1. a. **[3 points]** Argue whether the following is a valid argument by the truth table.

Either John isn't stupid and he is lazy, or he's stupid. John is stupid.

Therefore, John isn't Lazy.

(Consider `Either X or Y' as `X xor Y')

b. **[3 points]** Argue whether the above statement is a valid argument or not using inference rules.

2. **[6 points]** Prove using inference rules, S1 → S4

S1: P → Q

S2: R →¬ Q

S3: P → ¬ R

S4: S2 → S3

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P →

¬(P →

3. **[6 points]** Convert the following into a CNF $\neg(P \rightarrow (Q \wedge R))$.

4. **[1+2 points]** What was the AlphaGo system developed for ? Please explain the AI problem that it tackles and why this problem is difficult or challenging to solve ?

The AlphaGo system was developed for the game Go. It was developed based on human training data to play (and win) against the game Go. It is difficult as it has to solve a large number of problems and computations not solvable by brute force.

2.5

5. **[9 points]** Suppose a training set consists of points $x_1, x_2, \ldots, x_n$ and real values y_i associated with each point x_i. We assume there is a function with noise $y = f(x) + \varepsilon$, where the noise ε has a mean of 0 and variance σ^2. Please provide all steps of derivation for

$$E\left[\left(y - \hat{f}(x)\right)^2\right] = (Bias[\hat{f}(x)])^2 + Var[\hat{f}(x)] + \sigma^2$$

where $\hat{f}(x)$ is the best approximation for $f(x)$ identified by the machine learning algorithm.