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The Index contains a list of all Help topics available for ColorCodes. For information on how to use Help, press F1 or choose Using Help from the Help menu.

**Game Menu**

The Game menu allows you to start a game of ColorCodes or to quit from the program.

CodeMaker     Allows you make a code which the program tries to guess.
CodeBreaker  Allows you to try to guess a code the program has made.
Exit               Allows you to quit from the program.

CodeMaker and CodeBreaker both cause the ColorCode Palette dialog box to be displayed. The ColorCode Palette dialog box is used for building a code during a CodeMaker session, and for building guesses during a CodeBreaker session.

**Options Menu**

The Options menu allows you to set the level of difficulty for the game.

Pegs 4
Pegs 5

Either four or five colored squares are used for the secret code in the game.   The selected choice is checked in the menu.

---------------------------------------------
Colors 6
Colors 8
Colors 10

Six, eight, or ten colors can be used for building a secret code in the game.   The selected choice is checked in the menu.

---------------------------------------------
Duplicates Ok
No Duplicates

Duplicate colors may be allowed or not allowed in the secret code.   The selected choice is checked in the menu.

If duplicate colors are not allowed in the secret code, duplicate colors may still be used in guesses made trying to discover the secret code.

**Help Menu**

The Help menu gives you access to information about ColorCodes.

About ColorCodes    Shows the About... dialog box, giving the program version and information about the program author.

ColorCodes Help    Brings you into this help system for the ColorCodes game.

**Code**

The Code box in the ColorCode Palette allows you to build a code or a guess.   Use the radio buttons under each colored square to select that square for editing.   The selected square's color can be changed by selecting a color from the Colors box.

Either four or five colored squares are available for editing depending on the Pegs 4 or Pegs 5 selection from the main menu.

**Colors**

The Colors box in the ColorCode Palette allows you to change the color of the selected square in the Code box.   Use the radio buttons under each colored square in the Colors box to select a color.   When you select a color from the Colors box the selected colored square in the Code box is changed to that color.

Six, eight, or ten colored squares are available depending on the Colors 6, Colors 8, or Colors 10 selection from the main menu.

**Ok**

The Ok button in the ColorCode Palette provides several functions depending on the state of the game.

Under CodeMaker, the Ok button tells the program to use the colored squares in the Code box as the secret code and to begin trying to guess the code.   After the program has correctly guessed the code, both the Ok button and the Cancel button close the ColorCode Palette dialog box and return control to the main program window for another round of play.

Under CodeBreaker, the Ok button tells the program to use the colored squares in the Code box as your next guess.    After you have correctly guessed the code, both the Ok button and the Cancel button initiate the Challenge dialog box.

**Cancel**

The Cancel button in the ColorCode Palette provides several functions depending on the state of the game.

Under CodeMaker, before the Ok button has been pressed, the Cancel button tells the program to abandon the round of CodeMaker and return control to the main program window.    After the program has correctly guessed the code, both the Ok button and the Cancel button close the ColorCode Palette dialog box and return control to the main program window for another round of play.

Under CodeBreaker,   the Cancel button tells the program to abandon the round of CodeBreaker and return control to the main program window.   When you do this the program automatically reveals the secret code as the next play on the game board.

**Challenge**

The Challenge dialog box is activated after you have successfully identified the secret code during a round of CodeBreaker.   The program challenges you to see if it can discover the same secret code with fewer guesses.

You may select the Yes or No button in the Challenge dialog box.

A No choice on the Challenge dialog box closes it and returns control to the main program window for another round of play.

A Yes choice passes the current secret code to the program for the challenge, and closes the Challenge dialog box.   After the program has correctly guessed the secret code, the Challenge dialog box is redisplayed with your score and the program's score using the same secret code.   Clicking the Ok button on the Challenge dialog box closes it and returns control to the main program window for another round of play.

**General Rules of the Game**

The object of the game is to guess a secret code in the fewest possible trials. The code is a set of four or five colored squares. You must not only guess which colors are in the code, you must also guess the correct order of the colors in the code.   Each guess is given a score which gives some clue as to what the code may be.   Each score is a set of black and white squares with zero to four (or five) members.   The rules for scoring are as follows:

A black square appears in the score for every color in the guess which matches a color in the code and is in the same position in both the guess and code.

A white square appears in the score for every color in the guess which matches a color in the code but is not in the same position in both the guess and code.

If there is no match at all between the guess and code, no black or white squares appear in the score position.

A score of all black squares is a perfect score and ends a round of play.

NOTE:   The position of the white and black squares in the score DO NOT correspond to positions in either the code or the guess.

Examples of codes, guesses, and scores:

```
Code...: (White  Black  Green Red)
Guess..: (Yellow Blue   Pink  Brown)
Score..: No score
=>   No match.
```

```
Code...: (White Black Green Red)
Guess..: (White Black Green Red)
Score..: (Black Black Black Black)
=>   Perfect match.
```

```
Code...: (White Black Green Red)
Guess..: (White Brown Green Black)
Score..: (White Black Black)
```
 =>   The White and Green in the guess match the White and Green in the code, and are in the correct positions. So, two Black's appear in the score. The Black in the guess matches the Black in the code, but is not in the correct position. So, one White appears in the score.

**CodeMaker**

There are two basic play modes in ColorCodes:

CodeMaker     You make a code which the program tries to guess.
CodeBreaker   The program makes a code which you try to guess.

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**CC.INI File Contents**

The CC.INI file is an ASCII text file that the program uses to initialize a number of program parameters.   The CC.INI file contains a debug flag and sets of standard openings for each type of game.   The .INI file format is as follows:

Comments
Lines in the file beginning with a semicolon (ie "**;**") are comments and are not used by the program.   Blank lines should not be used in the file.   If a blank line is needed for clarity, a single semicolon must be placed at the beginning of the line.

Debug
The keyword "Debug" can be used.   Its presence in the .INI file is optional.   If it is used, it must be followed by either a 0 (zero) or a 1 (one).   If a 1 is used, information on the program memory usage is displayed in the main program window.   The number of bytes and cons units used by the program are displayed.   The bytes are the number of bytes of dynamically allocated memory used.   If this number is ever greater than 10K, you're in trouble.   Although this should never happen, if it does happen, quit the program as soon as possible.   The cons units are the number of linked list nodes used by the program.   This number should always be less than 1000.   Although it should never happen, if this number exceeds 1000, quit the program as soon as possible.

If the key word Debug is followed by a 0 (zero), the memory usage is not displayed.

If the key word Debug is not included in the .INI file, the memory usage is not displayed.

Standard Opening Plays
The remainder of the .INI file includes standard opening plays for each level of the game. Each game level is associated with a keyword.   After the key word, one opening play is given for that level.   The opening play is given by a list of integers which are associated with the colors used in the game.   The opening play must have the correct number of integers for the game level indicated by the keyword.   Each game level must have at least one opening play, and may have any number of opening plays, up to the maximum number of plays allowed on the game board (ie 15).   The program uses the opening plays in the same order in which they appear in the .INI file.

The keywords for the opening plays are as follows:

| Keyword | Description |
|---|---|
| OpenNoDups46 | Four colors in code, six colors total,  no duplicates allowed. |
| OpenNoDups48 | Four colors in code, eight colors total,      no duplicates allowed. |
| OpenNoDups40 | Four colors in code,                   ten colors total,      no duplicates allowed. |
| OpenDupsOk46 | Four colors in code, six colors total,  duplicates allowed. |
| OpenDupsOk48 | Four colors in code,                   eight colors total,     duplicates allowed. |
| OpenDupsOk40 | Four colors in code, ten colors total,          duplicates allowed. |
| OpenNoDups56 | Five colors in code, six colors total,  no duplicates allowed. |
| OpenNoDups58 | Five colors in code, eight colors total,       no duplicates allowed. |
| OpenNoDups50 | Five colors in code, ten colors total, no duplicates allowed. |
| OpenDupsOk56 | Five colors in code, six colors total,  duplicates allowed. |
| OpenDupsOk58 | Five colors in code, eight colors total,       duplicates allowed. |
| OpenDupsOk50 | Five colors in code, ten colors total, duplicates allowed. |

An example of a set of opening plays for the 4/6/no-duplicate game is given below.

Line number   Text in .INI file
    1        ;
    2        OpenNoDups46   0 1 2 3
    3        OpenNoDups46   1 2 3 4
    4        ;

The first line is a comment and is ignored by the program.   The second line is the first opening play, comprised of the number list, 0 1 2 3.   The third line is the second opening play, comprised of the number list 1 2 3 4.   The fourth line is a comment and is ignored by the program.

**Customizing the CC.INI File**

The CC.INI file is an ASCII text file that the program uses to initialize a number of program parameters.   See the help section **The CC.INI File Contents**.   Because the file is an ASCII text file, it can be modified by any text editor.   If you use a word processor such as Microsoft Word, or WordPerfect, be sure to save the file in a TEXT ONLY format.   The ColorCodes program can only read a text .INI file.   The easiest way to modify the .INI file is by using the Windows Notepad program.

You may include any comments in the file by putting a semicolon at the beginning of the line, followed by whatever text you like.

You may change the value following the Debug keyword to 0 (zero) or 1 (one), or you may delete the line containing the Debug keyword from the file, or you may comment-out the line by putting a semicolon at the beginning of the line.

You may change the opening plays for the various game levels, and you may add or delete opening plays for each game level.   Each game level must have at least one opening play. One, two, or three opening plays are reasonably adequate for good program performance (ie the number of plays required by the program to discover the secret code).   More than this does not help, and can in fact, cause poorer program performance.

**Builing and Using Alternate .INI Files for ColorCodes**

The CC.INI file is an ASCII text file that the program uses to initialize a number of program parameters.   See the help sections **The CC.INI File Contents** and **Customizing the CC.INI File**.

When the program starts it uses the CC.INI file by default.   This file must be located in the same directory as the CC.EXE file.   The program can also use an alternate .INI file by specifying the alternate file as a command line argument.   You can do this from Windows by choosing the File Run... option from the Program Manager or File Manager main menu.   A dialog box is displayed allowing you to type in the appropriate command line.

For example, suppose that you have built an alternate .INI file called MYCC.INI.   You may use it by typing the following into the File Run... dialog box:

CC.EXE     MYCC.INI

**Articles About MasterMind™**

A popular analog version of the ColorCodes game is MasterMind™.  The name MasterMind™ is a trademark of Invicta Plastics.  The MasterMind™ game is now (1992) distributed in the USA by Parker Toys under an agreement with Invicta Plastics.  The game of MasterMind™ and ColorCodes is based on an old British children's game called Bulls and Cows.  Bulls and Cows is essentially the same game as code-length-4/number-of-colors-6/no-duplicates-allowed game of MasterMind™.  It (B&C's) is traditionally played with pencil and paper using numbers instead of colors.  A secret code is a set of four numbers such as (1 2 3 4), with allowable numbers in the set (1 2 3 4 5 6).  A score is given as a set of two numbers, such as (1 2), or (0 3), or (4 0).  The first number in the score represents the Bulls, that is, the number of items in the guess which match items in the secret code and are in the correct position.  The second number in the score represents the Cows, that is, the number of items in the guess which match an item in the code, but are not in the correct position.  This terminology may seem a bit sexist today, but such is our 19th century heritage.

The game of MasterMind™ and/or Bulls and Cows has been studied by academics and hobbyists for many years.  A partial list of publications on the game is given below.  You are not likely to find any of the listed articles at your local mall bookstore, but most universities with reputable computer science departments will have at least some of the articles available in their libraries.  You very likely may find more which are not listed.

Knuth, D. E.:   The Computer as Master Mind.   Journal of Recreational Mathematics, Vol 9(1), 1976-1977

Irving, R. W.:   Towards an Optimum Mastermind Strategy,   Journal of Recreational Mathematics, Vol 11(2), 1978-1979

Neuwirth, E.:   Some Strategies for Mastermind.   Zeitschrift fur Operations Research, Band 26, 1982

Rao, T. M.:   An Algorithm to Play the Game of Mastermind,   SIGART Newsletter, No 82, Jan 1982

Gyllenskog, J.:   Writing a Computer Program to Play Mastermind that Appears to be Intelligent,   SIGART Newsletter, No 84, Apr 1983

Koppenstein, P.:   Mastering Master Mind Logically,   SIGART Newsletter, No 88, Apr 1984

Rada, R.:   Mastermind in SIGART,   SIGART Newsletter, No 89, Jul 1984

Powers, D.:   Playing Mastermind More Logically,   SIGART Newsletter, No 89, Jul 1984

Rao, T. M.:   Algorithms to Play Mastermind,   SIGART Newsletter, No 95, Jan 1986

Flood, M. M.:   Sequential Search Strategies with Mastermind Variants - Part 1,   Journal of Recreational Mathematics, Vol 20(2), 1988

Flood, M. M.:   Sequential Search Strategies with Mastermind Variants - Part 2,   Journal of Recreational Mathematics, Vol 20(3), 1988

Montgomery, G.:   Mastermind: Improving the Search, AI Expert, Vol 7(4), Apr 1992