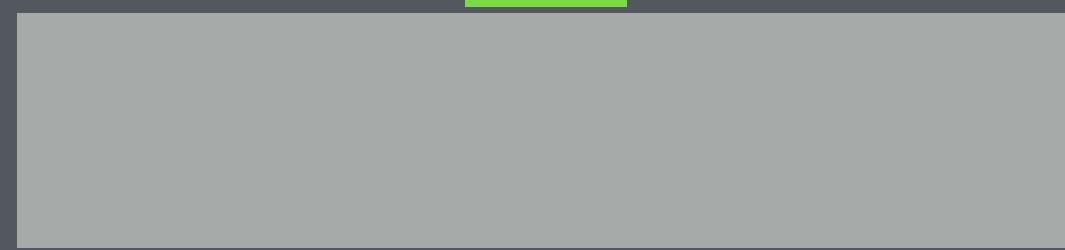
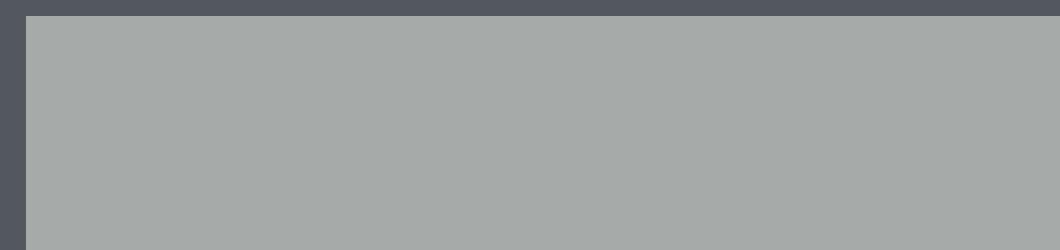
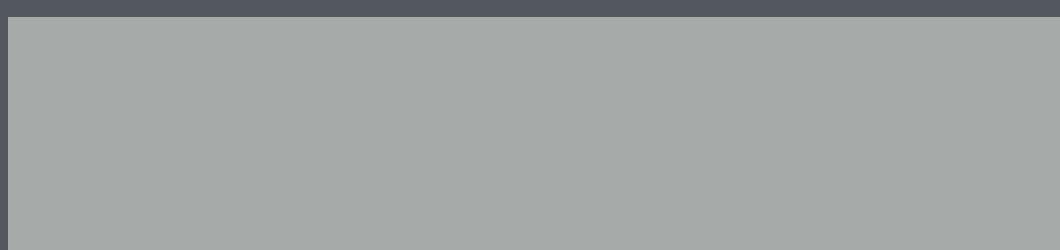
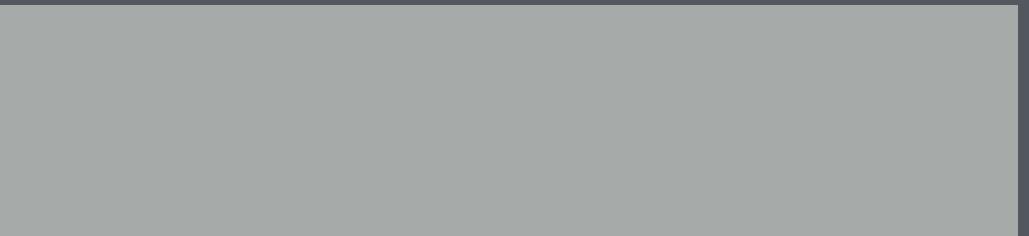
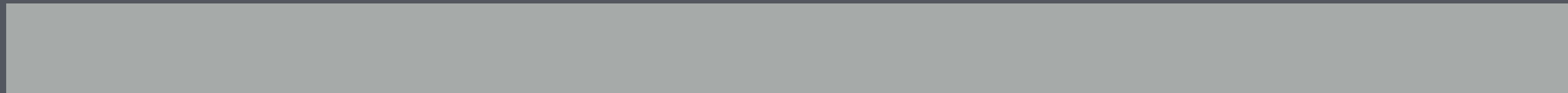
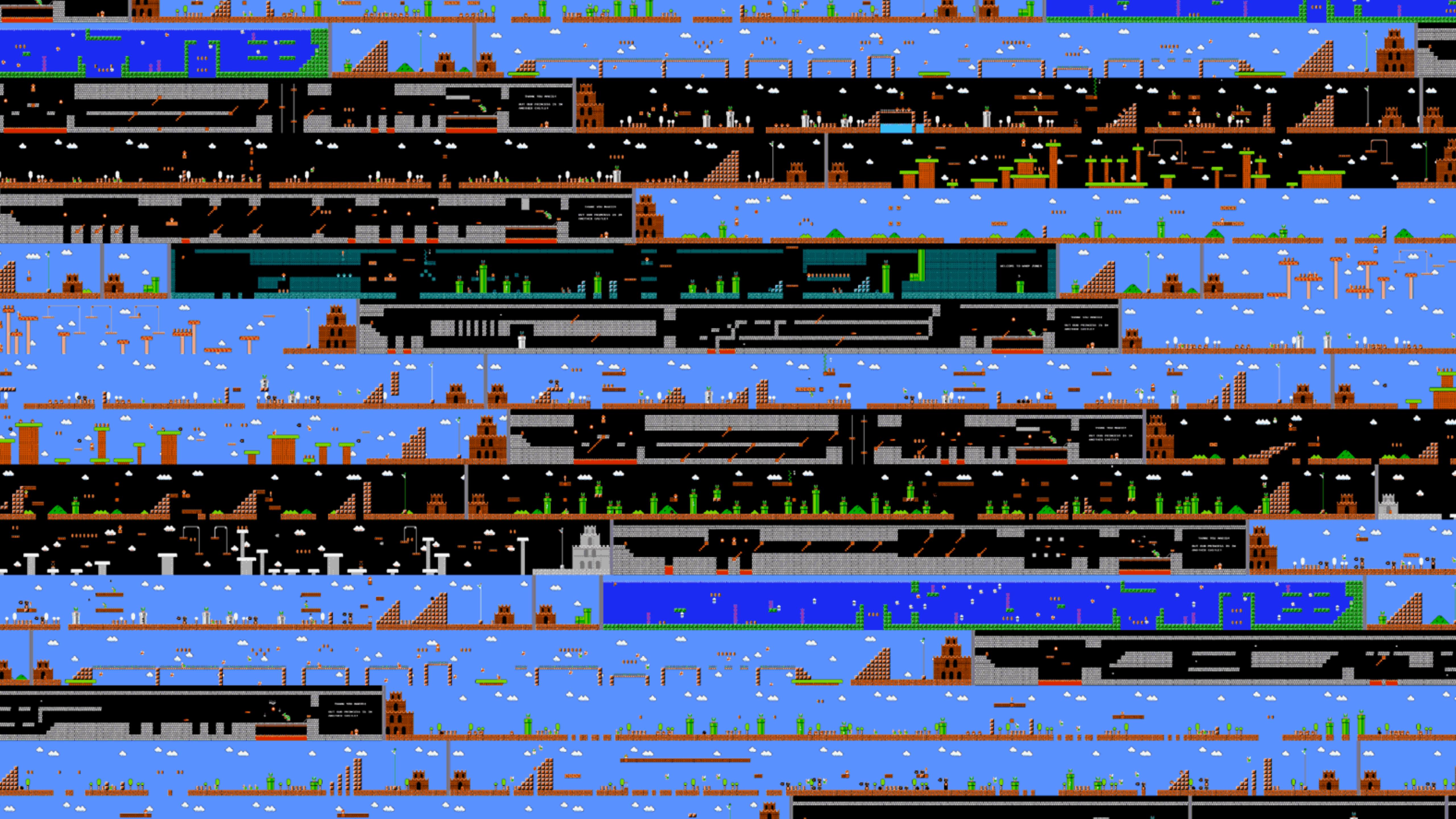


# Creating worlds.

Part 1









HEALTH



FUEL



BLAST-CARBINE

FPS: 59

TEXTURE: (PRESS N TO SWITCH)

TILED: FALSEPRESS T TO TOGGLE

X: 1828.409 - Y: 1476.546 - ROTATED: 3.150086

COLOR (KEYS UIOP TO CHANGE) --- RED: 1 - GREEN: 1 - BLUE: 1 - ALPHA: 1

MASS: IPRESS +/- TO INCREASE/DECREASE

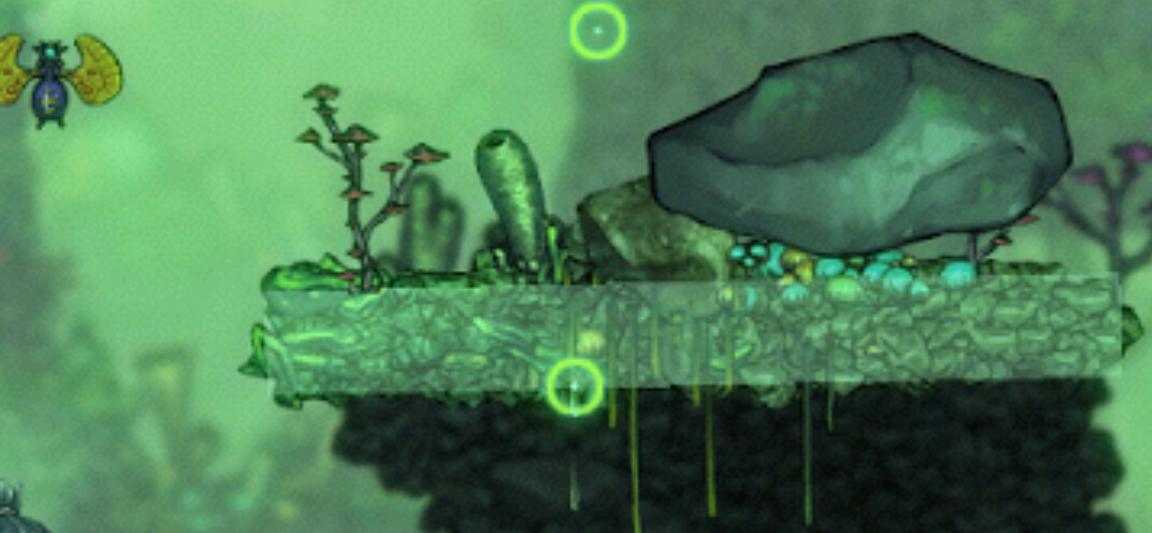
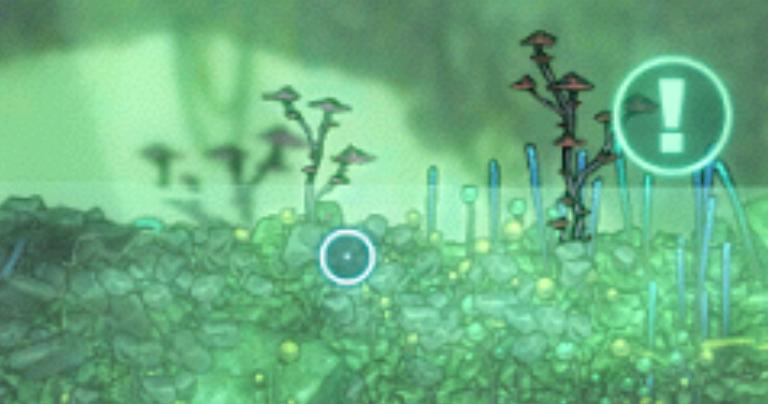
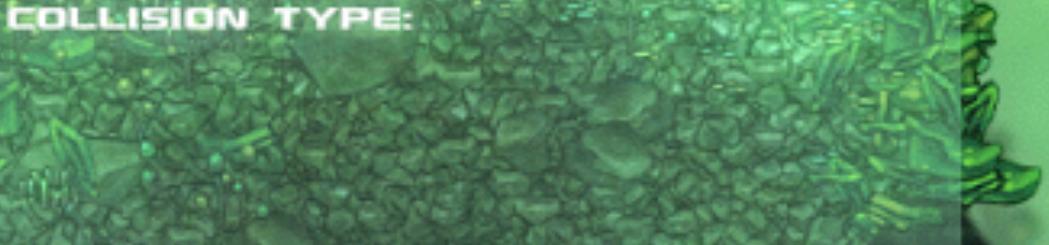
MOVEABLE: OPRESS M TO TOGGLE

NO ROTATE: FALSEPRESS R TO TOGGLE

GEM FROM TEXTURE: FALSEPRESS Z TO TOGGLE

HURT: D - PUSH (A/S): D

COLLISION TYPE:



# Tile-based levels.



MARIO  
000500



WORLD  
1-1

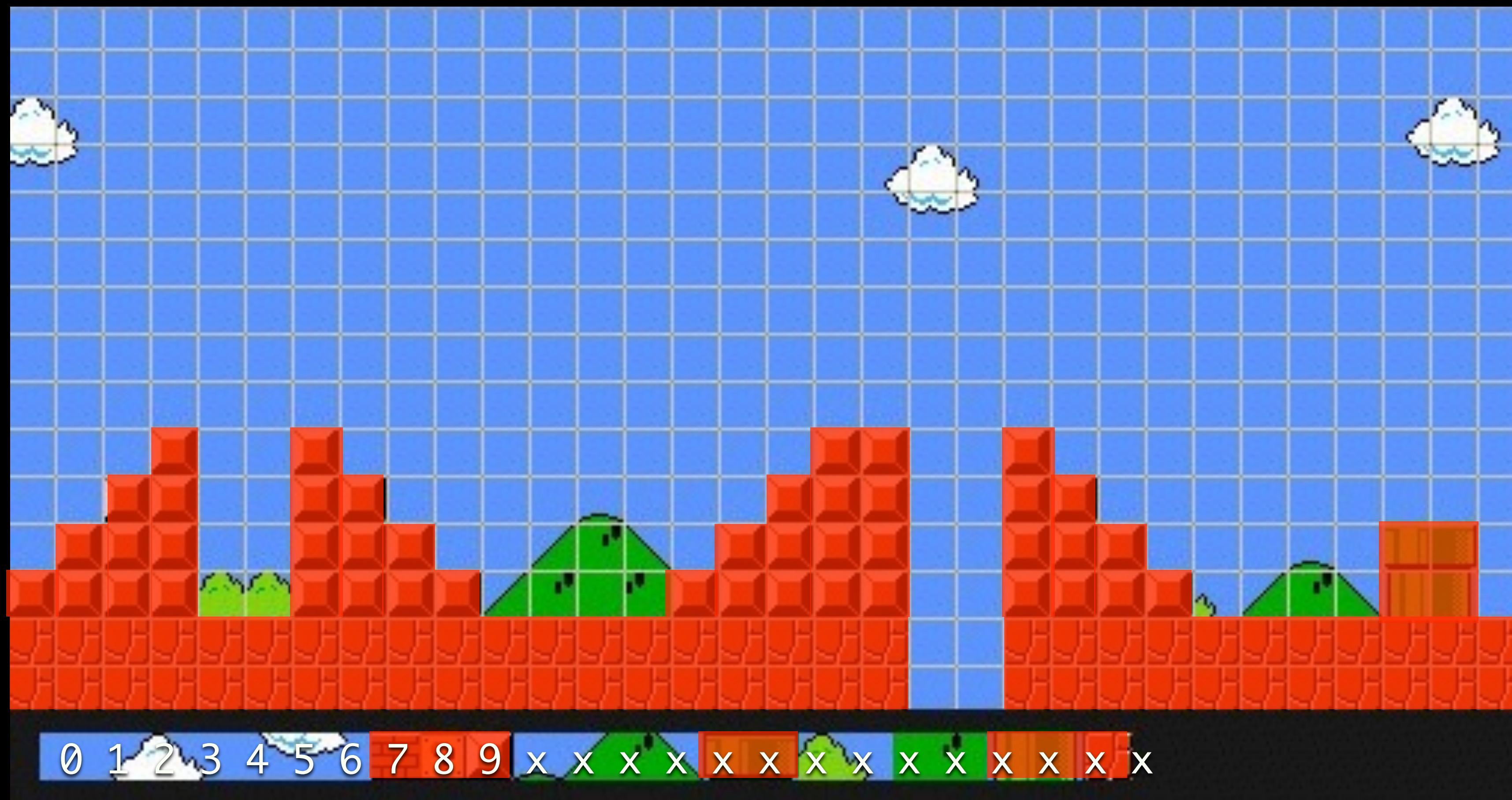
TIME  
321











solids = 7,8,9,14,15,20,21,22



1





1 4 4

\$0





```
void ClassDemoApp::buildLevel() {
    int blockIndex = 0;

    for(int i=0; i < 9; i++) {
        blocks[blockIndex].sprite = SheetSprite(spriteSheetTexture, 5);
        blocks[blockIndex].width = 2.0/8.0f;
        blocks[blockIndex].height = 2.0/8.0f;
        blocks[blockIndex].isStatic = true;
        blocks[blockIndex].y = (2.0/8.0f * -4) - 1.0f/8.0f;
        blocks[blockIndex].x = (-2.0/8.0f * 4) + (2.0/8.0f * i);
        entities.push_back(&blocks[blockIndex]);
        blockIndex++;
    }

    for(int i=0; i < 9; i++) {
        blocks[blockIndex].sprite = SheetSprite(spriteSheetTexture, 5);
        blocks[blockIndex].width = 2.0/8.0f;
        blocks[blockIndex].height = 2.0/8.0f;
        blocks[blockIndex].isStatic = true;
        blocks[blockIndex].y = (2.0/8.0f * 2) - 1.0f/8.0f;
        blocks[blockIndex].x = (-2.0/8.0f * 4) + (2.0/8.0f * i);
        entities.push_back(&blocks[blockIndex]);
        blockIndex++;
    }

    for(int i=0; i < 5; i++) {
        blocks[blockIndex].sprite = SheetSprite(spriteSheetTexture, 6);
        blocks[blockIndex].width = 2.0/8.0f;
        blocks[blockIndex].height = 2.0/8.0f;
        blocks[blockIndex].isStatic = true;
        blocks[blockIndex].y = (2.0/8.0f * -1) - 1.0f/8.0f;
        blocks[blockIndex].x = (-2.0/8.0f * 8) + (2.0/8.0f * i);
        entities.push_back(&blocks[blockIndex]);
    }
}
```

```
void ClassDemoApp::buildLevel() {
    int blockIndex = 0;

    for(int i=0; i < 9; i++) {
        blocks[blockIndex].sprite = SheetSprite(spriteSheetTexture, 5);
        blocks[blockIndex].width = 2.0/8.0f;
        blocks[blockIndex].height = 2.0/8.0f;
        blocks[blockIndex].isStatic = true;
        blocks[blockIndex].y = (2.0/8.0f * -4) - 1.0f/8.0f;
        blocks[blockIndex].x = (-2.0/8.0f * 4) + (2.0/8.0f * i);
        entities.push_back(&blocks[blockIndex]);
        blockIndex++;
    }

    for(int i=0; i < 9; i++) {
        blocks[blockIndex].sprite = SheetSprite(spriteSheetTexture, 5);
        blocks[blockIndex].width = 2.0/8.0f;
        blocks[blockIndex].height = 2.0/8.0f;
        blocks[blockIndex].isStatic = true;
        blocks[blockIndex].y = (2.0/8.0f * 2) - 1.0f/8.0f;
        blocks[blockIndex].x = (-2.0/8.0f * 4) + (2.0/8.0f * i);
        entities.push_back(&blocks[blockIndex]);
        blockIndex++;
    }

    for(int i=0; i < 5; i++) {
        blocks[blockIndex].sprite = SheetSprite(spriteSheetTexture, 6);
        blocks[blockIndex].width = 2.0/8.0f;
        blocks[blockIndex].height = 2.0/8.0f;
```

Defining a **tile map** level.

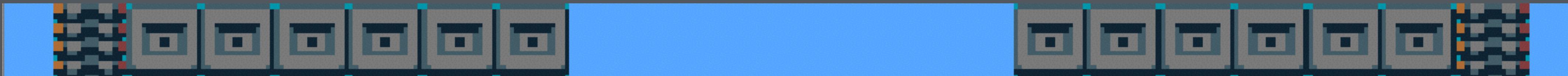


# Storing level data as a **2-dimensional array**.

```
unsigned char levelData[LEVEL_HEIGHT][LEVEL_WIDTH];
```



```
{0,20,4,4,4,4,4,4,0,0,0,0,0,0,4,4,4,4,4,4,4,20,0};
```



```
#define LEVEL_HEIGHT 16
#define LEVEL_WIDTH 22

unsigned char level1Data[LEVEL_HEIGHT][LEVEL_WIDTH] =
{
    {11,11,11,11,11,11,11,11,11,11,11,11,11,11,11,11,11,11,11,11,11,11},  

    {0,20,4,4,4,4,4,4,0,0,0,0,0,0,4,4,4,4,4,4,4,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,6,6,6,6,6,6,6,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,6,6,6,6,6,0,0,0,0,0,0,0,0,6,6,6,6,6,6,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,6,6,6,6,6,6,6,6,0,0,0,0,0,0,20,0},  

    {0,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,20,0},  

    {0,20,125,118,0,0,116,0,0,0,0,0,0,0,0,0,0,0,117,0,127,20,0},  

    {2,2,2,2,2,2,2,2,2,3,0,0,1,2,2,2,2,2,2,2,2,2,2},  

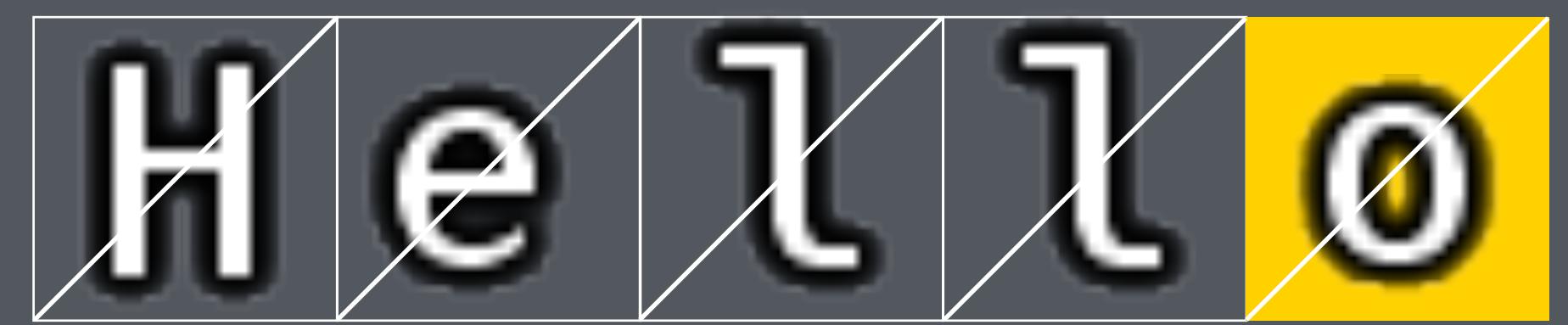
    {32,33,33,34,32,33,33,34,33,35,100,101,35,32,33,32,33,32,33,33}
};
```

};

```
void ClassDemoApp::buildLevel() {
    memcpy(levelData, level1Data, LEVEL_HEIGHT*LEVEL_WIDTH);
}
```

# Rendering a tile map level.

**Need to render the entire tilemap as one vertex array.**



Hello

Go through the tiles **line by line** and **add vertices to a single array**.  
(Keep in mind that our **Y axis** points **upwards**, while tile **indexes count downwards**)

```
std::vector<float> vertexData;
std::vector<float> texCoordData;

for(int y=0; y < LEVEL_HEIGHT; y++) {
    for(int x=0; x < LEVEL_WIDTH; x++) {

        float u = (float)((int)levelData[y][x]) % SPRITE_COUNT_X) / (float) SPRITE_COUNT_X;
        float v = (float)((int)levelData[y][x]) / SPRITE_COUNT_X) / (float) SPRITE_COUNT_Y;

        float spriteWidth = 1.0f/(float)SPRITE_COUNT_X;
        float spriteHeight = 1.0f/(float)SPRITE_COUNT_Y;

        vertexData.insert(vertexData.end(), {
            TILE_SIZE * x, -TILE_SIZE * y,
            TILE_SIZE * x, (-TILE_SIZE * y)-TILE_SIZE,
            (TILE_SIZE * x)+TILE_SIZE, (-TILE_SIZE * y)-TILE_SIZE,

            TILE_SIZE * x, -TILE_SIZE * y,
            (TILE_SIZE * x)+TILE_SIZE, (-TILE_SIZE * y)-TILE_SIZE,
            (TILE_SIZE * x)+TILE_SIZE, -TILE_SIZE * y
        });

        texCoordData.insert(texCoordData.end(), {
            u, v,
            u, v+(spriteHeight),
            u+spriteWidth, v+(spriteHeight),

            u, v,
            u+spriteWidth, v+(spriteHeight),
            u+spriteWidth, v
        });
    }
}
```

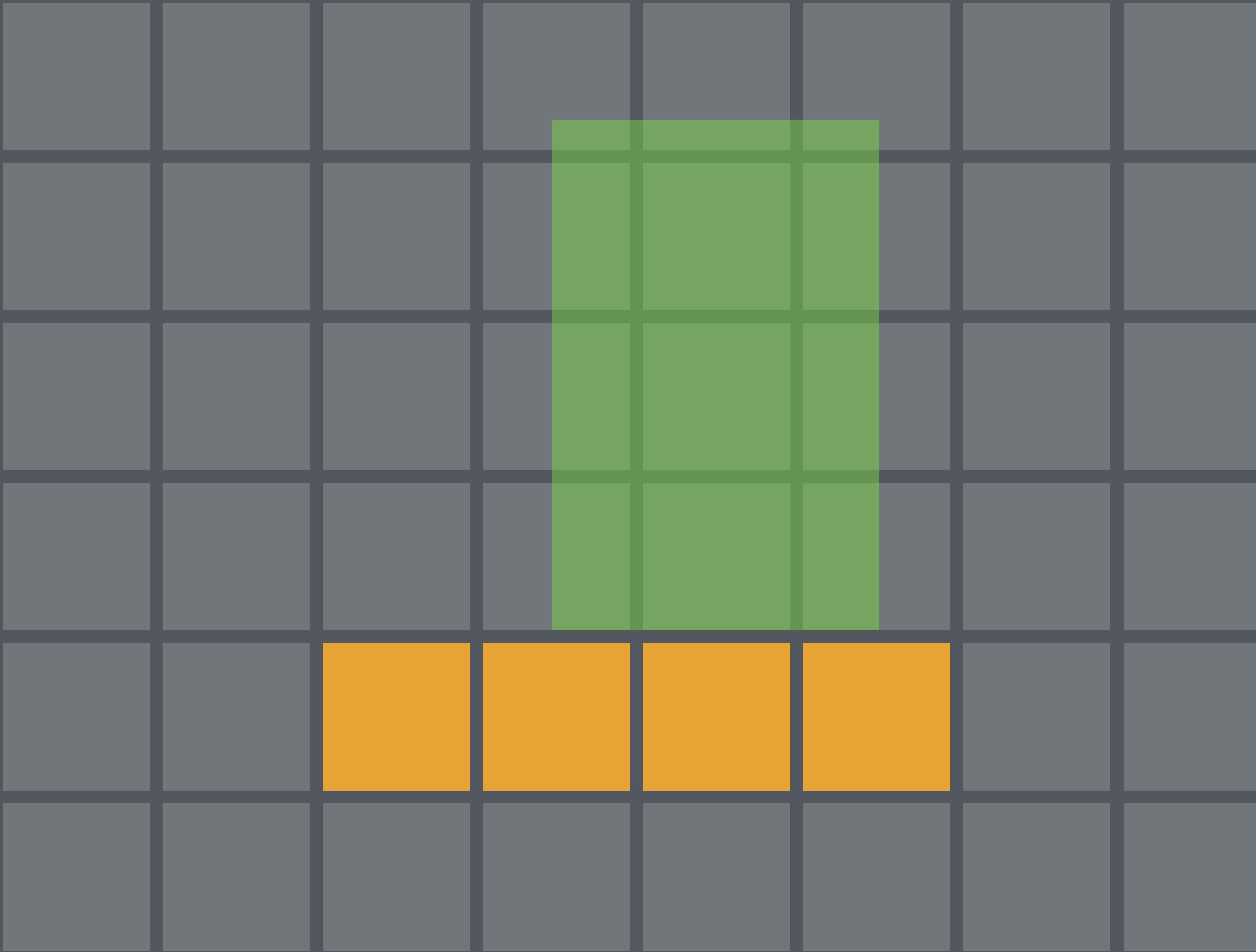
# We can optimize by not drawing empty grid tiles at all.

```
for(int y=0; y < LEVEL_HEIGHT; y++) {  
    for(int x=0; x < LEVEL_WIDTH; x++) {  
  
        if(levelData[y][x] != 0) {  
            // add vertices  
        }  
    }  
}
```

# Colliding with a tilemap.

**Separate axis movement again!**

First the Y axis...

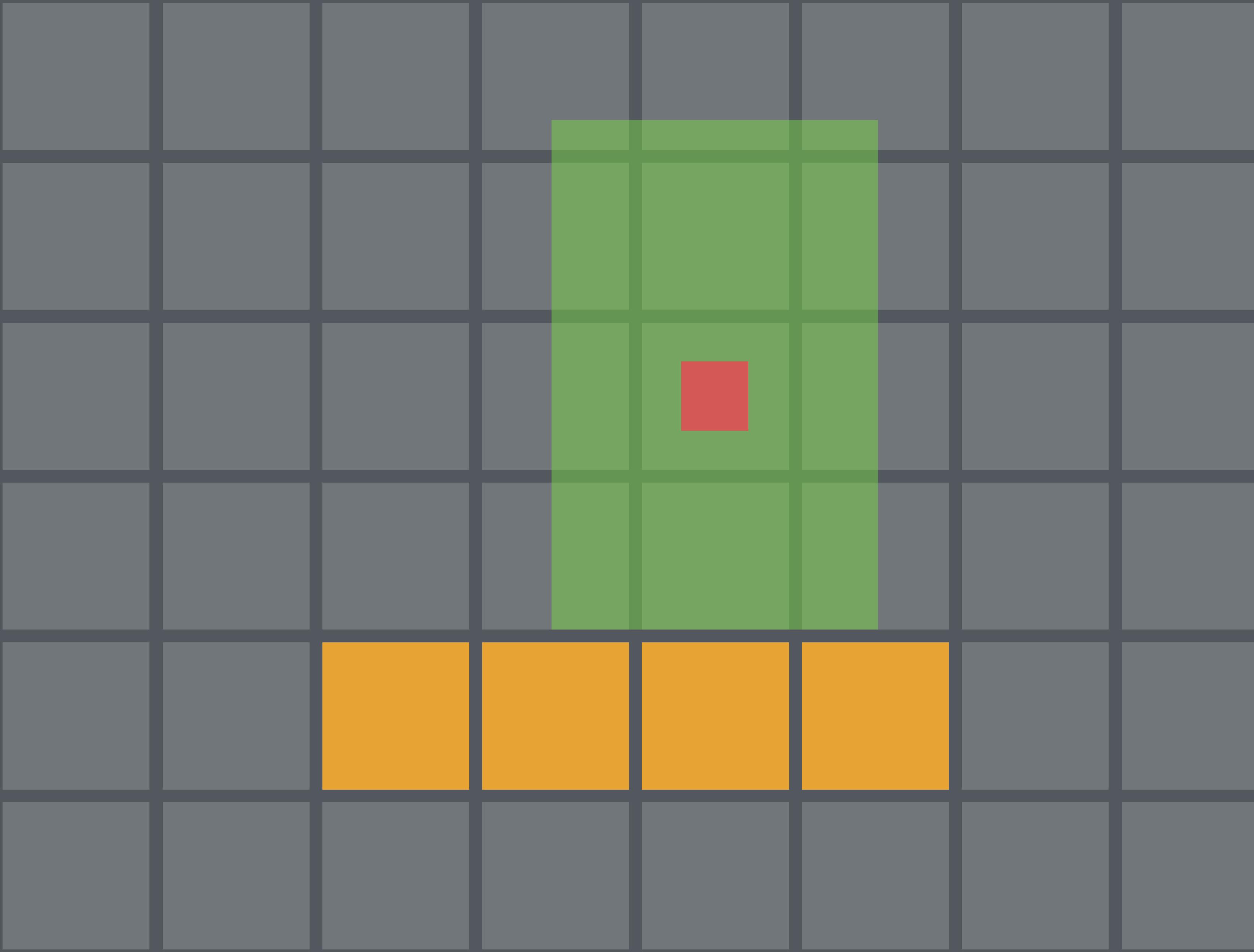


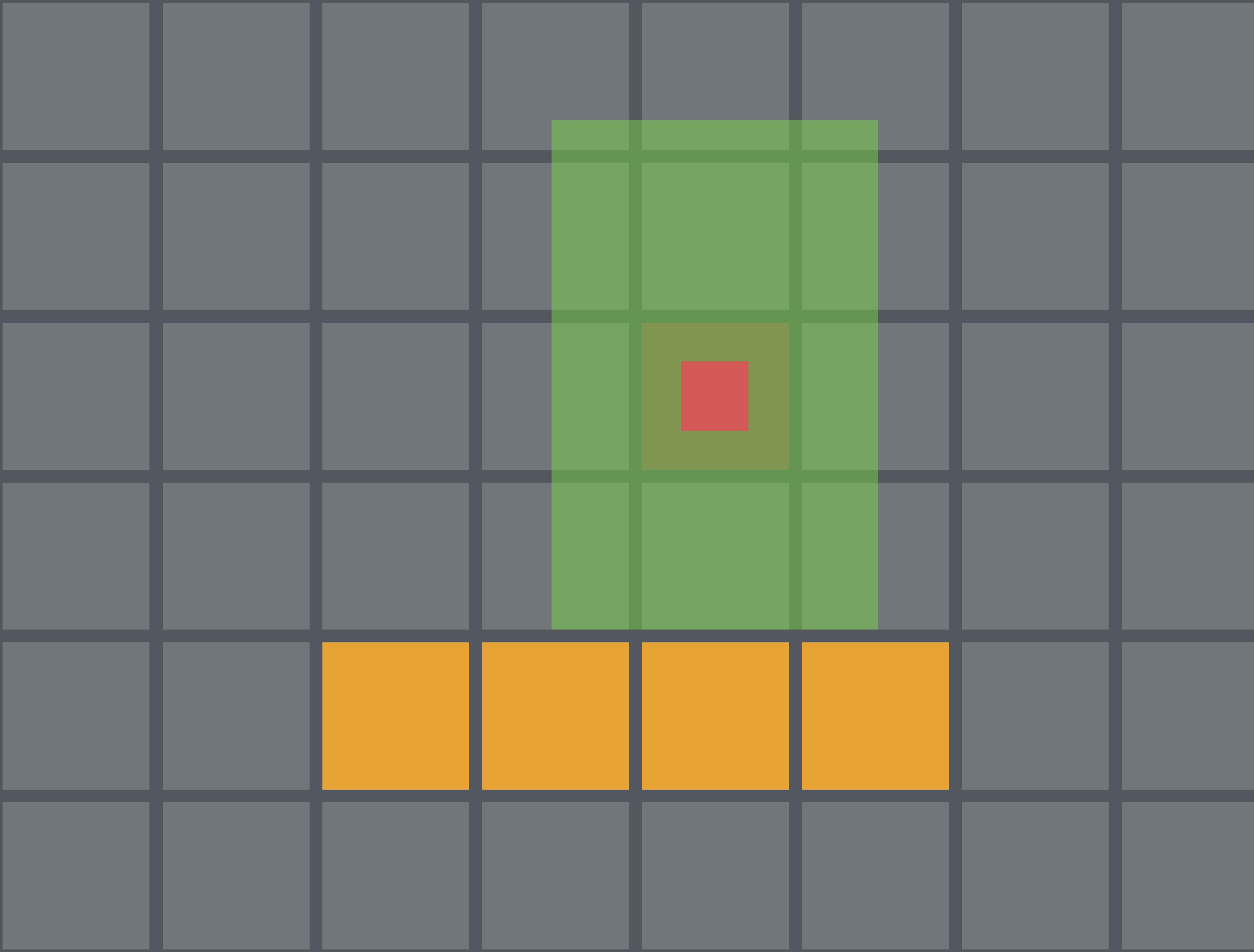
Convert our **entity position**  
to the **grid coordinates** and check  
if that **tile is solid**.

# What is a solid tile?

**It's up to you!**

Define the tile indexes that are considered solid!

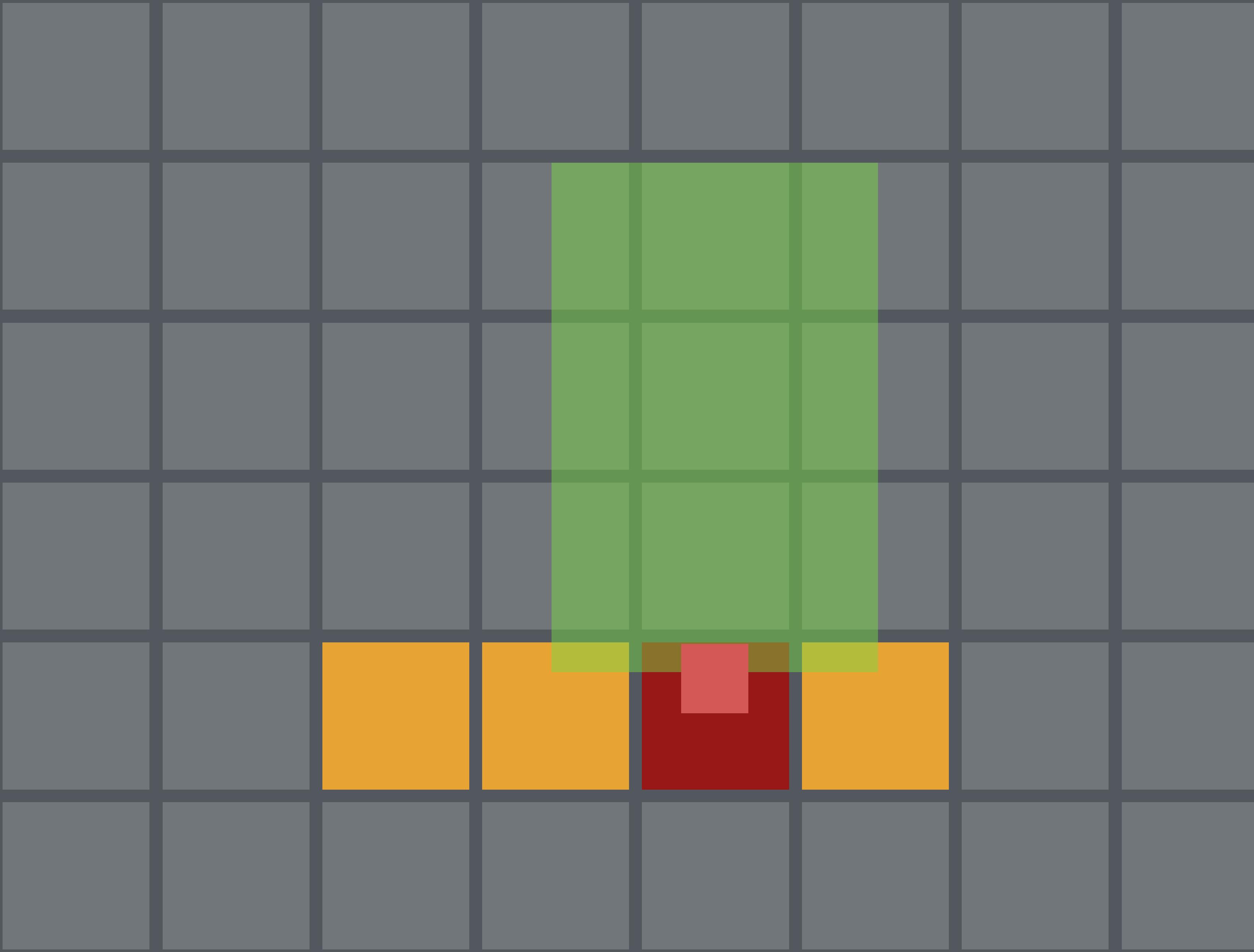


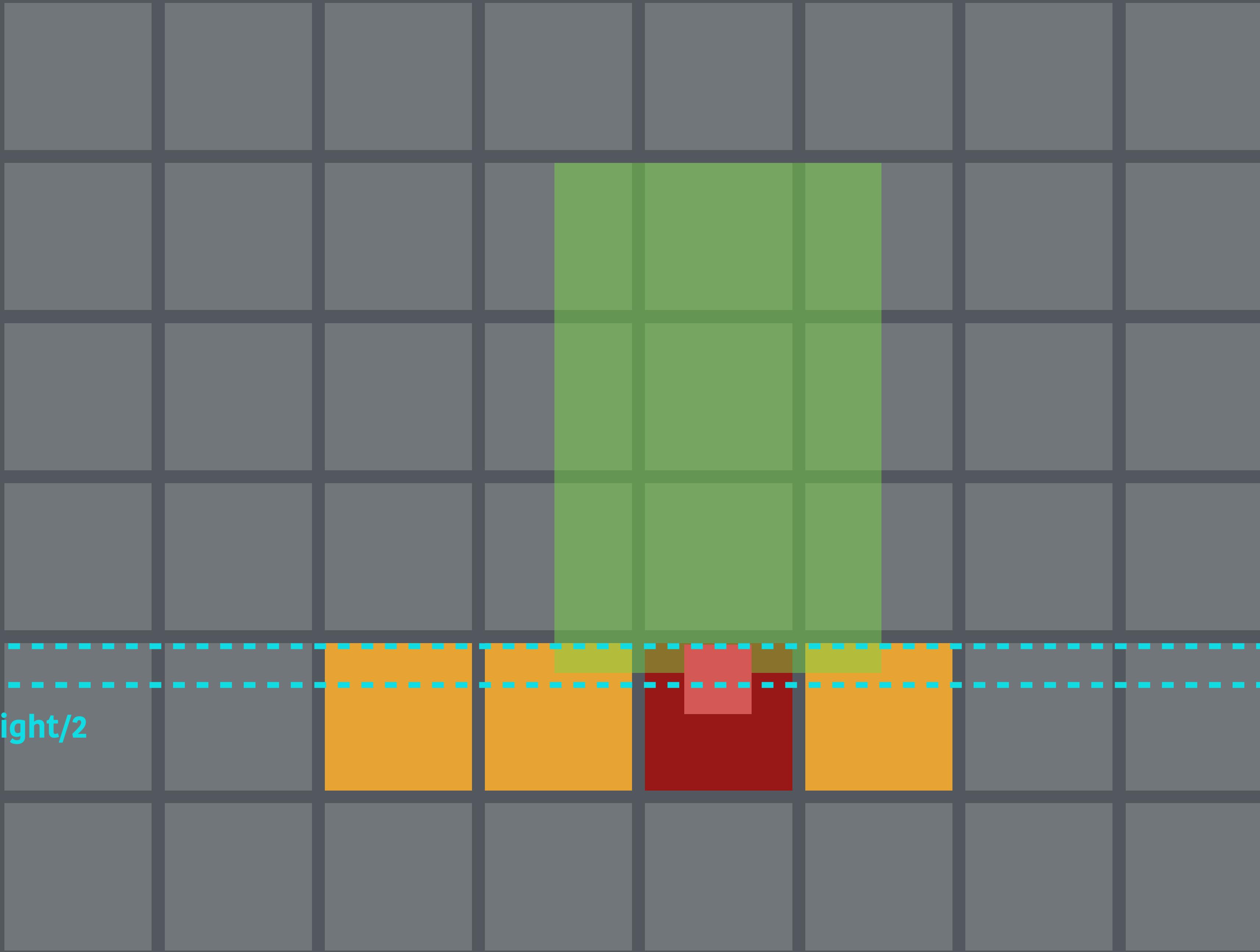


```
void worldToTileCoordinates(float worldX, float worldY, int *gridX, int *gridY) {  
    *gridX = (int)(worldX / TILE_SIZE);  
    *gridY = (int)(-worldY / TILE_SIZE);  
}
```

Make sure that your tile coordinates  
are **not negative** or **larger than your map!**

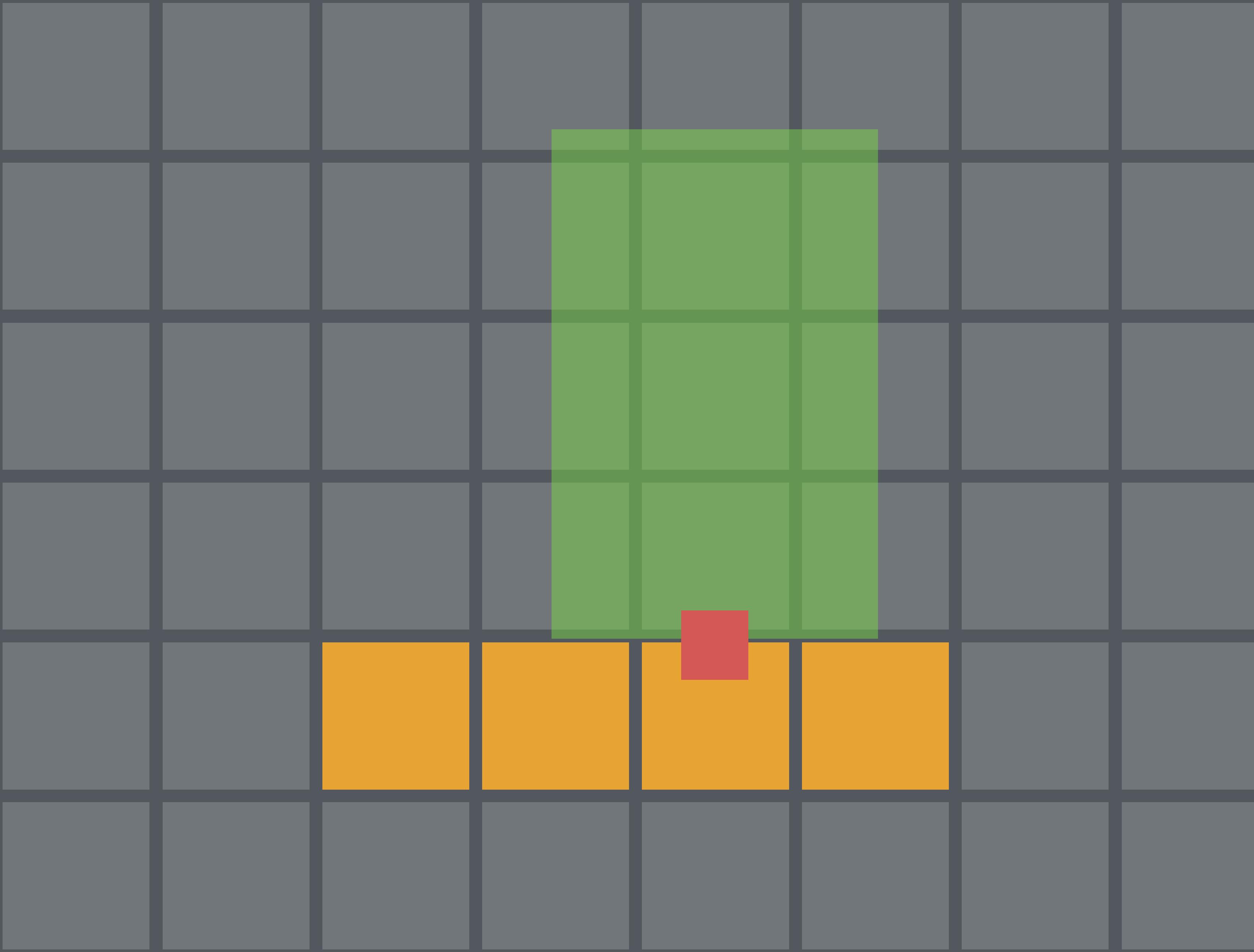
We don't want to collide using the entity's center, so check the point at the bottom (-half height).



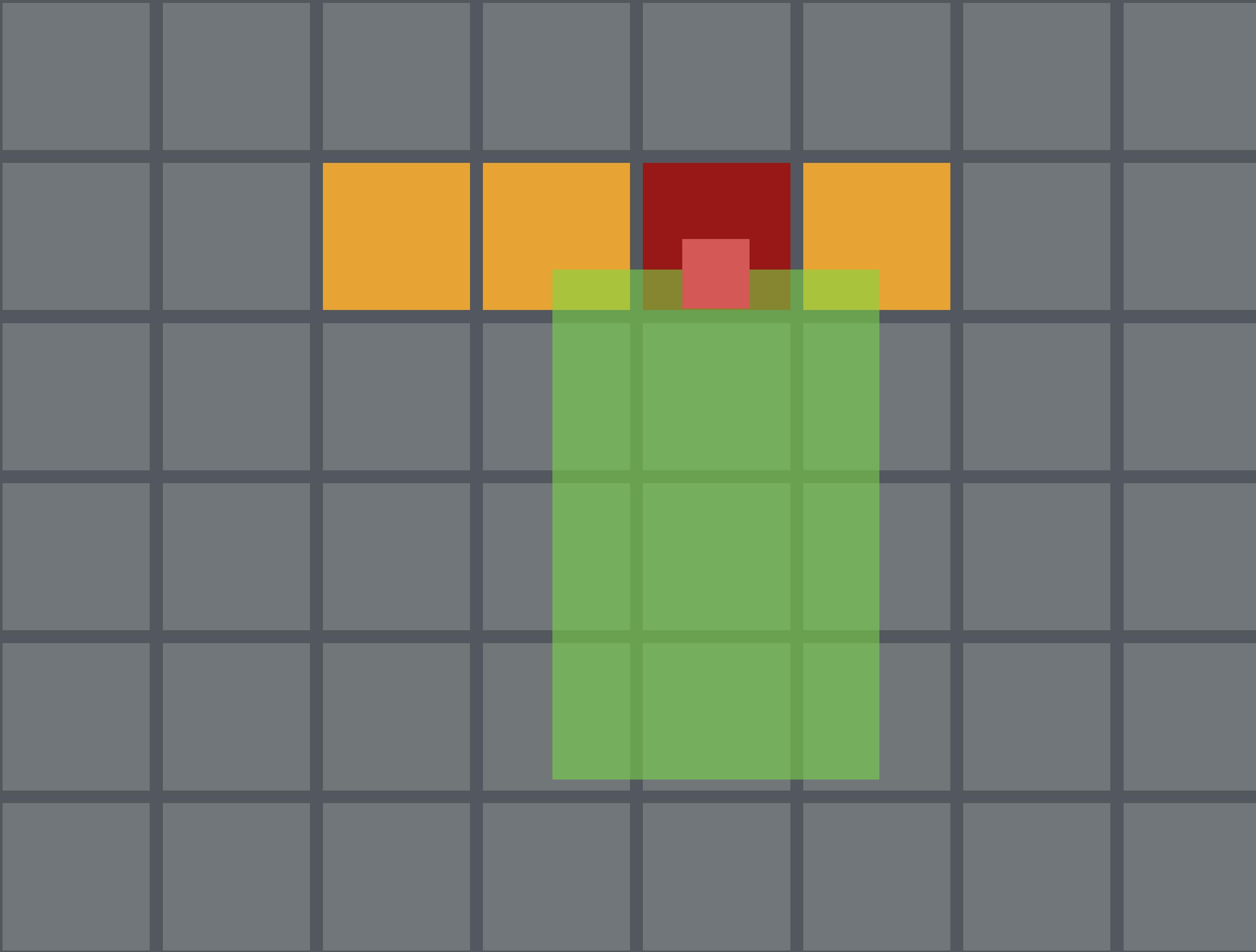


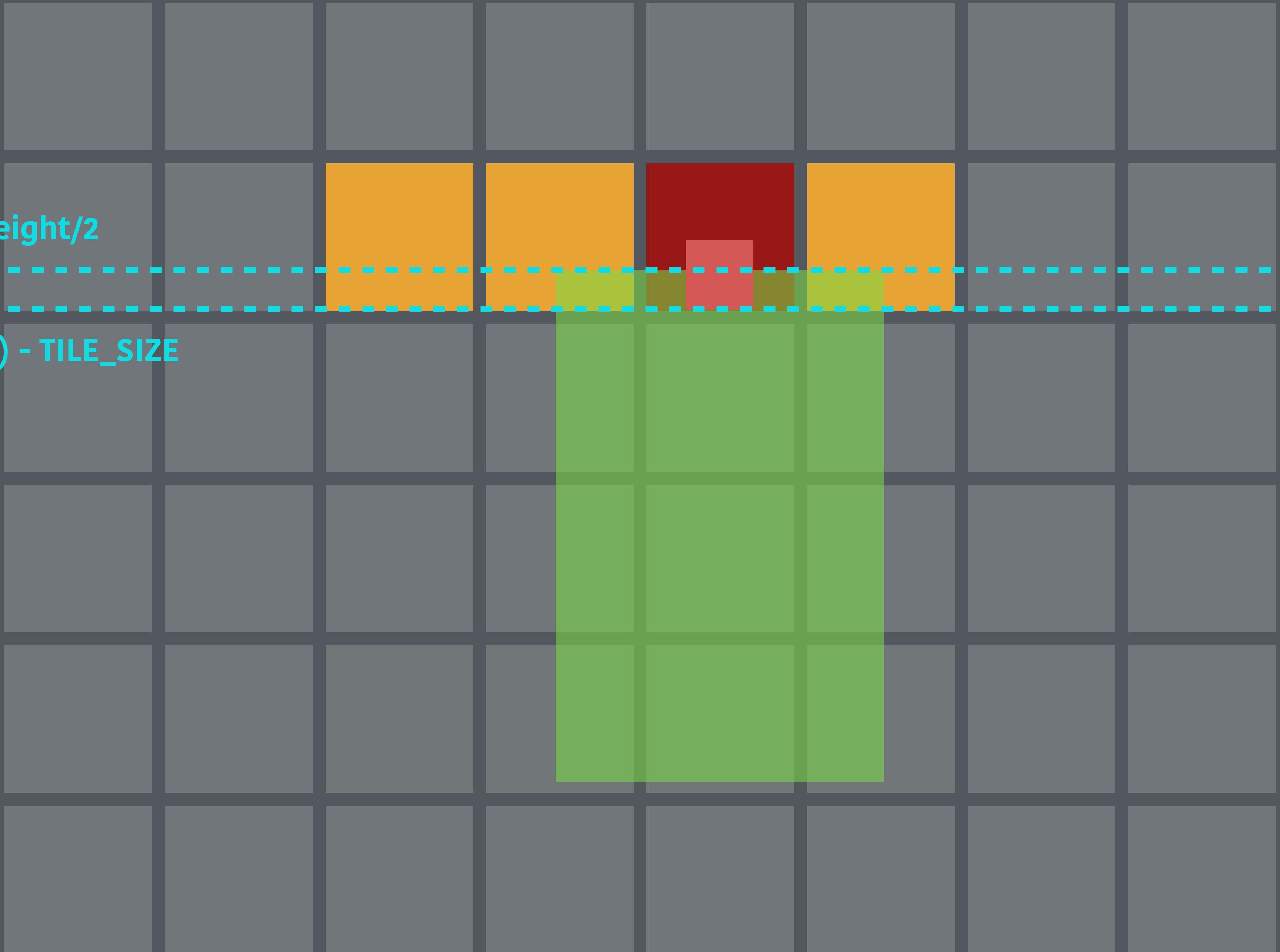
If the **tile is solid**, adjust our **Y-coordinate up** by  
the **difference** between **the point we are testing**  
and **the top of the tile** (plus a tiny amount).

Don't forget to reset velocity to 0  
and set your collision flags!

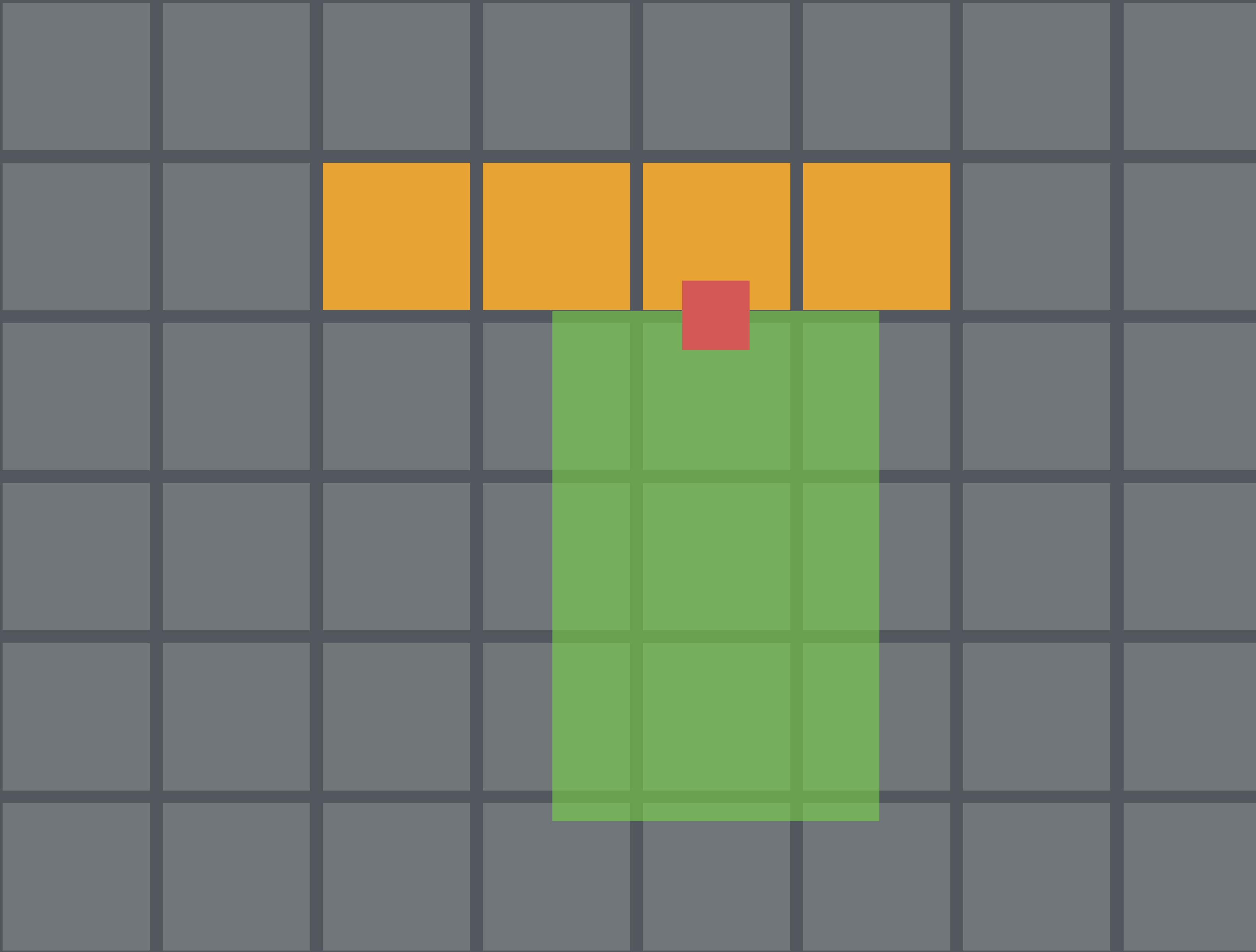


Now, check the point at the top...



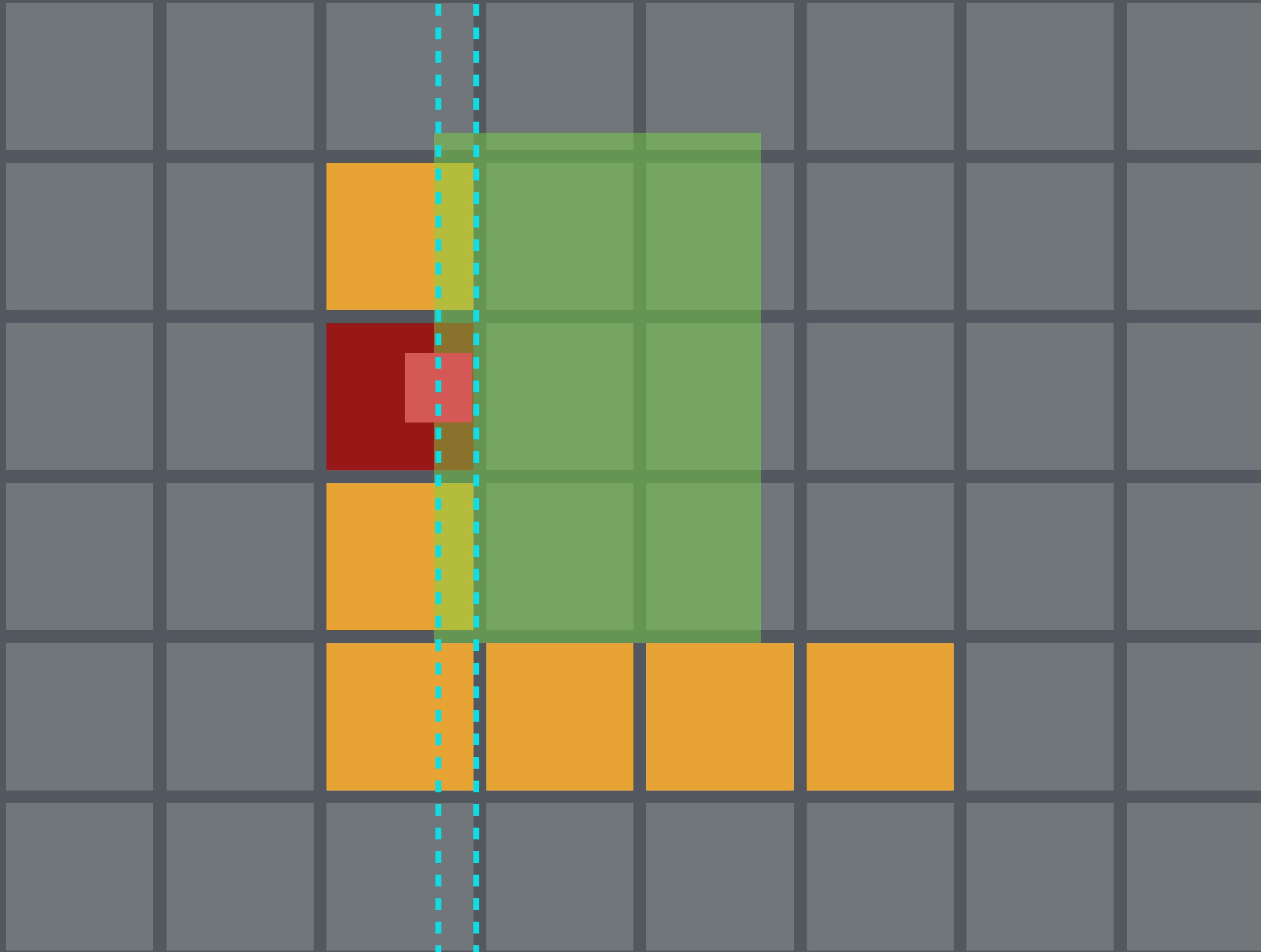


If the **tile** is **solid**, adjust our **Y-coordinate** down by  
the **difference** between **the point we are testing**  
and **the bottom of the tile** (plus a tiny amount).



Now the X axis...

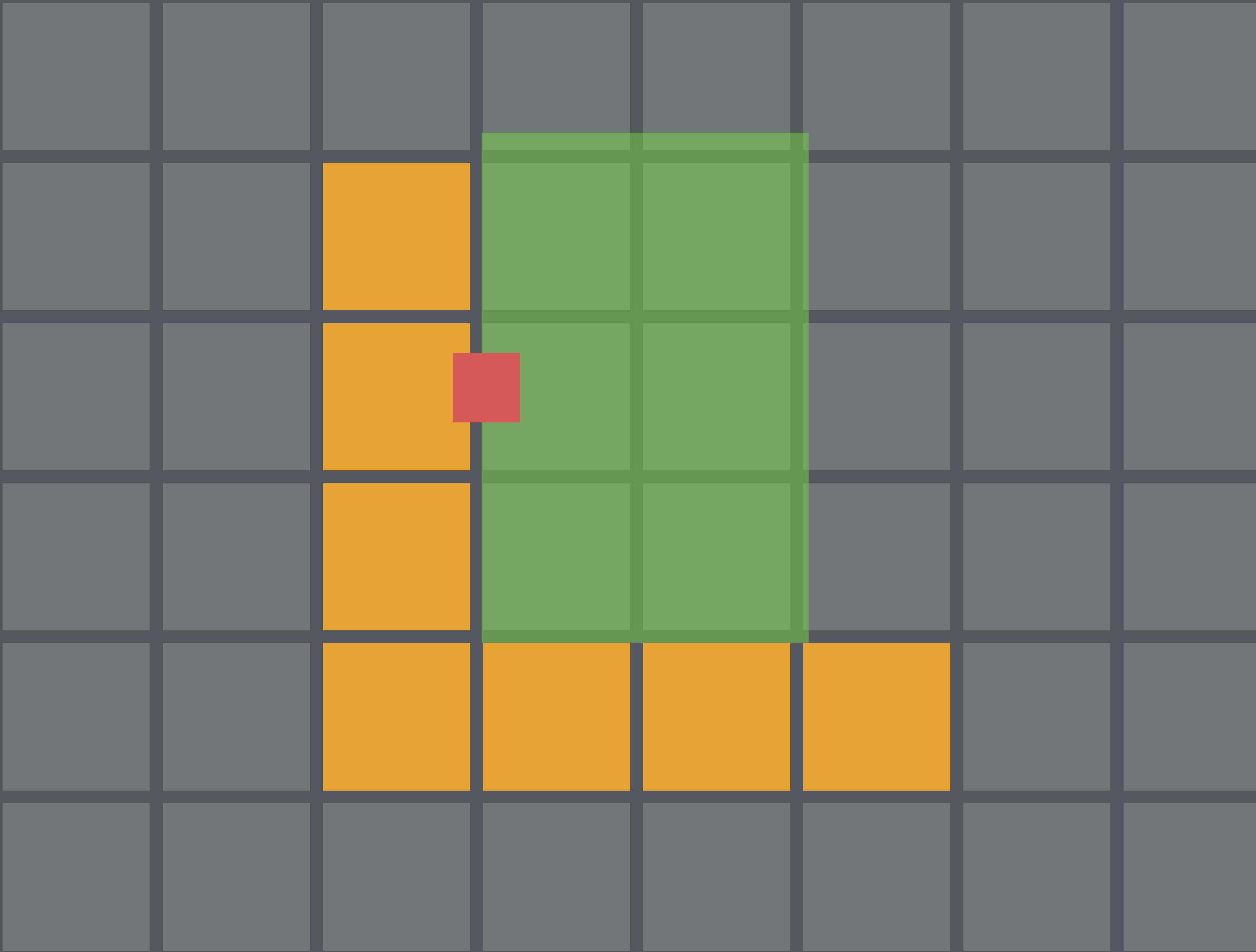
On the left...



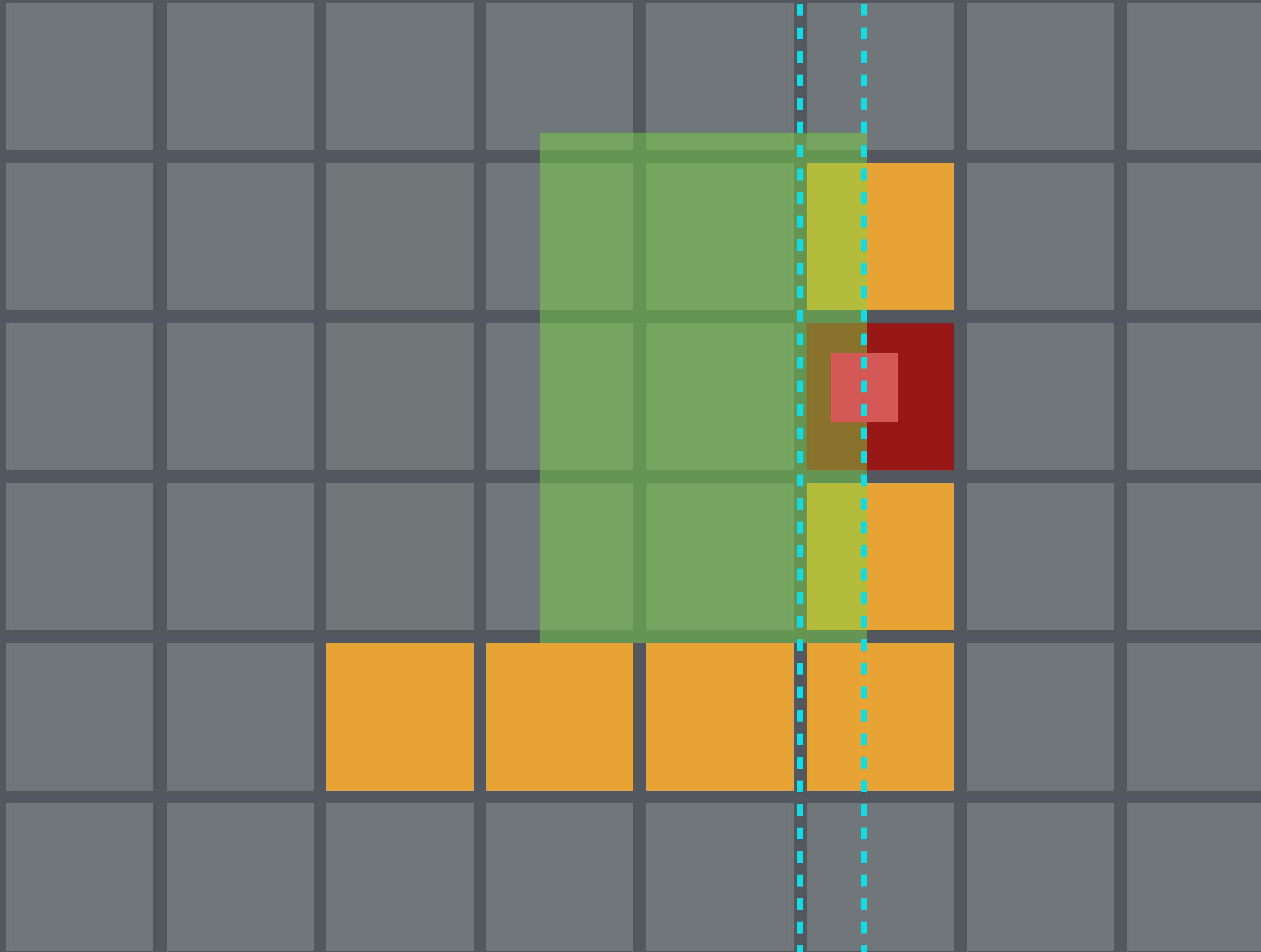
**entity.x - entity.width/2**

**(TILE\_SIZE \* tile\_x) + TILE\_SIZE**

If the **tile is solid**, adjust our **X-coordinate right** by the **difference** between **the point we are testing** and **the right of the tile** (plus a tiny amount).



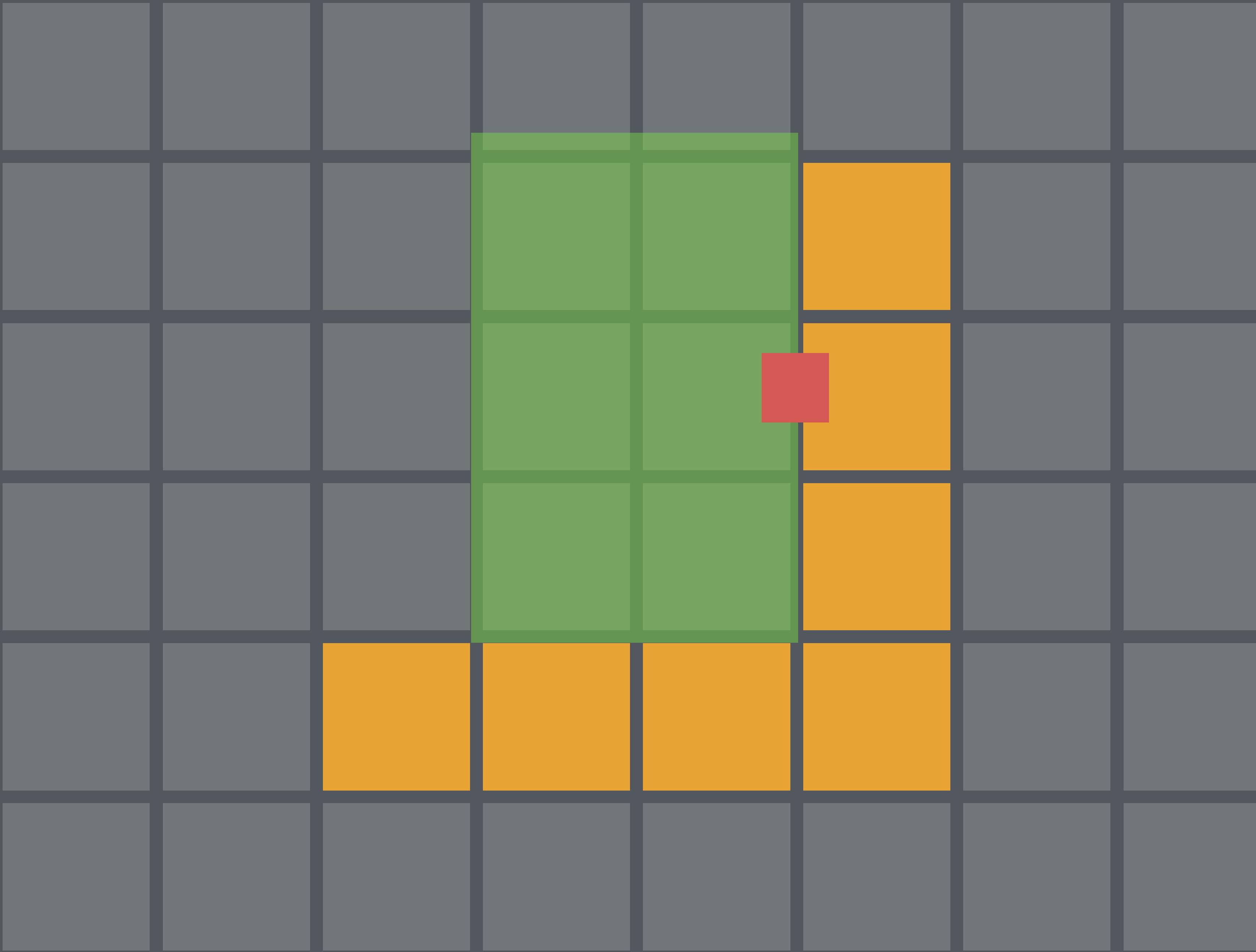
Now finally on the **right...**



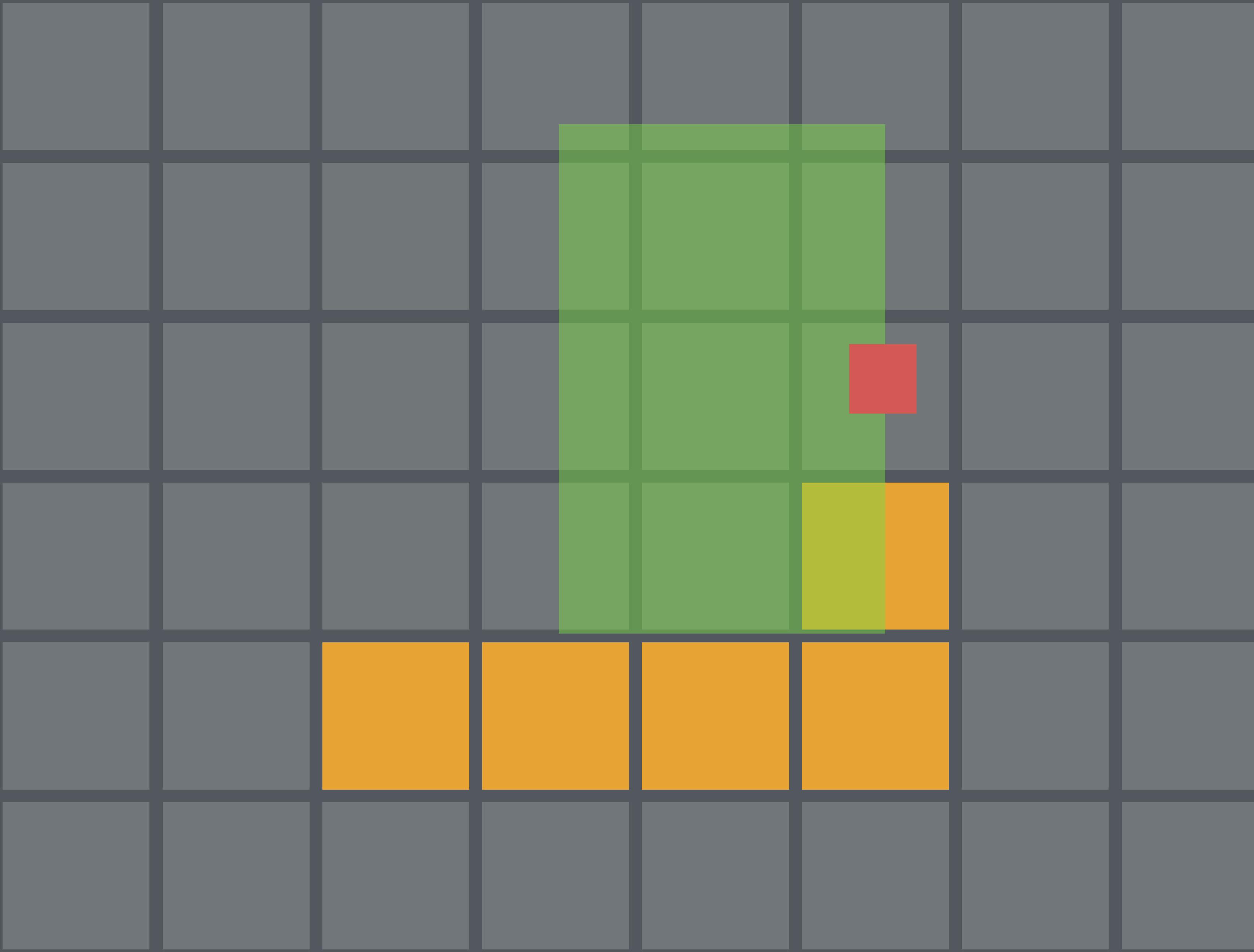
$(\text{TILE\_SIZE} * \text{tile\_x})$

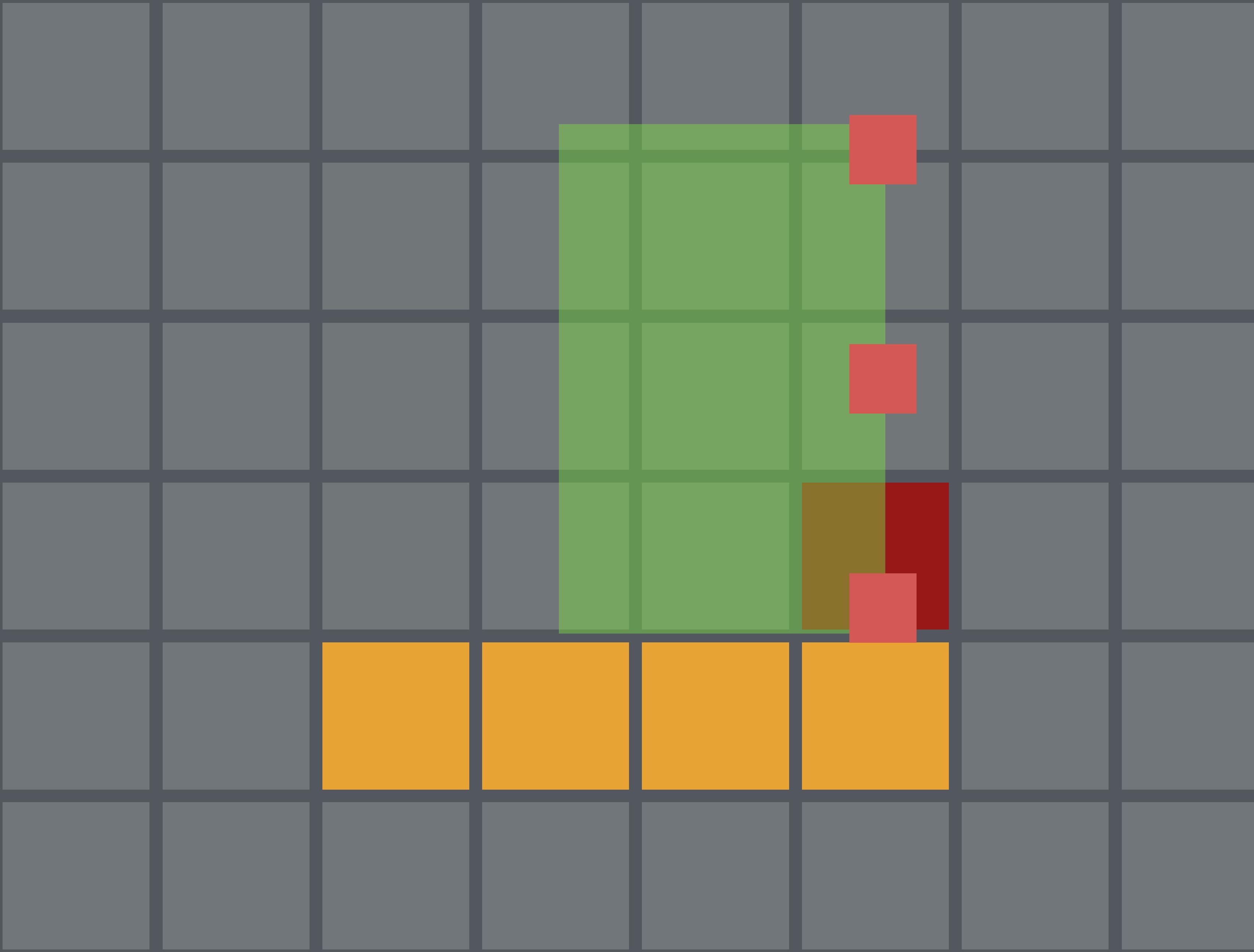
$\text{entity.x} + \text{entity.width}/2$

If the **tile** is solid, adjust our **X-coordinate left** by the **difference** between **the point we are testing** and **the left of the tile** (plus a tiny amount).



You may **test additional points** along the sprite  
if it is larger than a tile.

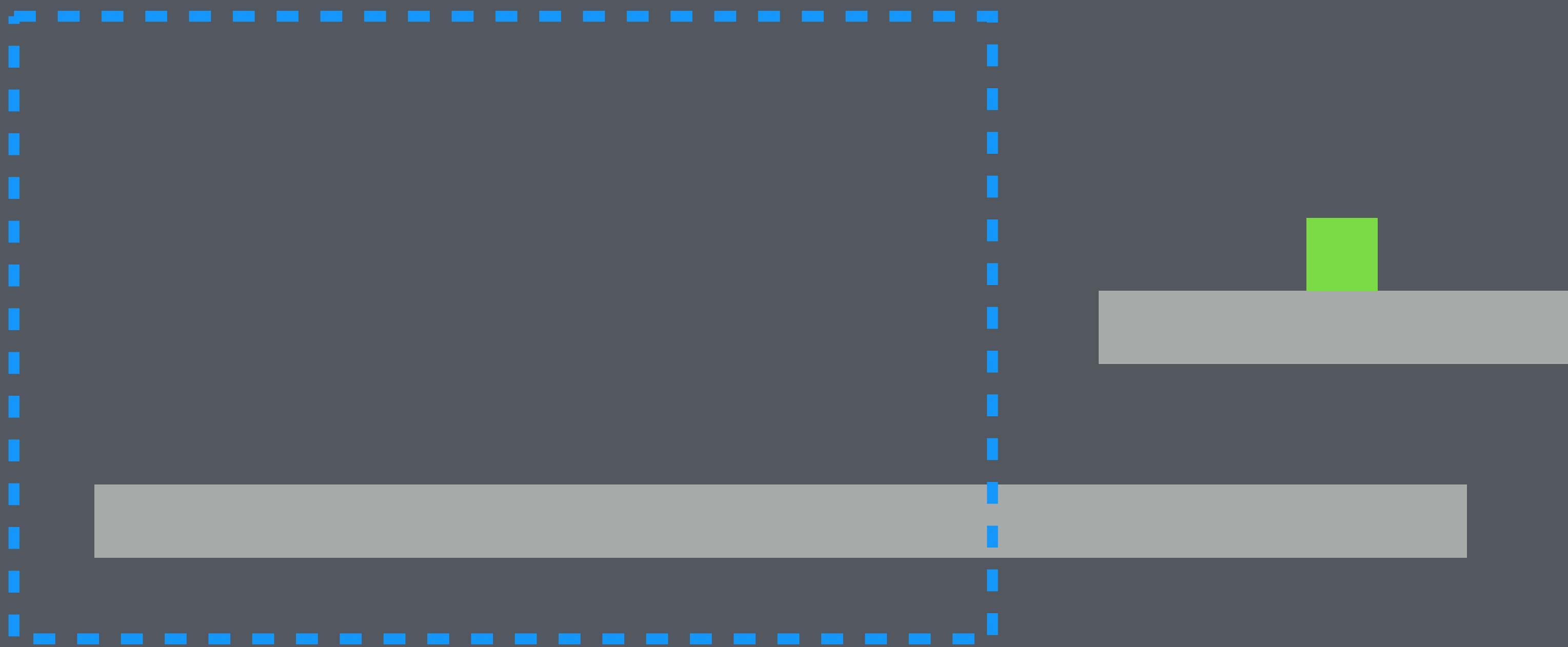




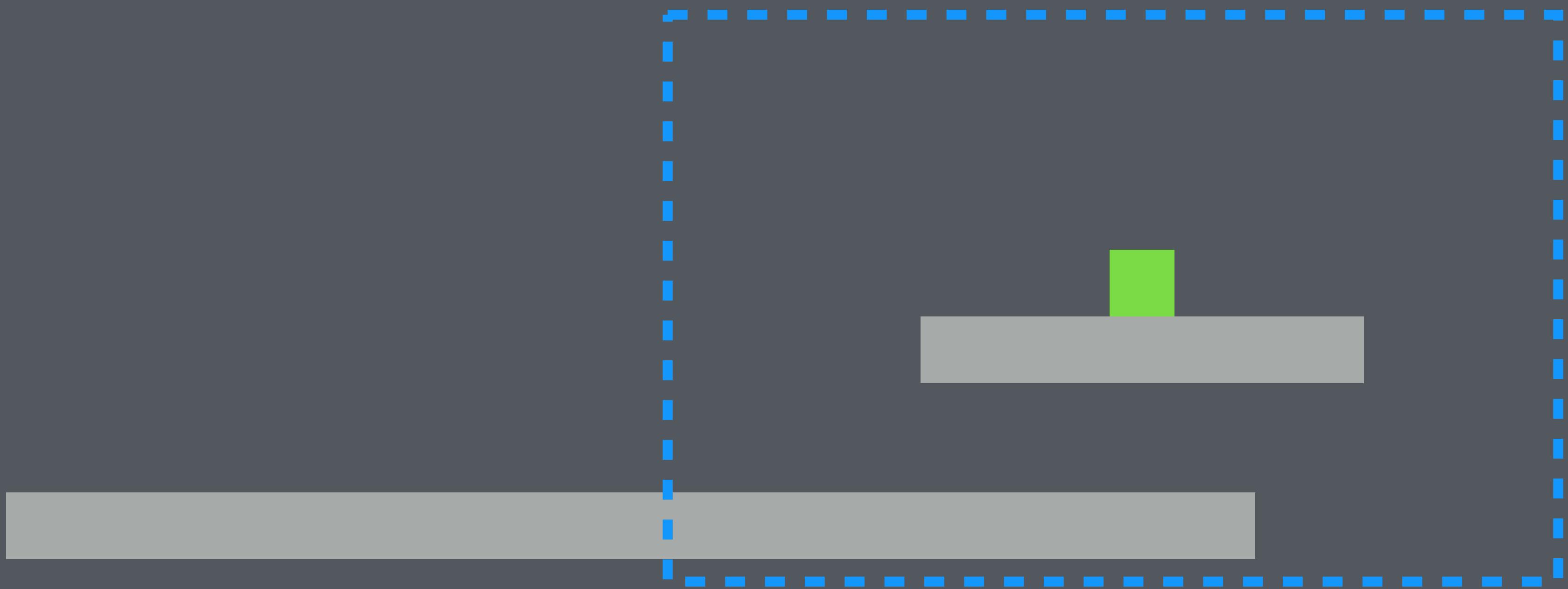
# Scrolling

# What is scrolling?

We need to **translate everything** so  
that the **player** is in the **center of the screen**.



We need to **translate everything** so  
that the **player** is in the **center of the screen**.



# The view matrix!

Translate the **view matrix** by the **inverse  
of the player's position!**  
(or whatever you want to center on)!