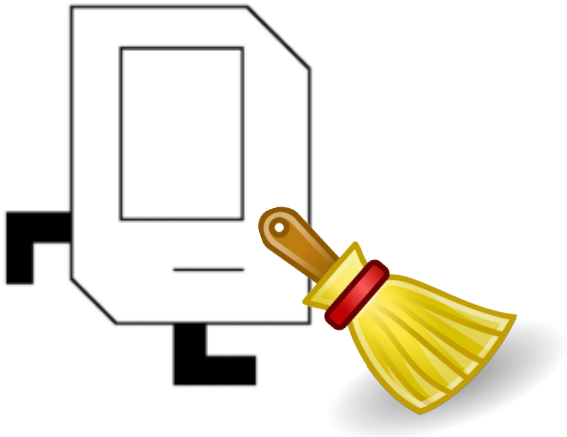
Animation

Chris Gregg
Based on slides by Chris Piech and Mehran Sahami
CS106A, Stanford University

Housekeeping

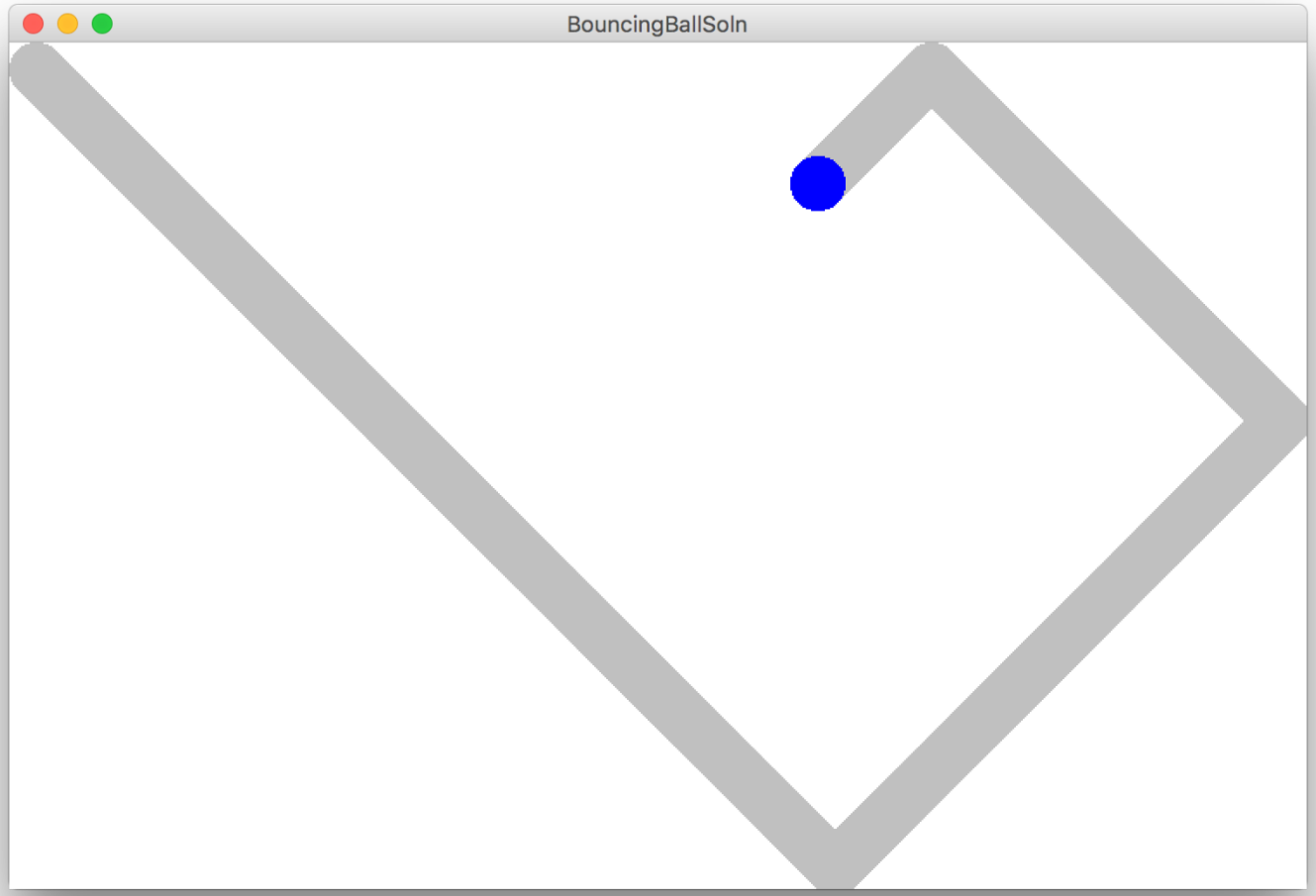


- Reminder: Diagnostic is on **Thursday, July 9th**
  - Takes place during class time
  - Download link for exam .json file (will be available July 9th at 10:30am, PDT):
  - https://web.stanford.edu/class/cs106a/cgi-bin/diagnostic-bluebook/get-password.html
  - Download the exam data and get started immediately
  - The exam will be a full hour long, and Bluebook forces you to submit after one hour

Learning Goals

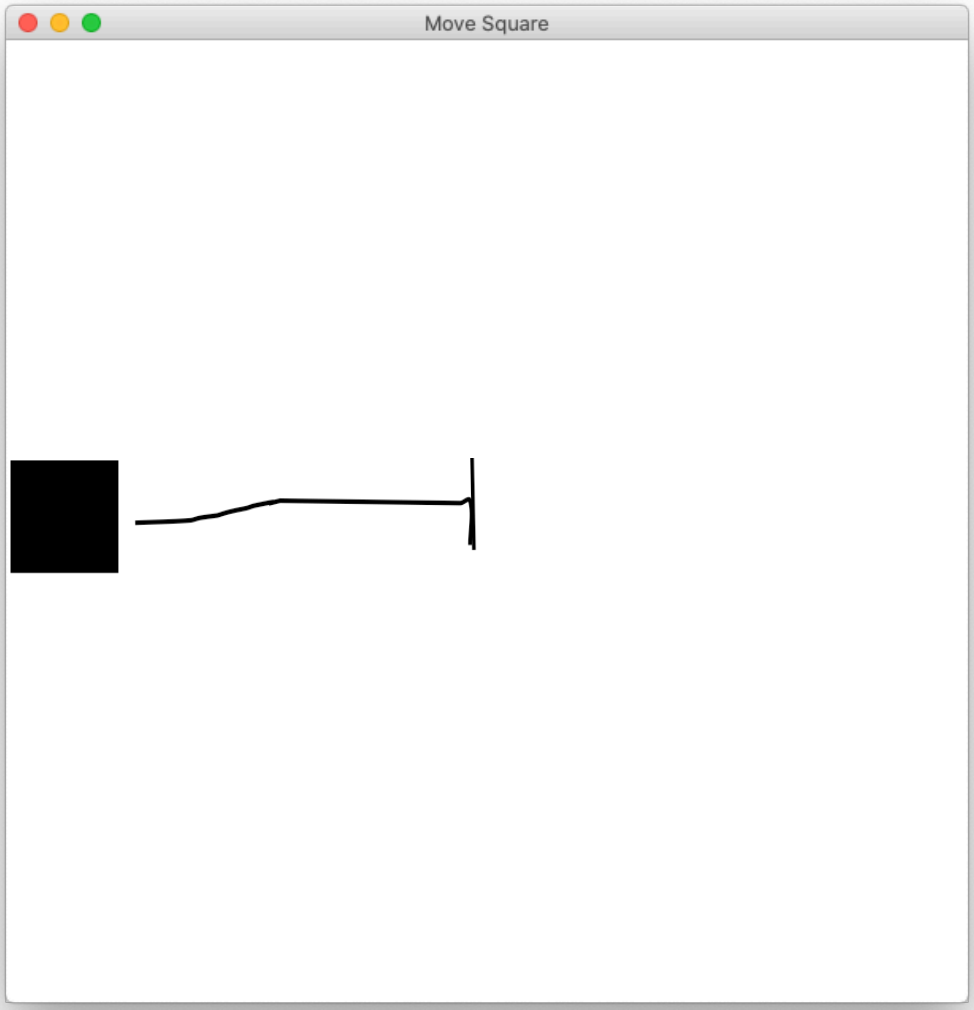
1. Feel more confident debugging
2. Write animated programs

You will be able to write Bouncing Ball



Great foundation

Move to Center



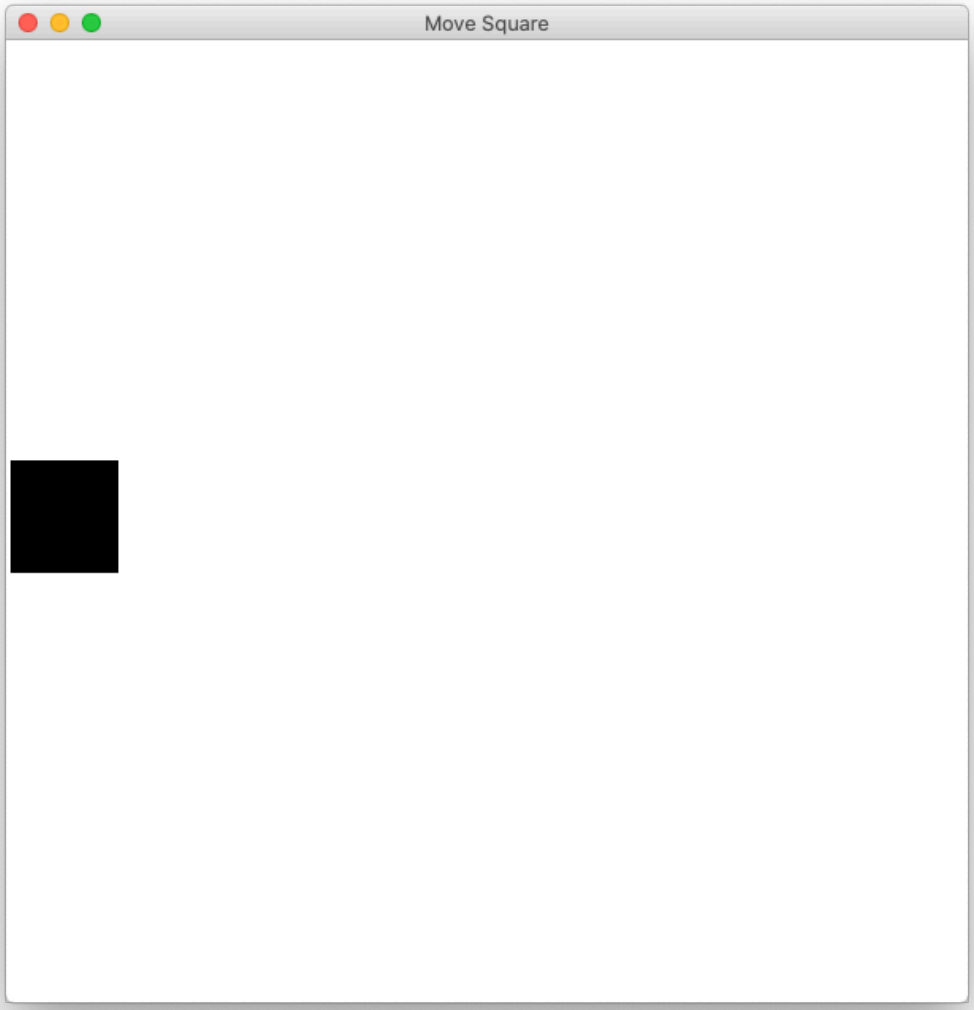
In our last episode...

Graphics from tkinter (aka tk)

```
import tkinter
```

```
# we write this for you, and include it
# in all of your projects!
def make_canvas(width, height, title):
```

Add square


Move Square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DIE LUFT DER FREIHEIT WEHT
1891

Graphics from tkinter (aka tk)

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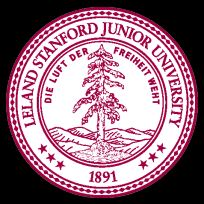
    start_y = CANVAS_HEIGHT / 2 - SQUARE_SIZE / 2
    end_y = start_y + SQUARE_SIZE
    rect = canvas.create_rectangle(0, start_y, SQUARE_SIZE, end_y, fill='black')
    canvas.mainloop()
```



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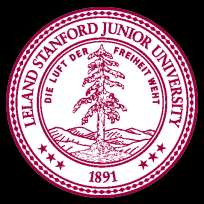

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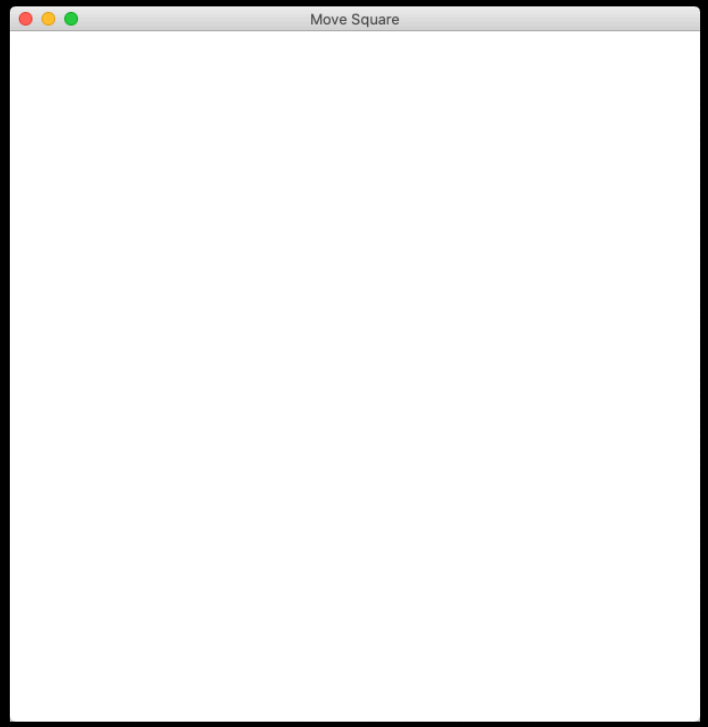

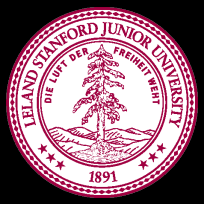

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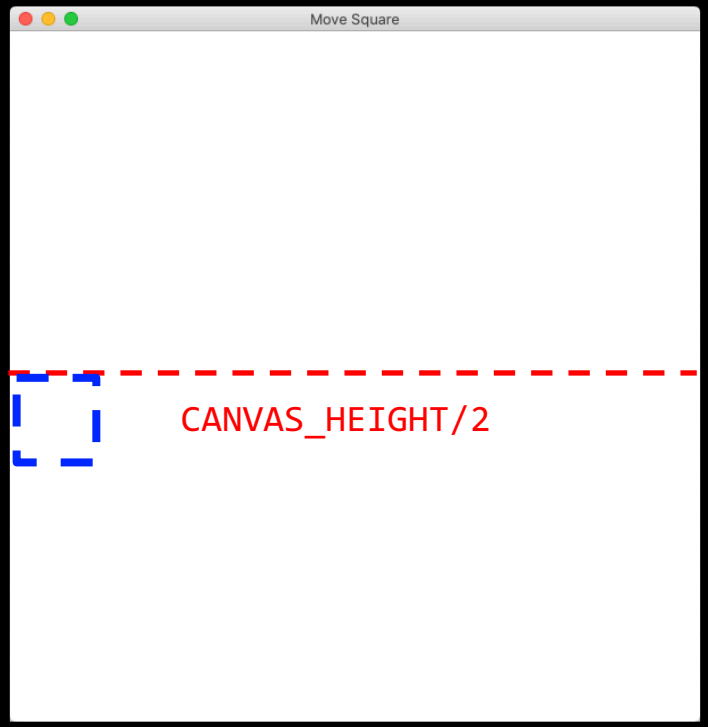

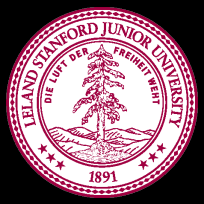

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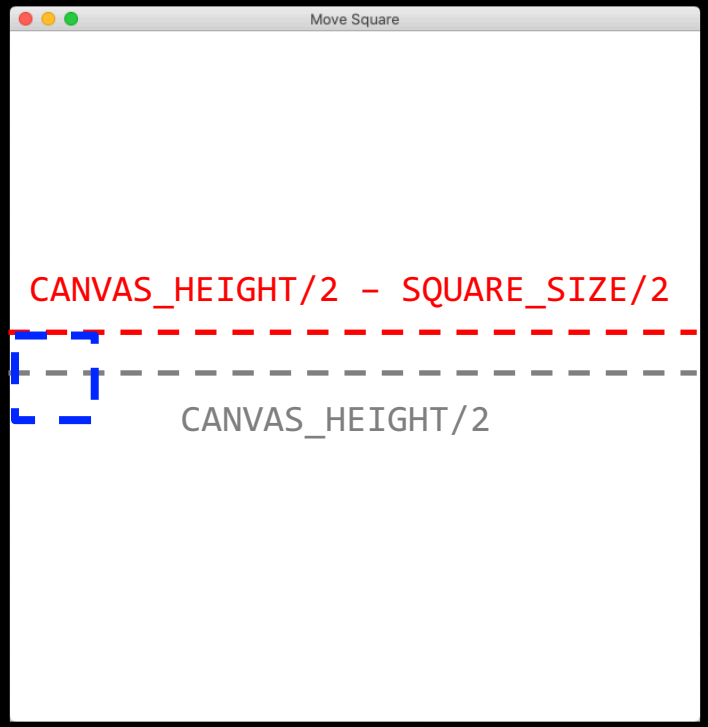

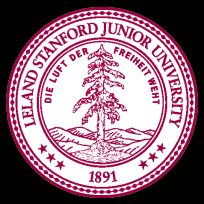

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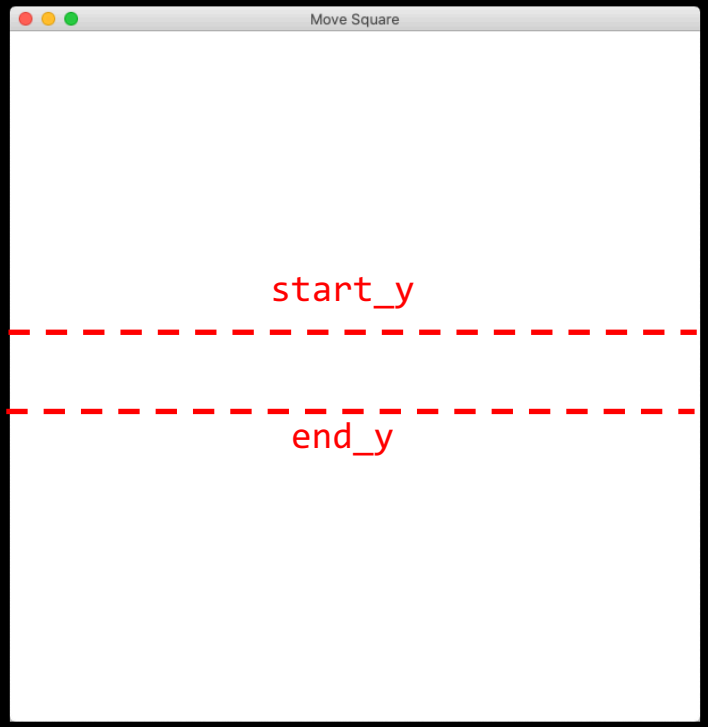

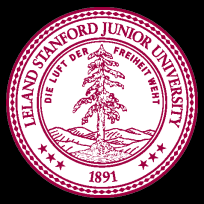

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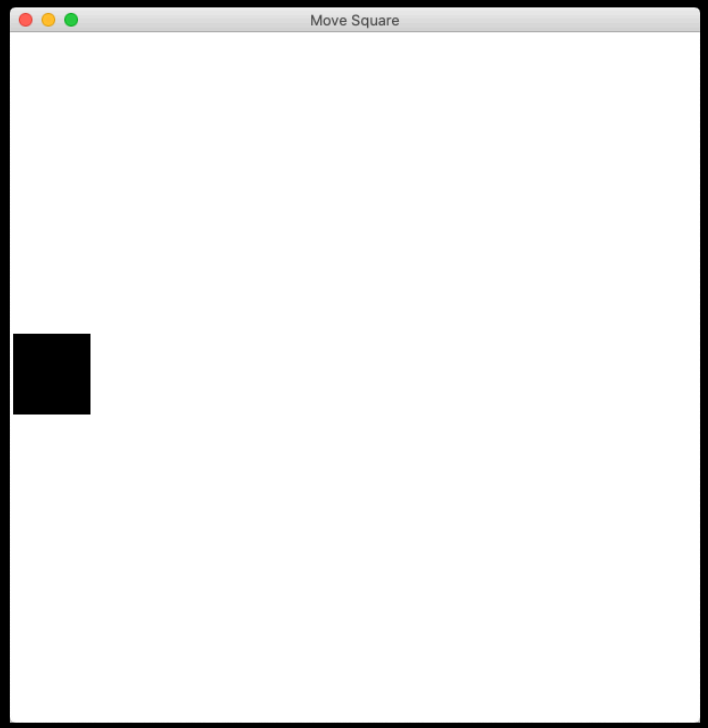

Some “heavy duty” variables allow you to call functions on them

```
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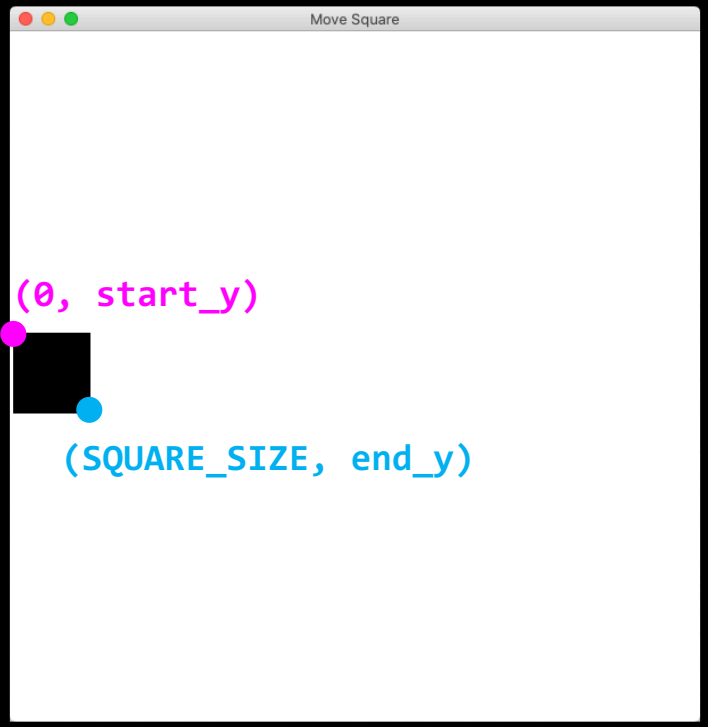
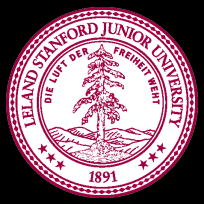
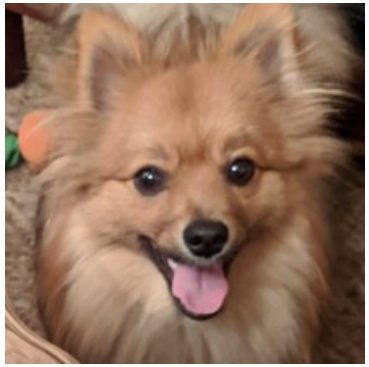




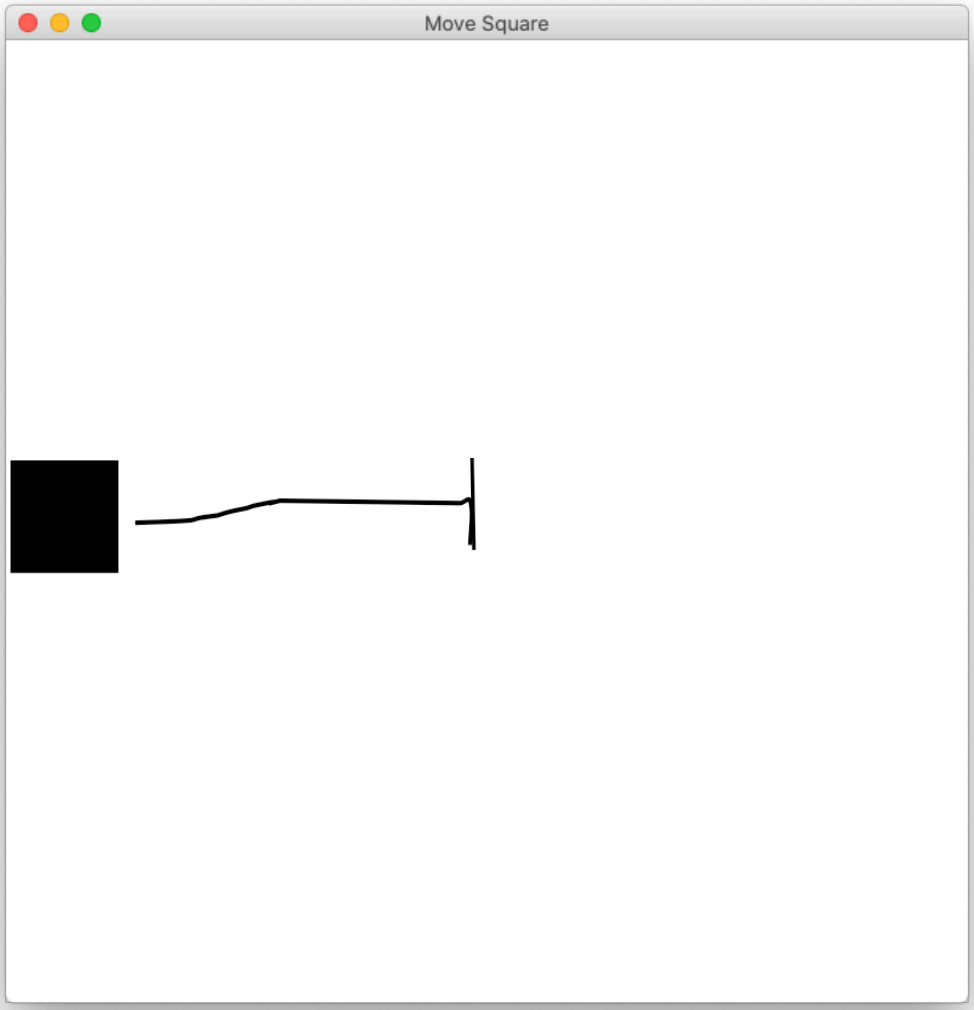
You're now all graphics programmers!



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)
```

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Make all the variables you need.

Animation Loop

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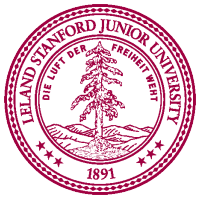
```

The animation loop is a repetition of heartbeats



Animation Loop

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def main():
    # setup

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```

Each heart-beat, update the world forward one frame

Animation Loop

```
def main():
    # setup

    while True:
        # update world

        # pause
        time.sleep(DELAY)
```

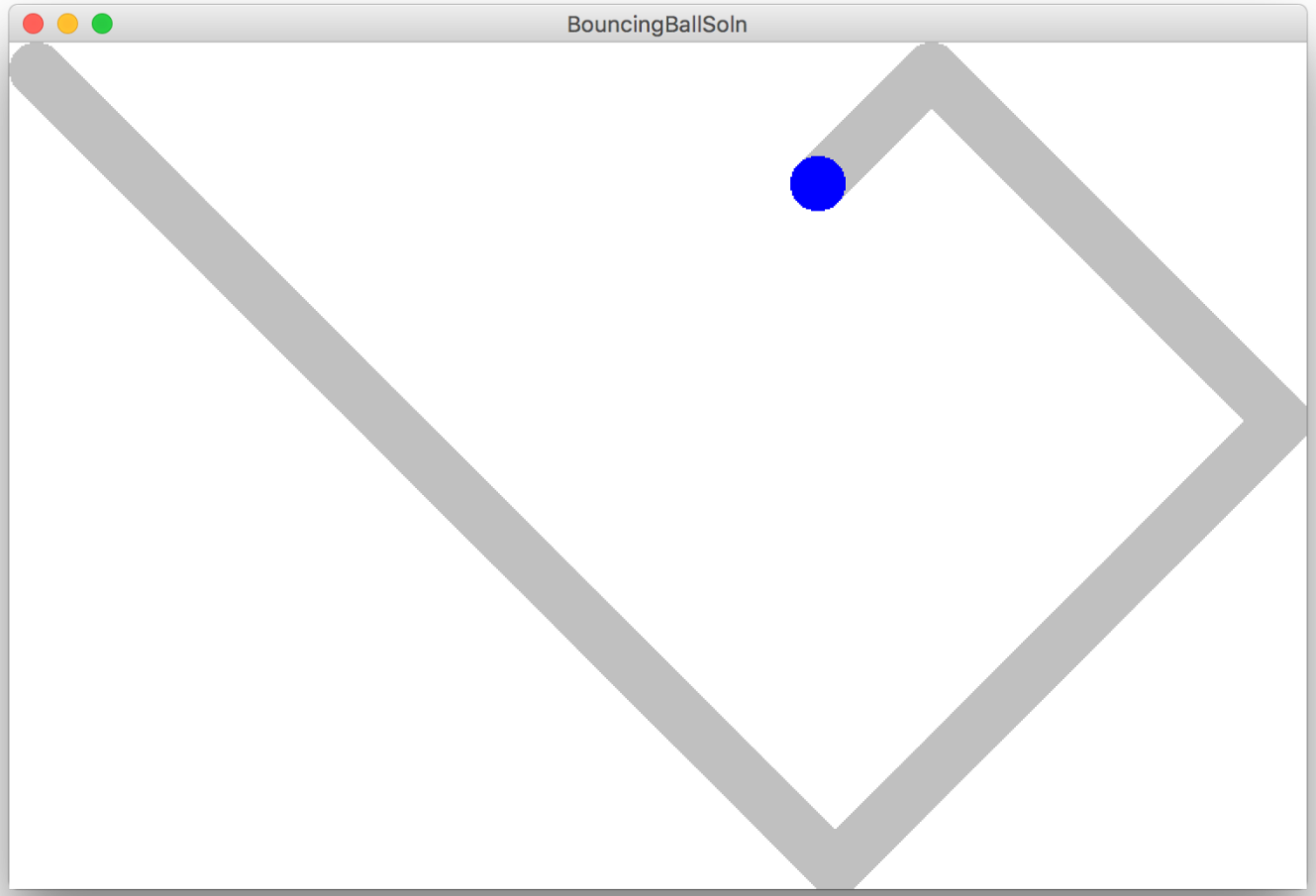
If you don't pause, humans won't be able to see it

Move To Center

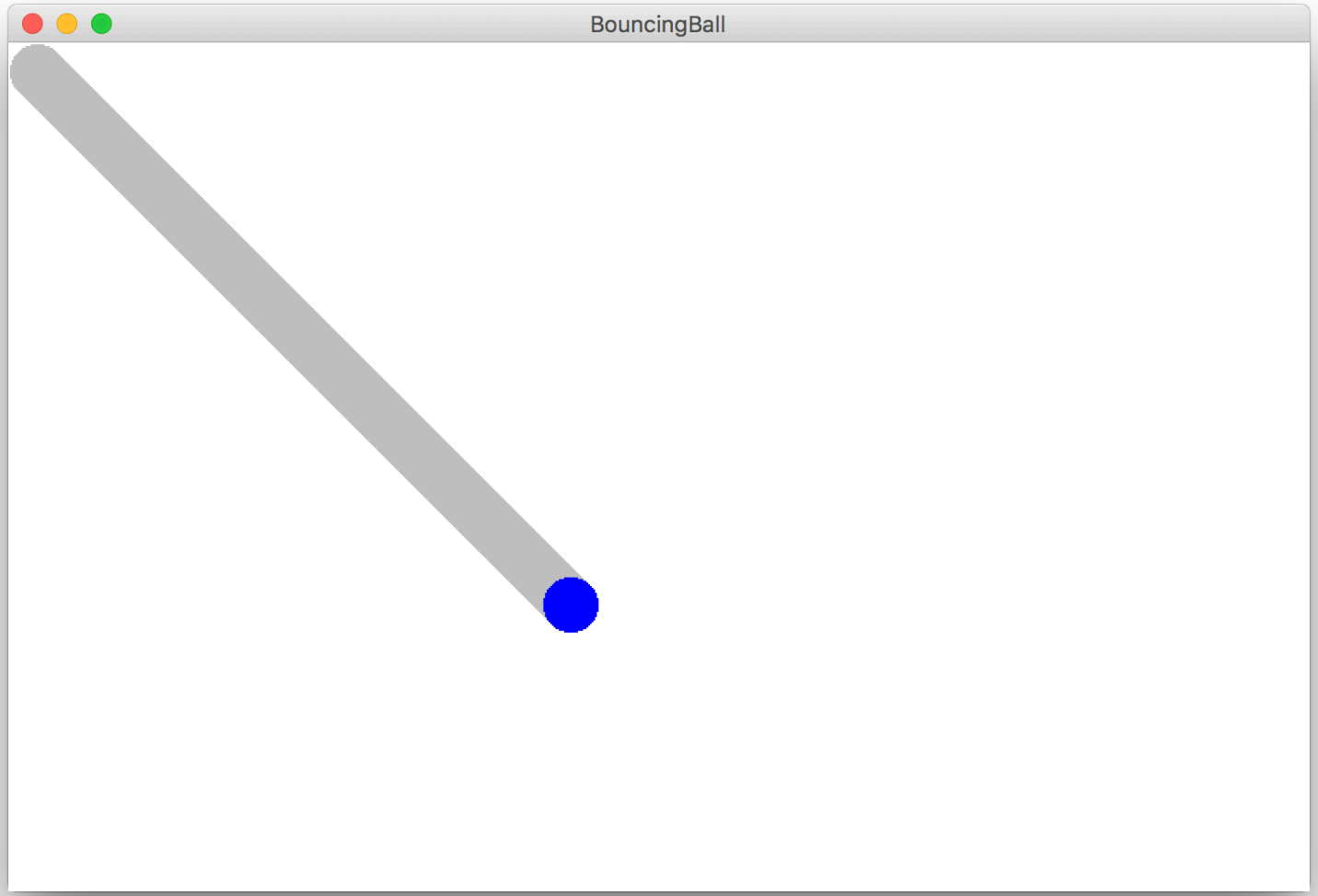
```
def main():
    # setup
    canvas = make_canvas(CANVAS_WIDTH, CANVAS_HEIGHT)
    r = canvas.create_rectangle(0, 0, 100, 100)
    while not is_past_center(canvas, r):
        # update world
        canvas.move(r, 1, 0)
        canvas.update()
        # pause
        time.sleep(DELAY)
```

We are ready…

Bouncing Ball



Milestone #1


BouncingBall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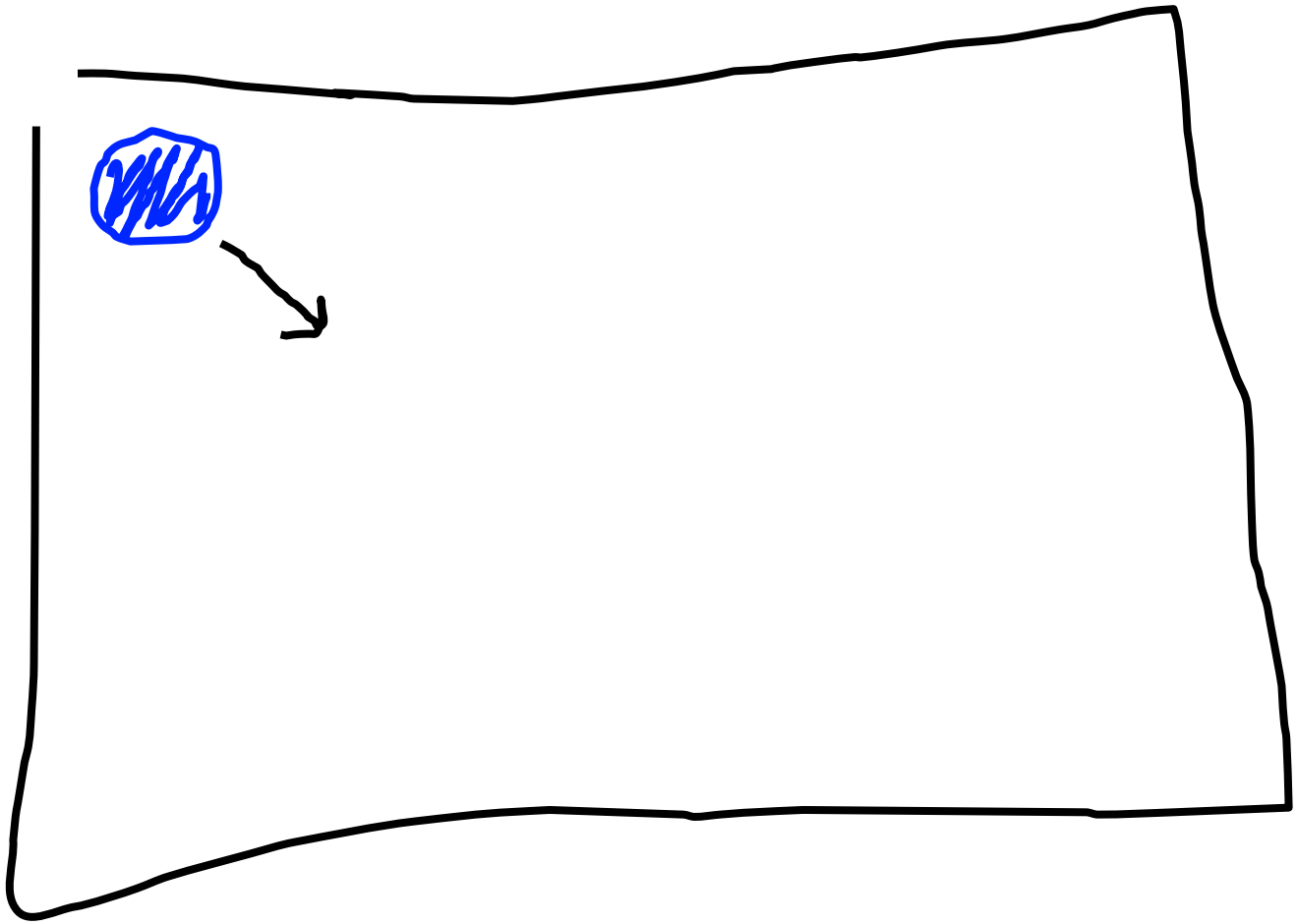
Bouncing Ball

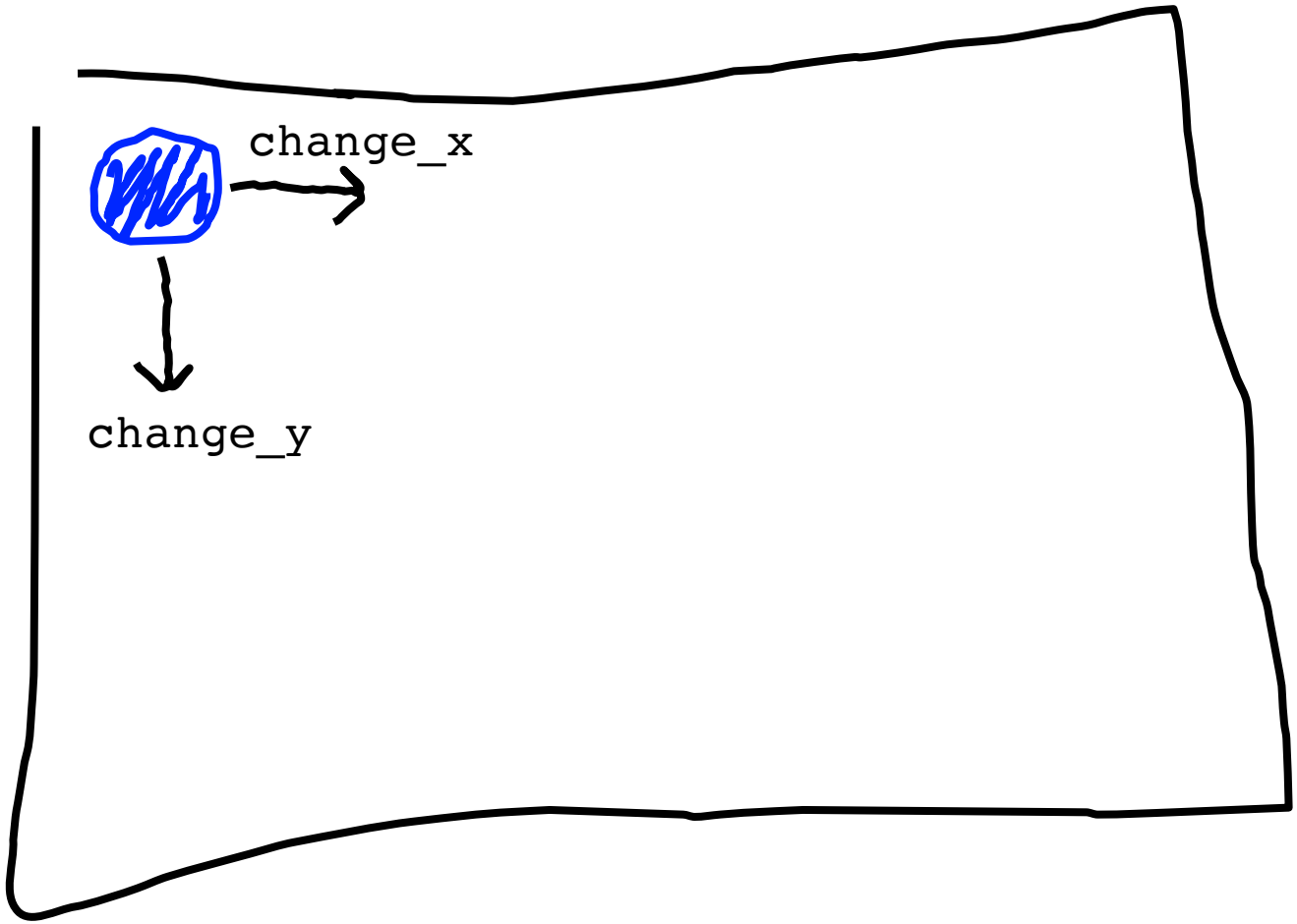
First heartbeat



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

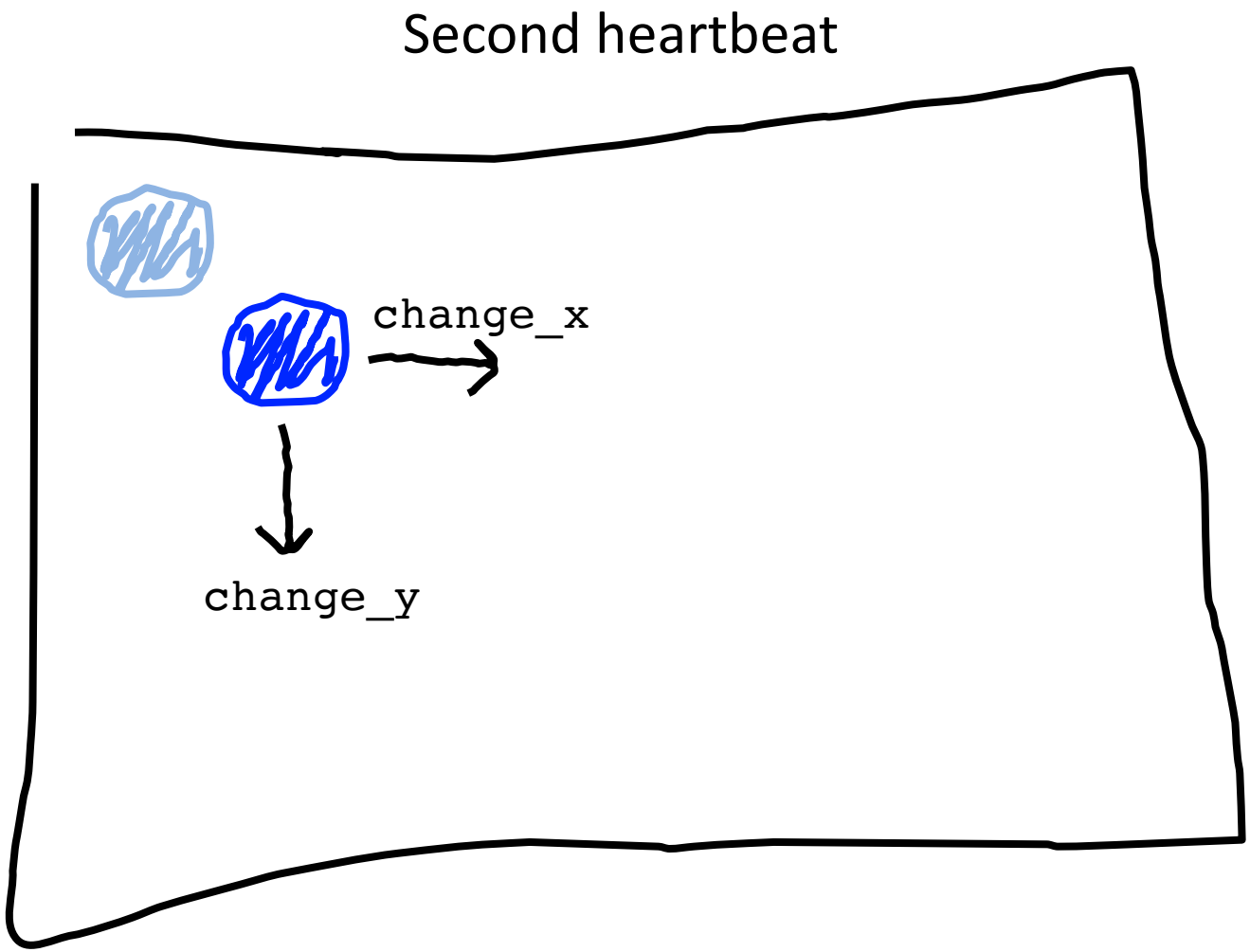
Bouncing Ball

First heartbeat

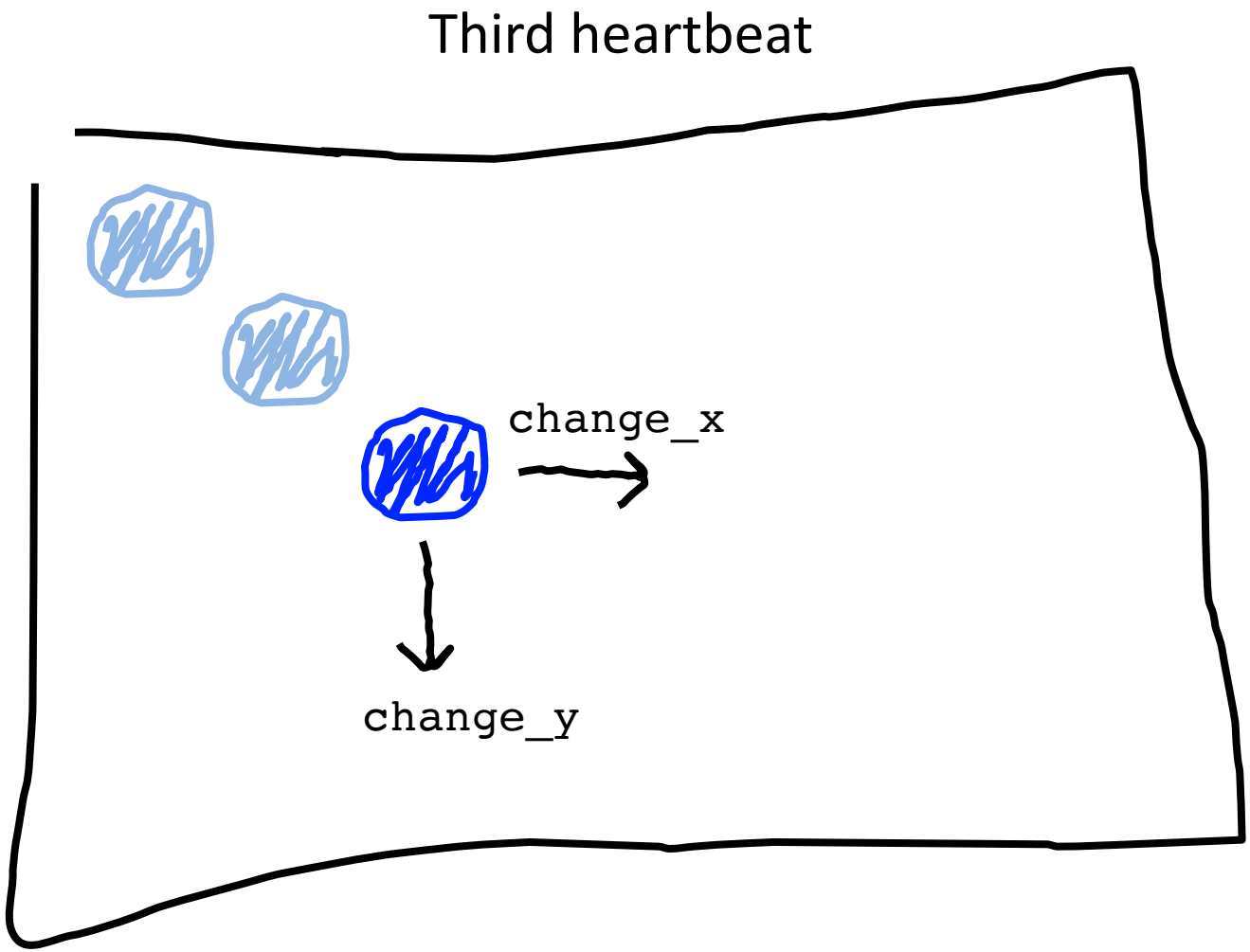


The **`move`** function takes in
a change in x and a change in y

Bouncing Ball

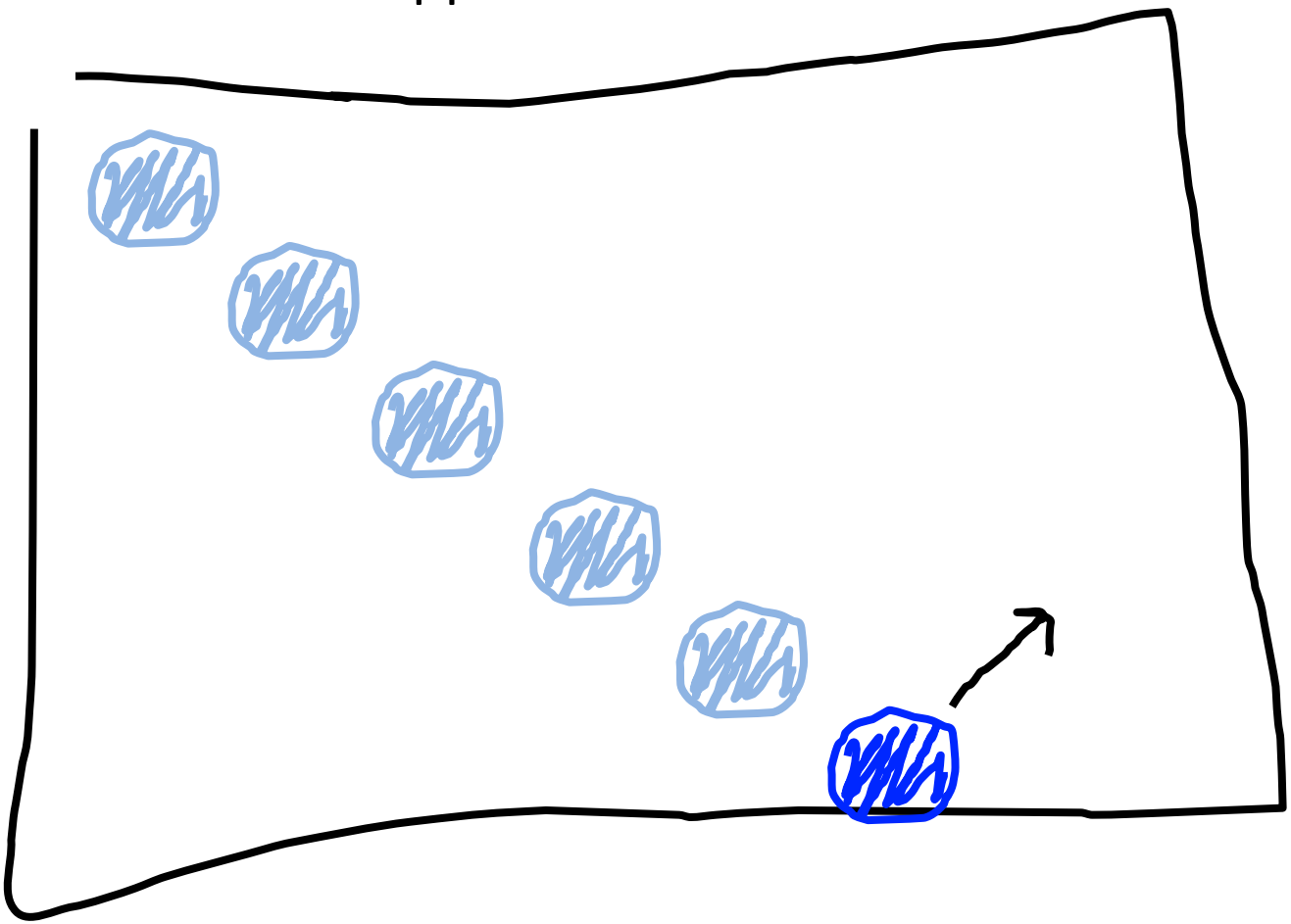


Bouncing Ball



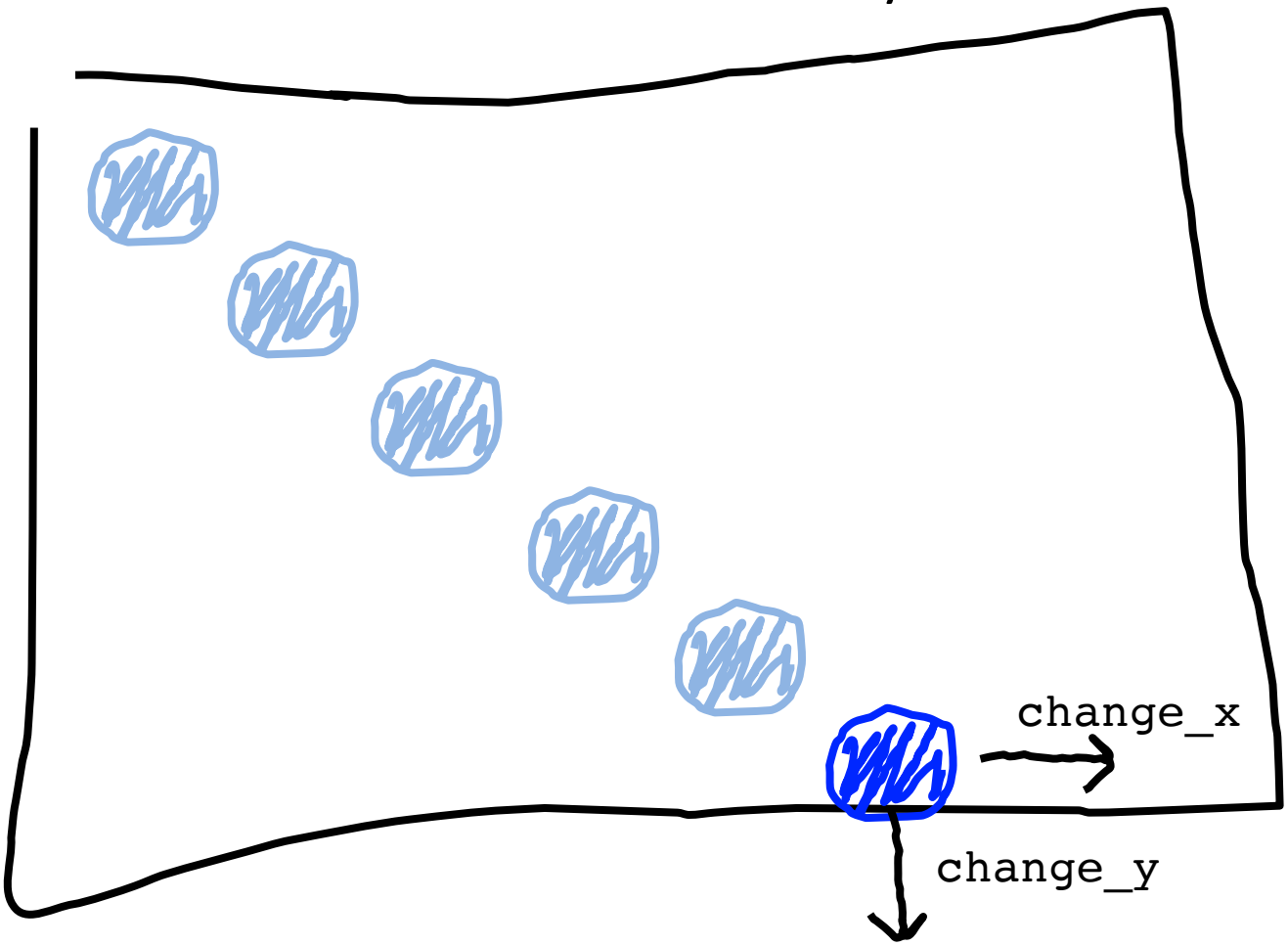
Bouncing Ball

What happens when we hit a wall?



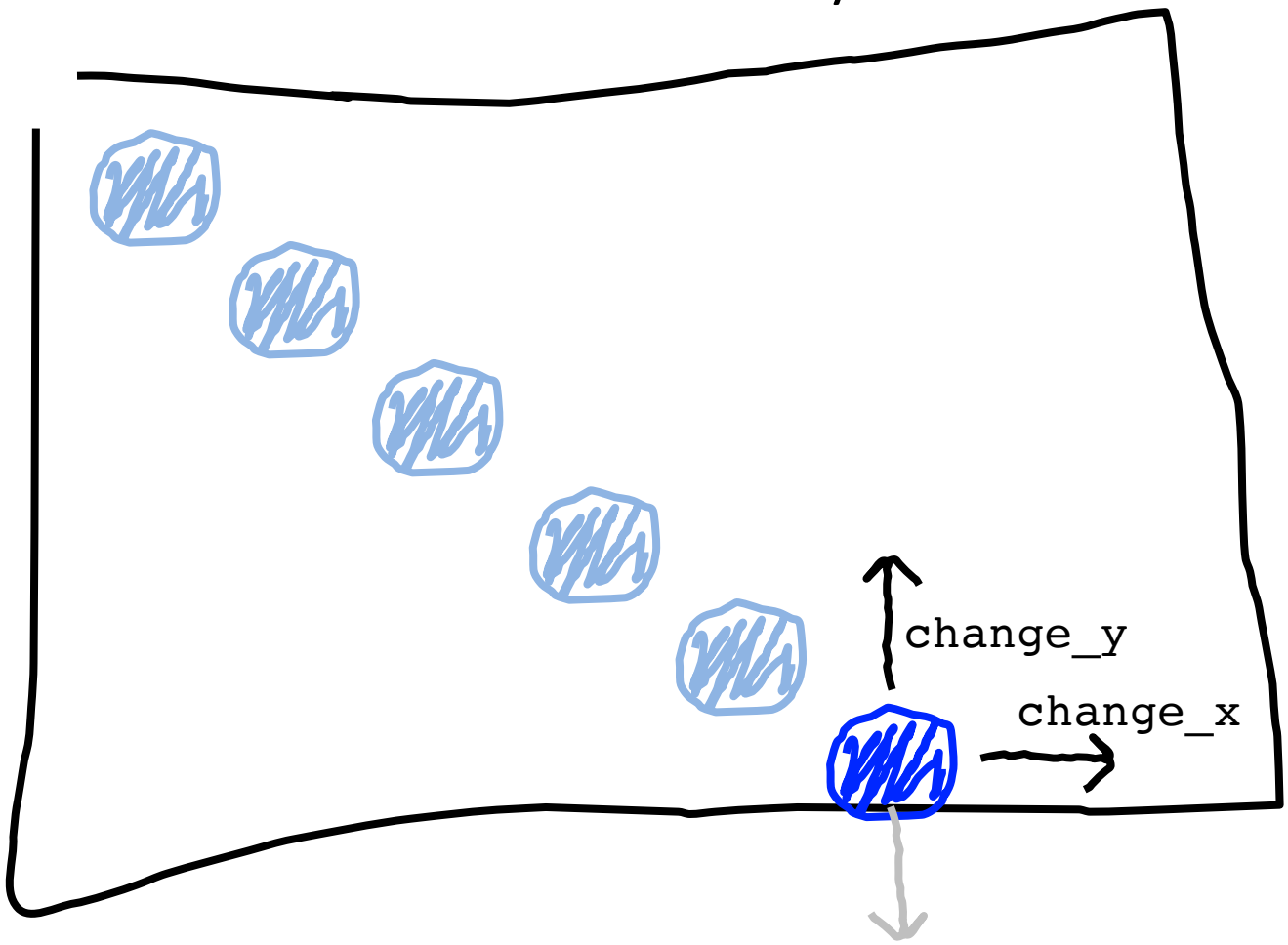
Bouncing Ball

We have this velocity

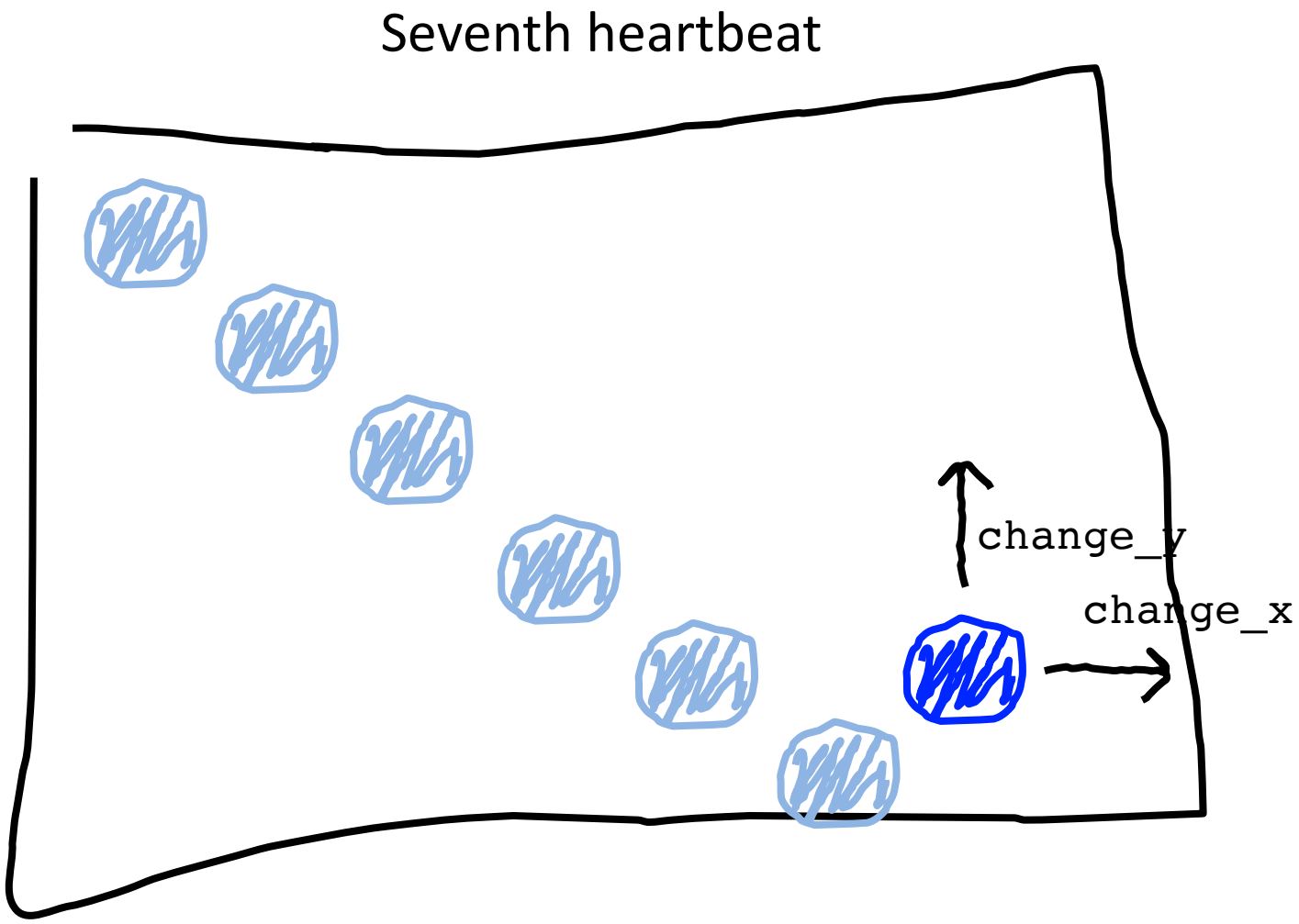


Bouncing Ball

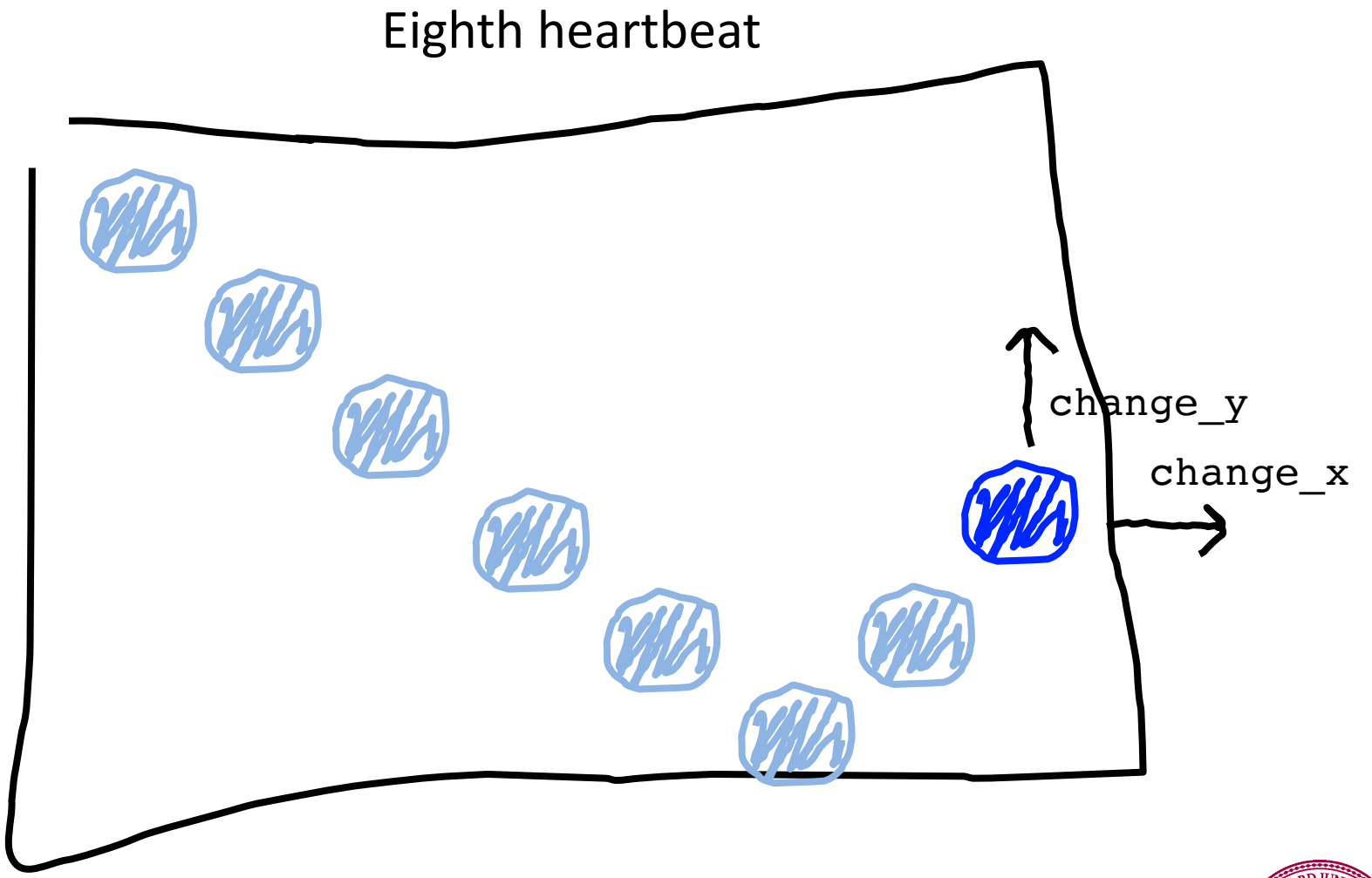
Our new velocity



Bouncing Ball



Bouncing Ball



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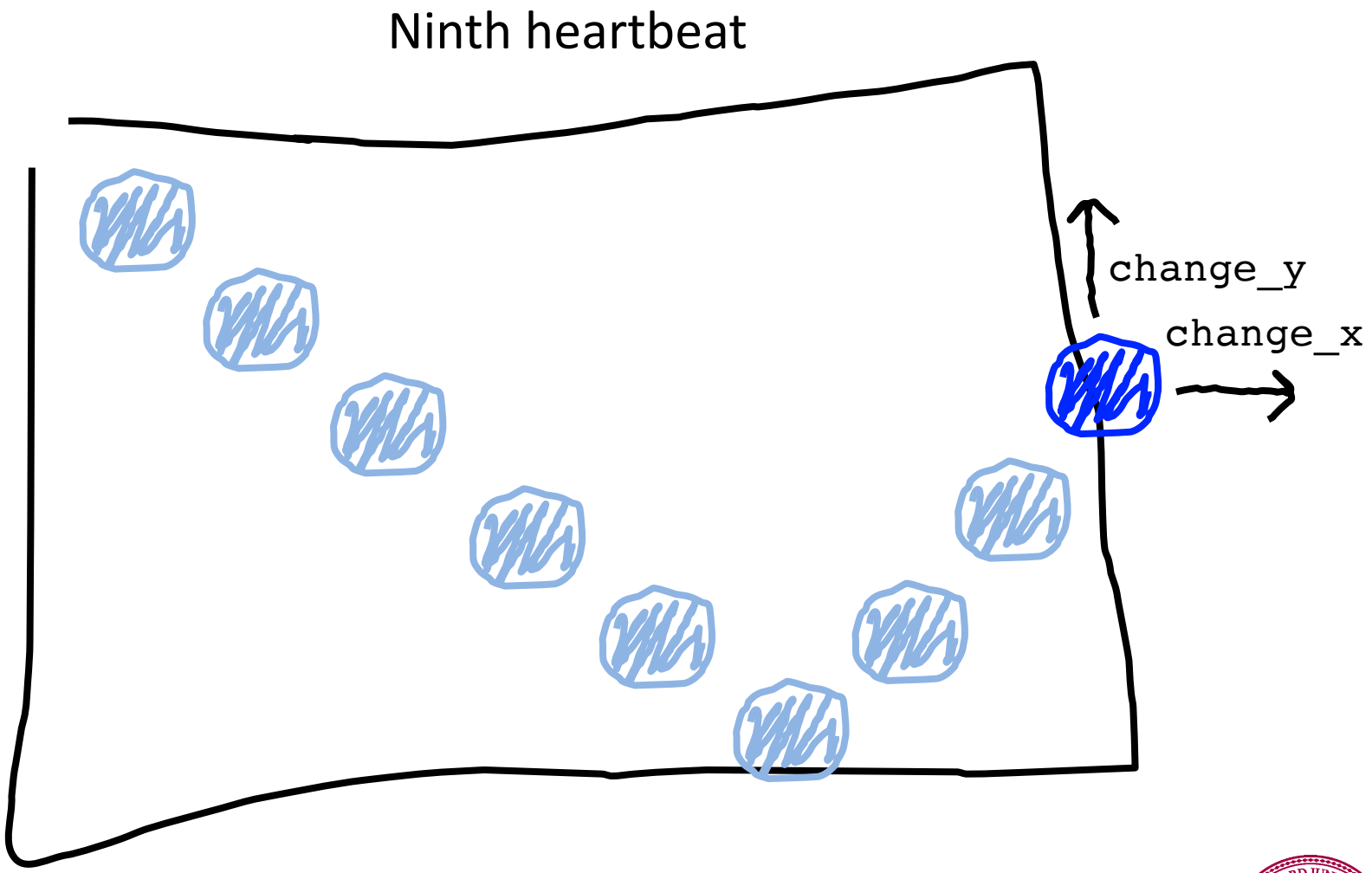
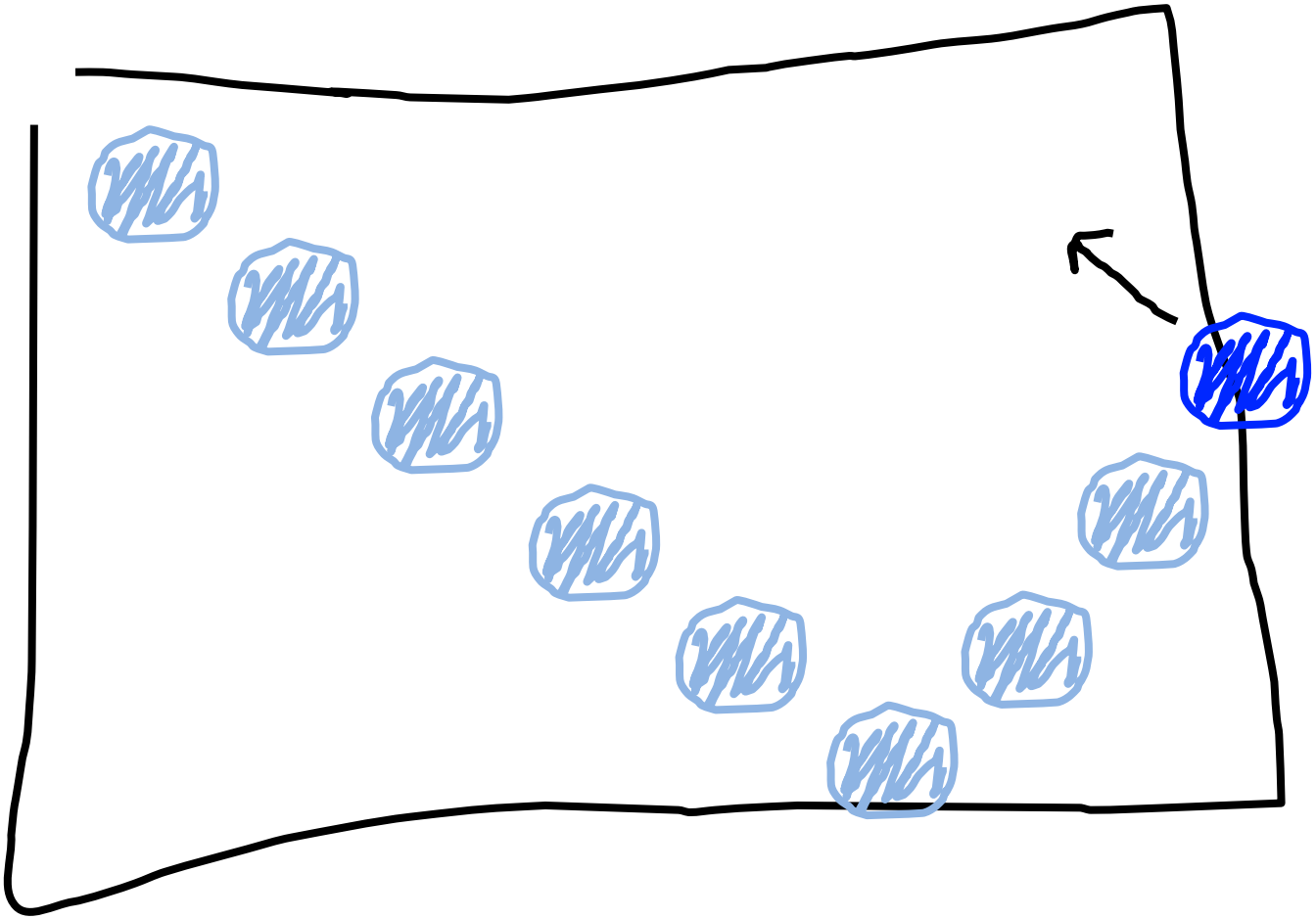


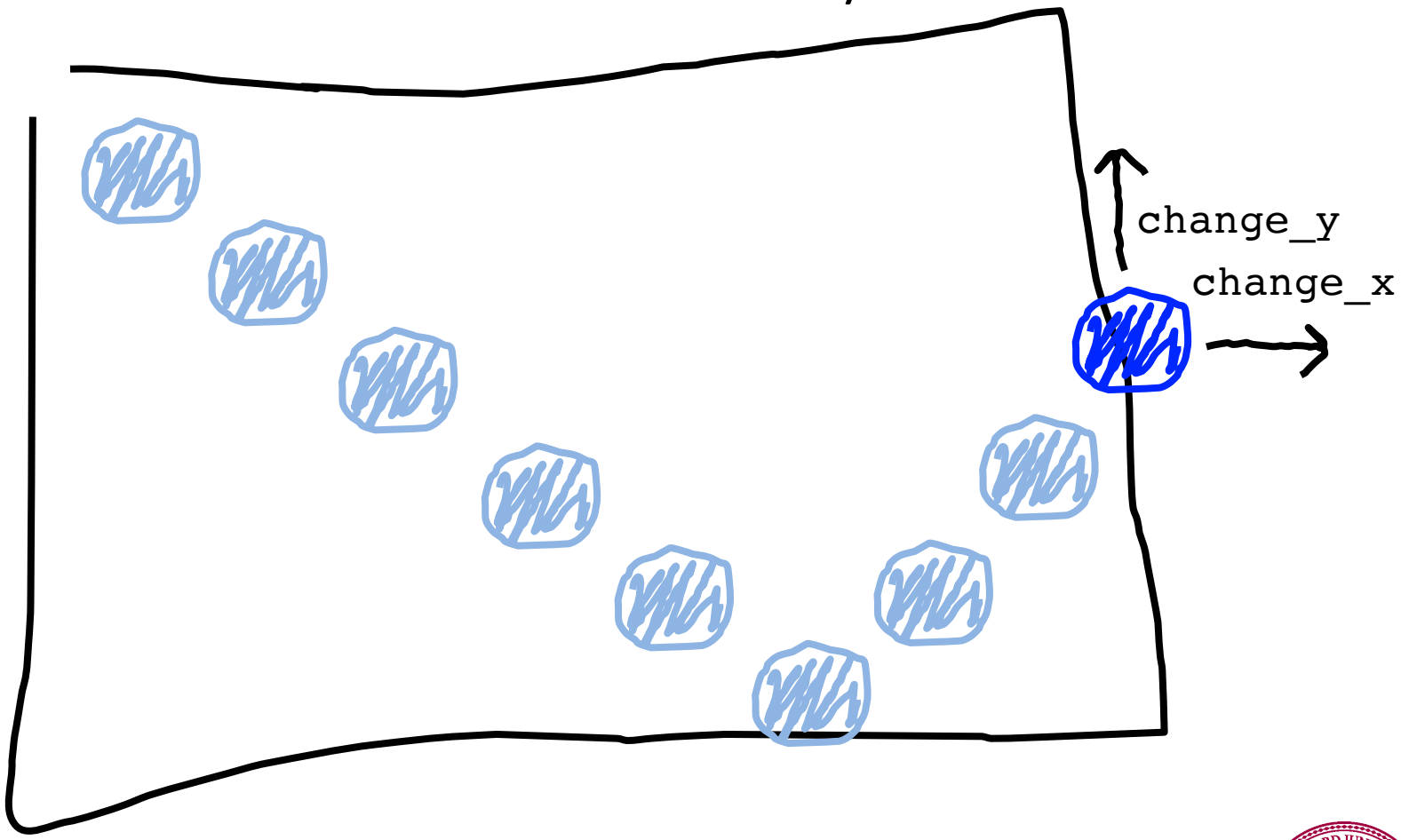
Bouncing Ball

We want this!



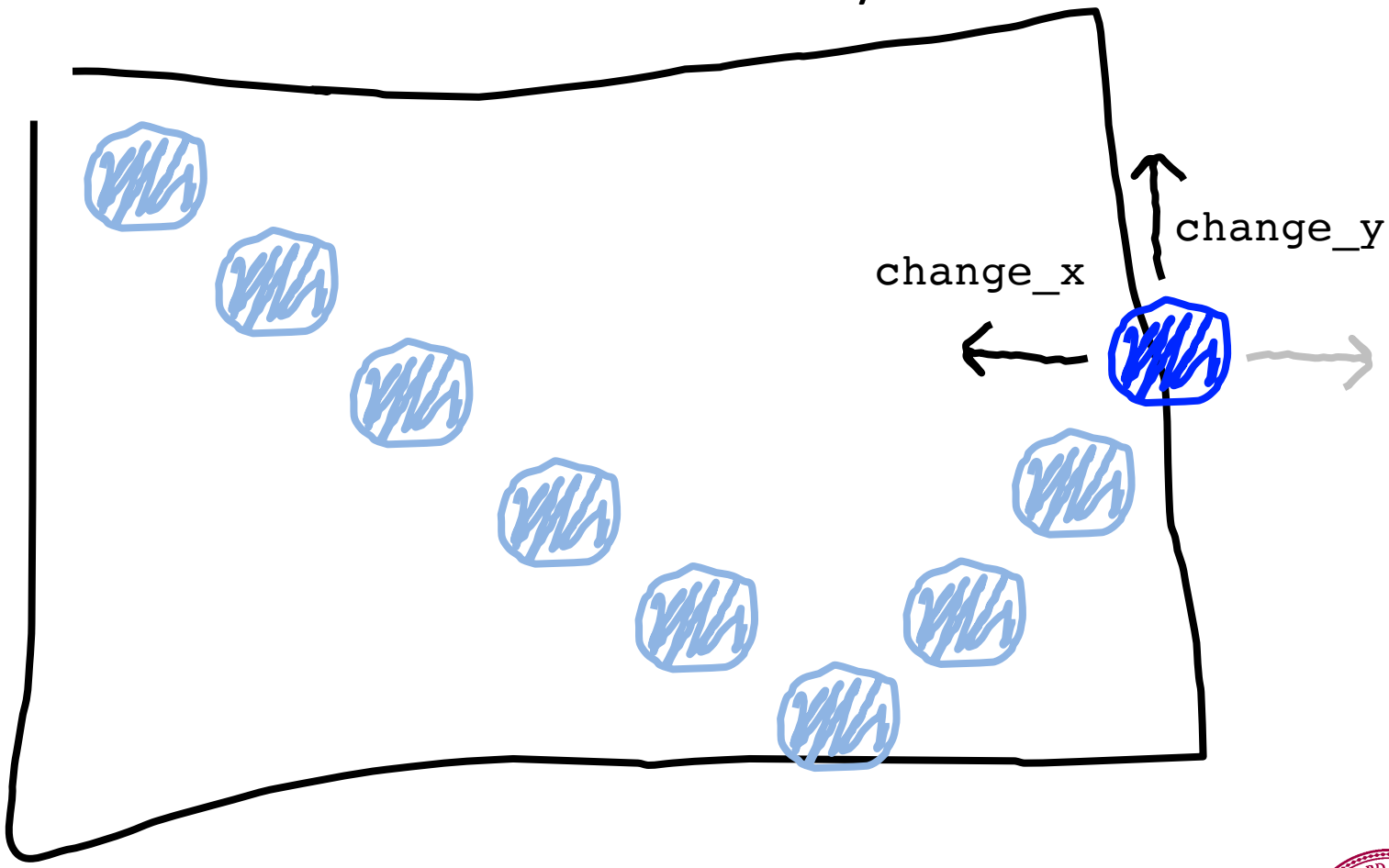
Bouncing Ball

This was our old velocity



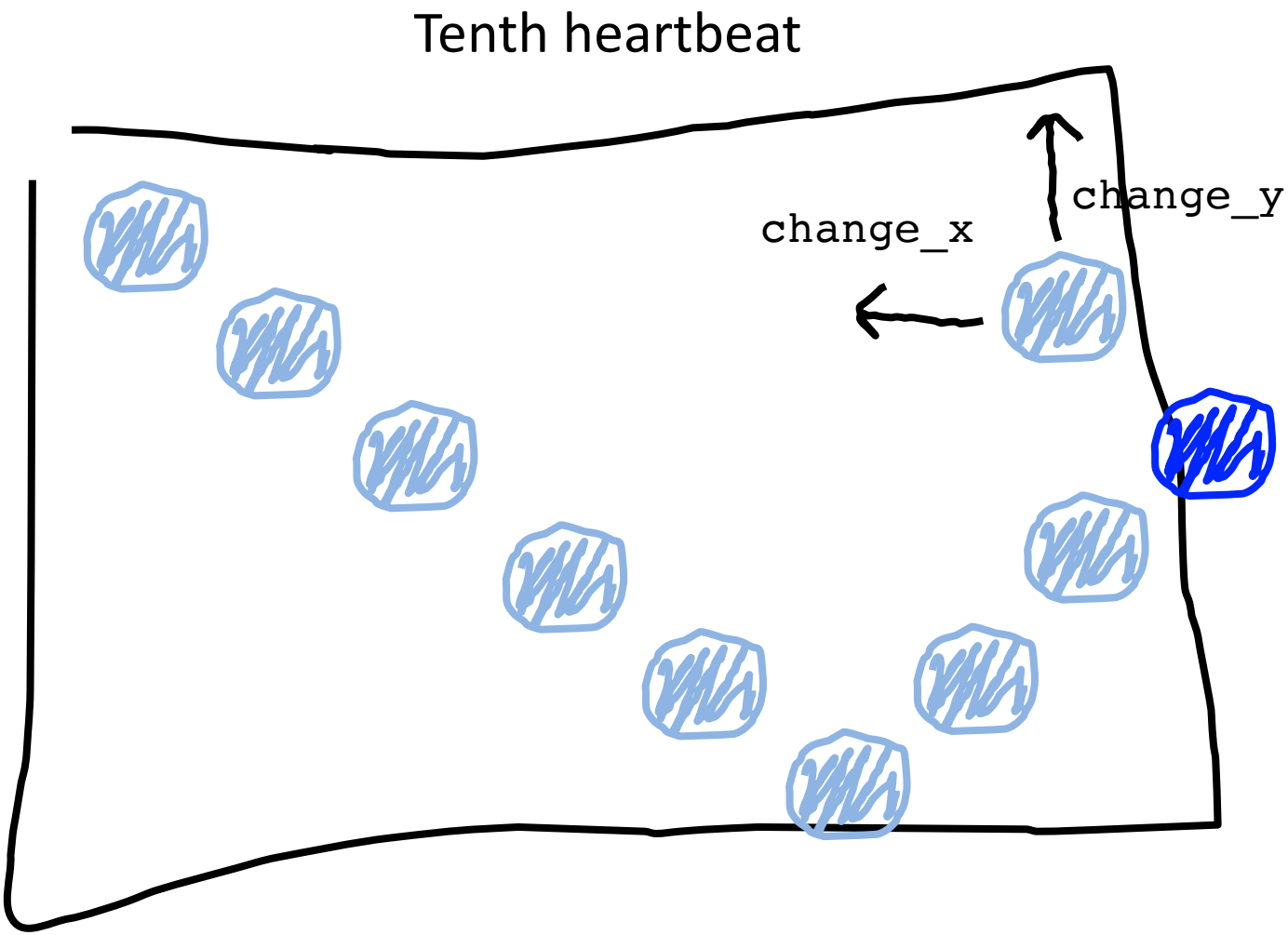
Bouncing Ball

This is our new velocity



When reflecting horizontally: `change_x = -change_x`

Bouncing Ball



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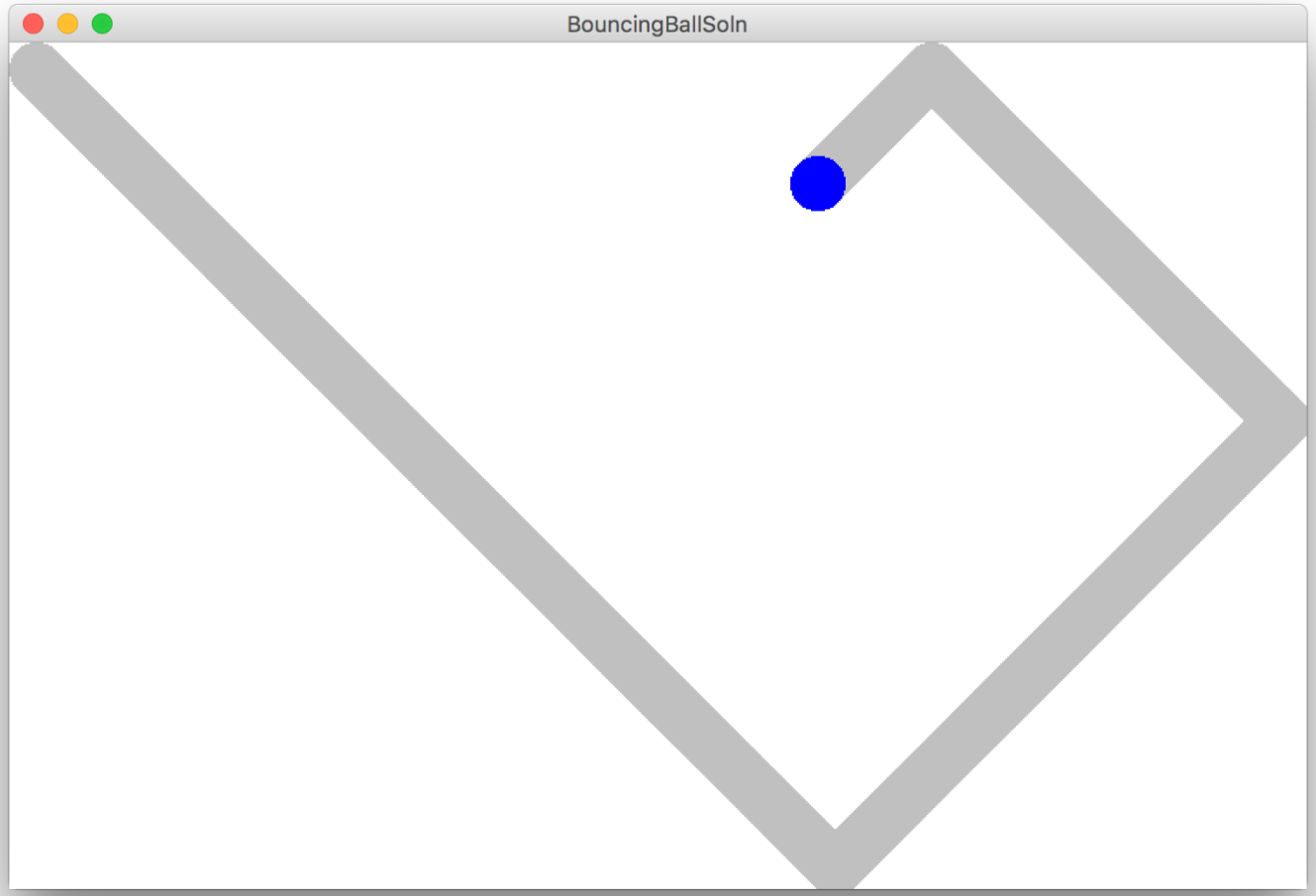


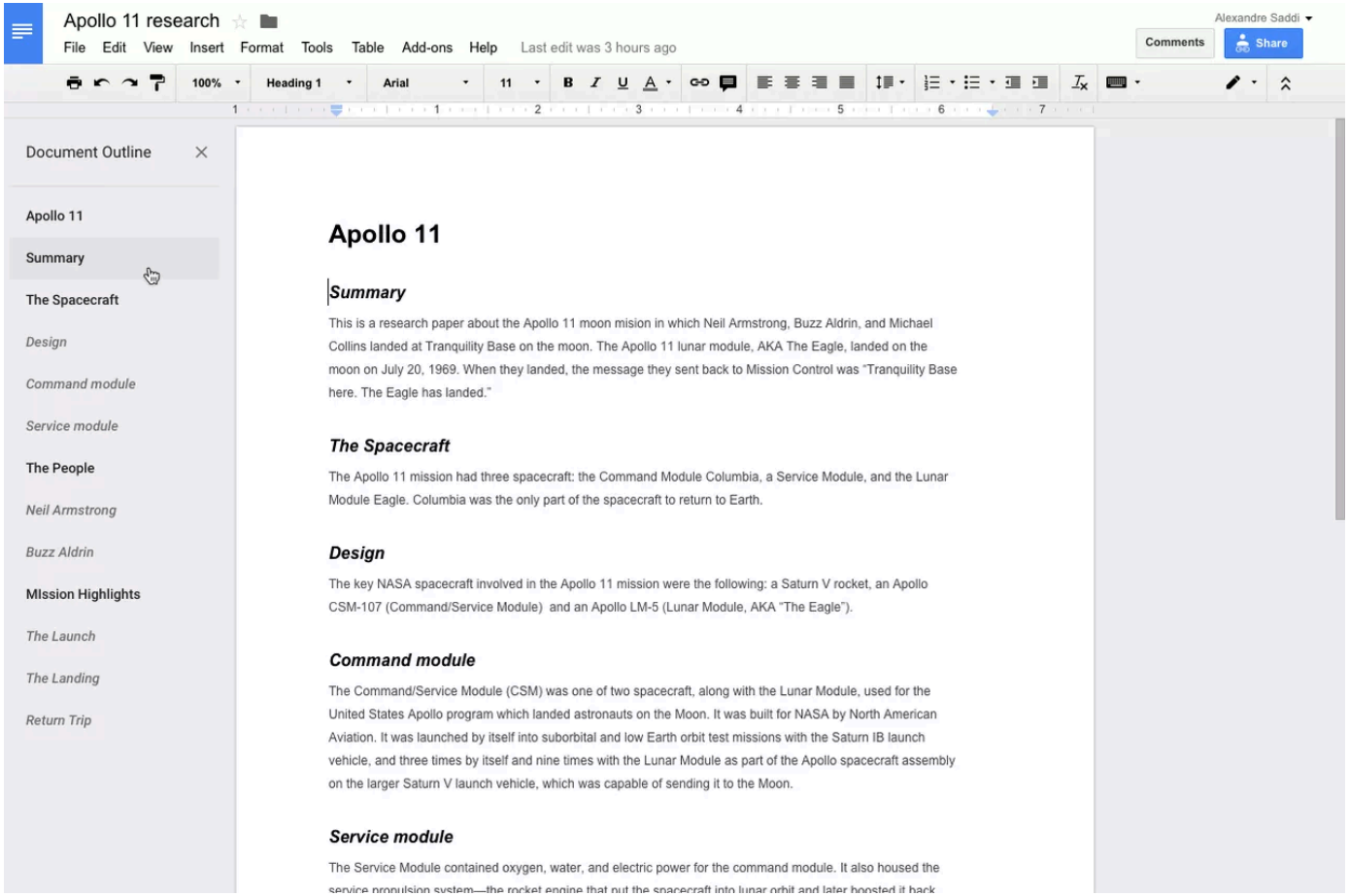
Hold up!

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

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

*Large variables (objects) 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 = make_canvas(…)
    make_ball(canvas)

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

---

stack

heap

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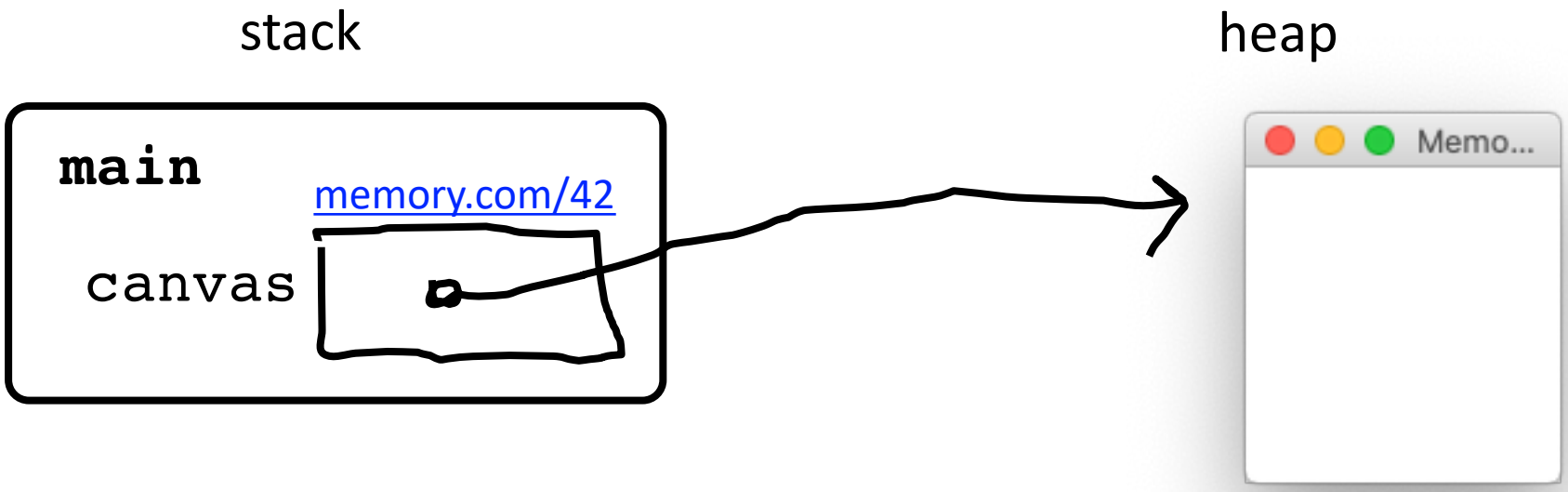

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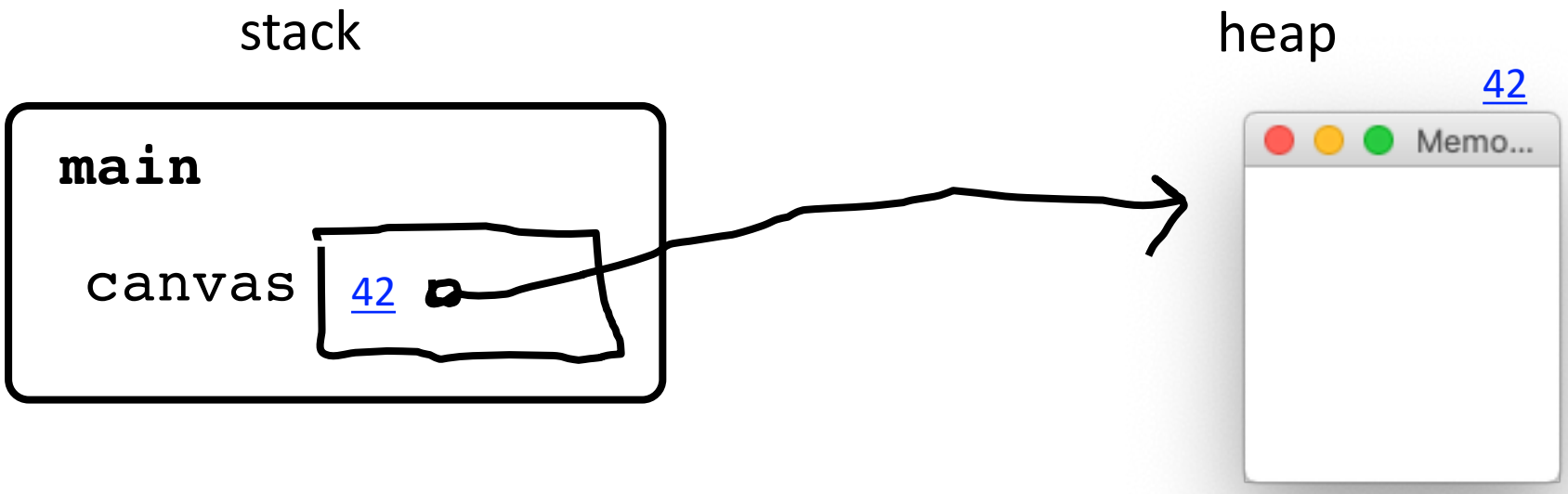

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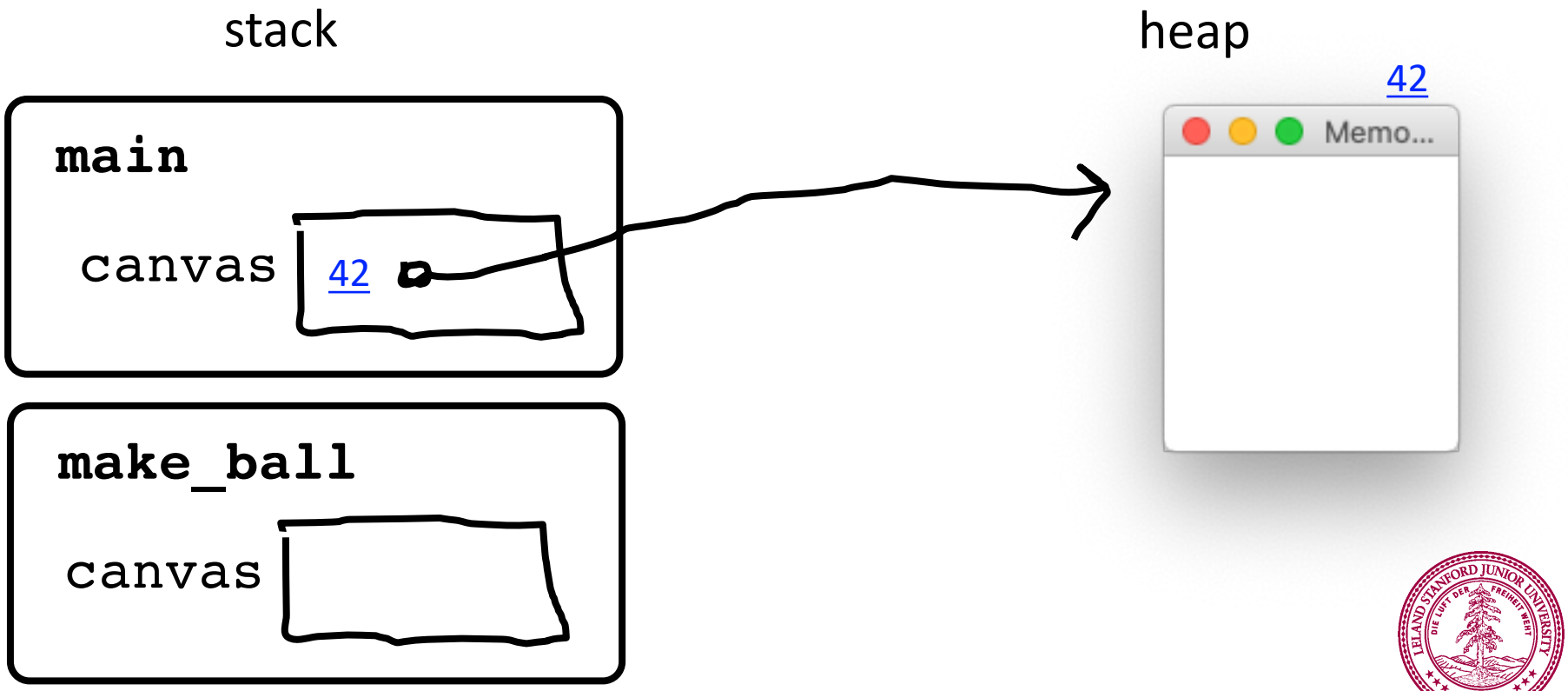

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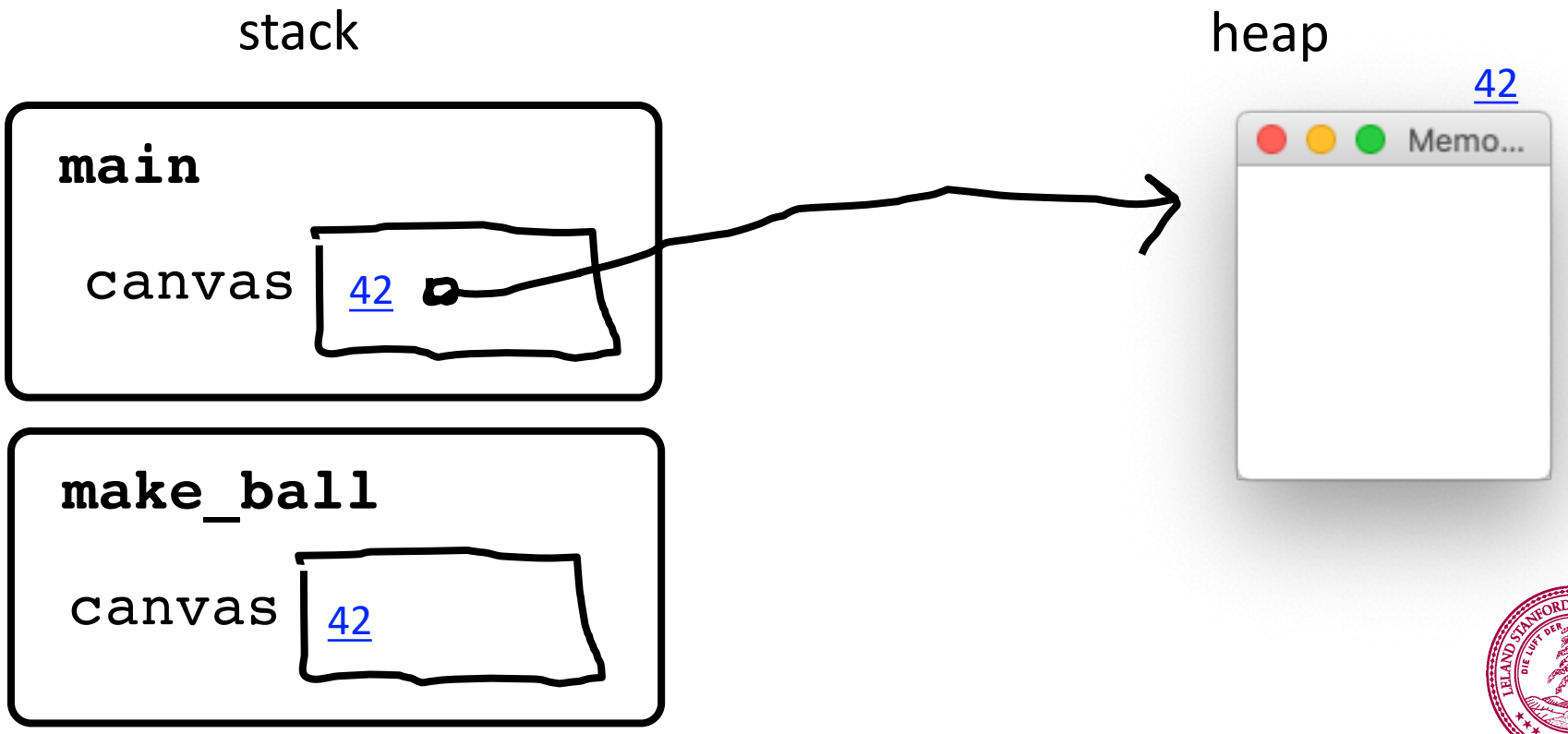

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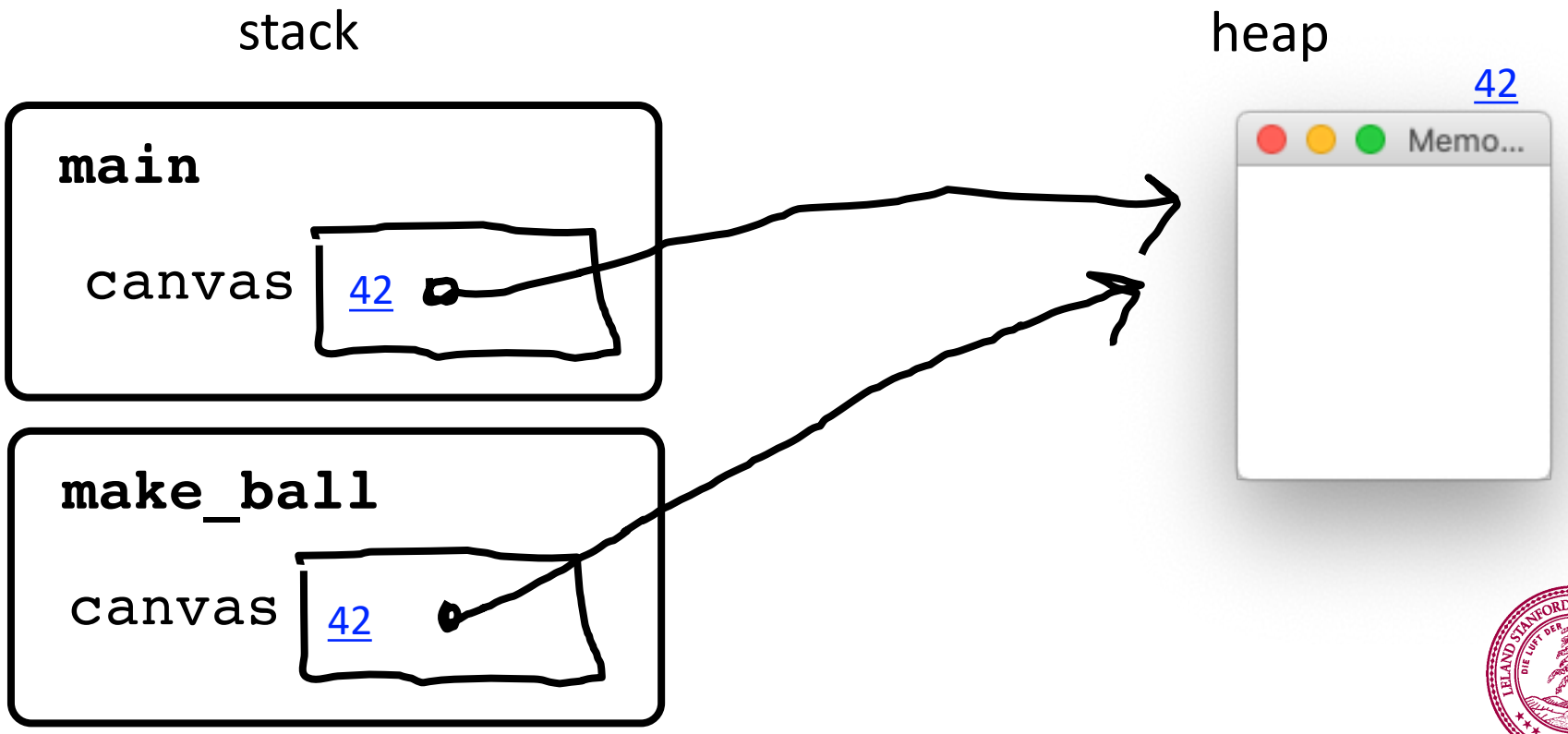

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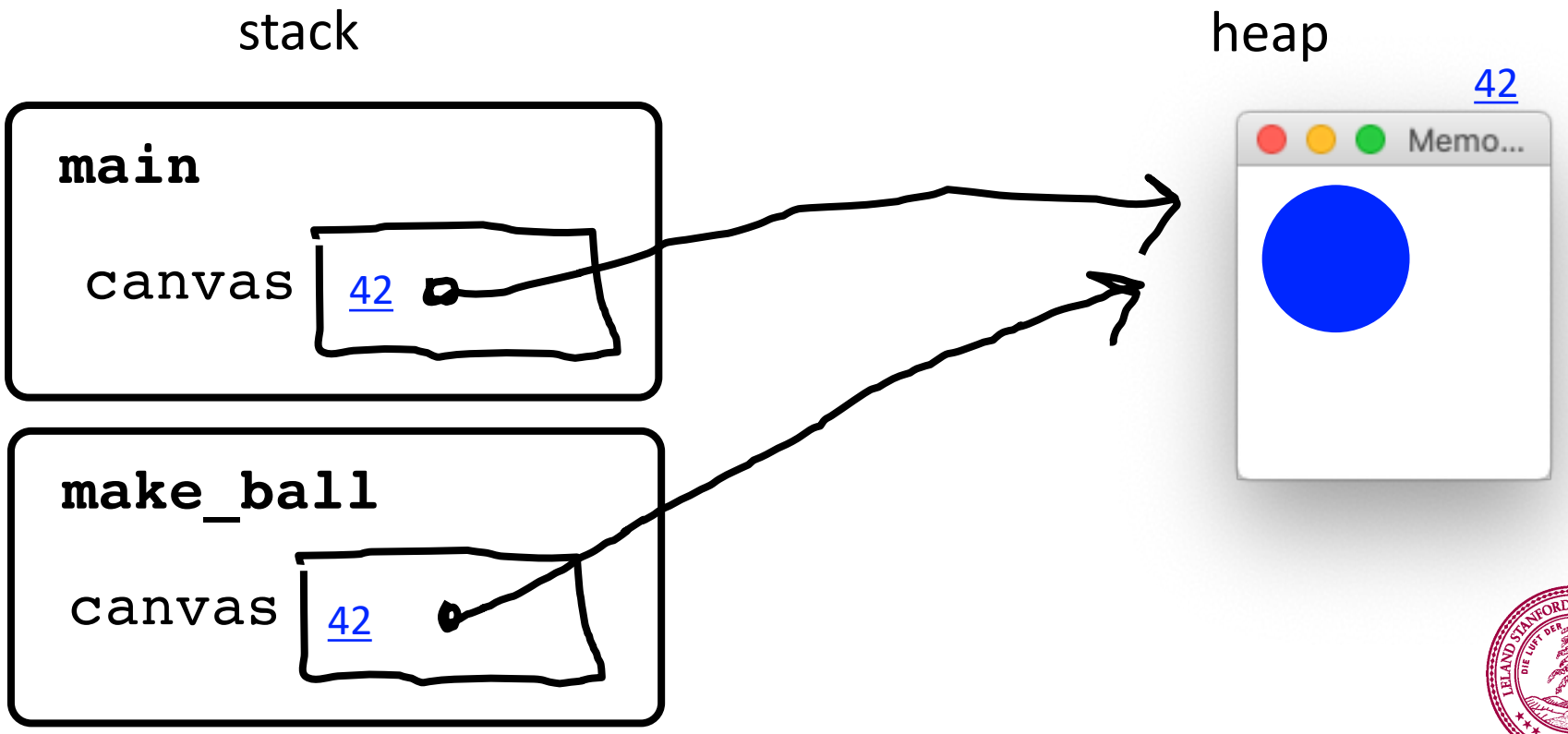
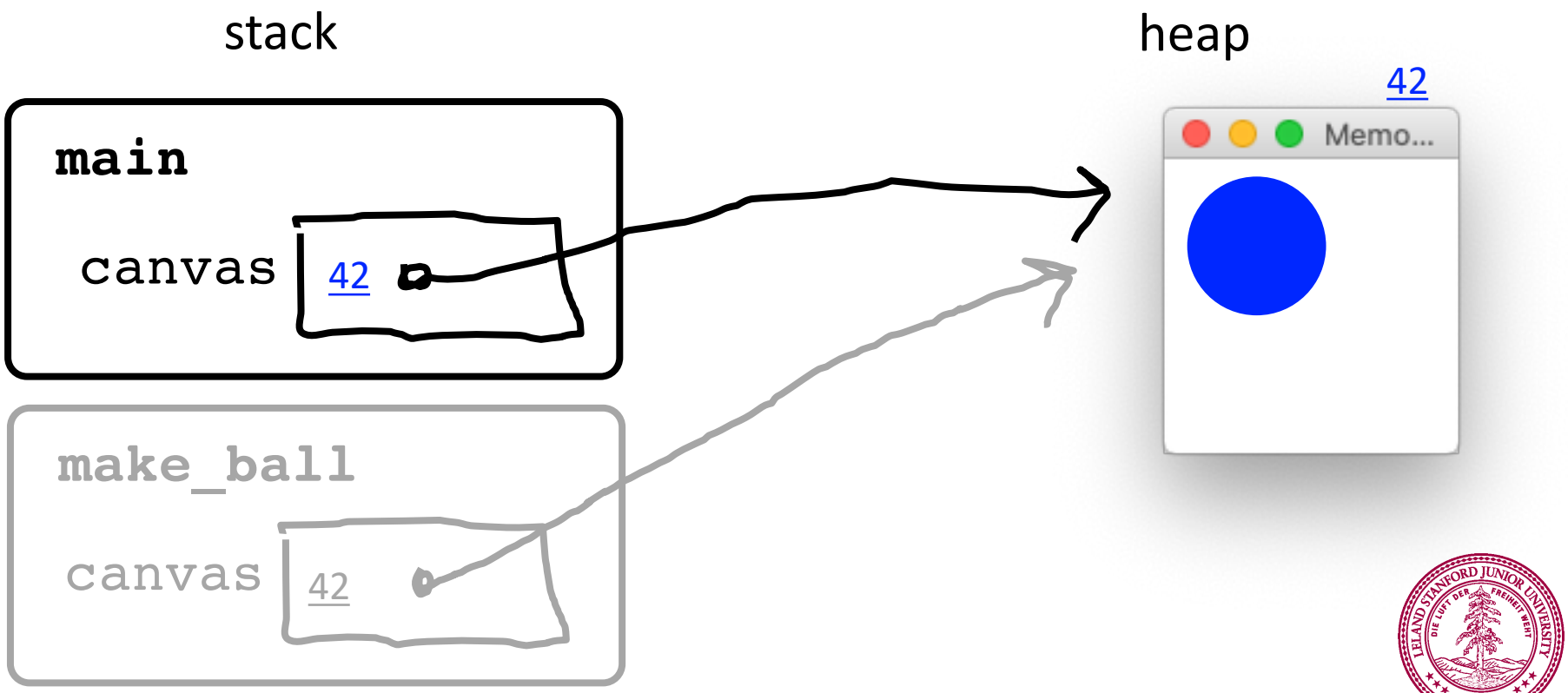
    canvas.create_oval( … , fill='blue')
```



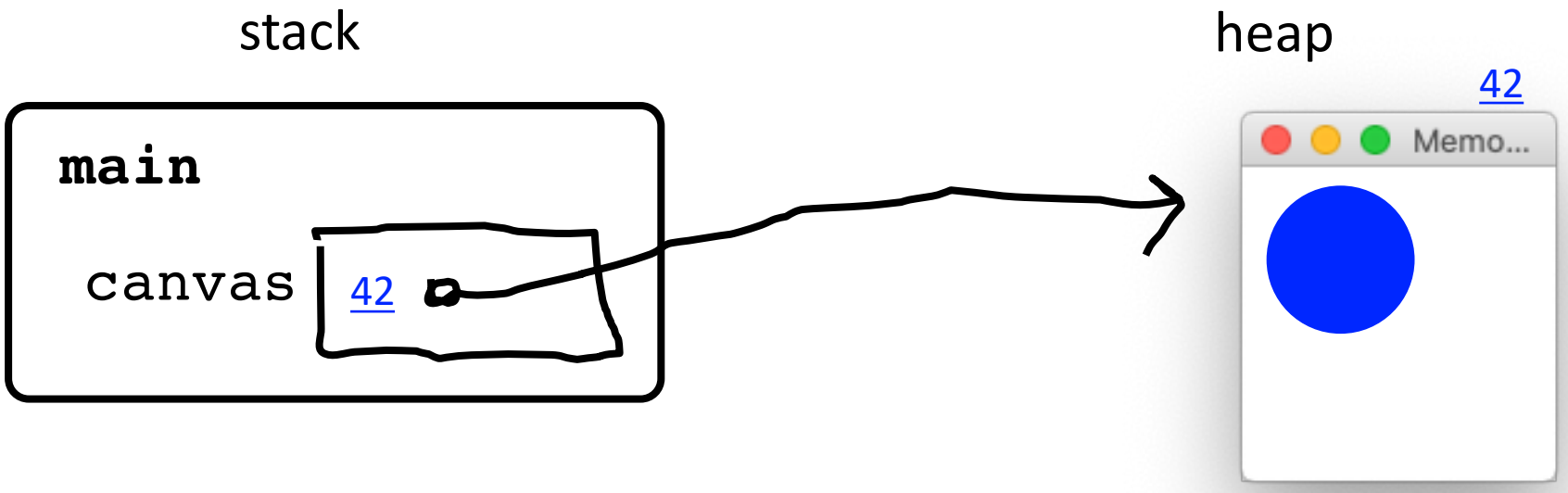
```
def main():
    canvas = make_canvas(…)
    make_ball(canvas)

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



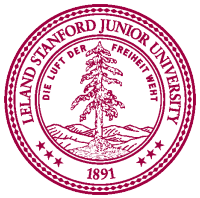
```
def main():
    canvas = make_canvas(…)
    make_ball(canvas)

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



Some variables are stored with references

(which are like memory URLs)



When passed as parameters

Variables that act like they are **copied**

```
boolean
integer
float
string
```

Variables that act like their **URL is copied**

```
canvas
pixel
SimpleImage
list
```

Learning Goals

1. Feel more confident writing methods
2. Write animated programs

Special Graphics Functions

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

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

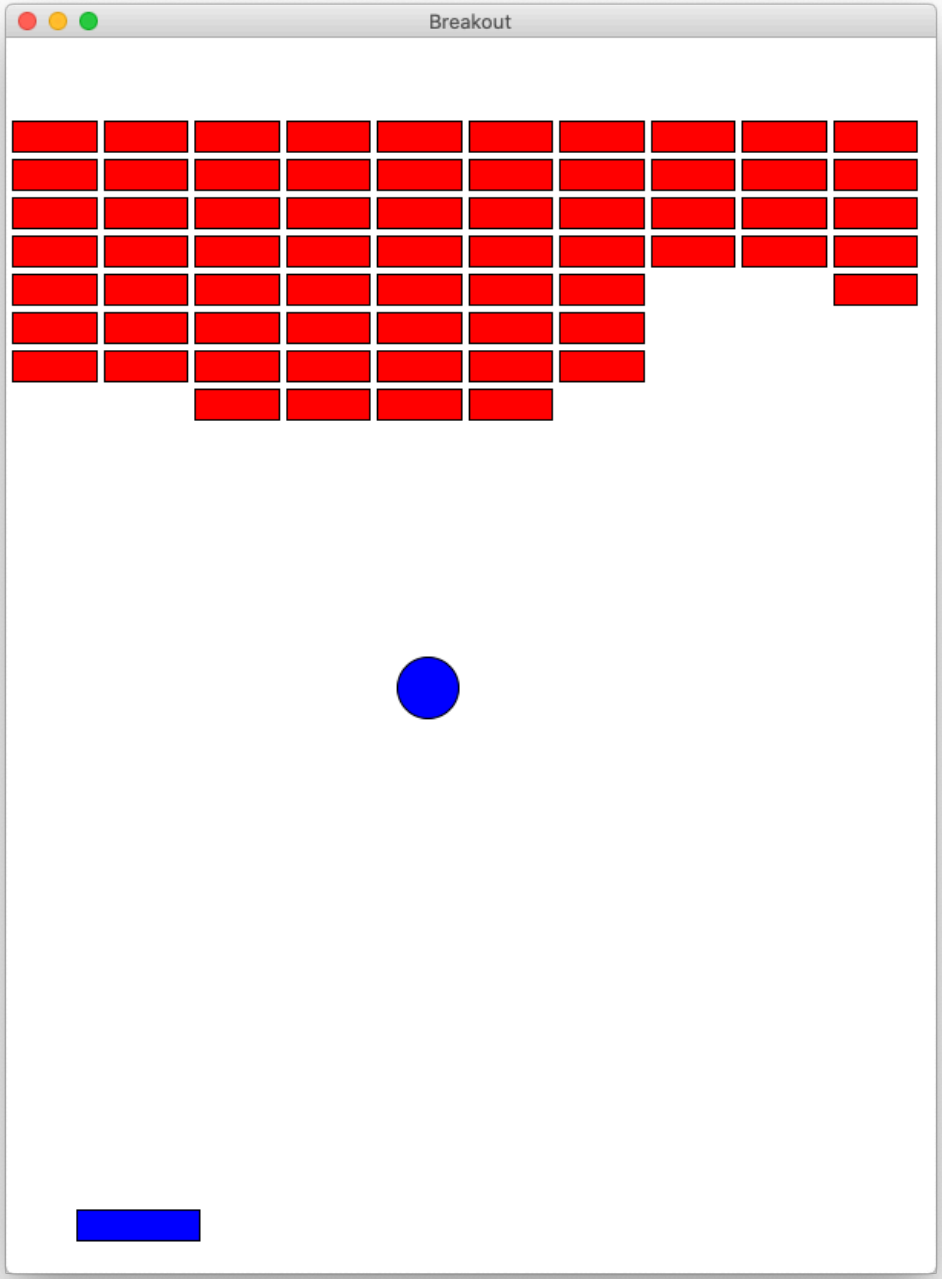
# move shape by a given change_x and change_y
canvas.move(shape, change_x, change_y)

# get the coordinates of a shape
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 shapes color too
canvas.itemconfig(shape, fill=new_color, outline=...)
```

Come back on Monday to learn about lists!


Breakout


LELAND STANFORD JUNIOR UNIVERSITY
DIE LUFT DER FREIHEIT WEHT
1891