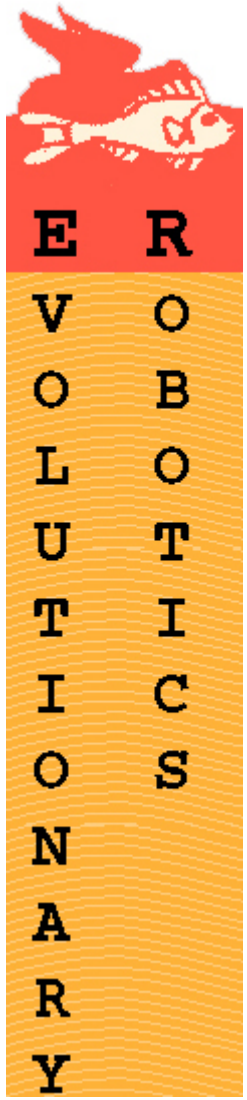

Evolutionary Robotics: A Practical Introduction

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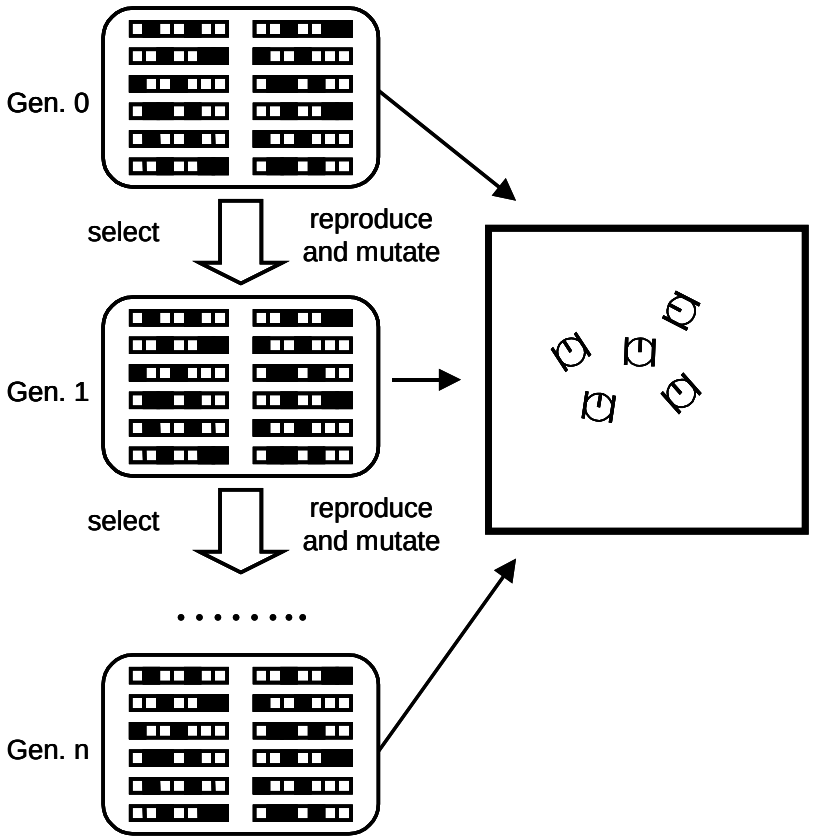
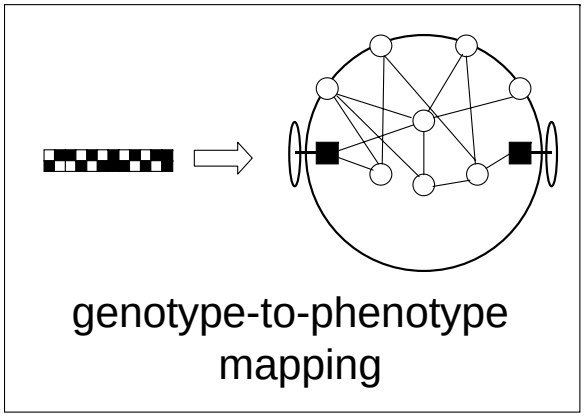
The Method

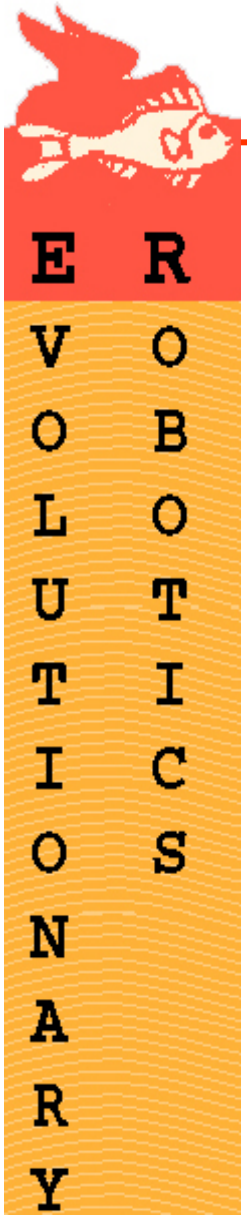




genotype-to-phenotype mapping

$$\Phi = V\left(1-\sqrt{\Delta v}\right)\left(1-i\right)$$

fitness function

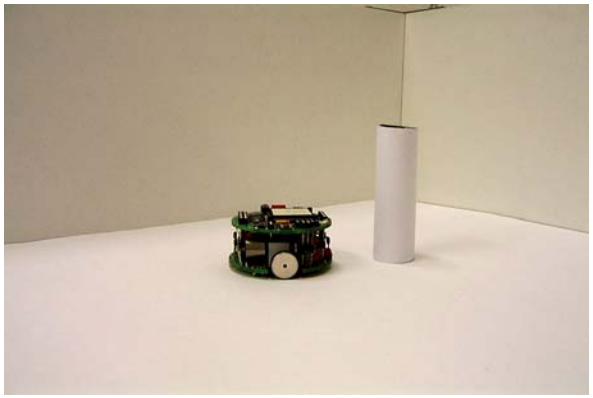


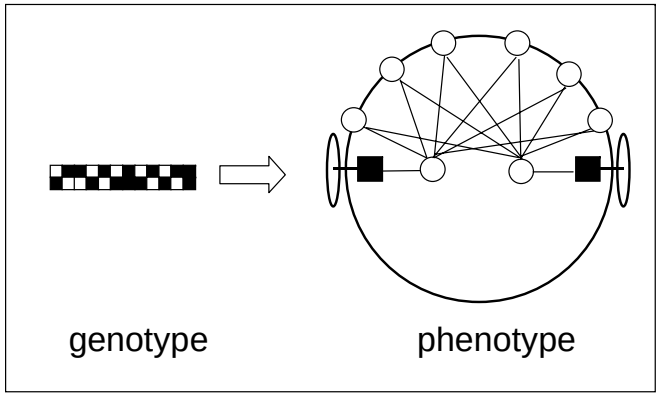
The genotype/phenotype mapping

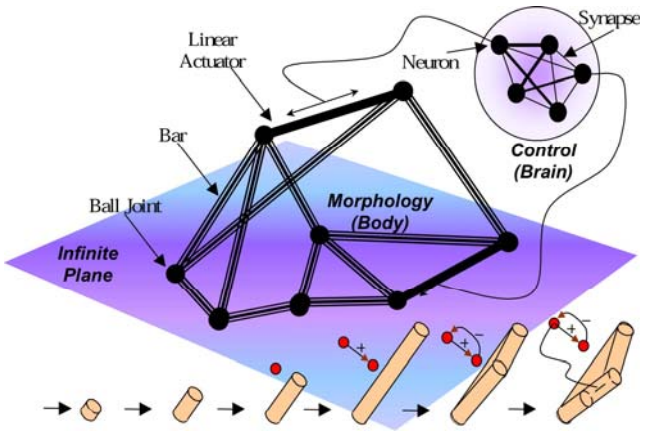
The genotype might encode: the connection weights of the robots' neural controller, the architecture of the neural controller, the characteristic of the sensory-motor system of the robot, the body shape, the learning rules which regulate how the phenotype adapt during its lifetime

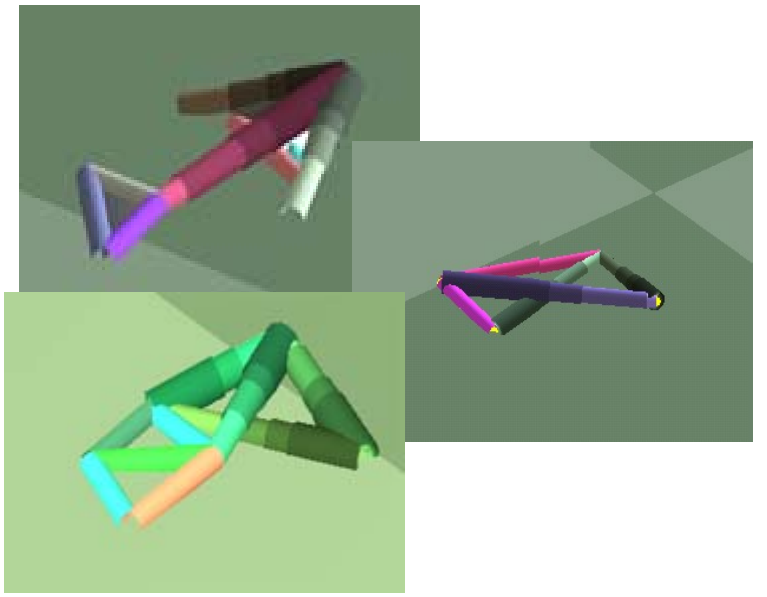
The mapping between the genotype and the phenotype might be direct or indirect. For example, in direct mappings each phenotypic characteristic subjected to variation is encoded in a corresponding gene of the phenotype. In indirect mappings the genotype might encode growing rules that regulate how initial elements that constitute the 'embryo' duplicate and differentiate by finally producing the mature individual phenotype

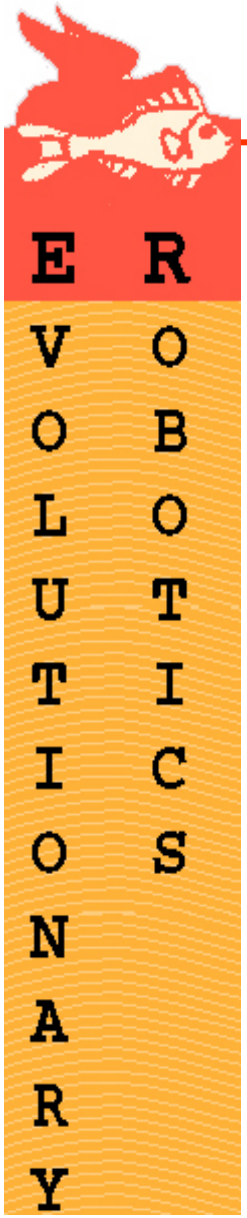
The genotype/phenotype mapping











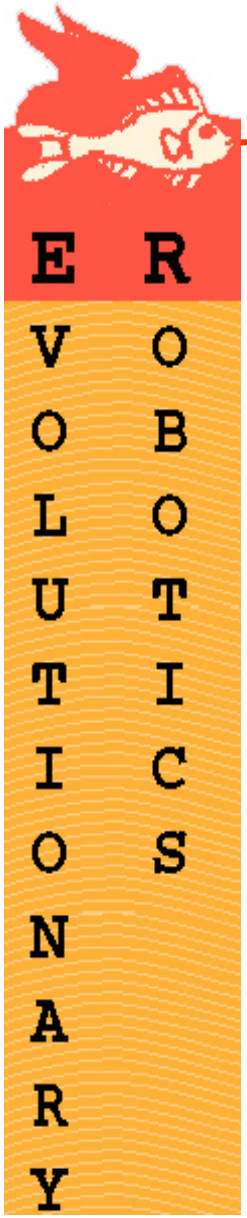
The fitness function

The fitness function provides a quantitative evaluation of the performance of an individual robot (i.e. the extent to which a robot successfully solve a given task).

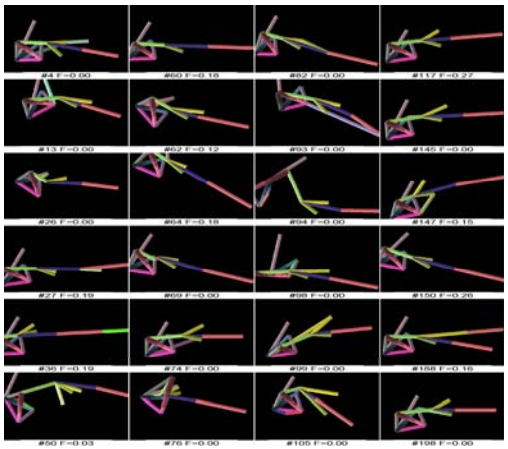
Implicitness: it should encodes the extent to which the overall problem is solved independently from the specific behavioral and cognitive skills which are selected to solve the problem and independently from the characteristics of the robot's body and controller which are selected to produce the selected behavioral and cognitive skills.

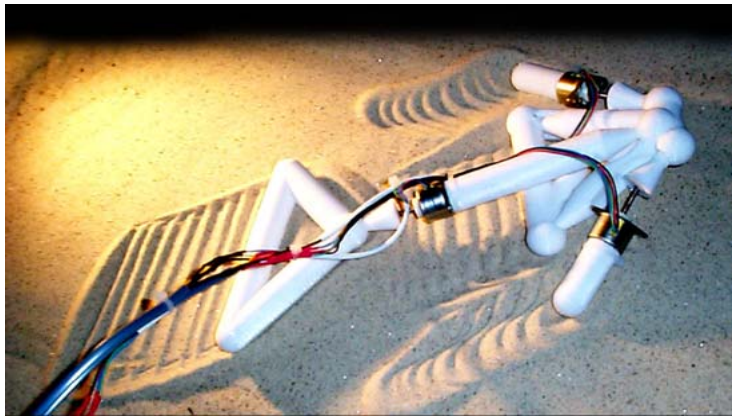
It might include task-aspecific measures (e.g. information theoretic measuses such us entropy, or mutual information) which might encode general properties of 'interesting' solutions.

Measurability: the information required to compute the fitness of an individual should be available to the individual itself (through its sensors) or should be accessible through a sensing device external to the evolving robots.

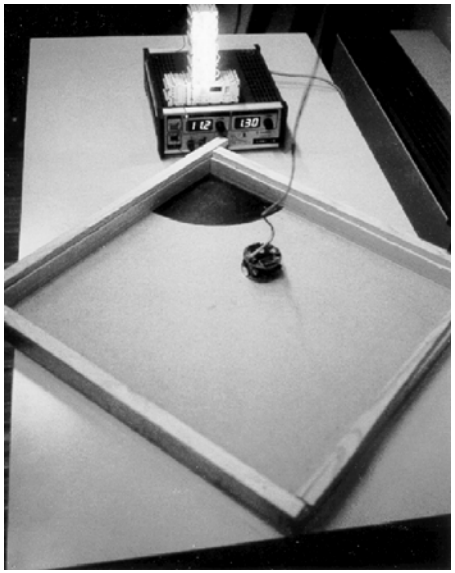


Evolution in simulation or in hardware





[Lipson and Pollack, 2000]



[Floreano and Mondada, 1996]

[Hornby, Fujita, Takamura, Yamamoto, Hanagata, 1999]