

# PROGRAMMING LANGUAGE CONCEPTS

Madhavan Mukund

SP Suresh

Haskell, Python, C, C++, Java, ...

Swift, Go, Rust, ...

What is common? What are the differences?

# Two styles of programming

## Imperative

Procedural

Explicitly describe variables,  
how to update them,  
concrete instructions to  
manipulate data

How to do it

## Declarative

Conceptual

Describe "structure"  
of the computation

What to do

## Imperative

sum = 0

for x in l:

sum = sum + x

C, C++, Java, Python, ...

## Declarative

sum [] = 0

sum (x:xs)

= x + sum(xs)

Haskell, ML, LISP, ...  
(functional)

Logic programming - PROLOG

Databases - SQL

# Imperative

Variables

Control flow

Abstraction

!  
Lemmas  
Proposition  
Definition

Storage?  
Types?

Function/procedure

!  
Data Abstraction

List vs Array  
Sequences

Object Oriented

"Abstract Data Type"

!  
Public interface  
Private implementation

$l[i]$

$insert(l, i, v)$

Concrete language to illustrate concepts

Java for Object Oriented programming

Quick intro as we go along

Concurrent programming [Java]

Bank - multiple transaction

PL support for concurrency

find(l, r)

↓  
generate exception

Errors & exceptions [Java]

Exception handling

# Event driven programming [Java]

Graphical interface

Create windows & other objects on screen

Each reacts to mouse clicks, key strokes

Start a long download - interrupt

Declarative (functional) programming

Haskell

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Foundations  $\lambda$ -calculus

Typing & type inference

Logic programming