Midterm Exam 2002

1. Select one of the following four problems. Write LISP program and answer all associated theoretical questions.

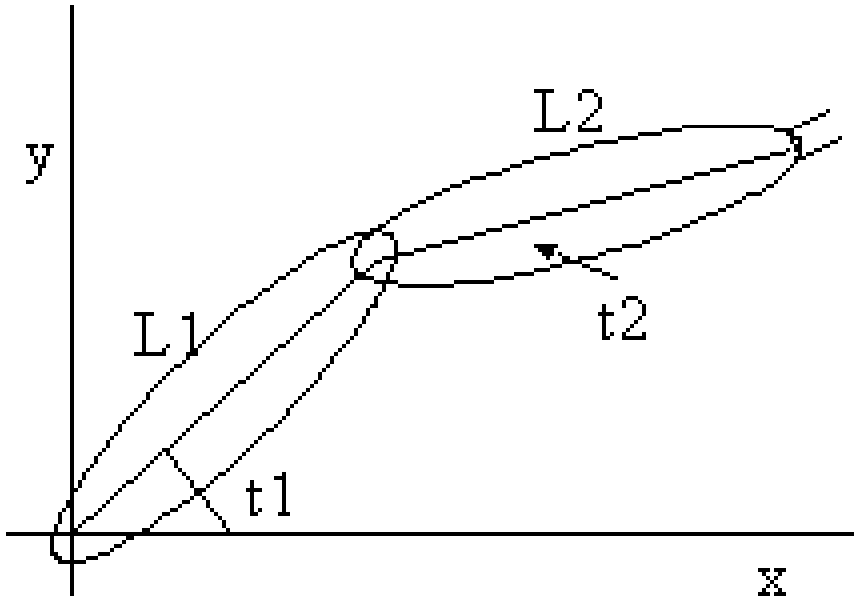
2. For Lisp program, make any simplifying assumptions that you deem necessary to complete the program

3. Give me the program source code and a printout that will prove that the program works

4. Explain ideas and theories behind your robot. You can use PPT rather than comments in the program. Discuss possible variants, not necessarily programming them.

LISP Problem 1

- Position of tip in (x,y) coordinates



$$x = L1*\cos(t1) + L2*\cos(t1+t2)$$
$$y = L1*\sin(t1) + L2*\sin(t1+t2)$$

•Given is a robot with three degrees of freedom, the two are shown above, the third one is rotation with respect to axis y.

•There is a tower of blocks of the same size standing on the floor, floor surface going through axis x.

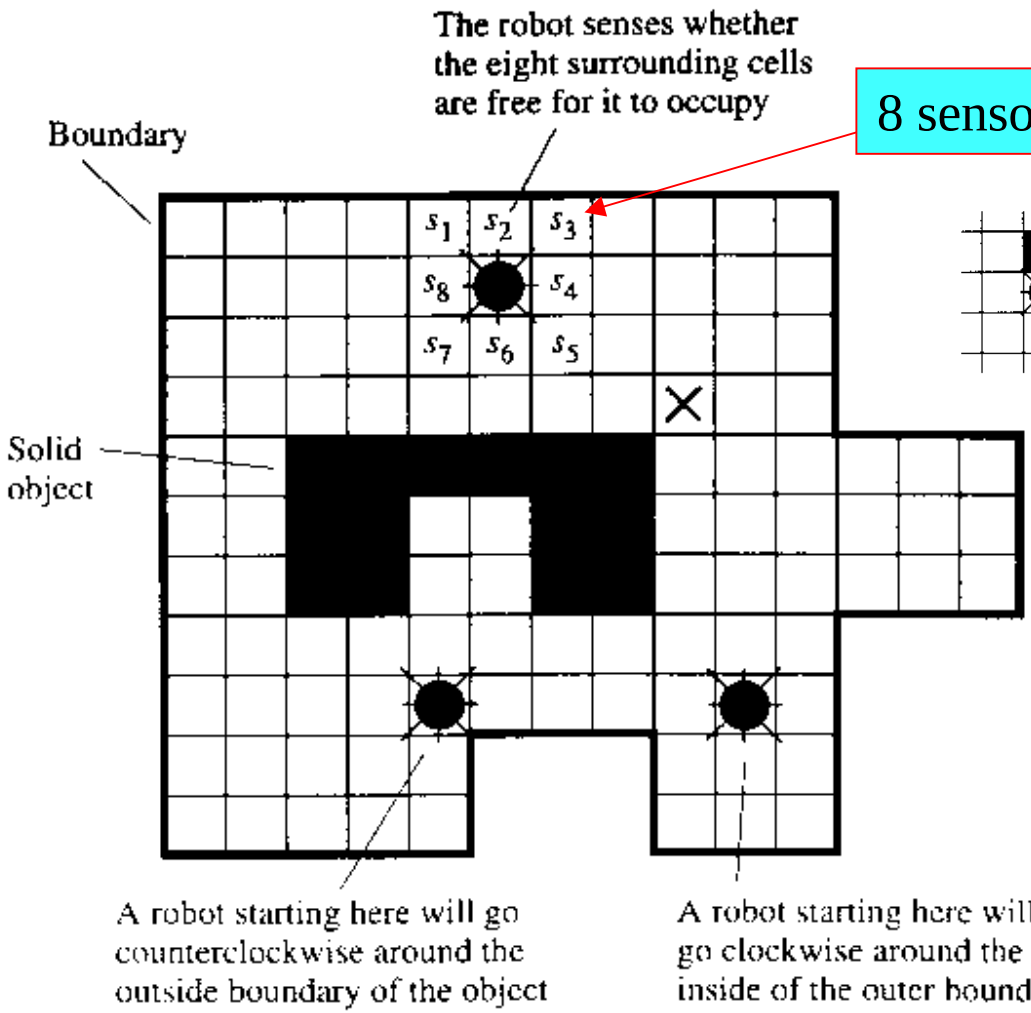
•The bottom of the pyramide is in location (x11,x21) on the floor.

LISP Problem 1

- **Write the LISP program that works as follows:**
- **knowing the size of the block, k*k*k and the number of blocks N in the pyramide, find first the pyramide (assuming a sensor on the tip) and next build a pyramide in a reverse order in new location (x12,x22).**
- **Assume that k*Nmax is approximately equal to L1.**
- **Values L1, L2, k and N are parameters.**
- **Assume that the gripper can grip the item from many positions. Create a specific procedure for gripper opening and closing.**

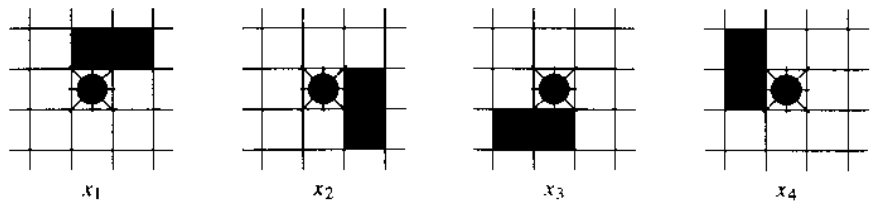
LISP Problem 2. Recall our old friend robot from class

- Sensory inputs:
- Robot movements
  - *north* moves the robot one cell up in the cellular grid
  - *east* moves the robot one cell to the right
  - *south* moves the robot one cell down
  - *west* moves the robot one cell to the left



8 sensors,s_i

Features:



Problem 2 continued. Rules example

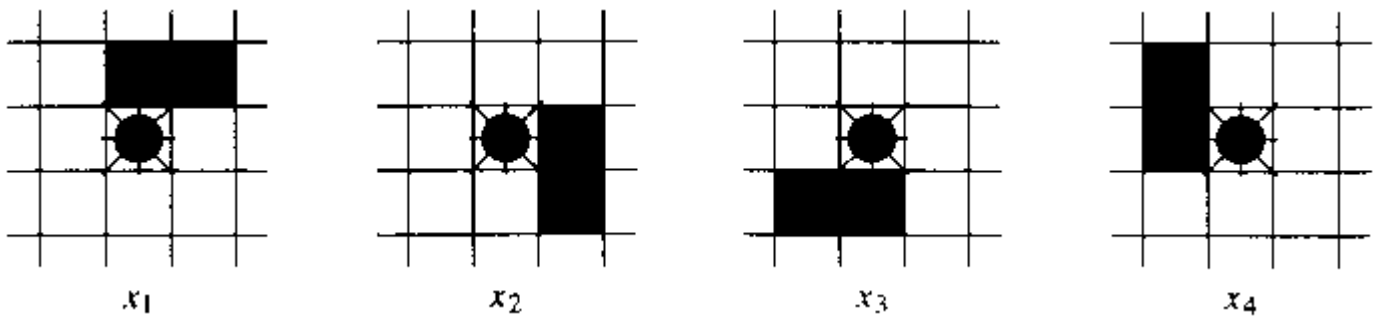
- Specifying a function that selects the appropriate boundary-following action

Values of features

Actions

$$\begin{cases} \text{if } x_1 = 1 \text{ and } x_2 = 0, & \textit{move east} \\ \text{if } x_2 = 1 \text{ and } x_3 = 0, & \textit{move south} \\ \text{if } x_3 = 1 \text{ and } x_4 = 0, & \textit{move west} \\ \text{if } x_4 = 1 \text{ and } x_1 = 0, & \textit{move north} \end{cases}$$

  - None of the features has value 1, the robot can move in *any* direction until it encounters a boundary



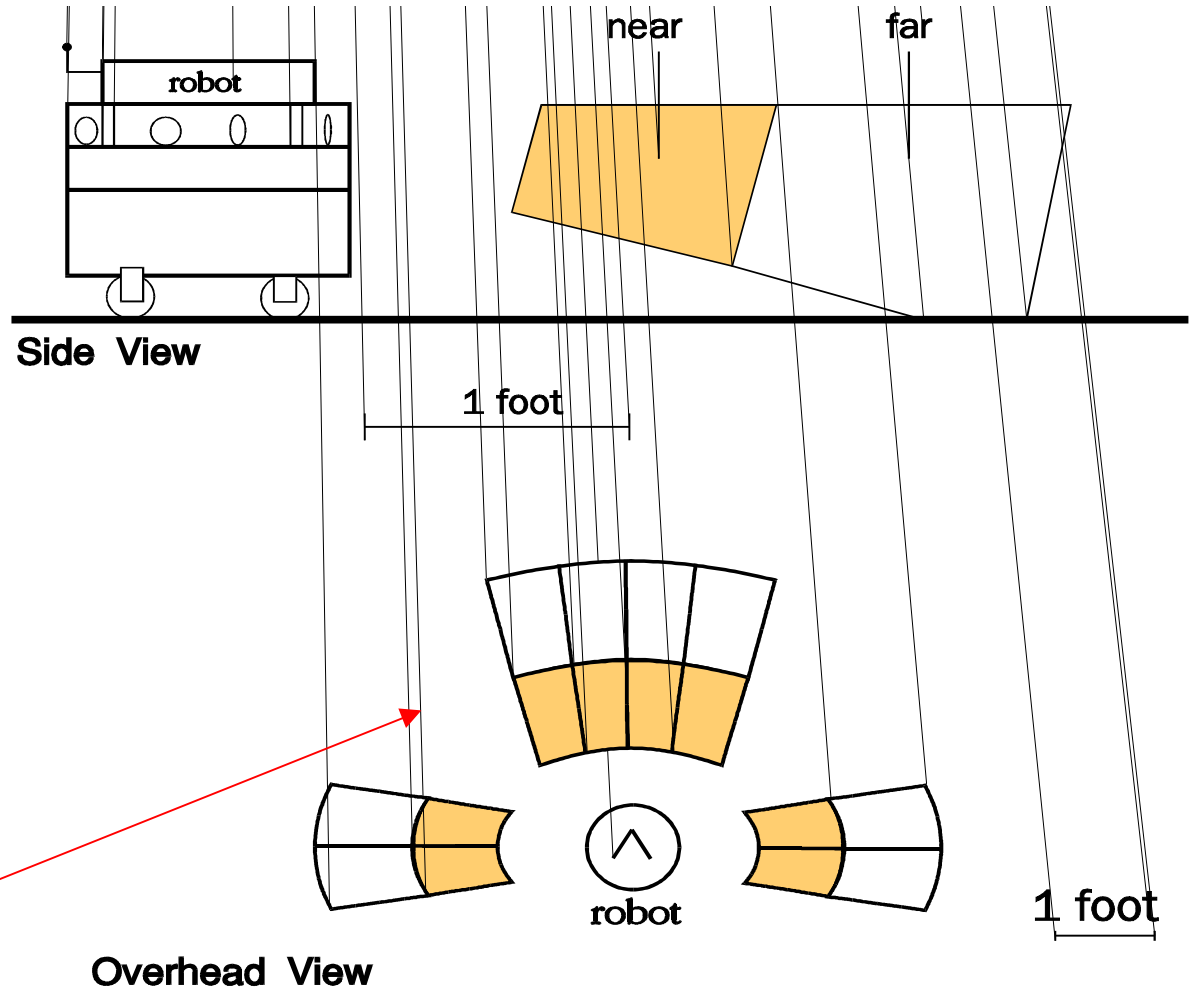
Your tasks

- Design stimulus-response (reactive) agent in LISP.
  - 1. Abstract sensory values into features
  - 2. Decides on Modes of action
  - 3. Design boolean functions to control motors.
- The task is to find a relatively short path from any point to any other point given as a start and end coordinates. The robot does not know the map, but knows its initial position and orientation.

LISP Problem 3. Obelisk robot

SENSORS:

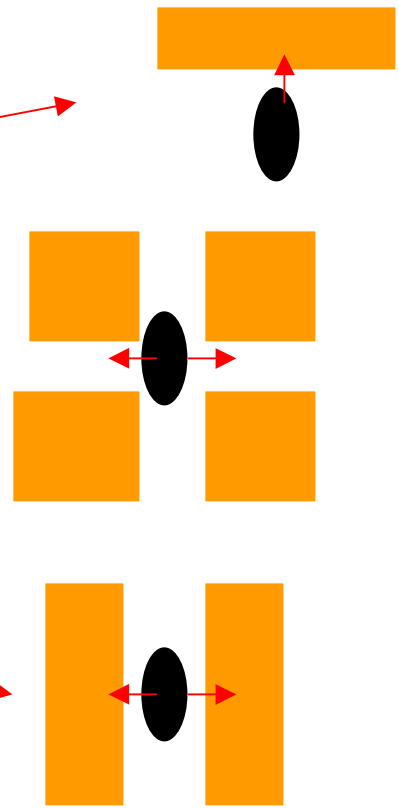
Two kinds of sensors



8 ultrasonic sonar sensors, 4 long IR's, 8 short IR's,
1 very-short-range IR

Feature Detectors on OBELIX

- **"Stuck":**
  - motor current > threshold
- **"Bumped":**
  - very-short-range IR on
- **"Intersection":**
  - Long side IR off
- **"Corridor":**
  - Two long side IR's on
- **"Box-detectors":**
  - boolean combinations of FAR and NEAR sonar bits



What to do?

- 1. Write the program for Obelisk robot that is located in the centre of an unknown building with many doors and internal obstacles connected always to walls.
- The robot has first to find the walls and be sure that it will not leave the room.
- Next it has to follow some path which will be such that whole area not covered by obstacles will be visible to the robot at least on some part of this path.
- This robot is like a guard of a factory that want to see each location from time to time in order that the thieves will not sneak in.
- First use boolean variables, next continues, replace AND with MIN and OR with MAX. Describe behavior differences of binary and continuous versions

Consider plans like those

I suggest to use a spiral movement

1. Be sure that robot will not go out of building seeking for walls in the initial phase.

2. Robot has infinite time to learn the map.

3. When the map is learned, the robot has to see (with sensors) every point on its path at least one in every loop.

Lisp Problem number 4

- The space is a binary tree, with entrance in the root of the tree. The gold is somewhere in the leaf. There can be more than one leafs with gold.
- 1. Write a program that will find gold.
- 2. Write a program that will find all locations of gold.
- The tree is represented as a single LISP expression. One example was shown in the class.
- You have to print all paths to the gold, or a single path to the gold.