TMIRI

During a few minutes I will show you how to play the **Minesweeper** (e.g. minesweeperonline.com/) that you will have to describe. I will use the on-line version of the game, but **you have to describe the game as a two-players game** in which one player is the *mine layer* (the person that *lays*, or *plants*, the mines and gives hints) and the other is the *mine sweeper* (the person that tries to *locate*, or *flag*, the mines). Note that in the on-line version the mine layer's job is done by the computer and humans play the minesweeper's task. You have to write **two descriptions** of the game:

- A **semi-formal** description with which a reader can grasp the rules of the game and most probably start playing on his own (may be asking for some clarification)

- A **formal** description with which a reader can learn without any ambiguity the rules of the game.

  In both cases, besides the rules of the game, **you should also talk about strategies**. That is, only a silly player would click randomly. A good player clicks cells following some reasoning.

  Delivering the test means that I will take a picture of your manuscript. Ideally, it **should fit in one page** and your name should be very clear on the top.

  After delivering the manuscript, you have 48 hours to **upload a pdf** electronic version of your manuscript generated with latex to the Racò. The electronic version **must be identical** to the manuscript except for editing aspects (italics, bold face, indentation,...)

Some additional vocabulary that you may find useful: The game board represents a mined field (field with hidden mines). When you believe that there is a cell where there is not a mine, you may **reveal** it. When you believe that there is a cell where there is a mine, you **flag** it. As you play, the board displays some **hints**.

Solution Semi-formal:

Minesweeper is a two-player game, which are the *mine layer* and the *mine sweeper*. The game takes place on a n by n board called the *mine field*. The game starts with the mine layer placing mines in the field cells. The mine sweeper only knows the number of mines, but not their location. His task is to sequentially reveal those cells where he believes that there is no mine. When he reveals a cell, the mine layer shows its content. If there is a mine, the mine sweeper loses the game. If there is not a mine, the game continues, but the mine layer tells the number of mines adjacent to the cell revealed. The mine sweeper can use this information to make less risky choices in future iterations. The mine sweeper wins when all cells not containing a mine are revealed.

Solution Formal:

The *Minesweeper* is a game played over a $n \times n$ grid. Each cell is identified by its coordinates (i, j). Thus, the *set of all cells* is C,

$$C = \{(i,j)|\ 1 \leq i, j \leq n\}$$

The game is played by two players: the *minelayer* and the *minesweeper*. The minelayer chooses M, a subset of C of size k. The task of the minesweeper is to discover M as a sequence of guesses. The minesweeper works by *elimination*: at each iteration he selects one cell that he believes *not to be* in M. The minesweeper *loses* if during the process he makes a wrong guess and selects a cell in M. He *wins* if he selects all the cells not in M without making any wrong guess.

The *neighborhood* of cell (i, j), noted N_{ij}, is the set of cells around it,

$$N_{ij} = \{(p,q) \in C|\ \ (p,q) \neq (i,j),\ \ 0 \leq |i - p| \leq 1,\ \ 0 \leq |j - q| \leq 1\}$$

What makes the game interesting is that each time the minesweeper makes a successful selection (i, j), the minelayer gives as a hint f_{ij} which is the number of neighbors of (i, j) in M,

$$f_{ij} = |N_{ij} \cap M|$$

This feedback can be used by the minesweeper to follow a strategy aiming at making less risky selections. A general strategy would be to chose a cell (i, j) if it is surrounded by many already chosen cells (p, q) with low f_{pq}. In some cases, even completely risk-free selections can be made. For instance, if there is a cell (p, q) such that $f_{pq} = 0$, then all its neighbors can be safely chosen[1].

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[1] This rule is automatically applied in the on-line version of the game