus



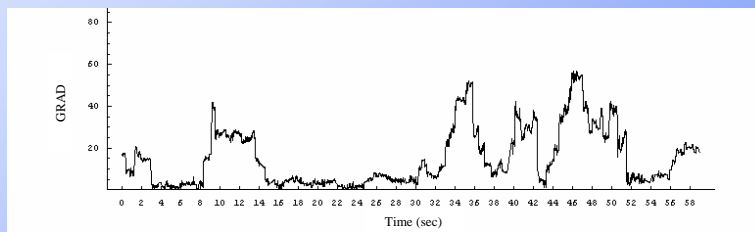
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Gaze Radial Angular Deviation



Avatars
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Data



Avatars

Methods

Nonlinear

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 - GRAD = POR \angle VMP (pubic, head)
 - For each condition, a vector of 3600 GRAD was obtained.
- 4 variables have been used for classification
 - 1- Saccades number.
 - 2- Saccades mean duration.
 - 3- Number of time a POR was within a VMZ (VMZ = VMP + 5°).
 - 4- Mean time POR was within a VMZ.
- For each participant 40 data were obtained (4 variables \times 5 conditions \times 2 VMZ).
 - 8 learning patterns (4 offenders, 4 non offenders).
- 2 participants were used for classification generalization

Avatars

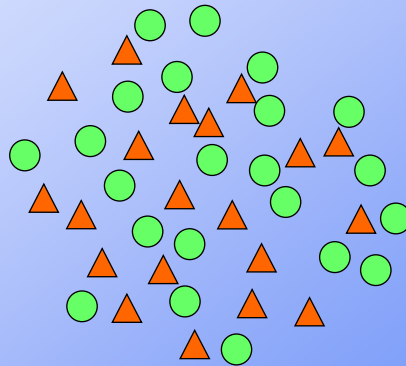
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Classification

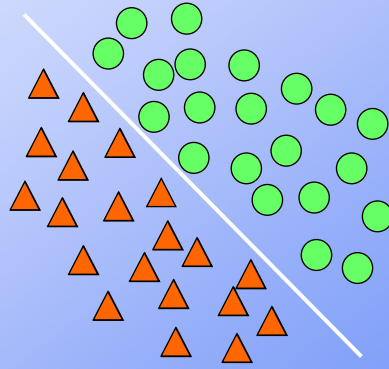
Results and discussion

Random Process



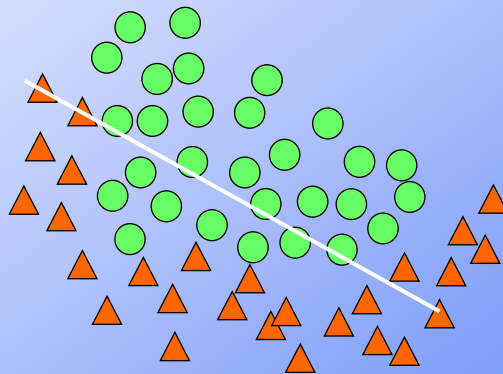
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Linear Separation



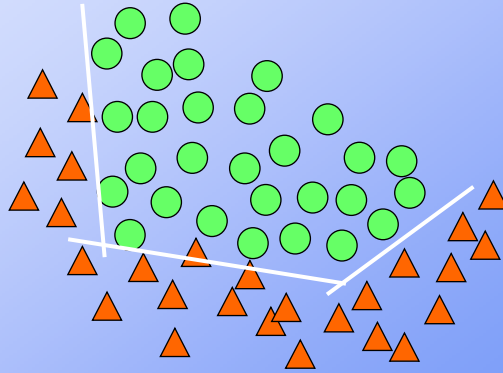
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Nonlinear Separation



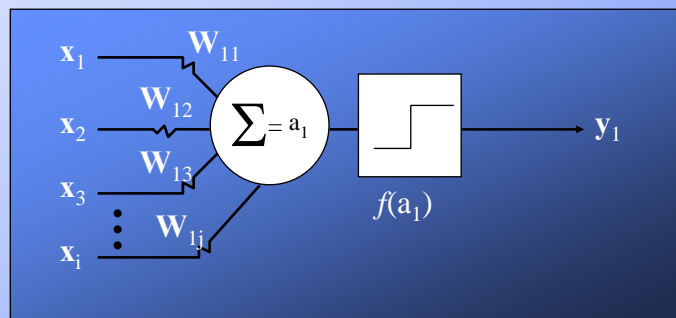
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Nonlinear Separation



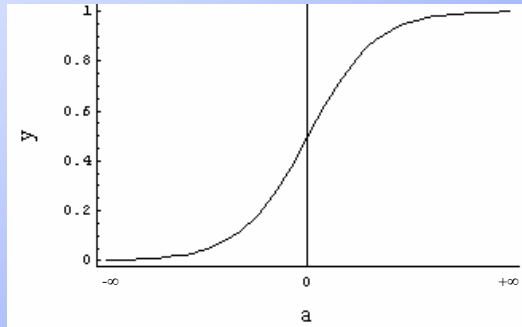
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Artificial Neural Network



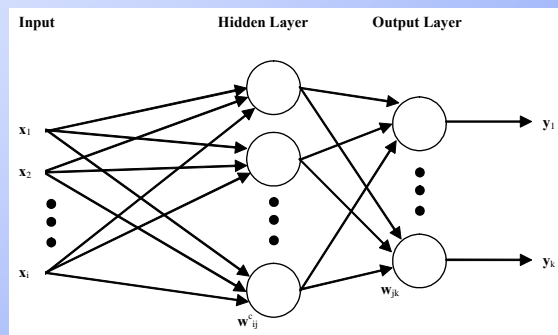
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Output Function



Avatars
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Multilayer Perceptron



Learning Rule

Error

$$\delta = (\mathbf{t} - \mathbf{y}) \times \mathbf{y} \times (1 - \mathbf{y})$$

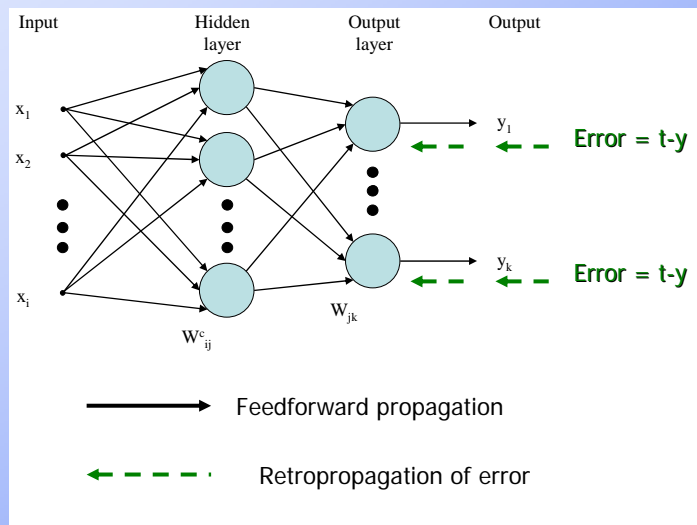
Output layer

$$\mathbf{W}_{k+1} = \mathbf{W}_k + \eta \delta \mathbf{y}^c \mathbf{T}$$

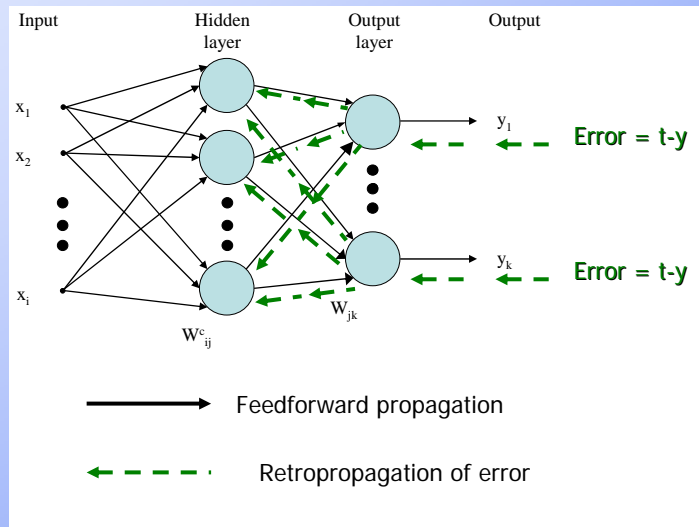
Hidden layer

$$\mathbf{W}_{k+1}^c = \mathbf{W}_k^c + \eta (\mathbf{y}^c \times (1 - \mathbf{y}^c) \times \mathbf{W}^T \delta) \mathbf{x}^T$$

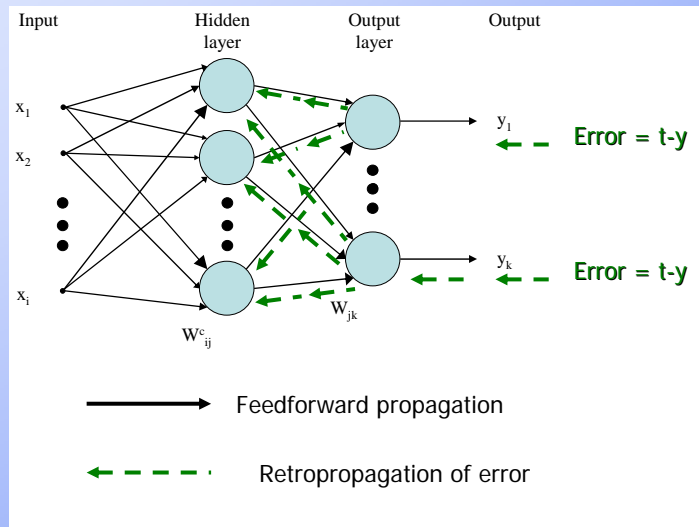
Multilayer Perceptron



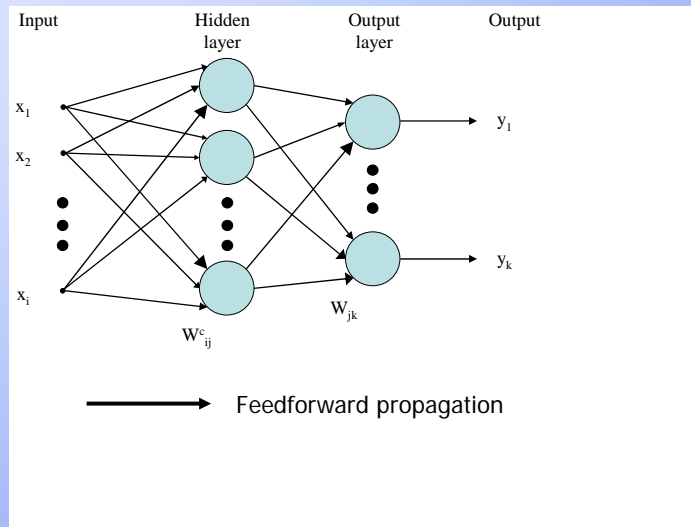
Multilayer Perceptron



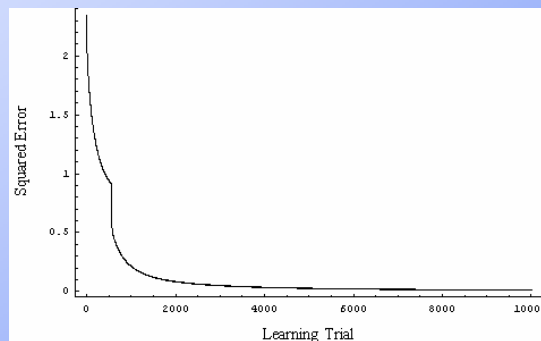
Multilayer Perceptron



Multilayer Perceptron



Learning Convergence



Recall Performance

	Data	Desired output
Learning patterns	Non offender 1	0.001
	Non offender 2	0.001
	Non offender 3	0.001
	Non offender 4	0.001
	Offender 1	0.999
	Offender 2	0.999
	Offender 3	0.999
	Offender 4	0.999

Recall Performance

	Data	Desired output	Observed output
Learning patterns	Non offender 1	0.001	0.0731
	Non offender 2	0.001	0.0438
	Non offender 3	0.001	0.0407
	Non offender 4	0.001	0.0438
	Offender 1	0.999	0.9530
	Offender 2	0.999	0.9705
	Offender 3	0.999	0.9875
	Offender 4	0.999	0.9705

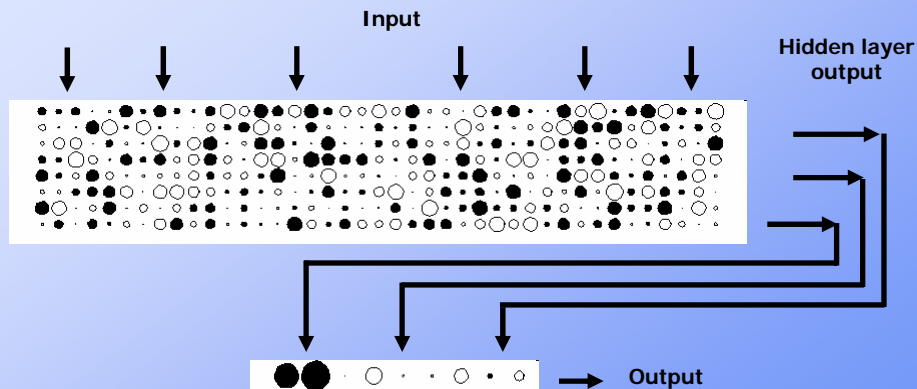
Recall Performance

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	Non offender 2	0.001	0.0438
	Non offender 3	0.001	0.0407
	Non offender 4	0.001	0.0438
	Offender 1	0.999	0.9530
	Offender 2	0.999	0.9705
	Offender 3	0.999	0.9875
	Offender 4	0.999	0.9705
Generalization	Offender test 1	0.999	0.9699
	Offender test 2	0.999	0.9640

Discussion

- Given the small sample, the results are preliminary only.
- Oculomotor patterns could be used to classify sexual offenders from non offenders.
 - Diagnostic, evaluation, ..., therapy
- Future investigations :
 - More “transparent” network.

Discussion



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- Given the small sample the data are preliminary only.
- Oculomotor patterns can be used to classify sexual offenders from non offenders.
 - Diagnostic, evaluation, ..., therapy
- Future investigations :
 - More “transparent” network.
 - New nonlinear measurement (e.g. fractal dimension, Renaud et al. 2005)
 - More detailed avatars
 - More participants

**Tell me how you look ...
...and I will tell you who you
are**