CIS 730 Artificial Intelligence
CIS 530 Introduction to Artificial Intelligence
Fall 2018

Homework 10 of 10: Machine Problem
Perception and Understanding, Part II:
Natural Language Processing (NLP) and Vision

Assigned: Fri 23 Nov 2018
Due: Fri 30 Nov 2018 (before **midnight**)

The purpose of this problem set is to exercise your knowledge of computer vision and of natural language processing (NLP), including: conversational agents and chatbots, machine translation (MT), and automatic speech recognition (ASR). You will solve problems and answer some discussion questions about perception and understanding. (This will include some practice final exam questions.)

This homework assignment is worth a total of 100%.

Each problem is worth 25% for CIS 530 students and 20% for 730 students.

References

- **AIMA Table of Contents:** http://aima.cs.berkeley.edu/contents.html
- **National Institute of Standards and Technology (NIST) Text Analysis Conference (TAC):** https://tac.nist.gov/tracks/

1. **(530/730) Robotics: Object Tracking and Visual Servoing.** Refer to Chapter 25 on Robotics. Explain object tracking tasks in your own words. Referring to Slide 5 of Lecture 33 Part B, explain what it means to "keep relative position under movement". That is, what are the input and desired output?
   Turn in `PS10-1.pdf` or incorporate your results into an overall `PS10.pdf`.

2. **(530/730) Natural Language: Question Answering (QA) vs. Recognizing Textual Entailment (RTE).** Refer to Section 22.4 (Information Extraction in the first chapter on NLP) and to the instructions for NIST TAC tracks. What is the difference between question answering (QA) and recognizing textual entailment (RTE) in natural language understanding? Specifically, what is the difference in the desired output of each?
   Turn in `PS10-1.pdf` or incorporate your results into an overall `PS10.pdf`.

3. **(530/730) Downloading, Installing, and Running *NeuroSolutions*.** Download and install the free trial version of *NeuroSolutions 7.1.1.1* for Windows (if you use MacOS 10.x or Linux, I strongly recommend using VMWare or VirtualBox with Windows 10 for this assignment, rather than NeuroSolutions v6 for Mac users under Microsoft Virtual PC for Mac).

   Go through the demo tutorial for building a multi-layer perceptron and step through it. Take a screenshot of your mean-squared error loss function graph after training the network. Name this `MP9-3a.jpg` and embed it in `MP9-3.pdf` along with the actual MSE value or incorporate your results into an overall `MP9.pdf`.

Now import the ARFF data and run NeuroSolutions' Multilayer Perceptron wizard (with default settings) to train an MLP for the wall-following task in MP9-1 and MP9-2. You will need to consult the documentation to convert ARFF to NeuroSolutions data. **Hint**: for the small robot control data set you are working with, this can be done by hand using a simple text editor or spreadsheet.

Take a screenshot of your mean-squared error loss function graph after training the network. Name this `MP9-3b.jpg` and embed it in `MP9-3.pdf` or incorporate your results into an overall `MP9.pdf`.

How would you compare your results from MP9-2 and MP9-3 with one another? **(Hint:** Can you find a way to count classification errors in NeuroSolutions the way WEKA does?**)**

4. **(530/730) Using ECJ.** Download Evolutionary Computation in Java (ECJ) **v26** from Sean Luke's ECLab at George Mason University. Follow Tutorial 4:

   https://cs.gmu.edu/~eclab/projects/ecj/docs/tutorials/tutorial4/

   to build a symbolic regressor using five functions – two variables and three operators (X, Y, +, -, *) for the target function

   $$f((x,y)) = x(y + xy) + y = x^2y + xy + y$$

   Print out the output of

   ```
   java ec.Evolve -file tutorial4.params -p
   stat=ec.gp.koza.KozaShortStatistics -p stat.do-size=true -p
   stat.do-time-true
   ```

   and turn this in as `MP9-4.pdf` or incorporate your results into an overall `MP9.pdf`. Include your Java sources as `MP9-4.zip`.

5. **(730 only) Building and Using A Real-World Robotics Data Set using Machine Learning.** Read and watch:

   http://www.pirobot.org/blog/0007/

   and describe in your own words how you would log and prepare this data to make a training data set, train an MLP or GP-based symbolic regressor for the tasks in MP9-1 through 3 and MP9-4, if you had a Pi Robot. (Specify whether you are training a classifier or regressor.) How would you use the *NeuroSolutions* or *ECJ* output to drive the robot as shown in the blog entry?

Class Participation (required)

Extra Credit (10%) – SUBMIT ONLY ONE CRITIQUE

Listen to or watch one of the following talks and write a **short (2-3 paragraph, approximately ½ page) critique** as specified.

1. Stuart Russell's IJCAI 2017 keynote address, "Provably Beneficial AI"
   http://bit.ly/russell-IJCAI-2017 (YouTube)

   Questions:
   a) Discuss briefly **one key benefit** of AI that is enabled by breakthroughs made in the last 5 years.
   b) Discuss **one key risk**.
   c) How does Russell characterize *beneficial* AI and how is this related to the idea of rational agents? Ethical agents?

2. Kai-Fu Lee's 2018 TED talk "How AI Can Save Our Humanity" on YouTube:
   https://www.ted.com/talks/kai_fu_lee_how_ai_can_save_our_humanity?language=en

   Compare this address to Ray Kurzweil's 1986 documentary *The Age of Intelligent Machines.*
   http://bit.ly/kurzweil-AOIM
   Linked from lecture video recording directory:
   http://www.kddresearch.org/Courses/KDD/Videos/ [http://bit.ly/kdd-lab-videos]

   Discuss briefly what predictions Kurzweil made have been accurate or inaccurate based on topics covered in this course and progress mentioned by Lee in the above address.

   Questions:
   a) What does Lee predict as near-term applications of AI that will emerge in the next decade?
   b) What problems are these applications related to that already have recent partial solutions, and what are open problems?
   c) What progress has there been in the past 31 years? **(Refer to Kurzweil's video above for examples.)** What advances occurred in the last 5 or so years?

3. Daphne Koller's invited talk "Rich Probabilistic Models for Holistic Scene Understanding" at IJCAI 2011 in Barcelona
   Lecture audio recording: http://videolectures.net/ijcai2011_koller_scene/

   Compare this talk to Koller's IJCAI 2001 Computers and Thought Award Lecture, "Representation, Reasoning, Learning", which she begins this talk with a reference to. (You may reference only the final slides of the 2001 talk, but you should read the notes or listen to the whole talk.)
   Linked from: http://ai.stanford.edu/~koller/activities.html
   Slides: http://stanford.io/TFV7qH
   Lecture audio recording:
   http://www.kddresearch.org/Seminars/Readings/koller-IJCAI-2001-A.mp3
   http://www.kddresearch.org/Seminars/Readings/koller-IJCAI-2001-B.mp3

   Questions:
   d) What does Koller identify as new in AI research on perception and representation, particularly using graphical models of probability, in the past 10 years?
   e) What are the primary areas of progress?
   f) What problems are still open?

   Originally posted as a note in a graphical models tutorial (Hsu, 2007) for the first University of Illinois Data Sciences Summer Institute (http://mias.illinois.edu).