BMI 861 Brain Automata
A Distance Learning Course
July 30 - Aug. 17, 2018
http://www.brain-mind-institute.org/

Brain-Mind Institute (BMI)   3 credits   Available via Internet

This course is intended for those majoring in biology, neuroscience, psychology, electrical engineering, and all others who have not learned the theory of Turing Machines. Students will learn the symbolic brain theory related to how the brain works, leaving the emergent brain theory to BMI 871. Agents. Continuous time and discrete time. Mathematical induction. Finite Automata. Concepts as actions. Spatial abstraction. Temporal abstraction. Turing Machines. Universal Turing Machines. Von Neumann computers. Rules vs. data. Formal languages. The controller of a Turing machine is a Finite Automaton. Brains as ground and emergent Turing Machines.

Lectures: Each lecture in video is available online, Monday to Friday, via Internet. Due to the material of this course, the instructor has decided to use chalkboard for lectures, instead of PowerPoint slides. You are encouraged to take the class notes if you like but this is not required. Unfortunately, Google is currently not available from China. Lecture video files will be available at Baidu Cloud `pan.baidu.com`. You will receive email for sharing the files, but the files are for your eyes only because they are copyright protected. I have also provided some of my personal notes (not including the last day) that I use for giving lectures which are probably not as detailed as your own notes you should take while watching the lecture video. Some lectures will mention the models taught at BMI 871, but treat them as a preview only if you have not taken BMI 871.

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    Course web: `http://www.brain-mind-institute.org/bmi-861.html`

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Prerequisites: An admission to a bachelor degree in any discipline is generally sufficient. Physical science and social science applicants are all encouraged. This course is self-contained for the course homework assignments and exams.

Required text: John Martin, Introduction to Languages and the Theory of Computation, 4th edition, ISBN: 978-0073191461, McGraw-Hill, New York, 2011. This text does not mention brains at all. Additional material related to brains will be added during the lectures.

Homework: There will be homework assignments, administered through LON-CAPA, an integrated system for online learning and assessment, at http://s10.lite.msu.edu. The due time for each homework is provided in Table 1 but you should complete the homework before the following lecture so that you can understand. Homework will be collected via email and some will be graded.

Table 1: Homework and Exams

Week	Day	Assignment	Due
1	1	Homework 1.1	End of Tue.
	2	Homework 1.2	End of Wed.
	3	Homework 1.3	End of Thu.
	4	Homework 1.4	End of Fri.
	5	Homework 1.5	End of Sat.
	7	Exam 1 (open 8:00am)	10:00am
2	1	Homework 2.1	End of Tue.
	2	Homework 2.2	End of Wed.
	3	Homework 2.3	End of Thu.
	4	Homework 2.4	End of Fri.
	5	Homework 2.5	End of Sat.
	7	Exam 2 (open 8:00am)	10:00am
3	1	Homework 3.1	End of Tue.
	2	Homework 3.2	End of Wed.
	3	Homework 3.3	End of Thu.
	4	Homework 3.4	End of Fri.
	5	Homework 3.5	End of Sat.
	7	Exam 3 (open 8:00am)	10:00am

Exams: Three exams, to be done during the following Sunday of each week, of 1.5 hours each. Each exam is opened during only 8:00am - 10:00am Eastern Daylight Time (EDT), 8:00pm - 10:00pm Beijing Time. Exams are closed book and must be done within the above time length. See Table 1. Reading textbook and doing homework are also important for doing well in the exams.

Exam proctor: You need to identify a keep-an-eye-on-you exam proctor who is a licensed librarian, one of your parents, or a licensed teacher. Send the proctor's name, address, email address, and proof of qualification required above to the instructor via email. Grading results of the exams are private and confidential, not known to the proctor. Ask the proctor to send a statement via email, at least 24 hours before the first exam, with email subject "BMI 861 Proctor Statement for First-Name Last-Name" to the instructor: "I guarantee to observe the responsibilities of the proctor, including the closed-book, no-access-to-electronics, and the exam time length requirements." The proctor is responsible for printing the exam before the exam and, within 1.5 hours after giving you the exam, taking a picture of your answer sheet and sending it back via email before the due time of the exam.

Grading: Three exams equally weighted, each counted as 100%/3. Homework is not counted for the total score. Pass: the total score is 60% or above. Those who successfully pass will receive a BMI 861 Certificate.

Piazza Discussion Forum We will use Piazza as a discussion and notification forum for this class. The web site is at https://piazza.com/brain-mind_institute. You will receive an invitation to

join Piazza in the first week of class. The instructor will monitor Piazza and may choose to 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 the first week of class contact the instructor. However, Piazza is not always effective for asking last-minute technical questions.

Schedule for Dues

See Table 1, where all the items are in the U.S. Eastern Daylight Time (EDT). Send your completed homework before the due time to the lecturer with email Subject: BMI861 Homework W.N by Your-First-Name Your-Last-Name. Send your completed exam before the due time to the lecturer with email Subject: BMI861 Exam N by Your-First-Name Your-Last-Name. The title format is important because the instructor receives too many emails everyday.

Course Schedule

The added contents are marked by asterisk ∗. The section numbers refer to the textbook.

- Week 1, Day 1, Monday: ∗ Agents and Brains. ∗ Symbols and Patterns.

- Week 1, Day 2, Tuesday: 1.1 Logic and Proofs. 1.2 Sets.

- Week 1, Day 3, Wednesday: 1.3 Functions and Equivalence Relations. 1.4 Computer Languages. ∗ Natural Languages.

- Week 1, Day 4, Thursday: 1.5 Recursive Definitions. 1.6 Structural Induction.

- Week 1, Day 5, Friday: 2.1 Finite Automata: Examples and Definitions. ∗ Brain Controls as Emergent Finite Automata.

- Week 2, Day 6, Monday: 2.2 Accepting the Union, Intersection, or Difference of Two Languages. 2.3 The Pumping Lemma.

- Week 2, Day 7, Tuesday: 2.5 How to Build a Simple Computer Using Equivalent Classes. 2.6 Minimizing the Number of States in a Finite Automaton

- Week 2, Day 8, Wednesday: ∗ Concepts and abstraction. ∗ Attention in Space and Time.

- Week 2, Day 9, Thursday: 3.1 Regular Languages and Regular Expressions. 3.4-3.5 Kleene's Theorem.

- Week 2, Day 10, Friday: 7.1 A General Model of Computation. 7.2-7.3 Turing Machines. 7.4 Combining Turing Machines. 7.5 Multi-tape TMs.

- Week 3, Day 11, Monday: 7.6 The Church-Turing Thesis. 7.7 Non-deterministic TMs. 7.8 Universal Turing Machines.

- Week 3, Day 12, Tuesday: ∗ Semantics and Syntax. 4.1 Using Grammar Rules to Define a Language. 4.2 Context-Free Language. 4.3 Regular Languages and Regular Grammars.

- Week 3, Day 13, Wednesday: 4.4 Derivation Tree and Ambiguity. 5.2 Deterministic PDA. 5.3 A PDA from a Given CFG. 5.4 A CFG from a Given PD. 8.1 Recursively Enumerable and Recursive. 8.2 Enumerating a Language. 8.3 More General Grammars.

- Week 3, Day 14, Thursday: ∗ Attentive FA.

- Week 3, Day 15, Friday: 11.1 The Time Complexity of a TM. ∗ Complexity of Brains. ∗ Traditional Complexity.