Name (print): ________________________________

• INTEGRITY: By taking this exam, you pledge that this is your work and you have neither given nor received inappropriate help during the taking of this exam in compliance with the Honor Code of Emory University. Do NOT sign nor take this exam if you do not agree with the honor code.

• INSTRUCTIONS:
  – Keep your eyes on your own paper.
  – Do your best to prevent anyone else from seeing your work.
  – Do NOT communicate with anyone other than the professor/proctor.
  – Do not use notes, books, calculators, etc during the exam.
  – Turn all mobile devices off and put them away now. You cannot have them on your desk.
  – Write neatly and clearly. What I cannot read, I will assume to be incorrect.
  – Academic misconduct will not be tolerated. You are to uphold the honor and integrity bestowed upon you by Emory University. Penalties for misconduct will be a zero on this exam, an F grade in the course, and/or other disciplinary action.

• TIME: This exam has 7 questions on 11 pages including the title page. Please check to make sure all pages are included. You will have 50 minutes to complete this exam.

I commit to uphold the ideals of honor and integrity by not betraying the trust bestowed upon me as a member of the Emory community. I have read and understand the requirements outlined above.

Signature: _______________________________________

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1. **Multiple Choice.** Choose the best answer and circle your answer.

   (a) (2 points) An *infinite loop* is code containing a loop that
   
   **A. never terminates.**
   
   B. executes a large number of times.
   
   C. approaches a terminating condition.
   
   D. also contains an *if* statement.

   (b) (2 points) In the book *I, Robot*, Susan Calvin is a:
   
   A. an anti-robot crusader
   
   B. a robot field tester
   
   **C. a robopsychologist**
   
   D. a mathematician.

   (c) (2 points) The only commercially successful agricultural robot is:
   
   A. a robot for harvesting citrus.
   
   B. a robot for automated sheep shearing
   
   C. a small weed pulling robot called AgAnt
   
   **D. an automated milking robot.**

   (d) (2 points) What does the acronym *HRI* stand for?
   
   A. Horticulture Robot Information
   
   **B. Human-Robot Interaction**
   
   C. Historic Robot Institute
   
   D. Hexagonal Robot Investment

   (e) (2 points) The operators *and*, *or*, and *not* are
   
   **A. logical operators.**
   
   B. comparison operators.
   
   C. mathematical operators.
   
   D. loop operators.

   (f) (2 points) Which of the following commands causes the robot to go forward for 1 second at half speed?
   
   A. `forward(.5)`
   
   B. `forward(1)`
   
   **C. `forward(0.5, 1)`**
   
   D. `forward(1, 0.5)`
(g) (2 points) In the story “Runaround,” the robot Speedy is caught in an infinite loop between getting the selenium requested by the humans and the environment which is toxic to him. What eventually breaks him out of the cycle?

A. Humans send another, more primitive robot to retrieve Speedy.
B. A human puts himself in danger so as to override the two laws of robotics which are in conflict.
C. A human manages to contact Speedy and gives him other instructions.
D. Nothing. The humans leave Speedy until he eventually breaks down.

(h) (2 points) In a programming language a conditional statement is a programming statement which evaluates to:

A. True or False
B. an integer
C. an integer or a floating point number
D. Yes or No

(i) (2 points) The term dead-reckoning in reference to robot sensors means

A. a measurement of movement based on external signals such as GPS.
B. a measurement of movement relative to internal frame of reference.
C. a measurement of movement based on sensor readings to an obstacle.
D. a measurement of rotational movement.

(j) (2 points) An example of an interoceptor on the Scribbler robot is:

A. IR sensor
B. Obstacle sensor
C. light sensor
D. stall sensor

(k) (2 points) In python, the term slicing refers to:

A. the ability to concatenate lists.
B. removing elements of a list.
C. using portions of an existing list to make sublists.
D. reversing and sorting lists.

(l) (2 points) The maximum and minimum values for color components in a jpg image are:

A. 255 and 0
B. -255 and 255
C. 256 and 1
D. 255 and 1
2. Short Answers. Briefly (2-3 sentences), answer the following questions.

(a) (4 points) What is the difference between active sensors and passive sensors?

**Solution:** Active sensors take readings by broadcasting signals into the environment and reading what signals are bounced back to a receiver on the robot. Passive sensors take readings of the ambient environment.

(b) (4 points) Explain why the following code will generate an error:

```python
myList = ["World", "Earth", "United States", "Georgia"]
print myList[len(myList)]
```

**Solution:** `len(myList)` returns the number of elements in a list. In the above example, it returns 4. However, since we begin indexing the list at 0, `myList[4]` doesn't exist and will generate an index out of bounds error.

(c) (5 points) What will the following code print when run?

```python
l = ["open", "close", "in", "out", "up", "down", "on", "off"]
for i in range(6):
    if i%2 == 1:
        print l[i]
print len(l)
```

**Solution:**
```
close
out
down
8
```
(d) (5 points) Describe an image as it appears on your computer and as we have discussed in class.

**Solution:** A grid/2D array of pixels. Each pixel contains color information. For color images, pixel contains 3 color values representing red, green, and blue color components. For grayscale image, pixel contains one color component representing shade of gray between black and white.

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(e) (6 points) List 3 of the 5 roles of human-robot interaction, and give a 1 sentence description of each role you listed.

**Solution:**
- **Supervisor:** oversees all robots, but doesn’t directly control/fix/help
- **Operator:** controls robots (degree of control depends on autonomy), but understands what robot “sees,” “hears,” and “understands.”
- **Teammate:** human works with robot to solve problems/accomplish task
- **Maintainer (mechanic, programmer):** fixes robot when robot does not function as intended.
- **Bystander:** no formal training, but coexists with robot.
3. (10 points) ROBOT DRAWING. Robot Drawing - Assume `turn90degrees()` has been defined as below so the robot turns right 90° and `nudge(x)` has been defined to move the robot forward x units.

```python
def turn90degrees():
    turnRight(1, 1)

def nudge(x):
    forward(1, x)
```

The following code makes the robot drive the trajectory drawn in the box to the right.

```python
nudge(1)
turn90degrees()
nudge(1)
nudge(2)
```

Draw the robot's trajectory when the following code is executed. Label the length of each move (nudge) using numbers as in the example above.

```python
def turn90degrees():
    turnRight(1, 1)

def nudge(x):
    forward(1, x)

turns = [3, 5]

for idx in [2, 3, 3, 5, 1]:
    if idx in turns:
        turn90degrees()
    nudge(idx + 1)
```
Solution:

Grading: +1 point for each correct line segment and length. +1 point for each correct turn. +1 no extra lines +1 no extra turns
4. (12 points) Lists. Assume the following program statements are executed in the order shown. For each print statement, write what will be printed.

```python
>>> mylist = [40, 92.5, 100, 36, 0, "Bob"]
>>> print len(mylist)
6

>>> print mylist[0]
40

>>> print mylist[3:]
[36, 0, "Bob"]

>>> print mylist[1:4]
[92.5, 100, 36]

>>> mylist.append(14)
>>> print mylist
[40, 92.5, 100, 36, 0, "Bob", 14]

>>> mylist[0] = 400
>>> mylist[3] = 160
>>> print mylist
[400, 92.5, 100, 160, 0, "Bob", 14]
```
5. (9 points) List the 3 Laws of Robotics as described by Issac Assimov in *I, Robot*. Describe 2 examples of conflicts which arose from the interplay of humans and robots following one (or more) of the three laws in *I, Robot*.

**Solution:**

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey any orders given to it by human beings, except where such orders would conflict with other laws.

3. A robot must protect its own existence as long as such protection does not conflict with other laws.

+1 for each correct law
+3 each for examples. Examples must have demonstrated conflict of some type.
6. (12 points) Write a function called `avgSensors` which takes an integer parameter, `n`. The function should take `n` IR obstacle sensor readings and return a floating point number which is the average of those readings. You can obtain obstacle sensor readings by using the function `getObstacle("center")` which returns a floating point reading via the obstacle sensors.

For example, if you call `avgSensors(3)` and the three sensor readings are 11.0, 16.5, and 20.2, your function should return the value 15.9.

```python
def avgSensors(n):
    total = 0
    for x in range(n):
        val = getObstacle("center")
        total = total + val

    avg = total/n
    return avg
```

Solution:

+2: function definition correct
+2: uses loop correctly
+2: gets `n` sensor readings
+2: keeps track of total value of obstacle readings
+2: correctly computes average
+2: returns average value
7. (9 points) Write a function named `status` which takes a parameter, `grade` which is a floating point number. If `grade` is greater than 70, the function should print out the string “Satisfactory progress!” If the parameter is greater than 60, but less than or equal to 70, the function should print out “Needs improvement.” If the parameter is less than or equal to 60, the function should print out “Unsatisfactory.”

For example, `status(60.0)` would print out “Unsatisfactory.” `status(85.2)` would print out “Satisfactory progress!”

Solution:

```python
def status(grade):
    if grade > 70.0:
        print "Satisfactory!"
    elif 70.0 >= grade > 60.0:
        print "Needs improvement."
    else:
        print "Unsatisfactory"
```

+2: function definition correct
+2: above 70 prints correctly
+2: between 60 and 70 prints correctly
+2: below 60 prints correctly
+1: correct print statements