

Intentional Goals: Affordances with Values?

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Abstract—Both goals and affordances are frequently employed concepts in psychology and have recently gained increased interest in robot learning. In this article we would like to point out the similarity of recent formulations of those two concepts. In particular, we point out the fundamentally interactionist character of both concepts and discuss the role of subjective values as distinct characteristic of goals. Further, we discuss possible future research direction to work out and utilize these aspects.

Index Terms—Goals, Affordances, Intentionality, Reward and Value Systems

I. INTRODUCTION

Both goals and affordances are thought to organize action of intelligent agents. Goals have a long history of discussion in psychology [1], [2] and also the philosophy of mind. They are thought to organize behavior by expressing desired states or conditions to which action can be directed. Goals have naturally be considered in AI and robotics from the very beginning, since hand-crafted goals express the engineers intend what an agent should do. The autonomous learning of goals has recently become an interesting area of research also for learning robots [3]. Affordances, on the other hand, are a more recent development in psychology [4] that also has gained increasing interest in robot learning [5]. Affordances are thought to be abstractions that can directly connect perception and action by providing categories of possible actions or action effects that an agent can apply to an object. While historically stronger rooted on the perception side of research, also affordances therefore allow to organize action. Both concepts can be viewed from different perspectives: the acting agent's, an observing agent's, and the object's perspective ([5], [6], see Fig. 1). Here, we are interested in the acting agent's perspective: how can a agent discover, learn to represent, and utilize goals or affordances for the purpose of steering its own behavior?

II. INTERACTIVIST ABSTRACTIONS

Goals and affordances do at first look like very different concepts. Affordances have a strong perceptual focus and describe possibilities of agent-environment interaction. Goals on the other hand have a strong focus the eventual action and describe desire and intention. Yet, some of these differences can be easily bridged both with respect to classic texts and modern formalization.

Perception: Also goals require a perceptual component. Already Lewin [1], [2] described that goals are of course mediated by general desires, but are concretely triggered by the perception of the environment. This process has also been

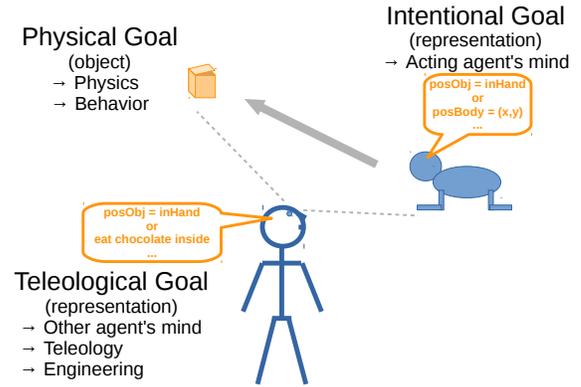


Fig. 1. Goals (like affordances) can be seen from three perspectives. We look at the acting agent's view: what does it mean to represent goals/affordances for action, and how can such knowledge be acquired? (Picture from [6])

called “goal detection” [7] which is a perceptual process discovering a to be pursued goal from sensory stimuli and internal state. In fact, this process allows to interpret that the environment “affords” a goal to the agent.

Interactivism: Therefore both goals and affordances are interactionist concepts: they can only be meaningful for an agent if they build on the combination of the agent's own action capabilities and the agent's actual environment. For affordances, early work [4] was mostly concerned with affordances as properties of solely the environment, but which turned into an interactionist stance in recent work [5]. For the possible development of goals, Balleine [8] stressed the notion that goals must reflect not only a desire but also the sensorimotor contingencies of the agent-environment system. This account was further strengthened by a goal formalization in [3].

Abstraction: Both goals and affordances have been stressed to be also *abstractions* between perception and perception: they abstract *from* irrelevant aspects to form representations that are both compact and expressive enough to effectively steer behavior. Sahin *et al.* [5] stressed the notion of affordances as equivalence classes of largely similar object/action effects, hence grouping relevant similarities and disregarding minor differences and not action-relevant aspects. Likewise, goals abstract from task irrelevant aspects and form compact low-dimensional abstraction [3] and therefore express the essential sensorimotor or action/perception contingencies necessary for a task [8]. In both cases action and perception are brought together in a common abstraction space (see Fig. 2) of “effects” [5] or “observations” [3].

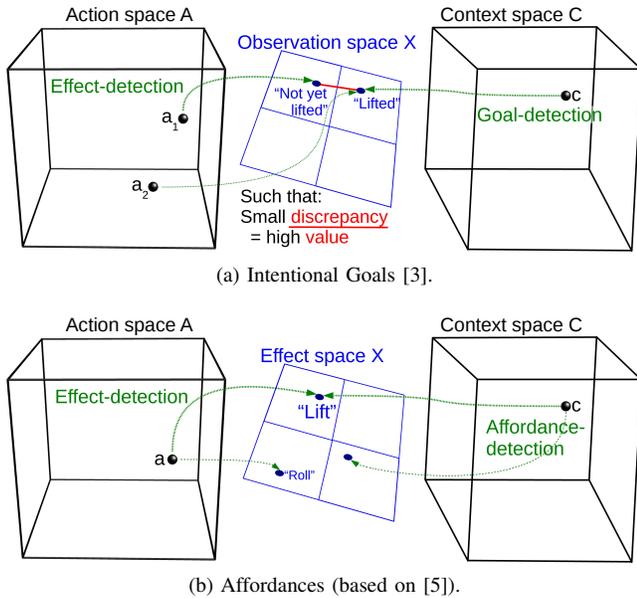


Fig. 2. Both goals and affordances relate the agent’s actions and its sensory context in a common effect or observation space. Goals further describe a discrepancy between a current and a future desired state.

The Discrepancy: An actual difference between goals and affordances is that goals describe a discrepancy [1], [2] between a present state and an imagined desirable state, while affordances do not. An affordance such as “liftable” can for instance describe pairs of perception and action that lift an object [5]. A goal, in contrast, could state the desire or intend to bring an object into the lifted state. The original state might not fulfill this condition yet, so that an action can be chosen to reach the “lifted” state (see Fig. 2). This discrepancy has a *direction* towards the state that is in some sense desirable or fulfills an agent’s need. This aspect of desire has been linked to subjective *values* which can be reflected in the expectation of *reward* signals [8], [6]. Affordances do not reflect any such component of desire, or value, or reward. By definition, they express things that can, or could be done instead of what should be done.

III. INTENTIONAL GOALS: AFFORDANCES WITH VALUES?

Affordances and goals share many common properties – except that goals describe valued or desirable things while affordances describe general possibilities. Goals can often easily be interpreted in terms of underlying affordances. The goal to touch an object (see Fig. 3) or to lift an object are result of the possibility (affordance) of that action plus an expected positive value for the agent within the present situation.

However, many questions about the relation of goals and affordances remain to be answered – both on a conceptual level and for practical robot learning. Can affordances generally lead to goals? In the line of this question unsupervised affordance learning could be seen as a pre-processing stage of goal development. Are also higher level goals (such as reaching a certain performance in a task) reasonably interpretable in

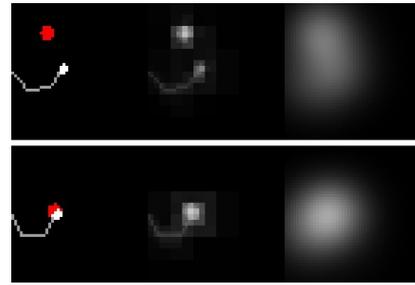


Fig. 3. A simulated robot arm and an object (left) cause high visual saliency (middle) if hand and object are close. Taking overall saliency (right) as curiosity based reward, the object “affords” to be touched with the hand.

terms of affordances? Since goals are often thought to exist in hierarchies up to such abstract levels, can affordance reach this level of abstraction as well? Can goal and affordance learning be put together for practical robot learning? Besides the aspect of value, current formalizations of goals and affordances differ in many details despite conceptual similarities; can they be brought together? Such formalization could end up having an action’s value as the only difference. Investigating this possibility should shed light on both concepts in any way. Practical advancement could for example be made in the area of tool use: even discovering the possibility for tool use in a complex environment might require motivational goals of exploration, then representational learning of affordances related to tool categories and affordances, and eventually the goal-directed application of the tool towards a next desired state of the environment.

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REFERENCES

- [1] K. Lewin, “Vorsatz, wille und beduerfnis,” *Psychologische Forschung*, vol. 7, pp. 330–385, 1926.
- [2] —, “Intention, will and need,” in *Organization and pathology of thought: Selected sources*, D. Rapaport, Ed. Columbia University Press, 1951, pp. 95–153.
- [3] M. Rolf and M. Asada, “Where do goals come from? A generic approach to autonomous goal-system development,” 2014, (submitted). [Online]. Available: <http://arxiv.org/abs/1410.5557>
- [4] J. J. Gibson, “The theory of affordances,” in *Perceiving, Acting, and Knowing*, R. Shaw and J. Bransford, Eds., 1977, pp. 67–82.
- [5] E. Sahin, M. Cakmak, M. Dogar, E. Ugur, and G. Ucoluk, “To afford or not to afford: A new formalization of affordances toward affordance-based robot control,” *Adaptive Behavior*, vol. 15, no. 4, 2007.
- [6] M. Rolf and M. Asada, “What are goals? and if so, how many?” in *IEEE Int. Joint Conf. Development and Learning and Epigenetic Robotics (ICDL-EpiRob)*, 2015.
- [7] —, “Autonomous development of goals: From generic rewards to goal and self detection,” in *IEEE Int. Joint Conf. Development and Learning and Epigenetic Robotics (ICDL-EpiRob)*, 2014.
- [8] B. W. Balleine and A. Dickinson, “Goal-directed instrumental action: contingency and incentive learning and their cortical substrates,” *Neuropharmacology*, vol. 37, no. 4, pp. 407–419, 1998.