PIXELATE

TASK:

The world has undergone a transformative era of technological advancements and international collaboration. The not-so-distant future unfolds against the backdrop of a united global effort to expand humanity's reach into the cosmos. With Earth facing environmental challenges and a growing interest in interplanetary exploration, the Moon emerges as the next logical step in the quest for knowledge and sustainability.

The event serves as a testing ground for innovations that will shape the future of space exploration. The compact but powerful Unmanned Ground Vehicles (UGVs) designed for Lunar Odyssey represent a leap forward in robotics and artificial intelligence. The challenges presented in the Moon Maze are inspired by the real-life obstacles and opportunities that lunar exploration poses, ensuring that participants engage in problem-solving scenarios that parallel the complexities of space missions.

The challenge is to design and build a compact but mighty Unmanned Ground Vehicle (UGV). Your UGV has to visit all 4 excavation sites on the moon and pick up the artifacts present at these sites. These artifacts have to be delivered to the respective research labs set up on the moon which are dedicated to the study of only one specific artifact. Since the artifacts are heavy, UGV can only lift one artifact at one particular time. These robotic pioneers are tasked with navigating a treacherous lunar landscape presented as a 10x10 tiles grid.

You'll have to make a fully autonomous robot that would be able to do the following:

- Identify locations of the excavation sites and the research labs.

- Unveil the research lab type by collecting the artifacts present at the excavation sites.

- Grab the artifact and take it to the respective research lab according to the conditions specified.

- Distract as little as possible.

Now, the UGV seeks the help of your amazing Image Processing Skills.

ARENA:

- The dimension of the arena will be 200cm x 200cm divided in 10 x 10 grids.

- Each block of the grid is therefore 20cm x 20cm.

- The Artifacts will be having different shapes and will be made out of a magnetic material weighing not more than 500g.

- Robot is not allowed to travel across the black tiles.
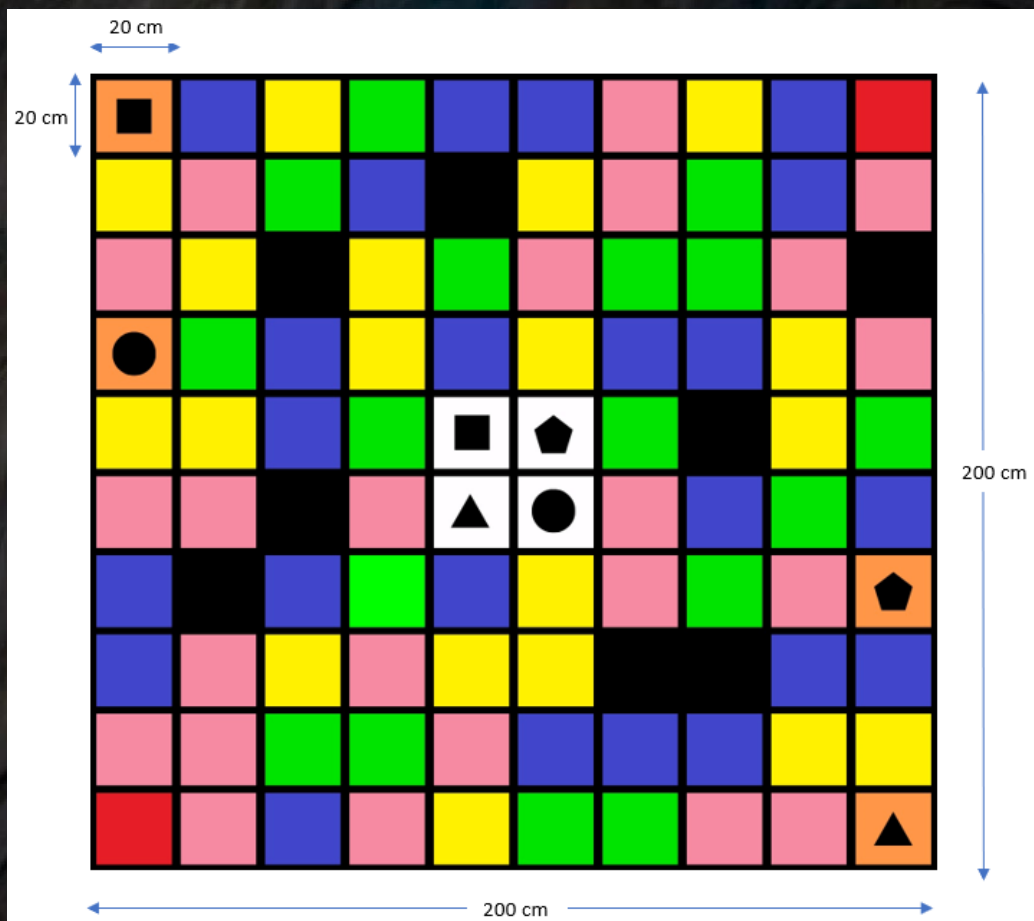
SAMPLE ARENA

Note: Final colors may vary in gradient from the colors in the arena image provided.

ARENA DESCRIPTION:

- The arena contains 10X10 square grids each of which contains following:

  - <u>EXCAVATION SITES</u> - Represented by White Tiles where the artifacts are present.
  - <u>RESEARCH LABS</u> - Represented by Orange Tiles with black shapes where the artifacts are to be delivered.
  - <u>STARTING TILE</u> - Represented by a red tile where the bot will be initially kept.
  - <u>ENDING TILE</u> - Represented by a red tile where the bot has to reach before the timer stops.
  - <u>VERY DEEP CRATERS</u> - Represented by Blue tiles.
  - <u>MODERATELY DEEP CRATERS</u> - Represented by Yellow Tiles.
  - <u>SHALLOW CRATERS</u> - Represented by Green Tiles.
  - <u>MASSIFS</u> - Represented by Pink Tiles.
  - <u>NO GO LOCATION</u> - Represented by Black Tiles.

- A live video feed from the overhead camera will be provided to the team. The team's computer should autonomously instruct their bot throughout the arena using this feed.

- The bot has to start from the Red Tile at the bottom left corner of the arena and end the task at the other Red Tile.

GAMEPLAY:

- **Qualifying Round:**
  The UGV (bot) should be able to navigate to the other red colored tile incurring the minimum amount of damage.

- **Final Round:**
  Carry out the full task as specified in the game procedure.

Note: Arena would be different for the final round provided that the dimensions and technicalities would be the same, just the arrangement of the tiles would be different.

GAME PROCEDURE:

- The problem is divided into two major tasks:

    1. Travel to the white tiles and collect the artifacts. Once the artifact is collected a shape will be revealed below it.

    2. You have to now transport the collected artifact to the research lab with the same shape. After you have collected all of the artifacts you now have to move to the final red tile which is your final destination.

- The bot has to start from a red-colored tile (starting point) at one corner and end at another red tile at another corner.

- The bot has to transfer artifacts (present on white-colored tiles) to their matching research lab (same shape as that revealed under the artifact) incurring minimum damage to the UGV (bot) based on the different colored tile causing different damages.

- After delivering all the artifacts to their final location the UGV must travel to the final red colored tile present at the opposite corner to the starting tile again incurring the minimum damage.

- The arena is divided into different terrains, each having a different damage index. Here is a list of the different terrains and their damage index:
    1. VERY DEEP CRATERS - Represented by Blue tiles. Damage index - 4
    2. MODERATELY DEEP CRATERS - Represented by Yellow Tiles. Damage index - 3
    3. SHALLOW CRATERS - Represented by Green Tiles. Damage index - 2
   4. MASSIFS - Represented by Pink Tiles. Damage index - 1

You have to traverse the arena incurring minimum damage.

EXAMPLE:

In this section, some of the possible situations have been described using examples to get a better idea of the problem statement.

o In the figure given below, the bot is currently placed at the starting position i.e. bottom left corner. It has to reach the white tile to collect the artifact while traversing a path with the least damage. In the figure, two possible paths are drawn P1 and P2.

Now, considering the bot travels through path P1, the total damage would be (1+4+1+3+1+2+4 =) 16. While if the bot takes path P2, then the total damage would be (1+4+1+3+1+3+4 =) 17. Therefore, from both the paths P1 and P2, P1 is the path with the least damage and may be traversed.
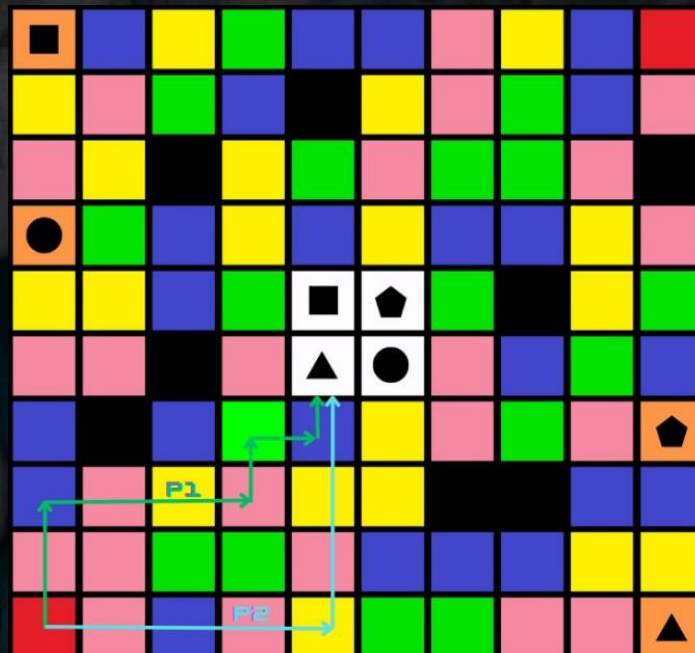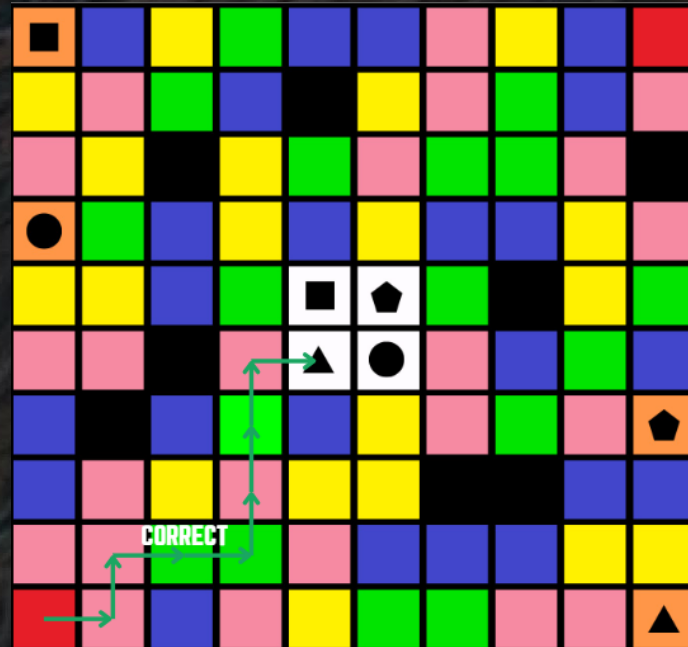

o Instead, if the bot travels through the path shown in the below image, then the total damage given to the bot would be (1+1+2+2+1+2+1 =) 10. Hence, the most OPTIMAL PATH to reach the artifact is shown in the figure below, thus the bot should be smart enough to analyze every path.
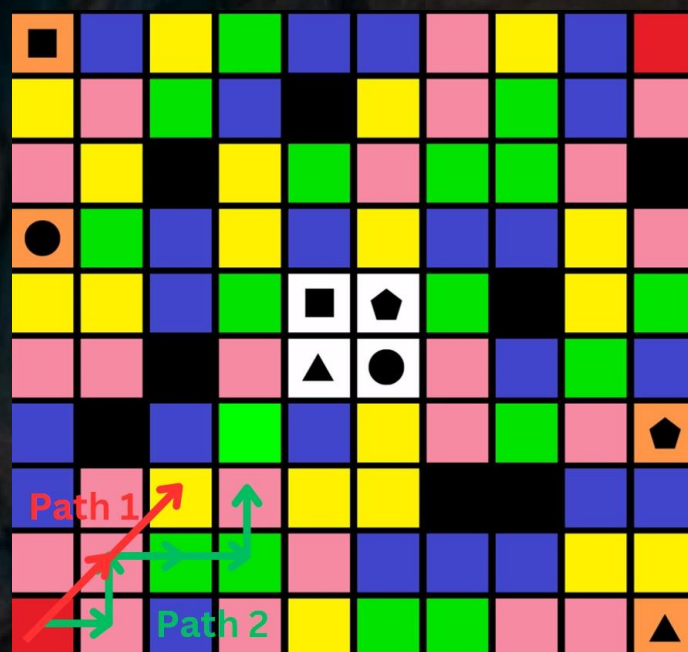
o Besides this, robot is NOT ALLOWED to travel Diagonally,
  the only movement allowed is UP, DOWN, LEFT and RIGHT. If
  the bot traverses diagonally, then it will attract a
  penalty of 30 for each tile crossed.

o   After the shape is revealed below the artifact, the bot
    should travel to the given shape orange tile. Suppose the
    revealed shape is a triangle, then the bot should travel
    to the orange tile with a triangle. Consider two paths
    shown to the given tile, P1 and P2. The bot is NOT ALLOWED
    to cross the ORANGE TILE. Thus, it cannot travel along
    path P1. Thus, for the rest of the possible paths, path P2
    will be the least damaging path with damage as (4+3+1
   +3+2+2+1+1 =) 17. Clearly P2 is a most optimal choice.
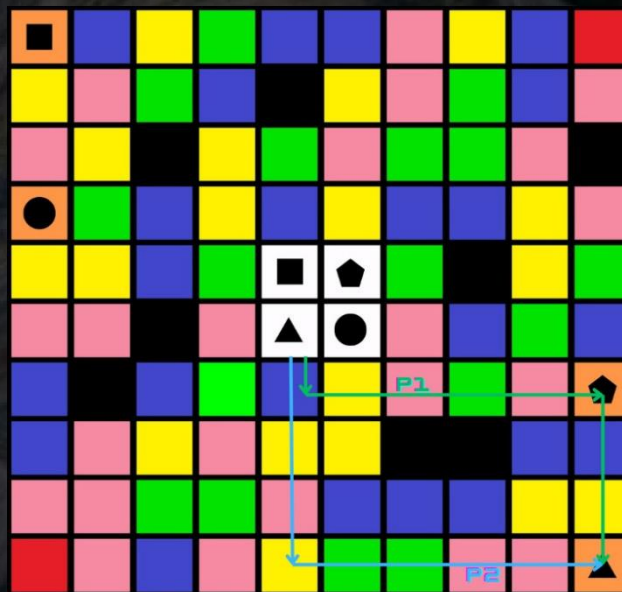
o   After the artifact is delivered, the bot needs to travel
    to the next white tile to collect another artifact as
    shown in the figure below. If the bot travels through the
    red path, the damage incurred would be (1+1+2+2+4+3+3 =)
    16 and if it goes through green path, damage would be
    (1+3+4+1+2+1+1 =) 13, hence the green path is the DESIRED
    path.
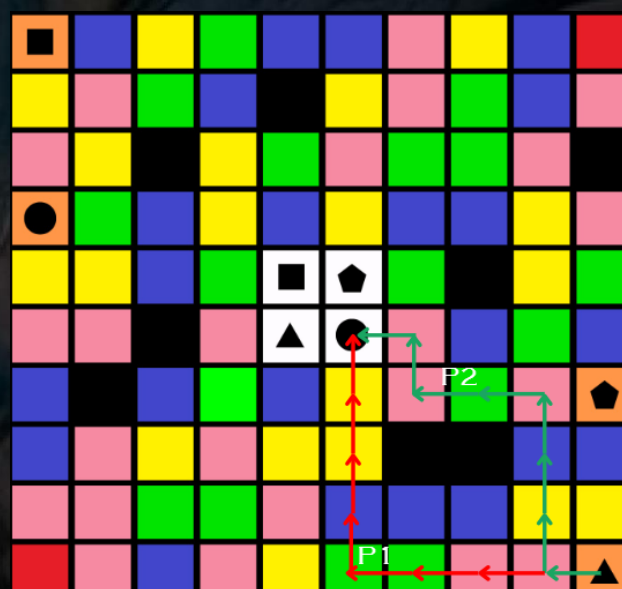
o After the bot has delivered all the artifacts to specified research station, then it needs to travel to the opposite red tile to finish the run. Here, if the bot took the red path, the damage would be (4+3+2+4+4+1+3+4 =) 25 and if it takes blue path, the damage would be (4+1+3+2+4+3+4+ 2+1+2+1+1+3+4 =) 35, in the case the RED path is more desirable, but there can be chances that the path looking larger is having least damage. Thus, the bot should look after every possibility.
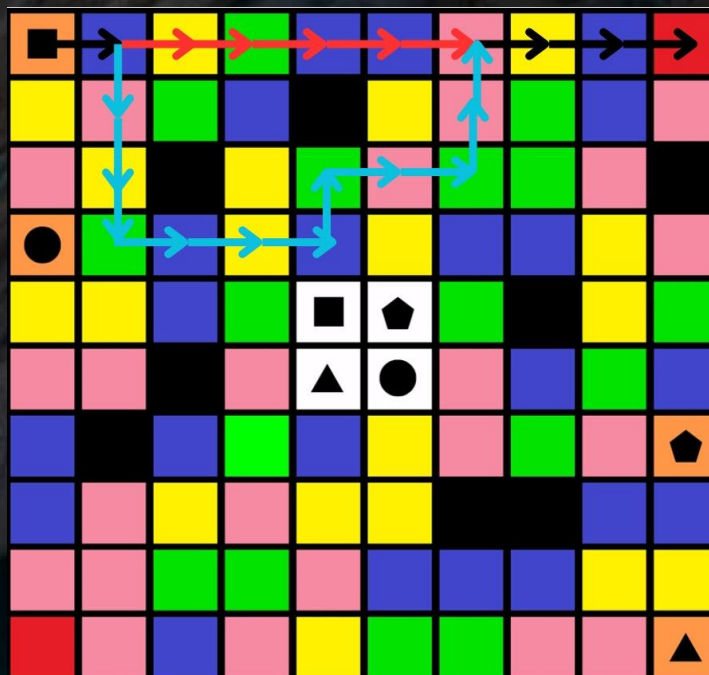
SCORING:

Awards:

o For every Artifact delivered to their respective research labs, there will be certain number of points depending on the shape of the artifact which will be revealed at the time of the event.

o 100 pts: Completion of PS.

o $(4 - d)$ additional points will be added for each tile crossed along the route where d = damage index of the tile.

o n^2/t: awarded, where n = number of blocks travelled through the correct path i.e. the path with the minimum cost or minimum damage and t = time taken to travel that distance. Note: If a tile is crossed which does not lie on the shortest path, then n would not include that tile.

Penalties:

o If the bot moves diagonally, then a penalty of -30 points will be given for each tile crossed diagonally.

o 10 points will be deducted for every 10 seconds delay if the bot takes more than 30 seconds to pick up the artifact after reaching the white tile.

o If the robot moves out of the arena, the team is allowed to restart the task with a penalty of -20 points.

o If the bot moves out of the arena 3 times, then the team is disqualified.

EVENT RULES:

o The robot should work purely on image processing-based principles.

o Each team will be given 30 minutes for calibration on a day prior to the 1st day of the event and 40 minutes for the final run (this does not include the time for Qualifying round).

o Only two participants are allowed near the arena at all times.

o The participants must bring their own laptops, adapters and batteries.

o The robot should be started by a single click or single command issued by participant.

o Only 3 restarts are allowed in the final round with a penalty of 20 points.

o The final codes must be submitted to the event coordinator.

o The arena would be setup in ambient lighting conditions.

o It will be the participant's responsibility if there is any data misinterpretation of image of the arena taken by the overhead camera due to obstruction by the body of the robot.

Note:

o The actual colors on the arena may be slightly different from the ones specified due to ambient light and texture of materials. All the adjustments can be made during the calibration time provided.

o Each team will also be given 20 minutes of calibration time just before their final runs in both the rounds.

o The arrangement of artifacts and research labs might be different from the one depicted in the sample image during the final event.

ELIGIBILITY:

o All students from authorized institutions and programmes are eligible to participate.

o Team Size limit is minimum 2 and maximum 4. The participants in a team may be from the same or different institutions and programmes.

o Students qualifying for the offline round must carry their valid School/College ID cards.

REGISTRATION:

All the Team members must be registered on technex.co.in to participate in this competition. Further guidelines will be issued to teams qualifying for the offline round.

ROBOT SPECIFICATIONS AND FABRICATION:

o The robot should fit within a box of 20cm X 20cm x 20cm.

o The weight of the robot should be less than 3 kg. The robot should be capable of moving the artifact.

o The Potential Difference between any two points on the robot must not exceed 24V DC.

o Teams are allowed to use readymade microcontroller circuits and gear assemblies. Use of Lego kits is prohibited.

Note: If any of the teams fail to comply to any of these rules, a heavy penalty of 200 points would be applied or even lead to disqualification.

CAMERA SPECIFICATIONS:

Logitech Brio Stream, Ultra 4K HD Video Calling, Optical Zoom, Noise-Canceling mic, HD Auto Light Correction, Works with Microsoft Teams, Zoom, Google Voice, Meet, PC/Mac/Laptop/ MacBook/Tablet

GENERAL RULES:

o Each member should carry a valid Student ID Card.

o Team should report at the arena 30 minutes before the start of the event.

o The robot should, in no way, cause any damage to the arena. Any kind of damage will lead to immediate disqualification.

o Participants should not dismantle their robots before the completion of the whole competition as the devices might need to be verified by the organizers at a later stage to ensure that the participants have not violated any of the rules.

o The organizers reserve the right to change the rules as they deem fit. Change in rules, if any, will be highlighted on the website and notified to the registered participants.

o The decision of the organizers shall be final and binding.

CERTIFICATION POLICY:

o The top three teams will be awarded a certificate of excellence.
o All teams qualifying the first round will be awarded a certificate of participation.
o Disqualified teams will not be considered for any certificates.

EVENT CO-ORDINATORS:

o Vaibhav Bansal (+91-9625268535)
o Dhrubajyoti (+91-9134892540)