Behaviour-based control in ARGoS: The Subsumption Architecture - *Intelligent Robotic Systems* -

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The Subsumption Architecture

The task for Laboratory Activity 03 is to implement the robot control program in ARGoS based on the subsumption architecture introduced by Rodney Brooks.

Task

The task remains consistent with the previous laboratory, where the robot is expected to:

- Locate a light source and navigate towards it
  - Reach the target as swiftly as possible (`MAX_VELOCITY` = 15)
  - Once arrived, maintain proximity to it, either by remaining stationary or by continuous movement
- Prevent collisions with other objects, including walls, boxes, and other robots.

The robot is equipped with both light and proximity sensors.

Competences

Firstly, I began by defining the basic task-achieving behaviors, also called competences according to Brooks' terminology, and their positions in the stack of competences:

0. **Obstacle avoidance competence**: corresponds to avoiding obstacles, whether they are moving or stationary
1. **Wander competence**: corresponds to walking randomly
2. **Explore competence**: corresponds to searching the target
3. **Identify objects competence**: corresponds to achieving the goal

Implementation description

The initial code was taken from the previous lab. I managed to create a one-to-one mapping from the states of the deterministic finite state machine to the identified competences. For this reason, I created four different functions, that directly send signals to the wheels but are called sequentially, from 0 to last level, so that higher levels can override the signals. Higher-level layers subsume the roles of lower-level layers when they need to take control.

To visually inspect the behavior, LEDs are utilized with colors corresponding to the competences:

- In the explore competence, black LEDs are assigned.
- In the obstacle avoidance competence, red LEDs are assigned.
- In the wander competence, green LEDs are assigned.
- In the identify object competence, yellow LEDs are assigned.

Performance evaluation

I have run the simulation 1000 times with different arena instances, and the results obtained by calculating the Euclidean distance are as follows, as demonstrated by the statistics in the table and depicted through histograms and box plots:

Subsumption Architecture							
Count	Mean	Std	Min	25%	50%	75%	Max
1000.0	0.577791	0.679170	0.135449	0.353845	0.377805	0.437811	4.422663

Table 1: Summary Statistics for lab_activity-03

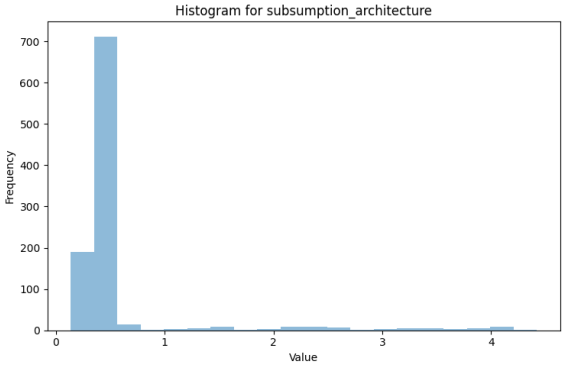

Figure 1: Histogram

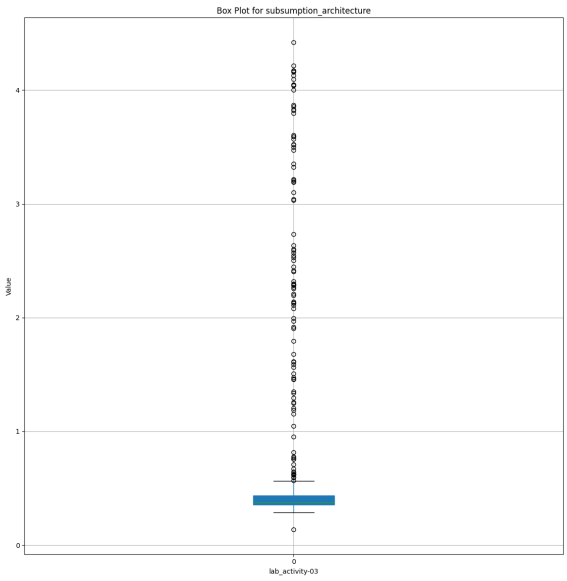

Figure 2: Box Plot

Observations

The issues encountered in the lab with composition behaviors have persisted in the subsumption architecture. Specifically, the threshold values to set, which are critical, and the particular conical shape that traps the robot in a loop.