

Matchbox Brain

Ages 8-14 + parents · 1-4 players · about 25 minutes · no screens

OBJECTIVE

Play Hexapawn against a robot that starts out knowing nothing. It picks its moves by rolling a die. Whenever it loses, you cross off the last move it made, so it can never make that move again. Nobody tells it why. Score a point every time you beat it. The game ends when the robot wins 4 games in a row (it graduates) or after 30 games.

MATERIALS

The 3-page Brain Mat (37 tiles) and the Learning Log, a pencil, one six-sided die, and six pawns in two kinds: coins, LEGO bricks, buttons.

SETUP

- 1 Lay out the Play Board (page 1 of the Brain Mat) with the robot's row at the top. Keep the mat facing the same way, robot's row at the top, so the tiles match what you see.
- 2 Trainer pawns go on the bottom row. Robot pawns go on the top row. Use two kinds of coins, two colors of LEGO, anything.
- 3 Pick the first Trainer (youngest goes first). Everyone else is the Robot's Hands. The Hands follow the mat and nothing else: no thinking for the robot.
- 4 Solo? You're the Trainer and the Hands. Just be honest with the die.

HOW PAWNS MOVE

- 1 The Trainer always moves first. Then take turns.
- 2 A pawn moves one square straight forward into an empty square. It can't capture that way.
- 3 A pawn captures one square diagonally forward. Take the enemy pawn off the board.
- 4 No moving sideways or backward, and no double steps.
- 5 You win when one of your pawns reaches the far row, when you've captured every enemy pawn, or when it's your opponent's turn and they have no legal move.

THE ROBOT'S TURN

- 1 Find the tile that matches the board exactly. Page 1 is the robot's 1st move, page 2 its 2nd, page 3 its 3rd.
- 2 Look only at moves whose box isn't crossed off. If there's just one, play it.
- 3 Otherwise roll the die and count along the live moves in letter order, starting again at the first one, until you reach the number rolled. With four live moves, roll again on a 5 or 6.
- 4 Play that arrow. Write the tile code and letter in the Learning Log, for example 2-07 B.
- 5 If every move on the tile is crossed off, the robot resigns. The Trainer wins.

AFTER EACH GAME

- 1 Trainer wins (or the robot resigns): cross off the last move in this game's row of the Learning Log, on the mat. That's the only way the robot learns.
- 2 Robot wins: change nothing.
- 3 Circle R or T in the Learning Log. The next player becomes Trainer.
- 4 If a 1st-move tile ever has every box crossed off, someone crossed off the wrong move. Erase that tile and keep playing.

HOW TO SCORE

- 1 Beat the robot: +1 point to that game's Trainer.
- 2 The robot graduates after 4 wins in a row. If it hasn't graduated after 30 games, stop there.
- 3 Most points wins. Ties share the win. Everyone signs the robot's diploma on the Learning Log.
- 4 Early games are easy points. Later games are hard ones, and that difference is the whole lesson.

WHAT THE ROBOT TEACHES

- 1 Reward signal: the robot is never told the rules of good play. It's only told when it lost. That's reinforcement learning.
- 2 Mistakes are data: 32 of the 90 moves on the mat lose against a smart Trainer. Every cross-off removes one, for good.
- 3 Exploration: the die makes the robot try moves before it knows which ones work.
- 4 Only what it has seen: tiles that never came up are still untrained. Look at the mat afterward.
- 5 Does it understand Hexapawn? No. It just has fewer bad moves left. Is that thinking?

VARIANTS

- 1 Two brains: print two mats. Train one carefully and one with random Trainer moves. Then a new player plays both. Which robot is tougher? The teacher matters.
- 2 Speed run: the whole table works together to graduate the robot in as few games as possible.
- 3 Same-opening trap: one Trainer always opens the same way until the robot graduates, then switches. The robot only learned the boards it saw.
- 4 The real thing: in 1961 Donald Michie built a learning machine out of 304 matchboxes and colored beads that learned tic-tac-toe. In 1962 Martin Gardner shrank the idea to 24 matchboxes for Hexapawn. This mat is that machine on paper.

PRINT TONIGHT

Plain paper, one side, Actual Size / 100%. Print the Brain Mat once per robot – it gets written on. You also need a pencil, one six-sided die, and six coins or small objects in two kinds for pawns.

Brain Mat: 3 pages. Learning Log: 1 page. Print a fresh mat for every new robot.