

# Programming 2023

## Minimal BASIC Interpreter

### DDL: Week13, Monday, 18:30

## Introduction

In this assignment, your mission is to build a minimal BASIC interpreter. You may start with the code TA provided.

## BASIC Language and Interpreter

The programming language BASIC - the name is an acronym for Beginner's All-purpose Symbolic Instruction Code - was developed in the mid-1960s at Dartmouth College by John Kemeny and Thomas Kurtz.

## A Plus B

In BASIC, a program consists of a sequence of numbered statements, as illustrated by the simple program below:

```
Line number      A comment line
10 REM Program to add two numbers
20 INPUT n1
30 INPUT n2      Request value from user
40 LET total = n1 + n2
50 PRINT total   Assignment Statement
60 END          Display value on console
               \ End of execution
```

The diagram shows a BASIC program with line numbers 10 through 60. Annotations with arrows point to specific parts: 'Line number' points to the line numbers; 'A comment line' points to the REM statement; 'Request value from user' points to the INPUT statements; 'Assignment Statement' points to the LET statement; 'Display value on console' points to the PRINT statement; and 'End of execution' points to the END statement.

## Lexical

Identifiers are formed by one or more letters. Keywords that are reserved words in the language and cannot be used as identifiers. Integer literals are composed of digits only. **In this lab, the language is case-sensitive**, which means *i* and *I* are different variables, and *IF*, *if*, *If*, and even *iF* have different

meanings.

## Line Numbers

The **line numbers at the beginning of the line** establish the sequence of operations in a program. In the absence of any control statements to the contrary, the statements in a program are **executed in ascending numerical order starting at the lowest number**.

Line numbers are also used to provide a simple editing mechanism. **Statements need not be entered in order**, because the line numbers indicate their relative position. Moreover, as long as the user has left gaps in the number sequence, new statements can be added in between other statements. For example, to change the program that adds two numbers into one that adds three numbers, you would need to make the following changes:

```
35 INPUT n3
40 LET total = n1 + n2 + n3
```

The standard mechanism for deleting lines was to **type in a line number with nothing after it** on the line. Note that this operation actually **deleted the line** and did not simply replace it with a blank line that would appear in program listings.

## Sequential Statements

<b>REM</b>	This statement is used for comments.
<b>LET</b> <i>var</i> = <i>exp</i>	This statement is BASIC's assignment statement.
<b>PRINT</b> <i>exp</i>	This statement print the value of the expression on the console and then <b>print a newline character</b> .
<b>INPUT</b> <i>var</i>	This statement print <b>a prompt consisting of the string " ? "</b> and then to read in a value to be stored in the variable.
<b>END</b>	Marks the end of the program. Execution halts when this line is reached. Execution <b>also stops if the program continues past the last numbered line</b> .

## Control Statements

For example, the following BASIC program simulates a countdown from 10 to 0:

```

10 REM Program to simulate a countdown
20 LET T = 10
30 IF T < 0 THEN 70
40 PRINT T
50 LET T = T - 1
60 GOTO 30
70 END

```

Jumps to line 70 if the result of comparison is true

Jumps to line 30 unconditionally

<b>GOTO n</b>	This statement transfers control unconditionally to line n in the program. If line n <b>does not exist</b> , your BASIC interpreter should <b>generate an error message</b> informing the user of that fact.
<b>IF exp cmp exp THEN n</b>	This statement performs a conditional transfer of control. On encountering such a statement, the BASIC interpreter begins by evaluating condition, which in the minimal version of BASIC consists of two arithmetic expressions joined by one of the operators <, >, or =. Notice that <b>we use the same = symbol as in the assignment statement</b> . If the result of the comparison is true, control passes to line n, <b>just as in the GOTO statement</b> ; if not, the program continues with the next line in sequence.

## Expressions

Expressions are used in LET, PRINT, and IF statements.

<i>int_const</i>	The simplest expressions are variables and integer constants.
<i>var</i>	
<i>( exp )</i>	These may be combined into larger expressions by enclosing an expression in parentheses or by joining two expressions with the operators +, -, *, and /, just as in the interpreter presented in the reader.
<i>exp op exp</i>	

## Executed Directly

The LET, PRINT, and INPUT statements can be executed directly by typing them without a line number, in which case they are evaluated immediately. Thus, if you type in "PRINT 2 + 2" your program should respond immediately with 4.

The statements GOTO, IF, REM, and END are legal only if they appear as part of a program, which means that they must be given a line number.

## BASIC Interpreter

These commands control the BASIC interpreter, which don't contained in BASIC program.

<b>RUN</b>	This command starts program execution <b>beginning at the lowest-numbered line</b>
<b>LIST</b>	This command lists the steps in the program <b>in numerical sequence</b> .

<b>CLEAR</b>	This command deletes all program and variables.
<b>QUIT</b>	This command exits from the BASIC interpreter by calling exit(0).
<b>HELP</b>	This command provides a simple help message describing your interpreter.

## Error Reporting

DIVIDE BY ZERO	Calculating some number divide by zero.
INVALID NUMBER	User types wrong value to answer INPUT statement.
VARIABLE NOT DEFINED	A variable used before assigned it.
LINE NUMBER ERROR	GOTO or IF statement's line number not exist.
SYNTAX ERROR	Any other errors.