

P''

P'' (P double prime^[1]) is a primitive computer programming language created by Corrado Böhm^{[2][3]} in 1964 to describe a family of Turing machines.

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P''	
Paradigm	Imperative, structured
Designed by	Corrado Böhm
First appeared	1964
Typing discipline	untyped
Dialects	
Brainfuck	
Influenced	
Brainfuck	

Definition

P'' (hereinafter written **P''**) is formally defined as a set of words on the four-instruction alphabet $\{R, \lambda, (,)\}$, as follows:

Syntax

1. *R* and *λ* are words in P''.
2. If *q*₁ and *q*₂ are words in P'', then *q*₁*q*₂ is a word in P''.
3. If *q* is a word in P'', then (*q*) is a word in P''.
4. Only words derivable from the previous three rules are words in P''.

Semantics

- $\{\square, c_1, c_2, \dots, c_n\}$ is the tape-alphabet of a Turing machine with left-infinite tape, \square being the *blank* symbol, equivalent to *c*₀.
- All instructions in P'' are permutations of the set *X* of all possible tape configurations; that is, all possible configurations of both the contents of the tape and the position of the tape-head.
- *α* is a predicate saying that the current symbol is not \square . It is not an instruction and is not used in programs, but is instead used to help define the language.
- *R* means move the tape-head rightward one cell (if possible).
- *λ* means replace the current symbol *c*_{*i*} with *c*_{(*i*+1) mod (*n*+1)}, and then move the tape-head leftward one cell.
- *q*₁*q*₂ means the function composition *q*₂ ∘ *q*₁. In other words, the instruction *q*₁ is performed before *q*₂.

- (q) means iterate q in a while loop, with the condition α .

Relation to other programming languages

- P'' was the first "GOTO-less" imperative structured programming language to be proven Turing-complete^{[2][3]}
- The Brainfuck language (apart from its I/O commands) is a minor informal variation of P''. Böhm gives explicit P'' programs for each of a set of basic functions sufficient to compute any computable function, using only (,) and the four words r, r', L, R where $r \equiv \lambda R, r' \equiv r^n$ with r^n denoting the n th iterate of r , and $L \equiv r' \lambda$. These are the equivalents of the six respective Brainfuck commands [,] , + , - , < , > . Note that since $c_{n+1} \equiv c_0 \equiv \square$, incrementing the current symbol n times will wrap around so that the result is to "decrement" the symbol in the current cell by one (r').

Example program

Böhm^[2] gives the following program to compute the predecessor ($x-1$) of an integer $x > 0$:

$$R(R)L(r'(L(L))r'L)Rr$$

which translates directly to the equivalent Brainfuck program:

```
>[>]<[-[<[<]]-<]>+
```

The program expects an integer to be represented in bijective base- k notation, with c_1, c_2, \dots, c_k encoding the digits $1, 2, \dots, k$ respectively, and to have \square before and after the digit-string. (E.g., in bijective base-2, the number eight would be encoded as $\square c_1 c_1 c_2 \square$, because 8 in bijective base-2 is 112.) At the beginning and end of the computation, the tape-head is on the \square preceding the digit-string.

References

1. <https://github.com/Pbtflakes/pdbl>
2. Böhm, C.: "On a family of Turing machines and the related programming language", ICC Bull. 3, 185-194, July 1964.
3. Böhm, C. and Jacopini, G.: "Flow diagrams, Turing machines and languages with only two formation rules", CACM 9(5), 1966. (Note: This is the most-cited paper on the structured program theorem.)

Weblinks

- *P''Online interpreter* (http://www.mathiaselsner.de/esolangs/EN/P_dblp_99btls.html): Demonstrating the iterative 99 Bottles of Beer song construed in 337568 P'' instructions.

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