Binary Search Visualization using Pygame in Python

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An algorithm like Binary Search can be understood easily by visualizing. In this article, a program that visualizes the Binary Search Algorithm has been implemented. The Graphical User Interface(GUI) is implemented in Python using pygame library.

Approach

Generate random array, sort it using any sorting algorithm, and fill the pygame window with bars. Bars are straight vertical lines, which represent array elements.

- Set all bars to green color.
- Use pygame.time.delay() to slow down the algorithm, so that we can see the searching process.
- Implement a timer to see how the algorithm performs.
- The actions are performed using 'pygame.event.get()' method, which stores all the events which the user performs, such as start, reset.
- The blue color is used to highlight the bar equal to the key if found.
- Orange color highlights the left and right bars.

Below is the implementation of the above visualizer:

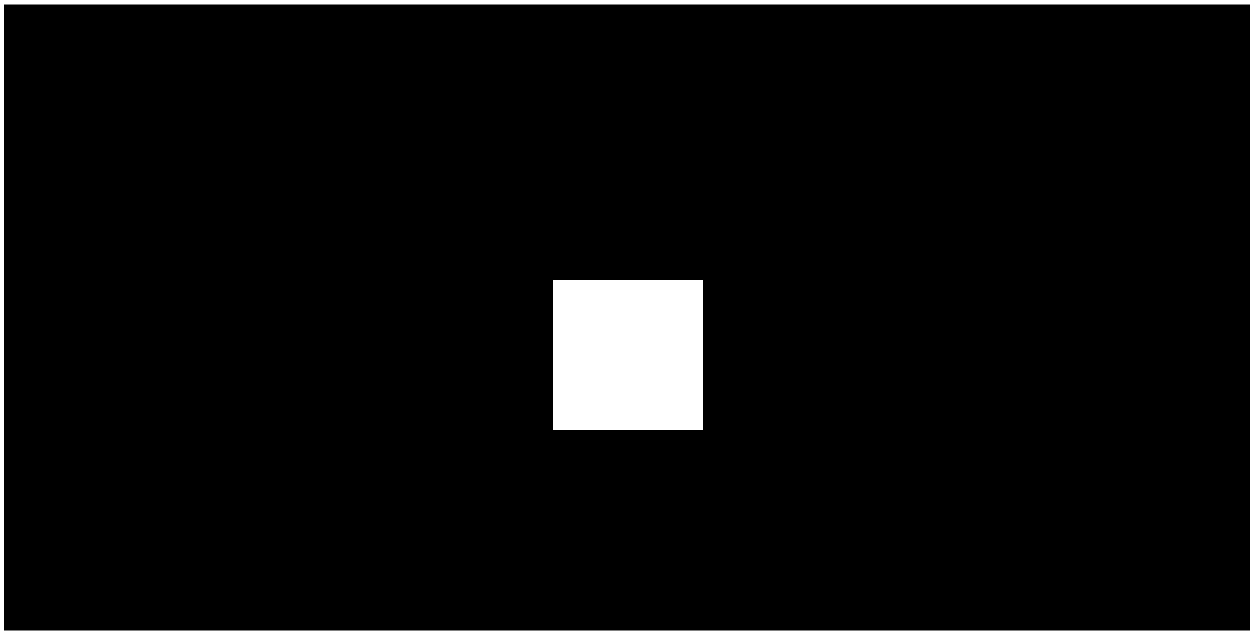
Python

```python
# Python implementation of the
# Sorting visualiser: Insertion Sort

# Imports
import pygame
import random
import time
```

```
pygame.font.init()
startTime = time.time()

# Total window
screen = pygame.display.set_mode(
    (900, 650)
)

# Title and Icon
pygame.display.set_caption(
    "BINARY SEARCH VISUALISER"
)

# Uncomment below lines for setting
# up the icon for the visuliser
# img = pygame.image.load('sorticon.png')
# pygame.display.set_icon(img)

# Boolean variable to run
# the program in while loop
run = True

# Window size and some initials
width = 900
length = 600
array = [0]*151
key = 0
foundkey = False

arr_clr = [(0, 204, 102)]*151
clr_ind = 0

clr = [(0, 204, 102), (255, 0, 0),
       (0, 0, 153), (255, 102, 0)]

bigfont = pygame.font.SysFont("comicsans", 70)
fnt = pygame.font.SysFont("comicsans", 30)
fnt1 = pygame.font.SysFont("comicsans", 20)

# Sorting Algorithm: Heap Sort
def heapSort(array):
    n = len(array)

    for i in range(n//2-1, -1, -1):
        heapify(array, i, n)

    for i in range(n-1, 0, -1):
        array[i], array[0] = array[0], array[i]
        heapify(array, 0, i)


def heapify(array, root, size):
    left = root*2+1
    right = root*2+2
    largest = root

    if left < size and array[left] > array[largest]:
        largest = left

    if right < size and array[right] > array[largest]:
        largest = right

    if largest != root:
        array[largest], array[root] = array[root], array[largest]
        heapify(array, largest, size)

# Function to generate new Array


def generate_arr():
    for i in range(1, 151):
        arr_clr[i] = clr[0]
        array[i] = random.randrange(1, 100)
    heapSort(array)


# Initially generate a array
generate_arr()

# Function to refill the
# updates on the window
def refill():
    screen.fill((255, 255, 255))
    draw()
    pygame.display.update()
    pygame.time.delay(200)


def binarySearch(array, key):
    left = 0
    right = len(array)-1

    while left < right:
        arr_clr[left] = clr[1]
        arr_clr[right] = clr[1]
        refill()
        refill()
        mid = left+(right-left)//2

        if array[mid] == key:
            arr_clr[left] = clr[0]
            arr_clr[right] = clr[0]
            arr_clr[mid] = clr[2]
            return 1

        elif array[mid] < key:
            arr_clr[left] = clr[0]
            left = mid+1

        else:
            arr_clr[right] = clr[0]
            right = mid-1
        refill()
    arr_clr[left] = clr[0]
    arr_clr[right] = clr[0]
    refill()
    return -1


# Function to Draw the array values
def draw():

    # Text should be rendered
    txt = fnt.render("SEARCH: PRESS 'ENTER'",
                     1, (0, 0, 0))

    # Position where text is placed
    screen.blit(txt, (20, 20))
    txt1 = fnt.render("NEW ARRAY: PRESS 'R'",
                      1, (0, 0, 0))
    screen.blit(txt1, (20, 40))
    txt2 = fnt1.render("ENTER NUMBER TO SEARCH:" +
                       str(key), 1, (0, 0, 0))
    screen.blit(txt2, (600, 60))
    text3 = fnt1.render("Running Time(sec): " +
                        str(int(time.time() - startTime)),
                        1, (0, 0, 0))
    screen.blit(text3, (600, 20))
    element_width = (width-150)//150
    boundry_arr = 900 / 150
    boundry_grp = 550 / 100
    pygame.draw.line(screen, (0, 0, 0), (0, 95),
                     (900, 95), 6)

    # Drawing the array values as lines
    for i in range(1, 151):
        pygame.draw.line(screen, arr_clr[i],
                         (boundry_arr * i-3, 100),
                         (boundry_arr * i-3,
                          array[i]*boundry_grp + 100), element_width)
    if foundkey == 1:
        text4 = bigfont.render("Key Found. Press N to Reset Key", 1, (0, 0, 0))
        screen.blit(text4, (100, 300))

    elif foundkey == -1:
        text4 = bigfont.render(
            "Key Not Found. Press N to Reset Key", 1, (0, 0, 0))
        screen.blit(text4, (30, 300))


# Program should be run
# continuously to keep the window open
while run:

    # background
    screen.fill((255, 255, 255))

    # Event handler stores all event
    for event in pygame.event.get():

        # If we click Close button in window
        if event.type == pygame.QUIT:
            run = False

        if event.type == pygame.KEYDOWN:
            if event.key == pygame.K_r:
                key = 0
                foundkey = 0
                generate_arr()
            if event.key == pygame.K_n:
                foundkey = 0
                key = 0
                for i in range(0, len(array)):
                    arr_clr[i] = clr[0]
            if event.key == pygame.K_RETURN and key != 0:
                foundkey = binarySearch(array, key)
            if event.key == pygame.K_0:
                key = key*10
            if event.key == pygame.K_1:
                key = key*10+1
            if event.key == pygame.K_2:
                key = key*10+2
            if event.key == pygame.K_3:
                key = key*10+3
            if event.key == pygame.K_4:
```

```
                key = key*10+4
            if event.key == pygame.K_5:
                key = key*10+5
            if event.key == pygame.K_6:
                key = key*10+6
            if event.key == pygame.K_7:
                key = key*10+7
            if event.key == pygame.K_8:
                key = key*10+8
            if event.key == pygame.K_9:
                key = key*10+9
    draw()
    pygame.display.update()

pygame.quit()
```

Output:



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