Spatial Routines for a Simulated Speech-Controlled Vehicle

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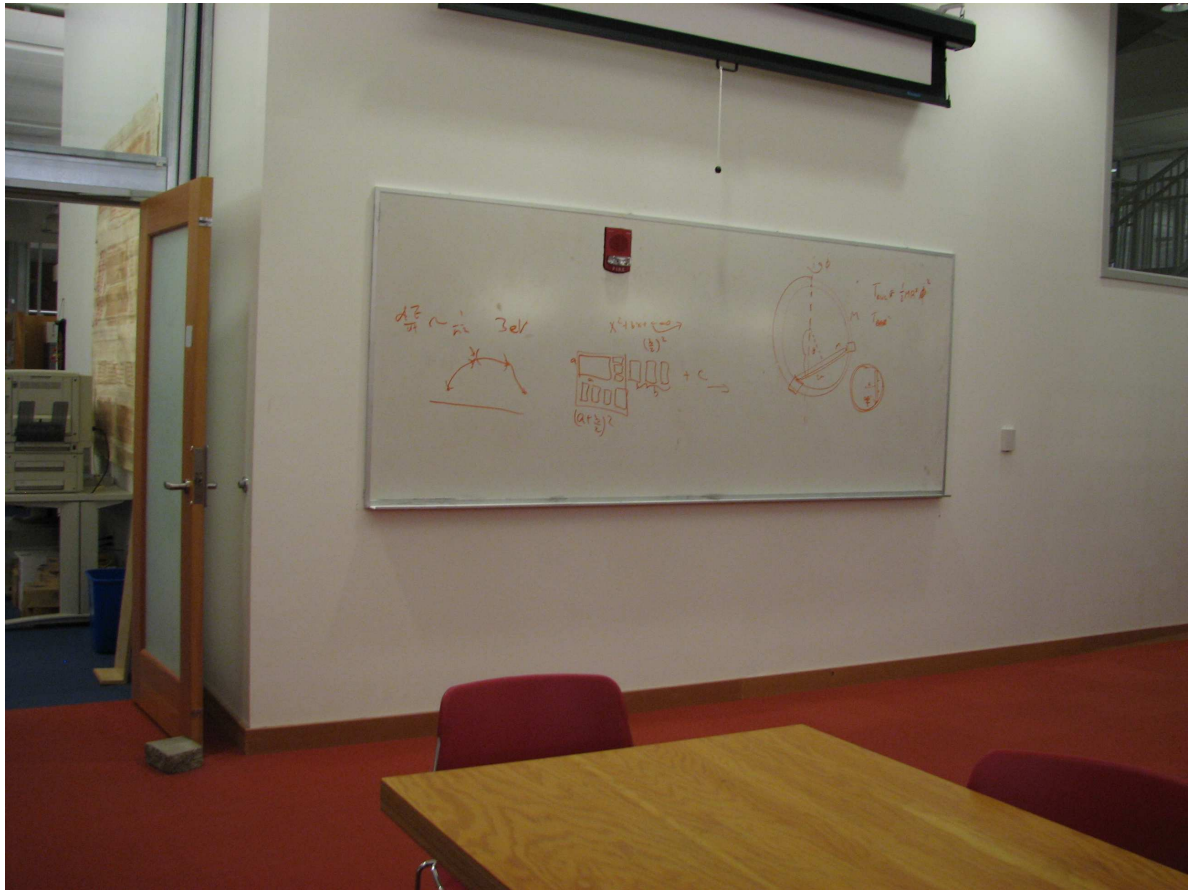
"Go left."



"Go left."

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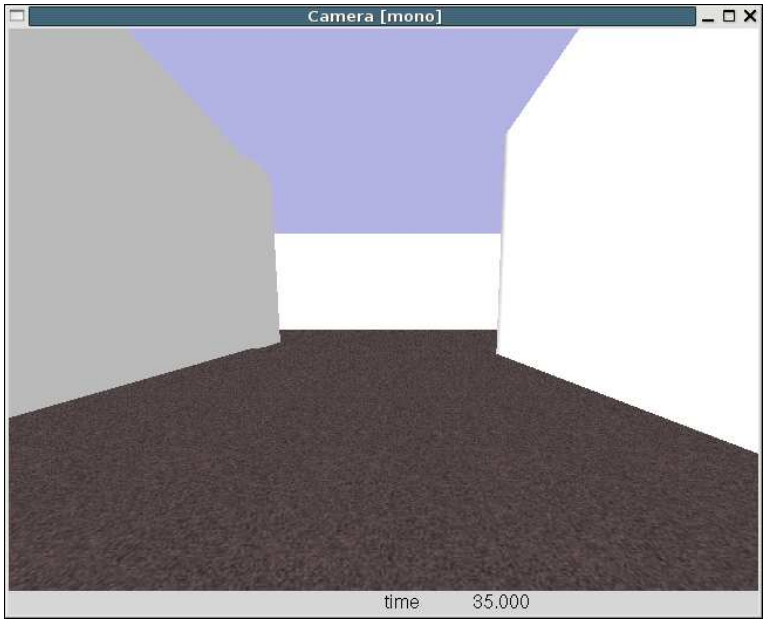
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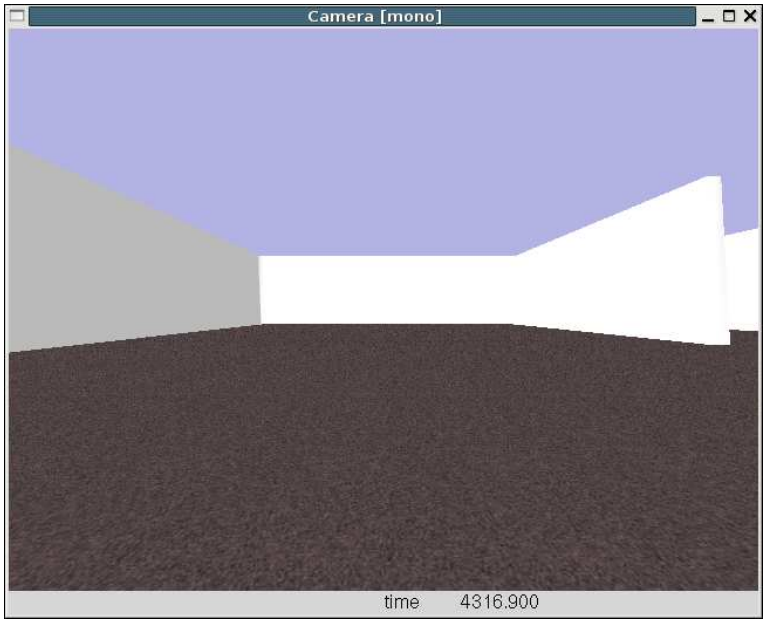
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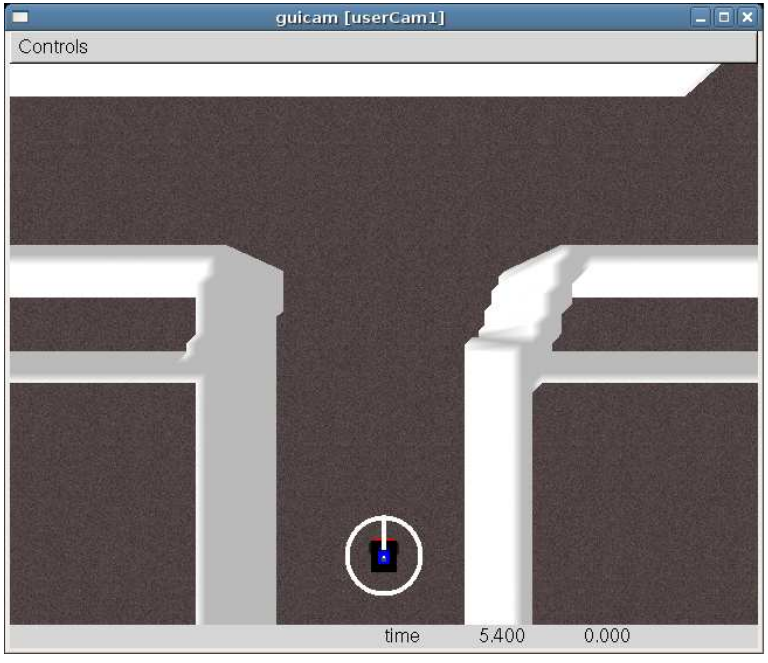
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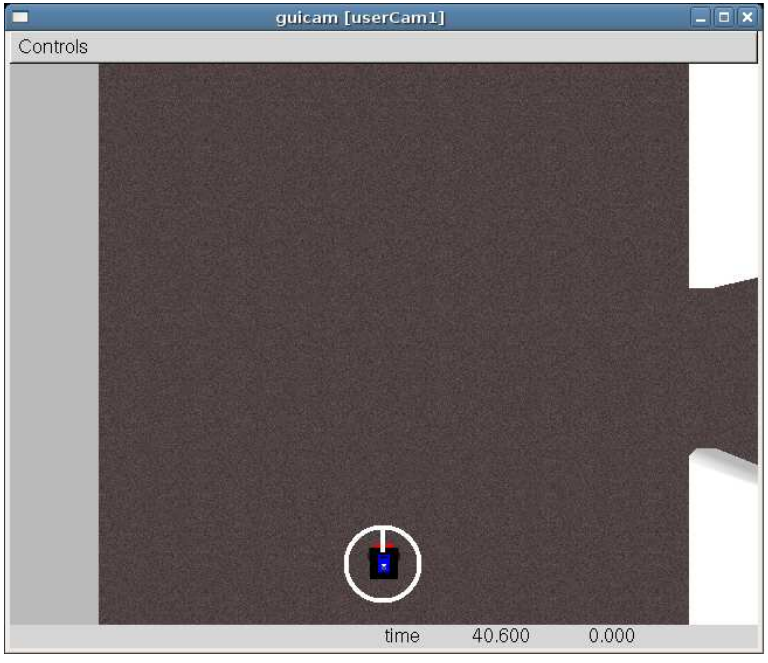
guicam [userCam1]
Controls
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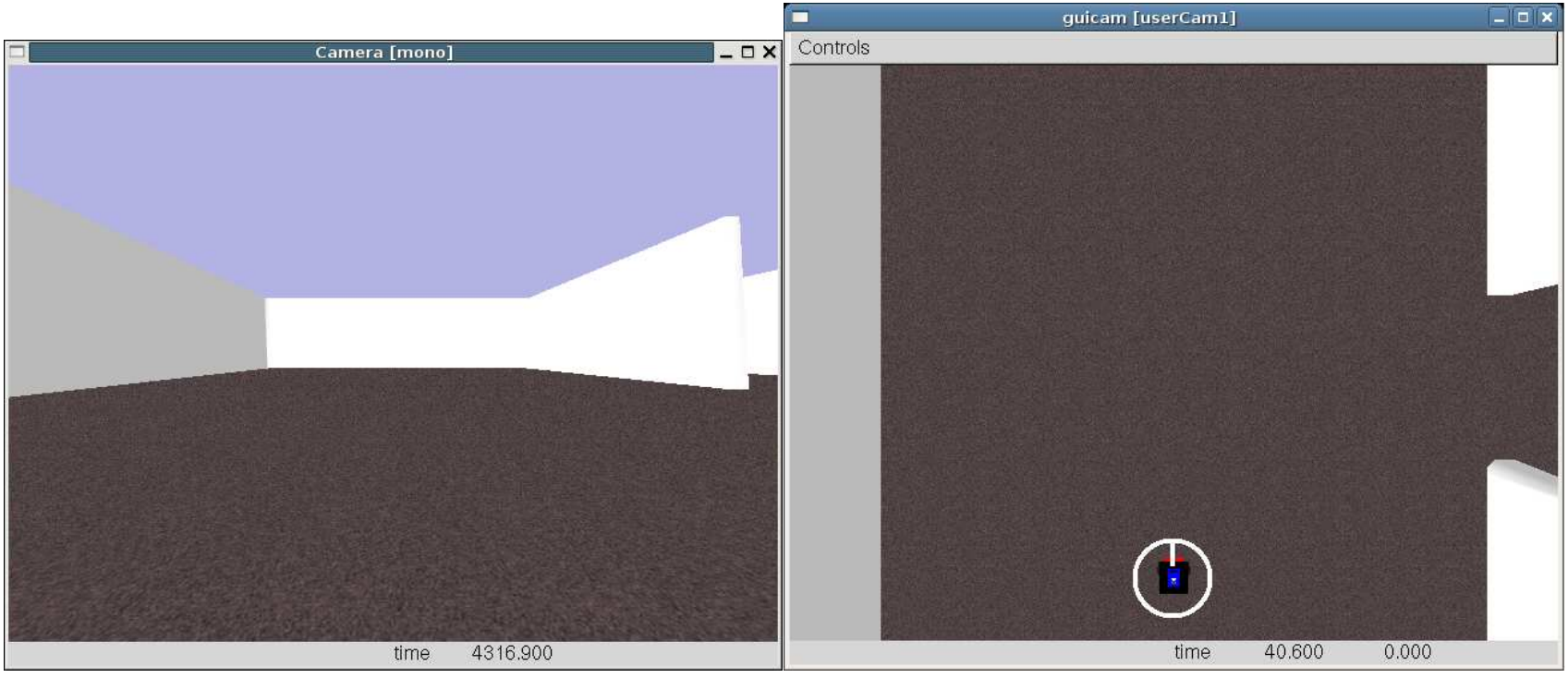
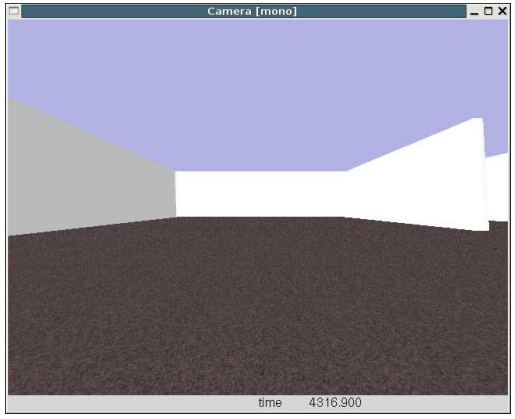
"Go right."

Execution Trace



"Go across the room."

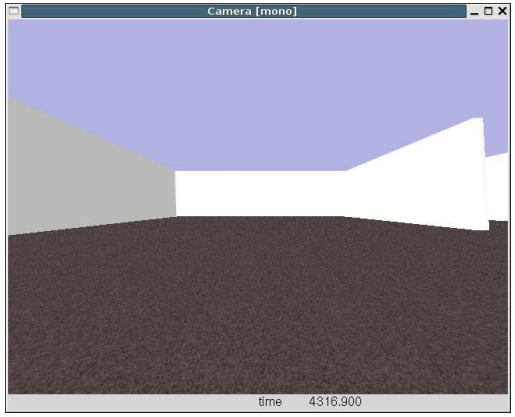
Execution Trace

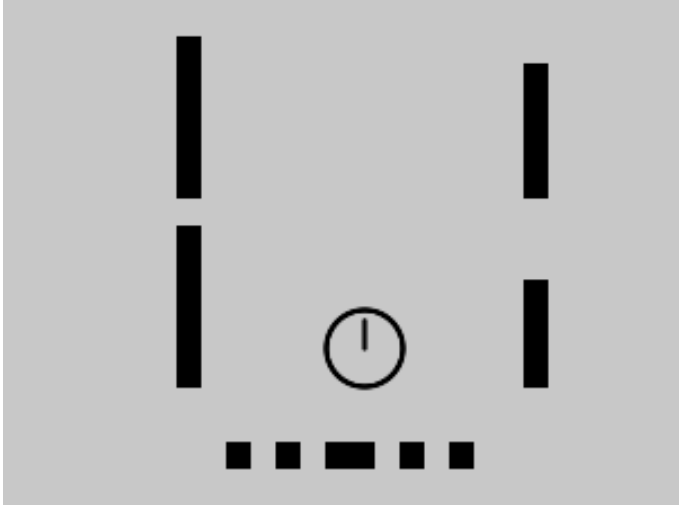


"Go across the room."

go(across(room))

“Go across the **room**.”





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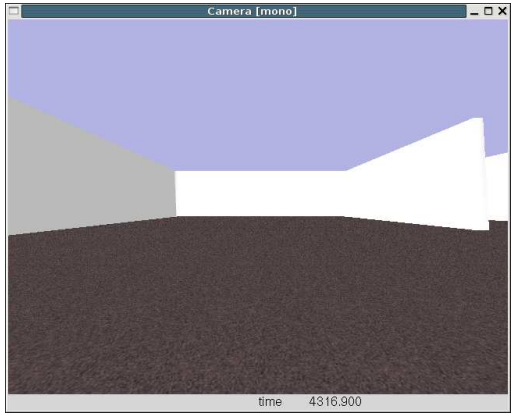

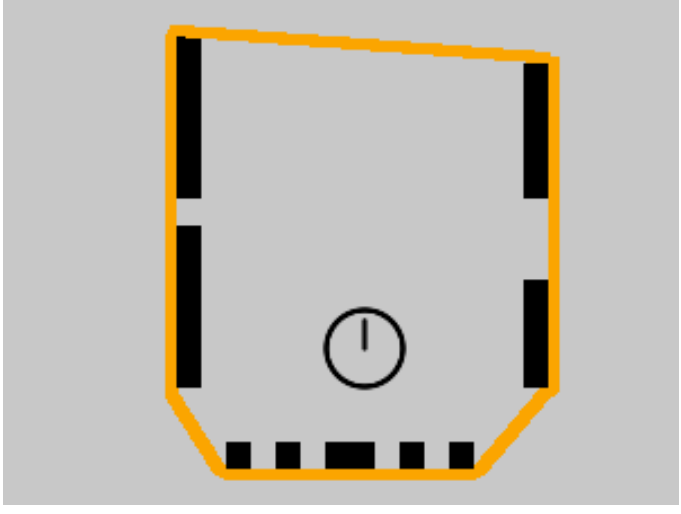

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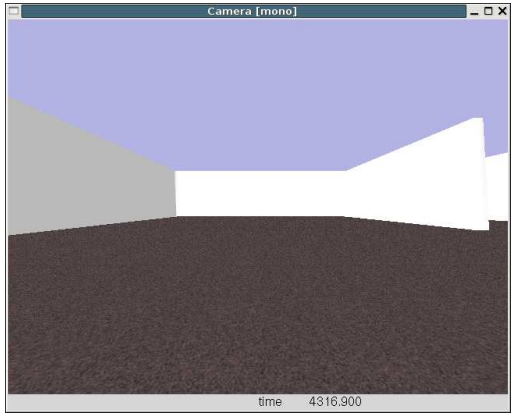

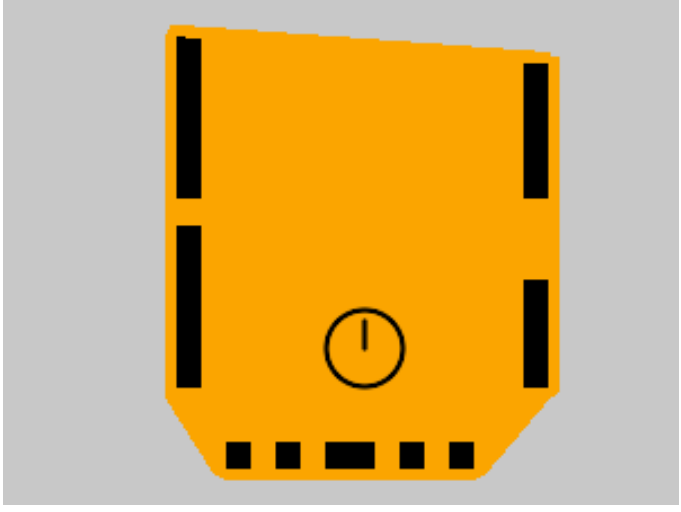

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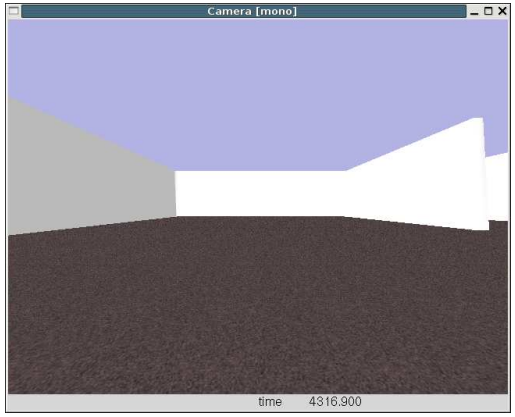
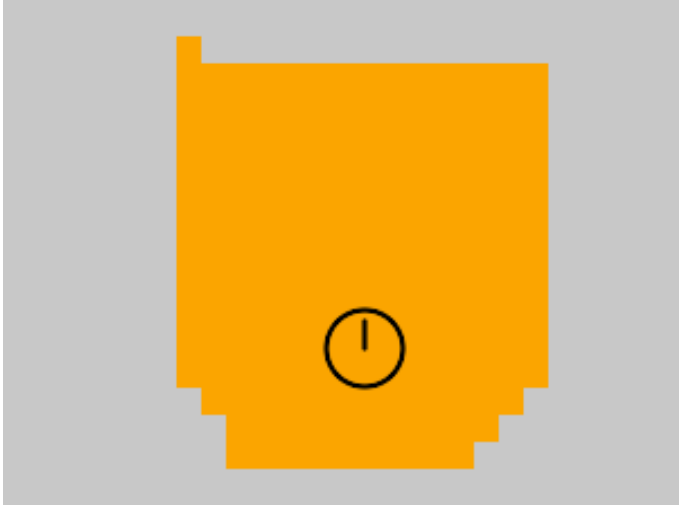
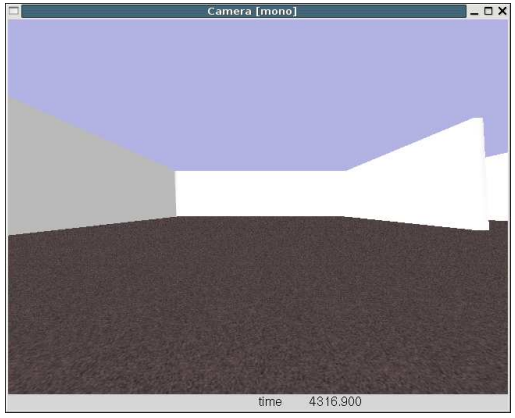
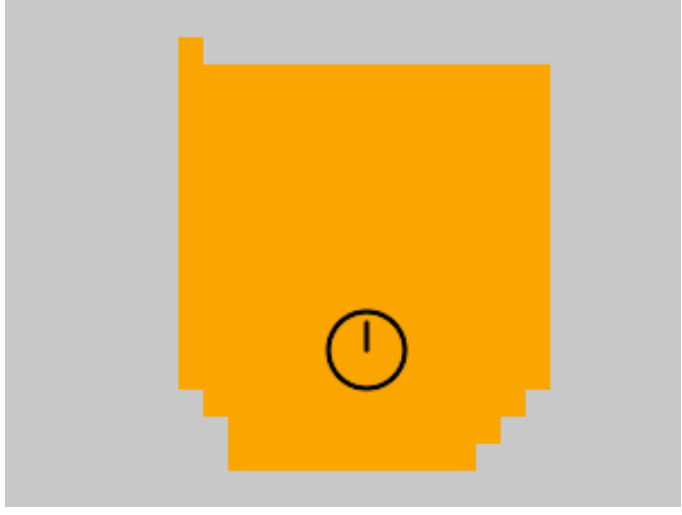
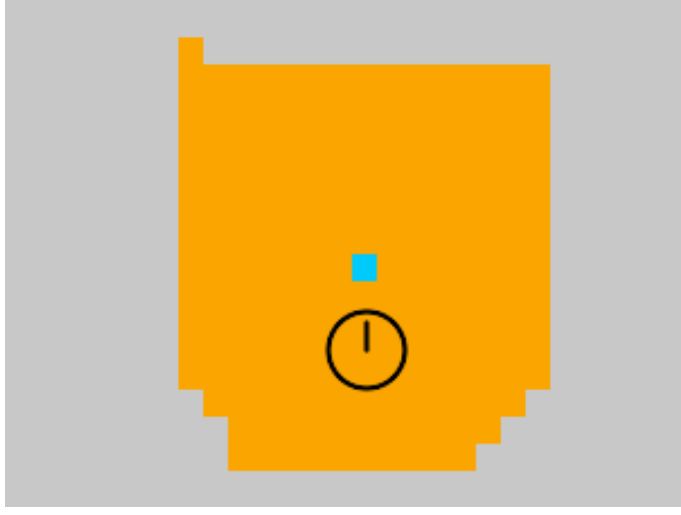




“Go **across** the room.”







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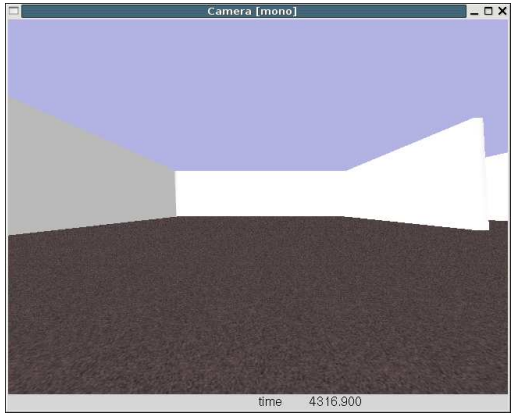

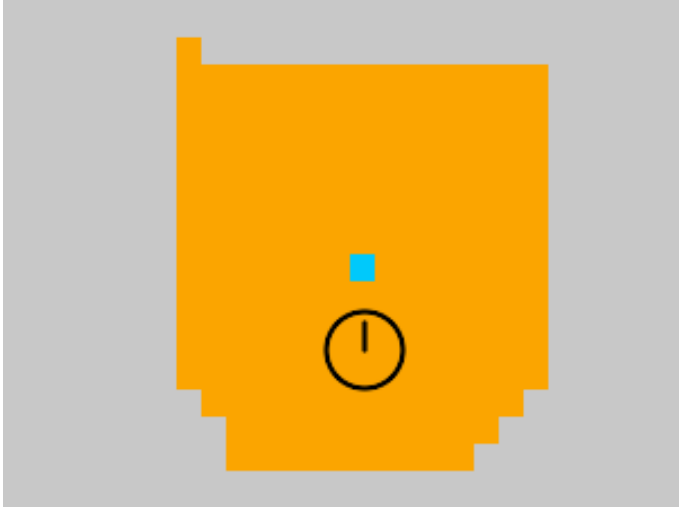

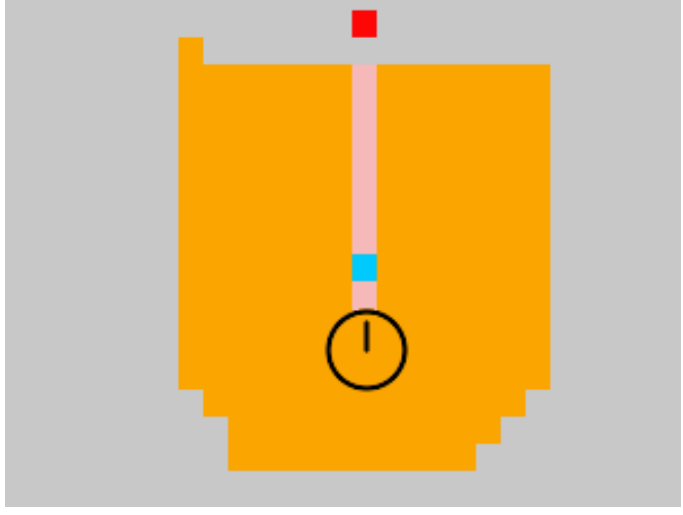

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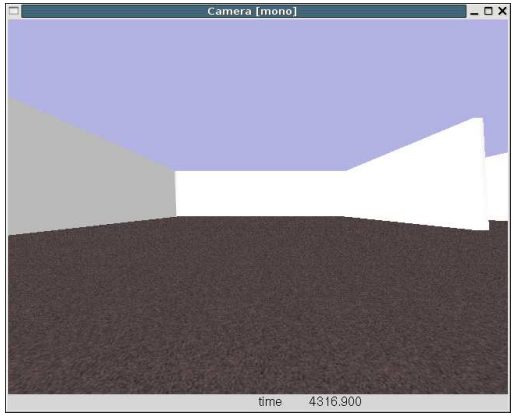
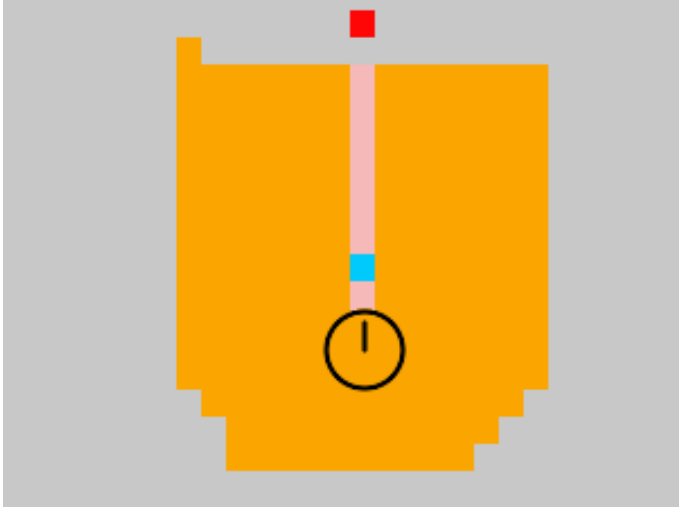
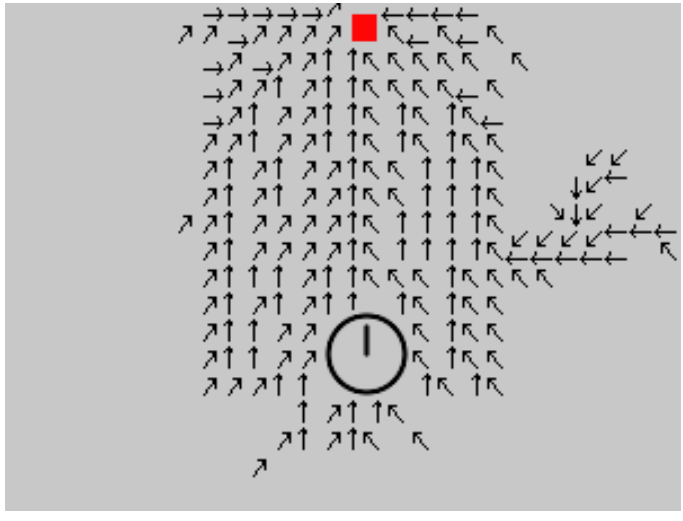
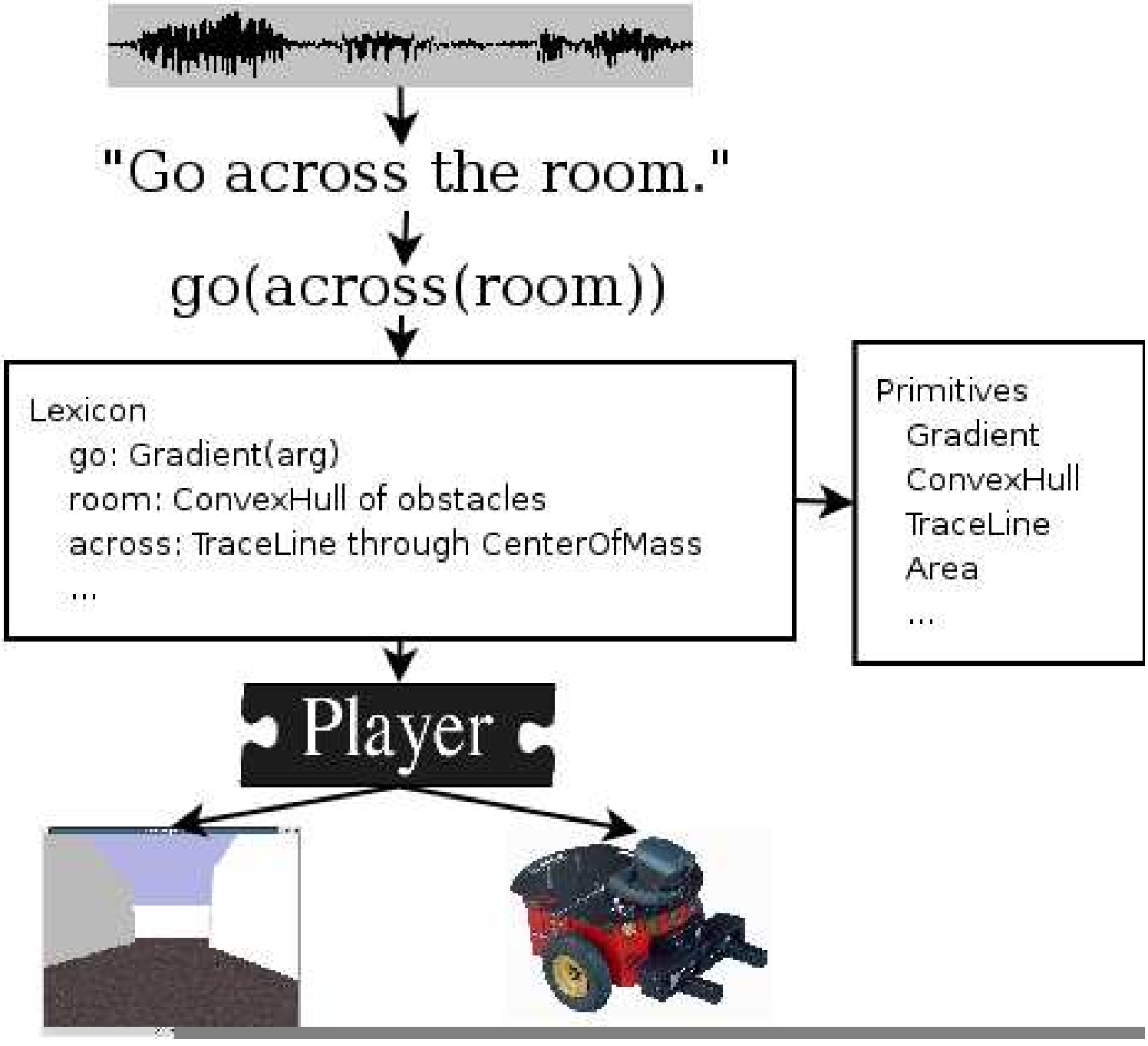




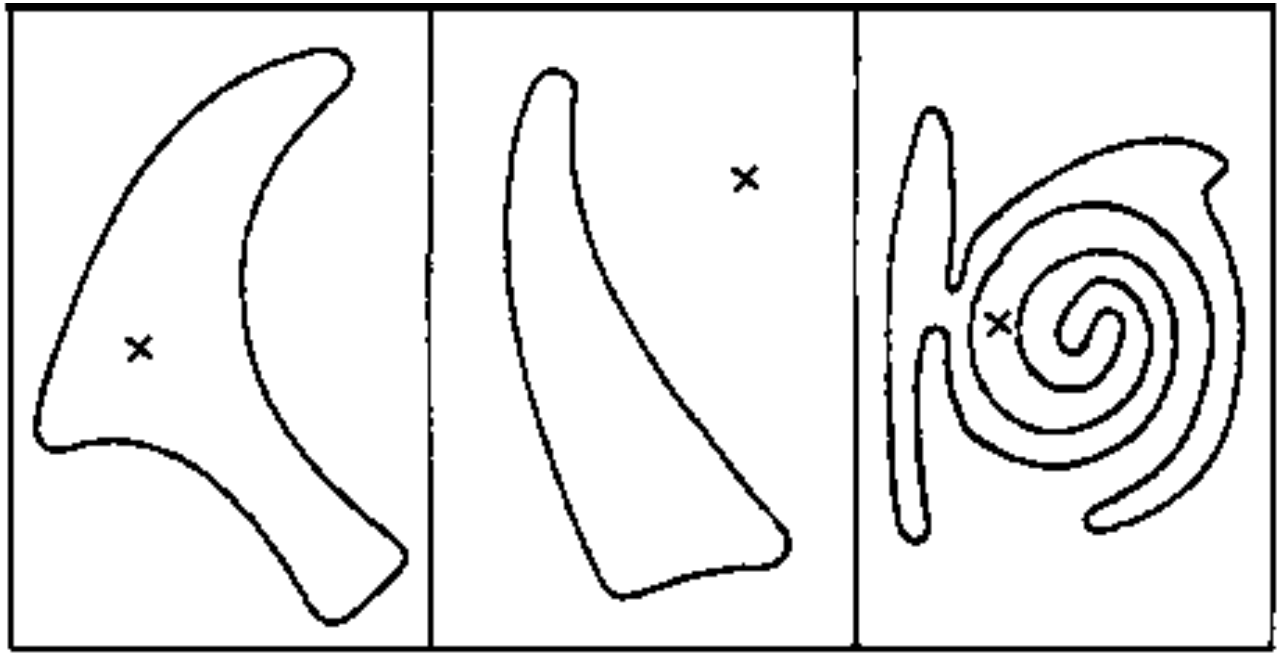



"Go across the room."
go(across(room))
Lexicon
go: Gradient(arg)
room: ConvexHull of obstacles
across: TraceLine through CenterOfMass
...
Primitives
Gradient
ConvexHull
TraceLine
Area
...
Player

RobChair	NavChair
Stop	Stop
Go forward	**Forward**
Go backward	Left/right (turn 30°)
Rotate right/left	Turn left/right (turn continuously)
Hard right/left (turn 20°)	**Pass door**
Soft right/left (turn 10°)	**Approach desk**
	Follow wall

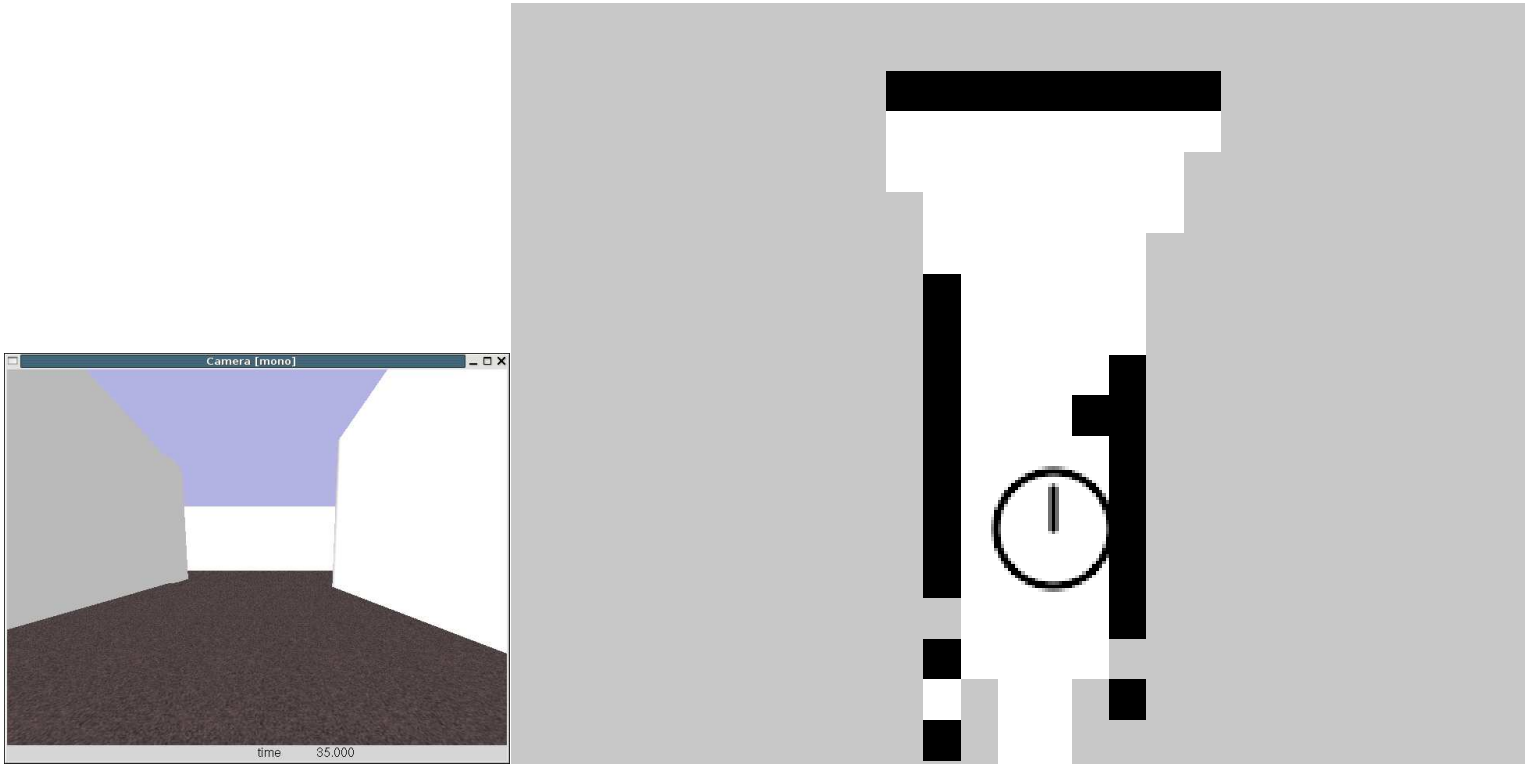
Wheelesley	Current System
Stop	Stop
Forward	**Go straight**
Back	Face left/right (turn 90°)
Left/right	**Go left/right**
	Turn around
	Go across the room
	Go to the object
	Go to the left/right of the object

Visual Routines

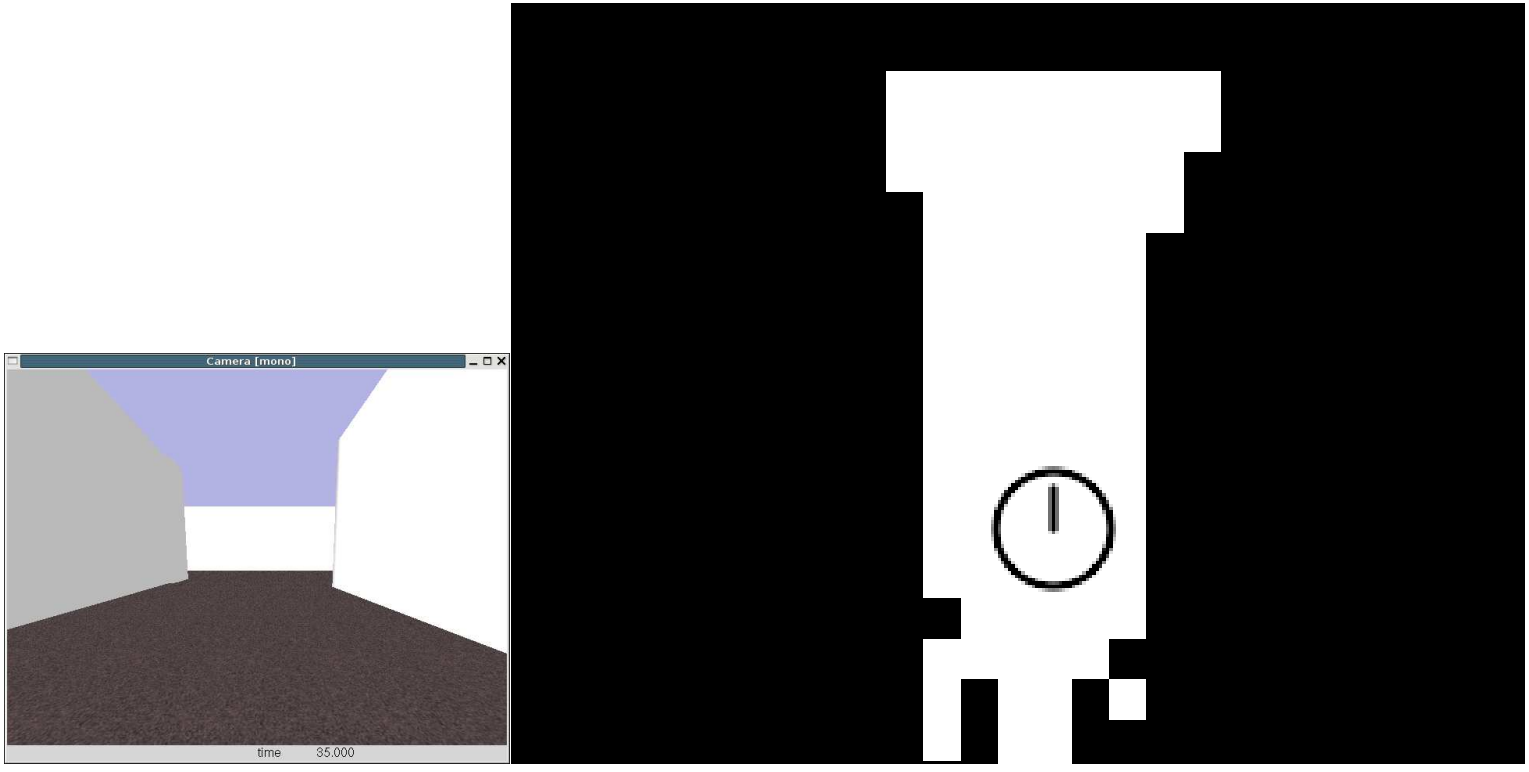


- Ullman's visual routines (Shimon Ullman, *Visual Routines*, 1983)
- Rao's thesis (Satyajit Rao, *Visual Routines and Attention*, 1998)

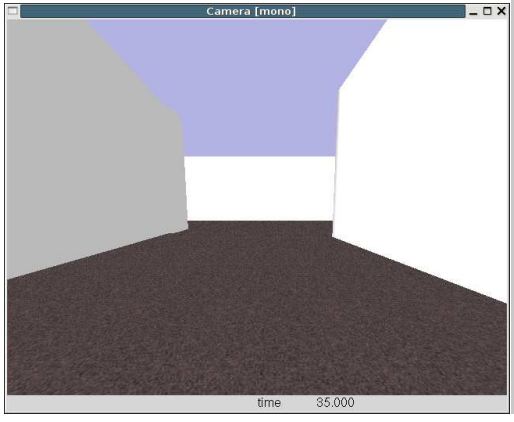
Datatypes - Grid

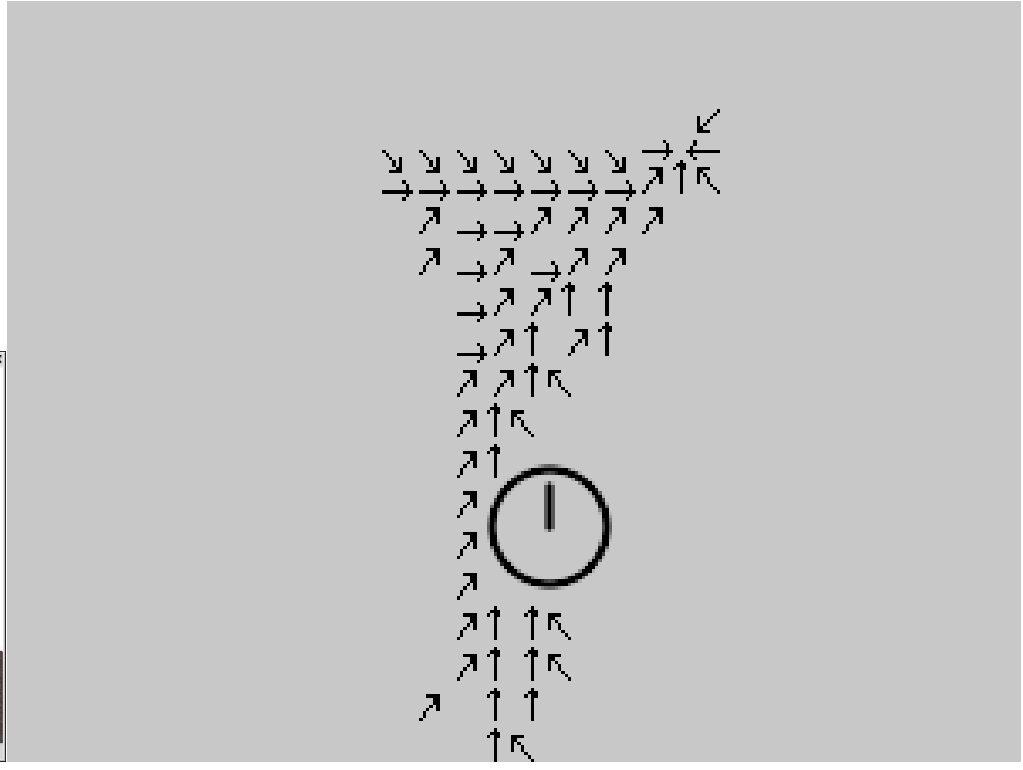


Datatypes - Mask

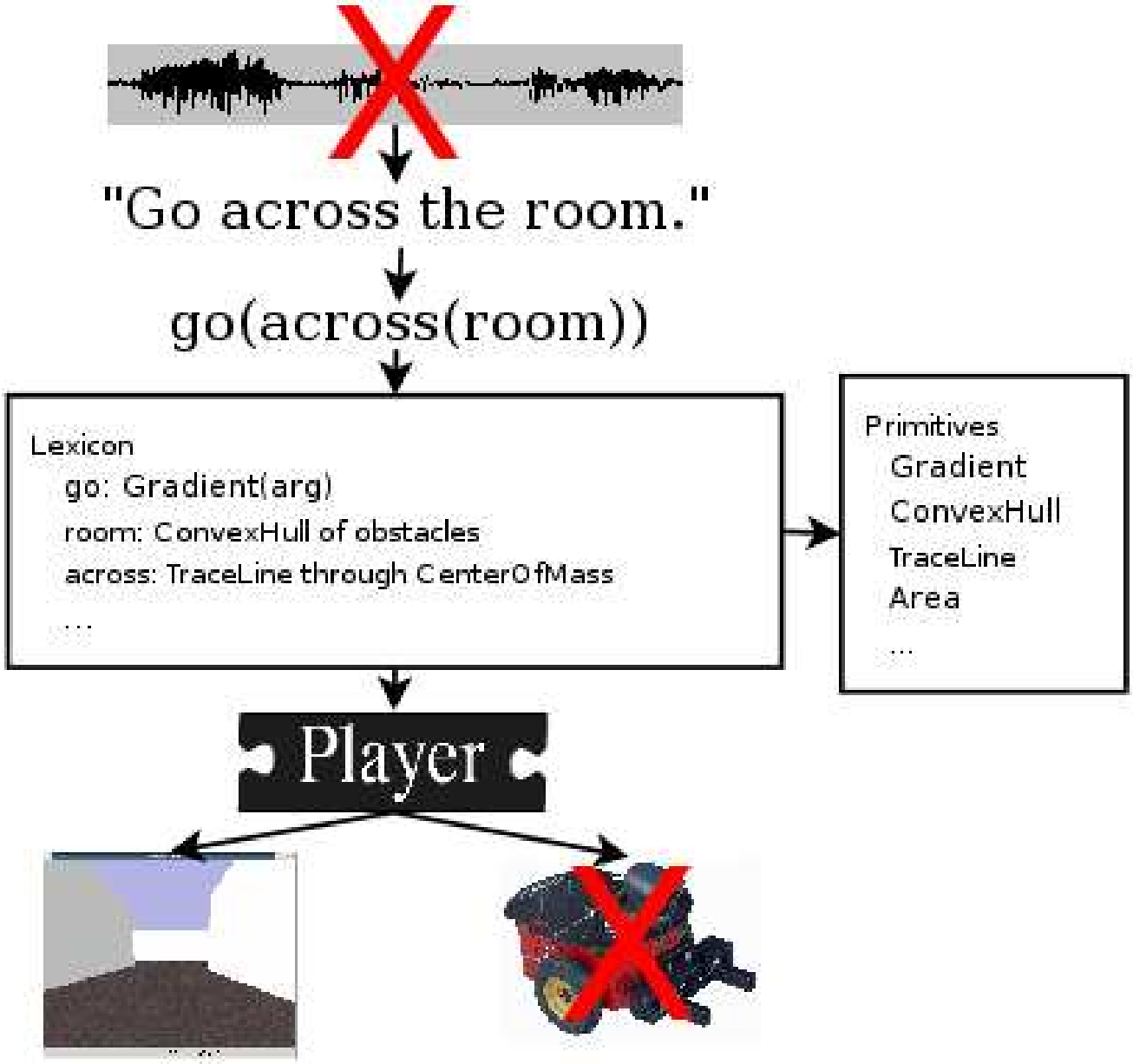


Datatypes - Paths





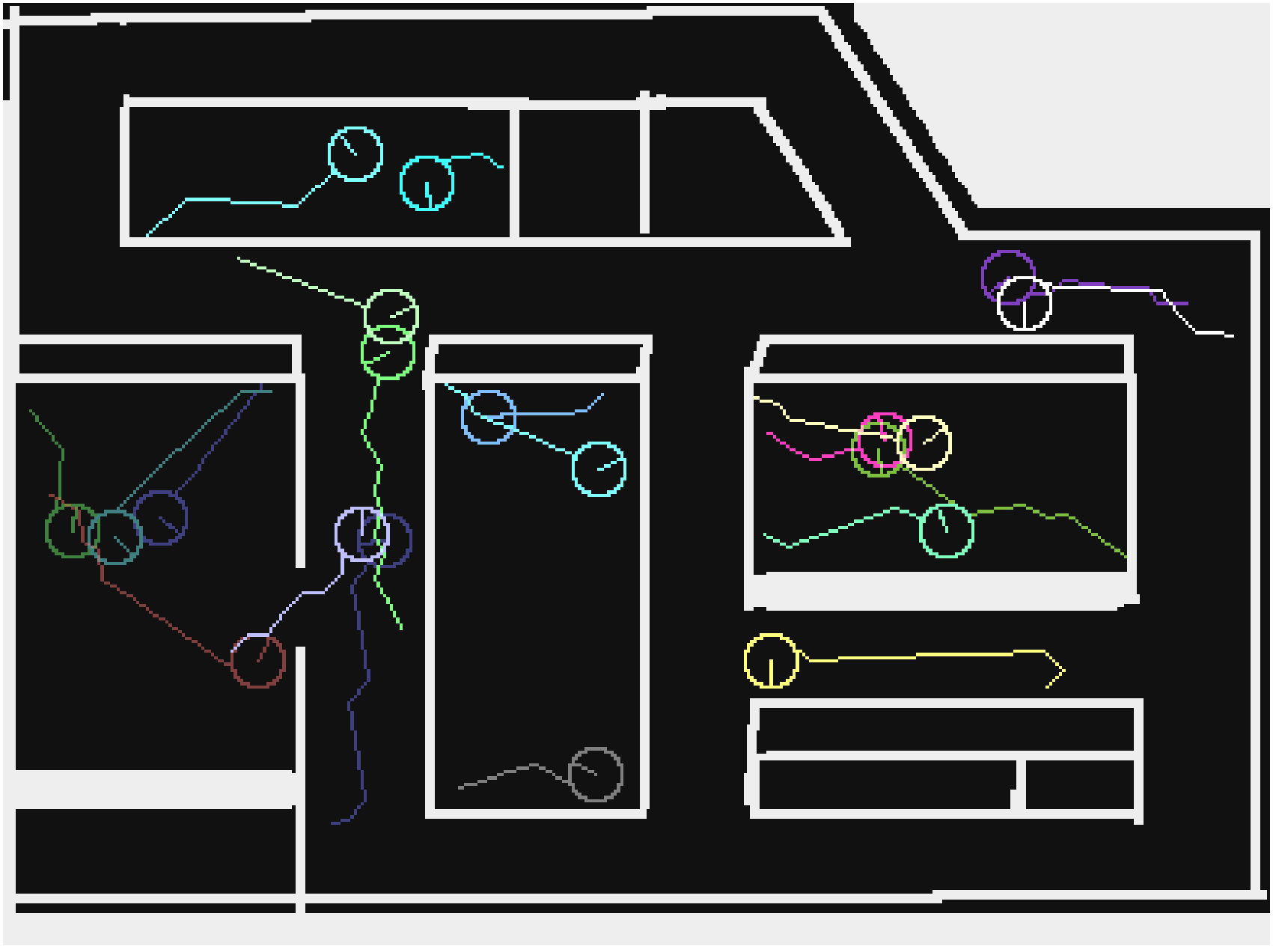
Evaluation


"Go across the room."
go(across(room))
Lexicon
go: Gradient(arg)
room: ConvexHull of obstacles
across: TraceLine through CenterOfMass
...
Primitives
Gradient
ConvexHull
TraceLine
Area
...
Player

Evaluation

- 5 subjects
- 20 examples of robot's planned path and actual path.
  - Focus of work is planned path.
  - Chosen from uniform distribution, two radii from walls.
  - Orientation chosen from uniform distribution.
- Each example marked as "correct", "incorrect", "n/a".
- Report:
  - Generous - Samples with at least one correct.
  - Stingy - Samples where most subjects marked it correct.
  - Light's Kappa

Evaluation Samples - “Go left.”



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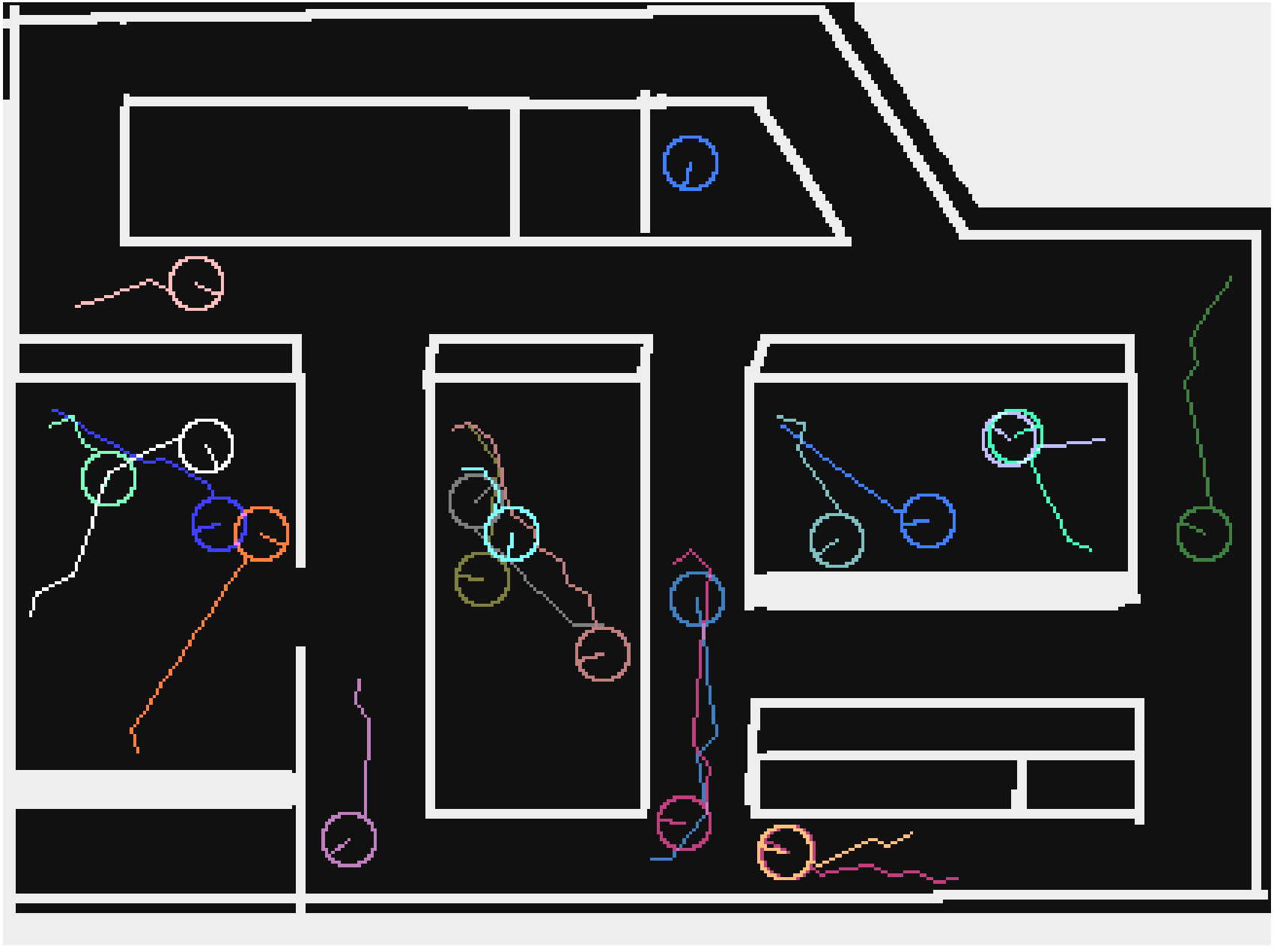

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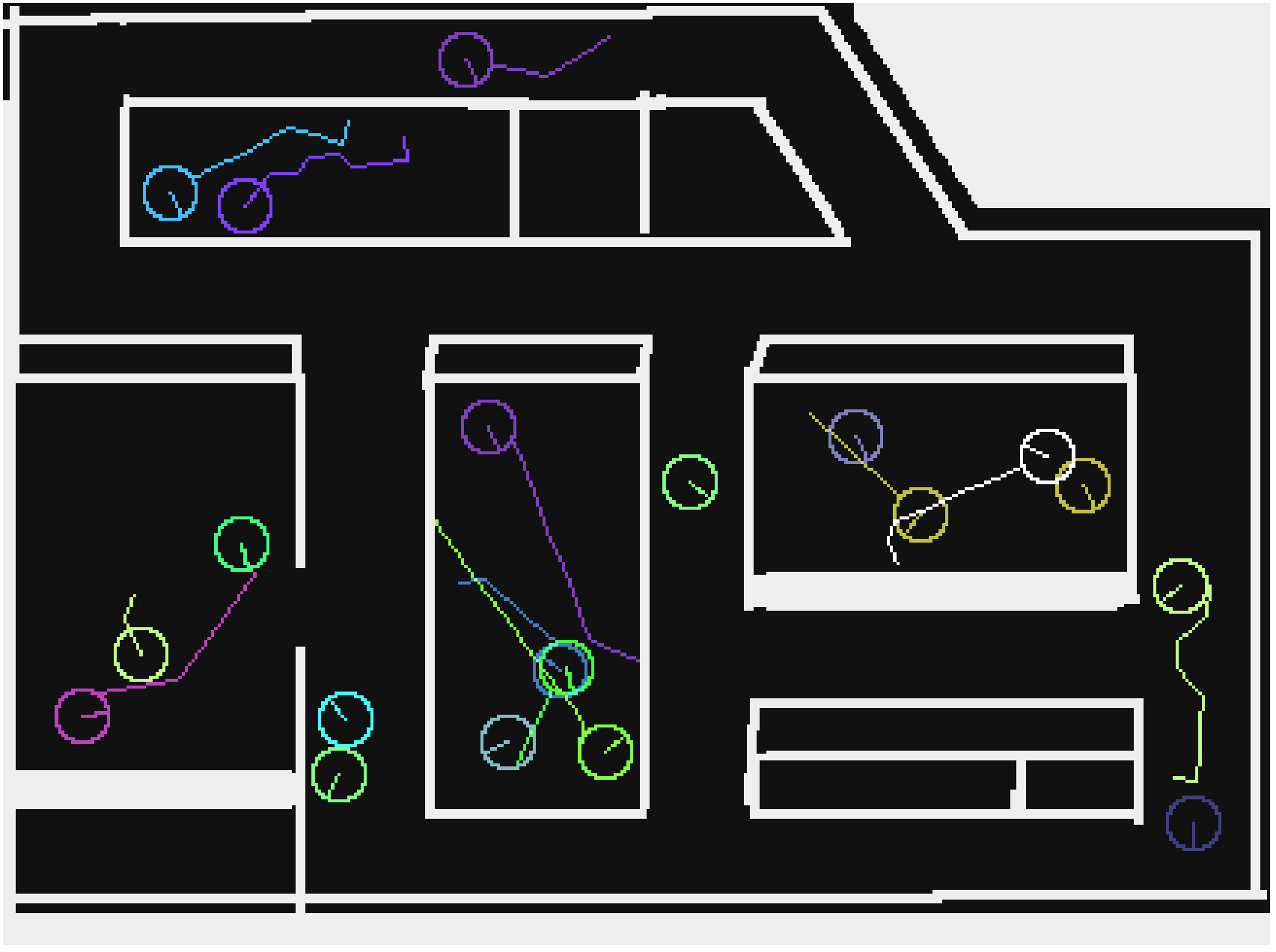
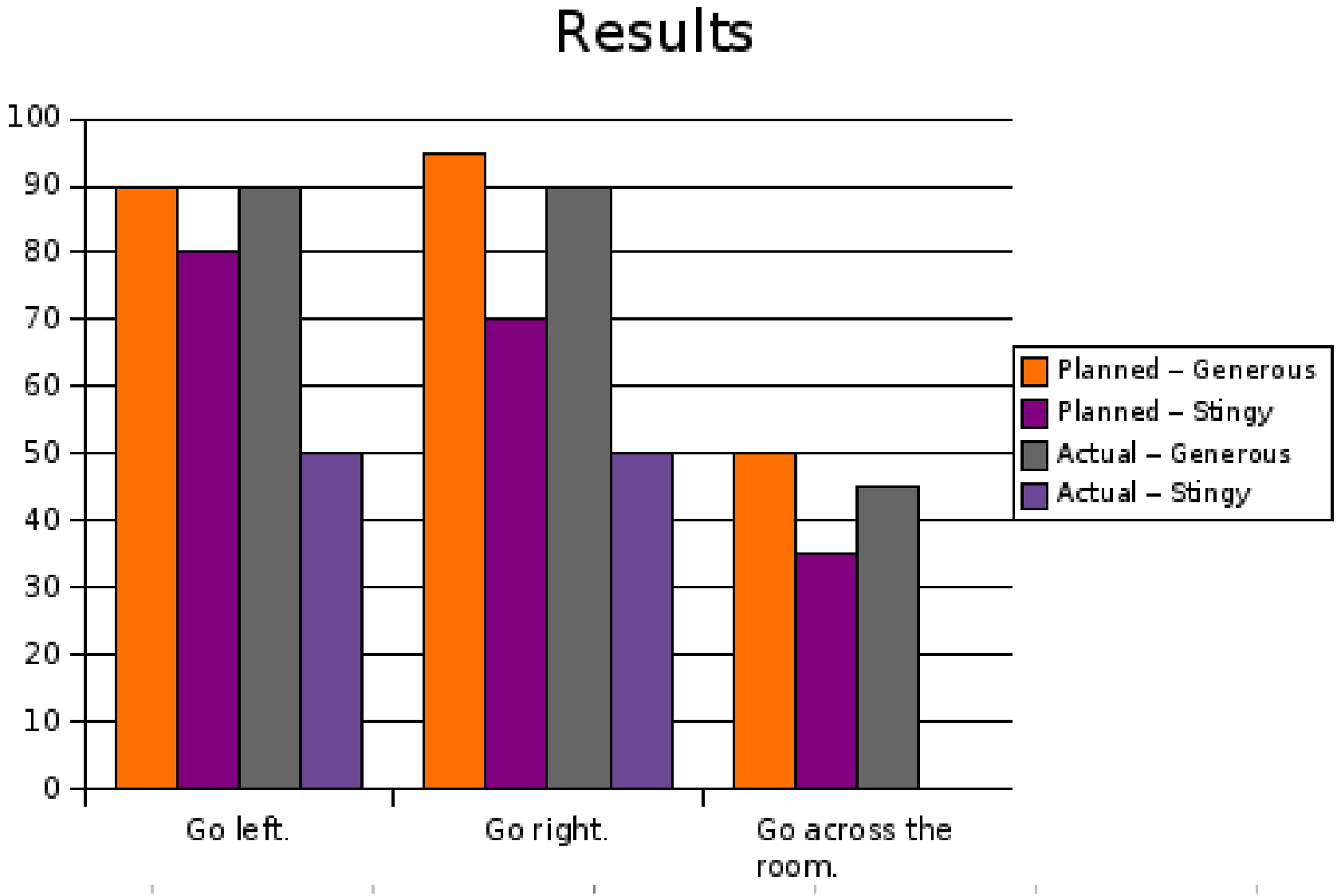


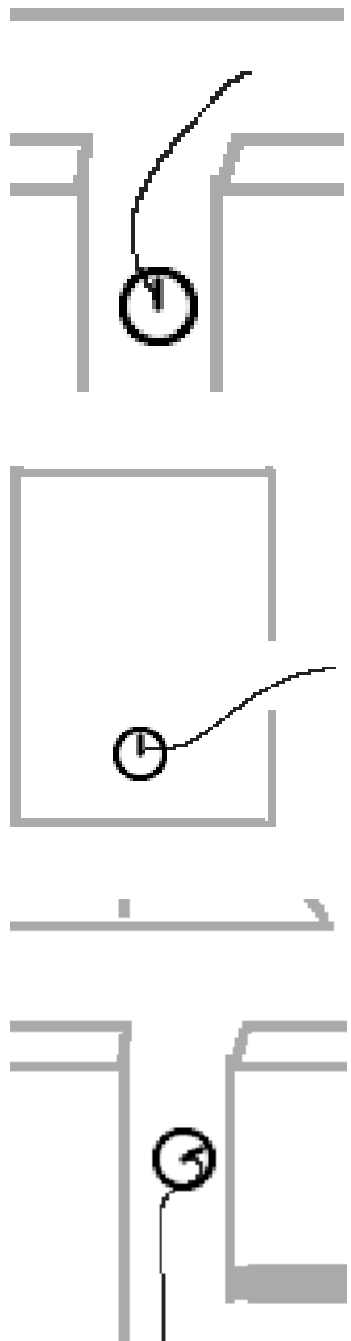

Results
100
90
80
70
60
50
40
30
20
10
0
Go left.
Go right.
Go across the room.
Planned – Generous
Planned – Stingy
Actual – Generous
Actual – Stingy

	Planned Path		
Command	% Correct		Light's Kappa
	Generous	Stingy	
Go left	90%	80%	0.12
Go right	95%	70%	0.12
Go across the room	50%	35%	0.53

	Actual Path		
Command	% Correct		Light's Kappa
	Generous	Stingy	
Go left	90%	50%	0.15
Go right	90%	50%	0.11
Go across the room	45%	0%	0.09

Command	Average Correct	Standard Deviation
Go left.	61%	30
Go right.	56%	27.25
Go across the room	36%	7.42

“Go right.”



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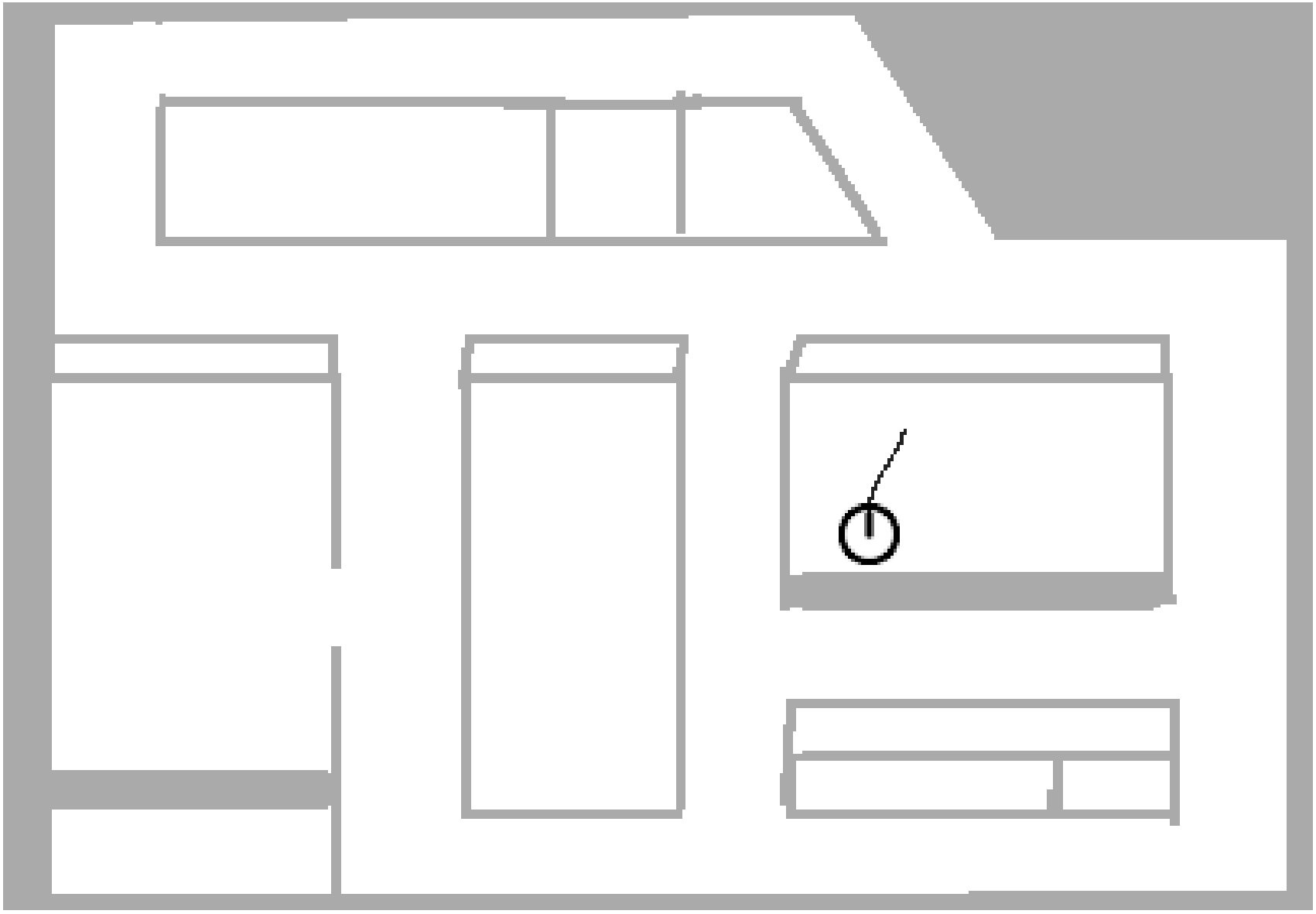

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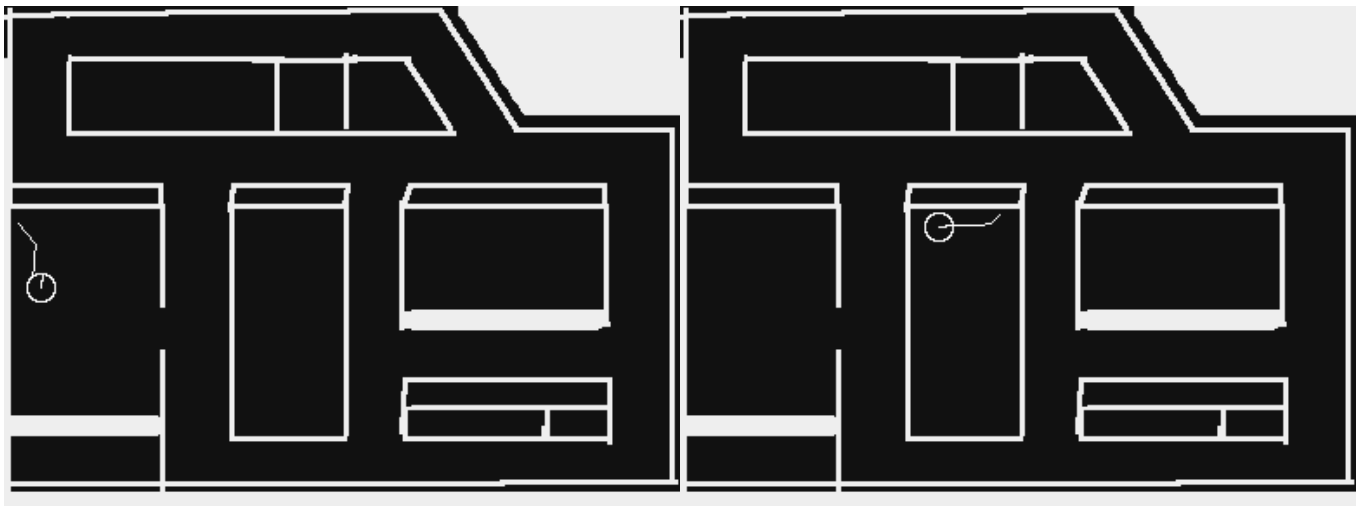
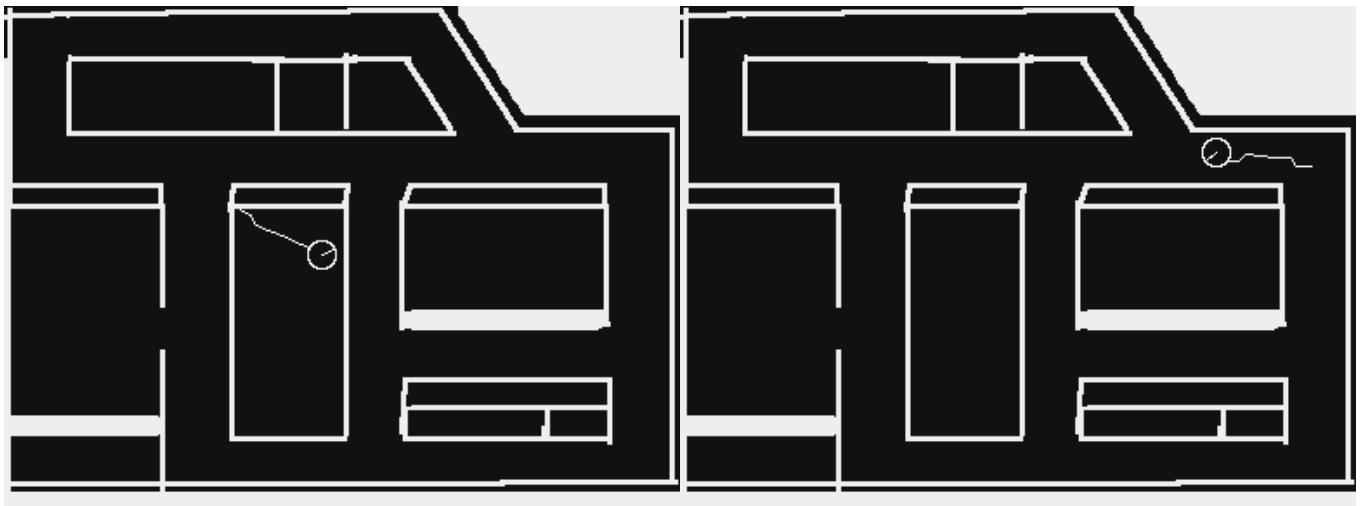


- The two worst samples for “Go left.”
- (Each had 4 incorrect, 1 n/a)

“Go left.”



- The two second worst samples for “Go left.”
- (Only one subject marked each of these correct.)

Lessons Learned

- Worked well for some people some of the time.
- Poor interannotater agreement.
- Not very realistic.
  - Empty environment.
  - Top down situation view.
- Better methods:
  - Movies of paths. (1st or 3rd person.)
  - Richer environment.
  - Paths generated by people (By drawing or driving.)

Future Work

- Applying spatial routines to real time strategy games.
- Learning routines using grammar induction/Earley parser.
- Using routines to label object trajectories.

Real Time Strategy Games

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