University of Portsmouth
BSc (Hons) Computer Science
Second Year

Programming Applications and Programming Languages (PAAPL)

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Teaching Block I

Programming Applications

There are no notes for this Teaching Block. It was entirely practical with the coursework involving no written component.

Teaching Block II

Programming Languages

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Lecture - Introduction To Progrmaming Languages

2024-01-26 1400 Jaicheng

This lecture will introduce us to the many different ways in which a programming language can be categorised.

1.1 Programming Domains

A *Programming Domain* is one way to think about & categorise a programming language. We have different different programming domains for different applications as each application requires a specialised instruction set to improve efficiency for the programmer. Everything humans do can be solved by a computer, the number of programming domains reflects this.

1.1.1 Scientific Applications

Scientific Applications of a programming language would be to do mathematical operations on some data which would result in an output. This could be used in applications such as weather forecasting where data on the current weather is fed into it - and a simulation is used to simulate the future weather conditions. Scientific applications will complete a large number of floating-point computations and use arrays. An example of a language in this domain is *Fortran* (FORmula TRANslating system, created by IBM).

1.1.2 Business Applications

Business Applications are designed to be used by businesses to complete business functions. For example, batch printing payslips. They use decimal numbers and characters. An example of a language in this domain is COBOL (COmmon Business-Oriented Language).

1.1.3 Artificial Intelligence

In the *Artificial Intelligence* domain, symbols are manipulated, rather than numbers and linked lists are used. Nowadays, this domain is now more talking about reasoning, facts and truth verification. An example of a language in this domain is LISP (LISt Processing).

1.1.4 Systems Programming

Systems Programming is concerned with the control of the hardware of the computer, the management of the storage, the display control and management of other components such as peripherals. The languages used, such as C, need to be specifically designed for this domain due to the required low level interactions between the program and the hardware.

1.1.5 Web Software

Web Software is arguably one of the most popular domains in these modern times. Much of the modern software is developed as a website, for easy use across multiple devices. The languages used are eclectic and each serve a particular purpose; for example, HTML for markup, PHP for scripting and JavaScript for adding interactivity.

1.2 Language Categories

1.2.1 Machine Languages

The *Machine Language* family of languages are hardware implemented languages; which means the instruction set available within them is the instruction set available on the CPU. This means the instruction set is limited in size and will be represented as binary (or hexadecimal) numbers.

1.2.2 Assembly Languages

The *Assembly Languages* family of languages are a simplification of Machine Languages. In essence, they are the machine language with a 'human-friendly' outside layer, meaning that they are legible to most people. To be executed, they require translating to machine code (which involves the use of a translator or interpreter). They come with labelled storage locations, jump targets and subroutine starting addresses in addition to the basic Machine Language instructions.

1.2.3 High Level Language

The *High Level Language* family is another step up from Assembly Languages. Their syntax is very close to natural language syntax, making it much more legible and easier for programmers to read, write, understand and memorise. They usually will come with variables, types, subroutines, functions, the ability to handle complex expressions, control structures, and composite types. Examples include: C and Java.

1.2.4 Systems Programming Language

The *Systems Programming Language* are effectively high level languages who also deal with the low level operations. For example C, C++, and Ada. They process the memory & process management, I/O operations, device drivers, operating systems.

1.2.5 Scripting Languages

The *Scripting Languages* are a set of languages which exist to automate tasks, saving humans time. They will commonly be used to: analyse or transform a large amount of regular textual information; act as a glue between different applications; or bolt a front end onto an existing application. The languages used are often interpreted and will often include lots of string processing functions, such as in Python or PHP.

1.2.6 Domain Specific Languages

The *Domain Specific Languages* are highly specialised languages which are used in a specific area only. For example the Adobe PostScript language is used for creating vector graphics for electronic publishing.

1.3 Categories by Paradigm

There are three different categories.

1.3.1 Procedural

A program is built from one or more procedures (can also be called subroutines or functions) and the program will revolve around variables, assignment statements and iteration. Some languages will also support Object Oriented programming as well as some supporting scripting. Examples of languages include: C, Java, Perl, JavaScript, Python, Visual Basic, C++.

1.3.2 Functional

Functional languages work by applying a function to a given parameter. Languages include: Haskell,LISP, Scheme, F#, Java 8.

1.3.3 Logic

Logical rules are used to do reasoning over given facts which draws conclusions. The logical rules do not have to be defined in any particular order. Languages include: Prolog.

1.4 Categories by How Tasks are Specified

1.4.1 Imperative Languages

In imperative languages, you have to explicitly instruct the computer what it needs to do to reach the goal, computing tasks are defined as a sequence of commands which the computer performs. The program will state in step-by-step instructions what the computer needs to do. This means that the implementation of the algorithms, and therefore the efficiency of the algorithms is down to the developer. Procedural languages belong to this category.

1.4.2 Declarative Languages

In declarative languages, the computer gets told the desired results, without explicitly listing the the commands or steps which the program must undertake to reach its goal. Functional and logical programming languages belong to this category.

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Lecture - Overview and Evaluation of Programming Languages

2024-01-26 14:00 Jaicheng

2.1 The 'TPK' Algorithm

The TPK algorithm was designed by *Trabb, Pardo* and *Knuth* in the 1970s for illustration purposes. It is designed to:

1. read 11 numbers (entered by the user using their keyboard) into an array,
2. process the array in reverse order, applying a mathematical function to each value
3. then for each value - reporting the value or a message saying that the value is too large

The algorithm includes all the basic constructs which would be expected to exist in a modern language therefore making it useful to use when understanding how languages work. A pseudocode implementation of the TPK algorithm is below:

```
input 11 numbers into a sequence A
reverse sequence A
for each item in sequence A
    call a function to do an operation
    if result overflows
        alert user
    else
        print result
```

2.2 Fortran

Fortran (*For*mula *Trans*lation) is the first well-known high-level programming language. It was developed by a team at IBM led b John Backus with the goals: to lower the costs involved with programming and debugging; and to compete with "hand coded" assembly language programs in terms of execution speed. The first Fortran compiler, built for the IBM 704 mainframe, was completed in 1957.

Early source code had a strict, specific, format which was in part due to it being a punched-card program where the column and row position of the punch is important.

The TPK algorithm in Fortran is shown below:

```
C THE TPK ALGORITHM IN FORTRAN
  FUNF(T)=SQRTF(ABSF(T))+5.0*T**3
  DIMENSION A(11)
```

```
    1 FORMAT(11F12.4)
      READ 1, A
      DO 10 J=1,11
      I=11-J
      Y=FUNF(A(I+1))
      IF(400.0-Y) 4,8,8
    4 PRINT 5,I
    5 FORMAT(I10,10H TOO LARGE)
      GOTO 10
    8 PRINT 9,I,Y
    9 FORMAT(I10,F12.7)
    10 CONTINUE
      STOP
```

A letter `C` in the first column indicated that the card was a comment and as such it should be ignored by the compiler. Non-Compiler cards were divided into four fields:

1-5 is the label field; a sequence of digits here indiciates the purpoose of the card and therefore the instruction.

6 is a continuation field whereby a non-blank character here caused the card to be taken as a continuation of the statement on the previous card.

7-72 is the statement field

73-80 are ignored by the compiler. This means that they can be used for card identification purposes in the event that the cards were dropped.

The restrictions on the structure of the code were removed in Fortran 90, where it became a Free-Form language.

2.3 COBOL

COBOL (*CO*mmon *B*usiness *O*riented *L*anguage) was created at the end of the 1950s by the US Department of Defence. It was initially developed as a language for business data processing from which comes its verbose syntax that was designed with the ability for managers to be able to read it in mind. COBOL was never designed to be used as a scientific language and has many critics, where programmers felt that the verbosity of the language increased program length, not readability.

2.4 Algol

Algo (*ALGO*righmic *L*anguage) was originally designed to overcome the problems with FORTRAN in the late 1950s. Arguably, it is one f the most successful high level programming languages of the time because it was influential over the design of subsequent high level languages.

Algol 60 introduced the use of formal notation for syntax, block structure (with locally defined variables, whoop whoop), supported recursive procedures (until this point, you could do it however the languages didn't like it) and readable if and for statements. Ultimately, Algol died out with the rise in FORTRAN's popularity. The TPK algorithm in Algol is shown below.

```
begin
  comment TPK algorithm in Algol 60;
  integer i; real y; real array a[0:10];
  real procedure f(t); real t; value t;
    f := sqrt(abs(t))+5*t^3;
```

```
  for i := 0 step 1 until 10 do
    read(a[i]);
  for i := 10 step -1 until 0 do begin
    y := f(a[i]);
    if y > 400 then
      write(i, "TOO LARGE")
    else
      write(i, y);
  end
end
```

2.5 Pascal

Pascal is a direct descendant of Algol, which was intended to be more efficient in order to compete with FORTRAN as a general purpose language. An early Pascal compiler was designed to be portable, compiling the source code to a virtual machine (*P-Code*). Pascal was popularised in the late 1970s as a good teaching language as it enforced a "good" programming style, it was especially popular amongst Universities. Pascal is still in development, with more recent versions adding modules and classes (for example, the Object Pascal Language, which is sometimes known as Delphi). The TPK algorithm in Pascal is shown below:

```
program example(input, output); (* TPK alg in Pascal *)
var i : integer; y : real; a : array [0..10] of real;
function f(t : real) : real;
begin
  f := sqrt(abs(t)) + 5*t*t*t
end;
begin
  for i := 0 to 10 do read(a[i]);
    for i := 10 downto 0 do
      begin
        y := f(a[i]);
        if y > 400 then
          writeln(i,' TOO LARGE')
        else
          writeln(i, y)
      end
end.
```