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A (new) non supervised neural learning algorithm for equilibrium (and homeostasis)

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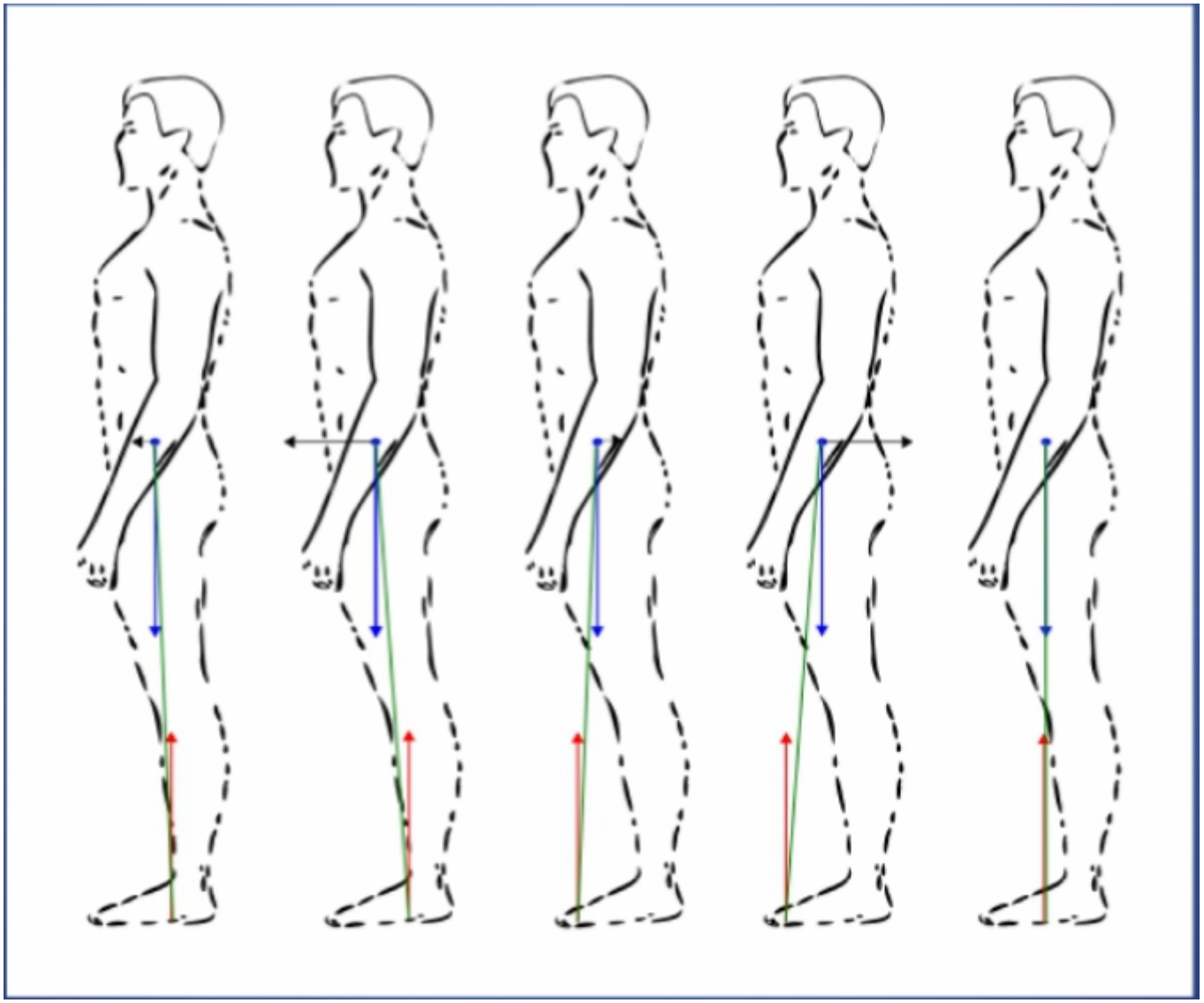
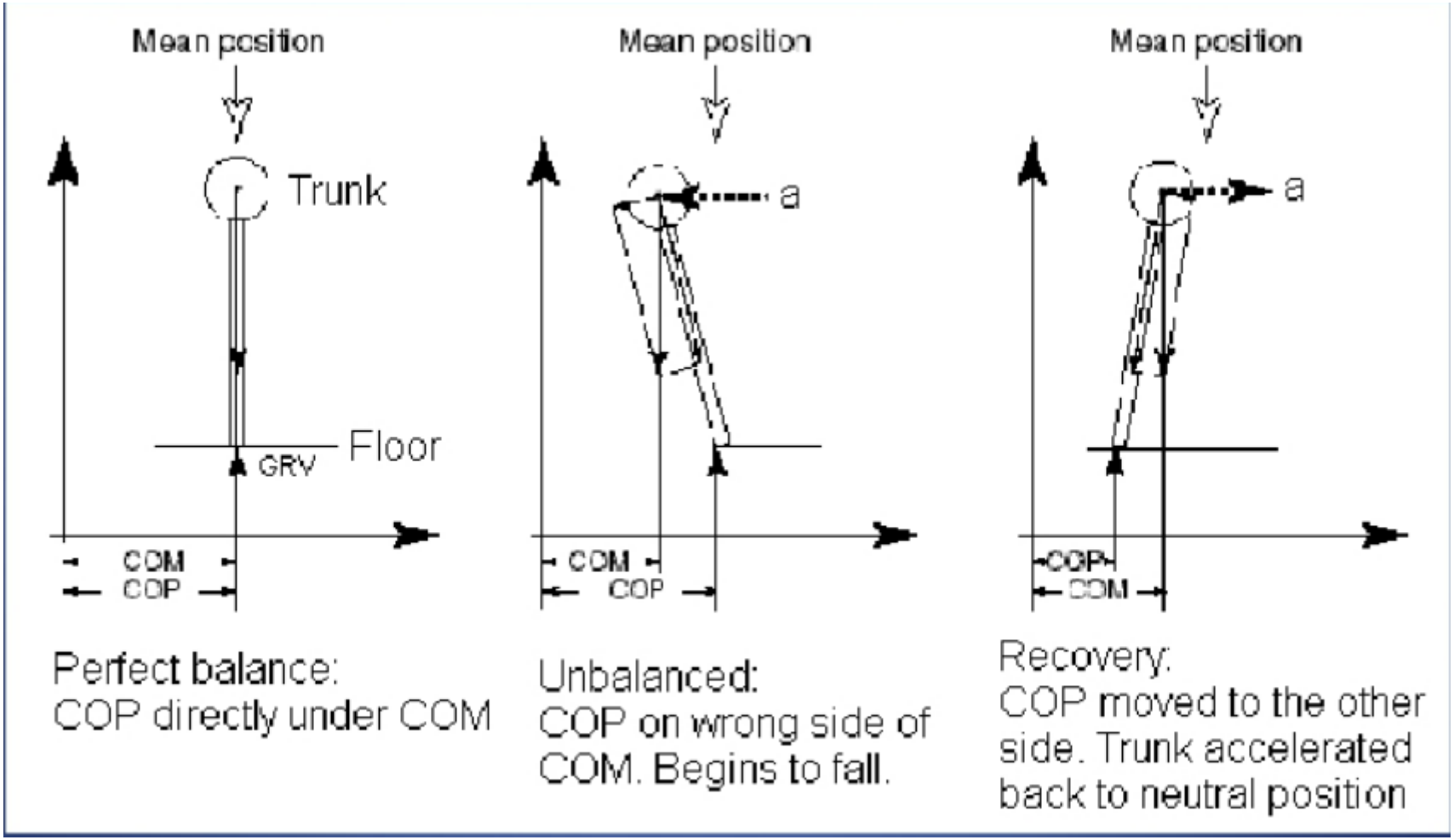
Summary

1. Obervations: posture experiments
2. Conclusion: the relativity of the equilibrium
3. Hypothesis: Learning without any reference
4. Model: time integration by the synapse efficiency modification
5. Experiment: the inverse pendulum
6. Conclusion: toward homeostasis

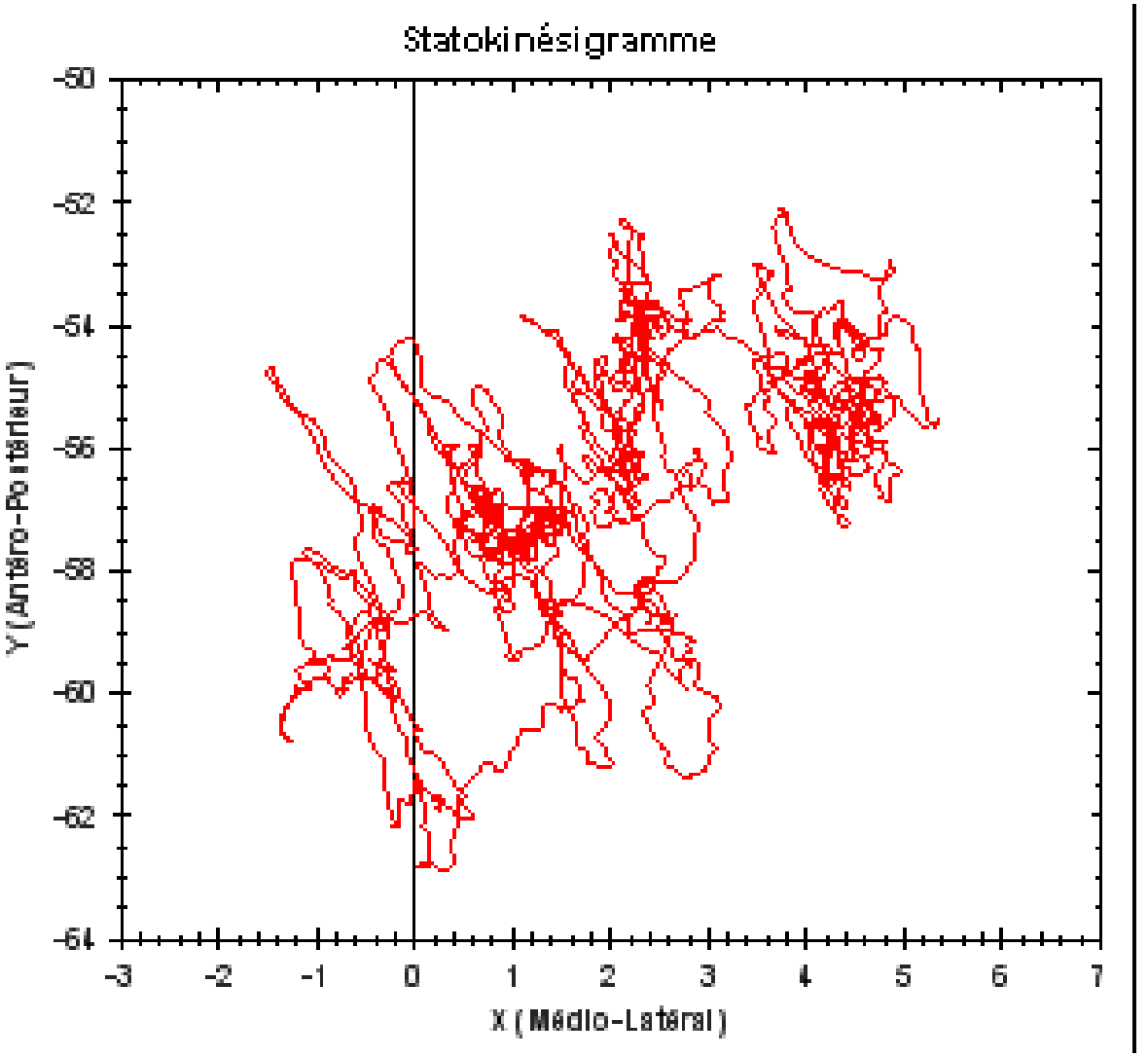
1.1 Obervations: posture experiments



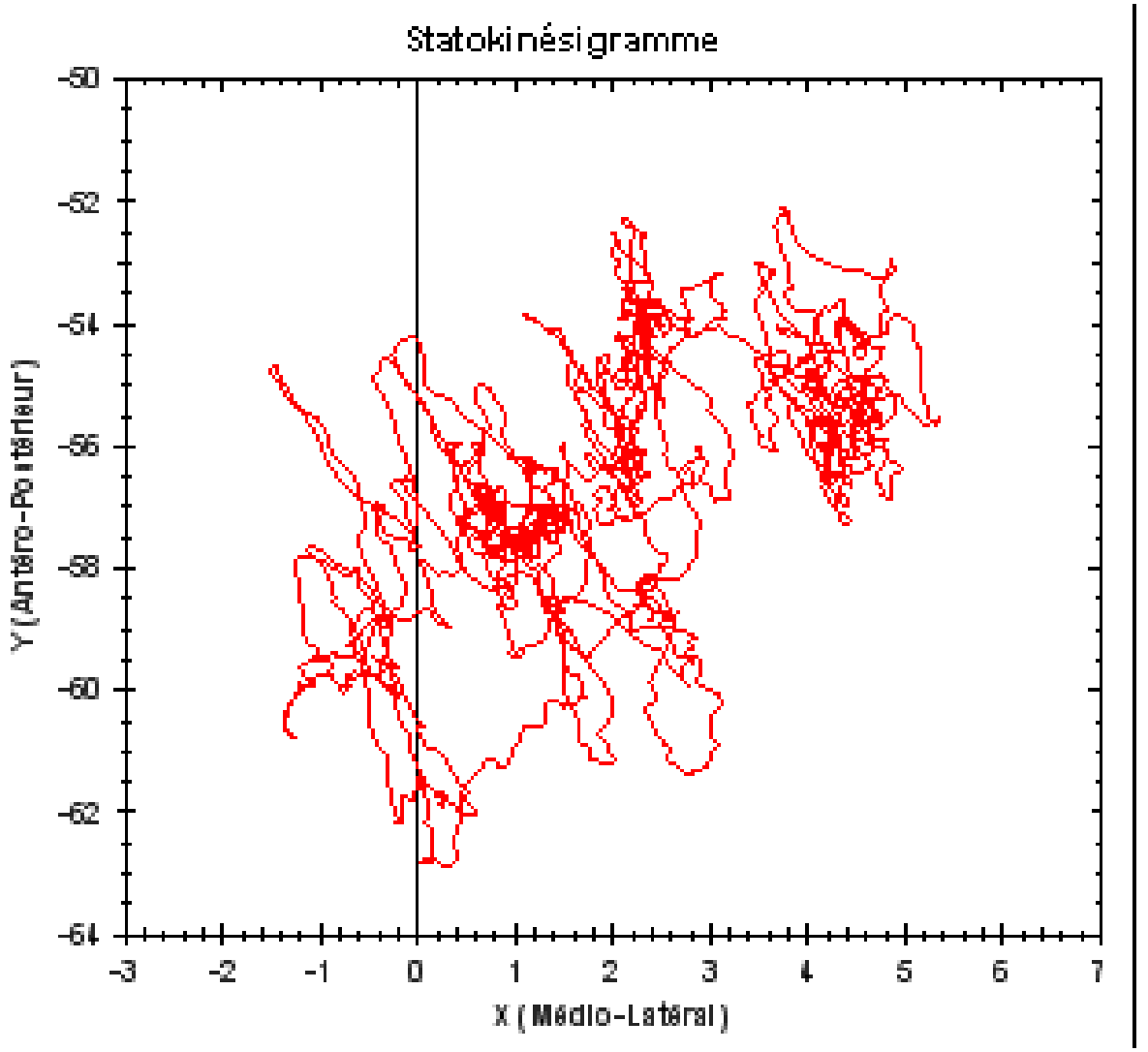
1.2 Obervations: posture experiments



1.3 Obervations: posture experiments



2. Conclusion: the relativity of the equilibrium



3. Hypothesis: Learning without any reference

« Verticality » is not required in order to stay erect. A subject may learn to stay erect just by experiencing moments of vertical equilibrium (moments during which he does not received any information).

How neurons can learn something in absence of events?

Informations from instability zones seem irrelevant, those of stability zones are absent. However...

4. Model: time integration by the synapse efficiency modification

The equilibrium is defined by the fact that the frequency of changes is particularly low.

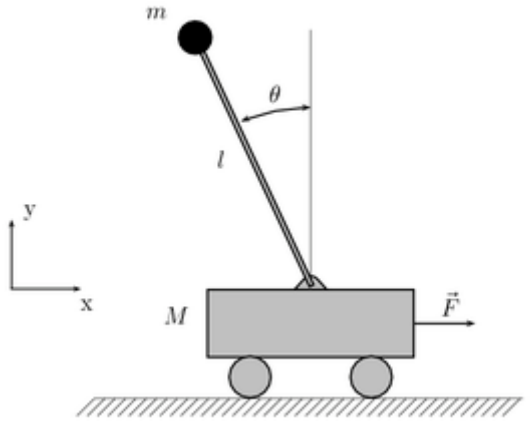
The last « action » of the neurons will be completely memorised – therefore, it will be easily done again in a similar situation next time.

We only need to take into account a time course for the modification of synaptic efficiency.

5.1 Experiment: the inverse pendulum

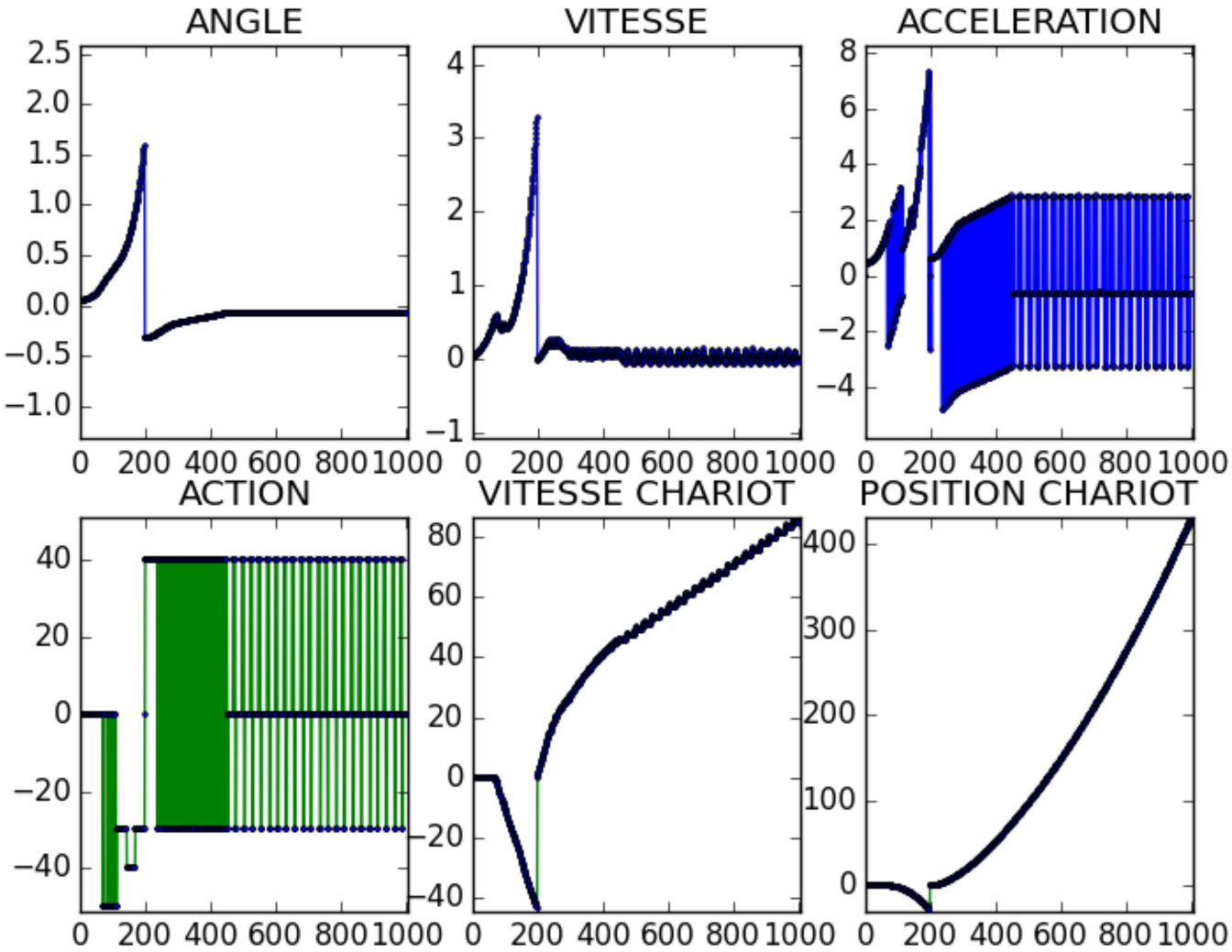
SOM: 7x7 neurons (inputs: angle, speed, action)
Learning: 100 events
Time required for full synapse modification: 1 s
Discretisation: 1/10 s

$g = 9.8\ m/s^2$
pendulum = 2 kg (m)
cart = 8kg (M)
length = 1m (lg)



alpha = 1.0/(m+M)
a1 = ((g*sin(theta) - alpha*m*lg*speed*speed*sin(2*theta)/2.0 – alpha *cos(theta)*(-action)) / (4*lg/3 - alpha*m*lg*cos(theta)*cos(theta)))

5.2 Experiment: the inverse pendulum (test: 10 seconds) + video



5.3 Experiment: the inverse pendulum

1D, 2D, 3D...

6.1 Conclusion: toward homeostasis

- Homeostasis: « regulation around an equilibrium position ».

- Examples of homeostasis: the state of « good » health.

6.2 Evolution of the learning algorithms toward less and less supervision:

- Supervised learning (Perceptron, 1959)
- Self-organisation (data base, 1977)
- Supervised learning (learning base, 1985)
- Reinforcement learning (evaluation function, 1994)
- Associative memory programming (targets, 2006)
- Palimpsest learning (2014)