Review

- Parameterizing a shape
  - Have a default size frame for your shape to fit in.
  - Alter position relative to the reference point and scale
  - Alter size relative to scale.
  - Instead of scale
  - Use a scaled reference size frame.
- Functions and named constants improve readability, reusability, and scalability of your code.
- Variable Lifetime and Scope
  - Global variables

Shadowing

- When there is a name conflict between variables of different scopes
  - Int x = 10;
  - Void setup() {
    - Int x = 5;
    - Int y = x;
  }
- The conflicting variables can not have different types (or it's considered a re-declaration and is not allowed)
- When shadowed, smaller (inner) scopes have precedence over larger (outer) scopes

Example

- ScopeLines

Code tracing

- We learn to read code by executing the code line by line
- Do not jump ahead
- Do exactly what the code says, step by step
- Keep a diagram of all variables and update them accordingly
- Mistakes are almost always due to skipping steps
Trace this

```java
int n = 365;
int sum = 0;
int digit;
while(n>0) {
    digit = n%10;
    sum += digit;
    n /= 10;
}
println(sum);
```

Nested loops

- You can put a loop within a loop.
- Nesting levels are unlimited, but in practice programmers rarely go beyond 3.
- Two loops nested is very common, especially when dealing with naturally 2-dimensional structures (grids).

```java
for(...){
    for(...){
        
    }
}
while(...){
    while(...){
        
    }
}
for(...){
    while(...){
        
    }
}
while(...){
    for(...){
        
    }
}
```

Nested for

```java
int i, j, end = 10;
for (i = 1; i <= end; i++) {
    for (j = i; j <= end; j++) {
        print("*");
    }
    println();
}
```

Examples

- `indexTile` (one loop)
- `indexTile` (loop with nested Loop)

Basics of Trigonometry assuming right/up axes

- `h` (hypotenuse)
- `a` (adjacent)
- `o` (opposite)
Basics of Trigonometry assuming right/up axes

Recall:
\[ a^2 + o^2 = h^2 \]

- \( h \) (hypotenuse)
- \( o \) (opposite)
- \( a \) (adjacent)

Definition
- \( \sin(q) = o/h \)
- \( o = h \sin(q) \)
- \( \cos(q) = a/h \)
- \( a = h \cos(q) \)
- \( \tan(q) = o/a = \sin(q)/\cos(q) \)

Trigonometry on a unit circle

Recall:
\[ x^2 + y^2 = r^2 \]
\[ \sin^2(q) + \cos^2(q) = 1 \]
Trigonometry on a unit circle

Examples
- Points on a circle
- Overlapping ellipses on a circle
- Spokes
- Polygon
- Nested version (star)

Example: cyclical change
- Drawing a sine wave
- Using sine to manipulate height of an object
- Using cosine to manipulate width of an object

Drawing points along a circle

```java
int steps = 8;
int radius = 20;
float angle = 2*PI/steps;
for (int i=0; i<steps; i++) {
    float x = cos(angle*i)*radius;
    float y = sin(angle*i)*radius;
    // draw a point every 1/8th of a circle
    ellipse(x, y, 10, 10);
}
```