





# Brooks Intelligence without representation Hardly anyone has ever connected a vision system to an intelligent central system. Thus the assumptions independent researchers make are not forced to be realistic. There is a real danger from pressures to neatly circumscribe the particular piece of research being done.

#### Brooks Intelligence without representation

When researchers working on a particular module get to choose both the inputs and outputs that specify the module requirements I believe there is little chance the work they do will fit into a complete intelligent system.

Until realistic modules are built it is highly unlikely that we can predict exactly what modules will be needed or what interfaces they will need.



#### Brooks Intelligence without representation

Decomposition by activity

The fundamental slicing up of an intelligent system is in the orthogonal direction dividing it into activity producing subsystems. Each activity, or behavior producing system individually connects sensing to action.

An activity is a pattern of interactions with the world.

# Brooks Intelligence without representation Decomposition by activity The idea is to first build a very simple complete autonomous system and test it in the real world.





Brooks Intelligence without representation Semantics and representation There are no variables that need instantiation in reasoning processes. There are no rules which need to be selected through pattern matching. There are no choices to be made. We hypothesize that much of even human level activity is similarly a reflection of the world through very simple mechanisms.



# Agre – Pengi

Interactionist metaphors

- Focus on an individual's involvement in a world of familiar activities.
- Agents relate to objects primarily in terms of the roles they play in activities, not in terms of their resemblance to mental models of them.

#### Architecture

Feedforward networks Visual routines as special actions Delays but no state Network compiled from high-level spec Arguments as a programming metaphor

# Richer (non)representations: Agre

Entities:

- The-car-I-am-passing
- The-coffee-cup-from-which-I-am-drinking

Not descriptions that an agent represents to itself as a linguistic structure.

Name a role that an object might play in a certain time-extended pattern of interaction between an agent and its environment.



Aspect

- The-car-I-am-passing-is-a-police-car

Under suitable circumstances, an agent can be said to register at a given moment, the value of such an aspect.

### How does it work

Entities in Pengi

- The-ice-cube-I-am-kicking
- The-bee-I-am-attacking
- The-bee-on-the-other-side-of-this-ice-cubenext-to-me

#### Aspects

 The-bee-I-am-attacking-is-running-away-fromme

#### Visual operators

Visual objects Indexing operations Markers

Each can run only once – there's hardware for them and a clock...

If you want two per cycle, need two copies (and to know who does what)

## A bit of network

(on chalkboard)

#### Note

Despite this vocabulary, many of the classically difficult technical problems of representation remain.

- What entities and aspects to represent
- Degrees of abstraction, complexity of inference
- (what entities and aspects do people relate to, and why?)

#### Issues for discussion

The objective identities of things are rarely perceptible, whereas the indexical and functional relationships that things bear to agents usually are.

Vision as an active processes structured to maintain the kinds of causal interactions that ground deictic representations.