PIXELATE

Task

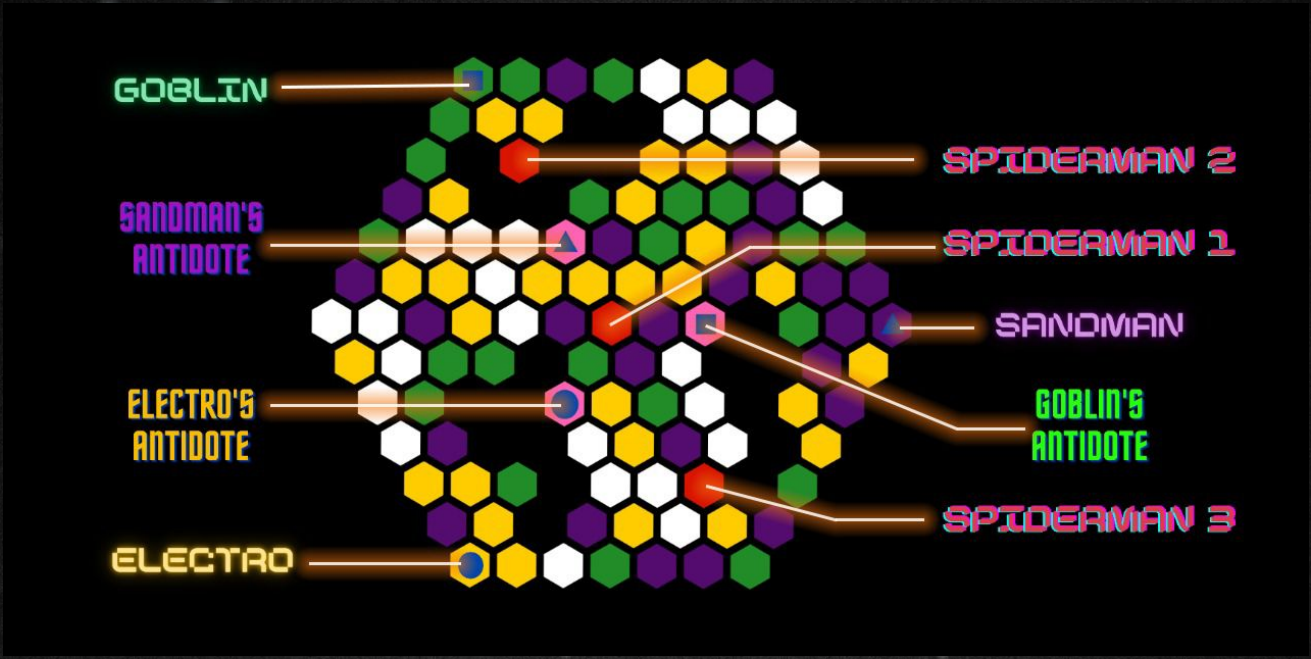
In the unfortunate summer of 2024, Spiderman's identity is exposed to the world, inviting ruckus onto his doorstep. He resights to the idea of his identity being forgotten and seeks Dr. Strange's help. Strange agrees at once. However, things take a wrong turn when he casts the spell, causing havoc in the flow of the Multiverse. Strange soon contains the spell gone wrong, but the damage has already been unleashed. All the enemies of Spiderman from every other universe have arrived in this universe, and it is now Strange's and Peter's job to send them back. After gathering all the villains, it comes to light that they will die if they are teleported back the way that they currently are. Peter wants to give the villains a second chance.

Peter frees the villains with a mutual understanding, promising to make the villains normal like other people. He cures Dr. Octavius first. The Green Goblin, with his own plans, convinces the other villains not to give up their powers. In the struggle, Peter manages to cure the giant Lizard. The others escape, setting up various traps throughout the city to obstruct the chase. Meanwhile, with his spidey sense, Peter feels the presence of other spidermen in his universe.

Peter must find the other spidermen first, figure out the cures using their collective intelligence, process them in the specialized laboratories, and treat the villains left with their respective antidotes. The laboratories will soon be closed as a precaution against the villains' escape, so the Spidermen must collect the antidotes first. The antidotes are also unstable in nature and need to be delivered as early as possible to the respective villain after its pickup. To maximize their chances, the Spidermen will try to take as little damage as possible in their way to achieve their noble objective.

The fate of Spiderman and the Multiverse now depends upon you. Use your image processing skills to find the best plan of action.

ARENA DESCRIPTION



The arena consists of 127 hexagonal tiles arranged in the shape of a regular hexagon. The properties of each of these tiles are as follows:

- *Spiderman 1:* This is the red tile at the center of the arena. The bot will be spawned here.
- *Spidermen from other universe:* The remaining two red tiles represent the two Spidermen from the other universes.
- *Antidotes:* The three pink tiles are the locations of the antidotes. Under these tiles, the actual antidote (circle for Electro, square for Goblin or triangle for Sandman) is hidden.
- *Villains:* There are three tiles for the three villains. The green tile with a square over it is where The Green Goblin dwells. Similarly, purple tile with triangle is the location of Sandman and yellow tile with circle is the location of Electro.

- *Electro's lightning attacks:* The remaining yellow tiles with no shape on them are the lightning attacks/obstacles by Electro.
- *Goblin's bombs:* The remaining green tiles with no shape are the bombs/obstacles spread by the Goblin.
- *Sandman's sandtraps:* The remaining purple tiles with no shape are the sand traps/obstacles set by Sandman.
- *Peaceful locations:* White tiles don't pose any obstacles to the Spiderman. They just consume his health because of the energy expenditure in walking through them.
- *Prohibited region:* Black tiles are the prohibited zones. The bot is not allowed to go there, else a heavy penalty will be deducted from the final points.

The bot has to end the task by meeting both Spider-Man 1 and Spider-Man 2, then collect all the antidotes and then cure the villains.

A video feed from the overhead camera will be provided to the team. The team's computer should autonomously instruct their bot throughout the arena in the simulation world.

An ArUco marker will be attached on the bot to get the current location of the bot.

GAMEPLAY

Qualifying Round:

- To qualify for the main round the bot has to carry out the following task.
  - Move the bot (Spider-Man 1) to Spider-Man 2's location in order to get access to Lizard's antidote, and then reach the Lizard's Location to cure him.
  - There are no points for this round.

Final Round:

- Carry out all the tasks mentioned in the procedure.

Game Procedure:

- The PS has three tasks for you.
  - Move Spider-Man 1(bot) to the locations of Spider-Man 2 and Spider-Man 3 (red tiles) to take their help in order to get access to the antidotes which are yet to develop at specified locations in the arena(pink tiles) for all the villains, **Electro** (Yellow tile with a blue circle), **Sandman** (Purple tile with a blue triangle), and **The Green Goblin** (Green tile with a blue square).
  - Then collect those antidotes from specified locations, go to the villains' lairs and cure them following the rules described below.
- The villains have spread different traps and bombs in the arena, to damage Spider-Man's suit and decrease his **health**. They are represented by **green**, **purple**, and **yellow** tiles showing **large**, **medium**, and **small** damage respectively.
  - As green tiles are bombs spread by The Goblin, whenever crossing, a green tile, damage of **4** units takes place to the bot (Spider-Man).
  - The purple tiles are Sand traps set by Sandman and are slightly less harmful, causing damage of **3** units to the bot.
  - The yellow tiles are lightning attacks by electro which can be dodged making it further less harmful but it still incurs damage of **2** units to the bot.

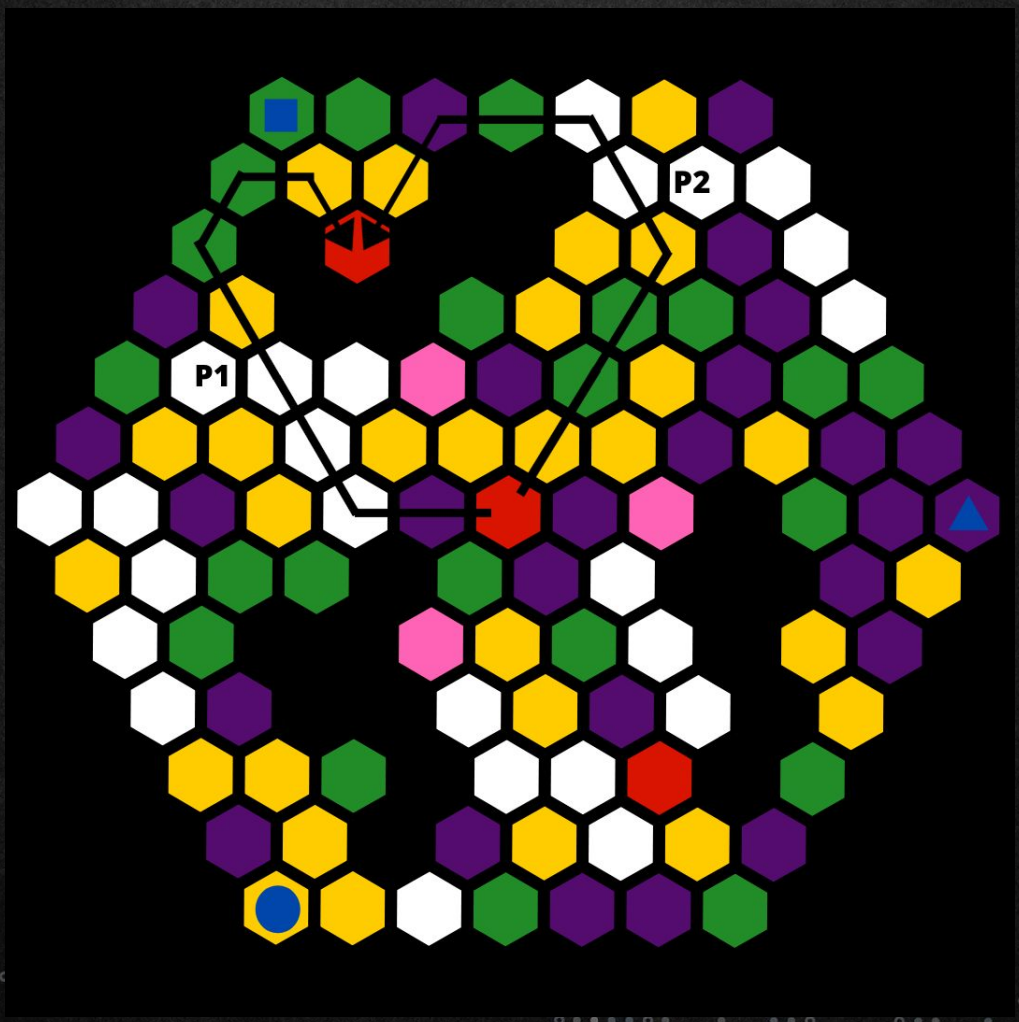
    - The white and pink tiles are peaceful locations and have a damage of **1** unit due to the consumption of energy by walking on them.
- As it is a matter of saving the universe Spider-man can't afford to be weak while curing the villains and has to reach the villains retaining the maximum amount of his health and strength possible, and hence he needs to traverse the path which incurs the least overall damage.
- The bot(Spider-Man) has to start from the center of the arena(Red tile).
- The bot first needs to move to the other two spider-men(red tiles) following the above rules. The antidotes are manufactured underneath the pink tiles. Once the bot reaches both spider-men, the pink tiles reveal the antidotes which were earlier concealed.
    - The symbols of the antidotes match with the respective villains they are meant for (the blue square, blue circle, and blue triangle on green, yellow, and purple tile).
- After knowing the location of the antidotes, the bot is supposed to carry the antidotes to the respective villains' lairs to cure them following the rule to take 'minimum damage path'.
- Note that after curing any one of the villains, if you collect any of the remaining antidotes, your run will not be considered. So make sure the bot takes all the antidotes at once and then treats the villains one after the other.
- To take an antidote for a given villain, the bot is supposed to move over the pink tile where the respective villain's antidote is kept once, and provide an indication which will be specified during the event.
- To cure the villains, the bot is supposed to go to the villain's location and stop over the villain's tile, given, it passed over the pink tile having the same symbol as the villains', and provide an indication which will be specified during the event.
- Also note that the bot is supposed to go to the villain's locations in the same order as it picked the antidotes of the respective villain.
- The rule to take 'minimum overall damage path' has to be applied for every motion in the arena.

EXAMPLES

Following are some sample paths in order to help you choose the optimal path to reach the villains.

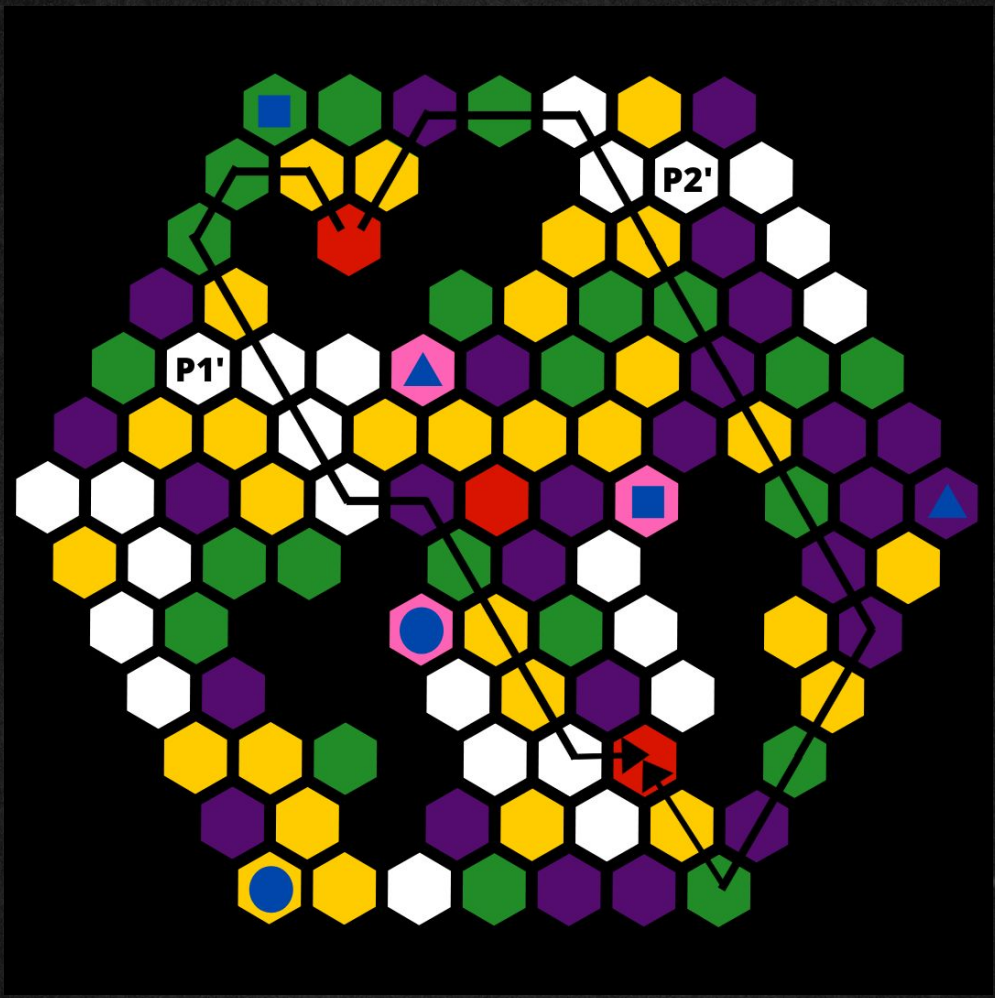
NOTE: These are not the most optimal paths. We leave that to you as an exercise.

The bot (spiderman 1) is currently placed at the initial position (center of the arena) from where it needs to go to the red tiles (spiderman 2 and 3) with minimum damage. In the following example, the bot first reaches the 2nd spiderman and then 3rd through various paths. To reach the second spiderman, two possible paths are considered P1 and P2 as shown in figure.



The damage caused to the bot while going through the path P1 is (3+1+1+1+2+4+4+2+1=19), while that in P2 is (2+4+4+2+1+1+4+3+2+1=24). Evidently, path P1 causes lesser damage and hence, P1 is a BETTER path AMONG P1 and P2 and the health reduction is 19.

Now, from the 2nd spiderman, the bot goes to the 3rd spiderman for which, again, two paths are considered, P1' and P2'.

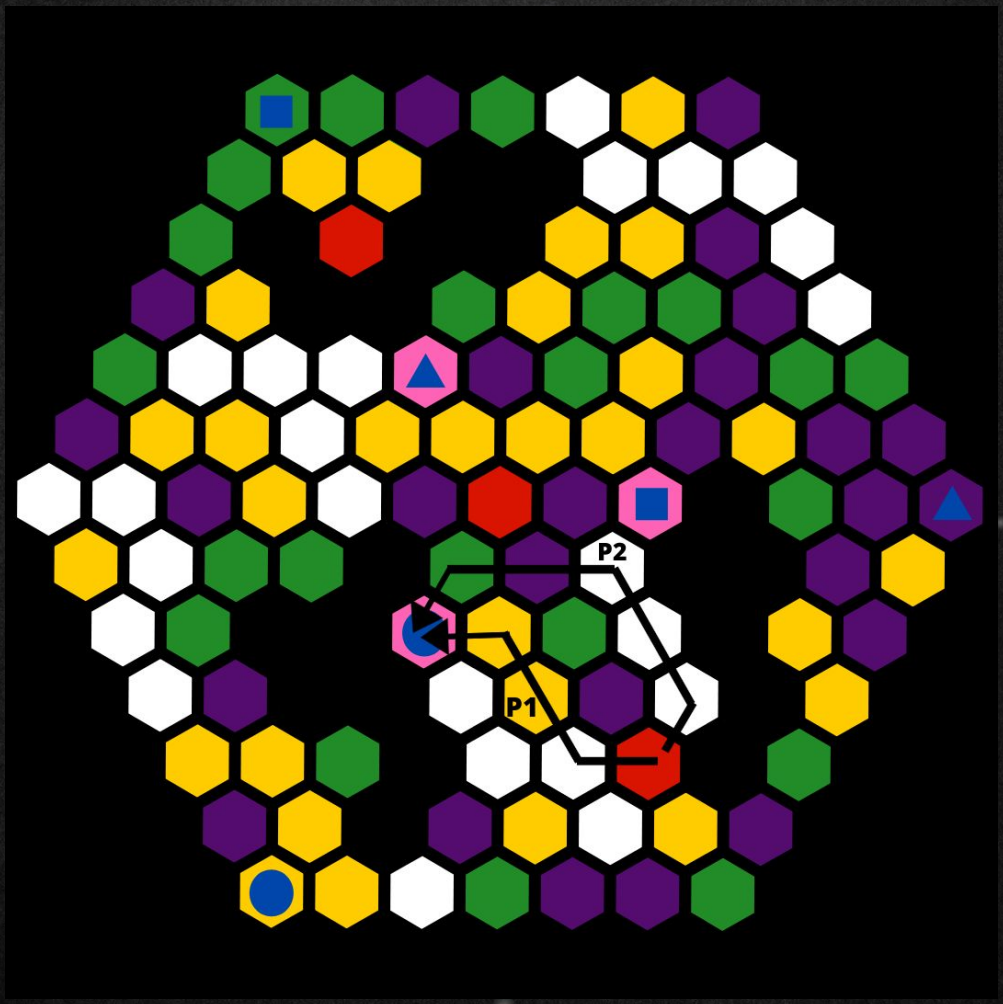


The damage caused to the bot while going through the path P1' is (2+4+4+2+1+1+1+3+4+2+2+1+1=28), while going through that in P2' is (2+3+4+1+1+2+4+3+2+4+3+3+2+4+3+4+2+1=48). Path P1' is BETTER among both of these paths because of its lesser damage. The reduction in health in this process is 28.

As the three antidotes are revealed now, so, for the rest of the journey, the Spiderman needs to go to the three pink tiles and then to the three villain tiles. Tiles can be traversed in any order provided that the order in which the bot travels the villain tiles must be same as the order in which the bot collects the antidote.

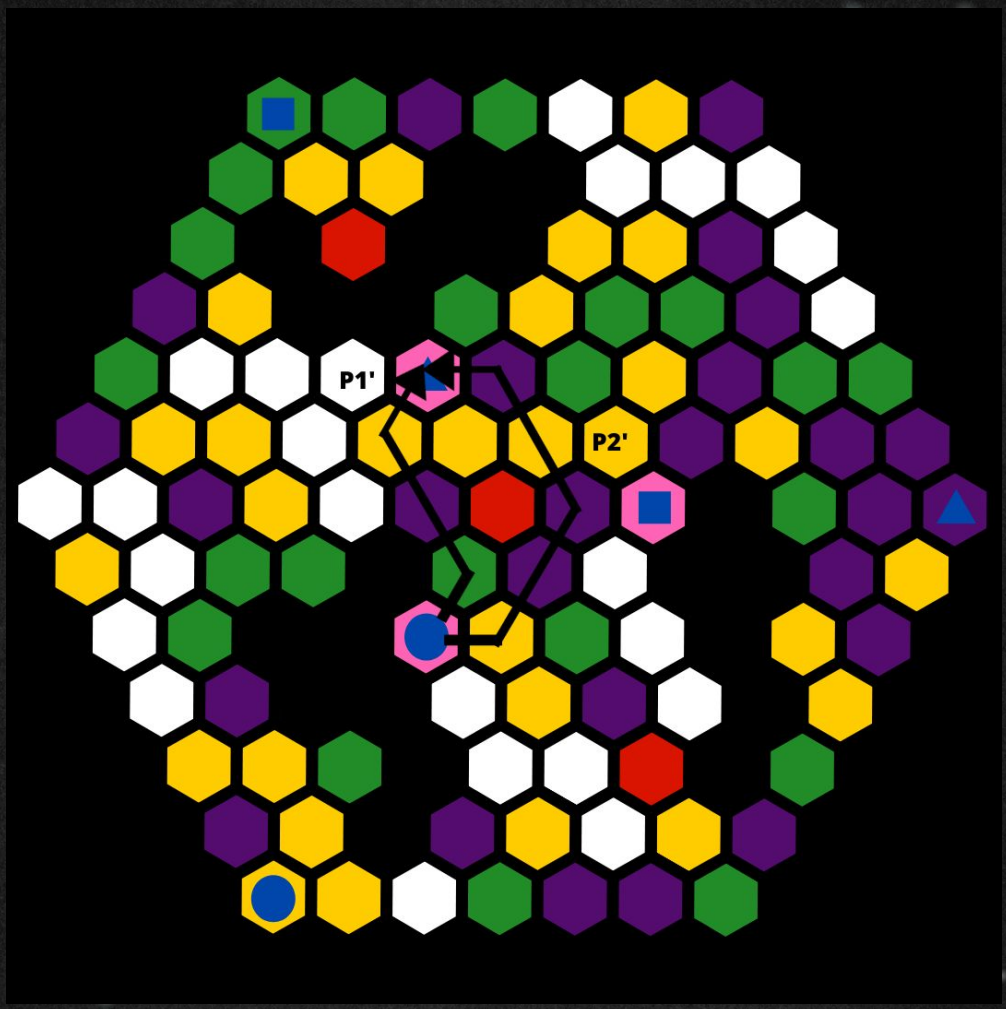
Now, the bot is on the tile of Spiderman 3. Let us consider a random case where it goes to the pink tile with blue circle (i.e., collects the antidote for Electro), then to the pink tile with blue triangle (i.e., collects the antidote for Sandman), then to the pink tile with blue square (i.e., collects the antidote for The Green Goblin).

Two paths P1 and P2 are considered to reach the pink tile with blue circle.

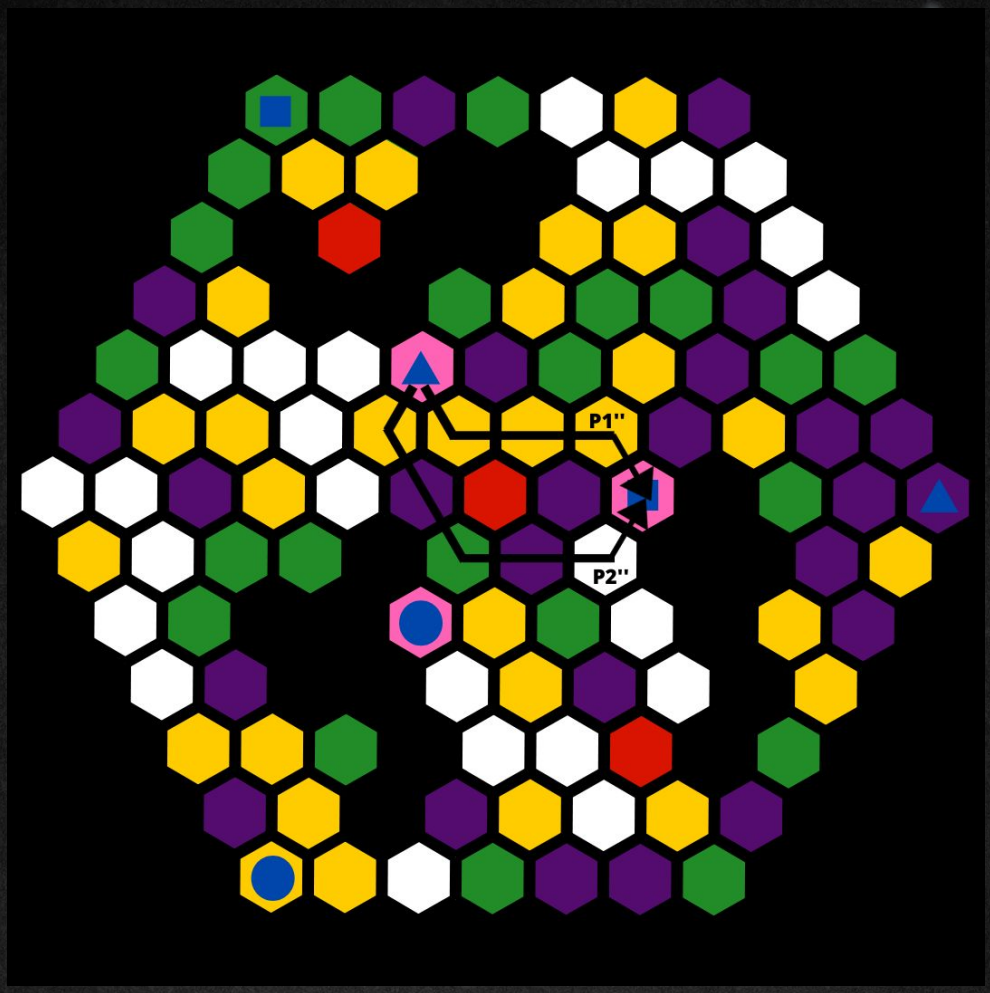


The damage caused by the path P1 is (1+2+2+1=6) and that due to P2 is (1+1+1+3+4+1=11). P1 path causes lesser damage and hence, is the BETTER path among P1 and P2. The reduction in health in this process is 6.

Now, to reach the pink tile with blue triangle, paths P1' and P2' are considered.



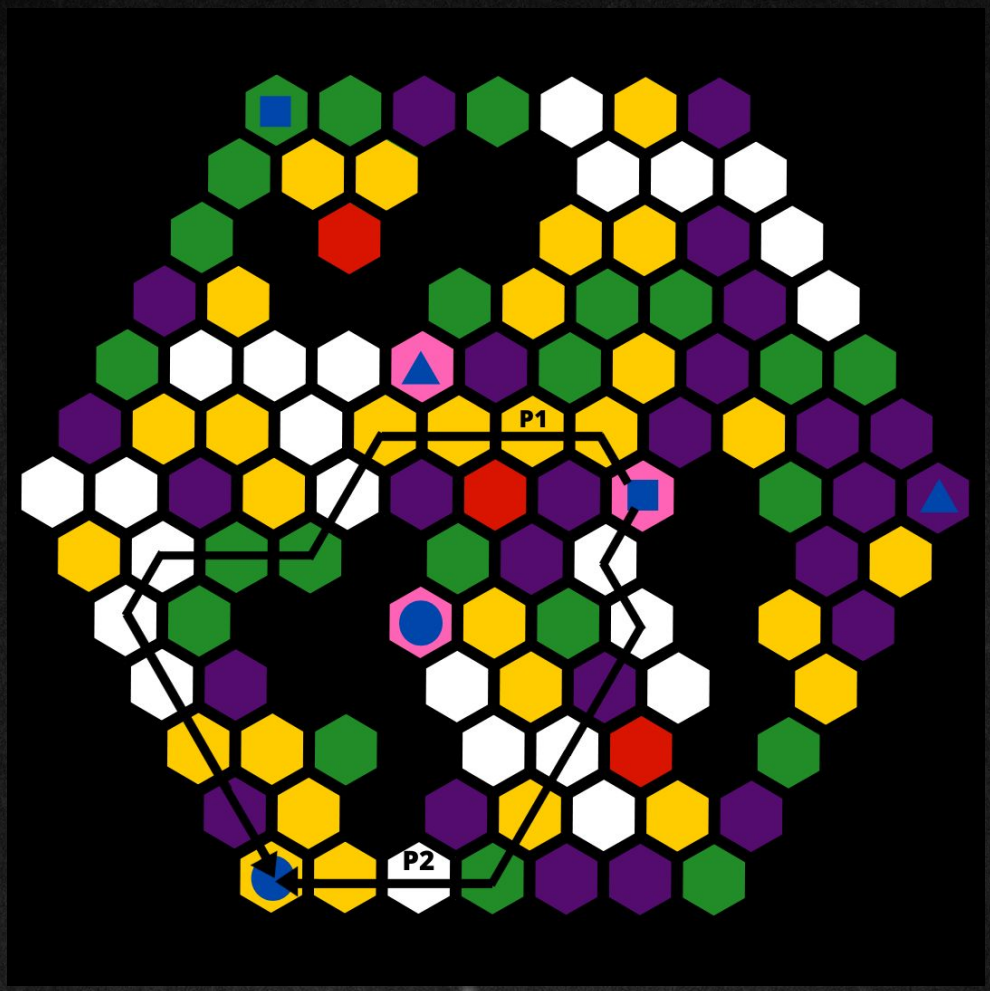
The damages caused by the path P1' is (4+3+2+1=10) and that due to P2' is (2+3+3+2+3+1=14) respectively. So, among P1' and P2', P1' is the BETTER path and the reduction in health is 10. Now, to reach the pink tile with blue square, paths P1'' and P2'' are considered.



The damages caused by the path P1" is (2+2+2+1=7) and that due to P2" is (2+3+4+3+1+1=14) respectively. So, among P1" and P2", P1" is the BETTER path and the reduction in health is 7.

Now, since the bot collected the antidotes in the order circle -> triangle -> square; the bot needs to cure the villains in the same order. Thus, it needs to travel to the yellow tile with the blue circle first, then to purple tile with blue triangle and then to green tile with the blue square.

Two paths P1 and P2 are considered from the pink tile with blue square to the yellow tile with blue circle.



The damage caused to the bot while going through the path P1 is (2+2+2+2+1+4+4+1+1+1+2+3+2=27), while that in P2 is (1+1+3+1+2+4+1+2+2=17). Evidently, path P2 causes lesser damage and hence, is the P2 is the BETTER path AMONG P1 and P2 and the health reduction is 17.

Now, similarly the bot will travel to the purple tile with blue triangle and then finally to the green tile with blue square. On reaching the green tile with blue square, the PS will be completed, i.e., all the villains will be cured using the collected antidotes.

SCORING

Awards:

- 20 points will be awarded on reaching the spidermen from the other universes, per spiderman, i.e., reaching the red tile that removes the plate present above the pink tile.
- 30 points will be awarded on reaching the tile where the antidote is present,per antidote, i.e., reaching the pink tile with a specific shape at its centre.
- 50 points will be awarded on reaching the villain with the correct antidote, per villain, i.e., reaching the blue shape present at the centre of any one of the villain's tiles.
- 200 points will be awarded on the completion of the Problem Statement.
- Additional points will be awarded using the following formula: -

$$Final\ score = points + K \cdot \frac{(H - d)}{t}$$

where: -

K, H = Scoring constant values (for example, 100, 200, 300, etc.),
d = Damage taken by the spiderman(s) after the completion of P.S,
t = Time in seconds required to complete the P.S.

Penalties:

- If the bot moves on black tiles, then 10 points will be deducted.
- If the bot moves across the villains tile without collecting all the antidotes then 20 points will be deducted and the villain will not be considered to be cured.
- If the antidotes are given to the villains in the wrong order , i.e., the antidotes are not given in the order in which they were collected, 40 points will be deducted for each villain and the villain will be considered to be cured.

EVENT RULES

- Participants will have to run the bot in simulation on PyBullet, a python library on their PCs. Participants will be called to present their solution by sharing screen in the evaluation meeting. Participants will be provided with the PyBullet arena and the robot, and the required functions to control the robot.
- The robot should work autonomously, purely on image processing-based principles.
- Each team will be given 10 minutes for calibration and 25 minutes for final run (this does not include time for qualifying round).
- The robot should be started by a single click or single command issued by the participant.
- Only 3 restarts will be allowed with some penalty.
- The final codes must be submitted to the event coordinator.
- A sample picture of the arena would be made available prior to the event.
- It will be the participant's responsibility if there is any misinterpretation of the image of the arena taken by the overhead camera due to obstruction by the body of the robot.

Note :

- The arrangement of the Spidermen, Antidotes and Villains might be different from the one depicted in the sample image during the final event.

Event Timeline :

- 1st March : Release of Sample Arena and Start of the Event
- 9-10 March : Round-1 Evaluations
- 11-12 March : Round-2 Evaluations on Main Arena

Eligibility :

- All students with a valid identity card of their respective educational institutions are eligible to participate in the event.

General Rules :

- Each team can have a maximum of 3 participants which can be from different institutions with valid ID Card
- Each team should be punctual with the allotted evaluation time.
- 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.
- The decision of the organizers shall be final and binding.

Certification Policy :

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

Contacts :

❑ Vikhyath Venkatraman: 8105975839
❑ Devendar Kachhwaha: 9119334108