CSE841 Artificial Intelligence

Dept. of Computer Science and Eng., Michigan State University   Fall, 2016

Course web: `http://www.cse.msu.edu/~cse841/`

Description: Graduate survey course in Artificial Intelligence. Types of intelligence, knowledge representation, cognitive models. Goal-based systems, heuristic search, games, deductive systems and expert systems. Computer vision, speech recognition, language understanding, robotics, learning, and development.

Class: Tuesdays and Thursdays, 12:40pm - 2:00pm, 1300 Engineering Building

Instructor: Juyang (John) Weng, phone: 353-4388, e-mail: `weng@cse.msu.edu`,
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Office hours: Wednesdays 5:00-6:00pm and Fridays 5:00-6:00pm or by appointment. Emails and telephone calls are not good for asking technical questions. See him.

1 Objectives

This is a graduate course in Artificial Intelligence. Types of intelligence; learning; development; brain-mind architecture; symbolic representation; emergent representation; knowledge representation; cognitive models; goal-based systems; heuristic search; games as environments; deductive systems and expert systems; vision; audition; touch; language understanding; robotics.

Rather than present AI as a loose collection of ideas and techniques, this course will strive to emphasize important unifying themes that occur throughout many areas of AI research. Further, to take advantages of recent exciting multidisciplinary advances in understanding and modeling the brain and the emergence of the mind, we will link this unifying theme with the natural brain-mind. These include:

- Many methods can be viewed as context-based searching through a space of learned experience.

- Search is made more computationally efficient through brain's representation of learned knowledge than the traditional AI representations.

- The viewpoint of an intelligent "developmental agent" as an effective one for describing and understanding AI approaches.

- The subject of the brain-mind and its development potentially will not only unify all the subareas of AI but also lead to wide-front advances in areas that have been shown to be challenging to AI, such as vision and language understanding.

2 Textbooks

Required: Juyang Weng, *Natural and Artificial Intelligence: Introduction to Computational Brain-Mind,* BMI Press, 2012. Available from Amazon and BMI Press http://www.brain-mind-institute.org/press.html

Recommended as a reference: Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd edition, Prentice Hall, 2010, as reading for traditional approaches.

3   Course Prerequisites

This course assumes the following prerequisites:

- Programming skills in a high-level language (e.g. Matlab, C, or C++).

- Exposure to concepts in discrete structures, probability/statistics, and algorithmic analysis.

4   Weekly Course Outline

Week	Week Dates	Topics	Weng	R&N	Papers
1	-, 9/1	Administrivia, course IDs	Preface	Preface	
2	9/6, 9/8	Agents and Tasks	Ch. 1	1-2, 25-27	Turing*
3	9/13, 9/15	Representation and Search	Ch. 2	3-6, 12	Boden
4	9/20, 9/22	Autonomous Development	Ch. 3	Not covered	ChineseRoom*
5	9/27, 9/29	Neurons and Features (I)	Ch. 4	18.7	McCarthy
6	10/4, 10/6	Neurons and Features (II)	Ch. 4	18.7	Weng*
7	10/11, 10/13	Properties of Representation	Ch. 5	13-15, 18-20	Mitchell
8	10/18, 10/20	Brain-Mind Architecture, **Exam 1**: Thur.	Ch. 6	Not covered	
9	10/25, 10/27	Spatial Processing (I)	Ch. 7	24	Brooks*
10	11/1, 11/3	Spatial Processing (II)	Ch. 7	24	Zweig
11	11/8, 11/10	Temporal Processing	Ch. 8	22-23	Cangelosi*
12	11/15, 11/17	Neuromodulation (I)	Ch. 9	21	Echo
13	11/22, -	Neuromodulation (II)	Ch. 9	Not covered	Urmson*
14	11/29, 12/1	Generalization	Ch. 10	7-12, 16-17	Hofstadter
15	12/6, 12/8	Group Intelligence, **Exam 2**: Thur.	Ch. 11	Not covered	

where Weng: Weng's textbook; R&N: Russell and Norvig's textbook. There is no final exam. The papers refer to papers that you are expected to read, and write a short critique for the ones marked with ∗. Note the file types on the web page. Some are pdf files and some are html pages. This is my best guess at the schedule. It is obviously subject to change.

5   Piazza Discussion Forum

We will use Piazza for a discussion and notification forum for this class. You will receive an invitation to join Piazza in the first week of class. The instructor will monitor Piazza and respond to questions posted to it; other students may also do so. If you have a question, you will often find that it has already been asked and answered on Piazza — so check. Important class notifications will be sent via Piazza. Be sure that you accept the invitation to join. If you do not receive an invitation to join in before the second class, notify your instructor. However, Piazza is not always effective for asking last-minute technical questions. See the instructor to interactively understand the questions and answers.

6   Papers

6.1   Write a Critique

Every week, you will be required to read a paper available from the class web page. For the ones marked with * in the table above, you are required to turn in a one-page (must count 450 - 500 words) critique of the paper, using the material taught in the course so far, due before the class. Points will be deducted for more and fewer words and longer than a page. Wrong papers will be graded as zero. One page is not a lot of room. Be concise about your analysis. It should includes three paragraphs:

1. *Summary* about the contributions (novelty) of the paper when the paper was published and the importance (why useful?),

2. *Limitations* of the paper and your analysis based on the course material covered so far,

3. *Your suggestions* for how to address these limitations.

Criteria for grading a critique include the following. The order is from basic to advanced.

1. Write English that is free of typos and grammar errors, clear, appropriate, and smooth to read.

2. Do not miss any of the above three major components, devote appropriate space for each, and provide convincing arguments in each.

3. Reflect that you understand what you learned from this course so far and your creative use of the new concepts and knowledge in the course.

Grading is done by anonymous classmates and me. Your grading of the critique is counted 20% of your own corresponding critique work. No comments in your grading will receive at most 50% of the 20%. Never tell anybody about you course ID number. Never try to know other's course ID number. Violation of the above double-blind review rule will result in a zero grade. On the date when a critique is due, we will discuss the paper of the day near the end of the class.

Print your critique as a single page. Always start with:

Line 1: Critique < number> for <Title of the paper>
Line 2: by <Authors of the paper>
Line 3: Critique by <Your CSE841 ID number > (Do not use your name)

6.2   List of Papers

The ones marked with * require critique.

1. Week 2: **Turing***: "Computing Machinery and Intelligence", Critique 1.

2. Week 3: **Boden**: "Creativity and Unpredictability"

3. Week 4: **Hauser***: "The Chinese Room Argument", Critique 2.

4. Week 5: **McCarthy**: "Little Thoughts of Thinking Machines"

5. Week 6: **Weng et al.*** "Autonomous Mental Development by Robots and Animals", Critique 3.

6. Week 7: **Craven, Mitchell et al.**: "Learning to Extract Symbolic Knowledge from the World Wide Web"

7. Week 9: **Brooks***: "Elephants don't Play Chess", Critique 4.

8. Week 10: **Zweig and Russell**: "Speech Recognition with Dynamic Bayesian Nets".

9. Week 11: **Cangelosi et al.***: "Symbol grounding etc.", Critique 5.

10. Week 12: **Hraber, Jones, Forrest**: "The Ecology of Echo"

11. Week 13: **Urmson et al.***: "Autonomous Driving in Traffic: Boss and the Urban Challenge", Critique 6.

12. Week 14: **Chalmers, French, Hofstadter**: "High-level Perception, Representation and Analogy, A Critique of Artificial Intelligence Methodology"

7 Assignments

- Assigned reading: text and one paper every week. One critique for each paper marked with *.

- Homework. We will give 5 homework assignments. Some require programming. You must start at least two full weeks early. Each of the homework 1 through 4 has a unit weight, Homework 5 (longer) has a weight of two units.

Week	Tuesday	Thursday	Subject
2		09/08	Critique 1 (Turing) due
3	09/13	09/15	Grading 1: handed out Tuesday and due Thursday
			Weekend: Homework 1 handed out
4		09/22	Critique 2 (Chinese room) due
5	09/27	09/29	Grading 2: handed out Tuesday and due Thursday
			Weekend: Homework 1 due, Homework 2 handed out
6		10/06	Critique 3 (Weng) due
7	10/11	10/13	Grading 3: handed out Tuesday and due Thursday
			Weekend: Homework 2 due
8		10/20	Exam 1; Weekend: Homework 3 handed out
9		10/27	Critique 4 (Brooks) due
10	11/01	11/03	Grading 4: handed out Tuesday and due Thursday
			Weekend: Homework 3 due, Homework 4 handed out
11		11/10	Critique 5 (Cangelosi) due
12	11/15	11/17	Grading: handed out Tuesday and due Thursday
			Weekend: Homework 4 due, Homework 5 handed out
13	11/22		Critique 6 (Urmson) due. Selection of Homework 5 topics.
14	11/29	12/01	Grading 6: handed out Tuesday and due Thursday
			Continue discussions with Weng for Homework 5 during the week
15		12/08	Exam 2
16			Final exam week, no class. Weekend: Homework 5 due via email

A hard copy of each due, including program source program, must be handed in at the beginning (not at the end) of the class on the due date. In case of documented schedule crisis (e.g., university team competition) contact the instructor well in advance and provide proof documents.

8 Grading Policy

You will receive grades for this course based on your performance measured as follows.

- Assigned reading, critiques and your grading of critique – 10 %.

  Totally 6 critiques. Within each critique, grading counts as 20%. Late grading will be counted as zero (i.e., you will receive at most 80% for the critique). Each day of late submission of the critique will deduct 20%.

- Assigned homework/programming – 60%.

  We will have about 5 homework/programming assignments. Each day of late work will deduct 20%.

- Two exams – 25%.

  There will be two exams.

- Class Participation – 5%.

  This will be based on in-class quizzes, entered during each class via ICliker. Each answer consists of 50% participation and 50% correctness. No answer before the ICliker poll ends will be therefore counted as 0% for the quiz.

9 Auxiliary Resources

Here is a source list of reading material pertinent to AI. At various points during the course, you may want more detail on some particular topic. Don't forget to check for AI resources on the web (e.g. the AAAI web page etc.).

9.1 Some AI Books

- *Natural and Artificial Intelligence: Introduction to Computational Brain-Mind,* by Juyang Weng, BMI Press, 2012.

- *Artificial Intelligence* by Russell and Norvig, Prentice-Hall, 3rd edition.

- *Handbook of AI*, Paul Cohen and Ed Feigenbaum (editors), published by Kaufmann. (in reserve collection).

- *Artificial Intelligence*, 3rd edition, by Pat Winston, Addison Wesley.

- *Pattern Classification*, 2nd edition, by Duda, Hart, and Stork, Wiley.

- *Essentials of AI*, Matt Ginsberg, Morgan Kaufmann.

- *An Introduction to Genetic Algorithms*, M. Mitchell, MIT Press. (Supplemental reading for genetic algorithms.)

- *Rethinking Innateness: A Connectionist Perspective on Development*, J.L. Elman and E. A. Bates and M. H. Johnson and A. Karmiloff-Smith and D. Parisi and K. Plunkett, MIT Press. (Supplemental reading for mental development.)

9.2 Some Supplemental Readings and Journals

- *Artificial Intelligence journal*, Elsevier press.

- *IEEE Transactions on Autonomous Mental Development.*

- *AMD Newsletters*, the publication of the IEEE CIS AMD Technical Committee.
  http://www.cse.msu.edu/amdtc/amdnl/

- Conference proceedings: AAAI, IJCAI, WCCI, IJCNN, International Conference on Development and Learning (ICDL, later ICDL-EpiRob), International Conference on Brain-Mind (ICBM).

- *Mental Development Repository* http://www.mentaldev.org/

- *Brain-Mind Magazine* published by the Brain-Mind Institute: http://www.brain-mind-magazine.org/

9.3 Cognitive Science Seminar Series at MSU

MSU hosts a Distinguished Cognitive Science Speaker series each year. The dates and speakers can be found at the URL **http://www.cogsci.msu.edu/**. Please try to attend these talks, as the featured speakers are some of the most well-known people in the field. These talks would provide you with some perspectives on the material covered in the course.

9.4   Software

DN software and data for the AIML Contest: http://www.brain-mind-institute.org/AIMLcontest/