Solving Maze

Team 8

202235002 KangGiwon
202235510 KimYoohyun
202235033 KimHyejeong
202235116 JeonYoungmin

TABLE OF CONTENTS

1 **INTRODUCTION**

The operation method of our game

2 **BACKTRACKING**

Where and how backtracking is used

3 **ANALYSIS**

The code we made with C/C++ language

4 **CONCLUSION**

A demonstration video for show the game

01

Introduction

The operation method
of our game

GOAL

Key

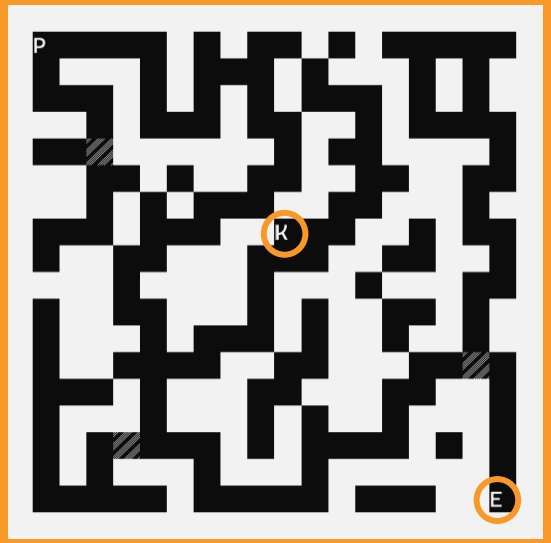
Need to get the key first

“K” in maze

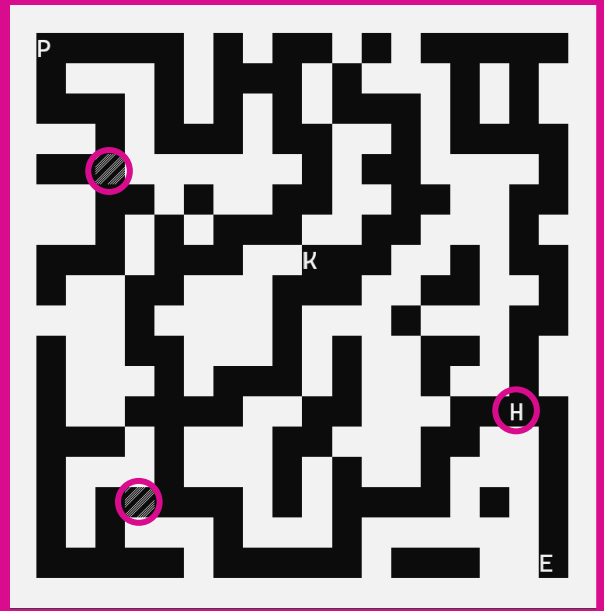
Escape

User’s destination

“E” in maze



How to Solve?



Breaking down a wall

It gives you chance to break setted block

Show Hint

Which block should break to get to escape

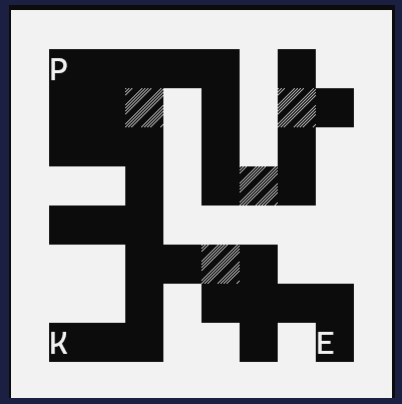
Try to click space bar !

BackTracking

How was the backtracking algorithm used in the game?

02

BackTracking for HINT



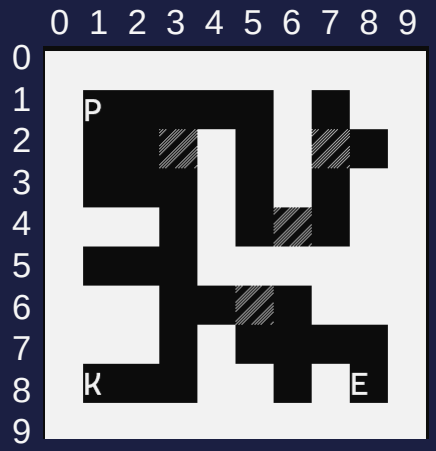
What the algorithm should think :

which block is the one that corresponds to the hint?

Pseudocode of Hint Function

```
Function Hint(Maze, Solve, canbreak, HstPlayer):
    havekey = HaveKey()  // 열쇠 보유 여부 확인

    if not havekey:
        // 열쇠가 없으면 Hint1 함수 실행
        Call Hint1(Maze, Solve, HstPlayer, havekey)

    if havekey:
        // Solve 배열 초기화
        Call InitSolve(Solve)

        // 열쇠가 있으면 Hint2 함수 실행
        Hint2Result = Call Hint2(Maze, Solve, canbreak, HstPlayer, havekey)

        Return Hint2Result  // Hint 2 실행 가능

    Return 0  // 열쇠가 없는 경우 Hint1로 return
End Function
```

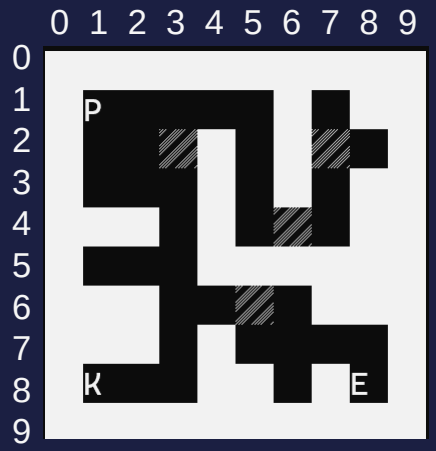
Process description



[2,7]	Candidate	branch
…		
[4,6]	Candidate	
…		
[1,5]		
[1,4]		
[1,3]		
[1.2]	branch	
[1,1]		

- [1,7] — Not found E
- [2,8] — Not found E

Process description



[2,7] Candidate branch

…

[4,6] Candidate

…

[1,5]

[1,4]

[1,3]

[1.2] branch

[1,1]

[1,7] Not found E

[2,8] Not found E

Basic Background

0		Wall
1		Available Way
2		Escape Rout
3		Breakable Wall
4	K	 Key
5	E	 Escape
6	H	Hint
10	P	Current Location

Which wall should break to get to escape

Hint Function

```
int Hint1(int Maze[MAZE_SIZE][MAZE_SIZE], int Solve[MAZE_SIZE][MAZE_SIZE], position HstPlayer, bool& havekey) {
    GotoXY(0, 6);
    printf("havekey : %d", havekey);

    if (Maze[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] == 4) {
        havekey = true;
        return 1;
    }

    if (H_isValid(Maze, HstPlayer, havekey)) {
        if (Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] == 2) {
            return 0;
        }

        Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 2;

        for (int i = 0; i < 4; i++) {
            int nx = HstPlayer.x + 2 * dx[i];
            int ny = HstPlayer.y + dy[i];
            if (Hint1(Maze, Solve, { nx, ny }, havekey) == 1) {
                return 1;
            }
        }

        Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 1;
    }

    return 0;
}
```

how many maze cells it corresponds to in that position

the corresponding cell is 4(key),
convert the **havekey** function to true and return 1

Move up, down, left, right, and call the **Hint1** at each location,
if the result is 1 (if the key was found), immediately to end the function

If there's nowhere else to move, backtracking

```
int Hint2(int Maze[MAZE_SIZE][MAZE_SIZE], int Solve[MAZE_SIZE][MAZE_SIZE], int canbreak, position HstPlayer, bool& havekey) { // havekey 존재 여부 추가
    GotoXY(0, 6);
    printf("havekey : %d", havekey);


    if (!havekey) { // havekey 없을때 hint 사용 불가
        return 0;
    }

    if (Maze[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] == 5) {
        Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 2;
        return 1;
    }

    if (canbreak && Maze[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] == 3) {
        Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 2;
        Maze[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 1;

        for (int i = 0; i < 4; i++) {
            int nx = HstPlayer.x + 2 * dx[i];
            int ny = HstPlayer.y + dy[i];
            if (Hint2(Maze, Solve, canbreak - 1, { nx,ny }, havekey) == 1) {
                Maze[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 6;
                return 1;
            }
        }
        // reset the wall for backtracking
        Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 1;
        Maze[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 3;
    }

    if (H_isValid(Maze, HstPlayer, havekey)) {
        if (Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] == 2) {
            return 0;
        }

        Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 2;

        for (int i = 0; i < 4; i++) {
            int nx = HstPlayer.x + 2 * dx[i];
            int ny = HstPlayer.y + dy[i];
            if (Hint2(Maze, Solve, canbreak, { nx,ny }, havekey) == 1) {
                return 1;
            }
        }

        Solve[HstPlayer.y - Y_AXIS][int(HstPlayer.x - X_AXIS) / 2] = 1;
    }

    return 0;
}
```

If you don't have the key, you can't run the function with return 0

Found escapes within the path to go and has key

If you can break a wall, break it and move

Recursively invokes the **Hint2** as it moves in four directions from the player's current position

If the hint is correct, mark it as 6 i.e. Hint

Same as hint1 function

If there's nowhere else to move, backtracking

Analysis

The code we made with
C/C++ language

03

Additional Function

```
//인게임
void GameMain(void) {
    int Maze[MAZE_SIZE][MAZE_SIZE] = {
        {0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
        {0, 1, 1, 1, 1, 1, 0, 1, 0, 0},
        {0, 0, 1, 3, 0, 1, 0, 3, 1, 0},
        {0, 1, 1, 0, 0, 1, 0, 1, 0, 0},
        {0, 0, 1, 1, 0, 1, 3, 1, 0, 0},
        {0, 1, 0, 1, 0, 0, 0, 0, 0, 0},
        {0, 0, 0, 1, 1, 3, 1, 0, 0, 0},
        {0, 0, 0, 1, 0, 1, 1, 1, 1, 0},
        {0, 4, 1, 1, 0, 0, 1, 0, 5, 0},
        {0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
    };
    int Solve[MAZE_SIZE][MAZE_SIZE] = {};

    SetConsoleSize(140, X_AXIS);
    Clear();
    drawMaze(Maze);
    InitSolve(Solve);
    InitPlayerState();
    CanBreak = 1;
    HaveKey = false;
    while (1) {
        drawMaze(Maze);
        InputProcess(Maze, Solve);
        if (MazeEscape(Maze)) break;
    }
}
```

Maze Settings

Visualization maze

```c
//키보드 입력
void InputProcess(int Maze[MAZE_SIZE][MAZE_SIZE], int Solve[MAZE_SIZE][MAZE_SIZE]) {
    prestPlayer.x = stPlayer.x;
    prestPlayer.y = stPlayer.y;

    if (GetAsyncKeyState(VK_SPACE) & 0x8000) { //힌트 사용
        position HstPlayer;
        HstPlayer.x = stPlayer.x;
        HstPlayer.y = stPlayer.y;
        Hint(Maze, Solve, 1, HstPlayer);
        //PrintSovle(Solve);

    }
    if (GetAsyncKeyState(VK_LCONTROL) & 0x8000) { //벽 부수기
        BreakWall(Maze);
    }
    if (GetAsyncKeyState(VK_LSHIFT) & 0x8000) { //디버깅용 열쇠 획득키
        HaveKey = true;
    }

    if (GetAsyncKeyState(VK_LEFT) & 0x8000) { //왼쪽 키 입력
        stPlayer.x -= 2;
        if (!isValid(Maze)) stPlayer.x += 2;
    }
    if (GetAsyncKeyState(VK_RIGHT) & 0x8000) { //오른쪽 키 입력
        stPlayer.x += 2;
        if (!isValid(Maze)) stPlayer.x -= 2;

    }
    if (GetAsyncKeyState(VK_UP) & 0x8000) { //위쪽 키 입력
        stPlayer.y -= 1;
        if (!isValid(Maze)) stPlayer.y += 1;
    }
    if (GetAsyncKeyState(VK_DOWN) & 0x8000) { //아래쪽 키 입력
        stPlayer.y += 1;
        if (!isValid(Maze)) stPlayer.y -= 1;
    }

    GotoXY(0, 0);
    printf("현재 위치  : %d, %d", int(stPlayer.x - X_AXIS) / 2, stPlayer.y - Y_AXIS);
    GotoXY(0, 1);
    printf("벽을 부술 수 있는 횟수 : %d", CanBreak);

    if (Maze[stPlayer.y - Y_AXIS][int(stPlayer.x - X_AXIS) / 2] == 4) {
        HaveKey = true; //열쇠 획득한 경우
        GotoXY(0, 2);
        if (HaveKey) printf("현재 열쇠를 보유중입니다.\n");
    }
    if (CanBreak <= 0) {
        GotoXY(0, 4);
        printf("벽을 더 이상 부술 수 없습니다!");

    }
    GotoXY(stPlayer.x, stPlayer.y);
    if (MazeEscape(Maze)) return;
    if (isValid(Maze)) Player(Maze);
    Sleep(50);
}
```

Click on the space bar

Click on Left Ctrl Key

Orientation key input setting

Describe the current maze search situation

```
//벽 부수기
void BreakWall(int Maze[MAZE_SIZE][MAZE_SIZE]) {
    GotoXY(0, 4);
    bool flag = false;
    if (CanBreak > 0) {
        for (int i = 0; i < 4; i++) {
            int nx = stPlayer.x + 2 * dx[i];
            int ny = stPlayer.y + dy[i];
            if (Maze[ny - Y_AXIS][int(nx - X_AXIS) / 2] == 3 || Maze[ny - Y_AXIS][int(nx - X_AXIS) / 2] == 6) {
                Maze[ny - Y_AXIS][int(nx - X_AXIS) / 2] = 1;
                flag = true;
            }
        }
        if (flag) CanBreak--;
    }
    //벽이 아닌 곳을 부수라고 했을 경우 ->
    if (CanBreak > 0 && flag == false) {
        printf("                    ");
        GotoXY(0, 5);
        printf("부술 수 없는 벽입니다!");
        Sleep(50);
        GotoXY(0, 5);
        printf("                    ");
    }
    return;
}
```

CanBreak represents the number of walls that can be broken.

Decrease the CanBreak value by 1 when the flag variable is set to true.
once you break the wall, the CanBreak value decreases.

```
//미로 탈출 여부
bool MazeEscape(int Maze[MAZE_SIZE][MAZE_SIZE]) {
    if (Maze[stPlayer.y - Y_AXIS][int(stPlayer.x - X_AXIS) / 2] == 5 && HaveKey) {
        return true; //열쇠를 가지고 탈출한 경우
    }
    return false;
}
```

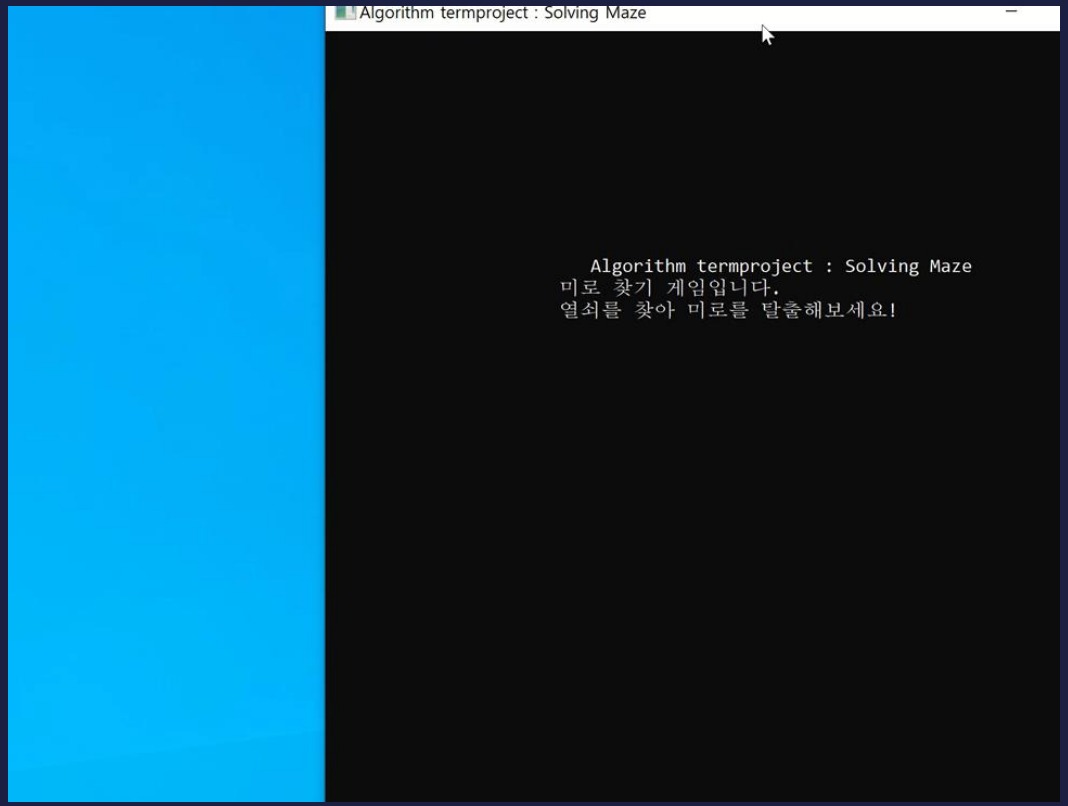
If you come to escape without eating the key, you cannot escape

Conclusion

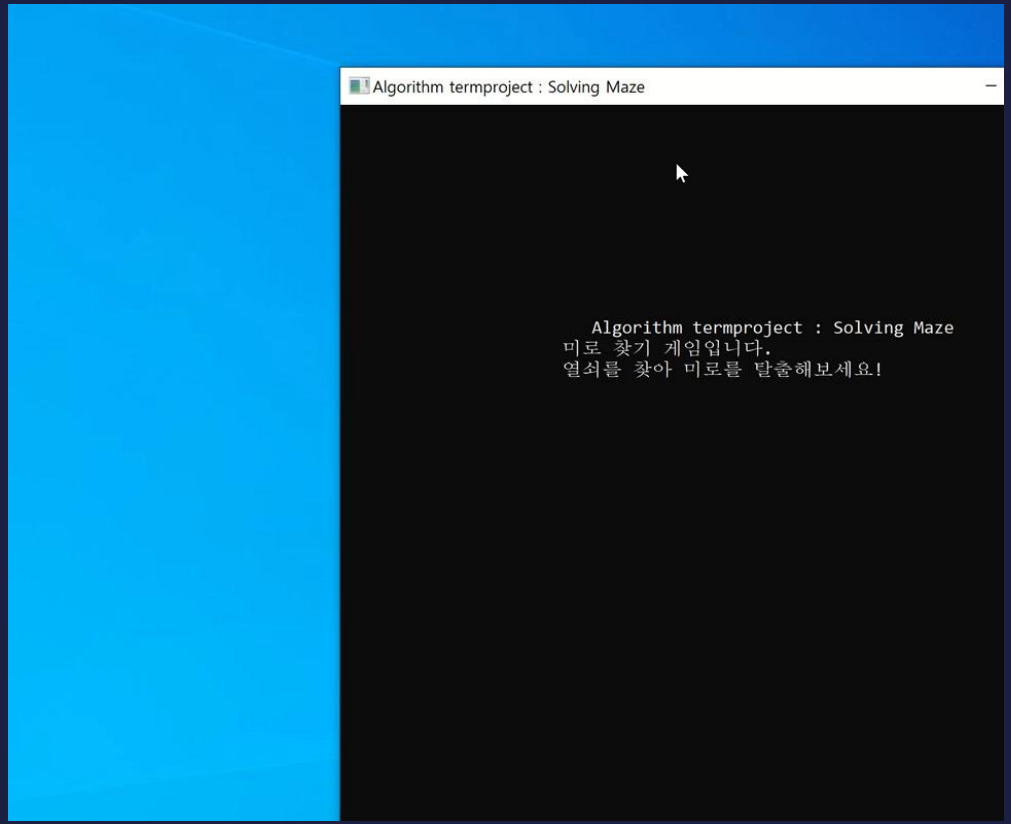
Play a demonstration video

04

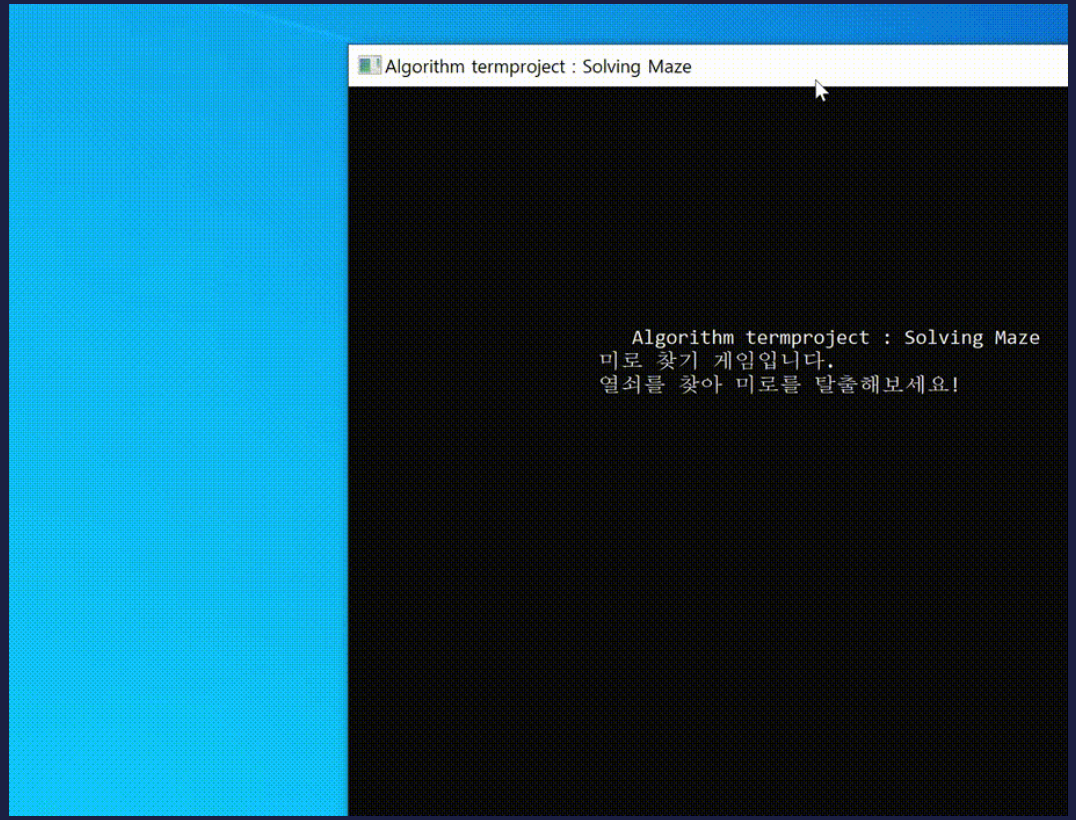
Game Debugging Video



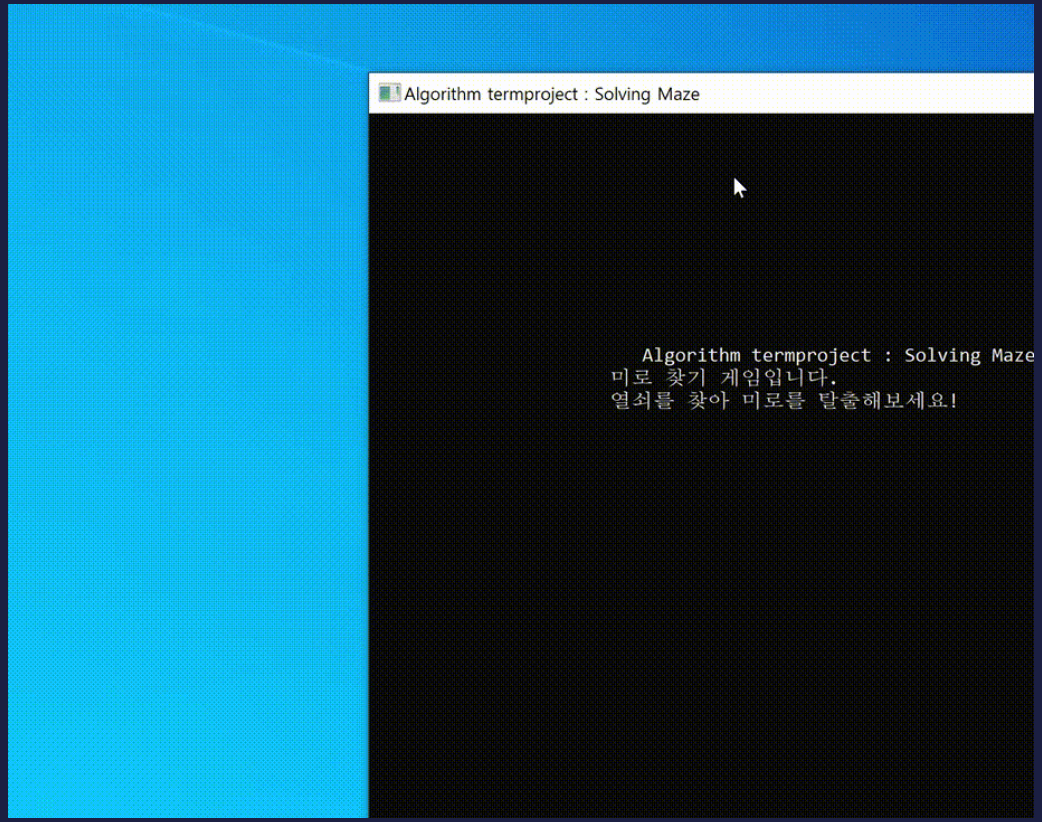
Game Execution Video



Game Debugging gif



Game Execution gif



Realization of TermProject

It was a meaningful time for me to learn more about how algorithms work in the process of coding because I was happy to use the knowledge gained through active learning to create results

KangGiwon

I think it was a good opportunity to learn more about backtracking by continuously advancing Maze solve, which started with Active Learning, to this Term project.

KimYoohyun

Realization of TermProject

It seems that we have learned more about this topic while thinking about what algorithms are needed for the project we want to proceed with.

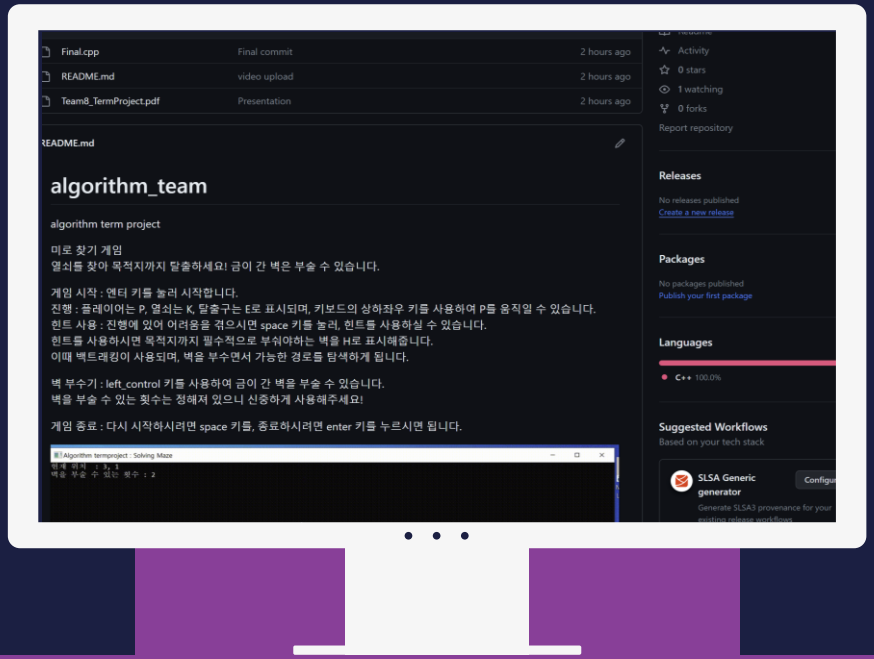
KimHyejeong

Following Active Learning, it was an opportunity to better understand backtracking through the process of deepening the Mazesolve problem by adding constraints such as
breaking down walls or allowing escape only after obtaining keys.

JeonYoungmin

GitHub Link

[jym8391/algorithm_team: algorithm term project (github.com)]



Thank You

From Team 8