

# A game of Bulls and Cows

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## 1 Overview of Bulls and Cows

### 1.1 History

Bulls and Cows is an old code-breaking paper and pencil game for two or more players, predating the commercially marketed board game Mastermind. The first computer program related to the game was written by Frank King at the University Of Cambridge as MOO, and was similarly implemented by J. M. Grochow at MIT. The user had to enter values of Bulls & Cows, and the program used a simple predictor algorithm developed by Dr. Larmouth to guess values. [1][2]

### 1.2 Gameplay

Each player thinks of a 4-digit secret number with no repeated digits. The other player then attempts to guess the number. For each guess the player is told the number of digits that match and are in the correct place (bulls) and also the number of digits that are in both numbers but in different positions (cows). For example: if the secret number is 1729, and the guess is 1092, the response would be 1 bull and 2 cows. [3]

## 2 Rules of the Game

The following rules have been adhered to while implementing the game.

- The secret code and the guess, both should be 4-digit numbers.
- The secret code cannot have repeated digits.
- The secret code should not start with zero.

## 3 Some techniques used to implement the game

### 3.1 Pruning

Pruning is defined as the process by which impossible outcomes of a decision tree are ruled out. In our program, we have used pruning to refine our set of possible codes. This is done as follows:

1. A guess is given out to the opponent.
2. Considering the guess (given out to the opponent) to be the secret and the numbers in the pruned set to be the guesses, the responses received are compared to the response given by the opponent. If these responses match, that number is retained in the pruned set or deleted otherwise.

This process helps in eliminating many possibilities and greatly reduces the number of guesses required before breaking opponent's secret code.[4]

## References

- [1] [https://en.wikipedia.org/wiki/Bulls\\_and\\_Cows](https://en.wikipedia.org/wiki/Bulls_and_Cows)
- [2] <http://vixra.org/pdf/1601.0302v1.pdf>
- [3] [http://slovesnov.users.sourceforge.net/bullscows/bulls\\_and\\_cows.pdf](http://slovesnov.users.sourceforge.net/bullscows/bulls_and_cows.pdf)
- [4] [https://en.wikipedia.org/wiki/Decision\\_tree\\_pruning](https://en.wikipedia.org/wiki/Decision_tree_pruning)