Aalto University
School of Arts, Design
and Architecture

Programming for Visual Artists

2024/2025
Department of Art and Media

Recap

IN CASE YOU
MISSED IT

- Some Creative Coding background
- Tools
- Boilerplate
- Processing 101
  - Colors, background, shapes

Some things to check

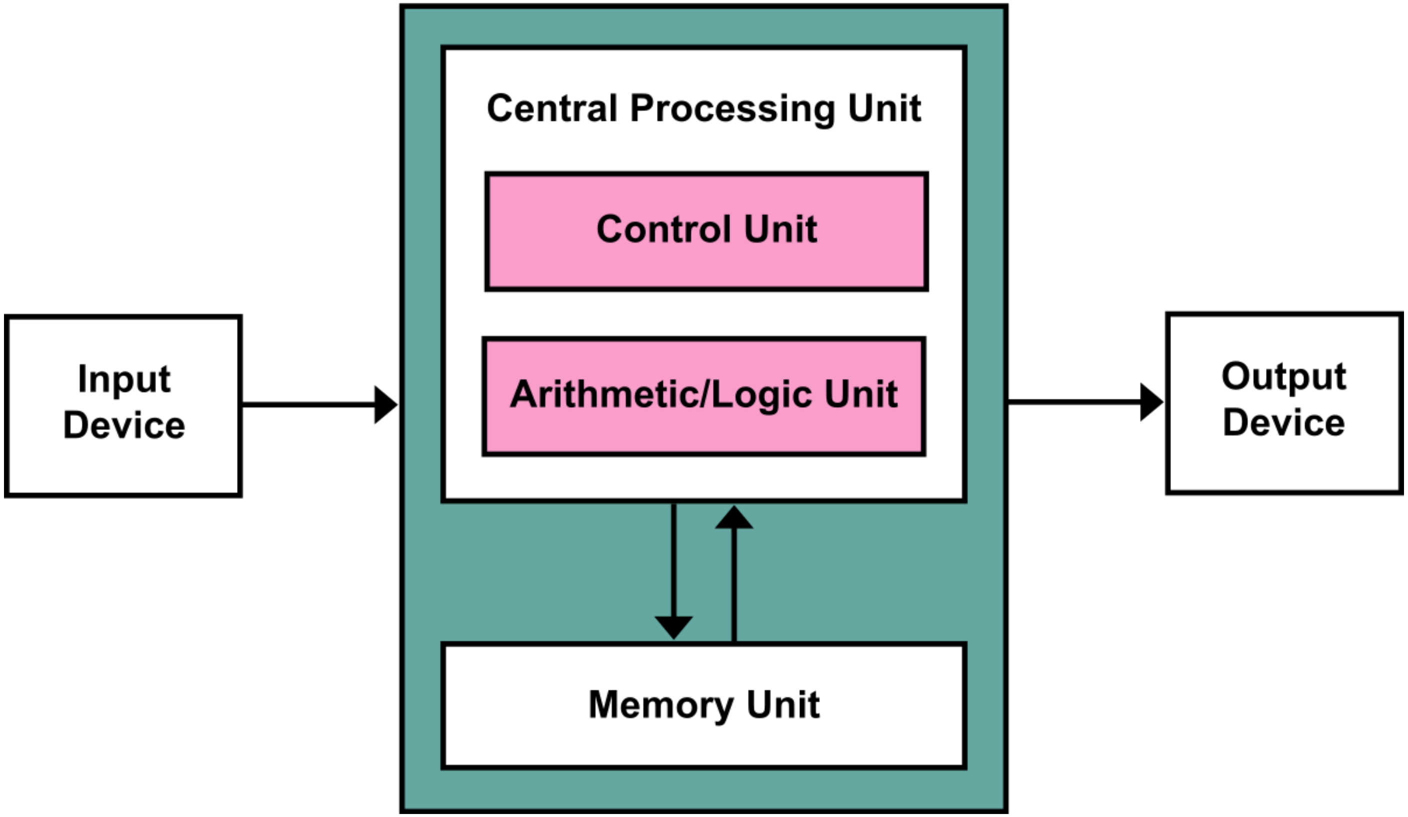
GitHub Pages: https://pages.github.com/

Hugo: https://gohugo.io/

Processing reference: https://processing.org/reference

Some basics

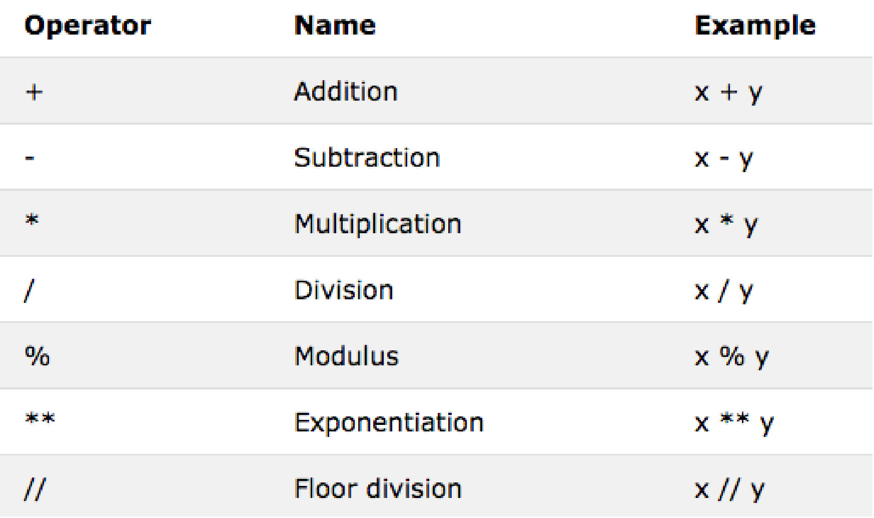
- **CPU (Central Processing Unit)** – Located on the **motherboard**, inside the CPU socket, usually under a heatsink and fan.
- **RAM (Random Access Memory)** – Installed in **RAM slots** on the motherboard.
- **ROM (Read-Only Memory)** – Usually built into the **motherboard** as firmware (BIOS/UEFI) or in specialized chips.
- **GPU (Graphics Processing Unit)** – Can be integrated into the **CPU** (integrated graphics) or installed as a **dedicated graphics card** in a PCIe slot on the motherboard.
- **SSD (Solid State Drive)** – Can be located in an **M.2 slot** on the motherboard (for NVMe SSDs) or connected via **SATA ports** (for 2.5-inch SSDs).
- **HDD (Hard Disk Drive)** – Installed in a **drive bay** inside the computer case and connected via **SATA ports** on the motherboard.
- **VRAM (Video RAM)** – Located on the **GPU** (inside a dedicated graphics card). Integrated graphics use part of the system RAM as VRAM.
- **ALU (Arithmetic Logic Unit)** – A component **inside the CPU**, responsible for arithmetic and logic operations.
- **Cache** – A small, high-speed memory located **inside the CPU**, used to store frequently accessed data for faster processing (L1, L2, and L3 cache).



Some basics

- The **Von Neumann architecture** is a computer design model proposed by **John von Neumann** in 1945. It describes a system where a **single memory unit** stores both **data and program instructions**. The CPU fetches instructions and data from memory, processes them, and writes the results back. This model uses a **control unit, ALU, registers, memory (RAM), and input/output devices**. A key characteristic is the **Von Neumann bottleneck**, where the shared memory bus can slow down processing due to limited data transfer speeds. This architecture is widely used in modern computers, from PCs to smartphones.
- **Used in Traditional CPUs like x86)! For ARM processors, Harvard architecture is used!**

Some basics



Operator	Name	Example
+	Addition	x + y
-	Subtraction	x - y
*	Multiplication	x * y
/	Division	x / y
%	Modulus	x % y
**	Exponentiation	x ** y
//	Floor division	x // y

Today…

Welcome

Recap

Today's Goals

Drawing and Interaction

Cartesian Coordinate System

Colour Theory basics

Interactivity

BREAK (10:30–10:45)

Coding tasks

Shapes follow the mouse and change colour

Invert movement and dynamic background

Q&A

Brief display of sketches

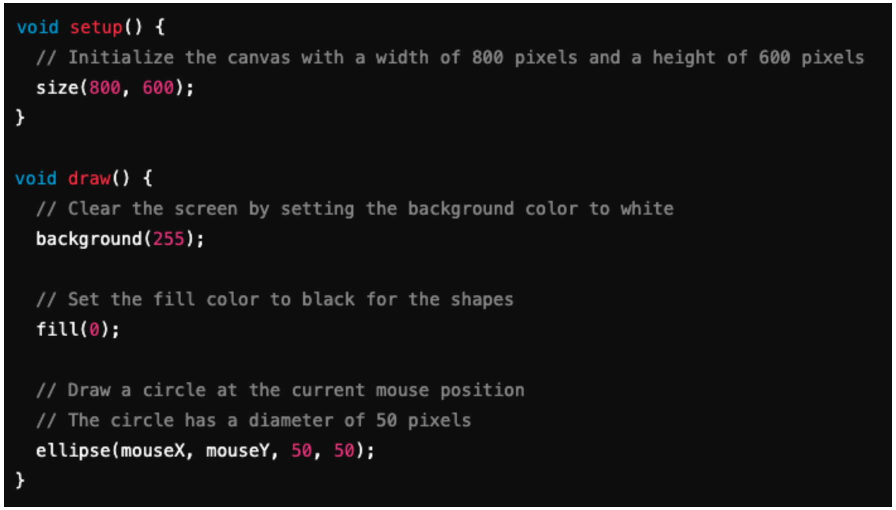
For tomorrow…

Drawing & Interaction

- mouseX and mouseY are built-in variables in Processing that store the current horizontal (x) and vertical (y) position of your mouse cursor, respectively.
- These values are updated automatically as you move your mouse around within the window.
- You can use these variables to create interactive experiences in your Processing sketches.

Drawing & Interaction

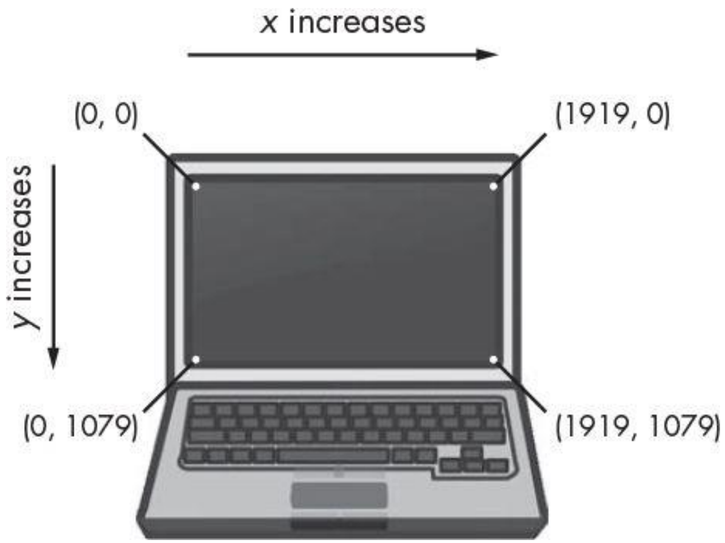
- In this example, whenever you move your mouse around within the window, a black circle will follow its cursor.
- The ellipse() function is called with mouseX and mouseY as arguments, which means that it's drawing the circle at the current position of the mouse.
- Since these positions are updated continuously in real-time, this creates an interactive experience where moving your mouse results in a visual response on the screen.



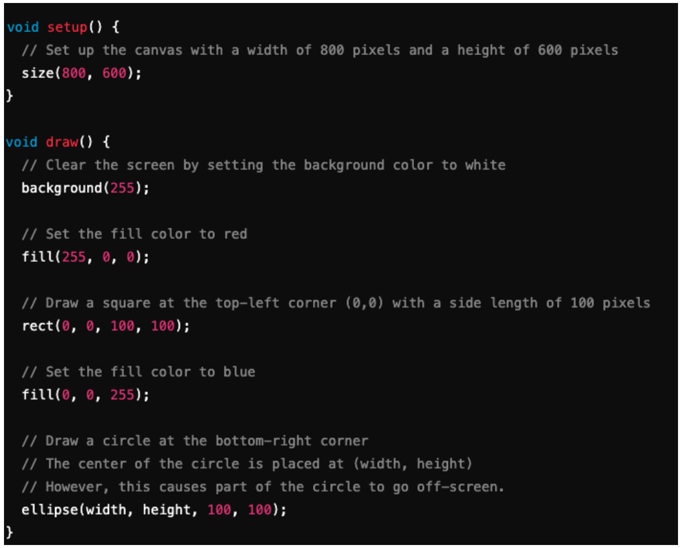
```
void setup() {
  // Initialize the canvas with a width of 800 pixels and a height of 600 pixels
  size(800, 600);
}

void draw() {
  // Clear the screen by setting the background color to white
  background(255);

  // Set the fill color to black for the shapes
  fill(0);

  // Draw a circle at the current mouse position
  // The circle has a diameter of 50 pixels
  ellipse(mouseX, mouseY, 50, 50);
}
```

Interaction - coordinates

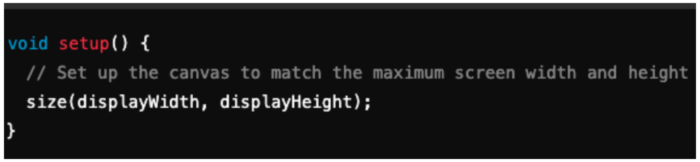
- In Processing (and others too), the coordinate system is Cartesian, with the x-axis representing width and the y-axis representing height.
- In Processing, the origin (0,0) is at the top-left corner. The x-axis increases to the right, and the y-axis increases downward.
- For an 800×600 canvas, (800,0) is the top-right corner, and (0,600) is the bottom-left. Negative coordinates position elements off-screen.
- Understanding the coordinate system helps accurately position objects in Processing. By specifying (x, y) coordinates, objects maintain their placement, enabling dynamic and responsive designs that adapt to different screen sizes.



Drawing & Interaction - coordinates



```
void setup() {
  // Set up the canvas with a width of 800 pixels and a height of 600 pixels
  size(800, 600);
}

void draw() {
  // Clear the screen by setting the background color to white
  background(255);

  // Set the fill color to red
  fill(255, 0, 0);

  // Draw a square at the top-left corner (0,0) with a side length of 100 pixels
  rect(0, 0, 100, 100);

  // Set the fill color to blue
  fill(0, 0, 255);

  // Draw a circle at the bottom-right corner
  // The center of the circle is placed at (width, height)
  // However, this causes part of the circle to go off-screen.
  ellipse(width, height, 100, 100);
}
```

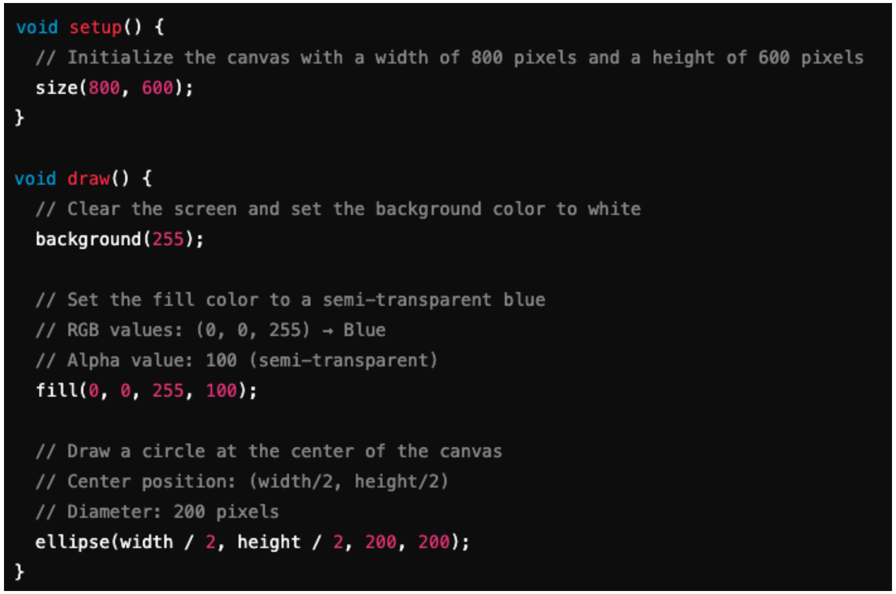


```
void setup() {
  // Set up the canvas to match the maximum screen width and height
  size(displayWidth, displayHeight);
}
```

- This example uses rect() to draw a square and ellipse() to draw a circle.
- The red square is positioned at (0,0), while the blue circle is placed at (width, height) to stay at the bottom right.
- Using width and height ensures correct positioning even if the canvas size changes.
- These principles apply to more complex designs and animations.
- To dynamically adapt the sketch to the full screen, use displayWidth and displayHeight for the screen resolution.
- In newer versions of Processing this was substituted by fullScreen()!

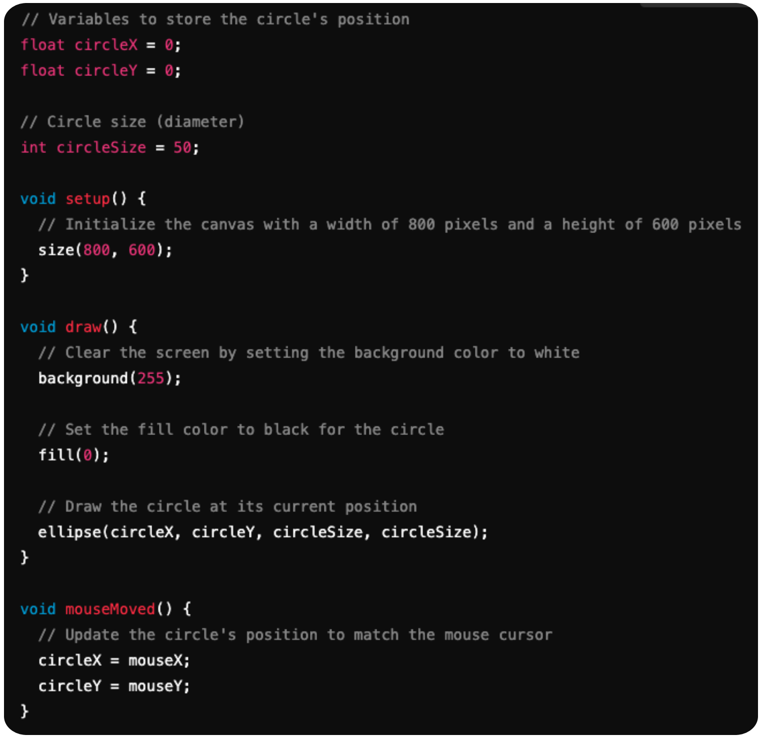
Drawing & Interaction - color theory basics

- Colour theory studies properties like hue, saturation, brightness, and contrast.
- Colours enhance visuals and convey meaning.
- The RGB model (Red-Green-Blue) represents colours using values from 0 to 255, allowing over 16 million combinations.
- An optional alpha channel (0–255) controls transparency for blending effects.



```
void setup() {
  // Initialize the canvas with a width of 800 pixels and a height of 600 pixels
  size(800, 600);
}

void draw() {
  // Clear the screen and set the background color to white
  background(255);

  // Set the fill color to a semi-transparent blue
  // RGB values: (0, 0, 255) → Blue
  // Alpha value: 100 (semi-transparent)
  fill(0, 0, 255, 100);

  // Draw a circle at the center of the canvas
  // Center position: (width/2, height/2)
  // Diameter: 200 pixels
  ellipse(width / 2, height / 2, 200, 200);
}
```

Drawing & Interaction - interactivity

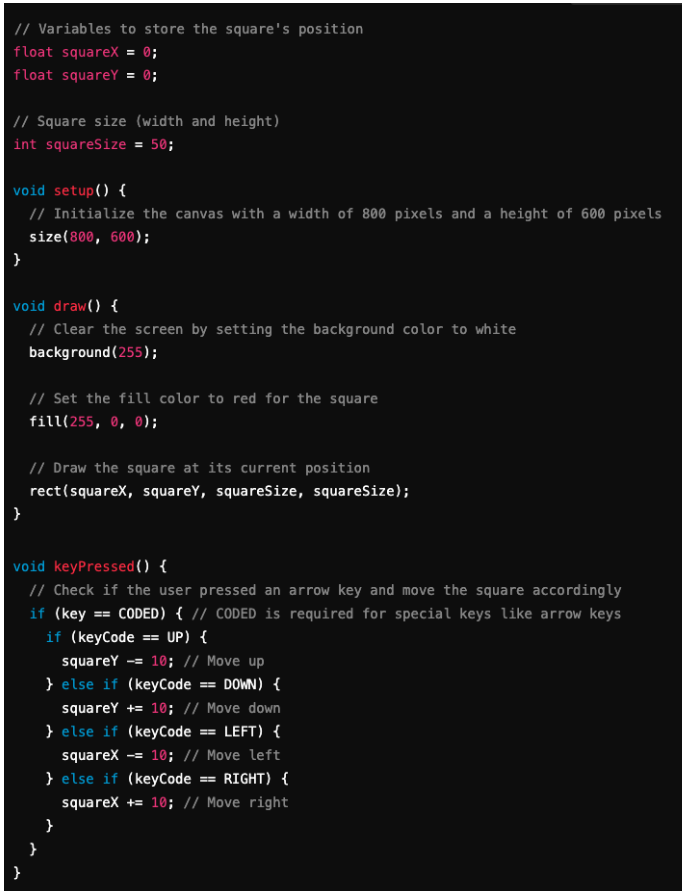


```
// Variables to store the circle's position
float circleX = 0;
float circleY = 0;

// Circle size (diameter)
int circleSize = 50;

void setup() {
  // Initialize the canvas with a width of 800 pixels and a height of 600 pixels
  size(800, 600);
}

void draw() {
  // Clear the screen by setting the background color to white
  background(255);

  // Set the fill color to black for the circle
  fill(0);

  // Draw the circle at its current position
  ellipse(circleX, circleY, circleSize, circleSize);
}

void mouseMoved() {
  // Update the circle's position to match the mouse cursor
  circleX = mouseX;
  circleY = mouseY;
}
```

- In Processing, you can handle mouse and keyboard events to create interactive animations that respond to user input in real-time.
- In this example, the mouseMoved() function updates a black circle's position to match the cursor, creating an animation where the circle follows the mouse.

Drawing & Interaction - interactivity

- The keyPressed() function detects when a user presses an arrow key, updating a red square's position to create movement.
- Handling mouse and keyboard events allows for dynamic, interactive animations in Processing.
- Experimenting with event handlers enhances interactivity.



```
// Variables to store the square's position
float squareX = 0;
float squareY = 0;

// Square size (width and height)
int squareSize = 50;

void setup() {
  // Initialize the canvas with a width of 800 pixels and a height of 600 pixels
  size(800, 600);
}

void draw() {
  // Clear the screen by setting the background color to white
  background(255);

  // Set the fill color to red for the square
  fill(255, 0, 0);

  // Draw the square at its current position
  rect(squareX, squareY, squareSize, squareSize);
}

void keyPressed() {
  // Check if the user pressed an arrow key and move the square accordingly
  if (key == CODED) { // CODED is required for special keys like arrow keys
    if (keyCode == UP) {
      squareY -= 10; // Move up
    } else if (keyCode == DOWN) {
      squareY += 10; // Move down
    } else if (keyCode == LEFT) {
      squareX -= 10; // Move left
    } else if (keyCode == RIGHT) {
      squareX += 10; // Move right
    }
  }
}
```

Drawing & Interaction - interactivity

Some Mouse Event Functions in Processing:

mousePressed()

mouseReleased()

mouseClicked()

mouseMoved()

mouseDragged()

mouseWheel(MouseEvent event)

Some Keyboard Event Functions in Processing:

keyPressed()

keyReleased()

keyTyped()

Drawing & Interaction – about animation

Animation in Processing enables dynamic visuals.

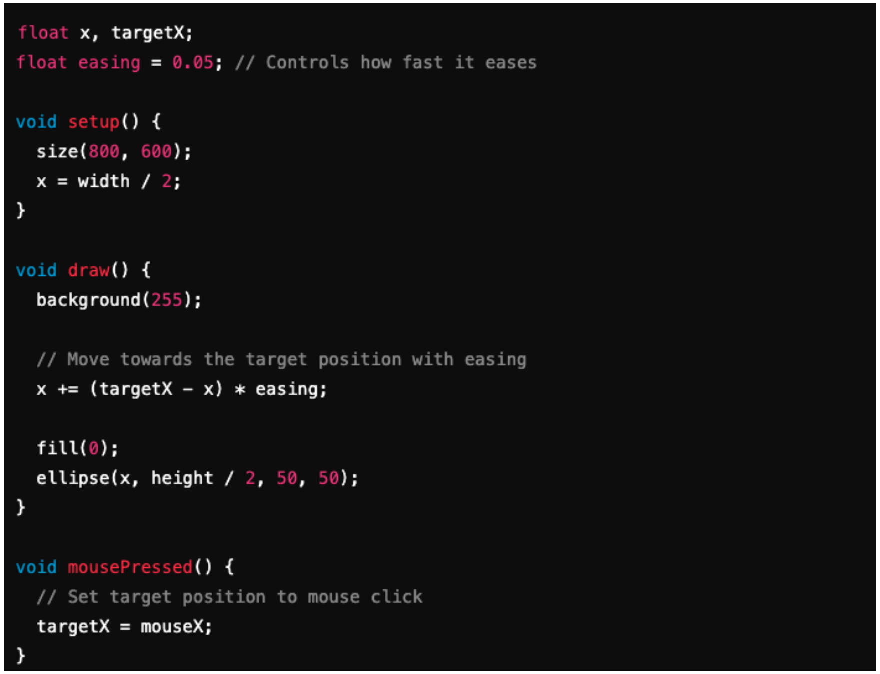
Key techniques include:

- **Easing functions**: Smooth transitions by controlling animation speed.
  (Smooth Movement)
- **Keyframes**: Define specific points in time for smooth interpolation.
  (Smooth Animation between Points)
- **Looping & bouncing**: Repeat sequences or add elasticity for lively effects.
  (Back-and-Forth Motion)
- **Particle systems**: Simulate multiple particles for effects like smoke or fire.
  (Simulating Multiple Particles)
- **Timeline-based animation**: Define property changes over time for complex transitions.
  (Controlling Multiple Properties Over Time)

These techniques enhance animation complexity and visual appeal.

Easing Functions (Smooth Movement)

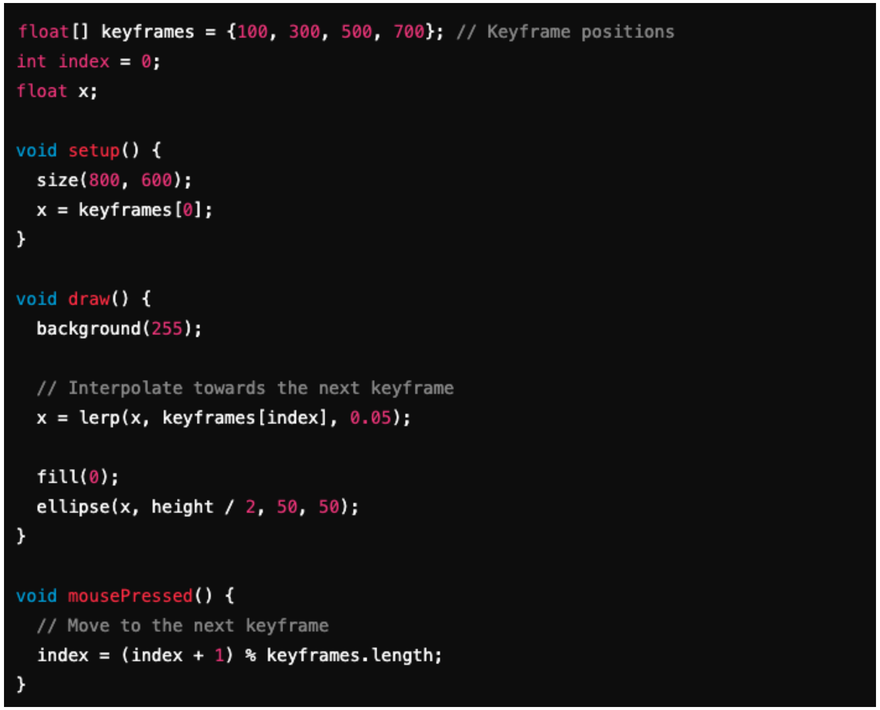
Drawing & Interaction – some examples



```
float x, targetX;
float easing = 0.05; // Controls how fast it eases

void setup() {
  size(800, 600);
  x = width / 2;
}

void draw() {
  background(255);

  // Move towards the target position with easing
  x += (targetX - x) * easing;

  fill(0);
  ellipse(x, height / 2, 50, 50);
}

void mousePressed() {
  // Set target position to mouse click
  targetX = mouseX;
}
```

Keyframes
(Smooth Animation between Points)

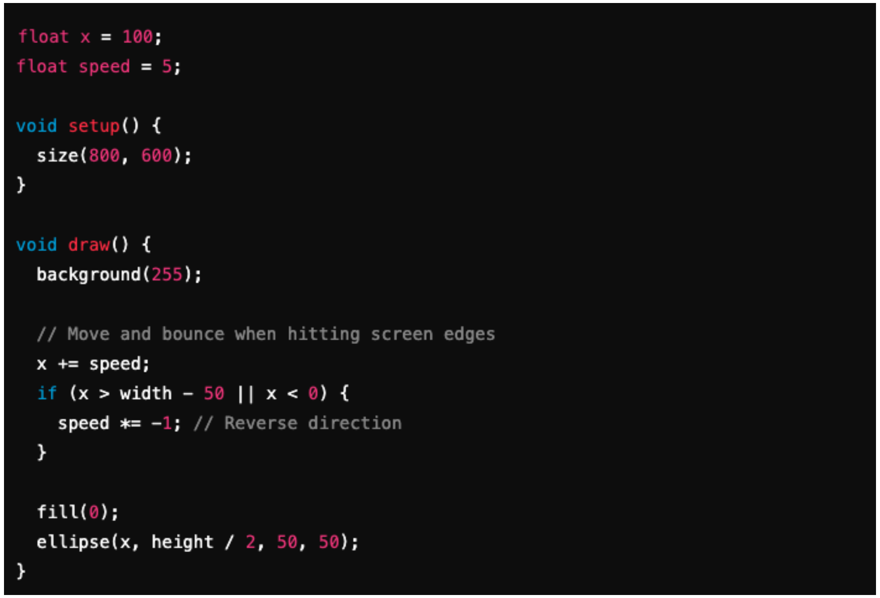
Drawing & Interaction – some examples



```
float[] keyframes = {100, 300, 500, 700}; // Keyframe positions
int index = 0;
float x;

void setup() {
  size(800, 600);
  x = keyframes[0];
}

void draw() {
  background(255);

  // Interpolate towards the next keyframe
  x = lerp(x, keyframes[index], 0.05);

  fill(0);
  ellipse(x, height / 2, 50, 50);
}

void mousePressed() {
  // Move to the next keyframe
  index = (index + 1) % keyframes.length;
}
```

Looping & Bouncing (Back-and-Forth Motion)

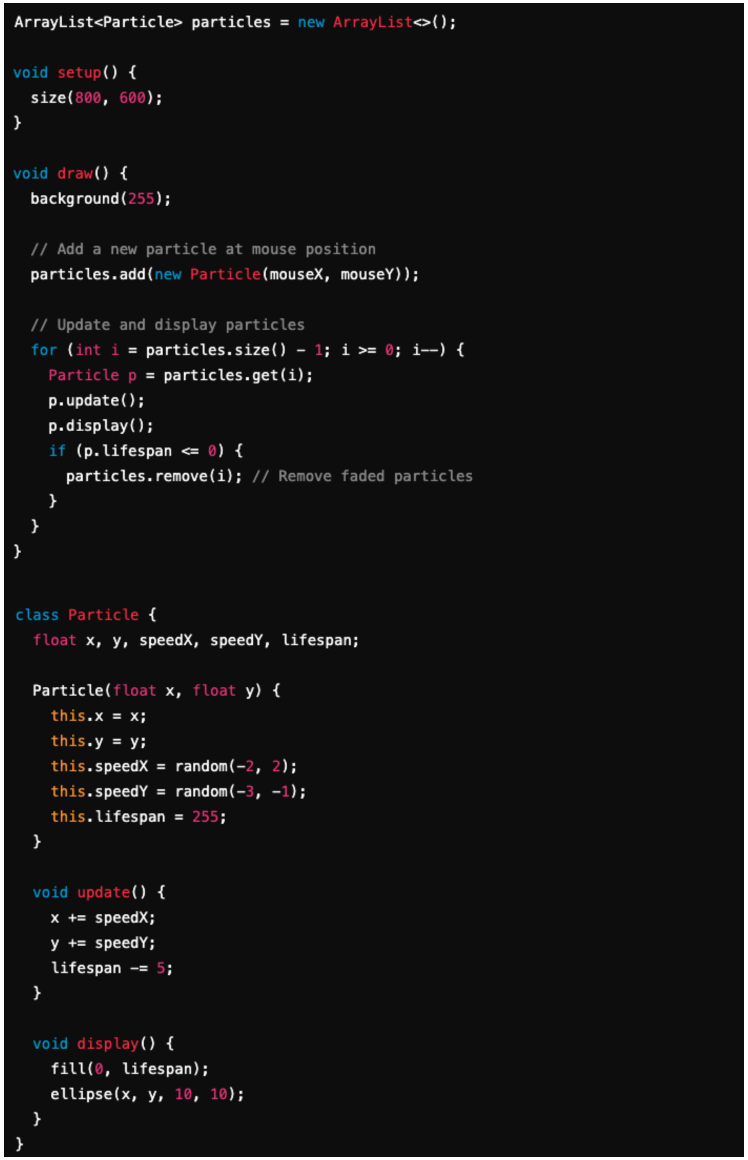
Drawing & Interaction – some examples



```
float x = 100;
float speed = 5;

void setup() {
  size(800, 600);
}

void draw() {
  background(255);

  // Move and bounce when hitting screen edges
  x += speed;
  if (x > width - 50 || x < 0) {
    speed *= -1; // Reverse direction
  }

  fill(0);
  ellipse(x, height / 2, 50, 50);
}
```

Particle System
(Simulating Multiple Particles)

Drawing & Interaction – some examples

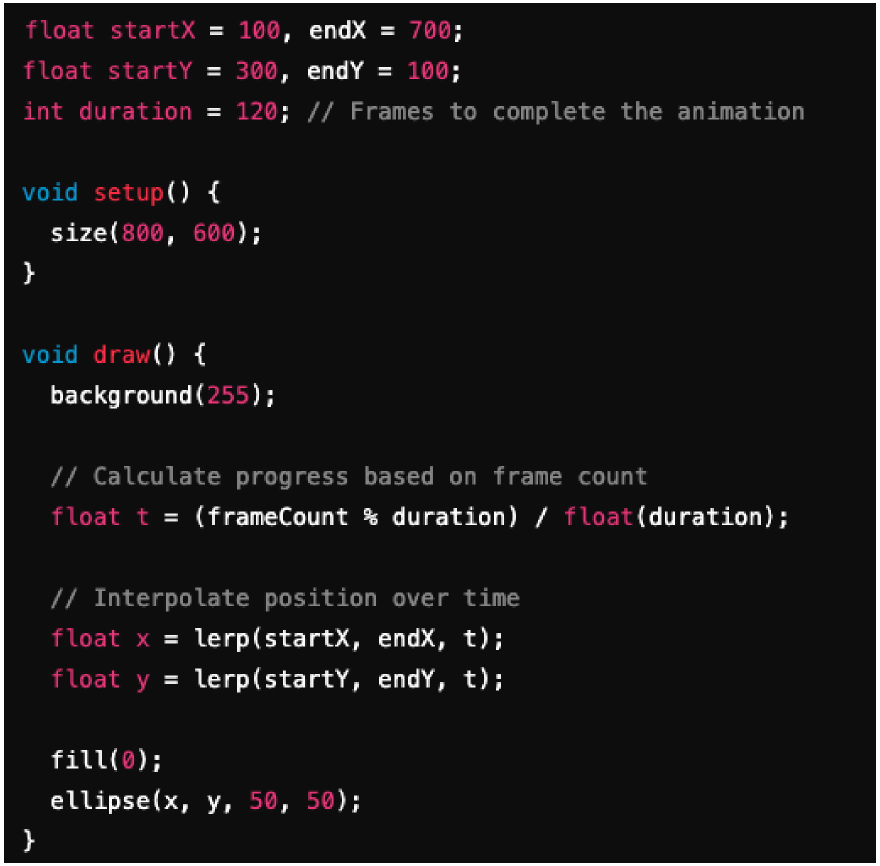


```
ArrayList<Particle> particles = new ArrayList<>();

void setup() {
  size(800, 600);
}

void draw() {
  background(255);

  // Add a new particle at mouse position
  particles.add(new Particle(mouseX, mouseY));

  // Update and display particles
  for (int i = particles.size() - 1; i >= 0; i--) {
    Particle p = particles.get(i);
    p.update();
    p.display();
    if (p.lifespan <= 0) {
      particles.remove(i); // Remove faded particles
    }
  }
}


class Particle {
  float x, y, speedX, speedY, lifespan;

  Particle(float x, float y) {
    this.x = x;
    this.y = y;
    this.speedX = random(-2, 2);
    this.speedY = random(-3, -1);
    this.lifespan = 255;
  }

  void update() {
    x += speedX;
    y += speedY;
    lifespan -= 5;
  }

  void display() {
    fill(0, lifespan);
    ellipse(x, y, 10, 10);
  }
}
```

Timeline-Based Animation

(Controlling Multiple Properties Over Time)

Drawing & Interaction – some examples

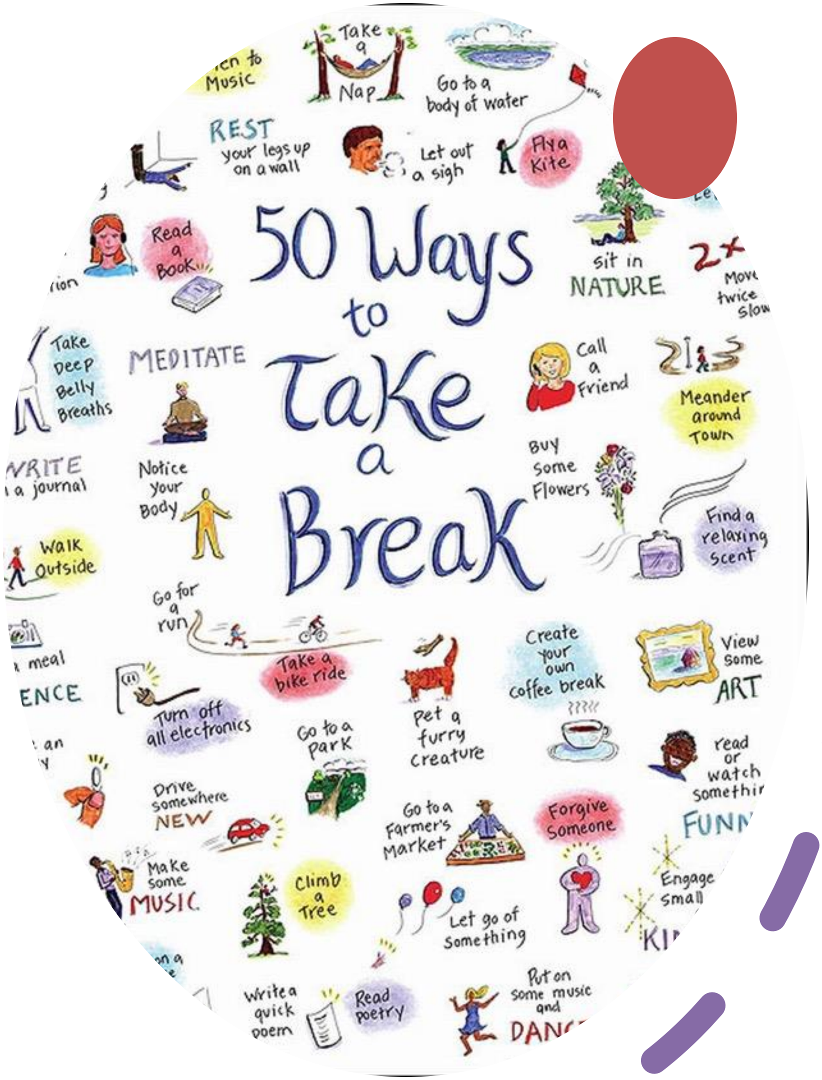


```
float startX = 100, endX = 700;
float startY = 300, endY = 100;
int duration = 120; // Frames to complete the animation

void setup() {
  size(800, 600);
}

void draw() {
  background(255);

  // Calculate progress based on frame count
  float t = (frameCount % duration) / float(duration);

  // Interpolate position over time
  float x = lerp(startX, endX, t);
  float y = lerp(startY, endY, t);

  fill(0);
  ellipse(x, y, 50, 50);
}
```

Break

15 min.!

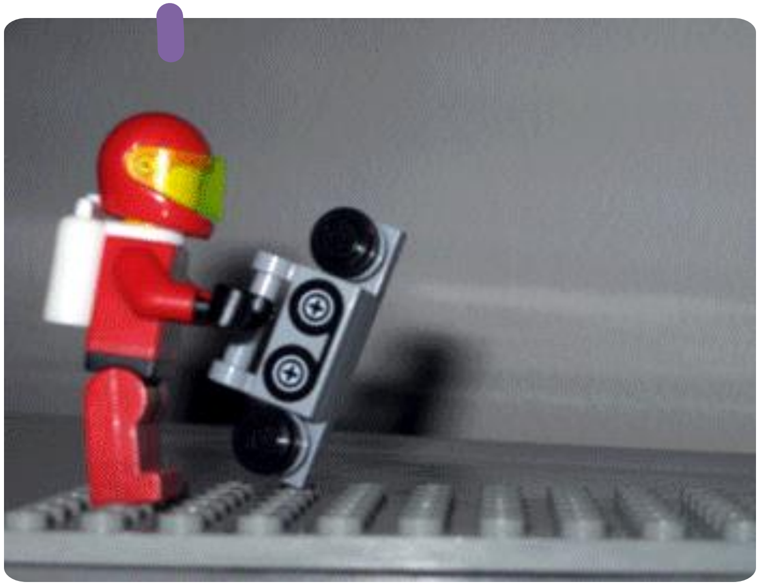
Please don't be late!



Hands-On Exercise!

Objectives:

- Shapes follow the mouse or change colour with mouse position.
- Invert movement for second shape, and dynamic background.
- Experiment! Try out things!



Get an example from here: https://github.com/ptiagomp/aalto-programming-visual-artists-24-25/tree/main/Session-02_25022025

(if bored, check for the “extra” files!)

Discussion & Q&A

Share your feedback!
Am I going too fast or too slow? Is this too easy or too hard?

Next week's topics:

- Control Structures (loops, conditionals), Transformations.
- Functions, Modular code.

Don't forget the assignments!