

ProgA

System Dependencies

Components of computer systems often have dependencies--other components that must be installed before they will function properly. These dependencies are frequently shared by multiple components. For example, both the TELNET client program and the FTP client program require that the TCP/IP networking software be installed before they can operate. If you install TCP/IP and the TELNET client program, and later decide to add the FTP client program, you do not need to reinstall TCP/IP.

For some components it would not be a problem if the components on which they depended were reinstalled; it would just waste some resources. But for others, like TCP/IP, some component configuration may be destroyed if the component was reinstalled.

It is useful to be able to remove components that are no longer needed. When this is done, components that only support the removed component may also be removed, freeing up disk space, memory, and other resources. But a supporting component, not explicitly installed, may be removed only if all components which depend on it are also removed. For example, removing the FTP client program and TCP/IP would mean the TELNET client program, which was not removed, would no longer operate. Likewise, removing TCP/IP by itself would cause the failure of both the TELNET and the FTP client programs. Also if we installed TCP/IP to support our own development, then installed the TELNET client (which depends on TCP/IP) and then still later removed the TELNET client, we would not want TCP/IP to be removed.

Dependence is transitive, e.g. if A depends on B, and B depends on C, both B and C are implicitly installed when A is explicitly installed and, conversely, B and C would both be removed if A is subsequently removed.

We want a program to automate the process of adding and removing components. To do this we will maintain a record of installed components and component dependencies. A component can be installed explicitly in response to a command (unless it has already been explicitly installed), or implicitly if it is needed by some other component being installed. A component can be explicitly removed in response to a command (if it is not needed to support other components) or implicitly removed if it is no longer needed to support another component (and has not been explicitly installed).

1. Input

The input will contain a sequence of commands (as described below), each on a separate line containing no more than eighty characters. Item names are case sensitive, and each is no longer than ten characters. The command names (**DEPEND**, **INSTALL**, **REMOVE** and **LIST**) always appear in uppercase starting in column one, and item names are separated from the command name and each other by one or more spaces. All appropriate **DEPEND** commands will appear before the occurrence of any **INSTALL** dependencies. The end of the input is marked by a line containing only the word **END**.

<i>Command Syntax</i>	<i>Interpretation/Response</i>
DEPEND [item1 item2 ...] item_n	item_n depends on item1 (and item2 ...)
INSTALL item1	install item1 and those on which it depends
REMOVE item1	remove item1, and those on which it depends, if possible
LIST	list the names of all currently-installed components

2. Output

Echo each line of input. Follow each echoed **INSTALL** or **REMOVE** line with the actions taken in response, making certain that the actions are given in the proper order. Also identify exceptional conditions (see *Expected Output*, below, for examples of all cases). For the **LIST** command, display the names of the currently installed components. No output, except the echo, is produced for a **DEPEND** command or the line containing **END**. There will be at most one dependency list per item.

3. Sample Input

```
DEPEND TCPIP NETCARD TELNET
DEPEND NETCARD TCPIP
DEPEND TCPIP NETCARD DNS
DEPEND TCPIP HTML BROWSER
INSTALL NETCARD
INSTALL TELNET
INSTALL foo
REMOVE NETCARD
INSTALL BROWSER
INSTALL DNS
LIST
REMOVE TELNET
REMOVE NETCARD
REMOVE DNS
REMOVE NETCARD
INSTALL NETCARD
REMOVE TCPIP
```

```
REMOVE BROWSER
REMOVE TCPIP
LIST
END
```

4. **Output for the Sample Output**

```
DEPEND TCPIP NETCARD TELNET
DEPEND NETCARD TCPIP
DEPEND TCPIP NETCARD DNS
DEPEND TCPIP HTML BROWSER
INSTALL NETCARD
    Installing NETCARD
INSTALL TELNET
    Installing TCPIP
    Installing TELNET
INSTALL foo
    Installing foo
REMOVE NETCARD
    NETCARD is still needed.
INSTALL BROWSER
    Installing HTML
    Installing BROWSER
INSTALL DNS
    Installing DNS
LIST
    HTML
    BROWSER
    DNS
    NETCARD
    foo
    TCPIP
    TELNET
REMOVE TELNET
    Removing TELNET
REMOVE NETCARD
    NETCARD is still needed.
REMOVE DNS
    Removing DNS
REMOVE NETCARD
    NETCARD is still needed.
INSTALL NETCARD
    NETCARD is already installed.
REMOVE TCPIP
    TCPIP is still needed.
REMOVE BROWSER
    Removing BROWSER
    Removing HTML
    Removing TCPIP
REMOVE TCPIP
    TCPIP is not installed.
LIST
    NETCARD
```

foo
END
