

# Iteration in Programming

## for loops

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# Topics list

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- There are three types of loop in programming:
  - **While** loops:
    - Counter controlled (n times) - covered in previous talk
    - Sentinel based (covered later in the course)
    - Flag based (covered later in the course)
  - **For** loops (this slide deck)
  - **Do While** loops (covered later in the course)
- Comparative use of while and for loops
  - Lab02a - Challenge 1
  - Lab02a - Challenge 3

# For loop pseudo-code

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General form of a for loop

```
for( initialization; boolean condition; post-body action)  
{  
    statements to be repeated  
}
```

# Recap: Processing Example 2.13

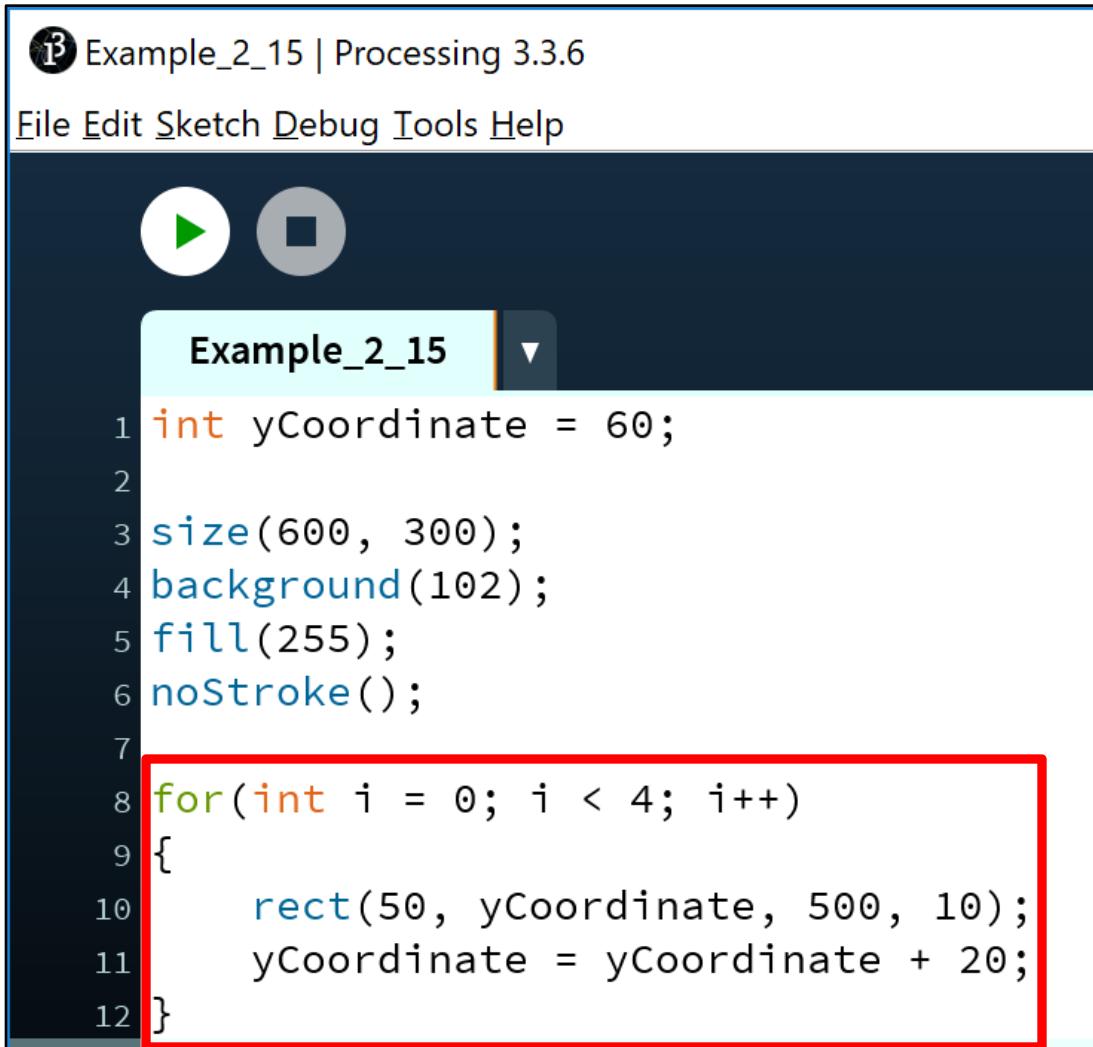
The screenshot shows the Processing 3.3.6 IDE interface. The title bar says "Example\_2\_13 | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". Below the menu is a toolbar with a play button and a square button. The sketch name "Example\_2\_13" is selected in the dropdown menu. The code area contains the following Pseudocode:

```
1 int yCoordinate = 60;
2
3 size(600, 300);
4 background(102);
5 fill(255);
6 noStroke();
7
8 int i = 0;
9 while(i < 4)
10 {
11     rect(50, yCoordinate, 500, 10);
12     yCoordinate += 20;
13     i++;
14 }
15
```

This was a slide from the previous talk. We used a while loop to repeatedly print the four rectangles to the display window.



# Processing Example 2.15



The screenshot shows the Processing IDE interface with the title bar "Example\_2\_15 | Processing 3.3.6". Below the title bar is a menu bar with "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The main workspace displays the code for "Example\_2\_15". The code uses a **for** loop to draw four horizontal rectangles. The first rectangle is at yCoordinate = 60, and each subsequent rectangle is positioned 20 units lower than the previous one. The code is as follows:

```
1 int yCoordinate = 60;
2
3 size(600, 300);
4 background(102);
5 fill(255);
6 noStroke();
7
8 for(int i = 0; i < 4; i++)
9 {
10     rect(50, yCoordinate, 500, 10);
11     yCoordinate = yCoordinate + 20;
12 }
```

This code does the same as the previous slide, except that we use a different loop: **for**



# For loop syntax

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The diagram illustrates the structure of a for-loop. At the top, a specific Java code snippet is shown:

```
for(int i = 0; i < 4; i++)
```

This code is then mapped to a general template below it:

```
for(initialization; boolean condition; post-body action)
{
    statements to be repeated
}
```

The mapping is indicated by three colored arrows: a red arrow points from the initialization part of the example to the *initialization* placeholder in the template; a green arrow points from the boolean condition part to the *boolean condition* placeholder; and a blue arrow points from the post-body action part to the *post-body action* placeholder.

# For loop syntax

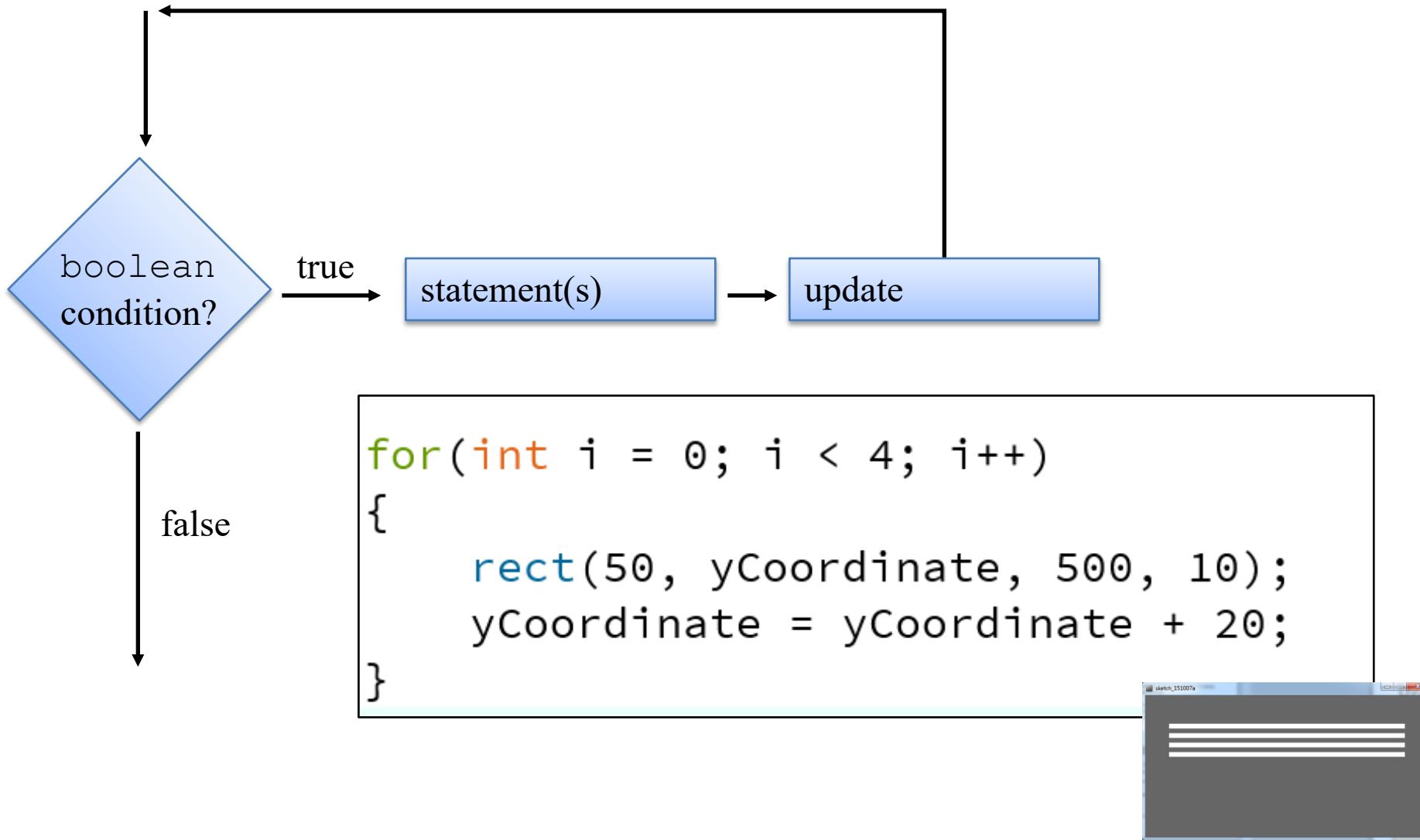
---

```
for(int i = 0; i < 4; i++)
```

<b>initialization</b>	int i = 0;	Initialise a loop control variable (LCV) e.g. i. It can include a variable declaration.
<b>boolean condition</b>	i < 4;	Is a valid boolean condition that typically tests the loop control variable (LCV).
<b>post-body action</b>	i++	A change to the loop control variable (LCV). Contains an assignment statement.

# for Loop Flowchart

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# Returning to: Processing Example 2.15

Example\_2\_15 | Processing 3.3.6

File Edit Sketch Debug Tools Help

Example\_2\_15

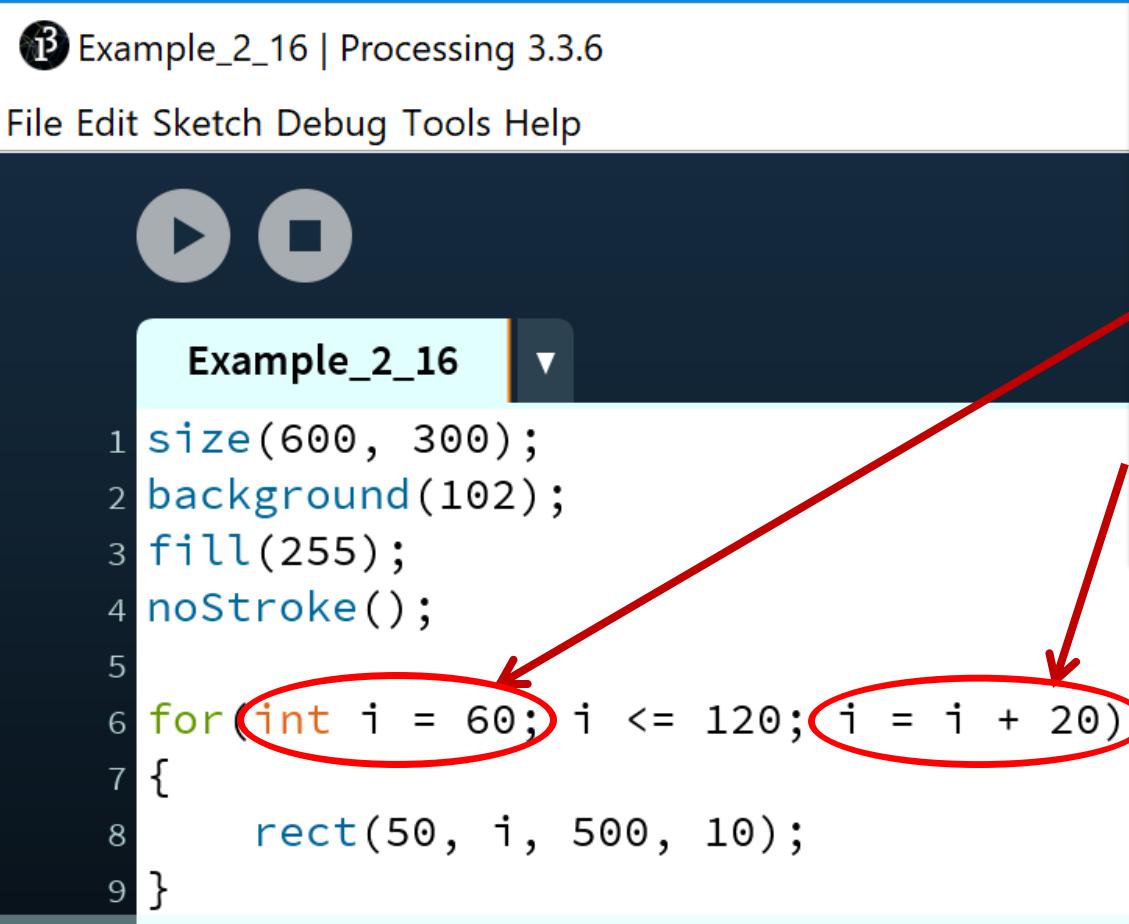
```
1 int yCoordinate = 60;
2
3 size(600, 300);
4 background(102);
5 fill(255);
6 noStroke();
7
8 for(int i = 0; i < 4; i++)
9 {
10     rect(50, yCoordinate, 500, 10);
11     yCoordinate = yCoordinate + 20;
12 }
```

**Q:** Do we need the **yCoordinate** variable?

Can you think of a different approach using a **for** loop?



# Processing Example 2.16



The screenshot shows the Processing IDE interface with the title bar "Example\_2\_16 | Processing 3.3.6". Below the title bar is a menu bar with "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The main workspace displays the code for "Example\_2\_16". The code is as follows:

```
1 size(600, 300);
2 background(102);
3 fill(255);
4 noStroke();
5
6 for(int i = 60; i <= 120; i = i + 20)
7 {
8     rect(50, i, 500, 10);
9 }
```

Two lines of code are highlighted with red ovals: "int i = 60;" and "i = i + 20". Red arrows point from these ovals to the explanatory text on the right.

A: We can eliminate the **yCoordinate** variable by setting the **i** variable to 60 and incrementing it by 20.



# For loop: all parts are optional

---

```
for ( ; ; )  
{  
    // statements here  
}
```

This is an infinite loop...

## For loops can be nested

```
for (int i=0; i < 4; i++)  
    for (int j=0; j < 4; j++)  
        println("The value of i is: " + i + " and j is: " + j);
```

The value of i is: 0 and j is: 0  
The value of i is: 0 and j is: 1  
The value of i is: 0 and j is: 2  
The value of i is: 0 and j is: 3  
The value of i is: 1 and j is: 0  
The value of i is: 1 and j is: 1  
The value of i is: 1 and j is: 2  
The value of i is: 1 and j is: 3  
The value of i is: 2 and j is: 0  
The value of i is: 2 and j is: 1  
The value of i is: 2 and j is: 2  
The value of i is: 2 and j is: 3  
The value of i is: 3 and j is: 0  
The value of i is: 3 and j is: 1  
The value of i is: 3 and j is: 2  
The value of i is: 3 and j is: 3

# Topics list

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- There are three types of loop in programming:
  - While loops:
    - Counter controlled (n times) - covered in previous talk
    - Sentinel based (covered later in the course)
    - Flag based (covered later in the course)
  - For loops (this slide deck)
  - Do While loops (covered later in the course)
- Comparative use of while and for loops
  - Lab02a - Challenge 1
  - Lab02a - Challenge 3



# for versus while

Processing Example 2.15(for loop)

```
for(int i = 0; i < 4; i++)
{
    rect(50, yCoordinate, 500, 10);
    yCoordinate += 20;
}
```

Processing Example 2.13 (while loop)

```
int i = 0;
while(i < 4)
{
    rect(50, yCoordinate, 500, 10);
    yCoordinate += 20;
    i++;
}
```

Variable **i** is the Loop Control Variable (**LCV**). It must be initialised, tested and changed.

**int i = 0** is the **initialisation**.

**i < 4** is the boolean condition i.e. the **test**

**i++** is the post-body action i.e. the **change**.

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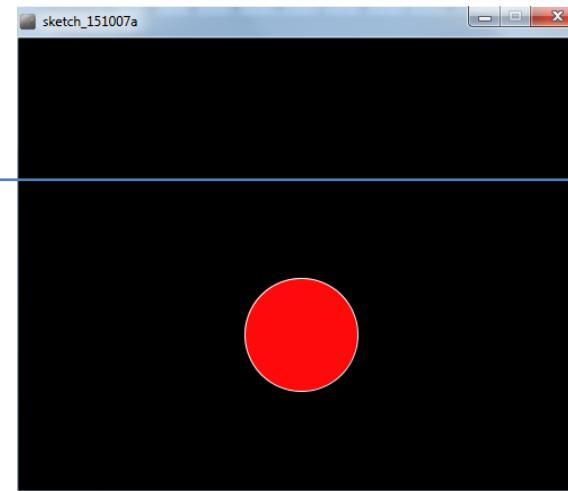
# Lab02a - Challenge 1 – bouncing ball

Draw a continuously bouncing ball. (vertical only)

- the **xCoordinate** remains the **same** value  
the **yCoordinate** will **change**.

Assumptions:

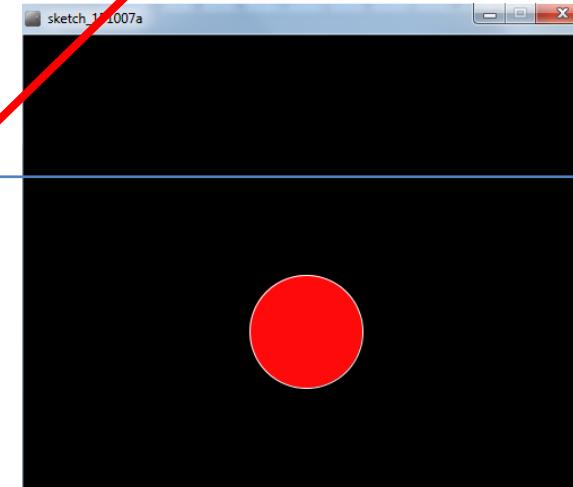
- display window is **500 x 400**
- ball is **100** in diameter.
- static **xCoordinate** is **250**.
- **background** is called in the **draw()** method.
- starting **yCoordinate** is **300**.



# Lab02a - Challenge 1

```
float yCoordinate = 300;  
  
void setup() {  
    size(500,400);  
    fill(255, 10, 10);  
    stroke(255);  
}
```

```
void draw() {  
    background(0);  
    ellipse(250, yCoordinate, 100, 100);  
}
```



## Assumptions:

- display window is **500 x 400**
- ball is **100** in diameter.
- static **xCoordinate** is 250.
- **background** is called in the **draw()** method.
- starting **yCoordinate** is 300.

# Lab02a - Challenge 1

```
float yCoordinate = 300;  
boolean bounceUp = false;  
  
void setup() {  
    size(500,400);  
    fill(255, 10, 10);  
    stroke(255);  
}  
  
void draw() {  
    background(0);  
    ellipse(250, yCoordinate, 100, 100);  
  
    if (bounceUp)  
        // code to bounce the ball up  
    if (!bounceUp)  
        // code when ball is falling  
}
```

- We need to track whether the ball is bouncing up or falling.
- To do this, we will use a boolean variable **bounceUp**.  
It will be:
  - **true** if the ball is bouncing up
  - **false** if the ball is falling and

```
float yCoordinate = 300;  
boolean bounceUp = false;  
  
void setup() {  
    size(500,400);  
    fill(255, 10, 10);  
    stroke(255);  
}
```

```
void draw() {  
    background(0);  
    ellipse(250, yCoordinate, 100, 100);
```

```
//ball is bouncing up  
if (bounceUp){  
    if (yCoordinate > 100)  
        yCoordinate = yCoordinate - 1;  
    else  
        bounceUp = false;  
}
```

```
//ball is falling down  
if (!bounceUp){  
    if (yCoordinate <= 350)  
        yCoordinate = yCoordinate + 1;  
    else  
        bounceUp = true;  
}  
}
```

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# Lab02a - Challenge 3 – Moving Line

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- In a new sketch, draw a **vertical line** that is the height of your display window.
- It starts in the left most position of your display window and **moves right, pixel by pixel**, until it reaches the right hand side of your display window.

# Lab02a - Challenge 3 – Moving Line

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- Upon reaching the right hand side, the vertical line should **reverse direction** and return, pixel by pixel, to the left hand side of the display window.
- As your vertical line is continually traversing the display window, your **grayscale background should be varying** very slightly in colour.

# Lab02a - Challenge 3 – Moving Line

---

## Assumptions:

- Window size 300x400.
- Background is initially set to 120.
- Stroke weight is 4

```
float background = 120;  
  
void setup()  
{  
    size(300,400);  
    background(background);  
    strokeWeight(4);  
}
```

# Lab02a - Challenge 3 – Moving Line

- Draw a **vertical line** that is the height of your display window.
- Call background to **clear the previously drawn line**.

```
void draw()
{
    background(background);
    line(xCoordinate, 0, xCoordinate, height);
}
```

```
float background = 120;
float xCoordinate = 0.0;

void setup(){
    size(300,400);
    background(background);
    strokeWeight(4);
}
```

# Lab02a - Challenge 3 – Moving Line

This vertical line should start in the left most position of your display window and **move right, pixel by pixel**, until it reaches the right hand side of your display window.

```
void draw(){  
    xCoordinate = xCoordinate + 1;  
    background(background);  
    line (xCoordinate, 0, xCoordinate, height);  
}
```

# Lab02a - Challenge 3 – Moving Line

As your vertical line is continually traversing the display window, your **grayscale background** should be **varying** very slightly **in colour**.

```
void draw(){  
    xCoordinate = xCoordinate + 1;  
    background = background + 0.5;  
    background(background);  
    line (xCoordinate, 0, xCoordinate, height);  
}
```

# Lab02a - Challenge 3 – Moving Line

---

- Upon reaching the right hand side, the vertical line should **reverse direction** and return, pixel by pixel, to the left hand side of the display window.
- We need to keep track of the direction that the line should be moving  
i.e. is it going left-to-right, or has it reversed direction and gone from right-to-left?
- We will use a boolean variable to do this:
  - boolean **reverseDirection** will be initially set to false.  
indicating a left-to-right direction.
  - **false** indicates a **left-to-right direction**
  - **true** indicates a **right-to-left direction**.

# Lab02a – Challenge 3

```
void draw()
{
    if (!reverseDirection){
        background = background + 0.5;
        xCoordinate = xCoordinate + 1;
    }
    else{
        background = background - 0.5;
        xCoordinate = xCoordinate - 1;
    }

    background(background);
    line (xCoordinate, 0, xCoordinate, height);
}
```

```
float background = 120;
float xCoordinate = 0.0;
boolean reverseDirection = false;

void setup(){
    size(300,400);
    background(background);
    strokeWeight(4);
}
```

# Lab02a - Challenge 3 – Moving Line

---

- But, we have no code written that will set the flag to true  
e.g.

**boolean reverseDirection = true;**

- Under what circumstances should the flag be set to true?
- And when should it be set back to false?

```
void draw(){
    if (xCoordinate == width)
        reverseDirection = true;
    if (xCoordinate == 0)
        reverseDirection = false;

    if (!reverseDirection){
        background = background + 0.5;
        xCoordinate = xCoordinate + 1;
    }
    else{
        background = background - 0.5;
        xCoordinate = xCoordinate - 1;
    }

    background(background);
    line (xCoordinate, 0, xCoordinate, height);
}
```

```
float background = 120;
float xCoordinate = 0.0;
boolean reverseDirection = false;

void setup(){
    size(300,400);
    background(background);
    strokeWeight(4);
}
```

# Questions?

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