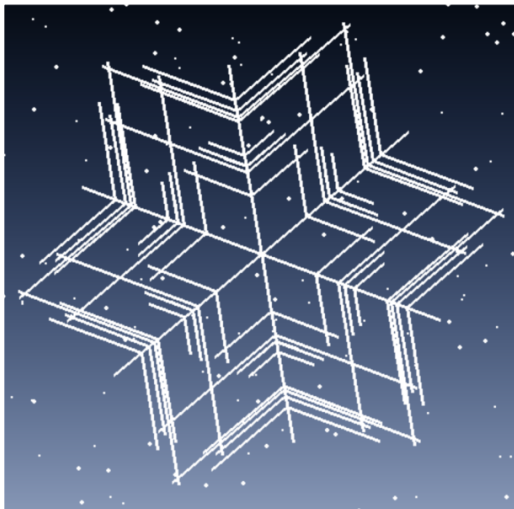


# Making a Snowflake

Difficulty: 🌶️🌶️🌶️🌶️🌶️

Language: Python

Requires: Laptop with Python, coderdojo [games] or pygame



Let's use Python and Pygame to make snowflakes, different every time!

Please take care with names and case. Python is case sensitive, so `Snowflake` is different to `snowflake`. If you get an error, check your spelling and capitalisation.

This sheet recommends using Thonny in Python 3 mode and the `coder-dojo-common-python[games]` package.

You do not need to type the whole example out again, only make changes where shown. Throughout this sheet we will use diff blocks to show you what changes we're making to code. Key:

```
+ this is a new line to add into your code
- this is a line to remove from your code
  and this is a line to leave the same.
```

## Step 1 - Setting up

Let's get ourselves a screen to draw on using PyGame. We'll collect some imports on the way too. In a new file add the following:

```
import math

import pygame

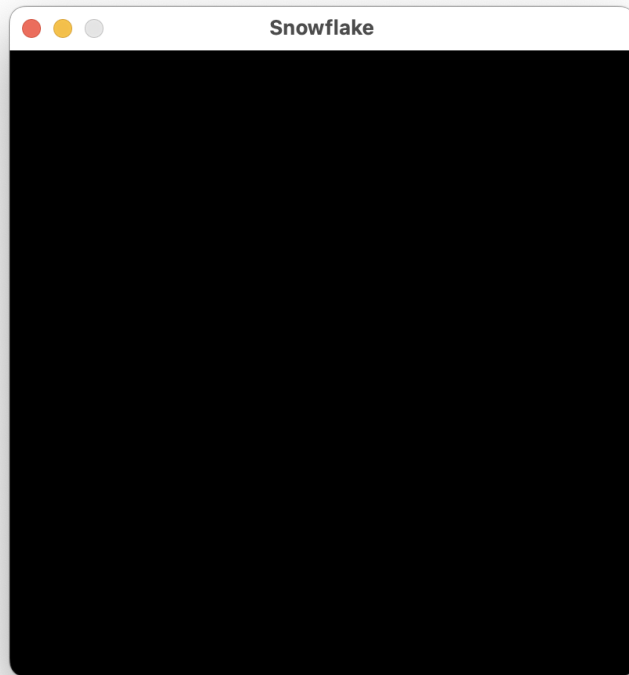
WIDTH=400
HEIGHT=400
FPS = 60
WHITE = (255, 255, 255)
BLACK = (0, 0, 0)

pygame.init()
screen = pygame.display.set_mode((WIDTH, HEIGHT))
pygame.display.set_caption("Snowflake")

running = True
while running:
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            running = False
    screen.fill(BLACK)
    pygame.display.flip()
pygame.quit()
```

We will be using `math` to generate our snowflake and `pygame` to draw our snowflake.

We've set up variables for screen size and colours. We set up a screen with a title "Snowflake" and a background colour. We also set up a main loop to keep our game running until we close the window causing a quit event. Running this should give a black screen with a title.



Let's make it more interesting.

## Adding the skeleton of our snowflake

The basic part of our snowflake would be a line. Here we are adding code, so the little plus marks show which lines to add and where (do not type the plusses).

```
import math

import pygame

WIDTH=400
HEIGHT=400
FPS = 60
WHITE = (255, 255, 255)
BLACK = (0, 0, 0)

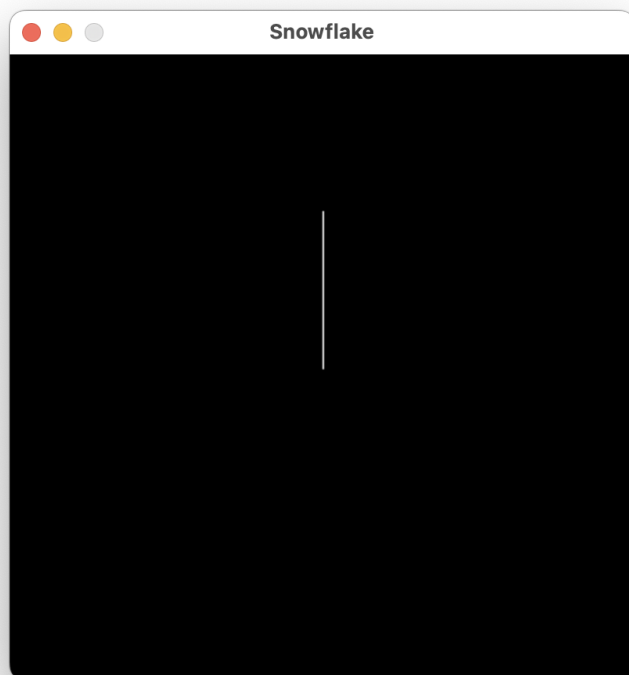
+ class Snowflake:
+     def draw(self, surface):
+         mid_x, mid_y = WIDTH/2, HEIGHT/2
+         pygame.draw.line(surface, WHITE, (mid_x, mid_y),
+ (mid_x, mid_y-100))

pygame.init()
screen = pygame.display.set_mode((WIDTH, HEIGHT))
pygame.display.set_caption("Snowflake")

+ snowflake = Snowflake()
```

```
running = True
while running:
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            running = False
    screen.fill(BLACK)
+     snowflake.draw(screen)
    pygame.display.flip()
pygame.quit()
```

This will get you a single line:



The line drawing takes coordinates to start at, and coordinates to end at. Not much of a snowflake yet, but we can fix that.

## Spokes

We want to repeat drawing a line 6 times, for the spokes, turning each time.

Note we are extending our snowflake class, so only add/remove lines with plusses/minus in front. We can also have a flake size to control the size of our snowflake:

```
BLACK = (0, 0, 0)
+ TURN_SIZE = math.pi / 3

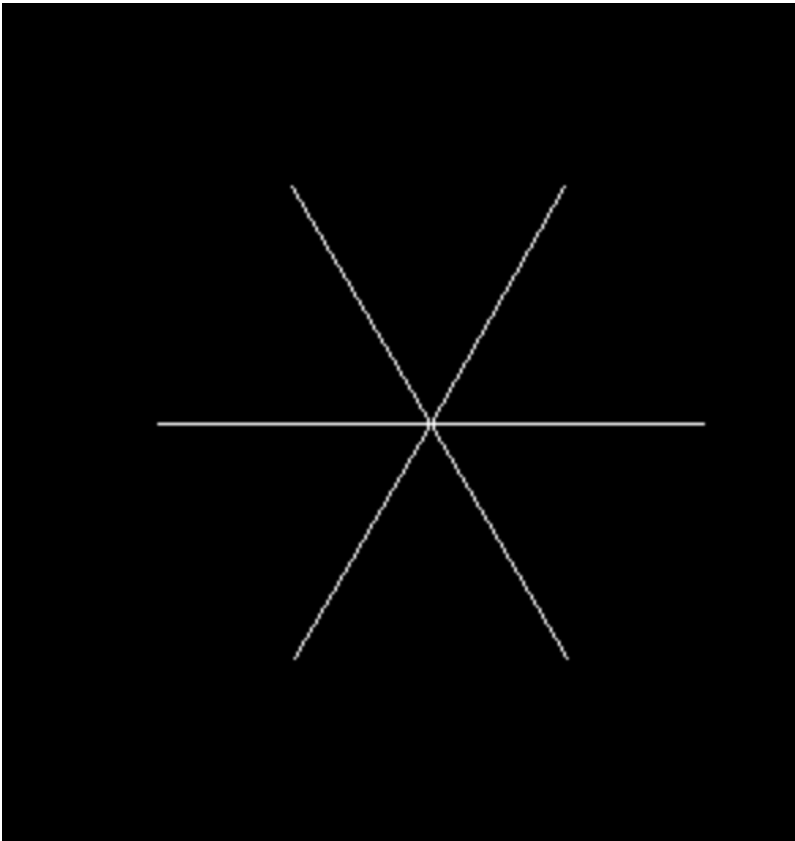
class Snowflake:
+     flake_size = 100
    def draw(self, surface):
```

```

        mid_x, mid_y = WIDTH/2, HEIGHT/2
-         pygame.draw.line(surface, WHITE, (mid_x, mid_y),
+         (mid_x, mid_y-100))
+         angle = 0
+         for n in range(6):
+             pygame.draw.line(surface, WHITE, (mid_x, mid_y),
+             (mid_x + math.cos(angle)*self.flake_size,
+             mid_y + math.sin(angle)*self.flake_size))
+             angle += TURN_SIZE

```

A full circle is  $2\pi$ . `TURN_SIZE` is 1/6 of a circle or  $\pi * 2/6$ , which becomes  $\pi/3$ . This should get you spokes of a snowflake.



We are using `cos` and `sin` to find the end of the line, think of these as making a point on a circle of size 1, we multiply by flake size to make it the right length, and add the mid point to move it to the right place.

## Using flake size to add more

Our snow flake is still a bit boring, we need some branches.

```

TURN_SIZE = math.pi / 3

+ class Branch:
+     distance = 1/2
+     size = 1/4
+
+     def draw(self, surface, mid_x, mid_y, angle,
+     branch_angle, flake_size):

```

```

+         scaled_distance = flake_size * self.distance
+         scaled_size = flake_size * self.size
+         x = mid_x + math.cos(angle) * scaled_distance
+         y = mid_y + math.sin(angle) * scaled_distance
+         x2 = x + math.cos(angle + branch_angle) *
scaled_size
+         y2 = y + math.sin(angle + branch_angle) *
scaled_size
+         pygame.draw.line(surface, WHITE, (x, y), (x2, y2))

class SnowFlake:
-     flake_size = 100
+     def __init__(self, flake_size = 100):
+         self.flake_size = flake_size
+         self.branch = Branch()

    def draw(self, surface):
        mid_x, mid_y = WIDTH/2, HEIGHT/2
        pygame.draw.line(surface, WHITE, (mid_x, mid_y),
(mid_x, mid_y-100))
        angle = 0
        for n in range(6):
            pygame.draw.line(surface, WHITE, (mid_x, mid_y),
                (mid_x + math.cos(angle)*self.flake_size,
                 mid_y + math.sin(angle)*self.flake_size))
+         self.branch.draw(surface, mid_x, mid_y, angle,
TURN_SIZE, self.flake_size)
            angle += TURN_SIZE

```

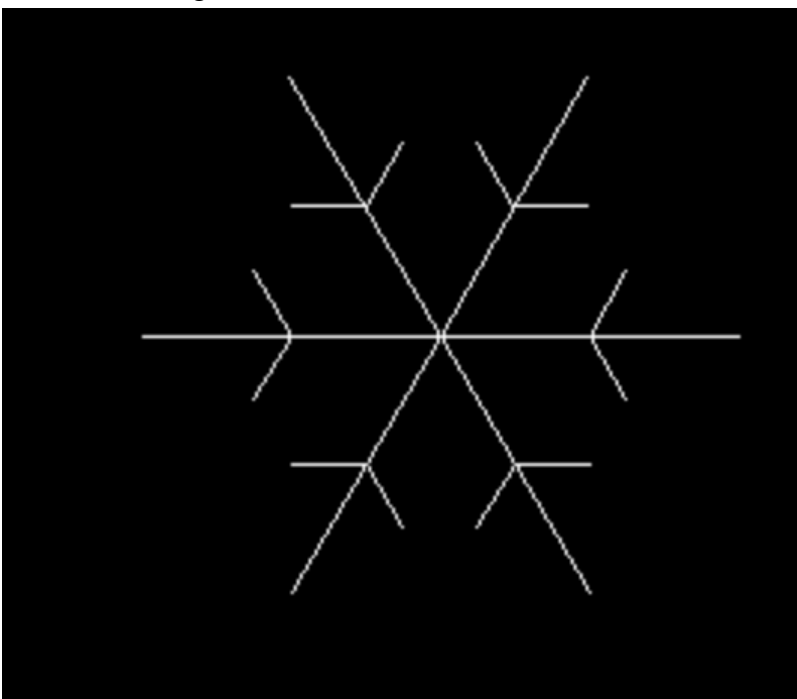
We have added a branch, with a distance (from the middle) and size scaled by the `flake_size`. We draw it for each turn, so the snowflake has 6 sided symmetry.



This is a bit one-sided, we can add the other side with 1 line of code:

```
for n in range(6):
    pygame.draw.line(surface, WHITE, (mid_x, mid_y),
                     (mid_x + math.cos(angle)*self.flake_size,
                      mid_y + math.sin(angle)*self.flake_size))
    self.branch.draw(surface, mid_x, mid_y, angle,
                     TURN_SIZE, self.flake_size)
+     self.branch.draw(surface, mid_x, mid_y, angle, -
TURN_SIZE, self.flake_size)
    angle += TURN_SIZE
```

This is starting to look like a snowflake!



# Checkpoint

At this stage, your code should look like this [stage\\_5.py](#):

```
import math

import pygame

WIDTH=400
HEIGHT=400
FPS = 60
WHITE = (255, 255, 255)
BLACK = (0, 0, 0)
TURN_SIZE = math.pi / 3

class Branch:
    distance = 1/2
    size = 1/4

    def draw(self, surface, mid_x, mid_y, angle, branch_angle,
flake_size):
        scaled_distance = flake_size * self.distance
        scaled_size = flake_size * self.size
        x = mid_x + math.cos(angle) * scaled_distance
        y = mid_y + math.sin(angle) * scaled_distance
        x2 = x + math.cos(angle + branch_angle) * scaled_size
        y2 = y + math.sin(angle + branch_angle) * scaled_size
        pygame.draw.line(surface, WHITE, (x, y), (x2, y2))

class Snowflake:
    def __init__(self, flake_size = 100):
        self.flake_size = flake_size
        self.branch = Branch()

    def draw(self, surface):
        mid_x, mid_y = WIDTH/2, HEIGHT/2
        angle = 0
        for n in range(6):
            pygame.draw.line(surface, WHITE, (mid_x, mid_y),
                (mid_x + math.cos(angle) * self.flake_size,
                mid_y + math.sin(angle) * self.flake_size))
            self.branch.draw(surface, mid_x, mid_y, angle,
TURN_SIZE, self.flake_size)
            self.branch.draw(surface, mid_x, mid_y, angle, -
TURN_SIZE, self.flake_size)
            angle += TURN_SIZE

pygame.init()
```



```

screen = pygame.display.set_mode((WIDTH, HEIGHT))
pygame.display.set_caption("Snowflake")

snowflake = SnowFlake()

running = True
while running:
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            running = False
    screen.fill(BLACK)
    snowflake.draw(screen)
    pygame.display.flip()
pygame.quit()

```

## Thicker lines

We can make this a bit less "stringy", by having thicker lines. make the following changes near the top of the file:

```

WHITE = (255, 255, 255)
BLACK = (0, 0, 0)
TURN_SIZE = math.pi / 3
+ PEN_WIDTH = 3

```

Then in Branch draw:

```

        x2 = x + math.cos(angle + branch_angle) * scaled_size
        y2 = y + math.sin(angle + branch_angle) * scaled_size
-         pygame.draw.line(surface, WHITE, (x, y), (x2, y2))
+         pygame.draw.line(surface, WHITE, (x, y), (x2, y2),
PEN_WIDTH)

```

And in SnowFlake draw:

```

def draw(self, surface):
    mid_x, mid_y = WIDTH/2, HEIGHT/2
    angle = 0
    for n in range(6):
        pygame.draw.line(surface, WHITE, (mid_x, mid_y),
            (mid_x + math.cos(angle)*self.flake_size,
-             mid_y + math.sin(angle)*self.flake_size))
+             mid_y + math.sin(angle)*self.flake_size),
PEN_WIDTH)

        self.branch.draw(surface, mid_x, mid_y, angle,
TURN_SIZE, self.flake_size)
        self.branch.draw(surface, mid_x, mid_y, angle, -

```

```
TURN_SIZE, self.flake_size)
    angle += TURN_SIZE
```

This thicker line makes it a bit nicer.

## Making it random

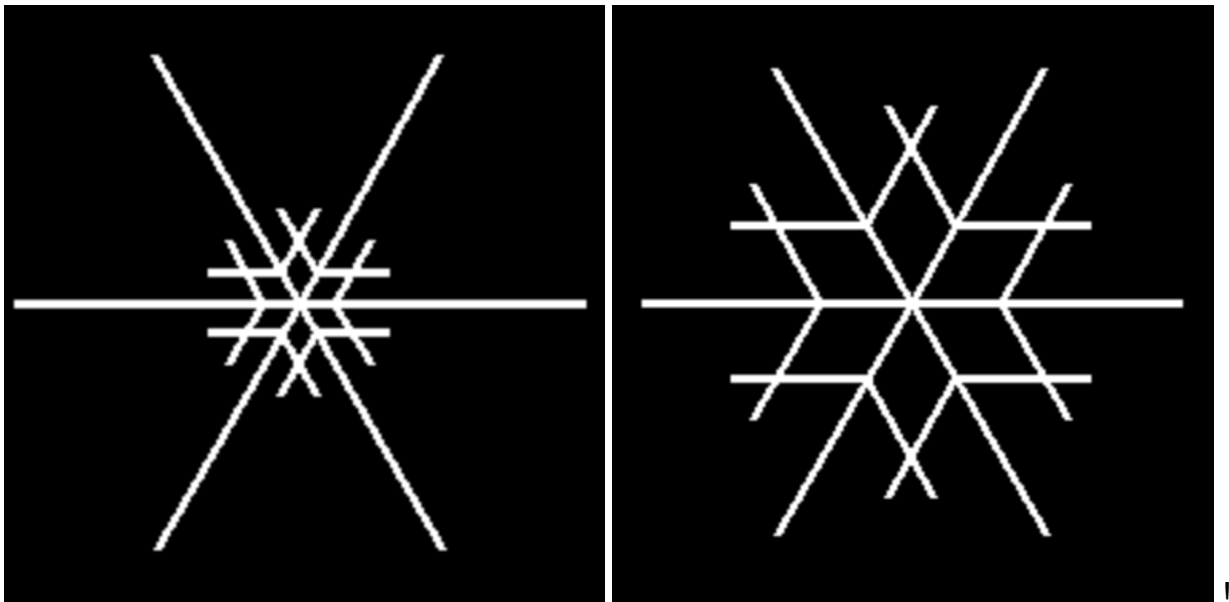
The snowflake is always the same. We wanted it a bit more random. We'll start with the branch distance and size. First we need to import random:

```
import math
+ import random
```

Now we can use this to make our branch different each time:

```
class Branch:
-     distance = 1/2
-     size = 1/4
+     def __init__(self):
+         self.distance = 1/ random.randint(1, 10)
+         self.size = 1 / random.randint(1, 10)
```

The arm will be a different length and size each time.



## Randomising the branch count

We can also randomise the number of branches. We can do this by changing the range in the for loop.

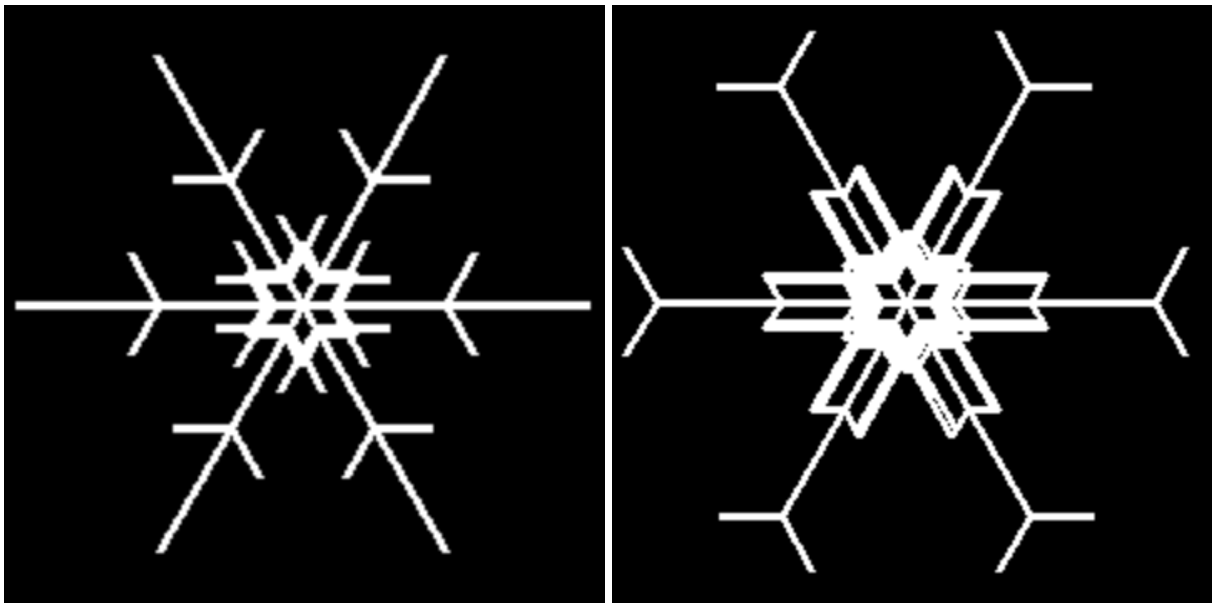
```
class Snowflake:
    def __init__(self, flake_size = 100):
        self.flake_size = flake_size
```

```
-         self.branch = Branch()
+         self.branches = [Branch() for _ in
range(random.randint(3, 10))]
```

We need to update drawing:

```
        for n in range(6):
            pygame.draw.line(surface, WHITE, (mid_x, mid_y),
                             (mid_x + math.cos(angle)*self.flake_size,
                              mid_y + math.sin(angle)*self.flake_size),
width=PEN_WIDTH)
-            self.branch.draw(surface, mid_x, mid_y, angle,
TURN_SIZE, self.flake_size)
-            self.branch.draw(surface, mid_x, mid_y, angle, -
TURN_SIZE, self.flake_size)
+            for branch in self.branches:
+                branch.draw(surface, mid_x, mid_y, angle,
TURN_SIZE, self.flake_size)
+                branch.draw(surface, mid_x, mid_y, angle, -
TURN_SIZE, self.flake_size)
            angle += TURN_SIZE
```

Run this and you should get images like these:



You have a random snowflake generator!

## Checkpoint

```
import math
import random

import pygame

WIDTH=400
```

```

HEIGHT=400
FPS = 60
WHITE = (255, 255, 255)
BLACK = (0, 0, 0)
TURN_SIZE = math.pi / 3
PEN_WIDTH = 3

class Branch:
    def __init__(self):
        self.distance = 1/ random.randint(1, 10)
        self.size = 1 / random.randint(1, 10)

    def draw(self, surface, mid_x, mid_y, angle, branch_angle,
flake_size):
        scaled_distance = flake_size * self.distance
        scaled_size = flake_size * self.size
        x = mid_x + math.cos(angle) * scaled_distance
        y = mid_y + math.sin(angle) * scaled_distance
        x2 = x + math.cos(angle + branch_angle) * scaled_size
        y2 = y + math.sin(angle + branch_angle) * scaled_size
        pygame.draw.line(surface, WHITE, (x, y), (x2, y2),
PEN_WIDTH)

class Snowflake:
    def __init__(self, flake_size = 100):
        self.flake_size = flake_size
        self.branches = [Branch() for _ in
range(random.randint(3, 10))]

    def draw(self, surface):
        mid_x, mid_y = WIDTH/2, HEIGHT/2
        angle = 0
        for n in range(6):
            pygame.draw.line(surface, WHITE, (mid_x, mid_y),
                (mid_x + math.cos(angle)*self.flake_size,
                mid_y + math.sin(angle)*self.flake_size),
PEN_WIDTH)

            for branch in self.branches:
                branch.draw(surface, mid_x, mid_y, angle,
TURN_SIZE, self.flake_size)
                branch.draw(surface, mid_x, mid_y, angle, -
TURN_SIZE, self.flake_size)
                angle += TURN_SIZE

pygame.init()
screen = pygame.display.set_mode((WIDTH, HEIGHT))
pygame.display.set_caption("Snowflake")

```

```

snowflake = Snowflake()

running = True
while running:
    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            running = False
    screen.fill(BLACK)
    snowflake.draw(screen)
    pygame.display.flip()
pygame.quit()

```

## Extension ideas

### Making a background

These look great, but we can add a background in, some sky?

Add this in the imports:

```

+ import colorsys
import math
import random

```

We are going to make a sweeping Sky, colorsys lets us make gradients in python, where we can go between a light and dark blue:

```

+ def make_background(surface):
+     light_per_row = 0.8 / HEIGHT
+     # Get a blue hue
+     hue = 0.6
+     for y in range(HEIGHT):
+         light = light_per_row * y
+         hsv = colorsys.hsv_to_rgb(hue, 0.1 + 0.7 * (1 -
light), light)
+         color = [int(255 * c) for c in hsv]
+         pygame.draw.line(surface, color, (0, y), (WIDTH, y))

pygame.init()

```

We then use this to make a background we can draw:

```

pygame.display.set_caption("Snowflake")

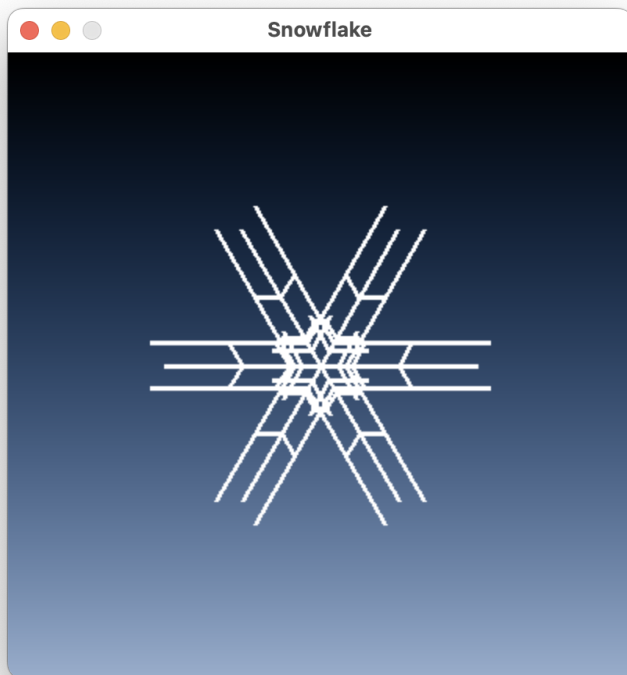
+ background = pygame.Surface((WIDTH, HEIGHT))
+ make_background(background)
snowflake = Snowflake()

```

And then we can draw it in our main loop:

```
- screen.fill(BLACK)
+ screen.blit(background, (0, 0))
  snowflake.draw(screen)
```

A hue makes a particular colour, with 0.6 being a nice blue (you can try other values between 0 and 1 for fun). We'll make the light value go between 0 and 0.8, so it's not too bright to see the snowflake. We divide this by screen HEIGHT so we have a factor to change it by going down the screen.



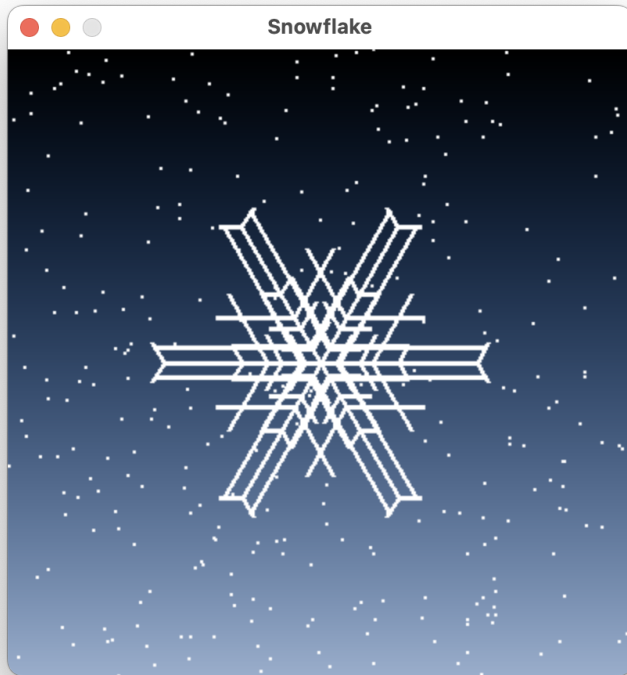
The for loop goes down each row of pixels, calculates a light value, and uses this to make HSV (hue, saturation, value) colour for each row. The saturation means how vivid a colour is between a grey and a very deep blue. We alter this by the light a little too so the sky goes a bit white.

## Background snow

We can also have some background snow in our scene:

```
        color = [int(255 * c) for c in hsv]
        pygame.draw.line(surface, color, (0, y), (WIDTH, y))
+     for n in range(300):
+         x = random.randint(0, WIDTH)
+         y = random.randint(0, HEIGHT)
+         pygame.draw.circle(surface, WHITE, (x, y), 1)
```

We draw 300 stars at random positions. You can make them bigger with the number at the end of the circle line, or change the number of them.



## More ideas

- If we pass in a facing to `Snowflake.draw` (instead of 0), and update it every frame in the main loop by some fraction (0.01), we could animate it so it rotates.
- You could add more than one snowflake and draw them - `snowflake2 = Snowflake()`. You might need to change where it's mid point is though.
- You could have the size and distance on the branches change a little bit, updating them every frame, so the snowflake changes and morphs.