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Behaviour Control Using a Functional and Emotional Model

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Abstract

Animals are capable of pursuing long term goals while coping with the ever-changing events in their scenario. In the quest of animats towards autonomy, we propose to use a functional model biased by emotions to drive their behaviours. In addition to that, we suggest that emotions can be used as source of reinforcement to build functional description of objects, on the grounds of which to decide what behaviour to take next.

1 Introduction

An autonomous agent should be able to pursue a variety of goals while coping with daily reality. To that aim, Gibson (1966) and von Uexküll (1921) assert that the structure of the body continuously evolves to adapt to changes in the environment. According to Gibson, to perceive implies the activation of the perceptual centres in our nervous system, that are sensitive to certain sensations, e.g. to a particular object, action or event. In his theory of perception he introduced the term *affordance* to designate the functionality objects offer to the agent. The affordances of an object derive from the constant features of the object under the view of that particular agent —shape, weight, size, etc. (Gibson, 1966)[1].

To close the perception-action loop, we suggest that affordances could function as bridge between the perception of an object and a goal-directed action. If the corresponding affordance is active, the goal related to its action or behaviour may be possible. This is supported by the research of Rizzolatti et al. (2000), according to which some groups of neurons in the pre-motor cortex of macaque monkeys are active when perceiving some objects and the actions these afford to them.

So far we have discussed how to relate goal-directed actions with the possibilities that objects in the environment offer to the agents. Nevertheless, triggering that particular functional neurological centre to execute a particular action also involves willingness to do it.

Humans are capable of coping with overall goals, but in fact, we do it in a very fuzzy way. Our relation to the environment is based on our perception, that gives rise to physiological changes in our body. This is one of the elements that influence the arousal of emotions (Izard, 1993). Emotions are a very controversial subject, but there seems to be some consensus in asserting that they play a role in evaluating situations and triggering one or another behaviour (Frijda, 1995).

An autonomous animat with several goals should encompass both *possibility* and *state of mind* to trigger a decision —functional and emotional stance.

2 Emotion and function together

We propose to build an animat model following the aforementioned ideas. Its **perception** will consist of two modules, the first capable of extracting affordances from objects in the scene and the second capable of providing an emotional stance (measure of its state of mind) on the basis of the agent's experiences and circumstances.

According to Gibson's theory, *affordances* are bound to features of objects and to the morphology of the agent. However, because affordances are *a priori* unknown, the animat will have to learn to associate correctly the perception of the object to its functionalities from the whole available set. This will point out the *possible actions* to the agent.

The *mood* of the agent will be instead provided by the *emotional stance* through a model derived from the work of Gadanho (1998), who developed a model for behaviour control using basic emotions, inspired in the research of Damasio (1994). The model includes a representation for feelings (hunger, pain, restlessness, temperature and eating), which monitor the body[2] and for fundamental emotions (happiness, sadness, fear and anger), which can

[1] Depending on the morphology of the agent, an object will have different affordances. E.g. a cup does not afford the same to a human (grasp) as to a dog (bite?).

[2] The definition of feeling is controversial. Though we have respected the name given by Damasio, this denomination has been widely discussed. Other authors refer to it as "drives".

be considered as indicators of the *mood* of the agent. The emotional model will be further grounded by including relevant neurologic processes, such as the double response circuit described by LeDoux (1997).

The emotional stance plays two different roles. Firstly to estimate the probability of an affordance being attached to an object. Once affordances have been first estimated, a decision to take a behaviour will follow. According to any variation in the emotional stance the estimation will be further refined. In order to make this reinforcement possible, we have **hypothesised** that *the agent's use of an affordance should not produce a negative emotional impact.*[3] Secondly, emotions play a role in biasing the decision for one or another behaviour. The decision making integrates both the *possibilities* of the scenario (affordances) and the *mood* provided by the emotional stance into a reinforcement learning scheme that by apprehending from past events, we expect will improve the autonomy of the agent.

3 The Animat Model

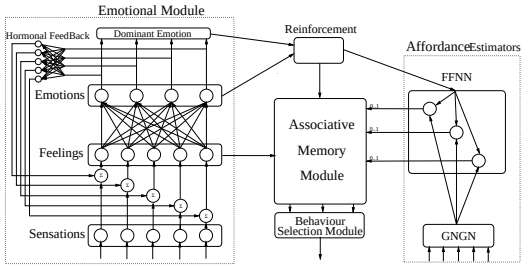

Figure 1: Behaviour Control Architecture

A model for an animat according to the aforementioned ideas is introduced in figure 1. Its three main modules are, from left to right: the emotional model, which represents feelings and emotions[4]; the associative memory, that integrates emotional and functional information for the decision making, and the affordance extractor. The latter consists of a set of estimators each of them associated to a particular affordance, that receive as input a fuzzy description of the sensed object, and an emotional reward.

The animat includes a reinforcement learning module to learn to choose behaviours (associative memory), whose state vector is defined by its feelings and emotions plus the affordances of the sensed objects. To close the circle, the associative memory calculates the expected outcome of performing each behaviour on the grounds of the state, and according to that decides which of them to execute. After some recursion, if there is some significant change in the emotional stance (feelings or emotions), we can use this to improve the decision process, i.e. what to decide according to the circumstances, and to refine the estimators of affordances of the objects in the scenario.

[3] If we try to sit on a large cactus it will surely be painful. This may indicate that it does not offer that functionality.

[4] E.g. the anger node gets input from all the feelings nodes (hunger, pain, restlessness), which contribute in some measure to the anger.

4 Approach

In a first stage we will perform experiments with the perceptual capabilities of Khepera robots for building the affordance estimator independently of the emotional stance. The first approach will be to point to very simple goals (survive) in a *toy* scenario composed of several easily distinguishable objects and an appositely built oracle to test the validity of the estimator.

On a second stage, experiments will be conducted to make a comparative study of the decisional process. Functional and emotional information can be used separately for the decision making. The hypothesis mentioned in section 2 can be then tested.

Finally, both sources of information can be merged together into a single state for testing the autonomy of the complete agent. Results can be compared with the ones obtained in earlier stages.

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