These problems were chosen to help you prepare for the first midterm, scheduled for Friday, October 17, 2014. Please try to solve as many as you can by this date. For every correct and complete solution that is turned in before the exam, one extra credit point will be added to your midterm score, up to a maximum of 15 points. (Attach extra pages if necessary.) Please note that some of the problems (marked with a ♦) are considerably more difficult than any problem likely to appear on the midterm. You may collaborate with other students, however, the work that you turn in should be distinctly your own, reflecting your own words, thoughts, and computations.

GOOD LUCK!

1. (1 point.) On October 17, 1777, General Burgoyne along with over 5,000 British troops surrendered to the Continental Army at Saratoga, an action that is regarded by many as the turning point in the American Revolutionary War. Use the doomsday algorithm to find the day of the week for this historical date.

2. (1 point.) Alan Turing was one of the most important computer scientists in history, often referred to as the “father” of the field. His leadership as a British cryptologist during the second world war resulted in the breaking of the Enigma cypher, the code used by the Germans to communicate with their troops, ships, and U-boats. This achievement likely saved the United Kingdom from German occupation as it allowed American supply ships, laden with food and arms, to avoid the Germans as they sailed across the Atlantic Ocean. Alan Turing was born on June 23, 1912. Use the doomsday algorithm to determine the corresponding day of the week.
3. (1 point.) In *Man, Play and Games*, Roger Caillois defined four categories of play. For each category identify one corresponding activity depicted within Pieter Bruegel’s painting *Kinderspiele*.

4. (1 point.) How many anagrams can be constructed using each letter in the word “illustrious”?

5. (1 point.) How many of the anagrams found in the previous problem begin with the letter *i* and end with the letter *s*?
6. (1 point) How many unique anagrams can be constructed from the letters in the word *supercalifragilisticexpialidocious*.

Use Dr. Racket to compute the exact answer and attach a printout of your interaction window.

7. (1 point) Six distinct coins (e.g., a penny, nickel, dime, quarter, half-dollar, and one-dollar coin) can be distributed to Alice and Bob in several ways. For example Alice can receive all six coins, and Bob none; or Alice can receive the penny, nickle, and dime, and Bob the quarter, half-dollar, and one-dollar coin. In how many ways can these six different coins be distributed to two people?

8. (1 point) Michelle bought a Euralpass for her summer vacation, along with a round-trip plane ticket to Paris, France. She would like to spend one night in each of the following cities: Bordeaux, Chartres, Dijon, Grenoble, Lyon, Marseille, Nice, Orléans, Rouen, Strasbourg, and Toulouse. After 11 nights, Michelle will return home. In how many different orders can she visit these 11 cities? Please provide a numerical answer.
9. (1 point.) In the following maze, please label the entrance, goal, each junction and dead-end with a unique symbol, e.g., $a, b, c, \ldots, z, \alpha, \beta, \gamma, \ldots$, as we did in the notes for the Hampton Court maze. Then in the space below, please construct an equivalent labeled graph. Is the graph connected? Is it cyclic? Can the maze be threaded by following either the right or left wall?
10. *(1 point.)* For the same maze (see below), apply Trémaux’s algorithm. Trace the path that a *left-bearing mouse* will follow, and place an *N* or *X* at the end of each path that is traversed, as appropriate.
11. *(1 point.)* A complete set of double-six dominoes consists of the following 28 tiles.

![Diagram of dominoes]

After the initial tile is placed on the board, players may only place a piece that matches one of the exposed ends. Use Euler’s theorem to show that it is possible to place all 28 dominoes in a single row so that the ends of the adjacent tiles match. *(Hint: Construct a graph that has 7 vertices, labeled 0, 1, 2, 3, 4, 5, and 6, and represent every tile by an edge in the graph. For example, the piece (1, 2) would be represented by an edge that connects vertices 1 and 2, and the piece (3, 3), by an edge (or loop) that connects vertex 3 with itself.)*
12. (1 point.) Evaluate the following expression in racket. (First try them using pencil and paper, then check your work with Dr. Racket.)

  (a) (+ 1 1)

  (b) (+ 1 (/ 1 (+ 1 1)))

  (c) (+ 1 (/ 1 (+ 1 (/ 1 (+ 1 1)))))

  (d) (+ 1 (/ 1 (+ 1 (/ 1 (/ 1 (+ 1 1)))))))

  (e) What number is being approached in this sequence? What is its exact value.

13. (1 point.) Create a racket function called (sum-of-squares n), that evaluates the sum

\[ 1^2 + 2^2 + 3^2 + 4^2 + \ldots + n^2 \]

for any positive integer \( n \). Thus, (sum-of-squares 3) should evaluate to 14, the sum of \( 1^2 + 2^2 + 3^2 \).
14. (1 point.) Using only your brain, please evaluate each of the following expressions. Then evaluate each expression using Dr. Racket to check your answers.

(a) (null? (quote ()))

(b) (null? '(quote ()))

(c) (null? 0)

(d) (eq? (even? 1) (odd? 2))

(e) (>= 1 2 3 4 5)

(f) (zero? (- 0 (random 1)))

15. (1 point.) Using only your brain, please evaluate the following expressions

(a) (car '(apple pear plum))

(b) (cdr '(apple pear plum))

(c) (null? (cdr (cdr (cdr '(apple pear plum)))))

(d) (cons 'ant '(bee caterpillar dragonfly))

(e) (list 'ant '(bee caterpillar dragonfly))

(f) (append '(peanut cashew walnut) '(filbert almond pecan))