Animation

Woah woah woah

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Housekeeping

- Breakout is released today, due **nxt Sunday (Jul 23) at midnight**. Grace period extends to Monday

- Midterm is Wednesday July 26th at 5pm, try not to use grace period! More info will be released this weekend

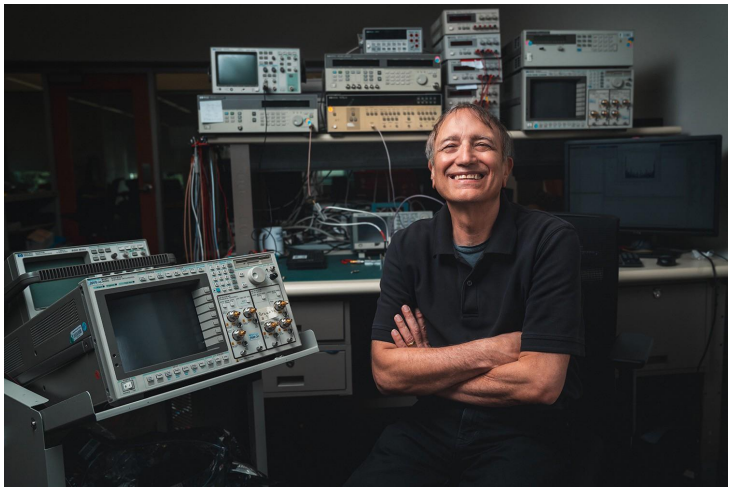
- Assn 2 (Images) is due tonight (grace period until tomorrow at midnight)

Today

- **Recap the graphics library**
  - **Use the Graphics reference!**
  - **Put a shape on a canvas**

- Introduce Animation
  - You have permission to use a while true loop
  - The sleep function exists!
  - Remember the DVD logo bouncing around the screen? We are making that

Turing Award Winner



- **Turing Award** is like the nobel prize in CS
- Professor Pat Hanrahan here at Stanford (CS107E, CS348)
- Founding employee at Pixar
- Wrote RenderMan, won 3 Academy Awards

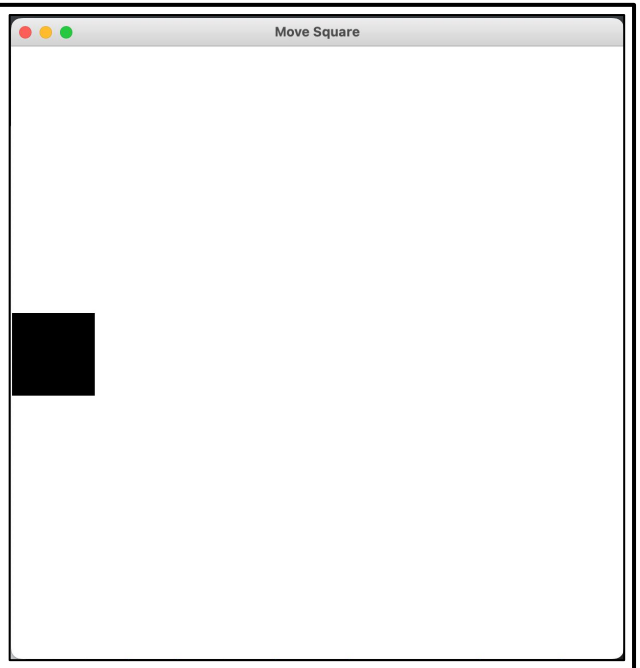
Sneak peek at you in 75 minutes

Graphics Recap

```
from graphics import Canvas
CANVAS_HEIGHT = 600
CANVAS_WIDTH = 600
SQUARE_SIZE = 20



def main():
    canvas = Canvas(CANVAS_WIDTH, CANVAS_HEIGHT,
                                        'Move Square')
    start_y = CANVAS_HEIGHT / 2 - SQUARE_SIZE / 2
    end_y = start_y + SQUARE_SIZE
    rect = canvas.create_rectangle(0, start_y,
                    SQUARE_SIZE, end_y, fill='black')
     canvas.mainloop()
```



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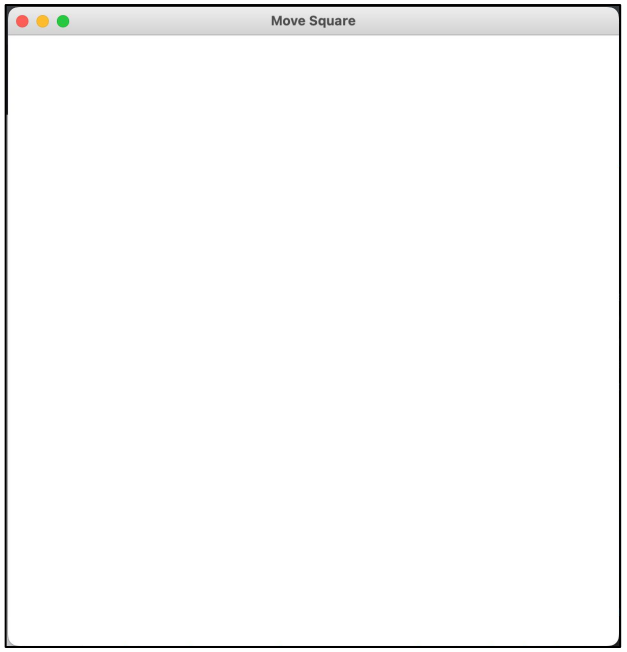

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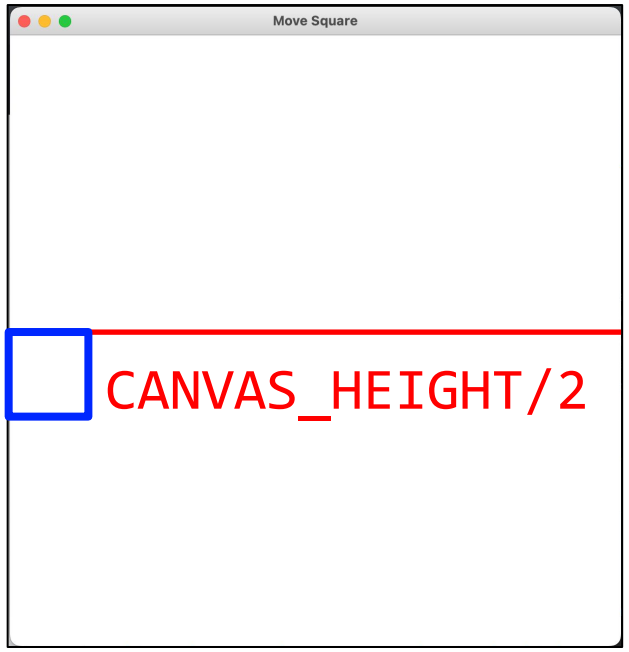

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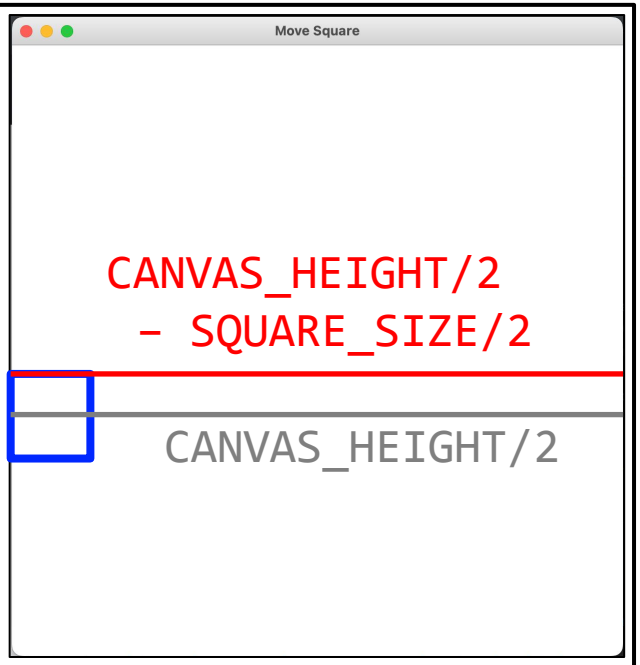

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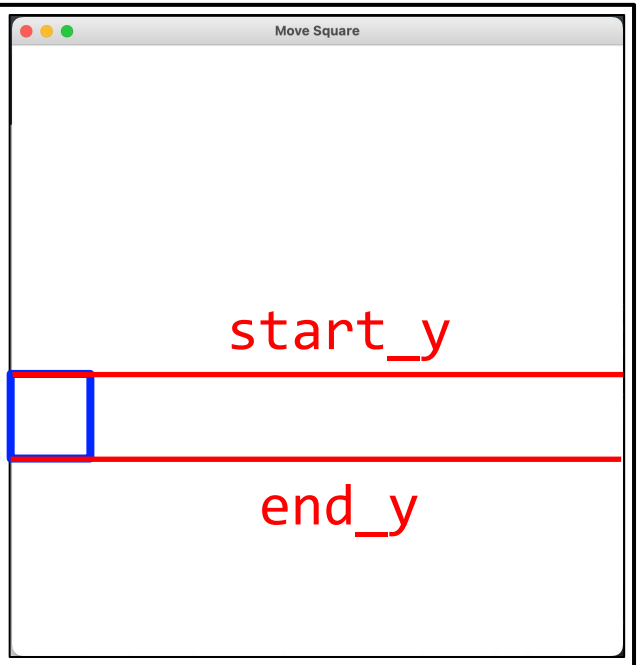
```



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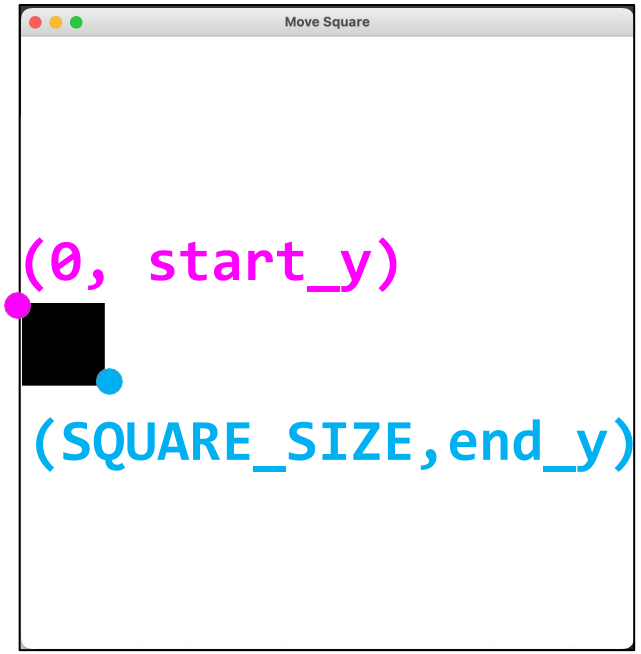

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    end_y = start_y + SQUARE_SIZE
    rect = canvas.create_rectangle(0, start_y,
                    SQUARE_SIZE, end_y, fill='black')
    canvas.mainloop() # need this to display!
```

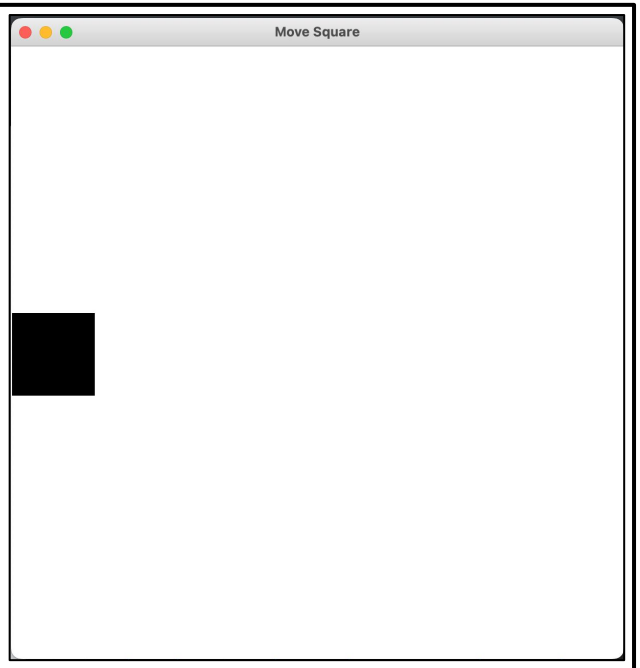

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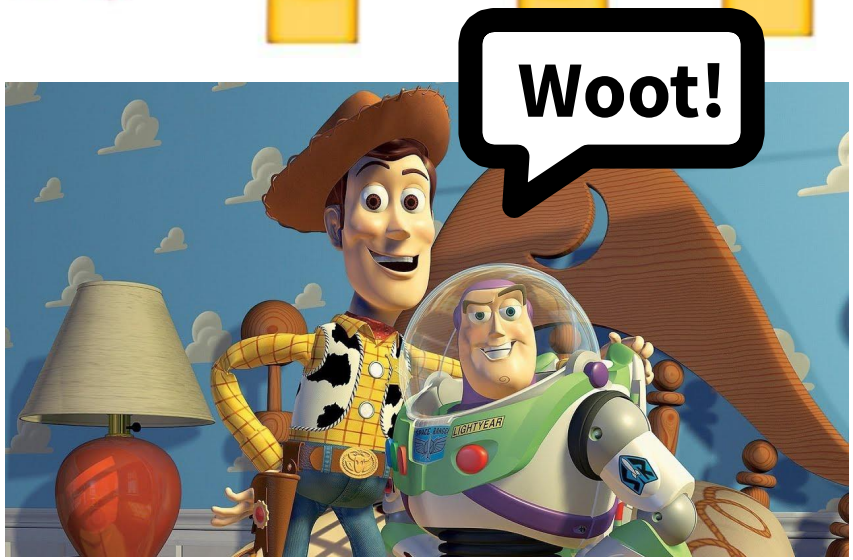
You're now all graphics programmers!

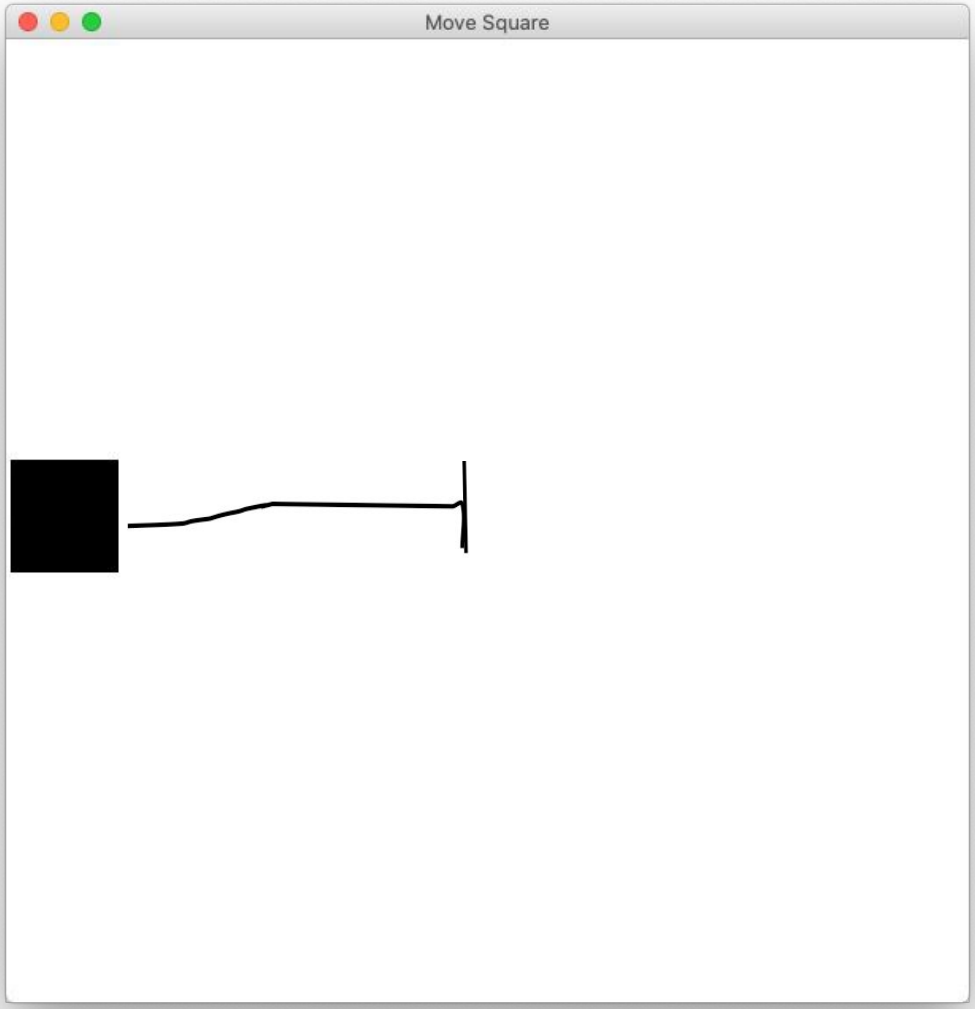


Today

- ~~Recap the graphics library~~
  - ~~Use the Graphics reference!~~
  - ~~Put a shape on a canvas~~

- **Introduce Animation**
  - **You have permission to use a while true loop**
  - **The sleep function exists!**
  - **Remember the DVD logo bouncing around the screen? We are making that**

Move to Center



- Goal: edit the previous program to make the square move towards the center and stop

- Not quite Toy Story, but it's a start!

The animation loop

```
DELAY = 1 / 120

def main():
  # setup

  while True:
    # update world
    canvas.update()

    time.sleep(DELAY)# pause before updating again
```

The animation loop

```
DELAY = 1 / 120

def main():
  # setup - make all the variables you need

  while True:
    # update world
    canvas.update()

    time.sleep(DELAY)# pause before updating again
```

The animation loop

```
DELAY = 1 / 120

def main():
    # setup

    while True:
        # update world
        canvas.update()

        time.sleep(DELAY)# pause before updating again
```

- **The animation loop is like a loop over "frames"**
- **During one iteration the canvas will look one way.**
- **On the next loop, it will look slightly different**

The animation loop

```
DELAY = 1 / 120

def main():
    # setup

    while True:
        # update world
        canvas.update()

        time.sleep(DELAY)# pause before updating again
```

- Pause for a fraction of a second so the user can see the update
- `DELAY` is like your "frame rate"
- Smaller `DELAY` + Smaller update to canvas = higher res animation

Move to center

```
DELAY = 1 / 120

def main():
  # setup
  canvas = Canvas(CANVAS_WIDTH,CANVAS_HEIGHT)
  rect = canvas.create_rectangle(0,0,100,100)

  while # the square is not past the center:
    # update world - move square right 1pixel

    canvas.update() # call update each loop
    # pause
     time.sleep(DELAY)
   # keep canvas open after moving
   canvas.mainloop()
```

Move to center - use Graphics reference!

```
DELAY = 1 / 120

def main():
  # setup
  canvas = Canvas(CANVAS_WIDTH,CANVAS_HEIGHT)
  rect = canvas.create_rectangle(0,0,100,100)

  while # the square is not past the center:
    # update world - move square right 1 pixel
    canvas.move(rect, 1, 0)
    canvas.update()
    # pause
     time.sleep(DELAY)
   # keep canvas open after moving
   canvas.mainloop()
```

Move to center - lets make a helper!

```
DELAY = 1 / 120

def main():
  # setup
  canvas = Canvas(CANVAS_WIDTH,CANVAS_HEIGHT)
  rect = canvas.create_rectangle(...)

  while not is_past_center(canvas, rect):
    # update world - move square right 1 pixel
    canvas.move(rect, 1, 0)
    canvas.update()
    # pause
     time.sleep(DELAY)
   # keep canvas open after moving
   canvas.mainloop()
```

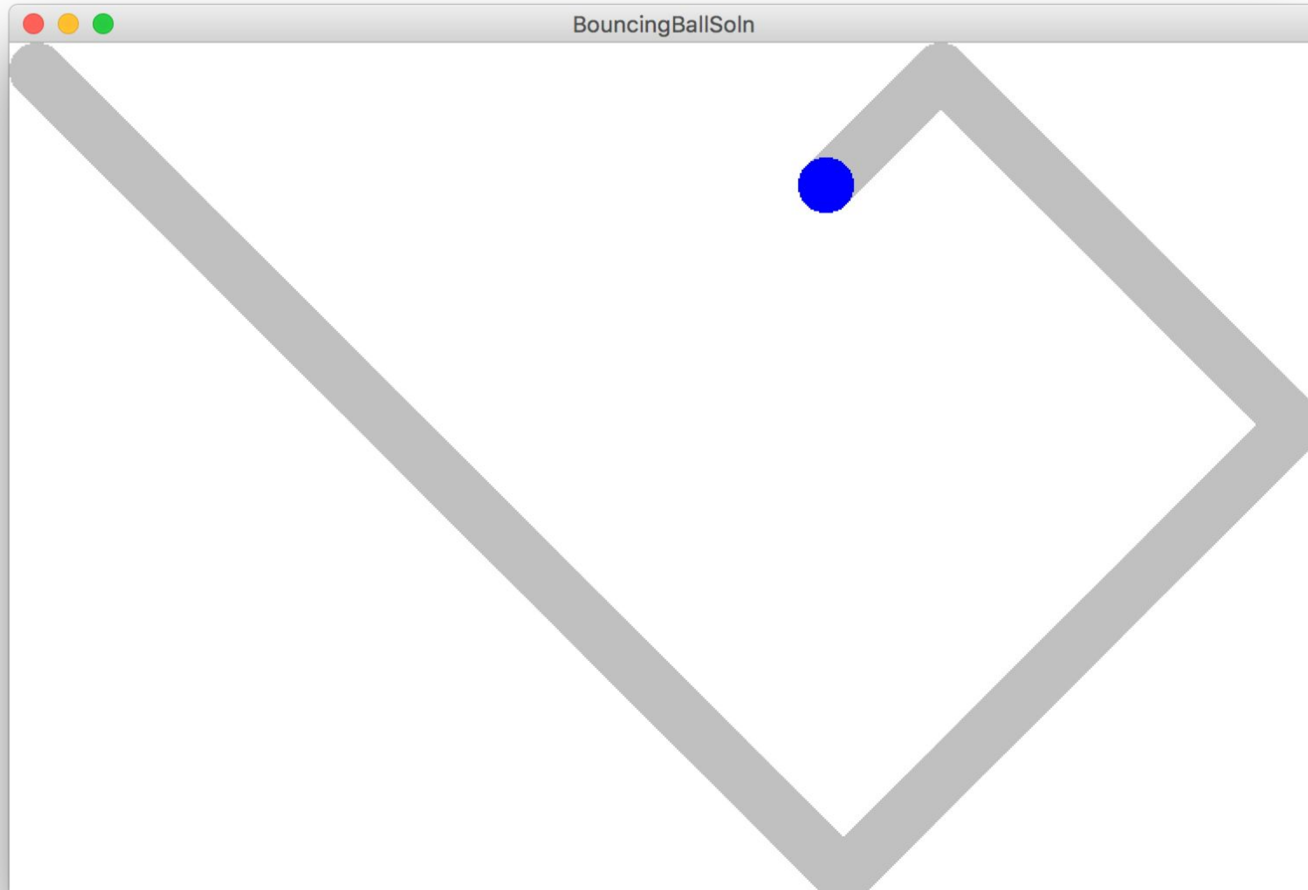
Move to center - Pycharm

We are ready

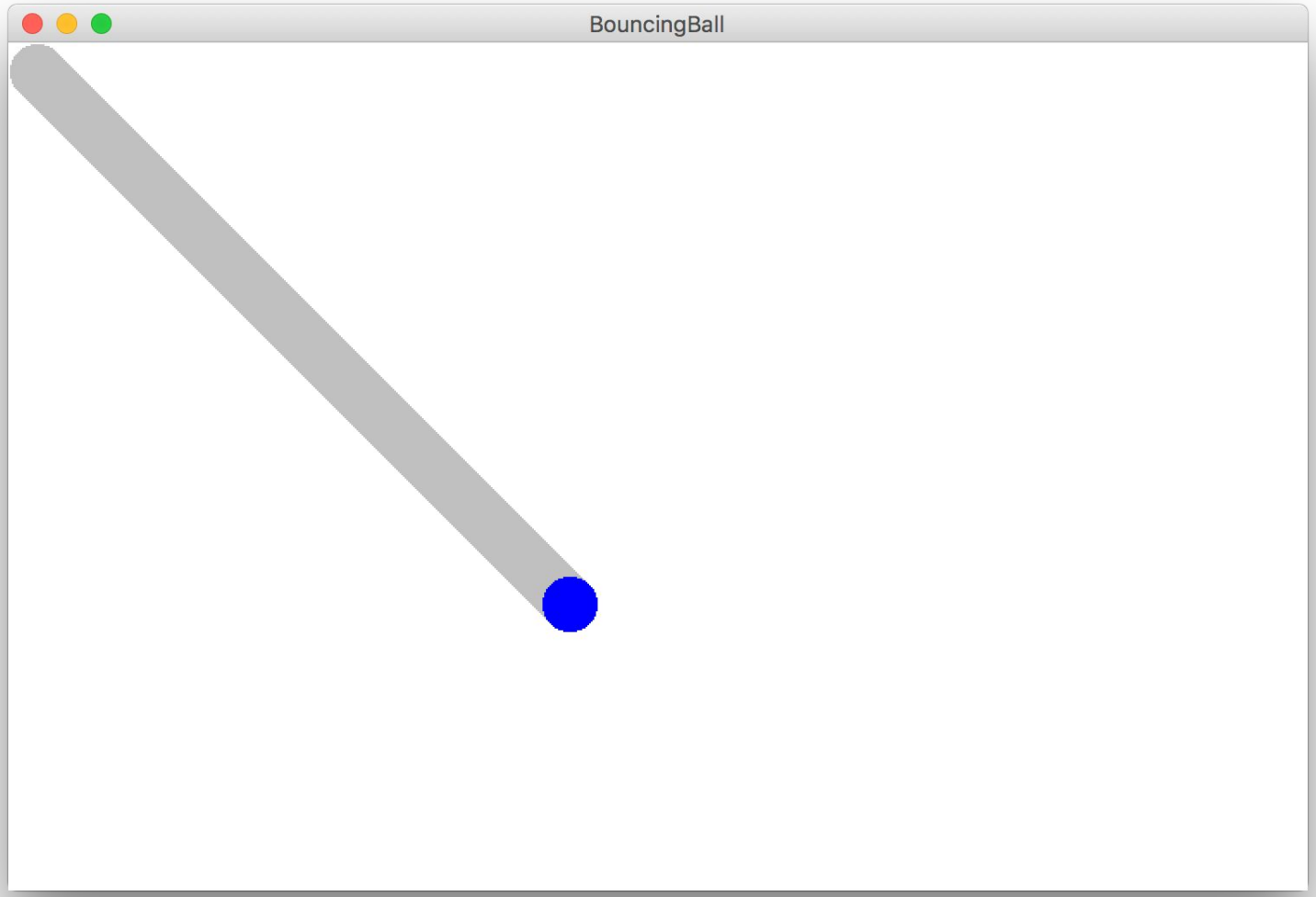
For some nostalgia

Goal

Milestone 1

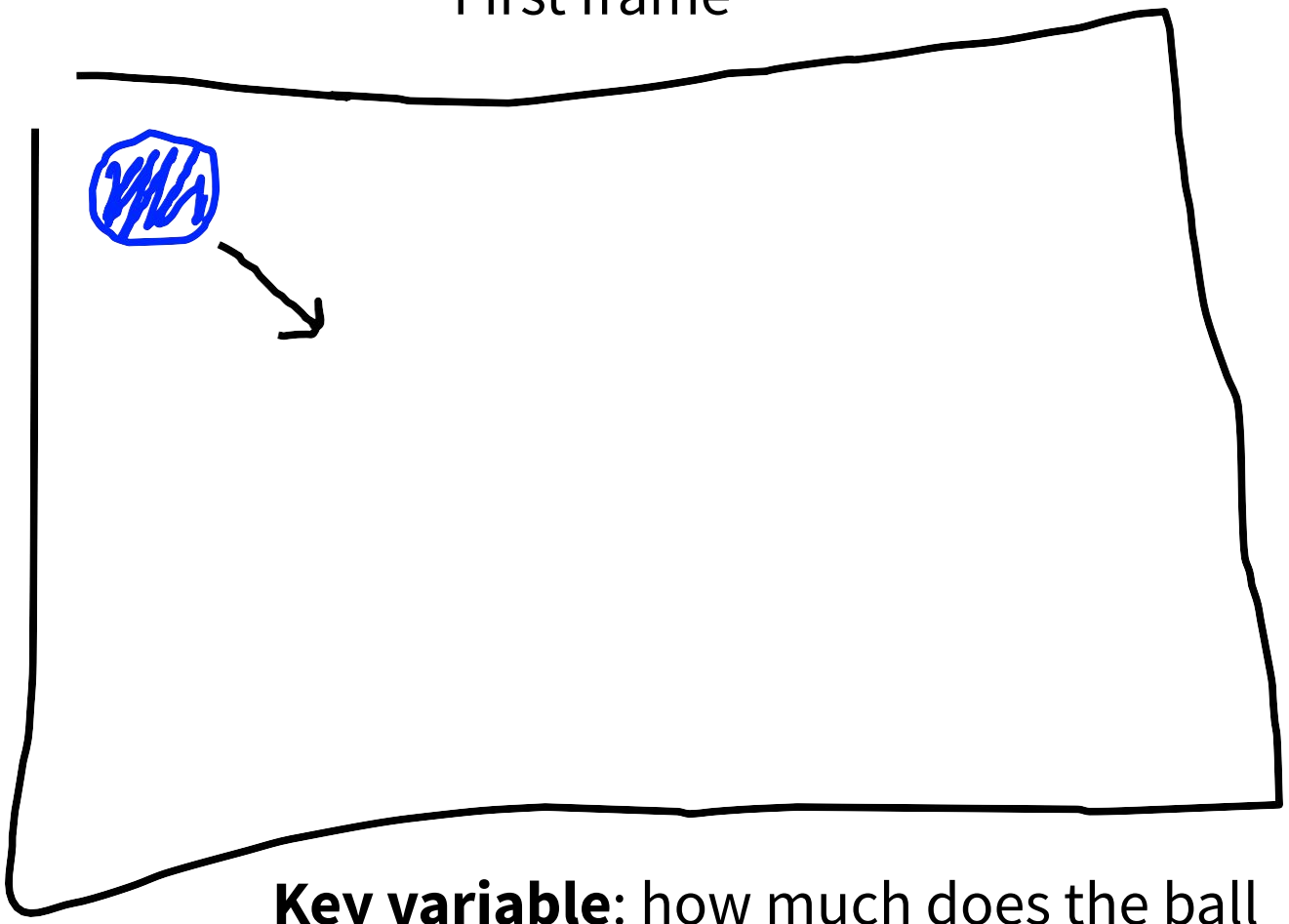


Milestone 1a



Bouncing Ball

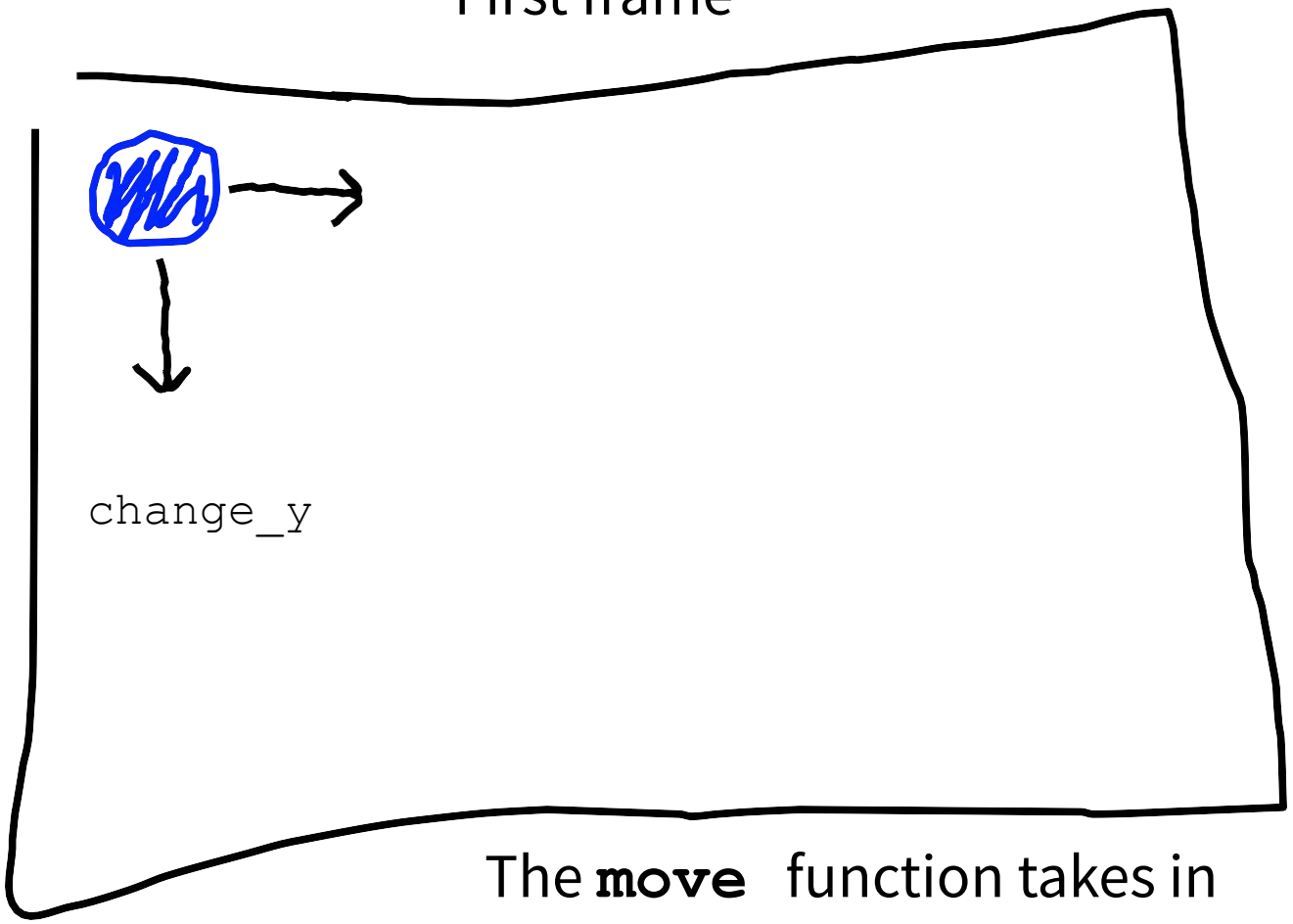
First frame



Key variable: how much does the ball position change each heartbeat?

Bouncing Ball

First frame

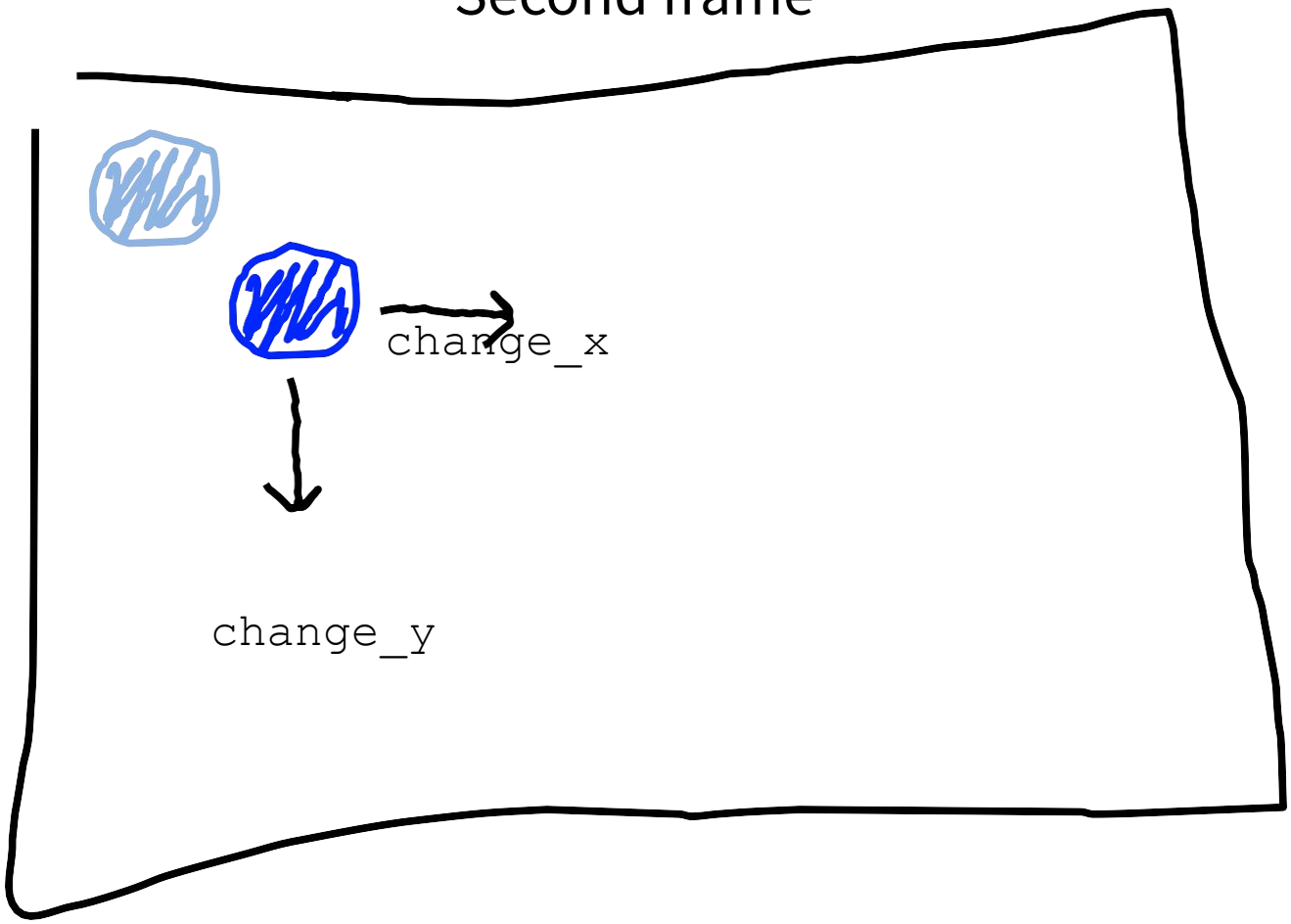


The **`move`** function takes in a change in x and a change in y

Pi

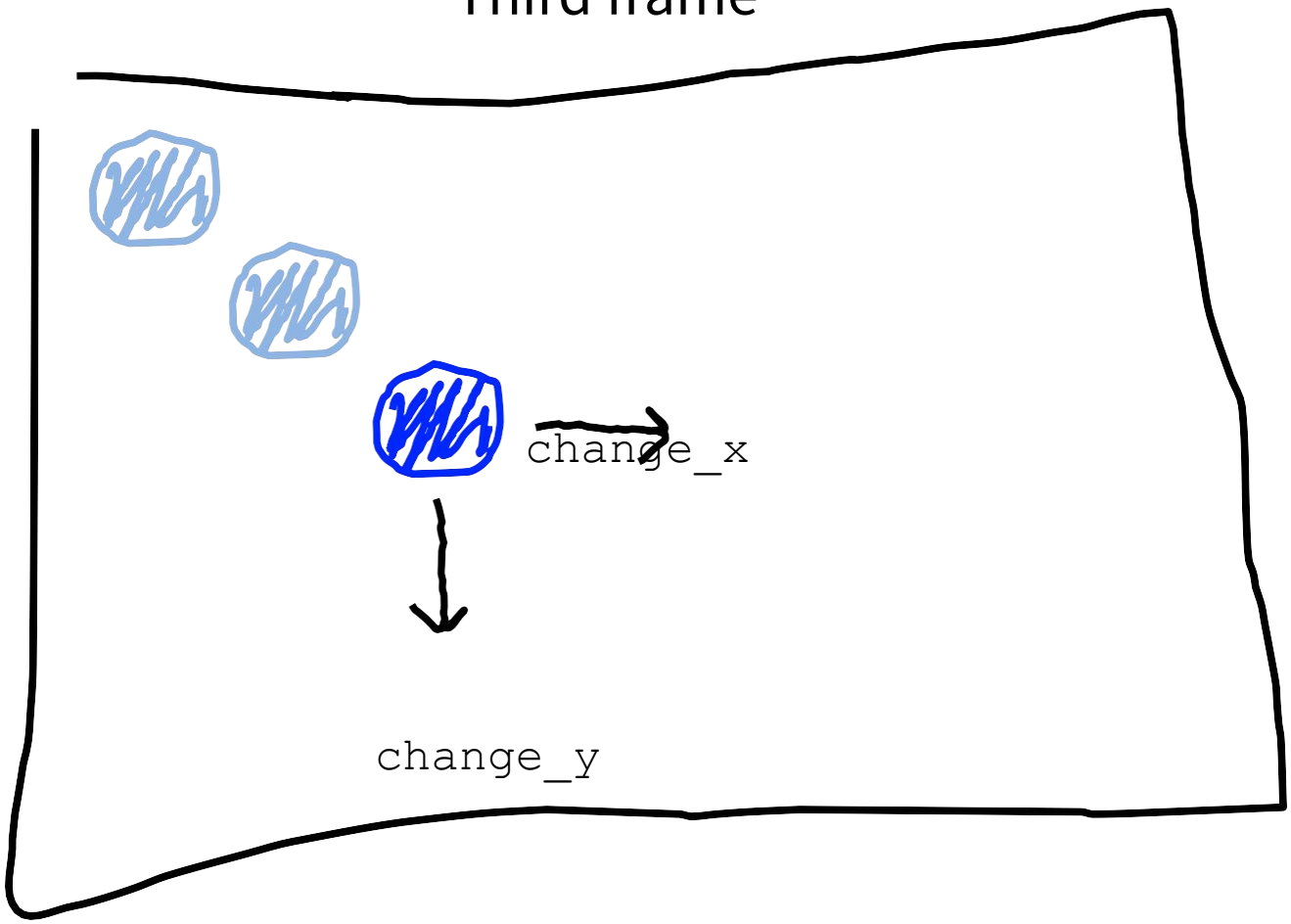
Bouncing Ball

Second frame



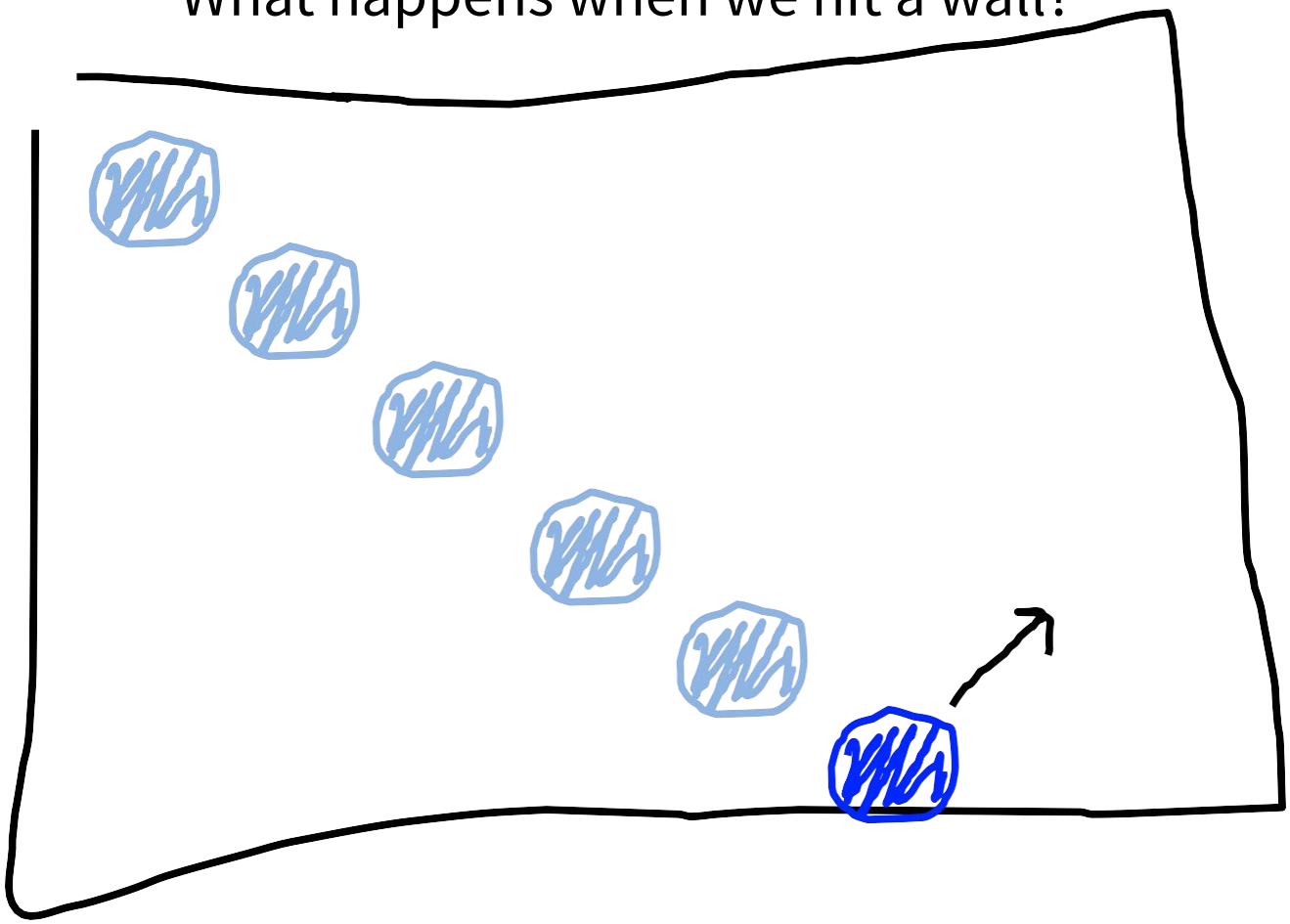
Bouncing Ball

Third frame



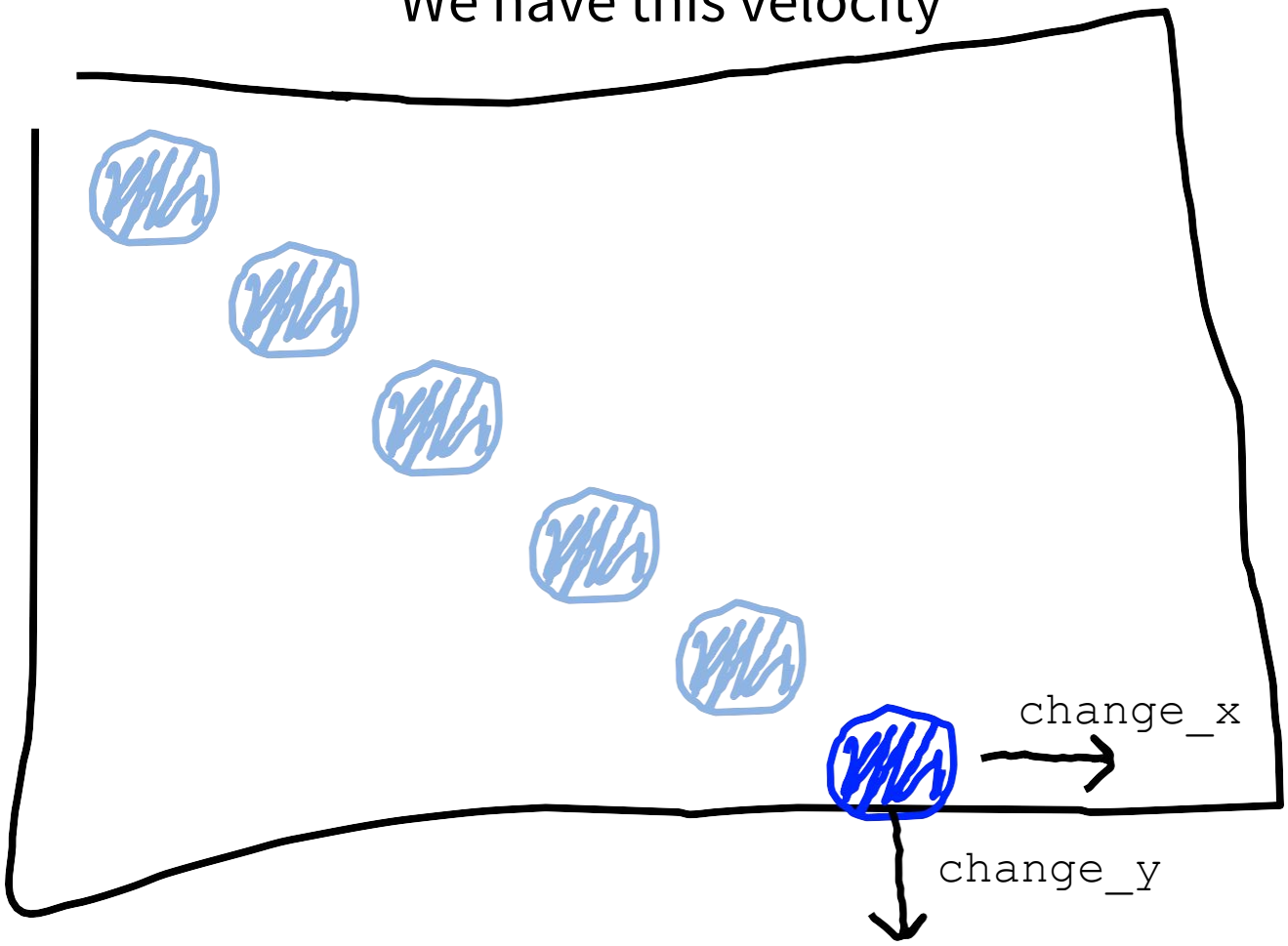
Bouncing Ball

What happens when we hit a wall?



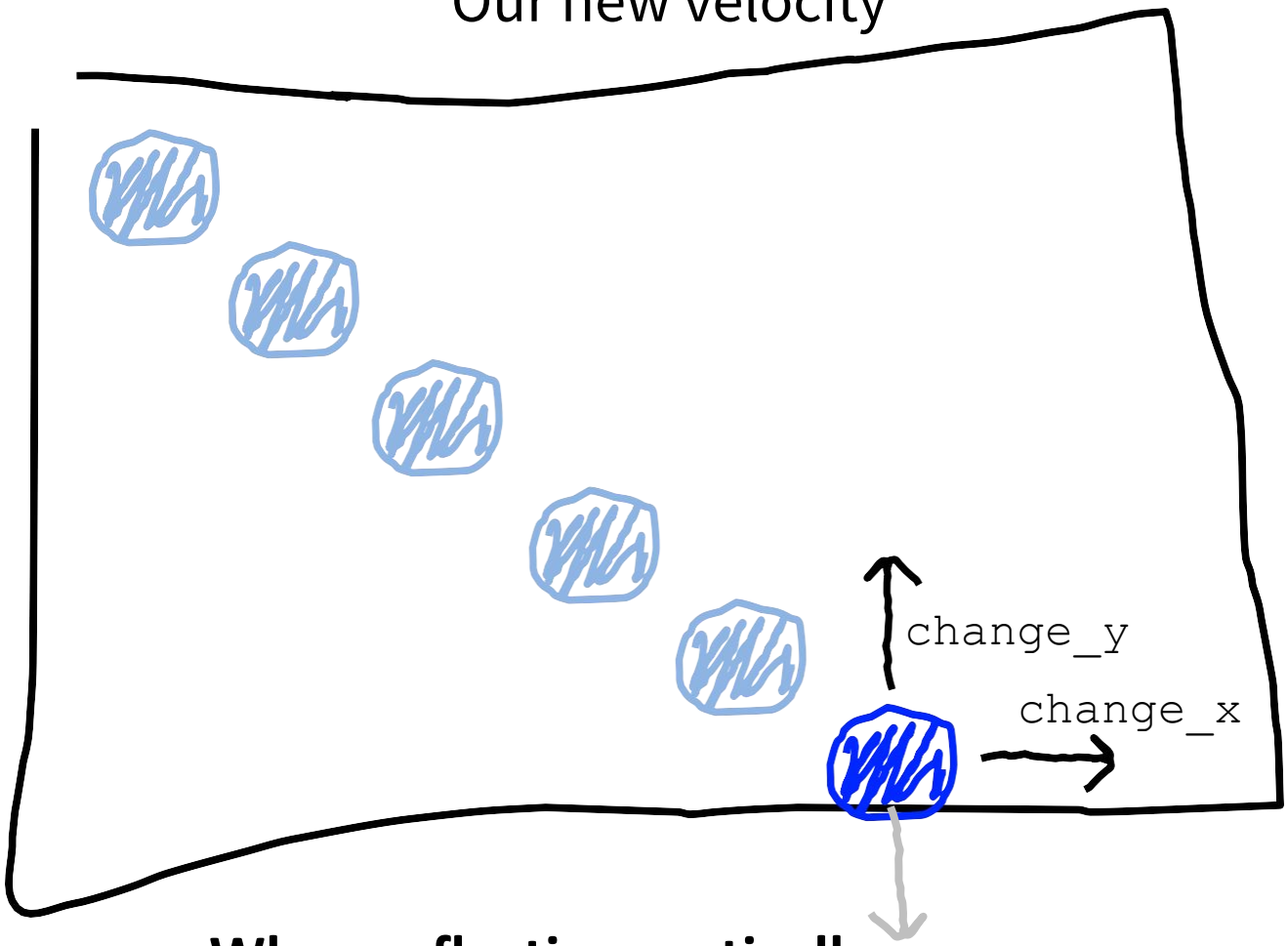
Bouncing Ball

We have this velocity



Bouncing Ball

Our new velocity



When reflecting vertically:

```
change_y = -change_y
```

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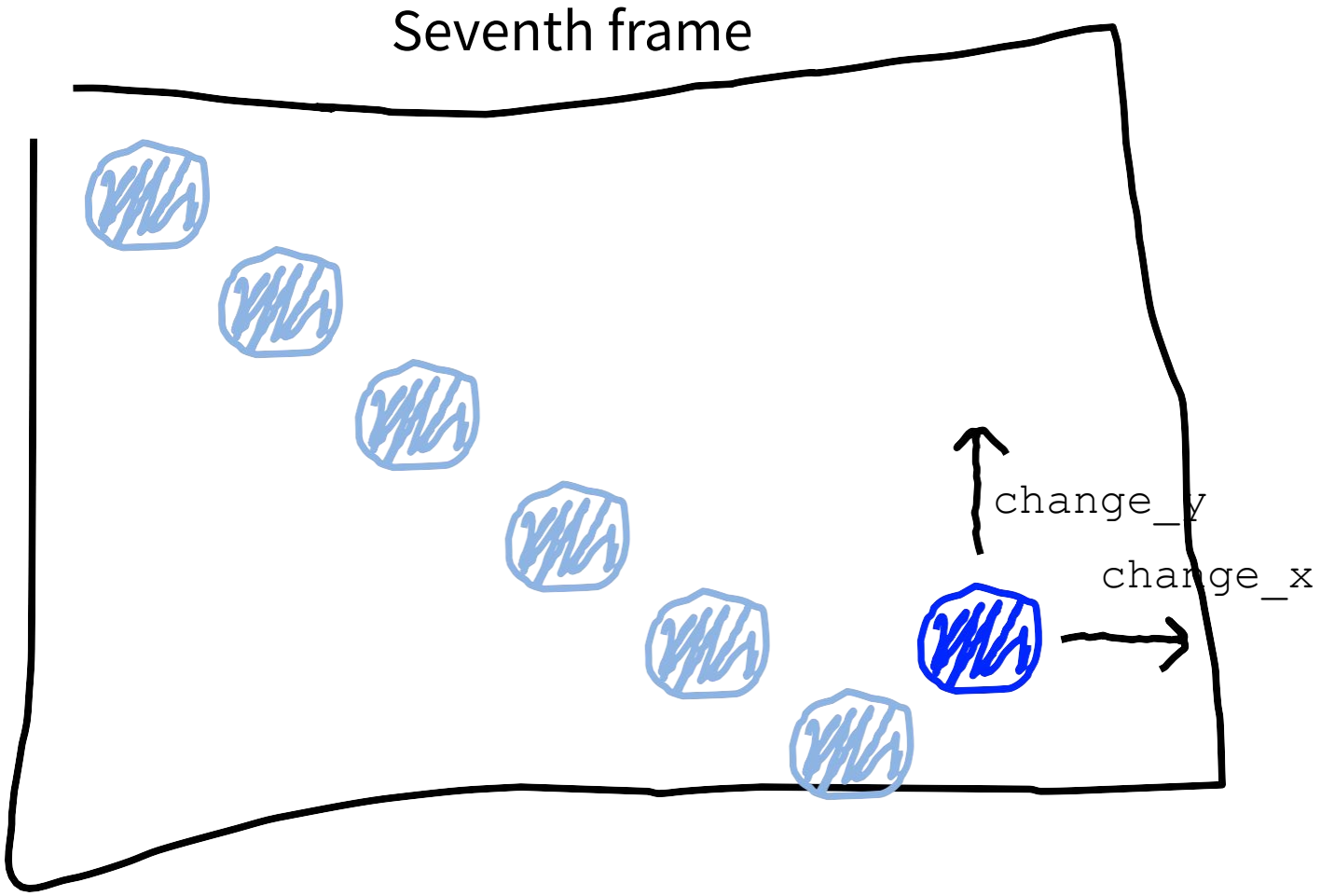
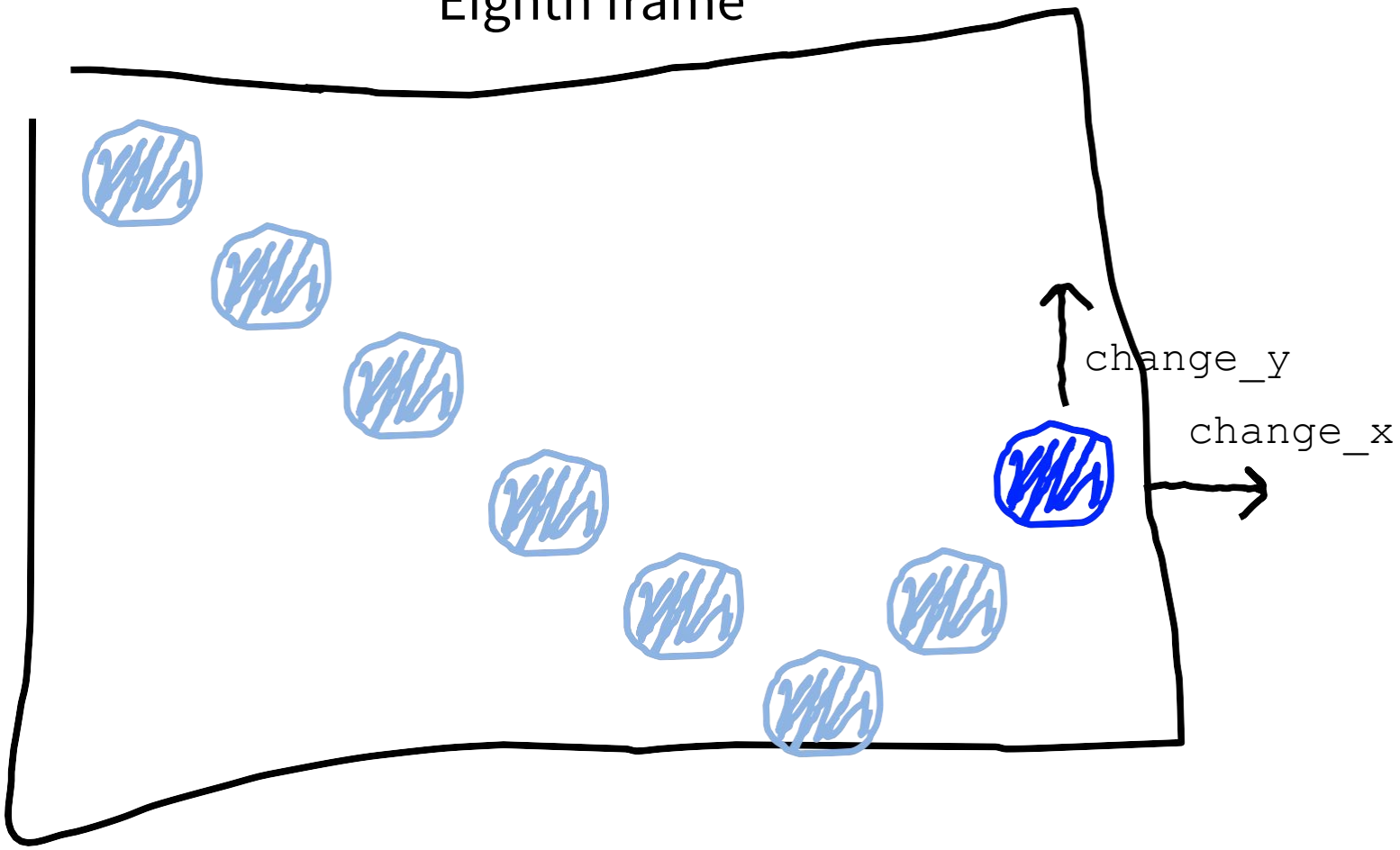
Bouncing Ball

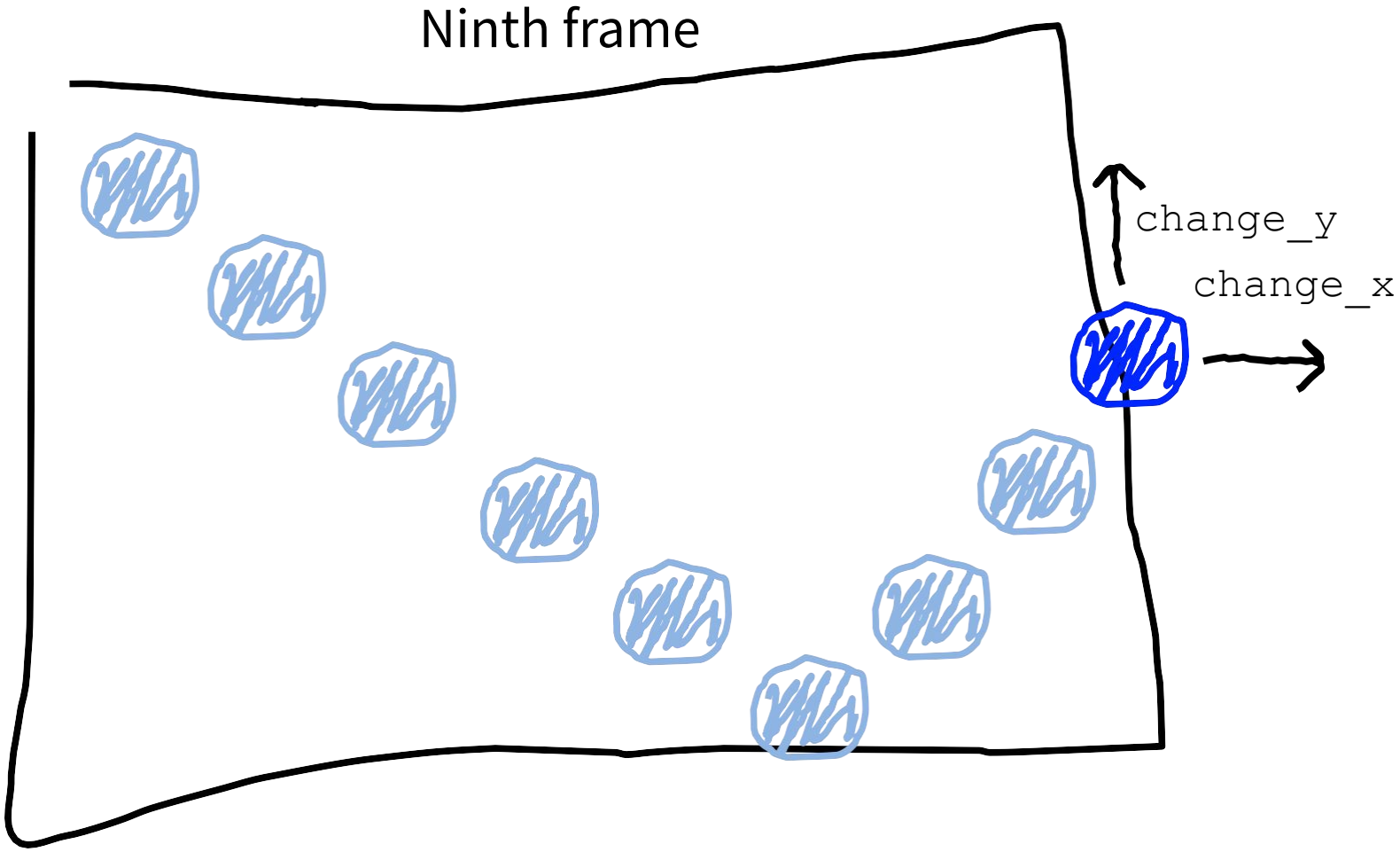


Bouncing Ball

Eighth frame

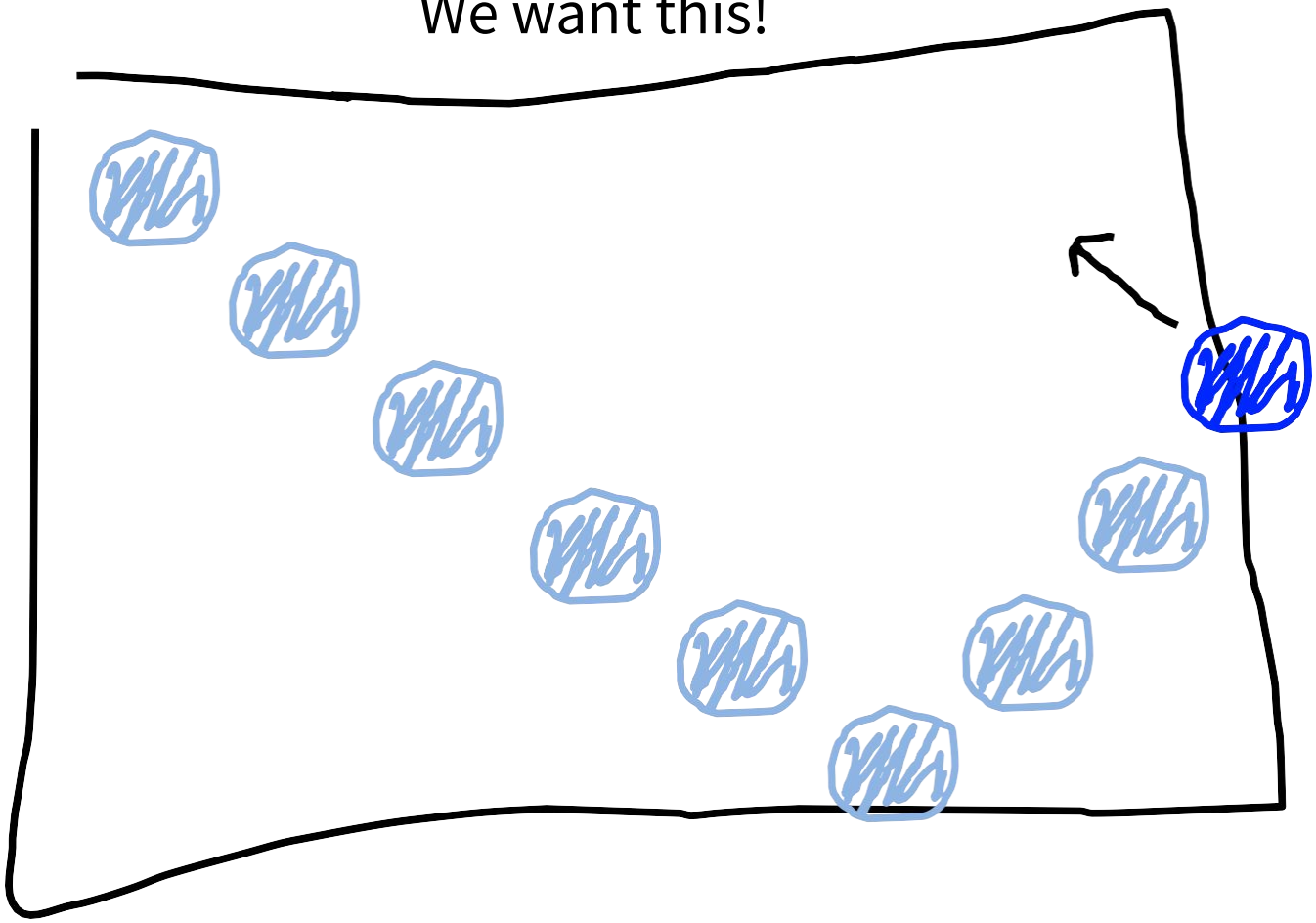


Bouncing Ball



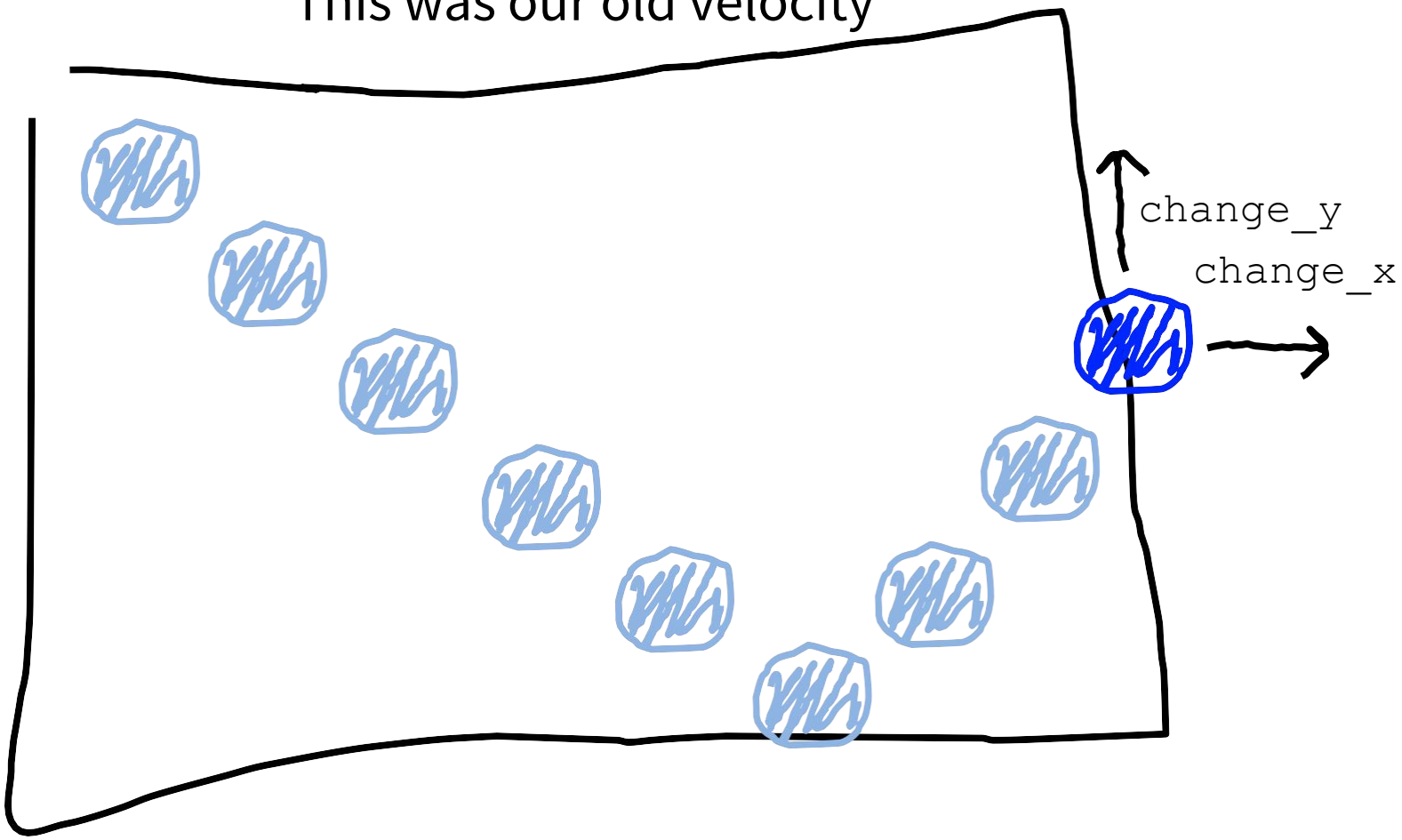
Bouncing Ball

We want this!



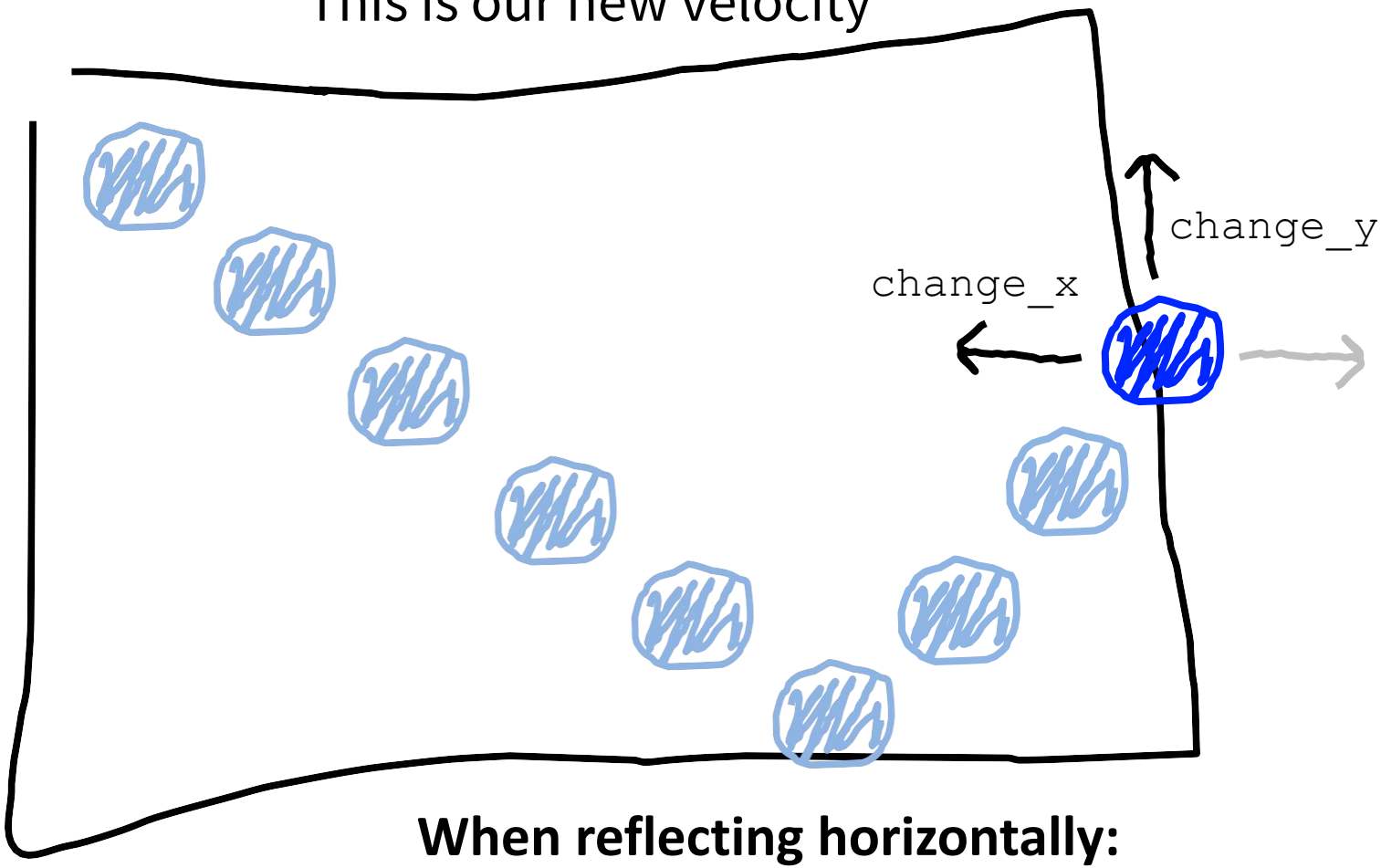
Bouncing Ball

This was our old velocity



Bouncing Ball

This is our new velocity



When reflecting horizontally:

```
change_x = -change_x
```

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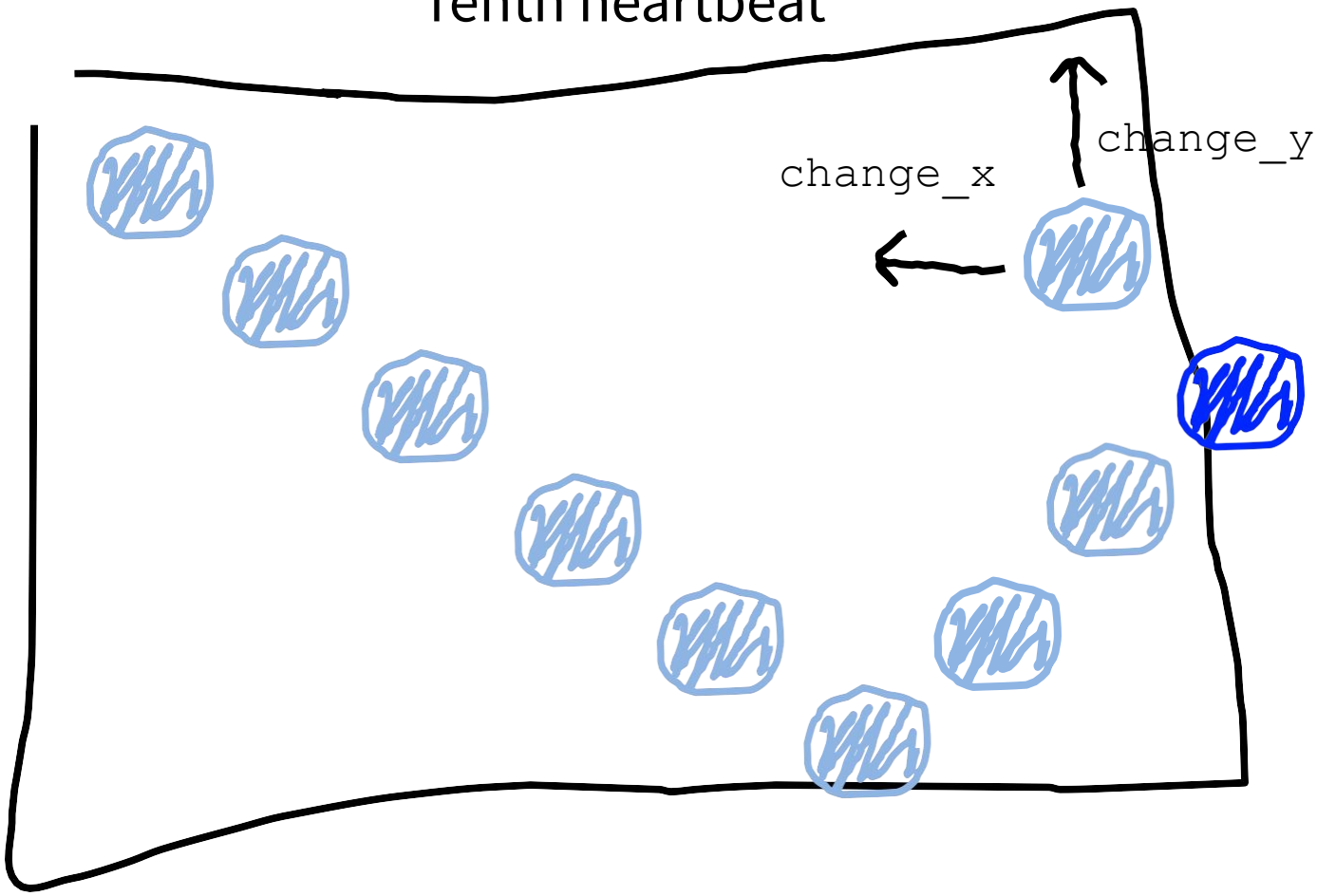
Bouncing Ball

Tenth heartbeat



Bouncing Ball General Idea

```
def main():
    canvas = Canvas(CANVAS_WIDTH, CANVAS_HEIGHT, 'DVD')
    # create "dvd"
    dvd = canvas.create_oval(...)
    # start with this initial velocity
    change_x = 1
    change_y = 1
    while True:
        canvas.move(dvd, change_x, change_y)
        if # we hit the top or bottom:
            change_y = -change_y
        elif #we hit the left or right:
            change_x = -change_x
        canvas.update()
        time.sleep(DELAY)
```

Off to Pycharm!

Milestone 2: Add randomness

- Currently, the ball always follows the same path and bounces in the same way
- To add randomness:
  - Start with `change_x = 1` and `change_y = 2`
  - When we bounce vertically, change the **sign** of the change_y, but also **randomly change its magnitude to be either 1 or 2**
  - To keep the ball a consistent speed, we will need to **change `change_x` to be the same sign as it was, but magnitude 1 if `change_y` has magnitude 2 and 2 otherwise**
  - Vice versa for horizontal bounces

Milestone 2: Add randomness

```
import random

# get a random number between 1 and 10, inclusive
num = random.randint(0, 10)

def sign(num):
    """
    returns the sign of paramter num
    """
    return num / abs(num)
```

Milestone 2:

- Decompose a function to find the sign of a number (previous slide)

- Decompose a function to find the value of **`change_x`** given the new value of **`change_y`** and the old value of **`change_x`**, and vice versa

```
def find_complement(new_change, old_change):
    """
    new_change: The new value of change_x or _y
    old_change: The old value of the other one
    return: The new value of the other one
    """
```

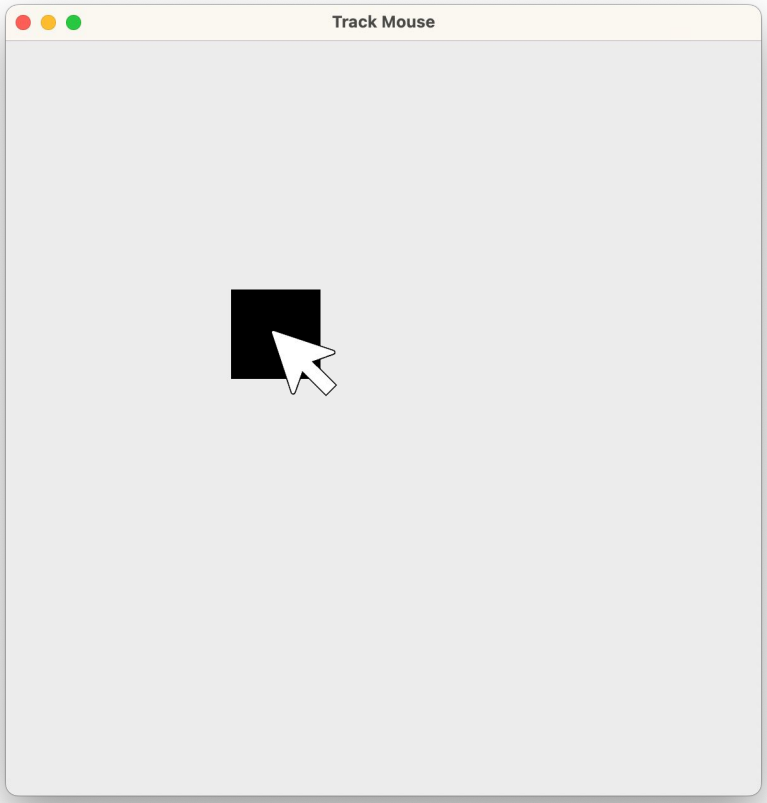
To Pycharm!

Milestone 3: Make the ball a DVD

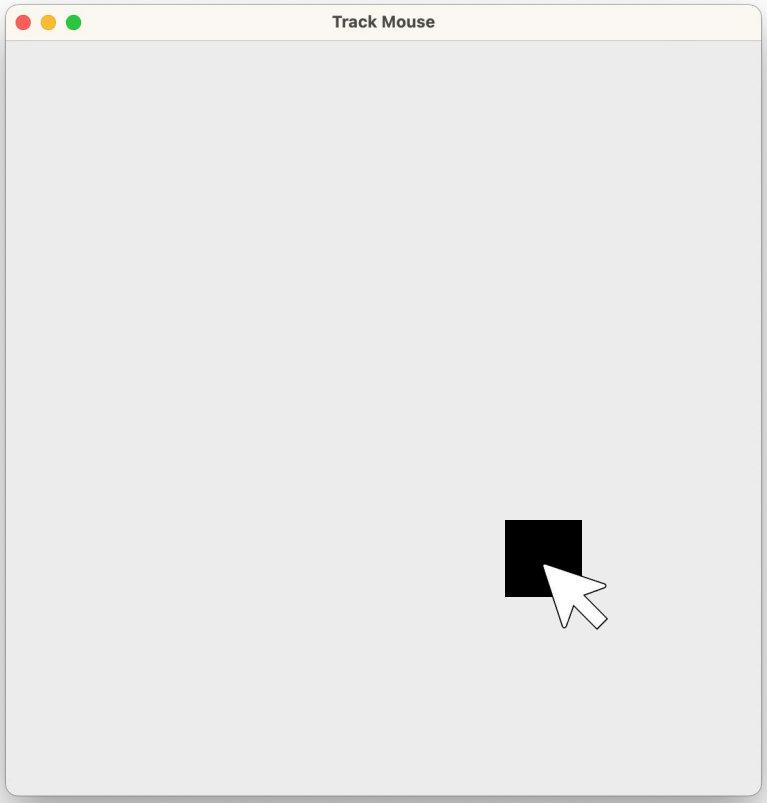
- There is a list, DVD_IMGS, of files containing dvd logos of different colors
- Start the logo as the first item in the list use create
  - Use **`canvas.create_image_with_size(...)`**
- When the logo bounces:
  - Delete the old logo
  - Make a new logo of a different color (next file in the list) exactly where the old one was
  - You will need to keep track of an “index” variable that tells you which logo file in the list to use
- Decompose a function that deletes and makes the new dvd logo

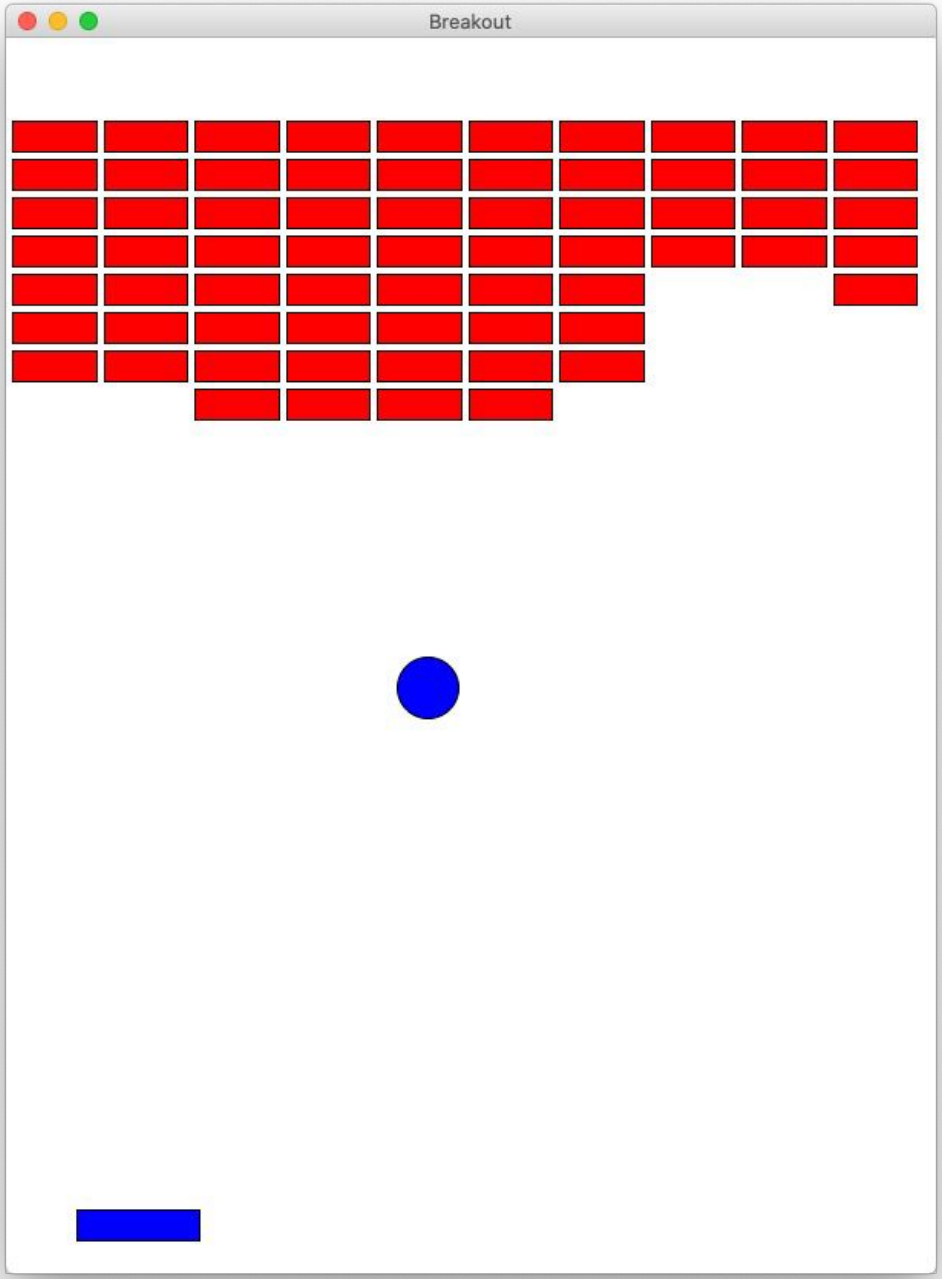
To Pycharm!

Tracking



Tracking




Breakout

More Graphics Functions Reference

```
# get the x location of the mouse
mouse_x = canvas.get_mouse_x()
```

More Graphics Functions Reference

```
# get the x location of the mouse
mouse_x = canvas.get_mouse_x()

# move shape to some new coordinates
canvas.moveto(shape, new_x, new_y)
```

More Graphics Functions Reference

```
# get the x location of the mouse
mouse_x = canvas.get_mouse_x()

# move shape to some new coordinates
canvas.moveto(shape, new_x, new_y)

# move shape by a given change_x and change_y
canvas.move(shape, change_x, change_y)
```

More Graphics Functions Reference

```
# get the x location of the mouse
mouse_x = canvas.get_mouse_x()

# move shape to some new coordinates
canvas.moveto(shape, new_x, new_y)

# move shape by a given change_x and change_y
canvas.move(shape, change_x, change_y)

# get the coordinates of a shape
top_y = canvas.get_top_y(shape)
left_x = canvas.get_left_x(shape)
coord_list = canvas.coords(shape)
```

More Graphics Functions Reference

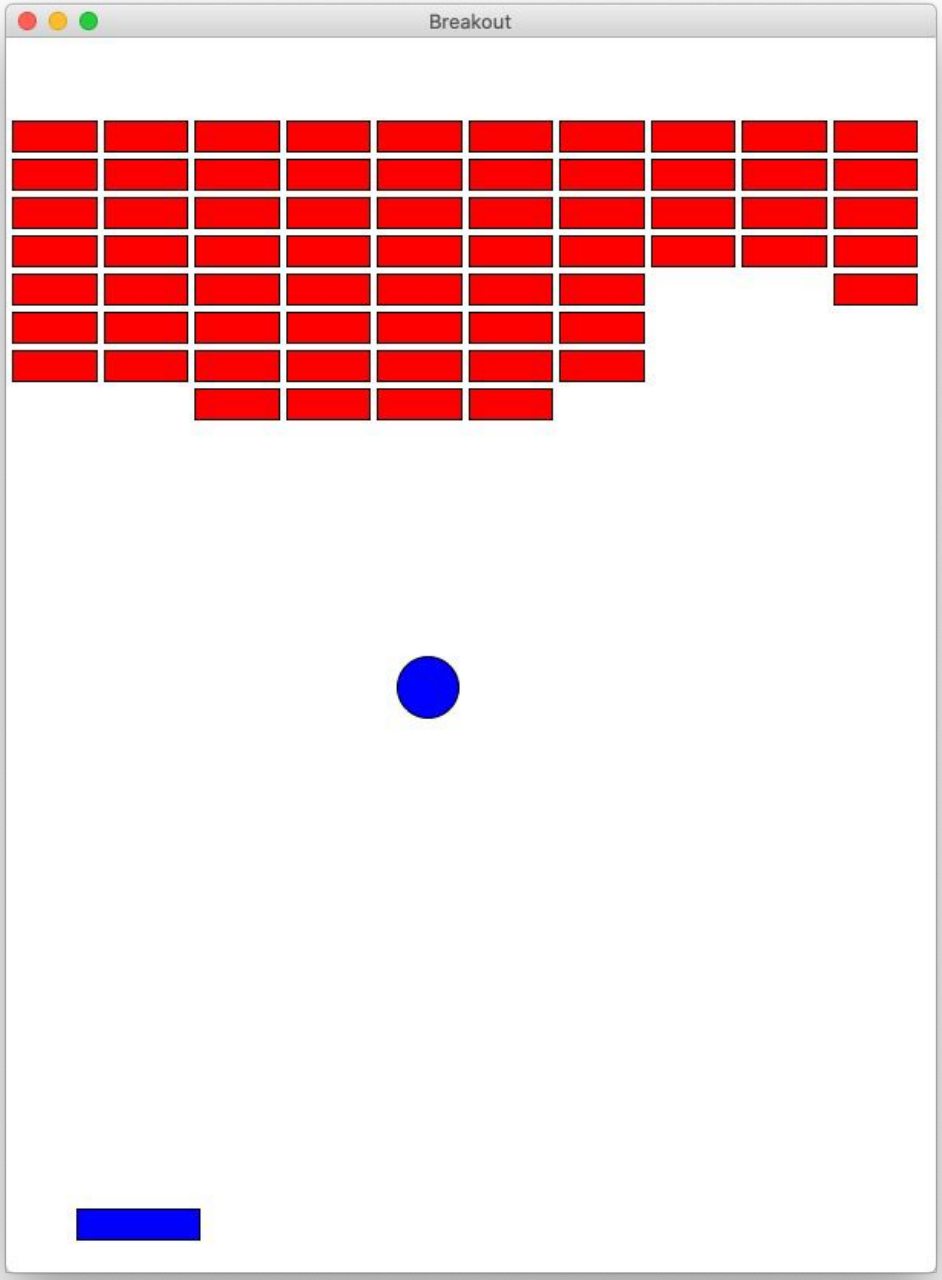
```
# get the x location of the mouse
mouse_x = canvas.get_mouse_x()

# move shape to some new coordinates
canvas.moveto(shape, new_x, new_y)

# move shape by a given change_x and change_y
canvas.move(shape, change_x, change_y)

# get the coordinates of a shape
top_y = canvas.get_top_y(shape)
left_x = canvas.get_left_x(shape)
coord_list = canvas.coords(shape)

# return a list of elements in a rectangle area
results = canvas.find_overlapping(x1, y1, x2, y2)
```

More Graphics Functions Reference

```
# get the x location of the mouse
mouse_x = canvas.get_mouse_x()

# move shape to some new coordinates
canvas.moveto(shape, new_x, new_y)

# move shape by a given change_x and change_y
canvas.move(shape, change_x, change_y)

# get the coordinates of a shape
top_y = canvas.get_top_y(shape)
left_x = canvas.get_left_x(shape)
coord_list = canvas.coords(shape)

# return a list of elements in a rectangle area
results = canvas.find_overlapping(x1, y1, x2, y2)

# wait for a click
canvas.wait_for_click()
```

Check out cleanup_circles.py

For some Breakout hints :0


Breakout