Processing 01

Environment

File handling

Syntax

Drawing

Conditionals

Loops

Variables

UIC / ART150 / Raaf

What is Processing?

From http://www.processing.org:

"Processing is an open source programming language and environment for people who want to program images, animation, and interactions.

It is used by students, artists, designers, researchers, and hobbyists for learning, prototyping, and production. It is created to teach fundamentals of computer programming within a visual context and to serve as a software sketchbook and professional production tool. Processing is developed by artists and designers as an alternative to proprietary software tools in the same domain."

The original authors of Processing are Casey Reas and Ben Fry, who studied together under John Maeda at MIT.

Casey Reas:
Biographical Info
Works

Ben Fry:
Biographical Info
dismap/
distellaprocess/

John Maeda:
Biographical Info
Paint by Numbers
Maeda Studio

Code References

http://processing.org/reference

alternatively: highlight a word within your Processing sketch code then ctrl (or command) click on it to bring up reference information

Tutorial sites (too many to list)

https://hello.processing.org/guide/

http://processing.org/learning

Nature of Code by Daniel Shiffman - https://natureofcode.com/

introduction/https://thecodingtrain.com/

Open Source Example Sites:

OpenProcessing.org

https://studio.sketchpad.cc/

http://studio.sketchpad.cc/sp/padlist/all-portfolio-sketches

Online Editors

https://editor.p5js.org/

https://openprocessing.org/sketch/create

Folder Architecture

All Processing projects are called sketches.

- **Where to find and save your sketch files?** Each sketch resides in its own folder. You can browse to this folder by choosing Sketch -> Show Sketch -> Folder from the Processing menu.
- Your sketches will be saved inside of the user/Documents folder on your computer
- You can change this location in the application Preferences

File handling and exporting

Each sketch (.pde file) sits in its own folder, within the Processing folder

Sketch name: “My_First_Sketch_01.pde",
Sits in a folder called "My_First_Sketch_01"

The main file and the folder need to have the same name. Do not rename the file, unless you also rename the folder (to the same name). Do not consolidate similar sketches into one folder. Folders should only contain one main sketch and any assets (such as pictures or videos) and/ or additional sketches that add functionality to the main sketch.

PREVIEWING FOR WEB: If you click on ‘export’ in the Processing menu bar, an ‘applet’ will be created in a subfolder. You can double-click it to view the sketch in a Web browser. However, applet support is being phased out so this is only good for a quick preview on your own desktop/ browser.

Environment + Toolbar

The GUI consists of a text editor for writing code, message area, console, menu, toolbar, tabs for managing files

Run: Compiles the code, opens a display window, and runs the program inside.

Stop: Terminates a running program, but does not close the display window.

Canvas size, Coordinates & Drawing in Processing

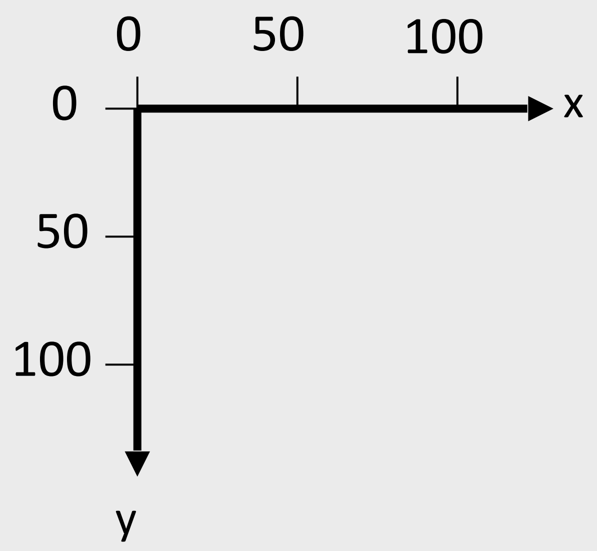
The size of the display window is controlled with the size() function:
size(width, height)

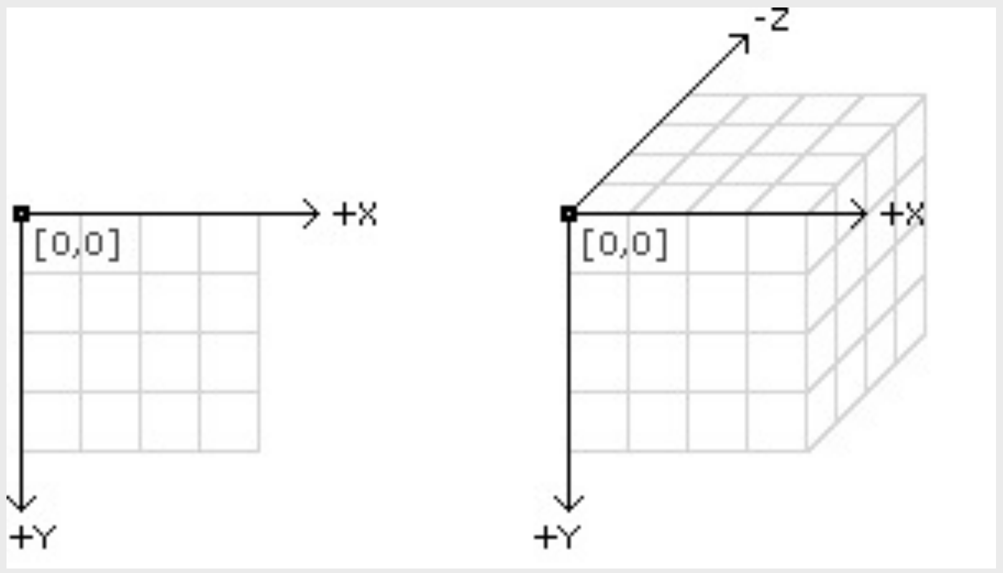
The size function has two parameters: the first sets the width of the CANVAS (ie, the window) and the second sets its height.

A position on the screen is comprised of an x-coordinate and a y-coordinate. The x-coordinate is the horizontal distance from the origin and the y-coordinate is the vertical distance.

In a 400 pixel wide by 400 high window, [0, 0] is the upper-left pixel, [320, 240] is in the lower-right. The last visible pixel in the lower-right corner of the screen is at [319, 239]

Coordinate system





Drawing

Defining the canvas size: `size(300, 300);` // 300 pixels wide, 300 pixels high

Setting the background color:

```
background(0); //black
background(255); //white
background(255, 0, 0); //makes canvas red in rgb syntax
```

COLOR

Color are represented in greyscale numerically as 0-255 in value. Alternatively, they are represented in RGB with Red, Green, Blue, and Aplha (transparency) values.

https://processing.org/tutorials/color/

Syntax

Common elements of the programming language and how they are used:

- a Statement followed by a Terminator (typically ';')
- a Function which defines a series of instructions. It can return a value or values.
  example void draw()
- a Variable - a placeholder for a value (numeric, text, etc)
- a Comment - //

```
//example statements
    line(10, 80, 30, 40);

    int i = i + 1;

    String txt = "Boots and Pants";  // create a variable named txt

    println(txt);  // println is a function
```

note: **Processing is case-sensitive**: String, not string!

Comments

- Comments are non-program text you put in the file to describe to others (and yourself) what you're doing
- Important for being able to look back at your code and understand it
- Single-line comments begin with `//`
- Multi-line comments begin with `/*` and end with `*/`

`Commenting and uncommenting lines useful for figuring out code`

Defining Stroke and Fill Color

```
stroke(120); // gray stroke
stroke(0, 0, 255); // blue stroke
stroke(200, 80); // gray fill, transparent
noStroke(); // no Stroke
fill(100); // gray fill
fill(255, 0, 0); // red fill
fill(0, 255, 0, 127); // green fill semi transparent
noFill();
```

Each hue or gray scale value may be 0-255.

- If there is only **one number** = a gray scale value
- If there are **three numbers** = R,G,B or red, green, blue values
- If there are **two or four numbers**, then the last number indicates an alpha - ie, transparency or opacity.

Alpha values also may be between 0-255. A value of 255 being opaque

strokeWeight() and smooth()

```
background(0);     // Sets the black background
stroke(255);       // Sets line value to white
strokeWeight(5);   // Sets line width to 5 pixels
smooth();          // Makes lines with smooth edges
line(10, 80, 30, 40);  // Left line
line(20, 80, 40, 40);
line(30, 80, 50, 40);  // Middle line
line(40, 80, 60, 40);
line(50, 80, 70, 40);  // Right line
```

example:

```
rect(10, 10, 50, 50);
fill(204);  // Light gray
rect(20, 20, 50, 50);
fill(153);  // Middle gray
rect(30, 30, 50, 50);
fill(102);  // Dark gray
rect(40, 40, 50, 50);
```

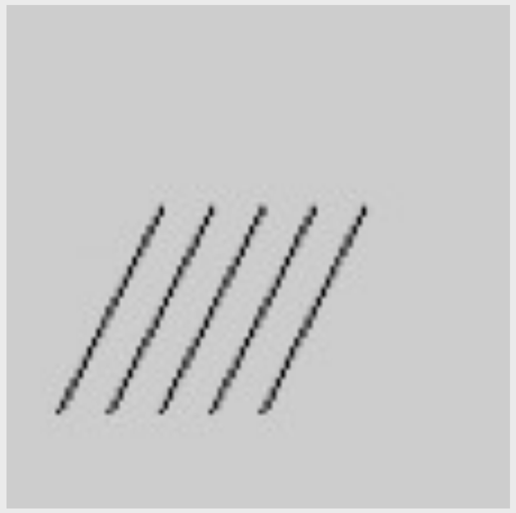
Drawing Graphic Primitives

```
size(200, 200);

//draws a point at x=10 and y=20
point(10, 10);

// draws a line from  x1, y1 to x2, y2
line(10, 10, 100, 100);

// draws a rectangle over  x1, y1, width, height
rect(10, 10, 180, 140);

// draws an ellipse x, y, width, height
ellipse(120, 50, 40, 40);

// draws a four sided polygon x1, y1, x2, y2, x3, y3, x4, y4
quad(38, 31, 86, 20, 69, 63, 30, 76);

// draws a triangle x1, y1, x2, y2, x3, y3
triangle(120, 120, 80, 160, 160, 180);
```

Lines

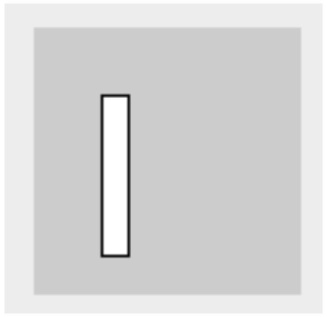
Example using lines:

```
line(10, 80, 30, 40);  // Left line
line(20, 80, 40, 40);
line(30, 80, 50, 40);  // Middle line
line(40, 80, 60, 40);
line(50, 80, 70, 40);  // Right line
```



Drawing Shapes

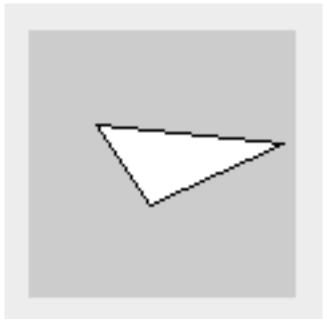
```
rect(x, y, width, height)
```



```
rect(25, 25, 10, 60);
```

Drawing Shapes

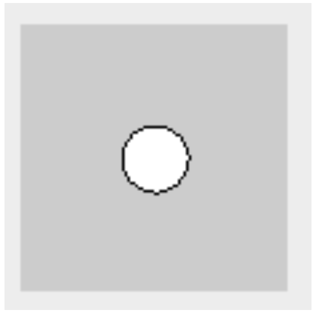
```
triangle(x1, y1, x2, y2, x3, y3)
```



```
triangle(25, 35, 45, 65, 95, 42);
```

Drawing Shapes

```
ellipse(x, y, width, height)
```



```
ellipse(50, 50, 25, 25);
```

Alternative methods to draw rectangles

- rectMode(CENTER)
- rectMode(CORNER) //default
- rectMode(CORNERS)

Example code:

```
rectMode(CENTER);
rect(35, 35, 50, 50);
rectMode(CORNERS);
fill(100);
rect(35, 35, 50, 50);
```

https://processing.org/reference/rectMode_.html

Programming

programming a **STATIC sketch**

the code runs through once, from start to finish.
it does not loop.

for example:

```
size(200, 200); // define the window size
background(255); // make a canvas with white background
noStroke();  // no outlines
fill(255, 204, 0);
rect(30, 20, 50, 50);
```

the code has no 'void draw ()' function to make it loop.
note: p5.js uses 'function draw ()' instead of void draw ().

Looping

programming a **CONTINUOUS** sketch

Adding more structure to a program opens further possibilities. The `setup()` and `draw()` functions make it possible for the program to run
continuously – this is required to create animation and interactive programs.

```
void setup()
{ size(200, 200);
  noStroke();
  background(255);
  fill(0, 102, 153, 20);
  smooth();
}

void draw()
{
  ellipse(mouseX, mouseY, 50, 50);
}
```

Syntax

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- a Function which defines a series of instructions. It can return a value or values.
  example void draw()
- a Variable - a placeholder for a value (numeric, text, etc)
- a Comment - //

```
//example statements
    line(10, 80, 30, 40);

    int i = i + 1;

    String txt = "Boots and Pants";  // create a variable named txt

    println(txt);  // println is a function
```

note: **Processing is case-sensitive**: String, not string!

Variables

- used to store values

- has a name (that you choose) & a value (choose a name that is descriptive)

- the name is Case-sensitive

- the name must not begin with special characters

```
String name = "ham";   // Declare and assign int
number = 32;   // Declare and assign
int counter = 12;   // Declare and assign
print(number);
print(name);
print(counter);
println(number); //  println prints the line with a carriage return afterwards
println(name);
println(counter);
```

Variable / Data Types

```
int //Integer: e.g. 1, 2, 3, ...
float //Floating point number: e.g. 0.1, 2.747, ...
char //Character: “$”, “A”, stores one character.
String //String: e.g. ”skinny jeans”, series of characters.
boolean //Boolean: true or false;  1 or 0.
```

```
int x;        // Declare the variable x of type int
float y;      // Declare the variable f of type float
boolean b;    // Declare the variable b of type boolean
x = 50;       // Assign the value 50 to x
y = 12.6;     // Assign the value 12.6 to f
b = true;     // Assign the value true to b
```

When we declare variable we want to tell Processing what type of information those variables will store. Think how a program would need treat a name such as "Sarah" (called a STRING datatype in processing) differently from numeric information such as a temperature reading like 98.6 (called a FLOAT data type in processing).

Common **data types**:

int - whole numbers, positive or negative. *See More on reference page.*
int age = 26;

float - decimal, positive or negative. *See More on reference page.*
float sensorValue = 2.751;

String - text as opposed to numbers. *See More on reference page.*
String currentName= "Grizelda";

boolean - true or false (1 = true, 0 = false). *See More on reference page.*
boolean mode1 = false;

char - a single character such as a letter or a symbol. *See More on reference page.*
char letter = 'A';

When you declare a variable, first write the **DATA TYPE**, then the **NAME OF THE VARIABLE** and then you can either leave the value unspecified (and define it later) or define it there on the spot by adding an equal signs and assigning it a value.

For example. If you know you only need whole numbers for a value, an integer (or int) is most appropriate:

int age;
OR
int age = 30;

If you know that you will need decimal based or fractional numbers, it is more appropriate to use a floating point number of float.

float weight = 116.52;

If you know you will be displaying text, then a String is most appropriate.

String label1 = "Great Visuals Require Work";

STEP 3: Putting it to use

Now we will look at a little Sketch that uses a float value to change the rotation of an ellipse with every frame. The code looks like this:

```
//**********************

float rval=0;

void setup(){
size(1200,800);
background(0);
stroke(0,0,225,45);
smooth();
noFill();
}
```

Scope of Variables

Local Variables

Declared inside a function.
Can only be used inside the function where it is declared.

```
void setup(){
      int bgColor = 200;    // local variable
      background(bgColor); // use local variable
}

void draw(){
   background(bgColor);    //Error: cannot use bgColor here
   line(0, 0, width, height);
}
```

Scope of Variables

Global Variable

Declared outside the setup() and draw().
Can be used anywhere in your sketch.

```
int bgColor = 200; // global variable

void setup(){
   background(bgColor); // use global variable
}

void draw(){
   background(bgColor); //use global variable
   line(0, 0, width, height);
}
```

Scope of Variables

If a local variable is declared with the same name as a global variable, the program will use the local variable to make its calculations within the function it is sitting in.

```
int bgColor = 200;   // set global variable

void setup() {
  int bgColor = 100;// local variable, redefine the
                      value of bgColor
background(bgColor); // uses local variable value
}

void draw() {
  background(bgColor); // use global variable because
                        we are in a different function
  line(0, 0, width, height);
}
```

Mouse Interaction

mouseX, mouseY
Stores the current position of the mouse inside the window

pmouseX, pmouseY
Stores the position of the mouse in the previous frame inside the window

mousePressed, mousePressed()
Used to detect if/when the mouse is being pressed (clicked)

mouseButton
Stores information about what button is being pressed

mouseReleased()
Called every time the mouse is released

mouseDragged()
Called every time when the mouse is dragged (pressed and moved)

mouseMoved()
Called every time when the mouse moves and not pressed

Mouse Interaction

mouseX, mouseY

```
void setup()
{
   size(500, 200);
   strokeWeight(5);
   stroke(0, 100);
   smooth();
}

void draw()
{
   ellipse(mouseX, mouseY, 5, 5);
}
```

Mouse position

`mouseX`: X-Position the mouse

`mouseY`: Y-Position

```
line(mouseX, 20, mouseX, 80);
```

mousePressed returns true while mouse is pressed, false if not.

```
void draw() {
  if (mousePressed == true) {
    fill(0);
  } else {
    fill(255);
  }
  rect(25, 25, 50, 50);
}
```

Mouse Interaction I

mouseX, mouseY

pmouseX, pmouseY

pmouseX and pmouseY contains the previous horizontal and previous vertical coordinate of the mouse. It is the position of the mouse in the frame previous to the current frame.

This is very useful to determine the velocity of a mouse movement or gesture. By subtracting the previous from the current mouse position the current mouse velocity can be determined.

```
void draw()
{
   background(204);
   line(mouseX, 20, pmouseX, 80);
}
```

Conditionals and *Program Flow* *(link)*

Statements within the `if` section are only executed in case the condition (`i < 35`) is `true`; statements within the `else` section are executed only in case the condition is `false`.

```
void setup () {
  size(300, 300);
}

void draw() {
  if(mouseX < 150) {
    line( 0, mouseY, 150, mouseY );
  }
  else {
    line( 150, mouseY, 300, mouseY );
  }
}
```

Relational Operators

Used to compare values (conditionals):

```
>   (greater than)
<   (less than)
>=  (greater than or equal to)
<=  (less than or equal to)
!=  (inequality)
==  (equality)
```

```
5 > 4     // True
5 < 3     // False
5 > 5     // False
5 >= 5    // True
5 >= 6    // False
5 != 5    // False(not equal)
5 == 5    // True
5 == 4    // False
```

Mouse Interaction II

mousePressed

mousePressed is a system variable which is true if the button is pressed and false if the button is not pressed.

```
void setup() {
   size(200, 200);
   rectMode(CENTER);
   background(255);
   smooth();
   noStroke();
}

void draw() {
   if(mousePressed == true) {
      fill(random(255), 100);
   } else {
      fill(0);
   }
   rect(mouseX, mouseY, 30, 30);
}
```

Mouse Interaction III

mousePressed()

The mousePressed() system function is called every time the mouse button is pressed.

```
int fillColor = 0;
void draw() {
   fill(fillColor);
   rect(25, 25, 50, 50);
}
void mousePressed()
{
   if(fillColor == 0) {
      fillColor = 255;
   } else {
      fillColor = 0;
   }
}
```

Loops: **For and While**

The `for()` loop uses defined conditions

```
for (int i=40; i<80; i=i+5) {
  line(30, i, 80, i);
}
```

The `while()` loop repeats as long as the condition is true

```
int i=0;
while (i<80) {
  line(30, i, 80, i);
  i = i+5;
}
```

note: if the test condition in the while loop cannot be false, the program freezes

Using Libraries

Libraries allow you to extend Processing capabilities.

To use a library

1. Download it and extract it.

2. Find the folder that contains the library subfolder and put it inside the Processing libraries folder (put the parent folder, not the library folder directly).

    Mac: Documents->Processing->libraries.
    PC: libraries folder inside your Processing main folder.

Look for libraries at: http://processing.org/reference/libraries/

Using Libraries

Interesting Libraries:

Sudden Motion Sensor:

Allows mac users to use the built-in accelerometer to control Processing sketches.
http://www.shiffman.net/p5/sms/

GUI libraries:

Control P5: http://www.sojamo.de/libraries/controlP5/
GUI Components: http://www.lagers.org.uk/g4p/index.html

Sprites for Processing:

Handles automatic motion of sprites and collision detection.
http://www.lagers.org.uk/s4p/index.html

Using Libraries

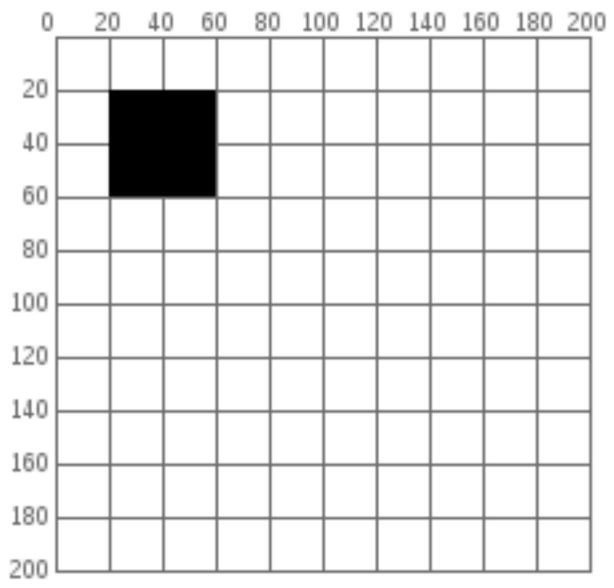
Traer Physics

Particle Systems and simple physics for processing (no collision detection though)
http://www.cs.princeton.edu/~traer/physics/

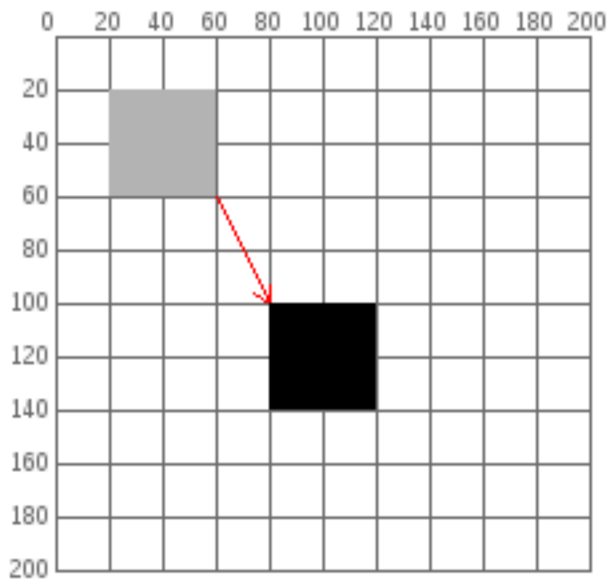
NextText

Auto text animations and control
http://www.nexttext.net/

Transformations

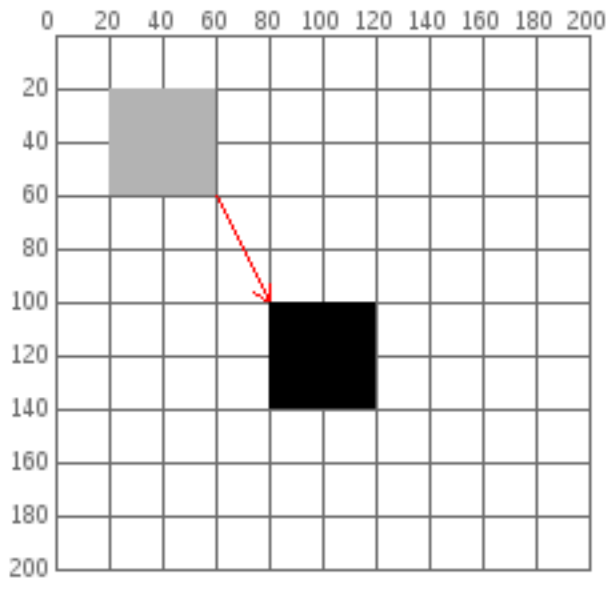


```
rect(20, 20, 40, 40)
```



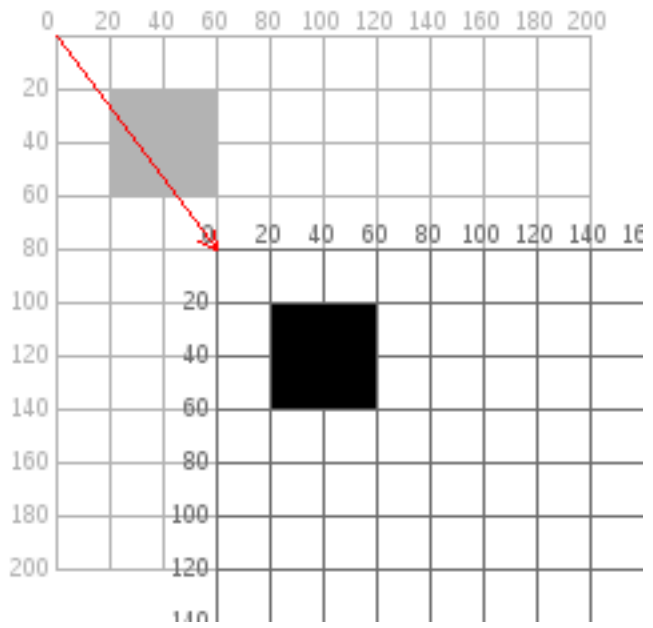
```
rect(20 + 60, 20 + 80, 40, 40)
```

Translate



```
rect(20 + 60, 20 + 80, 40, 40)
```

Using transformations: we move the coordinate system instead of individual objects



```
translate(60, 80);
rect(20, 20, 40, 40)
```

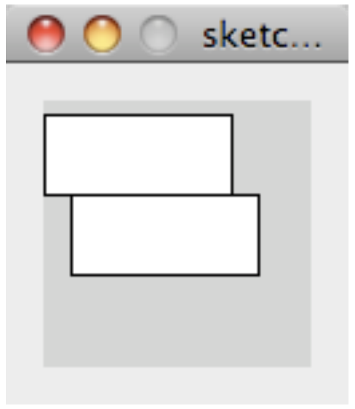
Translate

Follow the mouse using translate.

```
void setup()
{
  size(200, 200);
  noStroke();
  fill(255, 0, 0);
}

void draw()
{
  background(255);

  translate(mouseX, mouseY);
  ellipse(0, 0, 40, 40);
}
```

Translate

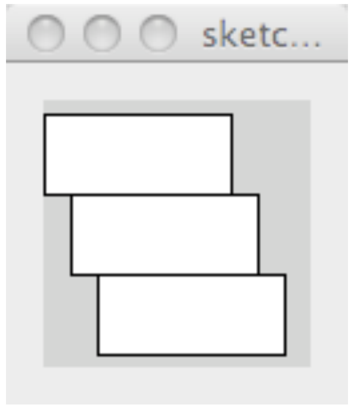
Only the second rect is affected by translate



```
rect(0, 5, 70, 30);
translate(10, 30);
rect(0, 5, 70, 30);
```

Translate

Transformation accumulate (are additive)



```
rect(0, 5, 70, 30);
translate(10, 30);
rect(0, 5, 70, 30);
translate(10, 30);
rect(0, 5, 70, 30);
```

Translate

```
void setup()
{
  size(200, 200);
  noStroke();
}

void draw()
{
  background(255);

  fill(255, 0, 0, 100);
  translate(mouseX, mouseY);
  ellipse(0, 0, 40, 40);

  // Note that this ellipse will move twice as fast as the previous,
  // because transformation accumulate
  fill(0, 255, 0, 100);
  translate(mouseX, mouseY);
  ellipse(0, 0, 40, 40);

}
```

Translate

```
void setup()
{
  size(200, 200);
  background(255);
  noStroke();

  // draw the original position in gray
  fill(192);
  rect(20, 20, 40, 40);

  // draw a translucent red rectangle by changing the coordinates
  // passed to the rect function
  fill(255, 0, 0, 128);
  rect(20 + 60, 20 + 80, 40, 40);

  // draw a translucent blue rectangle by translating the grid
  fill(0, 0, 255, 128);
  translate(60, 80);
  rect(20, 20, 40, 40);
}
```

Rotate

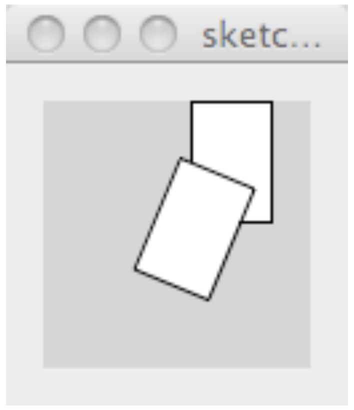
The rotate function rotates the coordinate system allowing you to draw shapes at an angle

Rotations are specified in radians and in clockwise direction.

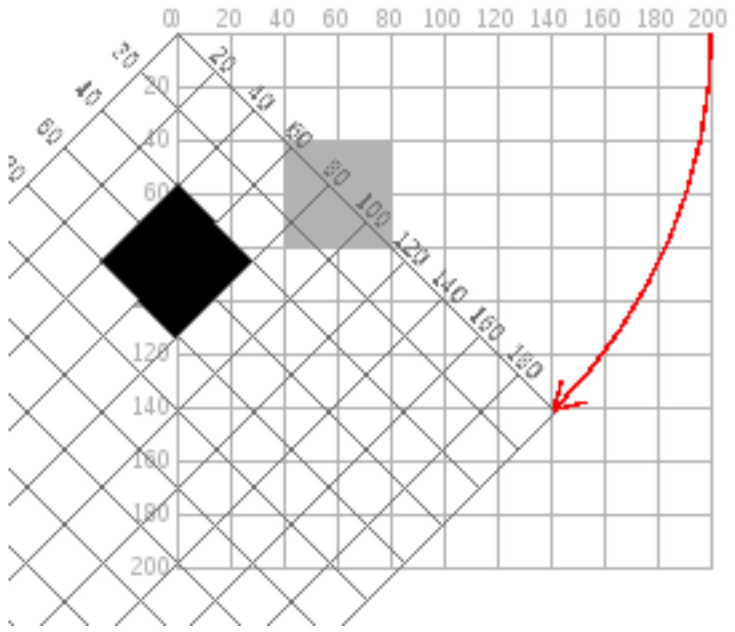
Rotations are also accumulated.

You can transform values to/from radians/degrees using the functions

```
radians(float value);
degrees(float value);
```



```
smooth();
rect(55, 0, 30, 45);
rotate(PI/8);
rect(55, 0, 30, 45);
```



Rotate

To rotate objects from their center, you need to combine translation + rotation.

Example with a square:

A. Translate the coordinate system's origin (0, 0) to where you want the upper left of the square to be.
B. Rotate the grid PI/4 radians (45°)
C. Draw the square at the origin.

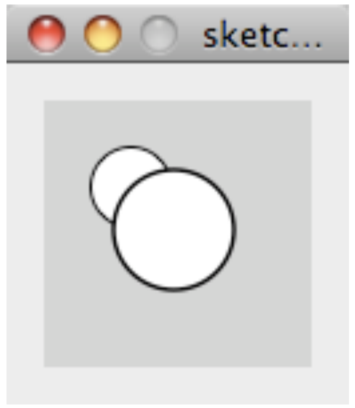
```
// Draw from the center
rectMode(CENTER);

// move the origin to the pivot point
translate(width/2, height/2);

// then pivot the grid
rotate(radians(45));

// and draw the square at the origin
fill(0);
rect(0, 0, 40, 40);
```

Scale

The scale function scales the coordinate system allowing you to draw shapes at an different sizes

The scales are specified as percentages in decimal mode: 2.0 = 200%.

Be careful, as scaling also affects the position of objects that are not drawn at 0, 0.

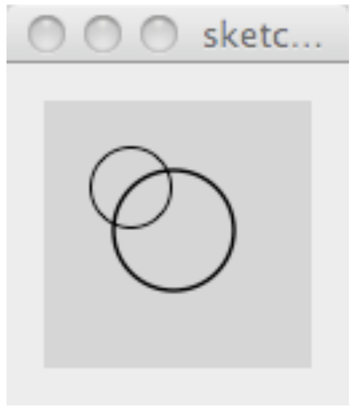


```
smooth();
ellipse(32, 32, 30, 30);
scale(1.5);
ellipse(32, 32, 30, 30);
```

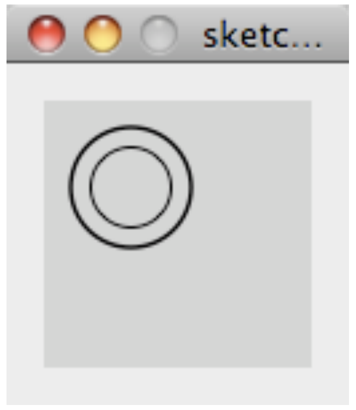
Scale

Be careful, as scaling also affects the position of objects that are not drawn at 0, 0.

See in this example, how drawing the ellipses at (32, 32) vs drawing them at (0, 0) with a translation of (32, 32) makes a different outcome when scale is involved.



```
noFill();
smooth();
ellipse(32, 32, 30, 30);
scale(1.5);
ellipse(32, 32, 30, 30);
```



```
noFill();
smooth();
translate(32, 32);
ellipse(0, 0, 30, 30);
scale(1.5);
ellipse(0, 0, 30, 30);
```

Examples

Drawing a color wheel

```
void setup() {
  size(200, 200);
  background(255);
  smooth();
  noStroke();
}

void draw(){
  if (frameCount % 10 == 0) {
    fill(frameCount * 3 % 255, frameCount * 5 % 255,frameCount * 7 % 255);

    translate(100, 100);
    rotate(radians(frameCount * 2  % 360));

    rect(0, 0, 80, 20);
  }
}
```

Examples

Using a for loop to accumulate transformations

```
size(200, 200);
background(0);
smooth();
stroke(255, 100);

translate(width/2, 80);
for ( int i = 0; i < 18; i++ )
{
  strokeWeight(i);
  rotate(PI/12);
  line(0, 0, 55, 0);
}
```