Arrays

Creative Coding & Generative Art in Processing 2

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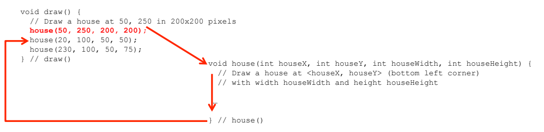
Sequencing

- Refers to sequential execution of a program's statements

```
do this;                    size(200,200);
then do this;               background(255);
and then do this;
etc.                        stroke(128);
                            rect(20, 20, 40, 40);
```

Function Application

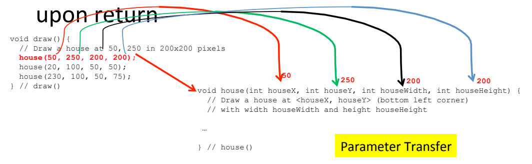
- Control transfers to the function when invoked
- Control returns to the statement following upon return



```
void draw() {
  // Draw a house at 50, 250 in 200x200 pixels
  house(50, 250, 200, 200);
  house(20, 100, 50, 50);
  house(230, 100, 50, 75);
} // draw()

void house(int houseX, int houseY, int houseWidth, int houseHeight) {
  // Draw a house at <houseX, houseY> (bottom left corner)
  // with width houseWidth and height houseHeight

  …

} // house()
```

Function Application

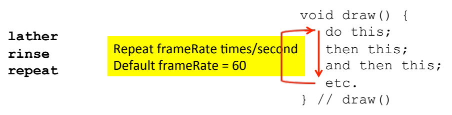
- Control transfers to the function when invoked
- Control returns to the statement following upon return



```
void draw() {
  // Draw a house at 50, 250 in 200x200 pixels
  house(50, 250, 200, 200);
  house(20, 100, 50, 50);
  house(230, 100, 50, 75);
} // draw()

void house(int houseX, int houseY, int houseWidth, int houseHeight) {
  // Draw a house at <houseX, houseY> (bottom left corner)
  // with width houseWidth and height houseHeight

  …

} // house()
```

Repetition

- Enables repetitive execution of statement blocks



```
lather
rinse
repeat
```

```
void draw() {
  do this;
  then this;
  and then this;
  etc.
} // draw()
```

Loops: Controlled Repetition

- **While Loop**

```
while (<condition>) {
   stuff to repeat
}
```

- **Do-While Loop**

```
do {
   stuff to repeat
} while (<condition>)
```

- **For Loop**

```
for (<init>; <condition>; <update>) {
   stuff to repeat
}
```

Writing Conditions in Processing

- Boolean expressions can be written using boolean operators.

  Here are some simple expressions…

<	less than	5 < 3
<=	less than/equal to	x <= y
==	equal to	x == (y+j)
!=	not equal to	x != y
>	greater than	x > y
>=	greather than/equal to	x >= y

Logical Operations

- Combine two or more simple boolean expressions using logical operators:

&&	and	(x < y) && (y < z)
||	or	(x < y) || (x < z)
!	not	! (x < y)

A	B	A && B	A || B	!A
false	false	false	false	true
false	true	false	true	true
true	false	false	true	false
true	true	true	true	false

Loops: Critical Components

- **Loop initialization**

  Things to do to set up the repetition
- **Loop Termination Condition**

  When to terminate the loop
- **Loop Body**

  The stuff to be repeated
- **Loop update**

  For the next repetition/iteration

Key Computing Ideas

- The computer follows a program's instructions. There are four modes:
  - **Sequencing**
    All statements are executed in sequence
  - **Function Application**
    Control transfers to the function when invoked
    Control returns to the statement following upon return
  - **Repetition**
    Enables repetitive execution of statement blocks
  - **Selection**
    Enables choice among a block of statements
- All computer algorithms/programs utilize these modes.

Selection: If Statement

```
if ( <condition> ) {
  do this
}
```

```
if ( <condition> ) {
  do this
}
else {
  do that
}
```

```
if ( <condition> ) {
  do this
}
else if ( <condition> ) {
  do that
}
else if (…) {
…
}
else {
  whatever it is you wanna do
}
```

At most ONE block is selected and executed.

Variables

- int x = 0;
- float delta = 0.483;
- color darkOliveGreen = color(85, 107, 47);
- String colorName = "Dark Olive Green";
- PImage castle = loadImage("myCastle.jpg");

A Set of Sample Values

Petroleum	Coal	Natural Gas	Nuclear	Renewable	Hydropower
40.0	23.0	22.0	8.0	4.0	3.0

```
float petroleum = 40.0;
float coal = 23.0;
float naturalGas = 22.0;
float nuclear = 8.0;
float renewable = 4.0;
float hydropower = 3.0;
```

Declaration

```
float[] consumption;
consumption = new float[6];
```

Creation

index	0	1	2	3	4	5
consumption	44.0	23.0	22.0	8.0	4.0	3.0

A Set of Sample Values

```
//Declare and create an array with size 6
float[] consumption = new float[6];
//store values
consumption[0] = 40.0;
consumption[1] = 23.0;
consumption[2] = 22.0;
consumption[3] = 8.0;
consumption[4] = 4.0;
consumption[5] = 3.0;
```

Fixed size

A Set of Sample Values

```
//Define, create and initialize the data in an array
float[] consumption = {40.0, 23.0, 22.0, 8.0, 4.0, 3.0};
```

Arrays

- // An array to hold the names of all the days in a week
  String[] weekDays = {"Monday", "Tuesday", "Wednesday", "Thursday", "Friday", "Saturday", "Sunday"};
- // two arrays, each containing high and low temperature values
  float[] highTemps, lowTemps;
- int[] count; // an array of integers
- PImage[] photos; // an array of photos
- // An array to hold the names of months in a year
  String[] months = {"January", "February", "March", "April", "May", "June", "July", "August", "September", "October", "November", "December"};
- // The colors in a rainbow
  color[] rainbow = {color(255, 0, 0), color(255, 127, 0), color(255, 255, 0), color (0, 255, 0), color (0, 0, 255), color (111, 0, 255), color (143, 0, 255)};

Indexing, Size and Loops

```
int[] n = new int[1000];
for (int i=0; i < n.length; i++) {
   n[i] = i;
}
```

```
int[] n = new int[1000];
for (int i= n.length-1; i>=0; i--) {
   n[i] = i;
}
```

for-each Loop

- Syntax
  - for (variable : arrayName) { // do something with the value of variable }
- Example

```
String[] energySource = {"Petroleum", "Coal", "Natural Gas", "Nuclear", "Renewable", "Hydropower"};
for(String str :  energySource) {
   println(str);
}
```

Example: A Simple Bar Graph

```
String[] energySource = {"Petroleum", "Coal", "Natural Gas", "Nuclear",
                          "Renewable", "Hydropower"};
float[] consumption = {40.0, 23.0, 22.0, 8.0, 4.0, 3.0};
void setup() {
   size(400, 400); smooth();
} // setup()
void draw() { // set up plot dimensions relative to screen size
   float x = width*0.1;
   float y = height*0.9;
   float delta = width*0.8/consumption.length;
   float w = delta*0.8;
   background(255);
   for (float value : consumption) { // draw the bar for value
      // first compute the height of the bar relative to sketch window
      float h = map(value, 0, 100, 0, height);
      fill(0);
      rect(x, y-h, w, h);
      x = x + delta; }
} // draw()
```

Array Operations

- String[] energySource = {"Petroleum", "Coal", "Natural Gas", "Nuclear", "Renewable", "Hydropower"};
- float[] consumption = {40.0, 23.0, 22.0, 8.0, 4.0, 3.0};

Printing

```
println(consumption.length);
println(consumption);
```

```
6
[0]  40.0
[1]  23.0
[2]  22.0
[3]  8.0
[4]  4.0
[5]  3.0
```

```
println(energySource);
```

```
[0]  Petroleum
[1]  Coal
[2]  Natural Gas
[3]  Nuclear
[4]  Renewable
[5]  Hydropower
```

Try it

Given the following arrays,

- String[] energySource = {"Petroleum", "Coal", "Natural Gas", "Nuclear", "Renewable", "Hydropower"};
- float[] consumption = {40.0, 23.0, 22.0, 8.0, 4.0, 3.0};

write commands to print the values from energySource and consumption in the format shown here:

```
Petroleum, 40.0
Coal, 23.0
Natural Gas, 22.0
Nuclear, 8.0
Renewable, 4.0
Hydropower, 3.0
```

Min, Max and Soring

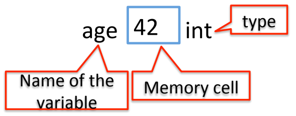
- float smallest = min(consumption);
- float largest = max(consumption);
- println(sort(consumption));
- println(sort(energySource));

Other Array Operation

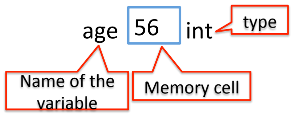
- Reverse the ordering of elements in an array
  - reverse()
- Expand the size of the array
  - append(), expand()
- Shorten it
  - shorten()
- Concatenate or split arrays
  - concat(), subset(), splice()
- Copy the contents of an array
  - arrayCopy()

Variables Types: Primitive Types

- Primitive types
  - int, long, short, byte, float, double, char, boolean
  - E.g.
    int age = 42;

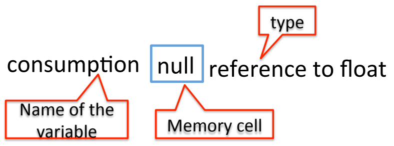


age = 56;



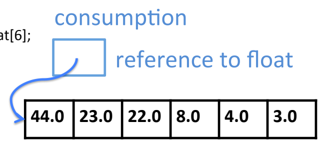
Variables Types: References

- Reference type
  - float[] consumption;



Variables Types: References

- Reference type
  - consumption = new float[6];
  - consumption[0] = 44.0;
  - Consumption[1] = 23.0;
  - Consumption[2] = 22.0;
  - Consumption[3] = 8.0;
  - Consumption[4] = 4.0;
  - Consumption[5] = 3.0;



  - The starting address of the first cell (that is, the one that becomes consumption[0]) is stored in the cell containing the reference to float.

Reference Variables

- Variables that denote arrays and objects (discussed in Chapter 6) are called *reference variables* (or *reference types*).
  - E.g., String, color, and PImage.

Binding for Primitive Types

- What is the binding for y?

```
int x = 10;
int y;
y = x;
```

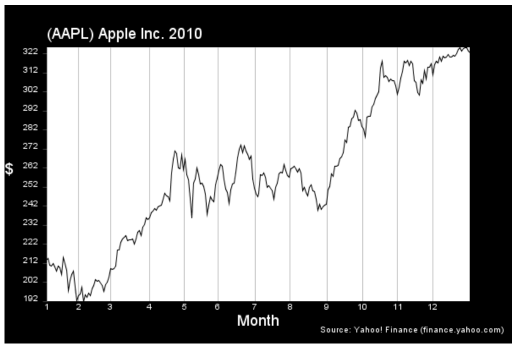
Binding for Arrays

- What is the result?

```
int[] a = {10, 20, 30};
int[] b;
b = a;
b[0] = 100;
println(a[0]);
```

Arrays as Parameters

```
// Bar Graph using a barGraph() function
String[] energySource = {"Petroleum", "Coal", "Natural Gas", "Nuclear", "Renewable",
                         "Hydropower"};
float[] consumption = {40.0, 23.0, 22.0, 8.0, 4.0, 3.0};
void setup() { size(400, 400);  smooth(); } // setup()
void draw() { background(255); barGraph(consumption);  } // draw()

void barGraph(float[] data) { // set up dimensions relative to screen size
    float x = width*0.1;     float y = height*0.9;
    float delta = width*0.8/data.length;
    float w = delta*0.8;
    for (float i : data) { // draw the bar for ith data value
        // first compute the height of the bar relative to sketch window
        float h = map(i, 0, 100, 0, height);
        fill(0); rect(x, y-h, w, h);
        x = x + delta;
    }
} // barGraph()
```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