Assessment Specification

SEMTM0043: Robotics Science & Systems

Academic Year 2025/2026

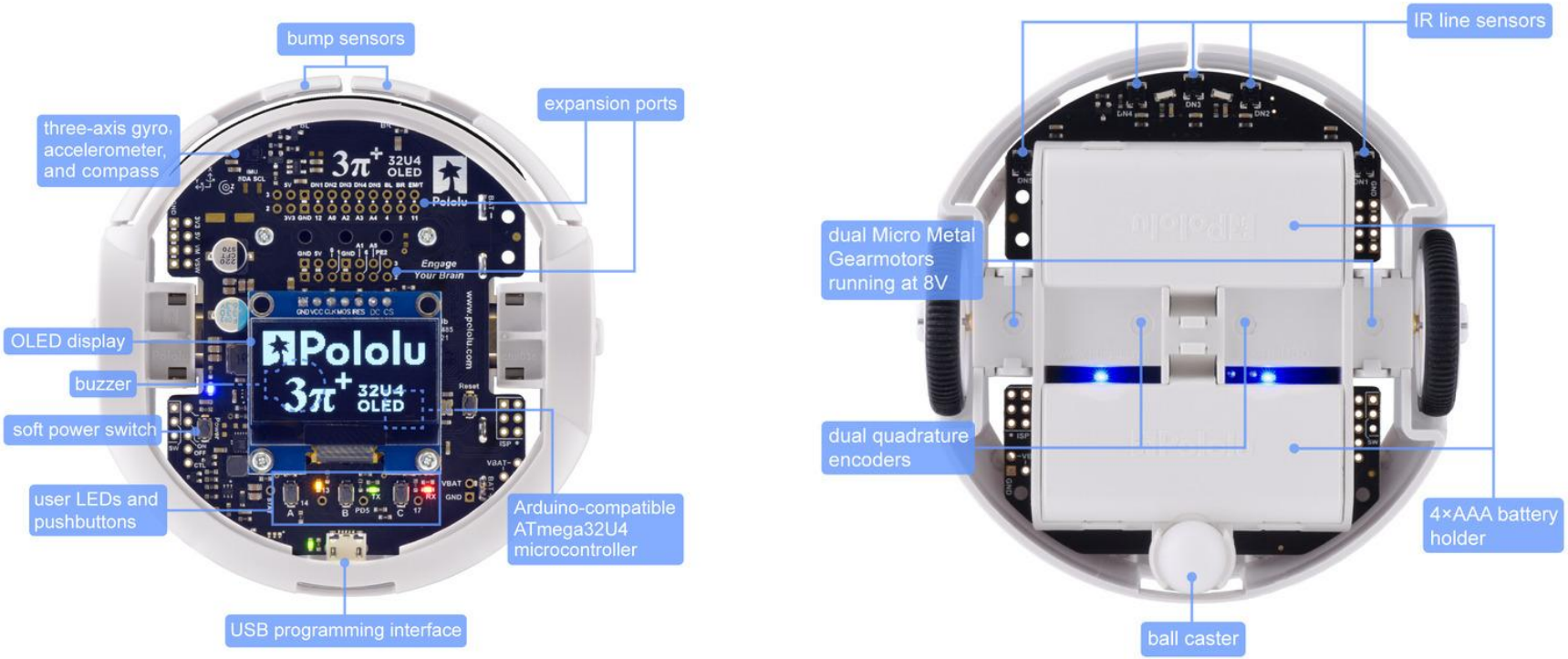
Unit Director:	Dr. Paul O'Dowd	paul.odowd@bristol.ac.uk
Deputy Director:	Prof. Helmut Hauser	helmut.hauser@bristol.ac.uk
Deputy Director:	Dr. Rui Wu	rui.wu@bristol.ac.uk

University of BRISTOL

Learning & Assessment in Brief

SEMTM0043 is assessed by 100% coursework split into two assessments, A1 and A2, weighted 30% and 70% respectively. The emphasis of this coursework is to prepare you to develop and conduct a scientific experiment with a robotic system, including how to report and evaluate results. The main teaching/learning mechanism of this unit is to give you direct, hands-on experience of these activities via project-based learning. You will be working with a robotic system: a Pololu 3Pi+ mobile robot. ***Working with hardware takes an investment of time and practice***. The unit is split into two periods. In the first 5 weeks, you will be primarily taught through practical lab sessions to develop fundamental skills with a robotic system by engaging with the "Foraging Challenge". In a second 5 weeks, working in teams (groups), you will be primarily taught through regular supervision for self-directed study to conceive, design, conduct, evaluate and report a scientific experiment conducted with your 3Pi+ robot, developing post-graduate critical thinking skills.

Pololu 3Pi+ Mobile Robot



Images from: Pololu Corporation, Pololu 3Pi+ product page, https://www.pololu.com/product/4975 [Accessed 24/09/23]

Assessment Structure, Key Dates & Rules

Assessment 1, Summative (30%), Individual basis: UoB Weeks 1-5, Deadline Thursday 23rd October 1pm

You must program your robot to autonomously complete the **Foraging Challenge**, adhering specification and requirements detailed from page 6. Your assessment submission must be individual work. Your code will be algorithmically checked for plagiarism against all other code submissions made to the unit.

- Deadline for final submission: UoB Week 5, **Thursday 23rd October 1pm**. Composed of:
  - An online self-assessment form with a valid URL to a web-hosted video of your robot completing the **Foraging Challenge**.
  - Your final version of working code used to uploaded Blackboard, which must compile without errors.
- The requirements for your video demonstration are provided on page 8.
- You must use Arduino C in programming your 3Pi+.
- You cannot attach extra electronics (e.g. sensors) to your 3Pi+.
- You are not permitted to use any external software libraries within your solution with the exception of standard C libraries (e.g. math.h), or those specified within the provided labsheets. Copying code from external libraries constitutes the use of the same libraries and is an assessment offense.

Assessment 2, Summative (70%), team basis: UoB Weeks 5,7-11, Deadline Thursday 4th December 1pm

Working in a team of 2, 3 or 4 students, your team must produce a 6-page report which details a scientific experiment conducted with your robotic system (3Pi+), adhering to the Assessment 2 Specification, detailed from page 15.

- Final Report Deadline: UoB Week 11, **Thursday 4th December, 1pm.**
- All team members must each provide via Blackboard:
  - A copy of the 6-page report prepared by the team.
  - The working source code used for the experiments, which must compile without errors.
  - An individual personal statement on the efficacy of your role within the project and team.
- You must use Arduino C in programming your 3Pi+.
- You cannot attach extra electronics (e.g. sensors) to your 3Pi+.
- You are not permitted to use any external software libraries within your solution with the exception of standard C libraries (e.g. math.h), or those specified within the provided labsheets.
- All team members must contribute equally to the body of work.
- Your team must attend weekly supervision meetings. Attendance to supervision meetings is mandatory.
- Supervision meetings will have minutes taken. On a weekly basis, the minutes will be emailed back to you, which will include your stated current progress, goals set, and an agreed distribution of equity to reflect team member contributions.
- The mark awarded for your 6-page report will be applied equally between members, unless there is a significant disagreement of contribution.
- If there is significant disagreement of team member contribution (>10% difference), a viva between all team members and two academics to determine a fair outcome. The recorded supervision minutes and the personal statements will be taken into consideration. A lack of any evidence will not support a case (e.g., absence from meetings).

Kit Contents

On Loan for 11 Weeks:

Register your kit with the QR code on the label, or via this link.

You can take it home.

- 1 Box
- Pololu 3Pi+ Robot
- 4 AAA Re-chargable Batteries
- Battery Recharger (UK)
- 2 Cable ties
- 4 Plastic Hooks
- 1 Puck with Magnet
- 1 USB cable
- 1 Dice

You are required to return all parts of the kit in week 11.

Cable ties and plastic hooks do not need to be disassembled on kit return.

Please remove the batteries from the robot on kit return.

Guidance: Plagiarism and the Use of AI

For any of the items below, you are encouraged to seek advice from the teaching staff if you have any doubts or questions.

- Review the University of Bristol guidance on Generative AI in Education

- What is Plagiarism?
  - Submitting your work for assessment can be understood as a process of claiming credit for your effort and achievements within the time period and method of assessment.
  - Therefore, submitting work that is not your own is attempting to claim credit that does not reflect your own capability and efforts.
  - Sometimes, plagiarism is applicable on *your own prior work* because it would constitute a claim for effort that was not conducted within the assessment method or period itself.

- Submitting work for assessment that has been produced by Generative AI (or similar tools) is considered **Contract Cheating**, the highest academic offense. You can review the University policy on contract cheating here.
  - You should assume that using Generative AI is forbidden, unless the materials provided to you (teaching materials and/or assessment specifications) explicitly state when and how Generative AI tools are allowed.

When is Generative AI use permitted on SEMTM0043?

- You may use Generative AI to assist you with authoring Python code to produce figures and plots.
  - The underlying data to be plotted must be captured from your robotic system under investigation.
  - You may submit for assessment the figures and plots produced without reference to the Generative AI tools used.

Examples of Assessment Offenses (Plagiarism and Cheating) on SEMTM0043:

- Publicly hosting your code on Github (or similar) represents a choice to freely share your work with others, which invites others to plagiarise. This is irresponsible. If someone else uses your code, even without your knowledge, you will be penalised for Academic Misconduct. You must keep work for assessment private, either in an individual or group/team context.
- Attempts to by-pass the intellectual challenges of the assessment design:
  - Employing any person or Generative AI to work on your behalf is forbidden.
  - Utilising third-party software libraries other than those explicitly specified in the provided teaching materials is forbidden.
  - Copying-and-pasting code from a third-party software library into your own code is forbidden.
  - Re-writing someone else's code (such as replacing names, or adjustments to sequence) is an attempt to obscure the foreign origin of work.
  - Any alterations to any of the provided materials that is not explicitly authorised in the teaching materials is forbidden.
  - For the Assessment 1 video, adjusting the video playback speed or removing frames to achieve more robot behaviours within a 4 minute playback time is considered cheating.

Assessment 1

Assessment 1 Marking Criteria, 30% Weighting

More detailed descriptions and context of these challenges are provided on subsequent pages.

Criteria Description	Mark (max 100)	Skills Demonstrated
Beginner Difficulty	(50-58%)	
Actively search within the map area for 4 minutes then stop. The robot must not leave the map area. Your video must demonstrate the robot interacting with the black boundary of the coursework map. The robot should not stop moving within the 4 minute period. The robot must be shown to stop after 4 minutes.	50	The ability to control motors and read sensors to produce safe autonomous behaviour within a time limited period. Example Video
Actively search area for 4 minutes as per "Beginner Difficulty". After 4 minutes, the robot is demonstrated to return to the start area, with the robot stopping with some part of the white robot body within the start area. The robot must be shown to come to a complete stop.	58	The ability to control motors and read sensors to produce safe autonomous behaviours within a time limited period. The ability to control the motion of the robot towards a target location with higher precision.
Intermediate Difficulty	(60-68%)	
Puck location must be randomised using the dice. Robot must actively search area, correctly detect puck, and push the puck outside the map area. The robot can then return to the start area, and stop with some part of the white robot body within start area, pausing moving for a minimum of 4 seconds to wait for a new puck location to be randomised using the dice. The robot should then repeat the above requirements. The robot must stop after 4 minutes of activity regardless of which activity it is engaged in. Apart from pausing for the puck relocation, your robot should remain active for 4 minutes without leaving the map at any point.	58 + (n * 2) where *n* is the number of pucks correctly pushed outside the map, requiring a minimum of 1 puck, up to 5 pucks total.	The ability to control motors and read sensors to produce a series of discrete robot behaviours to achieve different goals. The ability to control the motion of the robot towards different target locations with higher precision, and a repeatable level of performance within a time limited period. Example Video
Expert Difficulty	(70-100%)	
Puck location must be randomised using the dice. Robot must actively search area, correctly detect puck, push the puck back into the start area, stopping with some part of the puck within the start area. The robot should then pause for a minimum of 4 seconds to wait for a new puck location to be randomised using the dice. The robot must stop after 4minutes of activity regardless of which activity it is engaged in. Apart from pausing for the puck relocation, your robot should remain active for 4 minutes, only leaving the map to position itself to return a puck.	65 + (n * 5) where *n* is the number of pucks correctly returned, requiring a minimum of 1 puck, up to 7 pucks total.	The ability to control motors and read sensors to produce more complex autonomous behaviours, including basic path planning and fault tolerance. The ability to analyse and refine a solution to mitigate the effects of noise/error over extended periods of continuous robot operation with guaranteed reliability. Example Video

Assessment 1 Video Rules

Video Rules:

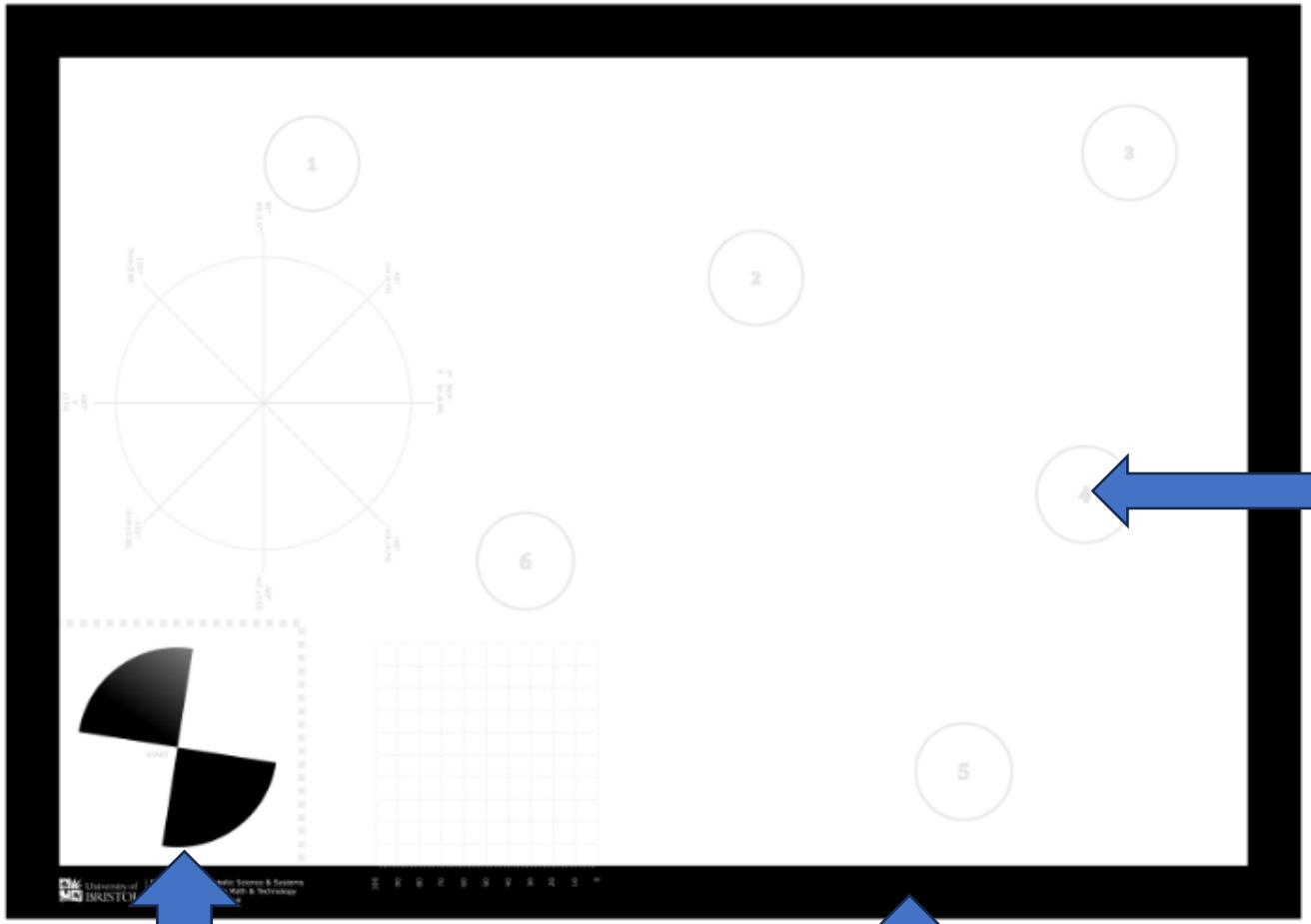
1. Your University of Bristol student ID card must be made visible at the start of your video recording. This constitutes your declaration that your video submission is your own independent work.
2. Your video must capture the performance of your robot running the code you developed. Your code submission will be checked against the performance demonstrated in the video.
3. You must provide a single video (no editing) that captures the performance of your robot completing the **Foraging Challenge.**
4. Once your robot has been powered-on, it must not be reset, touched or adjusted. At the point of interference, any further marks will be forfeit.
5. Your robot must have either the OLED or LCD display attached that shows the time remaining in seconds being updated from when your robot begins moving. Code for this functionality is provided for you.
6. The puck location must be determined by rolling the dice, and the puck must be placed on the corresponding map location by number. The puck must be centred on the location, covering the circle marking. If the puck is not placed centred on the location marking, the marks for collecting that puck may be forfeit.

Video Examples:

Beginner Difficulty,	50%:	https://youtu.be/d0cM0dXEfrA
Intermediate Difficulty,	68%:	https://youtu.be/wulDgOQa7a8
Expert Difficulty,	95%:	https://youtu.be/QU_3xKoStQk

7. Once a puck has been placed, it must not be repositioned or touched. If your robot pushes the puck out of position, the robot must continue to visit all 6 locations before the robot can return to start to initiate a puck relocation procedure (Step 5 for Intermediate and Expert difficulty descriptions, see pages 11 & 12).
8. The rolling of the dice must be visible within the video recorded. If the dice rolling or final dice face are not visible, no marks will be awarded relating to that dice roll.
9. Your robot must always be visible within the video.
10. Your robot must adhere to the 4minute time limit policy for robot operation. Time will be measured from when your robot first moves. No marks will be awarded for pucks returned outside of 4 minutes.
11. You must use the clear plastic puck and magnet provided to you without alterations.
12. You must use the coursework map provided to you without alterations, with the exception of clear tape that may be used to join two sheets of paper together.
13. Your robot must be demonstrated to come to a complete stop before the video recording ends.
14. If your video URL is not valid, if your submitted code does not compile, or if your code cannot produce the behaviours demonstrated in your video, your Assessment 1 mark will be based solely on the achievement evidenced in your code only and by the academic judgement of the unit director.

Assessment 1, Foraging Challenge Coursework Map



Start Area, boundary marked by the dashed line.

Map Area, boundary marked by the thick black line.

The **Coursework Map** to the left should be printed either on a single piece of A2 paper, or two A3 pieces of paper. These are provided to you. You may also download and print your own.

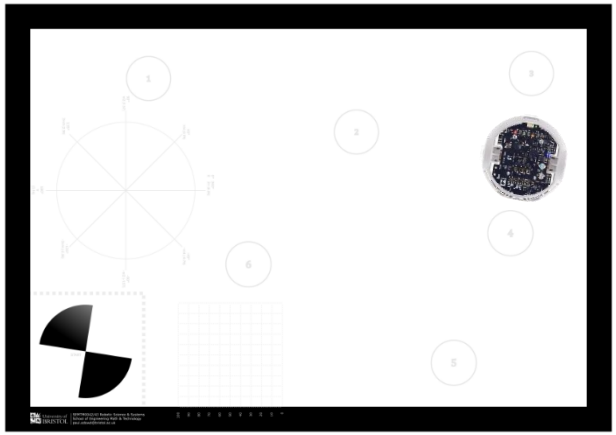
You are permitted to use clear tape to stick two sheets of paper together.

Puck locations labelled 1-6. Puck should be placed to cover the circle marking.

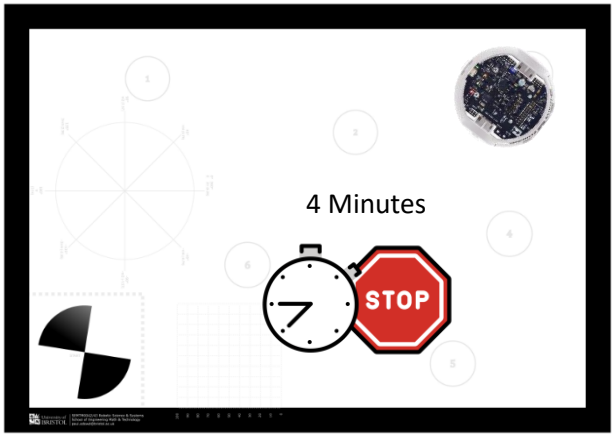
The 6 sided dice and **puck** provided to you.

Foraging Challenge Description: Beginner Difficultly (Marks 50-58%)

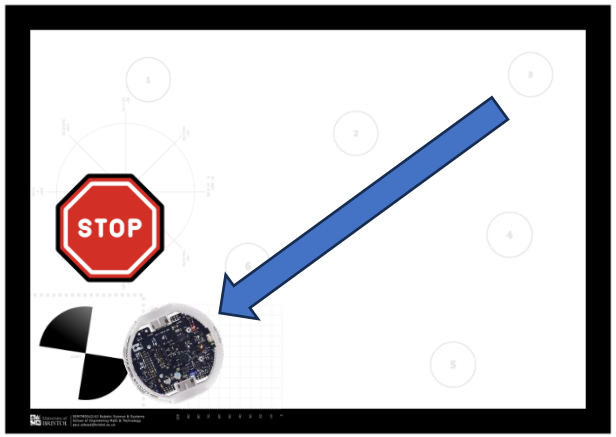
1. Place your robot in the start area. Power-on your robot.



2. Your robot should actively navigate within the area marked by the thick black boundary. Your robot should not stop moving. Your robot should be demonstrated to interact with the black boundary of the coursework map.

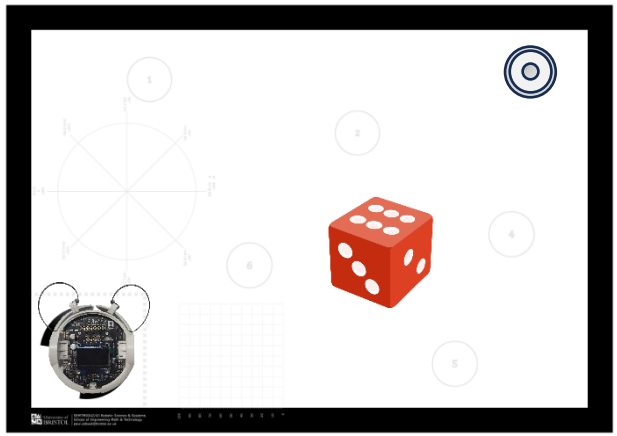


3. Four minutes from activation, your robot must stop regardless of what activity it is engaged in. This will secure a mark of **50%.**

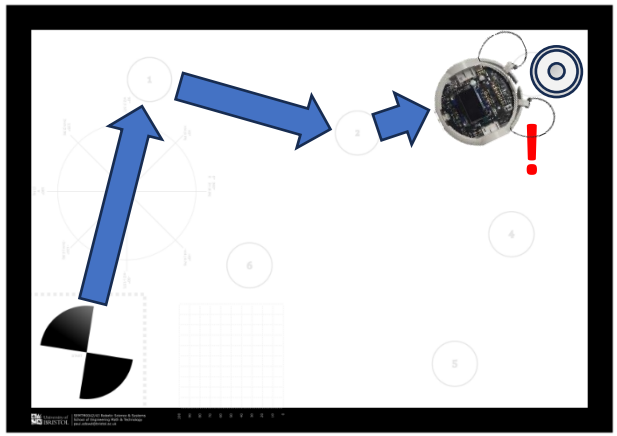


4. After completing step 3, if your robot can return to the start area (some part of the robot within the dotted line region), then you will achieve a mark of **58%.** Returning to the start will occur outside of the 4 minute requirement.

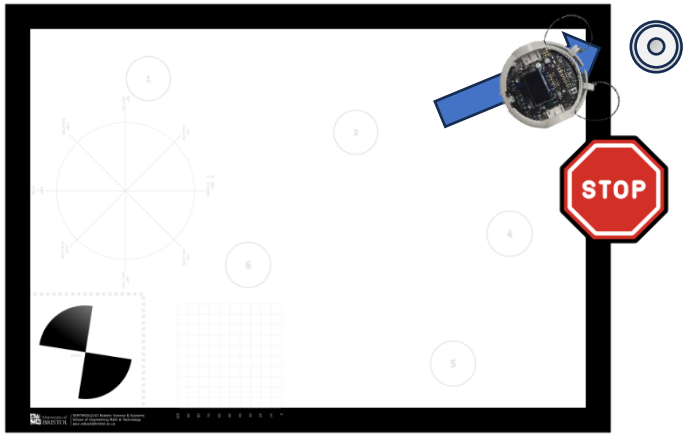
Foraging Challenge Description: Intermediate Difficulty (Marks 60-68%)



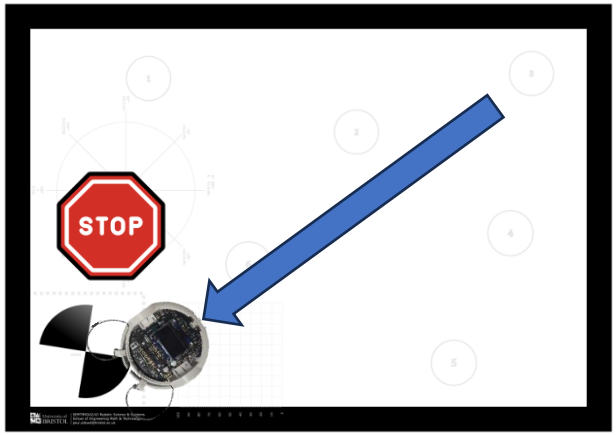
1. Place your robot in the start area. Place the puck at a location determined by rolling the dice and using the corresponding number on the map. Power-on your robot.



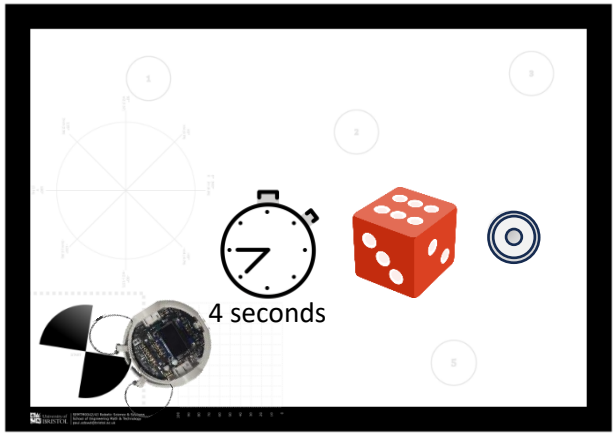
2. Your robot should attempt to visit each puck location to detect the puck. If your robot fails to detect the puck after visiting all 6 locations your robot can proceed from **Step 4** to initiate a relocation of the puck.



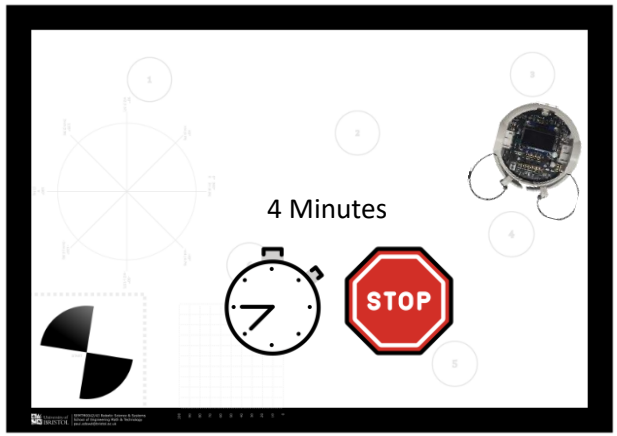
3. When your robot detects the puck, it should then push the puck out of the area marked by the thick black boundary. Your robot must not leave the area marked by the black boundary. If your robot continues to navigate the map area for the time remaining, up to 4minutes, you will achieve a mark of 60%.



4. After completing step 3, your robot can return to the start area (some part of the white robot body within the dotted line region) and stop, to allow you to proceed to **step 5**.

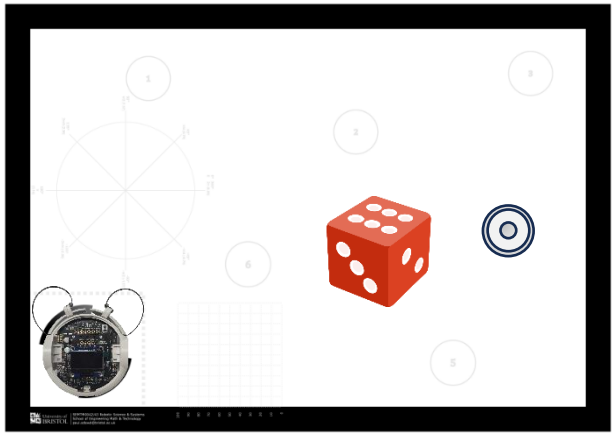


5. Your robot should wait for a minimum of 4 seconds whilst you roll the dice to determine the next placement of the puck at one of the six locations. Your robot should then proceed from **step 2**. You must not reset or power cycle (on-off-on) your robot.

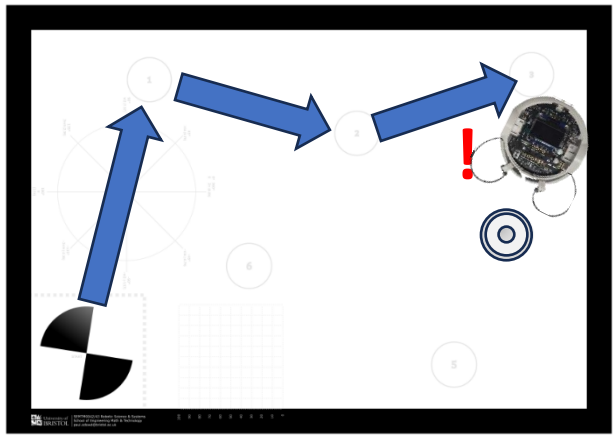


6. Four minutes from activation, your robot must stop regardless of what activity it is engaged in. Your final mark will be *58 + (n x 2)*, where *n* is the number of pucks correctly pushed out of the map, up to 5 pucks maximum. At least 1 puck must be returned to be eligible for these marks.

Foraging Challenge Description: Expert Difficulty (Marks 70-100%)

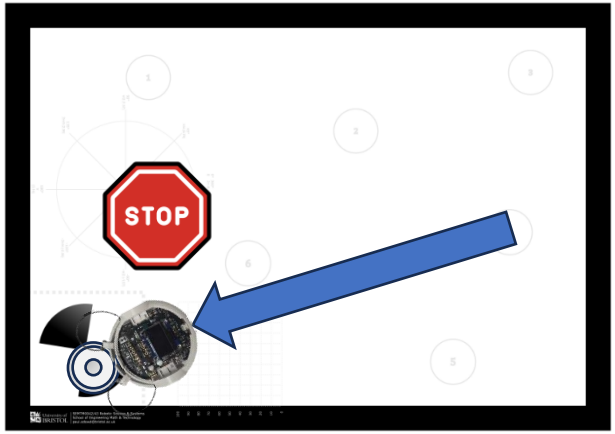


1. Place your robot in the start area. Place the puck at a location determined by rolling the dice and using the corresponding number. Power-on your robot.

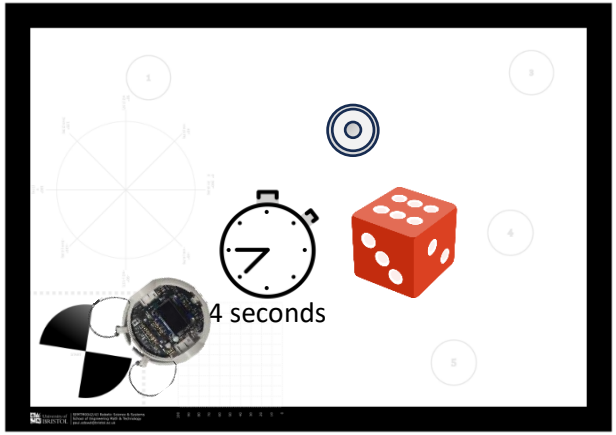


2. Your robot should attempt to visit each puck location to detect the puck. If the puck is not found after visiting all six locations, your robot may return to start, then proceed from **step 5** to relocate the puck.

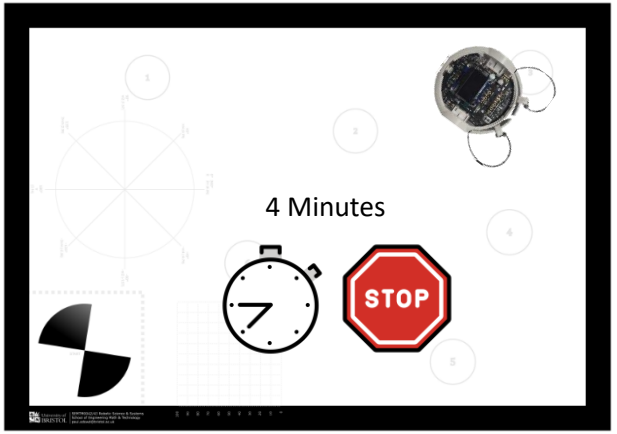
3. Your robot will need to move itself to prepare to push the puck back to the start area. <u>Your robot is permitted to leave the area marked by the thick black boundary to do this</u>.



4. Your robot should push the puck back to the start area and then stop. <u>Some part of the puck must be within the dotted line marking the start area to qualify for marks</u>. Each puck returned in this way will qualify for 5 additional marks, up to 7 pucks total (maximum +35 marks).

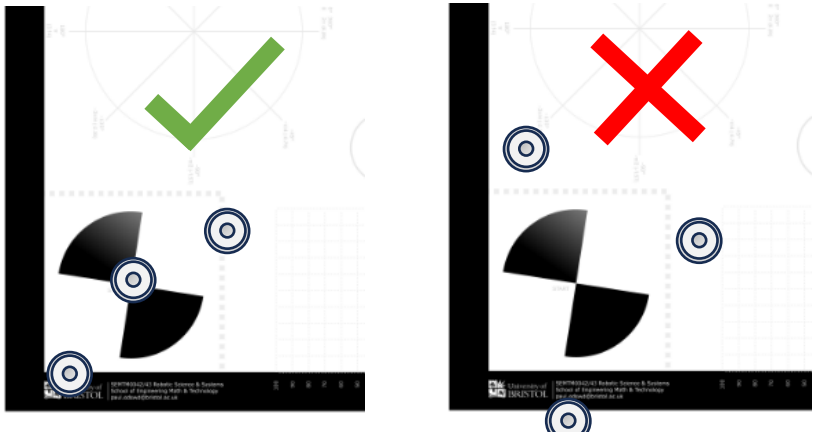


5. Your robot should wait for a minimum of 4 seconds whilst you roll the dice to determine the next placement of the puck at one of the six locations. Your robot should then proceed from **step 2**. You must not reset or power cycle (on-off-on) your robot.

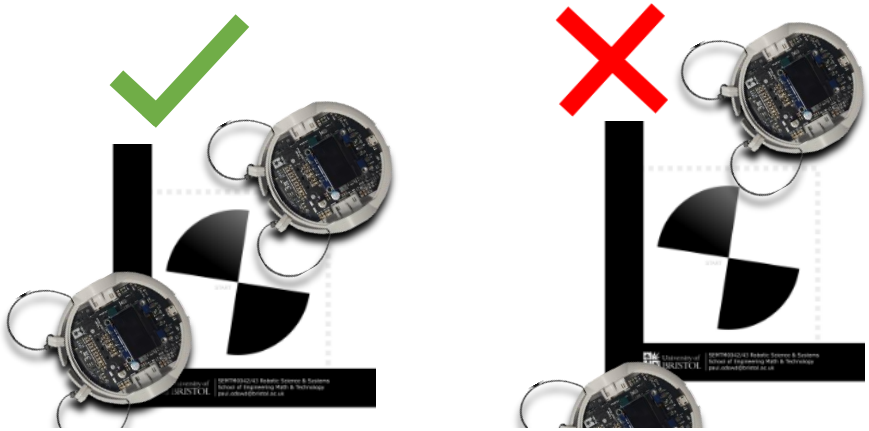


6. Four minutes from activation, your robot must stop regardless of what activity it is engaged in. Your final mark will be *65 + (n x 5)*, where *n* is the number of pucks correctly returned, up to 7 pucks maximum. At least 1 puck must be returned to be eligible for these marks.

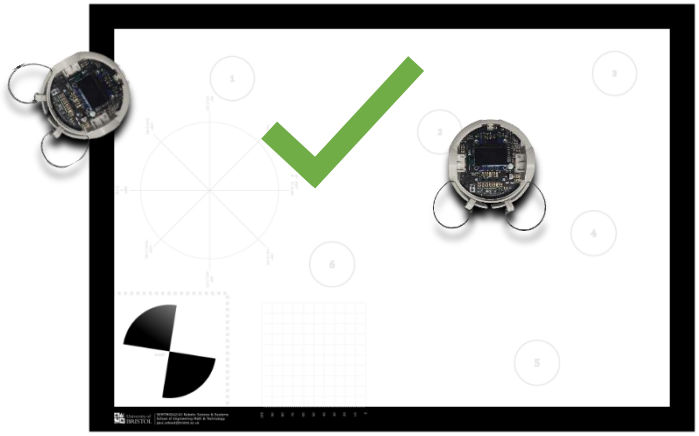
Clarity on Start Area and Map Boundary Conditions

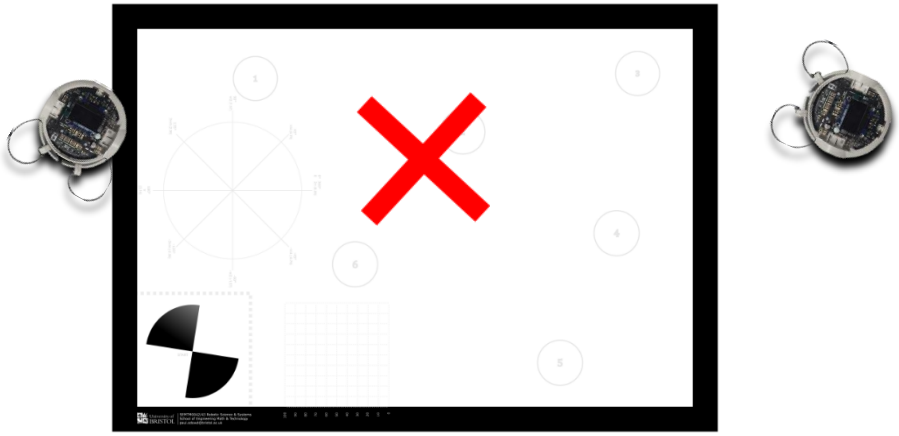


Left: some part of the plastic puck is within the start area.
Right: no part of the plastic puck is within the start area.



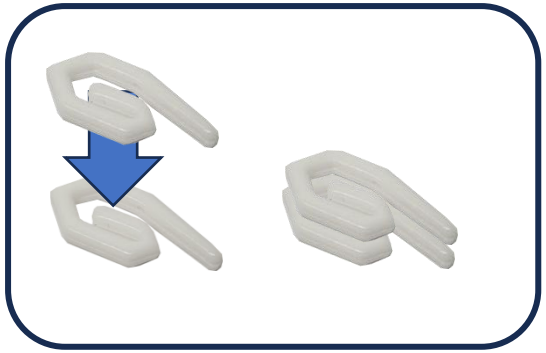
Left: some part of the white robot body is within the start area.
Right: no part of the white robot body is within the start area.



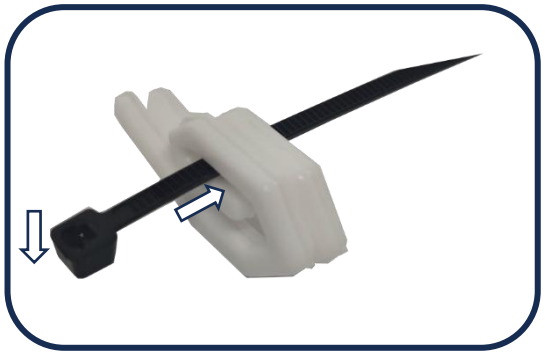


Top: some part of the white robot body is within the map area.
Bottom: no part of the white robot body is within the map area.

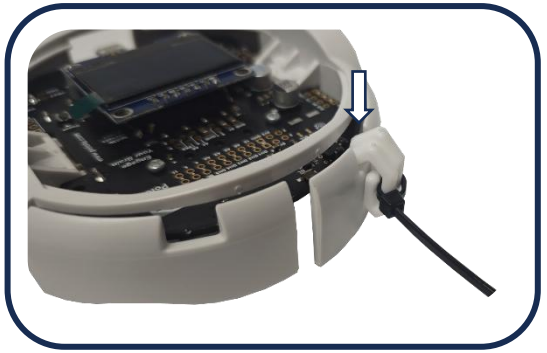
Modifying Your 3Pi+ for Foraging



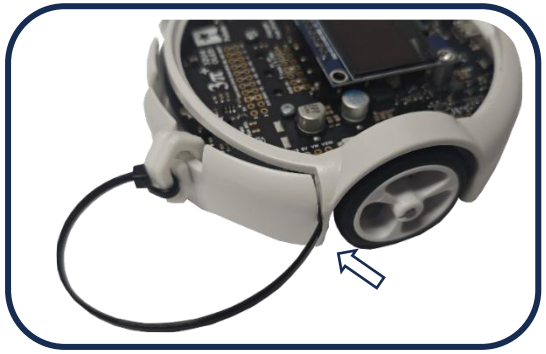
1. Stack 2 clips on top of each other.



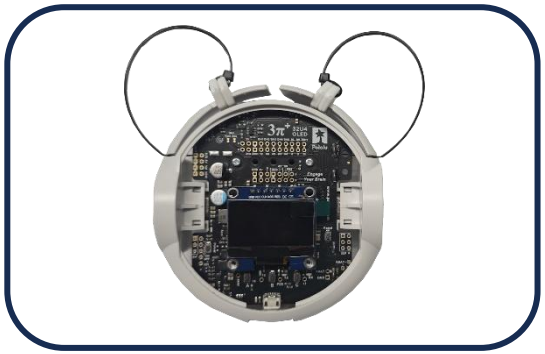
2. Thread one of the cable-ties provided to you through the inner loop of the clips. <u>Pay attention to the direction of the fixing block</u>.



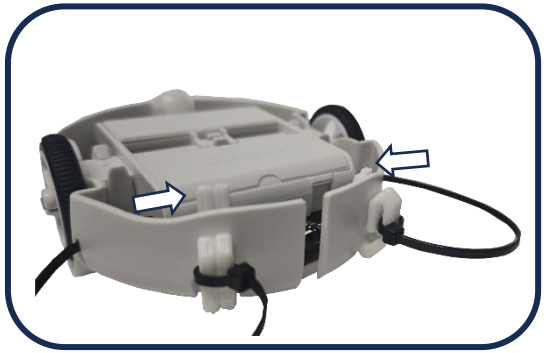
3. Close the cable-tie by threading itself through the fixing block. **Gently** insert the long arm of the clips into the gap on the bumper.



4. **Gently** Insert the loose thin end of the cable-tie into the gap between the bumper and body near the wheel arch. You may need to adjust the position of the cable-tie.



5. Repeat steps 1-4 in the other direction for the second bumper. If you make a mistake, talk to a member of the teaching staff who have spares.



6. You may want to cut the long arm of the clips to prevent it from catching on surfaces (such as the edge of the paper coursework map). You can ask a member of teaching staff to do this for you.

Assessment 2

Assessment 2 Specification, Summative (70%), Team Basis

Using the skills and software you have developed in Assessment 1 you must identify a scientific experiment to conduct with your robotic system. You should draw on critical insight(s) of your robotic system to form a hypothesis, to demonstrate via the analysis of collected results, of either:

- An improvement to the robotic system operation from a baseline level of autonomous operation.
- A proof of an underlying characteristic, phenomenon, or principle of a robotic system and its consequence on autonomous operation.

Your ability to conceive of a scientific experiment, to conduct the experiment, and to communicate the results is representative of the depth of your understanding of a robotic system, allowing you to demonstrate skills of analysis, evaluation and synthesis.

You should make the Pololu 3PI+ robot the focal point of your study – therefore, you are strongly advised not to conduct a study that focuses on off-board/offline tools, such as machine learning, data fitting, statistical analysis, etc. These may be components of your work but keep your primary investment and interest on the robotic system (Pololu 3Pi+ robot). We are interested in substantiating new knowledge about the complex relationship between an autonomous robot and its task environment. For example, it is recommended you avoid a study that demonstrates Machine Learning can classify a dataset, because this substantiates knowledge on Machine Learning and not the robotic system.

Your experiment should be designed such that the body of work is reproducible and repeatable via a robust implementation and experiment methodology. The conclusions you can draw and the insight you can articulate will be underpinned by the credibility of the results presented. The value and significance of your work should be reflected in the introduction where context is provided, and in the analysis, evaluation and conclusion of your study.

These elements will be assessed by the evidence provided in your team submission of a 6-page report in a conference style. A template of a report is provided which also contains guidance.

Working in a team of 2,3 or 4 students, your team must produce a 6-page report which documents a scientific experiment conducted with your robotic system (Pololu 3Pi+). Your report must be based on and include data retrieved through empirical study of your robotic system. Your report should effectively communicate against the four criteria on the following page, which gives guidance on how they can be demonstrated.

Assessment 2 Criteria:

Your team report will be assessed with consideration to the following Assessment 2 criteria below and the general University marking criteria and scales for level 7 (PGT/MSc). Feedback will be provided addressing the same criteria where appropriate. A spreadsheet of these same criteria and examples of common feedback is available on the Blackboard unit page.

	Criteria	Weight	Description	What to look for:
1	**Situation of Project**	0.25	This can be generally understood as the "**scholarly/academic basis**" for the presented study, which articulates value (i.e. applications), interest (i.e. knowledge gained) and relevance to scientifically investigating robotic systems. To be considered primarily against the Introduction and Literature Review sections, to support the presentation of Research Questions and/or Hypotheses.	A clear general description of the area of work/topic. - **review the problem area investigated** with **implications to support** the value of the undertaking. - discuss the constraints/affordances of the project area to define **scope**. - increase the readers knowledge & understanding of **specialist concepts** sufficiently. - **justify the scope/ambition** of the work as appropriate. - **support the merits of the specific investigation made**.
2	**Technical Contributions**	0.3	This can be generally understood as the **"technical contributions"** concerning the critical thinking and insight of conception, design, making, and preliminary testing, including technical mastery in identifying scientific methods for measuring the system, technology, or subject of study. This criteria can primarily be considered against the Implementation and Experiment Methodology documentation.	Sufficient technical detail for **reproducibility,** in both **construction and measurement approaches.** Insightful technical discussion of rationale for **attribution** of work to student. Justified choices via an **analytical problem discussion/decomposition**. Appropriate selection of methodological approaches for **measurement for credible data**. Appropriate design of experimental **evaluation techniques** for **meaningful data**.
3	**Knowledge Contributions**	0.3	This can be generally understood as the "**knowledge contributions**" concerning critical thinking and insight in the reasoning and argument for research questions/hypotheses, conception of experiment scenario(s)/task(s), the interpretation of results, insights gained and broader implications. This criteria can primarily be considered bridging the Hypothesis, Methodology, Results, Conclusion and Future Work sections.	**Clear reasoning** for insightful research questions/hypothesis. An experimental scenario/task that **facilitates testing against a hypothesis**. A **clear line of argument** that utilises **evidence to support intellectual insight/products**. Varied **qualitative** and **quantitative results**, utilising distribution in plots. Awareness and **evaluation of potential limitations**, such as interpretation of results, and/or ways to improve the intellectual rigour of future research. If engineering/solution focused: - a **critical argument/hypothesis on which performance characteristics to evaluate:** characterising the solution by evaluating positive performance, underlying causal factors, performance limitations and failure modes. - an argument for a fair and meaningful **comparative study**, to provide a relative evaluation of a new artificial system.
4	**Presentation & Communication**	0.15	This can be generally understood as a "**measure of quality, correctness & consistency of communication**" for the whole report with emphasis on critical choices of plots/figures, clarity, structure, use of language; correctness of citation, concepts, theory, academic conventions, etc. Criteria 1,2,3 can be appraised broadly for information content - in limited cases via inferred meaning and registering a shortfall in quality of presentation and communication against Criteria 4. High quality (i.e. work of distinction) work must achieve high marks across all criteria (1,2,3 & 4), taken as a whole and in synergy.	Clear **structuring to the document**, e.g. logical use of titled subsections. Internal document **referencing** (e.g. equations, figures) and sign-posting (sections) **Critical thought** exercised on which content to include and exclude. Communication that is **concise and progressively builds the readers understanding**. **Finessed use of varied diagrams**, photographs, figures, etc, as necessary. **High attention to d**etail, without spurious, redundant and/or unreferenced elements. **Clarity in the resolution of figures**, captions, labels, etc. **Correctness** of terminology, formatting, use of concepts, etc.