Computer Science Unplugged

Variants on The Intelligent Piece of Paper

Introduction

The Intelligent Piece of Paper (http://csunplugged.org/intelligent-paper) is an exciting unplugged activity that can be used as an introduction to the concept of an algorithm. The activity is extremely engaging because it approaches algorithms in terms of the "intelligence" they often *appear* to exhibit.

The Algorithm

The activity is centered around an algorithm that prescribes a player's moves during a game of noughts and crosses (tic-tac-toe). Pupils act on behalf of the "intelligent paper", following the instructions on the paper as they play against their classmates.

The original algorithm is not a perfect player. Although it never loses, it sometimes draws instead of winning (when the second player begins by writing an O in a side square). This observation can lead to an interesting extension to the activity.

In addition, the algorithm can only play first. The search for an algorithm for the second player could also lead to interesting variations on the activity.

Modifications and Extensions

In the three pages that follow, you can find:

1. A slightly *reformulated* version of the original Intelligent Piece of Paper.
2. An extension to the original algorithm that *always wins, when given the opportunity*.
3. An algorithm *for the second player*.

There are many ways that these algorithms can be used within the activity. We primarily suggest that pupils are asked to formulate these extensions themselves, using the versions provided here merely as *answer sheets*. This proves to be a very interesting exercise involving search trees, symmetry pruning, logic and generalization.

References

The Intelligent Piece of Paper Activitiy was originally created by Paul Curzon for Computer Science for Fun (CS4FN) and was subsequently included in CS Unplugged.

These extensions are provided by George Boukeas. The algorithm for the second player was formulated with Dimitris Kreatsoulas. This material is a translation from the corresponding Greek version.

I am a highly intelligent piece of paper.

Let's play Naughts and Crosses.
I am X and I go first...

Move 1

Write X in a corner.

Move 2

If the corner *opposite* to the first X is free,
    then write X in that corner.
Otherwise, write X in a free corner.

Move 3

If there are two X's and a space along the same line,
    then write X in that space. (Win)
Otherwise, if there are two O's and a space along the same line,
    then write X in that space. (Block)
In every other case, write X in a free corner.

Move 4

If there are two X's and a space along the same line,
    then write X in that space. (Win)
Otherwise, if there are two O's and a space along the same line,
    then write X in that space. (Block)
In every other case, write X in a free corner.

Move 5

Write X in the last free space.

I am a highly intelligent piece of paper.

Let's play Naughts and Crosses.
I am X and I go first...

Move 1

Write X in a corner.

Move 2

If there is an O in a side square,
    then write X in the center.
Otherwise, if the corner *opposite* to the first X is free,
    then write X in that corner.
In every other case, write X in a free corner.

Move 3

If there are two X's and a space along the same line,
    then write X in that space. (Win)
Otherwise, if there are two O's and a space along the same line,
    then write X in that space. (Block)
In every other case, write X in a free corner **not** alongside an O.

Move 4

If there are two X's and a space along the same line,
    then write X in that space. (Win)
Otherwise, if there are two O's and a space along the same line,
    then write X in that space. (Block)
In every other case, write X in a free corner.

Move 5

Write X in the last free space.

I am a highly intelligent piece of paper.

Let's play Naughts and Crosses.
I am O and I will let you go first...

Move 1

If the center is free then,
    write O in the center.
Otherwise, write O in any free corner.

Move 2

If there are two X's and a space along the same line,
    then write O in that space. (Block)
Otherwise, if both X's are in corners,
    then write O in a free side square.
In every other case, write O in a free corner, placing it alongside an X, if possible.

Move 3

If there are two O's and a space along the same line,
    then write O in that space. (Win)
Otherwise, if there are two X's and a space along the same line,
    then write O in that space. (Block)
In every other case, write O in any free space.

Move 4

If there are two O's and a space along the same line,
    then write O in that space. (Win)
Otherwise, if there are two X's and a space along the same line,
    then write O in that space. (Block)
In every other case, write O in any free space.