

The Race

The race is the final assignment in COMP105P and it is worth half of the marks for the course. One round of racing will take place over two days in the final week of the summer term (week ending Friday June 12th).

The goal is to be able to race as fast as possible through a maze against the clock. You will be penalized every time the robot touches a wall, so you will need to balance speed with accuracy.

The race builds upon the tasks completed so far. It is possible to complete the race with a modified wall-follower, so everyone should be able to submit a solution that actually works. However, the maze will be arranged so that a simple wall follower will perform relatively poorly compared to more intelligent solutions such as ones that perform a degree of mapping.

There will be no more short tasks as the race is the last assignment for the course. You will, however, need to qualify to take part in the race. Qualification requires that you demonstrate a working solution running on a robot by the end of term.

Setup and Track

You will be racing against the clock and at any time there will only be one robot in the maze. Your final score will be your best time from your two attempts, plus any penalties incurred on that attempt. We have designed the mazes to be fairly easy to go through slowly, but challenging enough to make you work hard if you want to achieve a good time.

Race Rules

1. You are allowed two attempts at the maze.
2. After an attempt has been successful, you can choose whether to immediately restart, or go again after another group has had a try. The brief delay is you allow you to change parameters if you wish to do so.
3. Each attempt consists of two phases:
4. **Phase 1**
 - (a) This phase not timed.
 - (b) The robot must start in the designated starting square, which is located at one corner.
 - (c) The robot must navigate through the maze, and enter each of the three other corner squares.
 - (d) The robot must then return to the starting square and enter this square completely.
 - (e) There is no time penalty for gently touching a wall. If the robot can detect the bump, and extract itself, the marshall will not interfere. If the robot cannot extract itself, the marshall will move it so it is not touching the wall. This may adversely affect any mapping being performed.

- (f) If the robot gets repeatedly stuck, the marshall may declare the attempt to have failed.
- (g) If the robot moves any walls sufficiently far that the course is no longer fair or no longer viable, the run will be declared failed.

5. Between Phase 1 and Phase 2

- (a) The software from phase 1 must continue running and the robot may receive no external assistance.
- (b) The robot may turn round.
- (c) The robot must cross its front sensors as an indication to the marshall that the robot is ready to start.
- (d) The robot must pause for one second.
- (e) The robot must position its front sensors ready to race.
- (f) The robot must pause for one second.
- (g) The robot should then start phase 2.

6. Phase 2

- (a) This phase will be timed.
- (b) The robot must be entirely within the starting square before it starts.
- (c) The robot may navigate by any path through the maze to reach the finishing square in the minimum time.
- (d) The finishing square will be the diagonally opposite corner to the starting square.
- (e) The timed run will finish when the robot is entirely within the finishing square.
- (f) There will be a five second time penalty (time will be added to your run) for each time your robot bumps into a wall - we do not want you just ramming ahead. We want to encourage you to produce careful and well thought out algorithms.
- (g) If the robot moves any walls sufficiently far that the course is no longer fair or no longer viable, the run will be declared failed.
- (h) The time from the best attempt will be your final time.

7. You will be allowed three runs on the practice track (see below).
8. If you do not complete a single timed run on the first two attempts, you will be allowed another attempt which will take place late in the day after all the other teams have finished their attempts.
9. If you do not complete a single timed lap in all your attempts, the time that will be applied will be your qualification time (see below) plus 30 seconds.
10. Your code must continue to run from Phase 1 into Phase 2, without being restarted.
11. You can run different code on your two attempts if you wish.
12. You may not embed a map of the Maze into your code. We list below what you can assume and embed into your code.

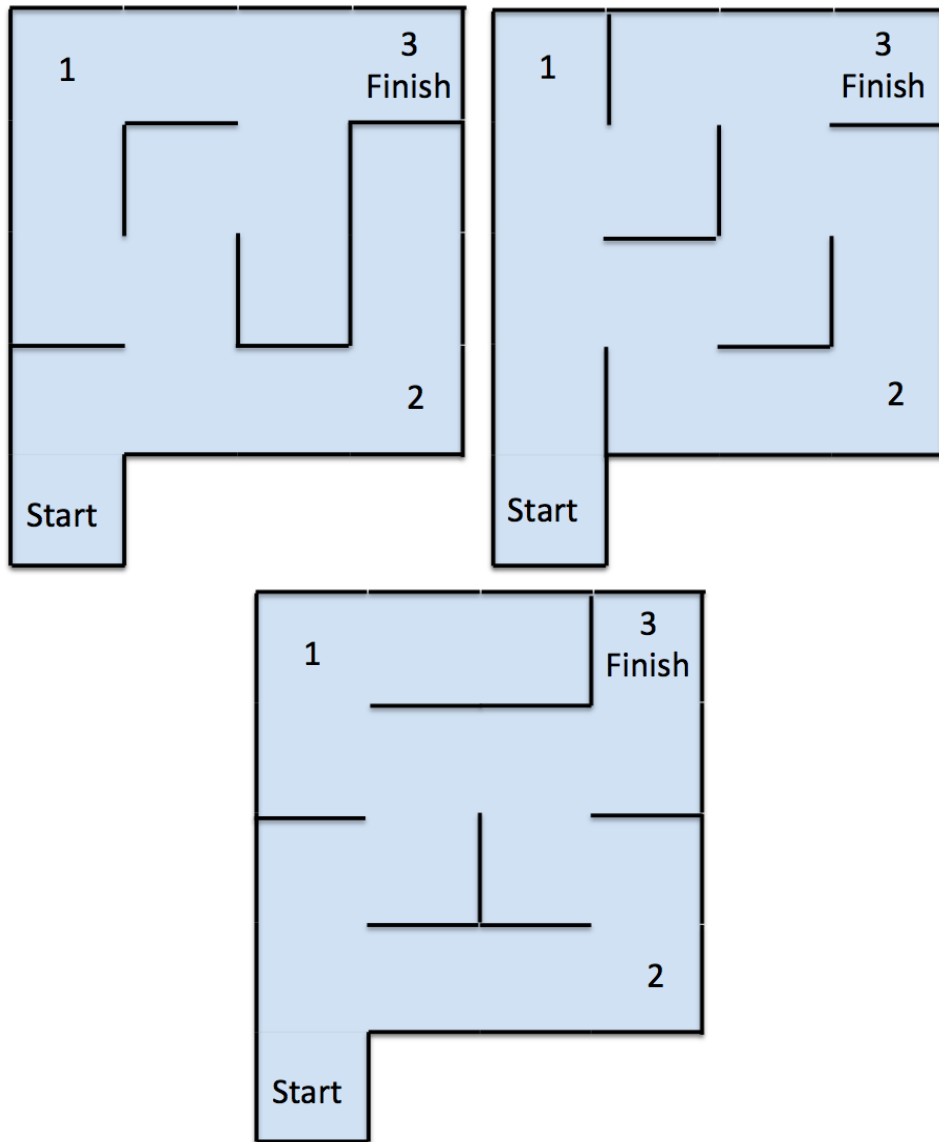
13. It is possible a robot may become lost. If a robot re-enters the starting square without exploring all three corner squares in phase 1, or without reaching the finish in phase 2, it will be declared “lost” and the time will not count. Similarly, if either phase 1 or phase 2 takes longer than five minutes, the examiners may (at their discretion) declare a robot to be “lost”, and the attempt terminated.
14. Please run “self test” on your robot when you receive it, and return the robot for a replacement if any of the tests show a problem.
15. Although we prefer you do not do so, you can switch robots between attempts - we will try to maintain two unallocated spare robots in case of a problem with the robot you first receive.
16. The robot must operate autonomously for each attempt from the point where it is started. No external control or manual influence is permitted.
17. Running order on each track will be chosen in advance by random assignment.
18. Teams will be allocated a race number indicating running order, and must attach that number to their robot for the duration of the time they have that robot.
19. We may amend these rules as necessary, up to the day before the race, but we will only do so to ensure that the race completes in a spirit of fairness.
20. We can apply arbitrary time penalties to any team that does not comply with the spirit of these rules. If you are in doubt as to whether a strategy complies with the spirit of these rules, ask before race day.
21. Our aim, above all else, is to be fair to you. If that turns out to be in contradiction of these rules, fairness takes precedent, at the discretion of the examiners.

Practice track

At the event there will be a practice track set up for you so you can perform any last minute tuning. It will be a replica of the track used for racing on that day. Runs on this track will not be graded and you will be able to use it to make last minute tweaks to your solution if necessary. We realize that there are a lot of teams and time will probably be scarce - you are allowed only three runs on the practice track. You can use these runs before your first attempt, or use some of them between your two attempts. As practice track time is limited, we suggest you perform any calibration outside the practice track, using, for example, code that drives in a small square or just rotates 360 degrees.

The Maze

Examples of mazes are shown below. The maze will be arranged as a 4x4 grid of 60cm squares. Your code can assume this, although the precise wall position may be off by one or two centimeters after previous robots have bumped the walls. The robot will start in a 60x60cm starting square that leads into the maze at the bottom left corner. You can use this width of the starting square to calibrate sensors before you start driving if you wish.



In Phase 1, your robot must enter all three other corner squares before returning to the starting square. If it does not enter all three corner squares, that attempt will be invalid and no time will be registered. For phase 1, the robot will be said to have entered a square if the center of the robot crosses the line on the floor demarking that square. The marshals are responsible for judging whether a square has been entered or not. If the decision is sufficiently borderline that they can't *clearly* determine whether a square was entered, they will declare that it was entered.

Because the corner squares are all on the outside edge, it is possible to find them all and return to the start by simply wall following. The fastest route from start to finish will not be one that can be achieved by simple wall-following though.

In Phase 2, the time will be from when the robot crosses the start line on the way in until it has completely entered the finishing square.

You are reminded that the front IR sensors do not read accurately below about 8-10cm, nor are they very accurate above about 45cm, so design your algorithms with these limitations in mind.

Qualifying

All teams must qualify in order to go through to the race meeting. This is to ensure that all teams on race day have at least one version of their code that should in principle be able

to complete the maze. To qualify, a team must have demonstrated their code successfully completing phase 1 and phase 2. Teams must demonstrate their solution to their TA during a normal lab session. A team must have qualified by the end of term 2 to be eligible to race.

Spectators

The races will take place in either the North Cloisters or in the Engineering Cafe. Both are open to the public. You are encouraged to watch and cheer on other teams if you are not preparing your own robot. You can, if you wish, invite friends or family along to watch you race, but space will be fairly limited, there will not be much in the way of seating, and we cannot predict exactly what time you will get to race. As the spaces are public, please be careful about leaving bags and valuables lying around.

Grading

The race is worth 50% of the marks for the course. There will be three components to grading.

1. **Ability to complete Phase 1 (5%).** We will award points for simply being able to complete the maze.
2. **Ability to complete Phase 2 (5%).** We will award points for simply being able to reach the finish in phase 2.
3. **Ranking (25%).** The better your robot performs (the lower your best phase 2 time, plus penalties) the more points you get. You will be competing against the other teams. We will rank each team based on how long it took the robot to complete the maze. The best team will get 25%, with marks linearly decreasing down to no ranking marks for the last team. If a team did not qualify for the race, they will rank below all teams that did qualify. Teams that fail to qualify will be scored on how many of the corner squares (from one to four, including coming back to the starting square) their robot manages to find during phase 1.
4. **Short reports and vivas (15%).** Each one of you (individually, not as a team) will have to produce a short (no longer than a single A4 page) report evaluating your own involvement and your partner's involvement. Those reports must be kept private and will not be seen by anyone but the examiners. After submitting the reports you will attend a brief discussion (again individually) where we will ask you questions about your group's solution and your personal report. The vivas and the personal reports will take place during the final week. The viva is a formal examination requirement on this course, and a schedule of the vivas will be available on Moodle. Failure to attend the viva may result in you being declared "incomplete" for the course.
5. **Style.** At the examiners' discretion, we may award a few bonus marks for elegant solutions, even if they are not the winning strategy. These are in addition to the marks above.