Animation

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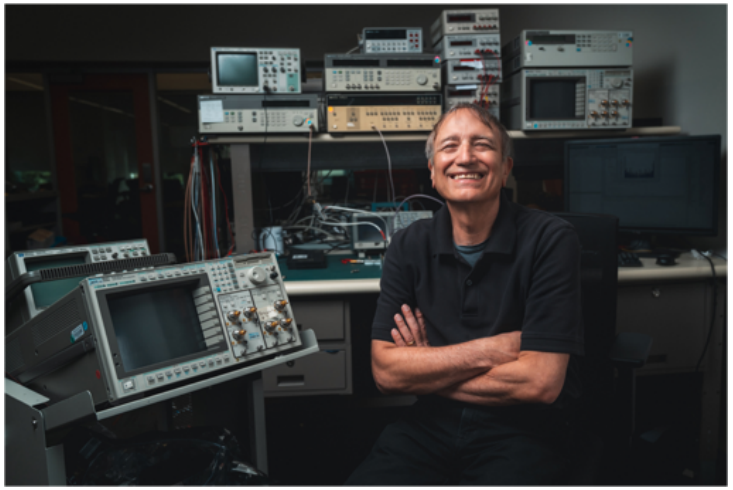
CS106A, Stanford University

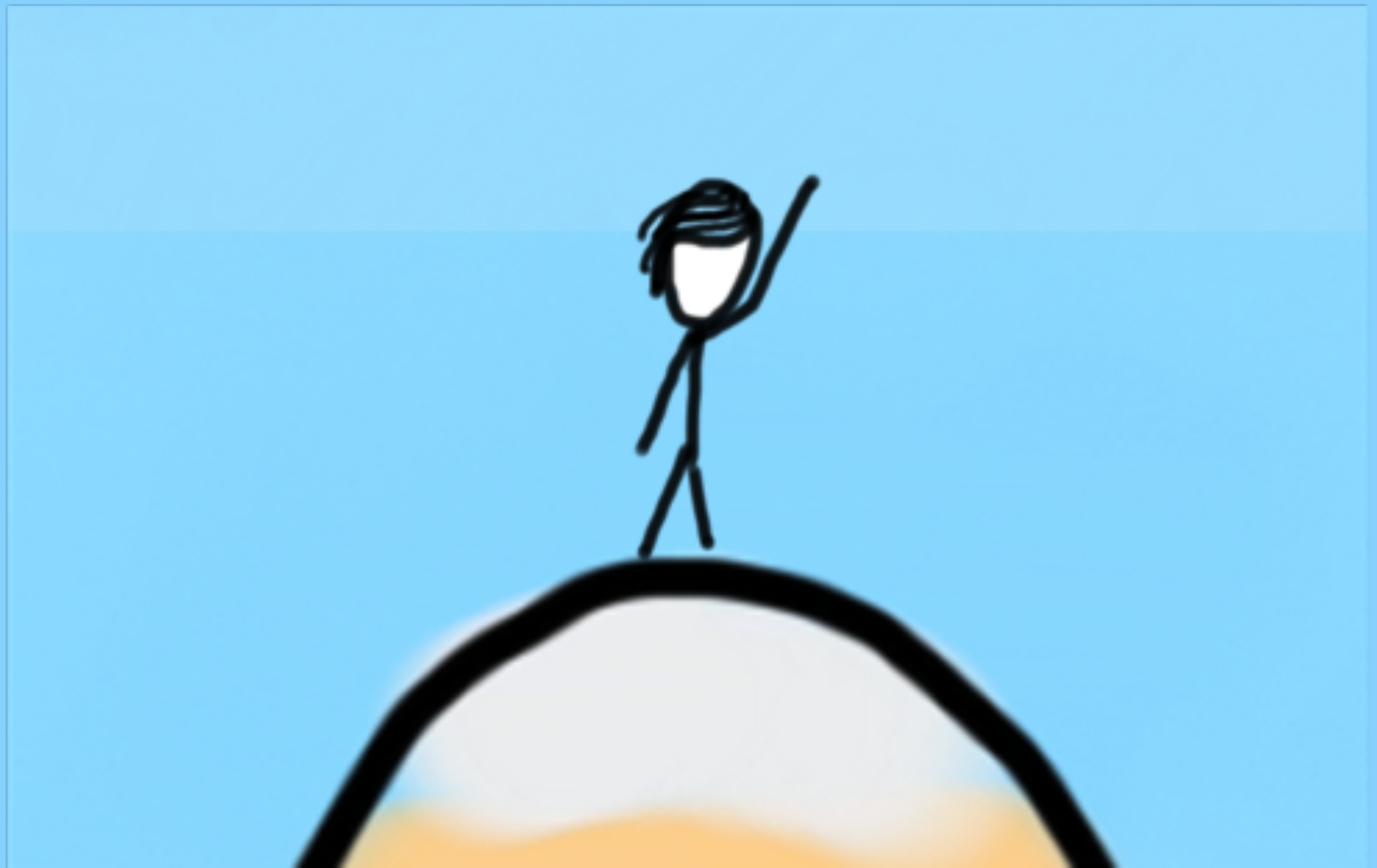
Turing Award Winner



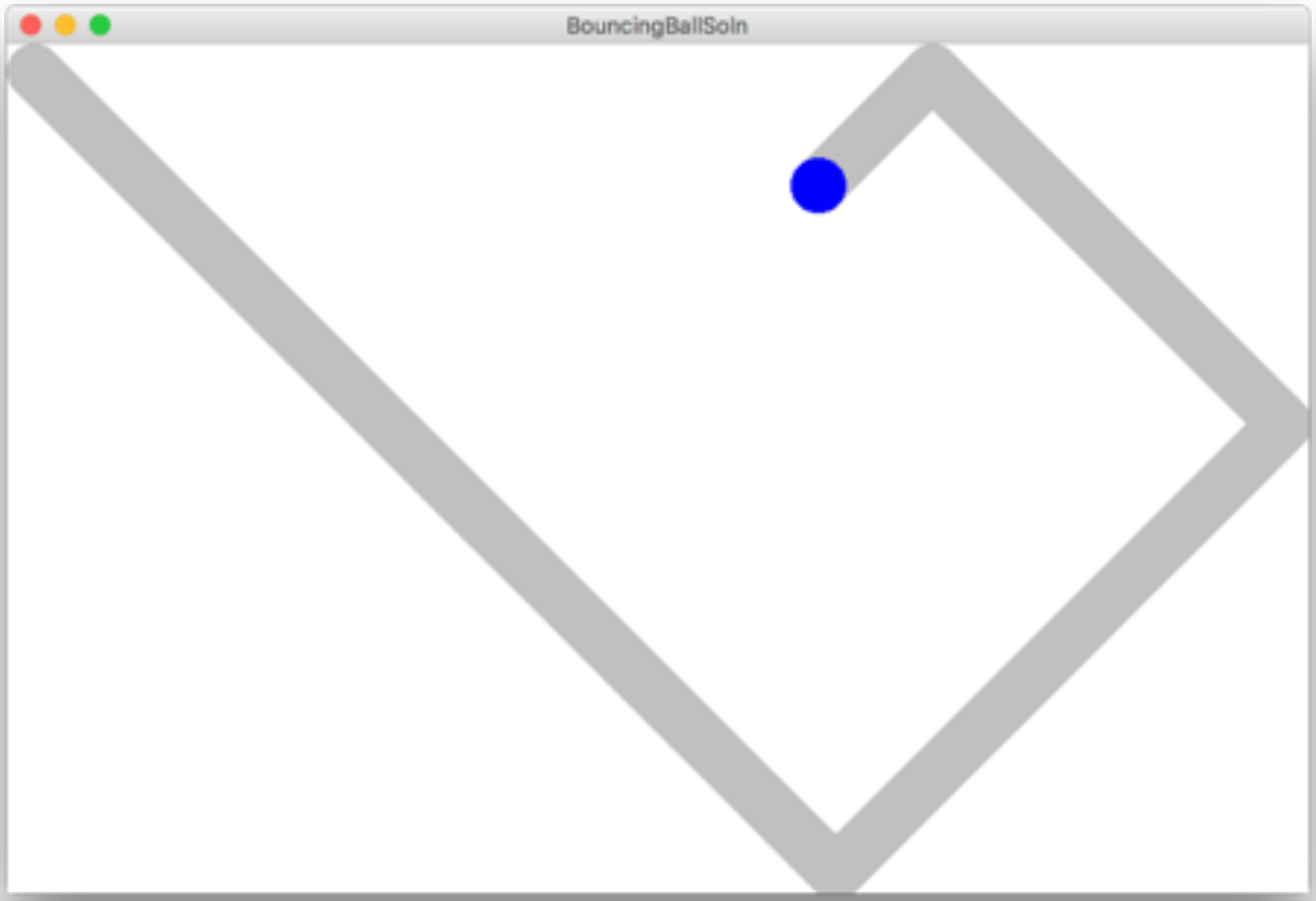
- **Turing Award** is like the nobel prize in CS
- Professor here at Stanford (CS107E, CS348)
- Founding employee at Pixar
- Wrote RenderMan, won 3 Academy Awards
- And just a really wonderful human.

Learning Goals

1. Write animated programs

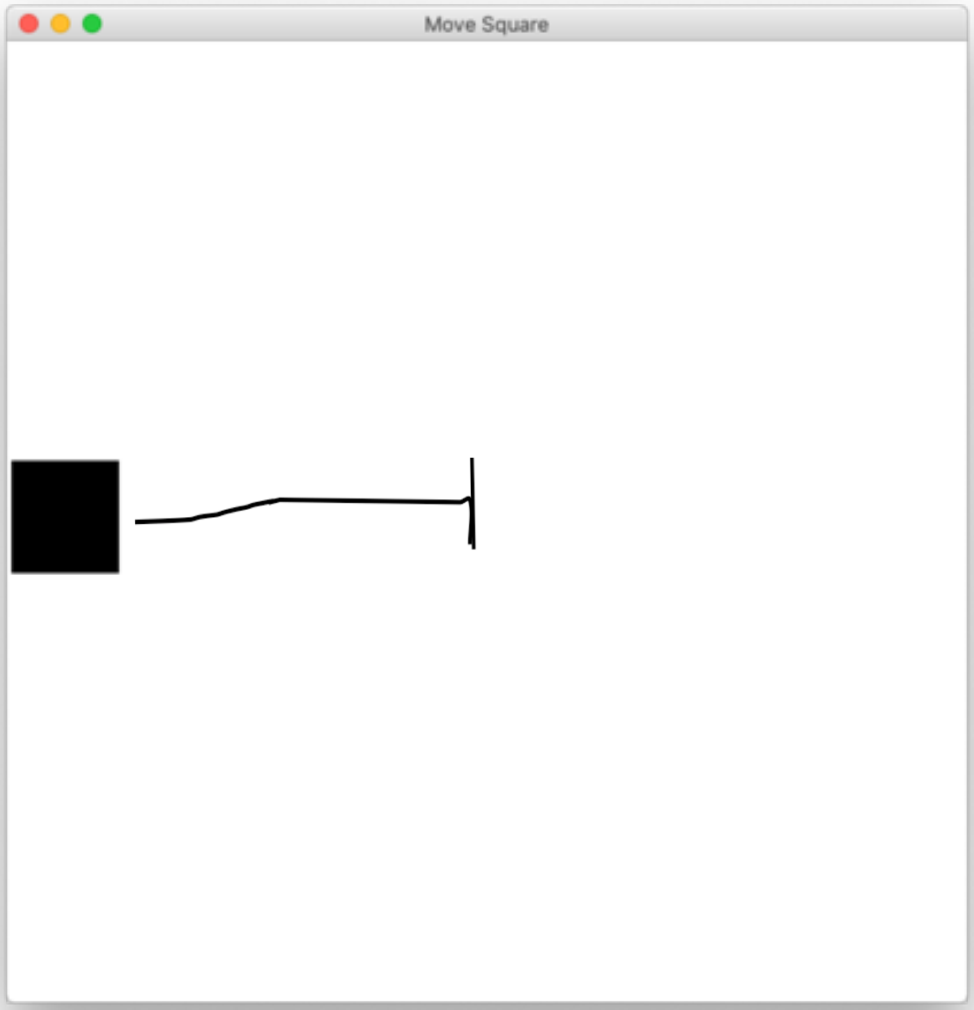


You will be able to write Bouncing Ball



Great foundation

Move to Center



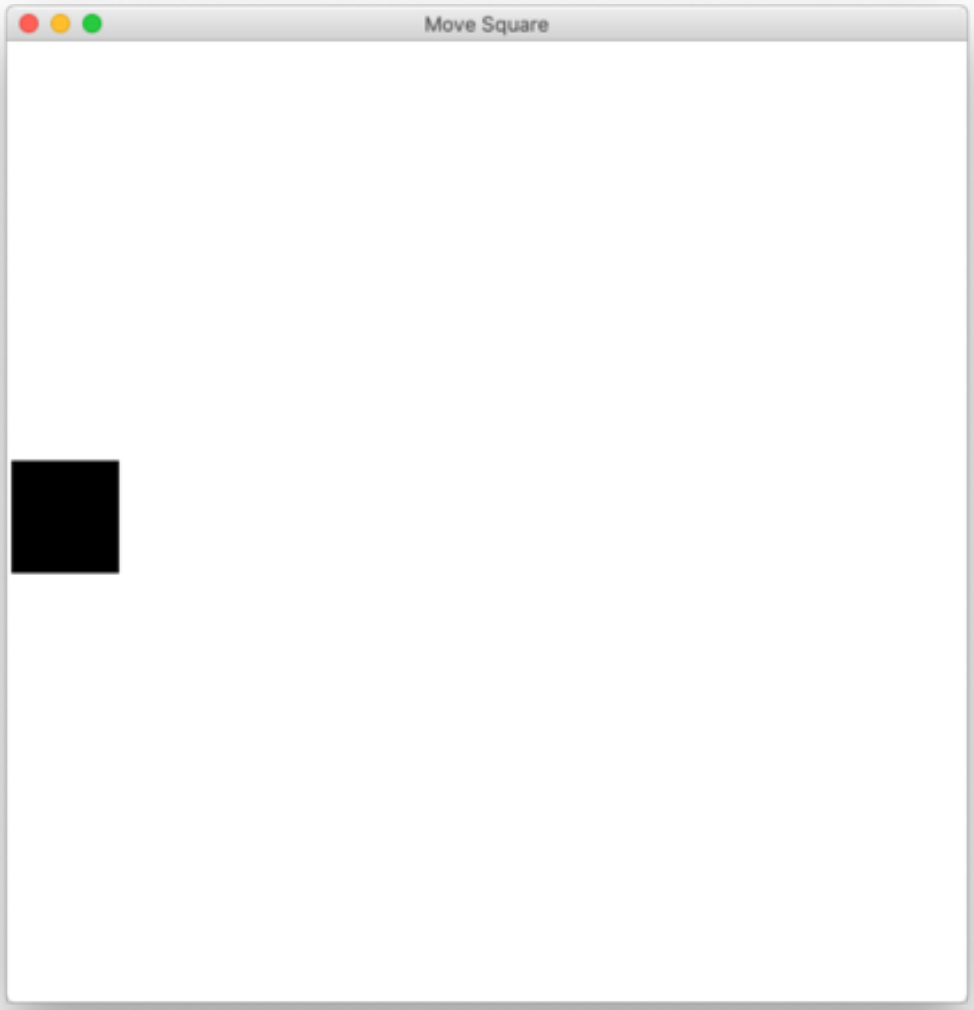
In our last episode...

Graphics from tkinter (aka tk)

```
import tkinter
```

```
# we write this for you, and include it
# in all of your projects!
canvas = Canvas(width, height, title)
```


Add square



Graphics from tkinter (aka tk)

```
import tkinter
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# we write this for you, and include it
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def Canvas(width, height, title):
```


```
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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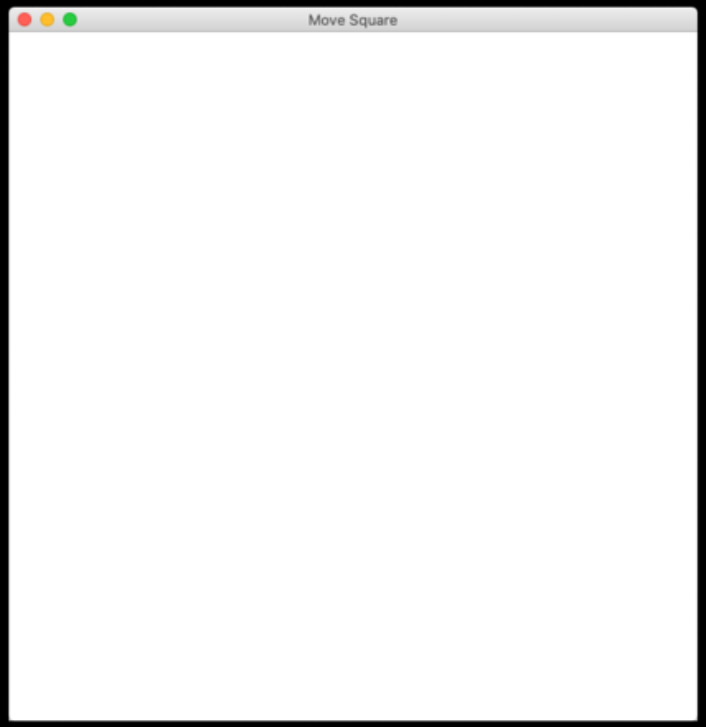

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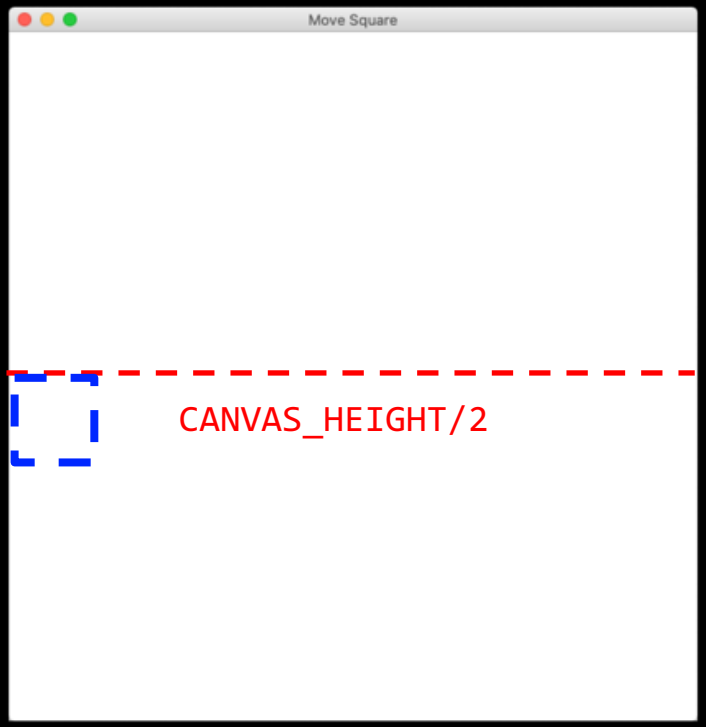

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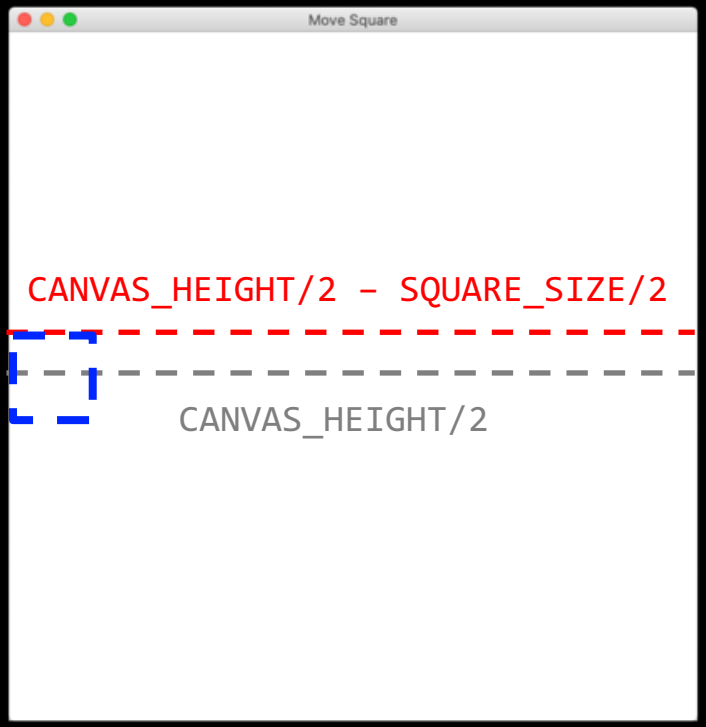

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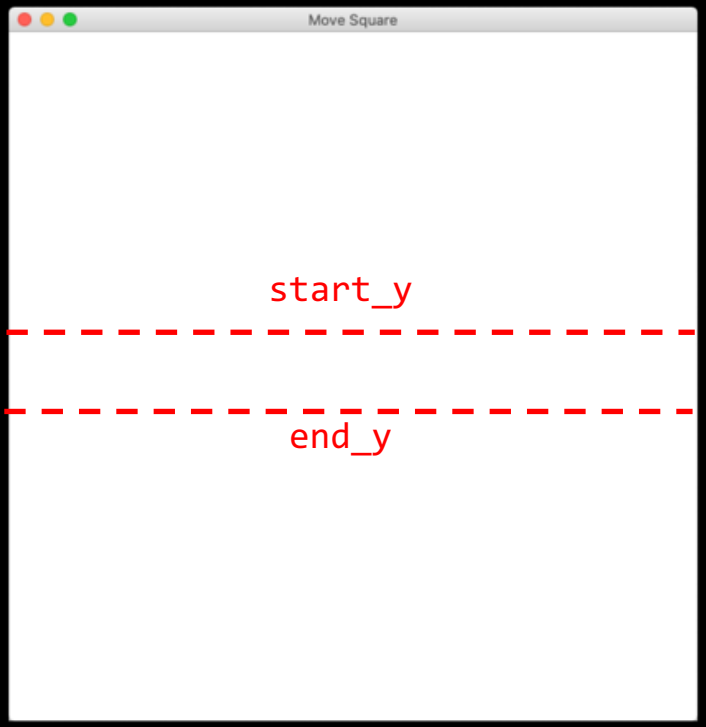

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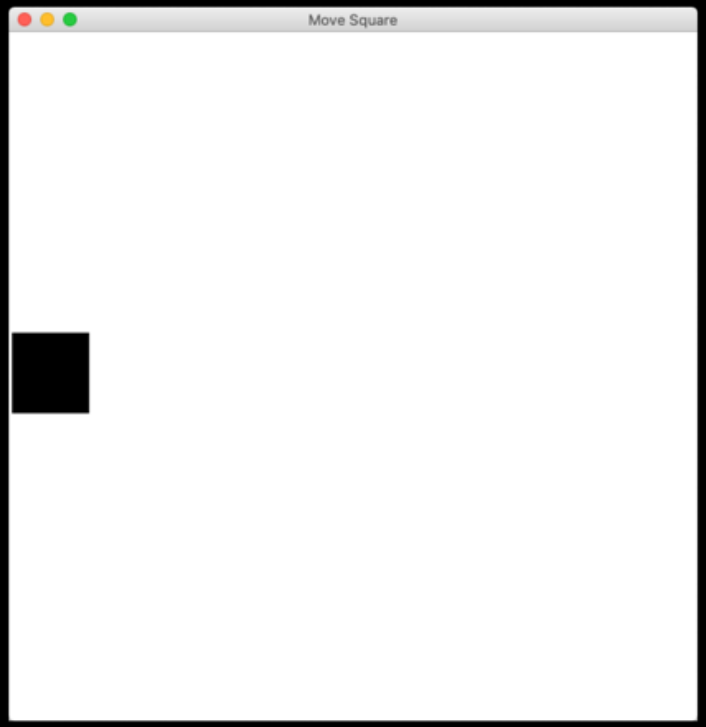

Some “heavy duty” variables allow you to call functions on them

```
def main():
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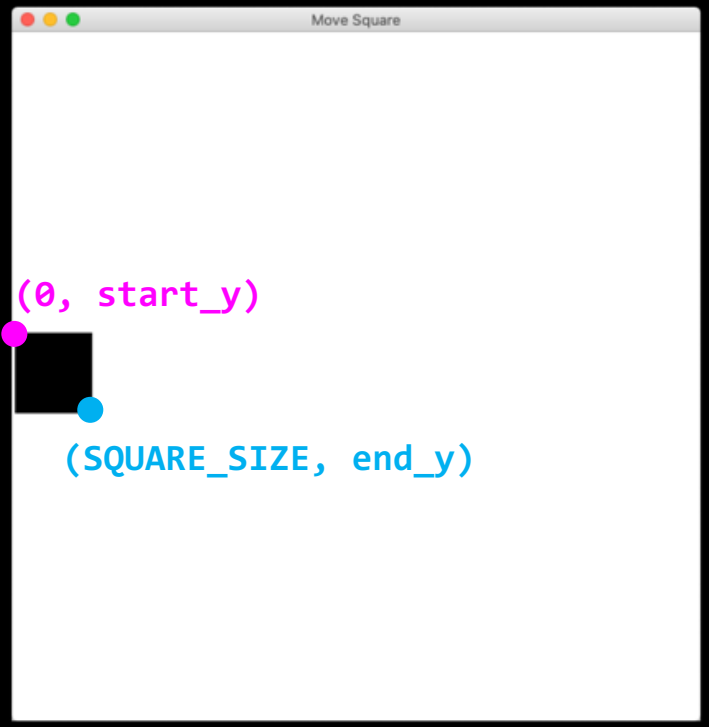
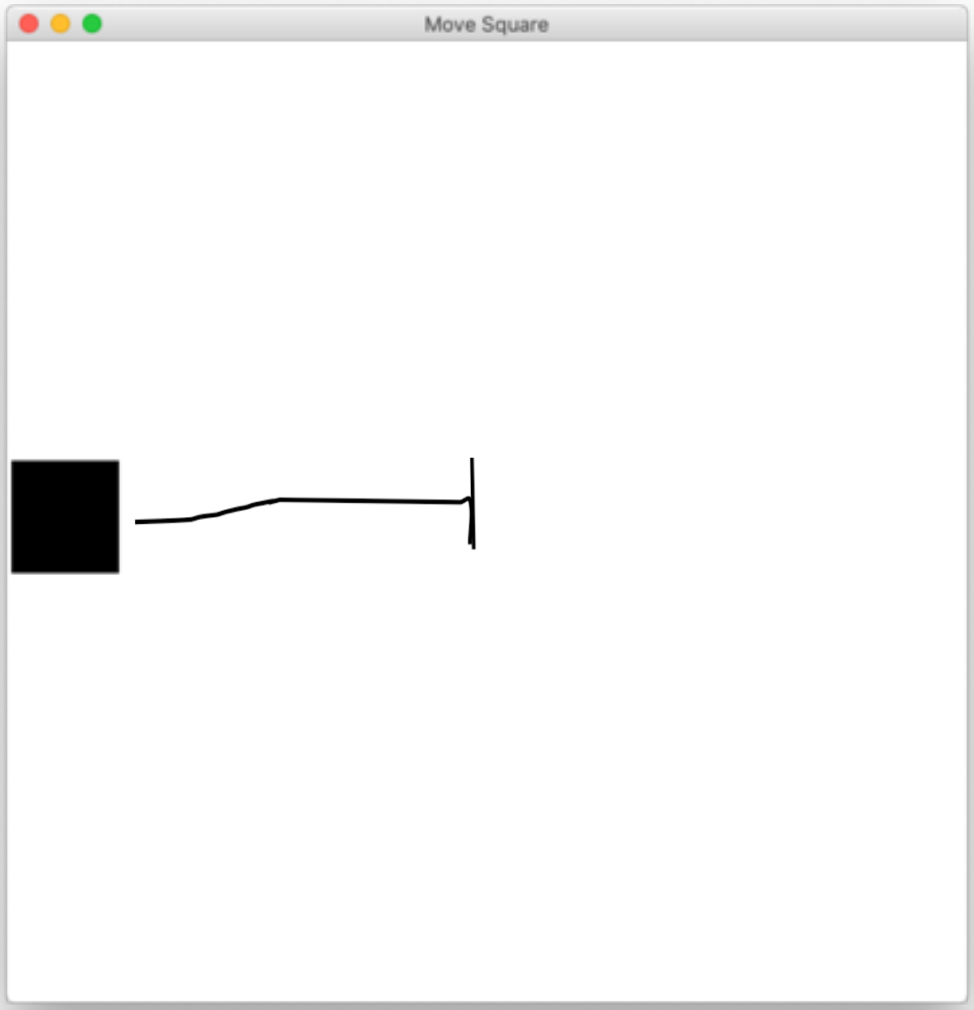


You're now all graphics programmers!

End review...

How do movies or games animate?

Move to Center



* That’s not quite toy story, but it is a start…

Animation Loop

```
def main():
    # setup

    while True:
        # update world

        # pause
        time.sleep(DELAY)
```


Animation Loop

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def main():
    # setup

    while True:
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```

Make all the variables you need.

Animation Loop

```
def main():
    # setup

    while True:
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        time.sleep(DELAY)
```

The animation loop is a repetition of heartbeats

Animation Loop

```
def main():
    # setup

    while True:
        # update world

        # pause
        time.sleep(DELAY)
```

Each heart-beat, update the world forward one frame

Animation Loop

```
def main():
    # setup

    while True:
        # update world

        # pause
        time.sleep(DELAY)
```

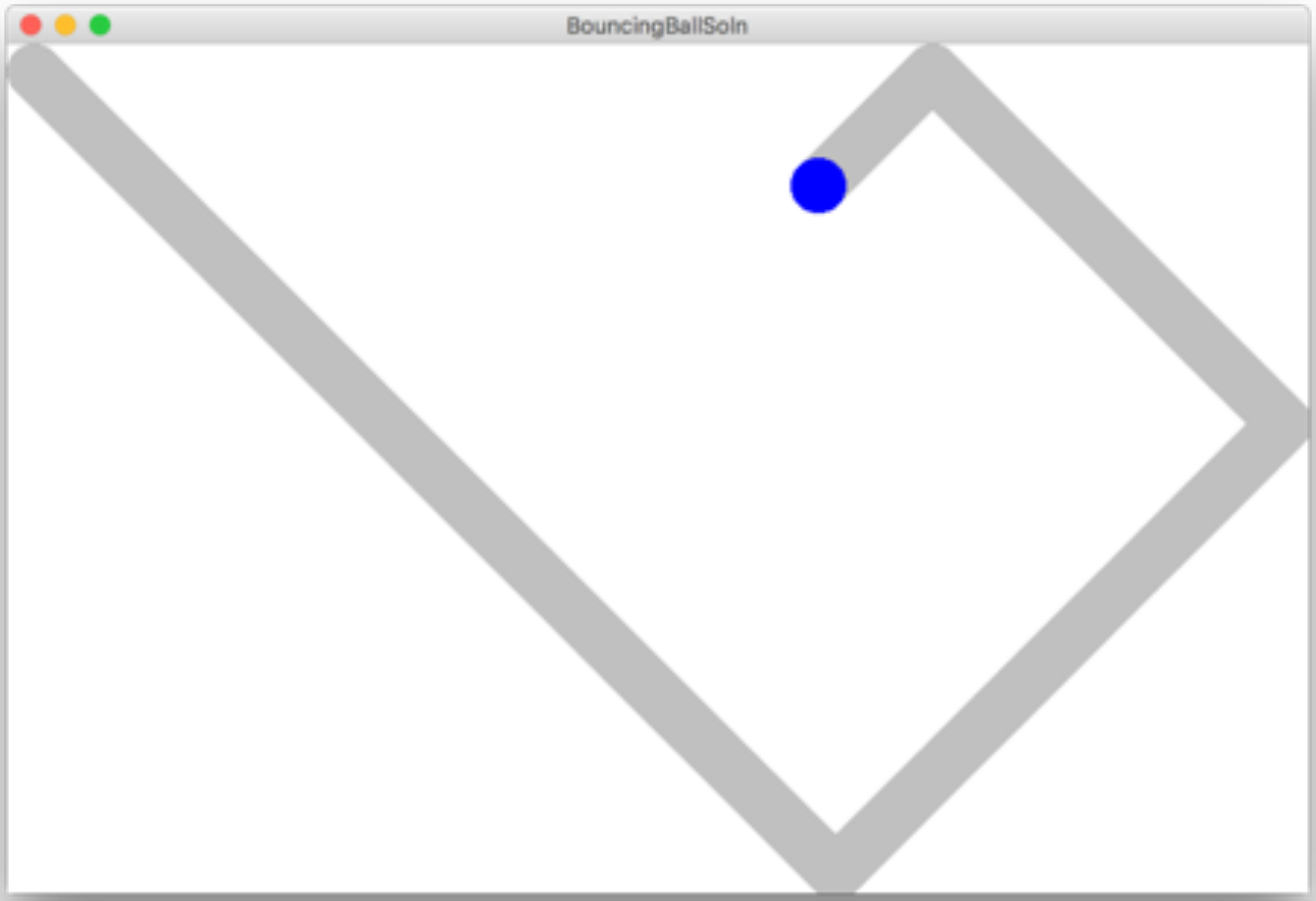
If you don't pause, humans won't be able to see it

Move To Center

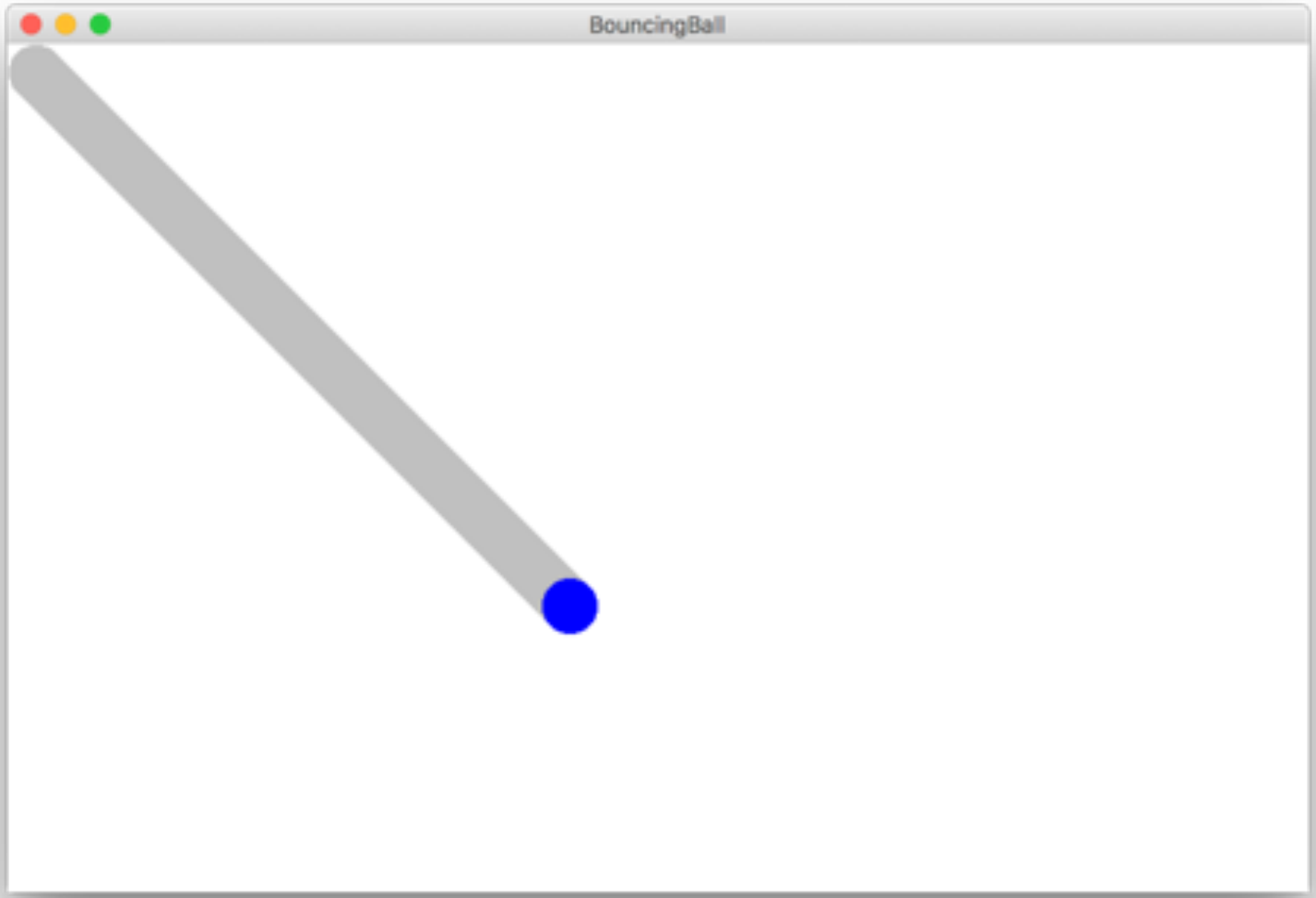
```
def main():
    # setup
    canvas = Canvas(CANVAS_WIDTH, CANVAS_HEIGHT)
    rect = canvas.create_rectangle(0, 0, 100, 100)
    while not is_past_center(canvas, r):
        # update world
        canvas.move(rect, 1, 0)
        canvas.update()
        # pause
        time.sleep(DELAY)
```

We are ready…

Bouncing Ball

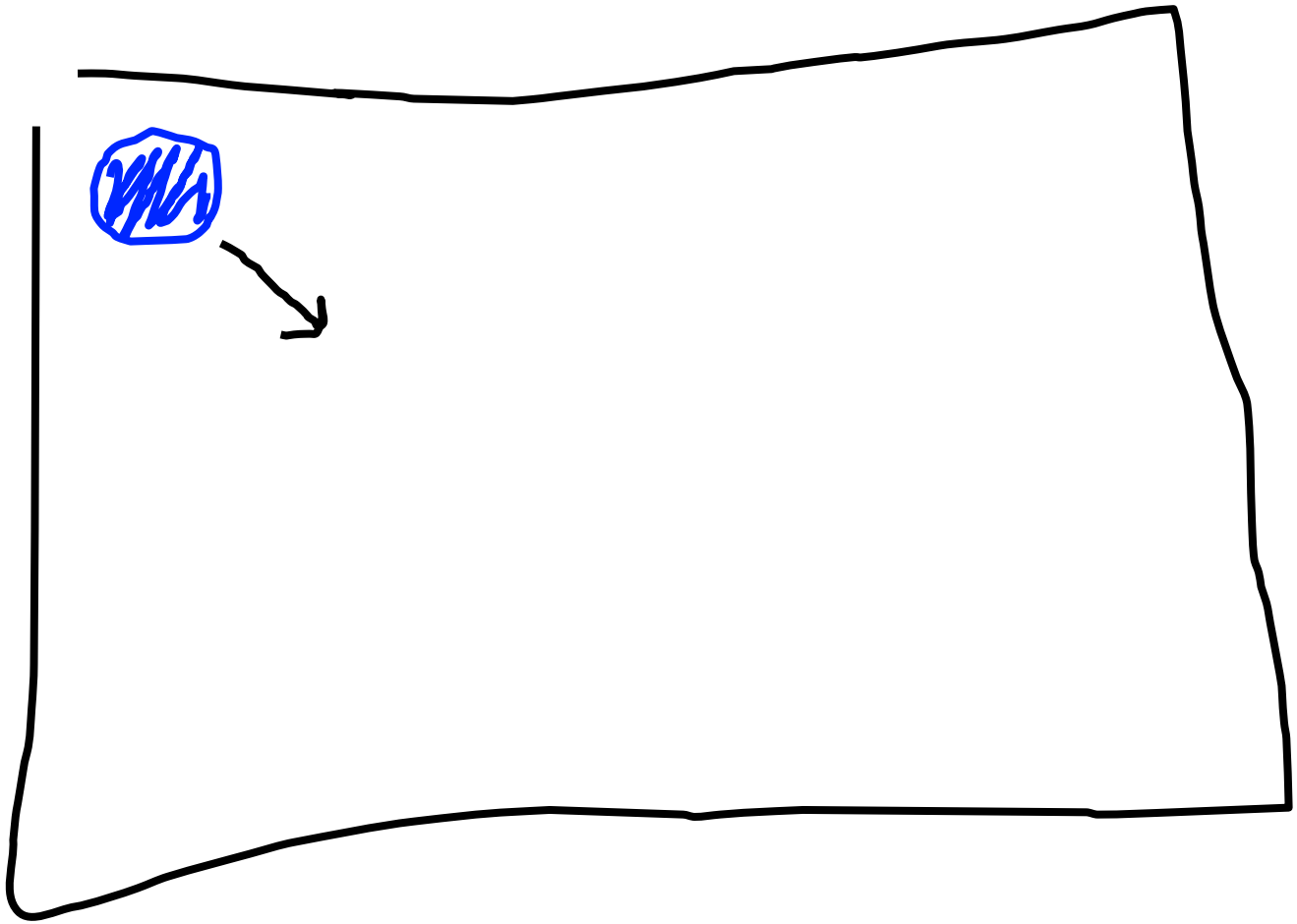


Milestone #1



Bouncing Ball

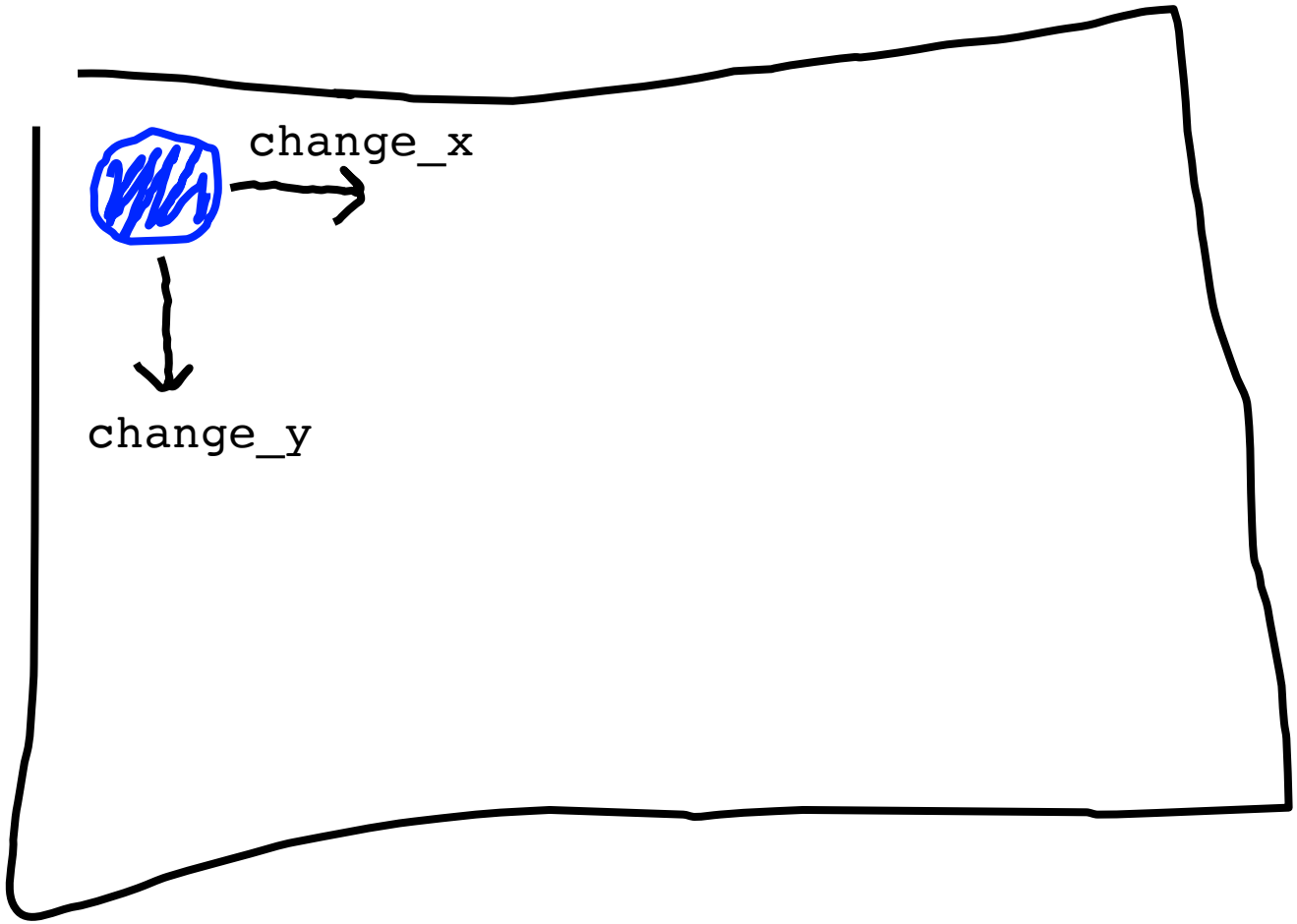
First heartbeat



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

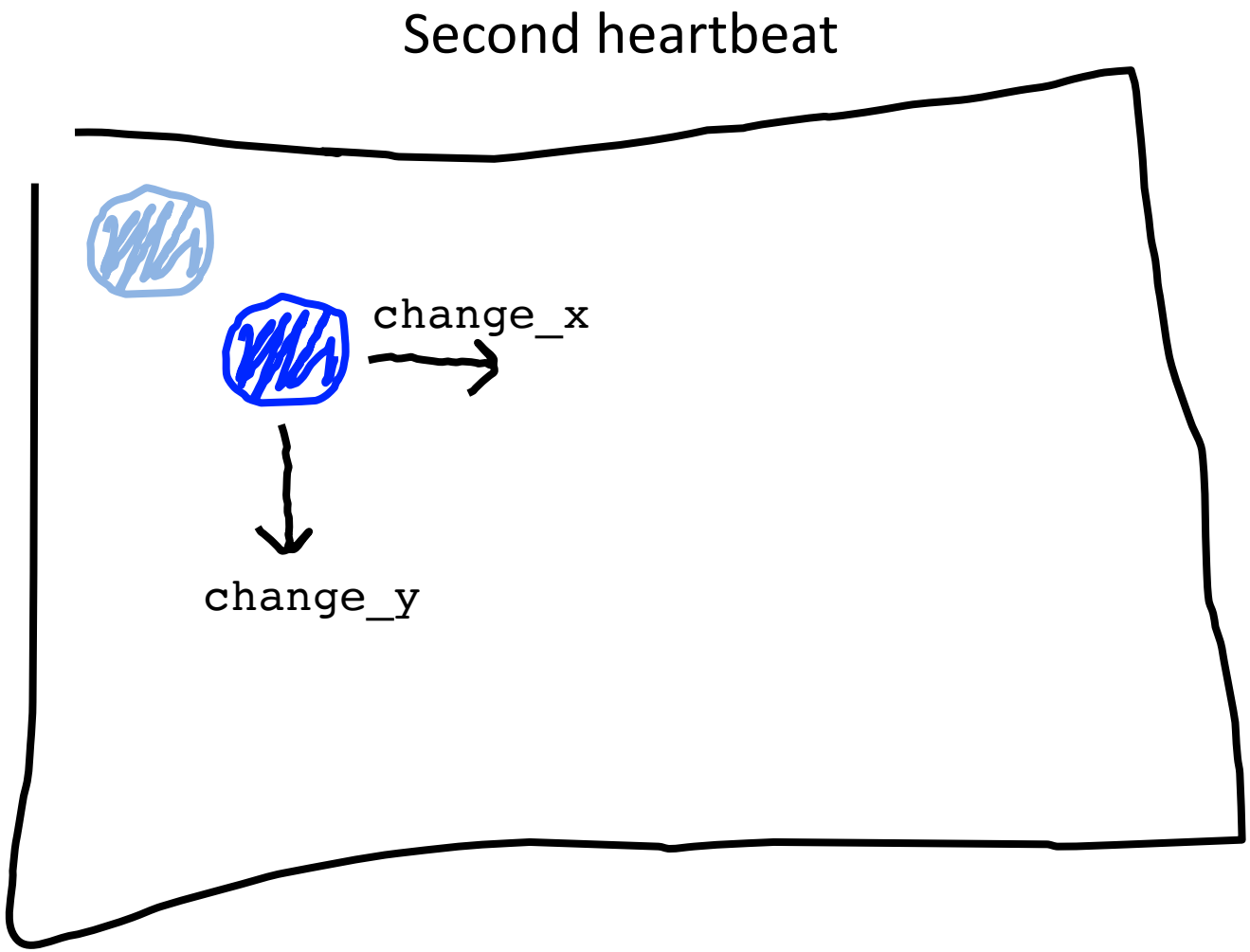
Bouncing Ball

First heartbeat

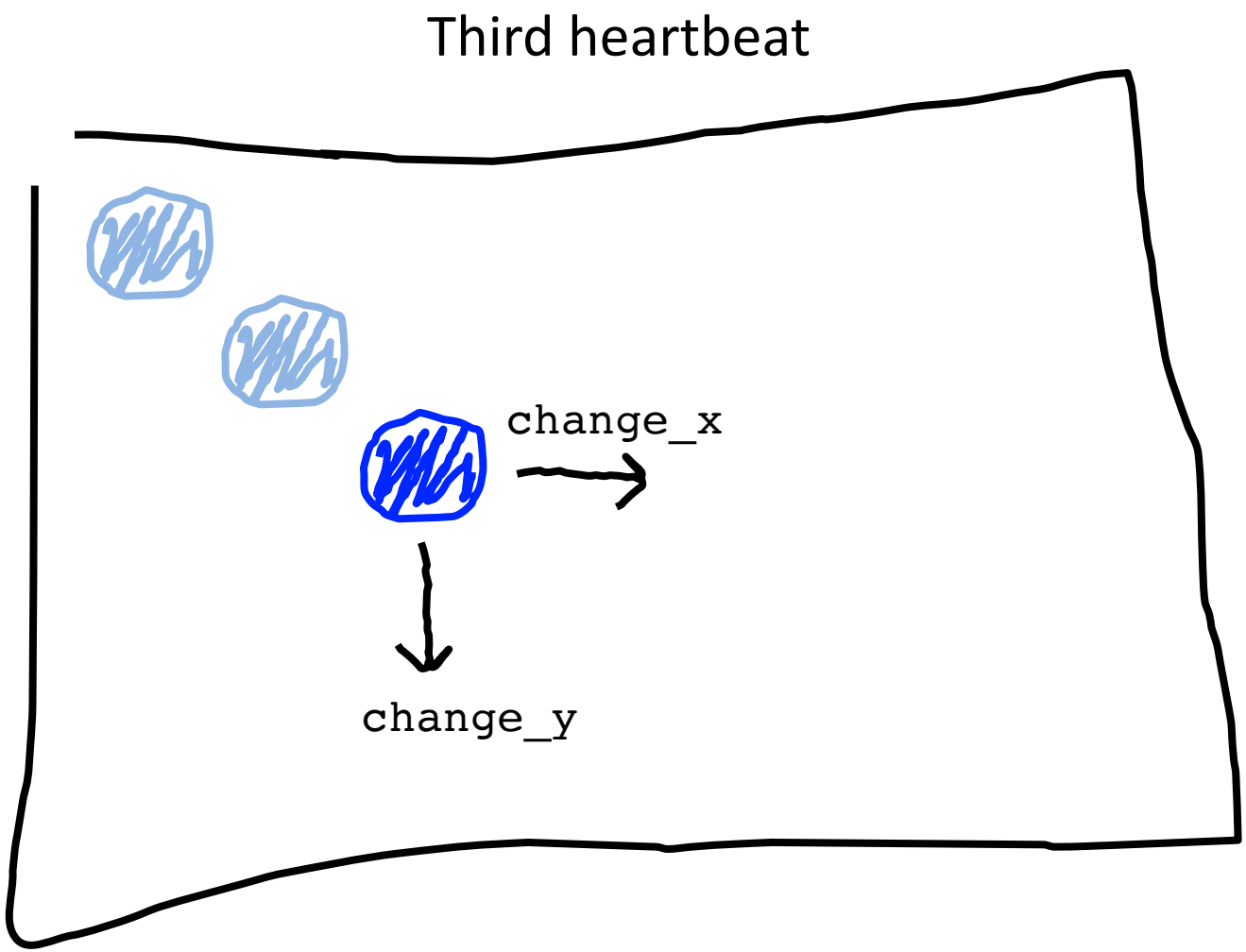


The **`move`** function takes in
a change in x and a change in y

Bouncing Ball

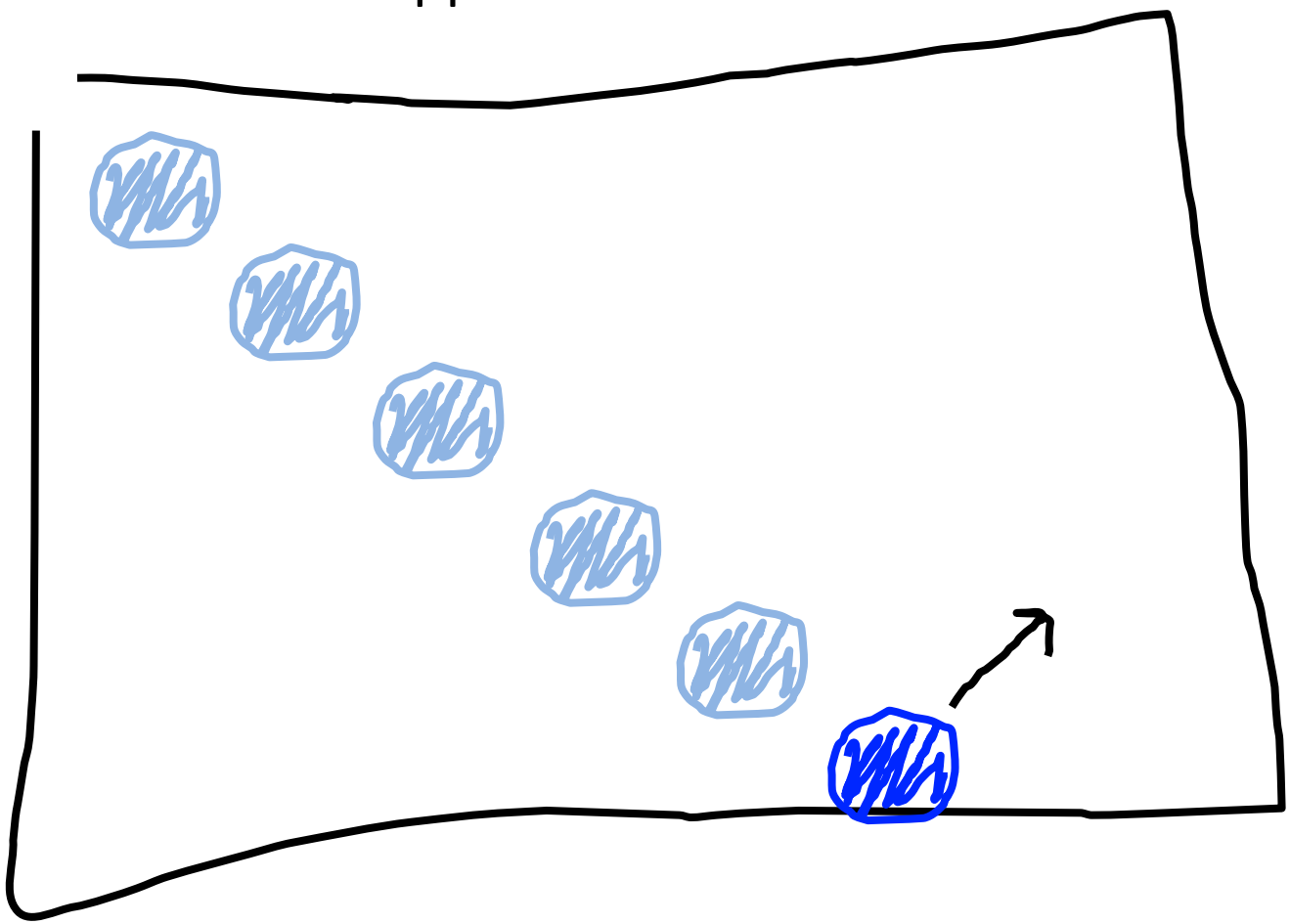


Bouncing Ball



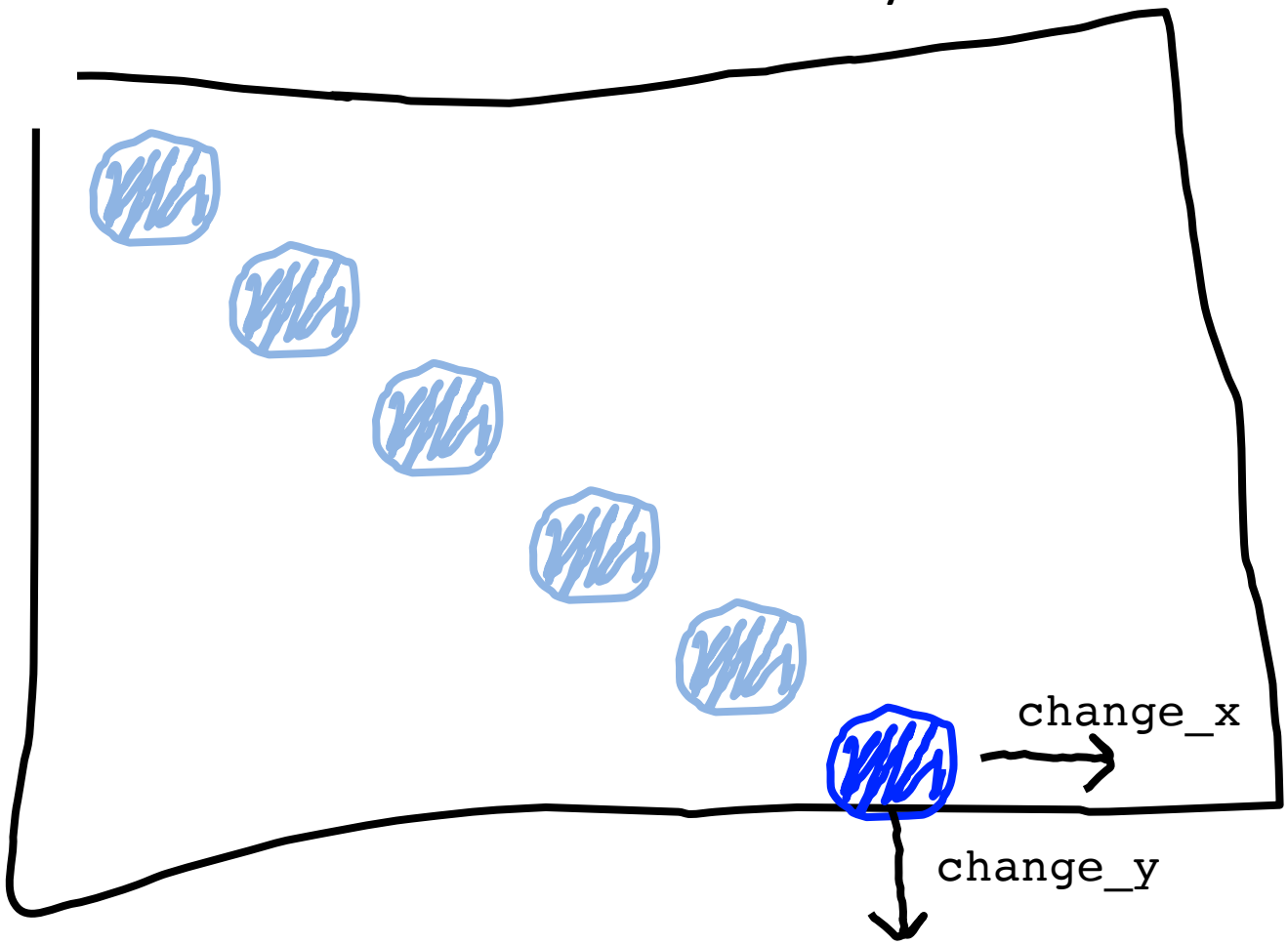
Bouncing Ball

What happens when we hit a wall?



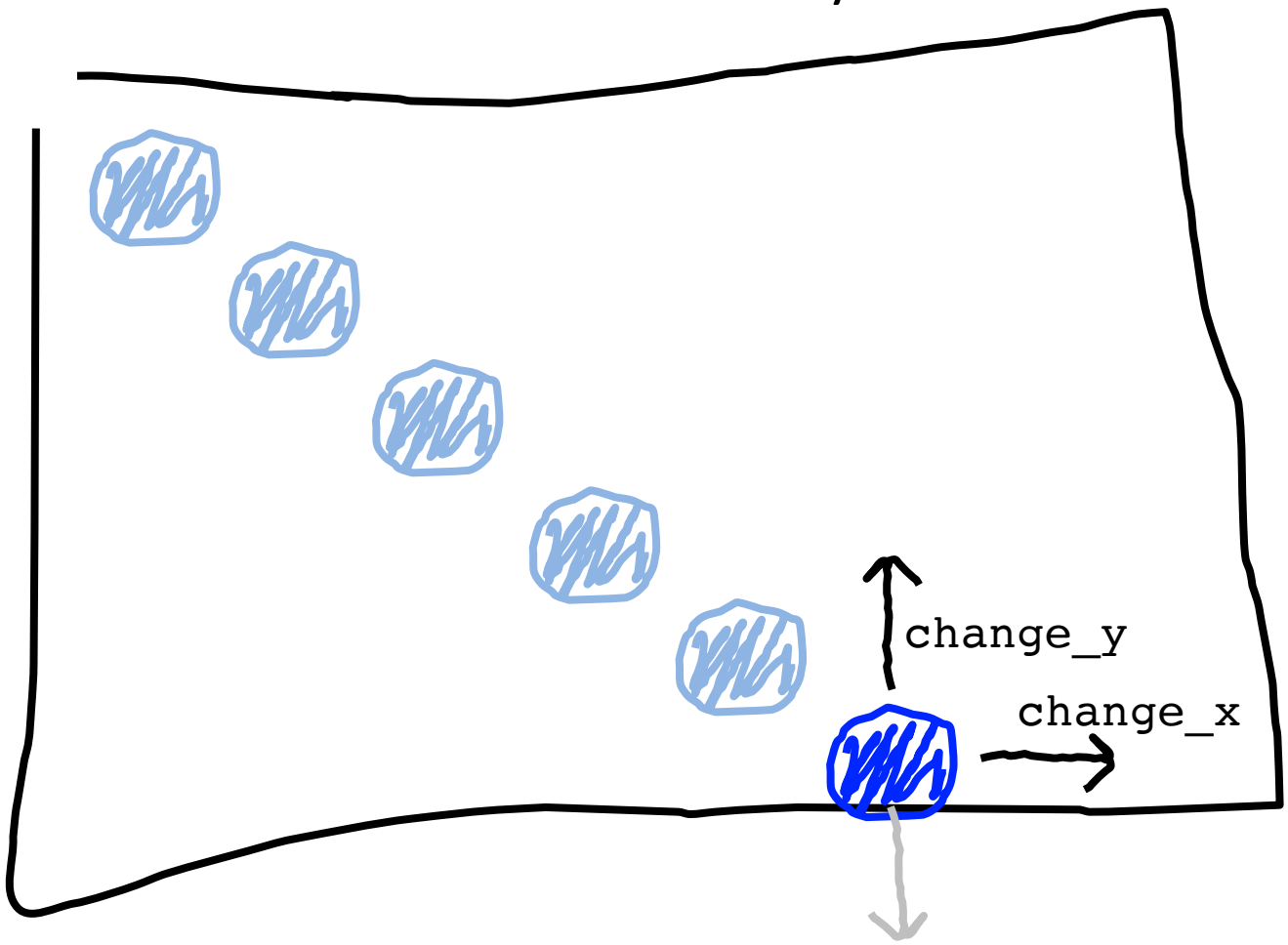
Bouncing Ball

We have this velocity

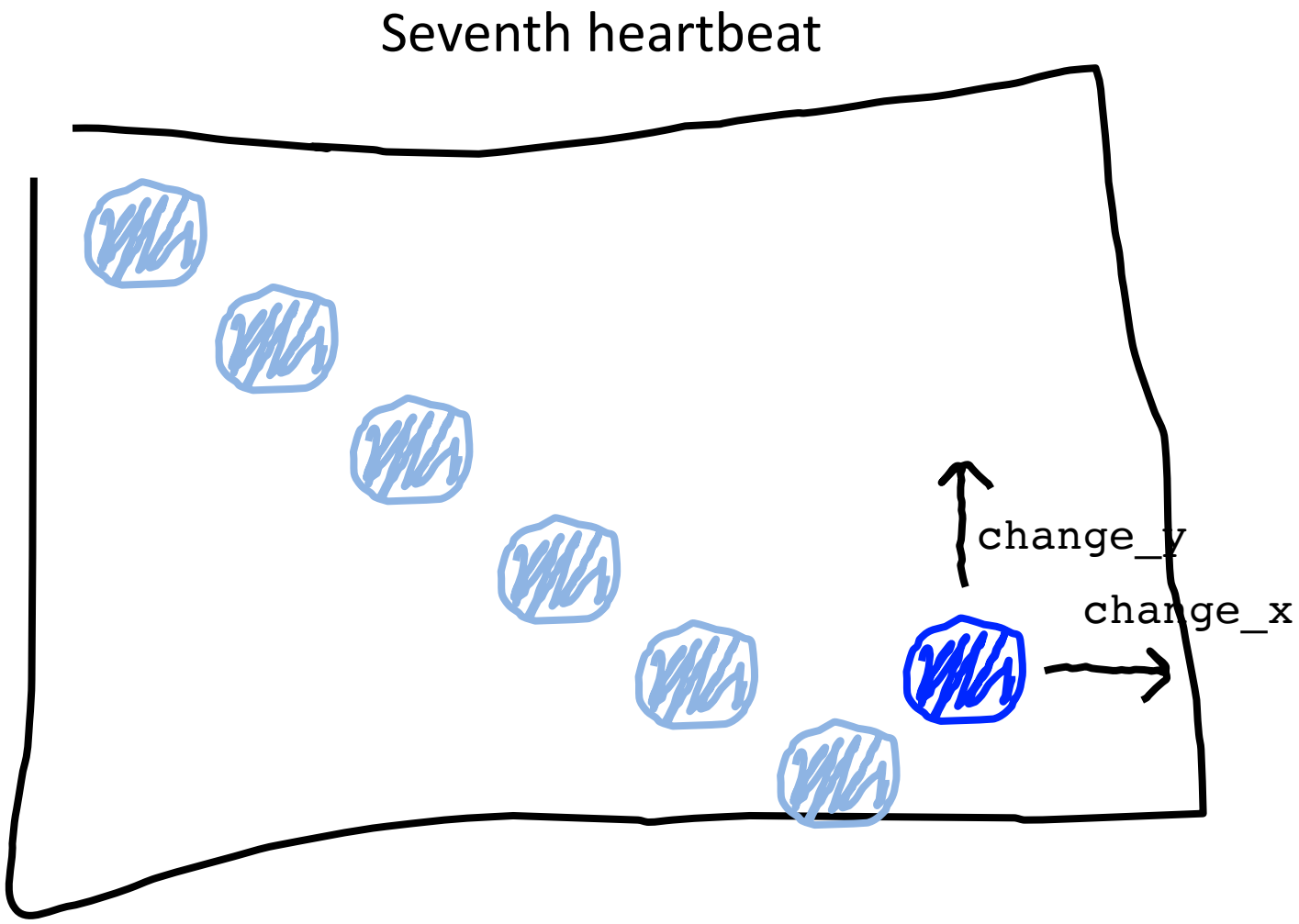


Bouncing Ball

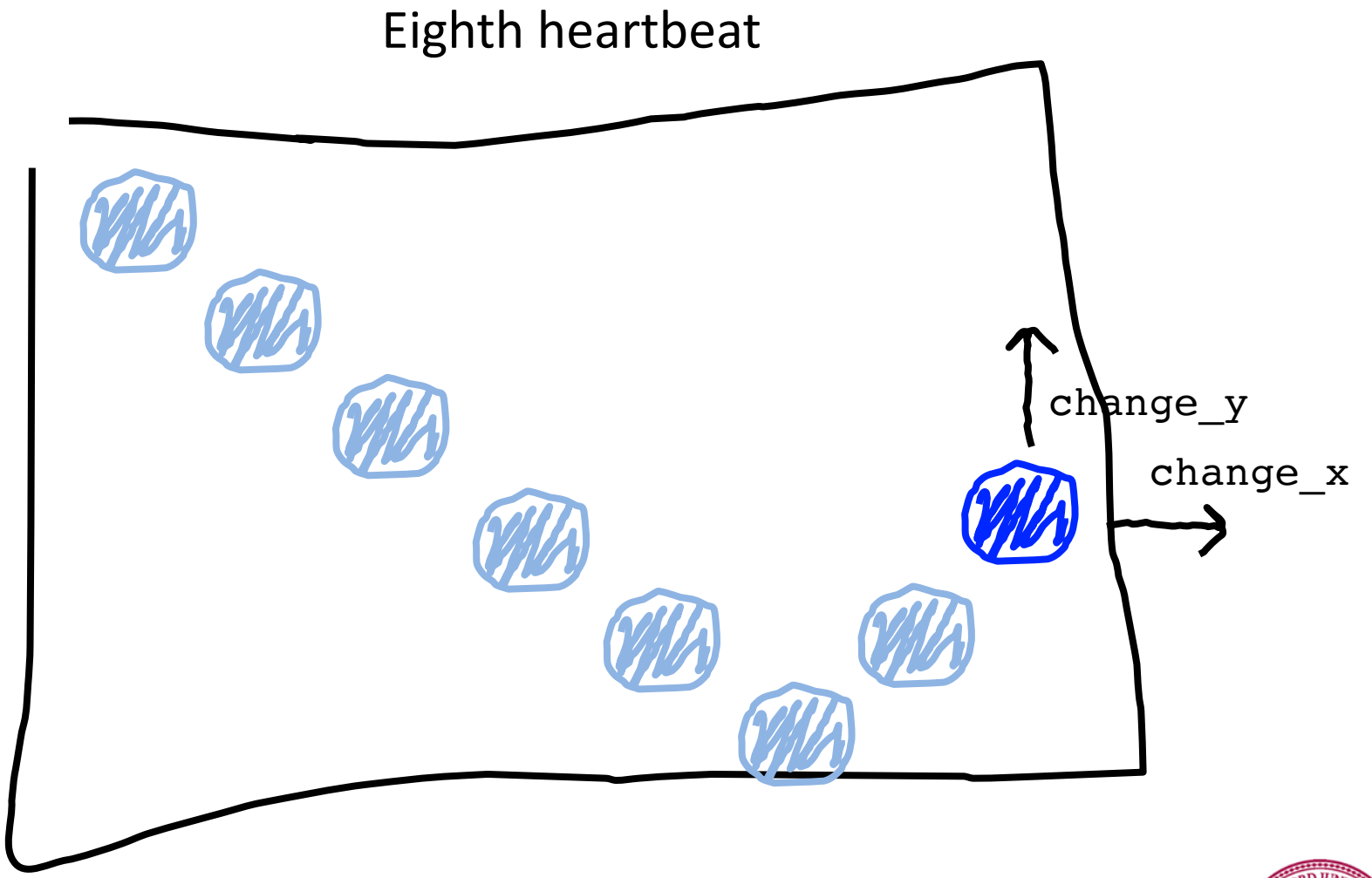
Our new velocity



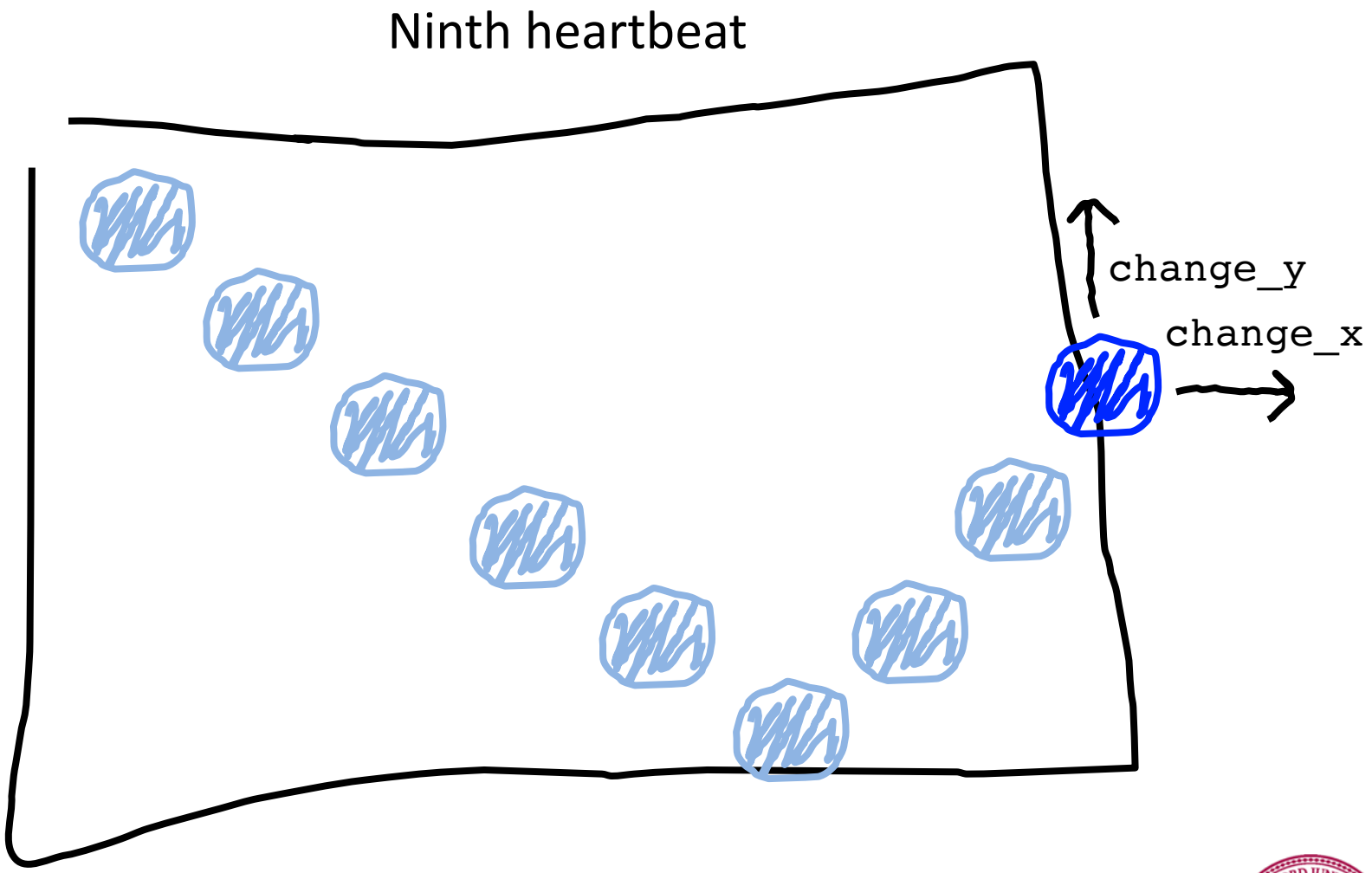
Bouncing Ball



Bouncing Ball

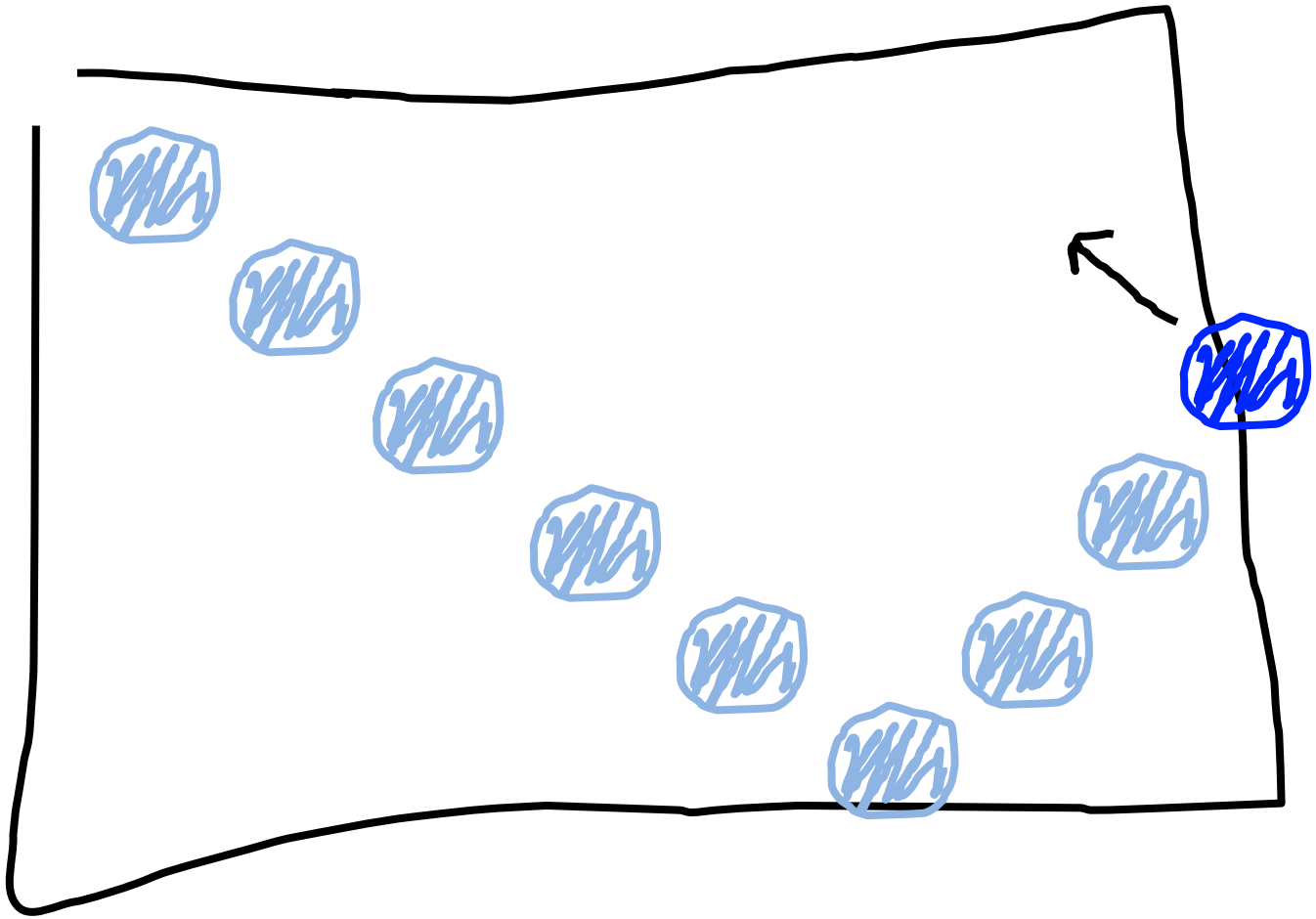


Bouncing Ball

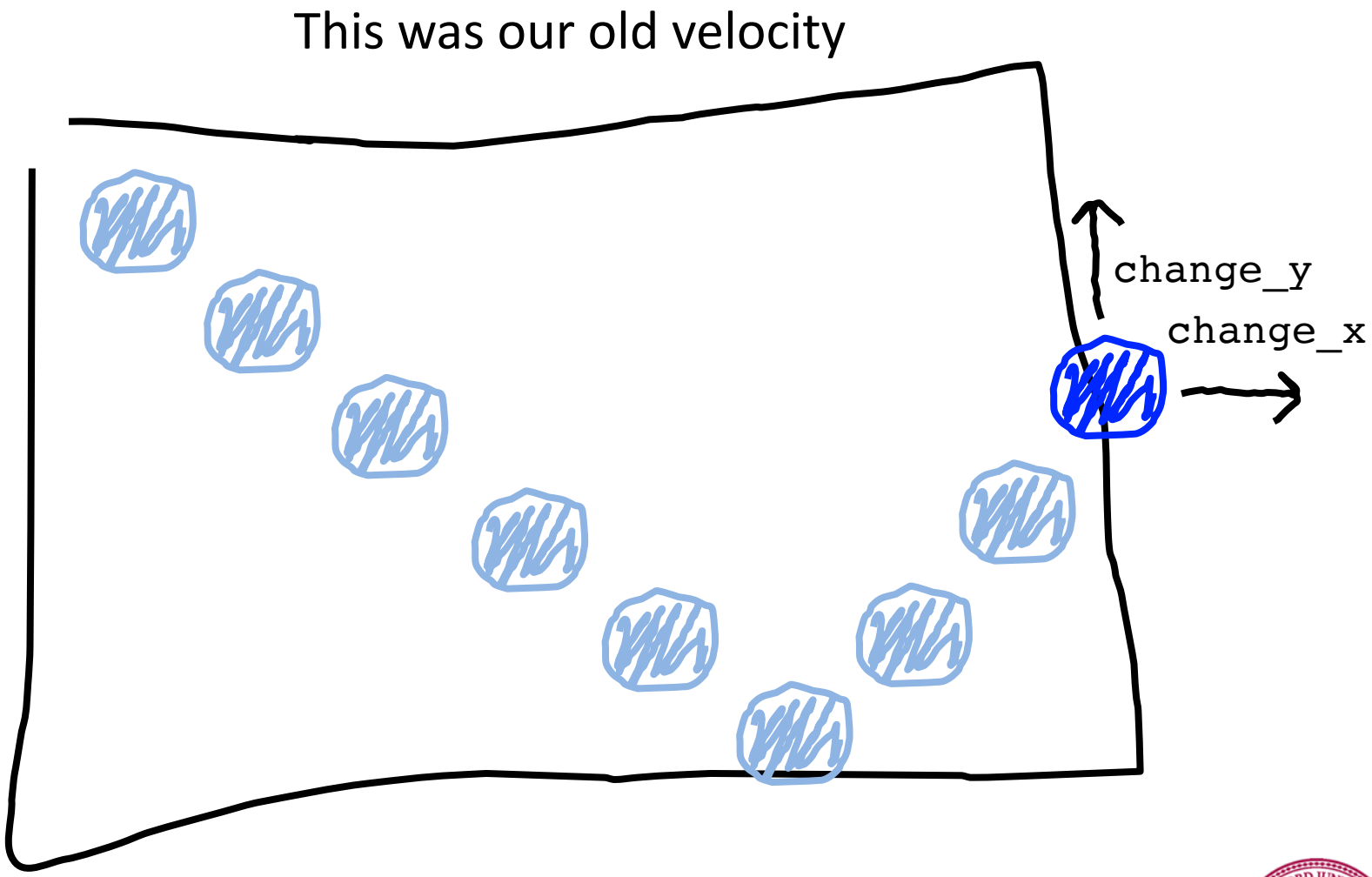


Bouncing Ball

We want this!

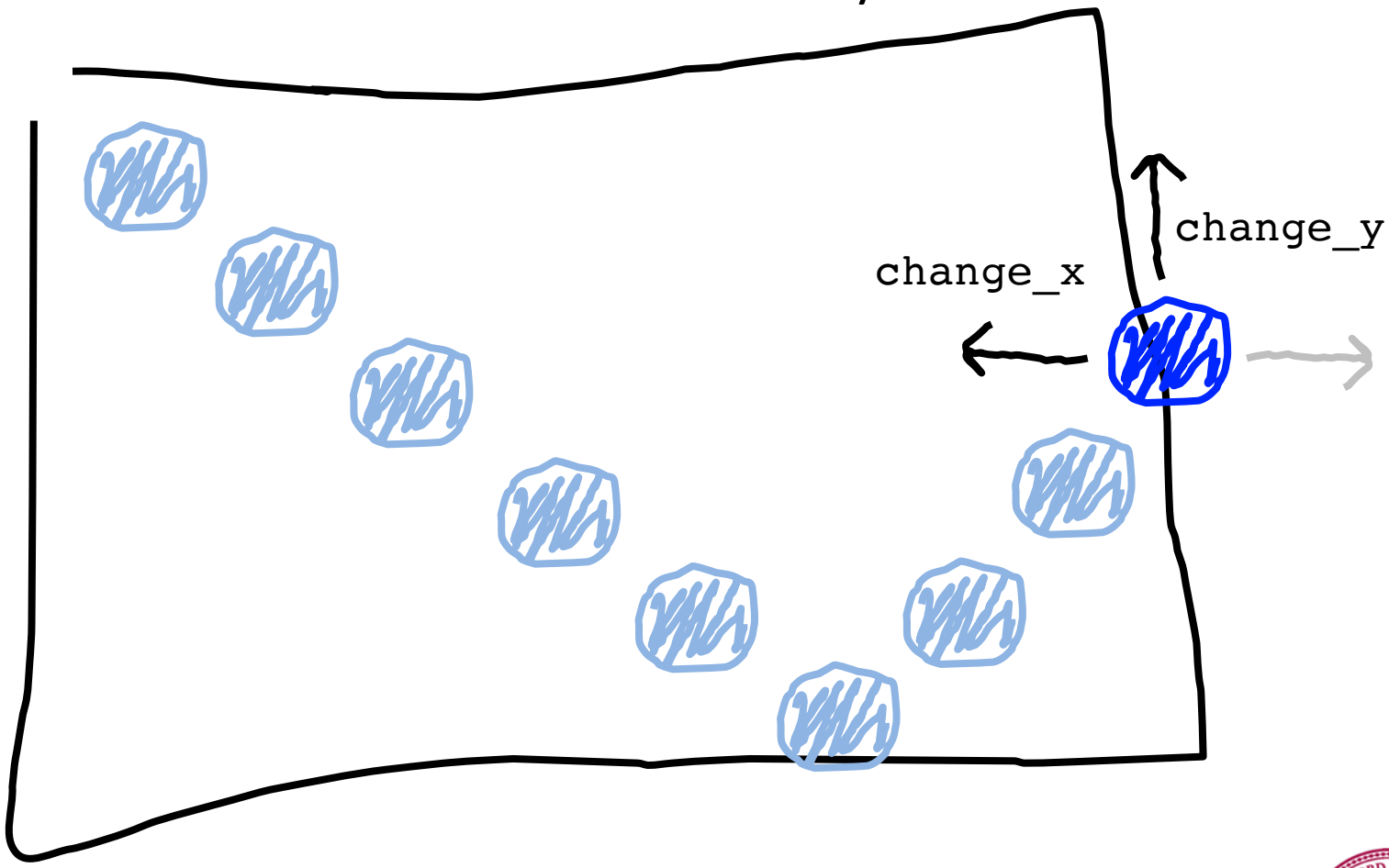


Bouncing Ball



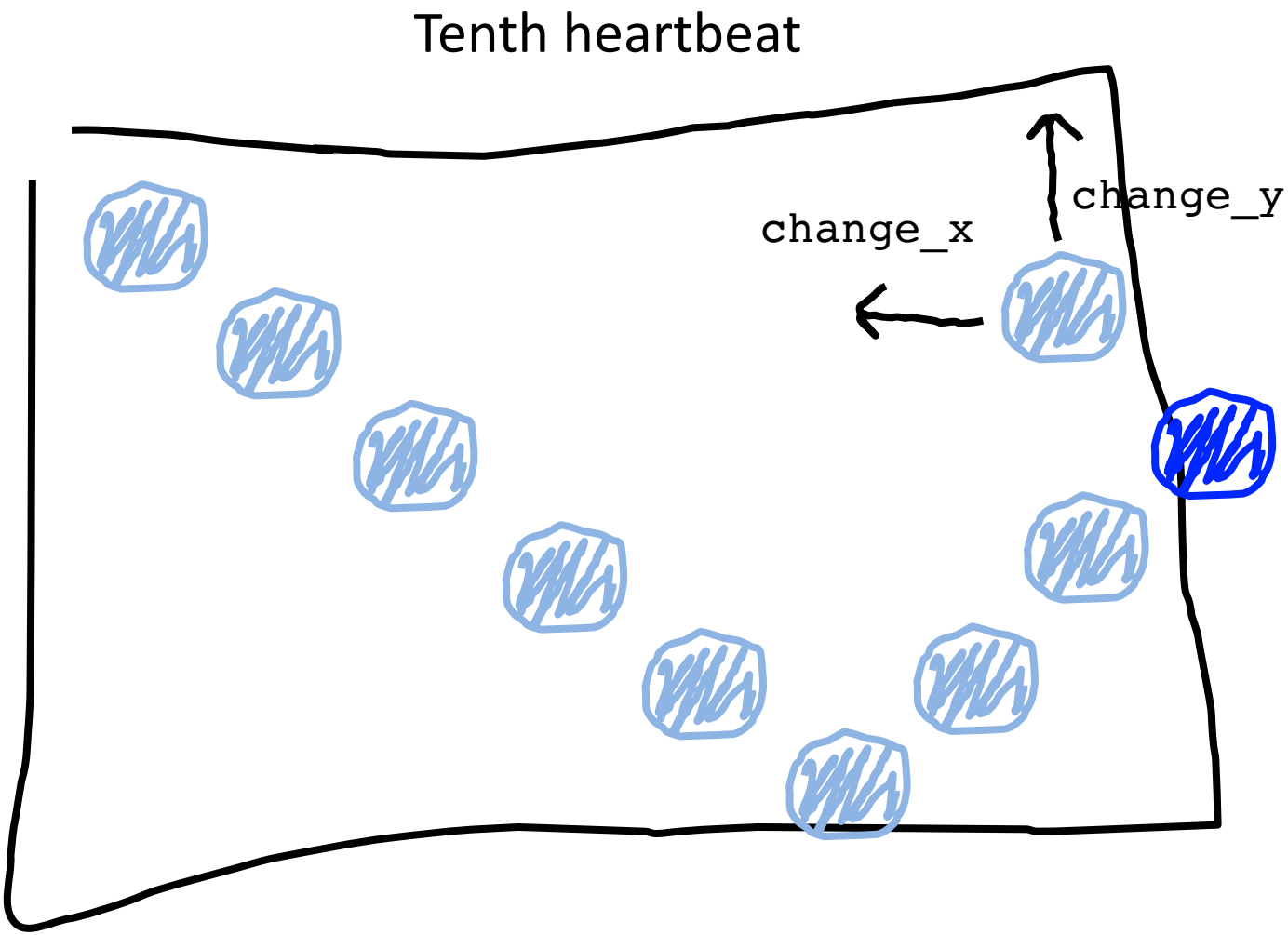
Bouncing Ball

This is our new velocity



When reflecting horizontally: `change_x = -change_x`

Bouncing Ball



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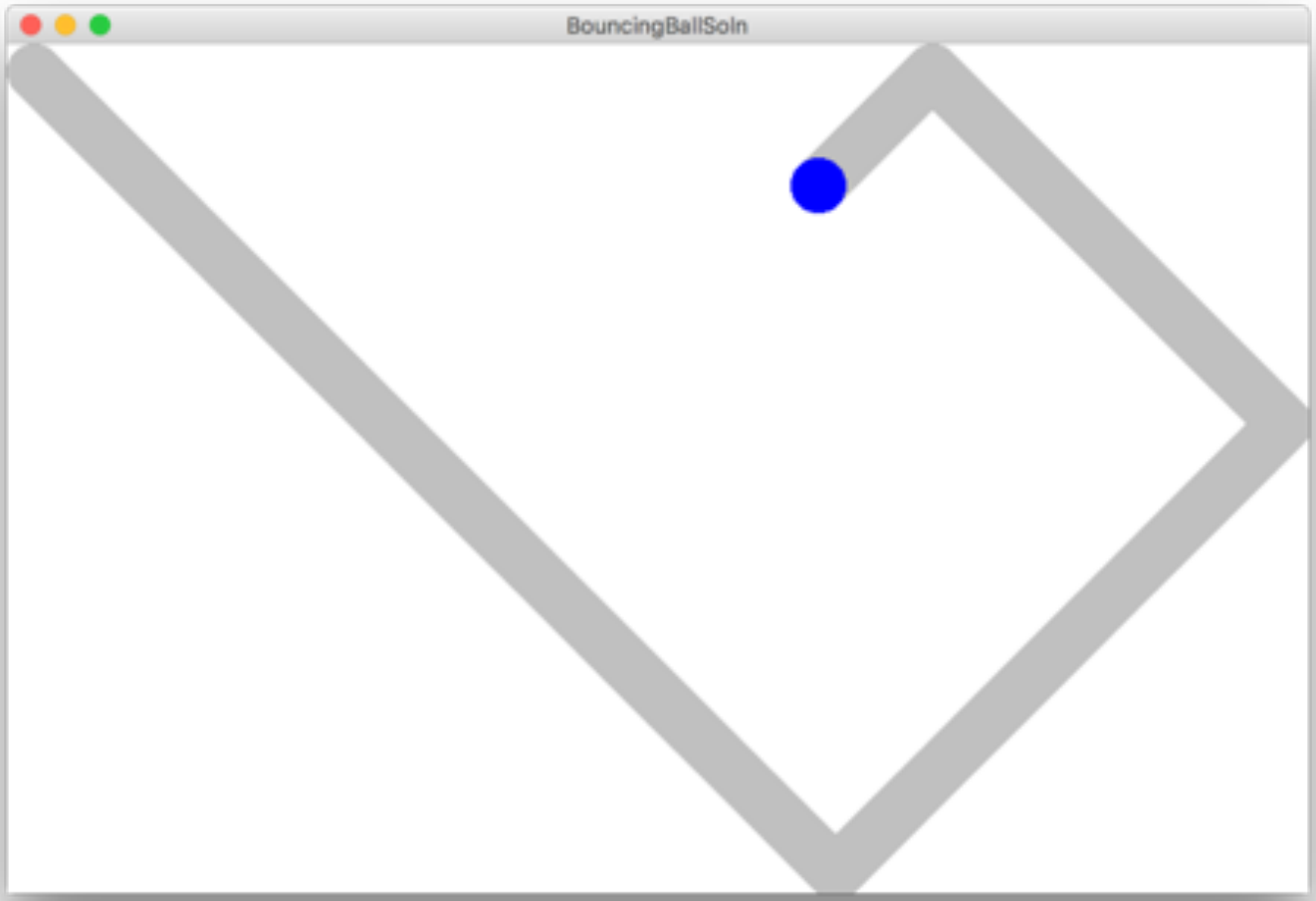


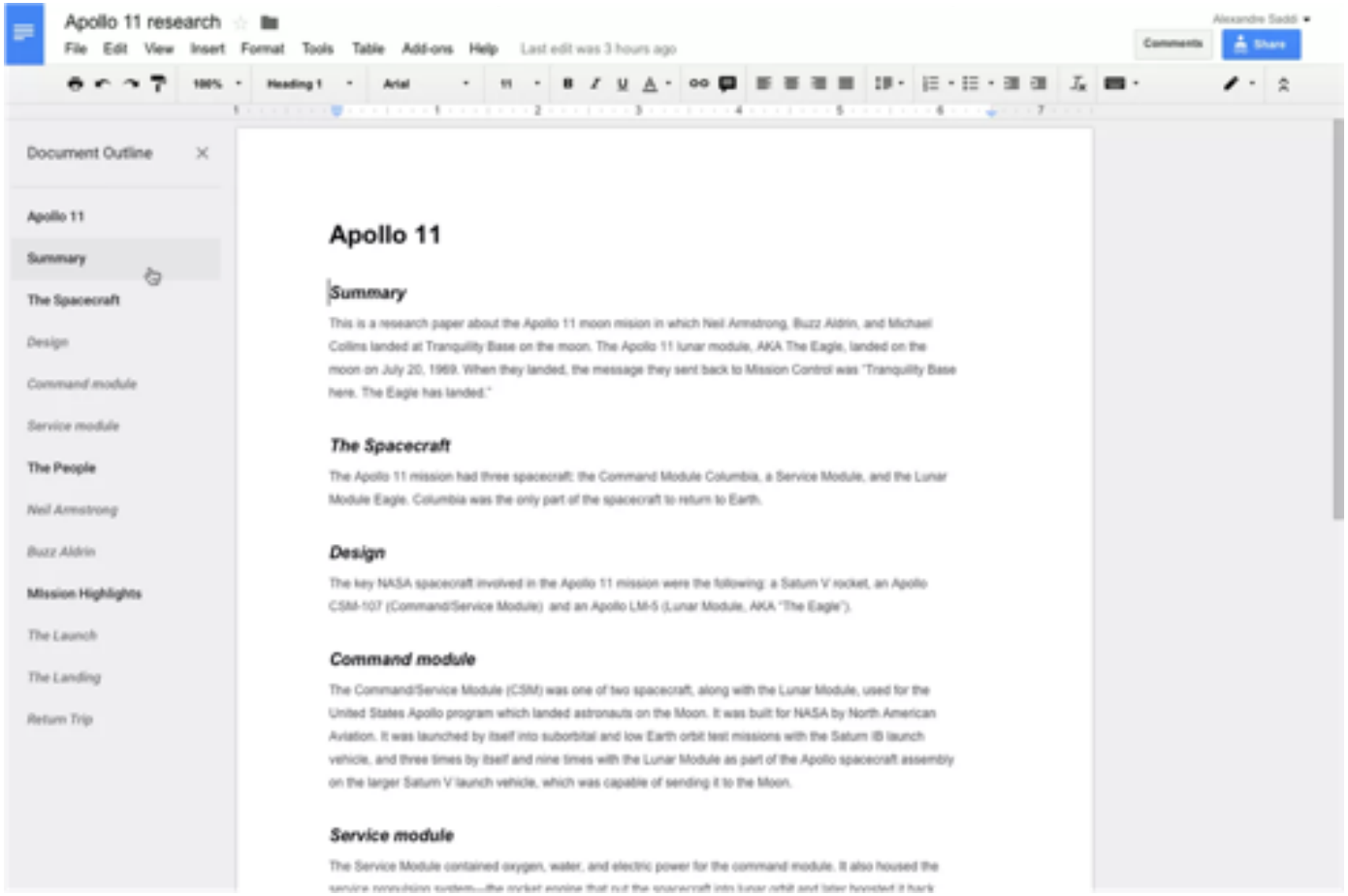
Hold up!

```
def make_ball(canvas):
```

If you get a copy when you pass a parameter. Does this copy the canvas??!!

*Python variables are stored using a reference. Which is like a **URL**. The URL gets copied when you pass the variable*

How do you share google docs?



https://docs.google.com/document/d/1eBtnEiII3KHefFS-kSAOpXqeSXpbfTTMlmOgj6I9dvk/

```
def main():
    canvas = Canvas(…)
    make_ball(canvas)

def make_ball(canvas):
    canvas.create_rectangle( … , fill='blue')
```

---

stack

heap

main

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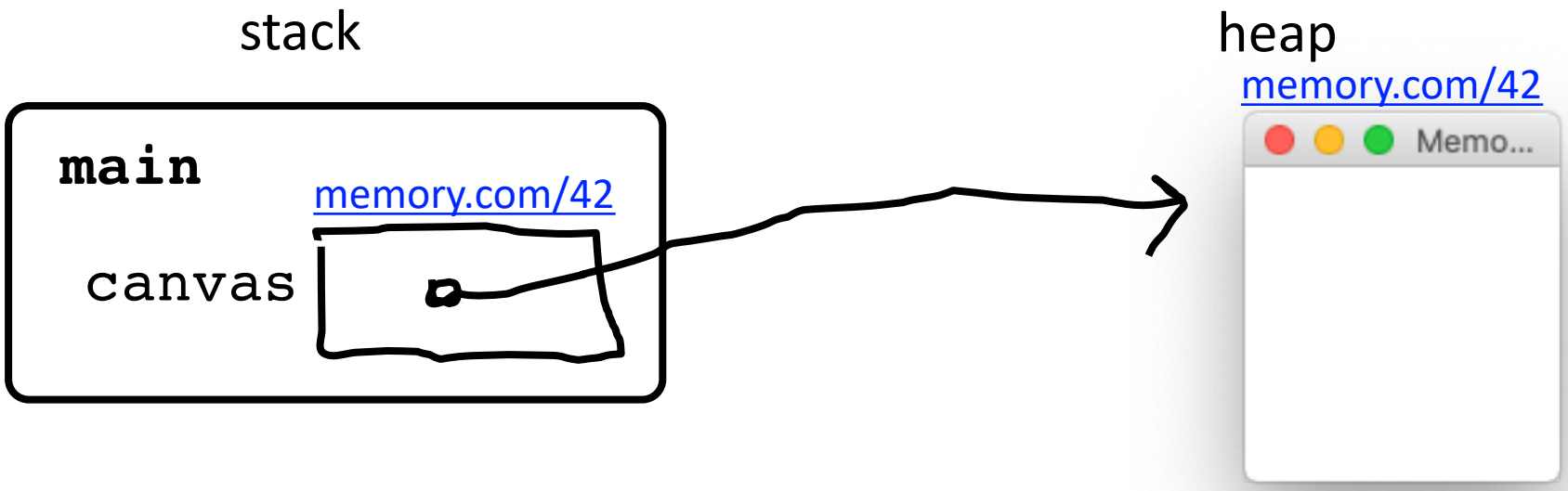

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def main():
    canvas = Canvas(…)
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def make_ball(canvas):
    canvas.create_oval( … , fill='blue')
```

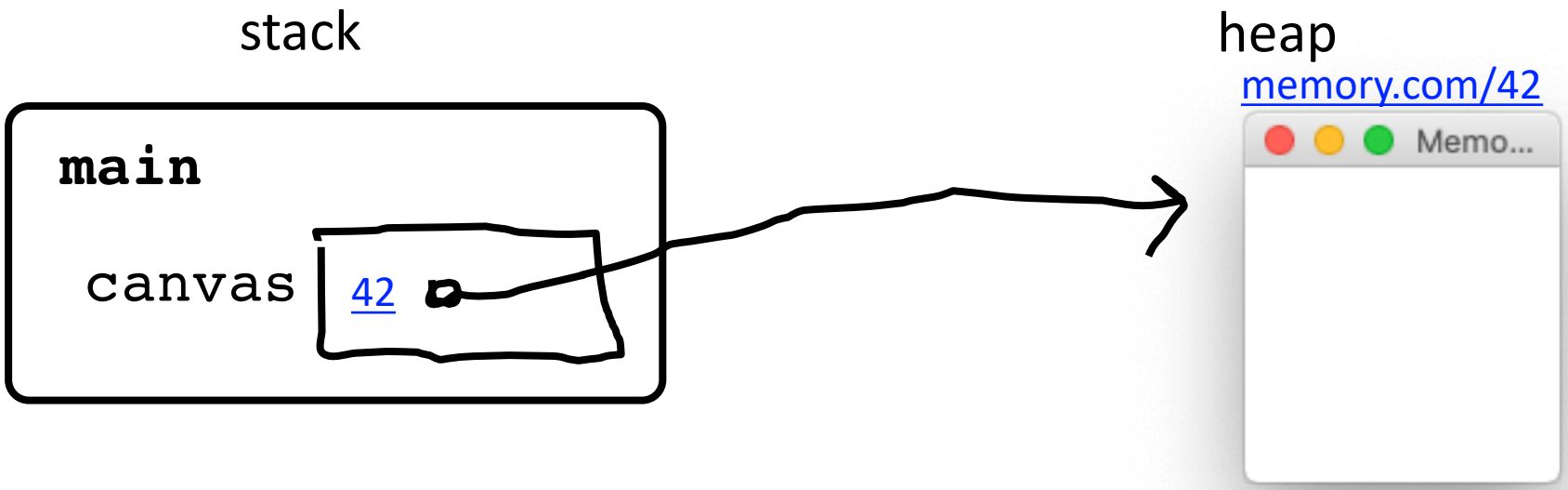

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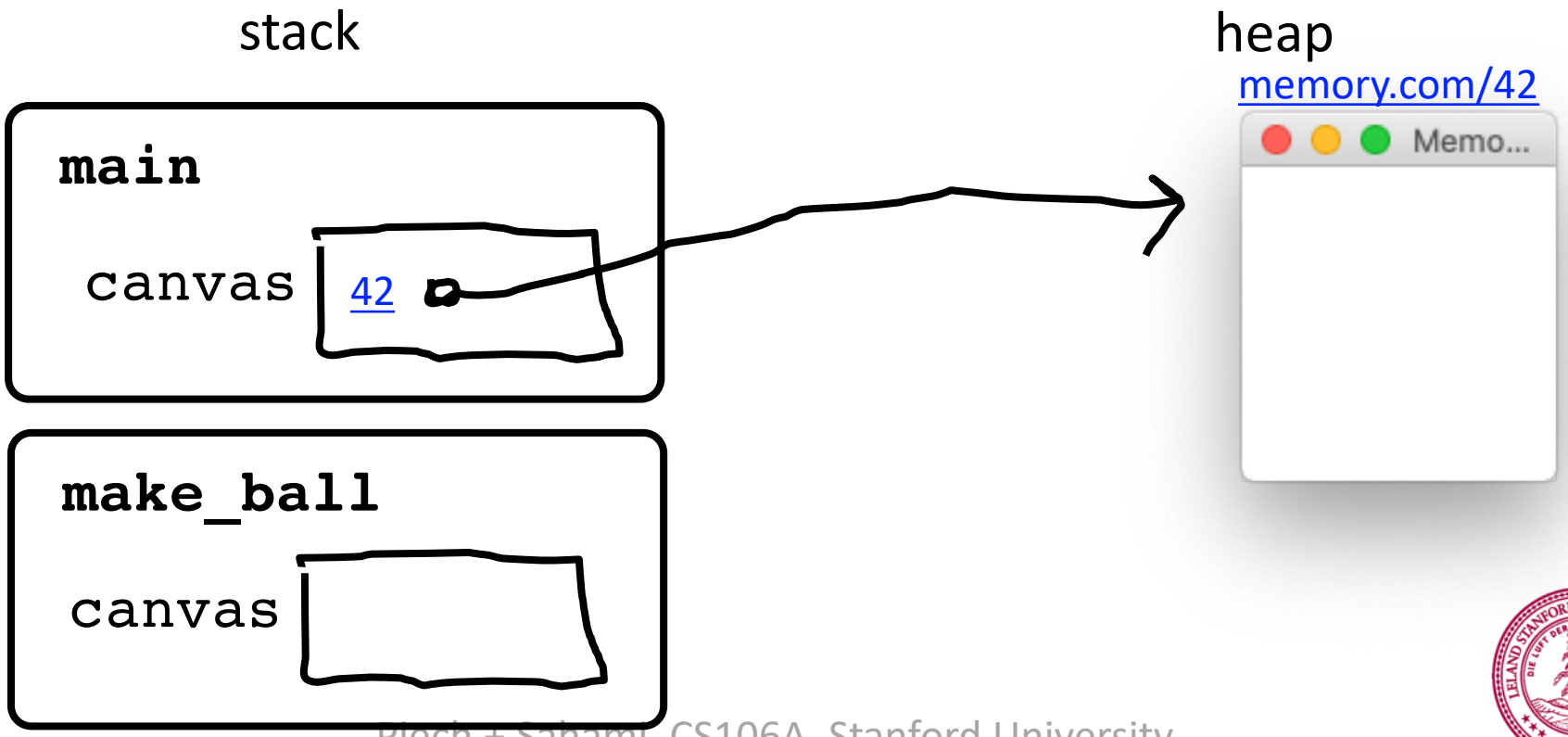

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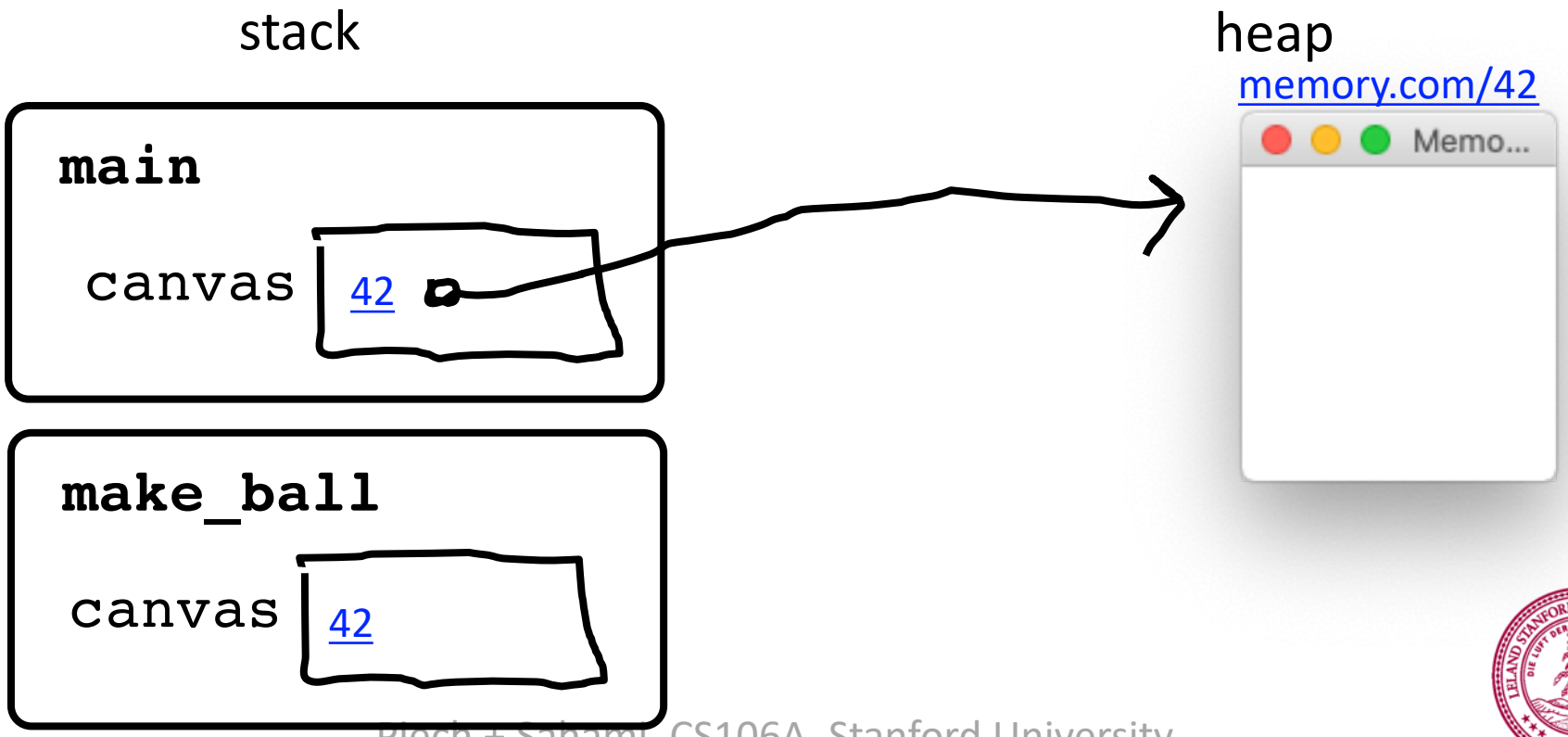

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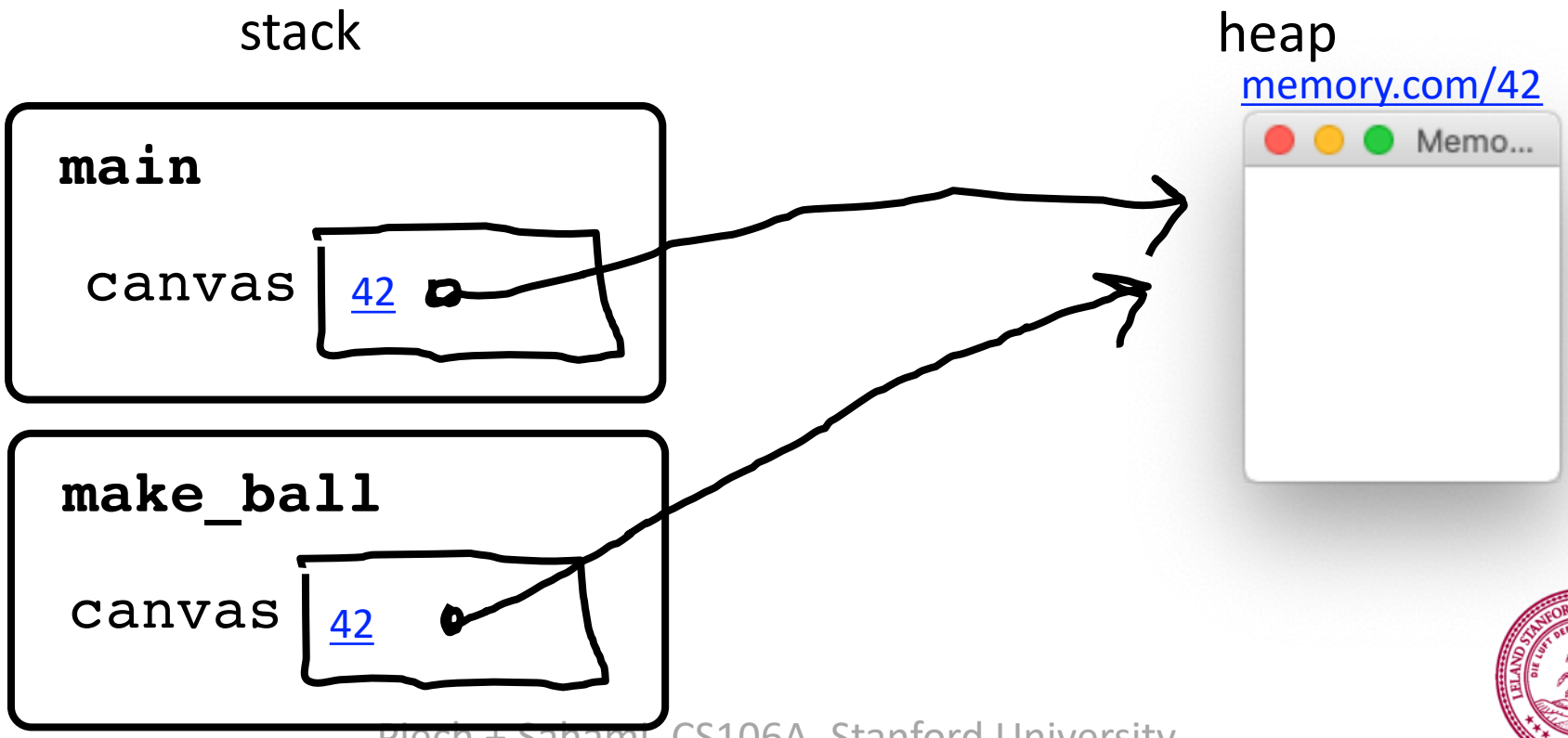

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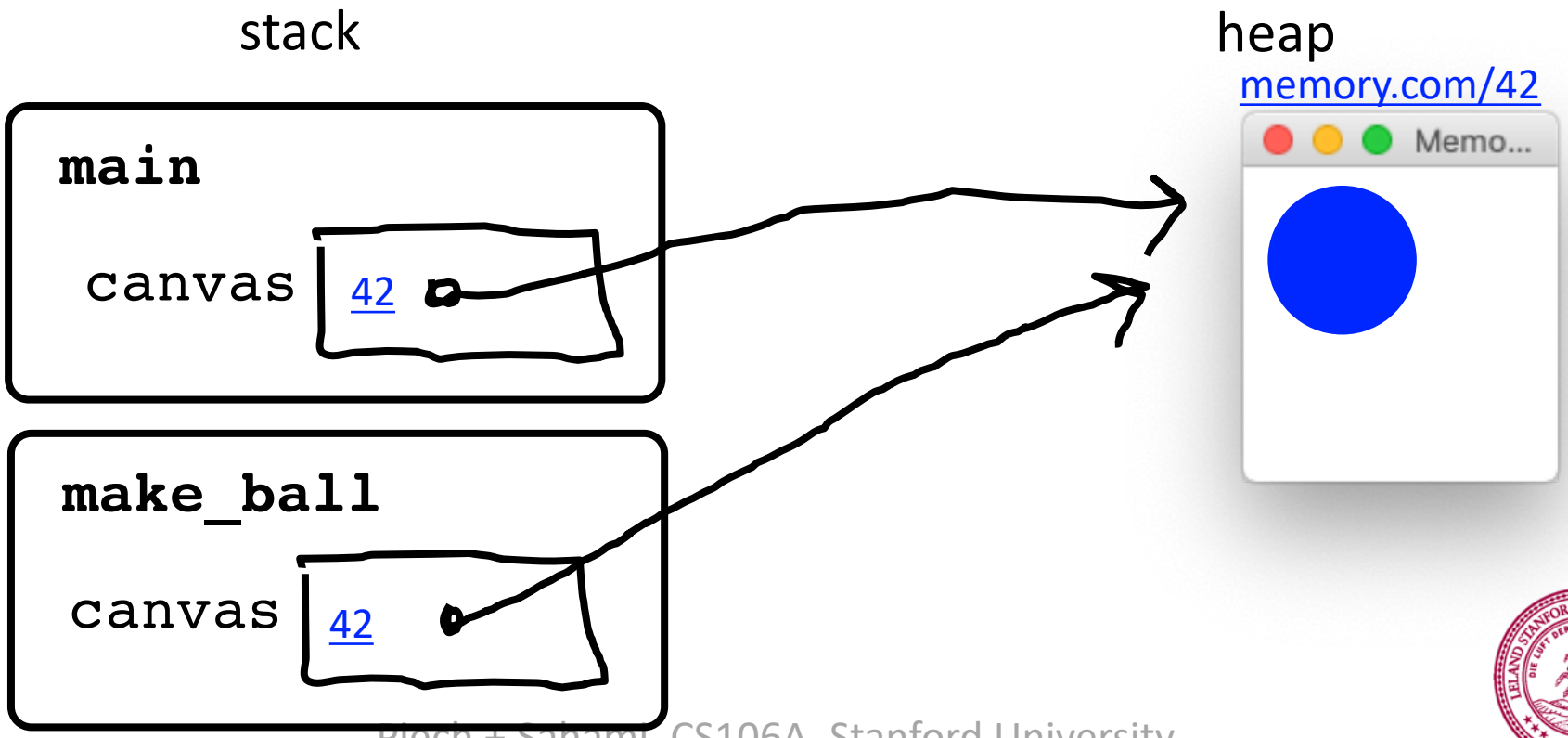

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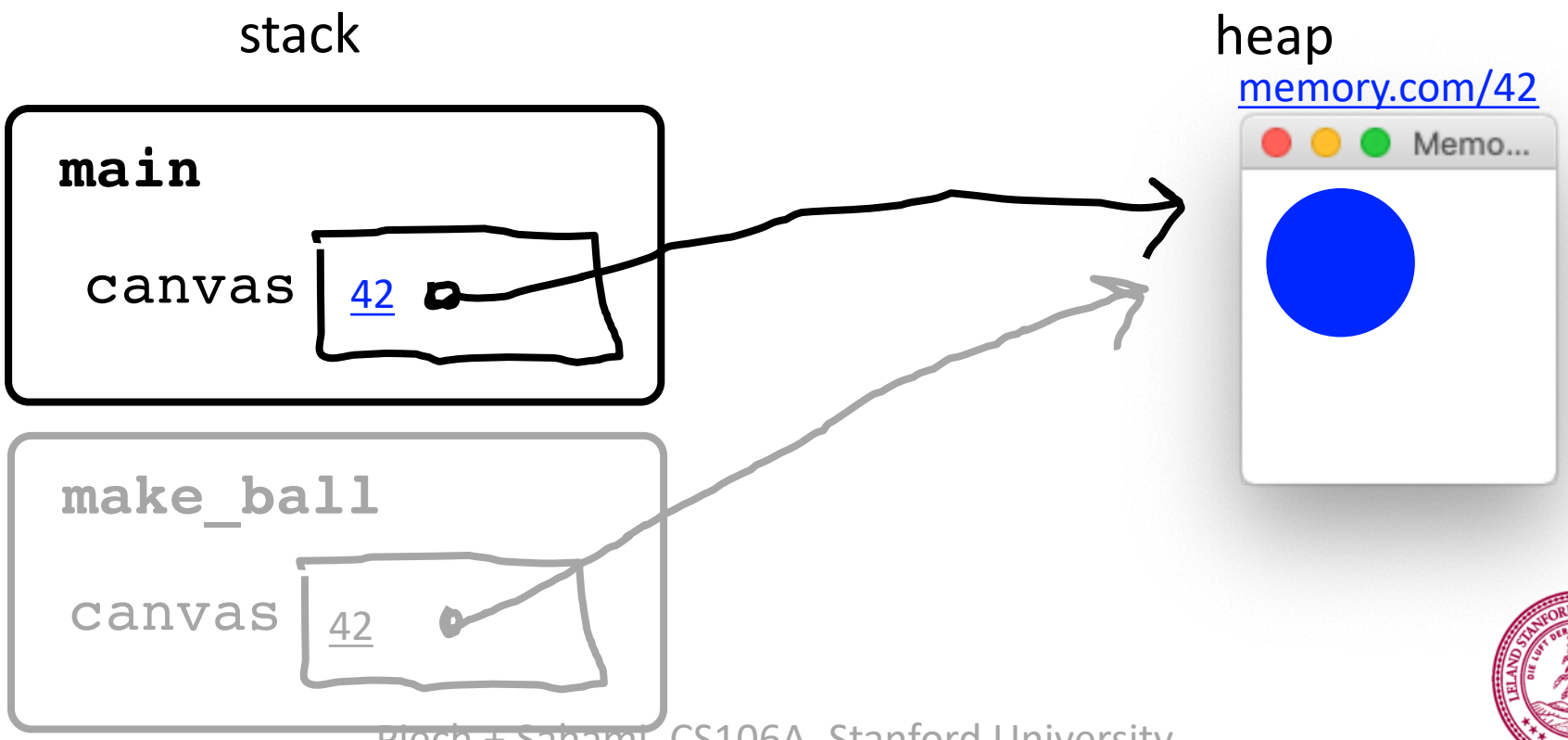

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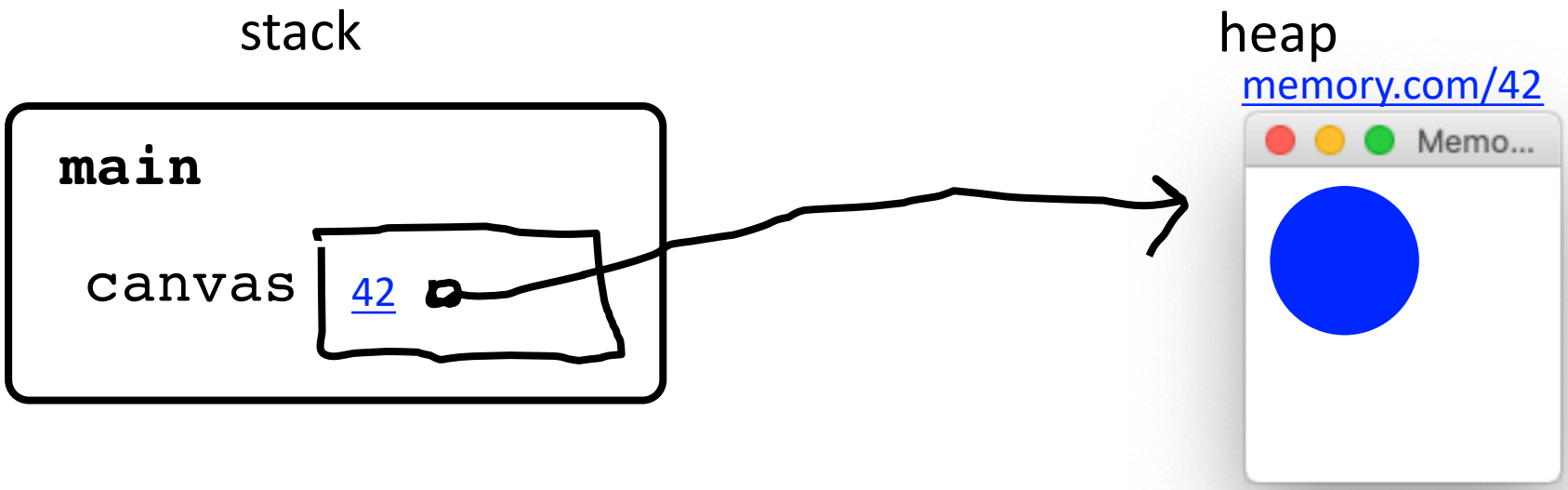
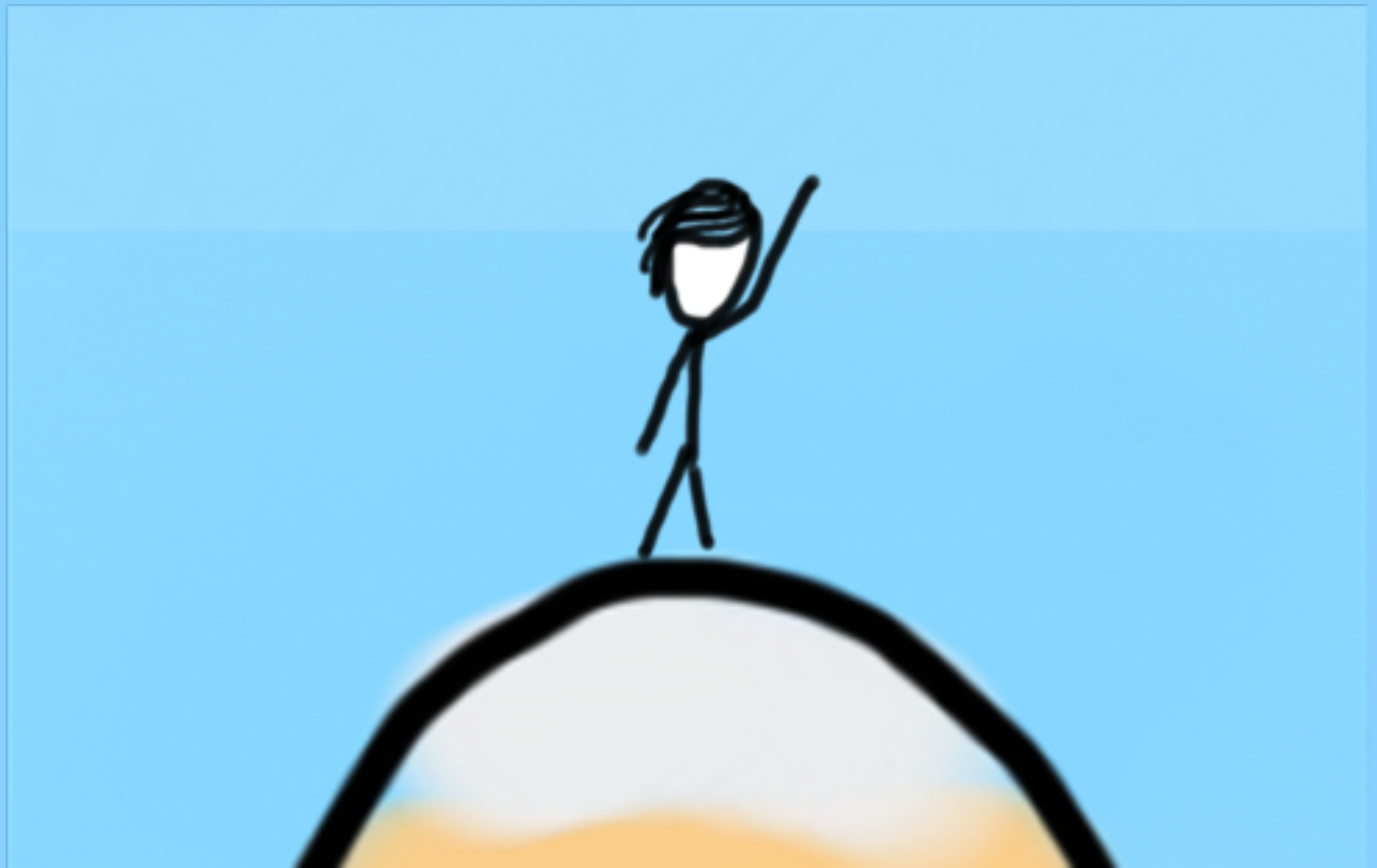


When passing variables, some act just like you are passing a URL.

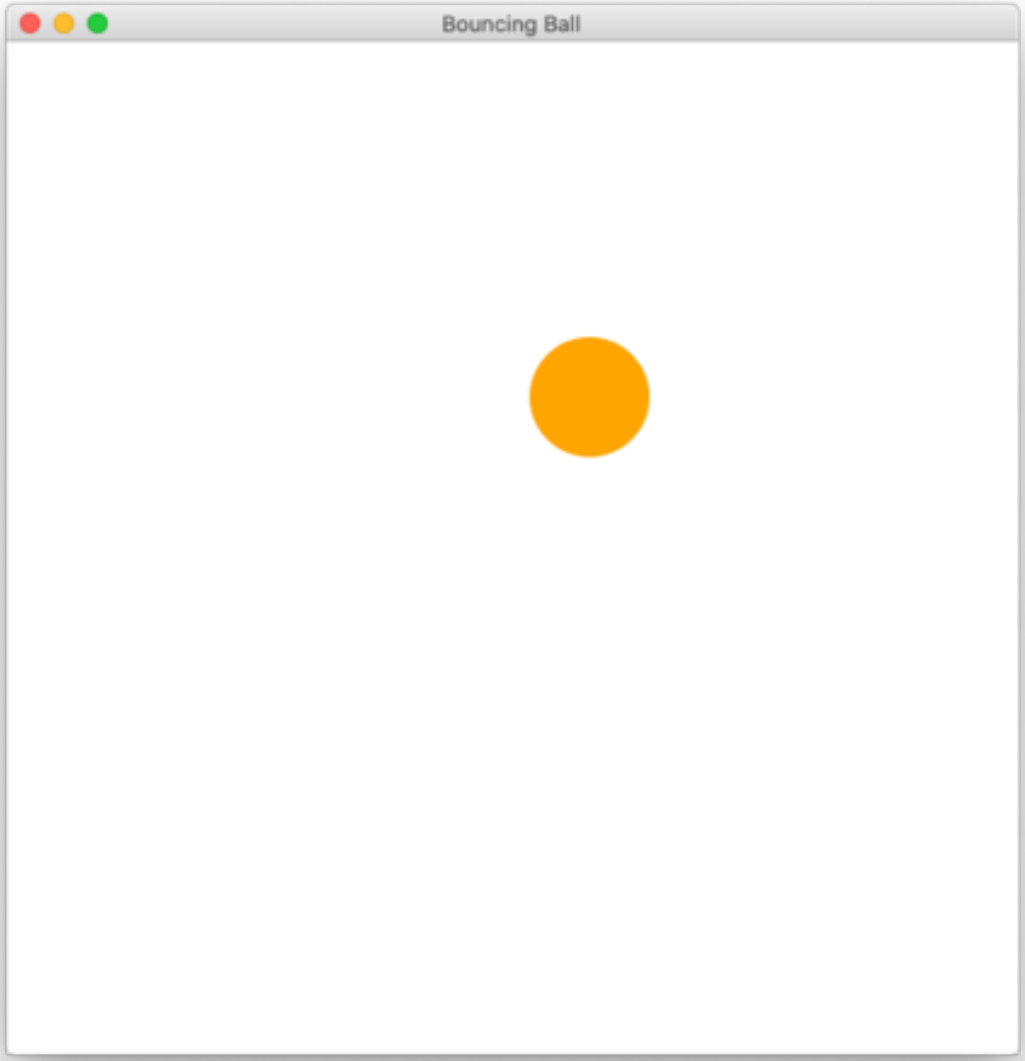
That allows functions to modify the variable

Learning Goals

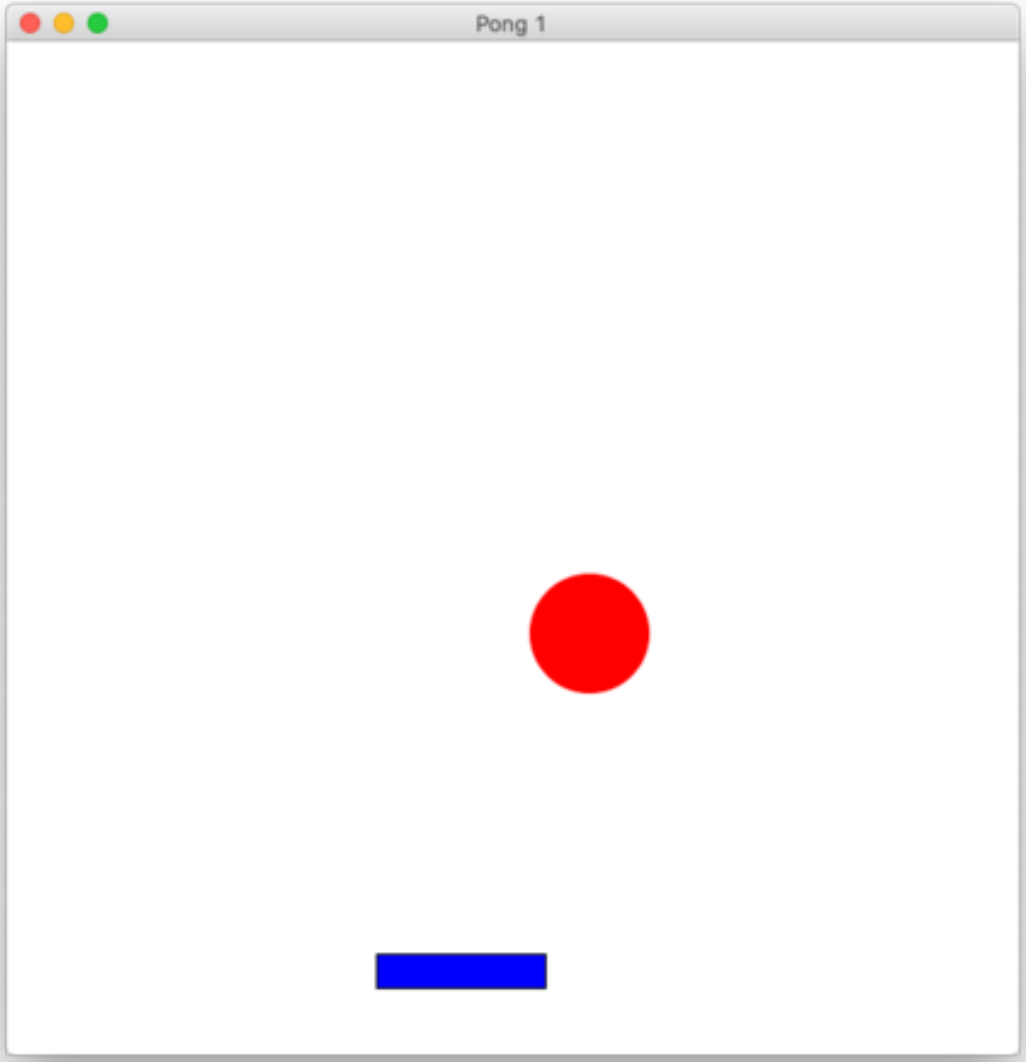
1. Write animated programs



ball_colors.py

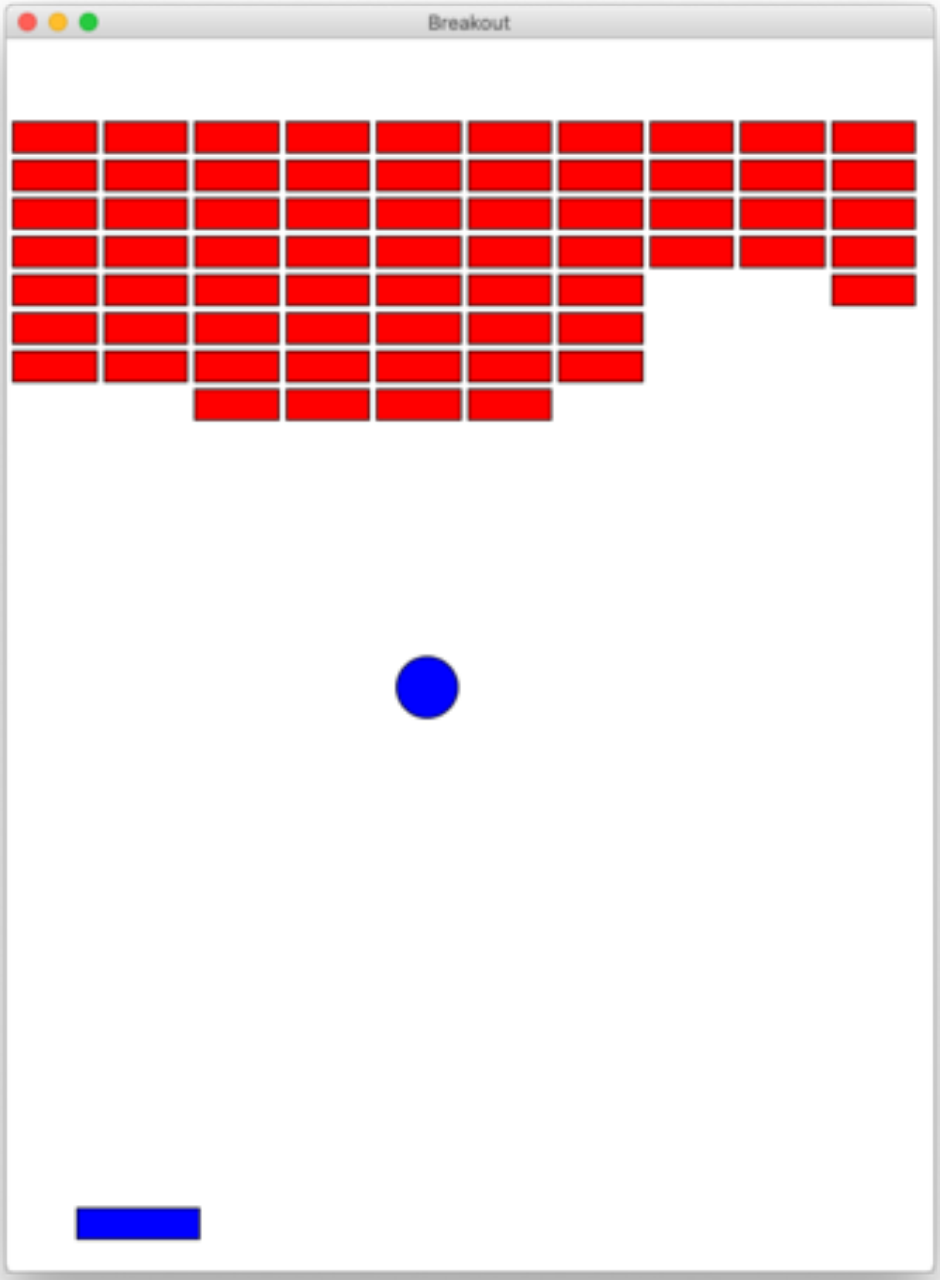


pong.py



Special Graphics Functions

```
# 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)

# you can change a shape's color too
canvas.set_fill_color(shape, new_color)
canvas.set_outline_color(shape, new_color)
```


Breakout