Iteration in Programming

for loops

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Topics list

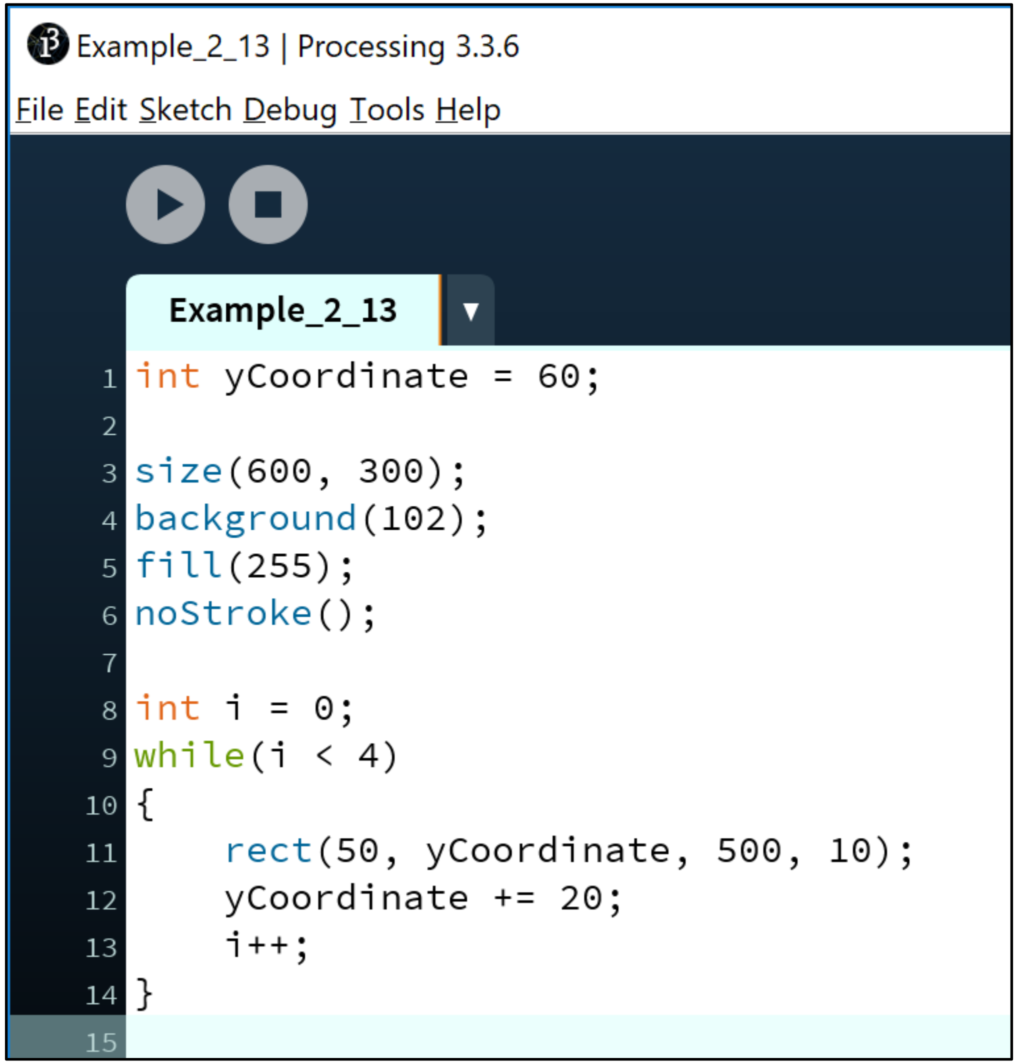
- There are three types of loop in programming:
  - **While** loops:
    - Counter controlled (n times) - covered in previous talk
    - Sentinel based (covered later in the course)
    - Flag based (covered later in the course)
  - **For** loops (this slide deck)
  - **Do While** loops (covered later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

For loop pseudo-code

General form of a for loop

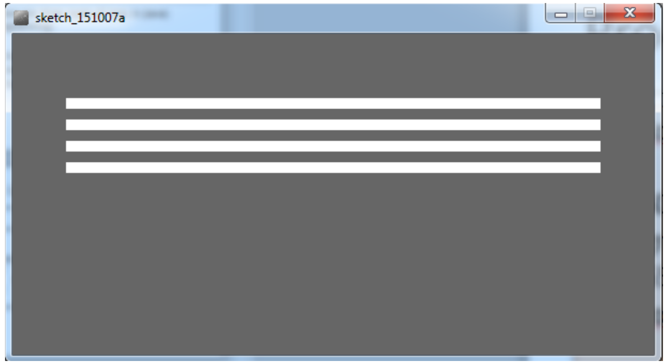
```
for( initialization; boolean condition; post-body action)
{
    statements to be repeated
}
```

Recap: Processing Example 2.13

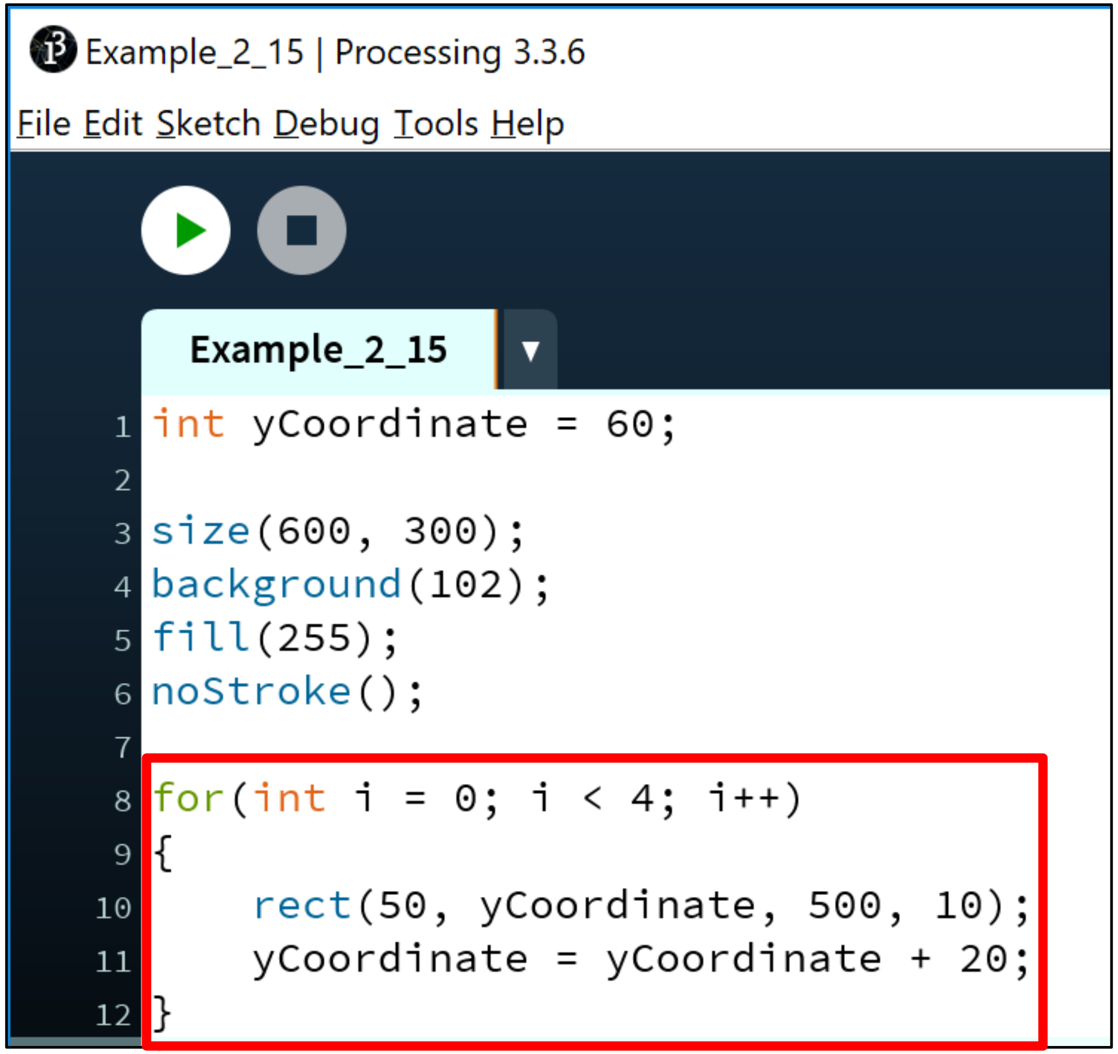

Example_2_13 | Processing 3.3.6
File Edit Sketch Debug Tools Help
Example_2_13

```
int yCoordinate = 60;

size(600, 300);
background(102);
fill(255);
noStroke();

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

```

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


Example_2_15 | Processing 3.3.6
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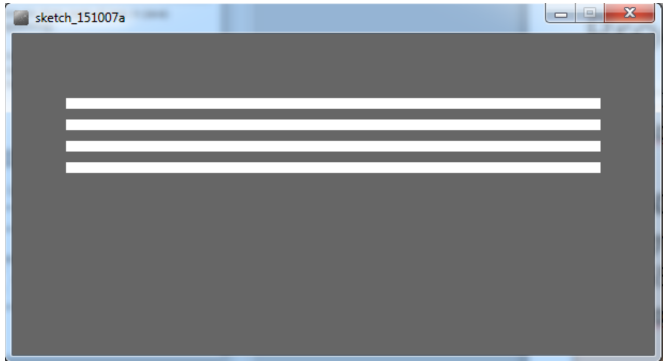
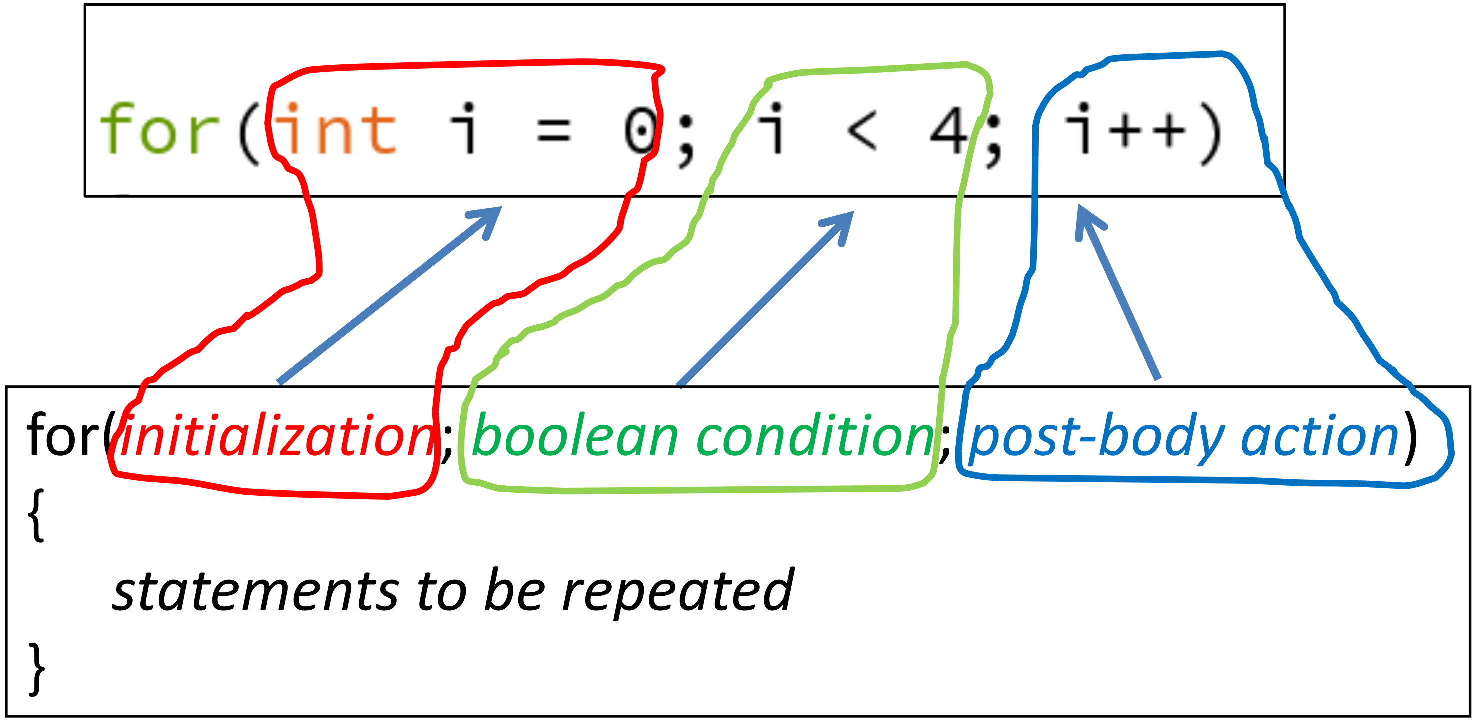
Example_2_15

```
int yCoordinate = 60;

size(600, 300);
background(102);
fill(255);
noStroke();

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

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



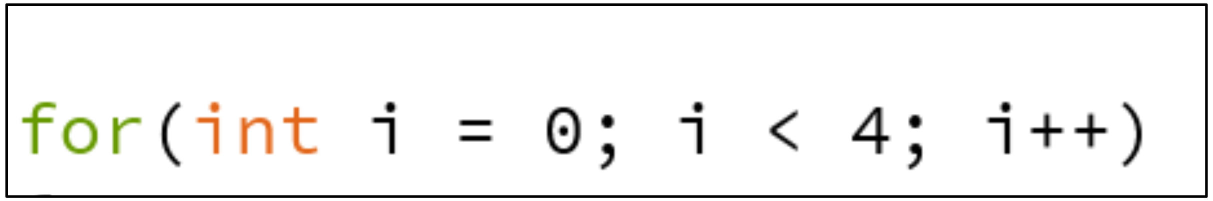
For loop syntax



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

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

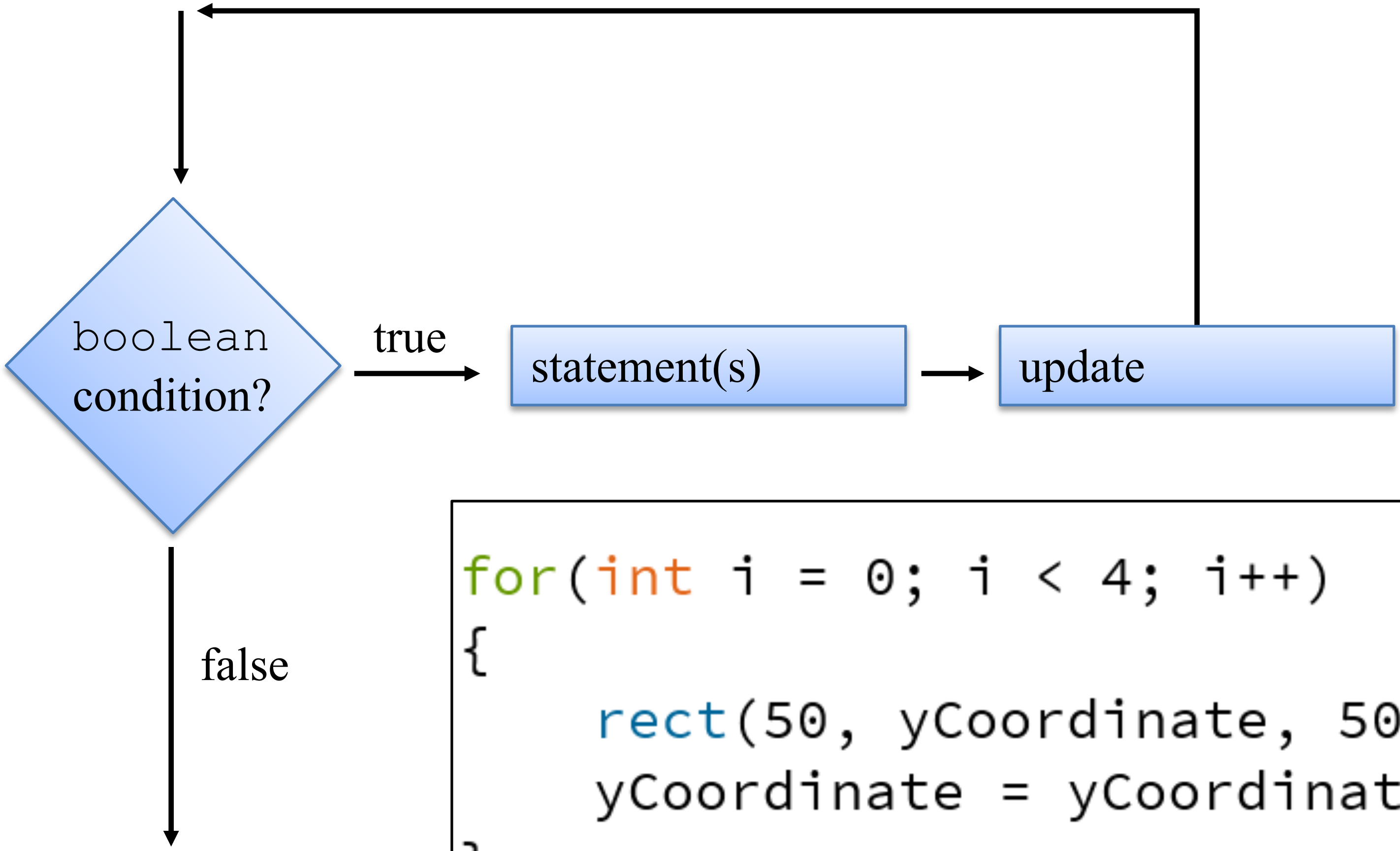
For loop syntax

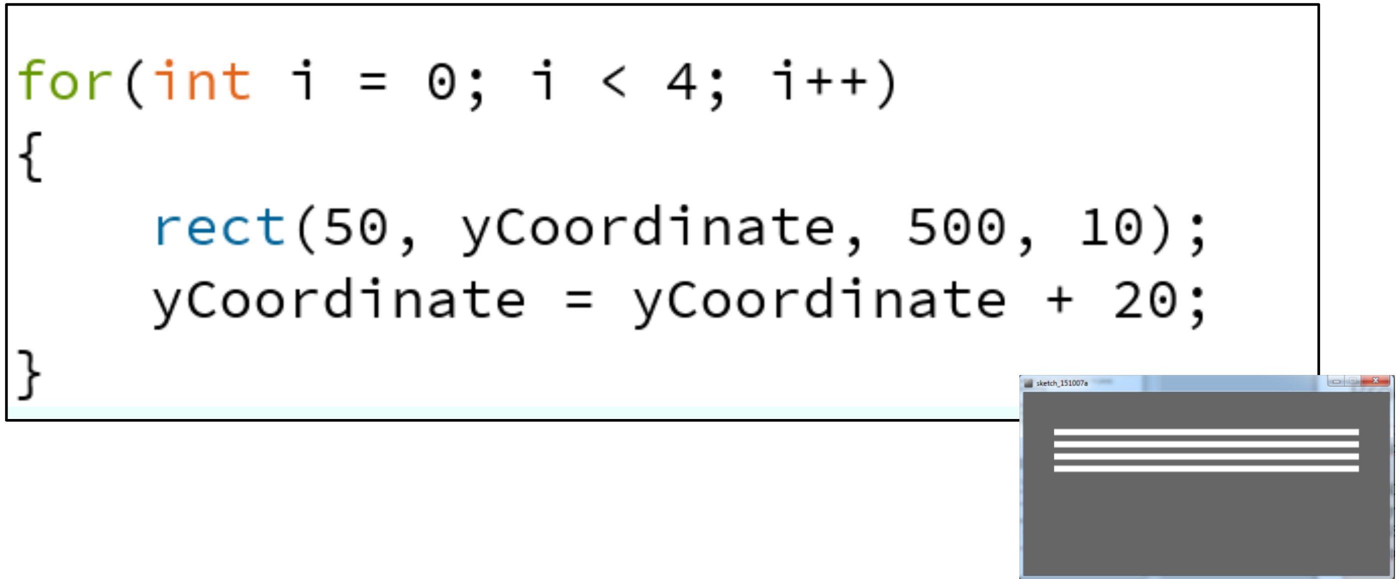


```
for(int i = 0; i < 4; i++)
```

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

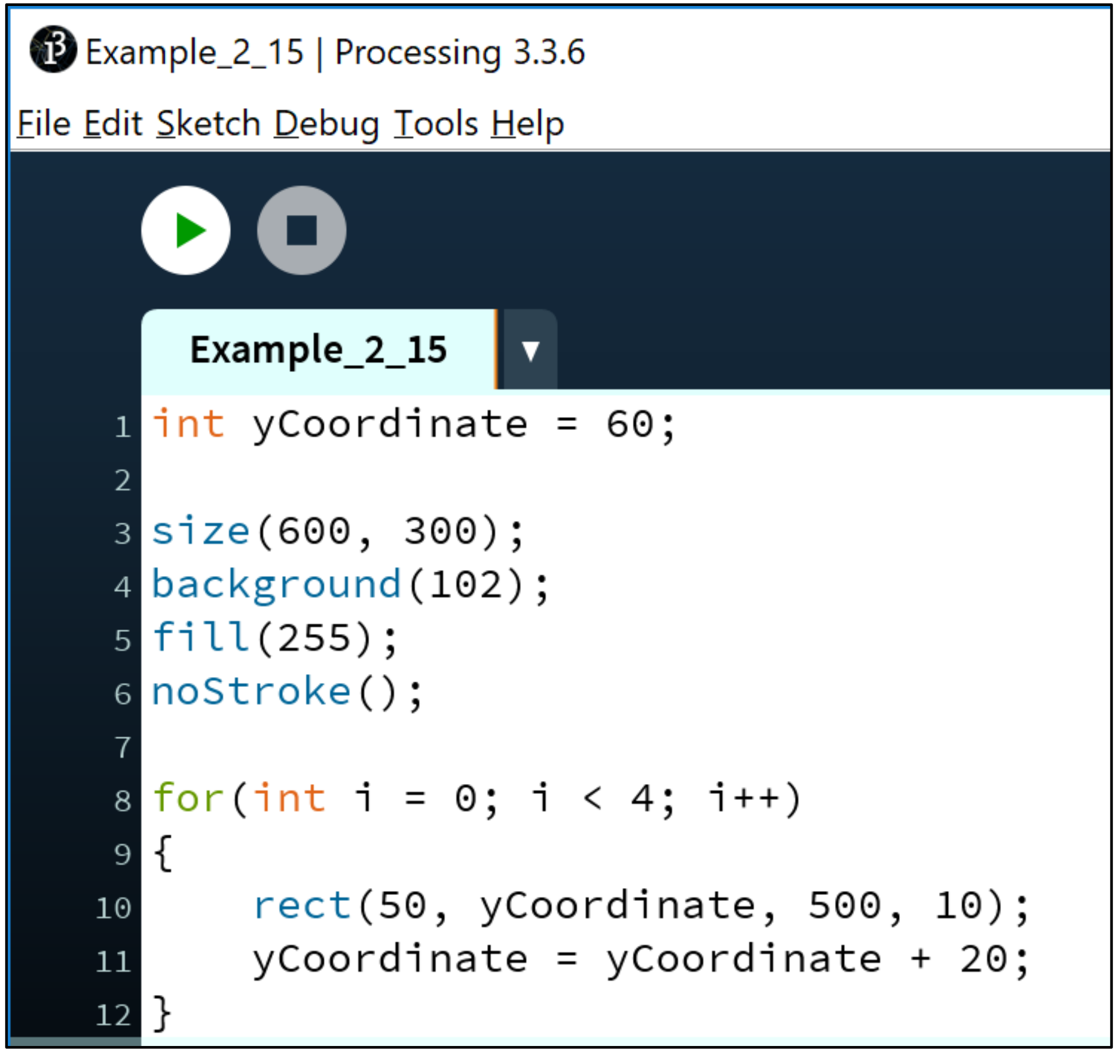
`for` Loop Flowchart





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

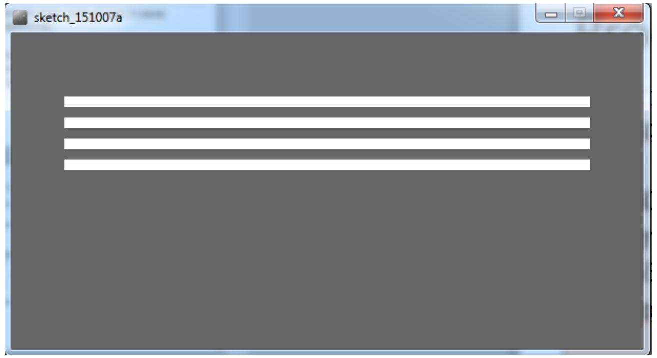
Returning to: Processing Example 2.15


Example_2_15 | Processing 3.3.6
File Edit Sketch Debug Tools Help
Example_2_15

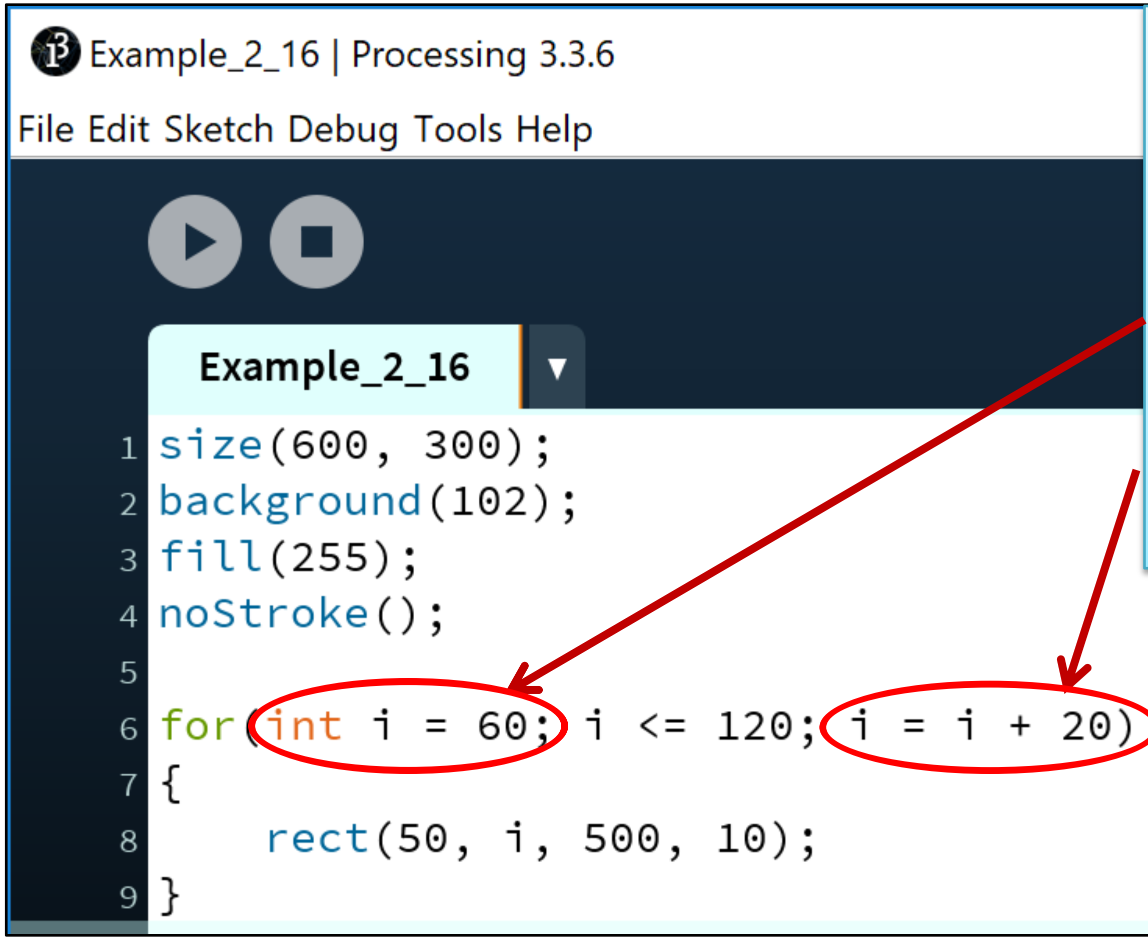
```
int yCoordinate = 60;

size(600, 300);
background(102);
fill(255);
noStroke();

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

Q: Do we need the yCoordinate variable?

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



Processing Example 2.16

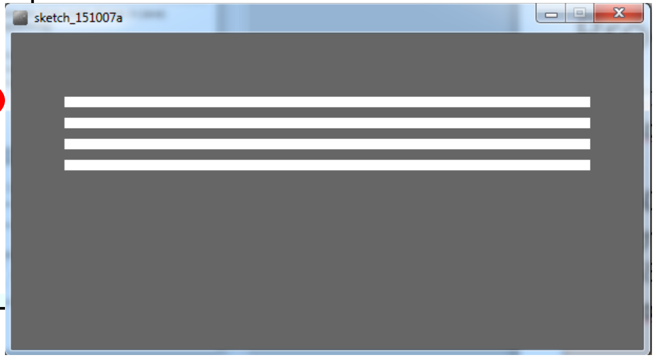

Example_2_16 | Processing 3.3.6
File Edit Sketch Debug Tools Help
Example_2_16

```
size(600, 300);
background(102);
fill(255);
noStroke();

for(int i = 60; i <= 120; i = i + 20)
{
    rect(50, i, 500, 10);
}
```

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

- There are three types of loop in programming:
  - While loops:
    - Counter controlled (n times) - covered in previous talk
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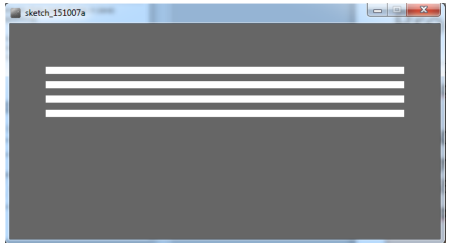
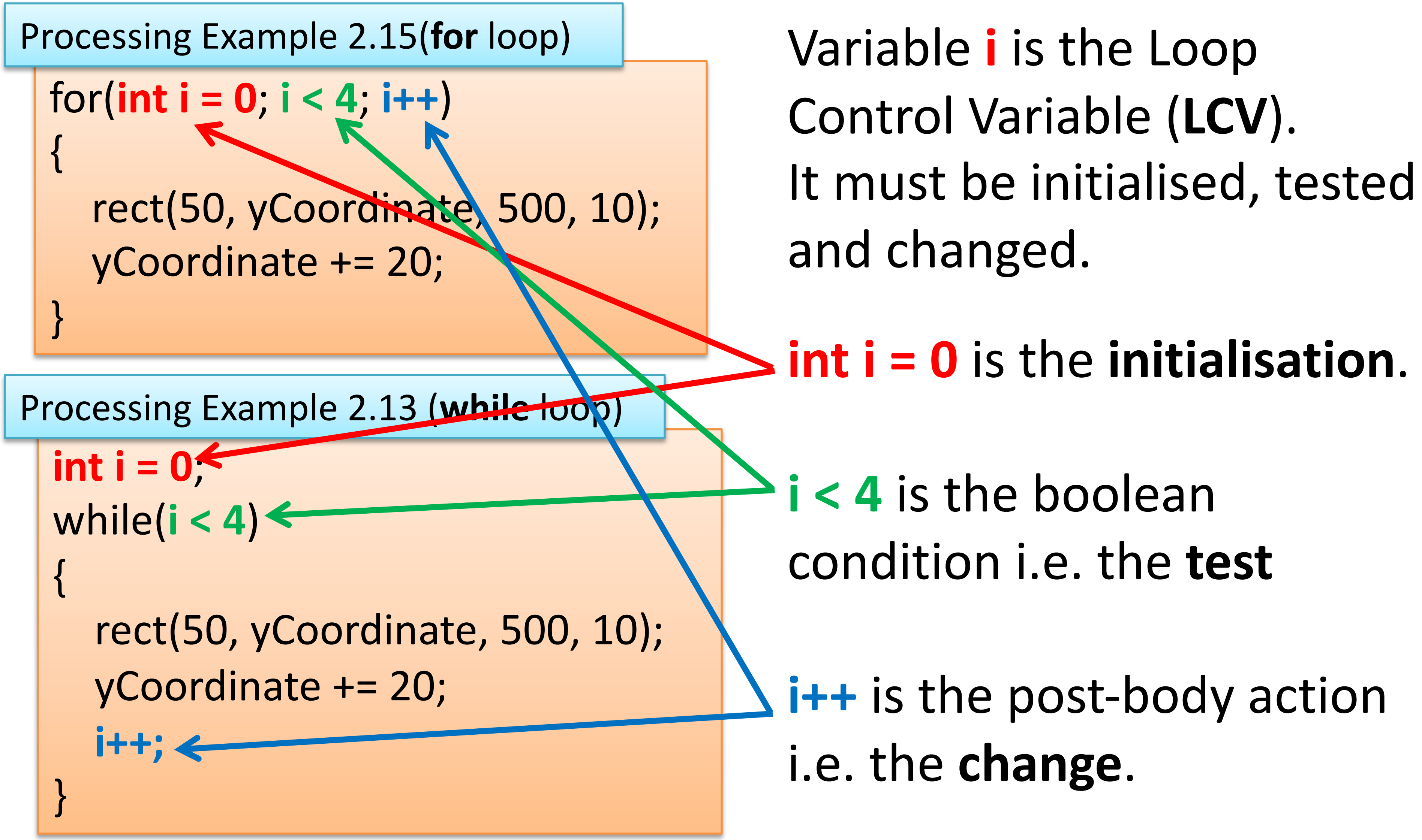


for versus while



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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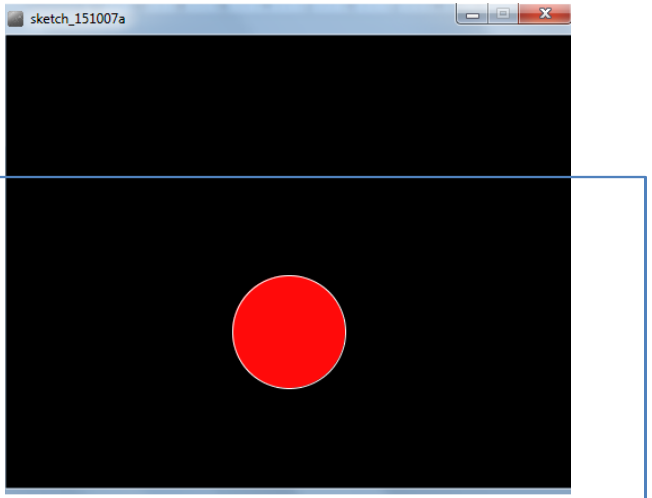
Lab02a - Challenge 1 – bouncing ball

Draw a continuously bouncing ball. (vertical only)

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



Assumptions:

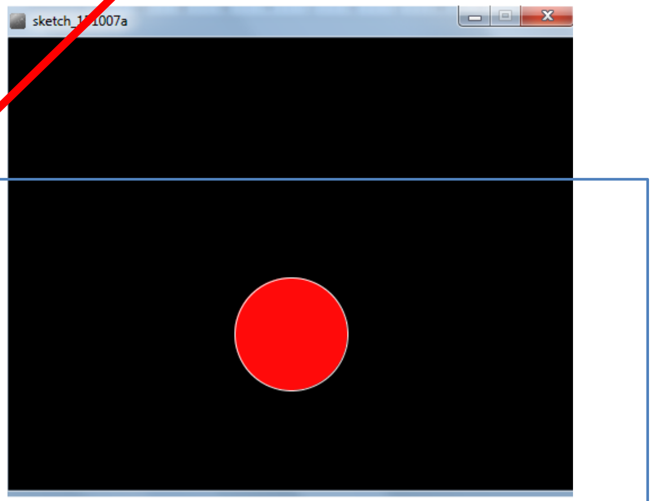
- display window is **500 x 400**
- ball is **100** in diameter.
- static **xCoordinate** is 250.
- **background** is called in the draw() method.
- starting **yCoordinate is 300**.

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

- In a new sketch, draw a **vertical line** that is the height of your display window.

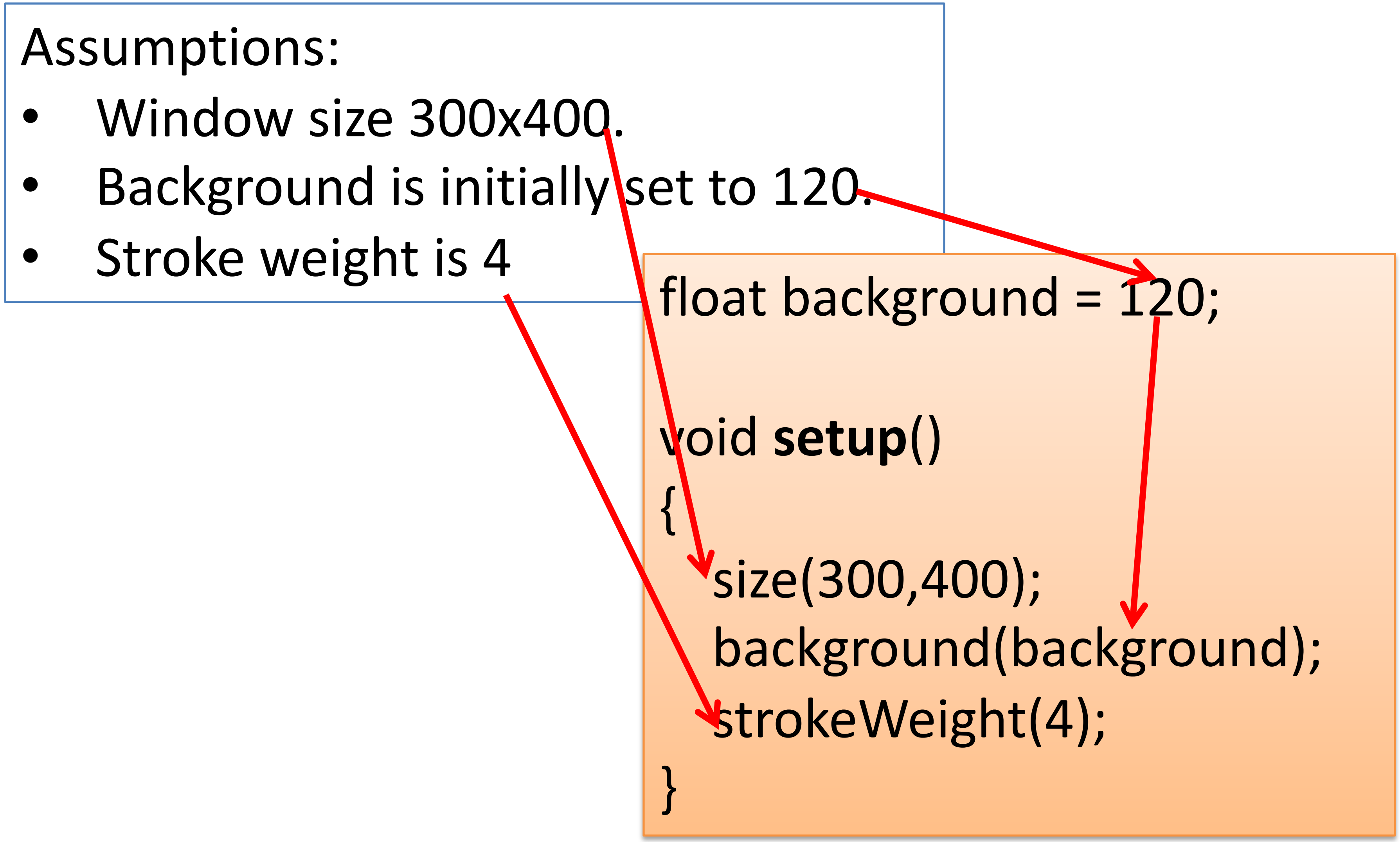
- It starts in the left most position of your display window and **moves right, pixel by pixel**,
  until it reaches the right hand side of your display window.

Lab02a - Challenge 3 – Moving Line

- 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



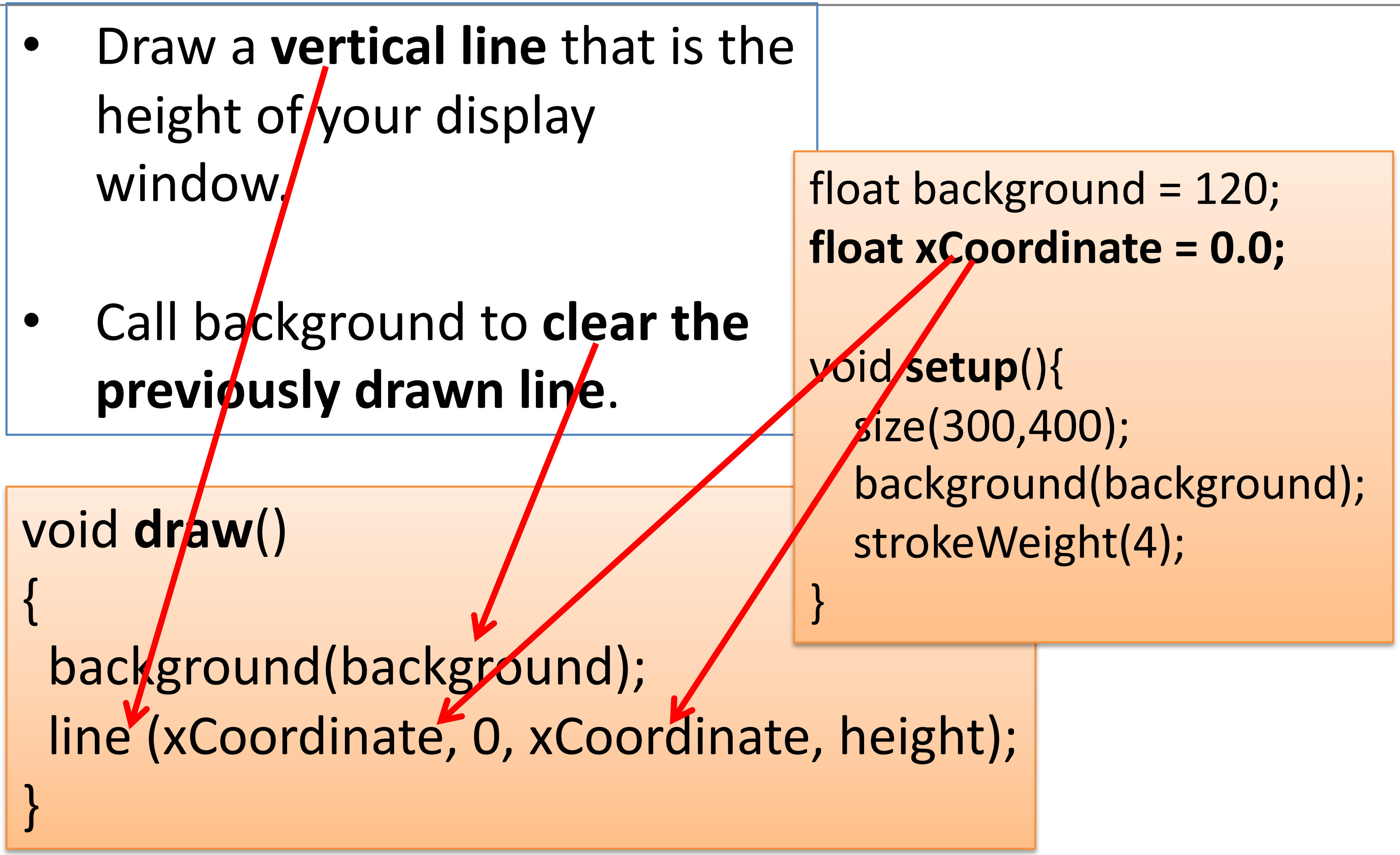
Assumptions:

- 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**.

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

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

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

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

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

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

```
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);
}
```

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?