REACTIVE AND ADAPTIVE CONTROL LOOPS FOR SOCIAL LEARNING IN HUMAN ROBOT INTERACTION

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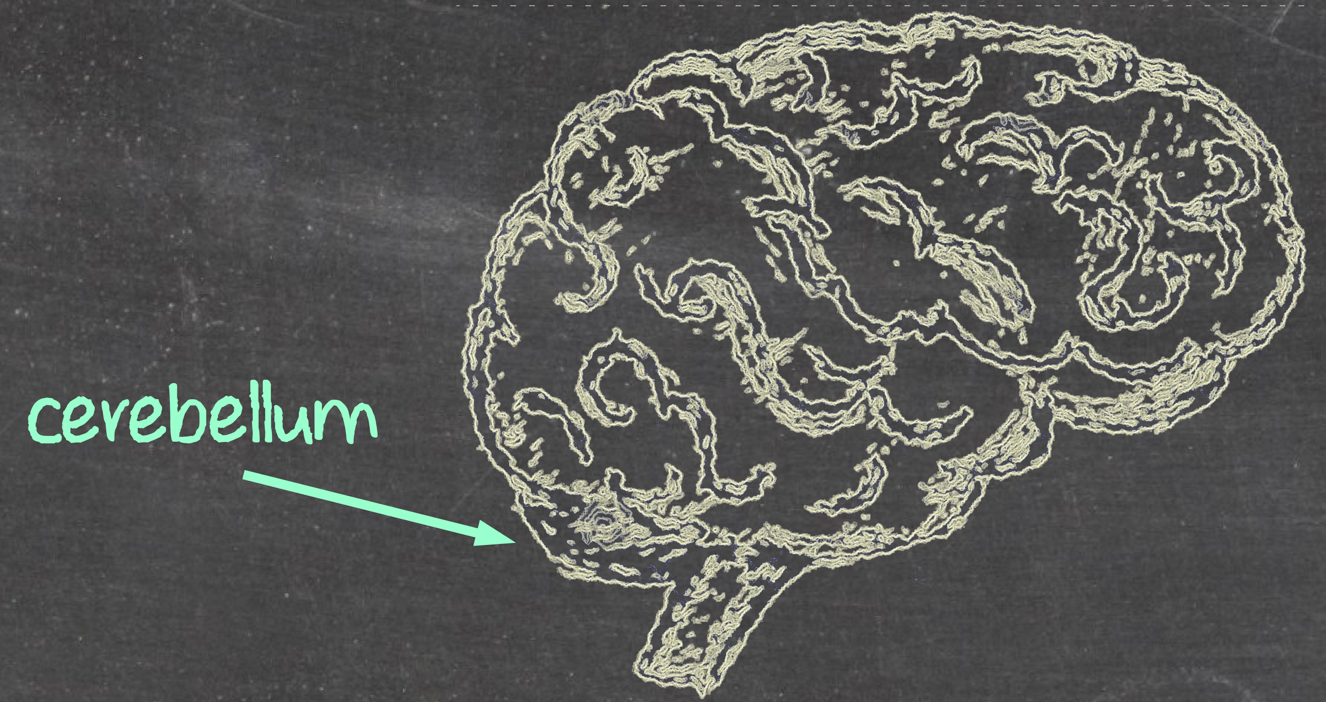
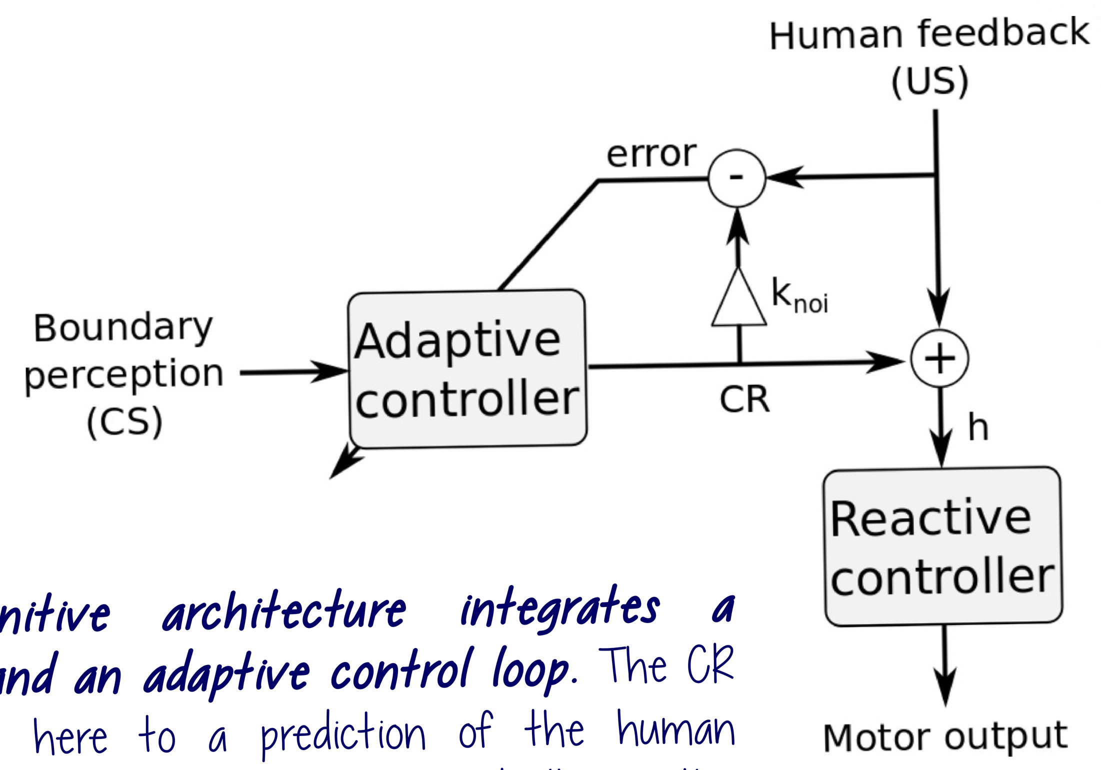
NEURAL BASIS

The **cerebellum** has been long studied in the context of classical conditioning. It acts as an adaptive controller that learns to **anticipate** aversive stimuli using contextual sensory information, which otherwise would trigger a purely reactive action.

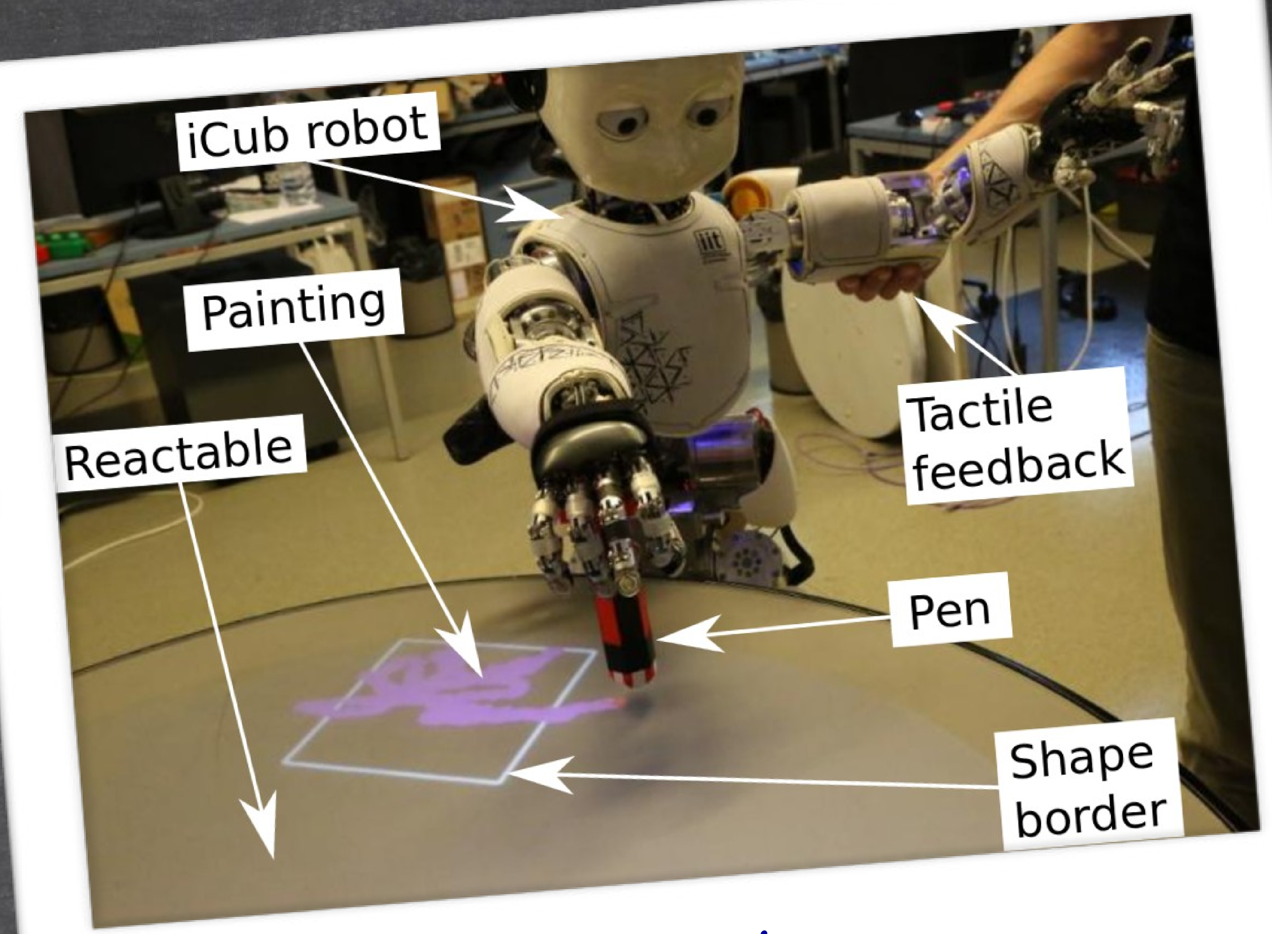




The cognitive architecture integrates a reactive and an adaptive control loop. *The CR corresponds here to a prediction of the human feedback, learned from experience and allowing the action anticipation.*

EXPERIMENTAL SETUP

We used an iCub robot painting in a Reactable. A figure was drawn on the interactive table. The robot could paint anywhere without restriction. Human feedback would restrain it from crossing the borders. We compared the performance of the reactive and the adaptive controllers.



The setup

CONTROLLER

We designed a **reactive controller** that:

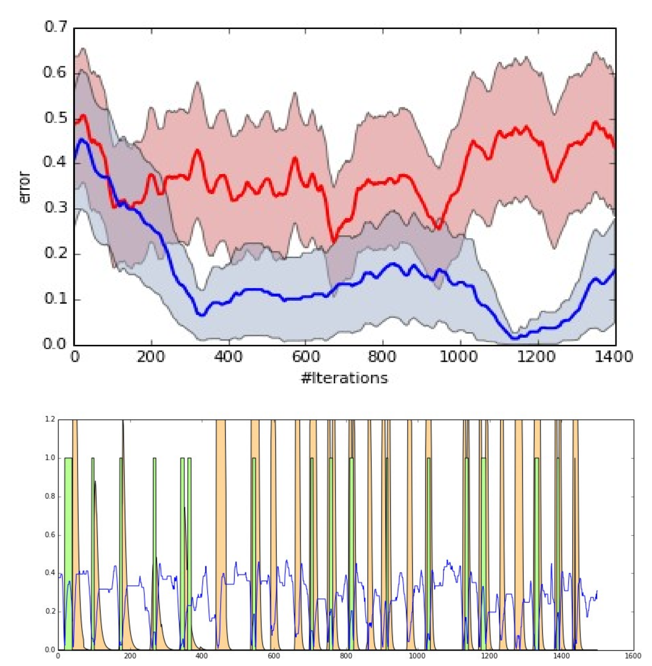
a) paints randomly over the drawing surface.

b) goes back to the initial position when human feedback is given.

Both actions are driven by intrinsic needs of the robot, where a **self-regulatory** process manages priorities.

An **adaptive controller**, a validated model of the **cerebellum**, modulates the reaction to anticipate human feedback.

Results



Errors decrease with time in the adaptive controller but not in the reactive. *Top: mean and standard error of feedback received in ten independent experiments, for the adaptive (blue) and reactive (red) architectures. Bottom: boundary perception (blue), human feedback (green) and anticipated feedback (orange) learned from experience by the cerebellar model.*

CONCLUSIONS AND FUTURE WORK

Results show a consistent decrease of human feedback. The model also displays interesting generalization properties, where the adaptive behavior learned adapts to online and offline changes in shape and position of the painted figure.

The general purpose of the algorithm allows its application to any situation where feedback can be anticipated through contextual information.

Current work is directed to adding the roles of the cortex and amygdala, which would allow the automatic extraction of the relevant features for the task (currently given by default).

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