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 Course Syllabus
 

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**Instructor:** Robert R. Snapp, email: [snapp@cs.uvm.edu](mailto:snapp@cs.uvm.edu), office: 353 Votey, phone: 656-0735.

**Office Hours:** Tue 1:30-3:00 PM, Wed 3:30-4:30 PM, Fri 9:30-11:00 AM, and by appointment.

**Lab Instructor:** Paul Haake, email: [phaake@uvm.edu](mailto:phaake@uvm.edu), office hours: *TBA*.

**Lectures:** MWF, 11:15 - 12:05 p.m. in 367 Votey Hall.

**Discussion/Lab Sessions:** In room 206 Votey Hall:

Lab	Day	Scheduled Time
L01	Wed	4:40-6:30 PM
L02	Thu	3:30-5:20 PM
L03	Thu	6:30-8:20 PM

**Web Page:** [www.cs.uvm.edu/~snapp/puzzles/](http://www.cs.uvm.edu/~snapp/puzzles/)

**Description:** An introduction to computer science that explores the history, rules, and strategies for puzzles and games, such as Rubik's Cube, chess, and go. We will introduce both mathematical and computational tools that allow computers to solve puzzles and play games. We will also learn and use the scheme programming language; however, we will emphasize *computational thinking* over *computer programming*.

This course satisfies the Mathematical Sciences distribution requirement for Bachelor of Arts students enrolled in the College of Arts and Sciences.

**Prerequisites:** None.

**Texts:** Online course notes. Some readings will be assigned during the course of the semester from books and articles distributed in class or placed on reserve in the Bailey-Howe Library.

**Materials:** The following materials are required:

- Two (or more) six-sided dice.
- Fifty to one-hundred counters (e.g., pennies, buttons, poker chips, dry beans, M&Ms).
- A standard  $3 \times 3 \times 3$  Rubik's cube, available at either Barnes & Noble, or Vermont Toy and Hobby.

**Computer Software:** Dr. Scheme. You may download this for free from the web site <http://www.drscheme.org>, for MS Windows, MacOS X, and Linux.

#### Grading Policy:

The final letter grade you receive on your transcript will be an absolute measure of your achievement and understanding, as follows:

Percentage	Grade	Percentage	Grade
98 — 100	A+	78 — 79	C+
92 — 97	A	72 — 77	C
90 — 91	A-	70 — 71	C-
88 — 89	B+	68 — 69	D+
82 — 87	B	62 — 67	D
80 — 81	B-	60 — 61	D-
		0 — 59	F

The course grade will be based on

- attendance and participation (20%),
- graded homework (20%),
- quizzes (20%, after dropping the lowest quiz),
- two midterm exams (20%), and the
- final exam (20%).

There will be many opportunities for extra credit: motivated students can complete an approved project, lead a discussion in a lab, or lecture session, etc.

**Attendance and Participation:** You are required to attend every lecture, one laboratory session per week, and the field trip (see below). You should come prepared for each session, and actively participate in discussions, and laboratory and classroom exercises.

**Field Trip:** On Saturday, *September 29* (rain date: October 13), we will visit and solve a corn maze situated in the Northeast Kingdom that has over two miles of twisty passages. Please bring a sack lunch and something to drink. The bus will leave UVM from the Royal Tyler Theater at 9:30 AM, and will return around 4:30 PM. (If you are not able to attend the field trip, you must notify the instructor by Friday, September 14, 2007, in order to receive an alternate assignment.)

**Homework:** Homework, which includes reading, writing, problem solving, programming, puzzle & game creation, and *play*, will be assigned on a regular basis. Graded assignments will be identified in advance. Late homework will be penalized 20% credit per day.

A significant fraction of the homework will consist of expository writing, which will be graded on relevance, creativity, correctness (grammar, spelling, punctuation, etc.), and style. A useful reference for the latter is *The Elements of Style*, by Strunk and White, listed in the bibliography below. You are also encouraged to consult the UVM Writing Center located both in the Learning Cooperative, 244 Commons, L & L, and in the Bailey-Howe Library (across from the reference desk). More guidance on written assignments, including citation style, will be provided later on in the course.

Some assignments will involve reading and writing simple programs with drscheme. Individual help for programming is available during the laboratory sessions, and office hours. The computer science department also supports some open help sessions for all computer science students at posted times in room Votey 246.

**Quizzes:** Approximately ten "pop" quizzes will be given during the term. Each quiz will consist of one or two short exercises that are usually similar to the homework, or to recent laboratory or class activities. The lowest quiz grade will be dropped. There will be no make-ups for missed quizzes.

**Midterm Exams:** Two midterm exams will be given in class: the first, on Friday, **October 12**; and the second, on Friday, **November 16**. The material covered on each exam will be announced one week in advance.

**Final Exam:** The final exam for this course is scheduled for 3:30–6:30 PM, Friday, **December 7**.

*Students entitled to special accommodation must notify the instructor by the second week of the semester.*

**Computer Accounts:** Each student will receive an EMCF computer account, which will allow you to use the computers in room 206, as well as all other public computers in Votey Hall. *Drscheme* should be installed on the both the Windows and Unix platforms.

**Collaboration:** You are *encouraged* to share your knowledge, discoveries, and ideas with other students outside of class. However, all work (e.g., ideas, opinions, analyses, algorithms, data, and source code) generated by others should be properly cited, preferably with an archival source (e.g., a printed book or a peer-reviewed article). In general, sources that appear only on the internet (such as *Wikipedia*) are not sufficient. Every phrase that is not your own should appear between quotation marks, with a footnote or end-note that indicates the source.

*Do not plagiarize. Do not cheat. Do not collude. Do not fabricate. Absolutely no collaboration or unauthorized material is allowed during any quiz or exam.* All violations will be forwarded to the University Coordinator of Academic Honesty, following the *new* policy of Academic Integrity posted at

[www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf](http://www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf)

The first deliberate violation of academic integrity by an undergraduate normally results in a course grade of XF; the second, with a second XF and expulsion.

**Etiquette:** If you own a laptop computer, you may find it useful on occasion to bring it to class. However, your computer activity must be relevant to the class or lab activity. The use of cell phones or other personal electronic devices (MP3s, iPods, radios, etc.) is not allowed. Absolutely no calculators, laptops, phones, or other electronic devices are allowed during quizzes or exams.

### Topics

*The following topics are subject to change. We will try to discuss puzzles and games that pique our interests, so if you have a favorite, please let me know as soon as possible. We will try to describe the history, rules, and strategies for each puzzle and game we study. We will also describe how computers can solve puzzles and play games.*

- Introduction to puzzles and games.
- *Homo ludens*: the importance of play, and what makes play fun?
- Word puzzles (crosswords, anagrams, etc.), card shuffles, & permutations
- Sudoku puzzles
- Introduction to scheme programming: factorials, Pascal's triangle, and Fibonacci numbers.

- The history of labyrinths and mazes.
- Graphs and trees.
- How to thread a real maze without getting lost!
- How computers can solve mazes and puzzles.
- Peg solitaire.
- Sliding block puzzles
- Rubik's cube.
- The Tower of Hanoi and Chinese rings.
- Games of perfect information: Tic-tac-toe, mancala, checkers, chess, go, and hex.
- Nim, kayles, game trees & Sprague-Grundy numbers.
- Games of decision (e.g., rock-paper-scissors and prisoner's dilemma).
- Games of chance, including dice games, poker, blackjack, raffles, and lotteries.

**References:** There are many useful reference books dedicated to puzzles and games. The following is my personal list of favorites, and is certainly not complete. Many of them are in the Bailey-Howe Library. The rest are available through interlibrary loan.

### PUZZLES & GAMES:

1. Bonnie Averbach and Orin Chein, *Problem Solving Through Recreational Mathematics*, Dover, NY, 2000.
2. W. W. Rouse Ball and H. S. M. Coxeter, *Mathematical Recreations and Essays*, Thirteenth Edition, Dover, New York, 1987.
3. Christoph Bandelow, *Inside Rubik's Cube and Beyond*, Birkhäuser, Boston, 1982.
4. John D. Beasley, *The Mathematics of Games*, Oxford University Press, Oxford, England, 1989.
5. John D. Beasley, *The Ins and Outs of Peg Solitaire*, Oxford University Press, Oxford, England, 1992.
6. Anatole Beck and Michael N. Bleicher and Donald W. Crowe, *Excursions into Mathematics*, Worth Publishers, Inc., New York, 1969.
7. R. C. Bell, *Board and Table Games From Many Civilizations*, Revised Edition, Dover, NY 1979.
8. Elwyn R. Berlekamp, *The Dots and Boxes Game: Sophisticated Child's Play*, A. K. Peters, Ltd., Natick, MA, 2000.
9. Elwyn R. Berlekamp, John H. Conway and Richard K. Guy, *Winning Ways for Your Mathematical Plays*, Second Edition, A. K. Peters, Ltd., Natick, MA Volume 1, 2001; Volume 2, 2003; Volume 3, (2003) & Volume 4, (2004), (*advanced*).
10. Elwyn Berlekamp and Tom Rodgers, *The Mathematician and Pied Puzzler: A Collection in Tribute to Martin Gardner*, A. K. Peters, Ltd., Natick, MA, 1999.
11. Ken Binmore, *Fun and Games: A Text on Game Theory*, D. C. Heath and Co., Lexington, MA, 1992.
12. Cameron Browne, *Hex Strategy: Making the Right Connections*, A. K. Peters, Natick, MA, 2000.
13. Roger Caillois. *Man, Play and Games*, University of Illinois Press, Urbana, IL, 1961.
14. Stewart T. Coffin, *The Puzzling World of Polyhedral Dissections*, Oxford University Press, Oxford, England, 1990.
15. John H. Conway, *On Numbers and Games*, Second Edition, A. K. Peters, Ltd., Natick, MA, 2001 (*advanced*).

16. Charles Cotton, *The Compleat Gamester*, R. Cutler, London, 1674. Reprinted by Cornmarket Reprints, Cambridge, England, 1972.
17. Marcel Danesi, *The Puzzle Instinct: The Meaning of Puzzles in Human Life*, Indiana University Press, Bloomington, IN, 2004.
18. Henry Ernest Dudeney, *Amusements in Mathematics*, Dover, New York, 1970.
19. Henry Ernest Dudeney, *The Canterbury Puzzles*, Dover, New York, 1958.
20. Henry Ernest Dudeney, *536 Puzzles & Curious Problems*, Scribners, New York, 1967.
21. Ross Eckler, *Making the Alphabet Dance*, St. Martin's Press, New York, 1996.
22. Anthony S. Filipiak, *Mathematical Puzzles and Other Brain Teasers*, Bell Publishing Company, New York, 1942.
23. David B. Fogel, *Blondie24: Playing at the Edge of AI*, Morgan Kaufmann, San Francisco, 2001.
24. Martin Gardner, *The Colossal Book of Mathematics*, W. W. Norton, New York, 2001.
25. Martin Gardner, *A Gardner's Workout: Training the Mind and Entertaining the Spirit*, A. K. Peters, Ltd., Natick, MA, 2001.
26. Martin Gardner, *The Unexpected Hanging and Other Mathematical Diversions*, The University of Chicago Press, Chicago, IL, 1991.
27. Martin Gardner, *Hexaflexagons and Other Mathematical Diversions*, The University of Chicago Press, Chicago, IL, 1988.
28. Martin Gardner, *The 2nd Scientific American Book of Mathematical Puzzles & Diversions*, Simon & Schuster, New York, 1961.
29. Martin Gardner, *New Mathematical Diversions from Scientific American*, Simon & Schuster, New York, 1966.
30. Martin Gardner, *Wheels, Life and Other Mathematical Amusements*, W. J. Freeman, San Francisco, CA, 1983.
31. Solomon W. Golomb, *Polyominoes*, Revised Edition, Princeton University Press, Princeton, NJ, 1994.
32. Catherine Perry Hargrave, *A History of Playing Cards*, Dover, NY, 2000.
33. L. E. Hordern, ed., *Hoffmann's Puzzles Old & New*, Cane End House, Reading, England, 1893 (*modern reprint*).
34. L. E. Hordern, *Sliding Piece Puzzles*, Oxford University Press, Oxford, England, 1986.
35. Jean-Marie L'Hôte, *Histoire des Jeux de Société*, Flammarion, Paris, 1994.
36. Johan Huizinga, *Homo Ludens*, Routledge & Kegan Paul, Ltd., London, 1950. Reprinted by The Beacon Press, Boston, 1955.
37. David Joyner, *Adventures in Group Theory: Rubik's Cube, Merlin's Machine & Other Mathematical Toys*, Johns Hopkins University Press, Baltimore, MD, 2002 (*advanced*).
38. Hermann Kern, *Through the Labyrinth: Designs and Meanings over 5000 Years*, Prestal, Munich, Germany, 2000.
39. Janice Kim and Jeong Soo-hyun, *Learn to Play Go*, Volumes 1–4, Good Move Press, Corte Madera, CA, 1997.
40. Boris A. Kordemsky, *The Moscow Puzzles: 359 Mathematical Recreations*, Dover, NY, 1972.
41. Sam Loyd, *Cyclopedia of Puzzles*, Lamb Publishing Company, New York, 1914.
42. Édouard Lucas, *Récréations Mathématiques*, second edition, Gautier-Villars et fils, Paris; vols. 1–4, 1882–94. Reprinted by Blanchard, Paris, 1979.
43. W. H. Matthews, *Mazes and Labyrinths: A General Account of Their History and Developments*, Longmans, Green, and Co., London, 1922 (*available in an inexpensive Dover reprint*).
44. Geoffrey Mott-Smith, *Mathematical Puzzles for Beginners and Enthusiasts*, The Blakiston Company, Philadelphia, PA, 1946.
45. S. Brent Morris, *Magic Tricks, Card Shuffling and Dynamic Computer Memories*, Mathematical Association of America, Washington, D.C., 1998.
46. H. J. R. Murray, *A History of Board-Games Other than Chess*, Oxford University Press, Oxford, 1951.
47. H. J. R. Murray, *A History of Chess*, Oxford University Press, Oxford, 1913.
48. Richard J. Nowakowski, *Games of No Chance*, Cambridge University Press, Cambridge, England, 1998, (*advanced*).
49. Richard J. Nowakowski, *More Games of No Chance*, Cambridge University Press, Cambridge, England, 2002 (*advanced*).
50. T. H. O'Beirne, *Puzzles & Paradoxes*, Oxford University Press, New York, 1965.
51. David Parlett, *The Oxford History of Board Games*, Oxford University Press, London, 1999.
52. William Poundstone, *Fortune's Formula: The Untold Story of the Scientific Betting System that Beat the Casinos and Wall Street*, Hill and Wang, New York, 2005.
53. Ernő Rubik and Tamás Varga and Gerzson Kéri and György Marx and Tamás Vekerdy, *Rubik's Cubic Compendium*, Oxford University Press, Oxford, England, 1987.
54. Stuart Russel and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Second Edition, Prentice Hall, Upper Saddle River, NJ, 2003.
55. Larry Russ, *The Complete Mancala Games Book*, Marlowe & Co., NY, 2000.
56. Arther M. Sackler Gallery, *Asian Games: The Art of Contest*, Asia Society, New York, 2004.
57. Sid Sackson, *Card Games Around the World*, Dover, NY, 1981.
58. Katie Salen and Eric Zimmerman, *Rules of Play*, MIT Press, Cambridge, MA, 2003.
59. Katie Salen and Eric Zimmerman, ed., *The Game Design Reader*, MIT Press, Cambridge, MA, 2005.
60. John Scarne, *Scarne's Encyclopedia of Card Games*, Harper & Row, New York, 1983.
61. John Scarn, *Scarne on Dice*, Stackpole Books, Harrisburg, PA, 1974.

62. Jonathan Schaeffer, *One Jump Ahead: Challenging Human Supremacy in Checkers*, Springer-Verlag, New York, 1997.
  63. David G. Schwartz, *Roll the Bones: The History of Gambling*, Gotham, 2006.
  64. Jerry Slocum, *The Tangram Book*, Sterling Publishing, New York, 2003.
  65. Jerry Slocum and Jack Botermans, *Puzzles Old & New*, University of Washington Press, Seattle, WA, Fourth Edition, 1994.
  66. Jerry Slocum and Dic Sonneveld, *The 15 Puzzle*, Slocum Puzzle Foundation, 2006.
  67. David Singmaster, *Notes on Rubik's Cube*, Enslow, Hillside, NJ, 1980.
  68. Claude E. Shannon, "Programming a computer for playing chess," *Philosophical Magazine*, **41**, 1950, pp. 256-275.
  69. Raymond Smullyan, *What is the Name of This Book: The Riddle of Dracula and Other Logical Puzzles*, Prentice-Hall, Englewood Cliffs, NJ, 1978.
  70. Edward Snow, *Inside Bruegel: The Play of Images in Children's Games*, North Point Press, New York, 1997.
  71. Bernard Suits, *The Grasshopper: Games, Life and Utopia*, University of Toronto Press, Toronto, Canada, 1978.
  72. Pieter van Delft and Jack Botermans, *Creative Puzzles of the World*, Abrams, Amsterdam, 1978.
  73. John J. Watkins, *Across the Board: The Mathematics of Chessboard Problems*, Princeton University Press, Princeton, NJ, 2004.
  74. David Wells, *The Penguin Book of Curious and Interesting Puzzles*, Penguin Books, London, 1992.
  75. Peter Winkler, *Mathematical Puzzles: A Connoisseur's Collection*, A. K. Peters, Natick, MA, 2004.
  76. David Wolfe and Tom Rodgers, *Puzzler's Tribute: A Feast for the Mind*, A. K. Peters, Ltd., Natick, MA, 2002.
  77. Craig Wright, *The Maze and the Warrior: Symbols in Architecture, Theology, and Music*, Harvard University Press, Cambridge, MA, 2004.
- SCHEME PROGRAMMING:
1. Matthias Felleisen, Robert Bruce Findler, Matthew Flatt, and Shriram Krishnamurthi, *How to Design Programs: An Introduction to Programming and Computing*, MIT Press, Cambridge, MA, 2002. (Available on line at [www.htdp.org](http://www.htdp.org).)
  2. Daniel P. Friedman and Matthias Felleisen, *The Little Schemer*, MIT Press, 1996.
- WRITING:
1. William Strunk Jr., E.B. White, *The Elements of Style*, fourth edition, Allyn & Bacon, Needham Heights, MA, 1999.