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Ontologies and Conceptual Metaphor in Autonomous Robotics

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TOPICS:

Ontologies

Conceptual Metaphor

Autonomous Robotics

Autonomous Robotics

A robot system such as OPRS permits one to set up pre-programmed "notions" (representations in memory) for paths, way-points, obstacles, for example and derive the presence of these by examining sensor data.
OPRS usually is run in reactive mode, but it is capable of a meta-level mode where deliberative processing can occur. Usually way-points and path usage are processed reactively at initialization time.

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Planning the path of travel, a typical job of on board computing systems in an autonomous mobile robot, might be performed using the A* approach.

A metaphorical planning system can choose to use higher-level geo-spatial objects in addition to points, lines / paths used in standard A*.

Autonomous Robotics 3

- Plans which substitute inexact values and inexact actions for precise ones give the plans a flexibility closer to that of biological systems, who never know precisely where their limbs are nor distances from themselves to things of interest in the world. This *situated-ness* (relating both perceptions and measurements of the world and reasoning relationships to oneself or substitute-other perceptual origin) is what provides biological systems with such reasoning power to cope with a complex world.

Autonomous Robotics 4

- Context is which features and dimensions of all those which the system "knows" of are relevant, salient to the moment or task at hand.
- Similarly when we were babies thrashing about in the crib we noticed the correlation between our reach (general arm movements for that matter) and what we saw with our eyes. That conceptual correlation provided us with a sense of space, of depth (3D volume, extent).

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- Measuring the distance from the laser range finder on a robot to the current location of the robot's hand does not provide a sense of depth.
- Many such measurements would have to be taken (with the hand at different locations obviously) and these would have to be combined with concomitant (robot limb) proprioceptive information (perhaps angles at inflection points and motor information as well).
- Metaphor-based planning is potentially much more flexible than exact-match approaches

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•Metaphors are used to "explain" or model phenomena or even concepts. They are productive because they are inexact, imprecise and yet capture or *represent the salient aspects or features* of the phenomena or concepts.
•High-quality computer games use a lot of code to “process physics”, like gravity, gas expansion, etc. and generate reasonable action / behaviour to make the games more like the real physical world. Autonomous mobile robots benefit from the same processing capabilities as it helps to interpret sensor data and generate expectancies for what may happen.
•Metaphors of various types help reasoning by providing a known description or process to address reasoning about something which is not a known description or process.

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- Words are containers for thoughts, which themselves are objects.
- It is the ability to functionally process inexact things which allows this very useful abstraction, the substitution of something *similar* or *corresponding* for unknowns. It allows reasoning about things that are not perfectly familiar by using those that are.
- Neither modeling nor abstracting (metaphors) can be performed willy-nilly but must be done in a principled manner in order that the result be functional.

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- Part of the solution is to use relevancy / conditionals, to use relevant domains and dimensions / aspects. Partial ordering of the innards of the metaphor is the answer to this.
- The sciences of astronomy and physics have long used conceptual metaphor productively, in such terms as “event horizon”, “gravity well”, “curved space”, “time dilation”.
- Productive conceptual metaphors can be used functionally on computers. This may be done by employing ontologies which provide requisite background knowledge to the system and qualitative logic processing.

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- In the case of "The squirrel ate the acorn near the foot of the tree.", we have fuzzy and metaphorical elements in the statement.
- The basis for the context which provides a scale for "near" in this case is "tree", specifically the comparison of the general distance from the (actual or estimated) center of the tree trunk to the (general or average, or even believed to be) outside edge of that tree, with some actual (or estimated) distance of the acorn from the (edge of) the tree.
- Foot of tree, foot, is a name which can be used in ontologies as a linguistically derived term.

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•When we look at the CYC knowledge-base we see that it has defined a number of valuable useful knowledge items to do with foot.
•CYC may be used to infer tacit information, that is information which is not explicitly present in an input / data set.
•This ontological semantic knowledge is valuable for it allows the program we are discussing in this paper to identify / locate a foot in a visual data set yet without being committed to a particular photograph of one, nor drawing or X3D three-dimensional data set of a foot.

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- *relevant transfer* of both goals and actions from the *activity* of an "easter egg hunt" to that (activity) of locating and acquiring dispersed objects of value at unknown and possibly hidden locations.
- Another metaphorical plan "Don't get too close to a deep hole."
- Looking at the comments in the CYC ontological items you may see that the natural language terms for fuzzy predicates, such as ABOVE, BELOW, Directly, Generally, Up, Higher occur there. Computing with words technology can provide real computations employing these concepts / predicates, as illustrated above with the fuzzy term “IsNear”.

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- Metaphors like “foot of..” use the same computing principles as these. By detecting and applying relevant contexts, such as which dimensions make sense to compare and process, these computations can bridge fuzzy systems / computing with words with ontological technologies. These contexts provide a measure / identity of the “partial” aspects of “partially structured metaphors.”
- Fuzzy actions, when we place things “by eye” we place them “generally near enough” to the (perceived) actual centroid of the receiving object, we never measure exactly where the centroid of things is to place objects.

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•SVG programs can be parsed with an XML parser and so semantic-web type technologies may examine SVG programs directly and discover semantic knowledge therein. Through such parsing and discovery the actual SVG program can be translated into fuzzy representations so as to allow them to be processed via computing with words technologies.
•(Gravity Well) A hypothesis forming / “discovery” system could take the data and generate theories.
•Years ago (1986) “Boyle's Law” was rediscovered by a discovery program (BACON) developed by Pat Langley.