

Structured programming. A tutorial guide

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Abstract: Structured programming is presented as a specific discipline of software engineering. The history of this discipline up to the mid-1970s is summarised and three subsequent approaches to its theory and practice are described. The emphasis is on providing a working familiarity with the underlying concepts and how they are formalised.

1 Introduction

1.1 Background

Structured programming is now almost 20 years old. When it was first emerging, Rascal was brand new, the cheapest ever IBM computer, offering 8K 16-bit words of core storage, cost over £12 000; R.K. Richards [53] wrote 'the fourth generation, whatever that will be, is not yet in sight'. Despite this relative novelty and the fact that hundreds of articles have been published on its theory and practice, there is still little agreement in the profession as to what structured programming actually means [56]. Practising programmers or systems analysts who claim familiarity with it may in fact be using one of a variety of methodologies, such as structured analysis [85], structured design [94] or top-down functional design; or they may regard all such approaches as expensive and pedantic computer science, adding to some of them [10].

In this tutorial paper we will present structured programming as a quite specific discipline and as a basis for developing a versatile engineering theory. By summarising the history of the subject and some modern approaches to it, we hope to provide readers with the means and motivation to adopt such a theory as one of the tools of their trade.

In the remainder of this introduction we describe the fundamental engineering principles underlying structured programming, explain how they are reflected in the study of program control structures and discuss their importance in modern software production and computer science.

1.2 What is structured programming?

A fundamental approach to engineering systems development is top-down design (or iterative refinement or programming tower [105]). A system is first viewed as a black box which performs some function linking a single input stream with a single output stream. To design the

system, we specify a decomposition of the box into a variety of simpler functions combining to produce the original function. Each of these simpler functions itself is one input, one-output black box to be designed in the same way. The design process is thus recursive or hierarchical in nature and may be represented as a tree (see Fig. 1). Every node in the tree is a black box, and every node has a group of adjacent 'successors' below it in the tree, unless it is on the bottom level. The tree is complete when all the nodes on the bottom level represent 'functional primitives' in that they are available off the shelf or, in our case, in the computer. These are functions that do not need to be designed.

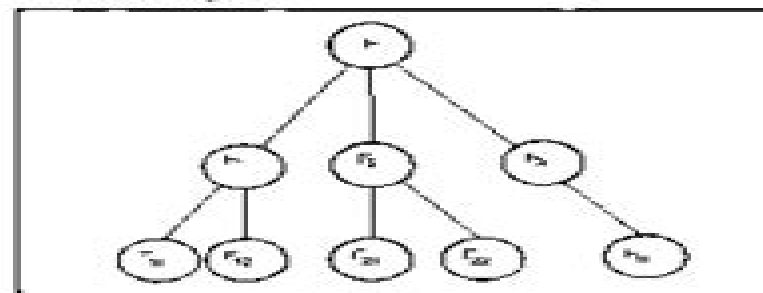


Fig. 1 Top-down functional design hierarchy

The functional hierarchy tree just described is not a complete design of the system — there is as yet no information about how the successors of any node (i.e. the functions within any black box) are to be combined in order that they collectively perform the function of that node. How this combination is made depends on the type of engineering involved. In sequential programming it is generally accomplished by specifying a conditional flow of execution of the functions. We refer to this as a 'control structure'.

Furthermore, any control structure at one level of the hierarchy has to replace some node in a control structure on the next level up (because, in the final implementation, only primitive functions and the control structures control

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