Measures of Specialisation

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1 Metrics from the Literature

1.1 Proportion of Items

Source: Ferrante et al 2015 [1]

Description: "Proportion of items retrieved by more than one [agent] over the total number of items retrieved".

Formula:

$$\frac{R_{cooperative}}{R_{total}}$$

where:

$R_{cooperative}$ is Resources retrieved by more than one agent

R_{total} is Total resources retrieved by the team

Pros:

- Simple

Cons:

- Agents can pick up and drop resources without contributing to their transportation e.g. Go to source, pick up and drop on the spot, transport another resource as a generalist.

1.2 Action Switches

Source: Nitschke et al 2012 [2]

Description: "The frequency with which the controller switches between executing distinct motor outputs (actions) during its lifetime".

Formula:

$$\frac{A}{N}$$

where:

A is Action switches over an episode

N is Number of possible switches over an episode

Pros:

- Calculates an agent's specialisation rather than a team's. Can identify non-specialists on a team.

Cons:

- Only works if the dropper and collector strategies could be executed with just one action.

1.3 •

Source:

Description:

Formula:

Pros:

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Cons:

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2 Metrics by Me

References

[1] E. Ferrante, A. E. Turgut, E. Duéñez-Guzmán, M. Dorigo, and T. Wenseleers, "Evolution of self-organized task specialization in robot swarms," *PLoS Comput Biol*, vol. 11, no. 8, p. e1004273, 2015.

[2] G. S. Nitschke, M. C. Schut, and A. Eiben, "Evolving behavioral specialization in robot teams to solve a collective construction task," *Swarm and Evolutionary Computation*, vol. 2, pp. 25–38, 2012.