CS 485/511: Robot Lab
Course Introduction & Player/Stage Setup

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Overview

- Course Introduction
- Player/Stage/Gazebo
- Installation
- Configuration
- Writing Clients
- Demo
- Future Assignments

Course Introduction

- Both online and in-person instruction.
  - All class communication should be done on BBVista.
- Design, analysis, and implementation of multi-robot systems in simulation.
- Weekly programming assignments.

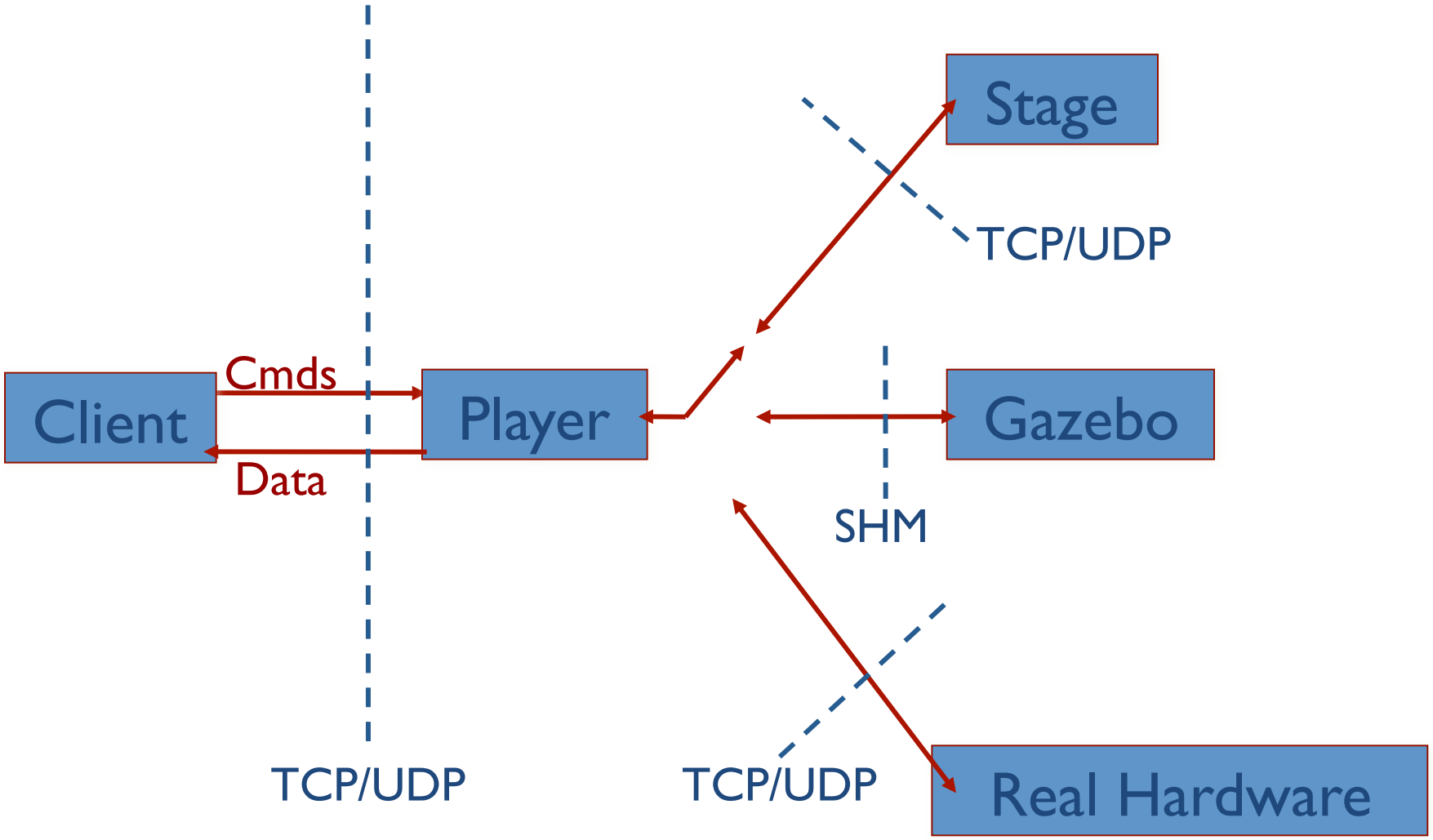
Simulation

- Approximate of the real-world.
- Why would we want to do this?
  - Faster, easier and cheaper to create;
  - Easier to experiment with and demonstrate;
  - Experimental repeatability.
- What are some draw backs of simulations?
  - Not reality;
  - Harder to transition to real life (although Player makes it a bit easier).

Software Overwiew

- Player:
  - A server, that provides an abstraction layer to robots.
- Stage:
  - A simulator;
  - 2D;
  - Low fidelity, but can emulate more virtual robots.
- Gazebo:
  - Another simulator;
  - 3D;
  - High fidelity, but can not emulate as many virtual robots.

The Big Picture



* Slide taken from a lecture by Nate Koenig at USC

What is Player?

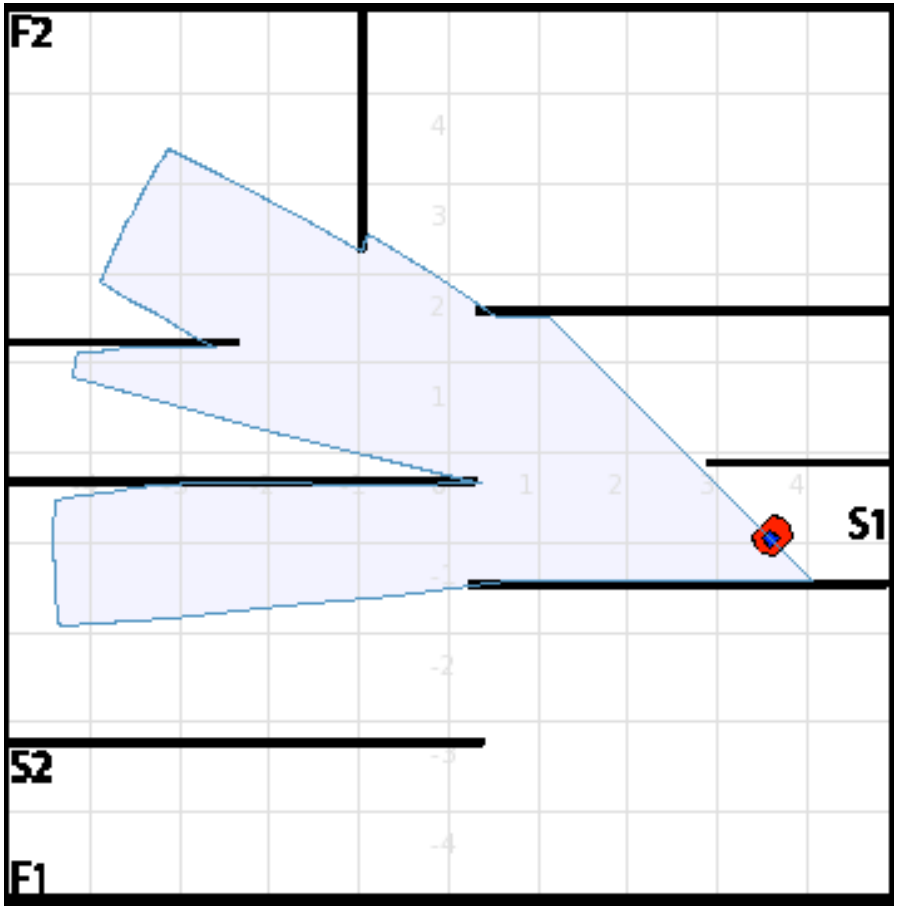
- Hardware abstraction layer for robots.
- Implements a client/server model.
- Communication over TCP sockets using the Player protocol.
- Officially supported client libraries:
  - C, C++, Python
- Unofficially supported client libraries:
  - Java, LISP, Matlab

Partial List of Supported Robotics Hardware

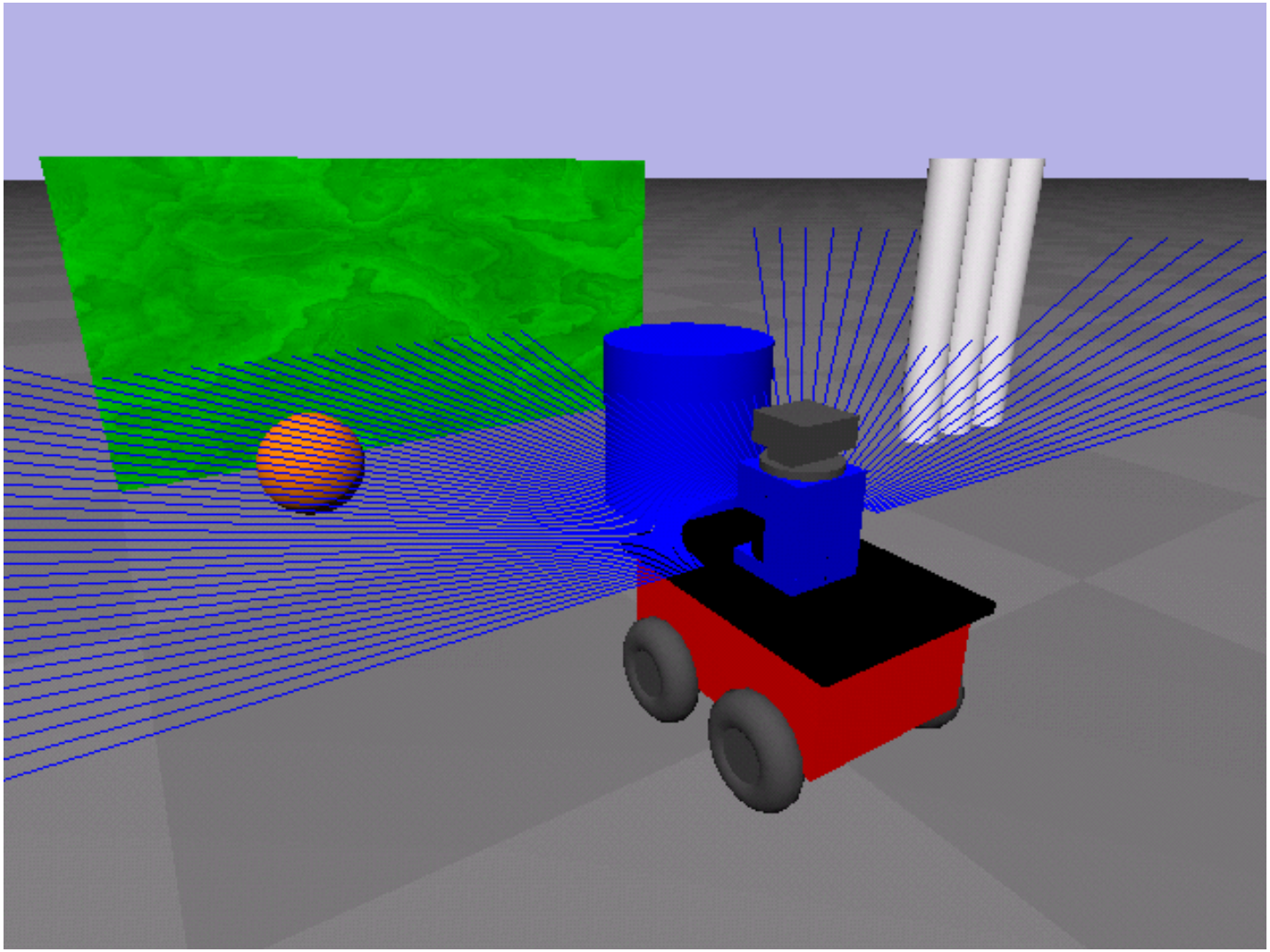
- **Manufacturer Device(s) Driver**
  - Acroname Garcia
  - Botrics Obot d100
  - Evolution Robotics ER1 and ERSDK robots
  - iRobot Roomba vaccuming robot
  - K-Team Robotics Extension Board (REB) attached to Kameleon 376BC
  - K-Team Khephera
  - MobileRobots (formerly ActivMedia) PSOS/P2OS/AROS-based robots (e.g., Pioneer, AmigoBot) and integrated accessories, including a CMUcam connected to the AUX port.
  - Nomadics NOMAD200 (and possibly related) mobile robots
  - RWI/iRobot RFLEX-based robots (e.g., B21r, ATRV Jr) and integrated accessories.
  - Segway Robotic Mobility Platform (RMP), a custom-modified version of the Human Transport (HT)
  - UPenn GRASP Clodbuster
  - Videre Design ERRATIC mobile robot platform
  - White Box Robotics 914 PC-BOT
- Also supports numerous devices (sensors, actuators), software (e.g.: for speech recognition), algorithms (e.g.: obstacle detection and avoidance), and simulators (which we talk about next).

* This list is taken from the Player Project Wiki.

What is Stage?



What is Gazebo?



Player/Stage Installation

- I recommend you install it on Ubuntu 10.10.
  - Other “possibilities” are Mac OS X or Windows.
- I recommend you install both Player and Stage from source to ensure compatibility.
- If your host operating system is not Ubuntu 10.10, I suggest you install it as a virtual machine (VM).
  - Use VirtualBox an open source VM creator.
- This is going to take awhile, budget 1-to-2 hours.

Player Installation

1. Download Player 2.1.3 from SourceForge
2. tar xvf player-2.1.3.tar.gz
3. sudo apt-get install g++ libltdl-dev libboost-all-dev swig libjpeg-dev
4. cd player-2.1.3
5. ./configure
6. sudo make
7. sudo make install
8. export LD_LIBRARY_PATH=/usr/local/lib:$LD_LIBRARY_PATH

Stage Installation

1. Download Stage 2.1.1 from SourceForge
2. tar xvf stage-2.1.1.tar.gz
3. sudo apt-get install cmake libfltk-dev libpng-dev libglu1-mesa-dev libgtk2.0-dev libgtkgl2.0-1 libgtkgl2.0-dev
4. cd stage-2.1.1
5. ./configure
6. sudo make
7. sudo make install

Was the Installation Successful?

- Run “player”
  - Should see the usage and version number.
- Run “player worlds/simple.cfg”
  - A map with a robot should appear.

Defining a Robot

- Three things:
  - Interfaces: A set way for drivers to send / receive data.
  - Drivers: Piece of code that talks to hardware (laser, camera, transporter).
  - Devices: A driver, bound to a particular interface so that Player can communicate with it.

Configuration Files

- For details about any configuration issues, check the Player website, or Google “player stage tutorial” and read the first hit (a PDF by Jennifer Owen)
- There are three main types of configuration files in Player / Stage:
  - .inc: Use these files to define objects that can appear in worlds.
  - .world: This describes everything in the world (robot, objects, their layout, etc)
  - .cfg: This describes your robot, what drivers it has (which will always be stage in this class), how to interface with each item, etc.

Example: map.inc

```
1.  define map model
2.  (
3.    # sombre, sensible, artistic
4.    color "black"

5.    # most maps will need a bounding box
6.    boundary 1

7.    gui_nose 0
8.    gui_grid 1
9.    gui_movemask 0
10.   gui_outline 0

11.   gripper_return 0
12. )
```

Example: maze-laser.world

```
# defines Roomba-like robots
include "roomba.inc"

# defines Roomba-like IR sensor
include "sick.inc"

# defines 'map' object used for floorplans
include "map.inc"


# size of the world in meters
size [50 50]

# set the resolution of the underlying raytrace model in meters
resolution 0.02

# update the screen every 10ms (we need fast update for the stest demo)
gui_interval 20
```

```
# configure the GUI window
window
(
  size [ 800.000 600.000 ]
  center [-23.0 23.0]
  scale 0.02
)

# load an environment bitmap
map
(
  bitmap "maze.png"
  size [50 50]
  name "maze"
)

# create a robot
pioneer2dx
(
  name "robot1"
  color "red"
  pose [-23.0 23.0 0.0]
  sick_laser(samples 361 laser_sample_skip 4)
)
```

Example: maze-laser.cfg

```
# load the Stage plugin simulation driver
driver
(
  name "stage"
  provides ["simulation:0" ]
  plugin "libstageplugin"

  # load the named file into the simulator
  worldfile "maze-laser.world"
)
```

```
driver
(
  name "stage"
  provides ["map:0"]
  model "maze"
)

# Create a Stage driver and attach position2d and laser interfaces
# to the model "robot1"
driver
(
  name "stage"
  provides [ "position2d:0" "laser:0"]
  model "robot1"
)
```

Map Descriptions

- Located in the world file;
- Accepts bitmaps;
- Black pixels are considered walls, everything else is ignored;
- Also describes the size of the simulation (the unit is meters).

Client Code

- After Player/Stage is installed and running, you need to start some client code for it to do something.
- I recommend using C, C++, or Python.
  - Previous classes have used Java, but finding a version of Player and Stage that works with the Java client library may be difficult.

C++ Client Code

```
1.  #include <iostream>
2.  #include <libplayerc++/playerc++.h>
3.  int main(int argc, char *argv[])
4.  {
5.    using namespace PlayerCc;
6.    PlayerClient    robot("localhost");
7.    SonarProxy      sp(&robot,0);
8.    Position2dProxy pp(&robot,0);
```

C++ Client Code

```
1.  for(;;){
2.  double turnrate, speed;
3.      // read from the proxies
4.      robot.Read();
5.      // print out sonars for fun
6.      std::cout << sp << std::endl;
7.      // do simple collision avoidance
8.      if((sp[0] + sp[1]) < (sp[6] + sp[7]))
9.        turnrate = dtor(-20); // turn 20 degrees per second
10.     else
11.       turnrate = dtor(20);
```

C++ Client Code

```
1.  if(sp[3] < 0.500)
2.        speed = 0;
3.     else
4.        speed = 0.100;
5.     // command the motors
6.     pp.SetSpeed(speed, turnrate);
7.  } //ends for loop
```

Compiling/Running

Compile:

```
g++ -o simple`pkg-config –cflags playerc++`
   simple.cc `pkg-config –libs playerc++`
```

Run Player:

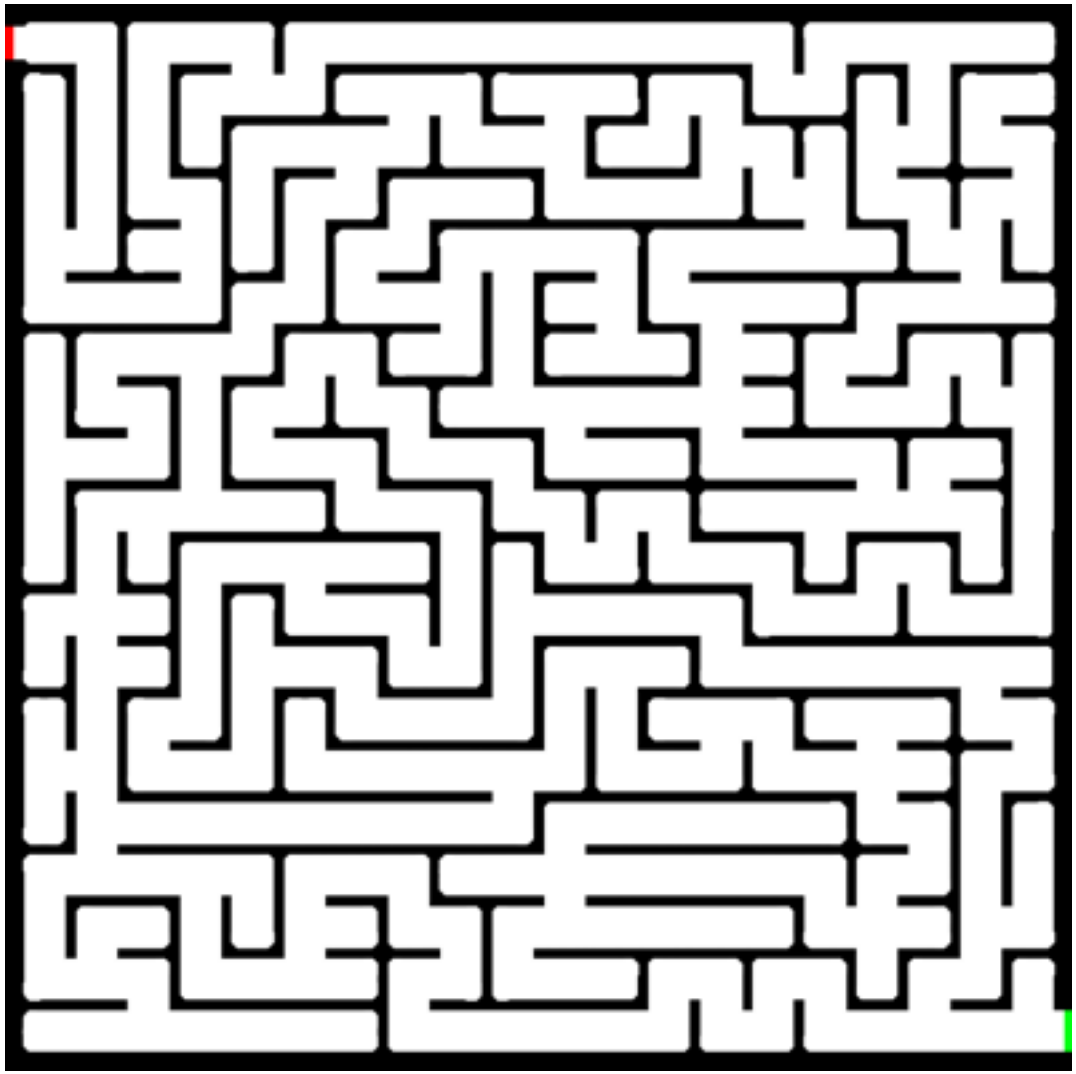
```
Player simple.cfg
```

Run program:

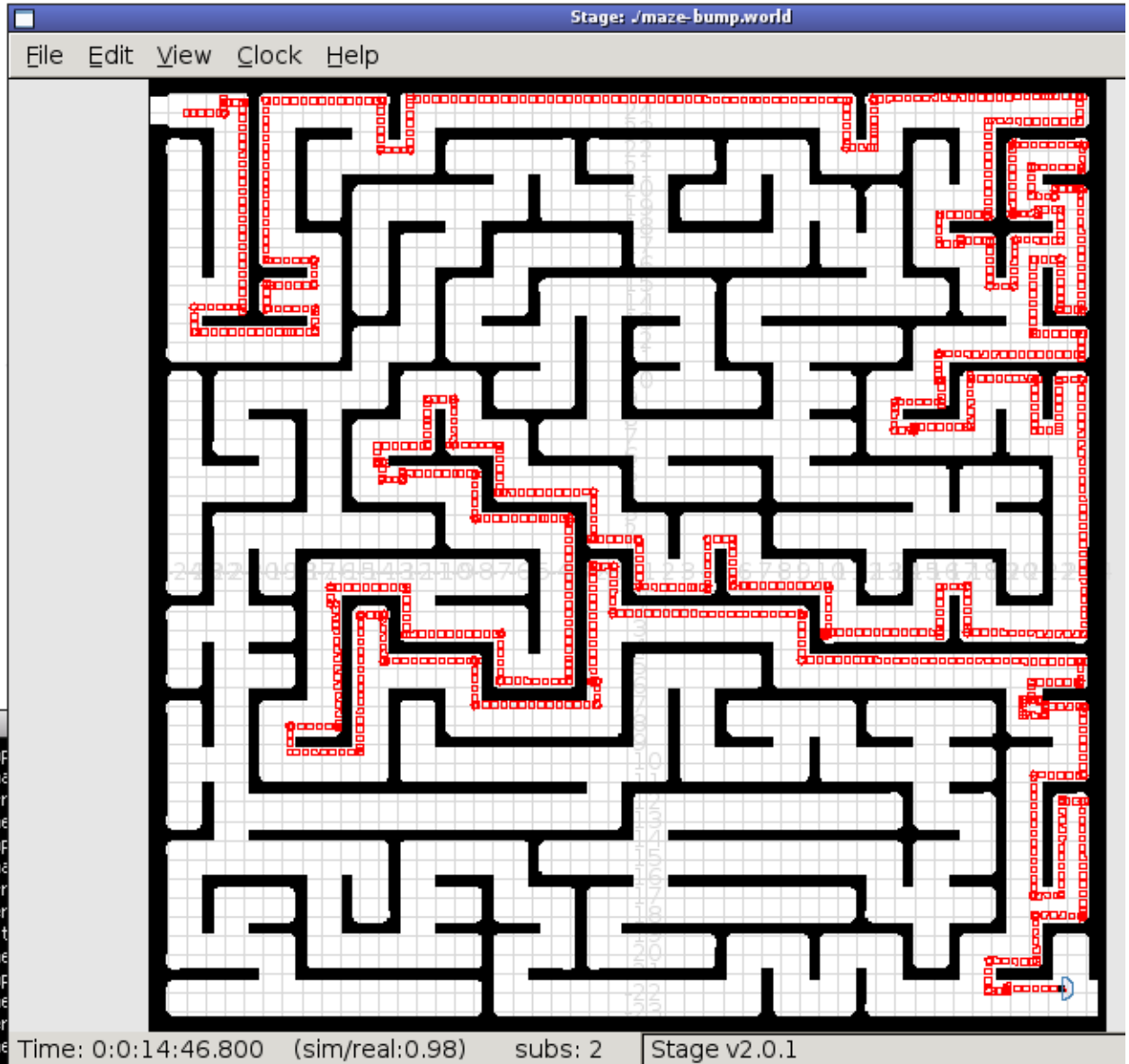
```
./simple
```

Demo

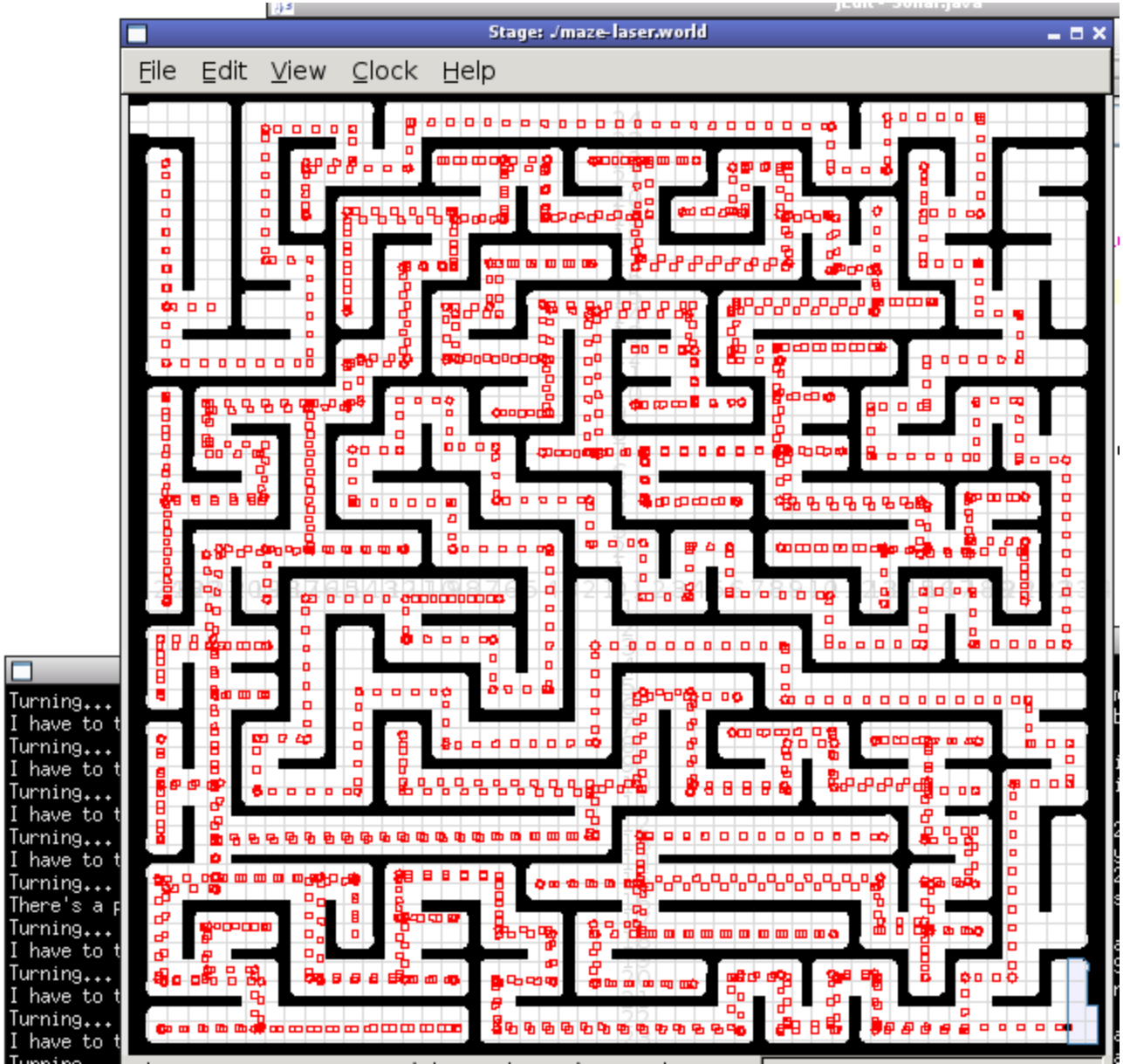
Previous Assignment: Wall Following



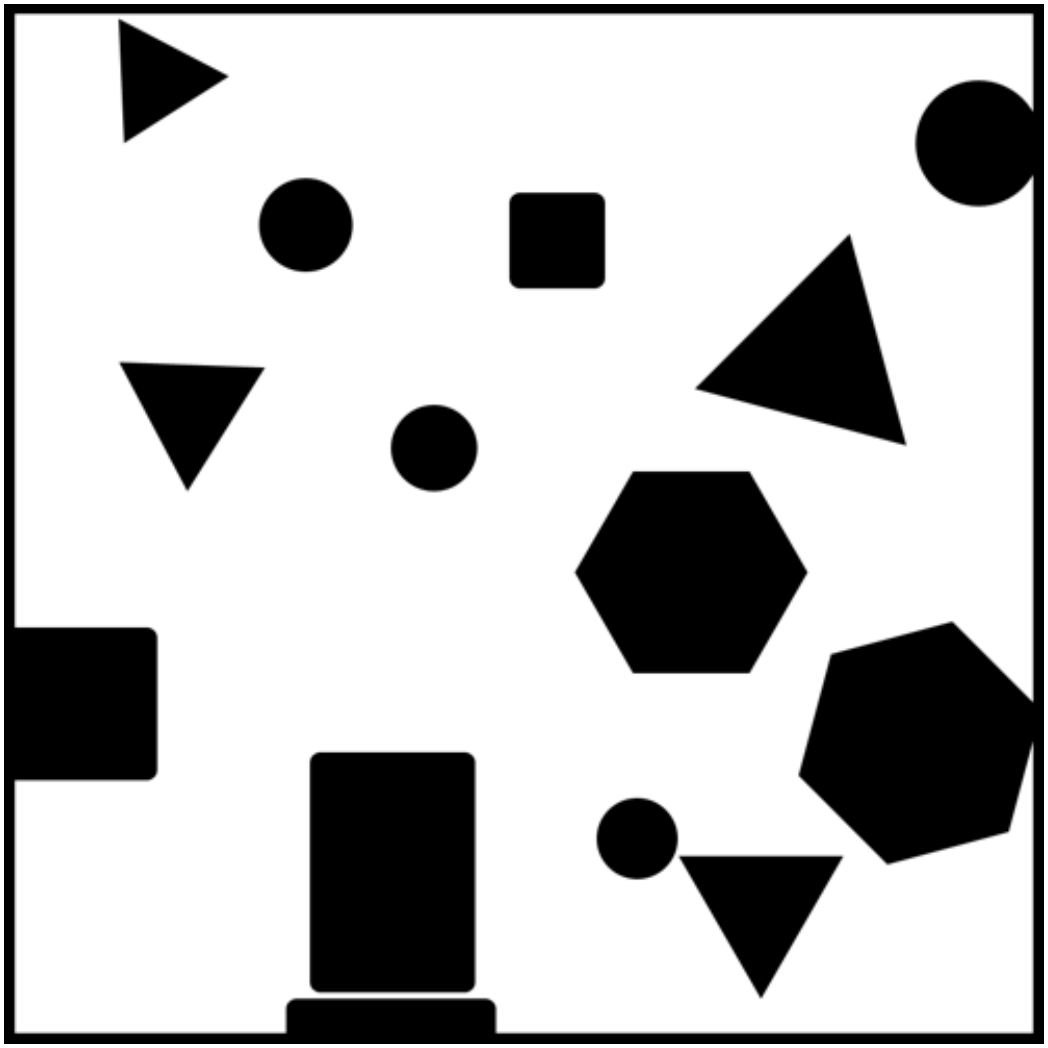
Left Wall Following



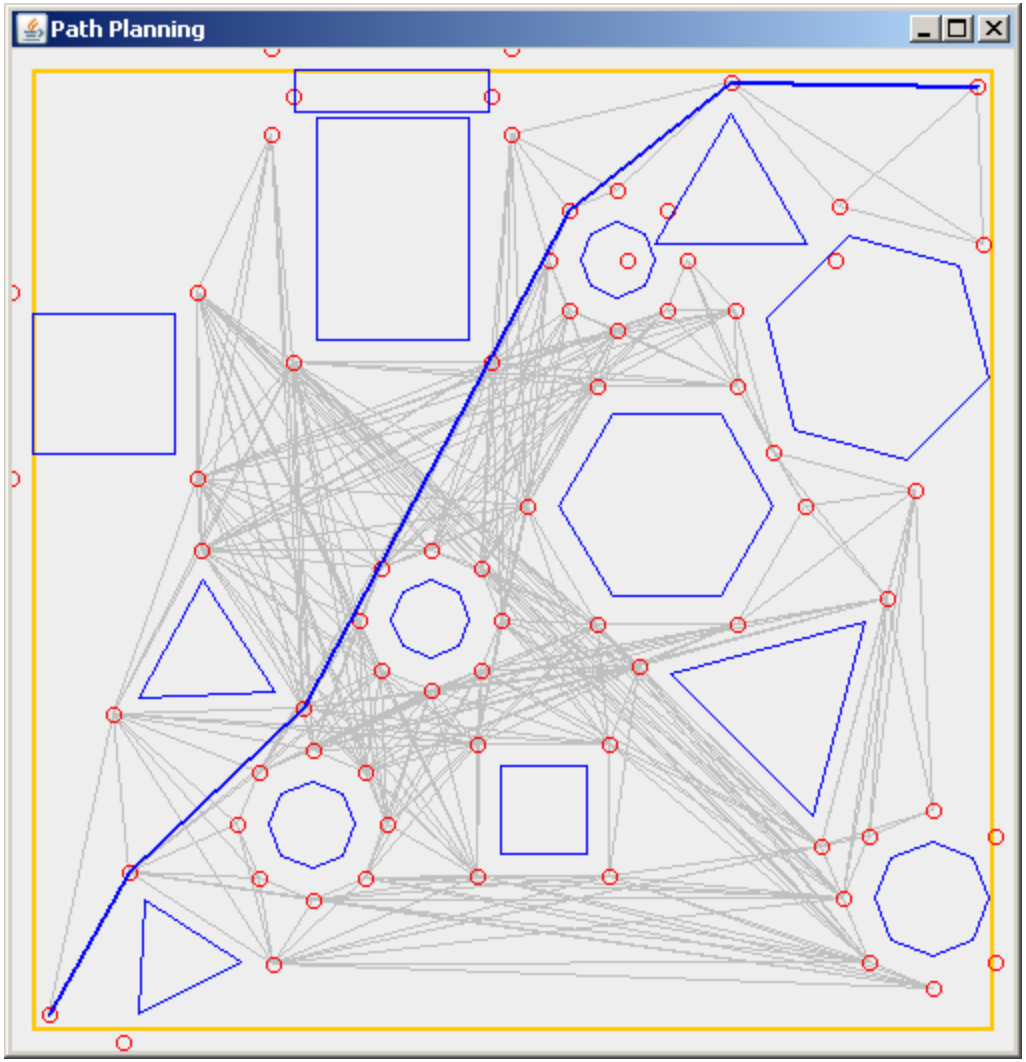
Right Wall Following



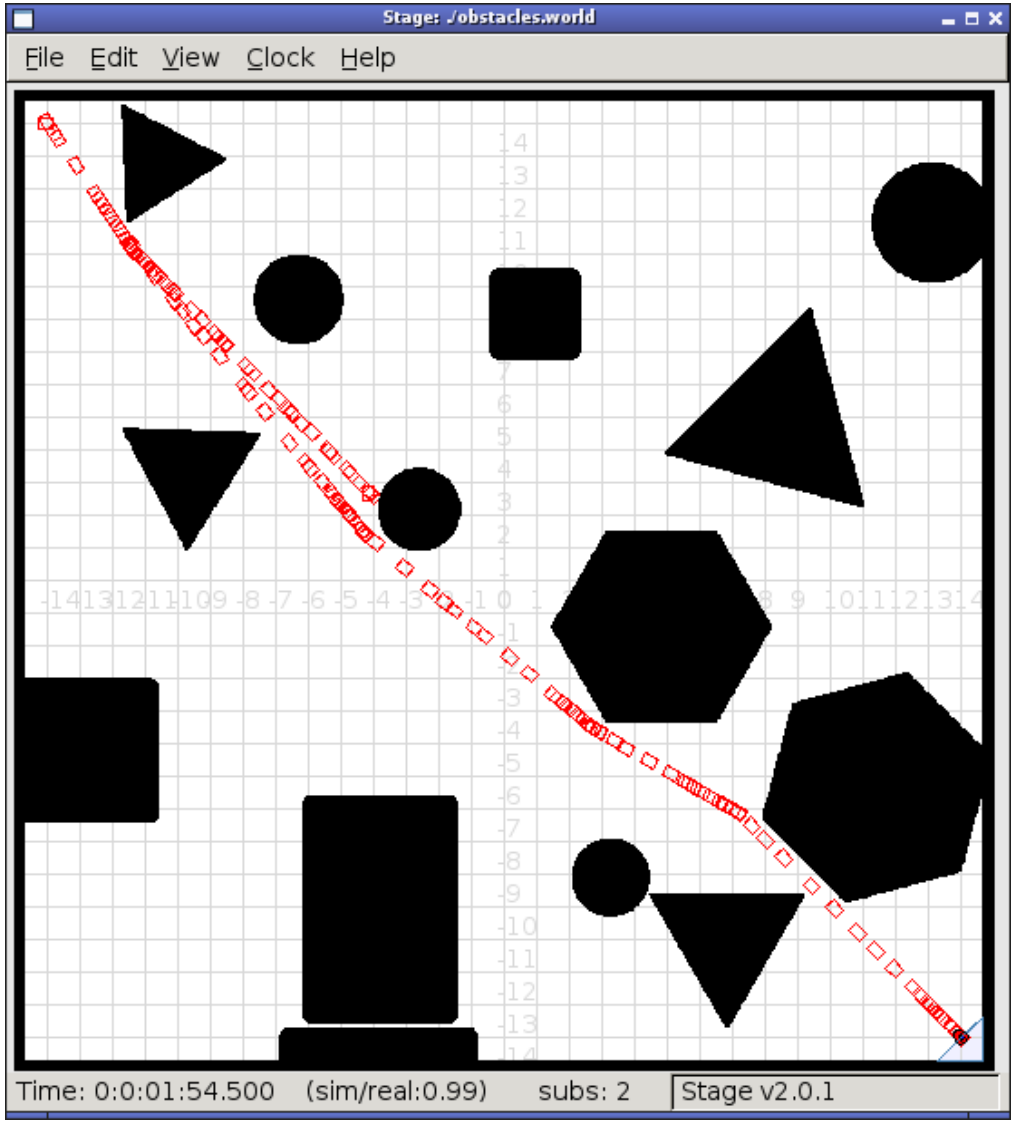
Previous Assignment: Path Planning



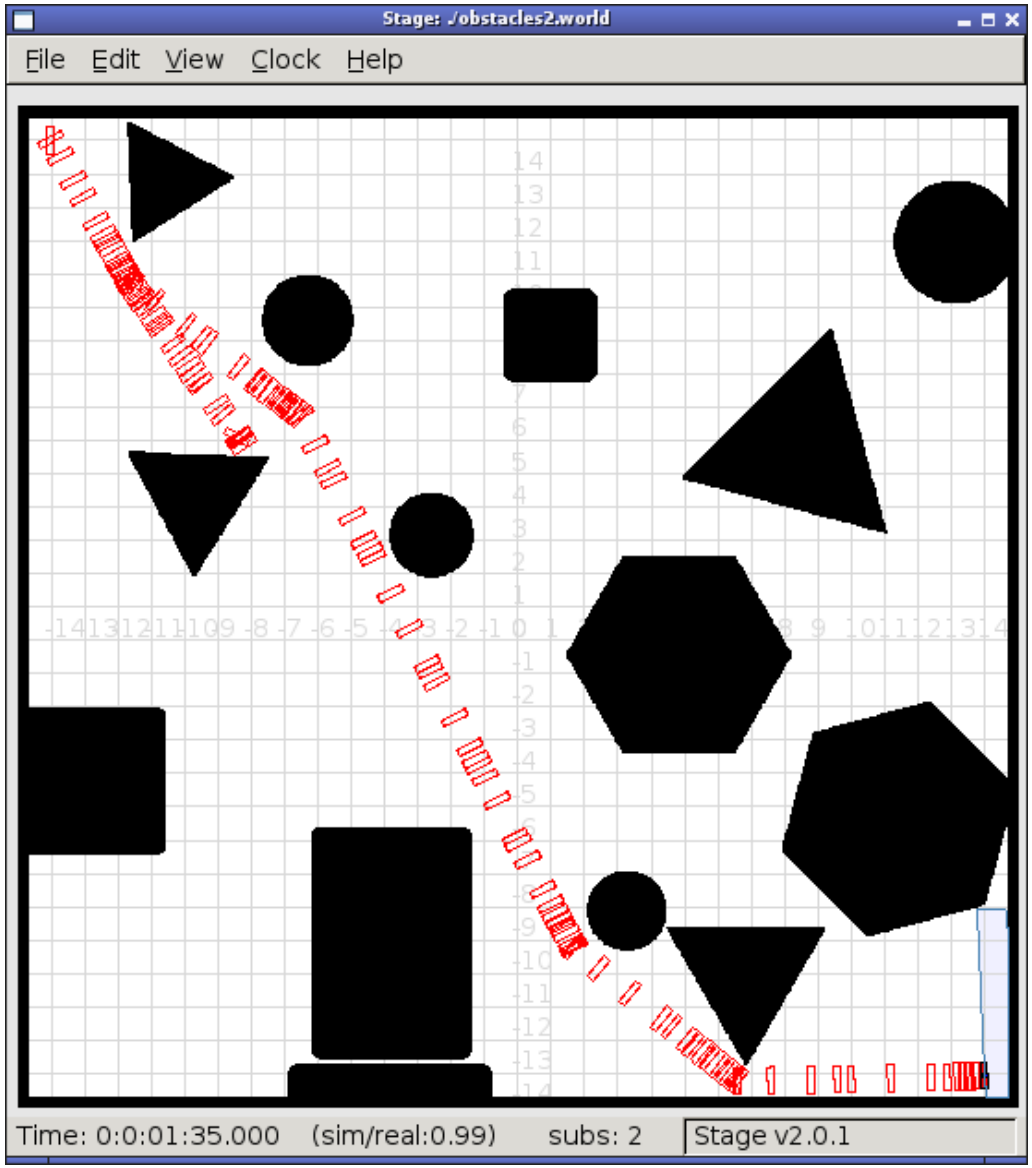
Path Planning with Minkowski Sum



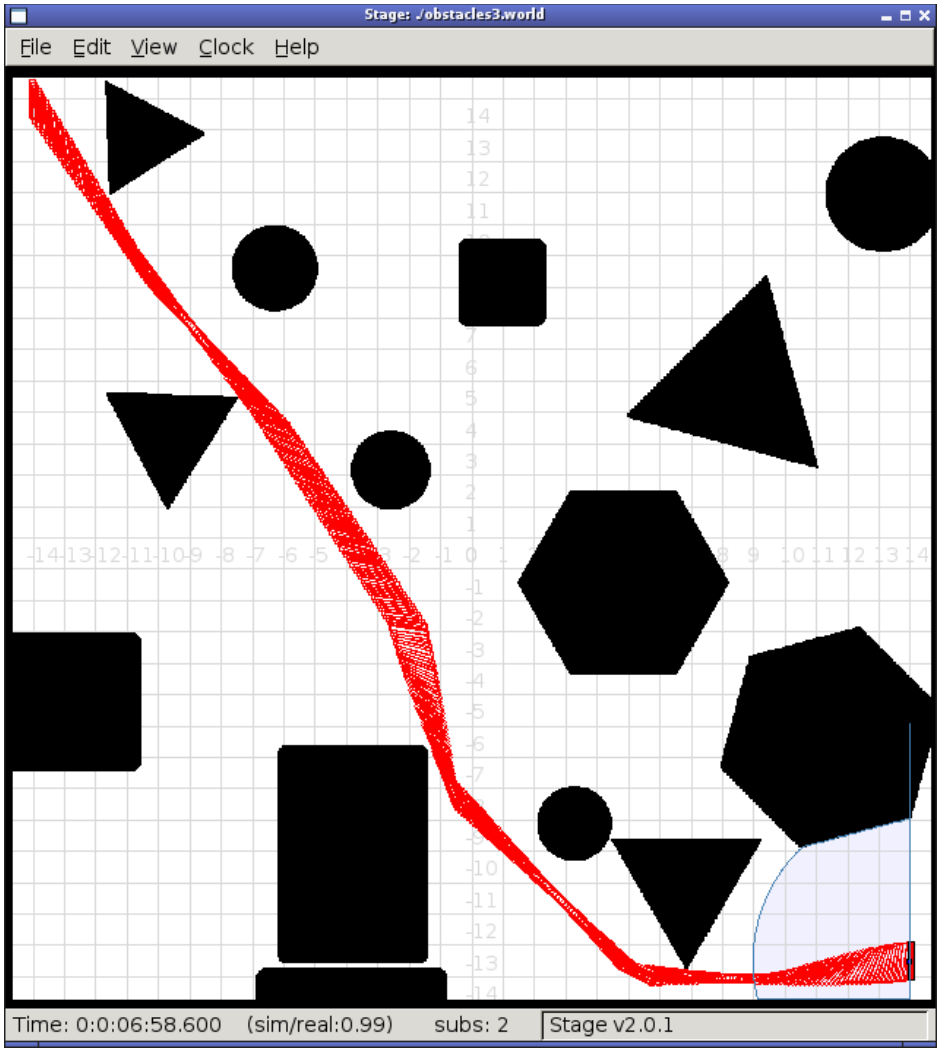
Point Robot Application



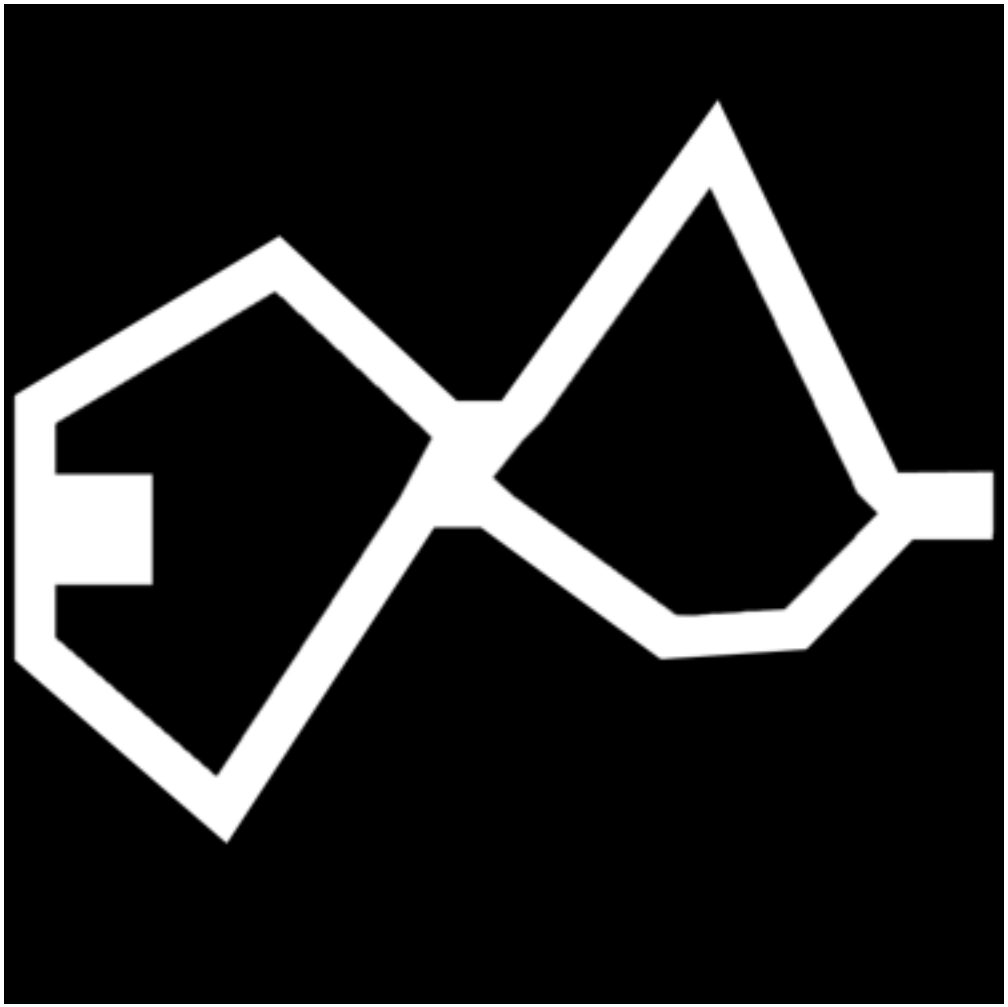
“Sofa” Robot Application



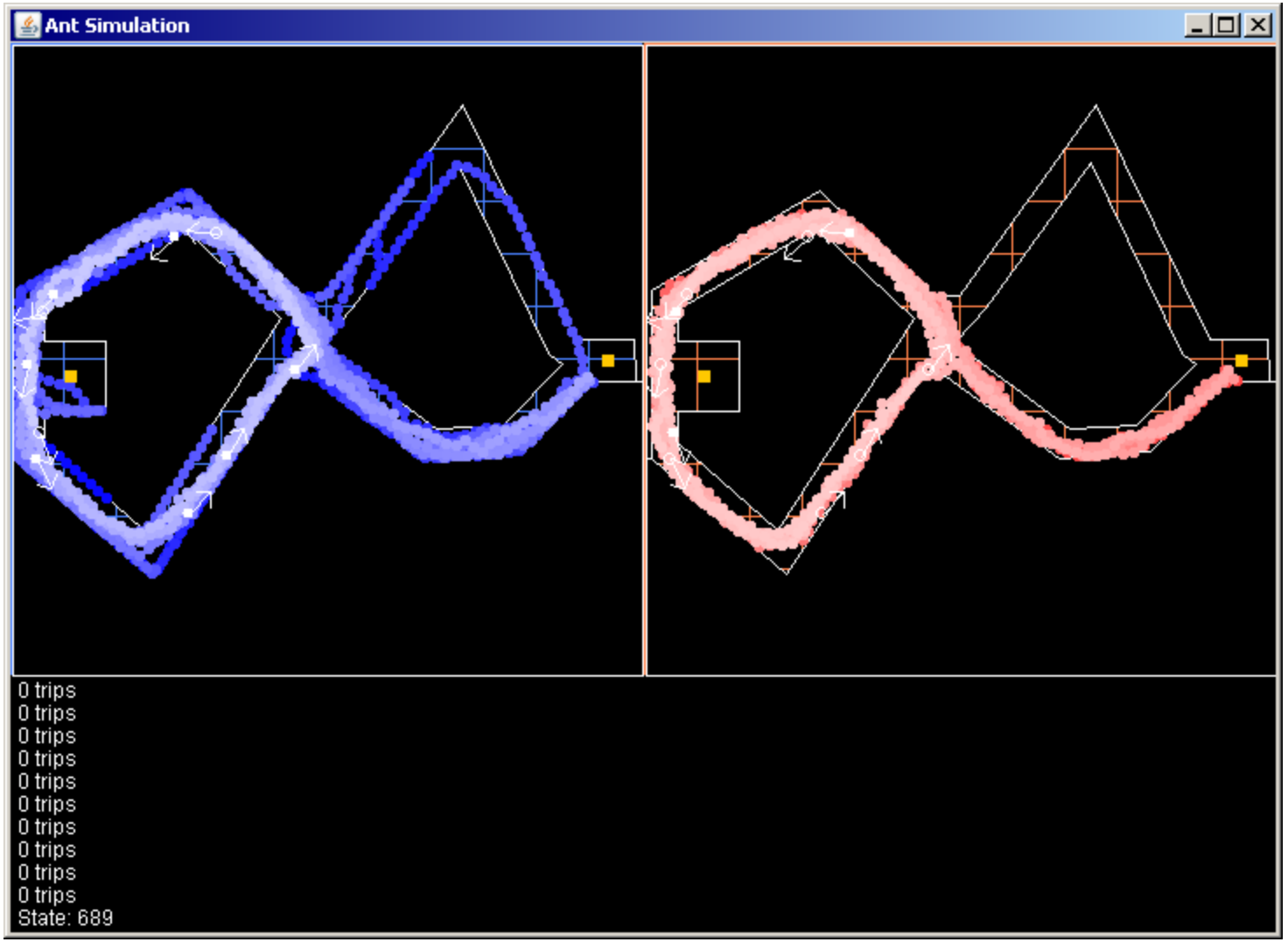
“Sofa” Robot with Extra Degree of Freedom



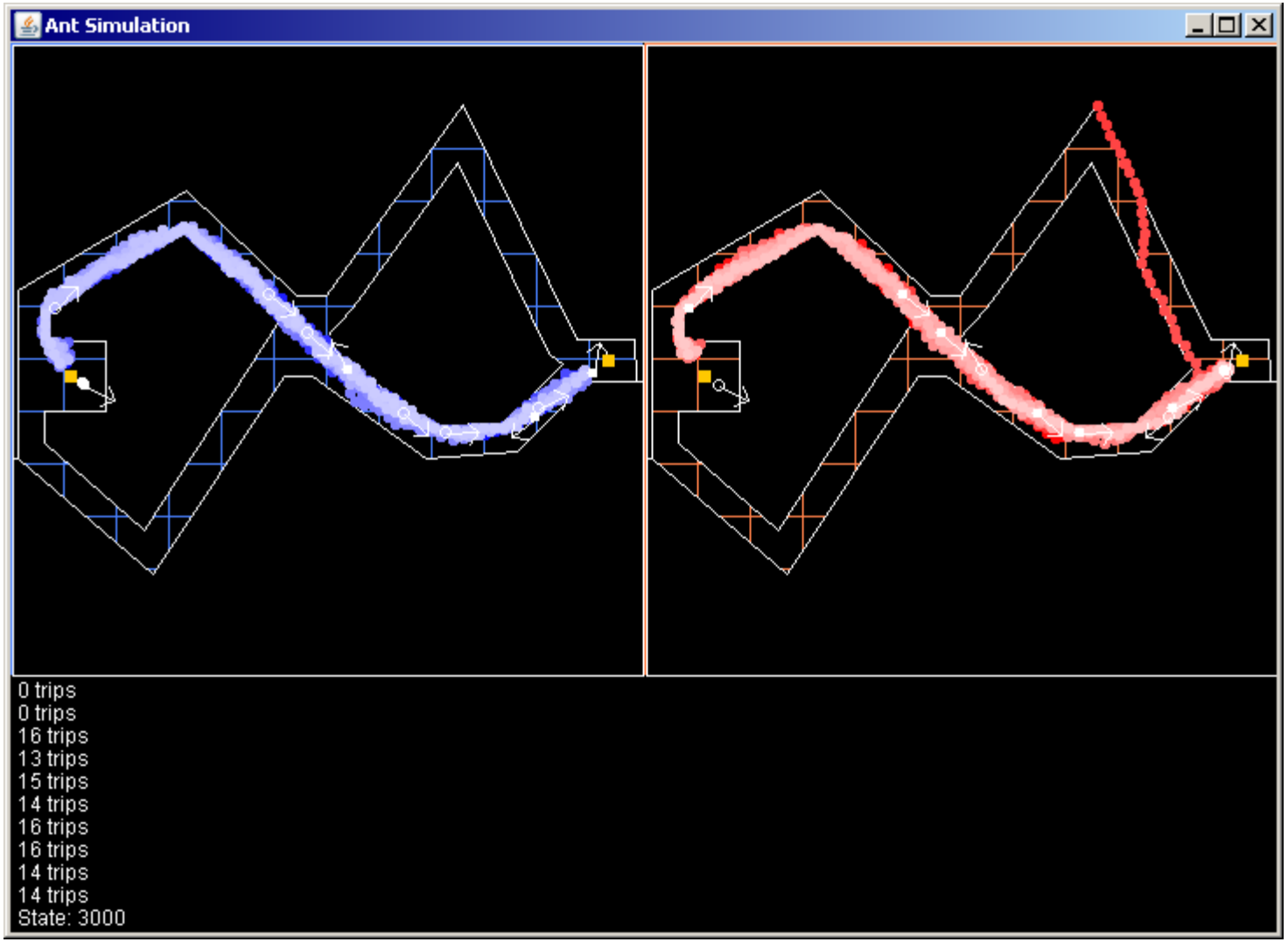
Previous Assignment: Ant Colony Optimization



Initial Pheromone Trail



Optimized Pheromone Trail



Thank you for your time and attention.