Tópicos Especiais em Computação Aplicada I
Fundamentos de Programação

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Some terms

Programming paradigm: a pattern that serves as a school of thoughts for programming of computers

Programming technique: related to an algorithmic idea for solving a particular class of problems

- Examples: 'Divide and conquer' and 'program development by stepwise refinement'

Programming style: the way we express ourselves in a computer program

- Related to elegance or lack of elegance

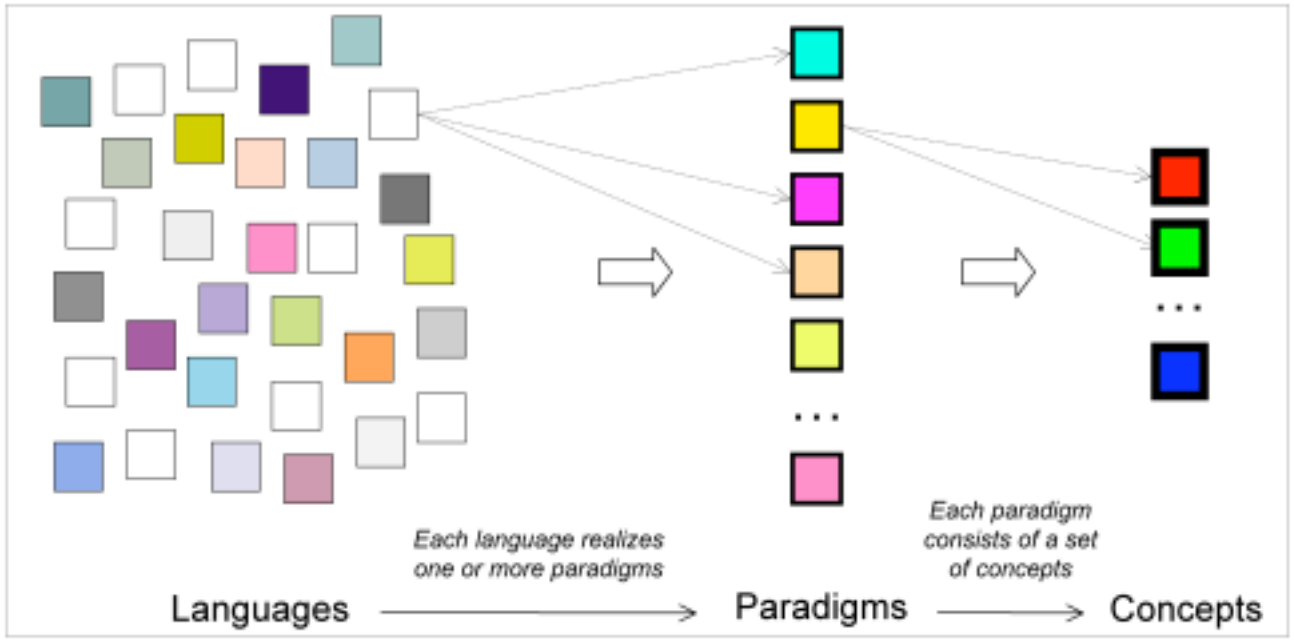
Programming culture

- The totality of programming behavior, which often is tightly related to a family of programming languages
- The sum of a main paradigm, programming styles, and certain programming techniques

Programming Paradigms

- Solving a programming problem requires choosing the right concepts
- All but the smallest toy problems require different sets of concepts for different parts
- A programming paradigm, or programming model, is an approach to programming a computer based on a mathematical theory or a coherent set of principles
- Languages realize programming paradigms
- There are many fewer programming paradigms that programming languages

Languages, Paradigms and Concepts



source: Roy, P.V; Haridi, S.; 2004

Programming Paradigm

Imperative: tell the computer how to do obtain an output

Declarative: tell the computer the result that you need

A way of conceptualizing what it means to perform computation and how tasks to be carried out on the computer should be structured and organized

Four main paradigms:

- Imperative : Machine-model based
- Functional : Equations; Expression Evaluation
- Logical : First-order Logic Deduction
- Object-Oriented : Programming with Data Types

Imperative paradigm

First do this and next do that

Ideas of Von Neummann

A command has a measurable effect on the program

The order of commands is important

Characteristics:

- Incremental change of the program state (variables) as a function of time
- Execution of commands in an order governed by control structures
- Procedures: abstractions of one or more actions, which can be called as a single command

Representatives: Fortran, Algol, Basic, C, Pascal

Example in Pascal Language

```
1   Program Example1;
2   Var
3       Num1, Num2, Sum : Integer;
4
5   Begin {no semicolon}
6    Write('Input number 1:');
7    Readln(Num1);
8    Writeln('Input number 2:');
9    Readln(Num2);
10   Sum := Num1 + Num2; {addition}
11   Writeln(Sum);
12   Readln;
13  End.
```

Most popular programming languages are imperative.

Functional paradigm

Evaluate an expression and use the resulting value for something

Mathematics and theory of functions

The values produced are non-mutable

Time plays a minor role compared to imperative program

All computations are done by applying functions with no side effects

Functions are firsts class citizens

Representatives: Haskell, Clojure

Example in Haskell language

JavaScript

```javascript
function evenSum(list) {
    var result = 0;
    for (var i=0; i< list.length ; i++) {
        if (list[i] % 2 ==0) {
            result += list[i];
        }
    }
    return result;
}
```

Haskell

```haskell
-- Version 4
evenSum :: Integral a => [a] -> a

evenSum = accumSum 0
    where
        accumSum n [] = n
        accumSum n (x:xs) =
            if even x
               then accumSum (n+x) xs
               else accumSum n xs
```

Logical paradigm

Answer a question via search for a solution.

The logic paradigm fits well when applied in problem domains that deal with the extraction of knowledge from basic facts and relations.

Based on axioms, inference rules, and queries.

Program execution becomes a systematic search in a set of facts, making use of a set of inference rules

Representatives: Prolog

Example in Prolog

```
domains
     being = symbol
predicates
     animal(being) % all animals are beings
     dog(being) % all dogs are beings
     die(being) % all beings die
clauses
     animal(X) :- dog(X) % all dogs are animals
     dog(fido). % fido is a dog
     die(X) :- animal(X) % all animals die
```

Object-Oriented paradigm

Send messages between objects to simulate the temporal evolution of a set of real world phenomena

Data as well as operations are encapsulated in objects

Information hiding is used to protect internal properties of an object

Objects interact by means of message passing

In most object-oriented languages objects are grouped in classes

Classes are organized in inheritance hierarchies

Representatives: C++, Java

Example in C++

```
class Employee
{
  public:
    Employee();
    const char *getName() const;
  private:
    char name[30];
};

class WageEmployee : public Employee
{
  public:
    WageEmployee(const char *nm);
    void setWage(double wg);
    void setHours(double hrs);
  private:
    double:wage;
   double:hours;
};

WageEmployee aWorker("Bill Gates");
const char *str;

aWorker.setHours(40.0);  //call WageEmployee::setHours
str = aWorker.getName(); //call Employee::getName
```

Other paradigms

The visual paradigm

One of the parallel paradigms

The constraint based paradigm

Aspect-oriented paradigm

Event-oriented paradigm

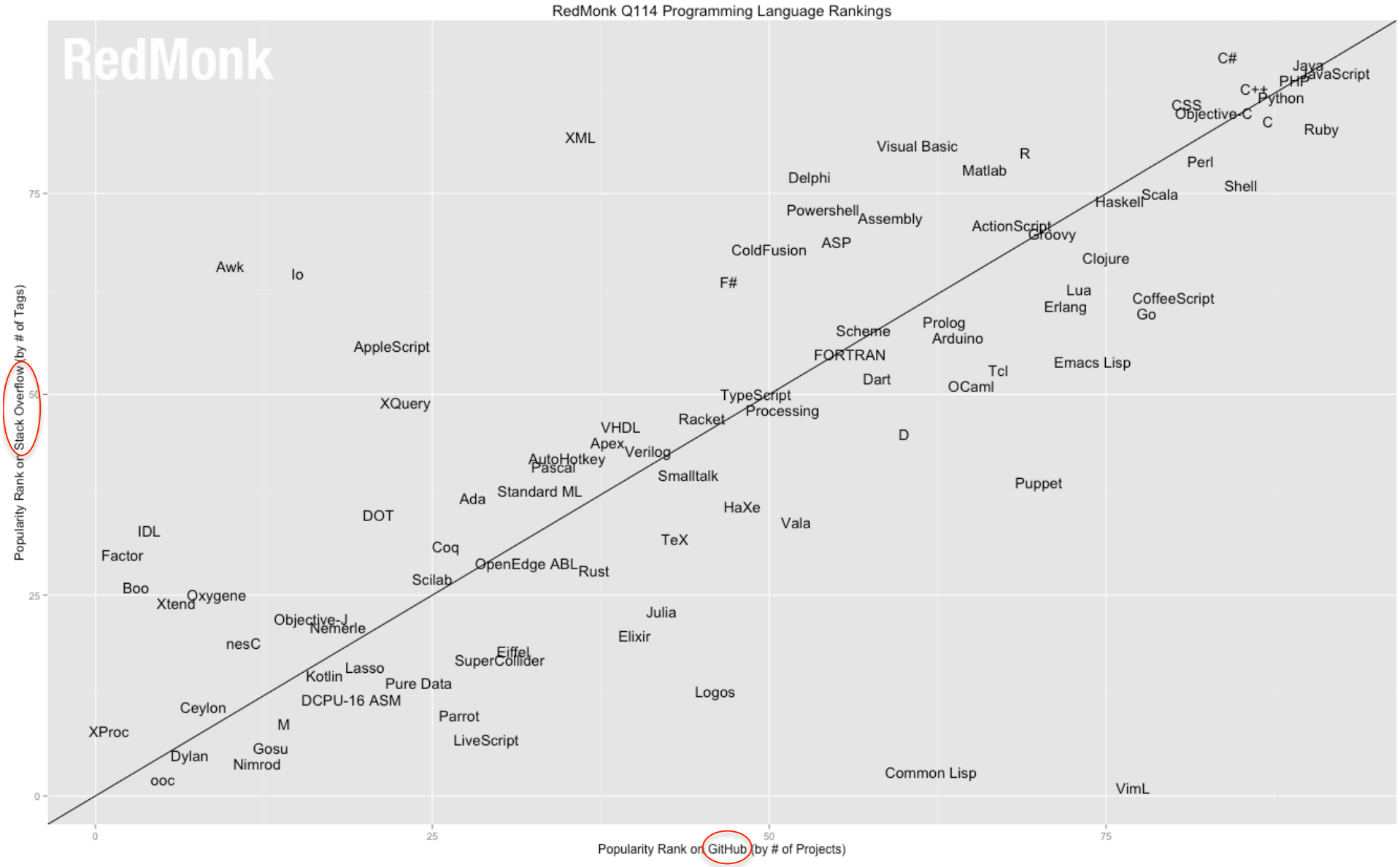
…

Programming Languages

- What we have to learn to study a programming language?
  - Syntax…
  - Semantics…
  - The programming environment…
- How many languages are out there?

C	PHP
C++	Haskell
Java	Prolog
Python	???

- Which languages should I know?



source: http://redmonk.com/sogrady/2014/01/22/language-rankings-1-14/

The top 20

source: http://redmonk.com/sogrady/2014/01/22/language-rankings-1-14/

1) JavaScript	6) C++	11) Perl	16) Matlab
2) Java	7) Ruby	12) Shell	17) Clojure
3) PHP	8) C	12) Scala	18) CoffeScript
4) C#	9) Objective C	14) Haskell	19) Visual Basic
5) Python	10) CSS	15) R	20) Groovy

Visit http://langpop.com/

Any ranking is influenced by:

- Communities of the development
- Investments from third parties and ubiquitousness of projects
- Statistics

The top 20

source: http://redmonk.com/sogrady/2014/01/22/language-rankings-1-14/

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This course is not about advocating the use of this or that language...

I first learnt how to program with algorithms, than I learnt PASCAL
I work with C++, SQL and I can do a few things in PHP
I believe I can learn other languages if I have to… ☺

I am not a radical champion for C++ or any other language...
I still believe in "*No Silver Bullet — Essence and Accidents of Software Engineering*"
This course will teach C++.

- Statistics

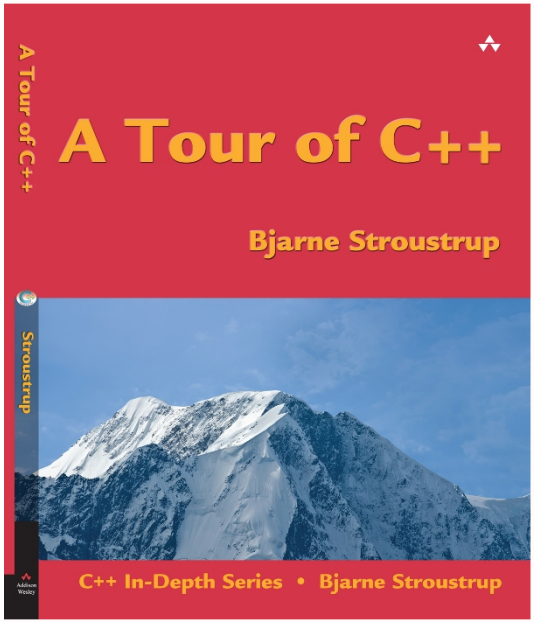
The C++ Language

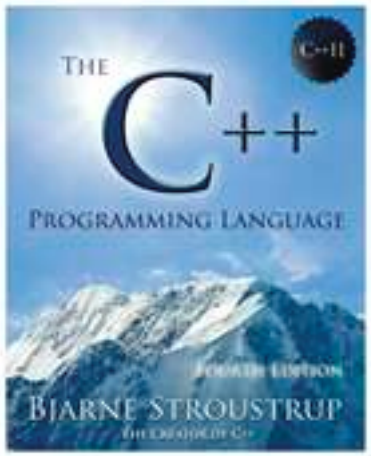
Bjarne Stroustrup

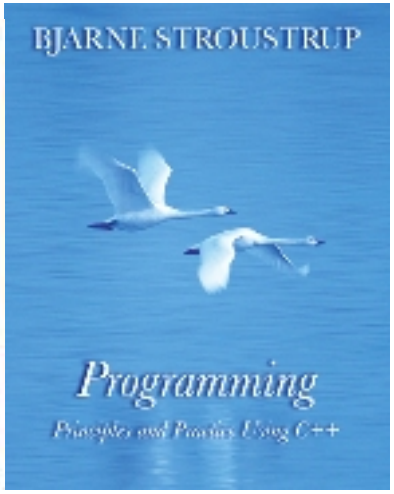
http://www.stroustrup.com/

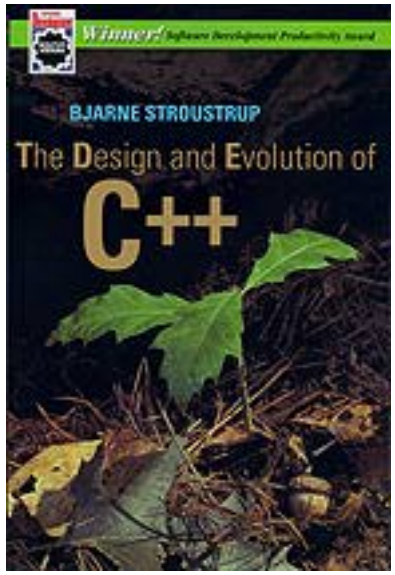
http://www.cplusplus.com/info/history/

Books


A Tour of C++
Bjarne Stroustrup
Stroustrup
C++ In-Depth Series • Bjarne Stroustrup


THE
C++
PROGRAMMING LANGUAGE
BJARNE STROUSTRUP


BJARNE STROUSTRUP
Programming


BJARNE STROUSTRUP
The Design and Evolution of
C++

The C++ Language

- ...is an open ISO-standardized language
  - For a time, C++ had no official standard and was maintained by a de-facto standard, however since 1998, C++ is standardized by a committee of the ISO.
- ...is a compiled language.
  - C++ compiles directly to a machine's native code, allowing it to be one of the fastest languages in the world, if optimized.
- ...is a strongly-typed unsafe language.
  - C++ is a language that expects the programmer to know what he or she is doing, but allows for incredible amounts of control as a result.

The C++ language

- ...supports both manifest and inferred typing.
  - As of the latest C++ standard, C++ supports both manifest and inferred typing, allowing flexibility and a means of avoiding verbosity where desired.
- ...supports both static and dynamic type checking.
  - C++ allows type conversions to be checked either at compile-time or at run-time, again offering another degree of flexibility. Most C++ type checking is, however, static.
- ...offers many paradigm choices.
  - C++ offers remarkable support for procedural, generic, and object-oriented programming paradigms, with many other paradigms being possible as well.

The C++ Language

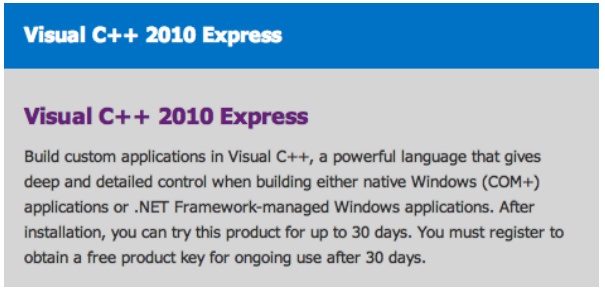
- ...is portable.
  - As one of the most frequently used languages in the world and as an open language, C++ has a wide range of compilers that run on many different platforms that support it. Code that exclusively uses C++'s standard library will run on many platforms with few to no changes.
- ...is upwards compatible with C
  - C++, being a language that directly builds off C, is compatible with almost all C code. C++ can use C libraries with few to no modifications of the libraries' code.
- ...has incredible library support.
  - A search for "library" on the popular project-management website SourceForge will yield over 3000 results for C++ libraries.

Programming environment

- Tools
  - Editor
  - Compiler: translate the source code to machine code to be executed
  - Interpreter: reads a little source code, translates it to machine code, and executes it, than reads a little more, etc.
  - Debugger: helps you step through code, shows you variables and flow of execution
- Interfaces / components / libraries
  - Linker: connects code from libraries with your code to make one executable
- Integrated Development Environments

IDEs for C++

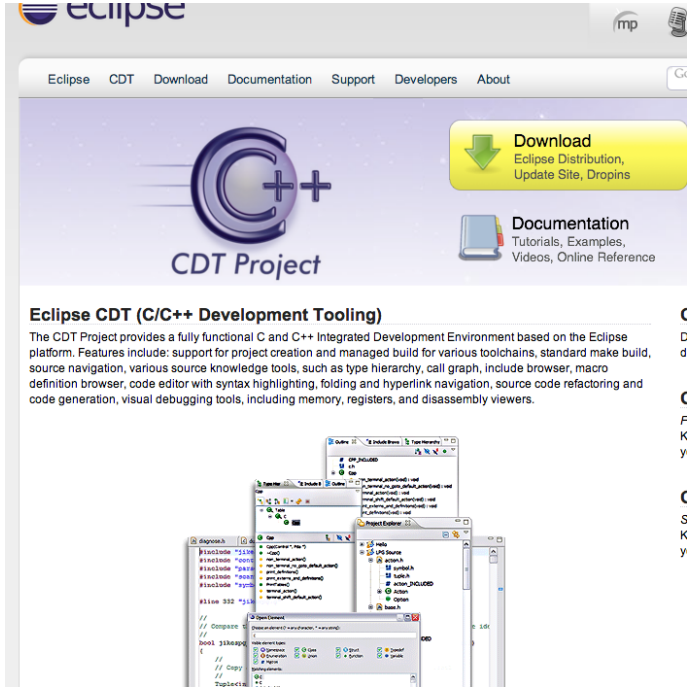
- Windows:
  - Microsoft Visual C++
  - http://www.visualstudio.com/



  - http://www.mingw.org/
  - HOWTO: http://www.mingw.org/wiki/HOWTO_Install_the_MinGW_GCC_Compiler_Suite

IDEs for C++

- Linux
  - Eclipse CDT
  - http://www.eclipse.org/cdt/



http://en.wikipedia.org/wiki/Comparison_of_integrated_development_environments#C.2FC.2B.2B

Administrative

- Classes: Wednesdays 08:15 to 10:00 at Auditório LabGeo. (We will not have classes on April 16th).
- Send me a message from your mail address that you read everyday lubia@dpi.inpe.br
- I will provide a wiki for the course (soon!).

- We will have programming assignments every week and one final exam. Final grade = 0.6 * assignments + 0.4 * exam

Hello World!

```
1 // my first program in C++
2 #include <iostream>
3
4 int main()
5 {
6   std::cout << "Hello World!";
7 }
```

```
Hello World!
```

Task 1: Prepare your programming environment and run Hello World!