There are 72 points possible.
According to the working definitions we have given in class:

1. (2 points) What is the difference between a “committal algorithm” and a “non-committal algorithm”.

2. (2 points) Which of the following is not currently a major subarea of Artificial Intelligence research:
   (a) a. Perception
   (b) b. Inference
   (c) c. Knowledge Representation
   (d) d. RPS Safari
   (e) e. Search

3. (2 points) Briefly explain what “overfitting” means.
4. Please answer the following questions True or False. No need to justify your answers (1 point each):

(a) If a row of a nonempty SAT matrix is all *s the matrix is definitely not satisfiable.
(b) Lisp can be compiled.
(c) Random agents are never intelligent.
(d) A system with 4 states has an entropy of no more than 2 bits.
(e) If a column of a nonempty SAT matrix is all *s the matrix is definitely not satisfiable.
(f) In Common Lisp all s-expressions are considered true unless they are \textit{nil} or \texttt{(} (the empty list).
(g) In Lisp \texttt{setf} can be used to assign a value to a symbol.
(h) Deterministic agents are never intelligent.
(i) Perceptrons can never be intelligent (as defined in class).
(j) Playing deterministically in RPS-Safari is illegal.
(k) If a function can be represented on a simple perceptron it can be learned by that perceptron.
(l) Finding optimal (smallest) decision trees that explain all the data is NP-hard.
(a) (6 points) Give a perfect perceptron and perfect decision tree and perfect nearest neighbor table for this data: (Show your work):

000 1
001 1
010 1
011 1
100 0
101 1
110 0
111 1

(b) (5 points) Prove or disprove: In N-pile NIM one should never move to a configuration in which the total number of sticks remaining is a prime number greater than 2.

(c) (5 points) Prove or disprove: All NxN tile puzzles in which exactly three tiles (not the blank) are out of place are not solvable.
(d) (3 points) What is weird definitionally about the phrase "uniformly random"?

(e) (3 points) Which is most true about the random number generator in Lisp?
   a) It produces random number sequences
   b) It is deterministic
   c) It is stochastic

(f) (3 points) Which relationship occurs least with financial instruments?
   a. As standard deviation of return drops, expected return drops.
   b. As expected return increases, standard deviation of return drops.

(g) (3 points) Briefly explain the main differences between the rules of P2, P3 and P4 in RPS Safari.

(h) (3 points) In what situation may breadth first search be better than iterative deepening? Why?

(i) (3 points) Give 3 examples of admissible heuristics for the tile puzzles.
1 Answer carefully:

5. (4 points) Prove the following propositional logic statement using either Resolution or SAT matrices or Existential Graphs OR Disprove by showing a counterexample!

\[ ((\neg P \rightarrow Q) \rightarrow (P \rightarrow (Q \land R \land S))) \]

Assume E and A are quantifiers below. GANESH is a constant.

6. (4 points)
Using resolution or EGs, show (or disprove using a counterexample) that

\[ ((\forall y \text{ Animal}(y)) \rightarrow \neg \text{Animal}(\text{GANESH})) \rightarrow [((\exists z \text{ Animal}(z)) \lor \text{Animal}(\text{GANESH})]. \]
2 LISP functions for you to write!

(a) (4 points) Write a Lisp function (defun substring (l1 l2) that takes two lists of integers l1 and l2 and returns t if l1 is a consecutive (no skips) substring of l2. For example, '(1 2 3) is a substring of '(4 1 2 3 5 6 7), but '(1 2 5) is not.

(b) (4 points) Write a Lisp function (defun maxbit (l) that takes a list of 0 or 1 and returns nil if the number of 0s and 1s are equal, else 1 if there are more 1s than 0s, or 0 if there are more 0s than 1s you may not use sort, count, length, any arithmetic functions or any lambdas or other defuns!

(c) (4 points) Define a Lisp function Summer that takes a list of triplets of integers and returns a list of the corresponding sums: e.g. (Summer '((1 2 3) (5 7 8) (0 1 -8))) should return (6 10 3). If the list is nil, (0 0 0) should be returned.