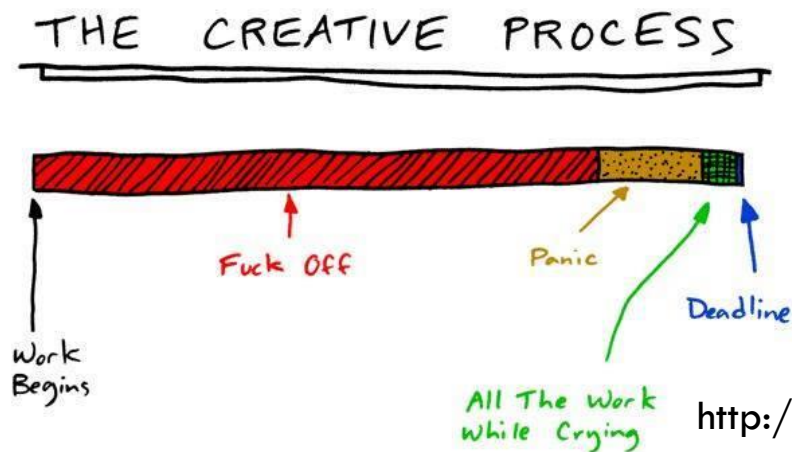




processing.org

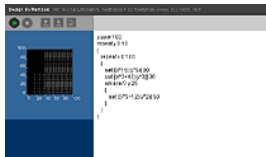


<http://www.irit.fr/~Philippe.Truillet>

v. 2.3 – december 2011 - december 2019

# Brief history

**Design by Numbers**  
<http://dbn.media.mit.edu>  
 Date: 1999-2001  
 Location: MIT Media Lab  
 John Maeda



**Processing**  
<http://www.processing.org>  
 Date: Spring 2001  
 Location: MIT Media Lab  
 Ben Fry / Casey Reas



**Processing 3**



**p5.js**

**Wiring**  
<http://wiring.org.co>  
 Date: 2003  
 Location: IDII  
 Hernando Barragán



**Arduino**  
<http://www.arduino.cc>  
 Date: 2005  
 Location: IDII  
 Massimo Banzi



**Visible Language Workshop**  
<http://museum.mit.edu/150/115>  
 Date: 1975  
 Location: MIT  
 Muriel Cooper



# What is Processing?

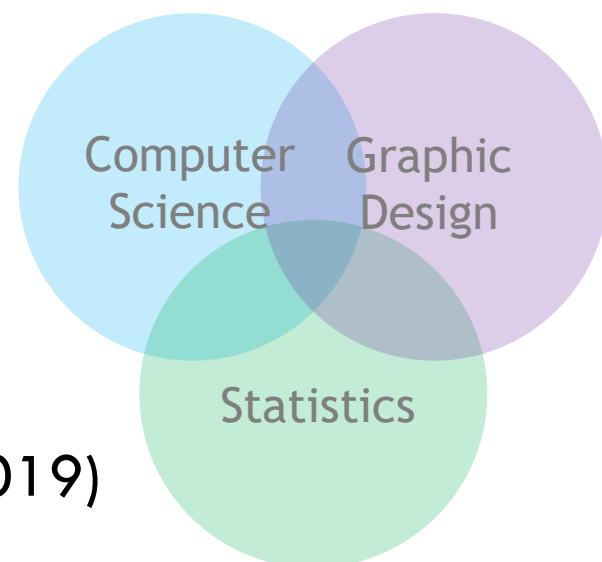
- Created in 2001 by B. Fry & C. Reas
- « *an electronic sketchbook for developing ideas* », « *language that was created to develop visually oriented applications with an emphasis on animation and providing users with instant feedback through interaction* »

→ <http://www.processing.org>

→ <http://processingjs.org>

→ <https://p5js.org>

**Currently:**      version 2.2.1 (19 May 2014)  
                      3.5.3 (03 February 2019)



# What is Processing?

Processing **IS** Java

- With another layout manager than AWT or swing
- Hence, we can use classes, threads, *external* jar files, ...

# Roots

Originally built as a domain-specific targeted towards artists and designers, Processing has evolved into a full design and prototyping tool used for work, motion graphics and complex data visualization.

Processing is based on Java but elements are fairly simple and so, you can learn to use it even if you don't know Java.

Fundamentals of Processing carry over nicely of other languages




# Hello Processing

[Click Here To Begin](#)




<https://www.youtube.com/shiffmanvideos>


#### Vidéos en ligne




Coding Challenge #50.2:  
Animated Circle Packing - Part ...  
1 922 vues • il y a 5 heures



Coding Challenge #50.1:  
Animated Circle Packing - Part 1  
14 607 vues • il y a 1 jour




Coding Challenge #49: Photo  
Mosaic with White House Soci...  
22 647 vues • il y a 4 jours




Coding Challenge #48: White  
House Social Media Data...  
12 056 vues • il y a 4 jours


#### Programming from A to Z




Session 1: p5.js, JavaScript and  
Strings - Programming from A t...  
Daniel Shiffman



Session 2: Regular Expressions -  
Programming from A to Z  
Daniel Shiffman




Session 3: Data, APIs and  
Language Processing Libraries...  
Daniel Shiffman




Session 4: Twitter API and Bots  
with Node.js - Programming fro...  
Daniel Shiffman


#### p5.js tutorials - JavaScript, HTML, and CSS




1-6: Foundations of Programming  
in JavaScript - p5.js Tutorial  
Daniel Shiffman



7: HTML / CSS / DOM - p5.js  
Tutorial  
Daniel Shiffman



8: Working with data - p5.js  
Tutorial  
Daniel Shiffman



9: Additional Topics - p5.js  
Tutorial  
Daniel Shiffman

#### Coding Challenges

Watch me take on some viewer submitted Coding Challenges in p5.js and Processing!



Coding Challenge #1: Starfield  
in Processing  
13:54



Coding Challenge #2: Menger  
Fractal  
14:01



Coding Challenge #3: The Snake  
Game  
27:27



Coding Challenge #4: Purple  
Rain  
12:14

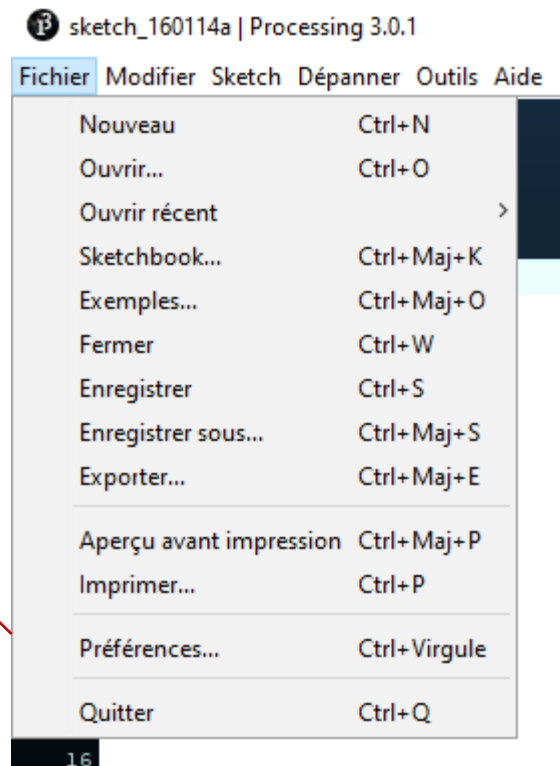
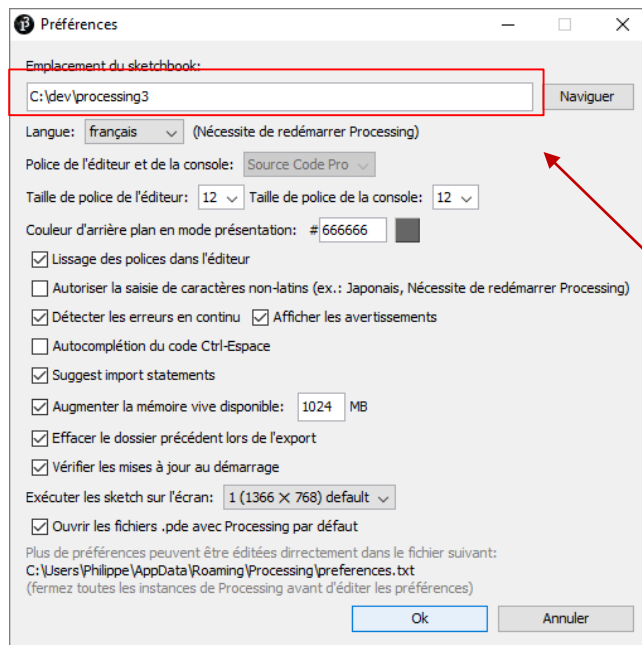
# The language

- Open source environment
- Data visualization programming language
- Built on top of Java language
- Strong typing
- Polymorphism
- Classical inheritance



# Structure

- « Sketches » (programs) are located in the « preferences » folder



# Structure

- One sketch is composed of :
  - At least one « **.pde** » file (should be more – one per class).  
The main file must have the same name than the sketch folder
  - Possibly, other folders
    - « **data** » folder in which you can put images, sounds, etc. (**resources**)
    - « **code** » folder in which you can put jar files (**external lib**)

ELIPSE (C:) > dev > processing3 > boutons\_img

Rechercher dans : boutons\_i...

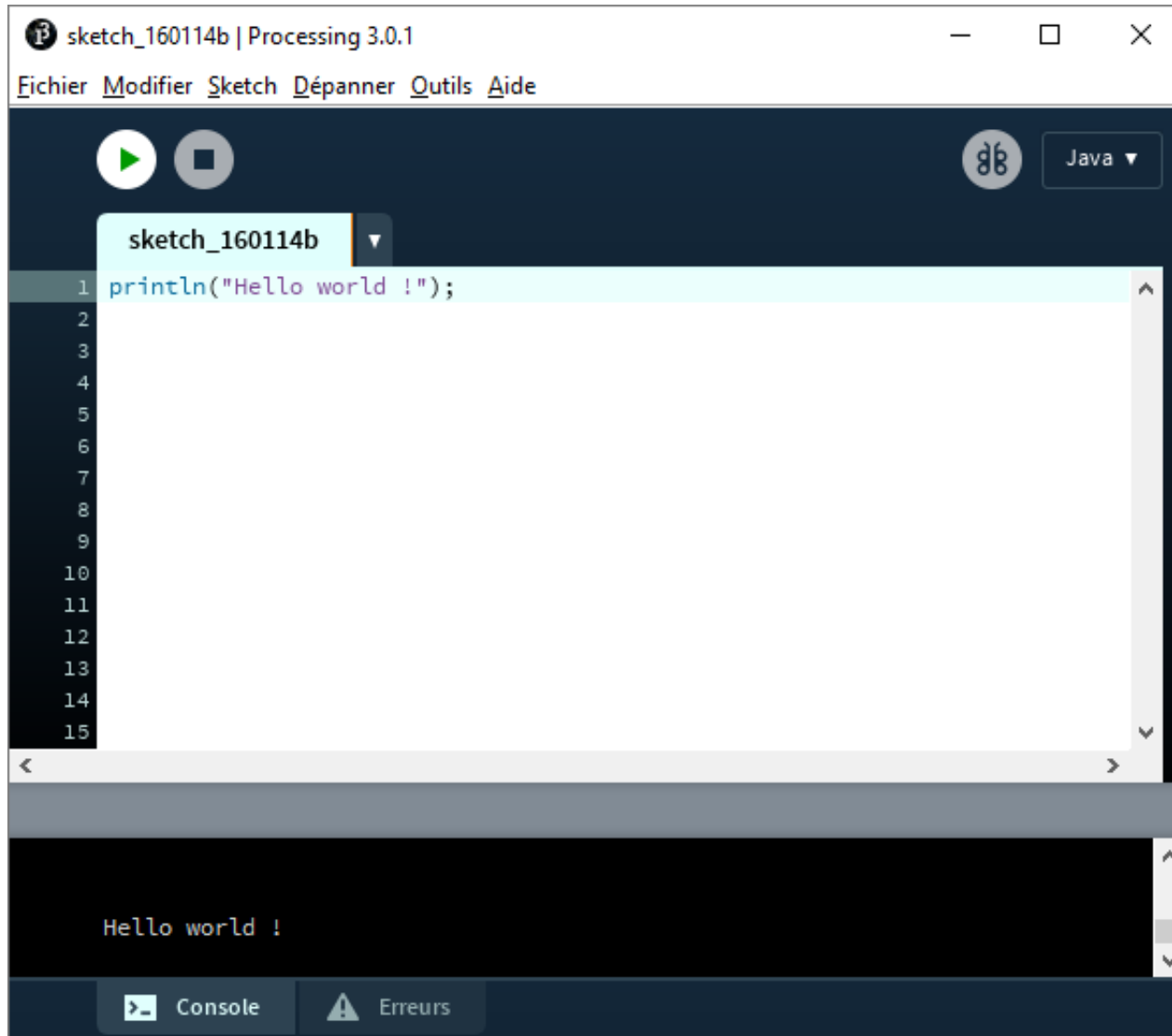
| Nom             | Modifié le       | Type                 | Taille |
|-----------------|------------------|----------------------|--------|
| code            | 05/12/2015 18:02 | Dossier de fichiers  |        |
| data            | 06/12/2015 21:18 | Dossier de fichiers  |        |
| boutons_img.pde | 06/12/2015 21:47 | Processing Source... | 1 Ko   |
| Button.pde      | 06/12/2015 21:47 | Processing Source... | 3 Ko   |

# First example (Java)

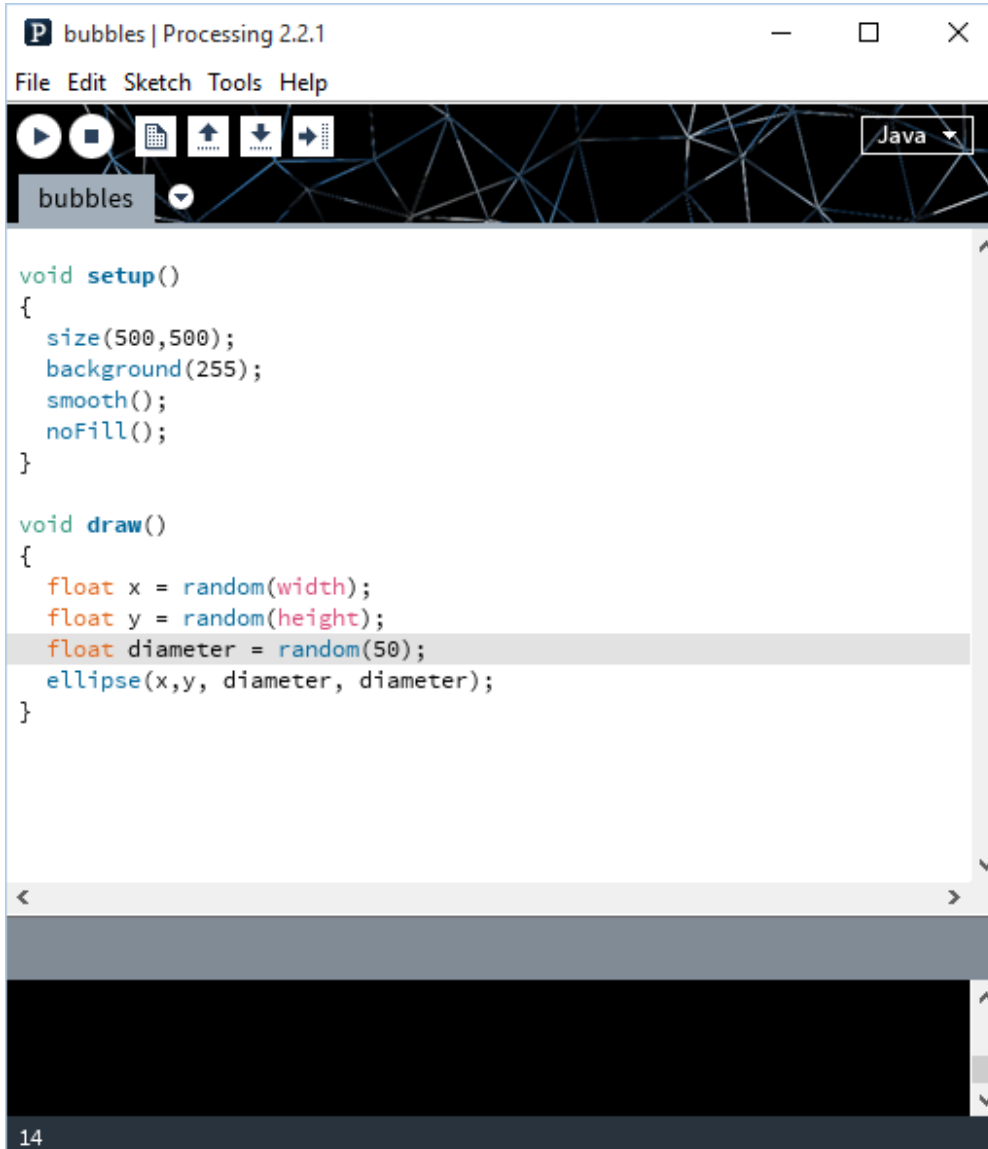
```
public class Hello
{
    public static void main (String args[])
    {
        System.out.println("Hello, world!");
    }
}
```

```
> javac Hello.java
> java Hello
> Hello, world!
```

# First example (Processing)

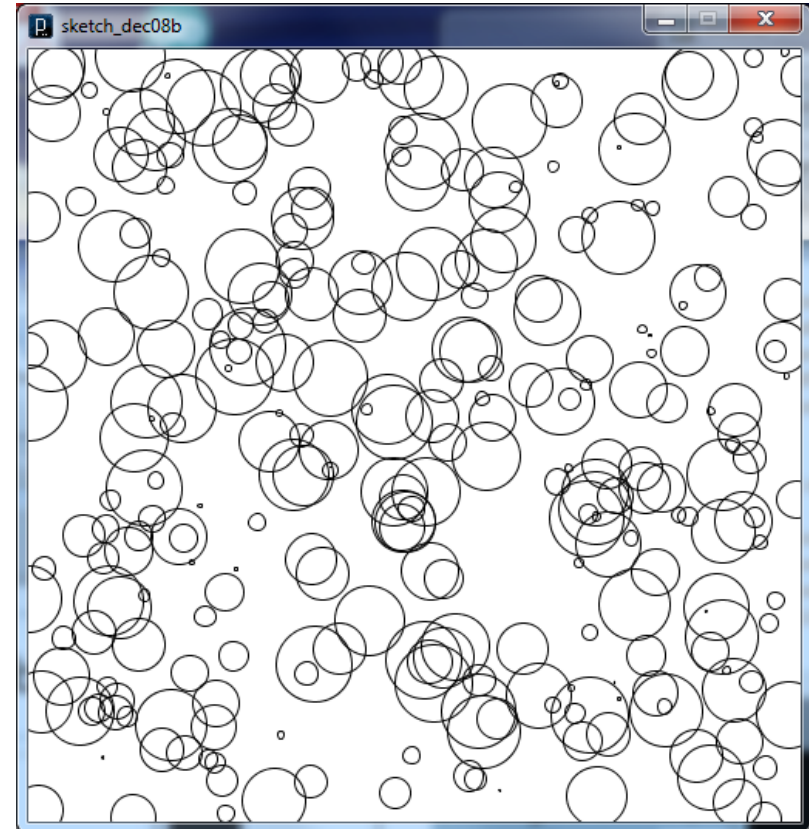


# Second example (bubbles)



```
void setup()
{
  size(500,500);
  background(255);
  smooth();
  noFill();
}

void draw()
{
  float x = random(width);
  float y = random(height);
  float diameter = random(50);
  ellipse(x,y, diameter, diameter);
}
```



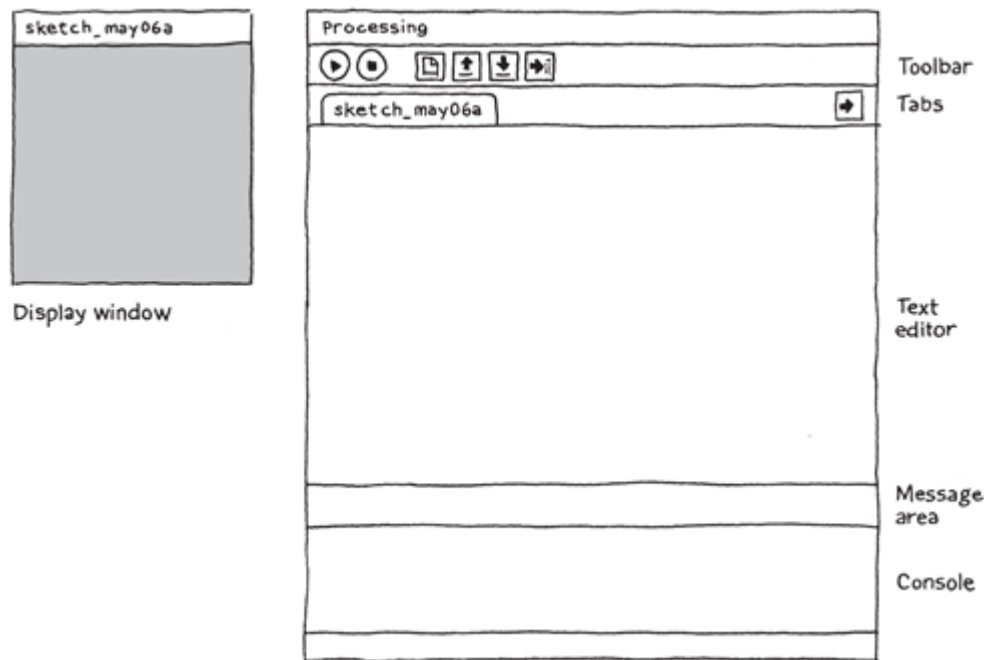
# Download & install

- Download the IDE from <http://processing.org/download>  
(stable version: 1.5.1, 2.2.1, 3.5.3)

## Stable Releases

|       |                            |                                                                                                                                                                  |
|-------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.0.1 | (23 October 2015)          | <a href="#">Win 32</a> / <a href="#">Win 64</a> / <a href="#">Linux 32</a> / <a href="#">Linux 64</a> / <a href="#">Linux ARMv6hf</a> / <a href="#">Mac OS X</a> |
| 3.0   | (30 September 2015, 3p ET) | <a href="#">Win 32</a> / <a href="#">Win 64</a> / <a href="#">Linux 32</a> / <a href="#">Linux 64</a> / <a href="#">Mac OS X</a>                                 |
| 2.2.1 | (19 May 2014)              | <a href="#">Win 32</a> / <a href="#">Win 64</a> / <a href="#">Linux 32</a> / <a href="#">Linux 64</a> / <a href="#">Mac OS X</a>                                 |
| 1.5.1 | (15 May 2011)              | <a href="#">Win (standard)</a> / <a href="#">Win (no Java)</a> / <a href="#">Linux x86</a> / <a href="#">Mac OS X</a>                                            |

uncompress the archive  
just start the executable!



3.0.1 (23 October 2015)

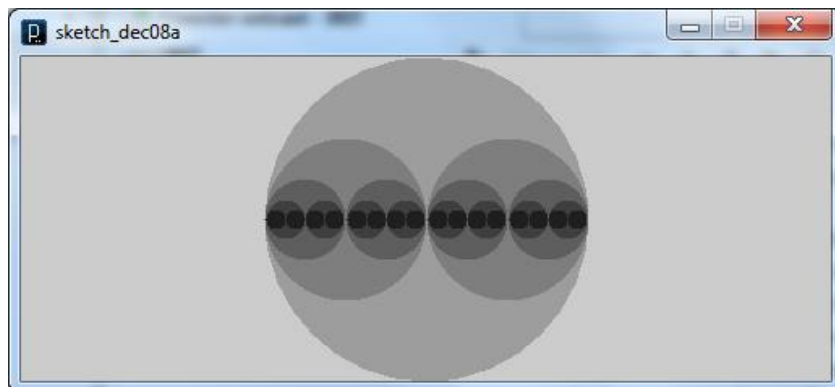
[Windows 64-bit](#)  
[Windows 32-bit](#)

[Linux 64-bit](#)  
[Linux 32-bit](#)  
[Linux ARMv6hf](#)

[Mac OS X](#)

# API

- Graphics
  - Procedural
  - Global scope
  - Graphics generation
  - Image processing



```
void setup()
{
  size(500,200);
  noStroke();
}

void draw()
{
  drawCircle(250, 100, 5);
}

void drawCircle(int x, int radius, int level)
{
  float tt = 126 * level/4.0;
  fill(tt);
  ellipse(x, 100, radius*2, radius*2);
  if (level>1)
  {
    level = level -1;
    drawCircle(x-radius/2, radius/2, level);
    drawCircle(x+radius/2, radius/2, level);
  }
}
```

# Naming convention

- Legal names can only contain letters, underscores, numbers and \$
- The initial character must be a letter, underscore or \$ sign (not a number)
- These names are called **identifiers**.



# Variables

- Container for storing data
- Allows data element to be reused
- Every variable has a name, value and data type
- A variable must be defined before it is used

# Data types

- **byte**: small integer number
- **int**: integer number
- **long**: huge integer number
- **float**: floating-point numbers
- **double**: huge floating-point numbers
  
- **char**: one symbol in single quotes
- **String**: words
- **boolean**: true or false
  
- every structure you can define!

# Operators

- **Mathematical operators**

- $+, -, *, /, \%$

- **Relational operators**

- $>, >=, <, <=, ==, !=$

- **Logical operators**

- $\&\&$  (and),  $||$  (or)

# Comments

- Ignored by the computer
- Same as java or C++ comments

```
/*
```

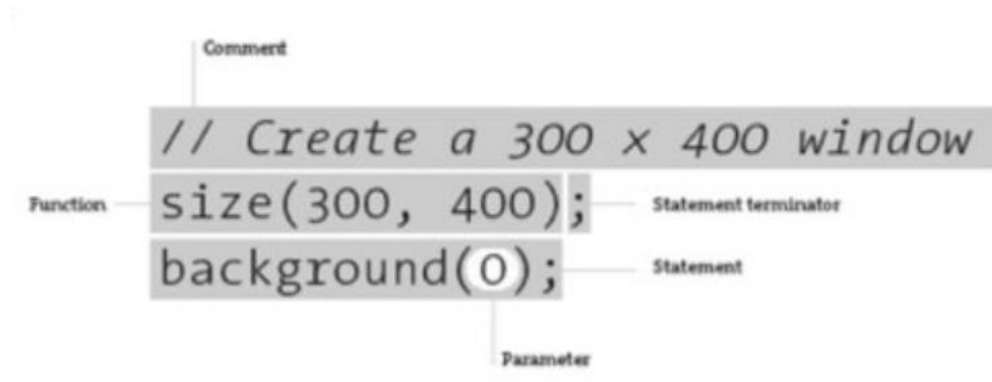
```
    Something there
```

```
*/
```

```
// just one line
```

# Expressions, statements

- An **expression** is like a phrase and often a combination of operators
- A **statement** is a set of expressions, like a sentence and ends with a statement terminator



# Control structures

- **Iteration: while**

The *while* structure executes a series of statements while the expression is true

- **Iteration: for**

A *for* structure has three parts: init, test and update separated by a semi-colon « ; ». The loop continues until the test evaluates to false

# Control structures

- **Conditional: if**

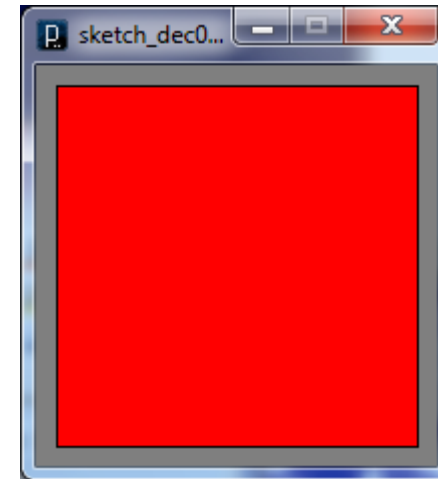
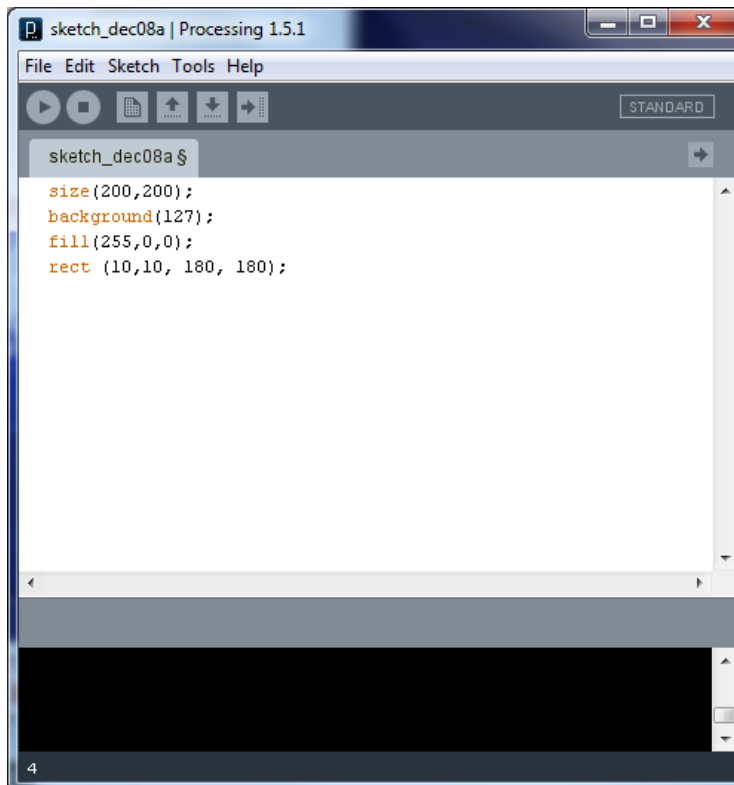
If the test evaluates to true, statements enclosed within the block are executed.

- **Conditional: switch**

*switch* is more convenient when you need to select three or more alternatives. Program jumps to the case with the same value as the expression. All remaining statements in the *switch* are executed unless redirected by a break.

# Programming modes

- **Basic mode** (scripting mode): this mode is used for drawing static images and learning fundamentals. Lines of code have a direct representation on the screen





# Programming modes

- **Continuous mode:** this mode provides a *setup()* function that is run once when the program begins and the *draw()* function which continually loops through the code inside.  
This allows writing custom functions and classes, using keyboard and mouse events.

# Initialization : **setup()**

- `size(w,h)`: sets the width/height of the drawing area
- Can call any other number of methods such as
  - `background(c)`: draws and fills a background color

```
void setup()  
{  
    size(200,200);  
    background(102);  
}
```

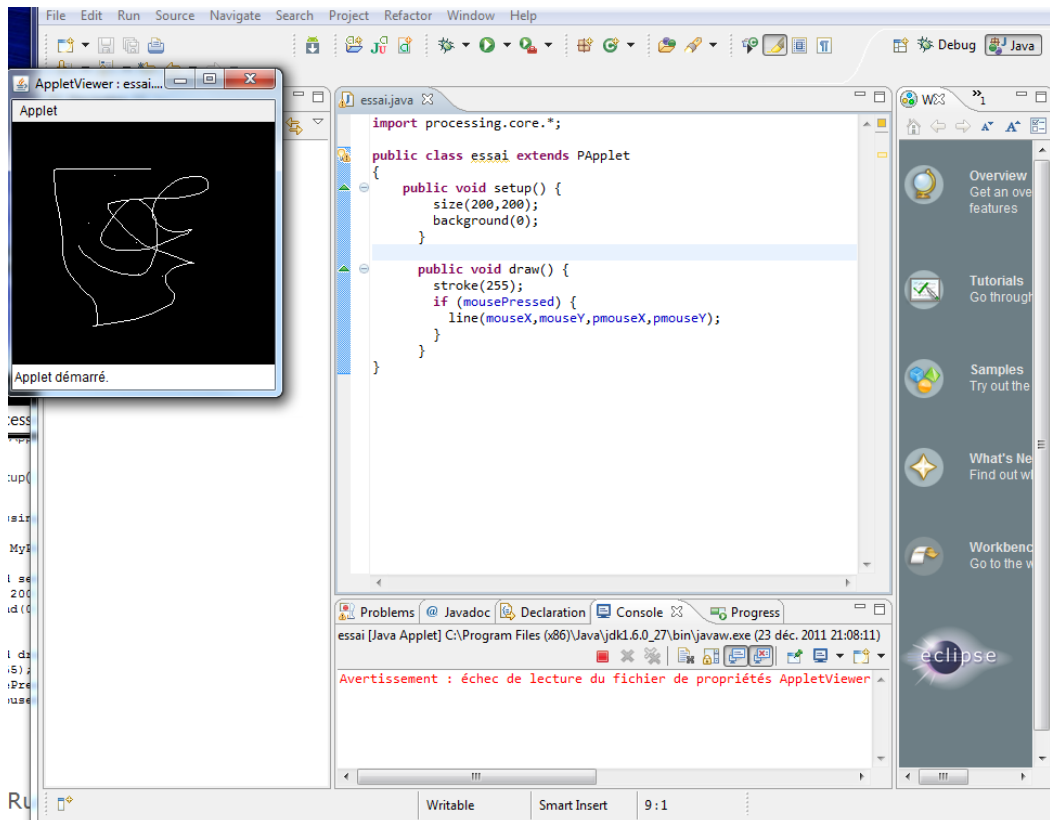
# Mainloop: **draw()**

`draw()` gets called as fast as possible unless a framerate is specified (with `FrameRate` function)

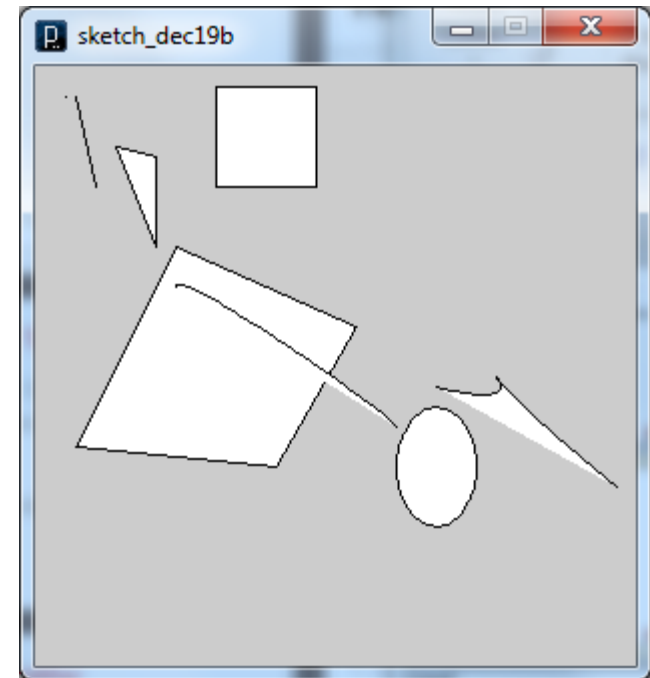
- Can call any other number of methods such as
  - `stroke(...)` sets color of the outline drawing
  - `fill(...)` sets color of *inside* drawing
  - Events:
    - `mousePressed` is true if mouse is down
    - Mouse position: `mouseX`, `mouseY`
  - Different drawing methods : `line()`, `rect()`, `arc()`, `ellipse()`, `point()`, `triangle()`, `bezier()`, ...

# Programming modes

- « **java** » mode: can be used as a library in Eclipse – « **just** » (hum ...) add `core.jar` and extend `PApplet`  
 → <http://processing.org/learning/eclipse/>

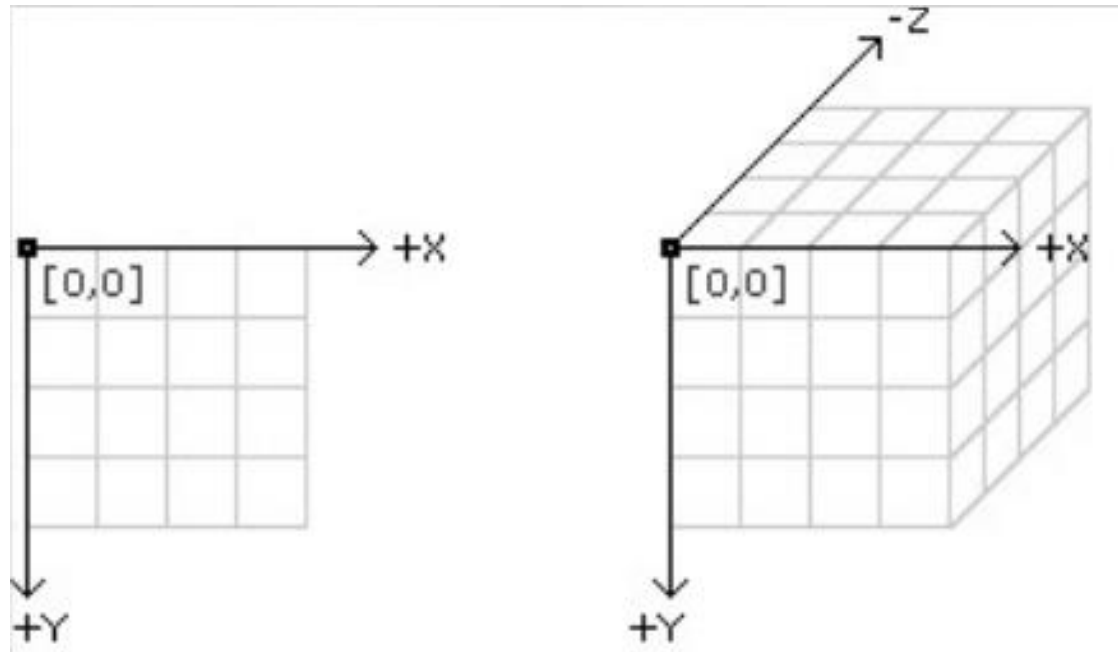


# #1 - Shapes



# #1: canvas

Processing uses a Cartesian coordinate system with this origin on the upper-left corner



The size of the display is controlled with the `size()` function

```
size(width, height)
```

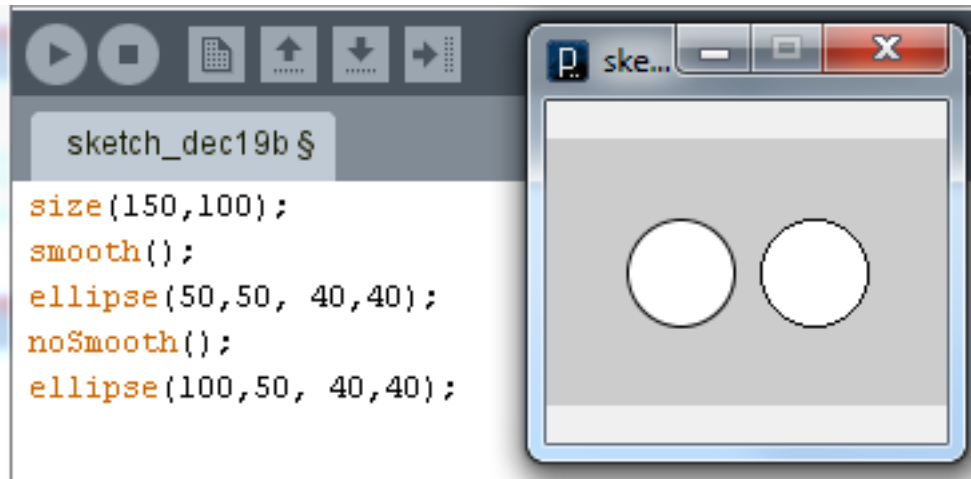
# #1: (main) primitives shapes

- **Point:** `point(x,y)`
- **Line:** `line(x1, y1, x2, y2)`
- **Triangle:** `triangle(x1, y1, x2, y2, x3, y3)`
- **Quadrilateral:** `quad(x1, y1, x2, y2, x3, y3, x4, y4)`
- **Rectangle:** `rect(x, y, width, height)`
- **Square:** `square(x, y, width)`
- **Ellipse:** `ellipse(x, y, width, height)`
- **Circle:** `circle(x, y, width)`
- **Curve:** `curve(x1, y1, x2, y2, x3, y3, x4, y4)`
- **Bezier curve:** `bezier(x1,y1, cx1,cy1, cx1, cy2,x2,y2)`

The order in which shapes are drawn in the code defines which shape appears on top of others.

# #1: drawing attributes

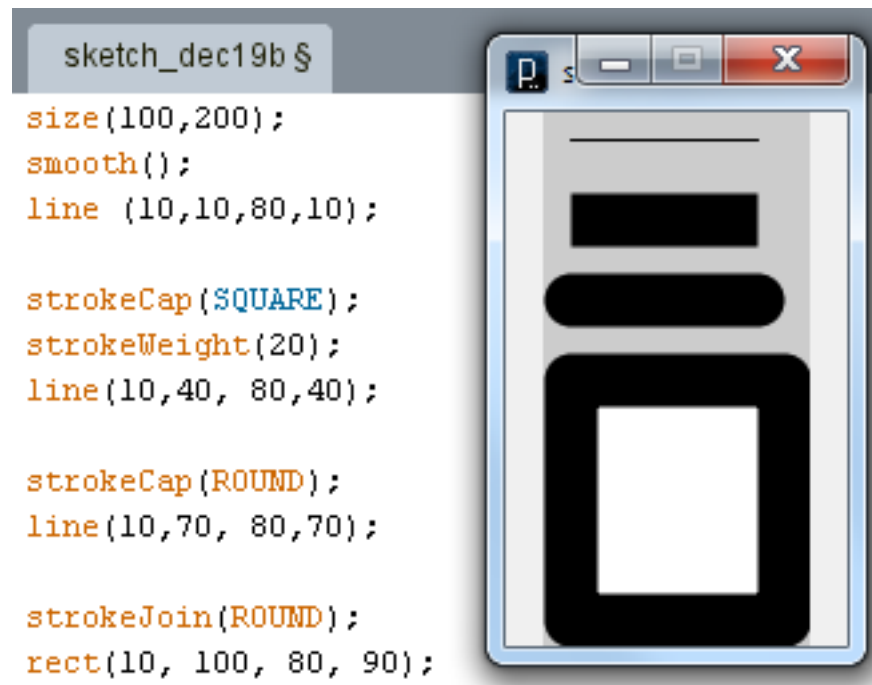
- `smooth()` and `noSmooth()`: enable and disable smoothing (aka anti-aliasing)





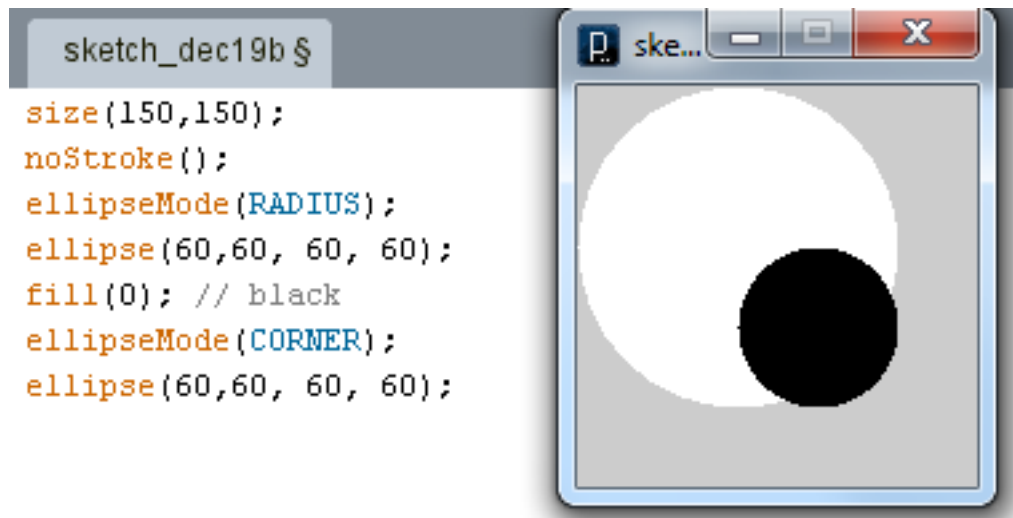
# #1: drawing attributes

- strokeWeight(numeric\_attr), strokeCap(ROUND | SQUARE | PROJECT), strokeJoin(BEVEL | MITER | ROUND): line attributes



# #1: drawing modes

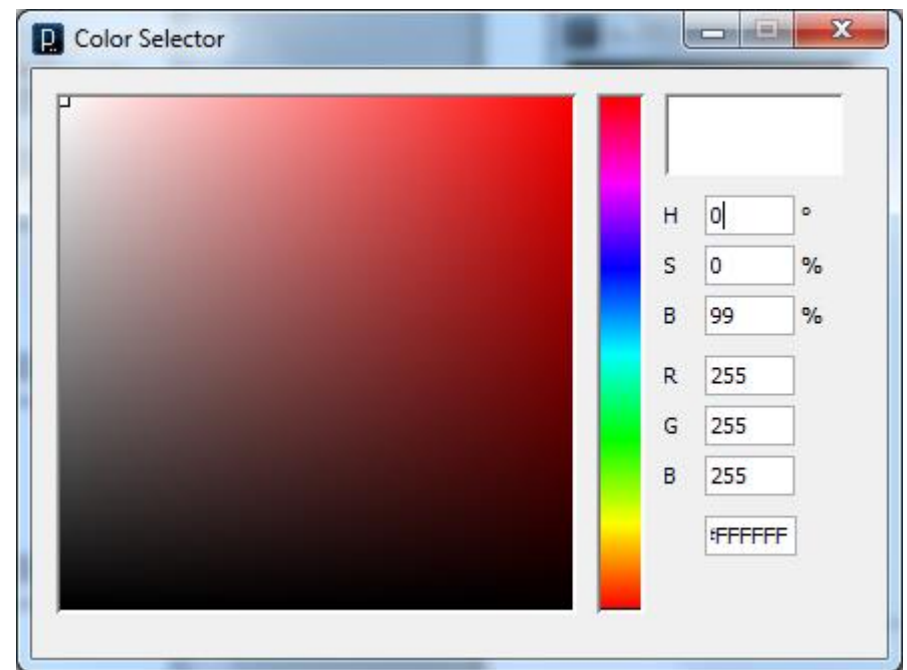
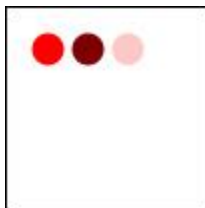
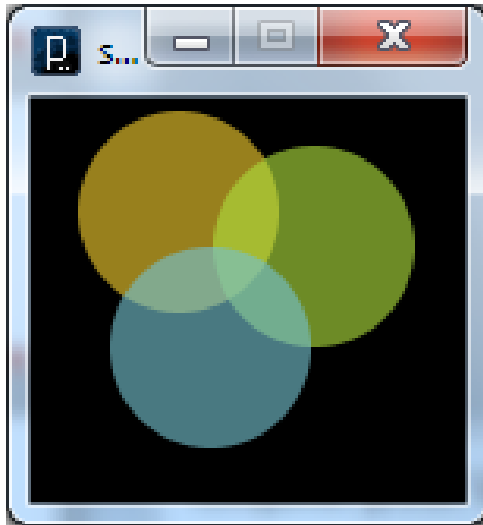
- `ellipseMode(CENTER | RADIUS | CORNER | CORNERS)`:  
change the way to draw ellipses
- `rectMode(CORNER | CORNERS | CENTER)`: change the way to  
draw rectangles



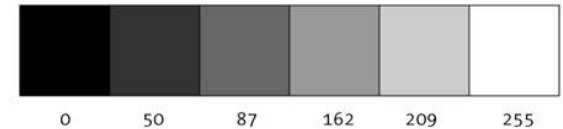
# #1: assignments

- Create a composition using at least one ellipse, one line and one rectangle
- Create a visual knot using beziers curve

## #2 - Colors



## #2: use colors



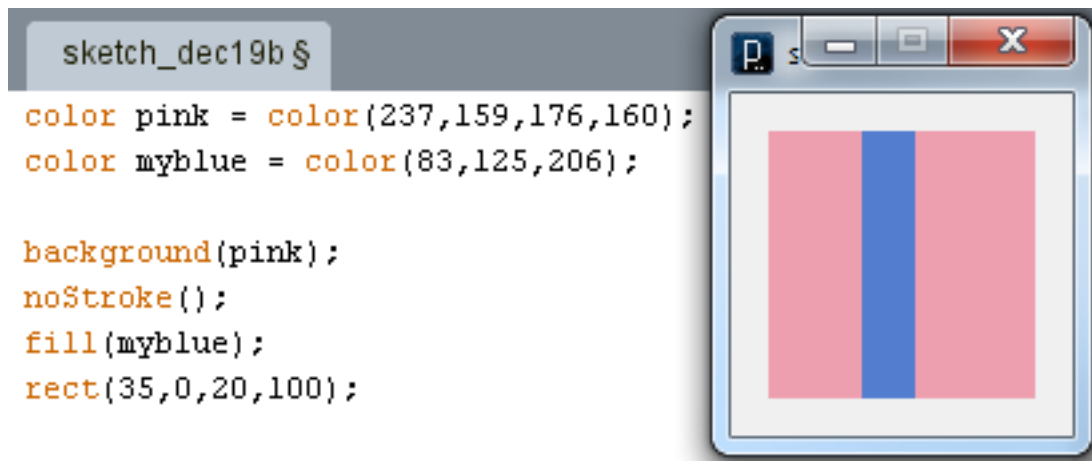
- Setting colors
  - **background**(value) or **background**(R,G,B): sets the colors for the background
  - **colorMode**(mode): changes the way Processing interprets color data
  - **fill**(value) or **fill**(R,G,B, *alpha*): sets the color to fill shapes
  - **noFill**(): disables filling geometry
  - **stroke**(value) or **stroke**(R, G, B, *alpha*): sets the color used to draw lines and borders around shapes
  - **noStroke**(): disables drawing the stroke (outline)

## #2: use colors

- Color Data

The color data type is used to store colors in a program.

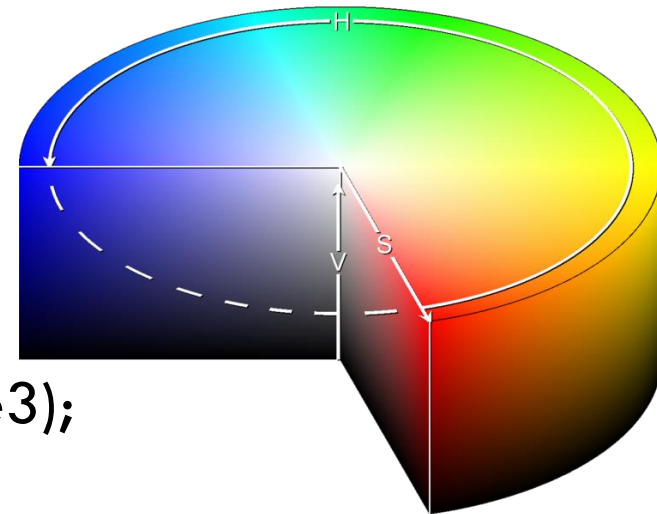
- `color(gray, alpha)`
- `color(R,G,B, alpha)`



## #2: RGB vs HSB

You can use HSB (Hue, Saturation, Brightness) specification instead of RGB colors

- `colorMode(mode)`
- `colorMode(mode, range);`
- `colorMode(mode, range1, range2, range3);`



## #2: HEX

Alternative notation for defining colors. Must begin with # sign

`background(255,255,255) = background(#FFFFFF)`



## #2: assignments

- Use HSB color and a for structure to design a gradient between two colors
- Redraw your composition from #1 assignments using colors.
- Draw a simplified picture like Mondrian (father of neoplasticisim)

# **#3 - *Mathematics***

## #3: arithmetic

Like any language, addition (+), subtraction (-), multiplication (\*), division(/) and modulus (%) [integer remainder after division] can be used to control position of elements or to change attribute values.

### **Order of operations:**

- Multiplicative: \*, /, %
- Additive: +, -
- Assignment: =

## #3: shortcuts

Code shortcuts are used to make program more concise

- `++`: adds the value 1 to a variable
- `--`: subtracts the value of 1
- The value can be incremented or decremented before or after the expression is evaluated (ex: `x++` or `++x`)

You can combine operations and assignments:

- `+=`, `-=`, `*=`, `/=` (ex: `x+=2` is equivalent to `x = x+2`)

The negation operator changes the sign of value to its right

## #3: constraining numbers

These functions are used to perform calculations on numbers that the standard arithmetic operators can't

- `ceil(value)`: calculates the closest int value greater or equal to the value of its parameter
- `floor(value)`: calculates the closest int value less or equal to the value of its parameter
- `round(value)`: calculates the closest int value the value of its parameter
- `min(a, b, ...)` and `max(a, b, ...)`: determines the smallest/largest value in a sequence of numbers.

## #3: normalizing, mapping

Numbers are often converted to the range 0.0 to 1.0 for making calculations. To normalize a number, you can divide it by the maximum value that it represents.

You can also use the *norm()* function

- *norm(value, low, high)*: the *value* parameter is converted to a value between *low* and *high* values

After normalization, a number can be converted to another range of values. You can use the *lerp()* - linear interpolation- function

- *lerp(value1, value2, amt)*: *value1* and *value2* define the min and max value and *amt* the value to interpolate.

## #3: normalizing, mapping

Finally, the `map()` function is useful to convert directly from one range to another.

- `map(value, low1, high1, low2, high2)`: *value* is the number to re-map from `[low1,high1]` range to `[low2,high2]`

## #3: exponents, roots

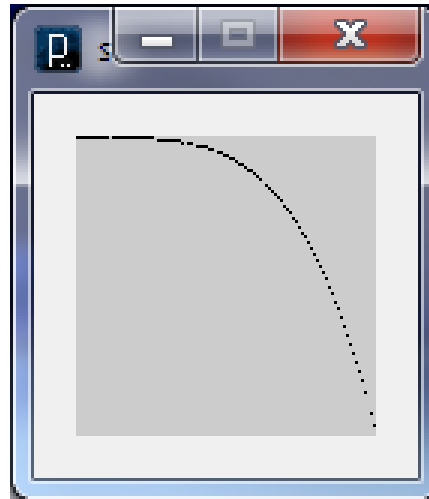
- `sq(value)`: squares a number and return the result (positive number)
- `sqrt(value)`: calculates the square root (opposite of `sq` function, always positive). *value* must be a positive number
- `pow(num, exponent)`: calculates a number raised to an exponent.



## #3: curves

Exponential functions are useful for creating simple curves. These equations have the form  $y = x^n$  (where  $x$  is between 0.0 and 1.0)

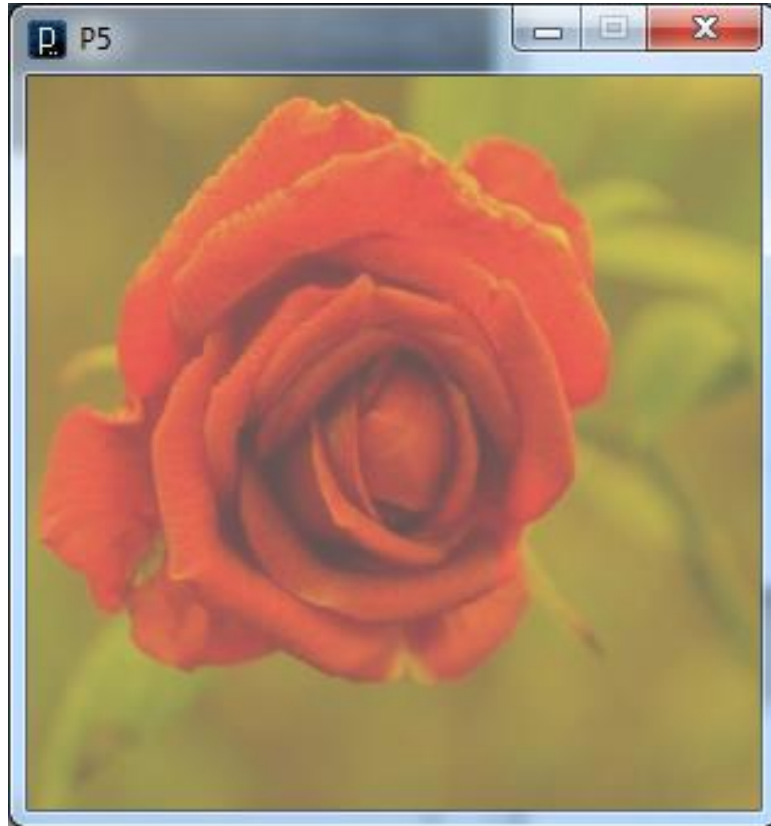
```
for (int x=0;x<100;x++)  
{  
    float n = norm(x, 0.0, 100.0);  
    float y = pow(n, 4);  
    y*=100;  
    point(x,y);  
}
```



## #3: assignments

- Draw the curve  $y=1-x^5$  to the display window
- Use the data from curve  $y=x^3+2x^2-5$  to draw something unique

## #4 – Images



## #4: display images

Processing can load images, display them or change their size, position, opacity and tint. Processing uses a special data type called *PImage*.

The image must be inside the data folder.



## #4: images

Processing can load from a file by using the function *loadImage()* or create automatically an image from scratch with *createImage()* Once the image is loaded, it is displayed with the *image()* function

- `loadImage("filename.ext")`
- `createImage(width, height, RGB | ARGB | ALPHA);`
- `image(img, origin_x, origin_y, [width, height]);`

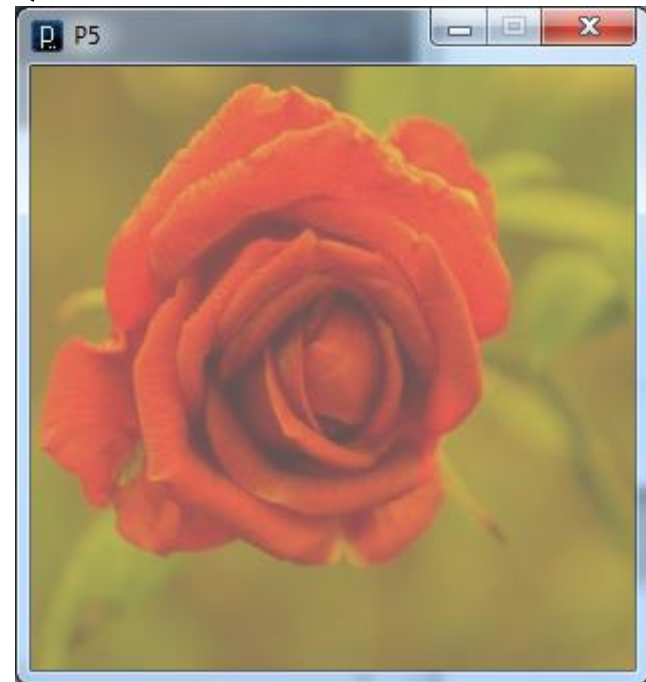
There are many other useful functions to deal with `PImage`!

## #4: tint

Images are colored with the tint() function. It affects only images.

- tint(gray, alpha)
- tint(value1,value2,value3, alpha)
- tint(color)

```
img = loadImage("rose.jpg");  
tint(255,204,0,153);  
image(img,0,0);
```



## #4: transparency

*gif* and *png* images retain their transparency (respectively 1-bit and 8-bit transparency) when loaded and displayed in Processing. This allows anything drawn before the image to be visible through the transparent section of the image.



```
PImage img;
size(160,200);
img=loadImage("fitg.png");
background(0,0,255); //blue
image(img,0,0);
```

## #4: filters

Digital images can be easily reconfigured and combined with other images.

Processing provides function to filter images. The PImage class has also a filter method that can isolate filtering to a specific image

- `filter (mode [, level])` where mode = THRESHOLD, GRAY, INVERT, POSTERIZE, BLUE, OPAQUE, ERODE, DILATE

Filter function affects only what has already been drawn.

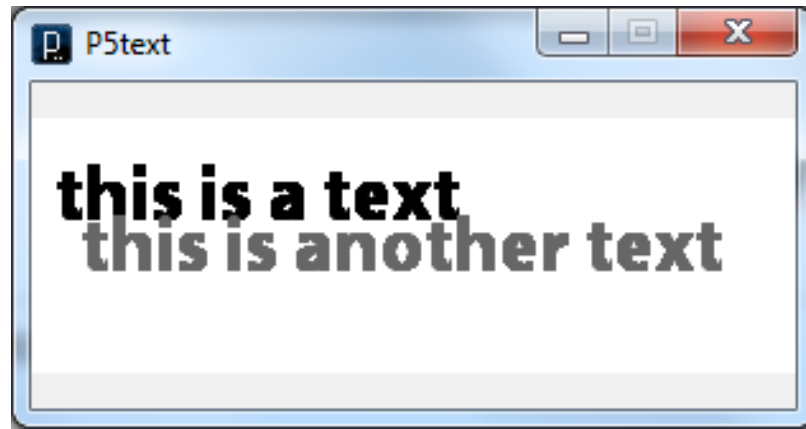
It is also possible to blend or mask some images and copy pixels with `blend()`, `mask()` or `copy()` functions.



## #4: assignments

- Draw two images in the display window with a different tint
- Load a png image with transparency and create a collage by layering the image.
- Apply BLUR filter to the png image

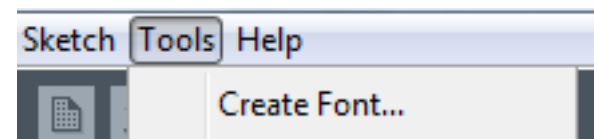
## #5 - *Typography*



# #5 – loading fonts, drawing text

Processing can load fonts and display. Processing uses a special data type called *PFont*.

Processing uses a special format e.g. VLB enabling Processing to render quickly text.



You will need to use the « *Create Font...* » in the « *Tools* » menu  
The font is saved in the « *data* » subdirectory of your project.

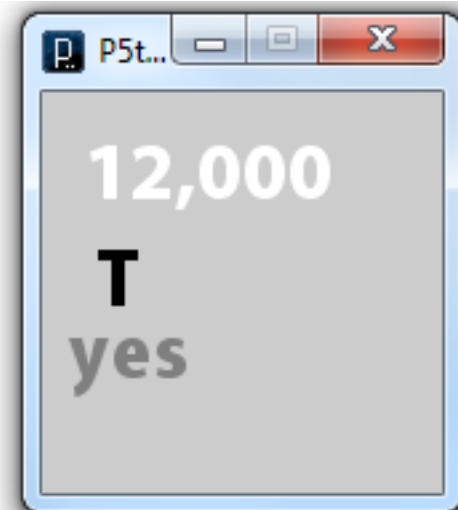
```
PFont myfont;
myfont = loadFont("MyriadWebPro-Bold-30.vlw");
textFont(myfont);
fill(0);
text("a text",10,40);
```



# #5 – loading fonts, drawing text

- 1) Use `loadFont()` function to create a `PFont` variable
- 2) Use `text()` function to draw characters to the screen
  - `text(data, x, y)` // data may be `String`, `char`, `int`, `float`
  - `text(stringdata, x, y, width, height)`

```
size(150,150);
PFont myfont;
myfont = loadFont("MyriadWebPro-Bold-30.vlw");
textFont(myfont);
text(12.0,10,40);
fill(0);
text('T', 20,80);
fill(127);
text("yes", 10, 80, 100, 200);
```

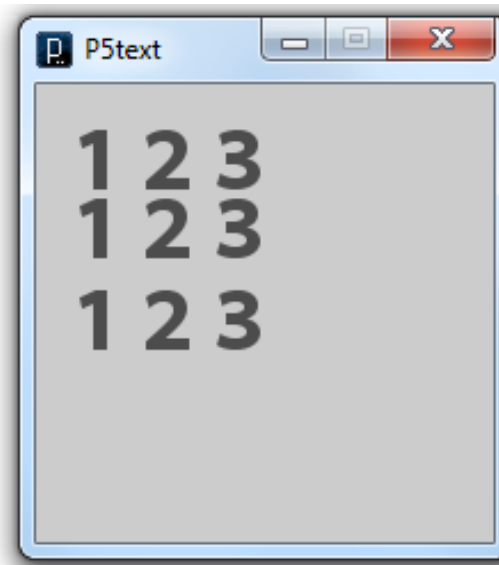


## #5: text attributes

- *textSize(size)*: set the current font size (in pixels). This function resets the text leading.
- *textLeading(dist)*: set the spacing between lines of text

```
size(200,200);
PFont myfont;
myfont = loadFont("MyriadWebPro-Bold-30.vlw");
textAlign(RIGHT);
textFont(myfont);

textSize(40);
fill(0,160);
text("1 2 3", 10, 10, 90, 90);
textLeading(30);
text("1 2 3", 10, 40, 90, 90);
textLeading(90);
text("1 2 3", 10, 80, 90, 90);
```

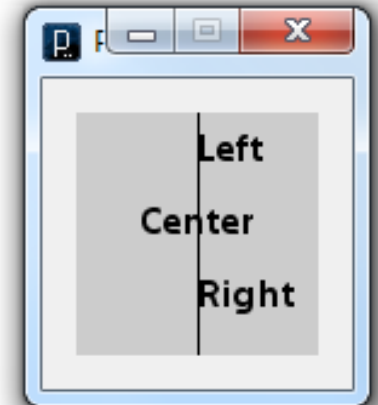


# #5: text attributes

- *textAlign*(*LEFT* | *CENTER* | *RIGHT*): set the alignment for drawing text

```
PFont myfont;
myfont = loadFont("MyriadWebPro-Bold-30.vlw");
textFont(myfont);
textSize(16);

line(50,0,50,100);
fill(0);
textAlign(LEFT);
text("Left", 50, 20);
textAlign(CENTER);
text("Center", 50, 50);
textAlign(LEFT);
text("Right", 50, 80);
```



- *textWidth*(): calculates and returns the pixel width of any character or text string.

## #5: assignments

- Draw your favorite word to the display window in your favorite typeface
- Use two different typefaces to display a dialogue between two characters.

# #6 - Data

165956862 MTM State=alive Cursors=3 t=952313484  
165956862 CIM TestPoint idFinger=1 x=826 y=214 precision=1 t=952313484  
165956862 CIM ResPoint idFinger=0 idObject=delimitation t=952344684  
165956862 CIM ResPoint idFinger=1 idObject=delimitation t=952344684  
165956862 CIM ResPoint idFinger=1 idObject=layer1 t=952344684  
165956862 CIM ResPoint idFinger=1 idObject=layer3 t=952344684  
165956862 CIM ResPoint idFinger=3 idObject=delimitation t=952344684  
165956862 MTM State=alive Cursors=3 t=952360284  
165956862 CIM TestPoint idFinger=1 x=826 y=214 precision=1 t=952360284  
165956878 CIM ResPoint idFinger=0 idObject=building006 t=952360284  
165956878 CIM ResPoint idFinger=0 idObject=layer1 t=952360284  
165956894 CIM TestPoint idFinger=0 x=908 y=122 precision=1 t=952313484  
165956894 CIM ResPoint idFinger=1 idObject=delimitation t=952313484  
165956940 CIM ResPoint idFinger=3 idObject=layer1 t=952391484  
165956940 CIM TestPoint idFinger=3 x=977 y=107 precision=1 t=952313484  
165956940 CIM ResPoint idFinger=3 idObject=building006 t=952391484  
165956940 CIM ResPoint idFinger=1 idObject=POI007 t=952391484  
165956940 CIM ResPoint idFinger=1 idObject=rond007 t=952391484  
165956940 CIM ResPoint idFinger=0 idObject=layer1 t=952391484  
165956940 CIM ResPoint idFinger=0 idObject=building006 t=952391484  
165956940 CIM TestPoint idFinger=1 x=826 y=214 precision=1 t=952391484  
165956940 MTM State=alive Cursors=3 t=952391484  
165956940 CIM TestPoint idFinger=1 x=826 y=214 precision=1 t=952375884  
165956940 MTM State=alive Cursors=3 t=952375884  
165956940 CIM TestPoint idFinger=1 x=826 y=214 precision=1 t=952375884  
165956940 MTM State=alive Cursors=3 t=952375884  
165956940 CIM ResPoint idFinger=0 idObject=delimitation t=952391484  
165956940 CIM TestPoint idFinger=3 x=977 y=107 precision=1 t=952391484



## #6: file import

Import text files: you can import data by using the *loadStrings()* function

- `String[] lines = loadStrings("myfile.ext");`

Once loaded, you can manage the strings with *split()* or *splitTokens()* functions

- *split(str, delim)*: *str* is a string and *delim* a character or a string
- *splitTokens(str)* or *splitTokens(str, tokens)*: if *tokens* parameter is not used, all whitespace characters (space, tab, new line, etc.) are used as delimiters

## #7- Inputs



# #7: mouse (coordinates)

Mouse input is a way to control the position and attributes of shapes on screen. The Processing variables *mouseX* and *mouseY* store the coordinates relatively to the origin of the display window (there are also *pmouseX* and *pmouseY* for previous coordinates)

```
void setup()
{
  size(100,100);
  smooth();
  noStroke();
}

void draw()
{
  background(127);
  ellipse(mouseX, mouseY, 33, 33);
  ellipse(mouseX+20, mouseY, 22, 22);
  ellipse(mouseX-20, mouseY, 11, 11);
}
```



## #7: mouse (buttons)

We can also use mouse states to interact with Processing.

- *mouseButton*: LEFT, CENTER, RIGHT independently or in combination
- *mousePressed*: **true** if pressed, **false** if not.

## #7: mouse (cursor)

The cursor can be hidden with the *noCursor()* function or be set with the *cursor()* function.

- *noCursor()*: hide the cursor
- *cursor*(ARROW | CROSS | HAND | MOVE | TEXT | WAIT)

```
void setup()
{
  size(100,100);
  smooth();
  noStroke();
}

void draw()
{
  if (mousePressed == true)
    cursor(CROSS);
  else cursor(HAND);
}
```

## #7: mouse (events)

An event is a polite interruption of the normal flow of the program. The code inside an event function is run once each time the corresponding event occurs. There are 4 event functions for mouse

- *mousePressed()*: when a button is pressed
- *mouseReleased()*: when a button is released
- *mouseMoved()*: when the mouse is moved
- *mouseDragged()*: when the mouse is moved while a button is pressed

## #7: keyboard (states)

Keyboards are typically used to input characters for composing documents. Processing can register the most recently pressed key and whether a key is currently pressed.

- *keyPressed*: **true** if pressed, **false** if not.

The *key* variable stores the most recently pressed key (a a char). BACKSPACE, TAB, ENTER, RETURN, ESC and DELETE are also recognized directly.

## #7: keyboard (states)

In addition, Processing is able to decode such as arrow keys, ALT, CTRL, SHIFT, ... keys (key value = CODED).

The variable *keyCode* stores ALT, CONTROL, SHIFT, UP, DOWN, LEFT, RIGHT key as constants



## #7: keyboard (events)

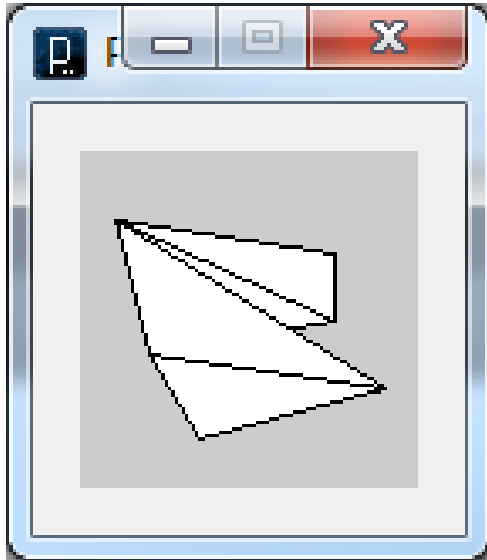
There are 2 event functions for keyboard

- *keyPressed()*: when a key is pressed
- *keyReleased()*: when a key is released

## #7- *assignments*

- Propose two unique shapes that behave differently in relation to the mouse.
- Use the number keys on the keyboard to modify the movement of a line
- Use the arrow keys to change the position of a shape within the display window

## #8 - *Transformations*



## #8: shapes

- PShape is a special datatype to store shapes (see the online doc for more)

The shape() function is used to draw the shape to the display window. Processing can load and display SVG (Scalable Vector Graphics) and OBJ shapes.

```
PShape s1, s2;  
s1 = loadShape("myshape.svg");  
s2 = createShape(RECT, 0, 0, 80, 80);  
...  
shape(s1, 10, 10, 80, 80);
```

## #8: transform function

Actually, the coordinates can be translated, rotated and scaled so shapes can be drawn with different positions, orientations and sizes.

The translation function moves the origin from the upper-left corner of the screen to another location

- `translate(x,y)` The value of parameters are added to any shapes drawn after the function is run.

The rotation function rotates the coordinate system

- `rotate(angle)`

The scale function magnifies the coordinate system

- `scale(size)` or `scale(xsize, ysize)`

## #8: pop and push

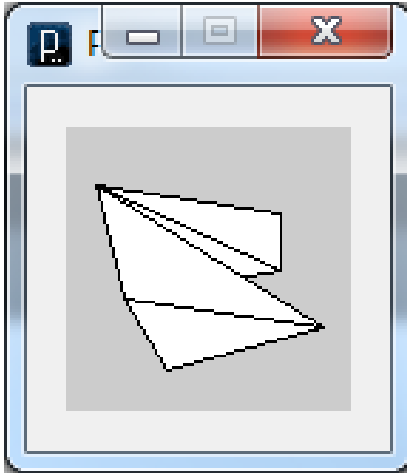
The transformation matrix is a set of numbers that defines how geometry is drawn on the screen. The *pushMatrix()* function records the current state of all transformations. To return to a previous state, we have to use *popMatrix()*

Each matrix can be seen as a sheet of paper with a current list of many transformations (translation, rotation, scale)

## #8- *assignments*

- Create a unique shape using PShape
- Use translate() to reposition the shape
- Use translate() and rotate() to rotate the shape around its own center

# #1 - Vertices



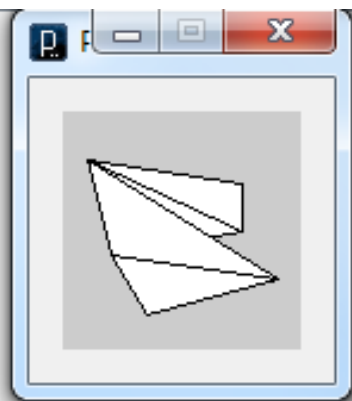


# #1: vertex

To create a shape from vertex points,

- first use *beginShape()* function
  - *beginShape*(POINTS | LINES | TRIANGLES | TRIANGLES\_STRIP | TRIANGLE\_FAN | QUADS | QUAD\_STRIP)
- specify a series of points with the *vertex()* function
  - *vertex*(x,y): all shapes are filled white and have a black outline connecting points
- then complete the

```
beginShape(TRIANGLE_STRIP);
vertex(75, 30);
vertex(75, 50);
vertex(10, 20);
vertex(20, 60);
vertex(90, 70);
vertex(35, 85);
endShape();
```



# #1: curve and bezier vertex

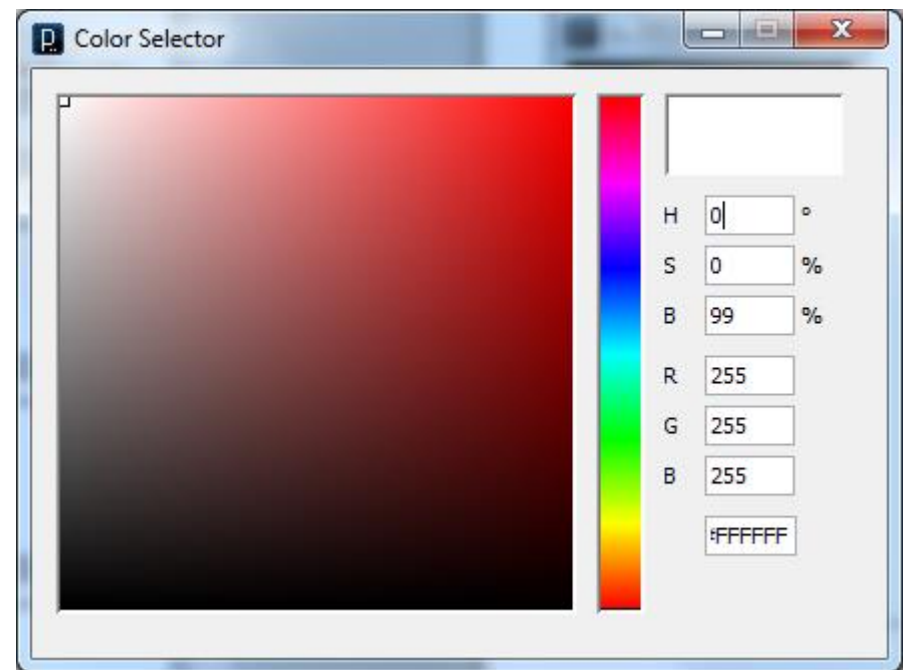
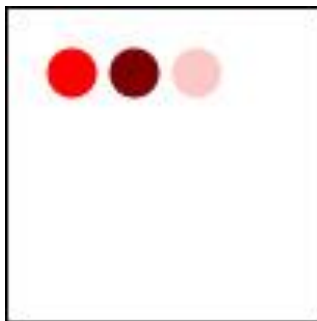
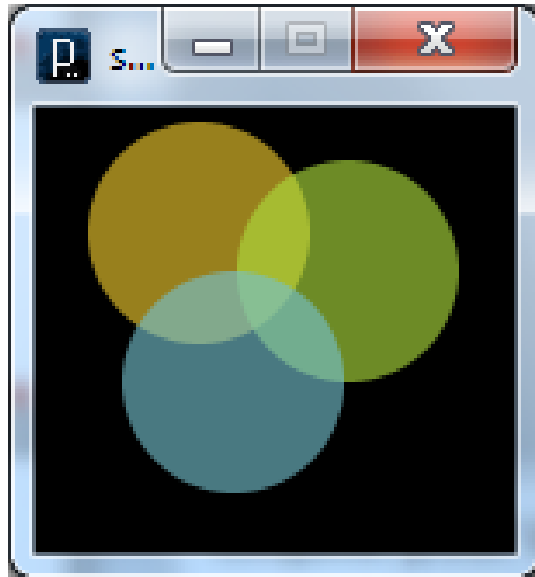
Two functions to create shapes made of curves.

- *curveVertex(x, y)*: there must be at least 4 functions to draw a segment
- *bezierVertex(cx1,cy1,cx2,cy2,x,y)*

A good technique for creating complex shapes is to draw them first on a vector drawing program such as Adobe Illustrator or Inkscape (<http://inkscape.org>)



## #2 - Colors



## #2: components

In Processing, *color* data type is a single number that stores the individual components of a color e.g. red, green, blue and alpha components.

It is possible to extract components from a color by using *red()*, *green()*, *blue()* and *alpha()* functions

The *hue()*, *saturation()* and *brighthness()* functions work like the previous ones but make really sense in the HSB color model.

You can switch from RGB to HSB color model by using *colorMode()* function

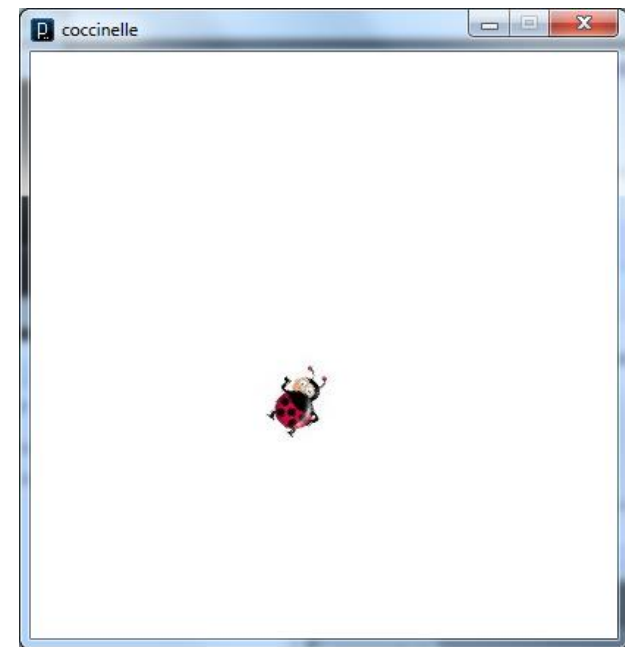
# #4 – *video*

# #4: animation and video

To animate images, you just have to modify some

## Images properties

```
PImage coccinelle;  
float x, y ;  
float rot; // image rotation  
  
void setup()  
{  
  size(400,400);  
  coccinelle = loadImage("coccinelle.jpg");  
  x = 0.0;  
  y = width / 2.0;  
  rot = 0.0;  
}  
  
void draw()  
{  
  background(255);  
  translate(x,y);  
  rotate(rot);  
  image(coccinelle, 0,0);  
  x+=1;  
  rot +=0.01;  
  if (x>width)  
  {  
    x=0;  
  }  
}
```



## #4: animation and video

- 5 basic steps to display video

```
/**
 * Utiliser une webcam
 *
 */

import processing.video.*;

Capture cam;

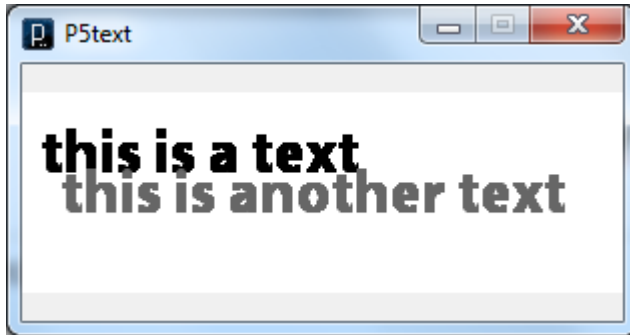
void settings(){
  size(640,480);
}

void setup() {
  cam=new Capture(this,640,480);
  // start webcam
  cam.start();
}

void draw()
{
  image(cam,0,0);
}

/** Événement lié à l'arrivée d'une nouvelle image */
void captureEvent(Capture c) {
  c.read();
}
```

# #5 - *Typography*





## #5: text in action

For typography to move, the program requires a `draw()` function.

```
PFont font;

void setup()
{
  size(100,100);
  font = loadFont("MyriadWebPro-Bold-30.vlw");
  textFont(font);
  noStroke();
  frameRate(15);
}

void draw()
{
  fill(204,24);
  textSize(random(10,30));
  rect(0, 0, width, height);
  fill(0);
  text("Random", random(-100,100), random(-20, 120));
}
```



# #5: text in action

To put text into motion, simply draw it at a different position each frame.

You can also change transparency or color of the text by using the *fade()* function

You can also apply the transformations *translate()*, *scale()* and *rotate()* to create motion

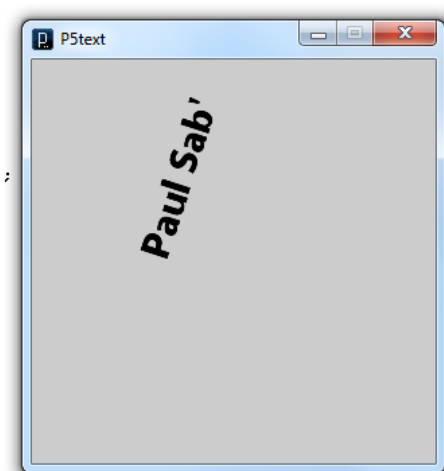
Finally, you can use rapid serial visual presentation (RSVP) to display words  
Store the words within an array.

```
PFont font;
String s = "Paul Sab'";
float angle = 0.0;

void setup()
{
  size(300,300);
  font = loadFont("MyriadWebPro-Bold-30.vlw");
  textFont(font, 10);
  fill(0);
}

void draw()
{
  background(204);
  angle += 0.05;

  pushMatrix();
  translate(100,150);
  scale((cos(angle/4.0) + 1.2) * 2.0);
  rotate(angle);
  text(s,0,0);
  popMatrix();
}
```



## #5: assignments

- Select a noun and a adjective. Animate the noun to reveal the adjective
- Use the transformation functions to animate a short sentence word per word

## #7- Inputs



## #7: time, date

Processing values can read the value of the computer's clock with *second()*, *minute()* and *hour()*, *millis()* and *day()*, *month()*, *year()* functions.

Placing theses functions inside *draw()* allow the time to be read continously.

# #7: assignments

- Make an abstract clock that communicates the passage of time through graphical quantity rather than numerical symbols.

# #9: OOP

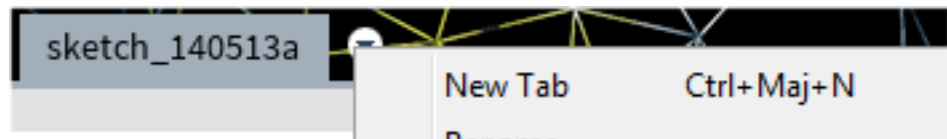
# #9: objects and classes

As Processing is written in java, you can use objects (initially, this part is hidden to users).

Defining a class is creating your own data type over the primitive ones (that means *int*, *float*, *boolean*, *String*, *PImage* and *PFont*)

To define a new class, you have to use the *class* keyword inside a new tab

```
class classname
{
    //Attributes
    // Constructor(s)
    //Methods
}
```





# #10: network

It's very easy to make connections with any network such as Serial, Zigbee, bluetooth or TCP/IP (+ different protocols {from sockets to MQTT} and formats {JSON, XML, RSS ...}).

# #10: Serial connection

- There is a special library to **read** and **write** data from external devices (for example Arduino)

```
import processing.serial.*;

Serial myPort; // The serial port
println(Serial.list()); // List all the available
serial ports
// Open the port you are using at the rate you want:
myPort = new Serial(this, COM9, 9600);
myPort.write(65); // Send an A out the serial port
...
```

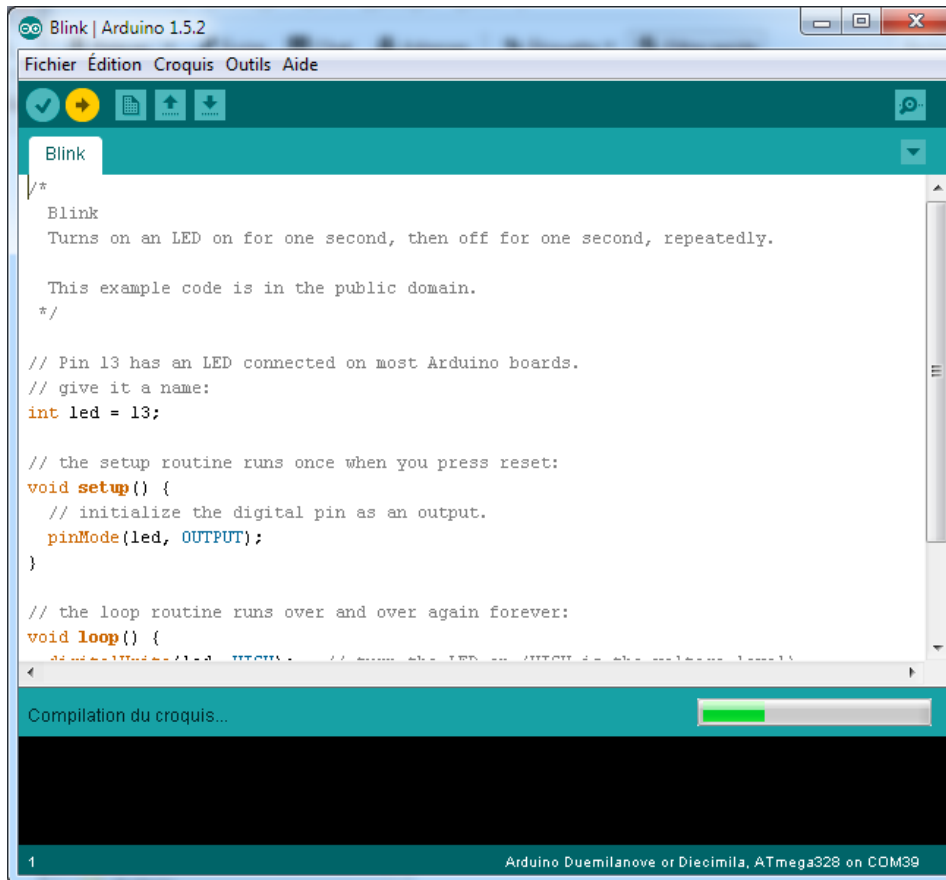
# #10: web client

```
import processing.net.*;
Client c;
String data;

void setup() {
  size(500, 700);
  background(50);
  fill(200);
  c = new Client(this, "www.processing.org", 80); // Connect to server on port 80
  c.write("GET / HTTP/1.0\r\n"); // Use the HTTP "GET" command to ask for a Web page
  c.write("\r\n");
}

void draw() {
  if (c.available() > 0) { // If there's incoming data from the client...
    data = c.readString(); // ...then grab it and print it
    text(data);
  }
}
```

# #10: Processing and arduino



# Arduino: how-to?

- Installation
  - Go to <http://arduino.cc/en/Main/Software>
  - Install the 'IDE and drivers able to use serial communication



## ARDUINO 1.8.10

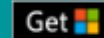
The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board.

Refer to the [Getting Started](#) page for Installation instructions.

**Windows** Installer, for Windows XP and up

**Windows** ZIP file for non admin install

**Windows app** Requires Win 8.1 or 10



**Mac OS X** 10.8 Mountain Lion or newer

**Linux** 32 bits

**Linux** 64 bits

**Linux** ARM 32 bits

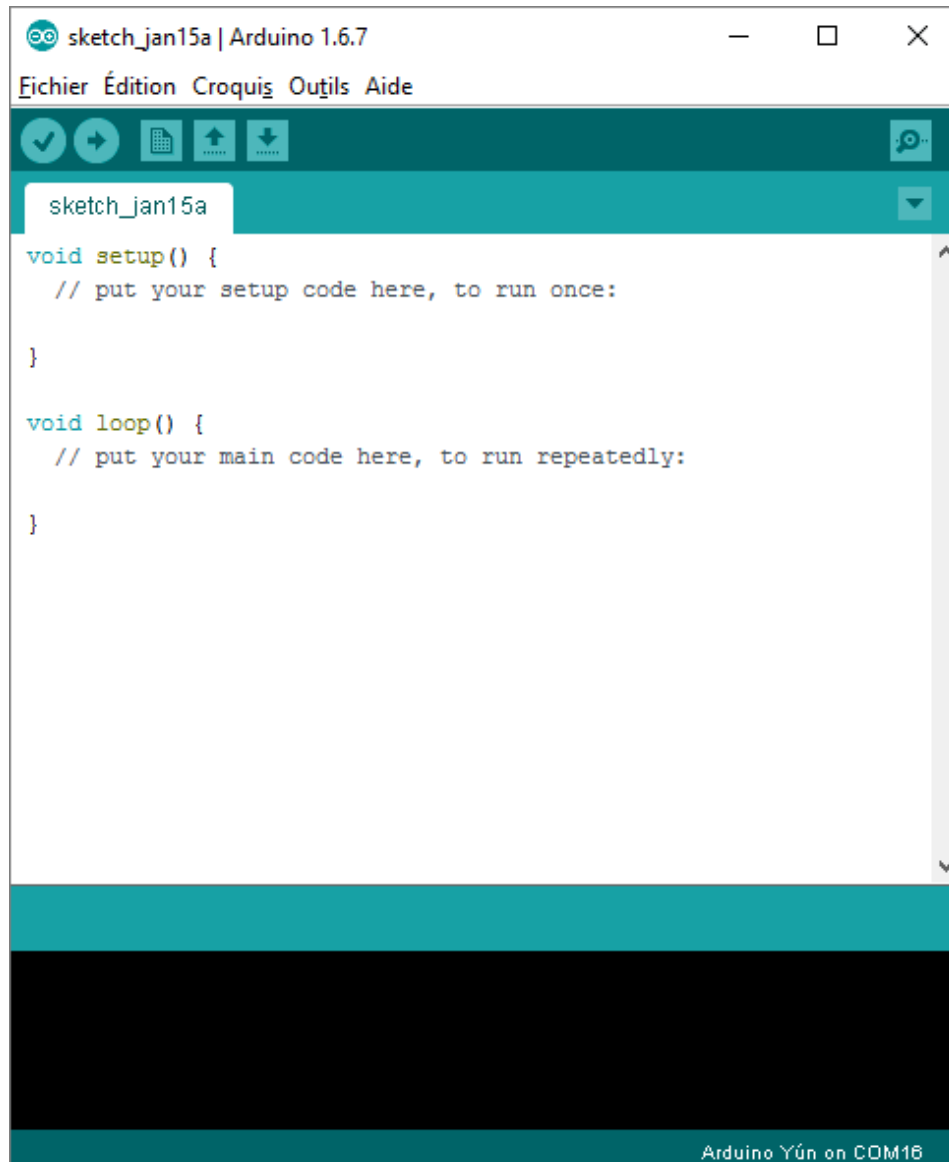
**Linux** ARM 64 bits

[Release Notes](#)

[Source Code](#)

[Checksums \(sha512\)](#)

# Arduino: how-to?



# Hardware

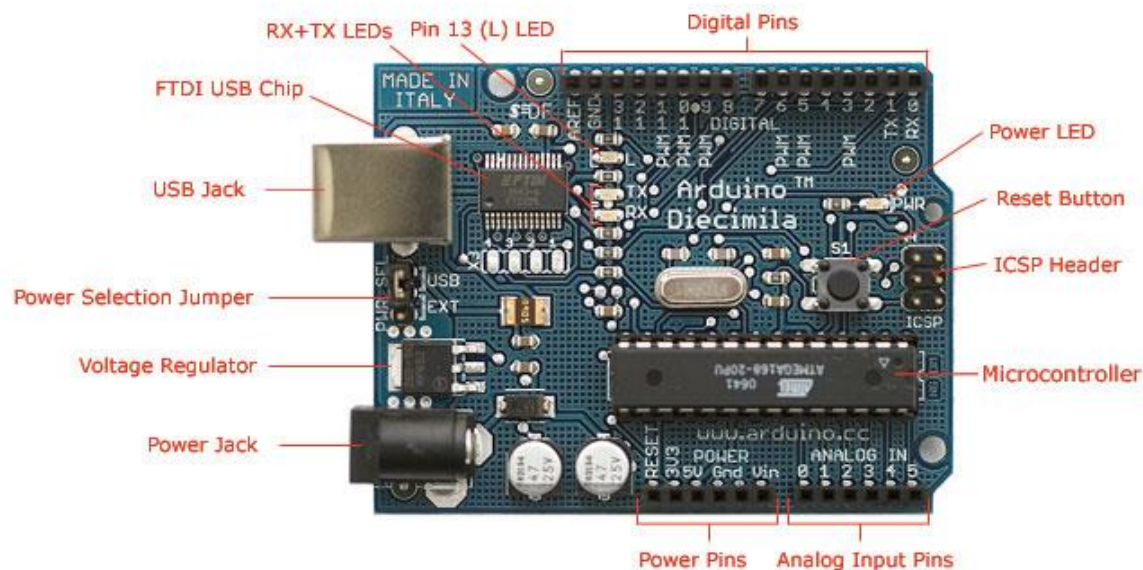


- Several versions:
  - Diecimila / ATmega 168 / 16 Ko
  - Duemilanove / ATmega 328 / 32 Ko
  - Mega / ATmega1280 / 128 Ko
  - UNO, Due, Yun (Linux one), Leonardo, ...
  - ESP8266, ...
- + IoT platform (Onion Omega, Airboard, Particle Photon, ...)

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# Power

- By USB connection (5 V until to 500 mA)
- Or external power (batteries)

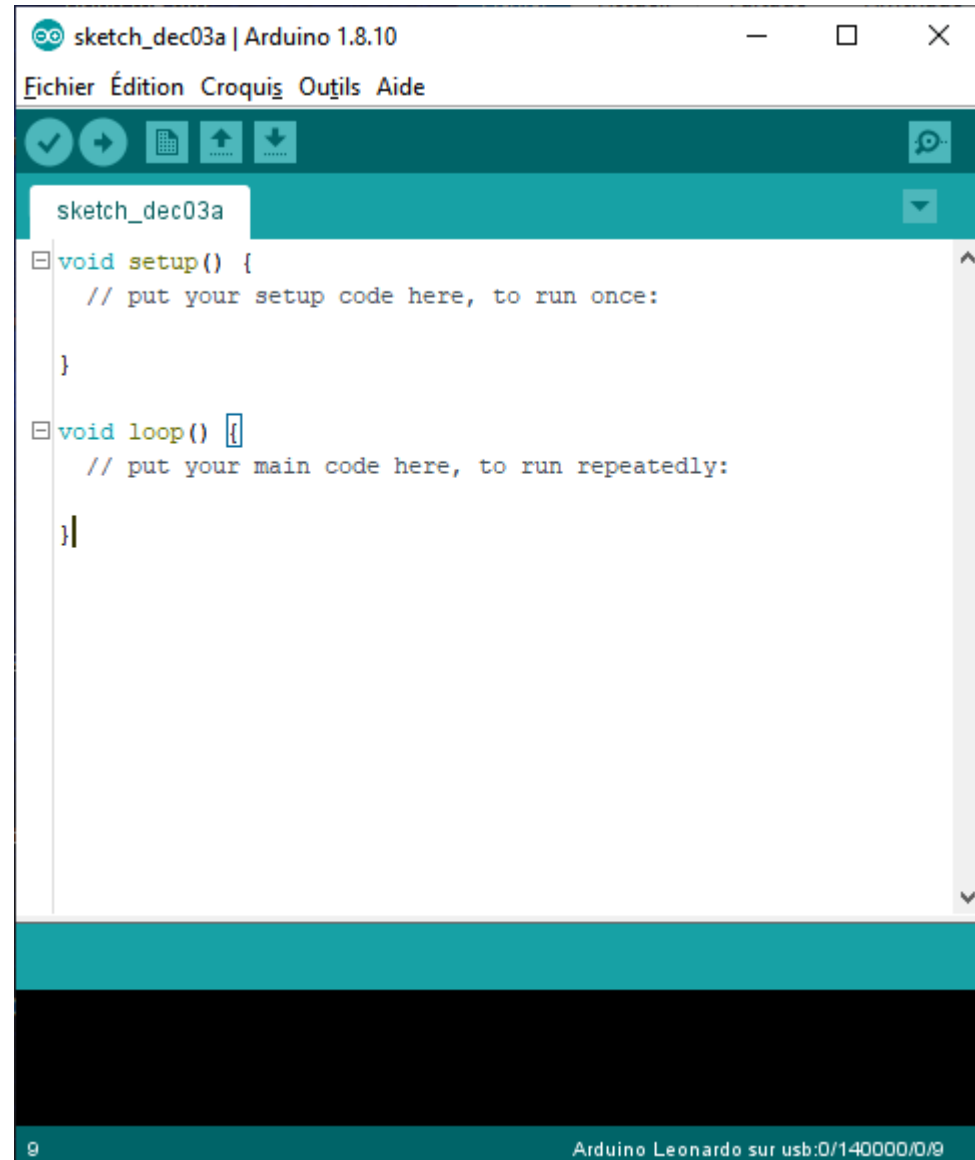


Photograph by SparkFun Electronics. Used under the Creative Commons Attribution Share-Alike 3.0 license.



# Programming ...

- Integrated environment multi OS based on java (v. **1.8.10** – 13/10/2019)



# Programming

- 2 main functions for a « sketch »
  - **setup()**: like in processing to init variables, I/O pins, ...
  - **loop()**: the mainloop (like the *draw* function in Processing)

# Programming

- C-like syntax
- Reference : <http://arduino.cc/fr/Main/Reference>

## Structure

### Fonctions de base

Ces deux fonctions sont obligatoires dans tout programme en langage Arduino :

- void setup()
- void loop()

### Structures de contrôle

- if
- if...else
- for
- switch case
- while
- do... while
- break
- continue
- return

### Syntaxe de base

- ; (point virgule)
- {} (accolades)

## Variables et constantes

Les variables sont des expressions que vous pouvez utiliser dans les programmes pour stocker des valeurs, telles que la tension de sortie d'un capteur présente sur une broche analogique.

### Constantes prédéfinies

Les constantes prédéfinies du langage Arduino sont des valeurs particulières ayant une signification spécifique.

- HIGH | LOW
- INPUT | OUTPUT
- true | false

A ajouter : constantes décimales prédéfinies

### Expressions numériques

- Expressions numériques entières

## Fonctions

### Entrées/Sorties Numériques

- pinMode(broche, mode)
- digitalWrite(broche, valeur)
- int digitalRead(broche)

### Entrées analogiques

- int analogRead(broche)

### Sorties "analogiques" (génération d'impulsion)

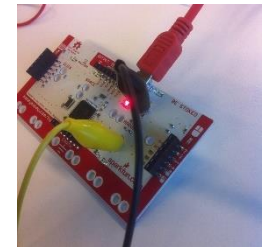
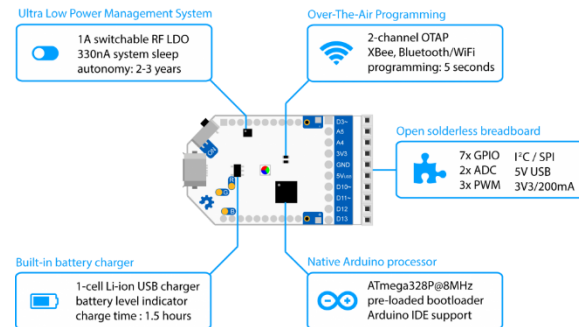
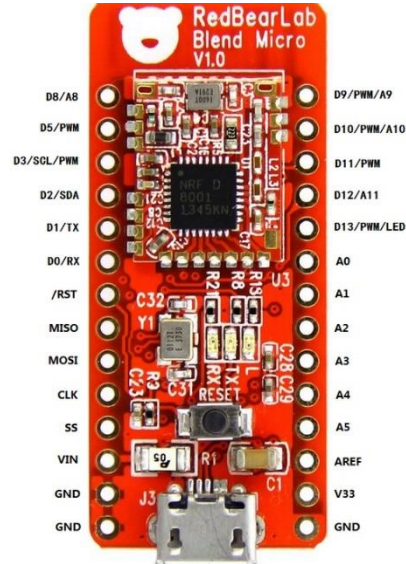
- analogWrite(broche, valeur) - PWM

### Entrées/Sorties Avancées

- tone()
- noTone()
- shiftOut(broche, BrocheHorloge, OrdreBit, valeur)
- unsigned long pulseIn(broche, valeur)

# Arduino: the family...

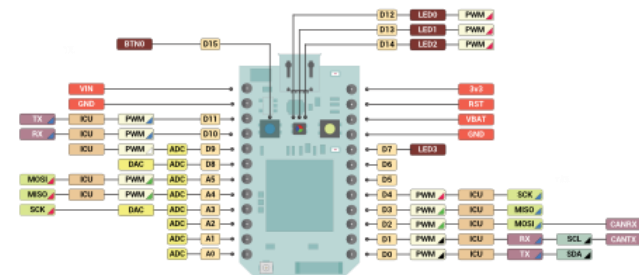
- Many other projects: Teensy, Makey-Makey, The Airboard, Particle Photon, clones, ...



VIPER  
—•—  
PRINTOUT DIAGRAM



Particle Photon



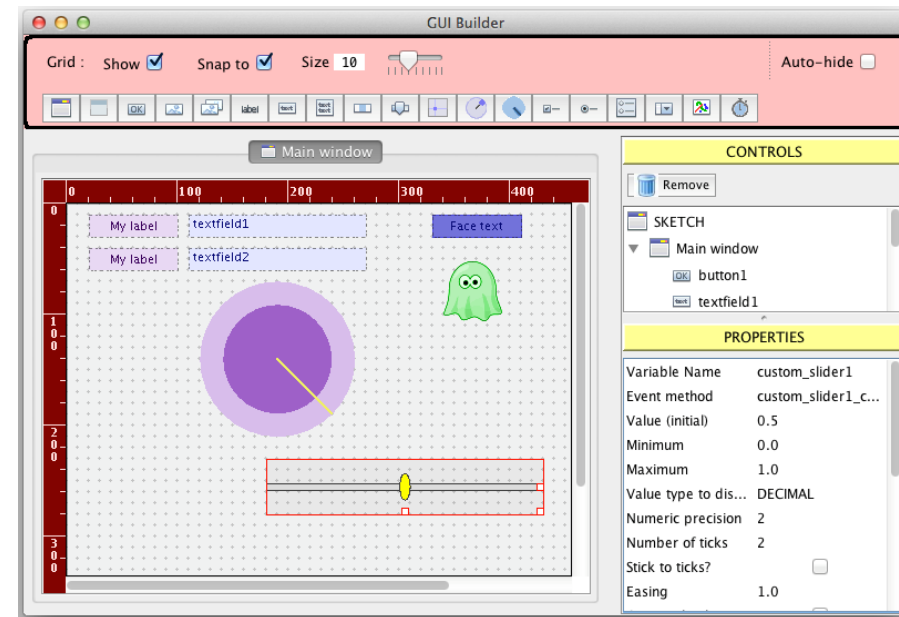
# #11: third-party libraries

Finally, you can (re) use some libraries (classes, functions) written by others to manage for example sound, mixed reality, networks, etc.

# #1 1: GUI Builder Tool

You can use G4P (GUI for Processing) and GUI Builder Tool (<http://lagers.org.uk/g4ptool/index.html>) to generate easily a “standard interface”.

Libraries are available for download or installation through the PDE

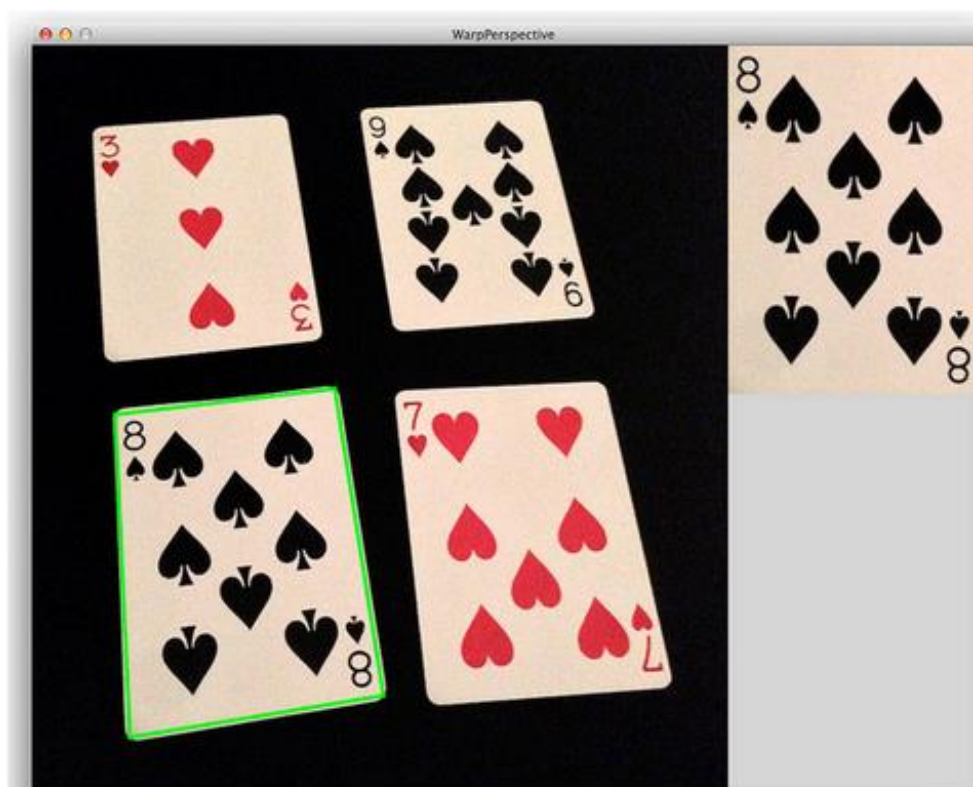


# #1 1: speech recognition and TTS

- Try to use STT library (<http://stt.getflourish.com>) to be able to use the Google speech recognizer in Processing!
- Try to use at the same time TTS library (<http://www.local-guru.net/blog/pages/ttslib>) at the same time

# #11: OpenCV

- Try to use OpenCV (<https://github.com/atduskgreg/opencv-processing/releases>) and enjoy image processing!





# #11: ... and more!

- You can find several libraries to manage kinect, Leap Motion, encode and decode QRCode (Zxing project), make augmented reality applications, use middleware, etc.

**Be curious and enjoy!**

# #12: my own libraries

Moreover, you can also create some new libraries (**classes**, functions) for you and for the entire community!

How to deal with classes?

Simply by putting them in different tabs 😊

# #12: assignments

- Create a new interactive object that reacts to mouse pressed and mouse released events (could be for example a pie menu or a button)
- Insert this interactive object onto a sketch to illustrate its capabilities.

# #13: tips

## Full screen :

- *Processing 2 :*

```
size(displayWidth, displayHeight, P2D); // SETUP
```

```
// Full screen mode
```

```
boolean sketchFullScreen() {  
    return(true);  
}
```

- *Processing 3 :*

```
fullScreen() // SETUP
```

# Links

- **Processing** : [www.processing.org](http://www.processing.org)



- **Processing.js** : [processingjs.org](http://processingjs.org)

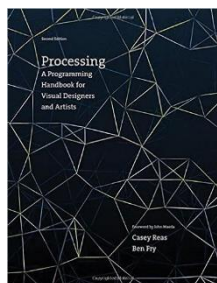


- **p5js** : [p5js.org](http://p5js.org)



- **Reference**: <http://processing.org/reference>
- **Learning Processing**: <http://www.learningprocessing.com>
- **Hello Processing** : <http://hello.processing.org>

# Links



**Processing: A Programming Handbook for Visual Designers and Artists, Casey Reas and Ben Fry**



**Learning Processing: A Beginner's Guide to Programming Images, Animation, and Interaction, Daniel Shiffman**

<http://learningprocessing.com>



**The Nature of Code: Simulating Natural Systems with Processing, Daniel Shiffman**

<http://natureofcode.com>