Human-like Planning for Humans and Humanoids

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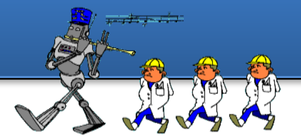


Abstract:

We propose a planning system suitable for:
✓ daily living support for people with mental disease encompassing the use of tens or hundreds of objects
✓ humanoid robots with advanced sensory-motor skills

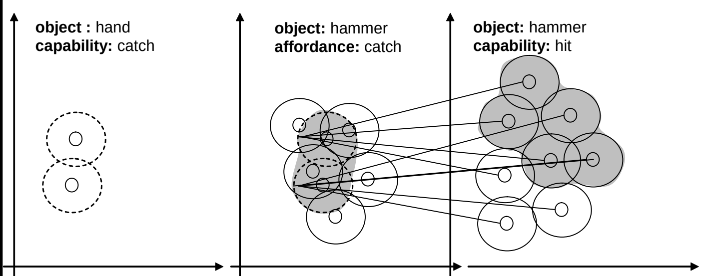
The domain representation is based on concepts related to *affordance* and *capability*:
✓ each object or location has affordances indicating possibilities for action
✓ an agent must have all the relevant capabilities to respond to affordances

A planning algorithm using conceptual spaces for representing both affordances and capabilities is introduced, which adopts techniques borrowed from *neural networks* and *self-organizing maps*.

Affordances & Capabilities:

Each entity is characterized by a number of affordances.

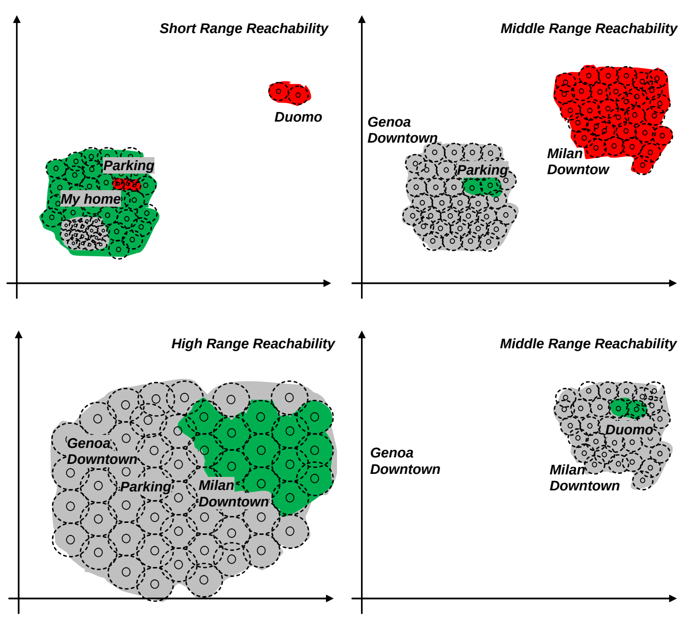
Representation of objects. A hammer has the affordance "catch" and the capability "hit". When somebody catches the hammer, he can use the hammer to hit nails.



✓ Affordances and capabilities are represented in the "affordance space".
✓ Agent capabilities are mapped to the same affordance space representing what the agent itself can do.
✓ The techniques used to plan actions are inspired by neural networks.
✓ The matching process between agent capabilities and object affordances as well as the acquisition of new capabilities by using objects is achieved through a mechanism akin to neural activation.

The capability space incrementally built depends on the initial agent capabilities!

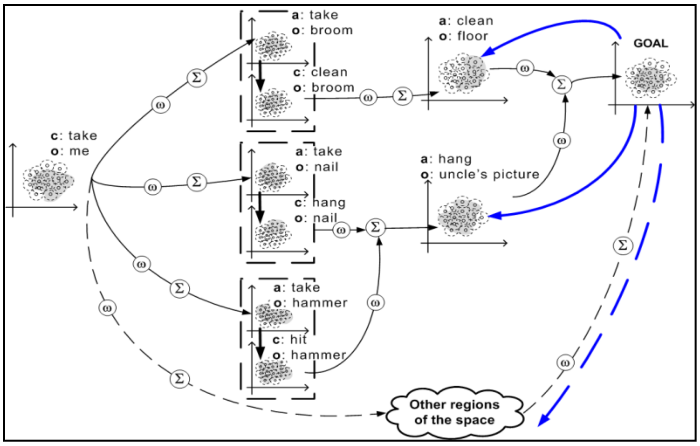
Representation of places. Locations in the real world can be represented and characterized by means of their affordances.

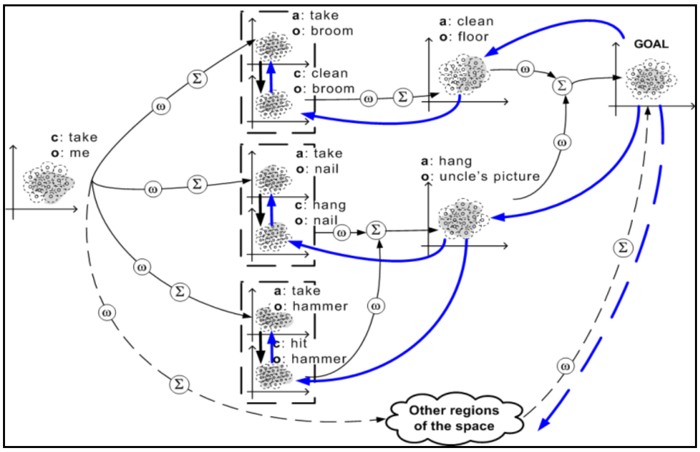


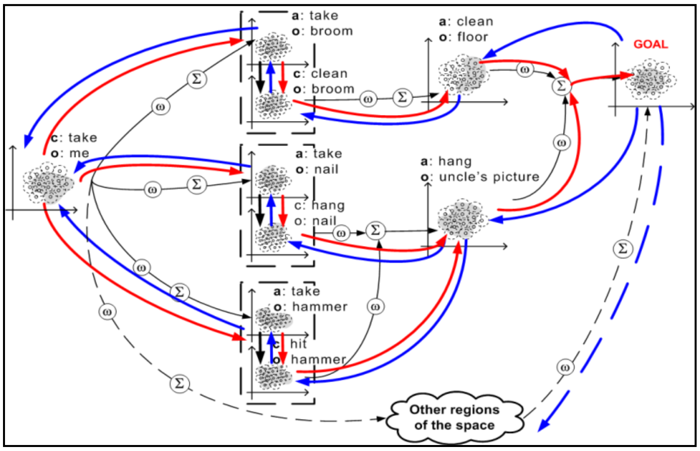
The Planning Process:

Example. An agent (e.g., "me") must clean the room and hang a picture to the wall. To this aim, he should use a *hammer* (along with a *nail*) and a *broom*.

1) In order to reach a given objective one must acquire a number of *capabilities*.
2) Each neural link corresponds to the acquisition of a capability necessary to reach the final goal.
3) The algorithm search for a neural activation path connecting the initial state (e.g., "my capabilities") to a point in the goal space.
4) When all the neural links (i.e., the acquired capabilities) are connected, the path between the initial agent capabilities and the goal is established.
5) Traversing the neural path corresponds to executing actions aimed at acquiring the necessary capabilities.







Conclusion:

The proposed planning system maintains a generic and efficient representation, which takes advantage of neural networks and the key idea of affordance. The envisaged planning algorithm is characterized by a lower complexity w.r.t. the existing logic-based planners and by an increased versatility, being the computational complexity only bounded with the number of considered affordances.