

91.451, Robotics II  
Spring 2004  
Prof. Yanco

### Take-Home Final

Out: Thursday, 13 May 2004

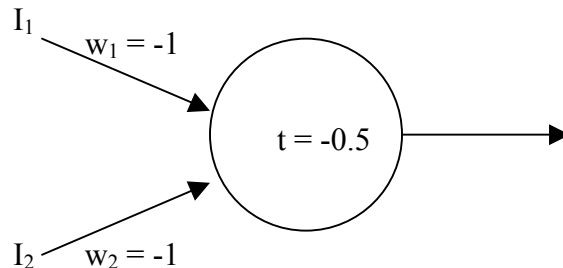
Due: Wednesday, 19 May 2004 by 4:00pm

This exam is open book and open notes. You may take as much time as you like on the exam, although it should not take more than a couple of hours. Complete this exam by yourself, without discussing any questions with your fellow students. Sign the line below to certify that you did not discuss the exam with fellow students or get answers from anyone. (Turn this page in with your answers.)

Signature: \_\_\_\_\_

#### Problem 1: Perceptrons (20 points)

- A. Describe a function that can not be represented by a perceptron, using either an equation or a graph. Explain your answer.
- B. What is an activation function?
- C. What logic function is represented by the following perceptron? (You may express it in terms of  $I_1$  and  $I_2$ , if you wish.)



**Problem 2: Vision (20 points)**

- A. What can make the color values of an object change over time, as read by a camera?
- B. Explain the difference between the Sobel and Canny edge detection algorithms?
- C. Explain how a median filter computes its result. You may use pseudocode or just explain the algorithm in a few sentences.

**Problem 3: Mapping (20 points)**

- A. Give an example of a problem that can occur when a robot tries to create a map using dead reckoning for localization. You may choose to draw a picture or describe with words.
- B. What's an occupancy grid?
- C. What method is used to update the occupancy grid in the Pyro mapping system?

**Problem 4: Designing a new robotic system (40 points)**

The Roomba has been a great success, selling millions of units. You've been retained as a consultant for iRobot (Roomba's designer) to design the next home application of robotics. Write a short essay (no more than 3 pages) describing your proposal for iRobot's next home application. Your essay should include a discussion of the following questions, but need not be limited to them.

1. What would you propose for your application?
2. How would the robot be designed and built? What sensors and actuators would be needed?
3. How large would the robot be?
4. How much would you expect someone to be willing to pay for a robot to perform the service you've designed your robot to perform?
5. What percentage of households would you expect to buy your device?
6. What alternatives to buying your robot would the households have?