**Instructions:**
Each student has already his group number (see the last page).
Contents: you will need to send a document (maximum 4 pages) + your program with comments written using : cpp, c, python, java, etc. + slides on pdf format for 10mn of talk.
Date due: ***January 8th, before 20h00 (french time)*** if the documents are sent ***after that deadline, you will have minus 10 points.***
***Mark :*** the maximum mark is 20 points.
Expose your solution (10mn) in english + (5mn) algorithm demonstration + (5mn) of questions.
Date of presentation : ***January, 10th from 8h30 until 12h30 (for SAA) and January, 11th from 13h30 until 17h30 (for CDI)*** each group has its own date of presentation.
Be careful! the document + program + slide should have just the number (e.g. 1.pdf, 1.cpp), which is given by the professor.

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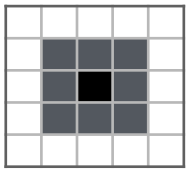
## Contents:

Localization and mapping become the basis of many mobile robotics systems. Vacuum cleaners and mowers are great illustrations in tune with the times. Such systems may also be of prime interest for defense, military applications and rescue. We are interested in rescue situations. The robot need to explore the environment and avoid obstacles (e.g. walls). At the same time it needs to find humans that are blocked in this environment.
To be able to explore the environment the robot needs a representation of the environment. We choose a discrete representation of the environment using the notion of grid. In this grid the robot needs to represent the obstacles and also the humans that are blocked in a place. Thus there are three steps in this project:

1. Environment representation.
2. Information update about obstacles and humans.
3. Exploration strategy.

**Environment representation (you can call the grid as GridProba)**:
The robot will divide the environment into several cells of two dimension. Each cell will represent a position: X and Y. Each cell contains ***three information***: one is related to *obstacle* existence or not (0 if there is no obstacle), another information related to *human* existence or not (0 for not existence) and the other one represents if the *robot explored* this position or not (0 didn't pass).
**Information update about obstacles and humans (represented in GridProba)**.
*obstacle*
We know that the obstacle is following this representation model (see the following figure):

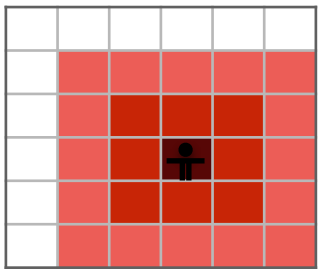


The obstacle is represented by black color (the robot can not reach this place). The robot knows that there might be an obstacle when it reaches the cell that has the grey color. To represent the different colors in the grid, you need to put, in the cells that are related to obstacles information, as 1 in the obstacle place, 0.5 when you are in the grey color and 0 when there is nothing.
The following table represents the associated environment representation of obstacles for the previous figure.

| | | | | |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0.5 | 0.5 | 0.5 | 0 |
| 0 | 0.5 | 1 | 0.5 | 0 |
| 0 | 0.5 | 0.5 | 0.5 | 0 |
| 0 | 0 | 0 | 0 | 0 |

*human*

The other information is related to human presence. The robot can detect that there is a human in the environment when it sens its temperature. The model of the temperature diffusion of the human is represented in the following figure.



There is a human lost in the grid. The highest temperature is in the cell where the human is. However, the temperature is propagated all around the human at maximum two cells far. Thus the representation of the human temperature propagation is shown in the next figure.

| | | | | | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 0 | 0.3 | 0.6 | 0.6 | 0.6 | 0.3 |
| 0 | 0.3 | 0.6 | 1 | 0.6 | 0.3 |
| 0 | 0.3 | 0.6 | 0.6 | 0.6 | 0.3 |
| 0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

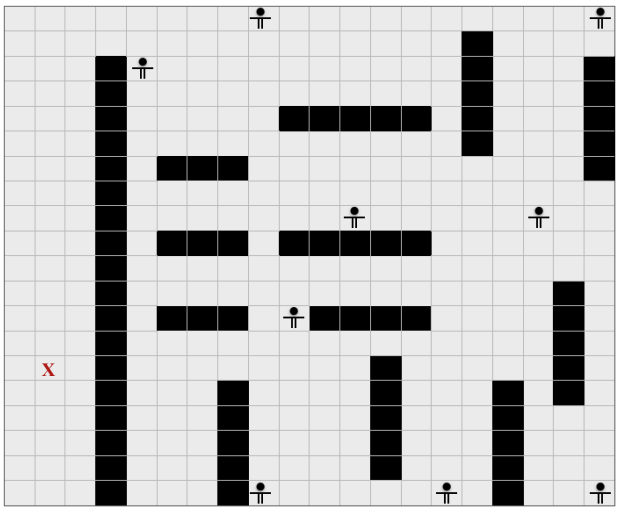
Remark: in the case where there is a wall, the temperature can not go through the wall.

**Exploration strategy**.

The robot will have two grids. One grid represents the whole environment (GridProba) and another one that represents the robot perception (GridBelieves). When the robot is at the cell (x1,y1), it can know perceive the different values of obstacle and human presence from GridProba. Knowing the model of the human and the obstacle (explained previously), the robot will update its own believes (GridBelieves) to be able to choose next cell to explore.

**What do you need to program?**

Using the following representation of the robot environment (knowing that the robot is at (2,6)):




1. Introduce these information into the GridProba.
2. Now the robot will have its own perception, show the contents of the GridBelieves at each time of the exploration.
3. Show the number of found human after 200 units of time or robot action.
4. At the end of the exploration strategy, show the different values of GridBelieves combined with the robot trajectory and the place of the founded human.

Try the same experiment using the robot position at (6,6).