```
\ ( ( (  (?>[^()]+) | (?R) )* ) \)
       ↑                       ↑
```

the string they capture is "ab(cd)ef", the contents of the top level parentheses. If there are more than 15 capturing parentheses in a pattern, PCRE has to obtain extra memory to store data during a recursion, which it does by using pcre_malloc, freeing it via pcre_free afterward. If no memory can be obtained, the match fails with the PCRE_ERROR_NOMEMORY error.

Do not confuse the (?R) item with the condition (R), which tests for recursion. Consider this pattern, which matches text in angle brackets, allowing for arbitrary nesting. Only digits are allowed in nested brackets (that is, when recursing), whereas any characters are permitted at the outer level.

```
< (?: (?(R) \d++  | [^<>]*+) | (?R)) * >
```

In this pattern, (?(R) is the start of a conditional subpattern, with two different alternatives for the recursive and nonrecursive cases. The (?R) item is the actual recursive call.

Subpatterns as Subroutines

If the syntax for a recursive subpattern reference (either by number or by name) is used outside the parentheses to which it refers, it operates like a subroutine in a programming language. An earlier example pointed out that the pattern

```
(sens|respons)e and \1ibility
```

matches "sense and sensibility" and "response and responsibility", but not "sense and responsibility". If instead the pattern

```
(sens|respons)e and (?1)ibility
```

is used, it does match "sense and responsibility" as well as the other two strings. Such references must, however, follow the subpattern to which they refer.

Regular Expressions References

The regular expression syntax supported by **Grep**, **GrepString**, **GrepList**, and **Demo** is based on the *PCRE — Perl-Compatible Regular Expression Library* by Philip Hazel, University of Cambridge, Cambridge, England. The PCRE library is a set of functions that implement regular expression pattern matching using the same syntax and semantics as Perl 5.

Visit <http://pcre.org/> for more information about the PCRE library. The description of regular expressions above is taken from the PCRE documentation.

A good introductory book on regular expressions is: Forta, Ben, *Regular Expressions in 10 Minutes*, Sams Publishing, 2004.

A good comprehensive book on regular expressions is: Friedl, Jeffrey E. F., *Mastering Regular Expressions*, 2nd ed., 492 pp., O'Reilly Media, 2002.

A good web site is: http://www.regular-expressions.info

Working with Files

Here are the built-in operations that you can use to read from or write to files:

Operation	What It Does
Open	Opens an existing file for reading or writing. Can also create a new file. Can also append to an existing file. Returns a file reference number that you must pass to the other file operations.
	Use Open/D to present a dialog that allows the user to choose a file without actually opening the file.
fprintf	Writes formatted text to an open file.