Nested Loops, Arrays

CSE 120 Winter 2018

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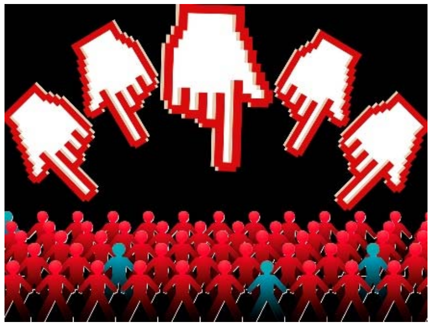
MiDAS Unemployment System: Algorithm Alchemy Created Lead, Not Gold

"34,000 plus individuals wrongfully accused of unemployment fraud… by Michigan Integrated Data Automated System (MiDAS). A review found that MiDAS adjudicated–by algorithm alone–40,195 cases of fraud, with 85 percent resulting in incorrect fraud determinations.

"As algorithms take on even more decisions in the criminal justice system, in corporate and government hiring, in approving credit and the like, it is imperative that those affected can understand and challenge how these decisions are being made."

- https://spectrum.ieee.org/riskfactor/computing/software/michigans-midas-unemployment-system-algorithm-alchemy-that-created-lead-not-gold



Administrivia

- Assignments:
  - Portfolio Update 1 due tonight (1/31)
  - Creativity Assignment (2/2)

- Midterm in class on Monday, 2/5
  - 1 sheet of notes (2-sided, letter, handwritten)
  - Fill-in-the-blank(s), short answer questions, maybe simple drawing

- Living Computers Museum “field trip” upcoming

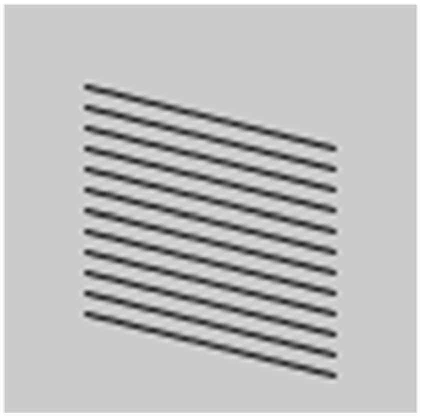
Outline

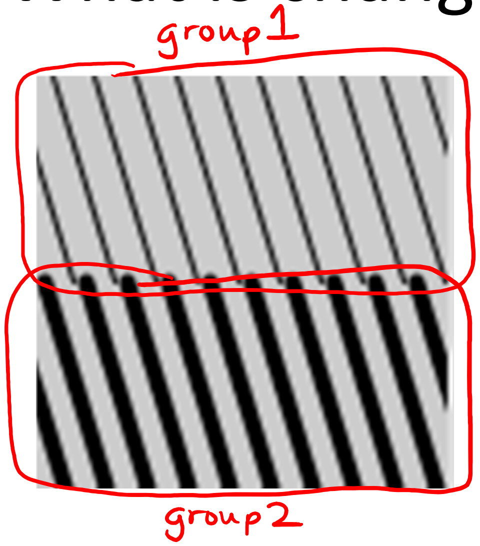
- **For-Loop Review**
- Nested Loops
- Arrays
  - Arrays and Loops

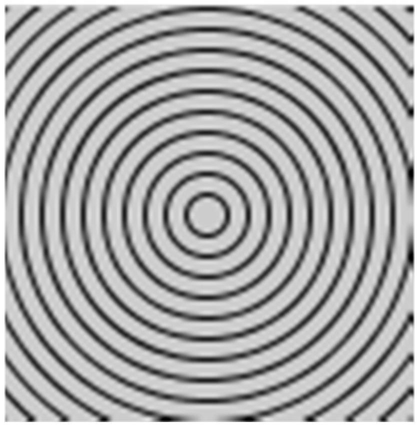
For-Loop Review

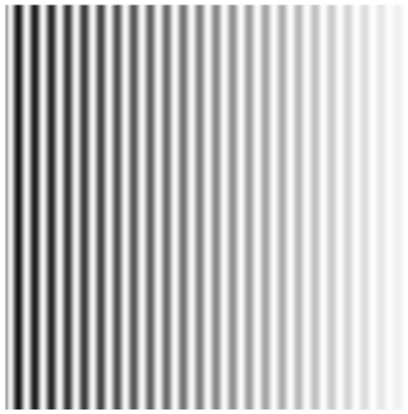
- Loops control a sequence of *repetitions*
  - Do the same thing (or similar things) over and over again

- Examples: What is changing?









Common:
diagonal lines

Change:
y-position

Common:
diagonal lines
(different thickness per group)

Change:
x-position

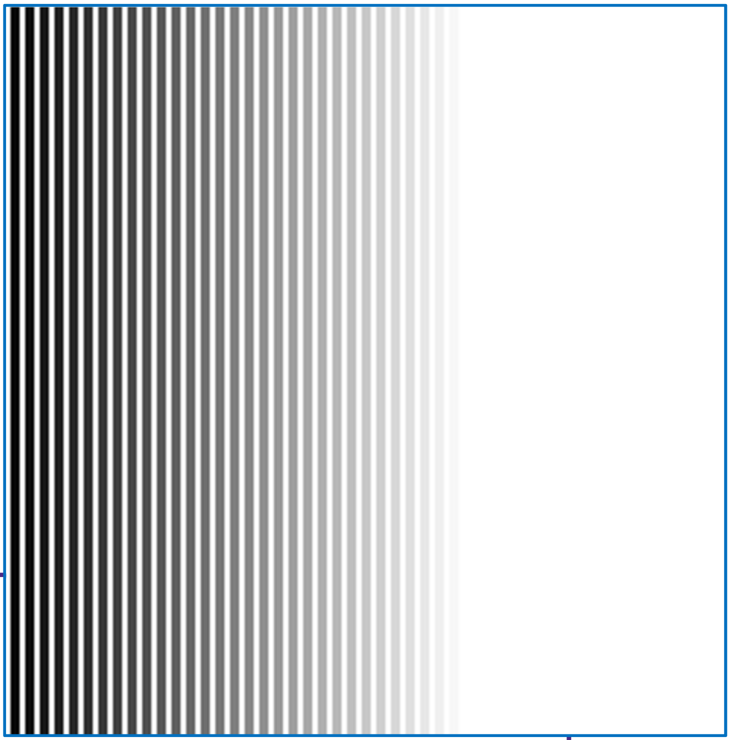
Common:
concentric circles

Change:
radius/size

Common:
vertical lines

Change:
transparency/color
x-position

Example: Line Gradient



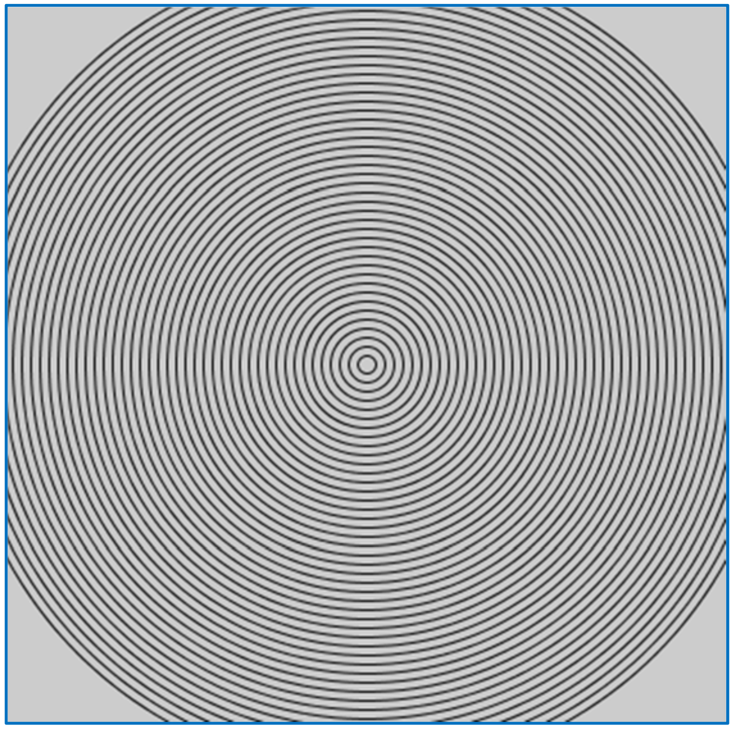
```
size(400, 400);

background(255);
strokeWeight(5);

for(int i = 0; i < 400; i = i + 8){
  stroke(i);
  line(i, 0, i, 400);
}
```

line color

x-position

Exercise: Circle Loop

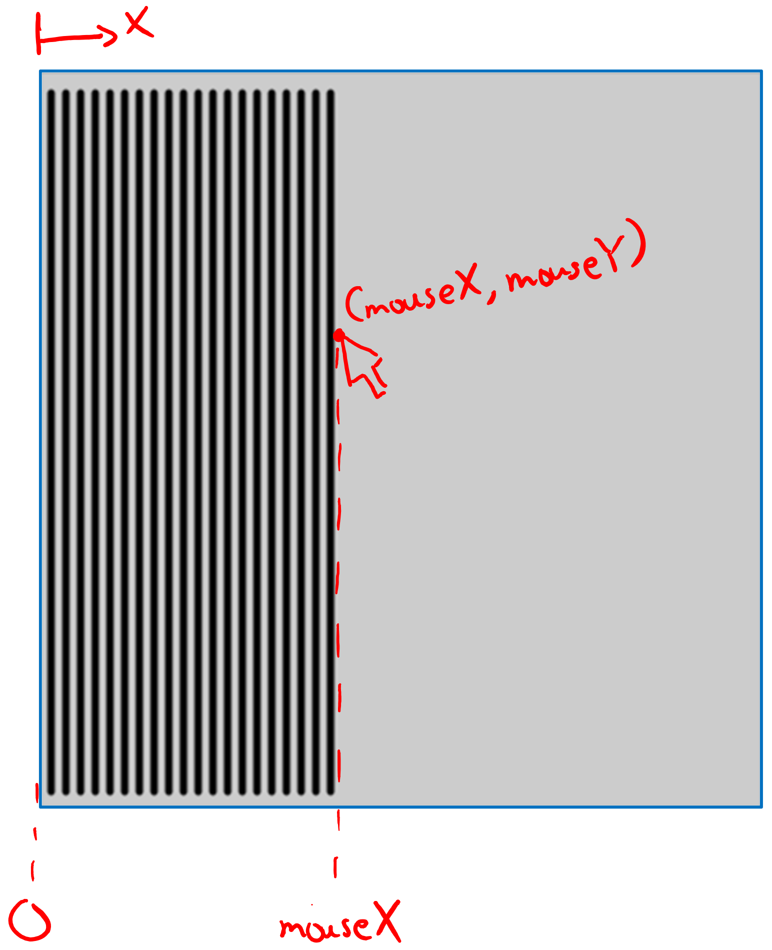
- Consecutive concentric circles differ in diameter by 10:



```
size(400, 400);
noFill();
also works:      int d = 10 ;     d <= 450 ;      d = d+10
for(int d = 450;    d > 0     ;   d = d - 10   ) {
        initialization  condition       update
    ellipse(  width/2  ,  height/2  ,    d    ,    d    );
              center X    center Y     width    height
}
```

Example: Looping with User Interaction?

- Draw lines from left side of screen to the horizontal position of the mouse: draw lines from x = 0 to mouseX



Example: Draw Lines to mouseX

```
void setup() {
  size(400, 400);
  strokeWeight(4);
}

void draw() {
  background(204);

  for(int i = 10; i < mouseX; i = i + 8){
    line(i, 10, i, 390);
  }
}
```

loop condition (when to stop)

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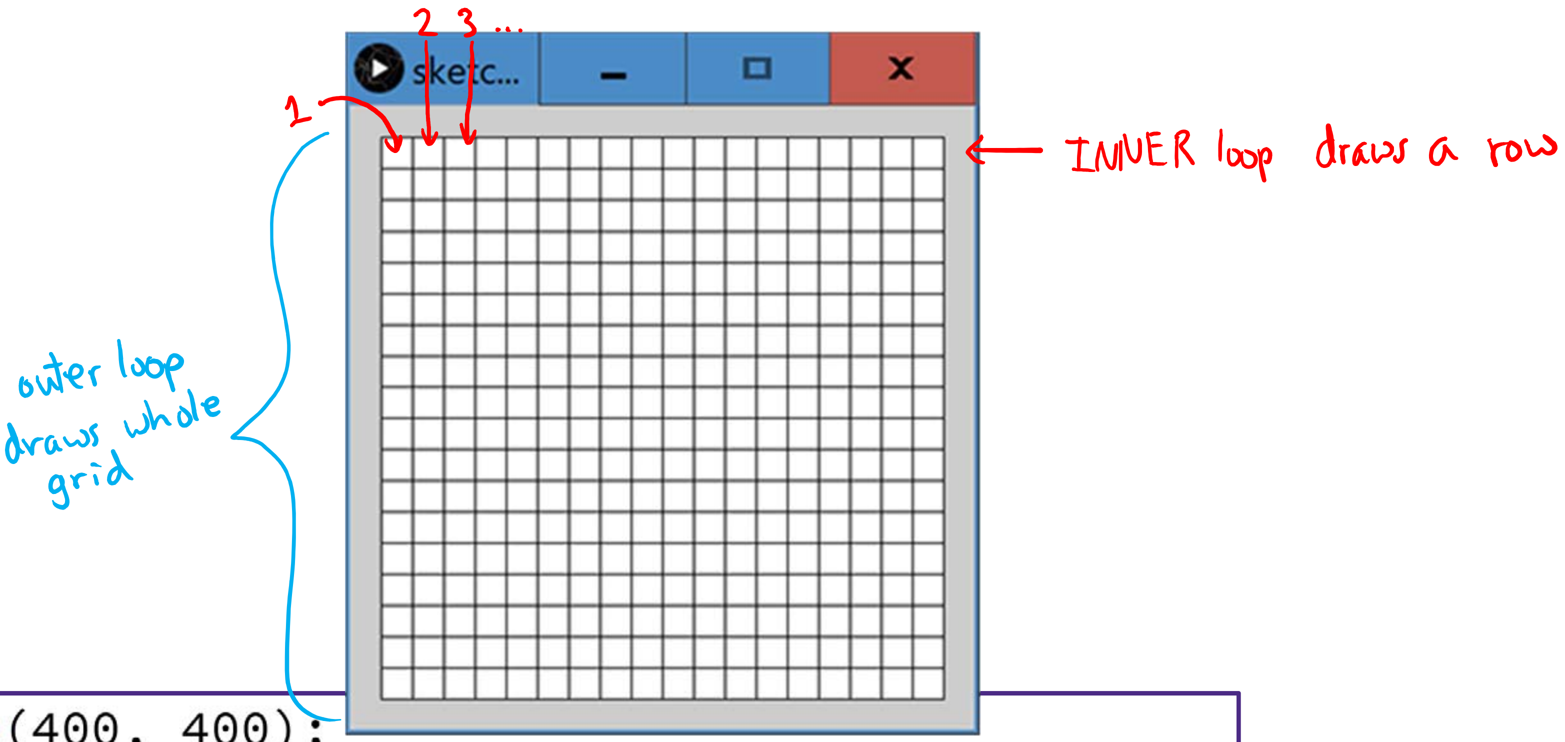
  - Arrays and Loops

Nested Loops

- Generally a for-loop has a single loop variable that changes with each iteration

- What if you need/want more things to change?
  - Can nest loops – *i.e.* put a loop inside of another loop

Example: Rectangle Grid



```
size(400, 400);

for(int y = 20; y < height-20; y = y + 20) {

  for(int x = 20; x < width-20; x = x + 20) {
    rect(x, y, 20, 20);
  }

}
```

body of OUTER loop

body of INNER loop

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- For-Loop Review
- Nested Loops
- **Arrays**
  - **Arrays and Loops**

Arrays

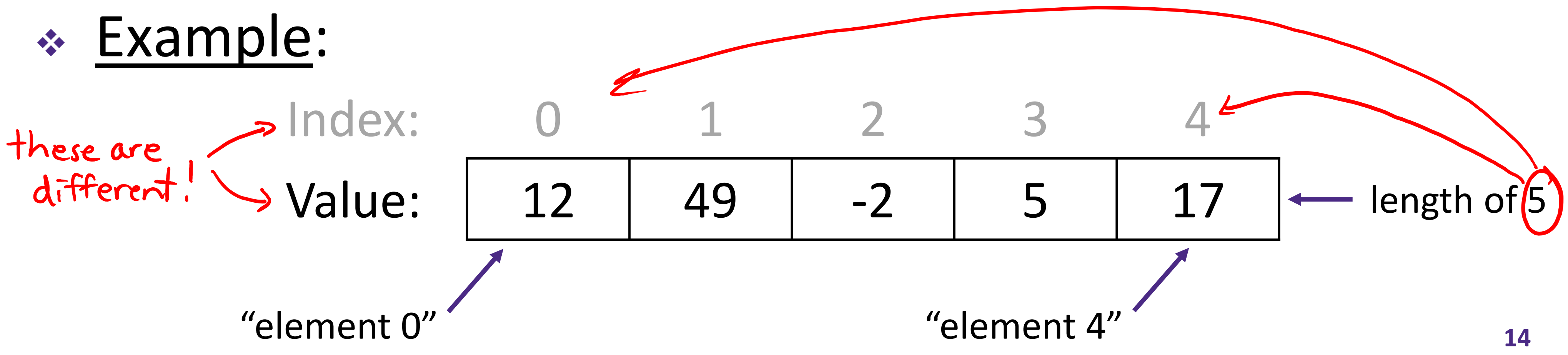
- "Structures" that store many values *of the same datatype*
  - Can think of as a group of related variables

- Arrays store large amounts of data that you can access using a single name
  - Accessing arrays with loops is very convenient

Arrays Terminology

- "Structures" that store many values *of the same datatype*
  - Element: a single value in the array
  - Index: a number that specifies the location of a particular element of the array
    - Start from 0 , so numbered 0 to length - 1
  - Length: total number of elements in the array

- Example:



Arrays in Processing

- Declaration: `type[] name` array variable (like a street name)
  - *e.g.* `int[]` is array of integers, `color[]` is array of colors

like building num houses on your street

- Creation: `new type[num]` length
  - *e.g.* `int[] intArr = new int[5];`
  - Default value for *all* elements is "zero-equivalent" (0, 0.0, **`false`**, black) color(0,0,0)
  - Remember that actual indices are from `0` to `num-1`

creation and

- Initialization: `{elem0, elem1, …, elemN};`
  - *e.g.* `int[] intArr = {12, 49, -2, 5, 17};`

Arrays in Processing

- Use element: `name[index]`
  - In *expression*, uses value of that index of the array (READ)
  - In *assignment*, modifies value of that index of the array (WRITE)
- Get length: `name.length`
- Example:

```
int[] intArr = {12, 49, -2, 5, 17};
println(intArr[0]);          // prints 12 to console
intArr[2] = intArr.length; // changes -2 to 5
```

access value

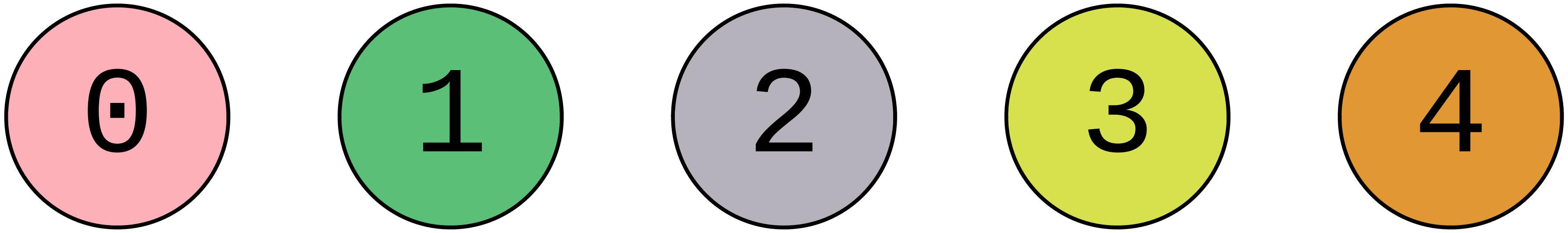
change value

Index:	0	1	2	3	4
Value:	12	49	~~-2~~ 5	5	17

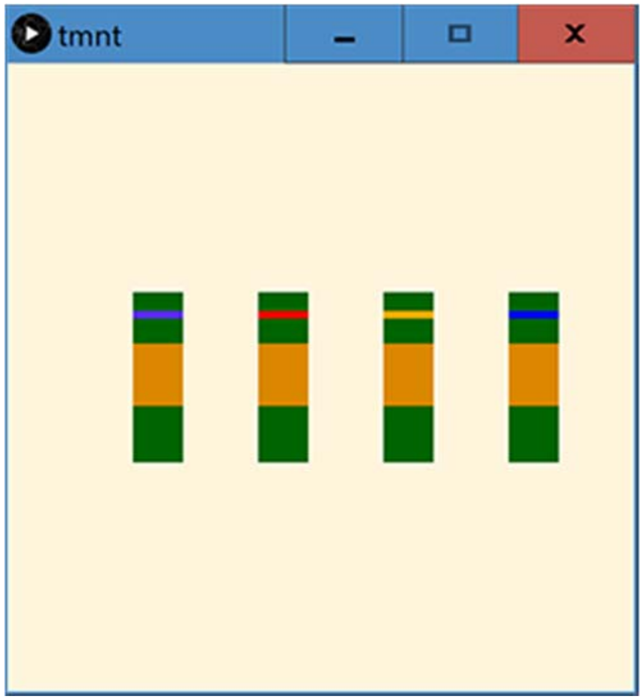
Arrays Worksheet

- Attach buckets to velcro when array is created
  - Creation of array automatically initializes it

- Access array using notation `ar_name[index]`
  - Indices are numbered starting from 0
  - Use just like you would a variable
  - When WRITING, replace ball in bucket
  - When READING, take ball of same color (leave current one in bucket)



Example: TMNT



```
// array order: {don, raf, mic, leo}
int[] tmnt_x = {100,200,300,400};
color[] tmnt_c = {color(88,44,1410),color(255,0,0),color(255,171,3),colo

// draw TMNT using arrays
void draw() {
  background(255,245,220);        // paint over drawing canvas
  for(int i=0; i<tmnt_x.length; i=i+1) {
    tmnt(tmnt_x[i],tmnt_c[i]);
  }
```

Example: Index of Smallest Number

- Algorithm:
  - Keep track of the *index* of the smallest number seen so far
    - Start with index 0
  - Check each *element* 1-by-1; if number is smaller, then update the smallest index

```
// returns the index of the smallest number in an array
int find_smallest(float[] list) {
  int smallest = 0;
  for(int i = 0; i < list.length; i = i + 1) {
    if(list[i] < list[smallest]) {
      smallest = i;
    }
  }
  return smallest;
}
```