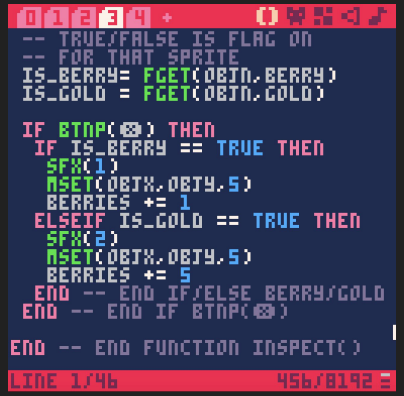
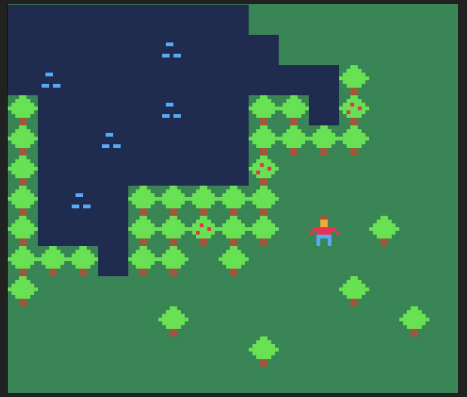
PICO-8
FANTASY CONSOLE

Making a Top-Down Adventure Game in PICO-8

Complete Walkthrough





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as seen in GAM-120: Intro to Game Logic

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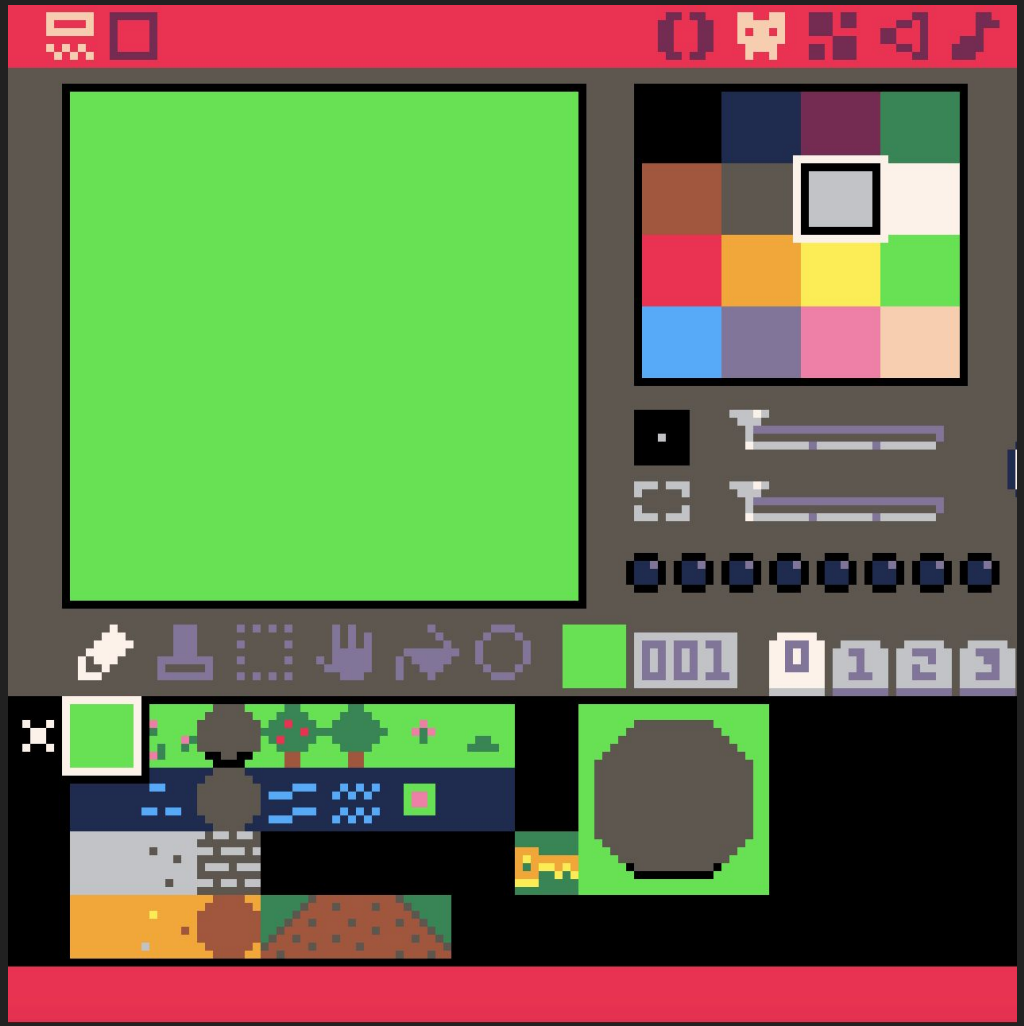
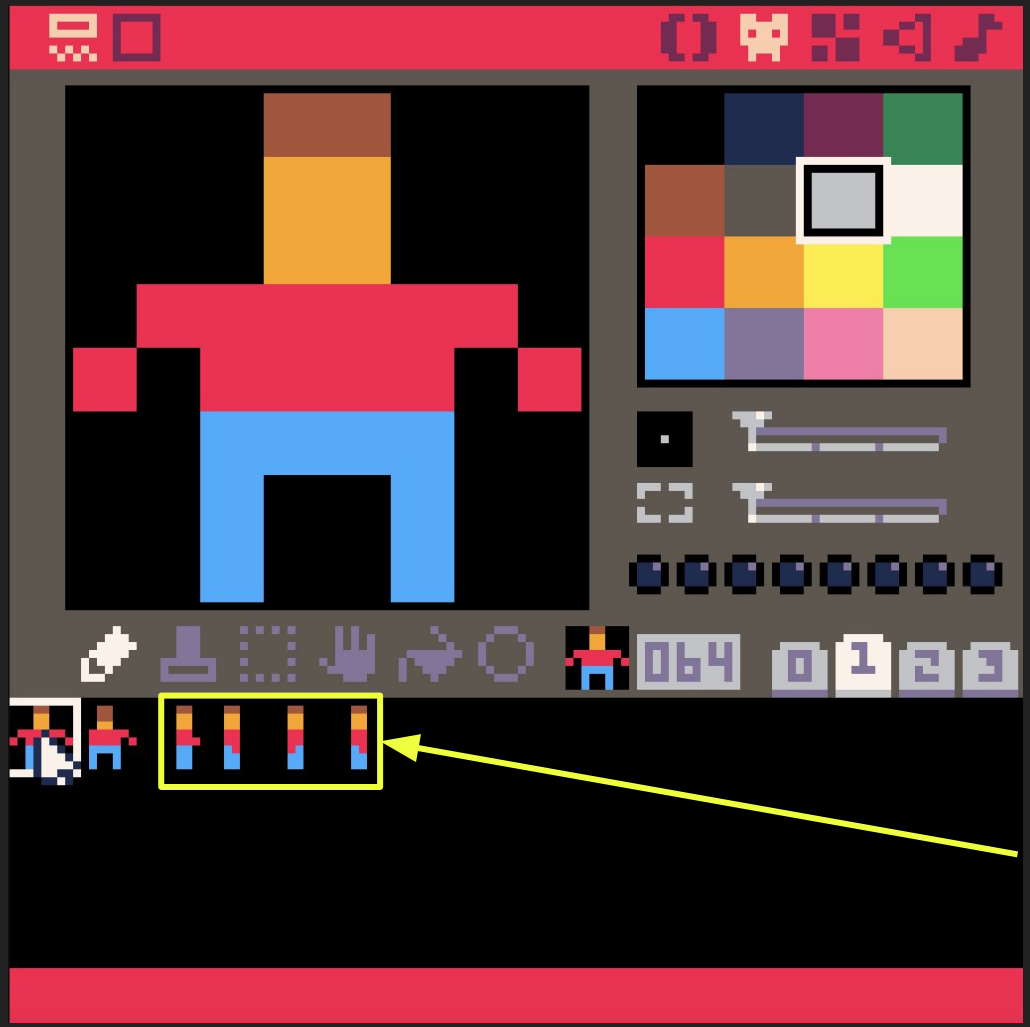
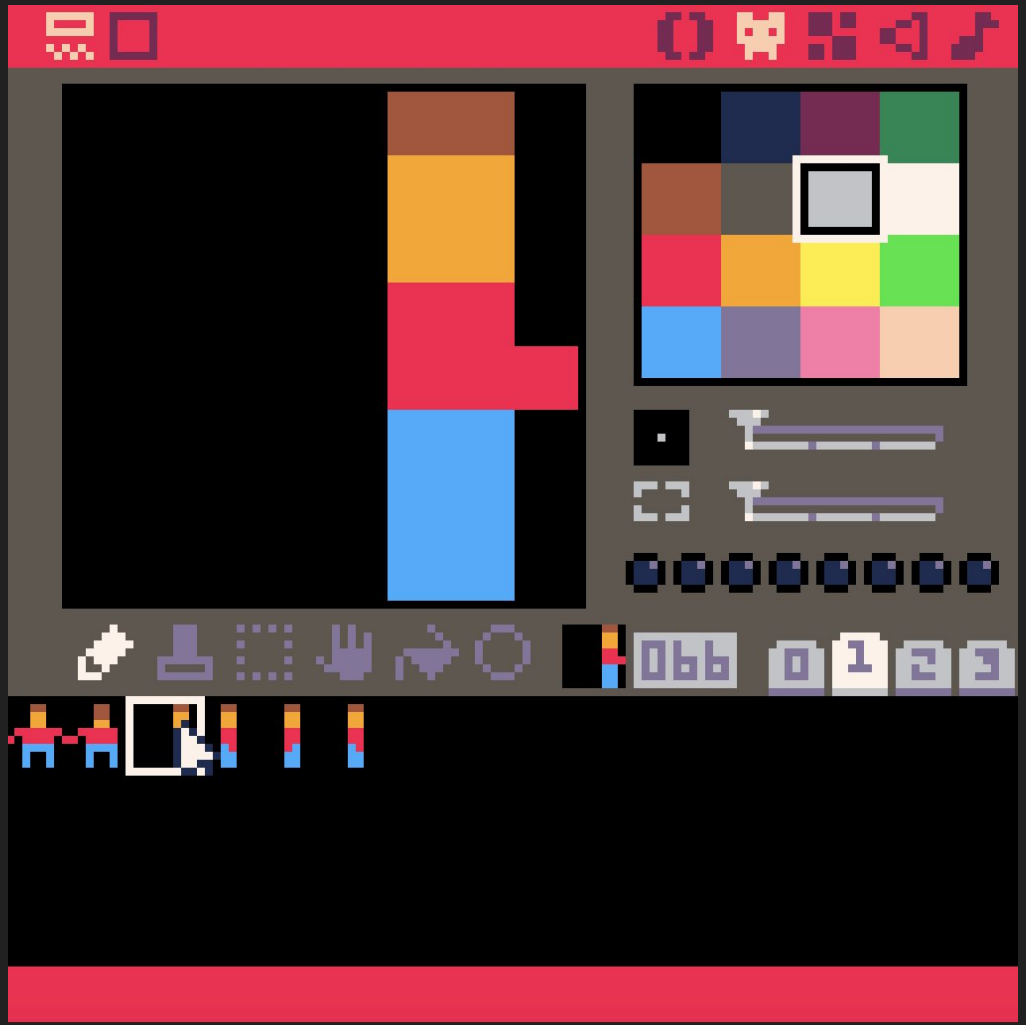


I’ve drawn a bunch of sprites for my map tiles



I’ve drawn player sprites on a separate tab

It’s a good idea to *draw frames for an animation on consecutive sprite sheet slots*

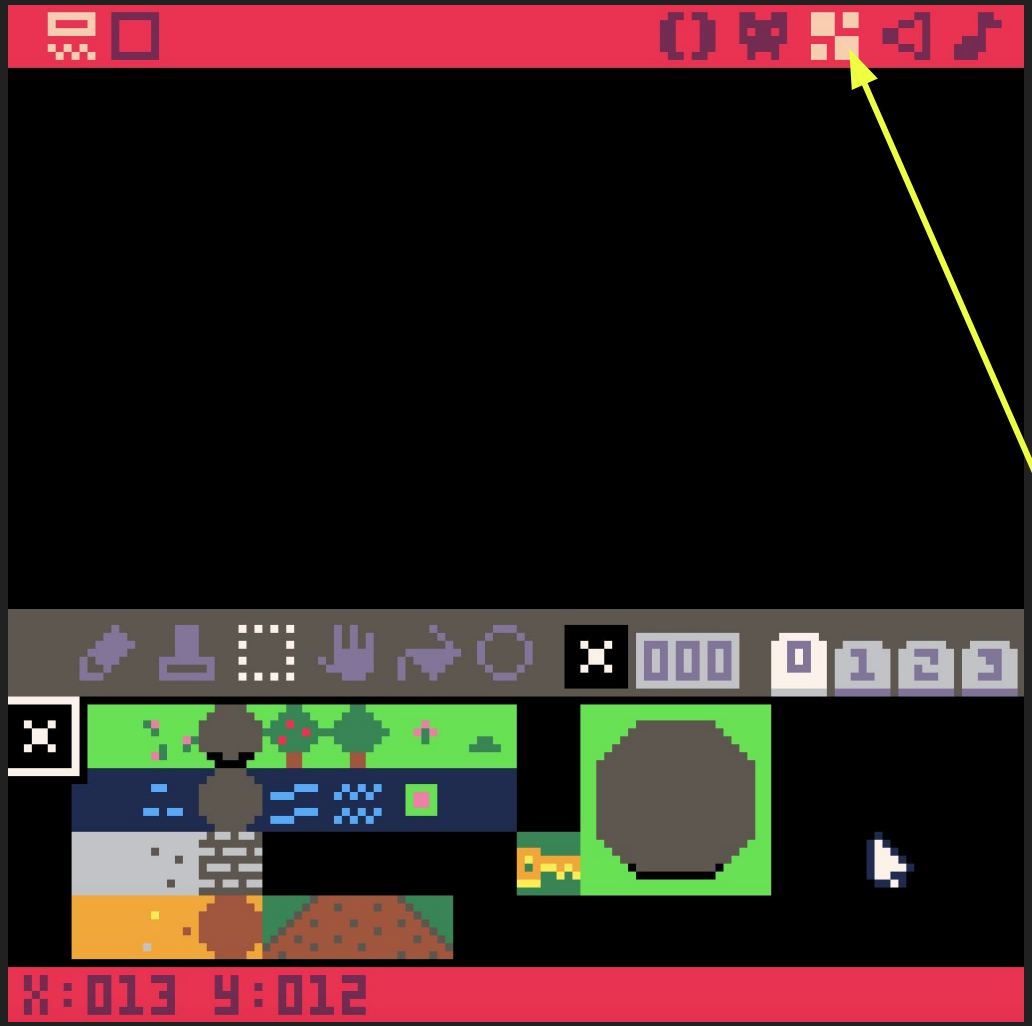


If a sprite will face both left and right (and is symmetrical), *you only need to draw it facing in one direction*

You can use code to flip the sprite on either axis

Using the Map Editor

Download Assets File: topdown_00_assets_only

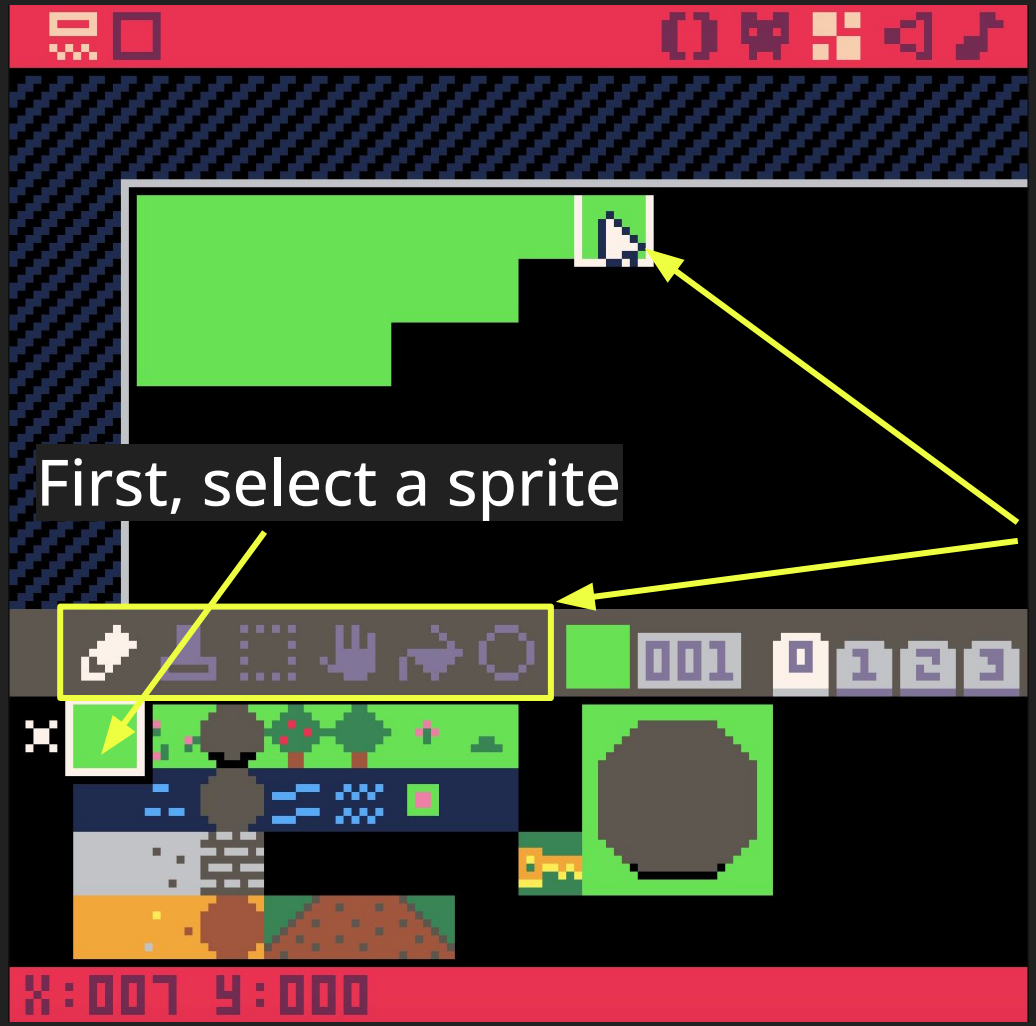


You can use your sprites to draw map tiles in the map editor – *navigate to the map editor by selecting the third option in the top right navigation*

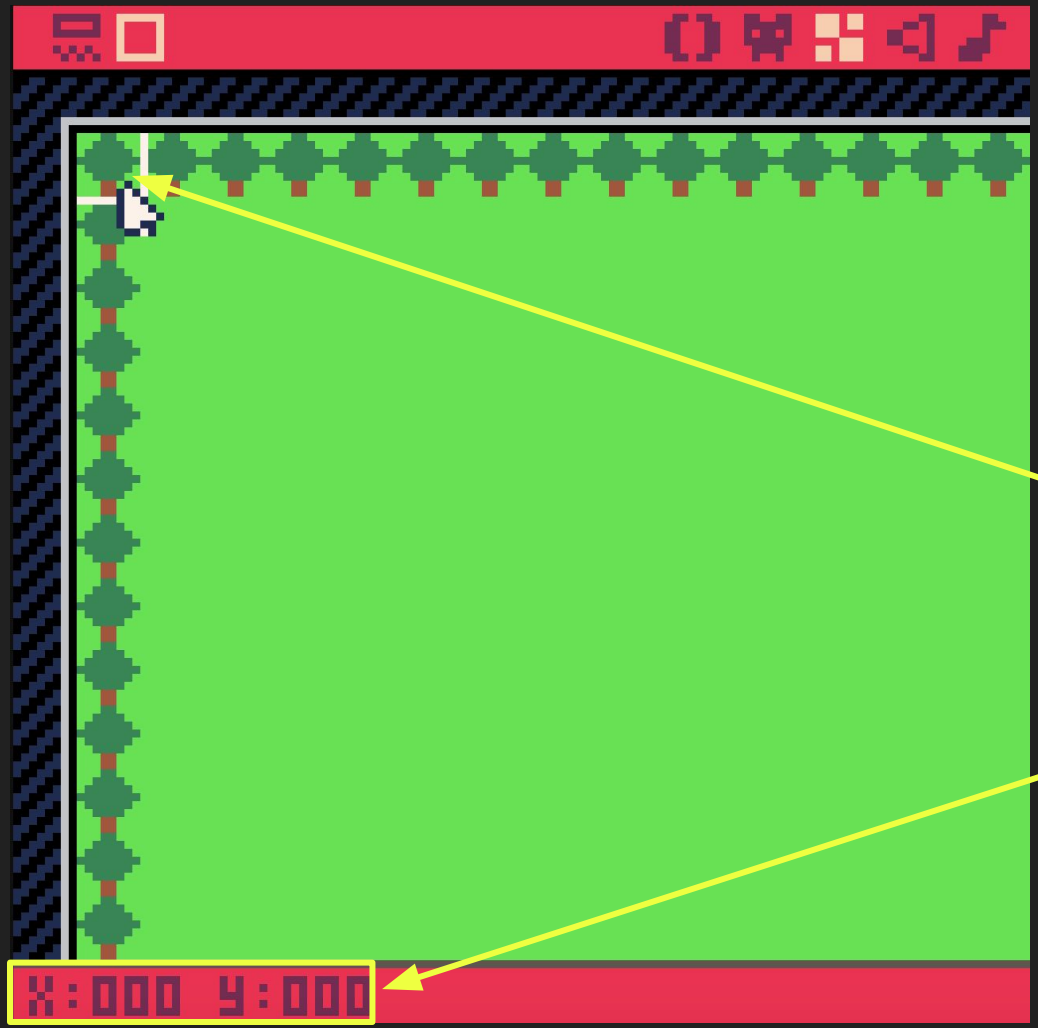
The map may not be apparent at first because it is blank and zoomed in

Scroll down to zoom out

(And scroll up to zoom back in)



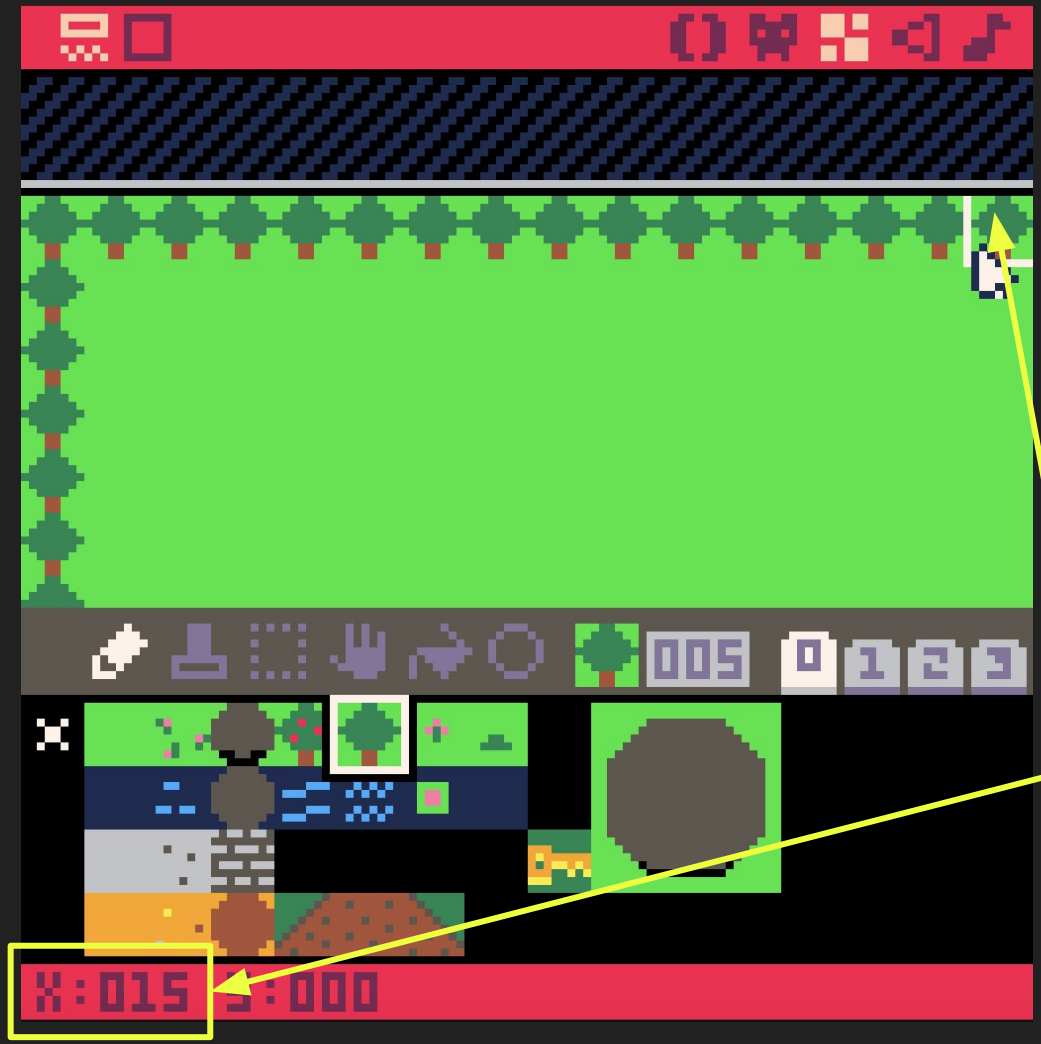
Then use the drawing tools (similar to those in the sprite editor) to paint with sprites in the map editor



Each map screen (as it will display in the game) is 16x16 tiles

But the top-left origin starts at 0,0

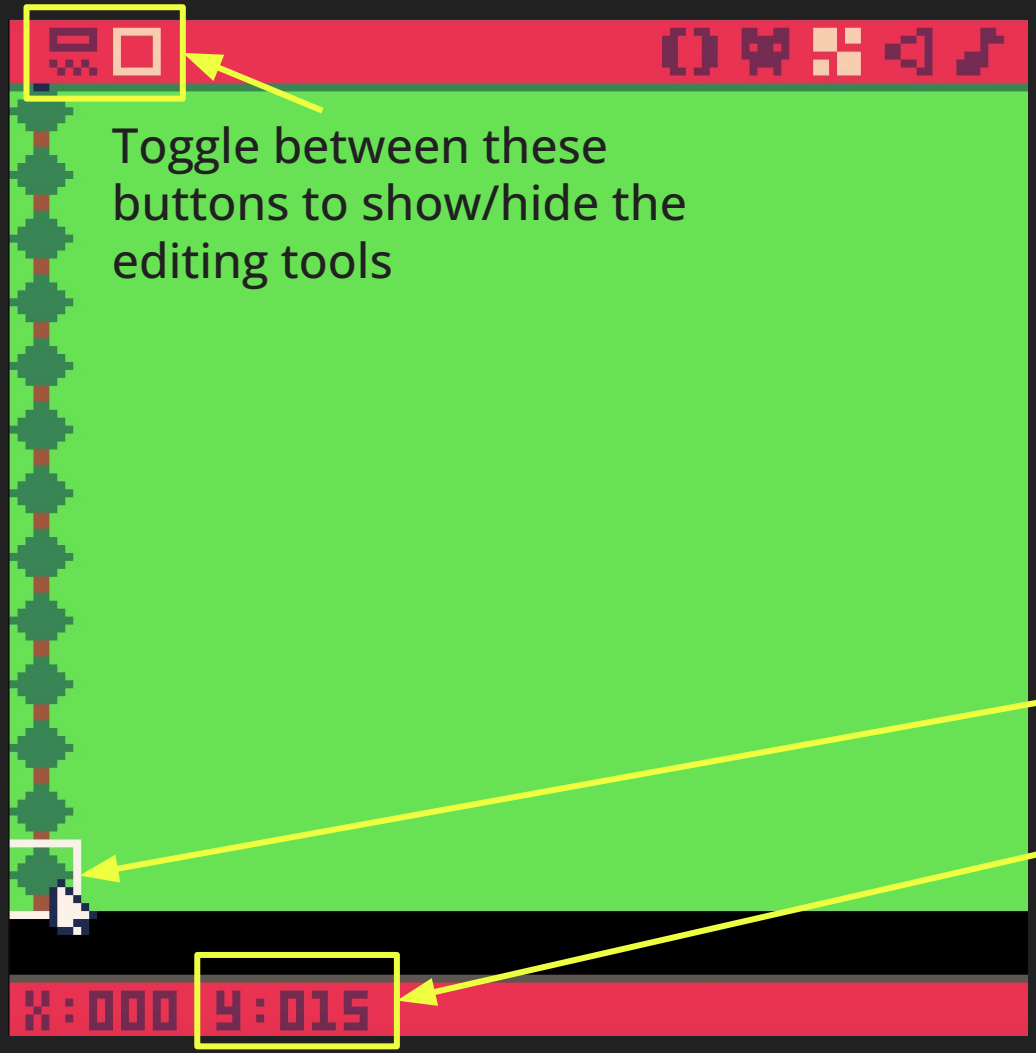
You can see the x,y coordinates of a selected tile in the bottom left of the map editor



Each map screen (as it will display in the game) is 16x16 tiles

But the top-left origin starts at 0,0

So the last tile on the first screen will have a value of ***15***



Each map screen (as it will display in the game) is 16x16 tiles

But the top-left origin starts at 0,0

So the last tile on the first screen will have a value of ***15***

I’ve added a variety of objects to give context to the player’s movement

Mouse over a map tile to see its x,y position in the bottom left

This can be helpful for determining the player's starting position

Types of Movement

Types of Movement

- For a top-down game, there are two types of movement you can choose between:
  - Tile-based movement (8 pixels at a time)
  - Pixel-based movement (a smaller number of pixels at a time)

Tile-Based vs. Pixel-Based Movement

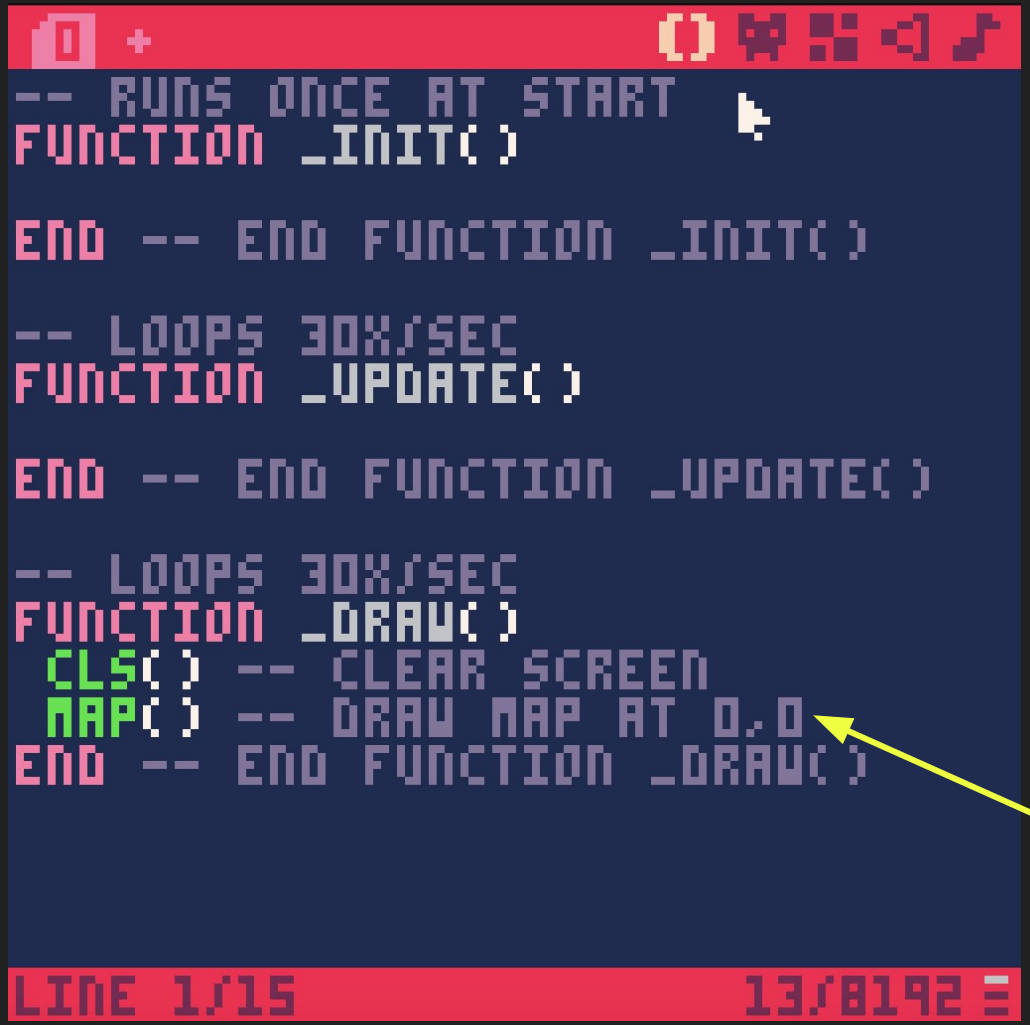
- Tile-based movement
  - 8 pixels at a time
  - Pros: Easier to implement
  - Cons: Less nuance in movement
  - Best for: games without an emphasis on real-time reaction (exploration and collection)
- Pixel-based movement
  - A smaller number of pixels at a time
  - Pros: More nuance in movement
  - Cons: More work for collision detection
  - Best for: games requiring real-time reaction (action, shooting)

Types of Movement

- Whichever type of movement you choose, it’s a good idea to make your character and map sprites the same size
- For tile-based movement, it’s a good idea to make your sprites move the same number of tiles as their size

Tile-Based Movement

Download Example File: topdown_01_tilebased_movement_and_collision.p8

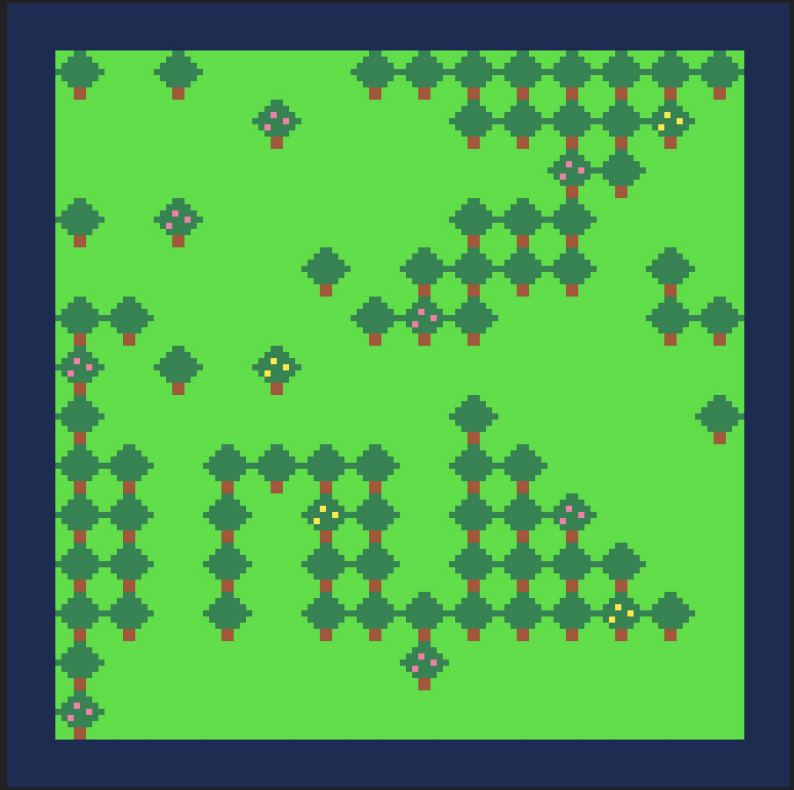


Create an empty game loop (the _init, _update, and _draw functions)

Use the **map()** function in **_draw()** to show the map

```
-- RUNS ONCE AT START
FUNCTION _INIT()

END -- END FUNCTION _INIT()

-- LOOPS 30X/SEC
FUNCTION _UPDATE()

END -- END FUNCTION _UPDATE()

-- LOOPS 30X/SEC
FUNCTION _DRAW()
 CLS() -- CLEAR SCREEN
 MAP() -- DRAW MAP AT 0,0
END -- END FUNCTION _DRAW()
```

LINE 1/15 13/8192



Use the map() function in **_draw()** to show the map

In the map editor, you can see the coordinates for a selected tile in the bottom left

7,3 looks like a good place to start my player

I'll create a function to make my player on a separate tab

The player sprite number was 64

And its x,y coordinates on the map were 7,3

```
-- TILE COORDINATES
PLYR.X=7
PLYR.Y=3

FUNCTION _DRAW()
 CLS()
 MAP()
 SPR(PLYR.N,PLYR.X,PLYR.Y)
END
```

However, when I plug these x,y coordinates into the spr() function, *my player does not appear at the expected position*

This is because the map editor uses **tile** values, but the spr() function uses ***pixel*** values

Each tile is 8x8 pixels, so *we need to convert the tile value into a pixel value*

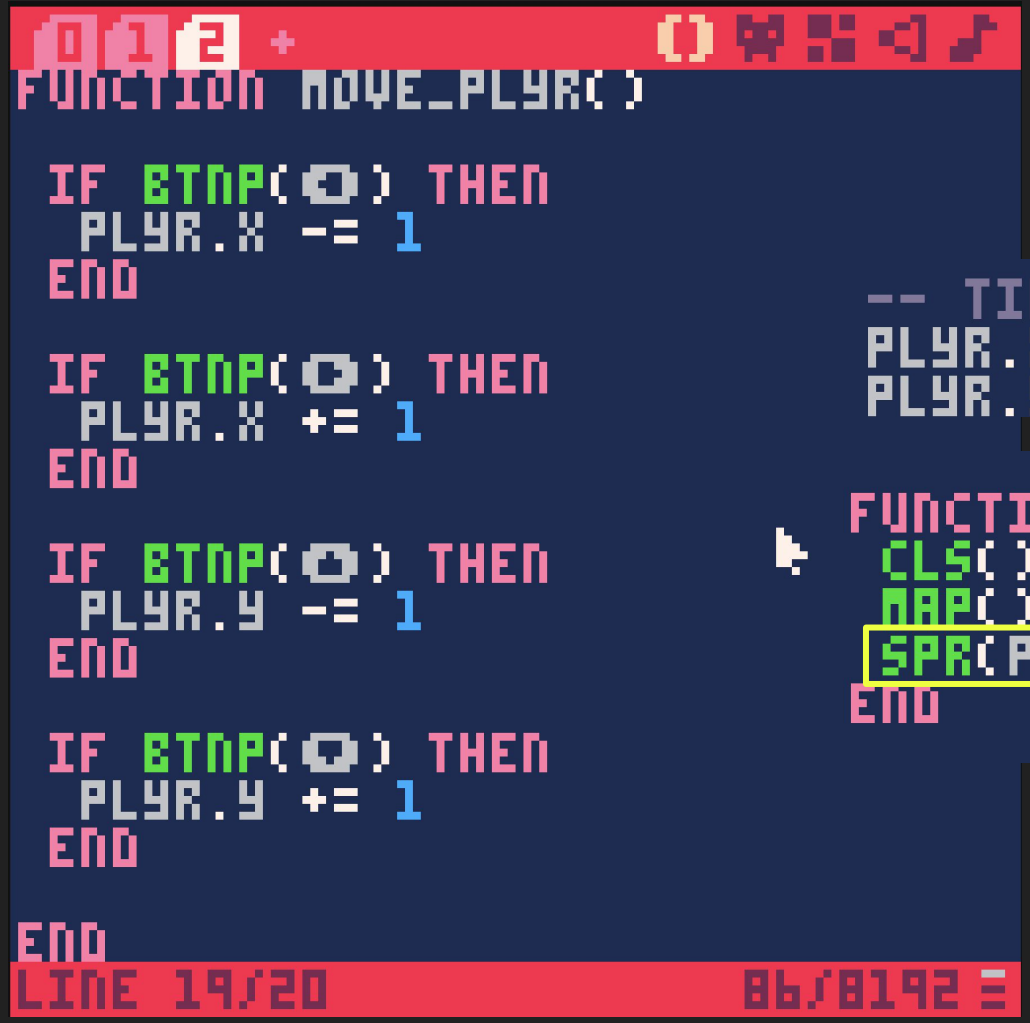
Tile Values vs. Pixel Values

- The map uses tile values
- But the spr() function uses pixel values
- Each map tile is 8x8 pixels square
- So we need to *convert from tiles to pixels*
- **We can multiply tile values by 8 to get the pixel value**


7 tiles * 8 pixels each = 56 pixels
3 tiles * 8 pixels each = 24 pixels
8 8
8 16
8 24
8 32
8 40
8 48
8 56
16 8
16 16
16 24
16 32
16 40
16 48
16 56
24 8
24 16
24 24
24 32
24 40
24 48
7,3
24 56

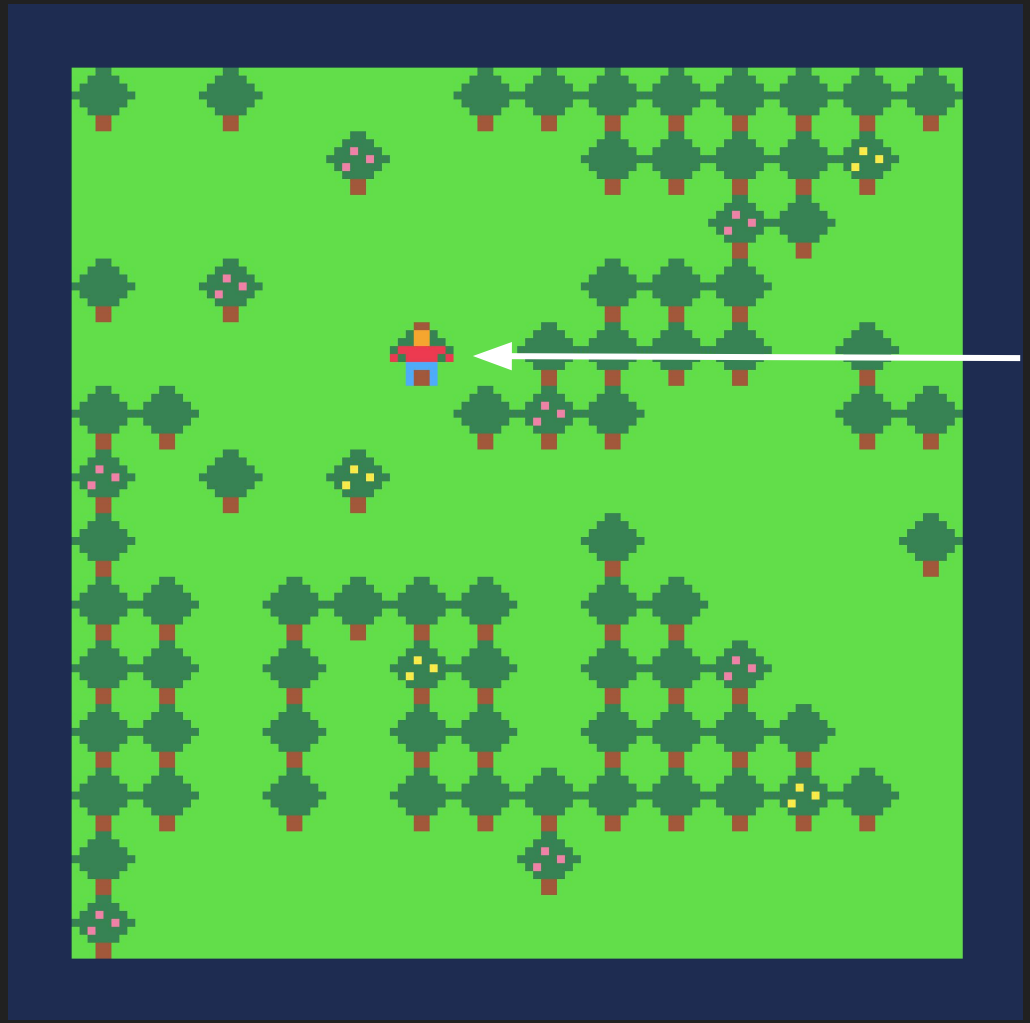
For *tile based movement*, leave the player's x,y coordinates as tile values in your make_plyr() function, and *do the conversion directly in the spr() function*, multiplying x and y by 8 to provide a pixel value

Moving the player by 1 tile will move them by 8 pixels




```
-- TILE COORDINATES
PLYR.X=1
PLYR.Y=3

FUNCTION _DRAW()
 CLS()
 MAP()
 SPR(PLYR.N,PLYR.X*8,PLYR.Y*8)
END
```

Moving the player by 1 tile will move them by 8 pixels



Of course, we haven’t implemented collision yet, so our player will still go through tiles that look like they should be solid

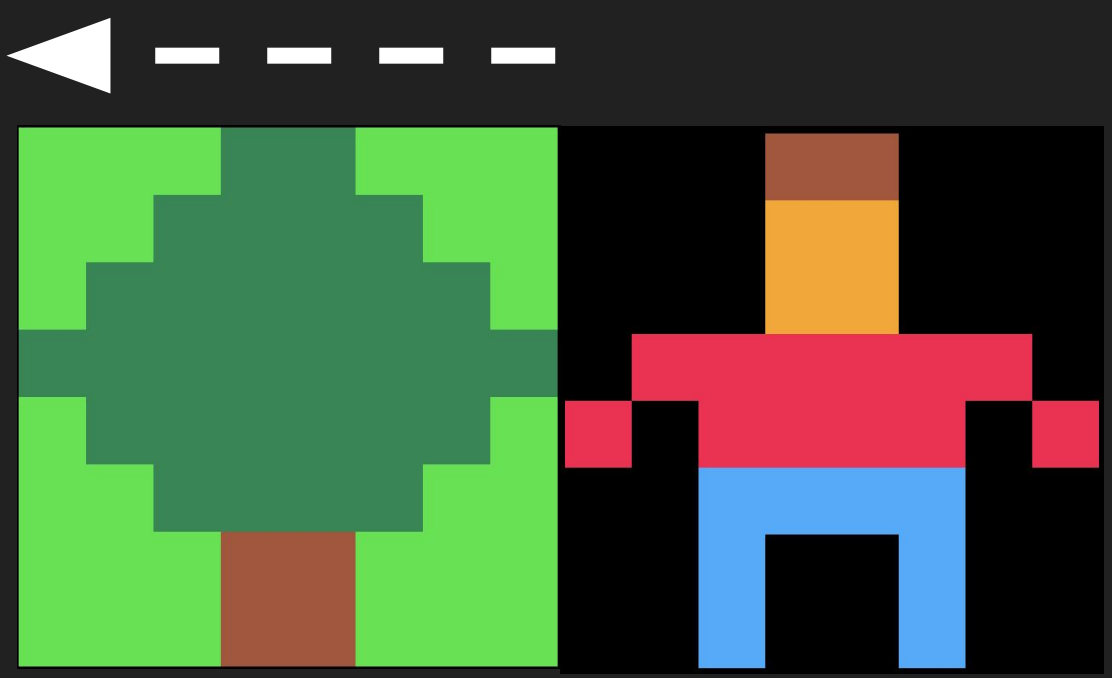
Implementing Collision with Map Tiles

Download Example File: topdown_01_tilebased_movement_and_collision.p8

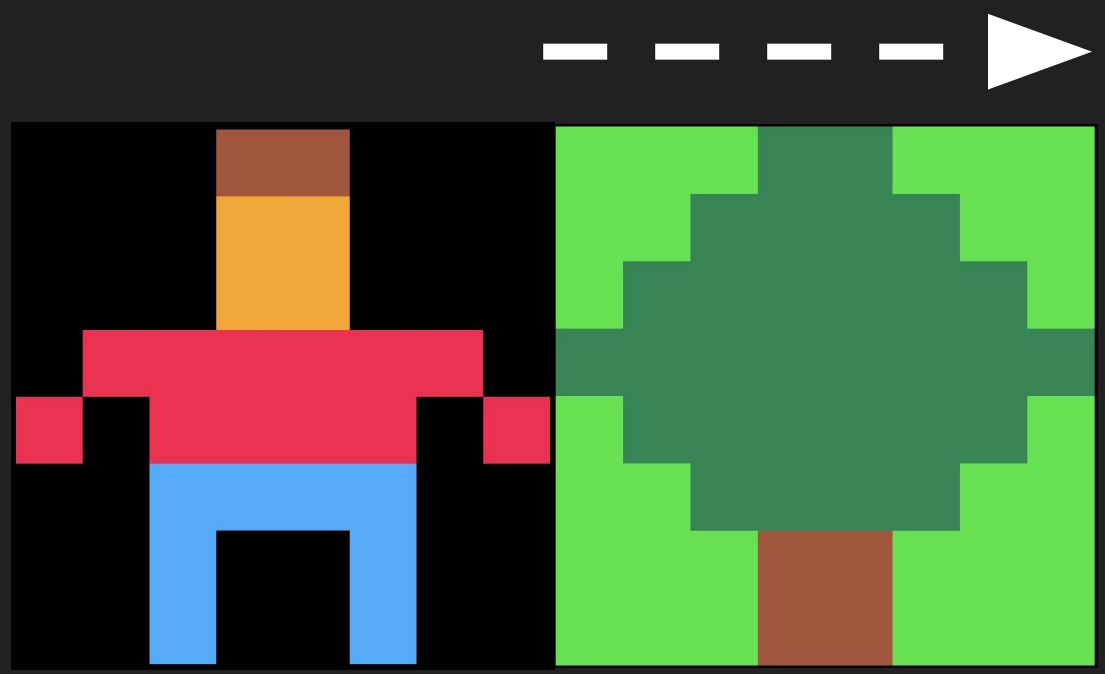
Implementing Collision with Map Tiles

- PICO-8 has a function called mget() that takes an **x,y location** and finds the **sprite number** at that location
- So if we know that sprite number **5** is a tree, and trees should not be walked through, all we need to do is calculate the x,y position of the tree tile

plyr.x - 1



- To calculate the location of a tree tile to the left of the player, we can express the tile's x coordinate as plyr.x - 1
- The tree has the same y coordinate as the player: plyr.y

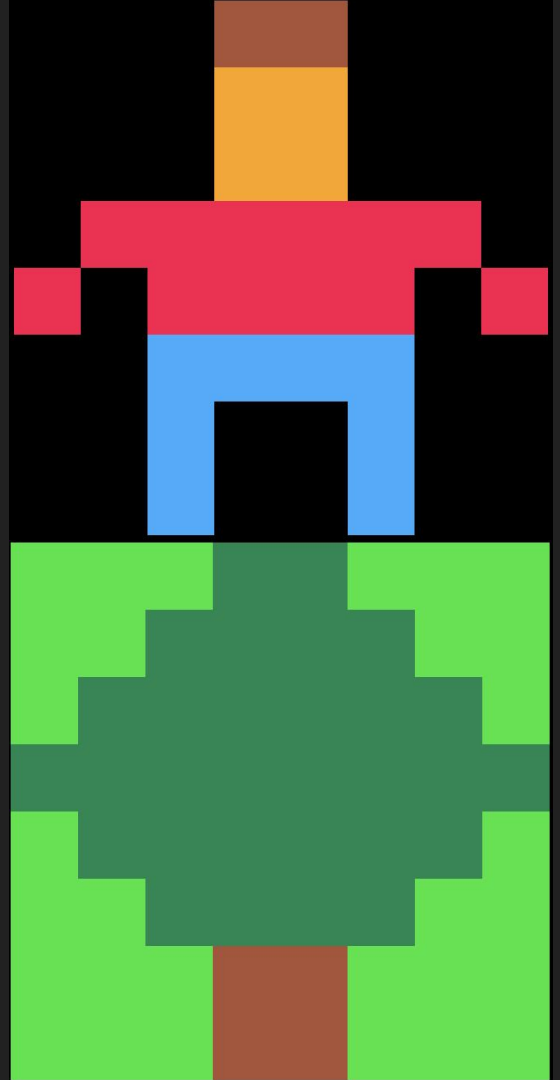


- To calculate the location of a tree tile to the right of the player, we can express the tile's x coordinate as plyr.x + 1
- The tree has the same y coordinate as the player: plyr.y

plyr.y - 1

To calculate the location of a tree tile above the player, we can express the tile's y coordinate as plyr.y - 1

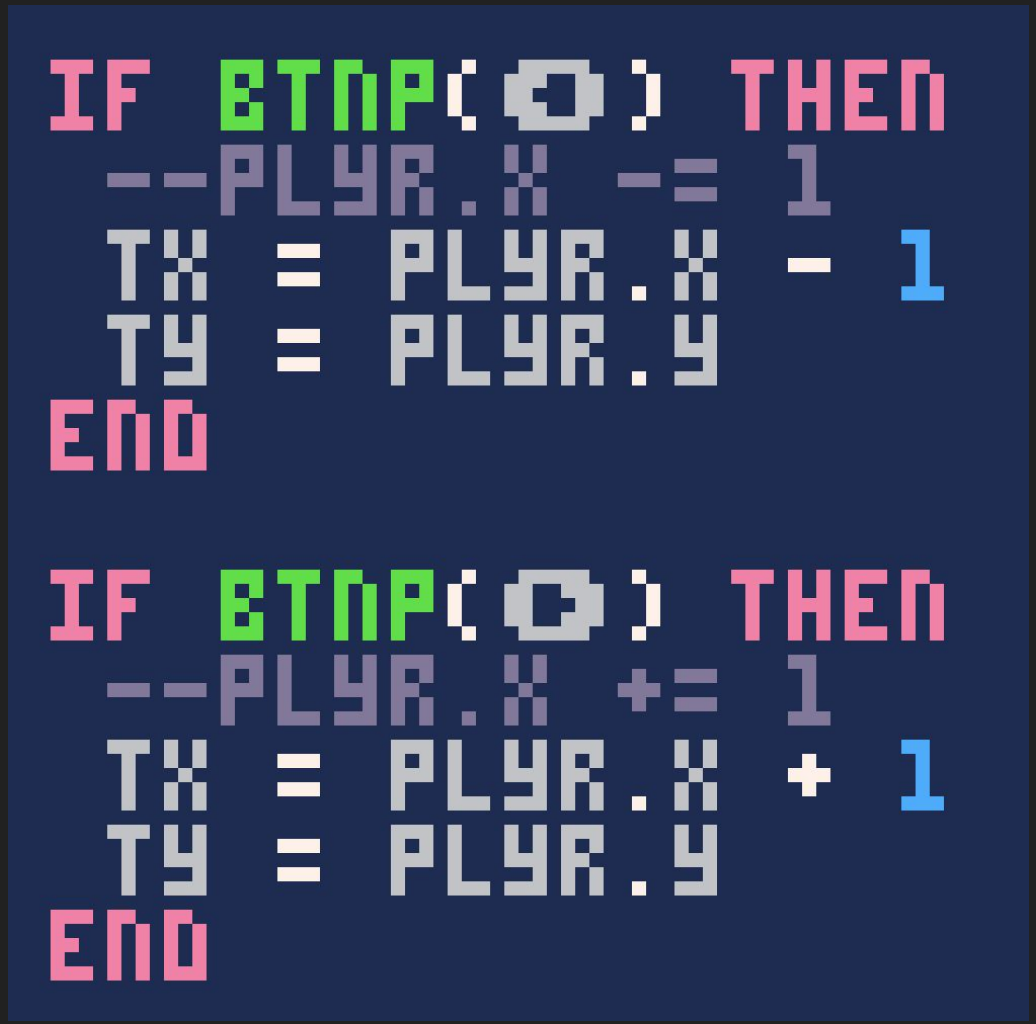
The tree has the same x coordinate as the player: plyr.x



plyr.y + 1

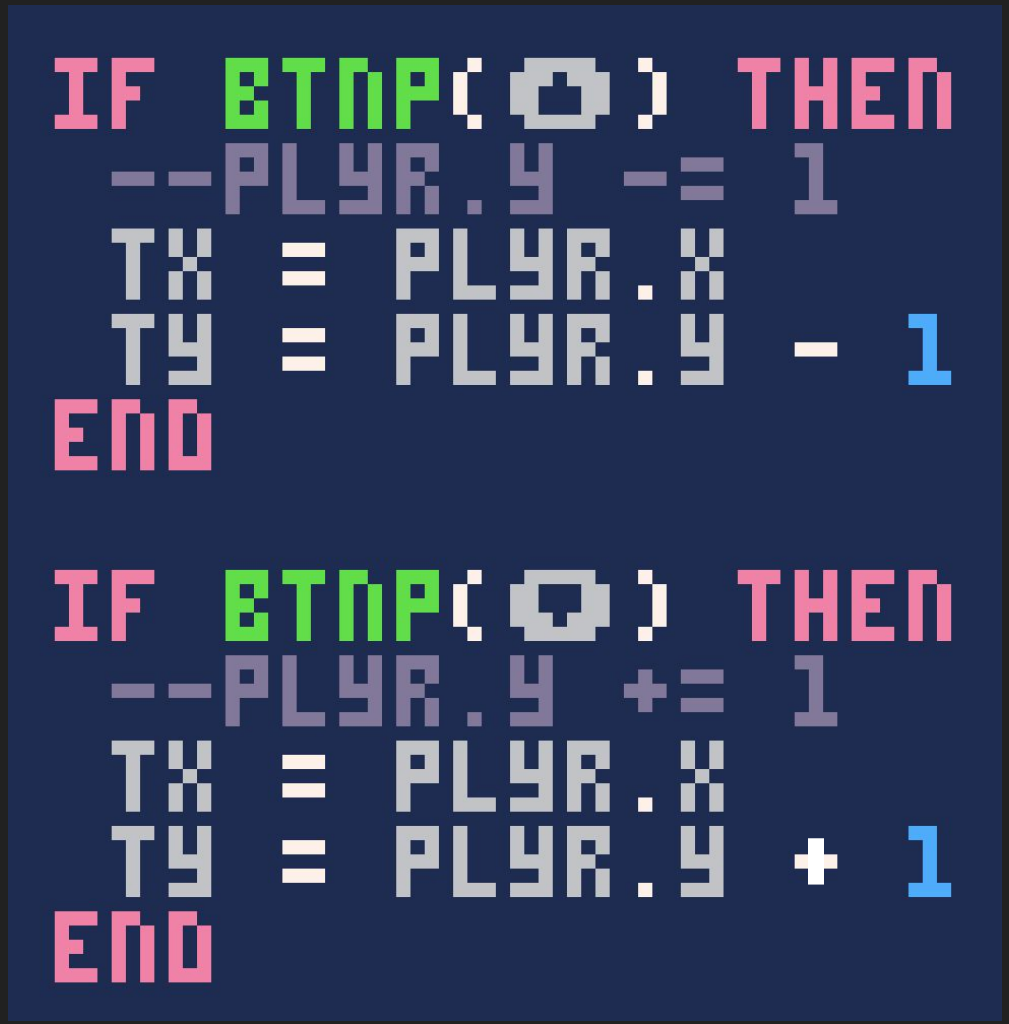
To calculate the location of a tree tile below the player, we can express the tile's y coordinate as plyr.y + 1

The tree has the same x coordinate as the player: plyr.x



We can use the variables **tx** and **ty** to track the player's target position based on which arrow key is being pressed, offsetting by 1 tile

Don't forget to declare tx and ty in _init() – I just set them equal to the player's x and y position initially



We can use the variables **tx** and **ty** to track the player's target position based on which arrow key is being pressed, offsetting by 1 tile

Don't forget to declare tx and ty in _init() – I just set them equal to the player's x and y position initially

```
IF BTNP(0) THEN
 --PLYR.Y -= 1
 TX = PLYR.X
 TY = PLYR.Y - 1
END

IF BTNP(0) THEN
 --PLYR.Y += 1
 TX = PLYR.X
 TY = PLYR.Y + 1
END

TILE_SPRITE_NUMBER=MGET(TX,TY)
```

Once we've calculated **tx** and **ty**, we can plug them into the mget() function to *get the sprite number of the tile the player is trying to move to* (trees are 5 in my example)

```
IF BTNP(🅾️) THEN
 --PLYR.Y += 1
 TX = PLYR.X
 TY = PLYR.Y + 1
END

TILE_SPRITE_NUMBER=MGET(TX,TY)
TREE=5

-- MOVE TO TARGET LOCATION IF
-- TILE IS NOT A TREE
IF TILE_SPRITE_NUMBER != TREE
THEN
 PLYR.X = TX
 PLYR.Y = TY
END -- END IF
```

Then once we know the sprite number, we can *move the player to the target location (tx,ty) only if the sprite number does not belong to a tree*

```
TILE_SPRITE_NUMBER=MGET(TX,TY)
```

```
TREE=5
TREE2=6
TREE3=7
ROCK=3
ROCK2=51
WALL=35
```

But what about all our other solid tiles?
This would require a lot of **OR** statements

... fortunately, there's a better way!

```
-- MOVE TO TARGET LOCATION IF
-- TILE IS NOT A TREE
IF TILE_SPRITE_NUMBER != TREE
THEN
  PLYR.X = TX
  PLYR.Y = TY
END -- END IF
```

PICO-8 has a feature in the Sprite Editor called “**flags**” which you can use to label or categorize tiles

Each flag has a corresponding number which you can track using code

Using Sprite Flags for Collision

Navigate to the **sprite editor** (not the map editor)

Click on a sprite – you'll see eight dots here – these are called sprite "**flags**" which are like labels

Click on a dot to turn that flag on

Each **flag** has a corresponding **number**, starting with **0**, which you can see in the **bottom left corner**

Turn on the same flag for all map tiles that you want to be **solid** (*that the player cannot move through*)

Using Sprite Flags for Collision

- Sprite flags are like labels
- Use the ***same flag*** to denote ***solid tiles***
- You can then use code to check whether the player is trying to move to a solid tile

Implementing Collision with Map Tiles

- PICO-8 has another function called fget() that takes a **sprite number** and finds whether a **flag** is turned **on**
- We can use this in conjunction with mget() to implement our map collision

Implementing Collision with Map Tiles

Calculate **tx**,**ty**

mget(**tx**,**ty**) = **sprite_number**

fget(**sprite_number**,flag_number) = **true or false**

```
-- SPRITE NUMBER OF TILE THE
-- PLAYER IS TRYING TO GO TO
TILE_SPRITE_NUMBER=MGET(TX,TY)

-- FOR SHORTER VARIABLE NAME
TSN=TILE_SPRITE_NUMBER

-- FLAG NUMBER FOR SOLID TILES
SOLID = 0

-- RETURNS TRUE OR FALSE
IS_SOLID=FGET(TSN,SOLID)

-- MOVE TO TARGET LOCATION IF
-- TILE IS NOT A TREE
IF IS_SOLID == FALSE THEN
 PLYR.X = TX
 PLYR.Y = TY
END -- END IF
```

LINE 42/45 149/8192

We plug the calculated **tx** and **ty** values into the mget() function, which returns the **sprite number** of the tile

Then we can **plug the tile's sprite number** into the fget() function – *along with the **flag number** we used, which was* **0** – to return **true** or **false**

Then we can *only move the player to the target position if **is_solid** is **false***

Collecting Items

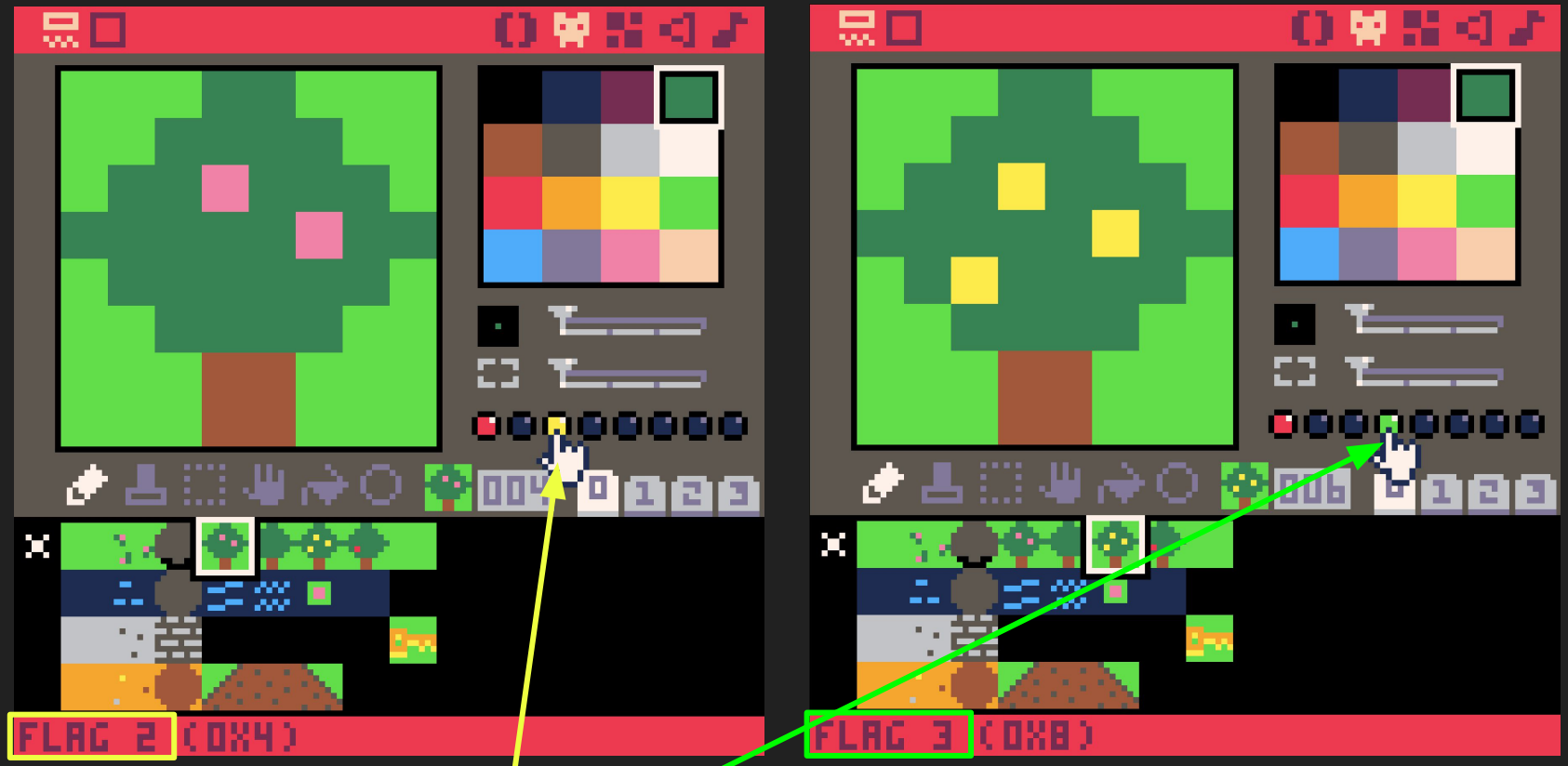
Download Example File: topdown_02_item_collection.p8

Collecting Items

- We can use sprite flags along with the mget() and fget() functions to implement item collection as well

*A sprite can have **multiple flags** turned on at once*

I can turn on flag 0 to treat this tree as a solid tile, but ***also*** turn on ***flag 1*** to indicate that it has a ***collectible*** property



I'll turn on flags **2** and **3** to indicate that the player will ***collect greater amounts of fruit*** from these trees

```
-- COLLECTIBLE FRUIT FLAGS
FRUIT1 = 1
FRUIT2 = 2
FRUIT3 = 3

IS_FRUIT1 = FGET(TSN,FRUIT1)
IS_FRUIT2 = FGET(TSN,FRUIT2)
IS_FRUIT3 = FGET(TSN,FRUIT3)

-- PRESS X NEAR TREE TO
-- COLLECT FRUIT
IF BTNP(❎) THEN
 IF IS_FRUIT1 THEN
  FRUIT += 1
 ELSEIF IS_FRUIT2 THEN
  FRUIT += 2
 ELSEIF IS_FRUIT3 THEN
  FRUIT +=3
 END -- END IF IS_FRUIT1/2/3
```

LINE 62/66 220/8192

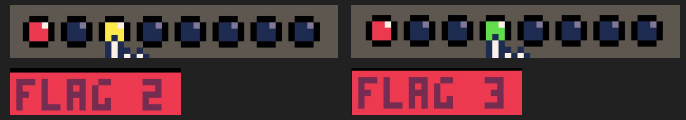
```
-- SPRITE NUMBER OF TILE THE
-- PLAYER IS TRYING TO GO TO
TILE_SPRITE_NUMBER=MGET(TX,TY)

-- FOR SHORTER VARIABLE NAME
TSN=TILE_SPRITE_NUMBER

-- FLAG NUMBER FOR SOLID TILES
SOLID = 0

-- RETURNS TRUE OR FALSE
IS_SOLID=FGET(TSN,SOLID)

-- MOVE TO TARGET LOCATION IF
-- TILE IS NOT A TREE
IF IS_SOLID == FALSE THEN
 PLYR.X = TX
 PLYR.Y = TY
END -- END IF
```

LINE 42/45 149/8192

Then, similarly to checking solid tiles, I can check whether a tile is a collectible tile

```
-- COLLECTIBLE FRUIT FLAGS
FRUIT1 = 1
FRUIT2 = 2
FRUIT3 = 3

IS_FRUIT1 = FGET(TSN,FRUIT1)
IS_FRUIT2 = FGET(TSN,FRUIT2)
IS_FRUIT3 = FGET(TSN,FRUIT3)

-- PRESS X NEAR TREE TO
-- COLLECT FRUIT
IF BTNP(❎) THEN
 IF IS_FRUIT1 THEN
  FRUIT += 1
 ELSEIF IS_FRUIT2 THEN
  FRUIT += 2
 ELSEIF IS_FRUIT3 THEN
  FRUIT +=3
 END -- END IF IS_FRUIT1/2/3
```

Set variables for each fruit tree's **flag number**



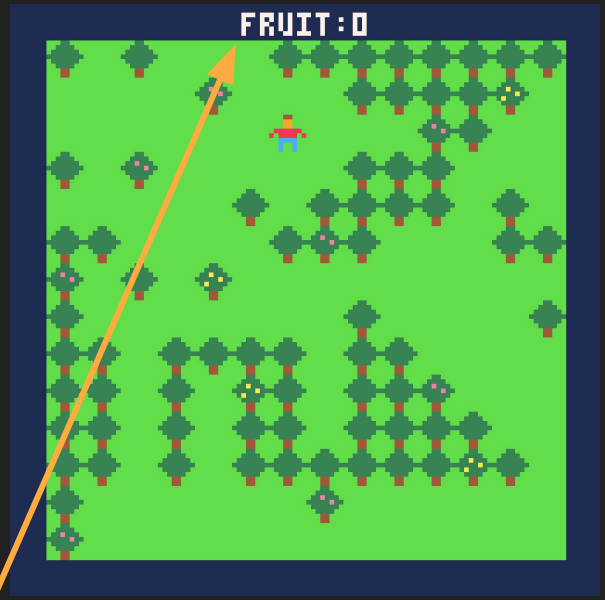
Plug in the sprite number of the tile the player's trying to collect from (stored as TSN here) as well as the **flag** for the fruit sprite

Then let the player interact with a tile by pressing X

If the tile is a fruit tree, increase the fruit count

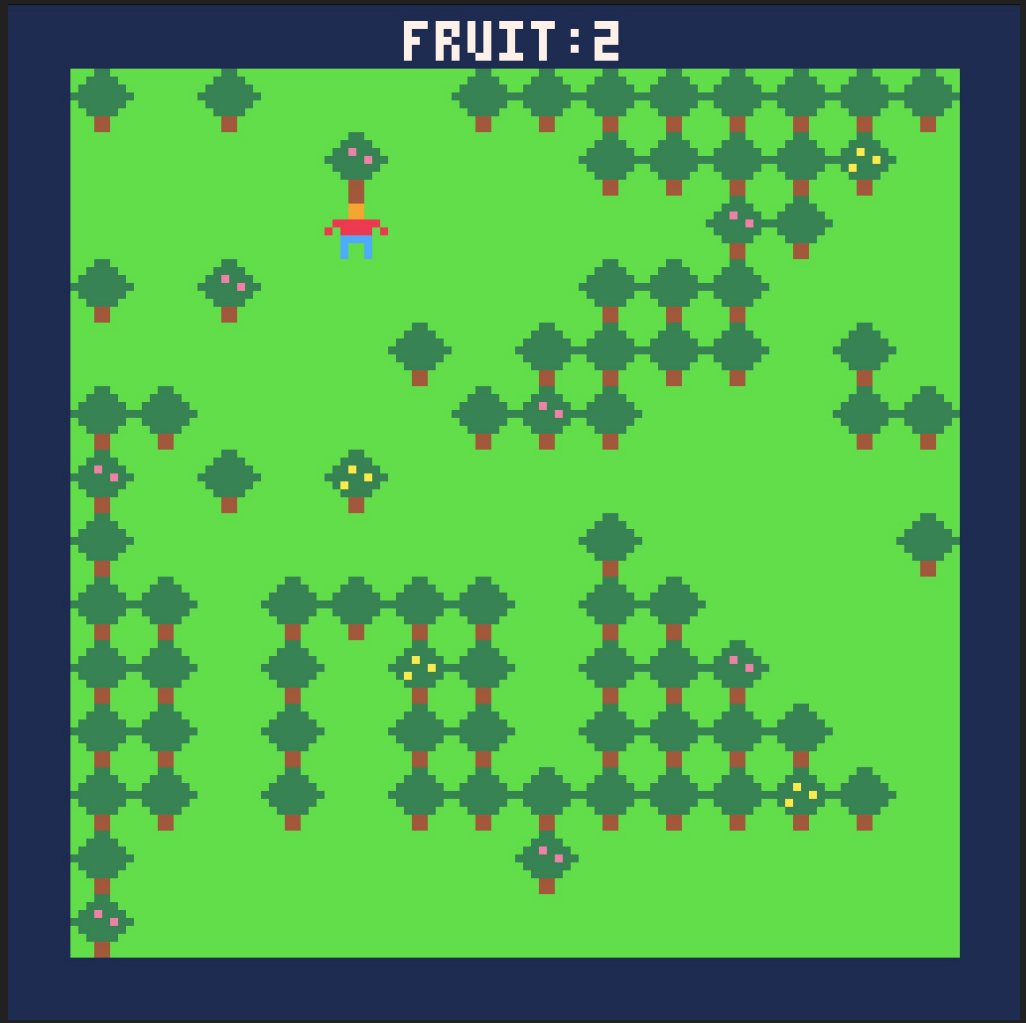
I added a variable called **fruit** in _init() and set **fruit = 0**

```
function _init()
 make_plyr() -- tab 1
 tx = plyr.x
 ty = plyr.y

 -- inventory
 fruit = 0
end
```




```
print("fruit:"..fruit,50,2,7)
```

I declared **fruit** in _init() and added a print() statement in _draw() to **output the value** through the HUD



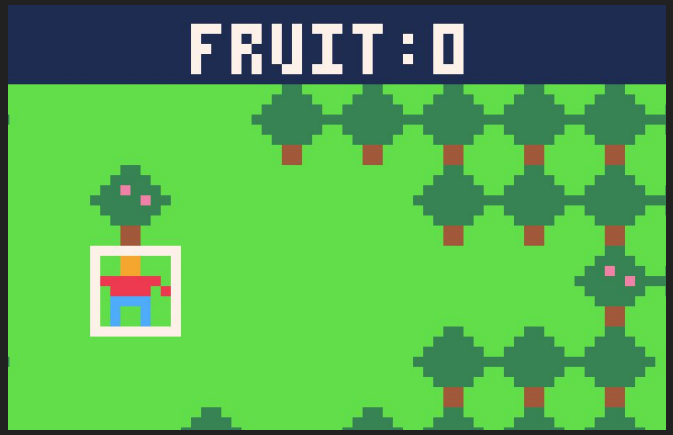
I can press X next to a fruit tree to increase my fruit count, *but it doesn't always work ...*

Why could this be?

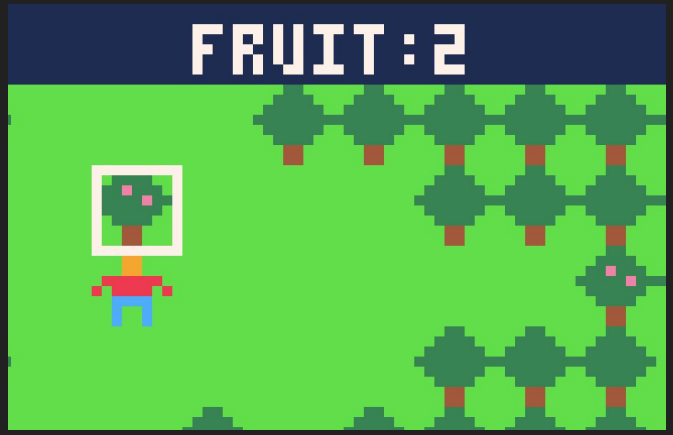
```
function _draw()
 cls()
 map()
 spr(plyr.n,plyr.x*8,plyr.y*8)

 -- draw a box over the
 -- target position
 rect(tx*8,ty*8,8+tx*8,8+ty*8)

 print("fruit:"..fruit,50,2,7)
end
```

I multiplied tx and ty by 8 to convert from tiles to pixels, and added 8 to the second pair of coordinates to draw the other sides of the box

To better understand where our code is checking for a fruit tile, let's draw a box around the target position



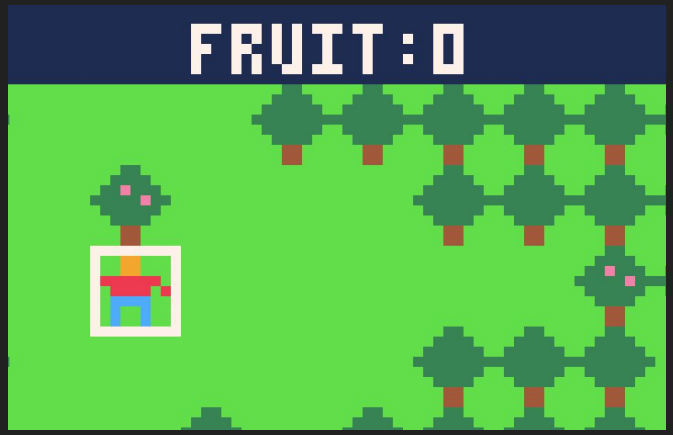
If I approach from below by pressing up until I reach the tree, I will fail to collect fruit because my target position is one tile short

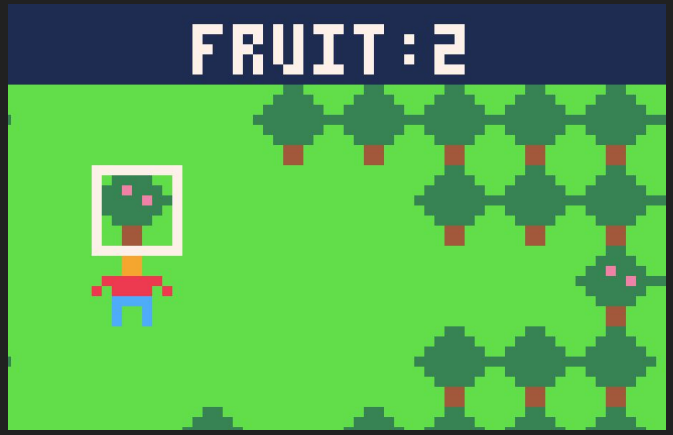


But if I press up once more, I can collect it

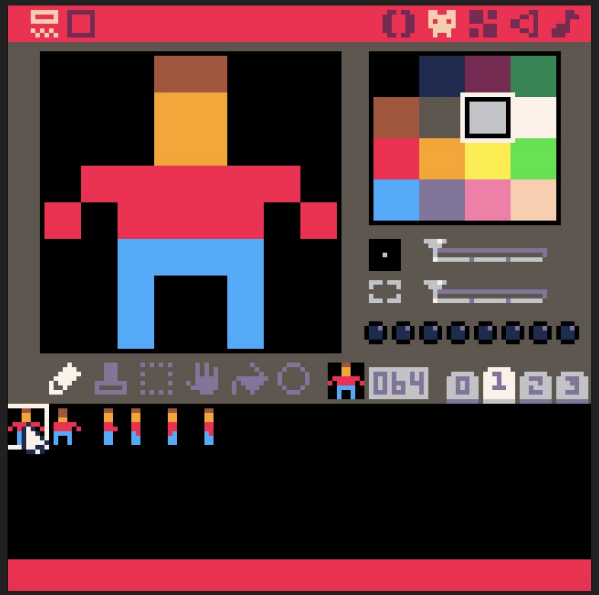
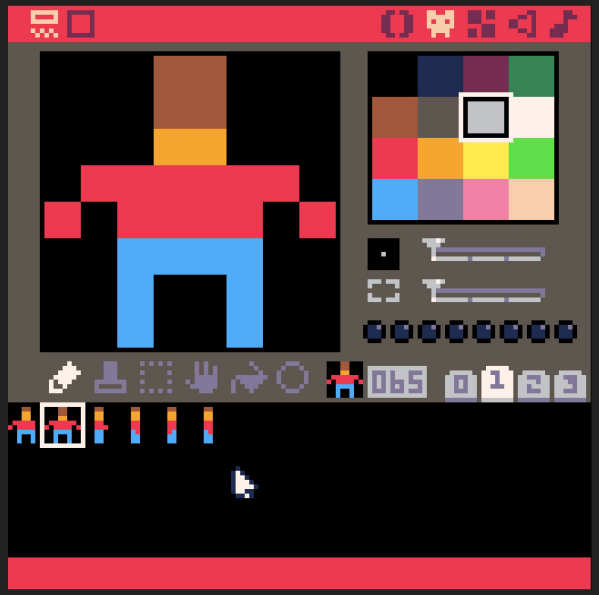
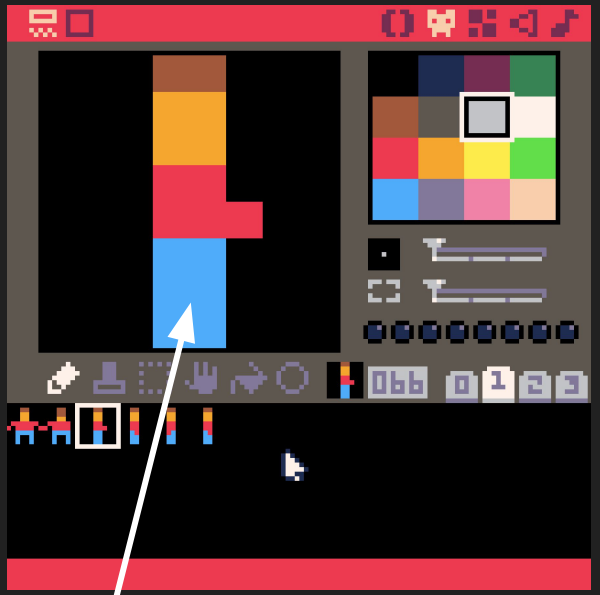
Collecting Items

- The problem is that tx and ty (which I am using to find the location of fruit tiles) are *only being updated when the player is moving*
- If the player ***stops***, we ***still need to know the location of the next tile in the direction they are facing***, in order to collect fruit



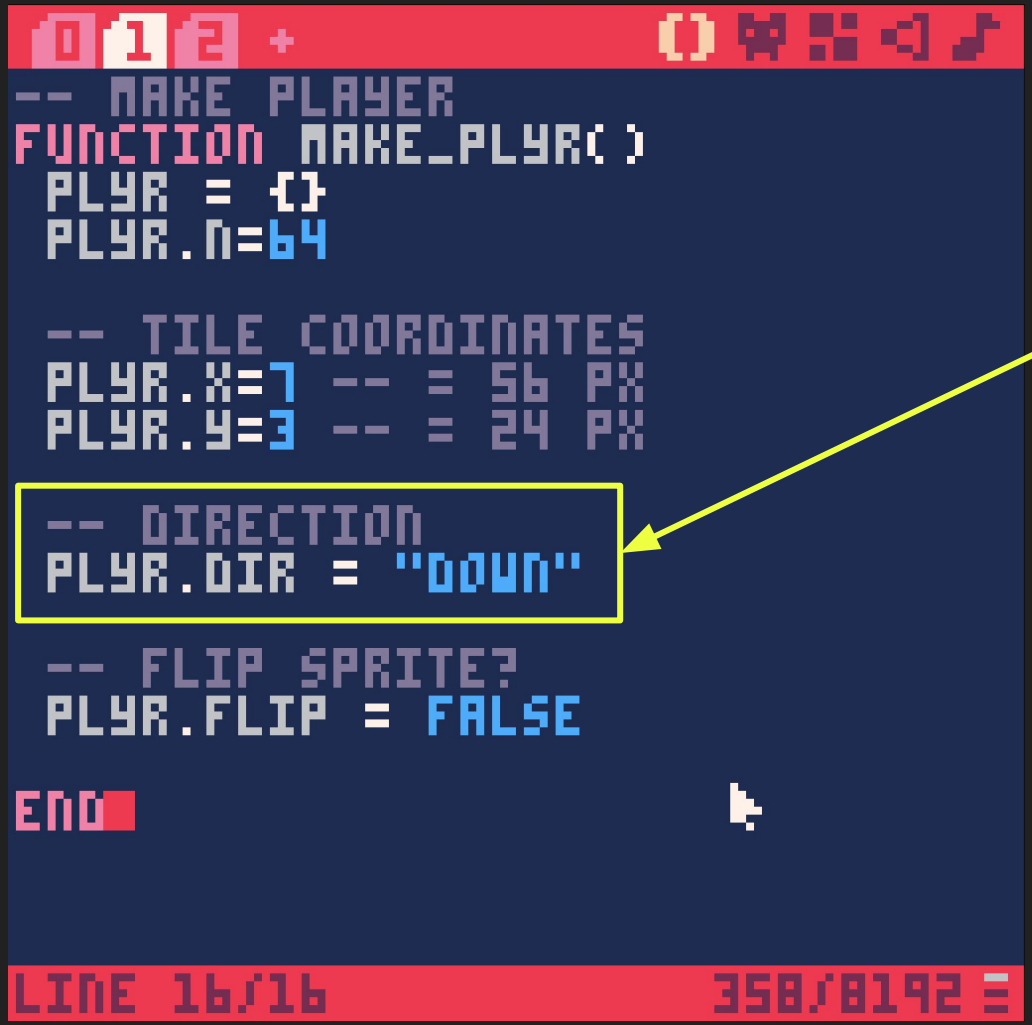


It would also help us solve this problem if we could see which direction the player is facing

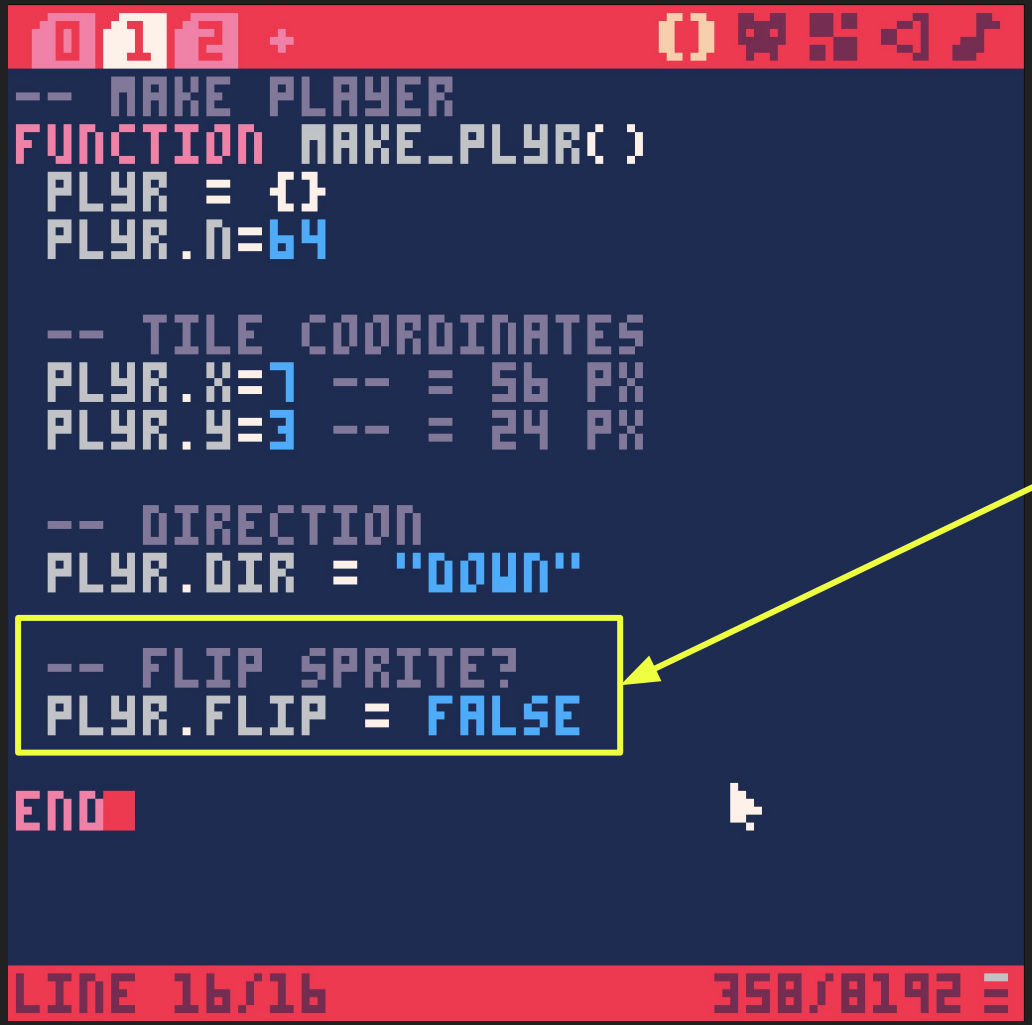
I’ve drawn player sprites for facing different directions

*(I did not draw one facing left, because I can **flip** a sprite using code)*

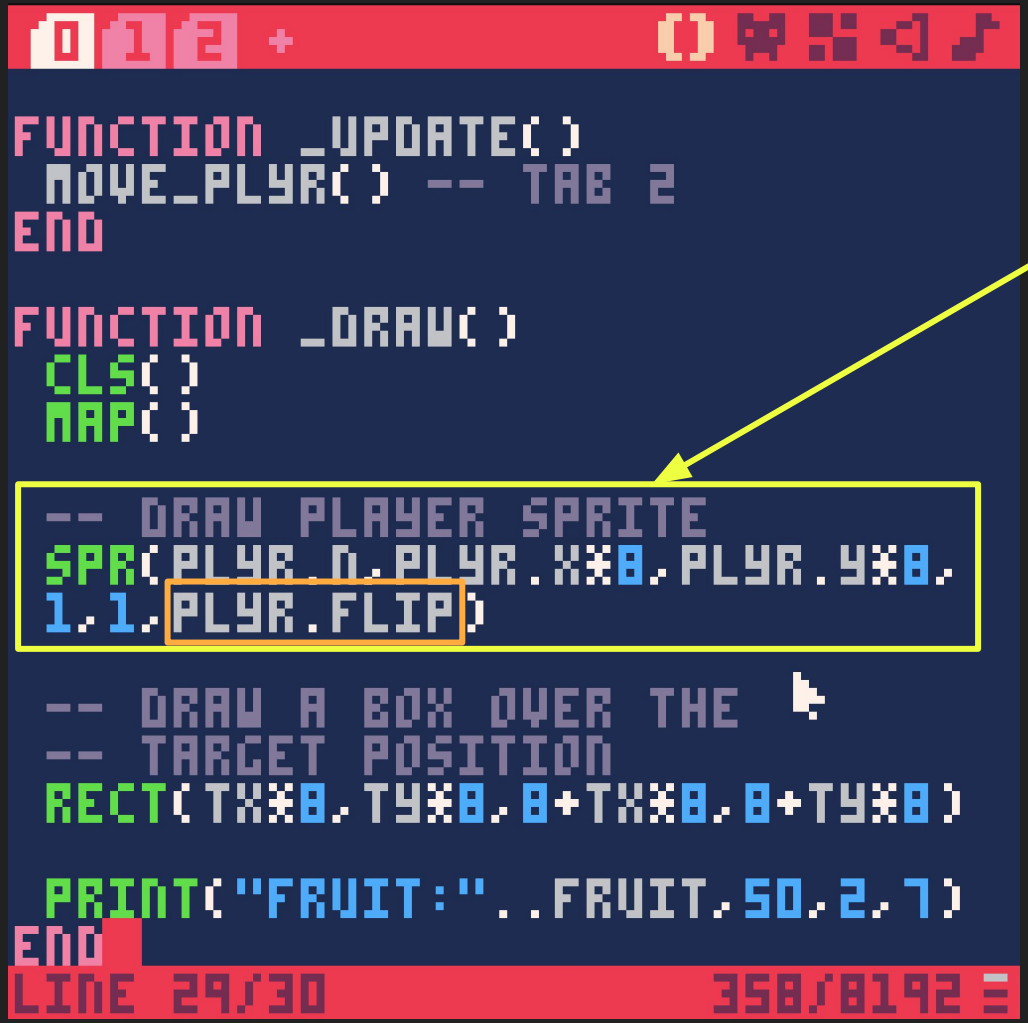


I've added a variable to keep track of which direction the player is facing, which is initially set to "DOWN"

You could also use faces of the clock (3,6,9,12) if that's easier to keep track of

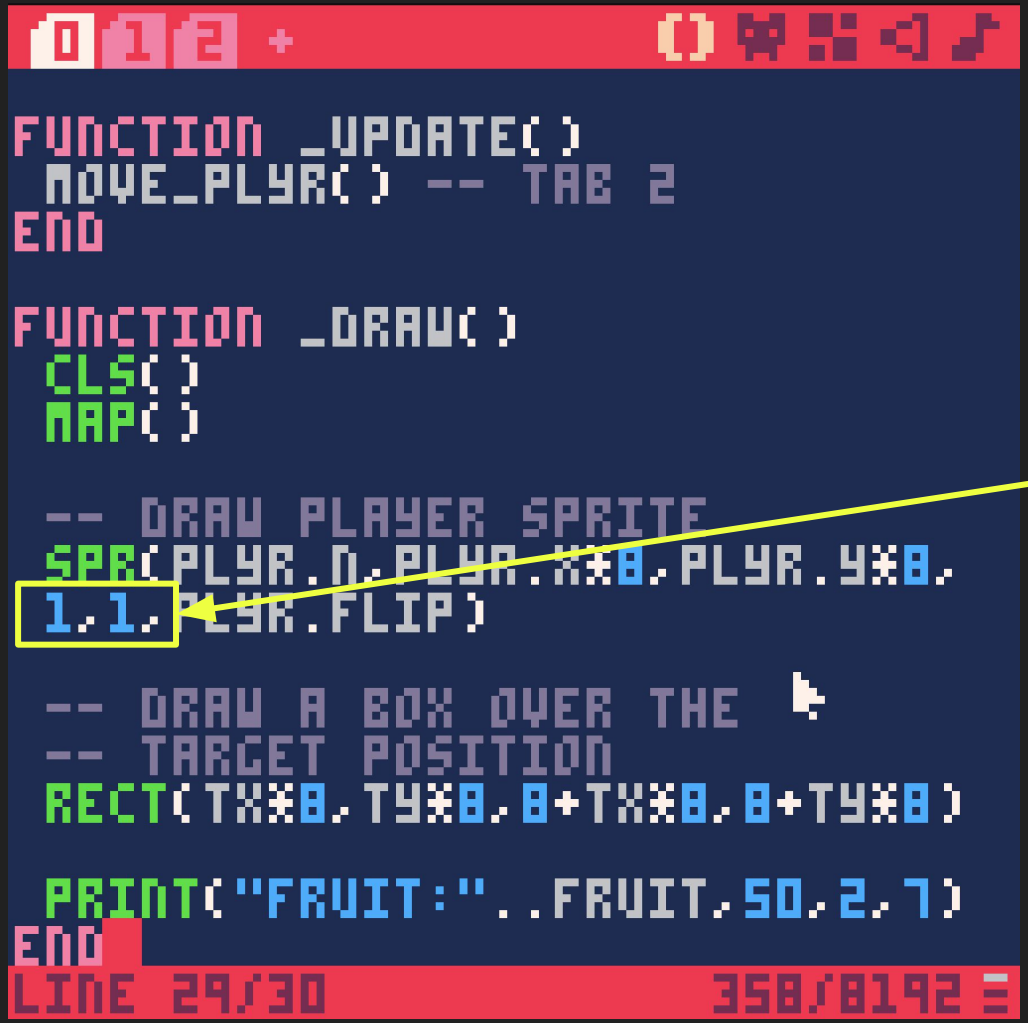


And the **plyr.flip** variable will be a boolean (either true or false) for whether to flip the sprite (horizontally) or not



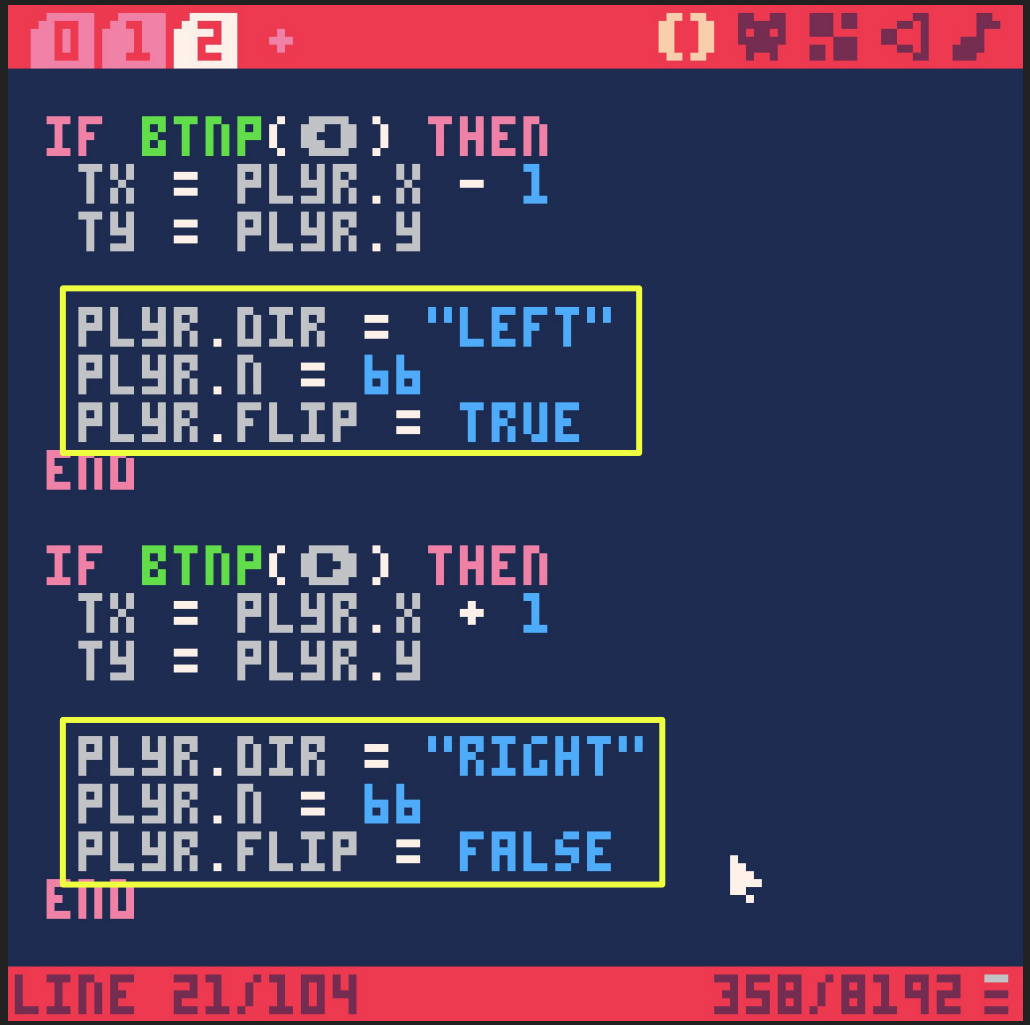
You can plug plyr.flip (a true or false value) into the spr() function to achieve the flipping

You'll have to tell the program when to flip the player sprite in your movement function

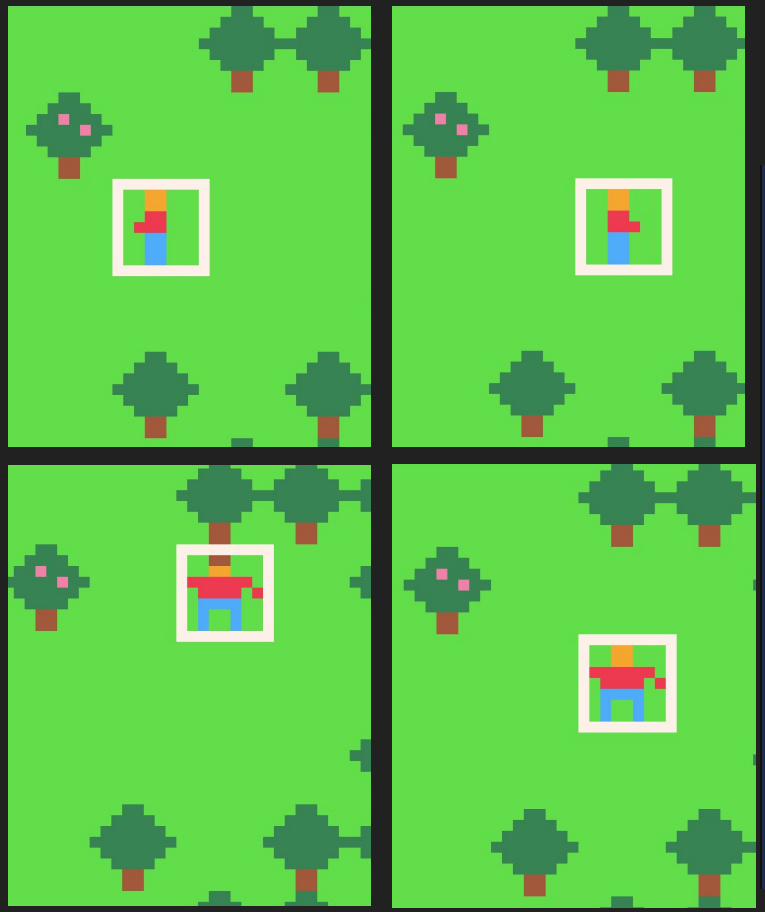


Please note that I must specify all spr() function values leading up to the flip

I used the default 1,1 for the number of tiles wide and tall the player sprite is



In my player movement function, I set the direction, sprite number, and flip depending on which arrow key is pressed

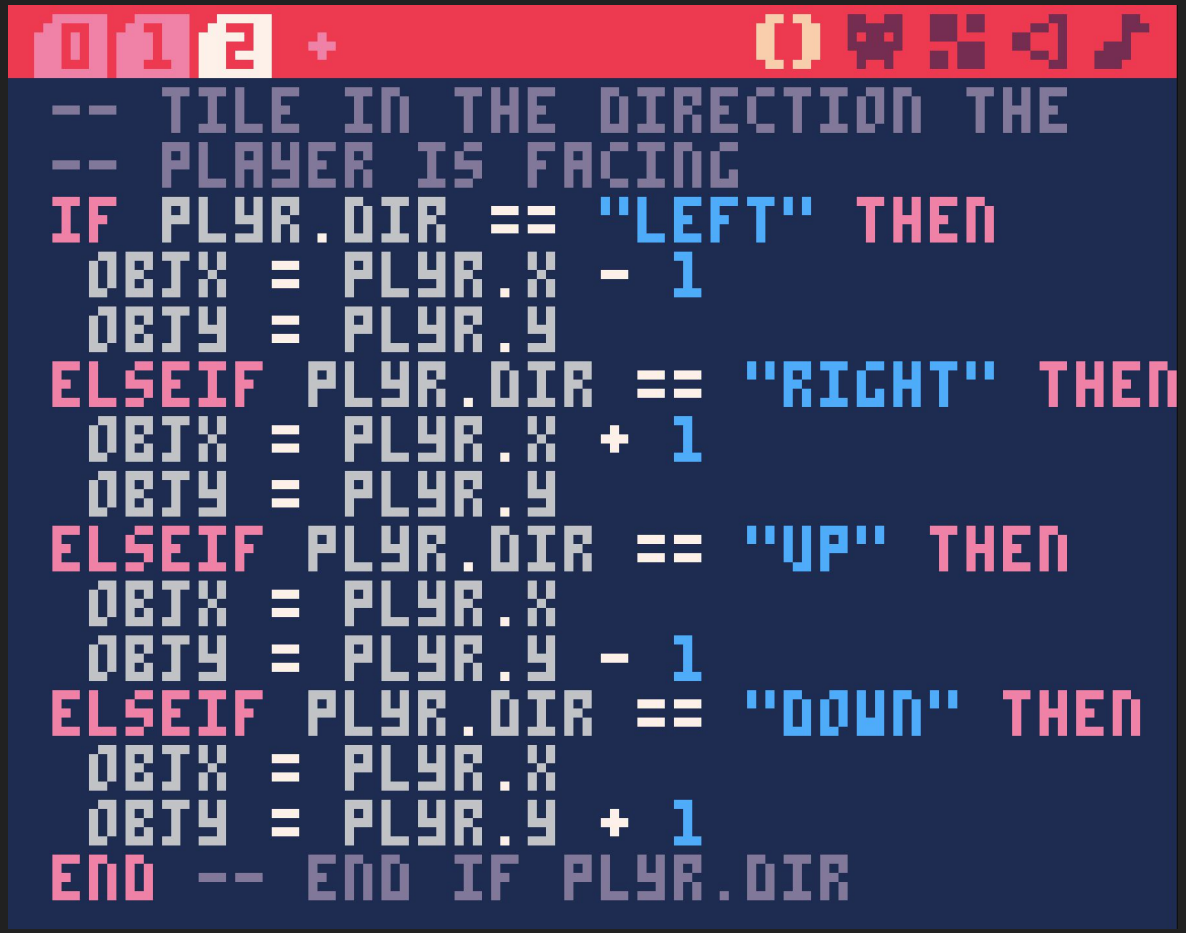


```
-- DRAW PLAYER SPRITE
SPR(PLYR.N,PLYR.X%8,PLYR.Y%8,
1,1,PLYR.FLIP)
```

```
IF BTNP(⬅️) THEN
 TX = PLYR.X
 TY = PLYR.Y - 1

 PLYR.DIR = "UP"
 PLYR.N = 65
 PLYR.FLIP = FALSE
END

IF BTNP(➡️) THEN
 TX = PLYR.X
 TY = PLYR.Y + 1

 PLYR.DIR = "DOWN"
 PLYR.N = 64
 PLYR.FLIP = FALSE
END
```

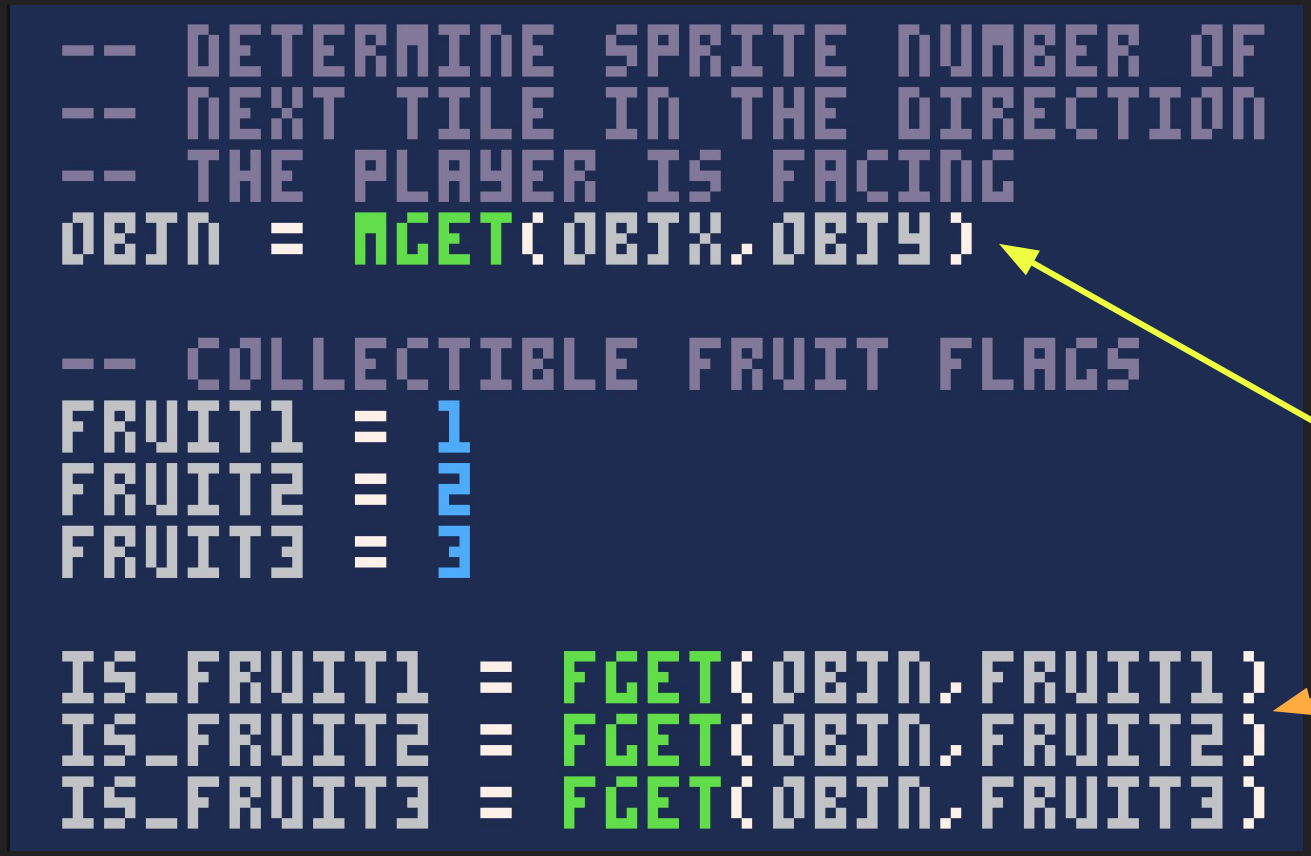
```
IF BTNP(⬅️) THEN
 TX = PLYR.X
 TY = PLYR.Y - 1

 PLYR.DIR = "UP"
 PLYR.N = 65
 PLYR.FLIP = FALSE
END

IF BTNP(➡️) THEN
 TX = PLYR.X
 TY = PLYR.Y + 1

 PLYR.DIR = "DOWN"
 PLYR.N = 64
 PLYR.FLIP = FALSE
END
```

Here’s the result as it all comes together

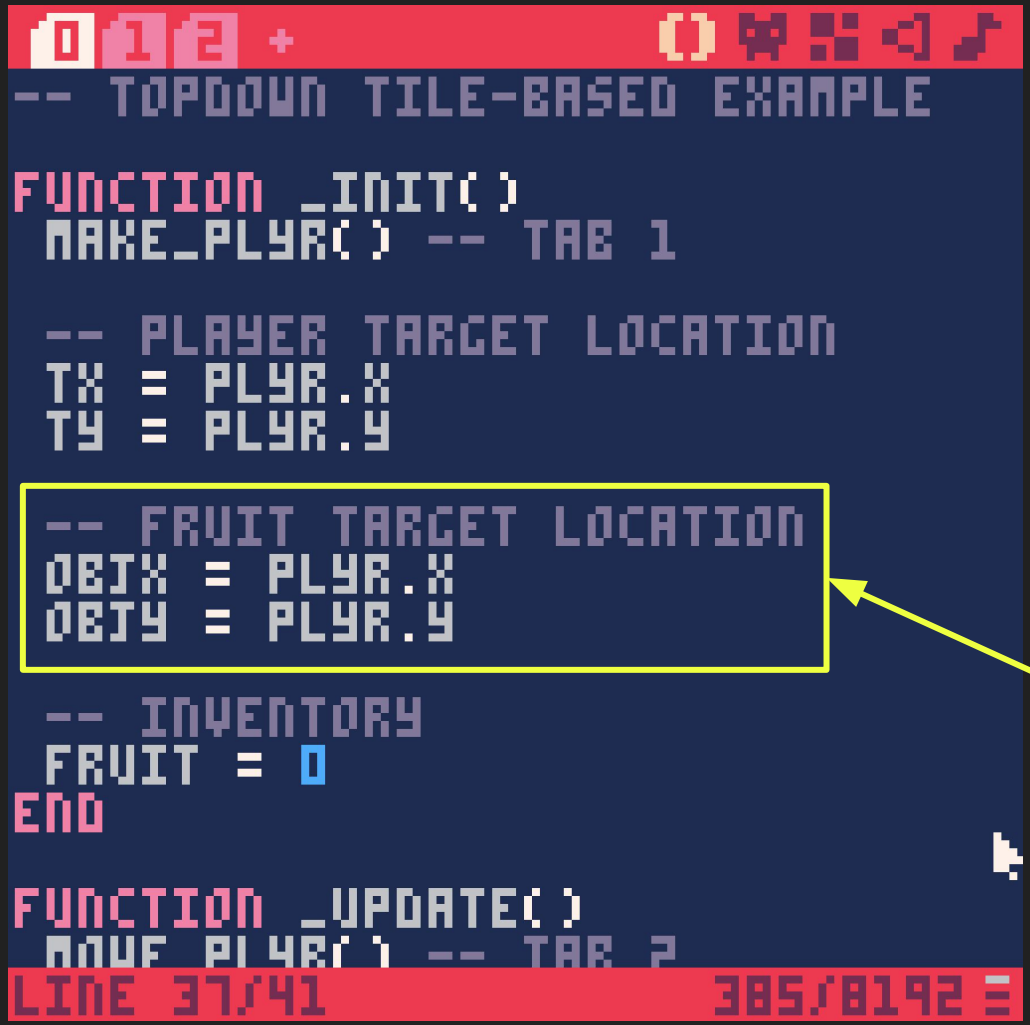


To determine the **location of the fruit I'm trying to collect**, I'll add new variables **objx** and **objy** (similar to tx and ty, but tracking a different thing)

The math is identical, but this is done after the key press



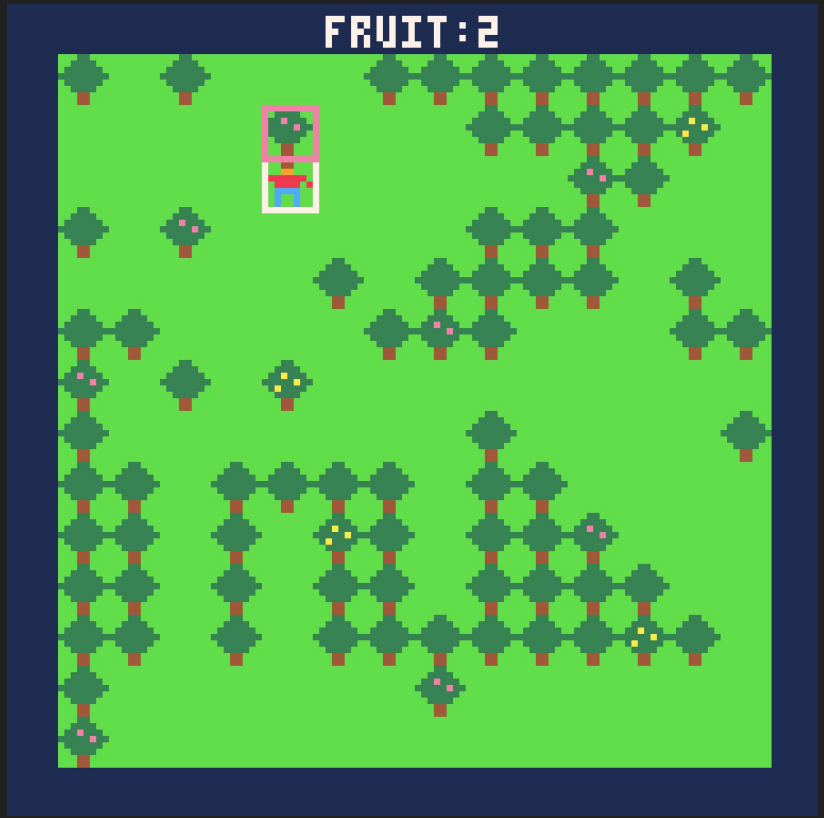
I can then follow a very similar process to the movement calculation, plugging **objx** and **objy** into the mget() function, then plugging the sprite number (**objn**) into fget()



To illustrate the location being calculated, I'll draw another box to represent where we're checking for fruit tiles

I declare **objx** and **objy** in _init()

```
0 1 2 +
function _draw()
 cls()
 map()

 -- draw player sprite
 spr(plyr.n,plyr.x*8,plyr.y*8,
 1,1,plyr.flip)

 -- draw a box over the movement
 -- target position
 rect(tx*8,ty*8,8+tx*8,8+ty*8)

 -- draw a box over the fruit
 -- target position
 rect(objx*8,objy*8,
      8+objx*8,8+objy*8,14)

 print("fruit:"..fruit,50,2,7)
end
line 37/41                385/8192
```



This code draws a pink box at **objx** and **objy**

Collecting Items

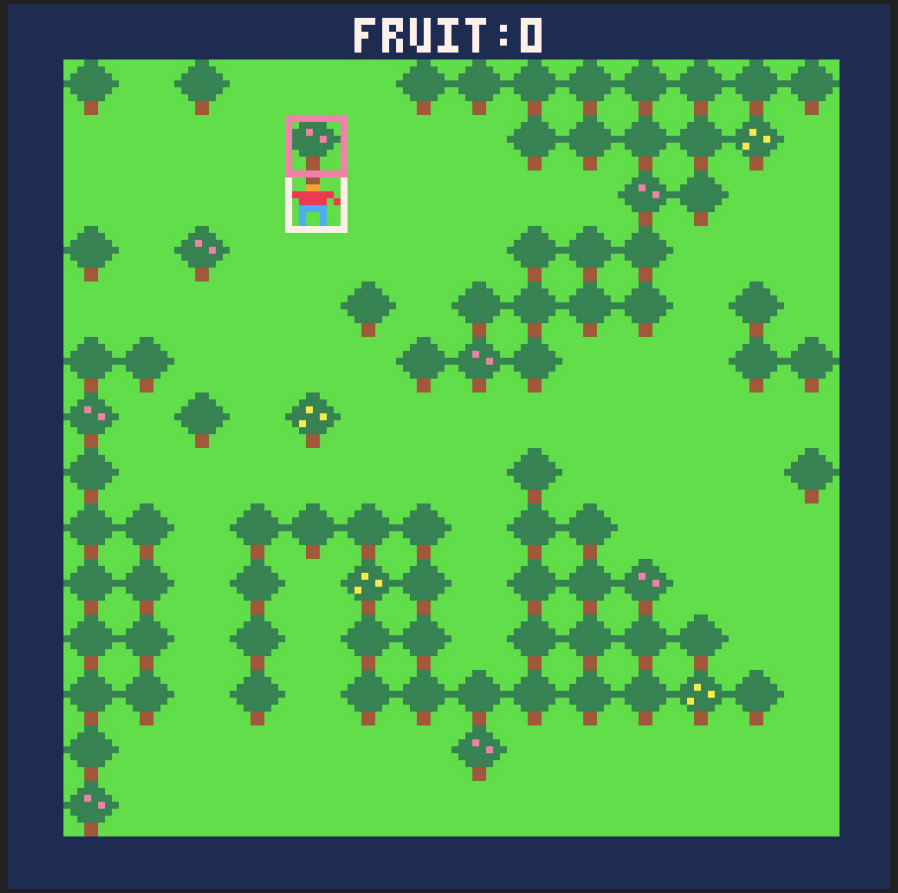
- The detection now works perfectly, but you'll notice another flaw: *the player can collect fruit from the same tile infinitely*
- PICO-8 has a function mset() that lets us **change a tile to a different sprite**
- We can use this to **change a fruit tree back to a regular tree** once collected from

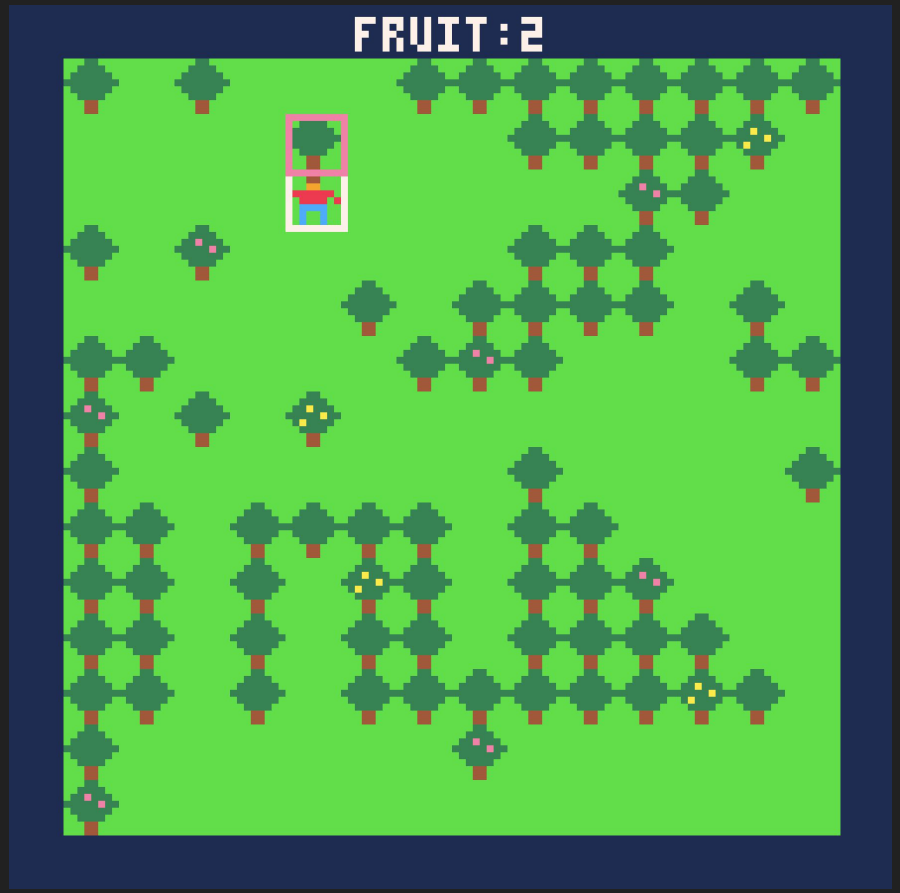
```
-- PRESS X NEAR TREE TO
-- COLLECT FRUIT
IF BTNP(❎) THEN
 IF IS_FRUIT1 THEN
  FRUIT += 1
  MSET(OBJX,OBJY,5)
 ELSEIF IS_FRUIT2 THEN
  FRUIT += 2
  MSET(OBJX,OBJY,5)
 ELSEIF IS_FRUIT3 THEN
  FRUIT +=3
  MSET(OBJX,OBJY,5)
 END -- END IF IS_FRUIT1/2/3
END -- END IF BTNP(❎)
```

Make sure to do this for each type of fruit tree

Plug into mset():

- the x,y coordinates of the sprite you want to change (**objx**,**objy**)
- followed by the sprite number of the sprite you want to change it to (**5** for regular tree in my example)






```
mset(objx,objy,5)
```

We can use flags and map functions to make lock and key systems, too

Lock & Key Systems

Download Example File: topdown_03_lock_and_key.p8

```
function _init()
    make_plyr() -- tab 1

    -- target tile coordinates
    -- (where the player is trying
    -- to move to)
    tx = plyr.x
    ty = plyr.y

    -- target object coordinates
    -- (what the player is trying
    -- to collect)
    objx = tx
    objy = ty

    -- show target box
    show=true
    text="🅾 = hide target box"

    -- sprite flags
    solid = 0
    fruit1= 1
    fruit2= 2
    fruit3= 3
    key   = 4
    door  = 5

    -- inventory
    fruit=0
    keys =0

end -- end function _init()
```

In my _init() function, I've added variables for key and door flags, as well as key inventory

```
function _update()
    move_plyr() -- tab 2
    inspect() -- tab 3
    pickup() -- tab 4
    toggle() -- tab 5
end
```

I've extracted my code for collecting fruit into a new function called inspect(), and called the inspect() function in _update()

```
-- check tiles for collectibles
function inspect()
    -- set objx,objy based on
    -- direction; must be 1 tile
    -- farther in that direction
    -- than player's position
    if plyr.dir=="left" then
        objx=plyr.x-1
        objy=plyr.y
    elseif plyr.dir=="right" then
        objx=plyr.x+1
        obj=plyr.y
    elseif plyr.dir=="up" then
        objx=plyr.x
        objy=plyr.y-1
    elseif plyr.dir=="down" then
        objx=plyr.x
        objy=plyr.y+1
    end -- end if/elseif dir

    -- sprite number of object tile
    objn=mget(objx,objy)

    -- true/false is flag on
    -- for that sprite
    is_fruit1 = fget(objn,fruit1)
    is_fruit2 = fget(objn,fruit2)
    is_fruit3 = fget(objn,fruit3)
    is_door   = fget(objn,door)
```

```
key    = 4
door   = 5

-- sprite number of object tile
objn=mget(objx,objy)

-- true/false is flag on
-- for that sprite
is_fruit1 = fget(objn,fruit1)
is_fruit2 = fget(objn,fruit2)
is_fruit3 = fget(objn,fruit3)
is_door   = fget(objn,door)
```

In the **inspect()** function, I'm now checking for **doors** in addition to fruit

And when I press X, I add an **elseif** case to handle what happens if the tile is a door

```
-- press x to inspect tile
if btnp(❎) then

    -- collect fruit
    if is_fruit1 == true then
        sfx(1)
        mset(objx,objy,5)
        fruit += 1
    elseif is_fruit2 == true then
        sfx(1)
        mset(objx,objy,5)
        fruit += 2
    elseif is_fruit3 == true then
        sfx(2)
        mset(objx,objy,5)
        fruit += 3

    -- open door
    elseif is_door == true then
        if keys > 0 then
            mset(objx,objy,42)
            sfx(3)
            keys -= 1
        else
            sfx(4) -- play error sound
        end -- end if keys > 0

    end -- end if/else fruit/key

end -- end if btnp(❎)
```

If the player presses X while next to a door tile, I *check whether the player has any keys*

If so, then I use mset() to get rid of the door tile, turning it to an open gateway (sprite 42)

*I also **subtract one from the key count**, and play an **error sound** if the player has **no keys***

```
-- open door
elseif is_door == true then
 if keys > 0 then
  mset(objx,objy,42)
  sfx(3)
  keys -= 1
 else
  sfx(4) -- play error sound
 end -- end if keys > 0

end -- end if/else fruit/key

end -- end if btnp(❎)
```

```
function _update()
    move_plyr() -- tab 2
    inspect() -- tab 3
    pickup() -- tab 4
    toggle() -- tab 5
end
```

To actually pick up a key, I wrote a separate function called **pickup()** that is *called in* ***_update()***

```
-- pick up items by walking over them
function pickup()

    -- get sprite number of tile
    -- at player's position
    local tn = mget(plyr.x,plyr.y)

    -- check for key flag
    is_key = fget(tn,key)

    -- collect key
    if is_key then
        mset(plyr.x,plyr.y,1)
        keys += 1
        sfx(3)
    end -- end if is_key

end -- end function pickup()
```

This works very similarly to the fruit collection, except I ***use the player's exact x,y position instead of target x,y***, because the key is directly beneath the player and not one tile away

```
-- pick up items by walking over them
function pickup()

    -- get sprite number of tile
    -- at player's position
    local tn = mget(plyr.x,plyr.y)

    -- check for key flag
    is_key = fget(tn,key)

    -- collect key
    if is_key then
        mset(plyr.x,plyr.y,1)
        keys += 1
        sfx(3)
    end -- end if is_key

end -- end function pickup()
```

Positioning the Camera

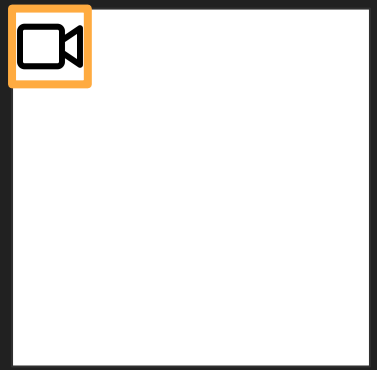
Download Example File: topdown_04_camera_modes.p8

Positioning the Camera

- There are two popular methods for positioning the camera in a top-down game:
  1. Centered on and following the player
  2. Fixed to one map screen at a time, scrolling all at once when the player moves to the next screen

Positioning the Camera

- There is a built-in PICO-8 function called camera() that requires a pair of x,y coordinates
- By default, the camera is at (0,0), the top left of the screen

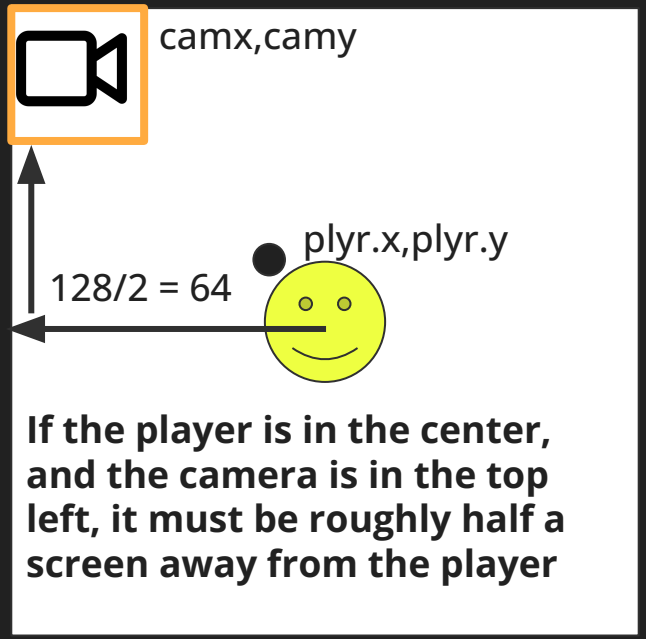


Positioning the Camera

To get the camera to center on the player, we can do a bit of math to calculate its position

Since the camera is above and to the left of the player, we subtract **64** from the player's x,y to get the camera's (rough) x,y

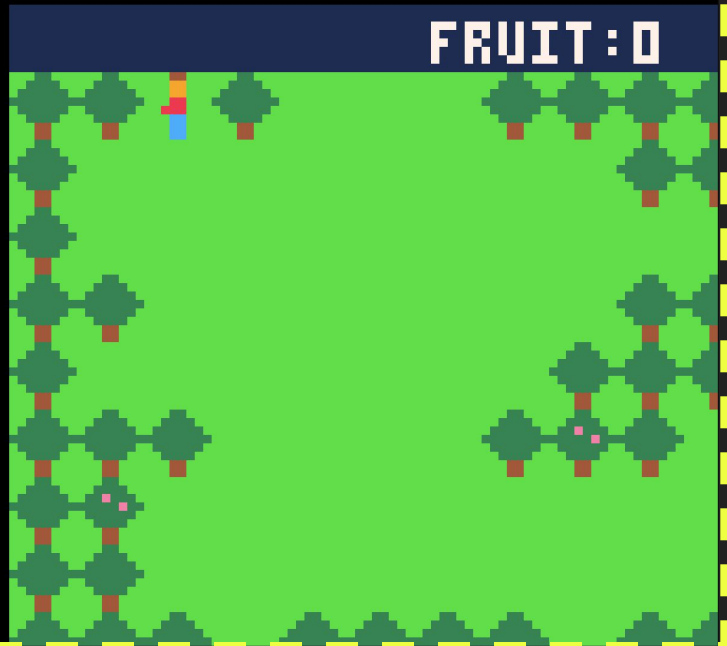
*We then just need to **add half the player's width and height** to get the precise position*




```
-- CAMERA
FUNCTION SET_CAMERA()
 CAMX = 8*PLYR.X-64+PLYR.W/2
 CAMY = 8*PLYR.Y-64+PLYR.H/2
 CAMERA(CAMX,CAMY)
END -- END FUNCTION SET_CAMERA()
```

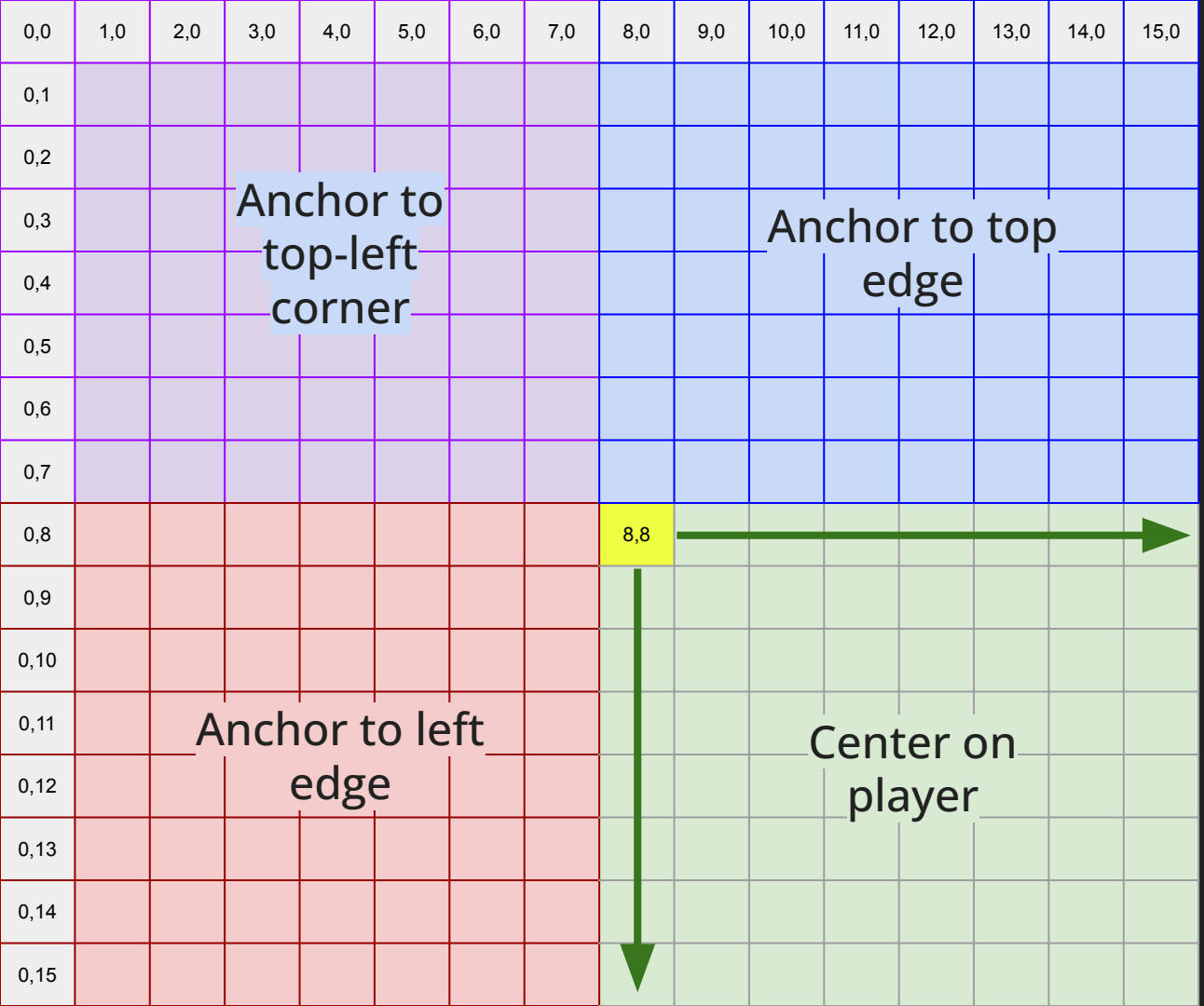
- We can express the camera's x,y position relative to the player like so
- We need to **multiply by 8** to convert from the player's **tile** coordinates to the camera's **pixel** coordinates

This blank space is *not just my slide background* – it's what you see when the game is running!



The previous calculation mostly works, but *we run into this issue when the player is at the **edges of the map***

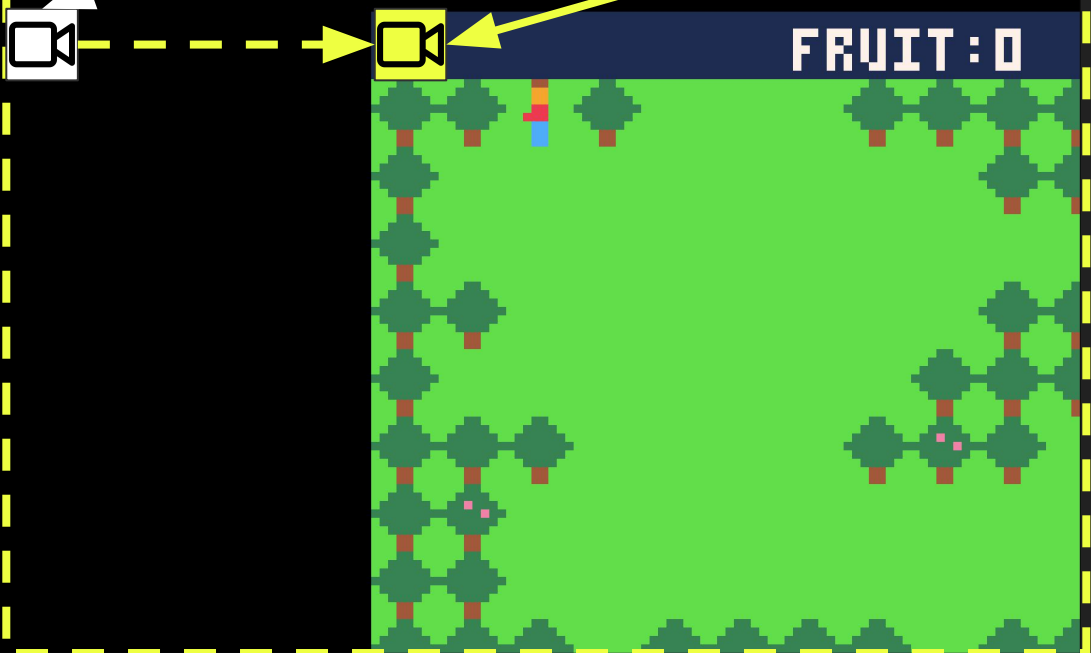
Because we made the camera **center the player on the screen**, this holds true even when that would mean showing an out-of-bounds area



We need to add overrides for when the player is close enough to the edge to anchor the camera to the edge

If the player is less than 8 tiles from the edge, we know part of the void will be showing while the camera is centered on the player – so if the player's x is less than 8, we know we need to *stop centering the camera on the player and anchor it to the edge of the map*

```
-- CENTER ON PLAYER
CAMX=8*PLYR.X-64+PLYR.W/2
CAMY=8*PLYR.Y-64+PLYR.H/2

-- ADJUST AT LEFT EDGE
IF PLYR.X < 8 THEN
 CAMX += 8*(7-PLYR.X)+PLYR.W/2
END
```



We can express how far the player is from the left edge as **7-plyr.x**

We then multiply that value by **8** to convert from **tiles** to **pixels**,

We add this amount, plus half the player's width, to the existing value of camx to move the camera from the void to the edge

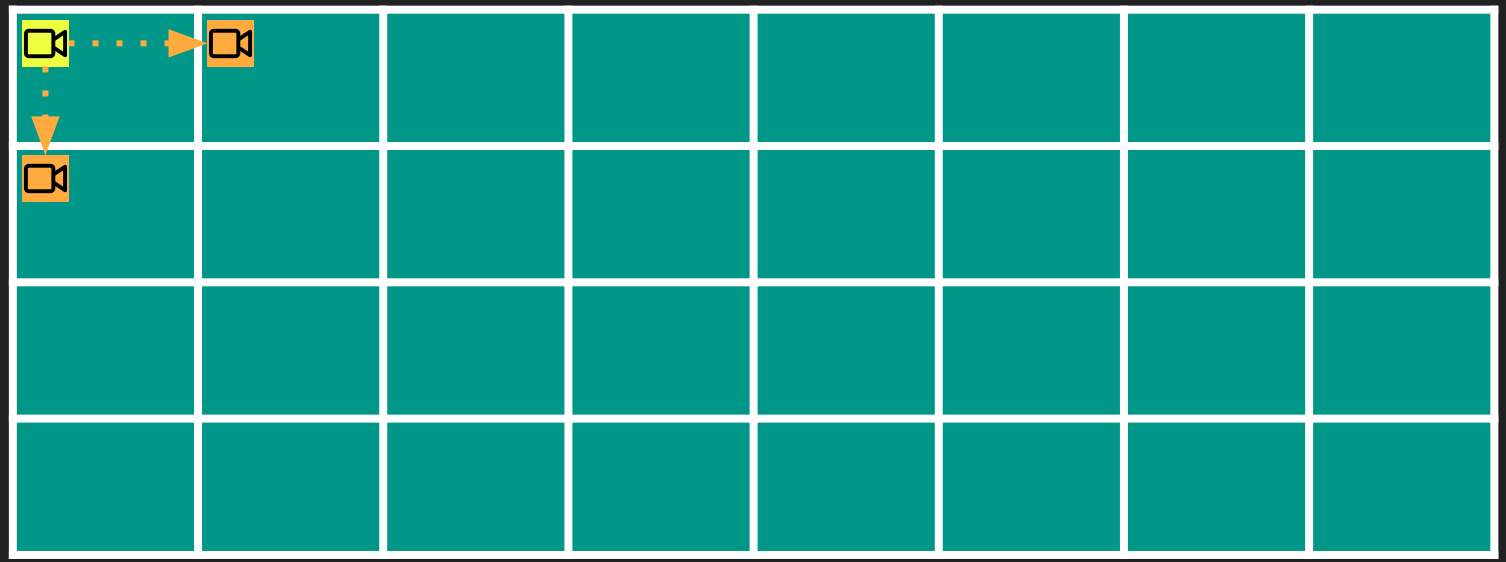

-- CENTER ON PLAYER
CAMX=8*PLYR.X-64+PLYR.W/2
CAMY=8*PLYR.Y-64+PLYR.H/2
-- ADJUST AT LEFT EDGE
IF PLYR.X < 8 THEN
CAMX += 8*(7-PLYR.X)+PLYR.W/2
END
-- ADJUST AT TOP EDGE
IF PLYR.Y < 8 THEN
CAMY += 8*(7-PLYR.Y)+PLYR.H/2
END
We can express how far the player is from the top edge as 7-plyr.y
We then multiply that value by 8 to convert from tiles to pixels
We add this amount, plus half the player's width, to camy to adjust

Screen-Based Camera

Download Example File: topdown_04_camera_modes.p8

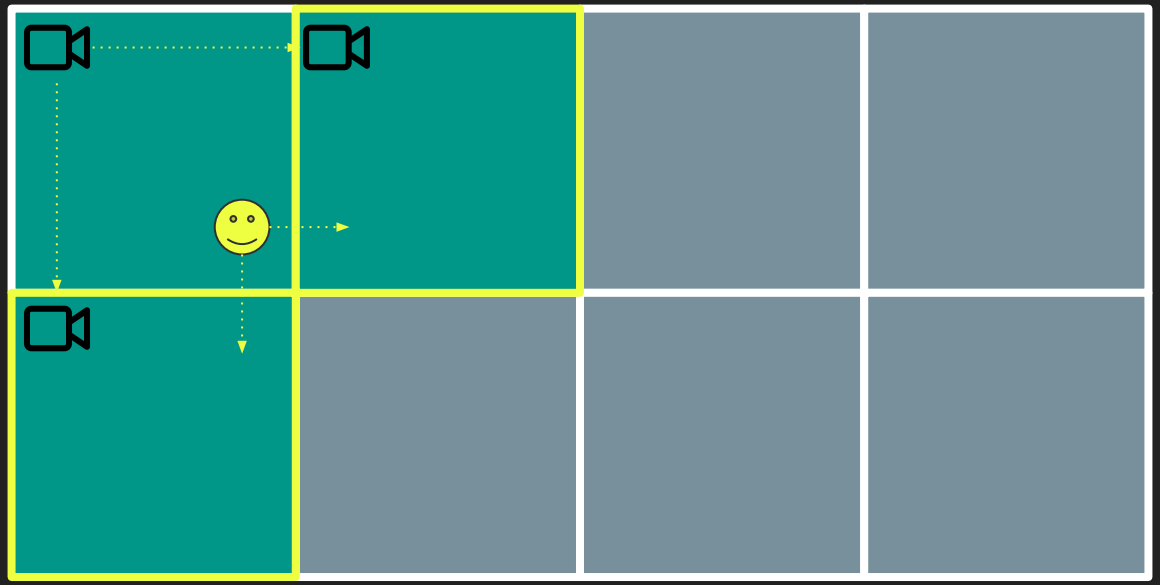
Screen-Based Camera

To show one screen at a time, we need to figure out what the top-left tile coordinates of the current screen are and position the camera there



Screen-Based Camera

If the player moves from one screen to another, the camera must be re-positioned in the top-right of the new screen



Screen-Based Camera

We can use this algorithm to place the camera in the top-left corner of the current screen

```
-- each tile is 8x8 pixels
tilesize=8

-- each screen is 16 tiles
screensize=16

-- calculate how many screens
-- to the right of the origin
-- (0,0) the player is
screenx=flr(plyr.x/screensize)

-- calculate how many screens
-- below the origin (0,0) the
-- player is
screeny=flr(plyr.y/screensize)
```

```
-- multiply the camera coords
-- by the number of pixels per
-- tile to convert the player's
-- tile coords to a pixel value
camx = screenx * tilesize
camy = screeny * tilesize

-- multiply the camera coords
-- by the number of tiles per
-- screen to position it at the
-- origin of the current screen
-- (set of 16 tiles)
camx*=screensize
camy*=screensize
```

Screen-Based Camera

To help visualize the math, we can plug in 16 and 8 directly

16 tiles per screen

8 pixels per tile

16 tiles per screen

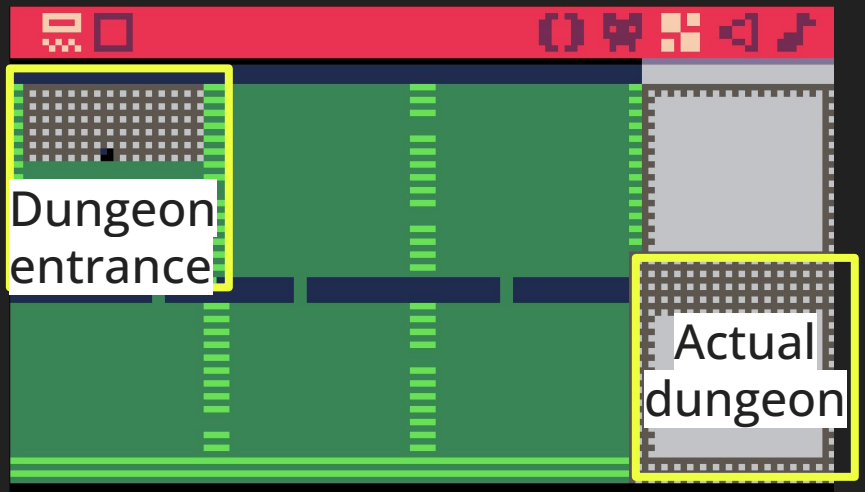
```
-- calculate how many screens
-- to the right of the origin
-- (0,0) the player is
screenx=flr(plyr.x/16)

-- calculate how many screens
-- below the origin (0,0) the
-- player is
screeny=flr(plyr.y/16)

-- multiply the camera coords
-- by the number of pixels per
-- tile to convert the player's
-- tile coords to a pixel value
camx = screenx * 8
camy = screeny * 8

-- multiply the camera coords
-- by the number of tiles per
-- screen to position it at the
-- origin of the current screen
-- (set of 16 tiles)
camx*=16
camy*=16
```

Warping

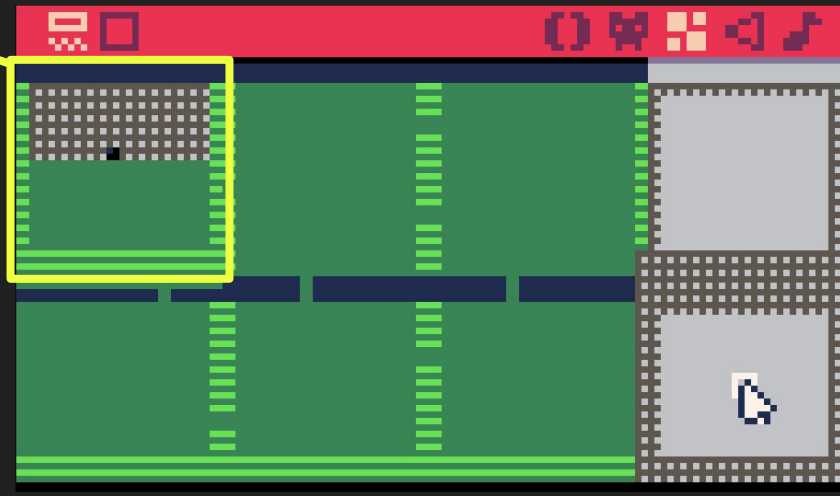
Download Example File: topdown_05_warping.p8

Warping

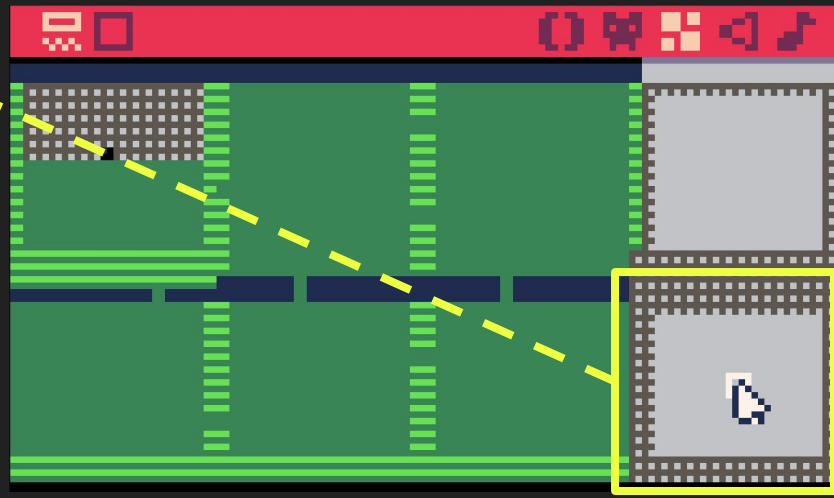
- Let’s say you want to divide your map into levels, or include houses or dungeons
- You can draw the interior portions anywhere on the map and then warp the player to that position when they touch the entrance

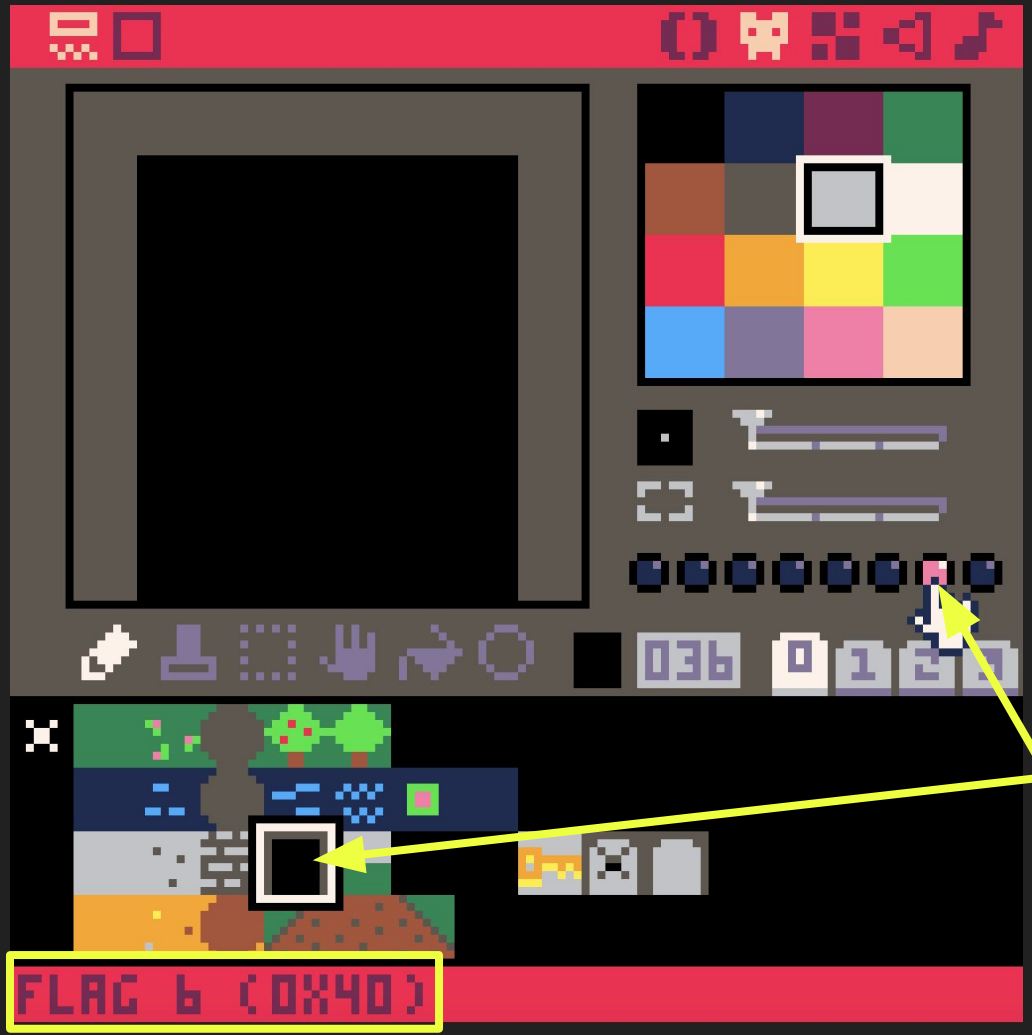


Here's the exterior for my dungeon, with its entrance at 23,7

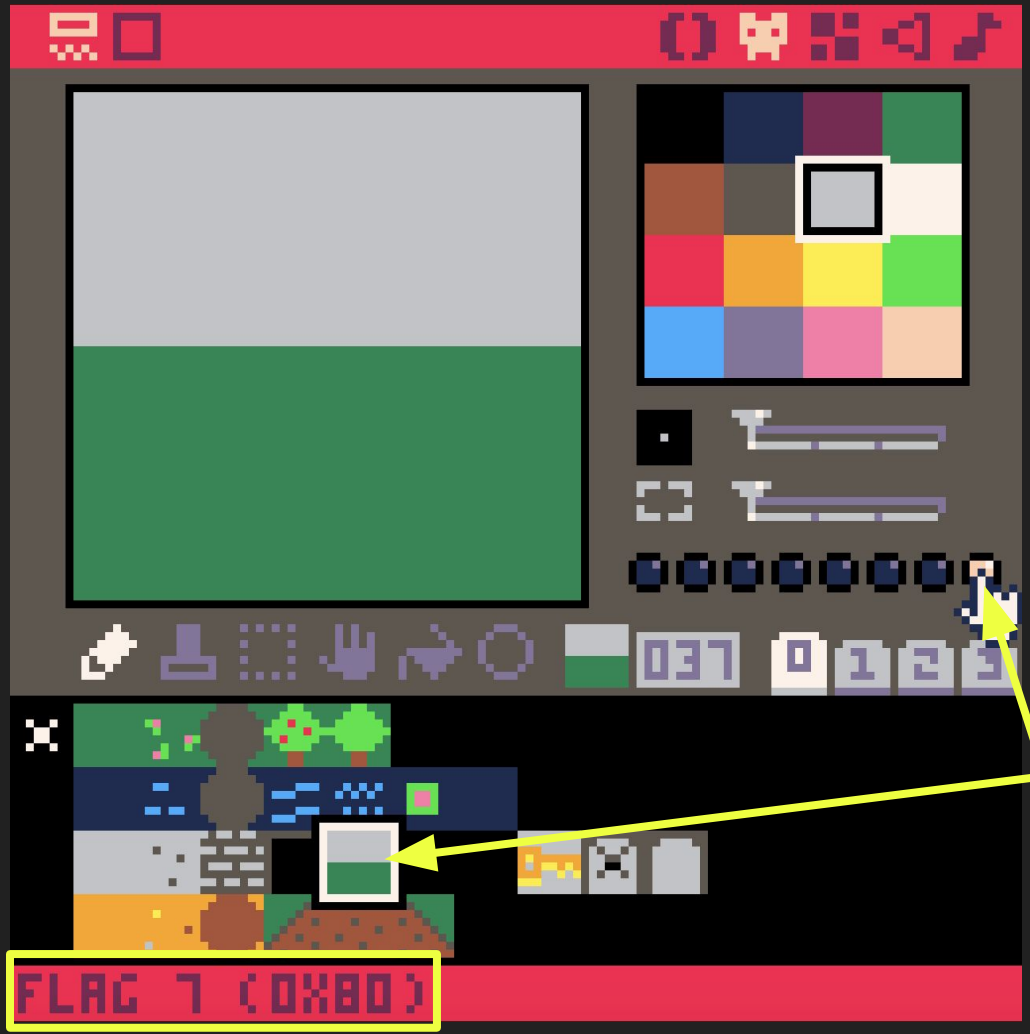


The dungeon itself is on the other side of the map, with the exit back outside at 88,31

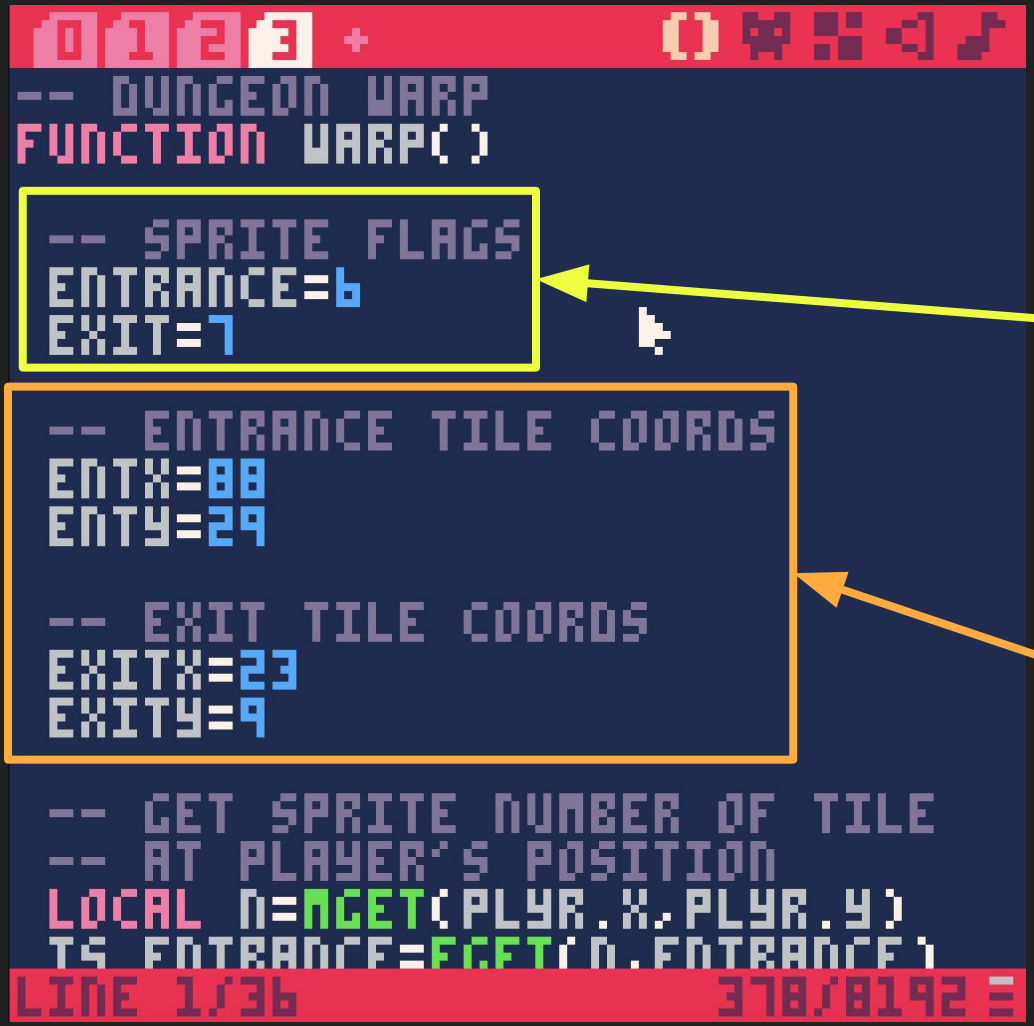




I've turned on flag 6 for the entrance tile



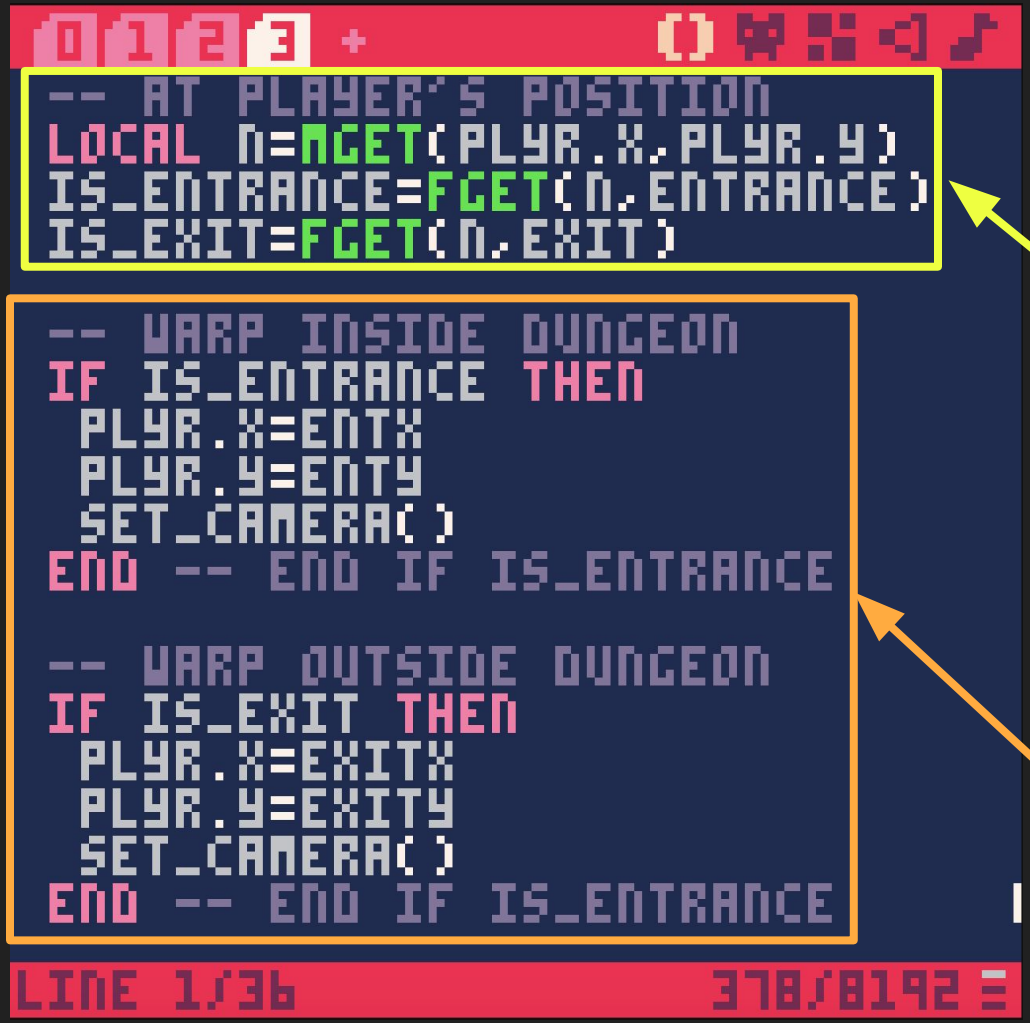
I've turned on flag 7 for the exit tile



In my code, I set those flag numbers as the values for my variables:

entrance=6
exit=7

I've also set the tile coordinates for the entrance and exit as variables



Similarly to the pickup key function, I use mget() and fget() to check for the entrance and exit flags at the player's x,y position

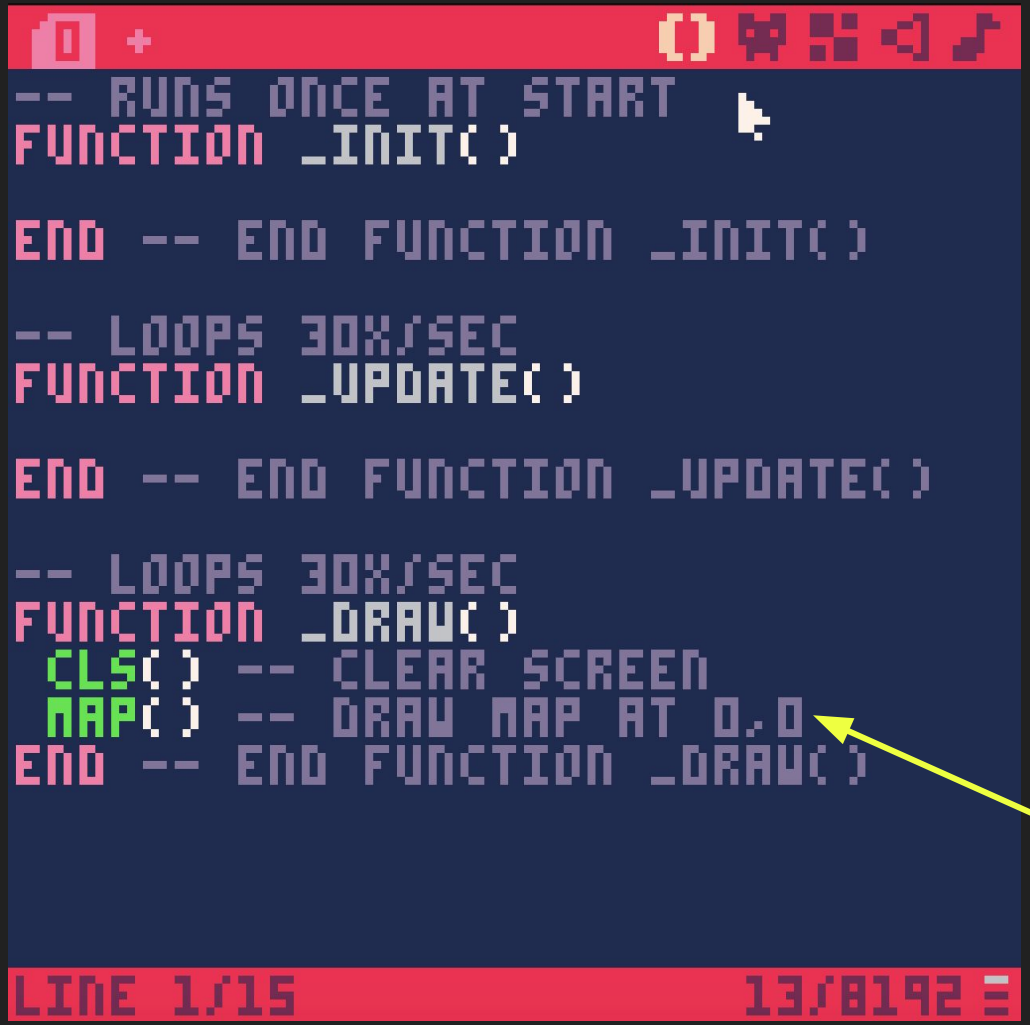
Then, if either **flag** returns **true** (*meaning the player is touching the entrance or exit tile*), I set the player's x,y location equal to the corresponding destination's coordinates

Pixel-Based Movement

Download Example File: topdown_06_pixelbased_movement_and_collision.p8

Tile-Based vs. Pixel-Based Movement

- Tile-based movement
  - 8 pixels at a time
  - Pros: Easier to implement
  - Cons: Less nuance in movement
  - Best for: games without an emphasis on real-time reaction (exploration and collection)
- Pixel-based movement
  - A smaller number of pixels at a time
  - Pros: More nuance in movement
  - Cons: More work for collision detection
  - Best for: games requiring real-time reaction (action, shooting)



Create an empty game loop (the _init, _update, and _draw functions)

Use the map() function in _draw() to draw the map

```
-- RUNS ONCE AT START
FUNCTION _INIT()

END -- END FUNCTION _INIT()

-- LOOPS 30X/SEC
FUNCTION _UPDATE()

END -- END FUNCTION _UPDATE()

-- LOOPS 30X/SEC
FUNCTION _DRAW()
 CLS() -- CLEAR SCREEN
 MAP() -- DRAW MAP AT 0,0
END -- END FUNCTION _DRAW()
```

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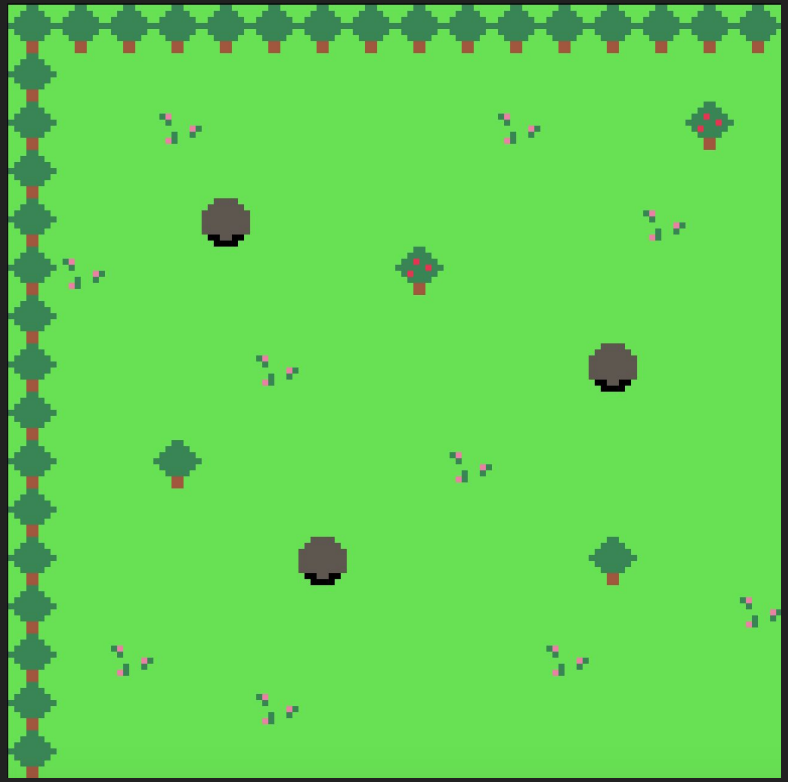
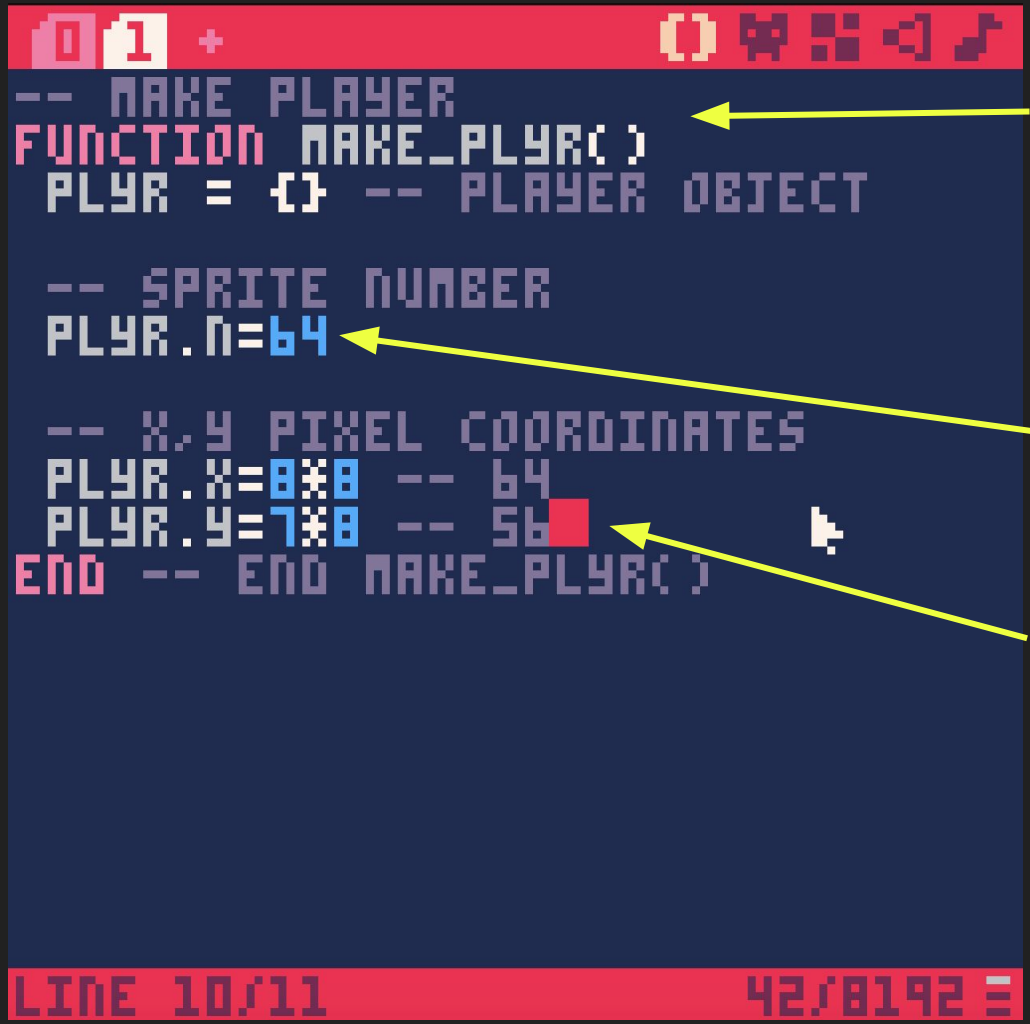


Use the map() function in _draw() to draw the map

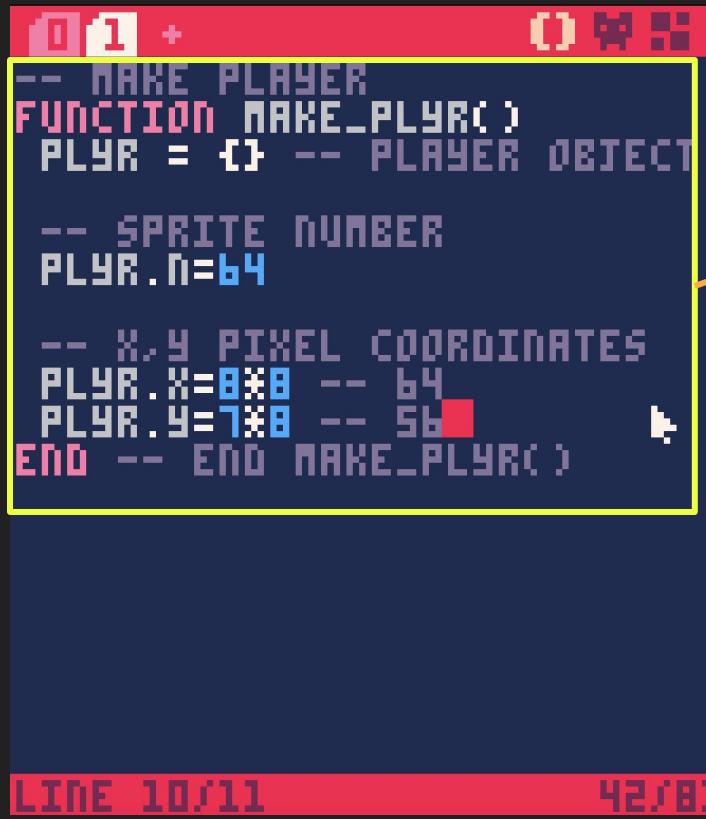


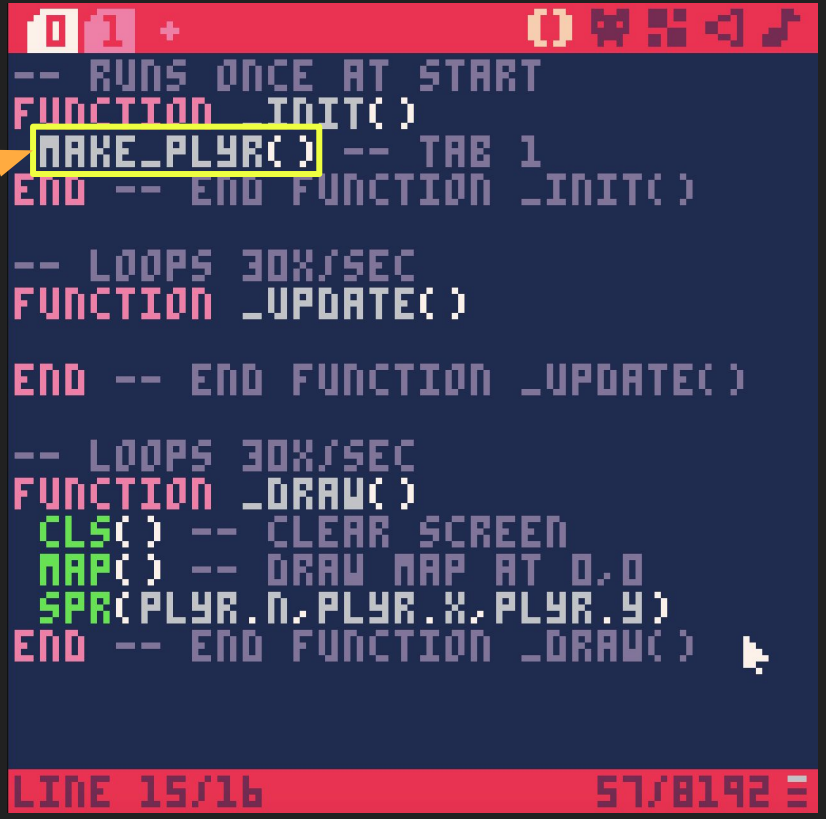
I'll create a function to make my player on a separate tab

The player sprite number was 64

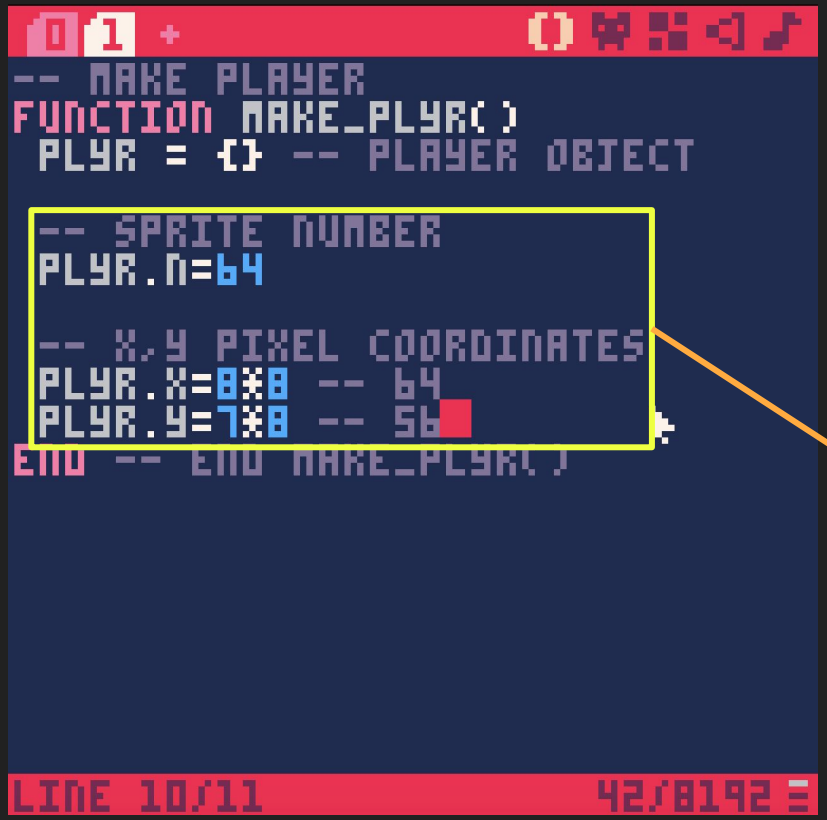
And its x,y coordinates on the map were 7,8

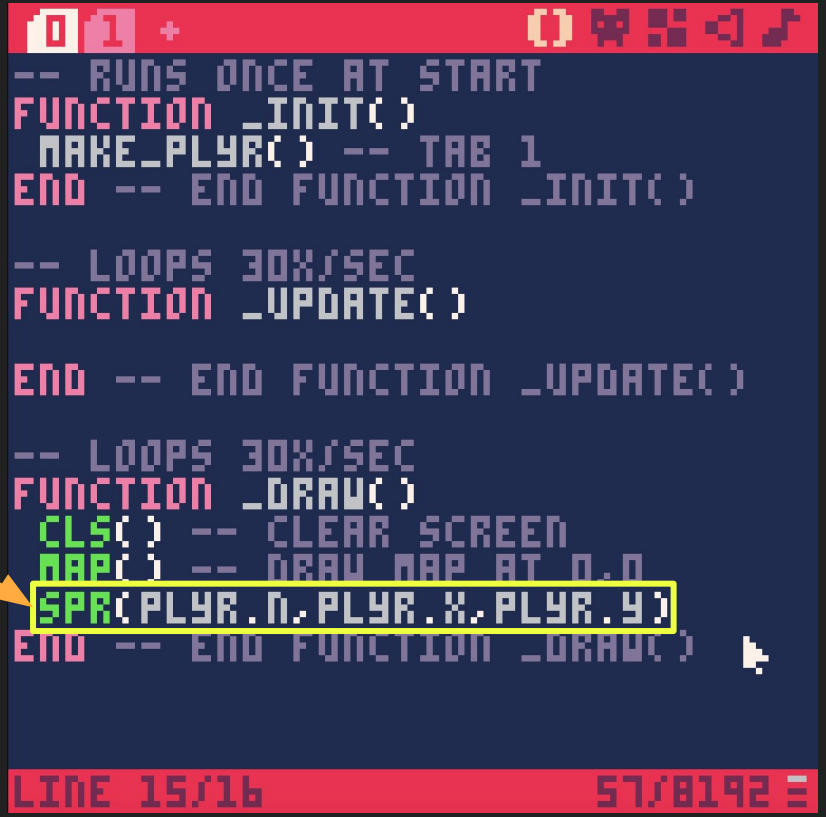
- The player's x,y coordinates on the map were 7,8
- *But the map editor displays tile values*
- Whereas *the spr() function requires pixel values*
- Each tile is 8x8 pixels, so we multiply 8 and 7 each by 8 to convert from tiles to pixels



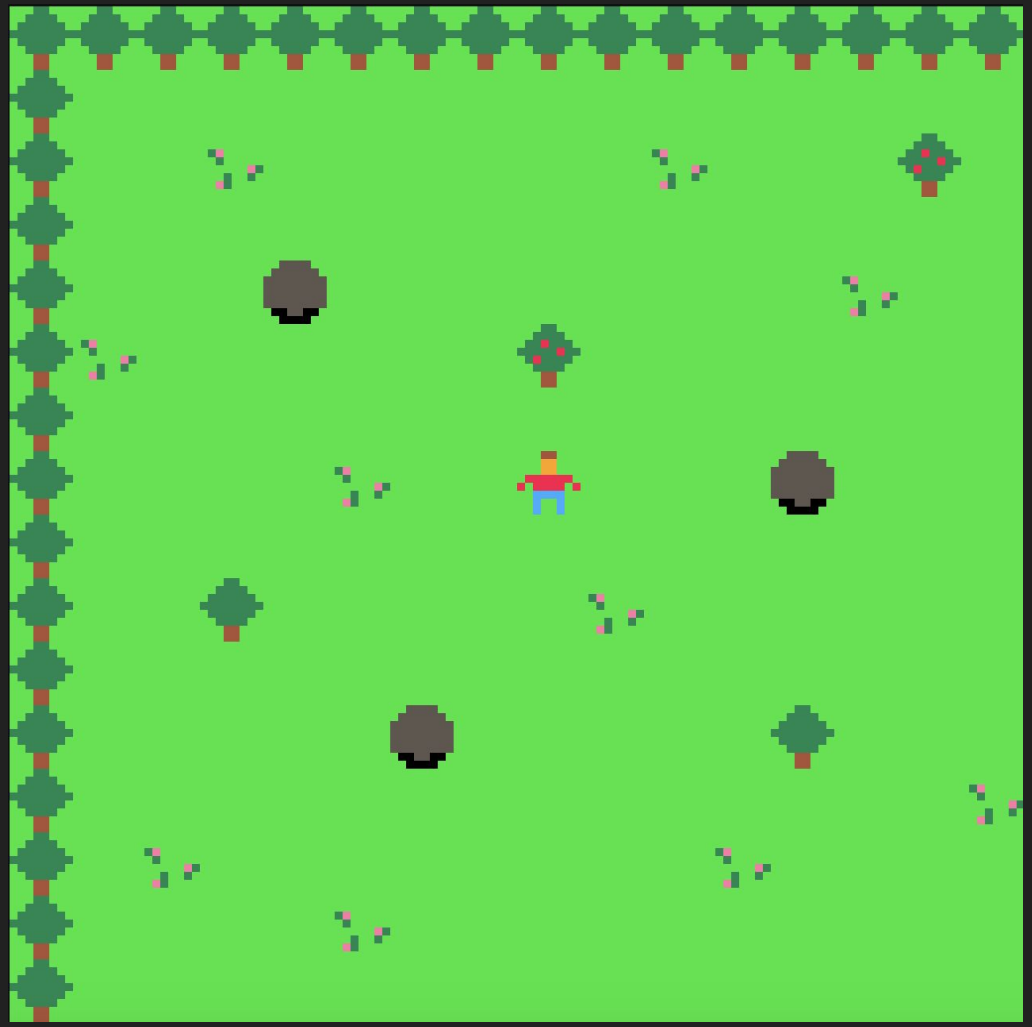


After writing our make_plyr() function on tab 1, we must *call make_plyr() in the _init() function* on tab 0





We can then plug the player's n, x, and y variables into the spr() function in _draw() to draw the player at the desired location



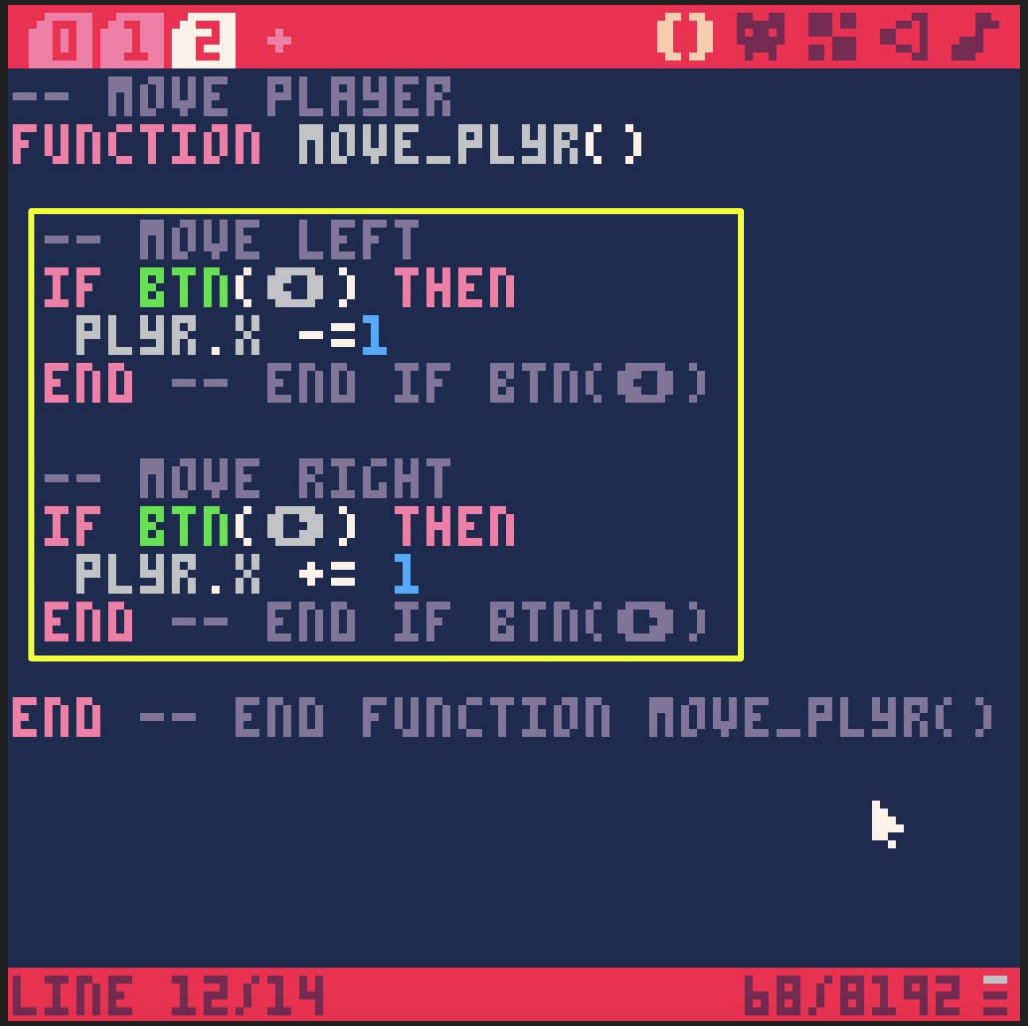
Our player at the tile coordinates 8,7

(*Pixel coordinates 64,56*)

```
-- MOVE PLAYER
FUNCTION MOVE_PLYR()

END -- END FUNCTION MOVE_PLYR()
```

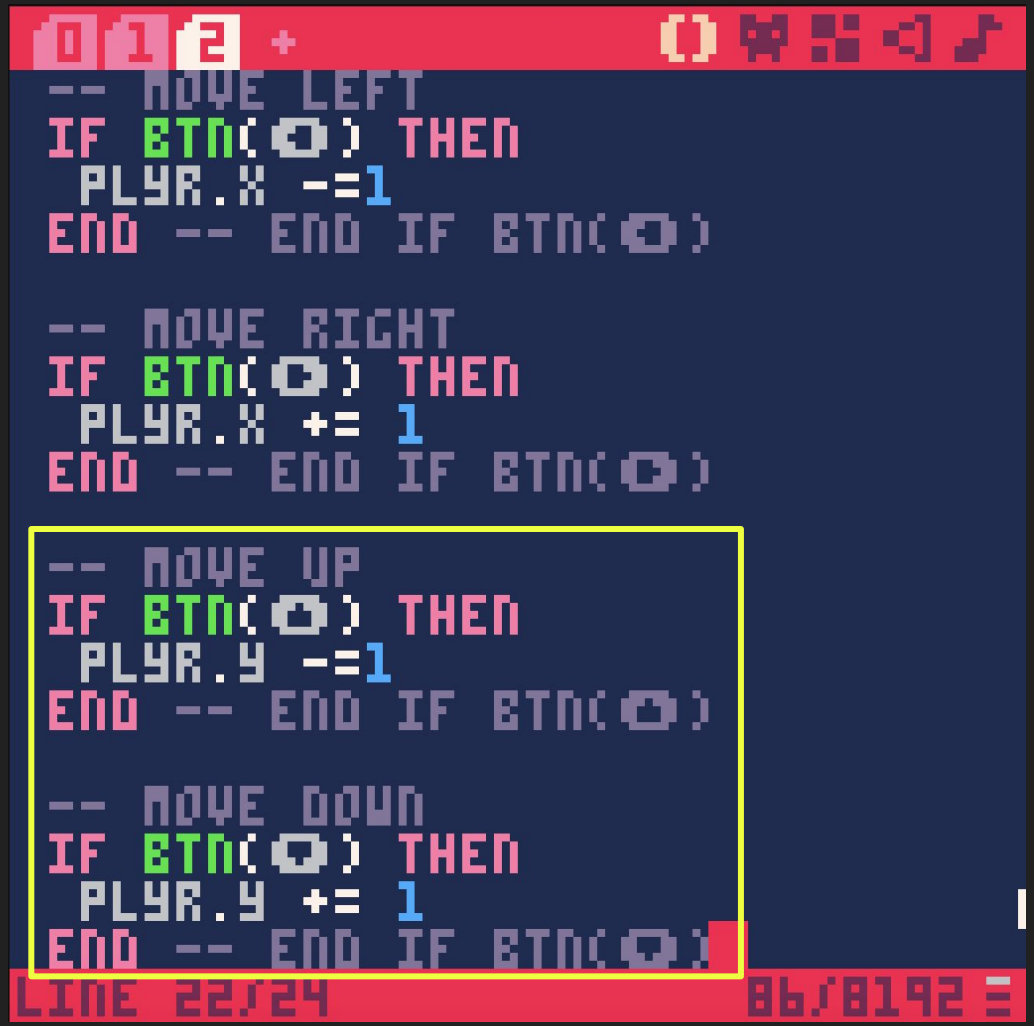
Next, we can begin a move_plyr() function in a separate tab ...

... and call move_plyr() inside the _update() function

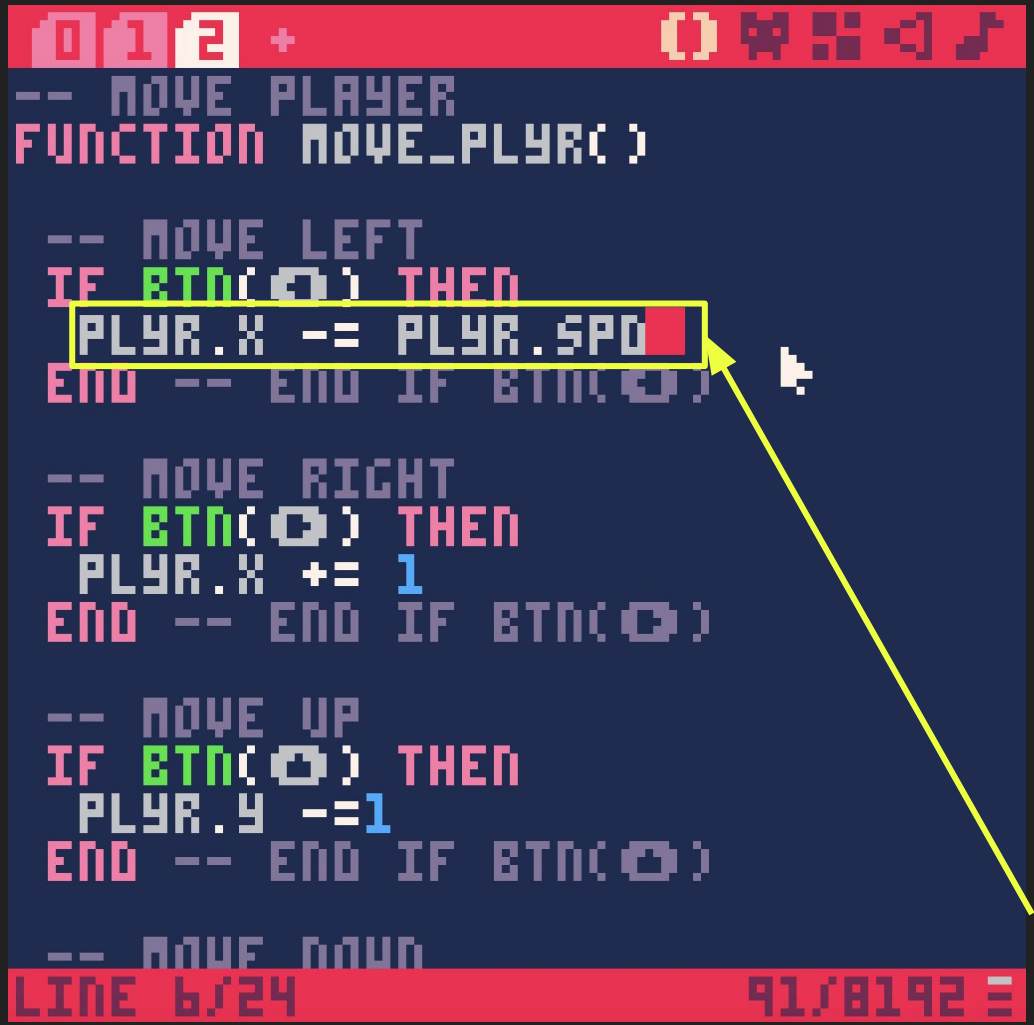


Let’s begin our move_plyr() function by allowing the left and right arrow keys to decrease and increase our player’s **x** value

Very similar to paddleball



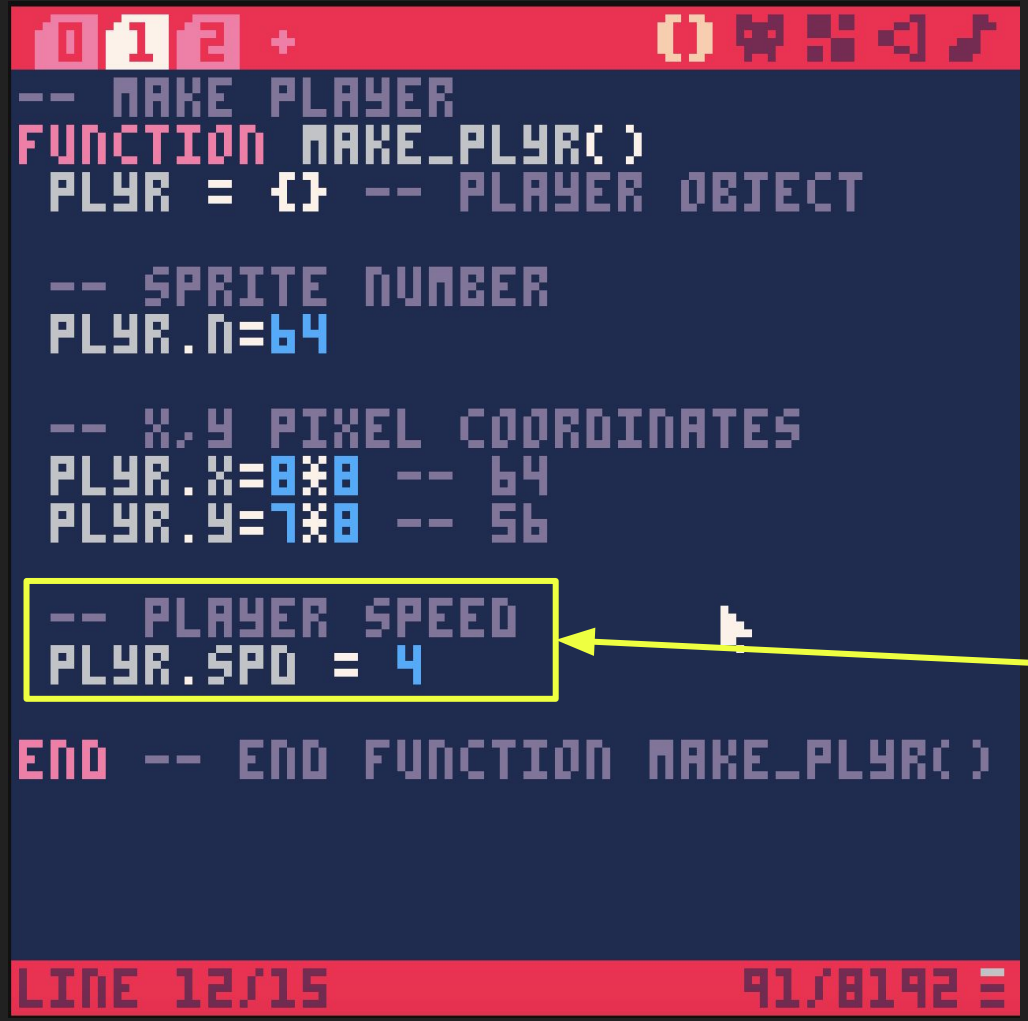
Likewise, we can use the ***up*** and ***down*** keys to decrease and increase our player's ***y*** value



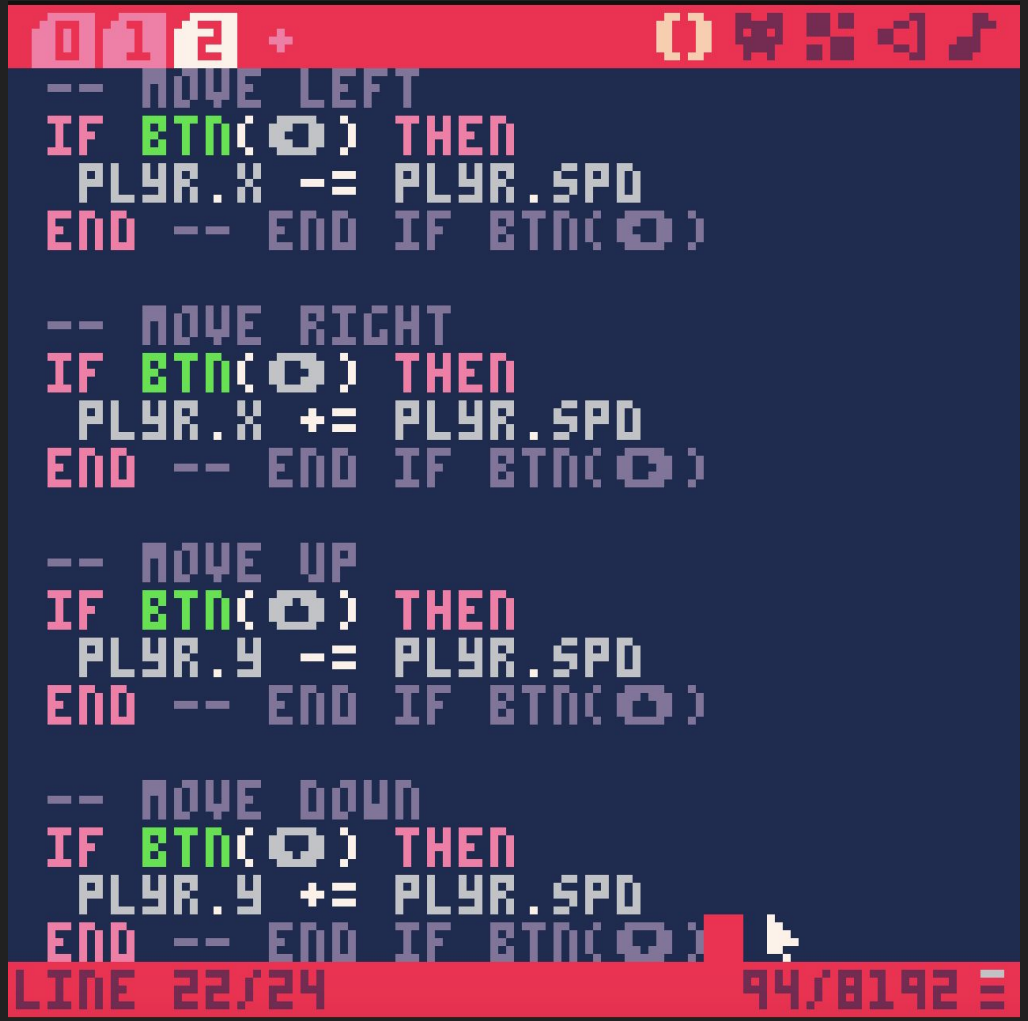
1 pixel of movement is very slow, and something you'll likely want to tweak

It makes sense to use a variable so you only need to change the value in one place instead of four places

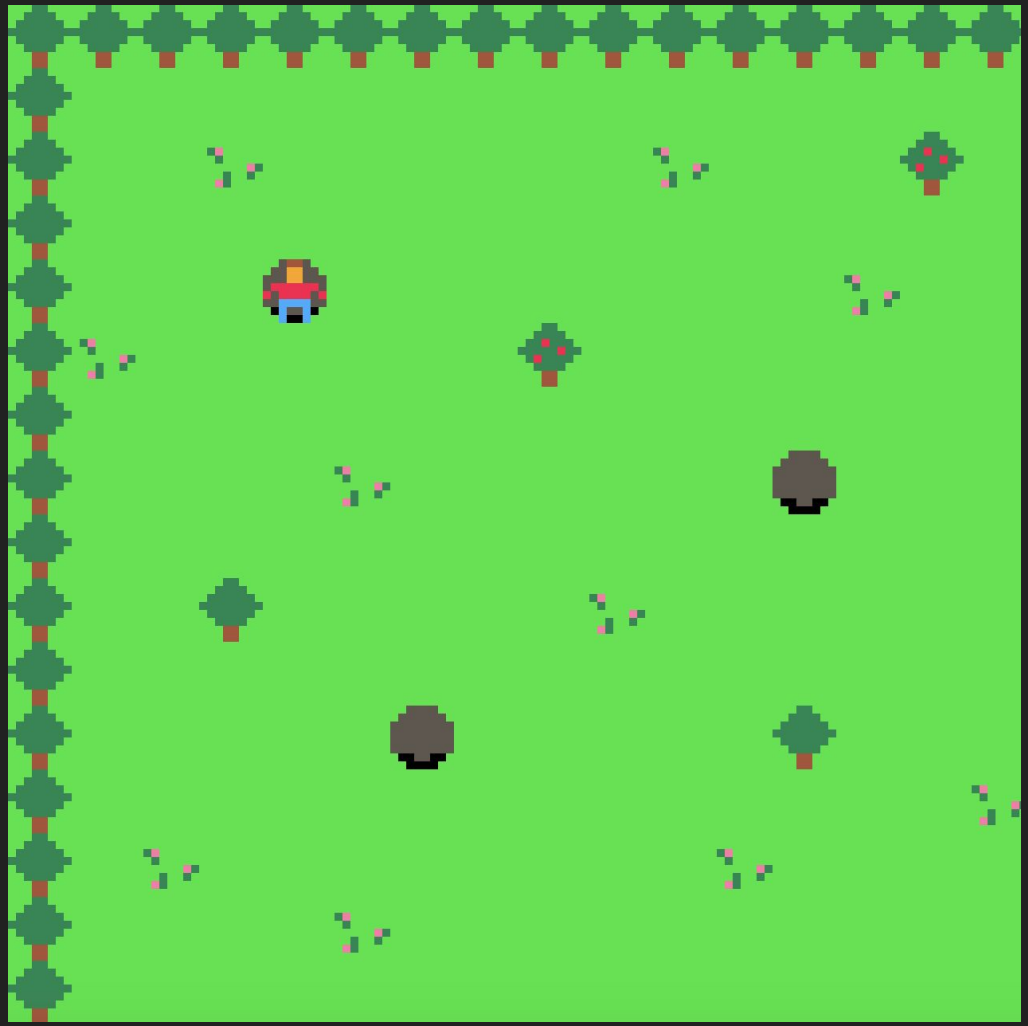
I used a variable called **plyr.spd** (for speed)



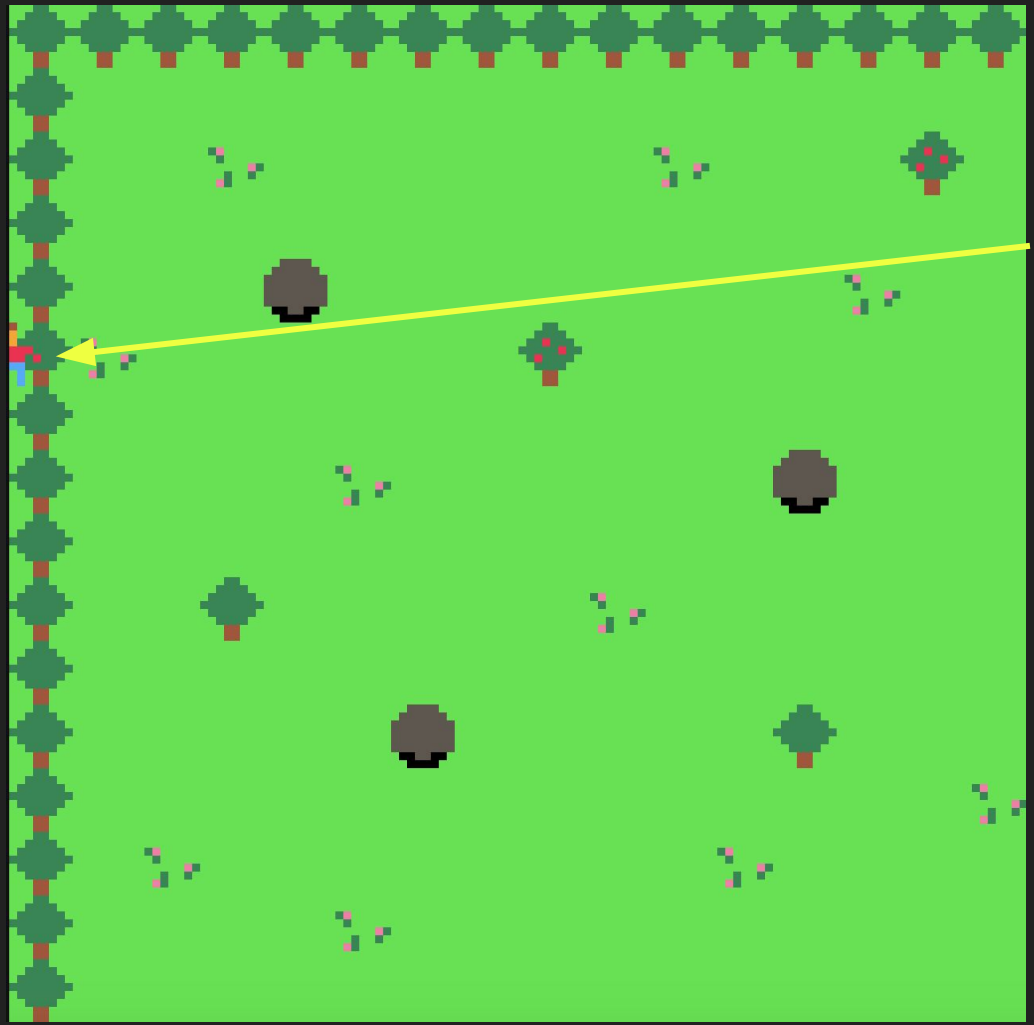
Just make sure you ***define the variable*** in your make_plyr() function



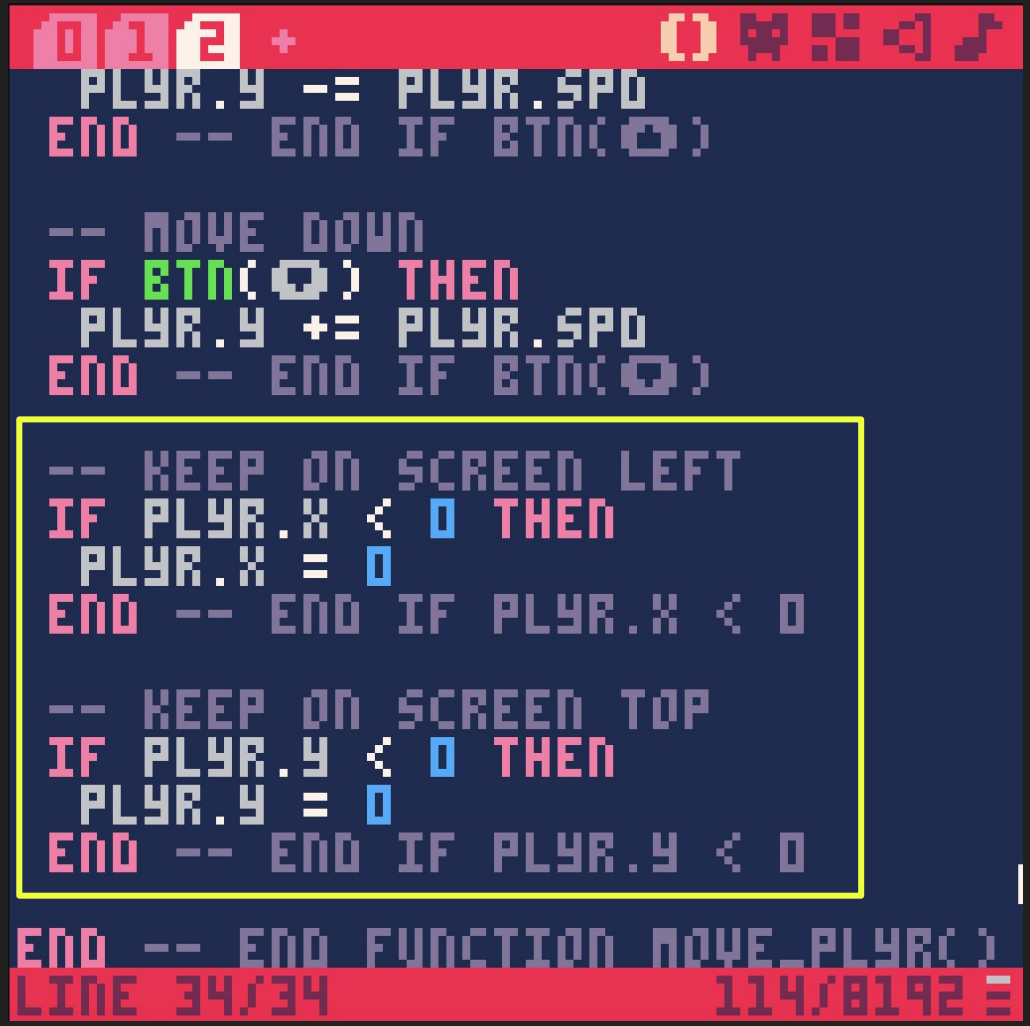
Here, I’m using **plyr.spd**, instead of a fixed number value, to increment and decrement my player’s x or y position



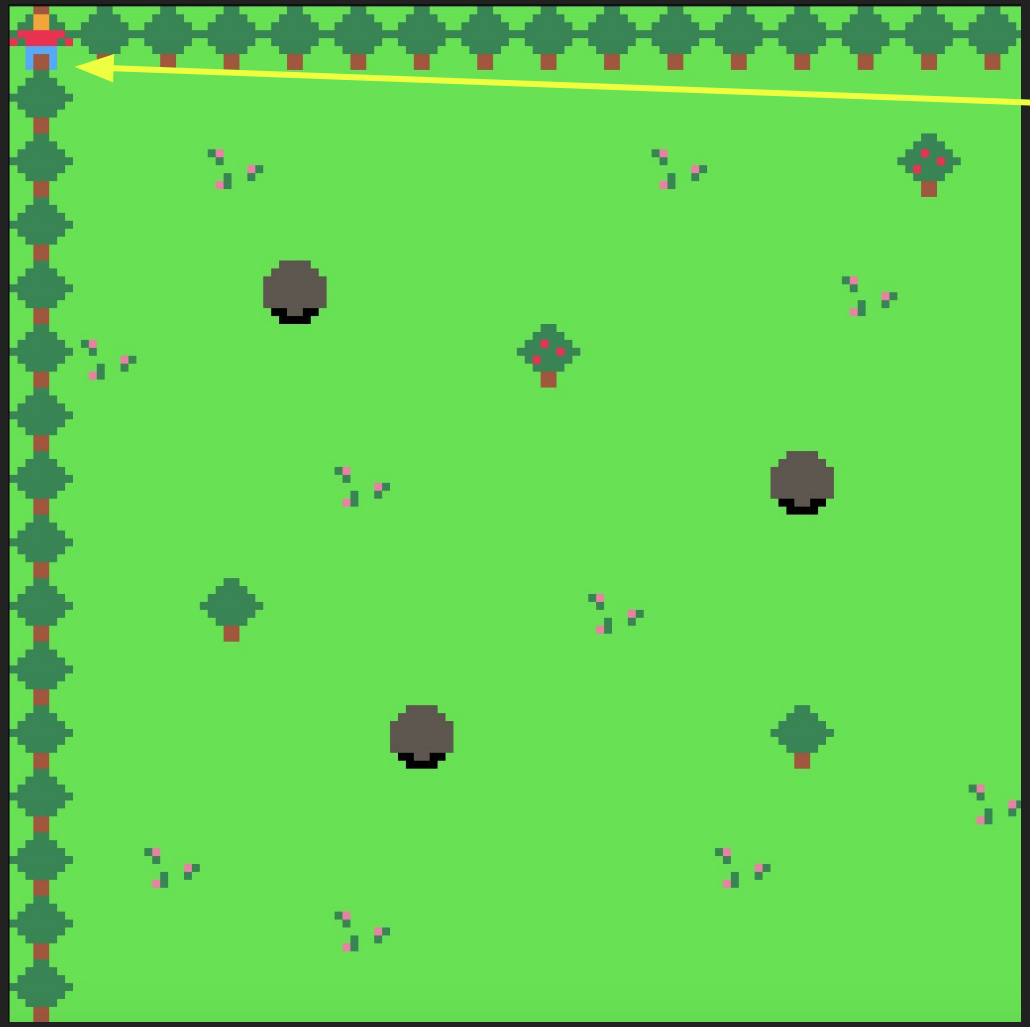
Of course, we haven’t implemented collision yet, so our player will still go through tiles that look like they should be solid



And we can even move off screen entirely



We can keep the player on screen much like we kept the ball and paddle on screen

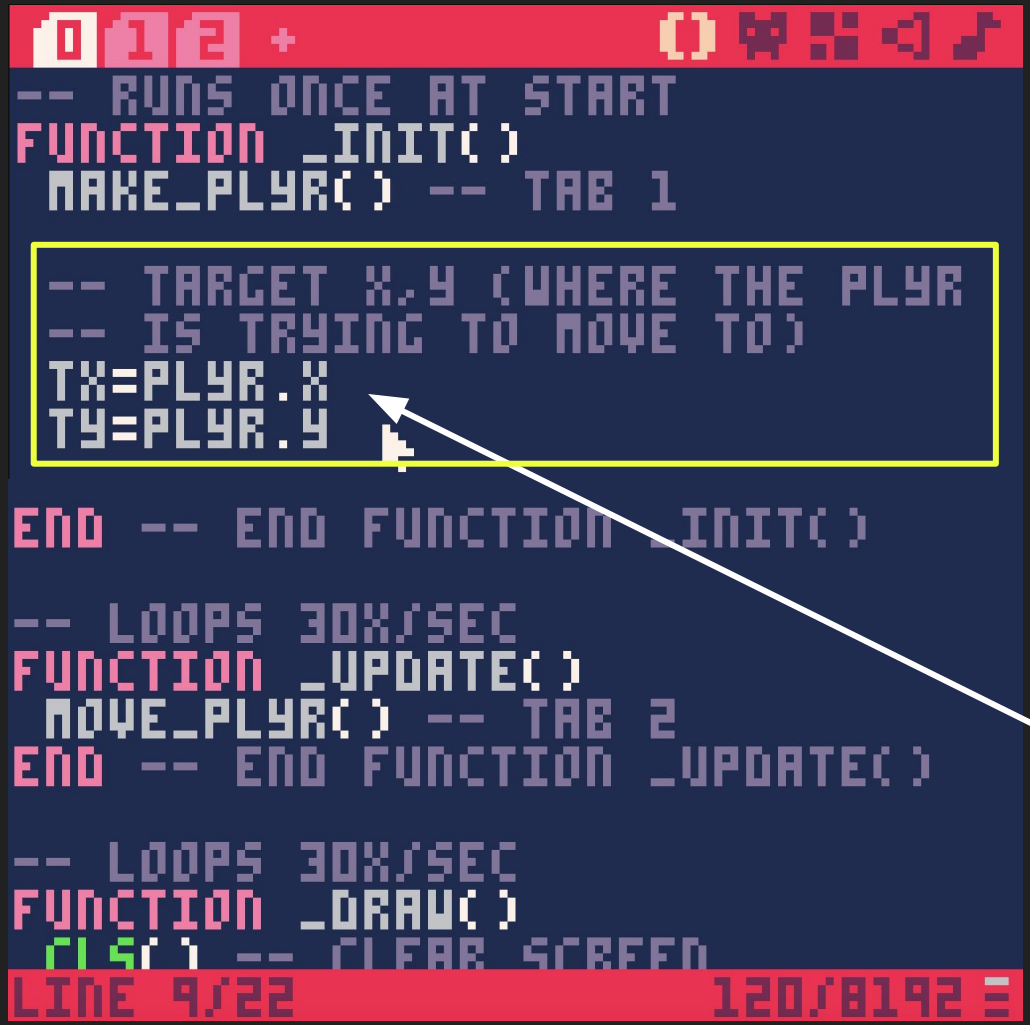


Now the player cannot move beyond the left or top edges of the map

```
-- KEEP ON SCREEN LEFT
IF PLYR.X < 0 THEN
  PLYR.X = 0
END -- END IF PLYR.X < 0

-- KEEP ON SCREEN TOP
IF PLYR.Y < 0 THEN
  PLYR.Y = 0
END -- END IF PLYR.Y < 0
```

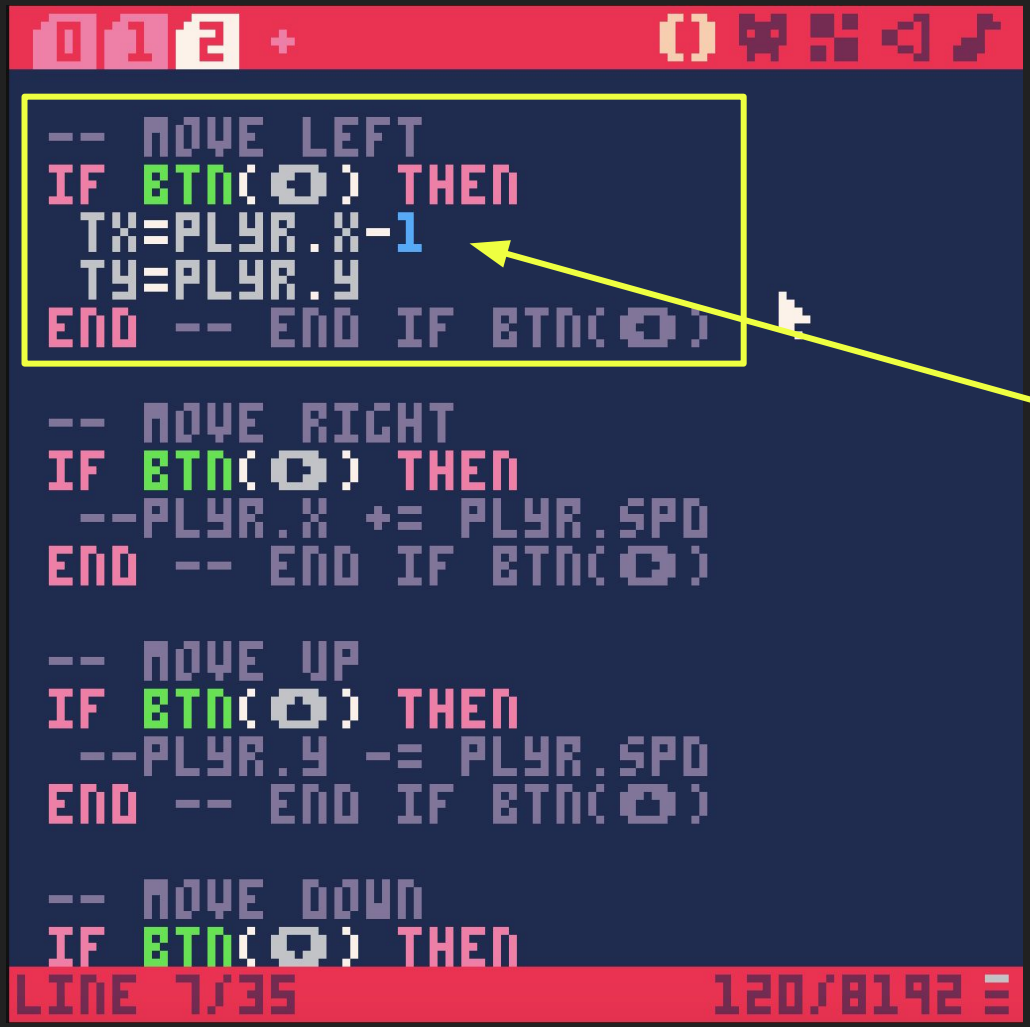
Implementing Collision with Map Tiles

Download Example File: topdown_06_pixelbased_movement_and_collision.p8



Like with tile-based movement, we'll use variables to track the x,y position the player is trying to move to – I'll call these **tx** and **ty** for target x and target y

I'll assign them a value in _init() for starters, but this value will change when the player presses an arrow key



We'll calculate the values for **tx** and **ty** in our **move_plyr** function

If we're trying to move left, the ***target x location is one pixel less than the current x location***

This is expressed as:
tx=plyr.x-1

(The target y will just be the same as plyr.y because we are not moving up or down)

```
-- MOVE PLAYER
FUNCTION MOVE_PLYR()

 -- MOVE LEFT
 IF BTN(⬅️) THEN
  TX=PLYR.X-1
  TY=PLYR.Y
 END -- END IF BTN(⬅️)

 -- MOVE RIGHT
 IF BTN(➡️) THEN
  TX=PLYR.X+PLYR.W+1
  TY=PLYR.Y
 END -- END IF BTN(➡️)

 -- MOVE UP
 IF BTN(⬆️) THEN
  TX=PLYR.X
  TY=PLYR.Y-1
```

LINE 12/38 163/8192

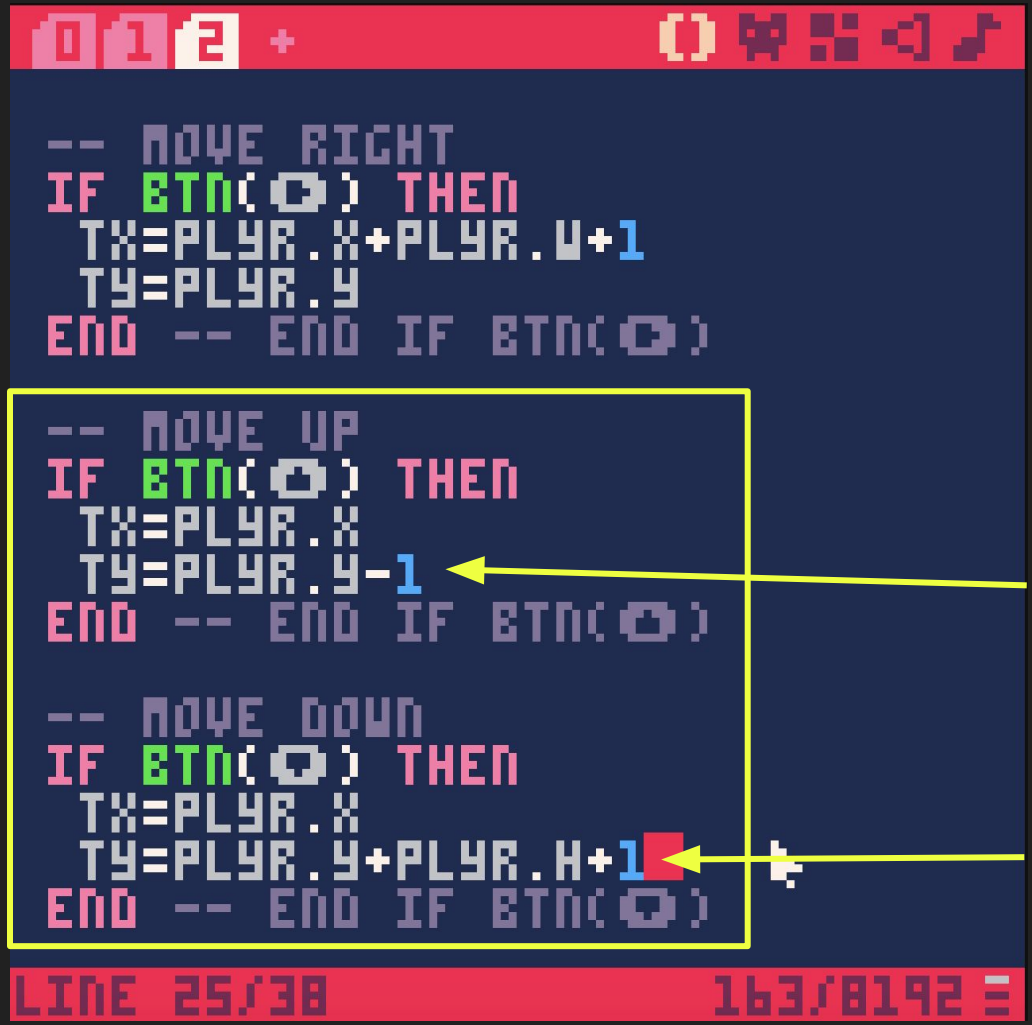
If we're trying to move right, we ***must account for the player's width***

This is expressed as:
tx=plyr.x+plyr.w

(*Make sure to declare* ***plyr.w*** *and* ***plyr.h*** *variables in* ***make_plyr***)

```
-- MAKE PLAYER
FUNCTION MAKE_PLYR()
 PLYR = {} -- PLAYER OBJECT

 -- SPRITE NUMBER
 PLYR.N=64

 -- X,Y PIXEL COORDINATES
 PLYR.X=8*8 -- 64
 PLYR.Y=7*8 -- 56

 -- WIDTH AND HEIGHT (IN PIXELS)
 PLYR.W=8
 PLYR.H=8

 -- PLAYER SPEED
 PLYR.SPD = 2

END -- END FUNCTION MAKE_PLYR()
```

LINE 1/19 57/8192



If we're trying to move up or down, we'll do the same thing, but changing ***ty*** while leaving **tx** equal to **plyr.x**

And account for the ***height*** moving **down** instead of the width

Implementing Collision with Map Tiles

- Now we've calculated the x,y location that the player is trying to move to (expressed in our code as **tx**,**ty**)
- Next, we can use this **target x,y location** to figure out whether the **sprite flag** for the **map tile** is turned **on**

Implementing Collision with Map Tiles

- PICO-8 offers two useful built-in functions for working with map tiles and sprite flags
- mget() – takes an **x,y location** and finds the **sprite number** at that location
- fget() – takes a **sprite number** and finds whether a **flag** is turned **on**

Implementing Collision with Map Tiles

Calculate **tx**,**ty**

mget(**tx**,**ty**) = **sprite_number**

fget(**sprite_number**,flag_number) = **true or false**

Here’s an overview of how that code would look …

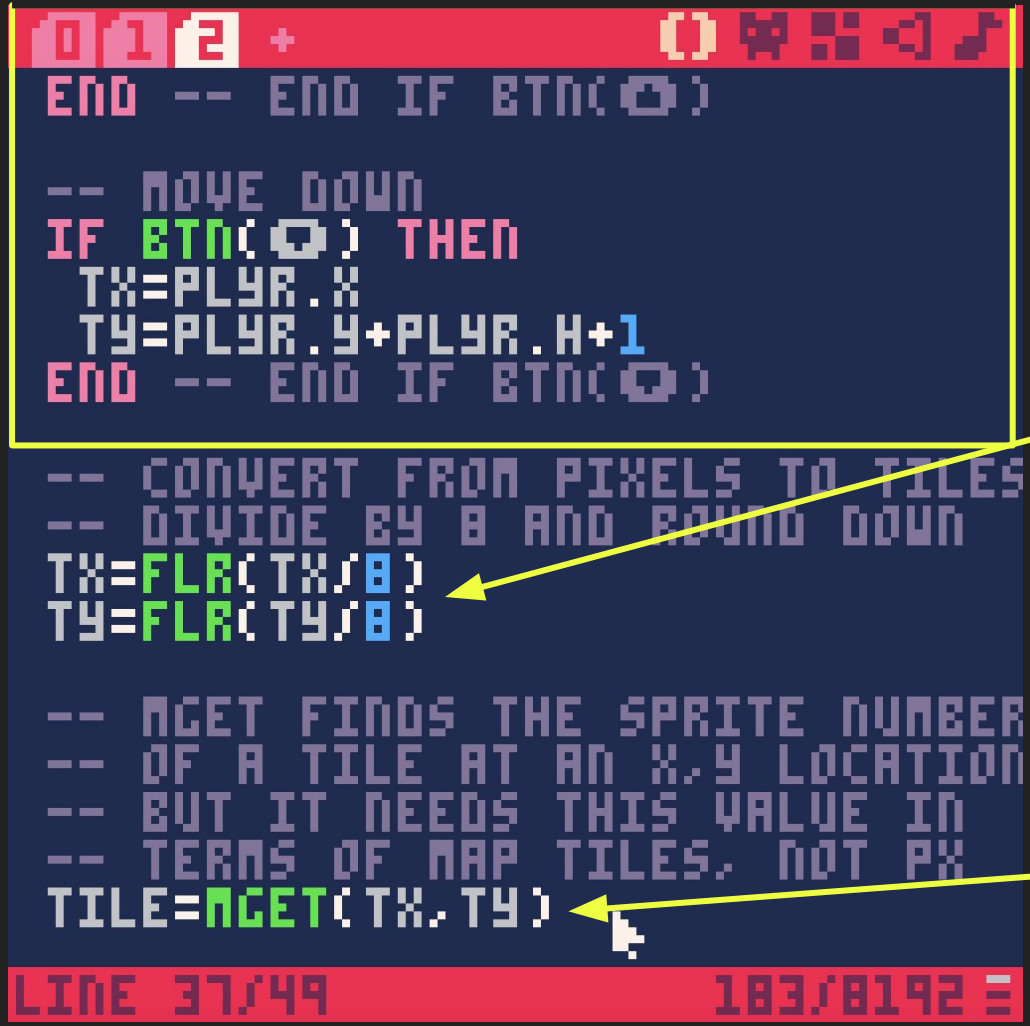
```
-- convert from pixels to tiles
-- divide by 8 and round down
tx=flr(tx/8)
ty=flr(ty/8)

-- mget finds the sprite number
-- of a tile at an x,y location
-- but it needs this value in
-- terms of map tiles, not px
tile=mget(tx,ty)

-- fget finds whether a flag
-- is turned on for a sprite
-- it needs the sprite number
-- and flag number
is_wall=fget(tile,0)
```

Calculate **tx**,**ty**

mget(**tx**,**ty**) = **sprite_number**

fget(**sprite_number**,flag_number)
= **true or false**

Let’s do this step by step



Above, we calculated tx and ty based on which direction the player is trying to move

Next, we need to **divide tx and ty by 8**, to *convert from pixels to tiles*, because *mget() requires a tile value*

We can use **flr()** to **round down**

Then we can plug the updated **tx** and **ty** values into the mget() function, which returns the **sprite number** of the tile

```
-- MGET FINDS THE SPRITE NUMBER
-- OF A TILE AT AN X,Y LOCATION
-- BUT IT NEEDS THIS VALUE IN
-- TERMS OF MAP TILES, NOT PX
TILE=MGET(TX,TY)

-- FGET FINDS WHETHER A FLAG
-- IS TURNED ON FOR A SPRITE
-- IT NEEDS THE SPRITE NUMBER
-- AND FLAG NUMBER
IS_WALL=FGET(TILE,0)

-- ONLY MOVE IF NOT A WALL AT
-- TARGET LOCATION
IF NOT IS_WALL THEN
 -- PLYR MOVEMENT HERE
END -- END IF NOT IS_WALL
```

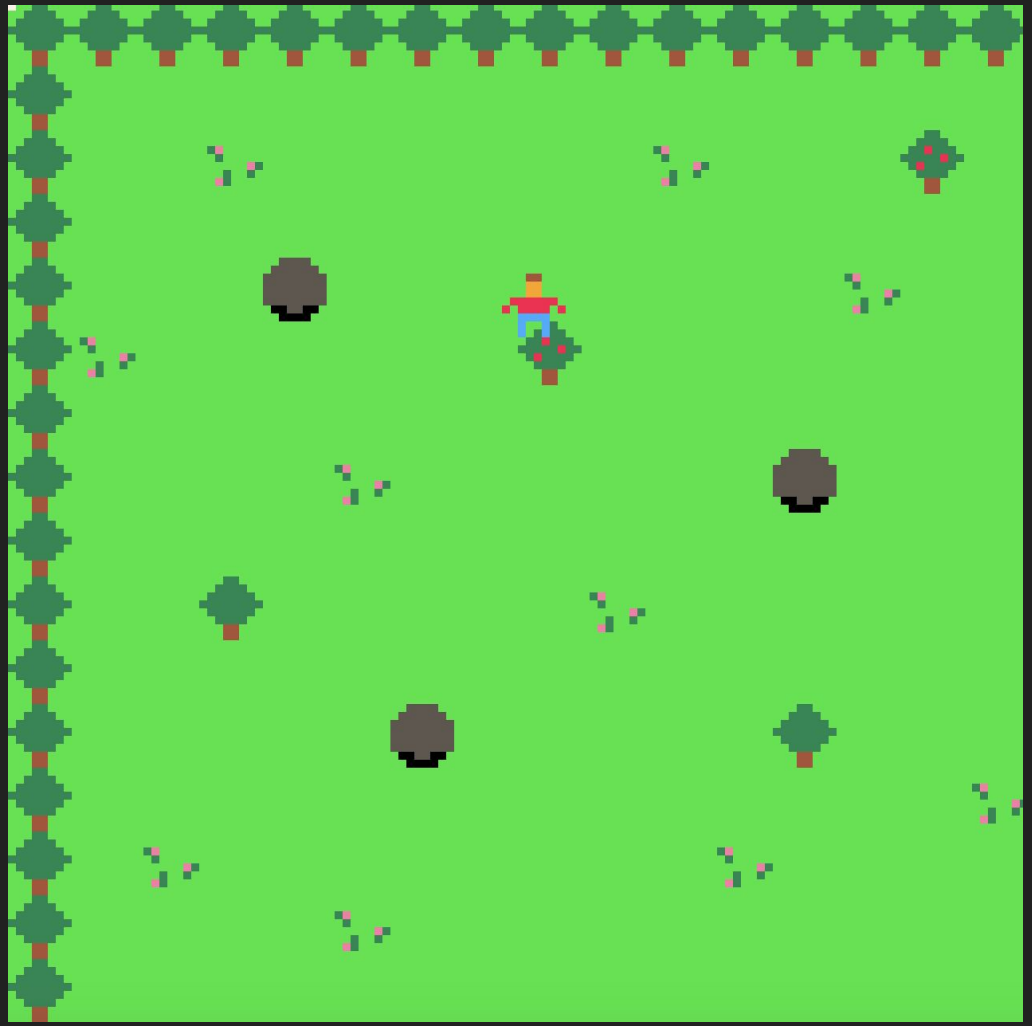
LINE 48/61 193/8192

We plug the updated **tx** and **ty** values into the mget() function, which returns the **sprite number** of the tile

Then we can **plug the tile's sprite number** into the fget() function – *along with the **flag number** we used, which was* **0** – to return **true** or **false**

Then we can *only move the player if **is_wall** returned **false***

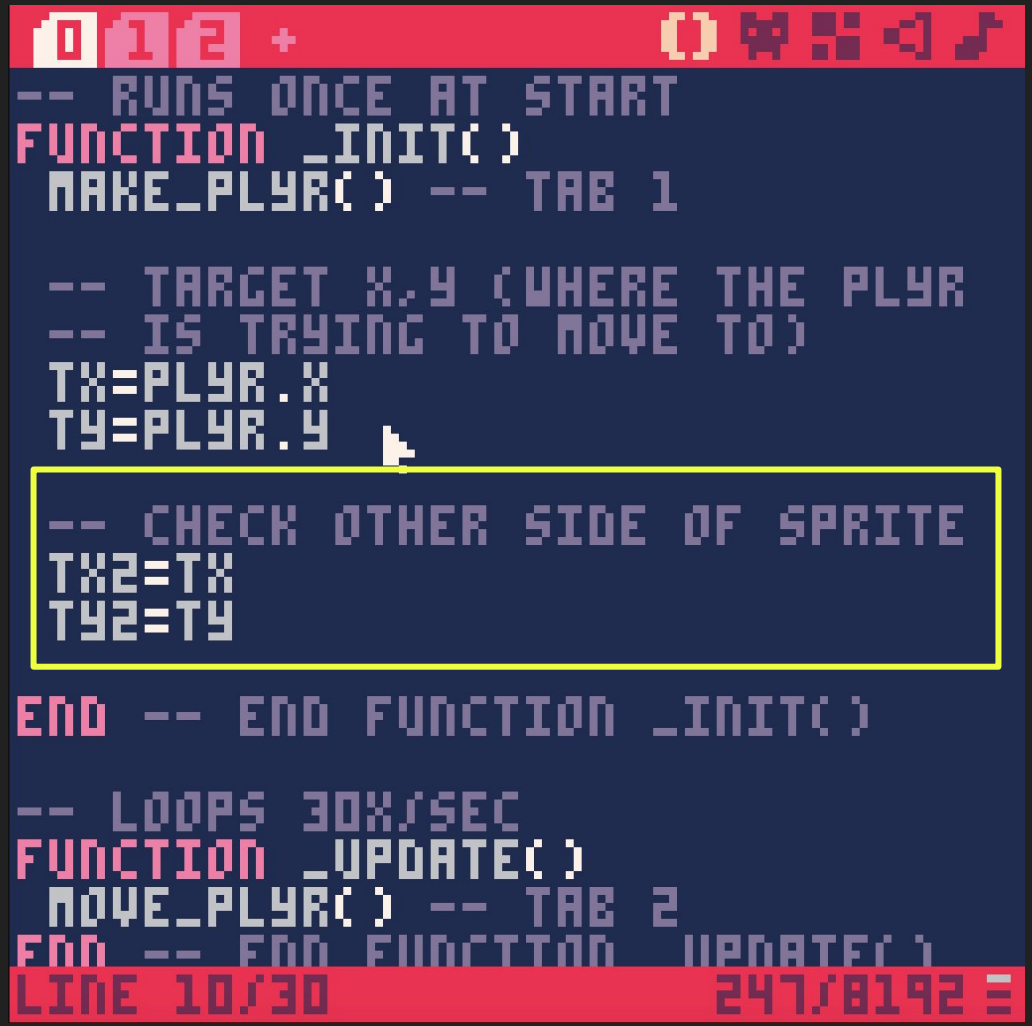
*We can use the keyword **NOT** to flip true to false or vice-versa*



This mostly works, except ***sometimes the player still goes through solid tiles***

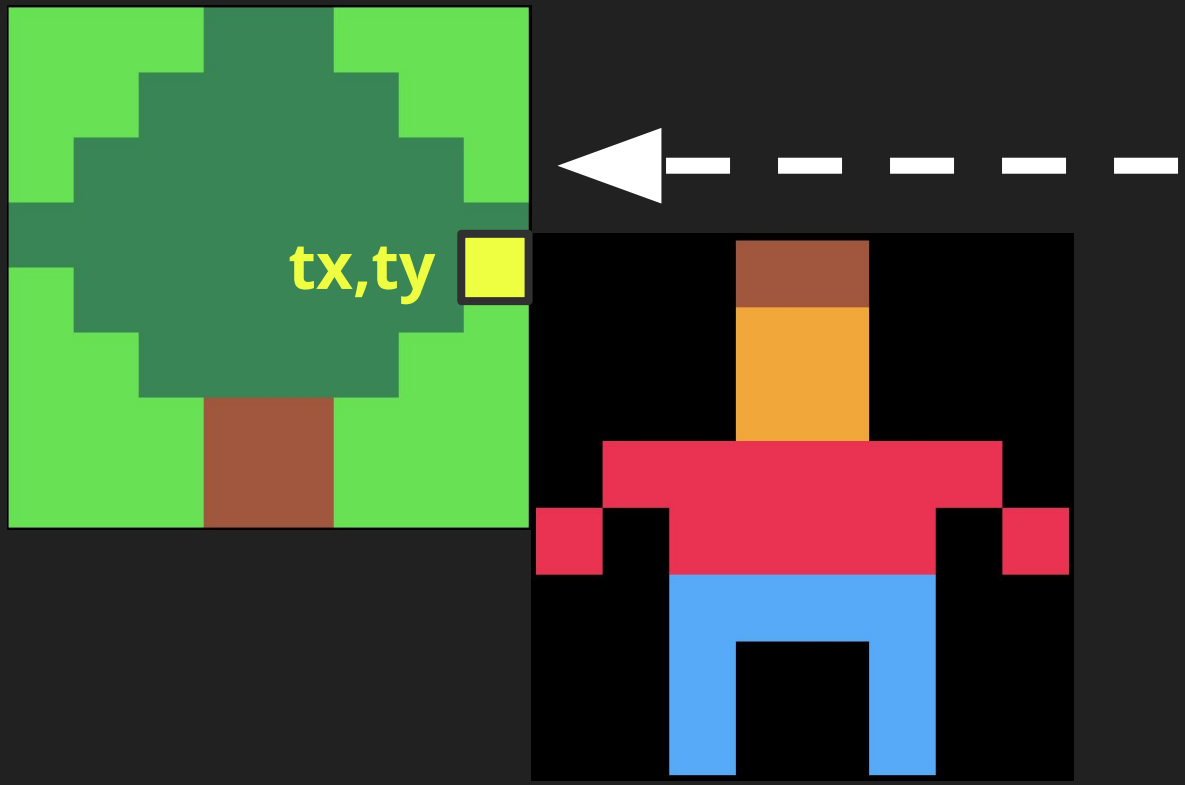
This is because we are ***only checking one point*** relative to the player

We'll need to ***check a point on the opposite side of the player*** to make our collision check comprehensive

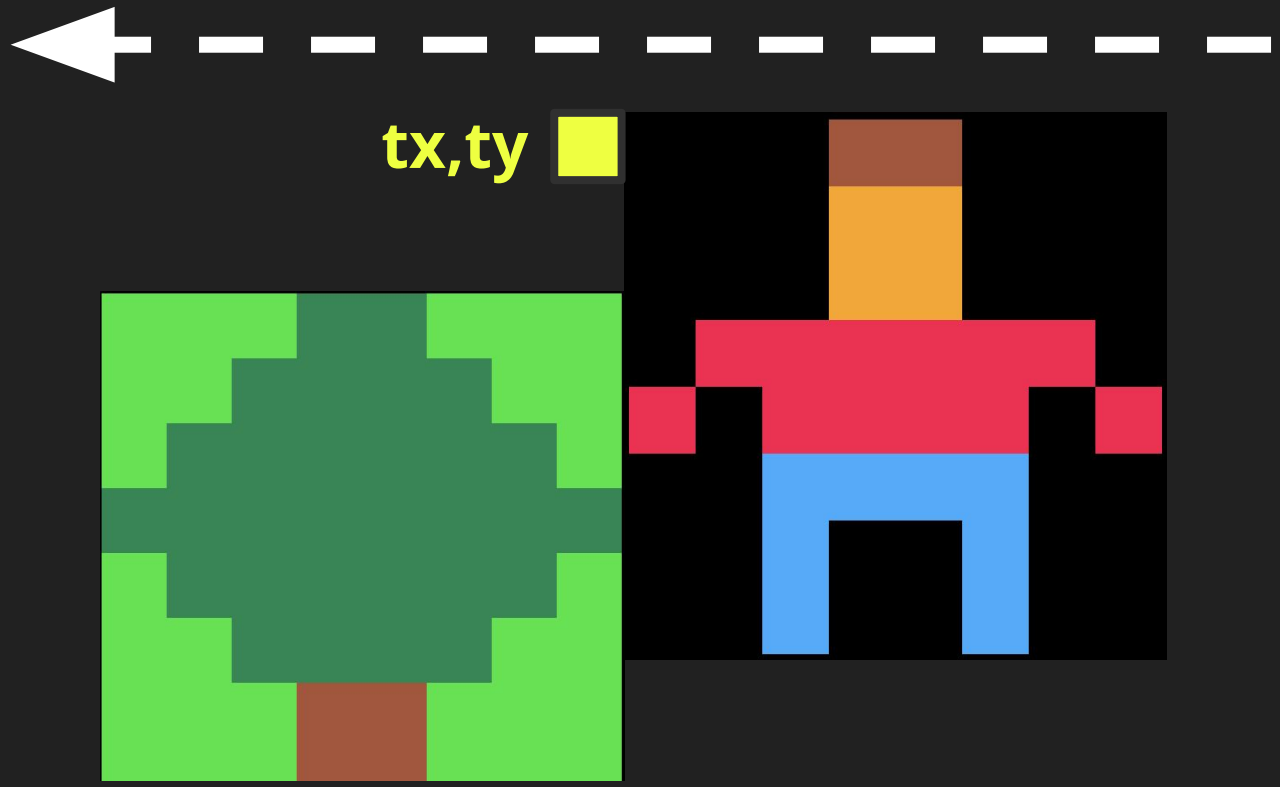


We'll create a **second pair** of **target x,y** variables

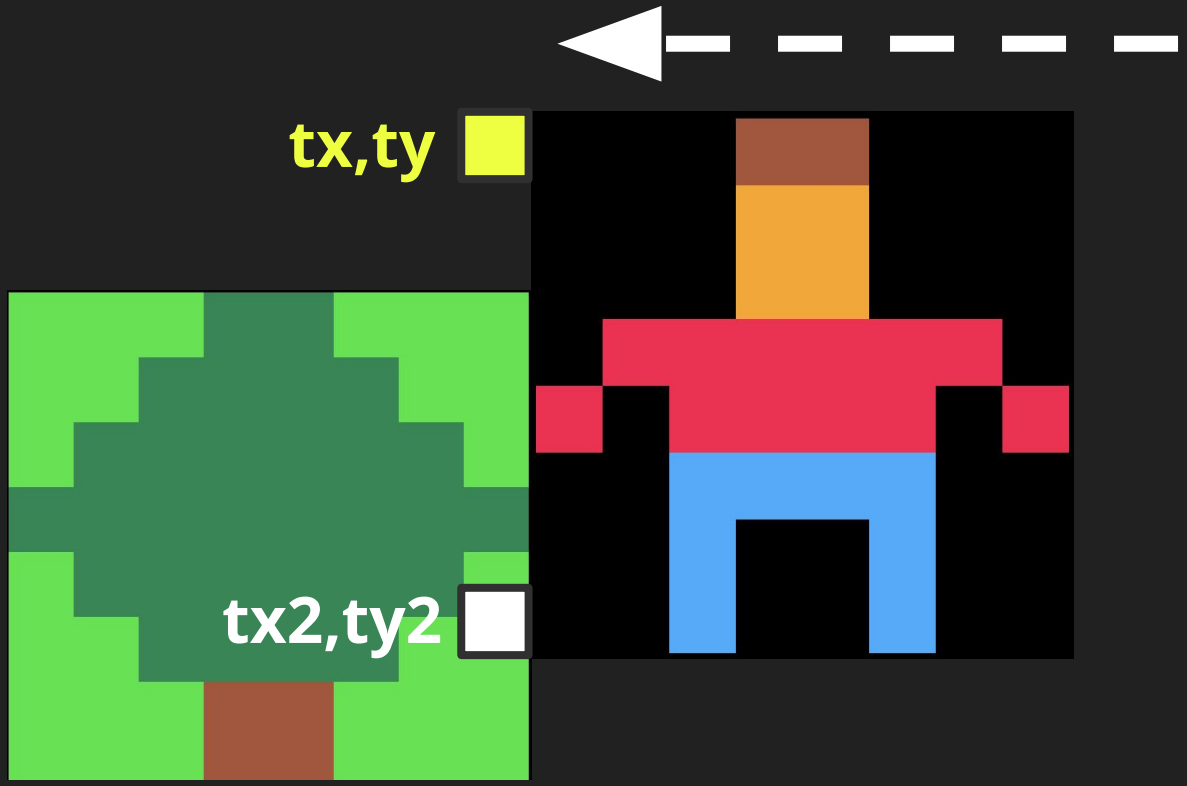
I named mine **tx2** and **ty2**



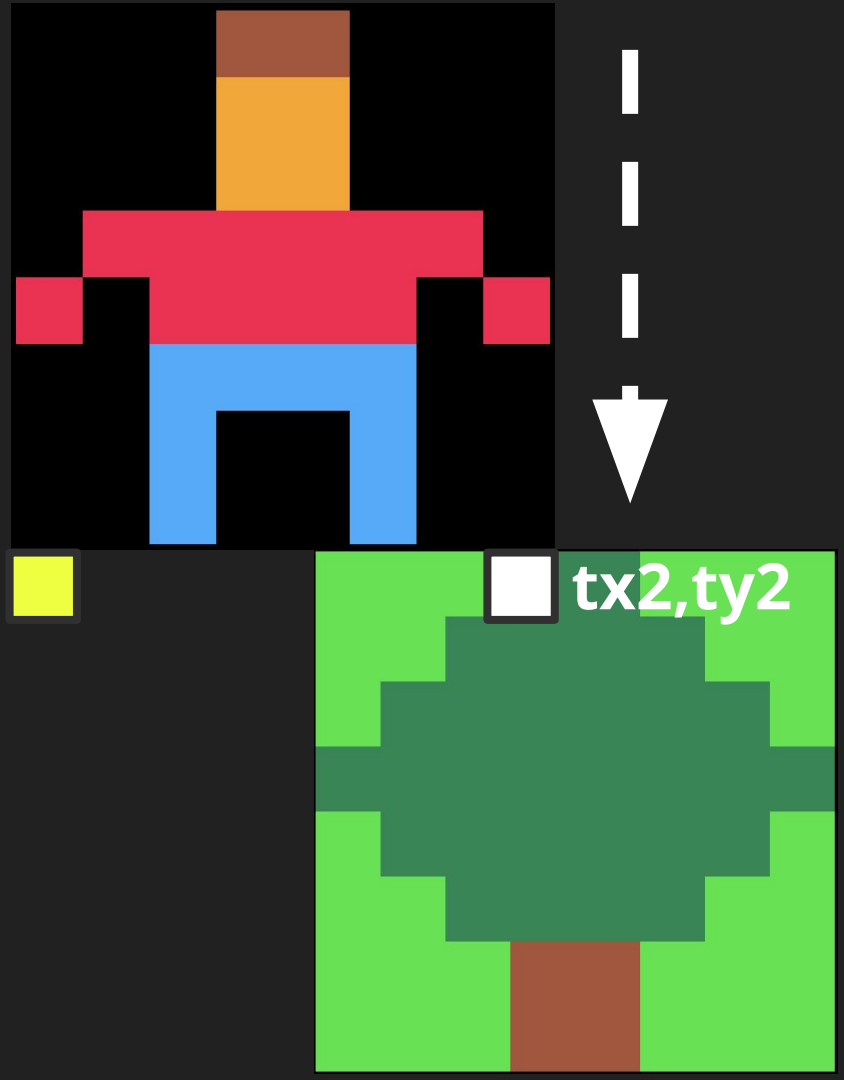
If the player is trying to move **left**, in this instance, the calculated position of **tx**,**ty** ***intersects with the tree sprite, preventing movement***



But if the tree is below the top of the player, ***tx,ty is above the tree, so the player will move through it***

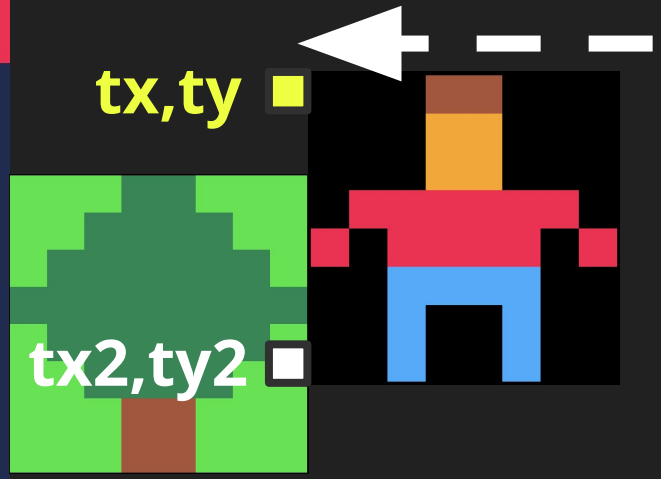


We'll create a second pair of x,y coordinates (**tx2,ty2**) to ***check the bottom of the player when moving left/right***



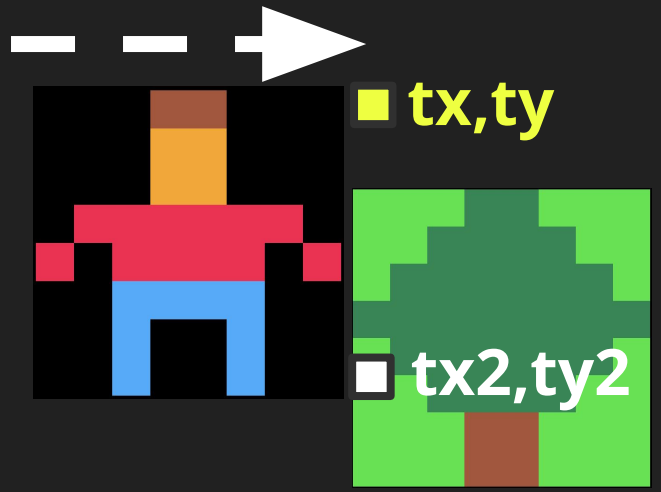
And we'll ***check the right side of the player when moving up/down***

```
FUNCTION MOVE_PLYR()

 -- MOVE LEFT
 IF BTN(⬅) THEN
  TX=PLYR.X-1
  TY=PLYR.Y

  TX2=TX
  TY2=PLYR.Y+PLYR.H
 END -- END IF BTN(⬅)

 -- MOVE RIGHT
 IF BTN(➡) THEN
  TX=PLYR.X+PLYR.W+1
  TY=PLYR.Y

  TX2=TX
  TY2=PLYR.Y+PLYR.H
 END -- END IF BTN(➡)
```



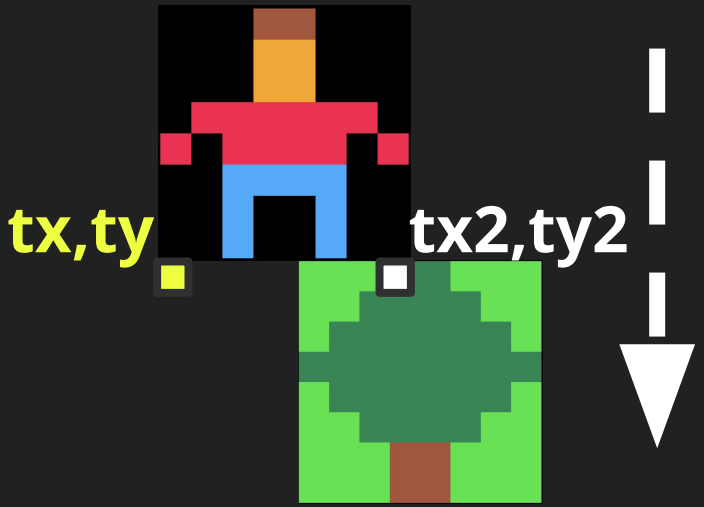
When moving **left/right**, we need to check the **lower** half of the player, so **ty2** will add the player's height

```
FUNCTION MOVE_PLYR()

 -- MOVE LEFT
 IF BTN(⬅️) THEN
  TX=PLYR.X-1
  TY=PLYR.Y

  TX2=TX
  TY2=PLYR.Y+PLYR.H
 END -- END IF BTN(⬅️)

 -- MOVE RIGHT
 IF BTN(➡️) THEN
  TX=PLYR.X+PLYR.W-1
  TY=PLYR.Y

  TX2=TX
  TY2=PLYR.Y+PLYR.H
 END -- END IF BTN(➡️)
```

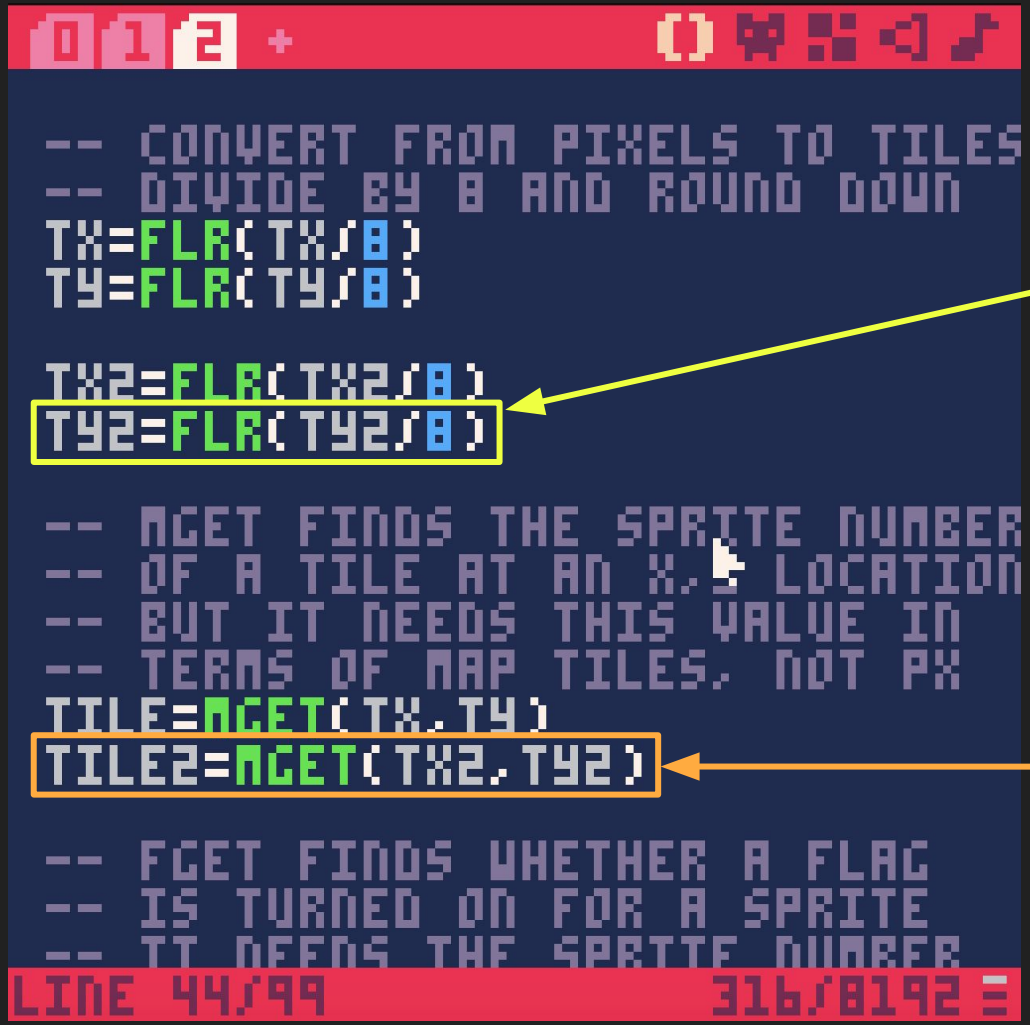


This **ty2** value will be the **same** when moving **right**

```
-- MOVE UP
IF BTN(⬆) THEN
 TX=PLYR.X
 TY=PLYR.Y-1

 TX2=PLYR.X+PLYR.W
 TY2=TY
END -- END IF BTN(⬆)

-- MOVE DOWN
IF BTN(⬇) THEN
 TX=PLYR.X
 TY=PLYR.Y+PLYR.H+1

 TX2=PLYR.X+PLYR.W
 TY2=TY
END -- END IF BTN(⬇)
```



When moving **up/down**, we need to check the **right** side of the player, so ***tx2*** will add the player's ***width***



We'll do the same conversion from tiles to pixels as we did for the first pair of coordinates

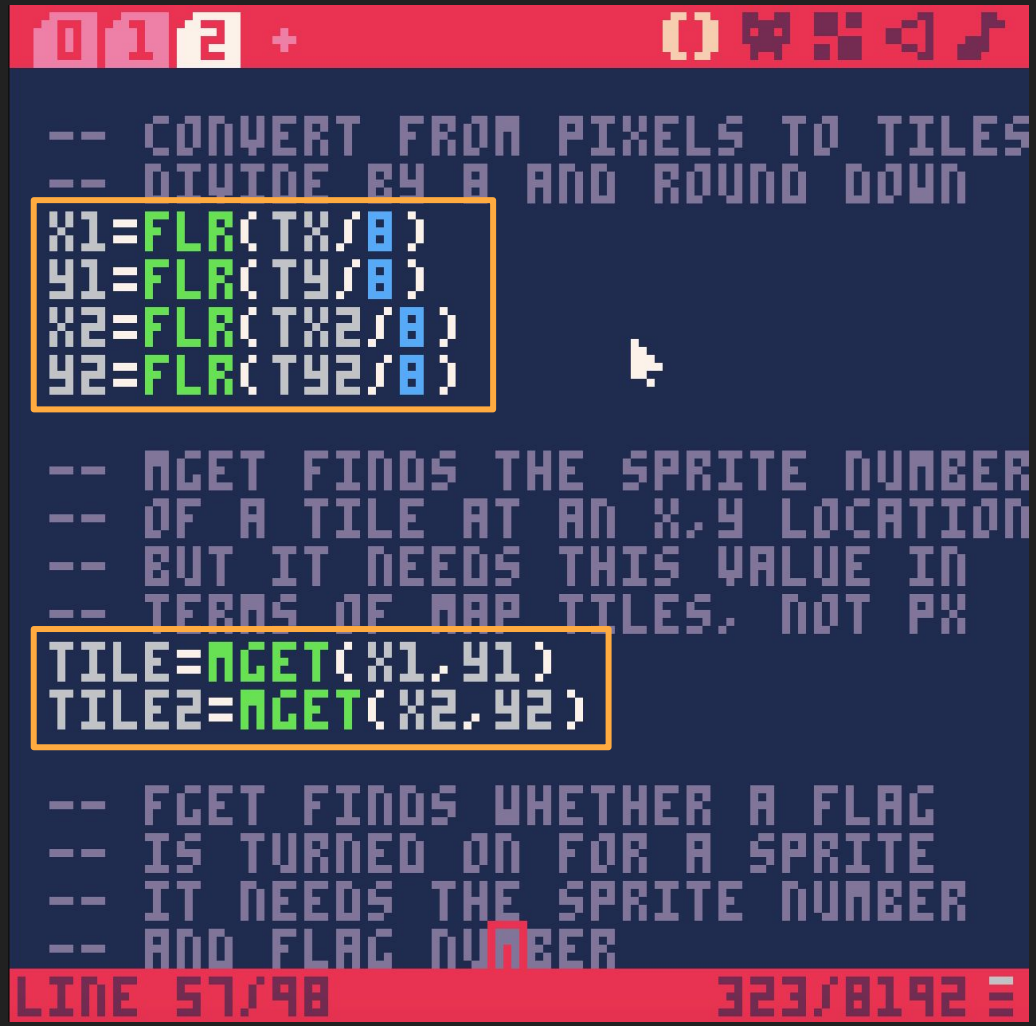
And then we'll need **another variable** for the **sprite number of the second point** we're checking

We'll also need another variable for the true/false of the second point

And then we'll need to **add a condition** that the **second point is *ALSO* not on a wall tile** in our **if statement** allowing movement

```
-- LOOPS 30X/SEC
FUNCTION _UPDATE()
 MOVE_PLYR() -- TAB 2
END -- END FUNCTION _UPDATE()

-- LOOPS 30X/SEC
FUNCTION _DRAW()
 CLS() -- CLEAR SCREEN
 MAP() -- DRAW MAP AT 0,0
 SPR(PLYR.N,PLYR.X,PLYR.Y)

 -- DRAW TARGET X,Y
 RECT(TX,TY,TX,TY,7)
 RECT(TX2,TY2,TX2,TY2,7)

END -- END FUNCTION _DRAW()
```

To visualize this (optional), we can **draw rectangles at the two points we're checking**



Because the rect() function uses pixel coordinates, and we *converted our **tx**,**ty** and **tx2**,**ty2** to **tile** values*, I found it simpler to use separate variables for the converted values

I used **x1,y1** and **x2,y2**

```
-- only move if not a wall at
-- target location
if not is_wall
and not is_wall2 then

 -- move left
 if btn(⬅️) then
  plyr.x -= plyr.spd
 end -- end if btn(⬅️)

 -- move right
 if btn(➡️) then
  plyr.x += plyr.spd
 end -- end if btn(➡️)

 -- move up
 if btn(⬆️) then
  plyr.y -= plyr.spd
 end -- end if btn(⬆️)

 -- move down
 if btn(⬇️) then
  plyr.y += plyr.spd
 end -- end if btn(⬇️)

end -- end if not is_wall
```

Condition

Movement code

End Condition

Finally, to actually implement movement:

I placed the movement code inside the **if statement** that checks whether **is_wall** and **is_wall2** are ***NOT*** **true**

Implementing Collision with Map Tiles

- Again, you can make your life a lot easier by keeping character and map tile sprites the same size
- If you had a player sprite that was 24x24 pixels and a wall tile sprite that was 8x8 pixels, you would need to add a *third* pair of target x,y values to account for collision with the middle of the player

Learning Resources

Learning Resources

Top-Down Adventure Game Tutorial Playlist by Dylan Bennett on YouTube

1. Map Setup
2. Add Player
3. Player Movement
4. Camera
5. Keys
6. Inventory Screen

Learning Resources

Top-Down Adventure Game Tutorial Playlist by Dylan Bennett on YouTube

7. Doors
8. Animated Tiles and Spike Traps
9. Game Over Screen
10. Reset and Package
11. Text
12. More Tile Types

Function Reference

- camera() Set the camera position
- ceil() Round up to nearest integer
- fget() Check for a flag on a sprite
- flr() Round down to nearest integer
- map() Draw the map
- mget() Get the sprite number of a tile
- mset() Set a tile to a different sprite

My Code Examples

From _helloworld_02_topdown_adventure.zip

1. Tile-Based Movement and Map Collision
2. Item Collection
3. Lock & Key Systems
4. Positioning the Camera
5. Warping
6. Pixel-Based Movement and Map Collision
7. Pixel-Based Item Collection

</lesson>

Questions? Email me at mdimatteo@rider.edu anytime!