Comments on Problem Set 3 (CSE 573)

1. **(R&N 18.4)**

   [2 points]

   Every one got full credit on this problem.

   (Solution by Daniel Lowd)

   In a given path, once we split on a variable, all children of the node where the split occured have identical values for the split variable. Splitting on the same variable again will thus have no effect on the entropy, so that variable will never be selected again.

2. **(R&N 18.14)**

   [2 points] for the formula, [1 point] for the computation of the 9 values, [1 point] for "the removal of independent assumption"

   Minor computation errors in the values of the nine error rates are not subject to penalty.

   (Solution by Noah Snavely)

   Because majority voting is used, in order for the ensemble to possibly give a wrong answer at least $\lceil \frac{M}{2} \rceil$ of the hypotheses must give a wrong answer. If M is even then there is a possibility of a tie, but we'll assume that ties are always broken by choosing the incorrect answer (so the calculated error of the ensemble will be an upper bound). Under the independence assumption, the probability that exactly k hypotheses give a wrong answer is $\binom{M}{k}\epsilon^k(1-\epsilon)^{(M-k)}$. So the probability that at least $\lceil \frac{M}{2} \rceil$ give a wrong answer is

$$E = \sum_{k=\lceil \frac{M}{2} \rceil}^{M} \binom{M}{k} \epsilon^k (1-\epsilon)^{(M-k)}$$

   Here are the values of E for various values of M and ϵ:

M	ϵ	E
5	0.1	0.00856
5	0.2	0.0579
5	0.4	0.317
10	0.1	0.00164
10	0.2	0.0328
10	0.4	0.367
20	0.1	1.011e-13
20	0.2	3.928e-10
20	0.4	9.531e-7

   It is possible for the error to be greater than ϵ if the independence assumption is dropped. Here's an example where this happens: Suppose $M = 3$ and $\epsilon = 0.2$. 70% of the time all 3 agree on the correct answer, however, the other 30% of the time exactly one gives the correct answer (this is consistent with $\epsilon = 0.2$ if each of the three is the one that gives the correct answer exactly one third of the time). This ensemble has an error of 0.3.

(Solution by Raphael Hoffmann)

If the independence assumption is removed, the error can get worse than ϵ. We show this by an example. We have 5 hypotheses $h_i, i \in 1..5$ and 5 elements $e_j, j \in 1..5$ that should be classified. In the following diagram, $\circ$ means correct result and $*$ means false result.

	h_1	h_2	h_3	h_4	h_5	ensemble
e_1	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$
e_2	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$	$\circ$
e_3	$*$	$*$	$\circ$	$\circ$	$*$	$*$
e_4	$\circ$	$\circ$	$*$	$*$	$*$	$*$
e_5	$*$	$*$	$*$	$\circ$	$\circ$	$*$

It can be easily seen that the error rate of each hypotheses is $\leq \frac{2}{5}$. However, the ensemble has an error rate of $\frac{3}{5}$.

3. (R&N 11.4)

[2 points for (a), 3 points for (b), 2 points for (c), 2 points for (d)]

Almost all people failed to include "*from* is not equal to *to*" in the preconditions of Go and Push in (b). It can be done without using a negation if you define a not-equal relation. No points were deducted if you used negations in the preconditions, although to be strictly compliant to STRIPS negations must be removed from preconditions.

4. (R&N 11.7)

[1 point for (a), 2 points for (b), 3 points for (c)]

Almost all people answered correctly to (a). Since (b) has umbiguity in the definition of "spurious", both yes and no with consistent reasoning were given full credit.

5. (R&N 5.4)

[4 points for (a), 4 points for the first part of (b), 1 point for the last part of (b) "question of which formulation is better"]

Most people got full credit for this problem.

6. (R&N 5.8)

[3 points]

Most people answered to this problem well enough to get the full credit.

7. Project

[4 points]

Everyone got the full credit.