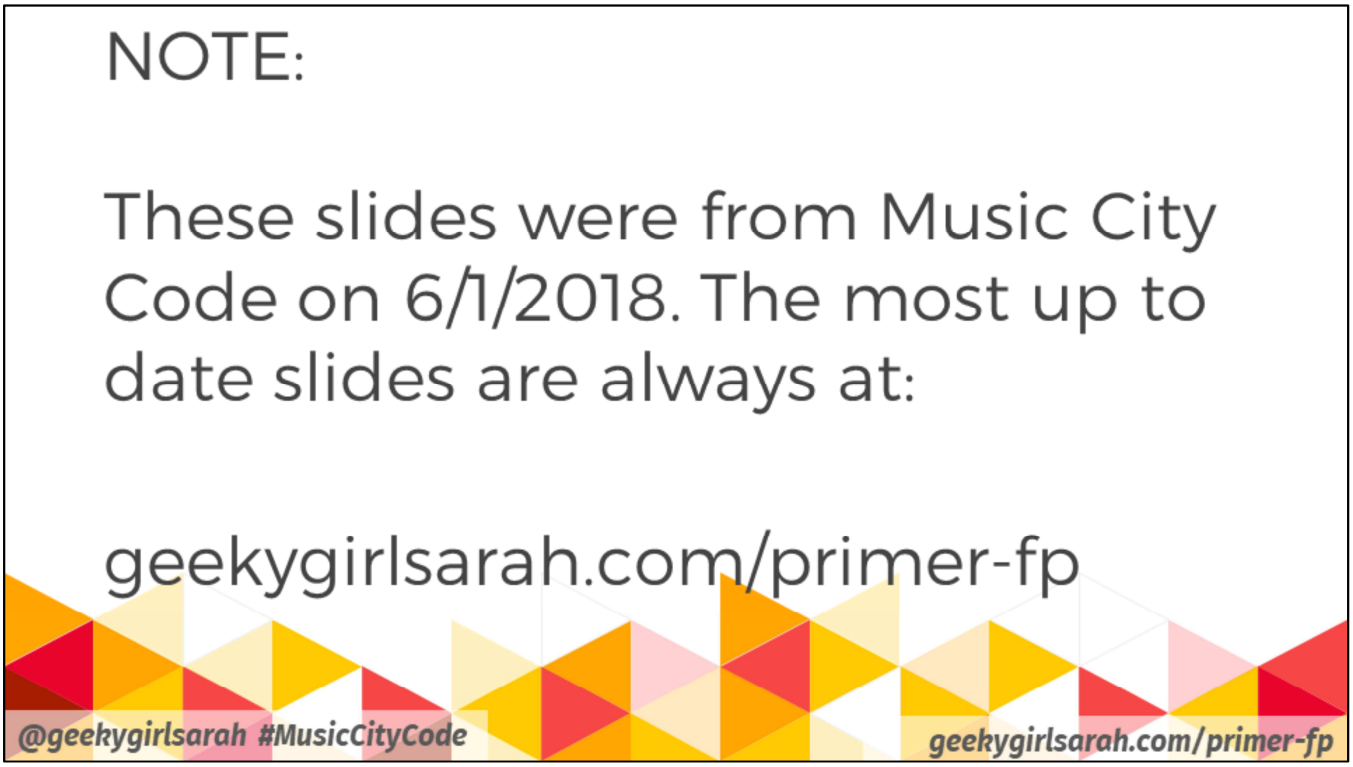



NOTE:

These slides were from Music City Code on 6/1/2018. The most up to date slides are always at:

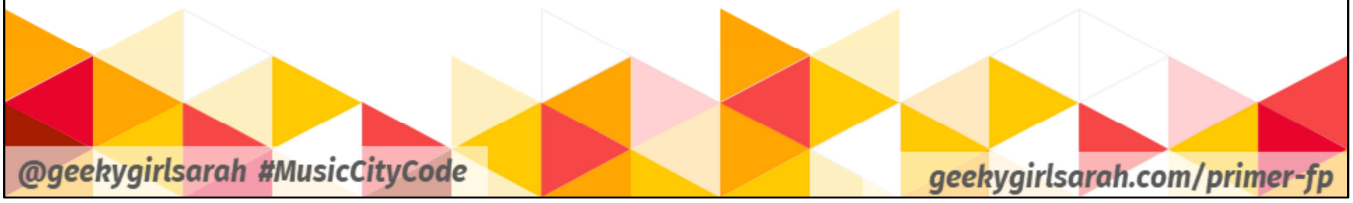
geekygirlsarah.com/primer-fp

# A Primer on Functional Programming

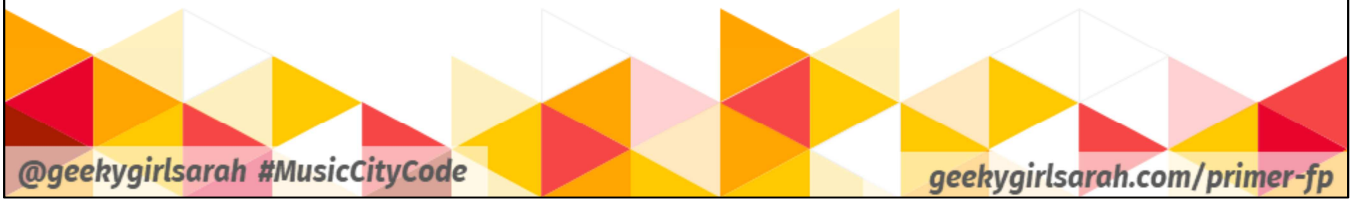
Sarah Withee
@geekygirlsarah

Slides: geekygirlsarah.com/primer-fp

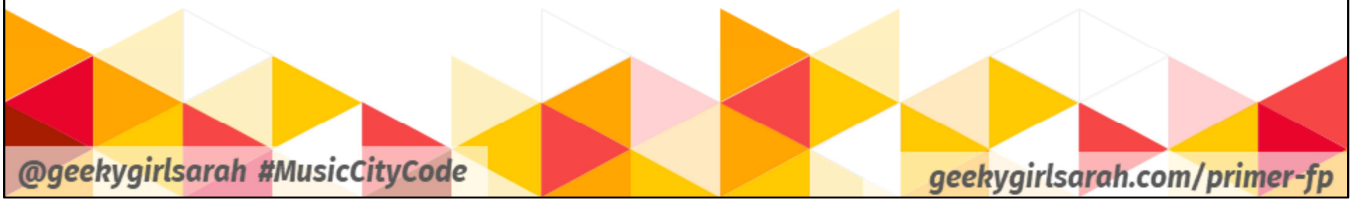
Who has heard of functional programming?



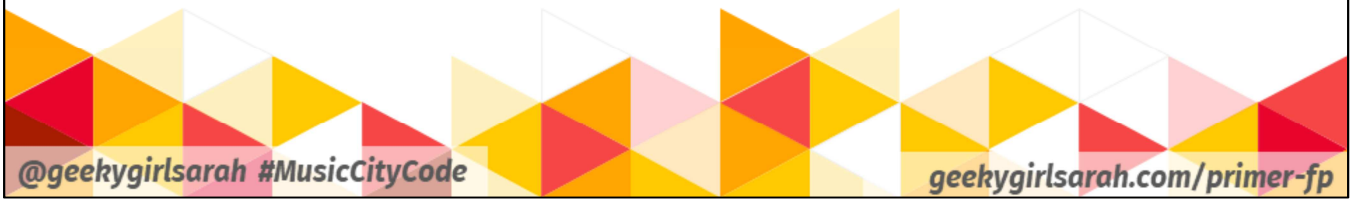
Who has done some form of functional programming?

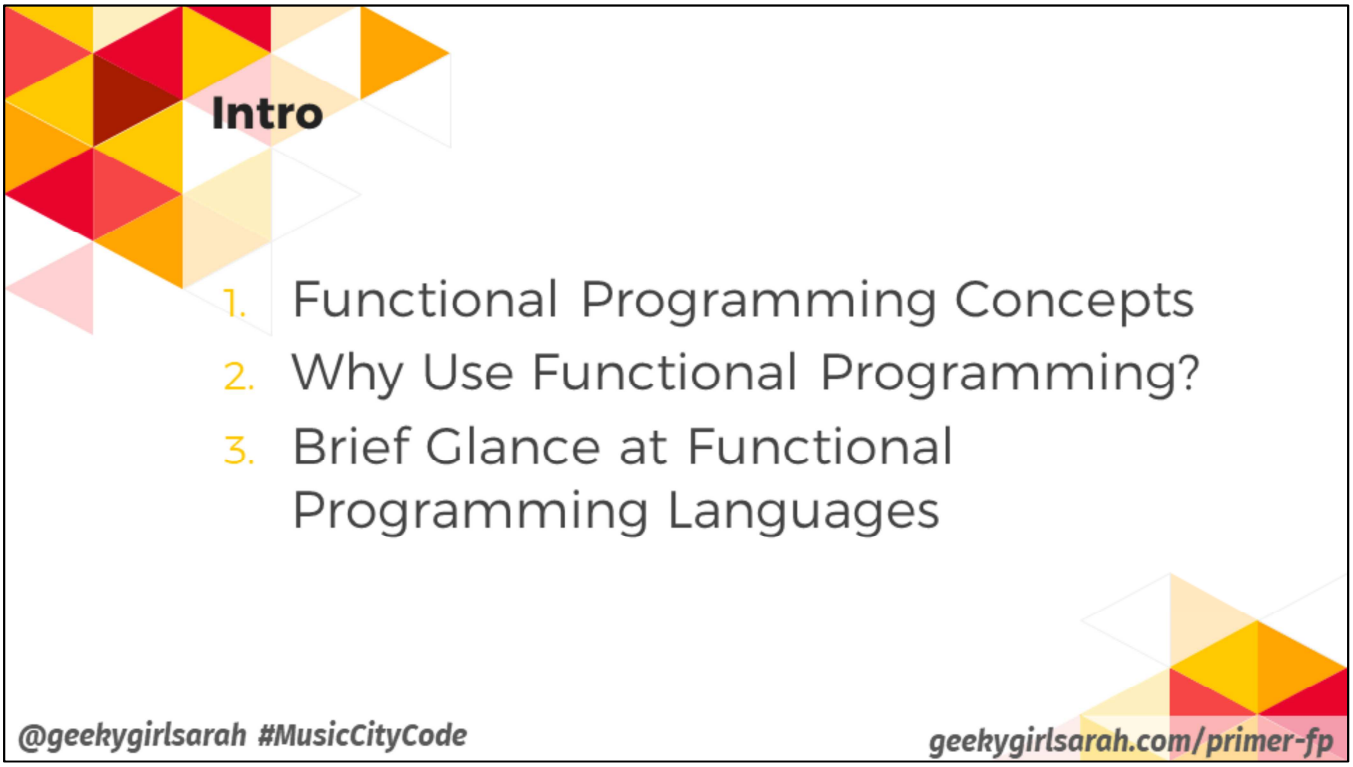


# Who IS a functional programmer?



Who has wanted to learn but never had time or good resources?




Intro
1. Functional Programming Concepts
2. Why Use Functional Programming?
3. Brief Glance at Functional Programming Languages
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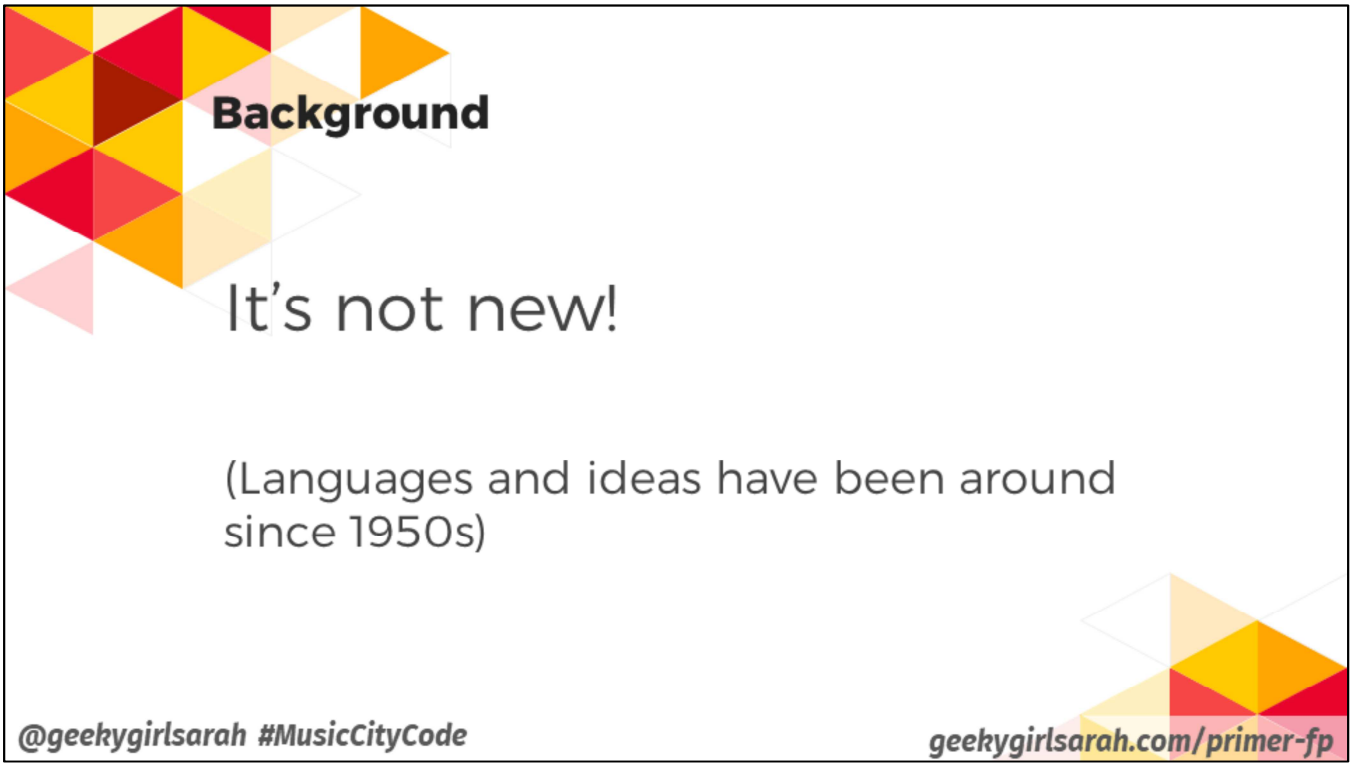
# Hello!

**I am Sarah Withee**

I'm a software engineer at Arcadia
I'm on social media as @geekygirlsarah

(Yes, you can tweet all the things!)


1.
Functional
Programming
Concepts


Background
It's not new!
(Languages and ideas have been around since 1950s)
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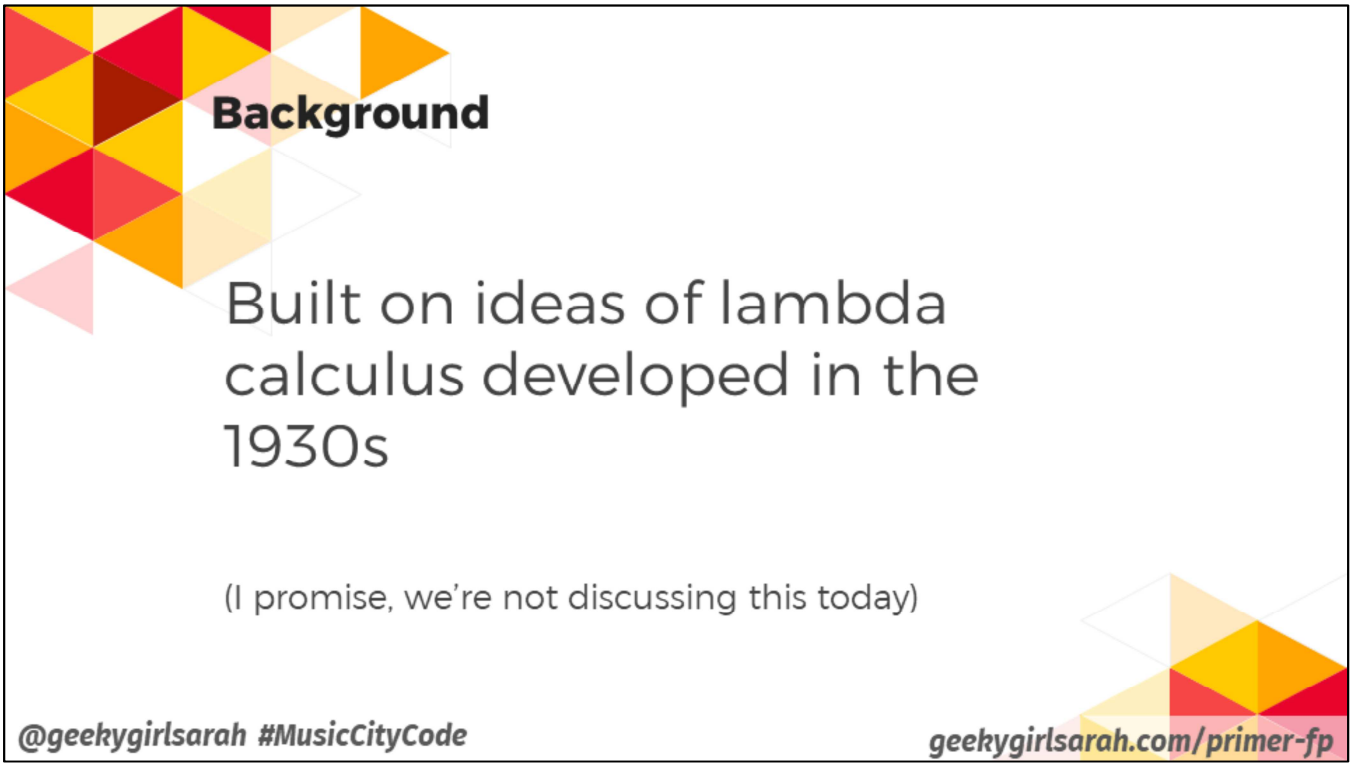
Background
Built on ideas of lambda calculus developed in the 1930s
(I promise, we're not discussing this today)
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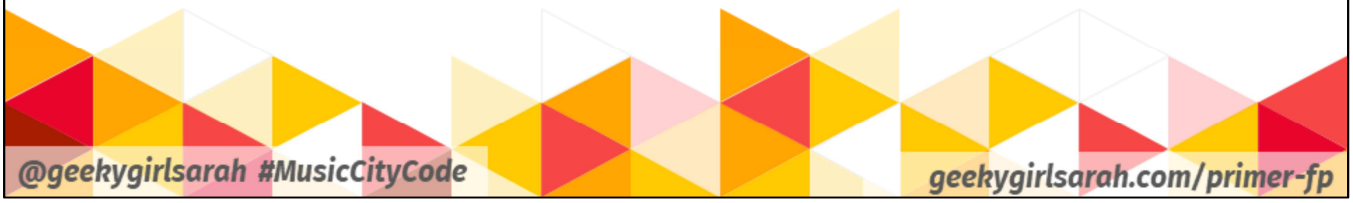
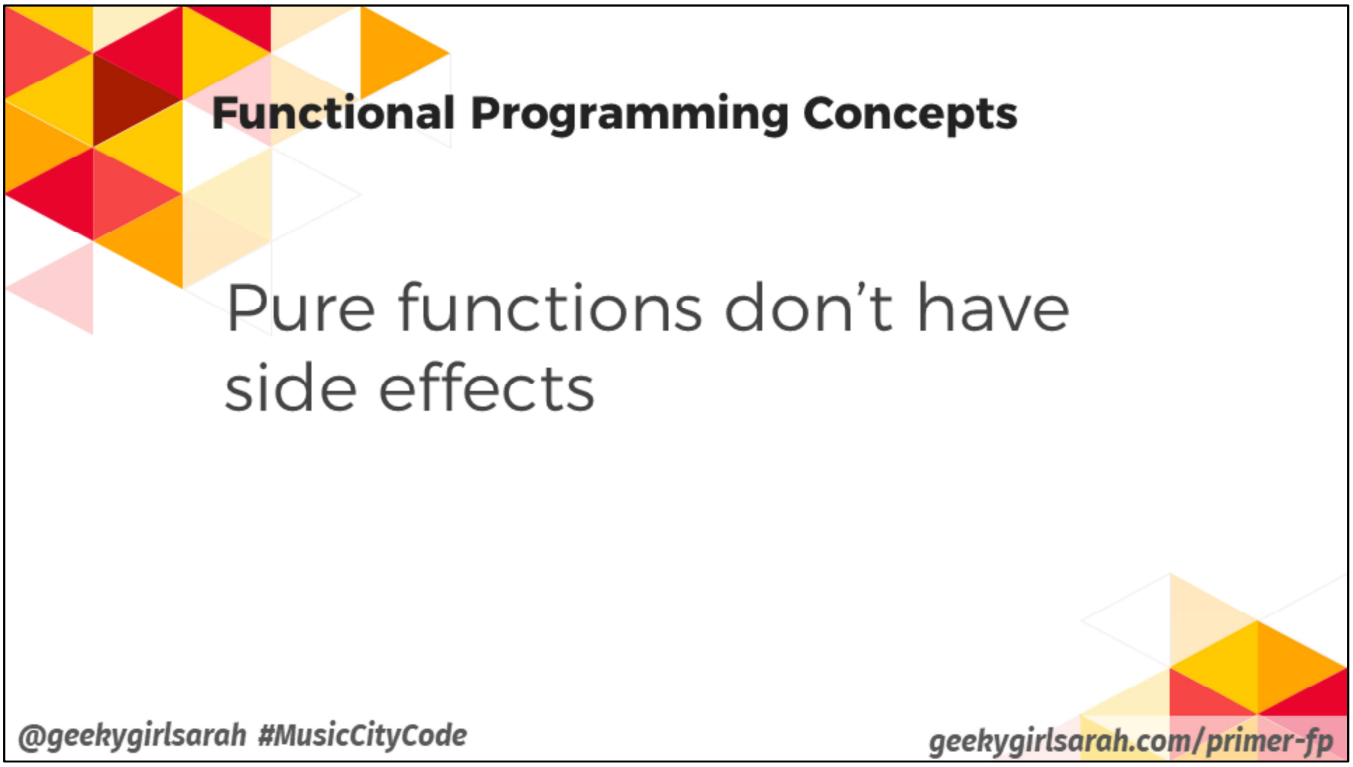
# Pure Functions:

Function that, given a certain input, *always* produces the same output.




Functional Programming Concepts
Pure functions don't have side effects
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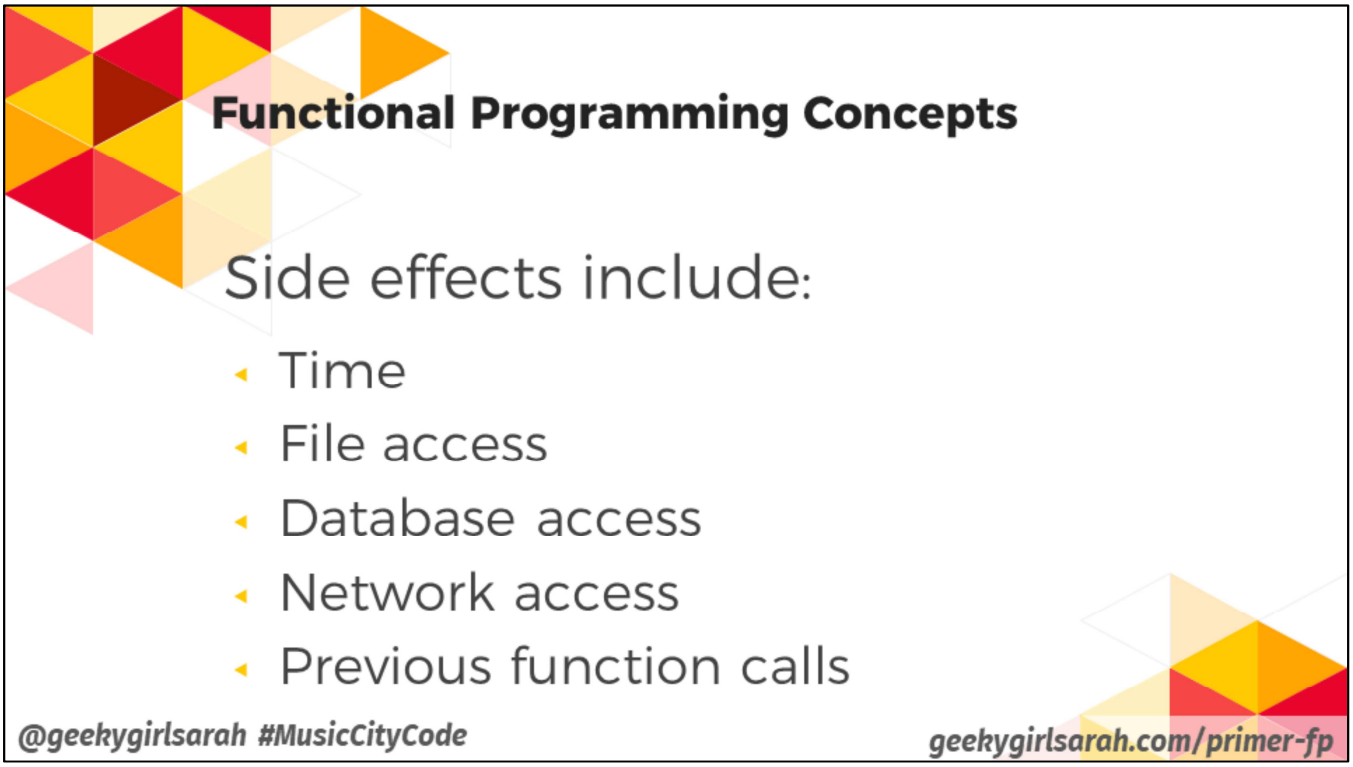
Functional Programming Concepts
Side effects include:
Time
File access
Database access
Network access
Previous function calls
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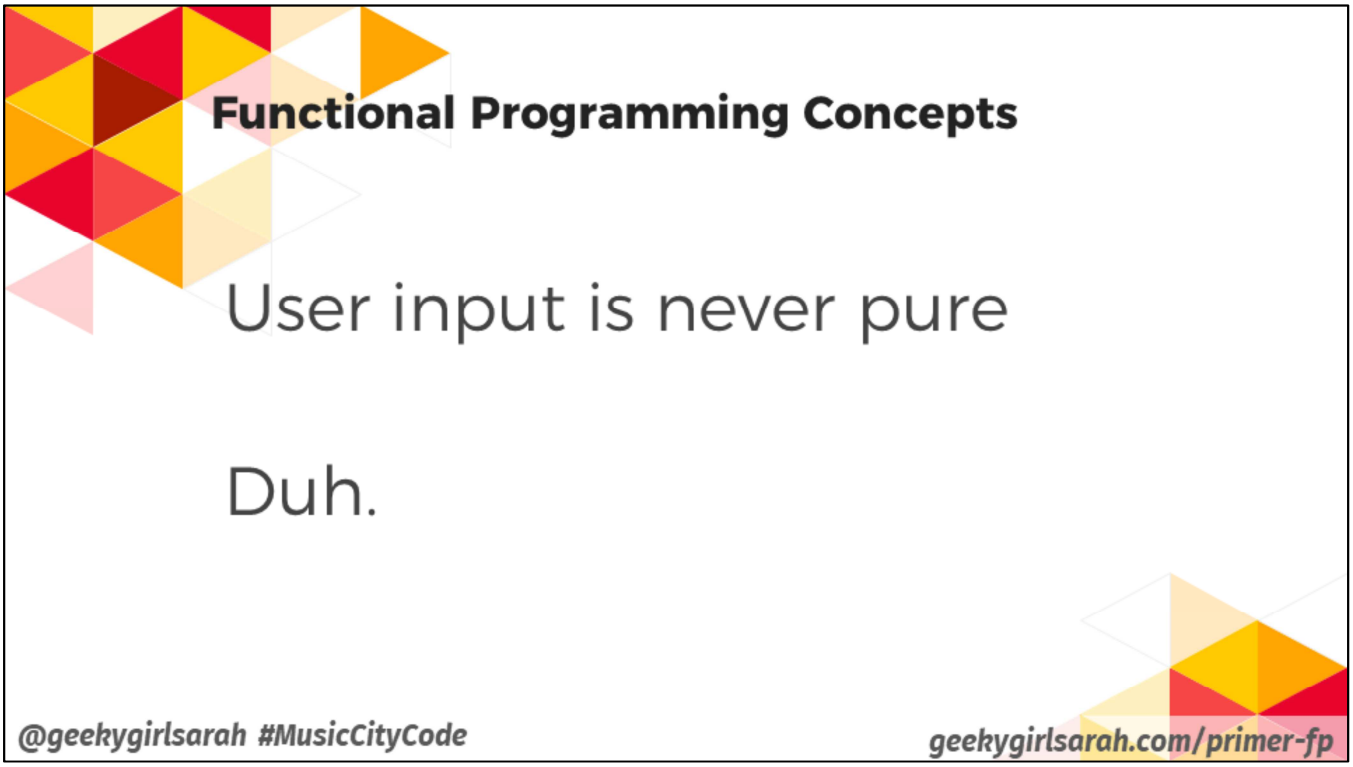
Functional Programming Concepts
User input is never pure
Duh.
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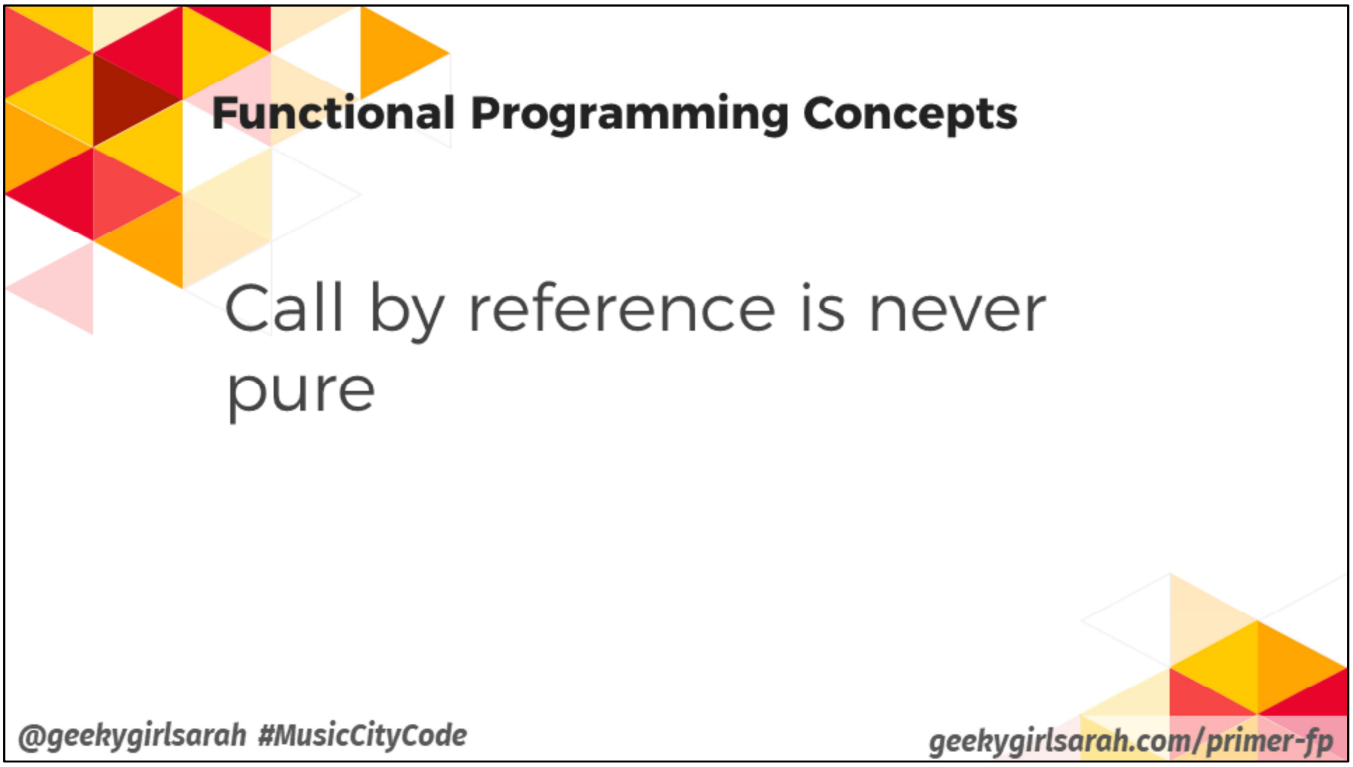
Functional Programming Concepts
Call by reference is never pure
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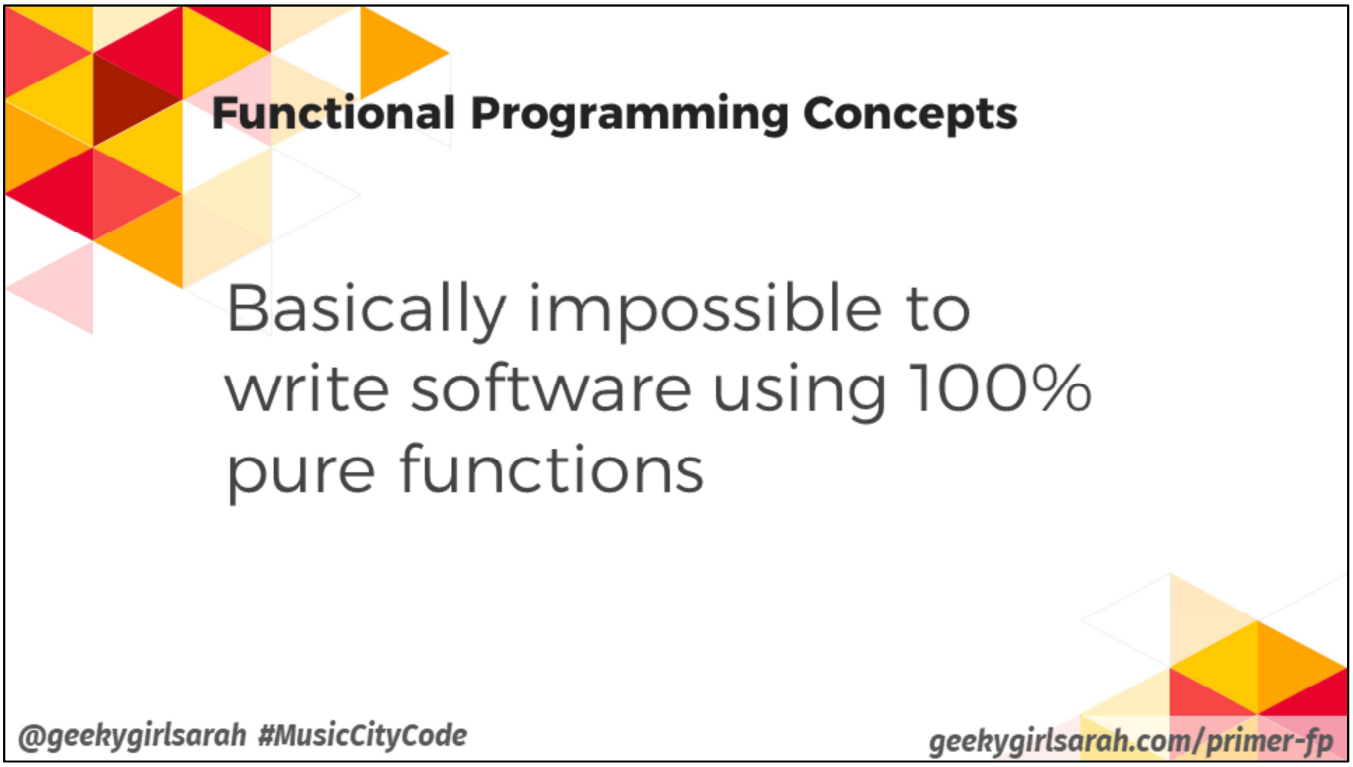
Functional Programming Concepts
Basically impossible to write software using 100% pure functions
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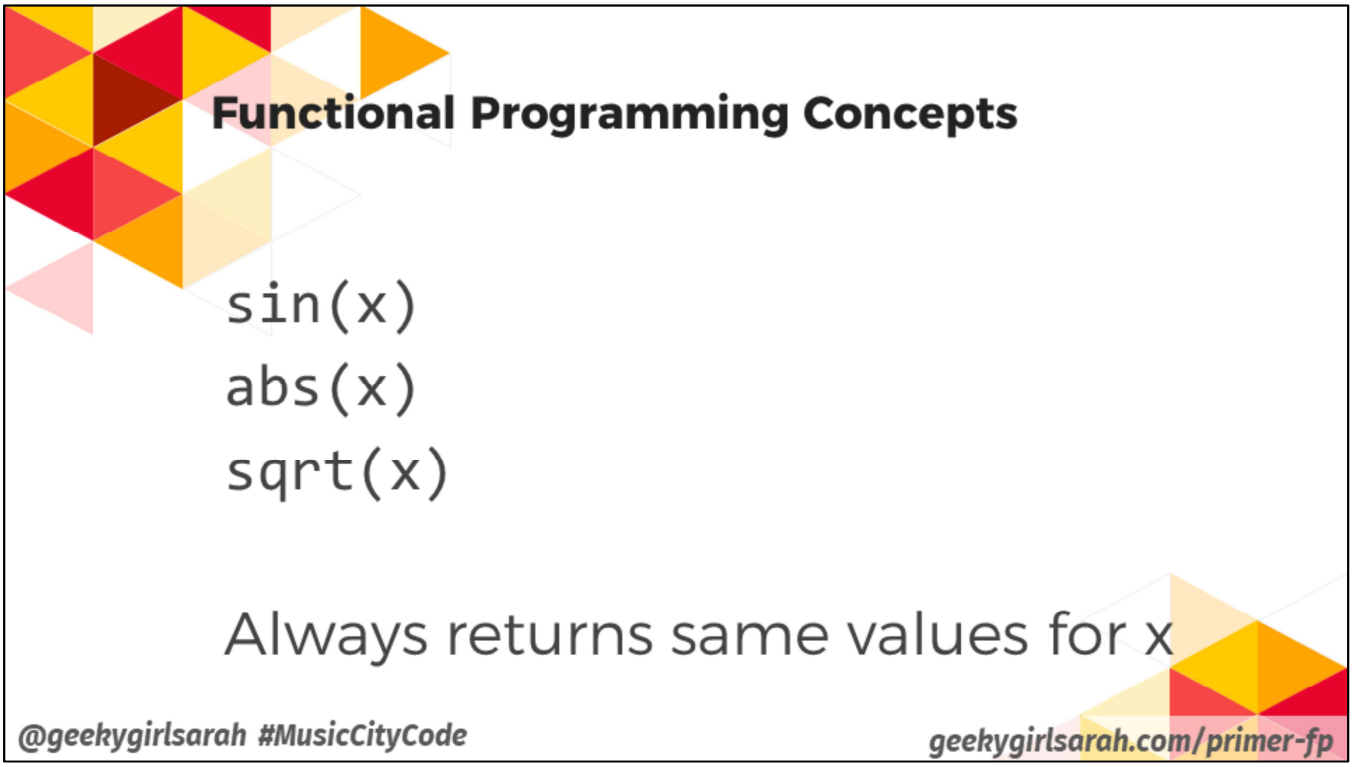
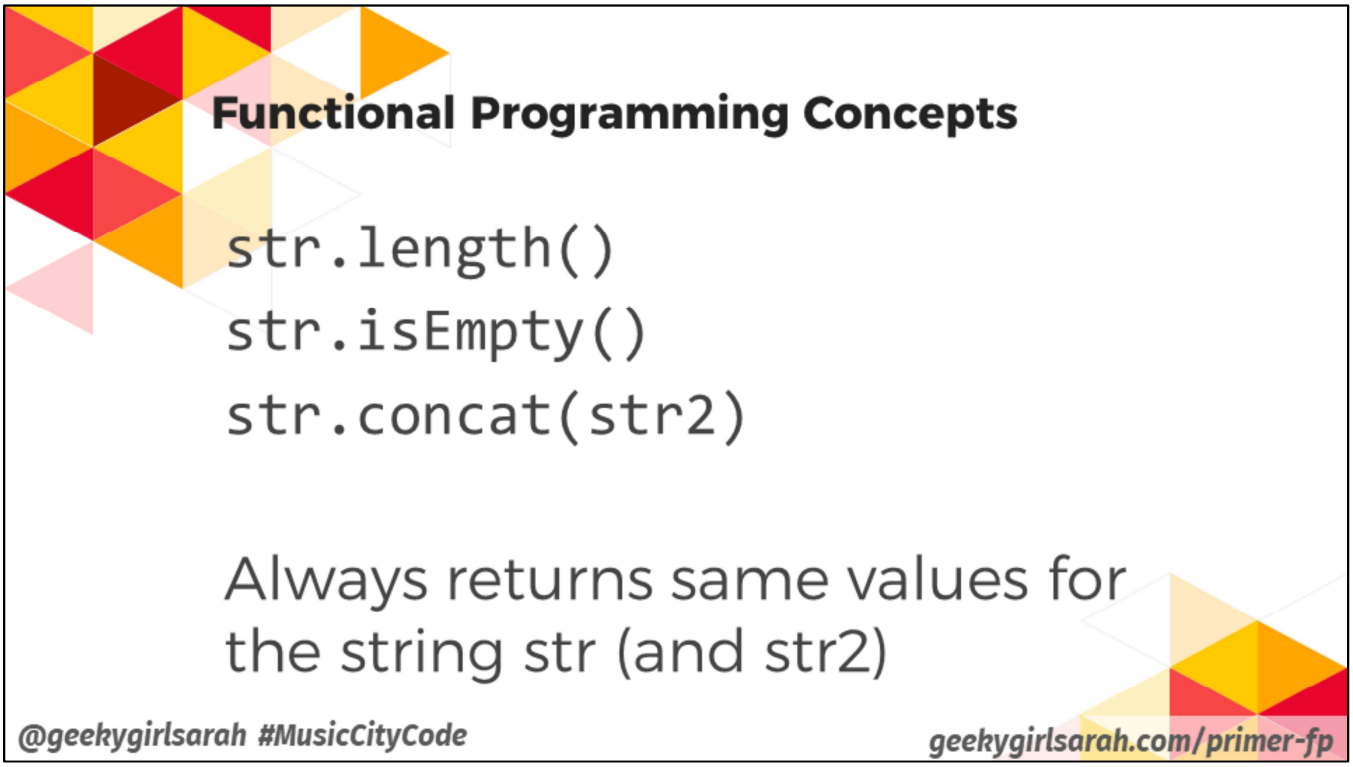
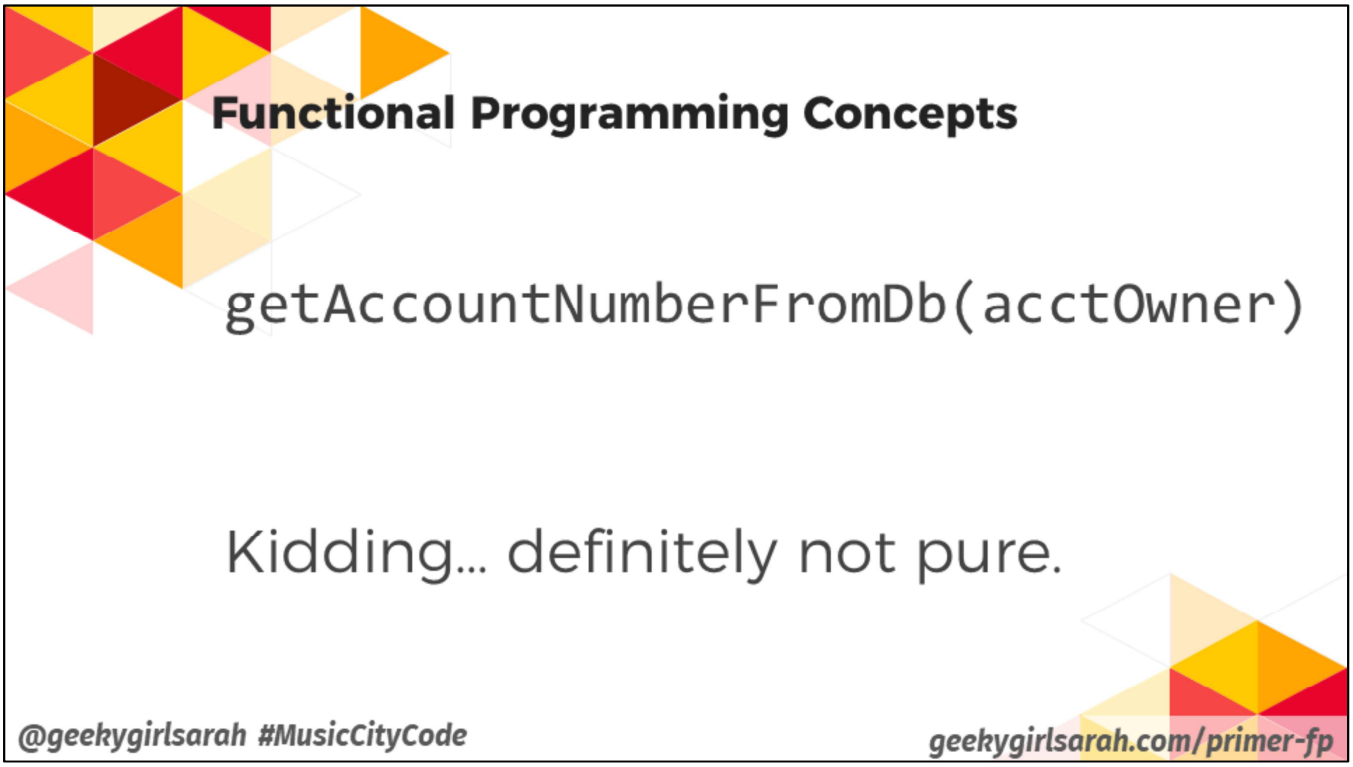



All math functions do this




Generally functions based on simple data types will be like this




Why?

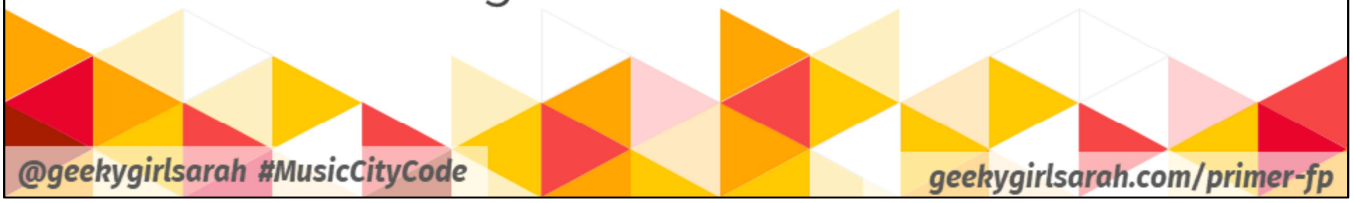
- What if someone changes their name?
- What if they close an account?
- What if the number changes (like debit card stolen)?
- What if database goes down?

## Review – Pure Functions

- Pure functions, given certain input, always produce same output
- No side effects
- User input is never pure
- Call by reference is never pure
- Impossible to write software in 100% pure functions

# Referential Transparency

Any expression that can replace a function with its return value with no behavior changes



## Functional Programming Concepts

Example:

If x = 3...

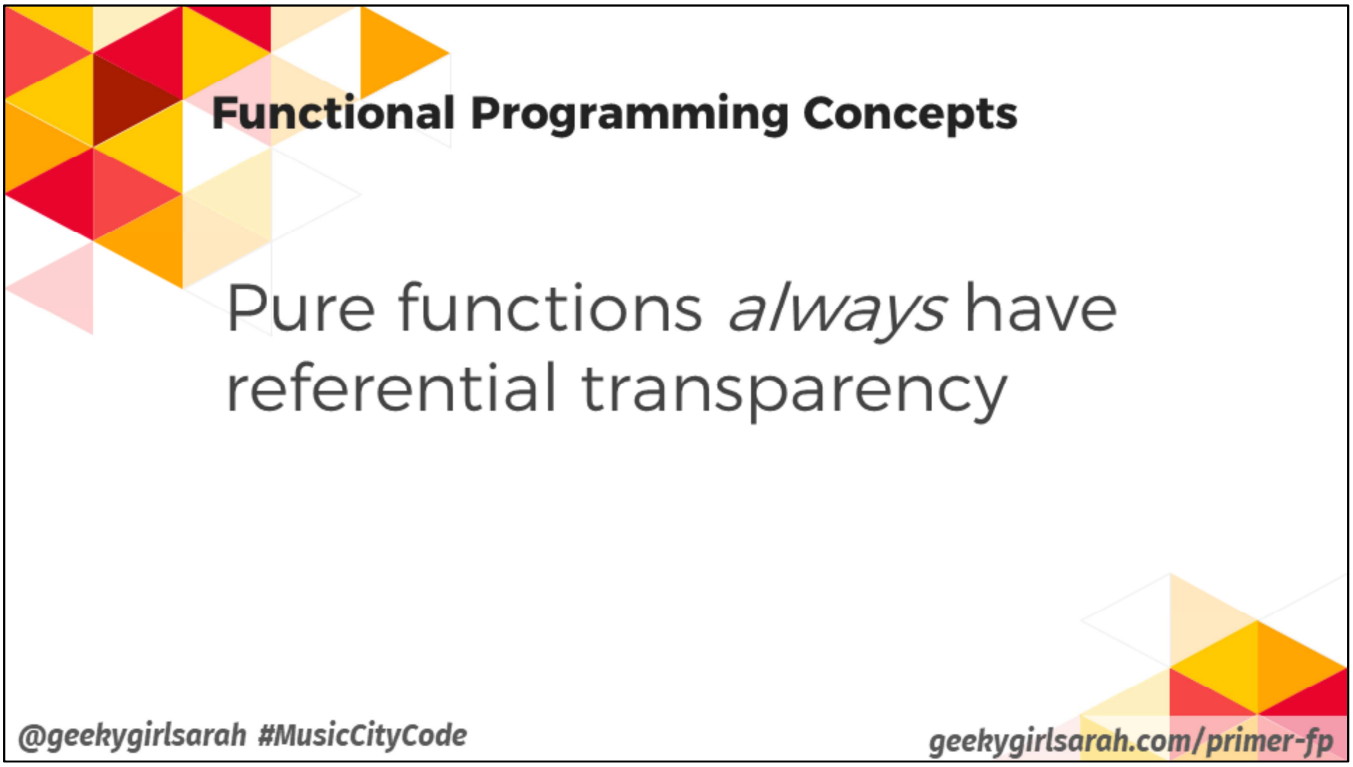
x + 5 = 8

3 + 5 = 8

## Functional Programming Concepts

(note: sin 30° = 0.5, cos 60° = 0.5)

```
x = 30
y = sin(x) + cos(x*2)   # y=1
y =  0.5   +    0.5     # y=1
```


Functional Programming Concepts
Pure functions *always* have referential transparency
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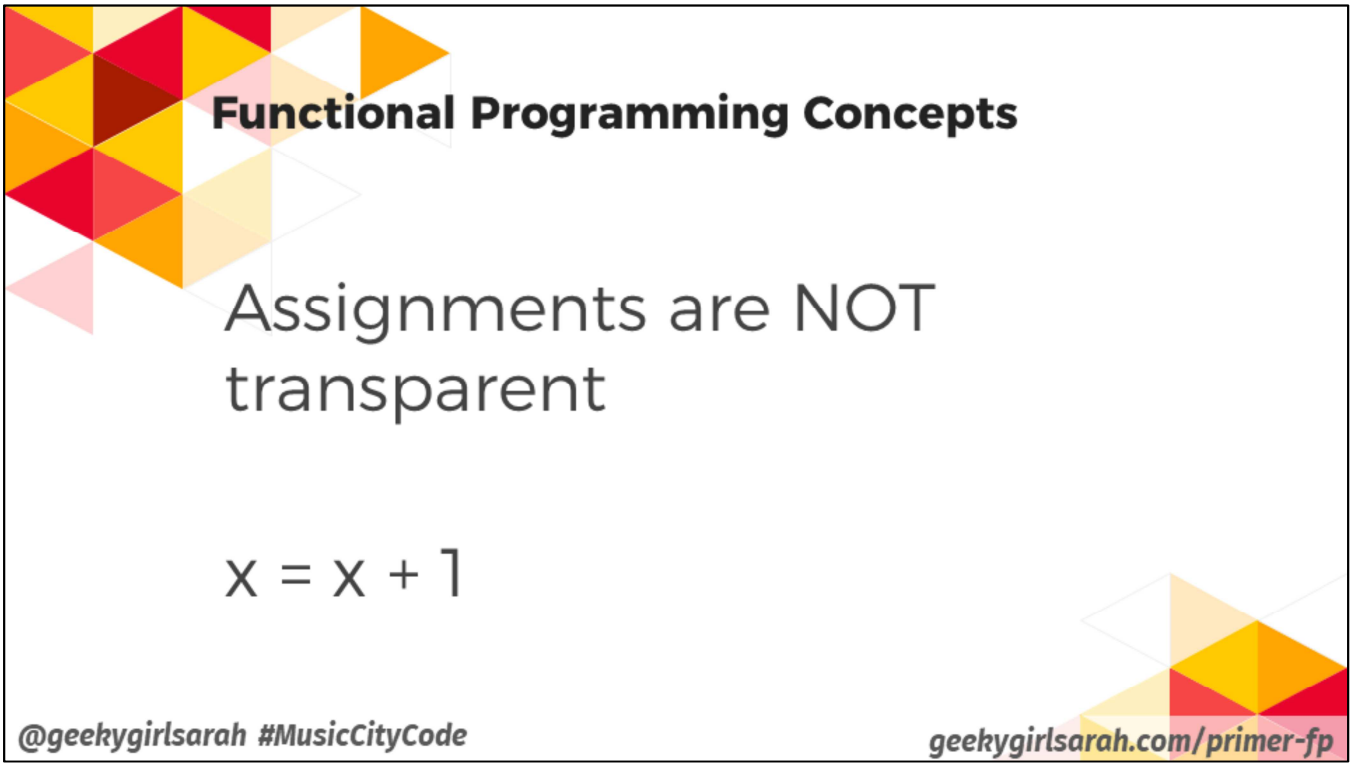
## Functional Programming Concepts

In mathematics, all functions are transparent

In programming, this is NOT true


Functional Programming Concepts
Assignments are NOT transparent
x = x + 1
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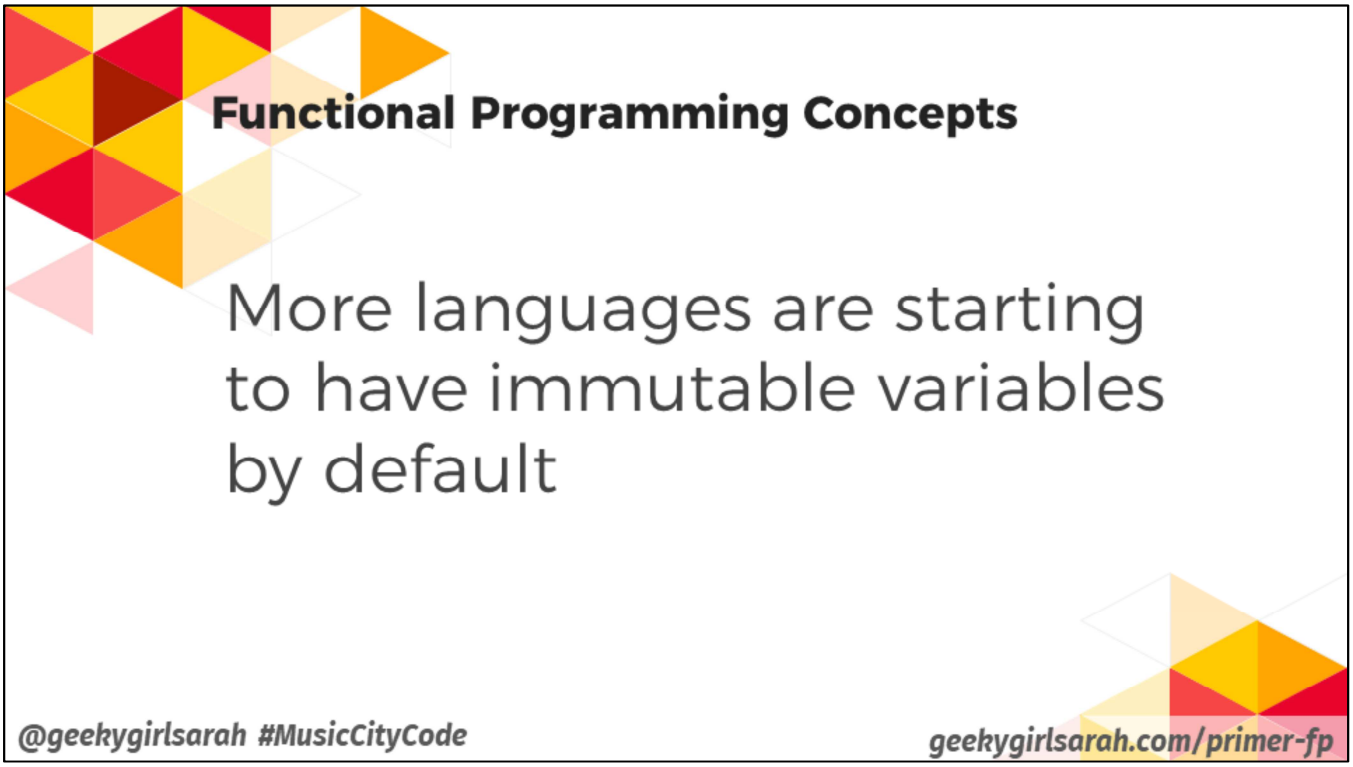
## Functional Programming Concepts

```
def addOne(int num):
    return num + 1;
```

If x and y are the same, then
`addOne(x)` and `addOne(y)`
give same result


Functional Programming Concepts
More languages are starting to have immutable variables by default
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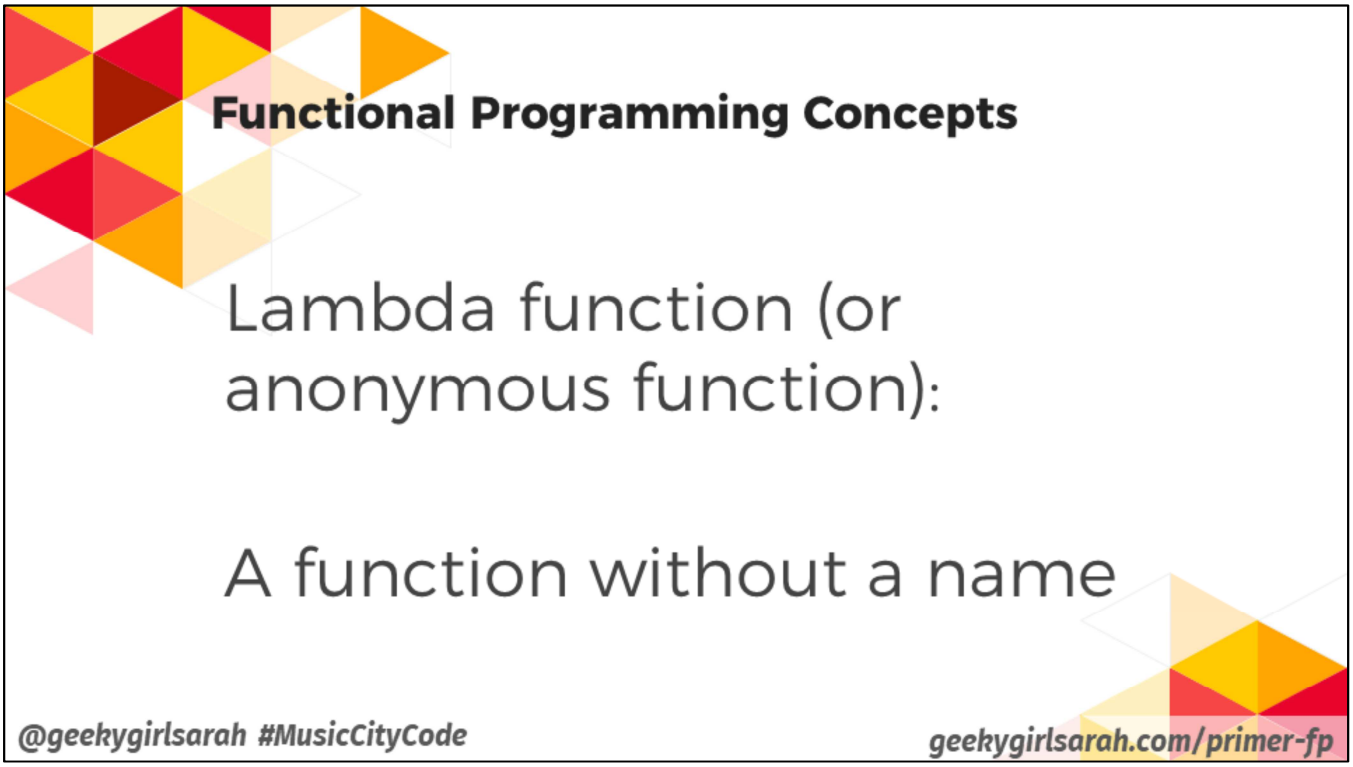
Functional Programming Concepts
Lambda function (or anonymous function):
A function without a name
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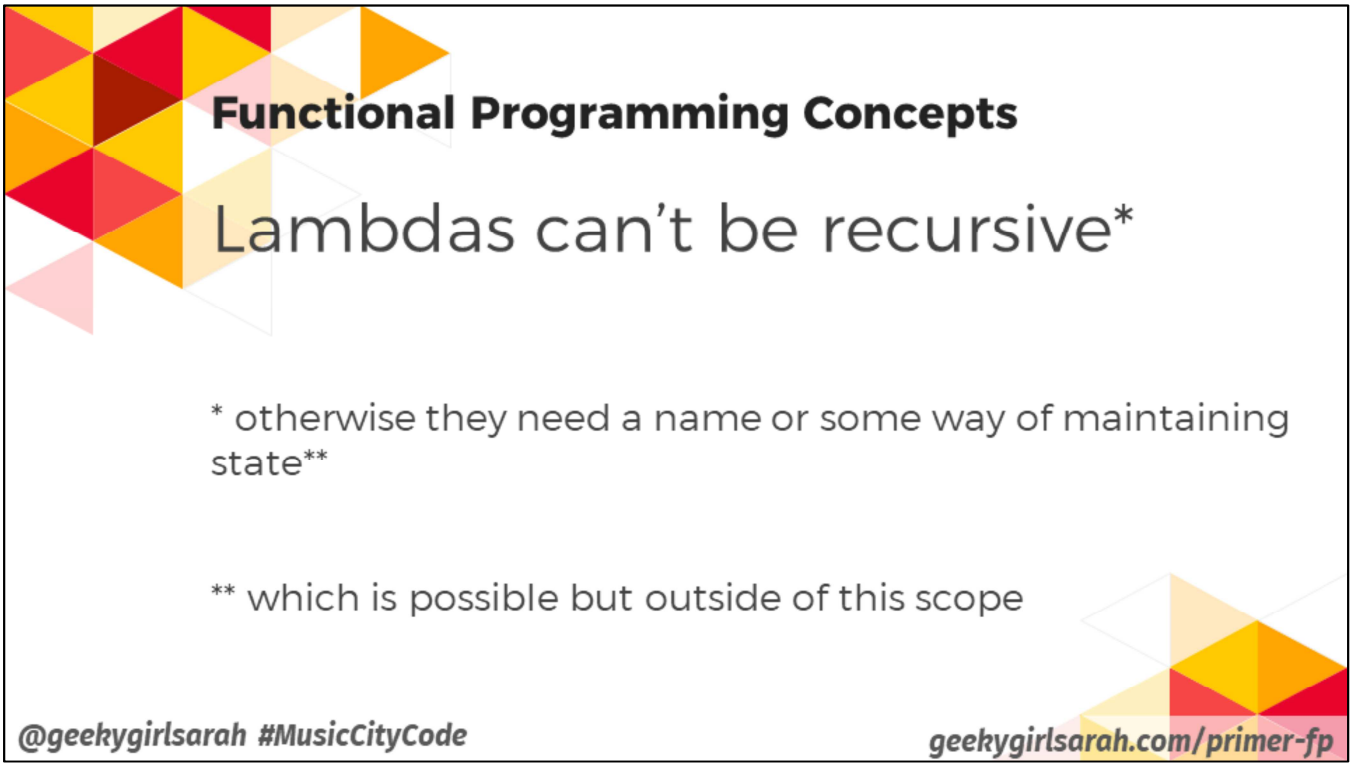
## Functional Programming Concepts

# Why lambdas?

For higher level functions or to pass arguments to a function

Usually used once to few times




https://stackoverflow.com/questions/2067988/recursive-lambda-functions-in-c11

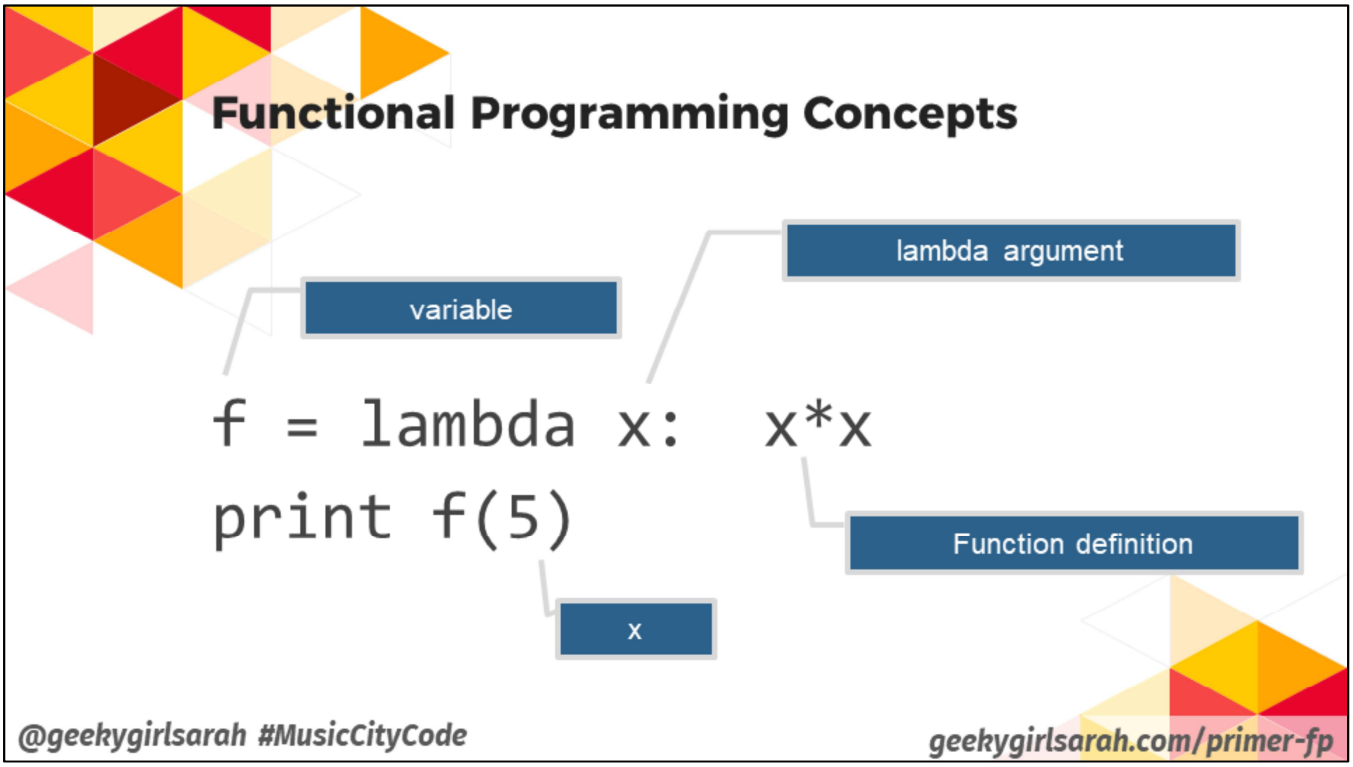
C++11:

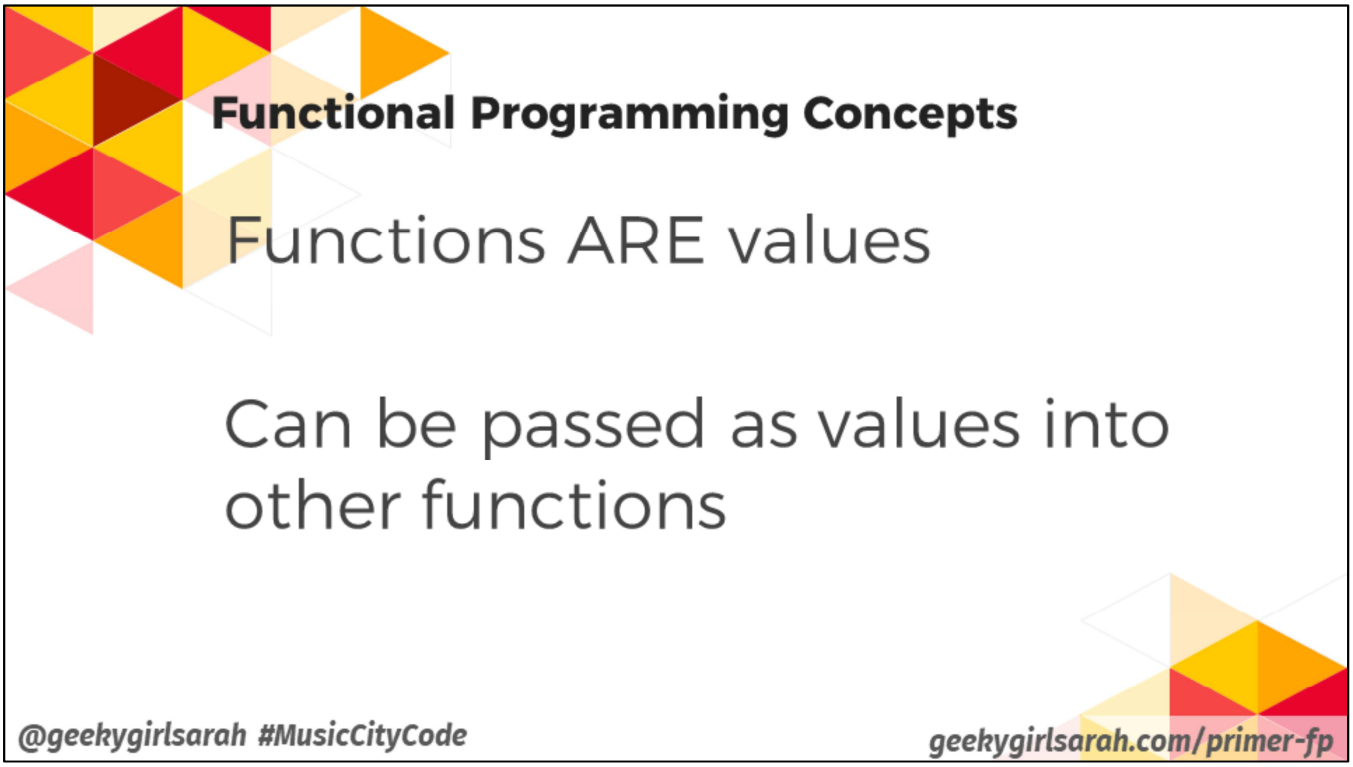
```
std::function<int(int,int)> sum;
sum = [term,next,&sum](int a, int b)->int {
    if(a>b)
        return 0;
    else
        return term(a) + sum(next(a),b);
};
```

C++14:

```
void f() {
    static int (*self)(int) = [](int i)->int { return i>0 ? self(i-1)*i : 1; };
    std::cout<<self(10);
}
```

# Functional Programming Concepts






- A lot of the core of functional programming
- Because of referential transparency and pure functions, this can be like passing in a regular value

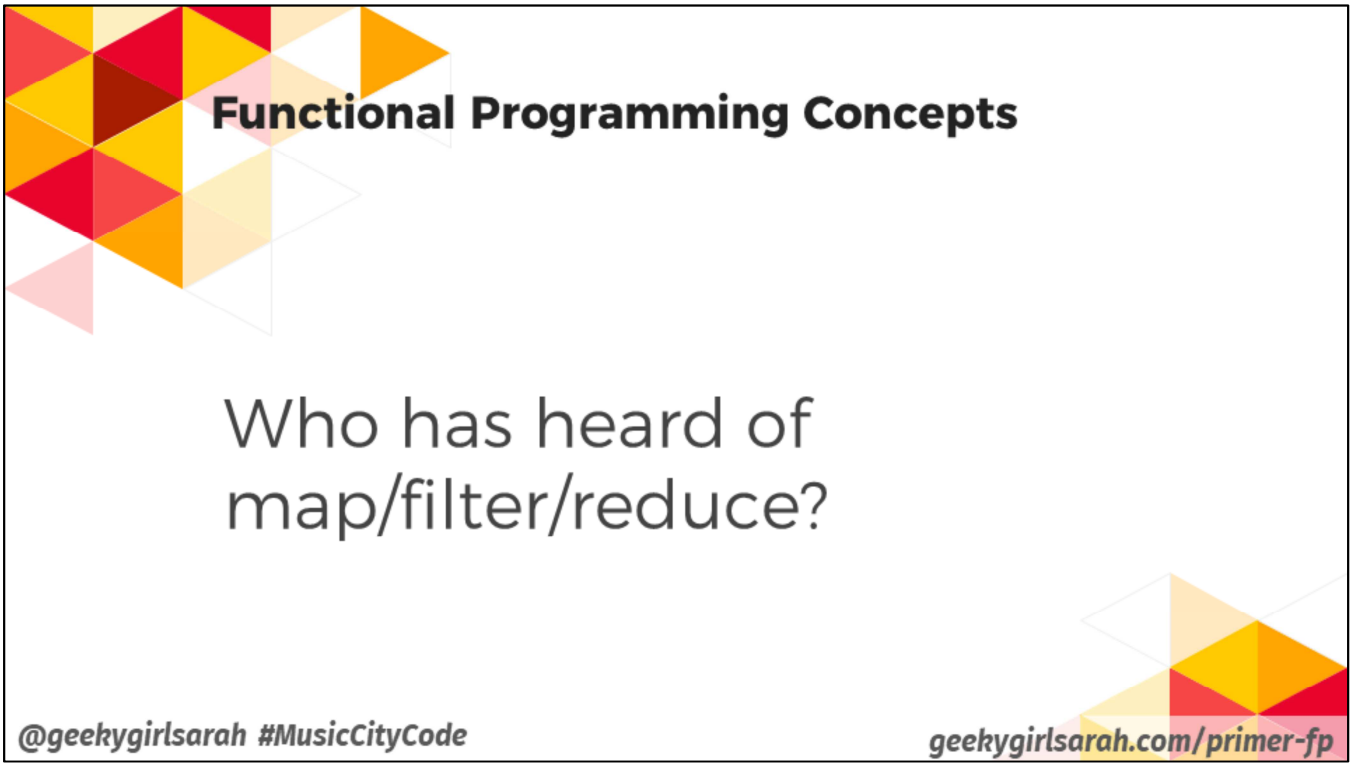
```
def divide(x, y):
    return x/y

def divisor(d):
    return lambda r: divide (r, d)

half = divisor(2)
print(half(32))
```

lambda r: divide(r, 2)

divide(32, 2)


Functional Programming Concepts
Who has heard of map/filter/reduce?
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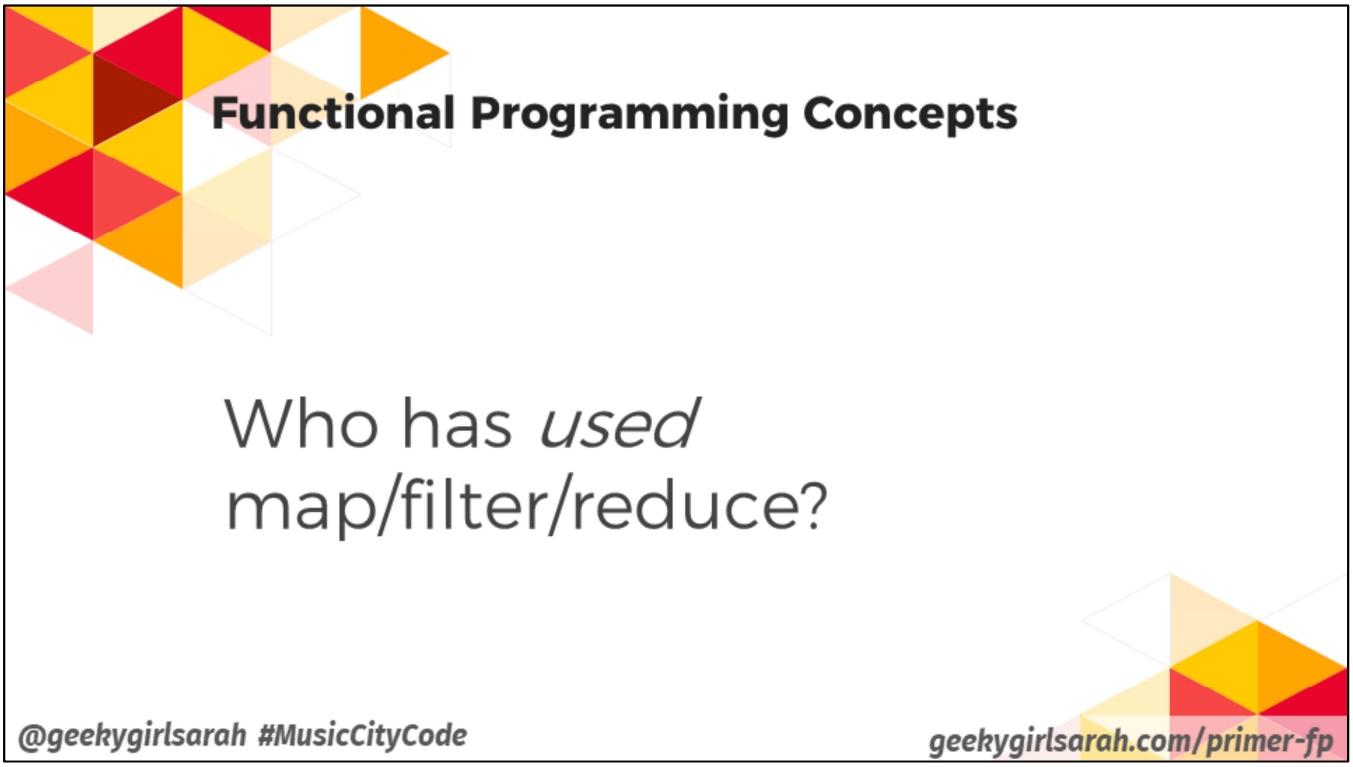
Functional Programming Concepts
Who has *used*
map/filter/reduce?
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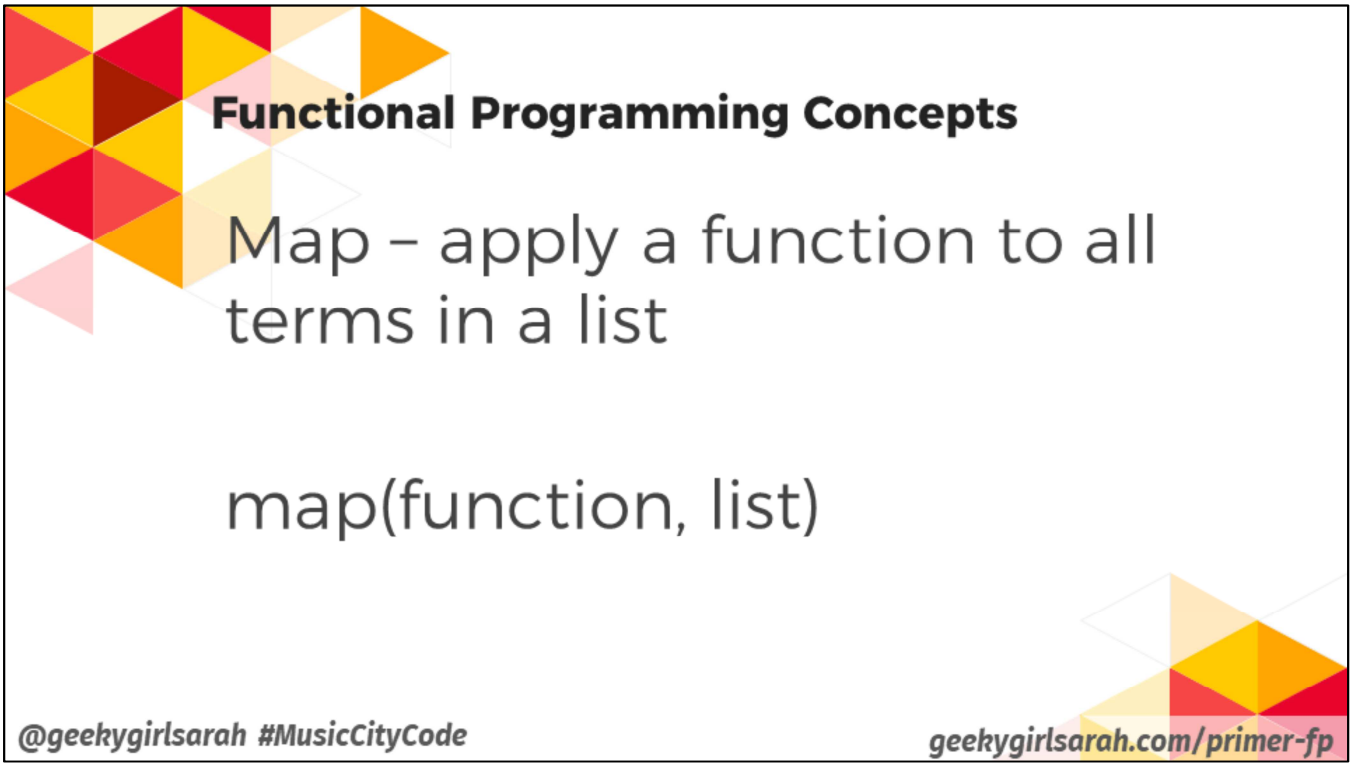



- Depending on language, the order of arguments may swap

```
items = [1, 2, 3, 4, 5]

squared = map(lambda x: x**2, items)
                # same as
squared = []
for i in items:
    squared.append(i**2)
```

## Functional Programming Concepts

Filter – creates a list for all items that match a filter (function returns true)

filter(function, list)

```
items = [1, 2, 3, 4, 5, 6, 7, 8]

under_5 = filter(lambda x: x<5, items)
                    # same as
under_5 = []
for i in items:
    if (i < 5):
        under_5.append(i)
```

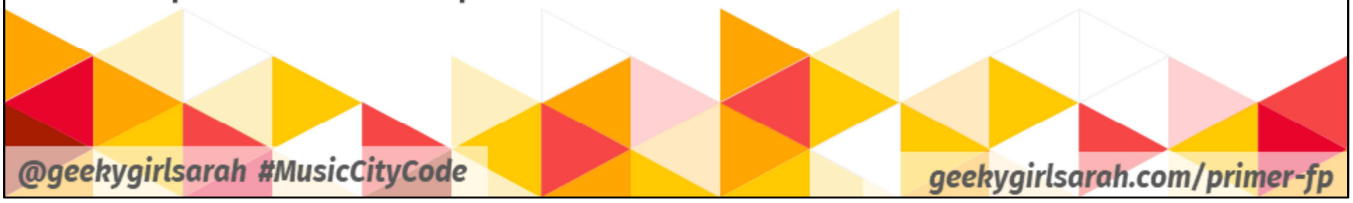
## Functional Programming Concepts

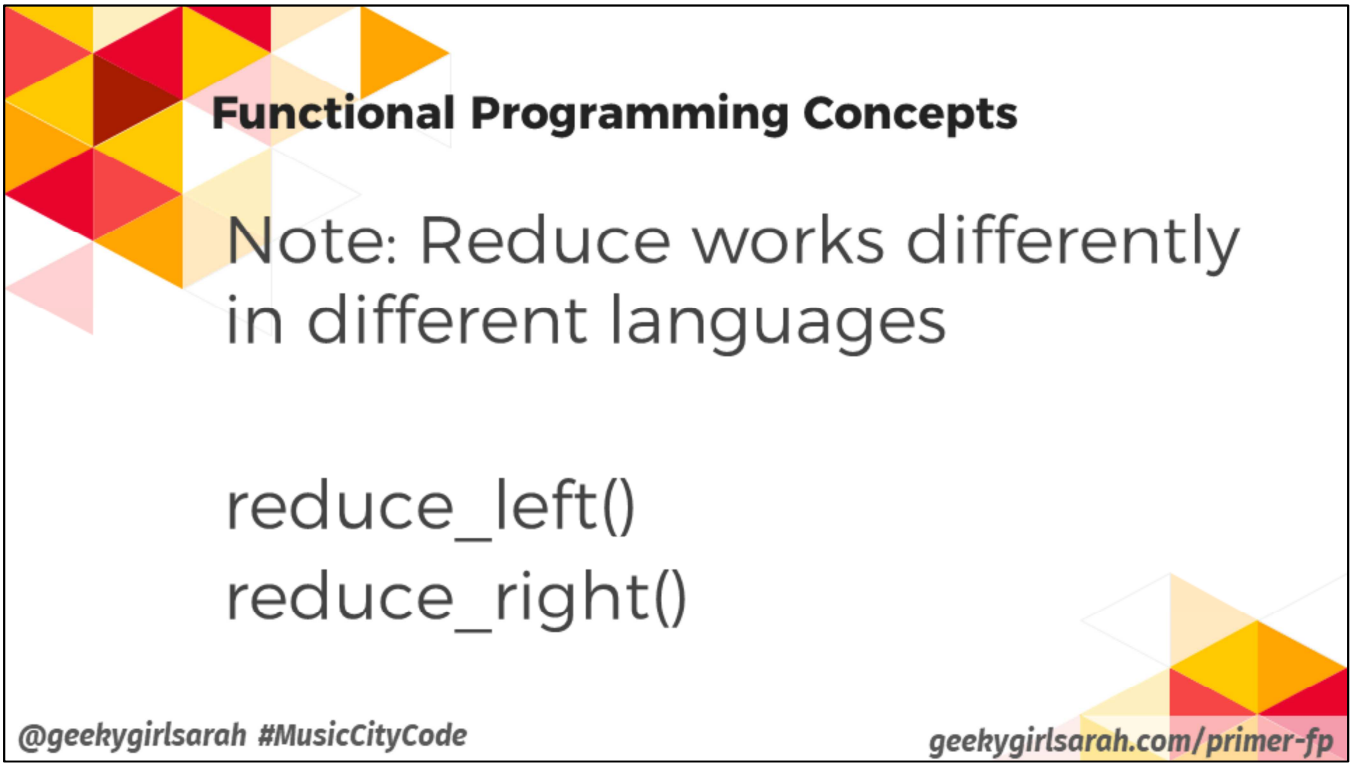
Reduce – returns result of some computation on a list

reduce(function, list)

```
items = [1, 2, 3, 4, 5, 6, 7, 8]

product = reduce(lambda x, y: x * y, items)
                  # same as
product = 1
for i in items:
    product = product * num
```




Functional Programming Concepts
Note: Reduce works differently in different languages
reduce_left()
reduce_right()
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Steven Luscher
@steveluscher
Follow
Map/filter/reduce in a tweet:
map([🌽, 🐮, 🍗], cook)
=> [🍿, 🍔, 🍳]
filter([🍿, 🍔, 🍳], isVegetarian)
=> [🍿, 🍳]
reduce([🍿, 🍳], eat)
=> 💩
RETWEETS
8,844
LIKES
9,296
7:08 PM - 9 Jun 2016
https://twitter.com/steveluscher/status/741089564329054208
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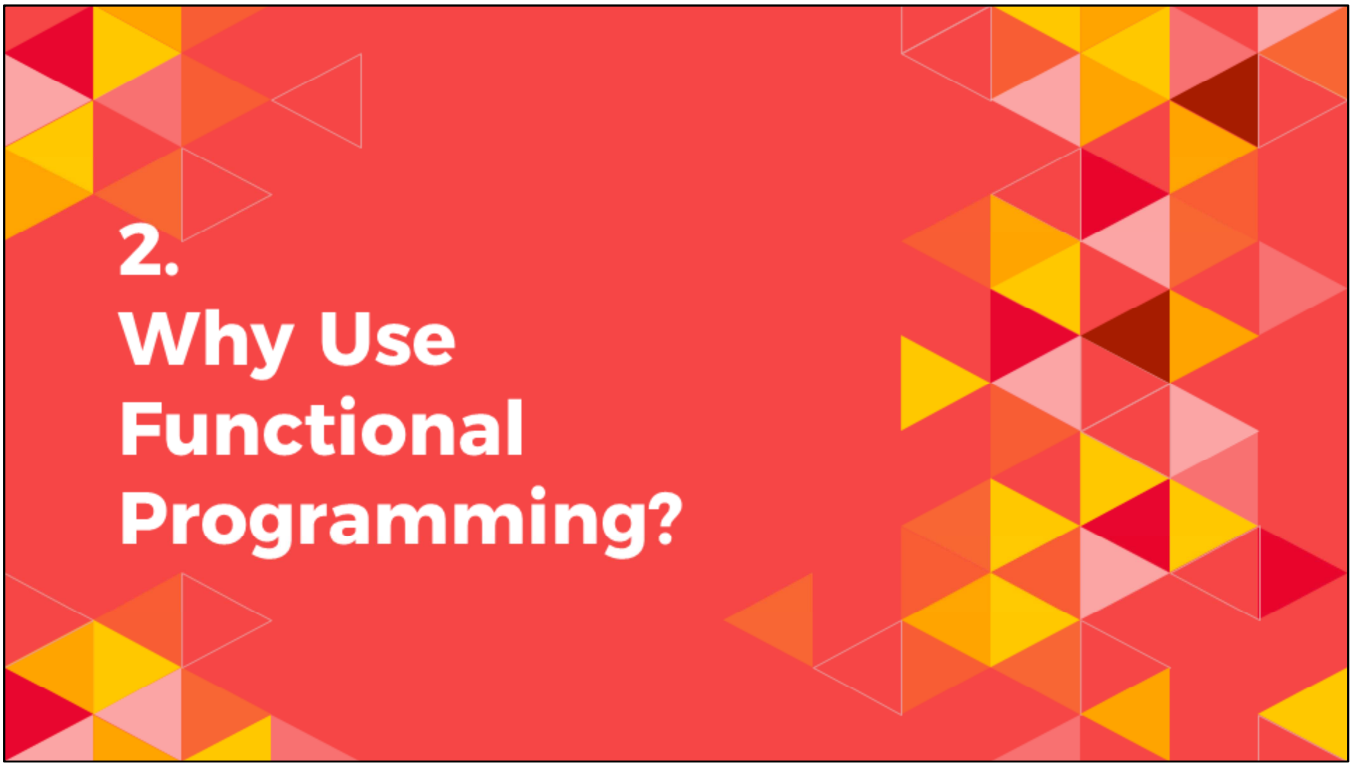
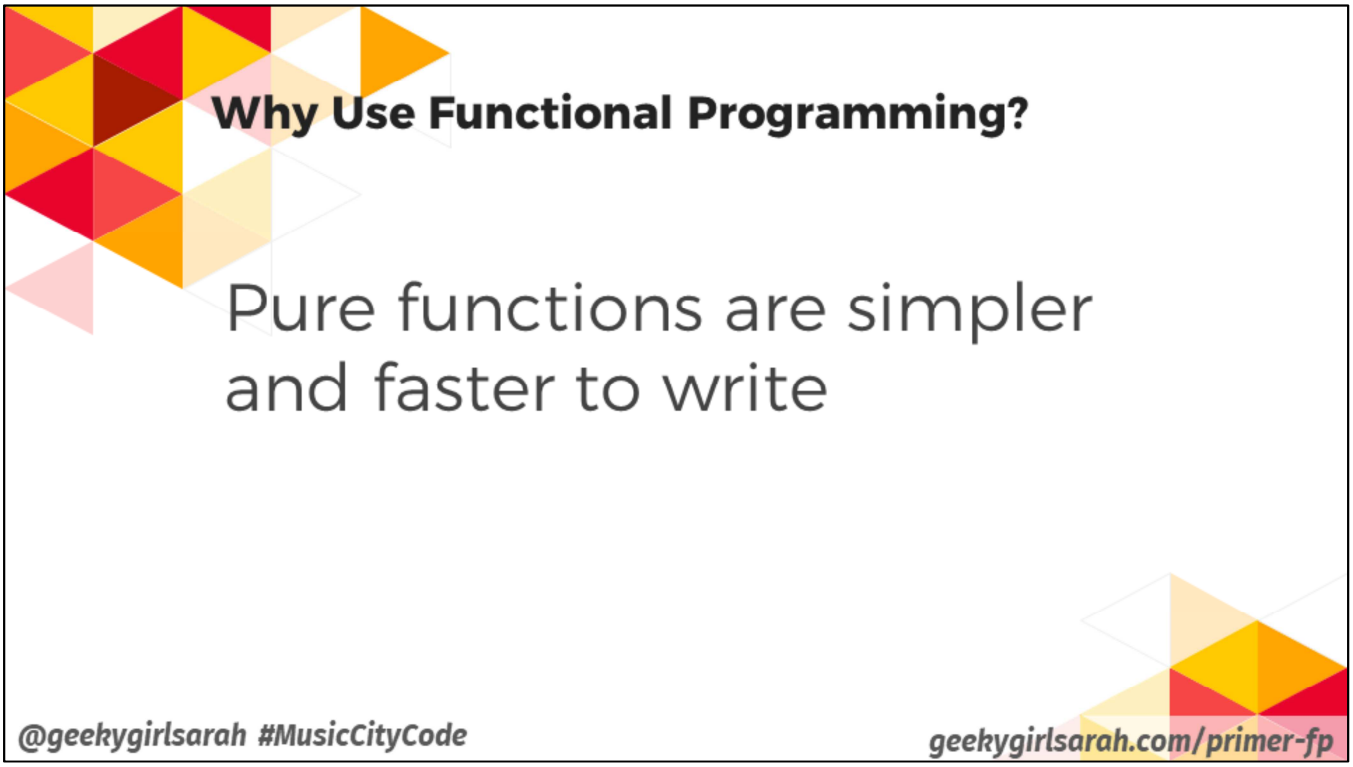



- A lot of things thrown at you
- The beginning might seem promising
- The later stuff might just be weird
- So…why?


Why Use Functional Programming?
Pure functions are simpler and faster to write
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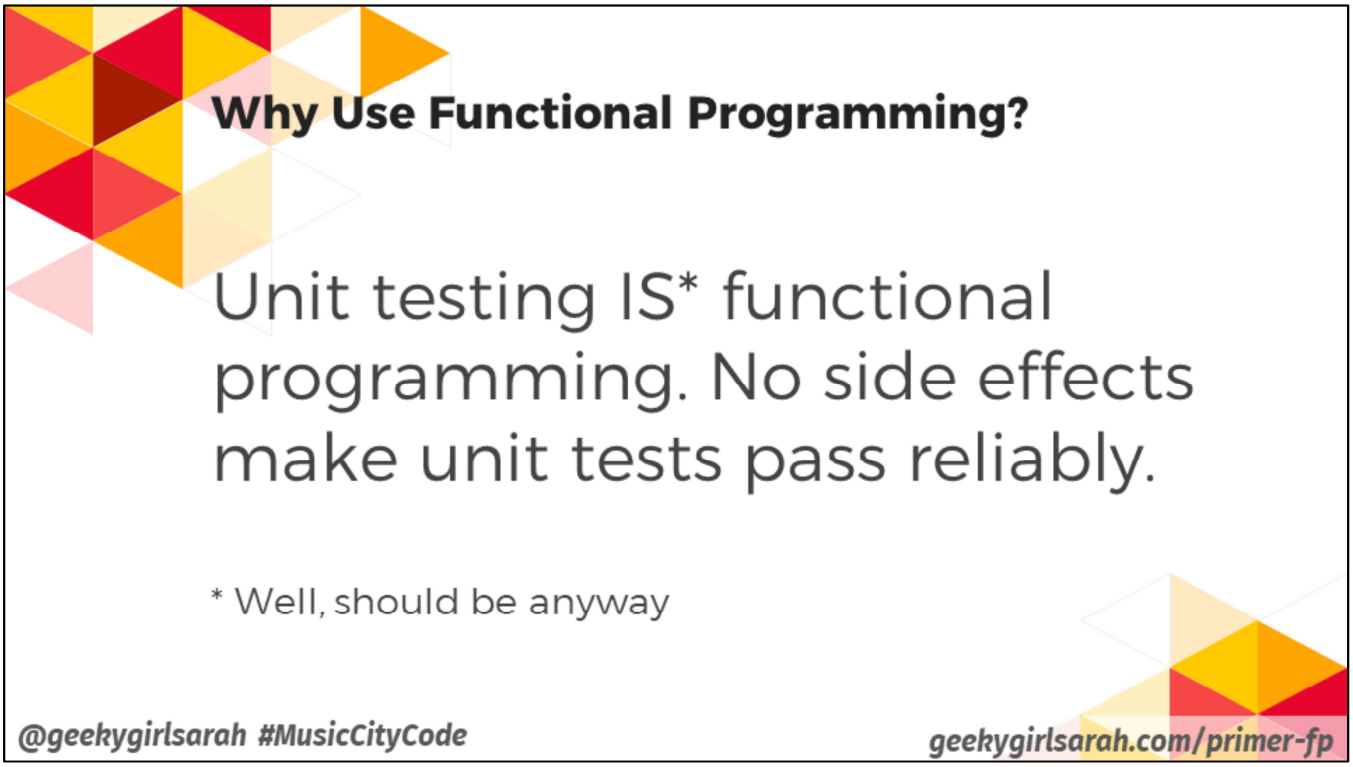
## Why Use Functional Programming?

Pure functions that work correctly will *always* work correctly

## Why Use Functional Programming?

Stack traces are a pain in OOP

Stack traces in FP simplify things




- Set up environment
- Run unit test
- Assert the result
- Clear out what you set up
- Should affect nothing else

## Why Use Functional Programming?

Global state of program isn't affected by pure functions

## Why Use Functional Programming?

Concurrency is WAY easier

## Why Use Functional Programming?

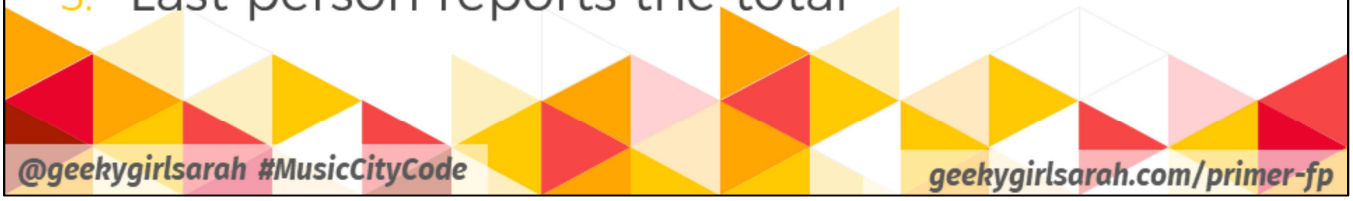
As code grows larger, it's all more reliable

*Better small modules*
*-> better large modules*

**Activity 1**

In a moment, everyone will stand up.

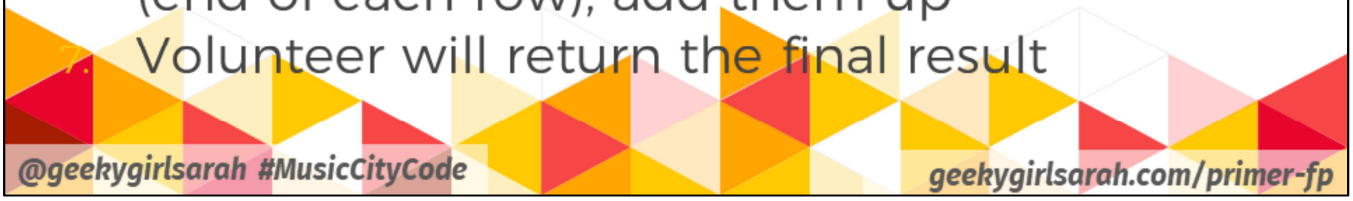
1. Start at the beginning of the room with 0
2. Each person will take the previous number, add 1 to it
3. Say the number out loud
4. Sit down
5. Last person reports the total



**Activity 2**

In a moment, everyone will stand up.

1. You are 1 person, so number is 1
2. Find a neighbor
3. Total your two numbers together
4. One of you sits down
5. Repeat steps 2-4 for each person in the row
6. Extra volunteer will count the array of results (end of each row), add them up
7. Volunteer will return the final result



## Why Use Functional Programming?

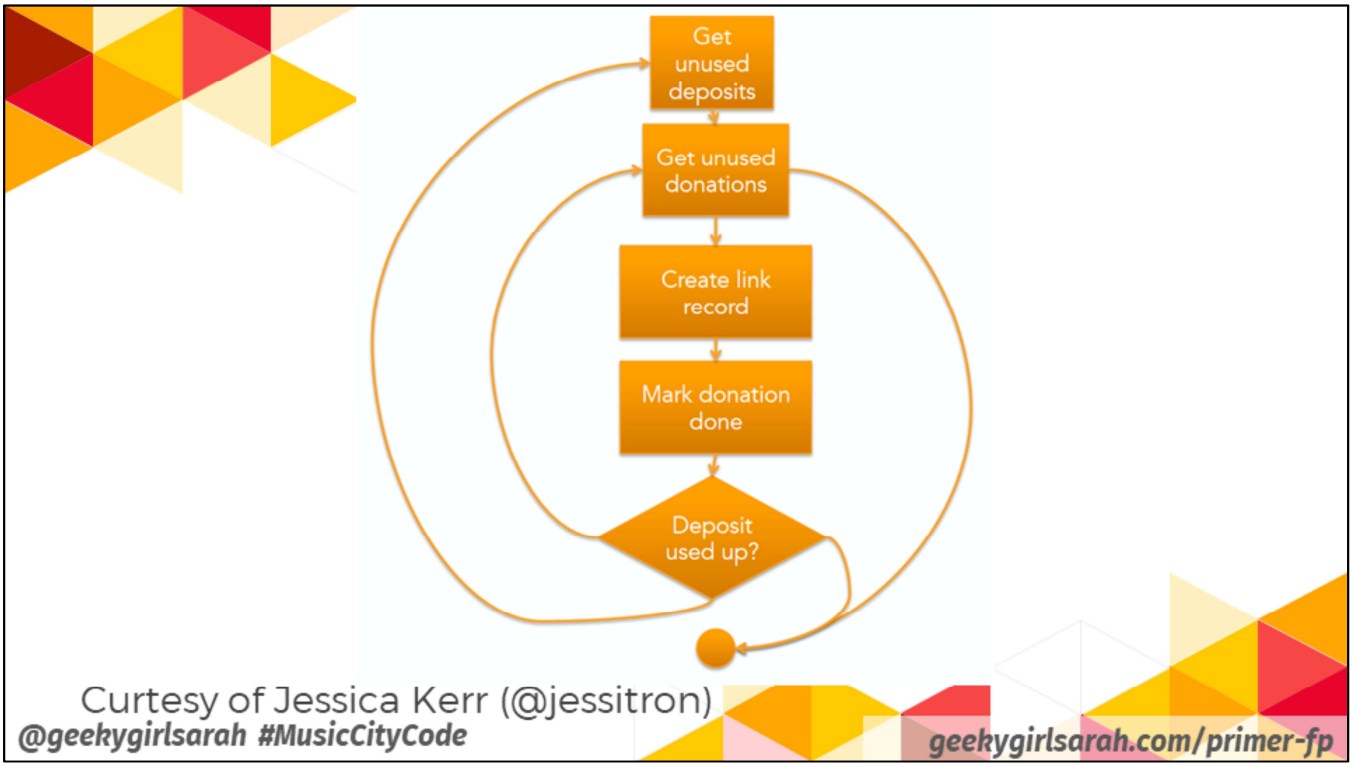
Activity 1 was like a for/while loop

- x = x + 1
- Took a long time

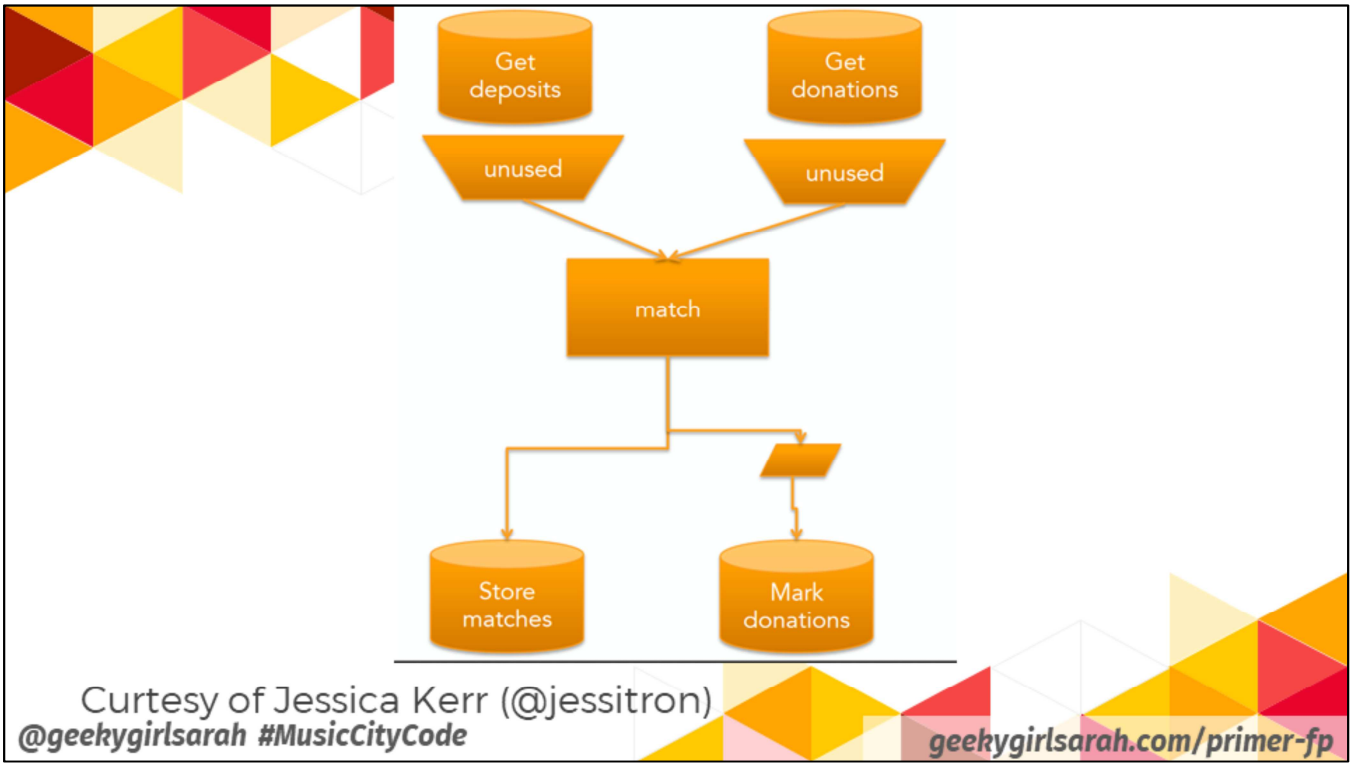
## Why Use Functional Programming?

Activity 2 was recursive and concurrent

- Rows counted independently (no side effects)
- Reduce all the totals together

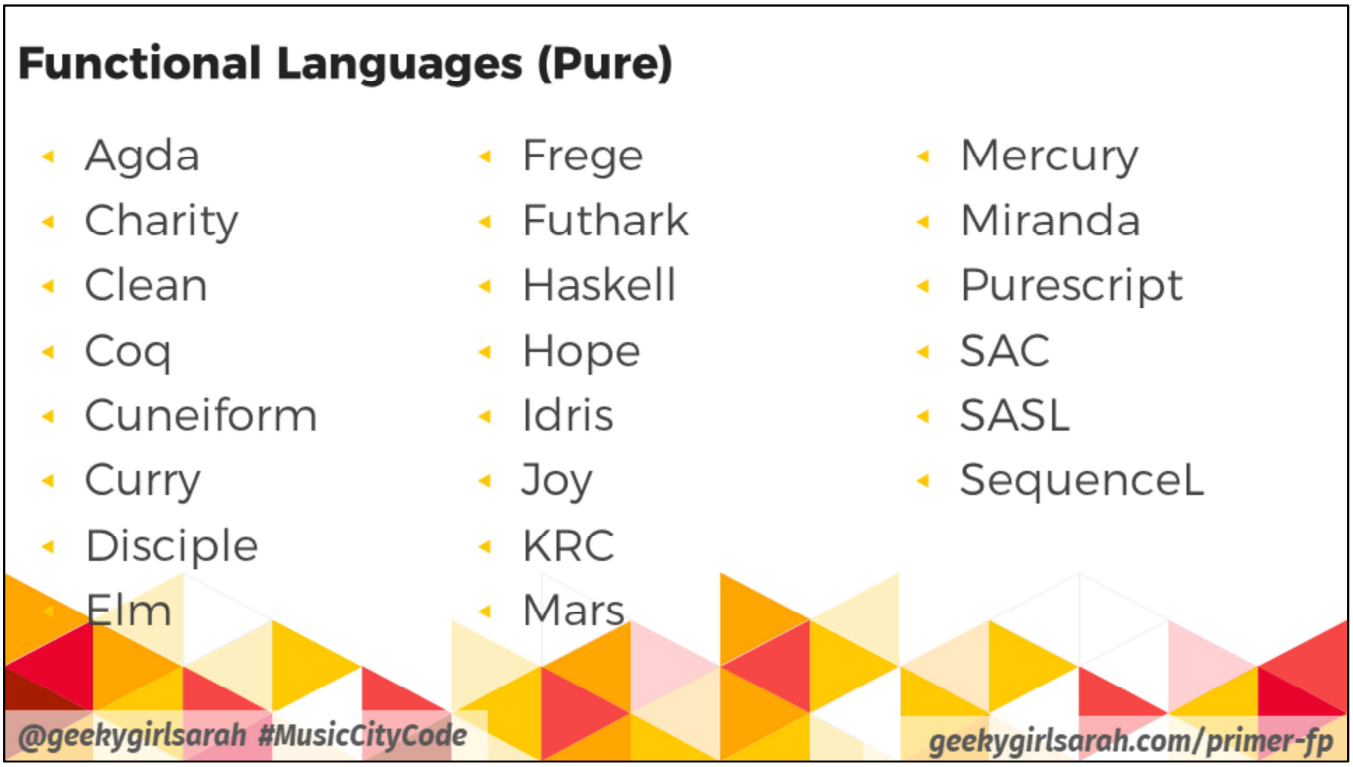



- A more imperitive/OOP way of doing non-profit donations

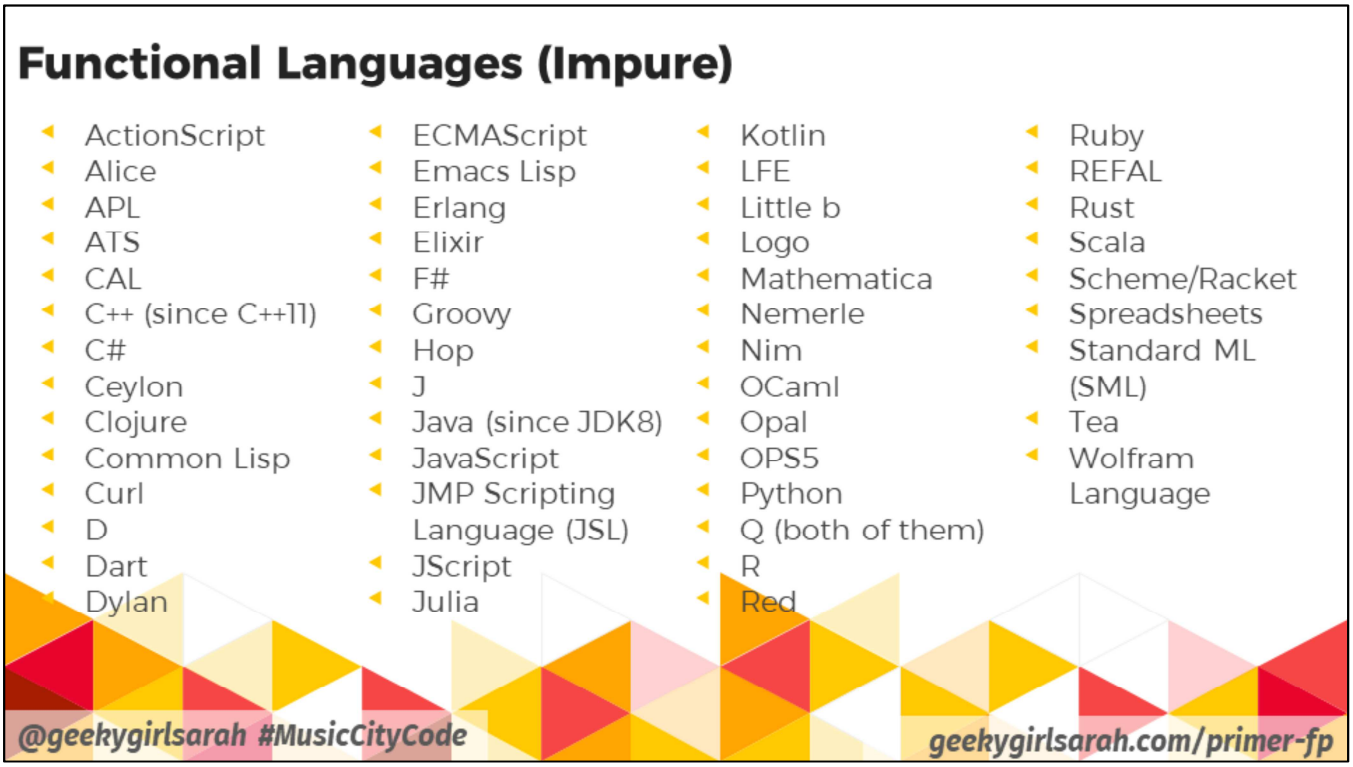



- A more imperitive/OOP way of doing non-profit donations


3.
Brief Glance at Functional Programming Languages




- 22 languages (at least)
- They don't allow side effects and guarantee referential transparency
- KRC = Kent Recursive Calculator
- SAC = Single Assignment C
- SASL = St. Andrews Static Language




- 50 languages (at least)
- For the most part, they implement lambdas and passing functions around (map/filter/reduce)
- Any surprises in here?

# 4.
# Conclusion

## Conclusion

- Functional programming is getting more popular, but been around for decades
- Functional principles make your code simpler, smaller, more reliable
- Functional concepts can work in nearly any language

# Thanks!

**Any questions?**

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Slides:
geekygirlsarah.com/primer-fp

## Credits

Special thanks to all the people who made and released these awesome resources for free:

- Presentation template by SlidesCarnival
- Example images by Jessica Kerr (@jessitron)

# Presentation design

This presentation uses the following typographies and colors:

- Titles: Montserrat bold
- Body copy: Montserrat light

You can download the fonts on this page:

https://www.fontsquirrel.com/fonts/montserrat

Yellow #ffc800 · Orange #ffa400 · Raspberry #f64646 · Crimson #e8062f