This is for CS5446 Homework1 written assignment by A0196990J, e0392432@u.nus.edu.

Thanks for reading!

Q1:Classcial Planning

1. (a)what (i) ignores is a proper subset of what (ii) ignores, so **(ii) is more relaxed**, and this means **heuristic (i) dominants (ii)**. And Both (i) and (ii) ignores part of the precondition, so they are both **admissible heuristics**. Finally, **(i)** will lead to fewer nodes explored.

- (b)This sentence "each plane can only carry one cargo" has 2 possible explanations to me, I will answer them separately:
  - A plane can carry one cargo **during its lifetime**, for this case, the following will be done:
    - Introduce a fluent called $Loaded(p)$.
    - In $Action(Load(c, p, a))$, add $\neg Loaded(p)$ to its **precondition**, and add $Loaded(p)$ to its **effect**.
  - A plane can carry one cargo **during one flying process**, for this case, the following will be done:
    - Introduce a fluent called $Loaded(p)$.
    - In $Action(Load(c, p, a))$, add $\neg Loaded(p)$ to its **precondition**, and add $Loaded(p)$ to its **effect**.
    - In $Action(Unload(c, p, a))$, add $Loaded(p)$ to its **precondition**, and add $\neg Loaded(p)$ to its **effect**.
- Based on the following equation:

$$F^{t+1} \Leftrightarrow ActionCausesF^t \vee (F^t \wedge \neg ActionCausesNotF^t)$$

  We can get that the answer is:

$$At(P_1, SFO)^{t+1} \Leftrightarrow Fly(P1, JFK, SFO)^t \vee (At(P_1, SFO)^t \wedge \neg Fly(P_1, SFO, JFK)^t)$$

Q2: Decision Theory

- (a): Because Bob is rational, he is likely to seek the max expectation of utility. Though C ensures 40 utility, the lottery will give a $100 * 0.6 + 0 = 60$ utility, Bob will choose the lottery.
- (b) Based on the previous question, let's imagine this scenario: Alice can choose from

- (1) a lottery with $\{p, U(x_1); 1-p, U(x_2)\}$ where $x_1 < x_2$. To see a concrete example, we can set $p = \frac{x_2}{x_1+x_2}$, so $1-p = x_1 x_1 + x_2$.
- (2) $U(x_3)$ where $x_1 < x_3 < x_2$, and $x_3 = px_1 + (1-p)x_2$. In the example, it's $\frac{2x_1x_2}{x_1+x_2}$.

Because her utility $U(x) = x^2$, so based on Jensen's inequality, $E(U(x)) > U(E(x))$, that means, the expectation of the lottery $pU(x_1) + (1-p)U(x_2)$ is always larger than $U(x_3)$. If we use the concrete example, the expectation of the lottery is

$$E = pU(x_1) + (1-p)U(x_2) = \frac{x_1^2x_2 + x_1x_2^2}{x_1 + x_2} = x_1x_2$$

and the $U(x_3) = \frac{4x_1^2x_2^2}{(x_1+x_2)^2}$

So $E/U(x_3)$ = $\frac{(x_1+x_2)^2}{4x_1x_2} > 1$

So we can see, Alice will always prefer a lottery. So she is risk-seeking.

- (c) This is quite straightforward, if Cathy prefers C to D, this means her utility function U satisfies $U(C) > U(D)$, which means $0.2U(A) + 0.8U(B) > 0.3U(A) + 0.7U(D)$. This will lead to $U(A) < U(B)$. This is contradictory to the claim "Cathy prefers A to B". So $U(A) > U(B)$ and at the same time $U(A) < U(B)$, there is not a such thing.