MIXED SIGNALS

THE CIRCUIT BOARD GAME

COMPONENTS

Your copy of the game should include the pieces listed below. Please make sure that you've received everything before continuing to the next section. If you're missing pieces, please contact the vendor that sold you this copy.

CIRCUIT TILES

These are the triangular tiles that will be used to construct a circuit board throughout the game. You should have received 64 of these, depicting different circuit parts.

BOOKLET

This is the booklet you're reading right now. Since you're reading it, we can safely assume that you've received it.

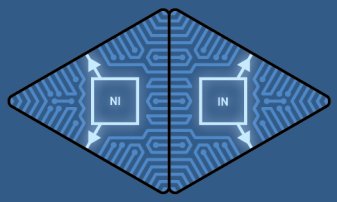
VOLTAGE TOKENS

These are the wooden tokens that will be used to keep track of the voltage output for each circuit tile. You should have received 24 of each color for a total of 48.

First and foremost, make sure both players are familiar with the different game pieces. Give new players a chance to look at the different circuit tiles as these have a central function in the game.

CIRCUIT TILES

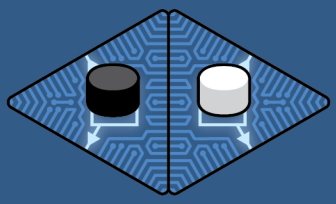
Start out by locating two input tiles with two output edges each and place them back to back as shown below. Place the remaining tiles face down in a pile and shuffle the pile thoroughly.



The game starts out by placing two input tiles with two output edges each like this.

VOLTAGE TOKENS

One player will be playing as low voltage (black) and the other one as high voltage (white). Place one black token at the center of one of the starting tiles and one white token at the center of the other one. Hand out all remaining tokens of each color to the corresponding player.



One token of each color is placed on the two starting tiles.

Real digital circuits are built from analog components and digital signals may carry either low or high voltages (below or above certain thresholds). Low and high voltages correspond to 0 and 1 in the binary domain and to false and true in the Boolean domain.

The game pieces are perfectly balanced and do not give either player an advantage. However, some of the logic in the game might be easier to reason about when playing as white and when thinking about black and white as false and true in the Boolean domain. It is therefore advised for inexperienced players to play as white.

CIRCUIT TILE PLACEMENT

The player playing as high voltage (white) starts the game by drawing a random tile from the pile of circuit tiles.

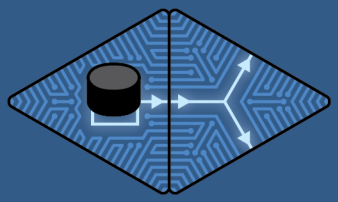
Each tile may have up to two input edges, indicated by arrows pointing inwards from the edges of the tile to its center.

Similarly, each tile may have up to two output edges. These are indicated by arrows pointing outwards from the center of the tile to its edges.

This tile has one input edge (left) and two output edges (top and bottom right).

The active player is only allowed to place their tile so that it shares at least one edge with a tile already placed on the board. In addition, tiles may only be placed so that all shared edges are compatible with each other.

Input edges may only be placed edge-to-edge with output edges and vice versa. It is not allowed to place input edges edge-to-edge with other input edges. The same thing applies for output edges.



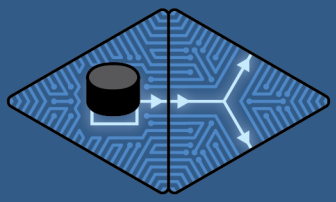
The rightmost tile may be placed like this because its input edge (left) is placed edge-to-edge with the output edge (right) of the leftmost tile.

Edges which are neither input, nor output, may only be placed edge-to-edge with other edges that are neither input nor output.

In the rare event that the tile cannot be properly placed anywhere on the board, the tile is discarded from the game and the active player gets to draw a new tile.

SIGNAL PROPAGATION

The input and output edges of a tile may carry a voltage that is known or unknown. The voltage of a single input edge of a tile is known when the output voltage of the tile across the edge is known. Known input edge voltages are not indicated on the tile itself.



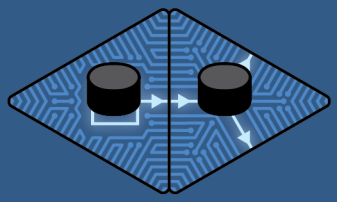
The output voltage of the leftmost tile is known (it has a black low voltage token). This implicitly makes the input edge (left) of the rightmost tile known.

The output voltage of a tile becomes known as soon as the voltages of all input edges are known. When there are multiple input edges, the output voltage is selected as decided by the tile.

Please refer to the circuit tile legend to learn more about how the voltages of multiple input edges are combined into a single output voltage.

SIGNAL PROPAGATION

When the output voltage of a tile becomes known, it is explicitly indicated by placing the corresponding token (black or white) at the center of the tile. Note that there can only be a single output voltage for each tile. Regardless of how many output edges it has.



The output voltage of the rightmost tile is known because the voltages of all of its input edges are known. A token is placed on the rightmost tile to keep track of the output voltage.

As you might have already guessed, signal propagation can cascade through the circuit. Output voltages become known causing voltages of input edges to become known causing output voltages to become known causing voltages of input edges to become known and so forth...

Figuring out how the signal propagates through the circuit is key to winning the game!

You will have to do this in your head though, as you are not allowed to change your mind and start removing voltage tokens from the board. As soon as you start the signal propagation step by placing a token, the tile may not be further moved. At least not as long as it's correctly placed on the board.

For tiles with multiple output edges, the active player gets to choose the order in which the signal propagates. The signal propagates through the entire first branch before it starts propagation down the second branch. The active player may not change their mind once a branch is selected and propagation is started.

If either player runs out of voltage tokens, they are instantly declared the winner of the game!

END OF TURN

When the active player has finished the signal propagation step, the other player begins their turn. This continues until there are no more tiles left to play.

END OF GAME

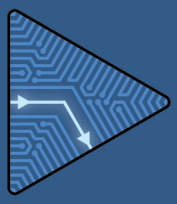
When there are no more circuit tiles left to play or either of the players run out of voltage tokens, the game ends.

If one of the players has run out of tokens, the player left without tokens is declared the winner of the game.

If both players still have tokens not placed on the board, both players count their remaining tokens and the player with the fewest tokens left wins the game! Well done!

CIRCUIT TILE LEGEND

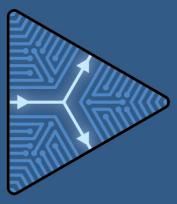
LANE



When the voltage of the input edge (left) becomes known, a token is placed at the center of the tile. The color placed is the same as the color across the input edge. The output voltage then propagates through the output edge of the tile (bottom right).

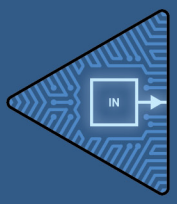
There is a mirrored version of this tile.

FAN-OUT LANE



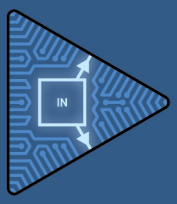
When the voltage of the input edge (left) becomes known, a token is placed at the center of the tile. The color placed is the same as the color across the input edge. The output voltage then propagates through both of the output edges of the tile (top and bottom right). The order is decided by the active player.

INPUT



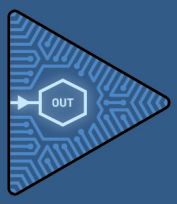
When the tile is placed, the active player places one of their voltage tokens at the center of the tile. The output voltage then propagates through the output edge of the tile (right).

FAN-OUT INPUT



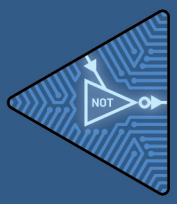
When the tile is placed, the active player places one of their voltage tokens at the center of the tile. The output voltage then propagates through both of the output edges of the tile (top and bottom right). The order is decided by the active player.

OUTPUT



When the voltage of the input edge (left) becomes known, a token is placed at the center of the tile. The color placed is the same as the color across the input edge. The output voltage does not propagate any further since the tile lacks output edges.

INVERTING BUFFER

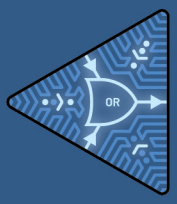


When the voltage of the input edge (top left) becomes known, a token is placed at the center of the tile. A white token is placed when the token across the input edge is black. Otherwise a black token is placed. The output voltage then propagates through the output edge of the tile (right).

There is a mirrored version of this tile.

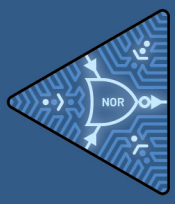
CIRCUIT TILE LEGEND

INCLUSIVE OR GATE



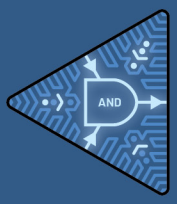
When the voltages of the two input edges (top and bottom left) become known, a token is placed at the center of the tile. A white token is placed when at least one of the input tokens are white. Otherwise a black token is placed (this is encoded on the tile). The output voltage then propagates through the output edge of the tile (right).

NEGATED INCLUSIVE OR GATE



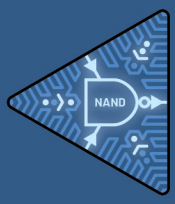
When the voltages of the two input edges (top and bottom left) become known, a token is placed at the center of the tile. A black token is placed when at least one of the input tokens are white. Otherwise a white token is placed (this is encoded on the tile). The output voltage then propagates through the output edge of the tile (right).

AND GATE



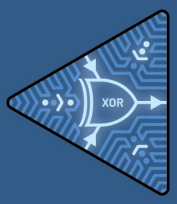
When the voltages of the two input edges (top and bottom left) become known, a token is placed at the center of the tile. A white token is placed when both of the input tokens are white. Otherwise a black token is placed (this is encoded on the tile). The output voltage then propagates through the output edge of the tile (right).

NEGATED AND GATE



When the voltages of the two input edges (top and bottom left) become known, a token is placed at the center of the tile. A black token is placed when both of the input tokens are white. Otherwise a white token is placed (this is encoded on the tile). The output voltage then propagates through the output edge of the tile (right).

EXCLUSIVE OR GATE



When the voltages of the two input edges (top and bottom left) become known, a token is placed at the center of the tile. A white token is placed when exactly one of the input tokens are white. Otherwise a black token is placed (this is encoded on the tile). The output voltage then propagates through the output edge of the tile (right).

NEGATED EXCLUSIVE OR GATE

When the voltages of the two input edges (top and bottom left) become known, a token is placed at the center of the tile. A black token is placed when exactly one of the input tokens are white. Otherwise a white token is placed (this is encoded on the tile). The output voltage then propagates through the output edge of the tile (right).

CREDITS

GAME DESIGNER

Joel Ek

GRAPHIC DESIGNER

Joel Ek

PLAY TESTERS

Lovisa Bergström

Dag Hansson

Martina Hansson

Lucas Correia

Elsa Stålner

Per Persson

Hanna Kulin