

Force Simulator

Processing

What we need to simulate an object in movement?

- Location x and y
- Velocity xVel and yVel

The velocity will make the object change its location:

$x = x + xVel;$

$y = y + yVel;$



How can we implement this in Processing?

Let's say the object we want to move is a ball, so let's create a class Ball:

```
class Ball{  
    float x, y, xVel, yVel;  
  
    Ball(float x, float y, xVel, yVel){  
        this.x = x;  
        this.y = y;  
        this.xVel = xVel;  
        this.yVel = yVel;  
    }  
  
    void move(){  
        // change location based on velocity  
    }  
}
```

The setup() and draw() method will create objects Ball and simulate the movement.



Let's start coding

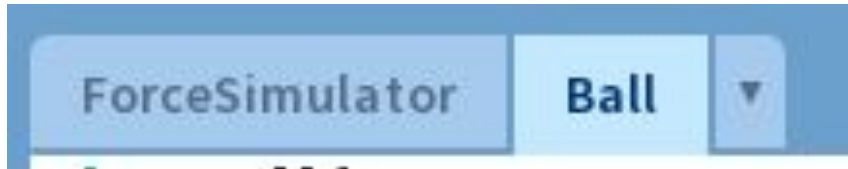
You will need to work with 2 files saved in the same processing folder

- ForceSmulator.pde
- Ball.pde

To add a second class to the project:



Click here and select "New Tab"



Vectors

A **vector** is an entity with magnitude and direction.

A **location** in terms of (x, y) in a Cartesian coordinate system refers to a vector that describes the displacement of a point from the origin of the coordinate system.

The x and y values are the horizontal and vertical components of a vector.

Velocity is the rate of change in the position of an object in a certain direction. Since it has both magnitude and direction, it is a vector.

$$\mathbf{v} = \mathbf{d}/t$$

$v \Rightarrow$ velocity, $d \Rightarrow$ displacement (change in position), t is time.

If an object has a velocity of 1 m/s, it changes its position by 1 meter in 1 second.



PVector

It is a class in Processing that stores the components of a vector (2 or 3 dimensional).

Fields: x, y, z

Methods: add(), sub(), mult(), div(), mag()

Documentation: <https://processing.org/reference/PVector.html>



Converting location and velocity to vectors

```
float x, y;  
float xVel, yVel;
```



```
PVector location = new PVector(x, y);  
PVector velocity = new PVector(xVel, yVel);
```

How should we update the location based on the velocity using vectors?

```
void move() {  
    x = x + xVel;  
    y = y + yVel;  
}
```



```
void move() {  
    location.add(velocity);  
}
```

Which means add the velocity x component to the location x component, same for the y component.

Acceleration

While velocity changes location over time. **Acceleration changes velocity over time**. It could make velocity change magnitude and direction.

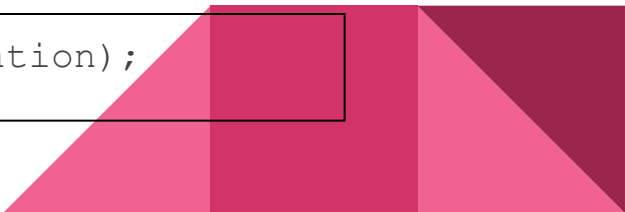
We can add acceleration to our programs and observe what happens:

We need a variable acceleration, which data type should it be?

```
PVector acceleration = new PVector(x, y);
```

How can we use this variable to Change velocity over time?

```
velocity.add(acceleration);
```



Let's update our code to use vectors and add acceleration.

You can add acceleration like this:

```
acceleration = new PVector(0.2, 0); // play with the numbers
```

OR

```
acceleration = PVector.random2D();
```

