Expressions & Control Flow

CSE 120 Spring 2017

Instructor: Justin Hsia

Teaching Assistants: Anupam Gupta, Braydon Hall, Eugene Oh, Savanna Yee

Administrivia

- Assignments:
  - Events due Tuesday (4/11)
  - Animal Functions due Wednesday (4/12)
- Make sure to ask for help *before* deadlines
  - All assignments (except Reading Checks) due at 11:59pm
  - If posting code, make the post private; see Piazza Usage Guidelines
  - Check rubrics – incomplete assignments submitted on time still eligible for partial credit
- "Big Ideas" this week: Algorithms

Outline

- **Expressions & Operators**
- Conditionals
  - if-statement
- Loops
  - while-loop
  - for-loop

Expressions

- "An expression is a combination of one or more *values*, *constants*, *variables*, *operators*, and *functions* that the programming language interprets and computes to produce another value."
  - https://en.wikipedia.org/wiki/Expression_(computer_science)

- Expressions are *evaluated* and resulting value is used
  - Assignment: `x = x + 1;`
  - Assignment: `x_pos = min(x_pos + 3, 460);`
  - Argument: `ellipse(50+x, 50+y, 50, 50);`
  - Argument: `mouse(rowX+4*sp,rowY,rowC);`

Operators

- Built-in "functions" in Processing that use special symbols:
  - Multiplicative: * / %
  - Additive: + -
  - Relational: < > <= >=
  - Equality: == !=
  - Logical: && || !

- Operators can only be used with certain data types and return certain data types
  - Multiplicative/Additive: give numbers, get number
  - Relational: give numbers, get Boolean
  - Logical: give Boolean, get Boolean
  - Equality: give same type, get Boolean

Operators

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  - Multiplicative: * / %
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- In expressions, use parentheses for evaluation ordering and readability
  - e.g. `x + (y * z)` is the same as `x + y * z`, but easier to read

Modulus Operator: %

- x % y is read as "x mod y" and returns the remainder after y divides x
  - For short, we say "mod" instead of modulus

- Practice:
  - `0 % 3` is ____
  - `1 % 3` is ____
  - `2 % 3` is ____
  - `3 % 3` is ____
  - `4 % 3` is ____
  - `5 % 3` is ____
  - `6 % 3` is ____

Modulus Operator: %

- `x % y` is read as "x mod y" and returns the remainder after y divides x
  - For short, we say "mod" instead of modulus

- Example Uses:
  - Parity: Number `n` is even if `n%2 == 0`
  - Leap Year: Year `year` is a leap year if `year%4 == 0`
  - Chinese Zodiac: `year1` and `year2` are the same animal if `year1%12 == year2%12`

Modulus Example in Processing

- Use mod to "wrap around"
  - Replace min/max function to "connect" edges of drawing canvas

- `x_pos = min(x_pos + 3, 460);`
- `x_pos = (x_pos + 3) % 460;`

Control Flow

- The order in which instructions are executed
- We typically say that a program is executed in sequence from top to bottom, but that's not always the case:
  - Function calls and `return` calls
  - Conditional/branching statements
  - Loops
- Curly braces `{}` are used to group statements
  - Help parse control flow
  - Remember to use indentation!

Outline

- Expressions & Operators
- **Conditionals**
  - **if-statement**
- Loops
  - while-loop
  - for-loop

If-Statements

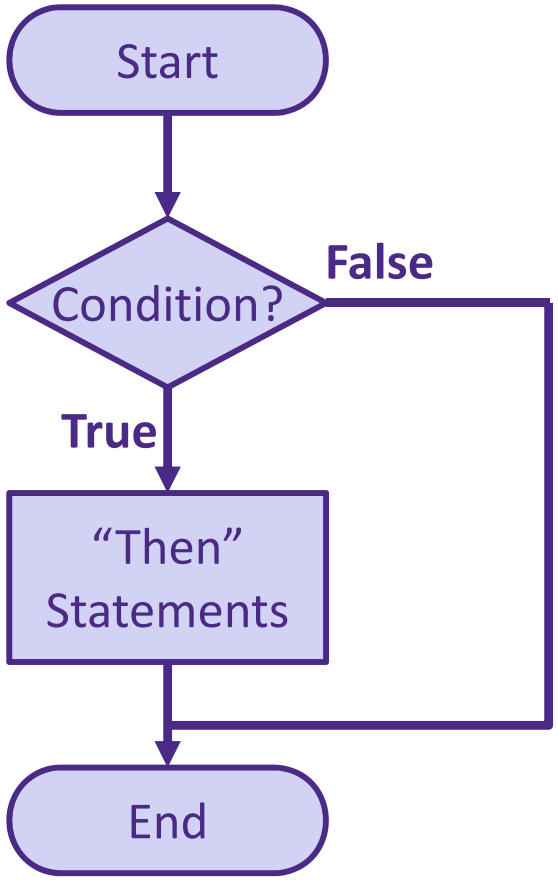
- Sometimes you don't want to execute *every* instruction
  - Situationally-dependent

- Conditionals give the programmer the ability to make decisions
  - The next instruction executed depends on a specified *condition*
    - The condition must evaluate to a `boolean` (*i.e.* `true` or `false`)
    - Sometimes referred to as "branching"
  - This generally lines up well with natural language intuition

If-Statements

- Basic form:

```
if(condition) {
    // "then"
    // statements
}
```

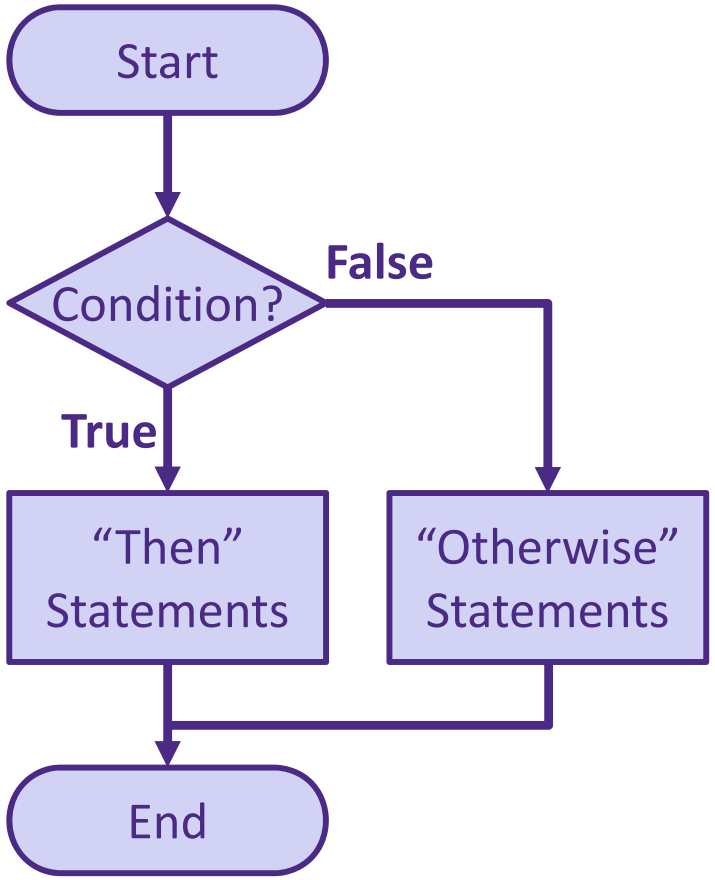


- Example conditions:
  - Variable: `if( done == true )`
  - Variable: `if( done )`
  - Expression: `if( x_pos > 460 )`
  - Expression: `if( x_pos > 100 && y_pos > 100 )`

If-Statements

- With `else` clause:

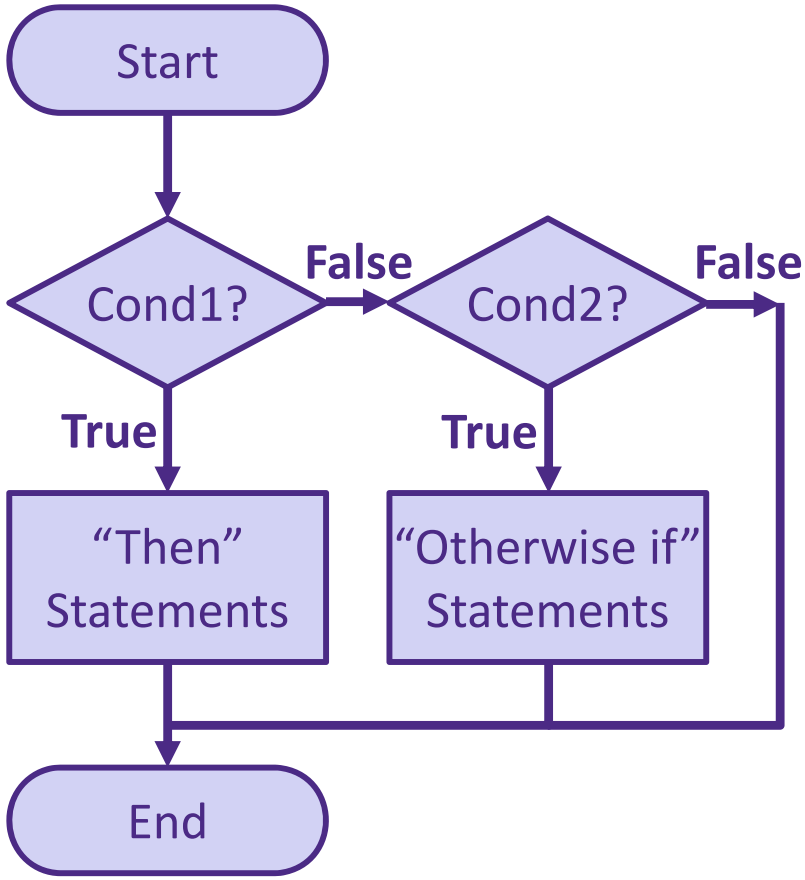
```
if(condition) {
    // "then"
    // statements
} else {
    // "otherwise"
    // statements
}
```



If-Statements

- With `else if` clause:

```
if(cond1) {
    // "then"
    // statements
} else if(cond2) {
    // "otherwise if"
    // statements
}
```



If-Statements

- Notice that conditionals *always* go from Start to End
  - Choose one of many *branches*
  - A conditional must have a single `if`, as many `else if` as desired, and at most one `else`

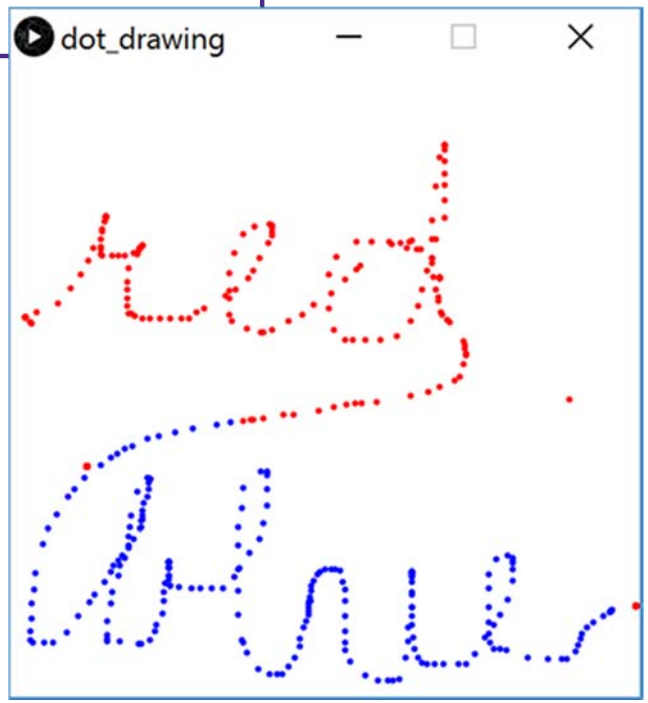
- Can nest and combine in interesting ways:

```
if(cond1) {
    if(cond2) {
        // statement1
    } else {
        // statement2
    }
}
```

```
if(cond1 && cond2) {
    // statement1
} else if(cond1) {
    // statement2
}
```

Processing Demo: Drawing Dots

```
14 void draw() {
15   if(mousePressed) {
16     fill(0, 0, 255);    // blue if mouse is pressed
17   } else {
18     fill(255, 0, 0);    // red otherwise
19   }
20   ellipse(mouseX, mouseY, 5, 5);  // draw circle
21 }
```



Outline

- Expressions & Operators
- Conditionals
  - if-statement
- **Loops**
  - **while-loop**
  - **for-loop**

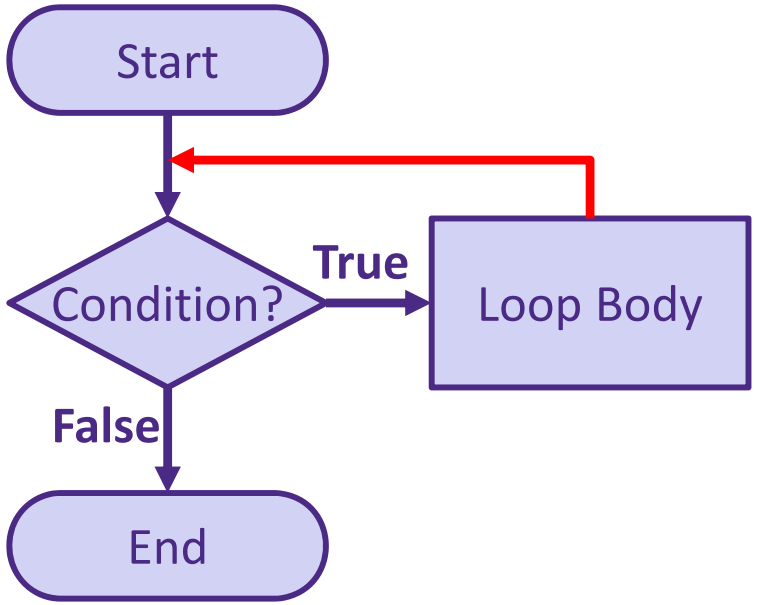
Looping

- Sometimes we want to do the same (or similar) things over and over again
  - Looping saves us time from writing out all of the instructions
- Loops control a sequence of *repetitions*

While-Loop

- Basic form:

```
while(condition) {
    // loop
    // body
}
```



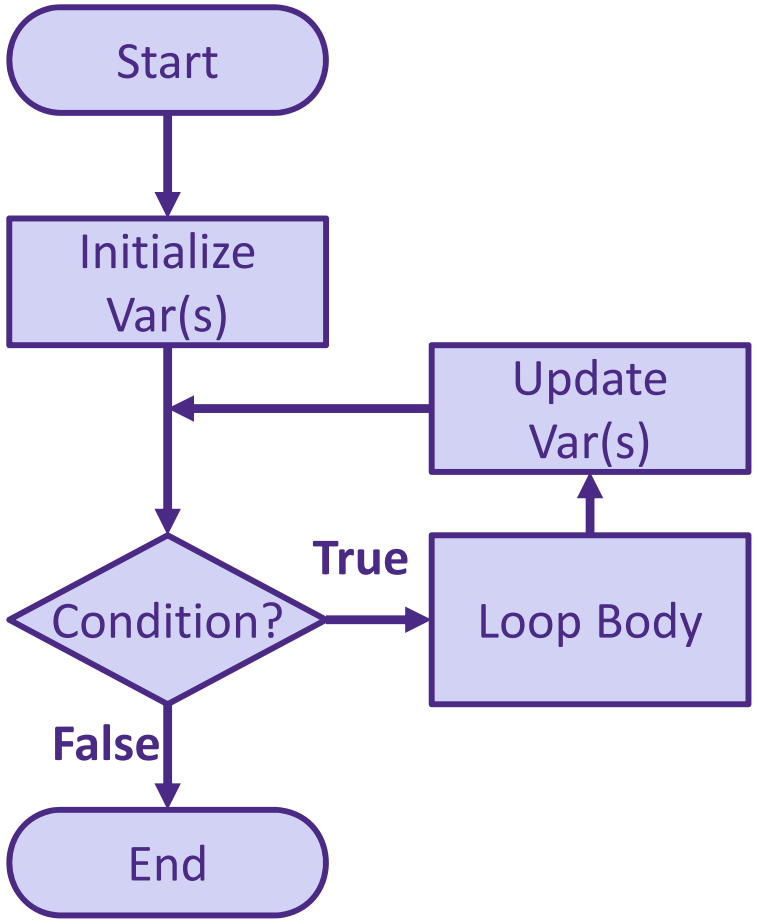
- Repeat loop body until condition is `false`
  - Must make sure to update conditional variable(s) in loop body, otherwise you cause an infinite loop

- `draw()` is basically a `while(true)` loop

While-Loop

- More general form:

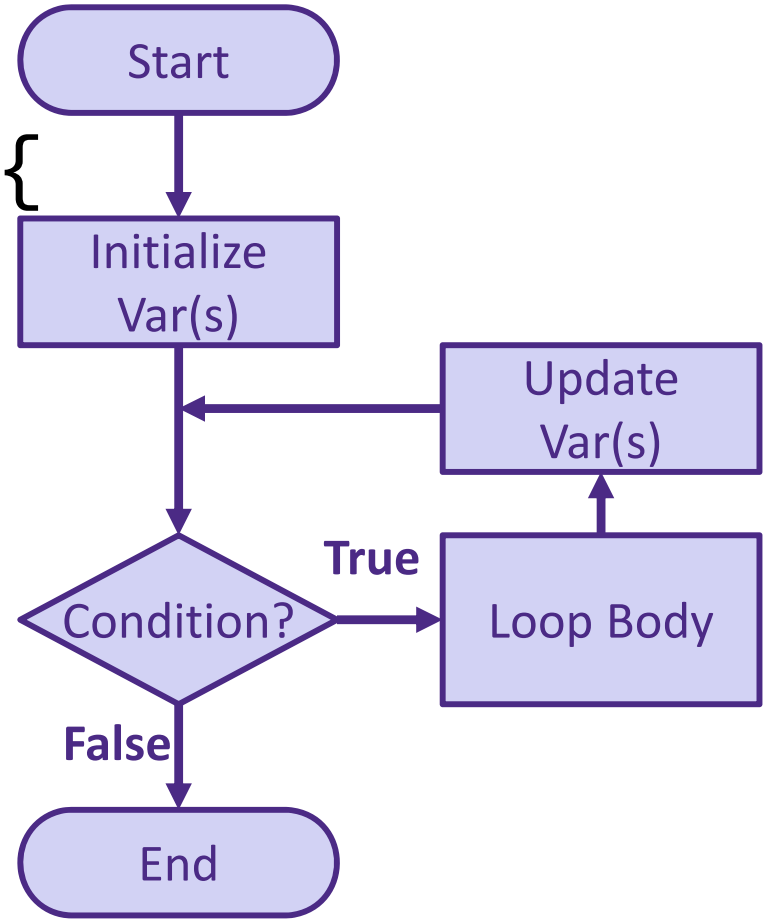
```
// init cond var(s)
while(condition) {
    // loop body
    // update var(s)
}
```



- This occurs so commonly that we create a separate syntax for it!

For-Loop

```
for(init; cond; update){
    // loop body
}
```



- First runs *init* expression(s)
- Then checks *cond*
- If **true**, runs loop body followed by update statement(s)

For-Loop Example

Without loop:

```
line(20, 40, 80, 80);
line(80, 40, 140, 80);
line(140, 40, 200, 80);
line(200, 40, 260, 80);
line(260, 40, 320, 80);
line(320, 40, 380, 80);
line(380, 40, 440, 80);
```

With loop:

```
for(int i = 20; i < 400; i = i + 60) {
  line(i, 40, i + 60, 80);
}
```

Understanding the For-Loop

initialization

```
4 for(int i = 20; i < 400; i = i + 60) {
5   line(i, 40, i + 60, 80);
6 }
```

- Choice of variable name(s) is not critical
  - Represent the value(s) that vary between different executions of the loop body
  - Think of as temporary variable(s)

- Variable scope: variable `i` only exists *within this loop*

Understanding the For-Loop

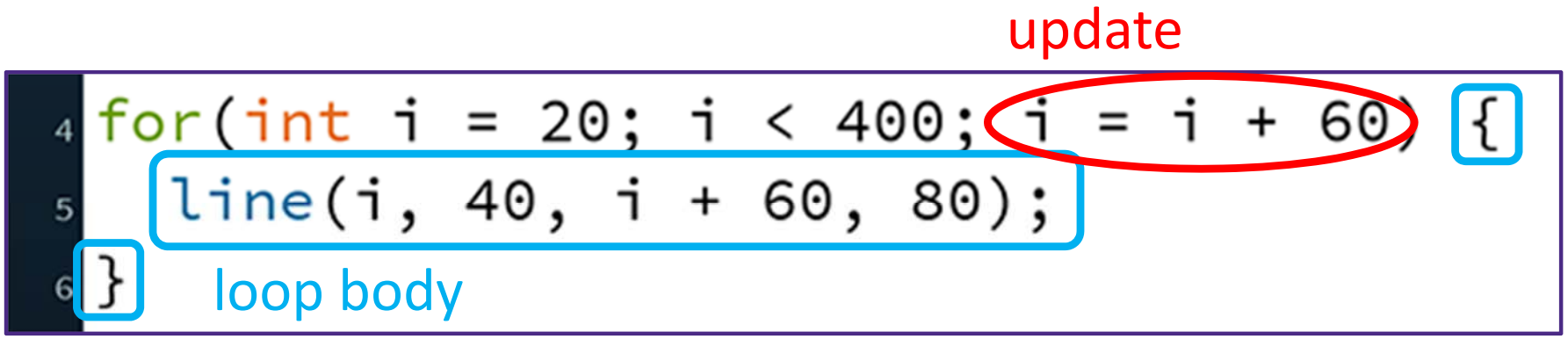
condition

```
4 for(int i = 20; i < 400; i = i + 60) {
5   line(i, 40, i + 60, 80);
6 }
```

- Condition evaluated *before* the loop body and must evaluate to `true` or `false`
  - Reminder:

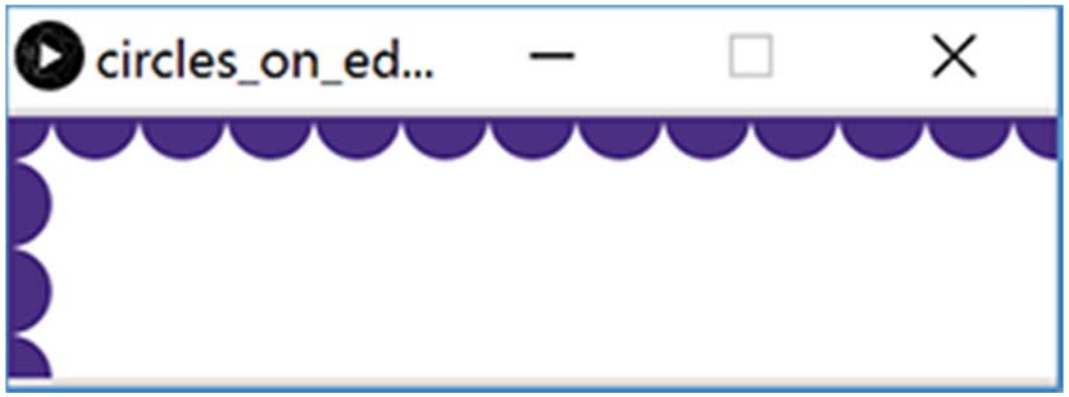
>	greater than
<	less than
>=	greater than or equal to
>=	less than or equal to
==	equal to
!=	not equal to

Understanding the For-Loop



- Update is an assignment that is executed *after* the loop body
- Loop body is enclosed by curly braces { } and should be *indented* for readability

Processing Demo: Circles on Canvas Edge




```
size(480, 120);
background(255);
noStroke();
fill(75, 47, 131);

// loop for circles along the top edge
for(int x = 0; x <= width; x = x + 40){
  ellipse(x, 0, 40, 40);
}

// loop for circles along the left edge
for(int y = 0; y <= height; y = y + 40){
  ellipse(0, y, 40, 40);
}
```