**CS3270 Intelligent Systems**

**Final Project: Robot Navigation**

**Wednesday, April 27, 11:55pm**

**Learning Objectives**

* Apply search methods to solve a problem.
* Solve a simple robotic navigation problem.
* Understand the uncertainties associated with sensors and how to deal with those uncertainties.
* Effectively function as a member of a team to apply fundamental concepts of artificial intelligence to solve real-life problems.

**The Robot Navigation Problem**

For this project you are to program a robot to navigate through a maze and detect as many different colored objects as possible. The robot may get hints by a human through sound. The project requires you to work independently in teams of two or three. You will have to familiarize yourself with new features you may want to use, like specific sensors. Check out the Robotics Lab course site for resources. You will also have to develop independently the search algorithm that navigates the robot through a maze.

The robot starts in one corner of a 6'x6' square box. There are various obstacles forming a maze. The colored objects to be detected can be anywhere in the maze. The robot must try to find the objects by traversing the maze. Whenever the robot has found an object it should name the color. The occurring colors are **orange, red, green, blue, and black**. The maze does not resemble a true labyrinth with corridors, but it contains obstacles. Some obstacles are isolated; some touch the wall and/or other obstacles; some objects may form a short corridor. The robot can use a sound sensor to receive help by a human. In turn, you can make a sound of any intensity (below 70 dB please) while your robot is searching for colored objects. Note that the sound sensor distinguishes only between the intensity of a sound.

**Project Requirements**

This project requires that you work independently and complete this project on your own. You may have to become familiar with additional sensors, like the sound sensor or the ultrasonic sensor. The teaching assistants can help you if you have questions about the usage of different sensors. However, they are not allowed to help you dealing with the uncertainties associated with sensors, debugging your source code, developing an algorithm, suggesting improvements etc. They cannot solve technical issues unless they concern the maintenance of the robots, e.g. empty batteries, or hardware malfunction. You must work in teams of two or three students.

Your team can choose RobotC or the LEGO MINDSTORMS Education NXT software for the implementation.

**A Note on Uncertainty**

By now, you have experienced that sensors and motors are not perfect and react differently under slightly changed conditions. For example, different light intensity changes the reading of a color sensor, low batteries affect the speed of the motors. Typically, we are not able to manipulate the environment to produce the same conditions in each experiment. For example, if you work with a sound sensor, there will be different noise in background. AI has to deal with these uncertainties and changing conditions. This is one of the challenges that makes many problems in AI so hard. If the hardware is limited and the environment changing, we have to address the problems in the software (or you may change your major, become an engineer, and improve the hardware). Refusing to address the problem is not a solution. But a solution will include trade-offs, and should be practical. As a final note, keep Occam’s razor principle in mind. In some situations a simple solution is better than a complex, error-prone approach.

**Teams**

On this assignment you will work in teams of two or three students. You will be responsible for finding your team partner. Enter the names of the team members on the wiki on the course website (below the Robot Project link). Submissions by individual students will not be accepted.

**Robots**

There will be several base models for this assignment available. You may add additional sensors to the base model or make some additional changes to the base model. Since we do not have a robot for each team, you have rebuild the base model after using the robotics lab. Make sure you maintain a description of your robot.

**The Robotics Lab**

As in the previous robot assignment, you will need to schedule time for the robotics lab using the calendar tool. See the Robotics Lab course site for additional lab rules. Any violation of the lab rules may exclude you from the lab and may result in a failing grade in the project.

**The Contest**

Every team and team member has to participate in the robot contest on April 29 from 11am to 1pm. During the contest, every team has two trials to let the robot detect objects. In each trial the robot has 2 minutes time to find the colored objects. After the first trial you are allowed modify your program. For each trial a score is computed by the formula *n* – 0.2∙*m* where *n* is the number of different, correctly identified colored objects and *m* is the number of different, wrongly classified objects. Thus an object that is identified several times correctly will contribute overall 1 point to your score. Analogously, an object that is identified several times incorrectly will incur overall a penalty of 0.2. Only the best of the two scores is considered in the contest. The team with the highest score is the winning team. The winning team of the contest will receive an A in the robot project. ☺

**The Project Description**

Every team has to turn in a project description of up to 4 pages. The document should describe

* the final implementation
* if applicable, alternative solutions that have been pursued
* conducted tests
* description of strength and weaknesses of chosen approach
* suggestions for improvements

**Submission**

Submit two files separately through the course website by Wednesday, April 27, 11:55pm: (1) the project description as a PDF file or as a Word document and (2) a zip-file with the source code of your implementation. Only one student in a team should submit the description and the implementation. In case of multiple submissions, I will grade the most recently submitted version.

**Grading**

If you do not turn in the implementation and description before the due date you will not receive any points. A team member who does not participate at the robot contest will not receive any points. You can receive up to 20 points in the project. The winning team of the robot contest will receive full points. Your project will be graded according to the following criteria:

* Robust implementation
* Effective performance during the robot competition
* Innovative ideas

The basis of the grade will be the performance of the robot at the contest and the description of your solution. I may inspect the source code, but in general the description should clearly explain all algorithmic solutions. In other words, you will not get points for great ideas that are not included in the description. For grading purposes, the performance at the contest does not only include the score, but also the overall execution. For example, your solution will be credited if your robot gets out of corners, if the robot explores the entire search space, etc. Note that the implementation has to conform to your project description. Otherwise, you will not receive points for the project.