Coordination of learning modules for competing navigation strategies into different mazes

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Objectives

Improving autonomous navigation in a bioinspired robot
Selection of navigation strategies, especially between ‘taxon’ and ‘locale’ ones, in various environments

Taxon
- Visible goal
- Learning of associations
- Stimulus – Response (cue–response)
- Egocentric reference

Locale
- Hidden goal
- Learning of associations
- Stimulus – Location – Response (place–response)
- Allocentric reference

Examples in the Morris water maze
Strategies learned in parallel (Taxon and Locale paths): Selection of the Locale one when the platform is hidden; of the Taxon one when the platform is located at another position (Devan & White, 1999)

Reimplementation of the model and test in two different mazes

Morris water maze: 6/10 selections of Taxon expert for reaching the new goal (old location: SW, new location: NE) Example starting from S

Compétition: on Day 10
Morris water maze: only 3/10 selections of Taxon expert for reaching the new goal (old location: S, new location: N) Example starting from S

Sensory inputs: Place cells activation (metric information about walls, odometry: allocentric reference)

Motor outputs of Taxon and Locale experts: 36 action cells (10° direction each)
A direction is selected at each time-step by the gating network

The Taxon expert (resp. Locale) learns associations between sensory cells (resp. place cells) and action cells.
The gating network selects the most appropriate strategy according to the external input and the internal state of the system.
Both the experts and the gating network modify their parameters by means of reinforcement learning (Q-learning algorithm).

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Main implementation differences:
Ad hoc place cells
Addition of an avoidance reflex

Separate training of experts: 10 experiments of 60 trials (visible goal for Taxon; hidden goal for Locale); different starting points.

Competition: same protocol as Chavarriaga’s experiments (Devan & White, 1999). 10 experiments with: 4 trials each day, different starting points.

Days 1, 2, 4, 5, 8: Visible platform, assuming the learning of both Taxon and Locale strategies.

Days 3, 6, 9: Hidden platform, assuming the learning of Locale strategy.

Day 10: Competition - New position of the platform, assuming the selection of Taxon strategy instead of Locale one.

Improve variable and results due to insufficient training; due to ‘bad’ segmentation of the state-space; due to the inefficient Taxon strategy when the stimulus is out of the visual field.

Results obtained with the Plus-maze highlight some trade-offs that were not apparent with the Morris water maze. Using an egocentric reference for the Taxon strategy, and a segmentation of the sensory state-space for both Taxon and Locale, improve the learning of navigation maps and Q-values. However, the variability of the results questions the relevance of the current selection criterion.

Conclusion - Perspectives

Even if this criterion seems appropriate in both environments, either mode of selection may be considered in the future e.g., different weighting for Taxon, Locale (and Praxis, Guidance?) sub-experts in different parts of the environment or in different testing of the task (Packard & McDougall, 2005).

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