

# Extension of the game instructions for teachers and instructors

## “Human vs Machine” in action – Game variations

This sheet describes various options for modifying “Human vs Machine” to make it as useful and effective as possible in your learning group.

### Game variations for different numbers of players

The activity is designed for five players. Every player takes one of five roles. One role represents the human player, while the other four roles take over the tasks of the machine. The following roles are usually filled:

- ▶ Human
- ▶ Machine
  - ▷ Situation Evaluator
  - ▷ Move Finder
  - ▷ Move Picker
  - ▷ Win Checker

However, these roles can be split or merged to make the game work for different numbers of players.



### Variation for three players

With only three players combine these machines roles:

- ▶ Merge the Situation Evaluator and the Move Finder
- ▶ Merge the Move Picker and Win Checker

Note that it is important that the Move Finder and Move Picker are in two different players, so that the randomness for picking moves for the machine becomes apparent.

### Variation for four players

With four players one player will get two roles: There are three reasonable combinations:

- ▶ Merge the Situation Evaluator and Win Checker
- ▶ Merge the Situation Evaluator and the Move Finder
- ▶ Merge the Move Picker and Win Checker

### Variation for six players

With six players, introduce the additional role of the observer, who takes over the recording tasks of the Situation Evaluator and Win Checker. That is, when the machine wins or loses, the observer writes down the results and crosses out the bad moves in the game cards and move overview as necessary.

## Variation by adapting the game system

### Reinforcement Learning

In general, this means that actions that lead to desired results are strengthened, while actions that lead to undesired results are weakened. The machine in “Human vs Machine” uses a very simple procedure of Reinforcement Learning to learn its strategy. That procedure requires data, in this case, plays of the game. The amount of data (the number of games played) and the quality of the data (in this case: playing strength of the human player) are both important for the machine’s learning process. Unsuccessful moves are strongly weakened by taking them out. The probability that they will be drawn again in the future is then 0. “Human vs Machine” does not use positive reinforcement, that is, it does not reward successful moves by increasing of the probability for drawing them. It generally takes at least 10 rounds for the machine to get through a learning progress. An optimal model is reached after the machine loses ten to 15 times.

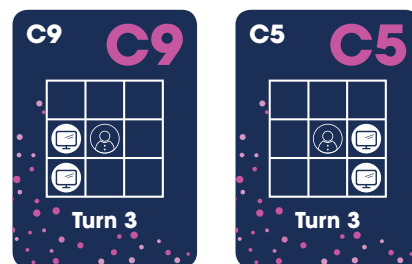
### Game variation by the integration of positive reinforcement

In this game variation the positive actions of the machine are strengthened by doubling the probability for successful moves – thus the machine is getting a “reward” for successful moves alongside the “punishment” for unsuccessful moves. To make this work, the Move Finder circles the color of the last move on the situation card and the situation overview, when the machine has won. Circled moves identify the successful moves. The Move Finder provides two color cards for each circled move and one color card for other moves indicated on the situation card. However, the machine’s learning process needs more rounds than in the originally variation, because this machine wins more often.

### Game variation: fast learning by using symmetric game situations

As in the game instructions stated, moving the left piece in the first move of the human is equal to moving the right piece. In this game variation, you will use the symmetry of the game situations even more now. If students explore the possible game situations more deeply, they will find there are five symmetric (mirrored) situations and therefore there are five pairs of symmetric situation cards (e.g. C5 and C9). You can remove one of each pair, for example, cards C8, C9, B11, C10 and C11 so that you only play with 19 situation cards.

This accelerates the computer’s learning progress because duplicates of unsuccessful moves are deleted as well. This does make it harder to find the right situation card while playing the game, however, so you need to weigh the advantages and disadvantages to decide whether use this variation or not.



### The “treat” version

Replace the color cards in the game with different snacks (e.g. fruits or sweets)! The treats should have the same size and they should feel the same. Every treat is placed on one of the colored boxes on the gaming board. To allow the Move Picker to draw the “colors” blind, the Move Finder places corresponding treats in a small bag or suitable container. Once a treat has been drawn, the color of the treat is checked on the game board and the corresponding move is made. The trick: If the game is played with treats, the colors of moves where the machine loses are simply eaten up. However, the move should still be crossed out on the move overview so that the learning progress of the machine is clear.