Minds for Mobile Agents

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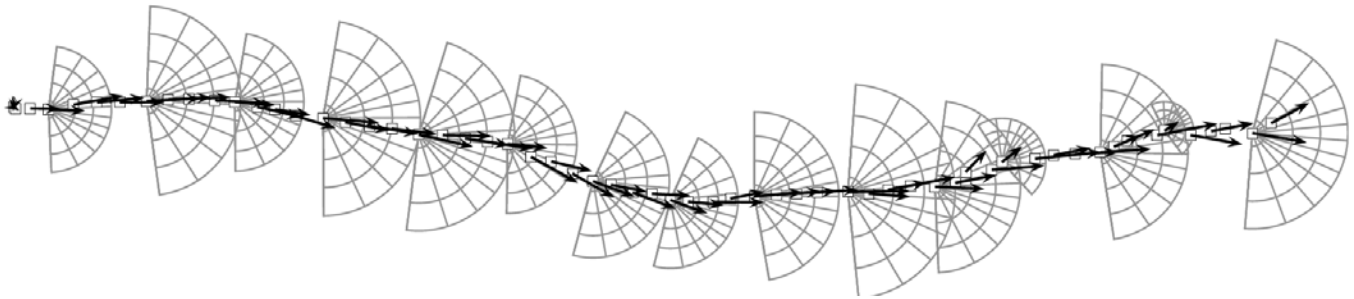
https://dataversuscorona.com/

Background and Objectives

- Effective training through simulation of multi-agent interactions requires autonomous agents with potentially diverse characteristics guided by realistically complex goals and mental models.
- We develop a framework to build, parametrize, and simulate agents moving around and interacting in order to achieve spatially defined goals, and demonstrate it here in a supermarket shopping scenario.
- Agent's step decisions are guided by an operational model using a flexible **utility-maximizing discrete-choice framework**.
- We then add a **strategic level** route finding and path planning abilities allowing agents to plan and re-plan individualized series of goals.

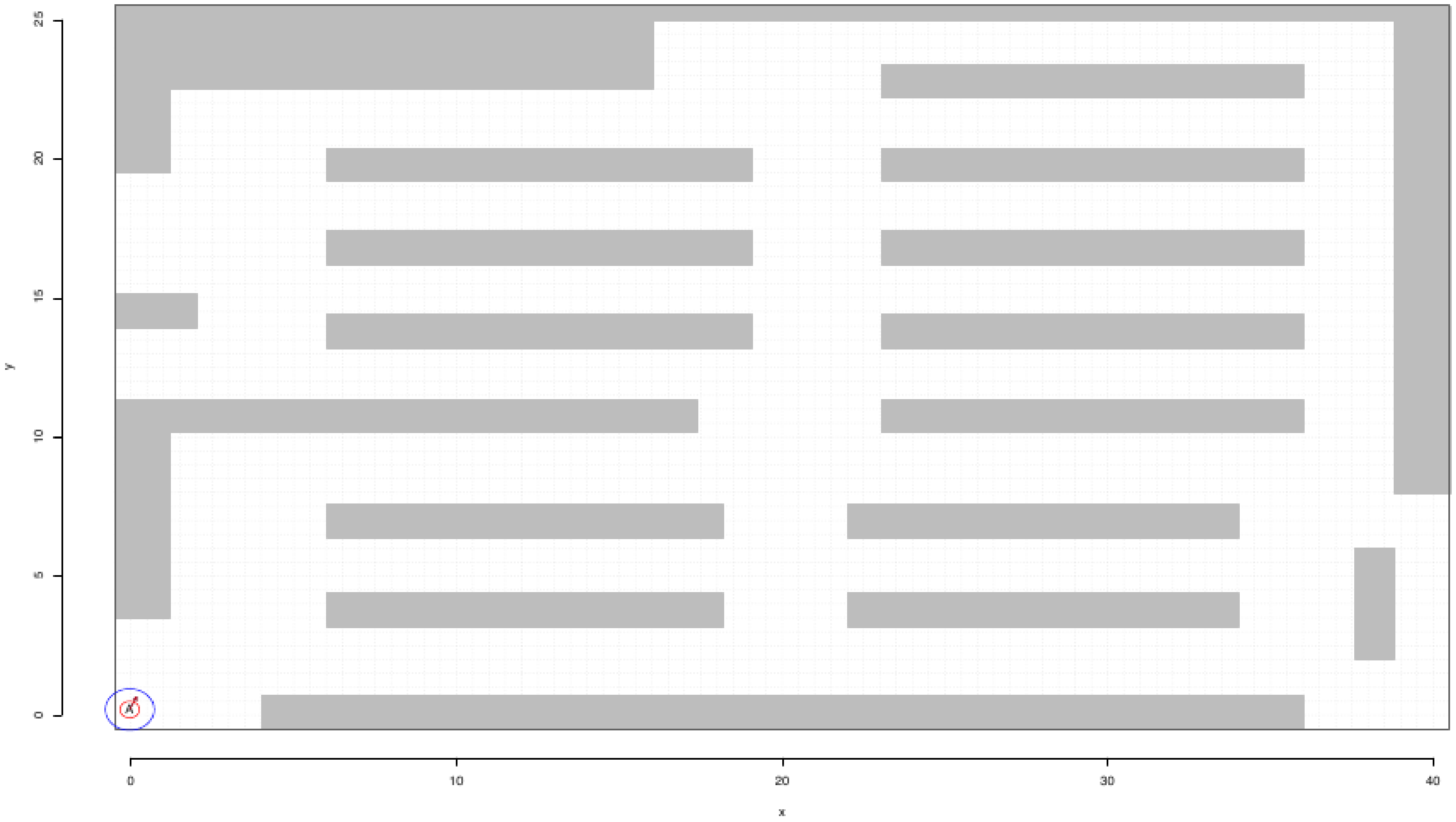
Operational Model



- Random utility (U) guides k=33 (11 direction “cones” x 3 velocity “rings”: slow/constant/speed up) step choices (r_U = randomness).
- $U_{ik=}\left(U_{ik}^{PS}+U_{ik}^{GA}+U_{ik}^{CA}+U_{ik}^{ID}+U_{ik}^{BA}+U_{ik}^{FL}+U_{ik}^{WB}\right)/r_U$
- Utility is a sum of scaled (*b*) power functions (*a*) of absolute differences (d≥0) between current position or velocity and **avoidance** or **approach** goals.
- ***Repulsion Utility = -b/d^a*** ***Attraction Utility = -bd^a***

[illegible]

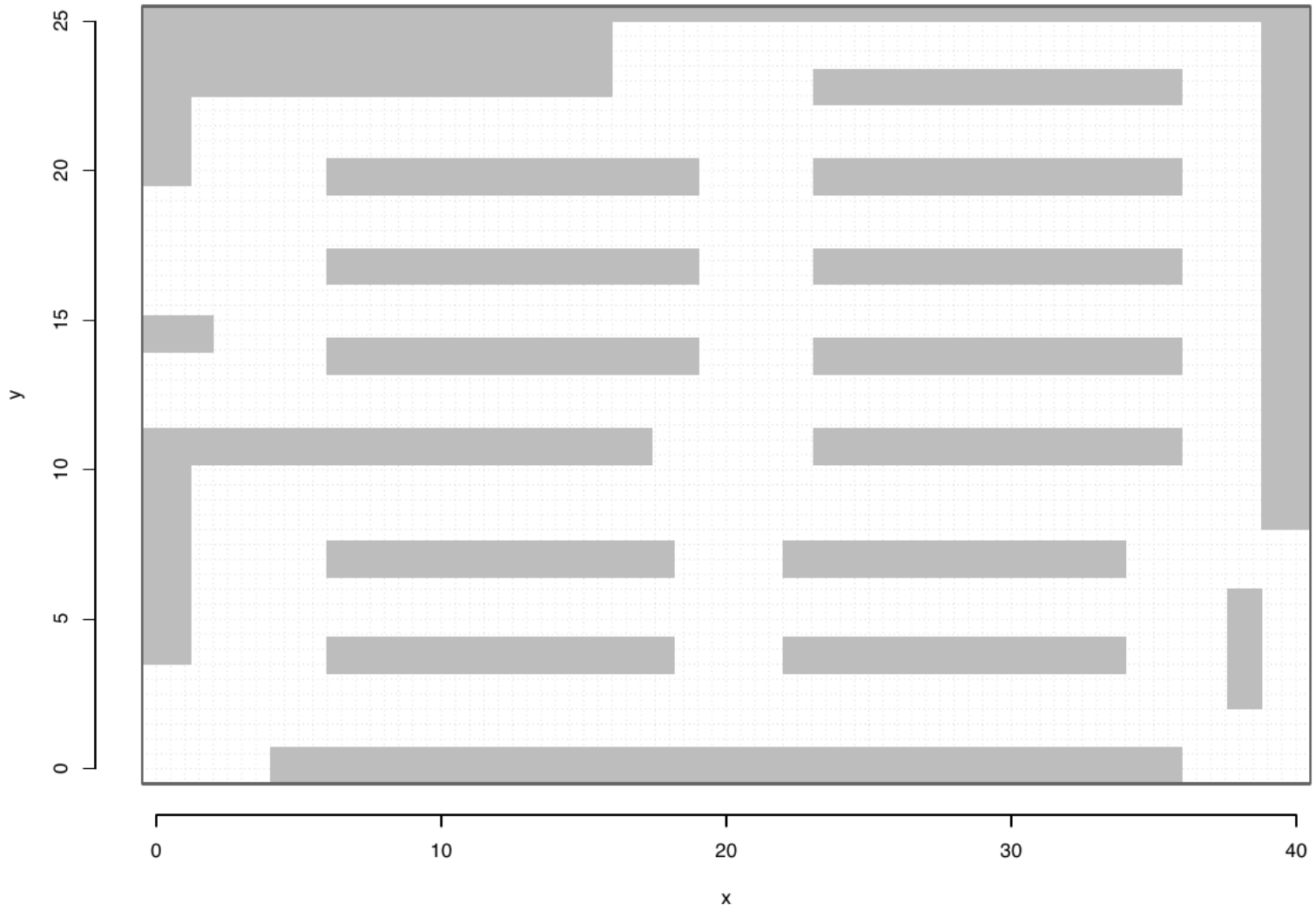
- [illegible] (e.g., **shopping in a supermarket**)
- [illegible]
- [illegible]
- Framework can be easily extended to add new behaviors and biases, with different weights for left and right side (e.g., to account for side preference)
- [illegible]



Strategic Model

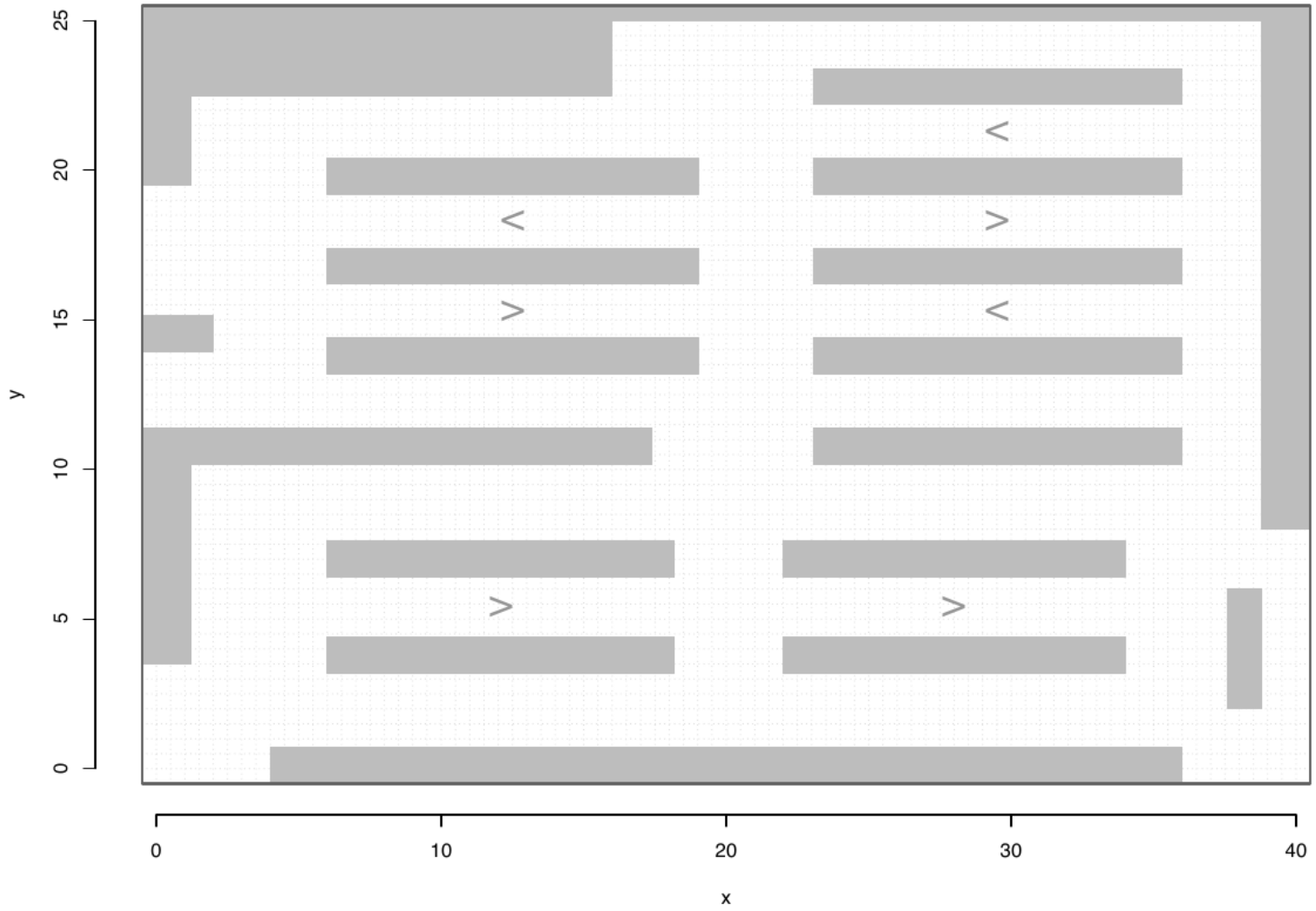
Each agent has a sequence of spatially defined goals of two types:

1) **“must visit”** goals satisfied when moving within a threshold distance;
2) **“way-point”** goals satisfied when the following goal becomes visible.



Strategic Model

- Route-finding and path algorithms build sequences (“goal stacks”) satisfying sets of must-visit goals (e.g., one-way regions).
- Operational factors compromising path plans (e.g., being pushed off course by other pedestrians) can be addressed by re-planning.
- Re-planning can also be used with changing conditions (e.g., crowds blocking the planned path at high densities).



Conclusions and Future Directions

- Our framework gives flexibly–specified “minds” to mobile agents, allowing them to operate competently and independently in complex and dynamic environments.
- The model is being used in projects investigating the effects of space design and movement rules on social distancing and virus spread.
- Future work will use position data from movement experiments to quantify individual differences and calibrate the model for veridical simulations of complex real-world scenarios.
- In a new project, the same framework is being used to model a navel escort task requiring participants to protect a high-value target from a submarine.