QUESTION 1

1a) **FALSE**. I had previously said this was true because I missed the part where it said "for the effect of X on Y". This statement would be true if it said "for the effect of Z on Y".

1d) **TRUE**. They both are MAP estimates, the only thing that differs is whether they use L1 or L2 regularization.

1f) **TRUE**. This is true by definition. Mentioned in lecture 10. I got confused b/w the link function and the activation function.

1i) **FALSE**.

According to HW4, a set of nodes S satisfy the backdoor criterion relative to (X, Y) if no node in S is a descendent of X and S blocks every path between X and Y that contains an arrow into X.

In this case, we don't know if we are looking for (B, D) or (D, B), so we will consider both.

CASE 1: (B, D)

C does not satisfy backdoor criterion as it is a descendent of B.

CASE 2: (D, B)

C does not satisfy the backdoor criterion as it does not block the path B → D.

Hence, we need more than C to satisfy the backdoor criterion.

QUESTION 2

2b) A. Decision Trees

C. Random Forest

D. Neural Networks

Previously, I had selected A, D but not C (Random Forests). In reality, decision trees and random forests can always achieve an accuracy of 1. That is, since random forests are simply decision trees aggregated, if decision trees can achieve 100% accuracy, then so can random forests.

QUESTION 3

3a) FALSE. Actually, the optimal policy only cares about the reward at the end of the game. It wants to maximize the total reward we get at the end of the game, but may require us to take a move with less reward in the current round.

3c) In the exam, I forgot to answer the second part of the question which was about how we can recover $V^*(s)$ with this extra variable.
Since $V^*(s)$ is the converged value of $V(s)$, we can recover $V^*(s)$ by taking $t \to \infty$.

QUESTION 4

4c) 2 arms. Since arms are the things you choose from, and here we are choosing either a Horror or Comedy movie, the arms should be the genre of the movie. Since the only genres in this setting are horror or comedy, we have 2 arms.

4d) I correctly defined R_t.

For A_t, it should instead be "the genre of the movie recommended to the user at time step t" because from (4c), our arms were genres - not movies.

4e) Previously, I only went into detail about why MABs would be preferable (since they solve the problem of exploration versus exploitation). However, I missed the fact that since the user has not watched any movies in the first place, there exist no features for us to use for our logistic regression model. So MABs are preferable b/c they are able to learn as they go, without requiring input features beforehand.

QUESTION 5

5a) C

A: This estimate does not depend on A, so it ignores the confounding effect of A. This means that the estimate produced would not be unbiased.

B: This estimate does not depend on A, so it ignores the confounding effect of A. This means that the estimate produced would not be unbiased.

C: This provides an unbiased estimate of the ATE.

D: This estimate does not depend on A, so it ignores the confounding effect of A. Also, it measures the target quantity. Therefore, the estimate produced would not be unbiased.

5b) Previously, I wrote that it was not reasonable to use artistic effort b/c it may depend on age. However, I missed the fact that in this question, the causal diagram holds true, so the artistic effort is indeed independent of age. Furthermore, it only affects the treatment (Costume Intricacy) so it is indeed a valid instrumental variable.

5d) Previously, I did not think about the numeric impact propensity scores near 0 or 1 would have on the IPW formula.

We know that the IPW formula is as follows:

$$\frac{1}{120}\sum_{i=1}^{120}\frac{C_i N_i}{\pi(A_i)} - \frac{(1-C_i)N_i}{1-\pi(A_i)}$$

In the above formula, if the propensity scores are very close to 0 or 1, then the denominators will tend to zero. This means that the estimate for the ATE will be very large, which would lead to a very high variance, which is a problem.